**Abstract.**

This research addresses the complexities and challenges of managing irregular migration within the Mexican migration corridor. This phenomenon not only affects migrants in terms of security and well-being, but also poses significant challenges to public policy and governance. Despite current institutional diffusion efforts, and international community commitments and research. Word widely, there’s still significant gaps in the effective protection of migrants and the availability of consistent and detailed statistical data to describe irregular migration. Resulting in a decreased ability of authorities to manage these irregular human flows adequately and reduce the vulnerability of migrants' fundamental rights within their journeys. The main cause of this situation is the irregular migrant's tendency to remain invisible during their journey, coupled with a lack of effort and willingness on the part of authorities to develop effective humanitarian methods of documentation and monitoring, which conduces to very vague appreciations available of key information for design making and policy planning, let alone, intelligent means to able to manage institutional and infrastructural capabilities assigned to the phenomenon.

Research on irregular migration vulnerability is important in both computational research and policy developments for different social causes because it aligns with the protection and promotion of international human rights principles for vulnerable populations. While also enriches good knowledge and fosters data-driven technological development in a multi-diverse contextual environment. Irregular Migration Transit (IMT) can present diverse scenarios for migrants, whose behavioral characteristics can be similar to those found in other risk groups. Factors such as country of origin, immigration reasons, language, skin color, gender, and budget configure various vulnerabilities. This study will employ innovative methodology and digital tools, combining data analysis with a multidisciplinary approach to advance understanding of migratory dynamics. By disassembling and reassembling the regional migratory framework's components, the study aims to inform the development of humane and effective public policies for protecting migrants' rights and facilitating their integration.

Using Geographic Information Systems (GIS) configured with data attributes, this work aims to update and improve previous methodologies for visualizing migratory flows in Mexico's corridor. The goal is to enhance collaboration between technological and humanitarian sectors, building a methodology based on solid empirical evidence. Hopefully, this work will influence the reform of migration policies at both national and international levels, promoting approaches that respect human rights and recognize the humanity of irregular migrants in our societies.

**\section{Introduction}**

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In recent years, the research community has made significant strides in developing data-centered approaches to address complex challenges across a broad spectrum of fields. These pioneering methods have played a crucial role in advancing new technologies such as Artificial Intelligence, Deep Learning, Robotics, and Blockchain, to elevate computational advancements and automation to unprecedented levels. Nevertheless, amidst this wave of innovative methodological and technological breakthroughs targeting public enhancement, we mustn't let behind our most enduring societal challenges. There is a critical need to evaluate the means employed within academic research, technology, and government through a comprehensive, multidisciplinary lens capable of integrating diverse inputs into a cohesive overview. Consequently, we advocate for the integration of technical and academic instruments that facilitate a thorough understanding of current trends and influential factors in phenomena related to human mobility and displacement, with a particular focus on irregular migratory transit as a case study that contains adequate characteristics for this work.

Moving forward with this work, our attention will focus towards proposing insights from the technical methodologies utilized for processing and analyzing the available data. Our objective is to uncover trends, connections, and correlations that shed light on the vulnerabilities in human rights encountered by migrants in irregular transit, thereby augmenting our comparative research capacity through a detailed, object-by-object examination. Specifically, our analysis will assess the influence of individual, collective, and comprehensive attributes and configurations that define the North American Migration System on the physical and economic well-being of migrants. This inquiry aims to expand and refine our analytical techniques, aligning them with the advancements in visualization and comparison noted in prior social and technological investigations, with particular emphasis on existing studies concerning the characterization of migrant flows. Through this approach, we endeavor to establish a compelling case that sets a precedent for a replicable line of inquiry applicable to other complex social phenomena.

**\subsection{The North American Migration Corridor: The Characterization of Irregular Transit Migration in the period of the 2000s}**

Few migration trends in the world are as characteristic in modern times as those seen in the Mexico-United States border corridor. This corridor, mainly composed of populations from the Central American isthmus, including Guatemalan, Salvadoran, and Honduran nationals, was notoriously later joined by populations from Mexico and a small percentage of other South American, Caribbean, African, and Asian migrants, coming from all over the world with very diverse origin contexts (Boletín Mensual de Estadísticas Migratorias, 2023). Geographically, the known paths of North American Migration cover both the southern and northern Mexican borders, extending into key southwestern U.S. states, and receiving the most 'on foot' migration flows through the border with Guatemala, making these regions key to the dynamics of migration flows in the US-Mexico border.

As for the North American migration corridor, the beginning of the 2000s was a defining period for contextualizing the phenomenon of irregular transit migration. As the major countries in the north of the continent began to understand more concretely the factors that constitute the origins, development, and migratory destinations of the region, they also started to recognize at a governmental institutional level the significant challenges of addressing these issues. These challenges include national security concerns, economic and demographic impacts within the transit and destination societies, the nourishment of organized crime networks in the region (Pérez Berestycki, J., 2015), and trends of political destabilization in origin societies (Redacción 24 Horas, 2021). Simultaneously, humanitarian organizations have raised critical concerns about the vulnerabilities of migrants' fundamental human rights, highlighting human rights violations within the entire infrastructural travel scheme, including governmental institutions established to oversee these matters. We just have to look at the atrocities occurring within the informal train railroad transportation system for migrants across Mexico (Amnistía Internacional, 2010). Despite the inherent complexity of the transmigrant's nature to remain invisible within transit and destination societies due to their irregular status and the fear of ending their journey, in combination with the political, geopolitical, and social consequences of characterizing and conceptualizing the phenomenon of undocumented movements at an institutional level being a fundamental part in the invisibility and vulnerability of the migrants (Casillas, R., 2008).

**\subsection{Systematic Injustices and Data Representation Challenges}**

To help condense the problem in alignment with the methodological approach of this study, it has been observed that a lack of representation in data is linked to the development of systematic injustices. These injustices range from informal cheap labor schemes in valued work fields (Krissman, F., 2001), corruption networks within institutions, and inadequate bases for policy development, to racism and xenophobia in the involved regions (Gall, O., 2018). Irregular Migration Transit (IMT) has emerged as a critical concern for human rights vulnerabilities globally, especially due to the modern migration crisis's statistical and informational underrepresentation. Many leading organizations focused on this issue have struggled to develop data sources adequate for describing the phenomenon comprehensively, leading to actual human vulnerability (Dearden, K., 2020). Furthermore, even governmental institutions tasked with overseeing IMT's dynamics often fail to accurately portray the data they compile, leaving the research community to rely on approximations and deductions to measure the statistical dimensions (Casillas, R., 2008). Importantly, we must acknowledge that the development of regulations for Irregular Migration Transit is a highly sensitive issue. The implications of such regulations could significantly impact the quality of life for many families worldwide, potentially in both positive and definitive or catastrophic ways. Research studies must integrate ethical considerations with the technological advancements they have pioneered. Addressing human issues should not solely focus on detaching the problem from its origins but rather understanding and addressing these roots comprehensively (United Nations, Department of Economic and Social Affairs, 2019).

**\section{Literature Review and Background}**

Geographic Information Systems (GIS) have emerged as a pivotal computational tool, continuing to evolve through ongoing practical applications addressing a variety of complex social challenges. Through the object-oriented approach, as discussed by Glennon (2010), geographic data models have demonstrated their capability to efficiently group, organize, and associate related data and functionalities. These models act as potent instruments in managing database frameworks that incorporate geographic attributes, enabling researchers to simplify complex phenomena to their fundamental elements. A notable illustration of this is the facilitation of space-associated data compilations, enabling the association of domain-specific meanings with primitive GIS elements, such as points, polylines, and polygons, which are essential computational features for representing geographic spaces in choropleth maps. Additionally, the significance of incorporating GIS models into the study of human mobility is paramount and necessitates further integration into broader social dynamics, as the one observed in this study. The capability to capture, analyze, and represent the flow of people in geographical spaces, particularly when utilizing temporality data, if optimally harnessed, can provide a comprehensive understanding of the spatial and temporal dynamics of mobility. This entails the projection of complete frameworks for interpreting human flows within specific geographical contexts, thereby offering critical insights for urban planning, disaster management, and migration policy, among other fields. This paper aims to explore such linkages, emphasizing the necessity of advancing in the development of robust and validated GIS models capable of capturing the complexity and dynamism of human flows. These models not only improve data collection and exchange but also augment the analytical and representational functionalities of GIS, as also observed by Glennon (2010). Being said this, in order to develop GIS models, we need to develop ways to create and integrate for descriptive data within social study contexts like irregular migration.

In GIS current technology, many software like ArcGIS, QGIS, GRASS GIS, etc., are designed to work on layers representing different configurations of geographic data. This approach is consistent with the object-oriented method of grouping different object combinations to work with each one. Examples of this functionality will be seen moving forward with the case implementation. Further in the document, Table 1 disassembles the objects and data formats of the general context into a digitized framework, as you can see in the column "Data Representation Layer", label attributes represent a single layer. For instance, to obtain a general image of Mexico's regional composition, the objects labeled 'Administrative Boundaries' denote the spatial limits of governmental geographic divisions; including country, state, and municipality limits in the form of discrete features like lines and polygons. In comparison, to achieve a broad infrastructural representation of the US-Mex Border, designing subsets of the object framework would be sufficient to create a new layer that includes a different combination of discrete features and area summaries. In this example, displays would include specific country limits, entry port’s locations, technologically monitored areas, and even the number of detentions. Lines, points, and polygons, as well as counts or densities, can be represented in various forms, including heat or choropleth maps. Furthermore, continuous data feature configuration allows researchers to display phenomena presented in the form of data series, allowing for the display of continuous phenomena, for example, "encounters with irregular migrants at the US-Mex Border" over a year.

While this kind of visualization scheme provides a clear and structured, framework-like representation of the data, the ability to input different data types in several formats, including CSV tables, enhances our analytical capabilities and offers a general perspective of the deconstructed irregular migration objects we wish to examine. Working with an object-oriented layer scheme allows the researcher to update the data individually when new data for that object are updated. It is also useful for sparking research creativity, as it enables viewers to explore different relations within the combinations of objects.

**\subsubsection{Case Study: Background}**

Principally, our focus will be on cataloging all available objects that play a role in the broader context of irregular migration, digitizing them to recreate an updated migratory scenario description of the North American Migratory Corridor (table 1, figure 1). This approach is inspired by and meant to build upon the pioneering work of Casillas 2006, who first applied GIS principles to study IMT in Mexico's corridor, in "Una Vida Discreta, Fugaz y Anónima: Los Centroamericanos Transmigrantes en México, 2006." While our introductory section briefly acknowledges Casillas's contributions, by doing this brief exercise we accomplish two things: 1) we delve deeper into the practical application of his insights by reconstructing them with modern computational tools and 2) we remark the natural resemblance of migratory flow studies with GIS like data visualization products.

**\section{Methodology}**