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Research Article

Evaluation of water use impacts caused by real estate development with gentrification traits in the metropolitan area of San Luis Potosí

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Abstract

Water resource management is a technical, social, and political issue worldwide. Water, being a public good, is characterized as follows: "Unlike private goods, public goods are indivisible and cannot be satisfactorily met by the market or other private initiatives. The provision of public goods requires cooperation or coercion, either through collective action or effective government." In this sense, water is a human right, as stated by the UN in its sixth sustainable development goal, which aims to "ensure availability and sustainable management of water and sanitation for all." Gradually, housing in the city of San Luis Potosí has shifted from being affordable for the entire population to becoming increasingly unattainable.

Due to the growing demand for housing driven by common population growth and urban development, in recent years, vertical construction-both residential and commercial-has been implemented as a potential solution to this phenomenon, now accounting for 10% of constructions in this area in the capital city, according to the *Registro Único de la Vivienda* as of 2023. However, such constructions have brought new challenges to urbanization in San Luis Potosí city. As noted by Lozano Niño Y., areas, where high-socioeconomic-status apartment buildings with gentrification features proliferate, were not planned to support high population densities. Eventually, one of the possible consequences of high densification in these areas will be the inadequacy of basic services such as water. While vertical housing offers an alternative to maximize land use within the urban sprawl and could address housing demands, there is also a need to improve public services and urban infrastructure in the surrounding areas where these constructions are planned to prevent social inequality in terms of public service distribution. This study aims to analyze the relationship between case studies—buildings with gentrification features-and their impact on the use and distribution of potable water among the inhabitants of the urban sprawl of San Luis Potosí, by using geospatial methods and technologies.

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Introduction

Scientific studies of water can never evade the fact that it is a subject with clear social impacts, whose regulation is the State's responsibility as it is the main generator of rules and institutions responsible for ensuring, as the last quote says, such availability, sustainable management, and respective sanitation for all. The provision of public goods requires cooperation or coercion, either through collective action or effective government." [1]. In this sense, water is a human right, as stated by the UN [2] in its sixth sustainable development goal, which aims to "ensure availability and sustainable management of water and sanitation for all." Regarding its demography, San Luis Potosí, a city like the rest of the capital cities of the Mexican Republic, has shown accelerated growth in the last 20 years. As noted by Lozano Niño Y. [3], areas, where high-socioeconomic-status apartment buildings with gentrification features proliferate, were not planned to support high population densities. According to the Population and Housing Census of 2020 (INEGI) [4], the metropolitan area already has more than one million inhabitants: 1,188,660 residents living in the urban areas of localities that comprise it.

The description above is an important point for understanding the gradual change in housing in the city: just over 78% of registered housing units with the Unique Housing Registry for the capital of San Luis Potosí state between 2013 and 2023 are from economical to traditional (with costs between $345,000 to just over $1,000,000).

It was between the 1960s and 1970s that, due to the installation of new industries, population growth was stimulated, and from then on, a real estate development of housing for the working classes began, allowing the city's expansion in all directions from the Historic Downtown, with a greater emphasis towards the southeast and west of existing urban sprawl.

This growth, which in some areas has not been uniform and has maintained large unoccupied areas (such as north and northeast of the capital), has eventually implied a strong real estate demand, which in turn has led to the increasing demand for basic public services such as street paving, police surveillance, public lighting, drainage, and piped water. It is important to note that many of these neighborhoods (some already established for 30 years to the present date) have had a considerable degree of backlog in these public services, and only in the last decade have they begun to have a slow implementation of them (according to field observations).

According to the Urban Development Plan of San Luis Potosí Population Center and Soledad de Graciano Sánchez - from the Municipal Planning Institute up to the year 2021- it is planned that urbanization of the current metropolitan area will begin to advance towards the north, northeast, and east. Due to the declaration of the Flora and Fauna Protection Area of Sierra de San Miguelito, urbanization in this area is now subject to greater restrictions. However, luxury developments that have already been established in this area are of considerable importance for research outlined in this document, as well as other areas with similar characteristics.

Gentrification, concept and dynamics

Regarding gentrification, the term was coined by Ruth Glass in 1964 to explain the urban renewal of certain neighborhoods in London. According to Smith and Hendel (2012) [5], gentrification in European and North American cities involved a struggle for space appropriation between old and new residents, such that the process of urban gentrification led to the displacement of the original population and the arrival of a middle and upper-class population. Although the phenomenon has been described for several decades, there is still debate about the causes and origins of gentrification, with definitions made by various authors, among which are "urban restructuring processes with different social, economic, and cultural implications, displacing the working classes, increasing land rents, gentrification of central neighborhoods, and private valorization of heritage, among others [6]."

The reconquest of urban centers by affluent classes, which entails the expulsion of low-income households, is what aforementioned researchers have termed gentrification. While there is abundant Anglo-Saxon literature on the subject, two geographic areas have particularly received little attention in this regard: Latin America and Spain.

A problem with Latin American studies on gentrification is that they are predominantly qualitative, lacking in-depth quantitative approaches that would be particularly relevant given the nature of the analysis object: neighborhoods and their social stratification, the actions of their inhabitants, as well as those of social organizations and activists whose purpose is to denounce the presence of speculative investors, buildings, and apartments adapted in areas where economic inequalities are noticeable [7]. Private investors and real estate developers play a significant role in the production of urban spaces, as they not only reshape the urban landscape but also alter existing social relationships. Consequently, inhabitants of these areas are segregated towards the periphery of metropolitan areas in search of more affordable housing and public services. The increase in rent and land costs is a direct consequence of gentrification processes [8].

Inzulza and Galleguillos [9] mention that gentrification in Latin America presents four particularities: 1) the presence of urban poverty and social exclusion, 2) trends of living in gated communities promoted by real estate projects sponsored by national and local governments through subsidies, leading to 3) people linked to the tertiary sector and middle incomes choosing central neighborhoods to establish a certain urban lifestyle that is "trendy" and close to their jobs. Additionally, the consequences of having gentrified spaces in large cities are several: the displacement of lower-class populations towards urban peripheries, fragmentation of social and spatial fabric, evictions of economically disadvantaged populations, an increase in land rents, overcrowding, and the emergence of mass social movements [10].

According to Boldrini and Malizia [11], the development of a gentrification process (from a neoliberal perspective, which is the pattern for generating process in Latin American cities) has

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the following characteristics:

- Proximity to commercial and financial poles of a city.
- Provision of infrastructure services from a public network.
- Consolidated urban images and places associated with collective memory: they possess their own identity in which particular local urban patterns remain valid.
- Deteriorated areas: implies degradation or devaluation of the neighborhood.
- Reinvestment of capital, mainly of private origin, in a defined space.
- Changes in the functional use of buildings to implement new commercial functions in that sector: include the construction of international hotels, shopping centers, and even gated communities.
- Direct or indirect displacement of the local population and its progressive replacement by other social groups with high incomes.

The information sources used by the authors of the research to address the problem posed are the result of the application of qualitative research techniques such as analysis of bibliographic, photographic, and cartographic documents, short interviews and/or informal conversations, and participant observation in the year 2013.

Materials and methods

An overabundance of qualitative studies over quantitative ones regarding the gentrification phenomenon mentioned earlier is linked to a more general trend in the field of academia and culture: the fragmentation between studies of natural sciences, called hard sciences (due to their rigor and mathematization) on one hand, and social sciences, still full of soft areas, on the other. Authors such as Kagan [12], Bunge [13], and Snow [14] have addressed the apparent division between studies in the natural sciences (with a more logical and technical approach) and the social sciences or humanities (with more descriptive and rudimentary approaches), correctly asserting that there should not be subordination between these sciences, but rather complementation through the proposal of hybrid models with radically different logic.

The hypothesis to be tested in this research is that real estate development with gentrification traits in the San Luis Potosí Metropolitan Area affects the use and impact of water through factors that can be related and explained quantitatively such as a) the volumes granted to INTERAPAS [15] (the city's water management body) wells for public use; b) the registered and delivered consumption in liters per day to the inhabitants of Basic Geostatistical Areas (BGA); c) the inhabitant's number of said BGA; d) the size of the occupied surface and estimated inhabitants of buildings with gentrification traits under study; e) the level of backlog observed in these areas, which, if "low" or "very low", indicates a high probability of observing luxury residential properties and high appreciation, and e) the number of days that the same mentioned areas have registered scarcity of piped water, through dispatch of water trucks.

The following steps of the methodology are contemplated:

Describe areas in the city within the urban development phenomenon, using the Comparative Qualitative Method (QCA) to define conditions of analytic necessity and sufficiency.

Evaluate water consumption demand according to volumes of water granted, regulated, and delivered to inhabitants of the San Luis Potosí metropolitan area.

Perform the analysis of various socioeconomic and demographic indicators using numerical and impact matrices to generate a mathematical model (impact index). And,

Generate, with geospatial techniques, an impact index that allows understanding quantitatively the degree of affectation of real estate development with gentrification traits in distribution and water use.

Study area

The case studies are not located in the same region of the San Luis Potosí metropolitan area, as they were randomly selected without considering external features other than those that seem to indicate very common characteristics of gentrification (vertical buildings, investment by a private entity, being luxury residences or constructions, and being located in places that contrast landscape-wise with their most superficial attributes). The fact that there are only 12 and not more is largely to ensure a successful implementation of the Comparative Qualitative Analysis.

It is important to highlight that ten out of the twelve cases in total are residential projects (Figure 1), with only two of them focused on economic or service activities. However, due to their importance in these areas, as well as their proximity to residential areas, they have been considered for analysis.

Methodology

The Comparative Qualitative Analysis Method "It is a method that allows comparisons between cases of a reduced N, less than a dozen or more than this - without reaching large numbers - in which binary comparison matrices are generated, that is, matrices that reflect the absence or presence of conditions related to the result being investigated." [16].

It is important to mention that QCA, as Ragin [17] demonstrates, is a comparison method in itself, and not just comparison software as it is often confused. Neither are the comparative methods previously cited by Mill exclusive to QCA, since, contrary to this, "QCA is built with and extends Mill's methods" (Ibid.).

The next step is to find the equations that will reflect the absence or presence of conditions in the development of a gentrification process. For this, it will be necessary to define, through literals each of the 7 aspects to be evaluated (Table 1), in such a way that:

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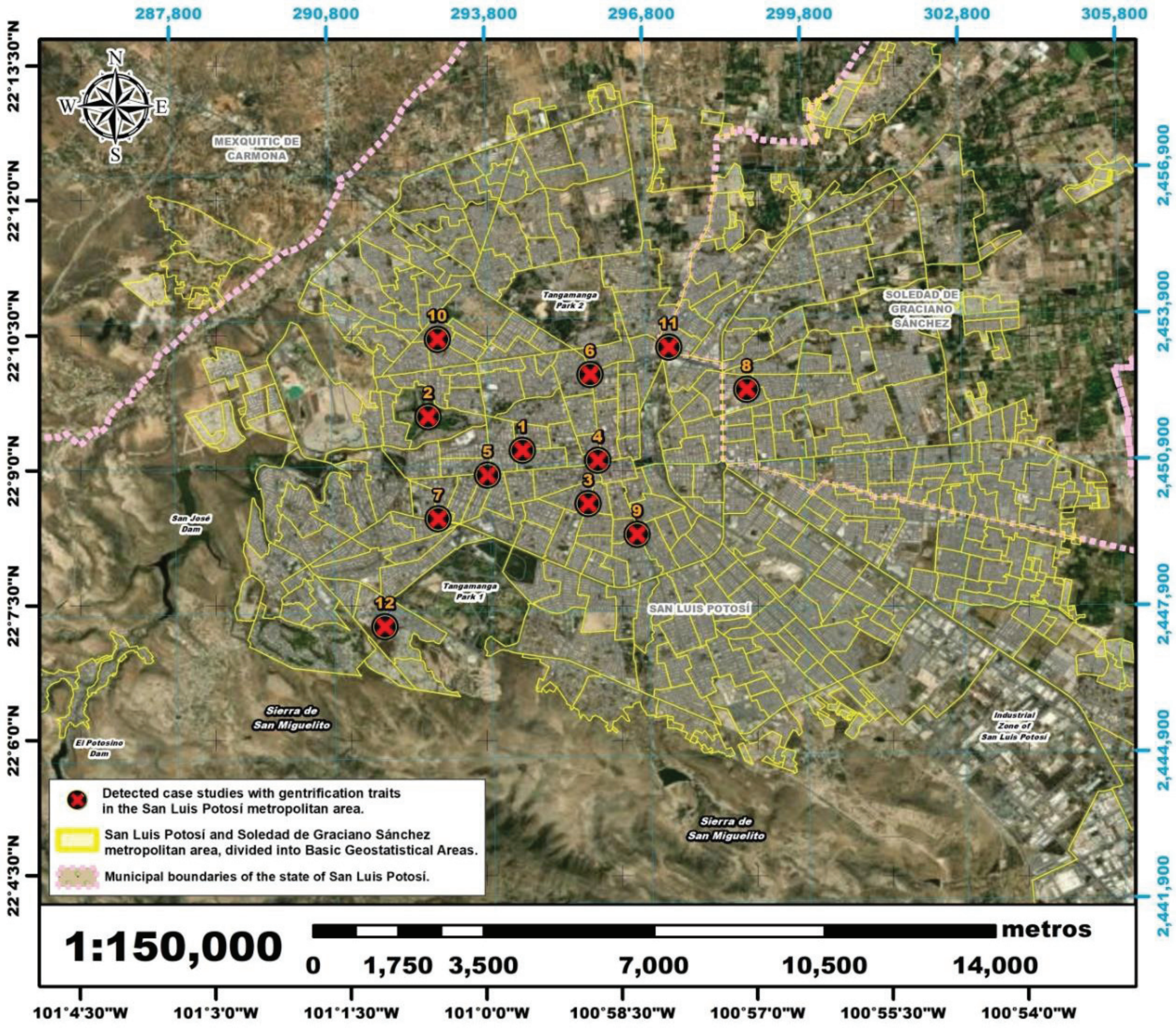

Figure 1: Case studies showing gentrification traits and their location in the city of San Luis Potosí, based on direct observations made in the area.

The importance of locating geological faults lies in the possibility of identifying areas with higher vulnerability to water leaks through the water use supply networks. Several of these fractures are relatively shallow, so considering them within the geospatial analysis of real estate developments with gentrification traits and their relationship to the distribution of vital liquid is essential, as it will provide a broader perspective on areas where significant leaks are more likely to occur due to the poor condition of the pipes.

For the Mathematical Model, the following values have been proposed, which will range between 0.00 (minimum value) and 1.00 (maximum value), and their variation will depend on the location of the case study and the fractures or geological faults present in the area of interest (Table 2).

Through an arithmetic operation, it is possible to determine the liters granted per inhabitant per day. This formula is expressed as:

Liters/Inhabitant/Day = ((Annual Volume) × 1000) / (No. of Inhabitants) ÷ 365

Table 1: Aspects to evaluate in the case studies to determine if they exhibit a gentrification process.

P	Proximity to Commercial Hubs
I	The case study has infrastructure services provided by the public network.
H	Consolidated urban images or places associated with historical memory.
A	Previously deteriorated areas.
C	Private capital investment to carry out the project.
F	Changes in the functional use of the areas.
D	Direct or indirect displacement of the population due to the new building project.

Table 2: Numerical range used for the Vulnerability to Leaks Index (F) of the implemented Mathematical Model.

0.00	If the case of the study is completely outside or far away from the Basic Geostatistical Area (BGA) that presents ground fractures or geological faults.
0.25	If the case of study is in a BGA that does not present ground fractures or geological faults but is close to one that does have such features.
0.50	If the case of study is within a BGA that presents ground fractures or geological faults but is still not close to the geological phenomenon (more than 300 meters).
1.00	If the case of study is within a BGA that presents ground fractures or geological faults and also very close to (or on) the geological phenomenon (less than 300 meters).

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For each of the five zones in which the distribution of granted wells has been administratively divided, indices have been established, which are defined based on the calculation of granted volume by a simple quotient:

Index of Granted Expenditure = (Liters per inhabitant per day (Admin. Zone)) / (Liters per inhabitant per day (City))

Therefore, the results used in the Mathematical Model, for each of the administrative zones in the city, are as follows in Table 3.

Finally, according to the Building Regulations of San Luis Potosí Municipality, in force in 2009 and developed by the Secretary of Urban Development, Housing, and Public Works (SEDUVOP), in its Title Fifth, Chapter XXVI, Article 114° regarding Hydraulic Installations in subsection a, it is established that in case of buildings intended for residential use, the minimum supply must be 150 liters per inhabitant per day.

Through a simple quotient, it is established that:

Index of Regulated Expenditure = (Liters per inhabitant per day (Admin. Zone)) / (Liters per inhabitant per day (Regulated))

Therefore, the Index of Regulated Expenditure for each administrative zone is described in Table 4.

The Leopold Method will help find an indicator considering different stages or phases of a project or phenomenon, so it could be used as a reference and make pertinent modifications based on the mentioned model. For all the objects of study in this research, it has been considered to take into account the phases that occur in gentrification processes observed in Latin America (thus assigning actions in the diagram); in turn, the assigned parameters will be divided into four major components: land, drinking water, economy, and social. All of them must have as their main characteristic the ability to be defined through a numerical impact (negative or positive) by the actions contemplated in the case studies with gentrification traits so that they can be understood quantitatively how they are affected by such actions. In any case of impact matrices associated with each of the case studies, none of the values in each cell can exceed 64, or be less than 10 due to the values of each attribute that make up the impact matrix.

The population density of Basic Geostatistical Areas (BGA) where the residential project is located will be another important factor in the generated formula. If the population density of the BGA surface where the residential project is located is greater than that of the latter, then the proposed indicator will be greater than one (1). The formula that explains it is then established as:

Population Density Index = (Population Density of the BGA) / (Population Density of the Case Study)

The arguments to establish the index in this way are the following: in the case of high-value residential projects targeted at users with high purchasing power, the fact that they have a lower population density than the neighborhood or subdivisions where they are located implies that they have greater access to public services including water, which is important for this research, and therefore the rest of users may have problems with the distribution of these services. On the other hand, if the index is less than 1 (and even close to zero), it can be understood that the population at risk due to lack of public services will be that of the case study (the residential project). In short, if the Population Density Index is:

Greater than 1: The population that could be vulnerable to a lack of public services is that of the BGA or neighborhood adjacent to the project.

Less than 0: The population most vulnerable to the future lack of public services is that belonging to the residential real estate project.

For the Mathematical Model, the following degree values of social backwardness have been decided, according to the location of the case study in the BGA where they are (Table 5).

The argument to define such figures is according to what is established in the Population Density Index: the lower degree of social backwardness in the case study, the greater impact and consequences in terms of the contribution of public services to the community, since they are taken into account more than other localities to have public lighting, security, electricity, communication networks, drainage, and of course the most important for this research, such as drinking water.

The weighted overlay tool

The mathematical model yields results that were calculated

Table 3: Numerical range used for the Index of Granted Expenditure (Q_C) in the Mathematical Model.

0.765	South Central administrative zone.
2.263	West administrative zone.
1.124	North administrative zone.
1.253	East administrative zone.
0.700	Soledad de Graciano Sanchez administrative zone.

Table 4: Numerical range used for the Index of Regulated Expenditure (Q_R) in the Mathematical Model.

1.107	South Central administrative zone.
3.273	West administrative zone.
1.627	North administrative zone.
1.813	East administrative zone.
1.013	Soledad de Graciano Sanchez administrative zone.

Table 5: Social Backwardness Index used for the Mathematical Model, with values ranging from 0 to 1.

0.20	VERY HIGH Social backwardness degree.
0.40	HIGH Social backwardness degree.
0.60	MEDIUM Social backwardness degree.
0.80	LOW Social backwardness degree.
1.00	VERY LOW Social backwardness degree.

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from arithmetic quantitative variables. For the graphic model, quantitative variables will also be used, but the Weighted Overlay tool of ArcMap Version 10.6 platform will be used. For this purpose, 8 cartographic variables were also available, distributed into two groups:

Vector information of a social nature:

- Population density of Basic Geostatistical Areas (BGA), from 1 to 5, compared to the density of San Luis Potosí city (6431 inhabitants per square kilometer).
- Degree of social backwardness, from 1 to 5, from “Very Low” to “Very High”.
- BGA with the presence of gentrification traits (where the 12 case studies of the research are located), with only two values: 0 and 5.

Vector information of a hydraulic nature:

1. Level of water expenses per public concession, by administrative zone, from 1 to 5.
2. BGA where the recharge zone of the shallow aquifer is located, only one value (5 if it is in the recharge zone of the aquifer).
3. BGA with vulnerability to leaks due to fractures or geological faults (a value of 5 if they are located on any fault or fracture).
4. BGA where private concession volumes exceed public concession volumes, from 1 to 5.
5. BGA with the highest water backlog, calculated from the number of days that neighborhood in the San Luis Potosí metropolitan area received water truck support, from 1 to 5.

Each of these variables has been reclassified and converted from vector format to raster format so that now each selected cell or pixel must have an integer value of floating type. Once the previous process is completed, each of the rasters that will be assigned to the multicriteria model must be weighted by a percentage, according to its importance in the process being carried out. Of course, if these weights are modified, the result is altered. Another important factor to consider for this procedure is that the areas to be excluded must be removed from the original raster or, failing that, assigned a value of 0 (zero).

Results

Similar to the model developed by López-Álvarez, et al. [18] to estimate the welfare level of households in the San Luis Potosí Valley based on the availability of water from their aquifers, each one of the variables previously described has been incorporated into a numerical model whose final result will be the Gentrification Features Impact on Water Use and Distribution Index (IG→A), expressed in the following formula:

$$I_{(G\rightarrow A)} = (30G+10R+10D+10S+10F+10Q_C+10Q_R+10Q_E) / 100$$

It was decided to assign weighted values to the equation to give greater importance to the Gentrification Features Index since the present investigation aims to evaluate buildings and real estate projects with these characteristics and how they will impact the use and distribution of water use. The resulting value can be less than 1 or greater than 1, and the higher it is, the greater the impact of real estate projects with gentrification features on the use and distribution of drinking water in the surrounding areas, and consequently in the San Luis Potosí metropolitan area. The closer it is to zero, it can be inferred that there is no clear or conclusive relationship between the real estate project and its impact on water distribution (Table 6).

- About the G index, of the five cases that obtained a value equal to or greater than 0.86, three of them were the highest in $I_{G\rightarrow A}$: cases 3, 4, and 12 (“Coronel” Commercial Plaza, Public parking lot, and “El Pedregal” housing development).
- Regarding the S index, of the five cases with values

Table 6: Results of the proposed Mathematical Model ($I_{(G\rightarrow A)}$ = (30G+10R+10D+10S+10F+10Q_C+10Q_R+10Q_E) / 100). Only the Index of Granted Expenditure (QE) could not be obtained due to the information obtained from various governmental entities. The figures in the $I_{G\rightarrow A}$ column indicate that, the higher the value, the greater the impact on the use of drinking water due to the case study with gentrification traits.

Case of study	Description	Socioeconomic indexes**				Water indexes				$I_{G\rightarrow A}$
		G	R	D	S	F	Q_C	Q_R	Q_E	
G1	Spaces used for local commerce.	0.71	1.00	0.047	0.44	1.00	0.765	1.107		0.651
G2	Country Club of San Luis Potosí.	0.71	1.00	0.880	0.624	0.25	1.124	1.627		0.765
G3	"Coronel" Commercial Plaza.	1.00	1.00	0.963	0.580	0.50	0.765	1.107		0.791
G4	Public parking lot.	0.86	1.00	0.624	0.44	1.00	0.765	1.107		0.750
G5	"Agora" Tower.	0.86	1.00	0.026	0.559	0.25	0.765	1.107		0.628
G6	"Bóvedas" Tower.	0.57	0.80	0.062	0.46	1.00	0.765	1.107		0.591
G7	"Eucaliptos" Apartment Tower.	0.57	1.00	0.023	0.38	0.50	0.765	1.107		0.549
G8	"Nuve" Housing Complex.	0.71	0.80	0.093	0.45	0.25	0.700	1.013		0.545
G9	Luxury apartments (horizontal condominium).	1.00	0.80	0.083	0.42	0.00	0.765	1.107		0.617
G10	"Veinte80" Apartment building.	0.86	1.00	0.093	0.47	0.25	1.124	1.627		0.714
G11	"Las Palmas" Tower.	0.57	1.00	0.068	0.596	0.00	0.700	1.013		0.509
G12	"El Pedregal" housing development.	0.86	1.00	1.406	0.666	1.00	2.263	3.273	2.333	1.451

** Data obtained from the population and housing census estimates by INEGI (2020) through Basic Geostatistical Areas and field observations.

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greater than or equal to 0.5, three of them were also among the highest in the $I_{G \to A}$ index: cases 2, 3, and 12 (Country Club of San Luis Potosí, "Coronel" Commercial Plaza and "El Pedregal").

- Cases 5, 10, and 11 ("Agora" Tower, "Veinte80" Apartment building, and "Las Palmas" Tower) have very high values in the G and S indexes but do not reach a value greater than 0.75 in the $I_{G \to A}$ index. However, they are equally important to consider because they are above 0.5 in this final result.
- The delivered expenditure (Q_E) for case study 12 ("El Pedregal") could only be confirmed through reports obtained from journalistic sources and civil society [3], which indicated a value of 350 liters per inhabitant per day in the western area of the San Luis Potosí metropolitan area. However, if this data (2.333, obtained from the quotient 350 liters per inhabitant per day divided by 150 per inhabitant per day, which is the regulated expenditure for the city) is removed from the equation, the result of $I_{G \to A}$ is 1.218, which is still significantly large compared to the other values for the other case studies.

It should be noted that the delivered expenditures for 11 of the case studies could not be verified or estimated due to the scarce information available and the refusal of personnel maintaining the closest water wells to the case studies, which may have been due to current political interests [5,13,18]. While having this data is of significant importance and would change the final model values, having 7 out of 8 variables is very illustrative for the ongoing research.

The weighted overlay using multicriteria analysis

The overlay of the eight layers according to the mathematical formula resulted in only two areas that could have a high impact on the distribution of drinking water in the city of San Luis Potosí: the first one is the El Pedregal housing development, located in southwest (in the western zone) of the metropolitan area of the city of San Luis Potosí (Figure 2).

This real estate development with gentrification features coincides geographically with the aquifer recharge area, vulnerable zones to urban infrastructure risks, the protected area of flora and fauna "Sierra de San Miguelito," and several important geological faults or fractures that, according to research conducted by CONACyT (2018) [19], can be useful for easily infiltrating water into underground water bodies, thus meeting all the characteristics of being in a highly vulnerable zone for both hydrological and ecological aspects due to the combination of all these features. It is worth noting the presence of the Faculty of Sciences of the Autonomous University of San Luis Potosí, whose main tower structure has been pointed out by various news media for slow and continuous weakening in its structure, representing maximum risk for its users.

The implementation of a graphical model using rasterized information has resulted in identifying another area that was not initially considered among the twelve initial case studies: the residential development "Puerta de Piedra," located south of the city, very close to several neighborhoods with medium (El Aguaje 2000) and high (Héroes de Chimalhuacán) levels of social backwardness. Additionally, there are other neighborhoods that, in the first months of 2023, reported a lack of piped water, leading their residents to request water tanker services for the distribution of this vital liquid. This situation applies to all neighborhoods surrounding this high-value development, such as Rancho El Aguaje, and Satélite Francisco I. Madero, Progreso, and Héroes de Chimalhuacán.

Discussion

It is important to note that this research is exploratory: in the last five years, there has not been an academic project in Mexico involving the measurement of the impact that a social phenomenon like gentrification can have on the distribution and use of drinking water in the city where it begins to emerge. Therefore, the models proposed in this article are subject to modification according to social and technical conditions that may arise in other regions of Latin America where they may be applied. It's still difficult to discern which towns or cities are susceptible to gentrification [20], but the research conducted provides important insights into observing changes in urban landscapes [21,22] while addressing the needs of natural processes occurring there, such as in this case study of providing drinking water to a city [23]. While many of the cited residential projects aim to integrate social, economic, and environmental factors for the benefit of the population majority, in practice, it's the logic of neoliberal markets that sets the tone for further reinforcing urban inequalities [24,25]. Although there's no consensus in all gentrification studies on its negative or positive impacts, some indicate a high correlation between social vulnerability to gentrification effects and environmental injustices across various sectors [26,27], thus expanding the understanding of the phenomenon in this project.

The difference between both proposed models is notable: the first model (mathematical) is entirely based on the collection of numerical variables obtained from both field observations and data obtained through public government institution portals. The second model (geographic) is also fed from the same information and retains such characteristics, but the data treatment approach involves the use of digitized information in the form of cells (raster).

According to the geospatial portal of the RUV, "Puerta de Piedra" is a residential development located within an Urban Containment Perimeter classified as U2, and it's just half a kilometer away from a U1 Urban Containment Perimeter (a commercial hub). This indicates that it is situated in an area that serves as residential support and provides basic services to its population due to its proximity to commercial or industrial hubs. Similarly, "El Pedregal" is an area with socio-economic characteristics (residential or premium residential households, proximity to shopping centers like Plaza San Luis, businesses dedicated to the sale of automobiles, and public services, the lack or absence of which is practically nonexistent among its inhabitants) that make it share this same characteristic with "Puerta de Piedra".

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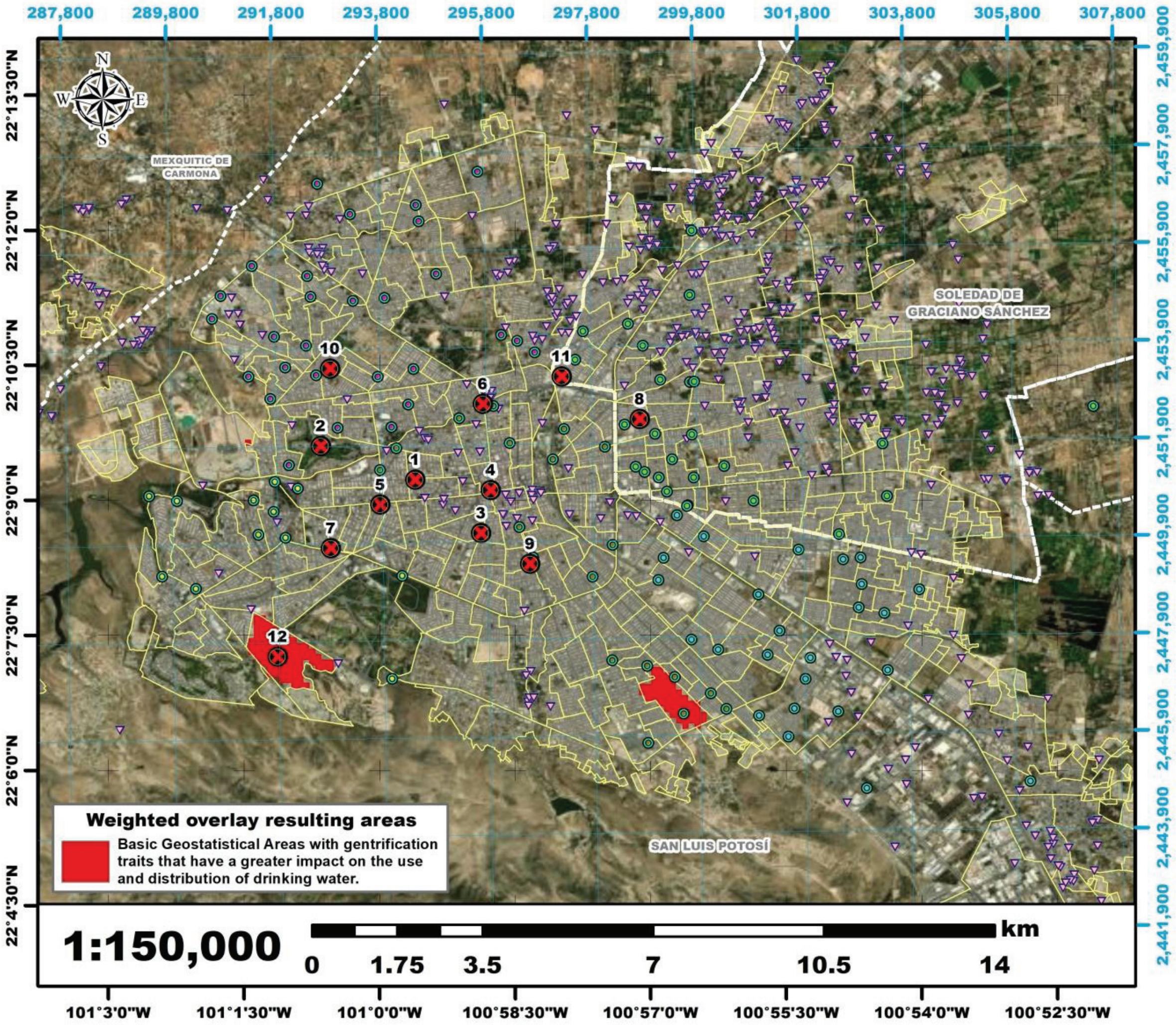

Figure 2: Results of the TA of multiple layers of vector information using geospatial techniques, employing a multicriteria analysis that allowed the identification of areas (in red) affected by real estate projects with gentrification traits, having a high impact on the use and distribution of drinking water.

For both cases, the infrastructure services they have (street lighting, electricity, drainage, sewerage, and the use of drinking water through a piped network) are provided by the public network managed by the Municipal Council of San Luis Potosí. Practically no neighborhood, residential development, or commercial or real estate development is provided for by its means, except for certain exceptions such as the neighborhoods Villantigua or the Country Club of San Luis Potosí, which are supplied by privately concessioned wells.

Regarding being established in places with a consolidated urban image, none of the cases fit this description. However, they do share a connection to places associated with the city's historical memory. In the case of "El Pedregal", this residential development was established in an area that historically had ejido (communal land) uses by the community of San Juan de Guadalupe. Decades later, it was discovered to be of high ecological and hydrological importance, serving as a recharge zone for the shallow aquifer. There are indications that it also provides some recharge to the deep aquifer, which, according to Cardona-Benavides and other authors [28], contains water of fossil origin. In some areas of the city, through various drilling surveys, water has been dated to ages of 5,000 years or more. Similarly, the area where the "Puerta de Piedra" residential development is now located was near what was then referred to as "La Presita" by the area's old inhabitants. A series of marshes and small ponds were located here mainly due to natural rainfall runoff from the "Cañada del Lobo", a small dam located near the city on the Sierra de San Miguelito, a few hundred meters from the South Ringway of San Luis Potosí. Due to these circumstances, both cases did not suffer considerable deterioration or pose a risk to the integrity of the city's inhabitants. However, the late last millennium's urbanization plans disrupted the natural balance of both sites. There's an urgent need for planning that places nature at the center of decisions, altering capitalist development models that prioritize the economic value of nature over aspects as vital to humans as cultural and traditional elements, emotional well-being, or aesthetics [29]. As explained in this section, it's also the reason why both research subjects underwent a radical transformation from being completely natural or rural landscapes to becoming urbanized landscapes with

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high-value residential housing. In addition to the above, the neighborhoods and housing developments in the western area of San Luis Potosí city are less than 2 kilometers away by road from another urban Basic Geostatistical Area with a high level of social backwardness: Escalerillas. For several years, the lack of water in this area of the city has been evident and problematic, as pointed out by Louis Mballa [30].

Conclusion

Gentrification is responsible for the increase in population density in certain urban areas. This can result in an increased demand for basic services such as water for various uses. Having inadequate infrastructure (combined with existing deficiencies in public services) in communities where luxury real estate developments, residential buildings, and commercial properties have begun to be implemented can exert additional pressure on local water sources, potentially affecting nearby water resources such as the overexploited aquifer in the San Luis Potosí Valley.

The real estate development with gentrification features impacts the use and distribution of drinking water. This argument is demonstrated in the matrices and the model used to analyze the relationship between both aspects (gentrification and drinking water), which show a city with unequal characteristics in urban development that impact the utilization and distribution of drinking water in the metropolitan area of San Luis Potosí. Such inequality is observed in the western zone of the city and it is related to the ecological impact of the recharge area of the shallow aquifer located very close to the Flora and Fauna Protection Area of Sierra de San Miguelito. Likewise, the water supply policy of the San Luis Potosí metropolitan area and its relationship with real estate developers has direct consequences on the organization of infrastructure and water supply for the population.

References

1. Josep C. Political Science. Madrid, Editorial Ariel S.A. 2009. ISBN: 8434418363
2. Brookes JD, Carey CC. Goal 6: Ensure Availability and Sustainable Management of Water and Sanitation for all – SDG Indicators. 2015. https://unstats.un.org/sdgs/report/2018/goal-06/ (accessed 8 August 2022).
3. Lozano Niño Y. Analysis of the development of vertical housing in san luis potos Prezi.Com. https://prezi.com/_gdj4njx2ea2/analisis-del-desarrollo-de-la-vivienda-vertical-en-san-luis-potosi/
4. INEGI. Dynamics of the population of the State of San Luis Potosí. 2020. https://cuentame.inegi.org.mx/monografias/informacion/slp/poblacion/dinamica.aspx?tema=me&e=24
5. Smith N, Hendel V. The new urban frontier: revanchist city and gentrification. Madrid: Traficantes de sueños. 2012.
6. Janoschka M, Sequera J, Salinas L. Gentrification in Spain and Latin America: a critical dialogue. International Journal of Urban and Regional Research. 2014; 38(4): 1234–1265. https://doi.org/10.1111/1468-2427.12030
7. Rasse A. Methodologies for identifying areas in gentrification. Santiago de Chile and Mexico City. Bitácora Urbano Territorial. 2019; 29 (1): 53 - 63. https://doi.org/10.15446/bitacora.v29n1.70035
8. Castillo-Oropeza OA, Delgado-Hernández E, García-Morales Á. Gentrification and disaster in the Condesa Zone. Dossier Central. 2018. https://doi.org/10.15446/bitacora.v28n2.70157
9. Inzulza J, Galleguillos X. Latin gentrification and polarization: socio-spatial transformations in pericentral and peripheral neighborhoods of Santiago, Chile. Revista de Geografía Norte Grande. 2014; 58: 135-159. http://dx.doi.org/10.4067/S0718-34022014000200008
10. Delgadillo V, Díaz I, Salinas L. (Perspectives on the study of gentrification in Mexico and Latin America. Mexico City: National Autonomous University of Mexico). 2015. https://doi.org/10.14350/rig.54953
11. Paula B, Matilde M. Gentrification and countergentrification processes: The Abasto and Northern markets in Greater San Miguel de Tucumán. Revista INVI. 2014; 29(81):157-191.
12. Kagan J. The Three Cultures: Natural Sciences, Social Sciences and Humanities in the 21st Century, Cambridge University Press, Reino Unido. 2009. https://doi.org/10.1017/CBO9780511576638
13. Bunge M. The social sciences in discussion: a philosophical perspective. Editorial Sudamerican, Argentina. 1999.
14. Snow CP. The Two Cultures and the Scientific Revolution, Martino Fine Books. E.U.A. 1959. DOI:10.1001/archinte.1961.03620010145021
15. Interapas Water management in the metropolitan area of San Luís Potosí, Cerro de San Pedro and Soledad de Graciano Sánchez 2013.
16. Héctor Ramón AV. Why does political corruption persist in Mexico? Comparative study of Federal Executives: 2000-2021, Doctoral thesis. Tesis Doctoral, El Colegio de San Luis A.C. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://biblio.colsan.edu.mx/tesis/DCS_HectorRamonAlonso.pdf
17. Ragin Charles C, Rubinson C. The Distinctiveness of Comparative Research. The SAGE Handbook of Comparative Politics. Landman, Todd y Robinson, Neil. SAGE, London, U.K. 2009. DOI:10.4135/9780857021083.n2
18. López Álvarez B, Santacruz G, Morán Ramírez J, Ramos Leal JA, et al. Calculation of the water poverty index in semi-arid areas: San Luis Potosí Valley case. International Journal of Environmental Pollution. Environmental Pollution International. 2013; 29(4),249-260.
19. Conacyt. 2018. What relationship do geological faults have with aquifer recharge? Water. https://www.iagua.es/noticias/mexico/conacyt/17/04/05/que-relacion-tienen-fallas-geologicas-recarga-acuifera
20. Rigolon A, Németh J. Towards a socio-ecological model of gentrification: How people, place, and policy shape neighborhood change. Journal of Urban Affairs. 2019; 41(7): 887-909. https://doi.org/10.1080/07352166.2018.1562846
21. Bryson J. The nature of gentrification. Geography Compass. 2013; 7(8):578-587. https://doi.org/10.1111/gec3.12056
22. Osman S. Gentrification matters. 2017. https://doi.org/10.1177/0096144216680247
23. Sanchez GM, Smith JW, Terando A, Sun G, Meentemeyer RK. Spatial patterns of development drive water use. Water Resources Research. 2019; 54:1633–1649. https://doi.org/10.1002/2017WR021730
24. Krings A, Schusler TM. Equity in sustainable development: Community responses to environmental gentrification. International Journal of Social Welfare. 2020; 29(4):321-334. https://doi.org/10.1111/ijsw.12425
25. Chapple K. Income inequality and urban displacement: the new gentrification. In New Labor Forum. Sage CA: Los Angeles, CA: SAGE Publications. 2017; 26: 84-93. https://doi.org/10.1177/1095796016682018

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DOI: https://dx.doi.org/10.17352/iast.000003

26. Kim H, Woosnam KM, Kim H. Urban gentrification, social vulnerability, and environmental (in) justice: Perspectives from gentrifying metropolitan cities in Korea. Cities. 2022; 122: 103514. https://doi.org/10.1016/j.cities.2021.103514

27. Zuk M, Bierbaum AH, Chapple K, Gorska K, Loukaitou-Sideris A, Ong P, Thomas T. Gentrification, displacement and the role of public investment: a literature review. In Federal Reserve Bank of San Francisco. 2015; 79.

28. Cardona Benavides A, Martínez-Hernández JE, Castro Larragoitia J. The age of the groundwater that supplies the San Luis Potosí region. Potosinos University Magazine.

29. López Álvarez B. Groundwater, a hidden resource: The case of the San Luis Potosí Valley aquifer. Arguments Critical Studies of Society. 2021; 1(95): 15–32. https://doi.org/10.24275/uamxoc-dcsh/argumentos/202195-01

30. Mballa L. Public policies for the supply of drinking water and sanitation for the town of Escalerillas, San Luis Potosí – Mexico: scenarios and citizen perception. Waterterritory. 2018.

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