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Articles

Local strategies to cope with urban flooding in the city of San Luis Potosí

Prácticas locales ante inundaciones urbanas en la ciudad de San Luis Potosí

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Abstract

This work evaluates the social construction of risk associated with urban flooding in the southern area of the city of San Luis Potosí, Mexico. Firstly, we examine the 1970s and 1980s urban policies that originated the current problem of annual flooding and that led to the social production of a risky urban space; also, we analyze the rainfall regime in the study area and the political speech that identifies precipitation as the main cause of urban flooding. Secondly, we analyze the social organization of the community and the local strategies to cope with floods. The neighbors use these strategies to prevent and reduce the damages caused by floods, but they are considered technically deficient by the city authorities.

The results of this research show the social construction of risky urban space in the context of land privatization, the industrialization of the city, and the social and economic inequality that led to the recurrent flooding in the study neighborhood (El Aguaje). Furthermore, the results show the local strategies used by the residents to protect their properties and safeguard their health. Such strategies include streets, housing modifications, and social organizations to demand action from the local government.

Keywords: Risky urban space, urban flooding, local management strategies, social inequality, San Luis Potosí.

En este trabajo se analiza cómo se desarrollan y construyen socialmente las inundaciones del sur de la ciudad de San Luis Potosí, México, y se evidencian las estrategias locales para hacerles frente. Para esto se examinan los discursos sobre el comportamiento de las lluvias en el área de estudio, y se estudian las políticas de urbanización del sur de la ciudad en la década de 1970 y 1980, además del patrón de poblamiento de la ciudad. En segundo lugar, se examina la organización social y comunitaria urbana a través de prácticas locales en el fraccionamiento El Aguaje para prevenir y enfrentar la inundación, las cuales son relegadas o rechazadas por las autoridades gubernamentales por considerarlas poco prácticas y sin sustento técnico.

Los resultados de la investigación muestran cómo se construyen estos espacios urbanos como riesgosos para la población en un proceso de diversos tiempos y espacios sociales, políticos y económicos; de esta manera, el contexto de privatización de la tierra, la industrialización y la amplia desigualdad social y económica han propiciado la generación de espacio riesgoso ante inundaciones en El Aguaje. Además, la investigación evidencia el actuar local para enfrentar las inundaciones y resguardar su

salud y patrimonio, el cual va de modificaciones a las calles y casas a la organización para demandar solución a las autoridades.

Palabras clave: espacio riesgoso, inundaciones urbanas, prácticas locales, desigualdad social, San Luis Potosí.

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Introduction

According to Conagua (Comisión Nacional del Agua), the floods associated with heavy rain affected at least 8 million people and caused economic losses of around 130 000 million pesos between 1980 and 2007 (Conagua, 2015). The states most affected were the State of Mexico, Mexico City, and the States of Veracruz, Tabasco, and Chiapas. However, the rest of

the Mexican states also presented floods in low-lying areas and even in arid and semi-arid regions.

To explain floods, Conagua argues that Mexico is constantly exposed to hurricanes and heavy precipitations that cause damage to infrastructure and affect the services and production systems. Despite the damage, these meteorological events also increase water storage volume in dams and lakes. In other words, the institution directly associates a disaster with a meteorological event. On the other hand, this research considers floods a social phenomenon based on the relationship between society and its political, urban, and environmental contexts.

This work evaluates the floods in the south of the Mexican city of San Luis Potosi, specifically in the urban area called El Aguaje. This locality was transformed from an agricultural to an urban area in the 1980s. Such transformation of the territory was allowed by Mexican institutions that implemented policies for the construction and sale of houses under the idea that the new urban area would be the ideal place to live in the city. However, the residents were affected by floods from the early years, causing property damages (e.g., cars, walls, yards, and movable assets). In addition, the floods cause the accumulation of garbage and debris in the streets, so people cannot transit to leave the area. Therefore, the surface streets run-off in this area of the city produces a space of risk in conditions of social inequality. In this context, the residents of El Aguaje

have implemented strategies to cope with floods and reduce damages, regardless of institutional policies.

The first objective of this work is the analysis of the social construction of the floods at El Aguaje, a neighborhood located south of the city of San Luis Potosi. In this regard, this research analyses the urbanization process in the city (from 1970 to nowadays) as a key factor that causes floods and creates a space of risk. The second objective is to describe the implementation of local strategies to cope with floods to reduce property damage and health preservation. The research allowed us to identify the strategy implemented before, during, and after the floods. In addition, the research shows the institutional management of floods at the municipal and state level.

The article is organized into four sections. The section "materials and methods" presents the epistemological framework of risk and disasters as a social process. Also, the study area is characterized, and the methodological strategy is described. The section "results" evaluates the causes of floods in the south of the city of San Luis Potosí and describes the local strategies to cope with floods. The next section discusses the main findings, and the last section concludes.

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Materials and methods

Rainfall, floods, risk, and disaster

The term flood is used to describe events of different magnitudes associated with various circumstances, such as fluvial floods related to annual or stational high rainfall season or infrastructure failure (Few, 2003). The National Center for Disasters Prevention (Cenapred) states that floods occur when water forcibly enters places where it is not present and generally causes damage to the population, property, and infrastructure and interrupts economic activities (Salas & Jiménez, 2014). In addition, Cenapred classifies floods according to their origin (pluvial floods, fluvial floods, and coastal floods) or by the timing (slow floods and flash floods).

The position of this definition traditionally associates floods with the physical behavior of rains. However, it is recognized that the occurrence of floods may be related to infrastructure deficiencies, the lack of public

policies, and the socioeconomic conditions of the affected people. Generally, the core of the definitions of the flood is naturalistic and considers the population defenseless when a flood disaster occurs (Lavell, 1993); Therefore, the disaster is positioned as caused by nature (generally by a meteorological event), and the affected population is considered a passive actor in this process.

In this research work, we consider that risk and disasters (particularly those related to floods) do not occur in what is considered "nature"; since such floods occur in societies, they are not natural. Therefore, a flood disaster is a social phenomenon arising from social, environmental, political, and urban circumstances related to institutions. The origin of a disaster must be found in the social trajectories of the economy and material culture, which have multiple and complex processes on a regional, national and international scale (Lavell, 1997; Oliver-Smith, 1999; Valencio, 2015).

In this way, a disaster is not a sudden or unexpected event caused by a meteorological episode, but rather it occurs in the socioeconomic processes of urbanization that lead to social inequalities; that is, the economic and political conditions induce the disaster (Valencio, 2014). When a disaster strikes, severe changes occur in the population's life, such as loss of life and health, destruction of property and damage to

living space, and modifications in the economic structure of a country, city, or neighborhood (Llanes, 2003).

Therefore, to study a disaster, it is necessary to evaluate the transformation of the territory and the way in which the social processes produce a space of risk. This type of analysis can lead to deep insights to explain the complexity of a disaster (Calderón, 2011). Consequently, a flood disaster can't be only described in terms of the precipitation and runoff. Still, the study of the disaster must characterize the transformation of a given geographic space into a risk space.

Study area

The Mexican city of San Luis Potosi is 22º 09' N 100º 58' W, 1 860 m above sea level (CEFIMSLP, 2012). The mean annual precipitation (between 1950 and 2019) ranges from 169 to 387 mm, with an average of 387 mm as evaluated with data from station 2049 of the National Meteorological Service. The annual precipitation regime presents a dry season from November to April (with an average of 69 mm) and a rainy

season from May to October (with an average of 323 mm). May and January have the higher and lower mean monthly temperature, respectively (20.9°C and 13.4°C). These conditions characterize the study area as a semi-arid temperate climate region (INEGI, 2009). The city is situated in the valley of San Luis Potosí, which is limited by the mountain ranges of Sierra de Alvarez (east) and Sierra de San Miguelito (south and west). The hydrological regime consists of ephemeral streams, of which the most important are Rio Santiago and Rio Españita, which flow into an endorheic basin (INEGI, 2002).

According to the study presented by Carranco, Ramos, Almanza, and Moran (2016), convection precipitation is frequent in the city with short-duration, heavy rain events; authors identify this precipitation as the main cause of floods in the city. The study also mentioned the occurrence of orographic precipitation originated at Sierra de San Miguelito as a generator of runoff in the city. Nevertheless, the description and study of precipitation face problems such as the lack of pluviometer measures and the loss of data in records (Santacruz & Eguía, 2016). In this sense, the description of the precipitation does not explain by itself the floods in the city. Figure 1 shows the hydrological features and the study area in the town.

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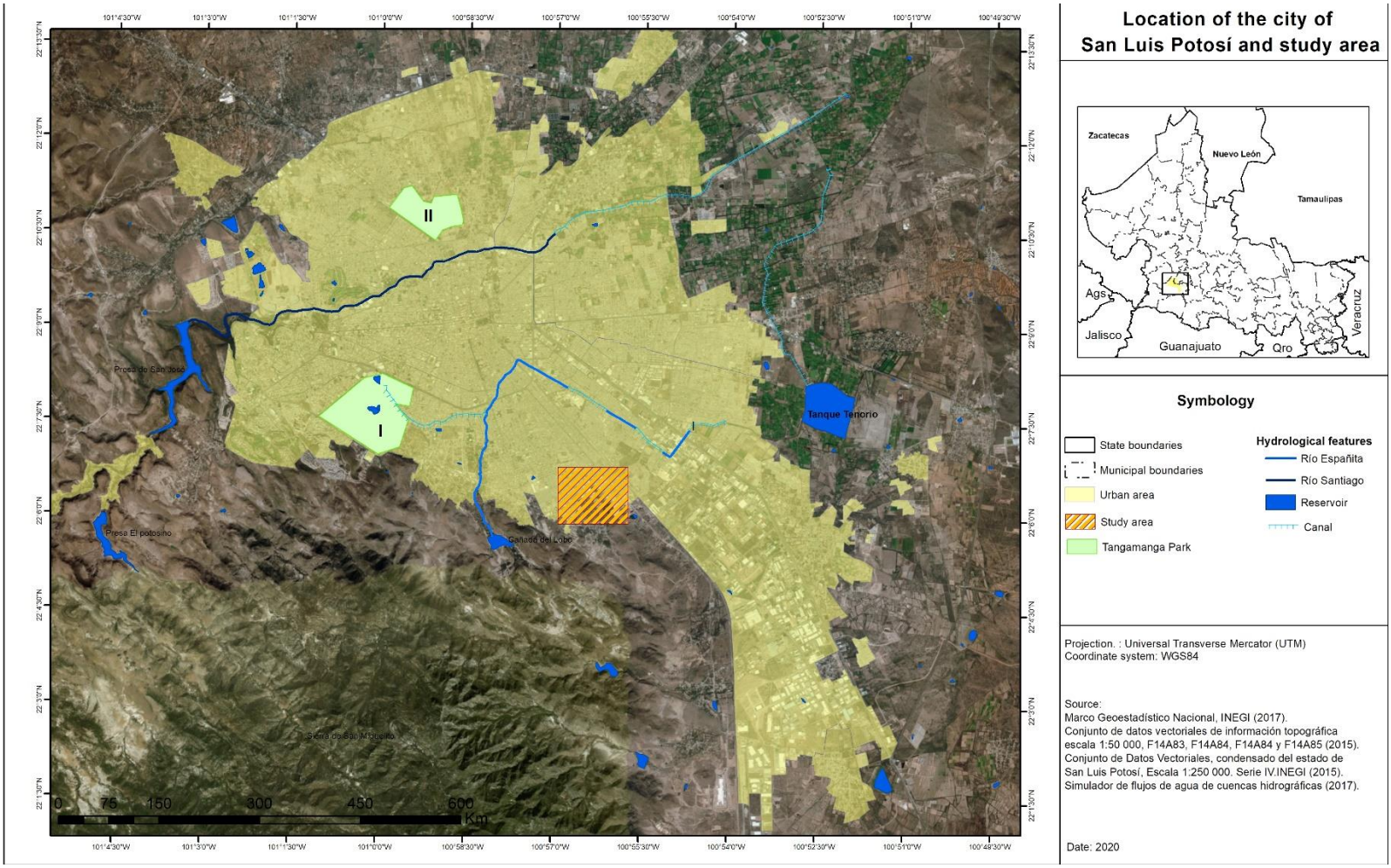

Figure 1. City Location and study area.

The metropolitan area of San Luis Potosí includes the city itself and urban areas located in the municipalities of Soledad de Graciano Sánchez,

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Zaragoza, Mexquitic de Carmona, Villa de Arriaga, Villa de Reyes and Ahualulco (INEGI, 2018). The population size is 1 271 366 inhabitants (INEGI, 2020). This metropolitan area is part of the industrial corridor of Central Mexico, composed of the chemical industry, textile and automobile manufacturing; The emergence of this industry has been promoted by policies such as the North American Free Trade Agreement (NAFTA). These policies have promoted population growth and urbanization in rural areas. The study by Cirelli (2012) affirms that starting in the 1940s, the population of San Luis Potosí increased steadily due to the first stage of industrialization in Mexico. In the 1970s and 1980s, the urban area grew in all directions and fragmented the rural areas. Figure 2 shows the increase in the population size of San Luis Potosí from 1950 to 2020, and Figure 3 shows the increase in urban area from 1970 to 2020.

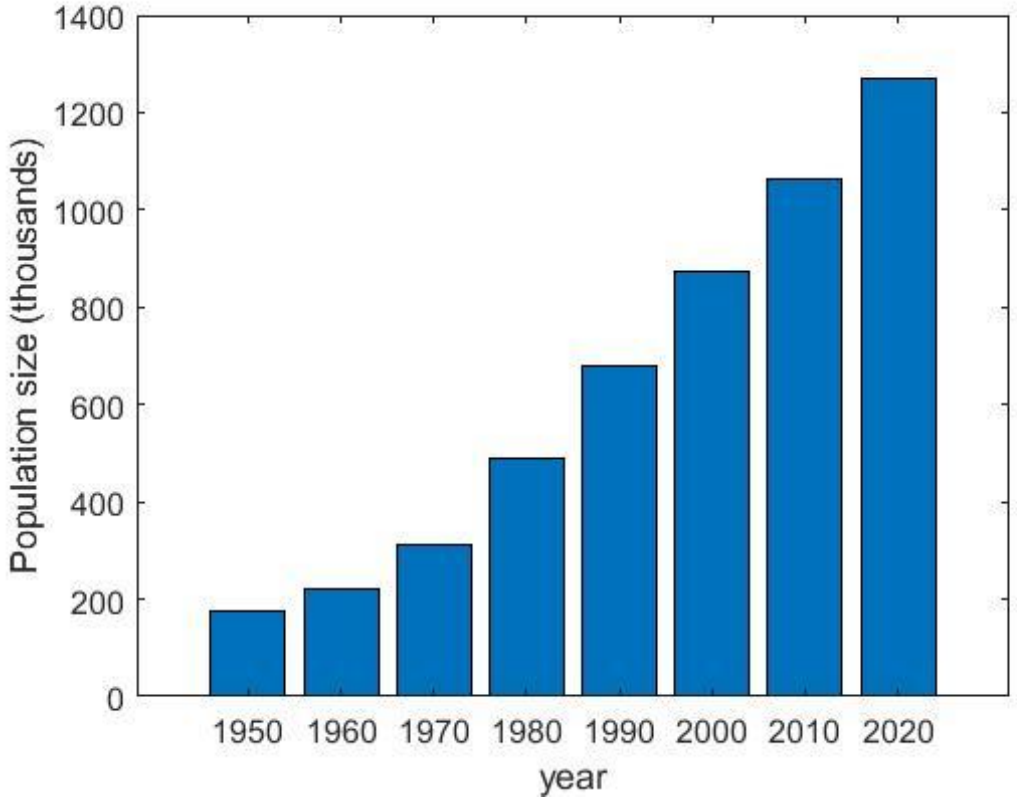

Figure 2. Increase in the population size in the metropolitan area of San Luis Potosí (1950-2020).

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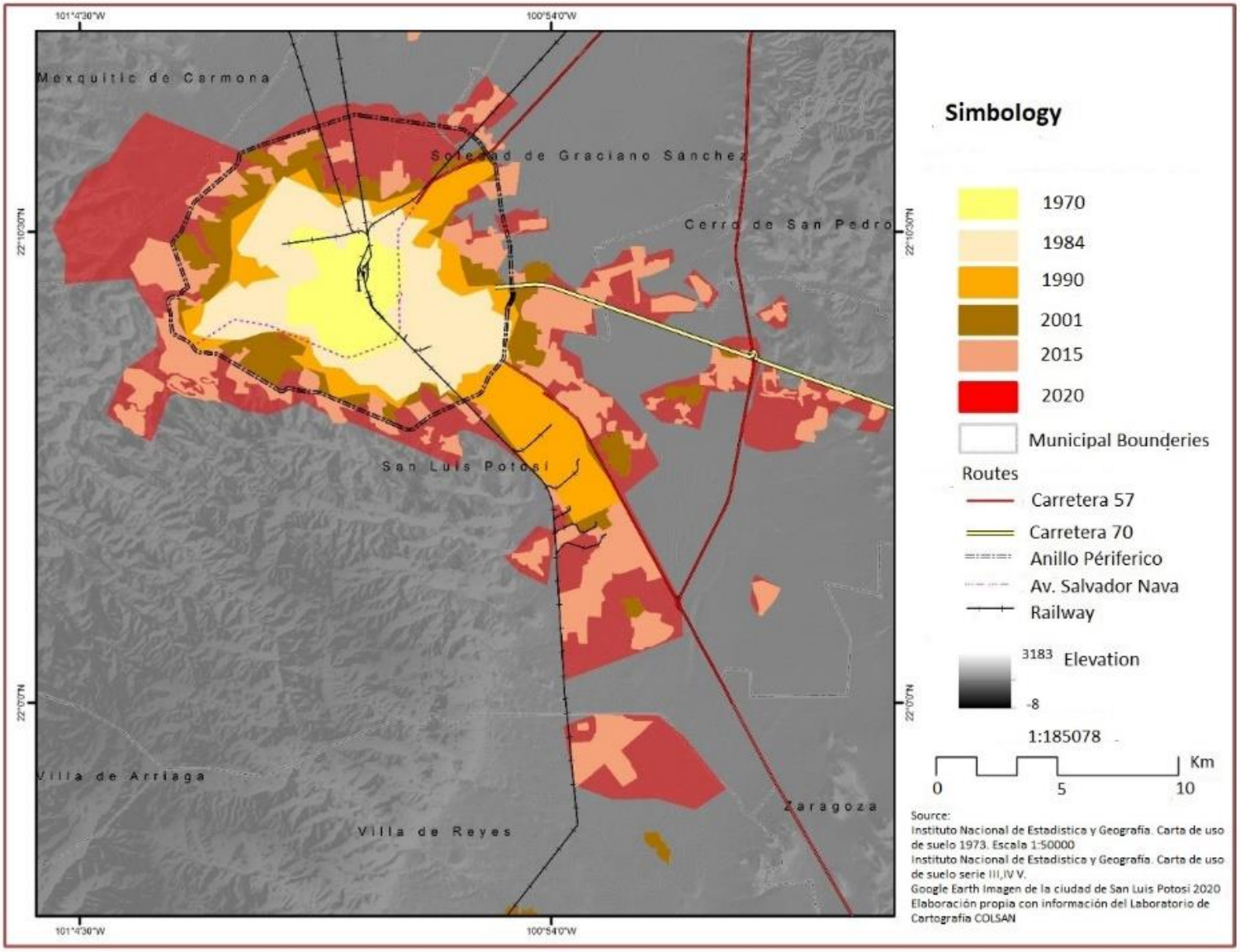

Figure 3. Urban development of the metropolitan area of San Luis Potosí (1970-2020).

The urban development of the city changed the hydrological features of the city. For instance, the main streams (Rio Santiago y Rio Españita) were transformed into boulevards in the 1980s and 1990s (López, Moreno, Alva, & Hernández, 2018). In this process, construction companies and governmental policies played a key role in transforming the city (Stevens, 2012), so rural land, ejidos (and other types of communal land) were fragmented and occupied. This process was developed under the model of "economic reconstruction" and "improvement" of the infrastructure at the national level. At the local level, the State government promoted the construction of new hydraulic infrastructure (sewage systems, water supply networks, and electrical grids). San Luis Potosí consolidated itself as an important service and industrial center (Castrejón & Azevedo, 2013).

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Methodological strategy

In a previous section, we established the theoretical and conceptual framework of the research. The investigation was developed in three steps, based on the triangulation methodology mentioned by Poteete, Janssen, and Ostrom (2012), which includes semistructured interviews, observation, and fieldwork; the latter involved taking notes in a field diary and taking pictures in the study area. In addition, we consult information from sources such as topographic maps, satellite images, and documentary information.

In the first step, the information-gathering phase, a selected bibliography on historical floods in San Luis Potosí was consulted, as well as the reports of the Civil Protection Office. Then, we consulted journalistic sources in the most important media of the city (i.e., Pulso Diario de San Luis, El Sol de San Luis, Plano informativo, and Codigo San Luis). Also, the web pages of the Facebook groups of residents of El Aguaje were consulted. This information allowed us to identify the sector of the neighborhood affected by the floods and define the study area. On the other hand, the semi-structured interview scheme was prepared to be used in the third step of the research.

The second step of the research included fieldwork in the summer rainy season of June and July 2017 and the cold front rainy season in November and December 2017. In this fieldwork, we established first contact with the residents of El Aguaje affected by the floods and asked them about their interest in participating in the research.

In the third step of the investigation, we carried out fieldwork with the residents of El Aguaje, and 25 semistructured interviews were applied. From this point on, close contact was established with the neighbors, who shared their files (photographs and documentation). It is important to mention that the interviewees' names were changed to preserve their identities. The information collected in the previous steps allowed us to make a flood mapping in El Aguaje that was shared with the residents. The applied methodology provides information to investigate the social construction of floods in the south of the city of San Luis Potosí, particularly in El Aguaje, and gives us evidence of the local strategies implemented by the residents to reduce damage.

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Results

The transformation of the territory in the city of San Luis Potosi and the floods

As mentioned in previous sections, in recent decades, San Luis Potosi has developed as an industrial city with infrastructure for transporting products and merchandise by railways and highways. This process was influenced by international, national, and regional policies that transformed the urban space and stimulated the growth of the urban area.

The first city development plan was published in 1967 by the government of Antonio Rocha Cordero (Castrejón & Azevedo, 2013). This plan promoted the transformation of the city and the arrival of foreign workers (both from Mexico City and the rural areas) to work in the city's industrial sector. From that moment on, the town took its current configuration under the policies of the stabilizing development model and the neoliberal model. In the latter period, the city transformed its

hydrological features, for example, the city's use of a reservoir (Tanque Tenorio, see Figure 1) as a sewer treatment plant and transformed the Rio Santiago and Rio Españita into boulevards and lineal parks (Cirelli, 2004). However, the water still runs off in those boulevards in heavy rains.

Recurrent floods appear in the new urban configuration; Figure 4 shows the flooding areas in the city of San Luis Potosí. The city authorities intend to direct rainwater outside the urban area. Still, every rainy season the city faces floods that pose a disaster risk to the population and damage to the infrastructure.

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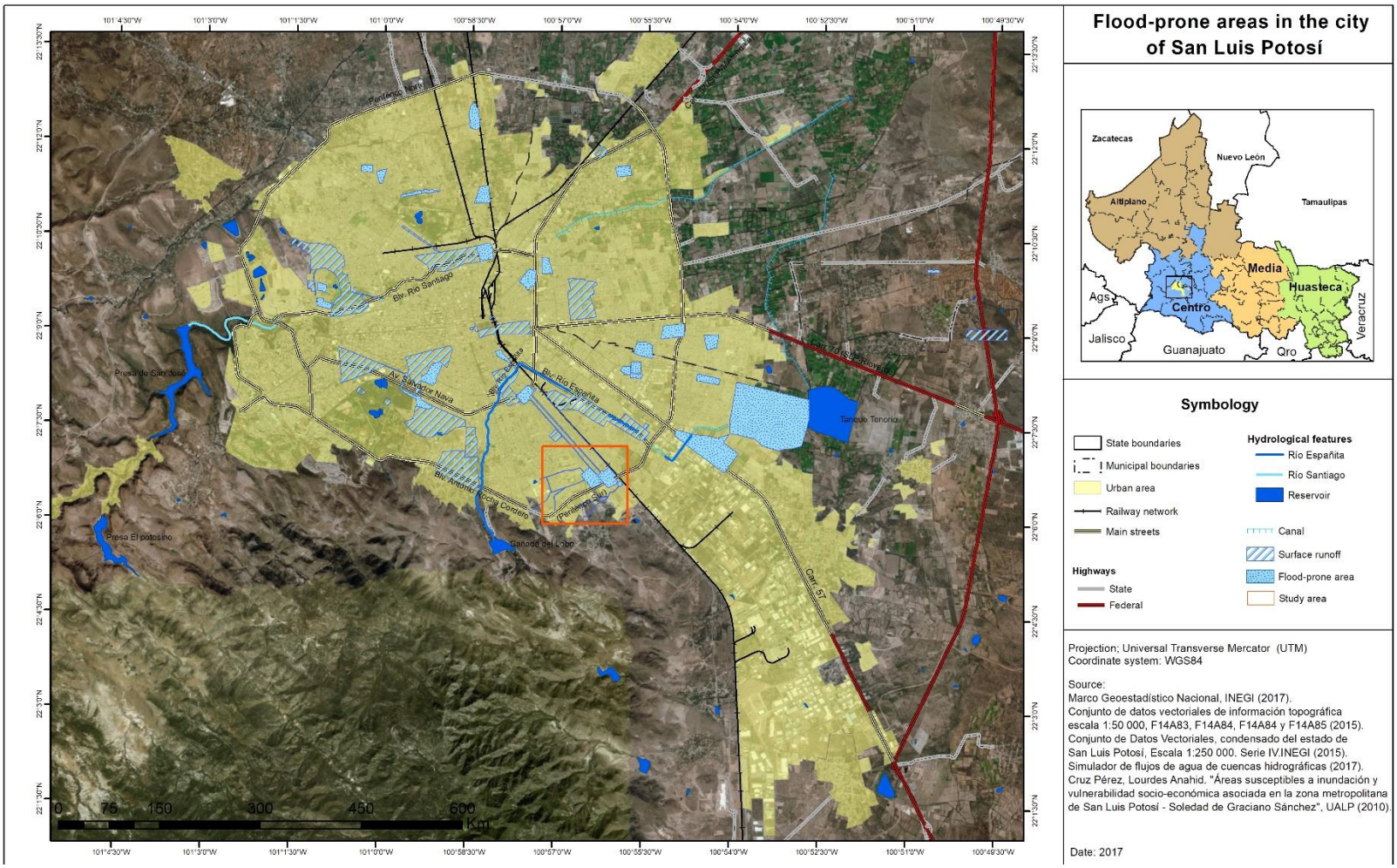

Figure 4. Flooding areas in the city of San Luis Potosí.

In the 1980s and 1990s, Neoliberal policies reinforced the fragmentation of rural areas by allowing the sale of communal lands

(ejidos) by modifying Article 27 of the Mexican Constitution. Therefore, rural areas were fragmented and urbanized in San Luis Potosí. The city's population moved their residence to previously ejido lands in the west and south of the town (as in the El Aguaje area).

During this period, a large urban park was also built on former ejido lands, Parque Tangamanga I (see Figure 1). This park is an important aspect of San Luis Potosí, as the western part of the city, with the most developed services (water supply network, sewage systems, and pluvial drainage), was built around it. Additionally, Parque Tangamanga I helps control runoff from the San Miguelito mountains as rainwater accumulates in various reservoirs within the park. The water leaves the park through a hydraulic channel to the Río Españita. Rainwater is also conducted to the Reforma storm drain to the Santiago River.

In the 1990s, the inter-municipal Water Office (INTERAPAS) was founded to manage the water supply network, the sewerage systems, and the pluvial drainage. INTERAPAS and other related offices conducted studies to characterize and classify the floods in San Luis Potosi. For instance, in 2000, the Protección Civil office identified 42 flood-prone areas, 30 were classified as recurrent flood areas, and the rest were flash flood-prone sites (Cruz, 2012). The study by Palacio (2011) describes the pattern of urban floods in the city of San Luis Potosí, which were classified by their potential for damage:

- Invasive: the flow height is about 20 cm, and floods can be slow or rapid. This kind of flood could limit the mobility of people and vehicles.
- Obstructive: the height of the flow is greater than 30 cm, and it remains in place for more than 1 hour before the water is dislodged from the site. This type of flood blocks the streets and damages infrastructure.
- Destructive: the height of the flow is greater than 30 cm, and it remains in place for one or more days. This type of flood causes damage to infrastructure, water supply networks, and property. This kind of flood is associated with heavy rains.

The last definition assumes that rain is the direct cause of flooding. From this point of view, the authorities decide the extent of damages, affectations, and disaster declarations. Therefore, when affected people demand solutions, their claims are generally relegated, as only the authorities have the prerogative to decide who is affected by a flood event.

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Local strategies to cope with urban flooding at El Aguaje

The policies that promoted the industrialization of México in the 1980s and 1990s transformed the territory of the city of San Luis Potosí and caused an increase in the urban area and the size of the population. The new urban areas were built by real estate developers related to political groups that encouraged the construction of houses under the policies of the Mexican state.

The construction of the urban area of El Aguaje was framed within the low-cost housing development policies for workers. In 1972, the Mexican State founded Infonavit (Institute of the National Housing Fund for Workers) and Fovissste (Housing Fund of the Institute of Social Security and Services for State Workers). Both institutions promoted the construction of 45 % of housing in Mexico between 1980 and 1990 (Boils, 2004). The social and political context of the construction of the urban area of El Aguaje is given by:

1. The impulse of the Mexican State to construct houses for workers.

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2. The modifications of the 27th article of the Mexican Constitution allowed the sale of communal land.
3. The increase in the population's size resulted from the industrial boom of San Luis Potosí under the NAFTA policies.
4. The new disaster protection policies after the 1985 earthquake in Mexico City and the 1922 explosions in Guadalajara.

The Saval Group developed El Aguaje (in association with FOVISSSTE) with the purpose of selling houses to low-income workers. The new urban area colonized an agricultural territory (ejido and small property) with a characteristic hydrological feature (streams, reservoirs, and irrigation infrastructure). Figure 5 shows the 1970 map of the south of the city of San Luis Potosí, including the El Aguaje area, which was constructed on a 15.37 ha surface.

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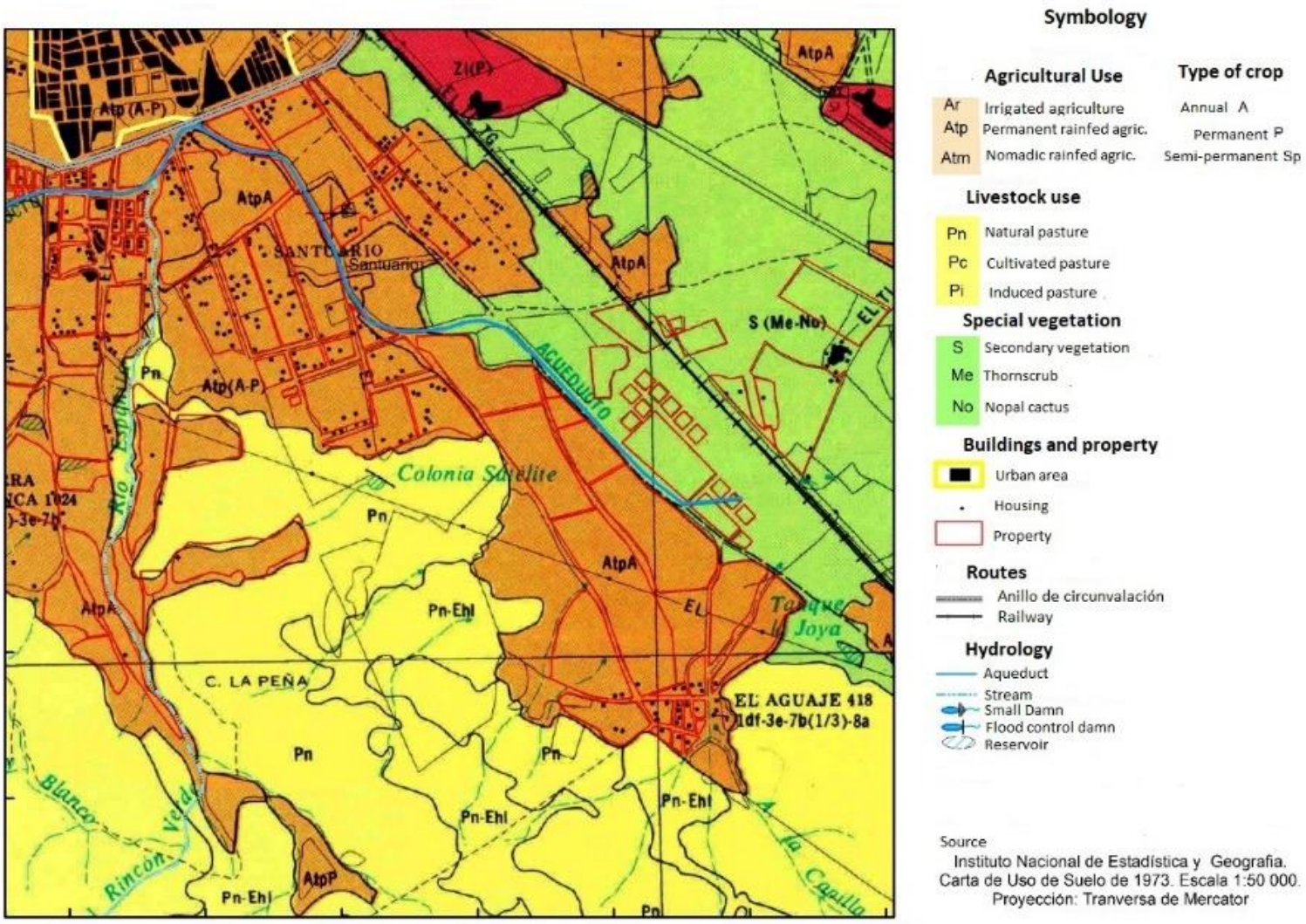

Figure 5. Geographical features of the south of the city of San Luis Potosí (1970).

The territory of the city was modified with the development of the new urban areas named Simon Diaz, Satelite, Progreso, Nuevo Progreso, and El Aguaje; the latter is an example of the new way of producing the urban space since the houses were built with the endorsement of the State and were sold by FOVISSSTE.

The current residents of El Aguaje report that they bought a house in this urban development because, for them, a property represented the confidence of owning their home. In addition, they were told that the urbanization had all the services and that El Aguaje was a safe space compared with other neighborhoods. The construction company promoted the new urbanization as:

> "El Aguaje will benefit 1492 families by offering a housing development that provides all urban services such as water supply and sewer systems, public lighting, road signs, and urban amenities. Each block is made up of only 60 houses" (personal communication, 2017).

State employees, mainly schoolteachers, bought the houses. A resident of El Aguaje mentioned: "The teachers viewed the opportunity to

buy a little house; everything was nice, the neighborhood was surrounded by cultivated land, it was a quiet place to raise a family because, compared with other neighborhoods in the city, there were no street gangs" (Juana, 2017).

An interviewee mentioned that the floods occurred in El Aguaje since the first rainy season:

> "I never imagined that rainwater would not run into the sewer system; the water entered my house, and I lost all my furniture; sometimes, stinking water and mud come out of the drains, even with a small amount of rain" (María, 2018).

Another person said:

> "One day, I arrived in the neighborhood, I had just moved a few weeks before, and I could not enter my house because the street became a stream carrying garbage, tree leaves and branches, plastic bottles, and many other things. Finally, I was able to go inside, and all the furniture was covered in mud and stinky water" (Esteban, 2018).

Figure 6 shows the urban areas prone to flooding in the south of the city of San Luis Potosi, which includes El Aguaje; Figure 7 is a photograph illustrating a 2015 flood in the study area; We can see in the image the flood level that covers half of the body of the depicted person.

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Figure 6. Urban areas are prone to flooding in the south of the city of San Luis Potosí.

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Figure 7. 2015 Flood in El Aguaje (Alamilla, 2015).

The residents mentioned that the floods are recurrent, so they organized to clean e streets, the sewer holes, and the common gardens, as shown in Figure 8 and Figure 9. In addition, the neighbors elevated some parts of the street with concrete as an obstacle for the water to prevent flooding. Besides, some neighbors have modified the entrance of their houses by adding steps as a water barrier and shortening the windows, as seen in Figure 10 and Figure 11. Residents also try to protect their cars by parking at the higher level of the streets.

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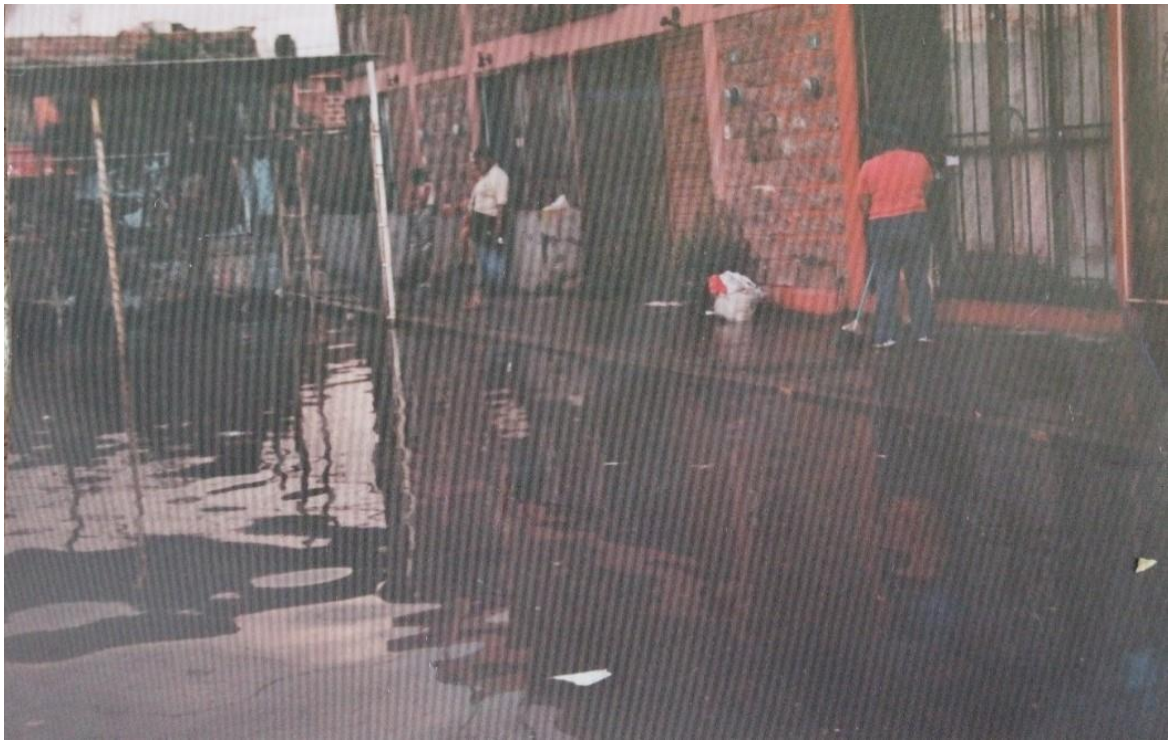

Figure 8. Neighbors cleaning the street after the flood (source: private archive, 2017).

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Figure 9. Street cleaning after a flood (source: fieldwork 2018).

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Figure 10. House modifications prevent rainwater from entering the houses (source: fieldwork 2018).

Figure 11. Adaptations are made inside the house to protect the property from flooding (source: fieldwork 2018).

The local social organization emerged as a way to address the neighborhood's problems based on the relationships between the neighbors since most of them were colleagues who worked as school teachers. Thus, residents organized street meetings to discuss the solution to the problems of their neighborhood.

A neighbor related:

> "From the beginning, we worked together to ask the government for solutions regarding the deficient drainage system; we demanded the construction of new infrastructure. That's why we blocked major avenues, and somehow it worked" (Andrés, 2018).

On the other hand, institutions such as the municipal government and the San Luis Potosi Water Commission minimized the damage caused by the flood, according to a neighbor:

> "The flood is only a few puddles of rainwater for these people, but I lose a part of the family property each rainy season. They say that the rainwater causes the flood, but the garbage blocks the drains; they must improve the clean service; that is the solution" (Ana, 2018).

The residents of El Aguaje have evaluated the speech of the authorities related to the floods and have also reflected on how their neighborhood was built:

> "The construction company caused the problem of recurring floods since they built the houses on agricultural land; they did not take into account the low level of the land" (Pedro, 2018).

Another topic of discussion among the residents of El Aguaje is the low efficiency of the infrastructure built to mitigate the problem of flooding; a neighbor said:

> "The rainwater collectors are not enough to drain the water, since they are not regularly cleaned, the flood continuous to occur" (Miguel, 2018).

On the other hand, the residents of El Aguaje had noticed small improvements; a neighbor said:

> "Currently, the flood water carries less garbage; I think the garbage collection service in the neighborhood has been improved."(Minerva, 2018).

The residents of El Aguaje had implemented local strategies to reduce the damage caused by the floods, such as modifications to their homes, raising the street level, and organizing street cleaning. These strategies helped reduce the problem, but the such strategy will not solve the floods since they originate on a larger territorial scale than the neighborhood itself.

Discussion

Few's (2003) work describes two main approaches to reduce the negative impacts of floods: the structural approach, which focuses on the construction of engineering projects to control the rainwater and protect areas flood-prone areas; on the other hand, the no-structural approach includes formal systems to monitor meteorological events and institutional evacuation plans (macro level) but also local strategies to cope with floods (micro-scale level). The latter is based on understanding

the environment and acquiring skills to cope with risk (Twigg, 2015). In recent decades, local strategies have become relevant in risk management programs (Lavell, 2003); However, this approach is not new, as societies have managed risk with adaptation strategies that include customs, traditions, and practices (García, 2006).

Twigg (2015) describes risk adaptation strategies as economic and material, for example, diversification of family income; Technological strategies, for instance, the identification of flood-prone areas to avoid the construction of houses in them; Social and organizational strategies, for example, support networks in a community; and finally, cultural strategies, for example, the subjective perception of previous risk experiences and religious aspects. A recent work by Ortega and Morán (2019) describes the local strategy implemented by the inhabitants of a rural community in the Huasteca region to reduce the damages associated with hydrometeorological events. The authors identify several strategies in the rainy and dry seasons. For instance, people cannot leave the house during the rainy season, so they change their economic activities to indoor activities. Among the technological strategies, the authors mention that the residents have elevated some parts of their houses to prevent rainwater from entering; In addition, they collect rainwater from the roofs of houses. The authors also identify organizational strategies; neighbors asked local authorities to buy boats to leave the community when the

road was flooded. Finally, the community also carries out cultural strategies such as religious offerings to ask for rain.

On the other hand, the work of Talledos and Medina (2019) describes local strategies to cope with meteorological risks (rains, frost, and fire) in Ejido La Trinidad, located in the Sierra Madre Oriental Mountain range (state of San Luis Potosí). The authors describe that the residents have relocated their homes out of flood-prone areas and excavated canals to drain water to an infiltration area. The authors highlight that the community implements these local strategies with the support of local authorities (Ejido Commissariat) and external authorities, such as the National Forestry Commission, to prevent fires.

Solis, Bocco, and Granados (2019) evaluated adaptation strategies in an indigenous region in the State of Michoacán. Their study describes the lack of institutional support to cope with the risks of tropical cyclones, so the local community organized itself. The activities implemented are community work to clean drains, repair roads, and monitor flood-prone areas. The authors claim that residents know to act when a meteorological event occurs for a quick return to everyday life.

Local strategies to cope with hydrometeorological risk have also been studied in the urban context. For instance, Castillo and De-Alba (2017) claim that adaptative strategies are actions that transform the territory (neighborhood, street, or house) that are generally not

recognized by authorities as they are considered not relevant. Furthermore, the authors affirm that these actions built social capital and empowered affected residents when institutions lack actions to prevent disasters. These characteristics were observed in our case study in El Aguaje since the residents implemented actions to reduce the negative impacts of floods, such as the modifications of streets and the adaptation of their houses to prevent the entry of rainwater. Also, the residents of El Aguaje had carried out these actions outside the local authorities' control, which generally minimizes the damage's extent. On the other hand, neighbors have formed a social organization to clean up the affected areas and to ask the authorities for solutions to the recurring floods.

Another case study is presented by Toscana (2014) that investigates the social reaction to the floods in Valle de Chalco Solidaridad (State of Mexico) that originated with the rupture of the canal that carries wastewater from Mexico City. The author evidences the social organization to prevent floods by monitoring the channel as an early warning system and the participatory mapping of flood-prone areas.

The case studies discussed above show that social, political, and cultural knowledge to cope with floods has emerged through the local experience in Mexican rural and urban communities. However, they are generally considered irrelevant by the institutional risk management approach (Castillo & De-Alba, 2017). In this regard, Lavell (2003) argues

that risk management with a centralized approach is not recommended, so local skills are needed since, often, a regional disaster is composed of several small disasters.

Conclusions

The first objective of this research was to investigate the social construction of floods in El Aguaje, a neighborhood located in the city of San Luis Potosí. Firstly, the modifications of the territory caused by the increase in an urban area in the last decades were evaluated. This process was driven by international, national, and local policies such as NAFTA, which integrated the city into central Mexico's industrial corridor. Among the national factors, we identify the modification of the laws to allow the sale of communal lands and the state policies that promoted the construction of cheap houses for the workers. At the local level, factors include the development of urban areas on former agricultural lands with a hydrological configuration (streams and reservoirs). The transformation

of the territory created a risk space affected by recurrent floods, such as El Aguaje. Other examples of this process have been evaluated in case studies in Valle de Chalco (Toscana, 2014), Ecatepec (Castillo & De-Alba, 2017), and Ciudad Valles (Peña, 2019).

Recurring floods in El Aguaje affect residents in such a way that they lose their personal belongings each year, and their property is damaged. The authorities neglect the demands for a solution to this problem and associate floods only with the amount of rainfall, showing the naturalist approach to public policies (Lavell, 1997). Therefore, neighbors take measures to reduce the damage caused by floods.

The second objective of this study is to characterize the local strategies implemented by the residents of El Aguaje to cope with the floods. Our findings show that residents have modified their streets and houses to prevent water from entering; In addition, they have coordinated street cleaning after the floods and have a social organization to demand solutions from the city authorities. Castillo and De-Alba (2017) argue that local strategies build social capital and politically empower neighbors. In this social organization, the decisions are generally taken by consensus, but some external organizations try to introduce their political themes.

The social construction of floods in San Luis Potosí continues to be a current process. For instance, real estate developers are planning the urbanization of the Sierra de San Miguelito; These new exclusive gated

urban areas are intended to be offered to a high-income public seeking "security" (Campos, 2018). The urbanization of the Sierra de San Miguelito in the last 20 years caused a flood problem in the area near the Parque Tangamanga (Stevens, 2012; IPICYT, 2018), as shown in Fig. 4. Despite the current problem of flooding, the authorities of the state of San Luis Potosi promote the transformation of 320 ha of the natural area into what they call "controlled development" (Exprés, 2020). This case exemplifies how the authorities do not contribute to risk management but rather contribute to generating risks in urban space (Toscana, 2014).

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References

Alamilla, F. (2015). *La Brecha información puntual. Cierres viales y caos provocan las fuertes lluvias en SLP (Galería y Video)*. Recuperado de https://labrecha.me/?p=68686

Boils, G. (2004). El Banco Mundial y la política de vivienda en México. *Revista Mexicana de Sociología*, 66(2), 345-367.

Calderón, G. (2011). Lo ideológico en los términos en los desastres. *Revista Geográfica de América Central*, (2), 1-16.

Campos, D. L. (2018). Infraestructura e hidrología urbana en la Sierra de San Miguelito. *Universitarios Potosinos*, 15(232), 14-19.

Carranco, S., Ramos, A., Almanza, O., & Moran, J. (2016). Balance hidrológico superficial del valle de San Luis Potosí. En: Santacruz, G., & Ramos, A. (coord.). *Condiciones hidrogeoquímicas y explotación del sistema acuífero del Valle de San Luis Potosí.* (pp. 23-44). San Luis Potosí, México: El Colegio de San Luis.

Castillo, O. A., & De-Alba, F. (2017). Estrategias sociales de adaptación frente a las inundaciones en la metrópolis de México. *Ponto Urbe Revista do Núcleo de Antropología Urbana da USP*, 20, 1-23. DOI:10.4000/pontourbe.3471

Castrejón, A., & Azevedo, E. M. (2013). Urbanismo moderno en México: el Plan Regulador de San Luis Potosí en los años sesenta y la creación de lugares en los años setenta. *Dearq, Revista de Arquitectura*, 12, 76-92. DOI:10.18389/dearq12.2013.08

CEFIMSLP, Coordinación Estatal para el Fortalecimiento Institucional de los Municipios. (2012). *Monografías de los municipios de México. San Luis Potosí*. Recuperado de

http://www.cefimslp.gob.mx/monografias_municipales/2012/sanluispotosi/files/san%20luis%20potosi.12.pdf

Cirelli, C. (2004). *Agua desechada, agua aprovechada. Cultivando en las márgenes de la ciudad.* San Luis Potosí, México: El Colegio de San Luis A.C.

Cirelli, C. (2012). Urbanización y conflictos por los efluentes urbanos en San Luis Potosí. En: Vargas, S., Mollard, E., & Güitrión, A. (coord.). *Los conflictos por el agua en México: caracterización y prospectiva* (pp. 112-148). Jiutepec, México: Instituto Mexicano de Tecnología del Agua.

Conagua, Comisión Nacional del Agua. (2015). *Programa contra Contingencias Hidráulicas para la Zona Urbana de Tamazunchale, San Luis Potosí. Región Hidrológico-Administrativa IX, Golfo Norte*. Recuperado de https://www.gob.mx/cms/uploads/attachment/file/281337/ZONA_URBANA_TAMAZUNCHALE__SLP.pdf

Cruz, A. (2012). *Áreas suseptibles de inundación y vulnerablidad socio-económica asociada en la zona metropolitana de San Luis Potosí-Soledad de Graciano Sánchez* (tesis de licenciatura en Geografía). Universidad Autónoma de San Luis Potosí, San Luis Potosí, México.

Exprés. (2020). *Podrían urbanizarse 320 hectáreas de la Sierra de San Miguelito. San Luis Potosí, México*. Recuperado de https://elexpres.com/2015/nota.php?story_id=238385

Few, R. (2003). Flooding, vulnerability and coping strategies: Local responses to a global threat. *Progress in Development Studies*, 3(1), 43-58. DOI:10.1191/1464993403ps049ra

García, V. A. (2006). Estrategias adaptativas y amenazas climáticas. En: Urbina, J., & Martínez, J. (comp.). *Más allá del cambio climático: las dimensiones psicosociales del cambio ambiental global* (pp. 29-46). México, DF, México: Instituto Nacional de Ecología, Universidad Nacional Autónoma de México.

INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2020). *Panorama sociodemográfico de San Luis Potosí. Censo de Población y Vivienda 2020*. Recuperado de https://www.inegi.org.mx/app/biblioteca/ficha.html?upc=7028251 9797

INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2018). *Delimitación de las zonas metropolitanas de México 2015*. Recuperado de https://www.inegi.org.mx/contenido/productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/702825006792.pdf

INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2009). *Prontuario de información geográfica municipal de los Estados Unidos Mexicanos San Luis Potosí, San Luis Potosí Clave geoestadística 24028*. Recuperado de https://www.inegi.org.mx/contenidos/app/mexicocifras/datos_geograficos/24/24028.pdf

INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2002). *Estudio hidrológico del estado de San Luis Potosí*. Recuperado de http://internet.contenidos.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/historicos/2104/702825224097/702825224097.pdf

IPICYT, Instituto Potosino de Ciencia y Tecnología. (2018). *Integración de los elementos técnicos para actualizar el Estudio Técnico de Factibilidad para el establecimiento del Área Natural Protegida Reserva Estatal "Sierra de San Miguelito" San Luis Potosí*. Recuperado de https://www.slp.gob.mx/segam/Documentos%20compartidos/LEGISLACI%C3%93N/ETF%20ANP%20Sierra%20San%20Miguelito%20versi%C3%B3n%20final%202%20agosto2018.pdf

Lavell, A. (2003). *La gestión local del riesgo. Lecciones y precisiones en torno al concepto y la práctica*. Ciudad de Guatemala, Guatemala: Centro de Coordinación para la Prevención de los Desastres en

América Central y República Dominicana, y Programa de las Naciones Unidas para el Desarrollo.

Lavell, A. (1997). Comunidades urbanas, vulnerabilidad a desastres y opciones de prevención y mitigación: una propuesta de investigación acción para Centroamérica. En: Lavell, A. (comp.). *Viviendo en riesgo. Comunidades vulnerables y prevención de desastres en América* (pp. 39-57). Lima, Perú: La RED.

Llanes, C. (2003). Los desastres nunca serán naturales. *Boletín del Instituto de la Vivienda*, 47(18), 41-53.

López, L. M., Moreno, F. A., Alva, B. F., & Hernández, J. (2018). From asset to liability: The sustainability of waterscape transformations in the Santiago River. In: Filho, W., Noyola R., Medellín, P., & Vargas, V. (eds.). *Sustainable Development Research and Practice in Mexico and Selected Latin American Countries* (pp. 339-355). Cham, Switzerland: Springer.

Oliver-Smith, A. (1999). "What is a Disaster?": Anthropological Perspectives on a Persistent Question. In: Oliver-Smith, A., & Hoffman, S. (eds.). *The Angry Earth. Disaster in Anthropological Perspective* (pp. 19-34). New York, USA: Routledge.

Ortega, L., & Moran, J. D. (2019). Ciclos hidrometeorológicos y la vida comunitaria en el barrio de Mantezulel, Aquismón, San Luis Potosí.

En: Peña, F. (coord.) *Aguas turbulentas y prácticas locales y comunitarias en la Huasteca. Riesgos hídricos y organización social* (pp. 147-190). San Luis Potosí, México: El Colegio de San Luis A.C.

Palacio, G. (2011). La gestión integral del riesgo para la planificación urbana en San Luis Potosí, México. *Revista de Geografía de América Central*, 2, 1-9.

Peña, F. (2019). Ríos urbanos en ciudades pequeñas: prácticas locales y resultados territoriales de riesgo. En: Peña, F. (coord.) *Aguas turbulentas y prácticas locales y comunitarias en la Huasteca. Riesgos hídricos y organización social* (pp. 93-120). San Luis Potosí: El Colegio de San Luis A.C.

Poteete, A. R., Janssen, M. A., & Ostrom, E. (2012). *Trabajar juntos. Acción colectiva, bienes comunes y múltiples métodos en la práctica*. Recuperado de http://ru.iis.sociales.unam.mx/bitstream/IIS/4415/1/Trabajar%20juntos.%20Accion%20colectiva%20bienes%20comunes.pdf

Salas, M. A., & Jiménez, M. (2014). *Inundaciones (Fascículo).* México, DF, México: Centro Nacional de Prevención de Desastres (Cenapred).

Santacruz, G., & Eguía, J. M. (2016). La importancia socioambiental de la precipitación pluvial en la cuenca endorreica, semiárida y urbanizada de San Luis Potosí, México. En: Santacruz, G., & Ramos,

A. (coord.). *Condiciones hidrogeoquímicas y explotación del sistema acuífero del Valle de San Luis Potosí* (pp. 45-66). San Luis Potosí, México: El Colegio de San Luis.

Solis, B., Bocco, G., & Granados, J. (2019). Estrategias sociales y gestión del riesgo en la etno-región nahua de la sierra costa de Michoacán. *Investigaciones Geográficas*, (99). DOI:10.14350/rig.59835

Stevens, G. S. (2012). La vulnerabilidad hídrica en la ciudad de San Luis Potosí. Un análisis espacial. *Revista de El Colegio de San Luis*, (4), 130-159.

Talledos, E., & Medina, E. (2019). Prácticas locales y riesgos en el ejido La Trinidad, Xilitla, San Luis Potosí. En: Peña, F. (coord.) *Aguas turbulentas y prácticas locales y comunitarias en la Huasteca. Riesgos hídricos y organización social* (pp. 191-214). San Luis Potosí, México: El Colegio de San Luis A.C.

Toscana, A. (2014). Actores sociales en la gestión local del riesgo de desastre en Valle de Chalco Solidaridad, Estado de México. *Espacialidades*, 4(1), 137-169.

Twigg, J. (2015). *Disaster risk reduction*. London, UK: Humanitarian Policy Group Overseas Development Institute.

Valencio, N. F. L. da S. (2015). *The Brazilian context of humanistic discussion over the de-naturalization of disaster. Working Paper*, 2(17). Sao Paulo, Brasil: Waterlat-Gobacit.

Valencio, N. F. L. da S. (2014). Desastres: tecnicismo e sofrimento social. *Ciência & Saúde Coletiva*, 19(9), 3631-3644. DOI: 10.1590/1413-81232014199.06792014