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Gran Sasso Science Institute, Italy
Vassilis Tselios,
Panteion University, Greece

*CORRESPONDENCE

Kristen Conway-Gómez
kconwaygomez@cpp.edu

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Why local is not enough! Constrains for adaptive governance in peri-urban areas. A case study in Mexico City

Pablo Torres-Lima¹, Kristen Conway-Gómez^{2*} and
Karla Almanza-Rodríguez³

¹Department of Agricultural and Animal Production, Metropolitan Autonomous University, Mexico City, Mexico, ²Department of Geography and Anthropology, California State Polytechnic University, Pomona, CA, United States, ³Doctoral Program on Sciences and Arts for Design, Metropolitan Autonomous University, Mexico City, Mexico

The current state of conceptual approaches to study peri-urban areas focusses foremost on land use changes and informal human settlements because of cities' urban expansion. The uncertainty and insecurity related to the expansion of the metropolis increases the complexity of the harmonization of institutional systems and the integration of local actors and communities to respond to urban planning processes. We address the calls for an examination of local community involvement in governance processes in Milpa Alta (MA), a peri-urban agricultural area in Mexico City (CDMX), a megacity with strong peri-urbanization trends. Livelihoods and adaptive capacities approaches were applied for analysis of the results of surveys, interviews, and participatory workshops. We report that in MA there is no integral adaptive capacity to deal with the effects of urban pressures, regional environmental deterioration, and local agricultural dynamics. There are close linkages between limited participation, low local organizational levels, and the social commitment of the population dedicated to agriculture and the existing distrust of government institutions. Sustainable management of peri-urban areas requires the creation of collaborative networks from which local institutional norms can emerge. Furthermore, peri-urban areas require the establishment of participatory systems for decision-making, including the recovery of community and local councils, to activate processes supportive of achieving peri-urban adaptive governance. We conclude that "local is not enough," based on an adaptive governance approach, to understand the paradigms of decision-making processes and public and local interests in resource management for agriculture in this peri-urban case study.

KEYWORDS

adaptive governance, Mexico City (CDMX), peri-urban (PE), livelihoods, agriculture

Introduction

Global population growth is being led by second and third-tier cities in developing countries. While this presents new opportunities, it also brings governance challenges. Latin America and the Caribbean is the most urbanized region in the world, which is the result of 60 years of significant growth and an increase in the total population living in cities from 40 to 80% between 1950 and 2010 (Low Emisison Development Strategies Global Partnership, 2017). Although most of the international literature address metropolitan processes and their contemporary trends and impacts on agricultural regions at specific sites (Thapa et al., 2021), the evaluation of the social and economic interdependencies of peri-urban areas in the different dynamics of territorial development and metropolitan processes is also relevant for the formulation of urban policies and decision-making (Berdegué et al., 2015). Likewise, although the conceptual literature on peri-urban areas has grown significantly in the past two decades, more information on peri-urban territories is still needed to contribute to integrated planning in the urban-rural interface (Karg et al., 2019) and the articulation of public policies with and for local communities and specific contexts (Figueroa, 2019). Given the importance and complexity of urbanization processes in Latin America, the concept of governance—with its focus on state and a diverse range of other actors—is useful for understanding the management challenges of peri-urban areas (Bourceret et al., 2021).

Peri-urban areas are distinguished by being highly sensitive to the social, economic, and spatial changes related to the evolution of cities, particularly in a context of renewed rural-urban relations (Drescher et al., 2021). As part of the shift toward integrating complementary policies, programs, and actions for more sustainable peri-urban areas, new governance arrangements are being defined by local actors. Since peri-urban livelihoods may also reflect some of the sources of community vulnerability (including the fluctuating nature of human, natural, social, financial, and physical livelihood assets), it is essential to recover the knowledge of different actors at different scales (e.g., individual, household, local) for new governance arrangements to emerge. The notion of livelihoods can be used to define potential trajectories toward achieving more sustainable peri-urban development, especially when social equality, environmental conservation, and new governance arrangements between institutions and social networks take into consideration the ecological and socio-cultural values of local communities (Pretty, 2020).

Currently, the risks and impacts (e.g., loss of natural vegetation and urban floods) of urbanization processes in various peri-urban areas of Mexico City (CDMX) are unevenly distributed across the region, differing according to location, demographic pressures, poverty levels, and dependence on natural resources. There is also poor coordination and

collaboration between different levels of government in facing the impacts of urbanization on varying regional ecosystems (e.g., urban wetlands or forested areas), thus undermining the creation and strengthening of local capacity and participation (Sosa-Rodriguez, 2014). The environmental and productive challenges of Mexico City's peri-urban areas, particularly in the forestry and agricultural sectors, are a critical dimension of governance and more sustainable development in this megacity. These challenges are also related to the different urban dynamics of change occurring across the interstices and rural peripheries of this complex metropolitan area (Aguilar, 2008).

As a first step, we argue that adaptive governance in peri-urban areas reveals possible relationships between different actors, institutions and trajectories of change based on interests, strategies, and responses to urbanization processes. In examining governance arrangements in a rapidly urbanizing megacity with varying local dynamics, a question that becomes particularly significant is: "Can we scale up from the local level to apply the approach of adaptive governance in peri-urban areas?" However, critical approaches also call for local research that addresses diverse institutional frameworks, social norms and actors to better govern the commons in a more sustainable way. In this paper, we use the governance challenges of a peri-urban area in CDMX as a case study to illustrate and broaden the research agenda required to consider the use of the adaptive management approach in peri-urban contexts. The study zone selected is the borough of Milpa Alta (MA), a territory of high ecological value subject to strict conservation policies given its natural characteristics and location in a large conservation zone (CZ) in southern CMDX (Aguilar et al., 2022). Using the livelihoods approach (Beringer and Kaewsuk, 2018) and specific adaptive capacities (Eakin et al., 2014), the research data presented here comes from a survey applied in December 2015 and from interviews and participatory workshops carried out in July 2017. Our article analyzes a range of indicators of livelihood assets (e.g. human capital, etc.) at the community level; using these indicators we then defined and evaluated agricultural producers' risks and vulnerabilities in terms of their adaptive capacity for governance. We also analyze the governance processes, structures and social networks that affect access to livelihood assets. Finally, based on an adaptive governance approach, adaptive strategies are presented to understand the paradigms of decision-making processes and public and local interests in resource management for agriculture in this peri-urban case study.

Adaptive governance of peri-urban areas and the "local"

Peri-urban areas of growing cities in developing countries have been conceptualized as highly dynamic landscapes

characterized by a mix of socio-economic structures, land uses, and functions (Karg et al., 2019) which determine different dynamics of change (i.e., population density, agricultural production processes, and ecotourism services), as well as shaping landscapes and territories (McGranahan et al., 2005). In this sense, peri-urban areas are known for their territorial, socio-cultural, institutional, and political complexity, as well as their geographical and institutional possibilities for adaptive governance (Torres-Lima et al., 2019). Peri-urban areas, like other broad geographical areas that offer a diversity of possibilities for constructing the adaptive capacity of natural and urban systems, are influenced by the nature of adjacent urban and non-urban systems (McGregor-Fors, 2013). The governance of these areas implies various environmental and institutional scale-adaptation and responses to the external changes (i.e., urban or climate change) and endogenous changes (i.e., land use) which impact regional populations and local communities. Thus, the adaptive capacity of these systems to respond to different types of urban risks (e.g., loss of natural vegetation) can be understood as a function of the environmental, socioeconomic, and governance variables embedded in urbanization processes. Also, this adaptation occurring within a specific location is shaped by different ways of life, groups of households and socio-institutional local profiles over time (Torres-Lima et al., 2015).

In the literature on the adaptive governance approach, the rural-urban interface of peri-urban regions represents a key challenge for environmental and risk management (Torres-Lima et al., 2015). This is related to the fact that the settlements of peri-urban areas are not necessarily connected to expanding metropolitan areas, and that the future of these spaces as part of formal and regulated metropolitan urban development is often uncertain (Eakin et al., 2010). In terms of adaptation pathways, urban authorities contribute to the production and mitigation of risk through their management choices that tend to focus on addressing external threats (e.g., climate change) and expanding physical infrastructure systems. However, the consideration of endogenous risk management and adaptation choices (e.g., conservation of local ecosystem services) are also required to identify sources of local vulnerability that may prove more adaptive (Tellman et al., 2018). Conflictual peri-urban issues, such as urban land use vs. rural land use, or deforestation and agricultural production vs. natural resource conservation, can be directed toward adaptive capacity building. Identifying current and potential risks at different scales and levels of intervention represents one possibility for adaptive capacity building. Another possibility is examining the type of adaptive capacity strengthening that integrates strategies to meet the needs of all sectors of the local population in the context of regional development processes (Torres-Lima et al., 2015).

Currently in contemporary peri-urban areas, diverse challenges of local governance rely on the management of environment and natural resources, and the coordination of

decisions and actions with common objectives by organized groups with collaboration between individuals and institutions (Rodríguez-Robayo et al., 2019). In particular, the adaptive governance approach refers to co-management experiences where the local community is coordinated and organized with larger-scale governance so that a desirable socioecological state can be achieved through either adaptation or transformation (Brunner et al., 2005). That is, since adaptive governance aims for the inclusion of a diversity of social actors and more participatory forms of decision-making (governance from the bottom up), collective learning, and the management of urban systems, this approach is more suitable for studying peri-urban areas. Thus, peri-urban adaptive governance remains an emerging policy domain across spatial scales that attempts to consider the complexity of physical-territorial, ecological, social, cultural, and institutional factors in peri-urban areas.

Larger urban centers often continue to be favored over small municipalities, rural regions, and peri-urban areas in terms of economic growth that foster high value-added activities and innovation. However, despite the impressive economic growth and prosperity of Latino American cities, such as Mexico City (Kim and Zangerling, 2016), extensively documented limitations of the rapid and uncoordinated growth of urban footprints, characterized as distant, dispersed, and disconnected, include: the lack of accountability downwards from regional and local governments to community and indigenous organizations; the lack of power and responsibility upwards in relation to state agencies and institutional drivers of regional development; the ongoing mismatch between ecological management of resources and local political boundaries; and the lack of administrative, scientific, and fiscal capacity at the local scale (Rondinelli et al., 1989). In addition, other limitations to consider include the fact that local governments and decision-makers may not have legitimacy with certain groups and interests (Agrawal, 2001). Therefore, adaptive governance is expected to include the ability to connect formal structures with socially constructed rules and processes within and between users and agencies in order to respond to different legal and historic contexts at multiple scales—in other words, a polycentric system of overlapping spheres that comprise a local governance system (Anderson and Ostrom, 2008). Sometimes, adaptive governance is described as a multi-tiered governance process that combines bottom-up participatory approaches with state structures, institutions, and political processes that facilitate collective decision-making (Brockhaus and Kambire, 2009). The literature on adaptive management also focuses on social learning and network governance to “scale up” community-based local government schemes (Berkes, 2010).

In this context, the approach of adaptive governance implies the political dynamics of the decisions and the interactions of social, civic, and formal institutions and negotiation of collective action to achieve common goals (Wyborn and Bixler, 2013). However, a focus on the “local” neglects the multilevel

nature of the institutional linkages needed for effective adaptive governance (Anderson and Ostrom, 2008). At the same time, it is important to avoid naïve assumptions about local capacity, such as: (1) that local governments always represent community organizations or interests and that communities are egalitarian and united rather than hierarchical and internally-divided (Agrawal and Gibson, 1999); (2) that the issues of scale are vertical from local to national and not horizontal and between sectors and actors that operate in a peri-urban local network; and (3) that issues of social and spatial exclusion and inclusion can only be addressed by understanding both local institutions and the broader context of interactions between user groups, private parties, and local governments (Ribot et al., 2005).

Case study and methods

The peri-urban territory of Milpa Alta, Mexico City

Mexico City has a total area of 148,645 hectares, divided between 60,203 hectares of “urban land” and 88,442 hectares of “conservation land” (also known as the conservation zone). Milpa Alta (MA) constitutes 17.9% (228 km²) of the total area of CDMX (1,486 km²) but only 1.4% of the city’s total population (8,918,653 inhabitants) (INEGI, 2017; Figure 1). The city’s conservation zone (CZ) represents 59% of the city’s total territory and represents a significant ecological area that enables: the capture and infiltration of rainwater to recharge aquifers, climate regulation, improved air quality, habitat biodiversity, and the production of food and raw materials. MA includes 32% (27,995 ha) of the total conservation zone (Secretaría del Medio Ambiente, 2006). MA has an average altitude of 2,420 meters above sea level; a sub-humid semi-cold climate with rains in the summer. MA has an annual average temperature of 14.4°C, and an annual average rainfall of 878.9 mm (Rodríguez and López, 2006).

The borough of MA has an irregular pattern of peri-urbanization, with dispersed and discontinuous rural towns and an incipient road network. Instead of only responding to drivers such as the relative increase in the economic value of land for amenity over agricultural use, and the availability of publicly- and privately-provided infrastructure (Darbas et al., 2010), MA is mainly shaped by rural landscapes and agricultural production activities, including the exchange of goods, activities or flows, and interaction between the borough of MA and the city. The case of the CZ in CDMX, in which MA is situated, is a clear example of a fragmented peri-urban expansion process in an area with high ecological value (Aguilar et al., 2022).

Regional interconnections, interscalar relationships, and dynamics of change represent significant studied aspects of adaptive governance in peri-urban areas (Quiroz-Ibarra et al., 2020). Relatedly, MA represents a suitable site to investigate

the local conditions in which these asymmetrical and diffuse urbanization forces occur in the peri-urban periphery of Mexico City. Milpa Alta is one of the 16 boroughs (alcaldías) that comprise CDMX (see Figure 1); each has its own elected mayor, local budget, and different departments in charge of administering local development. However, city government authorities (CDMX) set both the agenda and parameters for many key policy and strategic activity areas affecting boroughs in the CZ, such as MA, including those concerning the management of agricultural activities and the conservation of land and water resources. Despite being in the CZ, MA’s urban land use increased from 1,527 ha in 1994 (5.4% of the territory) to 2,845 ha in 2010 (10.0% of the territory); with the remaining land uses comprised of agricultural activities (41%) and forested areas (49%) (Bonilla, 2014). In 2016, three relevant crops were reported as being cultivated in MA: nopal (*Opuntia* spp.), grain corn (*Zea mays* L.) and forage oats (*Avena sativa* L.). With respect to property tenure¹ in MA, there are 26,913 ha of communal lands, 1,082 ha of ejido lands and 469 ha of private property. The entire forested area of MA is under the communal property regime (Bonilla, 2014). Of MA’s total population of 130,582, there are 25,951 peasants directly linked to agricultural and forestry production (INEGI, 2017).

Methods

The design of this research takes up two conceptual approaches that may be applied for analyzing adaptive governance in peri-urban areas: the livelihoods approach (Beringer and Kaewsuk, 2018) and specific adaptive capacities approach (Eakin et al., 2014), while also using participatory methods. This research strategy is useful as it takes a holistic view of livelihoods, incorporates governance processes, allows for the inclusion of different social groups, and enables local households to define their important livelihood assets, thus ensuring that our methodology is not dominated by a top-down approach (Ward et al., 2018). Our research data is derived from a survey applied in December 2015 and from two participatory workshops and seven interviews carried out in July 2017. Our survey focused on identifying and evaluating various indicators of livelihood assets (e.g., social, natural, financial, and physical capital) by applying 245 surveys to heads of households in 2015 in four

1 Rodríguez et al. (2015, p. 324) state that “three types of land property exist in Mexico: private, public, and social. The latter is a consequence of the Mexican Revolution that led to the restitution of land grabbed from rural communities by landlords (“communal land” as designated within the Constitution of 1917) and the endowment of land as a common property to Mexican peasants (“ejidal land”). In the country 53% of land property is of the social type. In Mexico City, 33,938 hectares under social property remains, mostly within the conservation zone ... and most conservation areas correspond to social property”.



towns: Villa Milpa Alta (105); Santa Ana Tlacotenco (70); San Antonio Tecomtl (35); and San Lorenzo Tlacoyucan (35).

Once adaptive governance at the level of a peri-urban area was the approach to be studied, we also included a mosaic of diverse MA towns based on their mix of urban and rural characteristics, thus three types of sites were chosen for our study: (1) high degree of urbanization with little presence of agricultural activities (San Antonio Tecómtil); (2) high degree of urbanization with a high presence of agricultural activities (Villa Milpa Alta); and (3) low degree of urbanization with a high presence of agricultural activities (Santa Ana Tlacotenco and San Lorenzo Tlacoyucan). Regarding land tenure, the majority of those surveyed in all of the communities have private or family property. Those surveyed in Villa Milpa Alta, and San Lorenzo are dedicated almost exclusively to the cultivation of nopal (*Opuntia* spp.) which is predominantly a market-oriented crop, in contrast to those surveyed in Santa Ana and San Antonio, where traditional crops such as corn, broad beans, beans, and some vegetables are still present. It is estimated that 69.2% of nopal producers in MA carry out production in a traditional way (Rodríguez et al., 2021). The survey sample size was determined according to the number of economically active producers in each community, with a confidence level of 90% and a margin of error of 5%. For the surveys, in terms of the selection of informants, we mainly looked for peasants who had extensive

historical knowledge of their community and who preferably were originally from the community. We used the “snowball” technique, which implies that the members of a community have a social network (Parker et al., 2019).

The study of adaptive capacity for governance requires the identification of risks and vulnerabilities in terms of livelihood assets at the household/community level (Quiroz-Ibarra et al., 2020). To analyze the results of the survey, we focused on organizing and then evaluating the indicators of livelihood assets (Steward and Crowley, 2005). To operationalize our evaluation of specific risks and vulnerabilities, we identified the most relevant attributes from the assets survey of livelihoods (e.g., sociodemographic data; social networks and financing; regional infrastructure; and conditions for regional development), translated them into an appropriate set of indicators at different scales. Indices were then constructed for each indicator (representing a percentage of the analyzed situation vis-à-vis an optimal reference value, where “1” represents the optimal contribution to adaptive governance and “0” represents no discernable contribution). To graph livelihood assets, we used an multicriteria AMOEBA type diagram (Quiroz-Ibarra et al., 2020). By integrating indicators using AMOEBA graphs, this analytical tool is useful for highlighting the multidimensional character of livelihood assets at a particular point of time (Astier et al., 2012).

In turn, our assessment of governance processes, structures, and social networks (e.g., state actors, non-governmental organizations, local communities) that affect access to livelihood assets was completed through two participatory workshops conducted in 2017 which included 73 informants, and seven structured interviews with key actors (e.g., local decision-makers and representatives from ejidal and communal entities and governmental agencies). Interviews have been reported as a valid instrument to identify which factors affect adaptive strategies for governance in peri-urban areas (Quiroz-Ibarra et al., 2020). By identifying institutions and their networks within the local community, we aimed to trace the influence of internal and external actors in decision-making processes and the relationships between different organizations. We then conducted a social network analysis using the Gephi 0.9.2 tool (Bastián et al., 2009) to identify the type of connections that social actors establish with each other in governance networks (Prell et al., 2009). This kind of social network analysis related to natural resource management issues in peri-urban landscapes is particularly useful when community groups contribute to landscape-scale change through their own local socio-environmental knowledge and actions (Beilin et al., 2013).

Results and discussion

Livelihood assets and capitals

With respect to human capital, we include the knowledge and skills mastered by farmers, as well as their physical health status and potential ability (Yang et al., 2021), and we use the education level of the head of the household and the profile of their labor force to measure human capital. We found that 14 and 7% of those surveyed in Villa Milpa Alta and Santa Ana have completed university studies, compared to only 3% in San Lorenzo and none in San Antonio. Since there is a tight interrelation between MA and CDMX that facilitates participation in the employment market, which represents an important support to compensate for low agricultural incomes, our survey reveals evidence of employment diversification in three of the four towns. For example, 44% of those surveyed in Villa Milpa Alta are engaged in agriculture and other non-rural types of employment (e.g., construction work and informal commerce). In terms of the technical qualifications of those surveyed, we found that their agro-environmental training is very limited, with less than a third of those surveyed in the four communities showing some familiarity with agricultural strategies that deal with the effects of climate change on crops. Apart from Santa Ana, those surveyed perceive diverse local impediments to maintain healthy household conditions, food security, and agronomic practices to reduce climate vulnerability. This may be associated with the complex mosaic

of interactions between former residents, migrants, and non-residents within a wide diversity of urban-rural livelihoods that imply different social, cultural, and ideological references (Gómez et al., 2021).

Another key livelihood indicator/asset is social capital, which refers to the social network of farmers and is a pivotal element for peri-urban changes, and which may be explained by their articulation with norms and networks that facilitate collective action for mutual benefits in varying degrees and forms of interaction among urban processes and these local societies that together shape the extent to which developmental (and related socio-political and environmental) outcomes are attained (Torres-Lima and Rodríguez, 2008). In our case study, most respondents are originally from MA and report that 77% of their family members participate in agricultural activities, although in Villa Milpa Alta this figure is only 42%. Community cohesion, an important element of social capital in the livelihoods approach (Beringer and Kaewsuk, 2018), appears to be one of the weaknesses of the borough, as fewer than 30% of those surveyed declared that they had received help from their community, participated in some form of community-based decision-making, or belonged to a traditional local organization. In addition, few respondents indicated that they would consider joining a community organization, even during a local crisis. These issues, while reflecting a political problem of historic inequality, in terms of social and labor organization of MA agricultural production systems, such as nopal or corn crops, may include socio-cultural values among the population surveyed based on a certain place (Houston, 2008). Most respondents also perceive a deterioration of social cohesion (defined as belonging to a local or community organization) in our case study communities over the last 10 years, dating back to 2005.

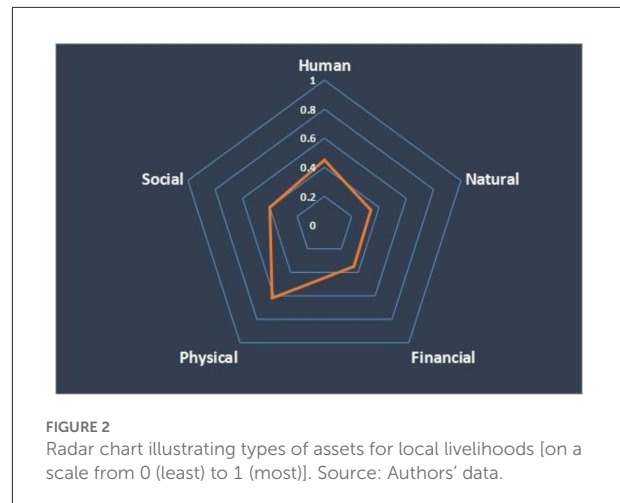
On the other hand, other forms of local social capital in MA have been referenced such as norms of reciprocity and networks of civic commitment (Torres-Lima and Rodríguez, 2008), which are linked to traditional practices for sociocultural community development. These community practice imply certain degrees of organization, participation, and social-communal mobilization (e.g., religious festivals, ejidal or communal assemblies, collective tasks, protection of forest resources, collective management of market spaces). However, most of the local social practices are controlled by certain powerful groups (e.g., community leaders, neighborhood leaders, political parties, and local governments) and are not incorporated into local planning processes and regional development policies, thus undermining the building of local social capital. In this sense, there is an existing yet limited collective capacity of local communities for long-term regional governance, based on land tenure as social property (ejido and communal assets) and on the social and economic structures of integration and association between community members, *ejidatarios*, and farmers. However, social capital is still a

driving force within the context of the promotion of adaptive governance for local sustainable development and social harmony considering the dilemmas and socio-environmental pressures of urbanization.

Financial capital, which refers to the cash that farmers can independently manage and raise from sources that mainly includes their own income, loans, and free assistance, is considered another important livelihood asset since it is expected that financial capital will increase producers' investment in agriculture, for instance by adopting advanced agricultural technology or by purchasing more agricultural inputs and machinery (Yang et al., 2021). Close to half of the respondents reported having received some government financial support in the previous year, among which short-term strategies for facing climate change stand out, mainly to confront the effects caused by frost and hailstorms. Also, our survey revealed that producers obtained from the state free organic fertilizer to support crop production, technical assistance to help with agricultural land conservation practices and with value-added to agricultural products, and the marketing of nopal crops. However, only 9% of respondents reported having received any financial resources from the state for the care and preservation of the environment. These data suggest that the government does not take into account the livelihood financial capital endowment to encourage farmers to use their financial capital advantages and social network to broaden income channels according to the pressures of local non-agricultural population and urban forces.

For natural capital and environmental conditions, which refer to the natural resources and services that people rely on for survival and development in MA, 45% of those surveyed perceive the existence of high to medium levels of biological diversity in the area (i.e., number and frequency of biological species), and 84% of respondents consider that the climatic conditions for agricultural production and natural landscape were better 10 years ago, particularly with less frequent heat-waves, frost, and hailstorms. Ninety percent of those surveyed have noticed changes in the climate and 80% state that these changes, such as more episodes of intense heat and rain, have caused crop performance and yield variations in their agricultural production. The vast majority also believe that heat, rainfall, ecosystem health, and water and air pollution will worsen within 10 years due to the impacts of increasing urbanization in MA. Respondents identify deforestation, pollution, and the abandonment of agriculture as the main causes of climate change.

For physical capital, which refers to the facilities and equipment used by farmers for production and living, 59% of our survey respondents reported preparing the soil with machinery (e.g., using a tractor) and 39% used herbicides and fertilizers. In each of our case study communities, respondents reported having access to some physical capital. The lack of access to a nearby market to sell their produce and to



public schools and health centers was also reported as a challenge. Generally, respondents in the four villages have access to municipal infrastructure and basic services for private housing (e.g., water and electricity), and for agricultural production, such as roads to transport agricultural machinery and market produce.

In general, our survey documents that respondents in our case study communities have a reasonable level of social wellbeing, as reflected by the indicators of human, social, financial, natural, and physical capital outlined above. As mentioned earlier, these livelihood assets potentially can be directed toward the construction of peri-urban socio-environmental governance strategies, especially in terms of strengthening the adaptive capacity of local communities to address challenges such as climate change. Improving services, village infrastructure, as well as building community cohesion and trust are all important for improving the wellbeing and resilience of the community and its capacity for environmental management (McCrea et al., 2019). However, as presented in Figure 2, the five main livelihood assets (for the four communities), show a “low profile” that constrain the integral achievement of improved livelihood outcomes, particularly the livelihood diversification that refers to a continuous adaptive process whereby households add new activities, maintain existing ones, or drop others (Mittra and Akanda, 2019). More specifically, Figure 2 shows the following values: 0.45 (human capital); 0.34 (natural capital); 0.40 (social capital); 0.62 (physical capital); and 0.35 (financial capital), with respect the ideal value of 1.0, in accordance with existing research on the sustainable livelihoods framework (Gómez et al., 2007).

We also conducted participatory workshops to build on the results of our survey research. In these workshops, local producers identified five main regional problems or constraints, all of which are associated with improving livelihood assets (e.g., Beringer and Kaewsuk, 2018). First, in terms of human

capital, participants reported a lack of training and agricultural extension support, and a division of urban vs. rural livelihoods, for instance migration or moving out of farming which results in off-farm and non-farm sources of income activities. In terms of natural assets, participants identified unregulated logging, new pests and crop diseases, and climate change as having significant impacts on local agriculture and natural resources. Thirdly, in terms of social capital, a lack of socio-political local leadership and the loss of social cohesion at the community level were also mentioned. Regarding physical assets, participants identified only a lack of water infrastructure for domestic use as a major problem. Finally, in terms of financial assets, participants mentioned several issues, including: the lack of proximal markets for selling agricultural produce or buying agricultural supplies; the lack of government support or institutional strengthening to promote sustainable agriculture; the lack of access to resources and economic support for agriculture; and the market risks and wide variability in the selling of agricultural products.

In our workshops, we found a diversity of perspectives among respondent farmers, reflected in the fact that they accord different priorities to their livelihood assets, for instance the importance or impact of non-agricultural activities on the welfare of local households. There are also different levels of participation among respondents in local governance. The general understanding of governance amongst producers, including how multilevel decisions are taken by local representatives (e.g., local ejidal commissioners) varies considerably among the local population in our research. However, it is mentioned for urban agricultural stakeholders, such as MA, that the understanding of local governance is based on agricultural values as the main source of livelihood of the farmers. It was stated that those who hold the power, authority, and responsibilities for local development, can support the formulation of legitimate and effective policies attentive to the processes of community construction, environmental sustainability, and food sovereignty (Piso et al., 2019).

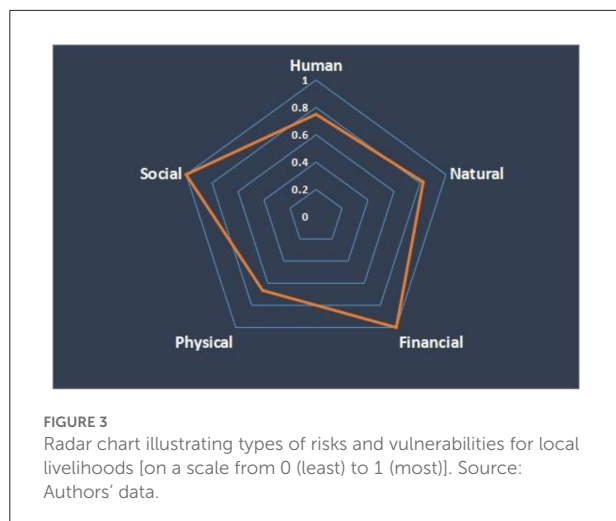
Classification of vulnerabilities

As outlined previously, MA is classified as a peri-urban area because of its features, that include: a low population density; small agricultural landholdings; a lack of state enforcement of land use regulations and policies; a scattered settlement pattern; the ongoing conversion of agricultural areas to residential land development; environmental degradation; a lack of basic services; and, a diverse range of off-farm livelihoods in addition to agricultural production (Beringer and Kaewsuk, 2018). Given these conditions, MA residents face new challenges and also opportunities in meeting their life needs and accommodating the by-products of urbanization, for instance although urbanization in these rural-urban fringe

areas provides opportunities for employment, better housing, education, knowledge and technology transfer, and ready markets for agricultural products, the increase in population places enormous stress on natural resources, existing social services, and infrastructure (Maina, 2013). In our research, we detected a large number of rural household vulnerabilities in our survey/communities in MA in terms of financial capital. These vulnerabilities correspond to a number of factors, including: the lack of a nearby market for selling agricultural produce; difficulty in accessing government support; and, a decrease in profits from the regional oversupply of nopal production. Associated with these financial vulnerabilities are additional factors that accentuate social precarity, such as: the decrease in social-communal mobilization; disinterest in political issues; loss of identity; fewer opportunities to access support programs; abandonment of agriculture; loss of market shares for agricultural products to extra-regional competition; and, increased poverty. Many of these factors are related to the important link between local communities in MA and both their income and employment dependence on urban-related activities and urban areas/markets for selling their produce (mainly nopal as a commercial crop), to improve their welfare in terms of health care, housing, and sustenance. However, it may be inferred that many of these vulnerabilities—which undermine livelihood security—could be mitigated by more participatory forms of governance that potentially redefine the aims of local rural-urban system development.

Additionally, the replacement of agricultural areas by urban housing and commercial poses another risk related to the local understanding that combining urban and rural households will maintain the perception among producers that agricultural activities imply broad constraints and vulnerabilities, such as the financial uncertainty in ensuring their wellbeing. As documented in our survey results, our research participants do not perceive their access to urban infrastructure as a major limitation or a source of vulnerability in threatening their livelihoods and their existence. Figure 3 shows the types of vulnerabilities for local livelihoods [on a scale from 0 (least) to 1 (most)], with the financial and social assets presenting the highest degree of concern (1.0), followed by natural (0.82) and human (0.75) while physical (0.66) shows a lesser degree of involvement. However, it is important to note that the classification of MA vulnerabilities derived from our survey, completed at a single point in time, may mask important aspects of the dynamism of local livelihood strategies and the consequent transformations of peri-urban areas over time. This is particularly relevant when addressing governance issues since multiple local network processes are intertwined with dimensions of governance.

From an institutional perspective, when interviewing key government actors, they agree with respondent producers that urban infrastructure related to agriculture, physical assets such as roads, communication and storage, does not represent a



significant problem, since producers have the financial means to access inputs, services, equipment, and machinery that facilitate agricultural work, despite their high costs. However, other financial risks and vulnerabilities identified by government actors with respect to local livelihoods in MA include the following: lack of savings culture; low support for agricultural production because benefits do not go to those who work the land; variability of market prices; and limited income derived from agricultural production. These findings show that in MA the community-based and market-based modes of governance, as informal or non-state institutions, are scarcely represented and, therefore local livelihoods may have limited influence on the interactions between actors and peri-urban area development.

A number of other vulnerabilities were also reported by respondents, such as: the scant training and technical assistance that farmers receive, not only from federal and state governments but also from regional or local organizations; low levels of education among producers; lack of commitment of local communities to promote regional agricultural development; degradation of soils due to the use of pesticides; uncontrolled release of sewage; reduction of agricultural land due to urban expansion; and increasing frequency of droughts, frosts, and hailstorms because of climate change. These constraints may be crucial for the potential outcomes of local dimensions of governance, such as adaptive governance that should reflect the lack of actors' decision making, in particular the integration of possible learning processes in governance. The integration of learning in governance is especially important in the context of increasing uncertainty due to urbanization as an adaptive response to the peri-urban system. The adaptive capacity framework for resource governance asserts that livelihood vulnerabilities must be considered part of a multilevel learning process involving both design and self-organization of modes of governance,

interaction between formal and informal institutions, and new governance arrangements that better connect state agencies, markets, and local networks (Pahl-Wostl and Patterson, 2021), which may be applied in peri-urban areas. However, one of the greatest weaknesses of regional farming in MA is related to the lack of local organization and social cohesion. Additionally, the few organizations that do exist have partisan political tendencies and, in general, a distrust of political leaders persists. Thus, the limited organization between producers and local networks in MA restricts access to the diversity of regional markets of the CDMX. Above all, increasing urban expansion and the abandonment of agriculture represent the most significant risks for peasants and local communities in this peri-urban area. Given this, their participation in peri-urban governance is essential.

Governance assessment

Since we are interested in showing how the dimensions of governance in MA are influenced by interactions between institutions (formal and informal) and local actors in peri-urban areas and are in turn influenced by trajectories of change based on interests, strategies, and responses to urbanization processes, the evaluation of specific adaptive capacities (Eakin et al., 2014) of local governance in MA is helpful to analyze livelihood changes. Populations in peri-urban areas are not necessarily connected to concentrically expanding metropolitan zones, and the future of these spaces as part of metropolitan urban development is often uncertain (Eakin et al., 2010), therefore it is relevant to distinguish what are the possibilities to enhance the roots of adaptive capacities based on the local livelihoods' interdependency.

According to results from our survey, despite the values and rules of MA community organization that are based on the communal land and culture, there are several critical issues concerning limited local specific capacities. For instance, 82% of the respondents do not actively participate in community organizations and 81% do not receive any type of support from the communal assets representative. The lack of supporting community structures through a balance in the power relationships between the various local actors also means that 77% of respondents do not perceive the presence of community actions that strengthen the well being of the population and agricultural activities and, 85% identify that there are no specific rules to participate in decision-making that affect local communities. The latter becomes relevant since there is a need to define and improve community mechanisms enhancing robustness and local adaptation capacity facing urbanization, since 58% report that environmental quality and regional wellbeing will be worse within the next 10 years. In this sense, it is perceived as a weak social network configuration, including leadership and political and power

relations, and associated organizational arrangements, since 85% of respondents report the absence of social norms and community strategies to face political-environmental crises (e.g., impacts of unplanned urbanization processes in their territory). Finally, in terms of the current dysfunctional local networks and institutional arrangements, 49% of farmers identify that both the community and the regional governance system were better 10 years ago when political parties did not offer a diversity of political offerings.

An obvious example of the above mentioned limited participation of stakeholders in building an adaptive governance is the paucity of local and community organizations that provide services or support for improving for the management of agriculture and forest systems as a crucial economic activity. These response mechanisms might include, for example, crop technical assistance, the provision and sale of farming technology, agricultural financing, and control of market price variations as an ensemble of strategies to increase or strengthen community capacities to address the challenges of urban growth and economic development in a peri-urban area. Encompassing both farming and governance attributes through specific local and communal organizations are much-needed for an adaptive transformation of the crop production systems in terms of enhancing the capacity to create new stable domains for peri-urban development based on improved livelihood asset thresholds.

Regarding building livelihood assets and mitigating risks and vulnerabilities, it is our contention that what is particularly lacking is a peri-urban governance system in MA working in conjunction with state actors (e.g., federal and CDMX) in order to strengthen local participation in multi-scale decision making and planning in this peri-urban area (Torres-Lima et al., 2010). In the absence of an integrated policy and governance framework created with the participation of communities, *ejidatarios*, and producers, it will be challenging to increase and achieve adaptive capacities for new governance institutional arrangements. Such a framework needs to also address ongoing urbanization pressures and adopt an integrated approach to governing the conservation of natural resources, agricultural activities, and informal settlements in the southern periphery of CDMX. In this mega-city, peri-urban areas are important because they are crucial parts of the controversy around economic development and the environment, which must go beyond the empirical and local evidence to broaden understanding about the extraction of natural resources or deforestation of peri-urban areas, and the level of urbanization. With a focus on peri-urban governance, the above considerations deserve particular attention and distinctive policy approaches given that the territorial impact of national policies in Mexico vary across regions and environmental systems and is mediated by the characteristics of the population (Biles and Pigozzi, 2000), particularly since it is reported that peri-urban areas have enormous potential to play

a positive role in enhancing urban sustainability at the global level (Wandl and Magoni, 2017).

In this study, investigating local social networks was a task that appears to be challenging for adaptive governance in MA. The survey results show a very low density [of social networks] on average (0.19) (see Table 1), which implies low [social] cohesion among the group of respondents. It might be expected that for a relatively small network, the cohesion between stakeholders would be high, but this is not the case. This, in part, is explained by the fact that 76% of government actors and institutions do not belong to the local sphere of the case study communities, and therefore, greater geographic distance to some extent complicates social cohesion (Bodin and Crona, 2009).

According to the survey, the respondents attributed great importance to the Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (SAGARPA), since it is the main institution that offers agricultural support for the development of local agriculture (see Table 1). Thus, based on a social network analysis to identify the type of connections that social actors establish with each other, by using the Gephi 0.9.2 tool (Bastián et al., 2009), SAGARPA has the highest scores of 1.0 (connections, how many of them a particular node possesses) and 25 (betweenness centrality, measures how important it is to the flow and how quickly the node accesses information from the network), which indicates that this institution is a key node with the most control in the MA social network because more information passes through it. As social network analysis focuses on both positive and negative relationships between sets of individuals, a social network with low cohesion has a high possibility of not circulating information due to the lack of connectivity among actors, groups, organizations, and institutions. Clearly, this has implications for finding solutions to emerging socio-environmental planning problems (Dempwolf and Lyles, 2012), such as urban growth.

Even though the existence of a high diversity of actors in MA suggests the potential for collective action and the transmission of knowledge within local social networks (Beilin et al., 2013), it is suggested that innovation and action also require collaborative networks and strong trust levels (Bodin and Crona, 2009). In the case of the MA peri-urban area, the local social network could be better promoted by governmental actors acting as intermediaries in bringing nodes, and therefore individuals and local communities, to cooperative relationships for strengthening the governance of the farming systems (i.e., SAGARPA). However, regarding community organization, there are few state actors and institutions that intervene in a cohesive way in the dynamics of peri-urban agriculture in MA or that facilitate learning processes through collaborative networks between communities and individuals. In part, this is explained by the fact that most government actors and institutions are not active at the local level. Also, the low diversity of local actors combined with socio-spatial remoteness

TABLE 1 Mapping of institutions and actors by social network analysis indicating connections and their strength in MA (Source: Authors' data).

Institution	Importance	Value	Connection with junctions	Betweenness centrality
CORENA	0.02	0.34	0.82	13
UNTA	0.00	0.12	0.28	4
SEDEREC	0.09	0.39	0.94	19
SEMARNAT- CONAFOR	0.00	0.29	0.71	12
Nopal producers of morelos	0.00	0.11	0.27	4
Foreign loggers	0.00	0.05	0.12	2
Regional leaders	0.00	0.16	0.38	6
SAGARPA	0.31	0.41	1.00	25
Local church	0.00	0.10	0.24	4
Mayor of Milpa Alta	0.30	0.34	0.83	19
Health center	0.00	0.05	0.12	2
Communal assets representative	0.13	0.35	0.86	18
Local organizations	0.00	0.21	0.50	8
Community members	0.04	0.32	0.79	13
State plant health committee	0.00	0.06	0.15	2
Political parties	0.00	0.11	0.27	3
INIFAP	0.00	0.00	0.00	1
INCA rural	0.00	0.06	0.15	2
CDMX	0.00	0.12	0.28	4
Ejidal commissioner	0.00	0.00	0.00	1
Peoples council	0.00	0.05	0.12	1

CORENA, Natural Resources Commission; UNTA, National Union of Agricultural Workers; SEMARNAT, Ministry of Environment and Natural Resources; CONAFOR, National Forestry Commission; INIFAP, National Institute of Forestry, Agricultural and Livestock Research; INCA, National Institute for the Development of Capacities of the Rural Sector.

Connections with junctions represent the connections between actors; the higher the score the more connections noted. Betweenness centrality represents the degree to which nodes stand between each other; the higher the score the more control over the network, because more information passes through the entity.

and geographic distance are conditions that likely constrain collective action, the establishment of relationships between actors, and the transmission of knowledge in MA (Beilin et al., 2013; Mardones, 2017). The transmission and exchange of traditional, scientific, technical information, and knowledge between local organizations, government institutions, and neighborhood groups, is desirable for its potential to build mutual trust, foster social networks, and improve peri-urban governance based on agriculture.

As our research suggests, however, the social network in MA is not very cohesive, thus hindering the potential for learning processes and collaborative networks that are key to enhancing adaptive capacities for governance. There is an option that the network fragmentation in MA (modularity) may be practical and efficient for the exchange of knowledge and collaboration among multiple actors. However, this is not a guaranteed outcome, since a social network may be fragmented and remain weak in terms of information exchange and governance (Calvet-Mir et al., 2015). This means that the social network vulnerability may be due to a low density of nodes that depends on a few actors and institutions that tend to concentrate social ties, such as SAGARPA (the federal

government agency in charge of agricultural support in MA), which is the state institution with the largest number of connections in this social network in MA. Therefore, for a collaborative network to be viable and effective, a wide diversity of relationships among different actors, including trust and regulatory systems based on sharing similar interest and goals, may be necessary to perform the reliable social enhancements of adaptive governance. In sum, since the structure of the social network in MA depends on relations, interactions, or links among the network's entities, social processes directed toward adaptive governance in this peri-urban area should be directed to solve a lack of: local organization, interaction between local organizations and state actors, and social cohesion. We contend that, in simple terms, the local network in MA is not enough! This is especially relevant in a peri-urban area such as MA, where it is so necessary to promote adaptive capacities that counteract the adverse effects of accelerated and unregulated urbanization that in turn may exacerbate livelihood vulnerabilities.

The issue of connectivity in social networks also highlights the importance of including the most vulnerable (i.e., residents in informal settlements) in adapting to socio-environmental

changes in the region. The inclusion of these groups can be promoted in local communities and through collective action. For example, the strengthening of rural organizations, collective community capacities, and socio-environmental awareness is vital to generating appropriate actions and development agreements, leading to new governance arrangements for peri-urban areas in Mexico City. Clearly, the governance of peri-urban areas requires greater integration of state and non-state actors as well as greater institutional flexibility to achieve more sustainable peri-urban agricultural production and more secure livelihoods.

Adaptive strategies for governance

In accordance with the framework of adaptive governance, local communities represent the guiding axis for new governance arrangements and adaptive strategies need to integrate the perspectives of both communities and institutions (Pahl-Wostl and Patterson, 2021). Despite this, complex adaptive systems pose substantial challenges, such as non-linear feedbacks, strategic interactions, individual and spatial heterogeneity, and variable timescales (Levin et al., 2013). In our fieldwork, our research uncovered the lack of community strategies that may be referred to as adaptive governance in the medium term (i.e., adjustment), such as participatory, deliberative, and anticipatory planning processes; and over the long-term (i.e., transformation) related to the implementation of mechanisms and actions that are directed at fundamental changes for the functionality of the peri-urban area and the transformation of behavior through social learning, awareness, self-organization, and legal instruments [dealing with] facing urbanization processes. For instance, producers report from interviews several issues related to government support, mainly by SAGARPA: the readjustment of the institutional operating rules to the context of local livelihoods and farming systems; the introduction of agricultural insurance against weather events, mainly frost and hail; the provision of agricultural extension services for the treatment of pests and crop diseases; and training for a full range of value-adding activities to agricultural commodities (i.e., nopal). According to our interviews, government actors suggest that medium and long-term programs should be focused on generating strategies that favor alliance-building and the organization of farmers for the restructuring of the regional market. If these supports for peri-urban agriculture are created—with the participation of the communities and aimed at promoting social organization and cohesion—we believe that the livelihoods and adaptive capacities of agricultural producers could be strengthened in MA. All of these agricultural issues are related to the potential of local farming performance and its crucial role in enhancing relevant adaptive strategies for promoting community organization and new governance arrangements.

In relation to agriculture in MA, power is concentrated in some institutions and actors at the national and city levels, such as SAGARPA (federal) and SEDEREC and CORENA (CDMX), respectively. At the borough level, it is concentrated in the Mayor's Office of Milpa Alta and in the Representative of Communal Assets², however, both local institutions have not been able to generate and promote more participatory and democratic decision-making processes at the community level, including systems of trust within the community. SAGARPA, SEDEREC and CORENA, as state institutions, are related to agricultural production through various financial support programs (e.g., fertilizers, credits, or agricultural insurance). However, their modes of operation make difficult to include the most vulnerable groups in these programs, such as women, newcomers and informal settlement dwellers, because the local network in MA has weak social connectedness in terms of social relationships. Also, these types of population lack access to some basic public services, such as electricity, drinking water, or wastewater treatment.

These kinds of expected collaborative processes among institutions can also strengthen the integration of local responses of the communities involved in peri-urban agriculture in public policies. The inefficient and irregular application of general rules of local policies in MA or in the CDMX government has also impeded the potential for more democratic governance, which would allow progress toward local development with trajectories for community harmonization to face urban changes and urbanization pressures. This is particularly pertinent when thinking of peri-urban communities as adaptive social systems in highly complex regions undergoing dynamic environmental and urbanization changes (Nousala et al., 2021).

Historically, the peri-urban areas in CDMX and MA have been subjected to a series of policies framed without the consensus of local smallholder farmers. One of the greatest governance challenge consists of integrating effective peri-urban agriculture policies, including development opportunities into peri-urban and metropolitan planning strategies in such a way that they reinforce beneficial outcomes for urbanization and agricultural livelihoods under an adaptive governance framework. In sum, to deal with disturbances originating from economic, environmental, social and institutional challenges, it has been suggested that, in the context of multi-level adaptive governance, different adjustments are needed in decision-making processes in terms of both farming systems and related policies (Manevska-Tasevska et al., 2021), such as the unplanned urbanization in MA. The above should be substantially linked to opportunities to establish processes

2 Communal land in Mexico is mostly rural territory in which a community holds secure and exclusive collective rights to own, manage and/or use land and natural resources, as common pool resources, including agricultural lands, grazing lands, and forests. These types of land are administered through a Representative of Communal Assets.

of community organization and social learning, particularly since all learning processes are complex, requiring multi-level learning and cycles with instances of transformative change, resistance, change in broader social discourses, and local niche developments (Pahl-Wostl and Patterson, 2021).

From this perspective, a proposal for a new governance arrangements framework for the peri-urban area of MA should give more importance to the development of the adaptive capacities of livelihoods and institutional planning, mainly to enhance peri-urban assets. This type of policy reorientation has to do with the following goals: (1) the creation of local-regional productive networks for agricultural credit, supply, and marketing; (2) the socialization of local agricultural and environmental dynamics and needs, such as climatic variations; (3) local development planning that includes the guarantee of adequate housing and urban services for future generations, avoiding chaotic urban growth such as informal settlements; (4) the creation of environmental and ecosystems services education processes among local producers; and (5) the generation of multiple mechanisms for evaluating the socio-environmental and economic performance of both public policies and local agriculture. In other words, a complex of local governance structures where the producers and local inhabitants of agricultural peri-urban areas regain control of economic production and social reproduction based on their local adaptive capacities.

The spectrum of adaptive capacities revealed in this study mostly involve farmers livelihoods within their local network. Thus, the use of the livelihoods approach has served to trace some trajectories of sustainable development of the peri-urban area that forcibly adjust to the conditions of local agricultural production. However, “*local is not enough*,” especially since local actors are not always capable or willing to govern their farming systems effectively, because the actors’ decision-making process does not appear to be linked to the peri-urban governance and because despite the importance of local institutions, many institutional arrangements operate at other levels of governance—such as at the level of national and regional government agencies.

In the current Mexico City context where increasing recognition is given to the need for peri-urban agriculture, we emphasize the need to add the design of governance arrangements for enhancing producers’ adaptive capacities since farming systems are integral economic and socio-environmental entities at the regional and family unit levels in MA. Above all, it has been suggested that those producers not only have scarce rural assets, but also limited resources and options to define adaptation strategies for the whole peri-urban environment (Mendez-Lemus, 2012). Another important finding from this study is the lack of participation of local producers in formal planning processes and support programs for peri-urban agriculture in MA. Socio-environmental problems by urban growth in MA are affecting dynamics of change in agricultural activities, producing alterations in the quantity

and quality of livelihood assets, and modifying the structure of the local network and the socio-institutional processes of local governance.

Conclusions

At present, the effects of urbanization processes in Mexico City vary according to the environmental and socioeconomic conditions in specific peri-urban locations. The governance challenges of peri-urbanization of this mega-city are embedded in multiple settings and scales, and in the case of MA, livelihood assets and their adaptive capacities are crucial to tracing the possible trajectories of sustainable development that adjust to the conditions of local agricultural production. Based on the findings of this study, the peri-urban area of MA does not yet have the local networks to offer feasible possibilities to move toward adaptive governance.

Although urbanization in Mexico City seems to be a dominant process for peri-urban communities, urban growth in MA appeared to have dysfunctions in urban governance, for example, with agricultural extension issues for agricultural production. For instance, as reported by the producers, urbanization processes negatively impact the vulnerability of livelihoods of agricultural communities by increasing the exposure of crops to climatic variations, such as more frequent episodes of intense heat and rain.

Until now, producers in MA have not identified local collective action with multiple actors and with the various policies at the local, regional, and state levels, to address the complexity of the challenges of urbanization and obtain benefits at the local level on multiple scales, particularly those concerning the governance and conservation of natural resources, agricultural activities, and informal settlements. Due to the internal weakening of informal norms and guidelines and organizational cultural customs, a fragile relationship exists between local social organization and the management trajectories of agriculture, social ownership of land (communal and ejidal), and natural resources. These limitations, of both form and content, restrict the momentum of adaptive governance from the local perspective.

The traditional community organizations have been dismantled and, therefore, collective action practices such as networks of cooperation, solidarity, and trust are decreasing in the agricultural settings we studied. Moreover, other community organizations have been co-opted by agriculture support institutions or by political parties.

For peri-urban transformations in Mexico, further research must include new analytical and theoretical approaches for livelihoods strategies in adaptive governance processes and structures, institutions, regulation frameworks, populations, and local socio-environmental dynamics, particularly including areas with a strong agricultural component. Therefore, the possibility of reaching adaptive governance of peri-urban

areas, spaces and systems requires the evaluation of social participation in decision-making processes at farming systems level and policy level aligned with organizational processes and with interconnected local networks to prioritize socio-environmental problems.

Weaknesses of this study include our limited consideration of political aspects and wider institutional contexts, such as details on Mexico City's urban and environmental policies. However, through surveys, interviews, and participatory workshops, we point to some of the key impacts of metropolitan expansion on local communities largely engaged in agricultural livelihoods. By identifying livelihood assets and vulnerabilities, the local governance network (actors and institutions), and adaptive capacities and strategies for governance, we illustrate the potential and constraints for adaptive governance in peri-urban contexts. In addition, this study on MA confirms that potential trajectories toward achieving more sustainable peri-urban development depend on producers' livelihood assets, including the specific adaptive capacities of each local agricultural community.

Finally, there is a need for future comparative peri-urban research from which important contextual differences can be elucidated and, in turn, allow for a more robust understanding of adaptive governance processes, and the contributions of institutional contexts and related local network structures. In our case study, we show that "local is not enough" due to diverse constraints in decision-making processes for feasible adaptive governance approaches. In particular, we found that the current local dynamics and organizational structures related to collective capacities of the agrarian communities we studied do not presently support a shift toward adaptive governance and the transformation of institutions and social organizations. A new set of norms of reciprocity, social practices, networks of civic commitment, and new rules and mechanisms for the redesign of territorial management in peri-urban areas such as MA, which are facing new risks, vulnerabilities, and socio-environmental pressures arising from urbanization, are needed.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of the Division of Biological and Health Sciences at the Autonomous Metropolitan University, Campus Xochimilco. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

PT-L and KC-G: conceptualization, writing—original draft preparation, and writing—review and editing. PT-L and KA-R: methodology. PT-L, KC-G, and KA-R: validation, formal analysis, investigation, and funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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