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Evolution and Collapse of *Ejid*os in Mexico: How Far is Communal Land Used for Urban Development?

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Abstract:

The *ejido* system in Mexico based on communal land was transformed for private ownership due to neoliberal trends during 1990. This research describes the evolution of Mexican land policies that changed the *ejido* system into private development to answer why land tenure change is shaping urban growth. To demonstrate this, municipalities of San Andrés Cholula and Ocoyucan were selected as a case study. Within this context, we evaluated how much *ejido* land is being urbanized due to real estate market forces and what type of urbanization model is created. These two areas represent different development scales: S.A. Cholula where its *ejidos* were expropriated as part of a regional urban development plan; and Ocoyucan where its *ejidos* and rural land were reached by private developers without local planning. To analyze both municipalities, historical satellite images from Google Earth were used with GRASS GIS 7.4 and corrected with QGIS 2.18. We found that privatization of *ejidos* fragmented and segregated the rural world for the construction of massive gated-communities. Therefore, a disturbing land tenure change occurred during the last 30 years, hence this research questions the role of local authorities in permitting land use change without regulations or local planning. The resulting urbanization model is a private sector development that isolates rural communities in their own territories, for which we provide recommendations.

Keywords: land tenure in Mexico; *ejido* system; land expropriation; gated-communities; San Andrés Cholula, Ocoyucan.

1. Introduction

Mexico has an intricate land-tenure-system with historical bonds between communal lands, and public and private ownership. The *ejido* is, thus, an endemic land tenure model and one of the most important bequests of the Mexican Revolution consisting on “an area of communal land used for agriculture, on which community members individually farm designated parcels and collectively maintain communal holdings”[1]. Conversely, during the past 100 years the evolution of tenure systems changed radically when *ejido* land was opened to the free-market.

As a system, *ejido* is widely studied in Mexico and Latin America because of its complexity and importance as an agrarian land policy [2][3][4], its fragile socioeconomic structure [5][1][6], its socio-spatial organization [7][8][9], its urbanization [10][11][12], and its liberalization [13][14][15] through the reforms of the Article 27 of the Mexican Constitution. Most *ejido* land underwent a transformation in response to neoliberal trends during the 1980s and 1990s, when private ownership was secured by *ejidatarios* and farmers, which, while on the face of a positive step, subsequently opened the door to corporate predation.

The paradox of *ejido* system is, as it is going extinct because it is considered for land policies as an “irregular land tenure system”, half of Mexico’s territory is still held by *ejidos* and agrarian communities, including mountains, forests, natural reserves, mines, and lakes, among others [16].

“More than 5.6 million of *ejidatarios* offer to National and international markets food, cattle, raw materials, fodder, as well as construction materials, handcrafts and touristic services. Moreover, they provide invaluable environmental services for biodiversity conservation, carbon capture and aquifer recharge” [idem]

Privatization of *ejido* tenure means, thus, that agricultural and natural land are potentially urban. Adding *ejido* and communal land to urban development has different approaches, described by Riveros Fragoso in terms of urban impact, ecological implications, transformation of rural economy, socioeconomic issues, land policies, and governance accountability[17]. The legal and tenure approach, however, has not been addressed before although it is essential to get an integral understanding of the implications of the urbanization of the rural world.

Riveros Fragoso identifies three main periods for *ejido* land incorporation to urban land uses: 1940-1973 (irregular tenure), 1970-1992 (regularization of *ejidos*), and 1992 till today (de-regularization of *ejidos*). During this latter, the last *Ejidal* Census of 2007 counted 3,097,658.83 hectares of *ejido* land sold to buyers outside of rural communities. The last Agrarian Census from 2017 counted a decrease in the number of *ejidos* in Mexico, from more than 31,000 to 28,000. While the number of *ejidos* is decreasing at a rate of 10% in ten years, more than 198.5 million hectares of the National territory are still communal-based land tenure, such as *ejidos*.

The transformation of the rural world was triggered by NAFTA and the reforms of the Article 27, which challenged the survival of rural communities. The immediate needs of *ejidatarios*, farmers and peasants together with the political and socioeconomic conditions set by urban rather than rural stakeholders were addressed in the form of land expropriation for urban development.

These conditions were faced in the municipalities of San Pedro Cholula and San Andrés Cholula, in the Metropolitan Area of Puebla-Tlaxcala, where the life of rural population changed radically when the regional Government [18] expropriated 1,092 Hectares of *ejido* land for the implementation of an urban development plan called “Programa de Ordenamiento Territorial Angelópolis” PROTA – commonly named as *Plan Angelópolis*.

On one hand, the implementation of PROTA was an exemplary case of urban planning in Mexico that shaped urban growth and gave tenure security to *ejidatarios* and farmers. On the other hand, in its implementation, the plan triggered the fragmentation of *ejidos* and the segregation of the rural population [19]. These twin effects fuel the current debate about modern land policies in Mexico and the extent to which they promote urban-private development in the country.

This paper contributes to the research on the *ejidos* and periurban growth in order to answer three main questions: **A) How does land tenure change shape urban growth in Mexico? B) How**

¹ Authors’ translation from original in Spanish.

much *ejido* and rural land is used for private sector urbanization? C) Which model of urbanization emerges from this? To respond these questions, we first reviewed the evolution of the land tenure system in Mexico, as a historical review of land policies is fundamental to understand the reasons *ejidos* were created and then liberalized. Second, we conducted a visual geo-analysis of satellite images, selecting the case studies of the municipalities of San Andrés Cholula and Ocoyucan as typical *ejidos*, in order to quantify their urbanization from 1995 to 2018.

This research is divided into four sections: first, we describe the theoretical framework of land and urban development; second, we outline our approach to the modern land tenure system in Mexico with a description of local urban planning through PROTA; third, we conduct a geo-visual analysis to measure how much land was urbanized in the cases under study. Fourth, we provide our results and in the discussion, critically assess private sector urbanization of *ejido* land and the role of public policies and local administrations in promoting land privatization. Finally, we conclude that the tendency of the model of urbanization based on private development to isolate rural communities in their own territory means that the benefits are outweighed by the negative impacts.

2. Theoretical framework: land and urban development

The core object of study of this paper is *ejido* land. Based on Robles [20] description, a typical *ejido* had 1822 hectares distributed by 104 *ejidatarios*. Normally, for an *ejido* of this size it was divided in 134 plots with a maximum of 10 hectares per each. In every *ejido* it should be considered the area for human settlements with an average of 9.4 hectares where *ejidatarios* and neighbors lived.

On one hand, *ejidos* became the axiom of Mexico's rural land distribution. On the other hand, they became an obsolete tenure system that did not achieve better quality of life nor wealth to its tenants. And, due to socioeconomic change, the *ejido* land near to urban areas became an object of desire for land speculators. According to the original National Agrarian Law, selling, buying or developing *ejido* land was not permitted, however this condition did not stop informal settlements. After the liberalization of *ejidos* in 1992, low-priced *ejido* and rural land was available for the big housing market, especially when conurbated with urban areas. Through this public policy, the urbanization of *ejidos* caused massive urban sprawl outside urban cores, thus huge metropolitan areas emerged.

Harvey defines metropolitan areas as large collaborative enterprises of competitive processes, diversifications, production of built environments and public spaces, divergent temporalities, values, lifestyles and means of production [21]. In these terms, all territorial politics (be they local, urban or regional) are based on the collective development of a particular political vision on the part of particular persons in particular places at particular times [p.p.188]. These politics, be it from the state or stimulated by real estate developers, may clash with local cultures and community interests threatening their rights and values as threatening powerful political forces. All public policy should thus confront the issue of 'locality' and 'community' somehow seeking for alternative and responsible forms of social change [p.p.192]

In metropolitan areas, certain areas experience a net gain in land value while others suffer a net loss impacting the geography of accumulation and formation of centers and peripheries at every spatial scale [26 p.p.113]. In terms of potential use of the urban land, a struggle frequently rises from the exploitative structures of the vertical and horizontal class divisions of society, in a socio-spatial dialectic triggering the articulation of social and spatial praxis [p.p.98] and creating a socio-territorial division of the city. Thus, themes of power, coercion, and collective resistance shape to the urban territory as a social microcosm the spatiality of which reflects the mode of production in corresponding to its time [22 p.p.149]. As stated by Zukin, "from this perspective, the underlying cause of repetition and singularity in the landscape is the profit motive, shifting capital between

investment in industry and in property, cycling it into new construction or reconstruction, shuttling it between the downtown and the suburban periphery" [p.p.19].

In today's struggle for expansion in the built environment and control over the land use, economic power predominates over both the state and community interests. "Capital creates and destroys its own landscape." [23 p.p.38]. As the consequence, new urban forms and territorial articulations are produced under nearly the same social conditions as consumer products following similar patterns of both standardization and market differentiation [p.p.42]. Moreover, in the context of globalization it has become practically impossible to separate the perception of urban form from the effects of global financial flows, investment, production, and consumption [idem].

In globalizing metropolis, property values seem to point to a renaissance, and redevelopment through "better" uses looks like a zone's new lease on life. Thus, local governments have no quarrel with real estate developers as it depends on the private sector to build the city.

"Through a kind of reciprocity, developers allow politicians to take the credit for it. But any relation that is ruled by mutual advantage also implies obligation. Operating in an economic system where capital mobility is the norm, both politicians and developers want guarantees. Developers want to know that the project they undertake today will not be subverted by external factors tomorrow. Politicians want the jobs and dollars that developers promise to last until the next election day" [23 p.p. 149].

Kivell [25] explains the importance of land as a primary element with "extraordinary features" such as: fixed supply, no cost of supply, irreplaceable, immobile, and permanent, denoting that land is a finite resource. Still, the alternation of movement and settlement are key activities of human life and interaction [26], therefore urban and population growth are always the main elements of land development [27]. Land uses are fundamental to control future production systems, but in association with land tenure, they are essential tools that seek developable land in order to manage urban growth.

According to Font [28], when expansive urban growth and sprawl occur, spatial development is affected by: population growth outside urban cores, decentralization of industrial and commercial activities, population mobility, flows and goods, fragmentation of the environment, and creation of new centralities inside metropolitan areas impacts on spatial development. These factors are as well agents of change that participate in the production and control of urbanization, well defined by Lefebvre[29]. Therefore, the concept of urbanization as an agent of change is taken for this paper to describe how rural land is transformed into urban with "simultaneous role as places of consumption and as consumable places"[29], as market forces are a mechanism that transforms urban morphology.

In regard to the concept of peri-urbanization used in this paper, we must refer to Vázquez's concept of "new suburb", which describes the multifunctional and extensive urban peripheries in which urban areas are "liquidated" together to form a brand new plural territory that does not respect state and municipal limits [30]. This "liquidated city" can be found in Puebla's metropolitan area in which several communities are fused together and the urban growth has extended beyond the administrative boundaries between Puebla and Tlaxcala states. Hence, in our case study the prediction of Lewis Mumford, Frank Lloyd Wright and Le Corbusier has come true: the urban territory is dissolving into a gigantic and fragmented region in which it is difficult to distinguish centricities and borders [p.p 141]. In these galaxy-like urban patchworks of a profoundly heterogeneous territories urbanized areas, enclaves of surviving nature and agricultural zones

converge [p.p 142]. The city is thus not a unified spatial unit anymore but an archipelago of enclaves without connection to the urban whole forming a diffuse, extensive and multi-hierarchical territory difficult to understand and to define [p.p. 151].

Edward D. Soja points out that under the complex contemporary urban conditions, it is impossible to separate the center from the suburbs and these from the agricultural land [31] [p.p. 151]. Edward E. Land [31 p.p. 152] on the other hand complements this stance with the observation of the emergence of a new peripheral concept, "the city without borders" of an extremely disperse and amorphous urban territory, with different kinds of land occupation scattered over it, characterized by very low density and modest edifications, present in the Mexican perirural areas. In the context of contemporary metropolitan areas, Mike Davis [33 p.p 153] highlights the struggle for the land as part of the processes of "colonization" of the peripheries, in which "conquerors" of the higher social classes clash with the peripheral population in struggles of the possession of land in which the latter resist to abandon their territories. When the first achieved to gain possession of new lands through expropriations or aggressive real estate business, they feel the necessity to protect themselves of the seemingly different others perceived as dangerous. The result is the emergence of gated communities and other systems of urban surveillance. Davis called these walls and surveillance systems as new socio-spatial borders or "new urban frontiers" triggered by real estate business promoted by the public administration and its public policy.

Schumacher[19] abounds in the changes described by Davis, as the result of a global attraction to urban quality of life. Pierre Bourdieu [34] defines the specific planning tools that are used to create the "New urban frontiers" mentioned by Davis and to promote "urban quality of life" as stated by Schumacher. In order to establish their presence and land occupation in an area, the "conquerors" promote land occupation favoring boutiques, shopping centers, art galleries, bars, restaurants and other entertainment centers able to hold off undesirable socio-economic groups and classes. Simultaneously, housing costs inside urban cores generates another type of spatial development beyond rural territory: periurbanization.

As a process, Schumacher [19 p.p 37] states that periurbanization has a particular interest between rural and urban boundaries, especially for "land developers and informal settlements" but this does not mean that local communities lose completely their rural essence. This factor is elementary to understand rural-urban ambiguity in Latin America where socioeconomic groups are physically and socially fragmented. James Corner [35] in his article "Terra Fluxus" explained the necessity to pay more attention to processes of change-"terra fluxus" in planning, in order to understand the metropolitan areas as stratifications of "fields of action" generating interactive ecosystems considering culture, collective memories and desires of the citizens. This concept has usability in Latin American periurbanization as a flexible model for sensitive planning.

"We live in an era when ideals of human rights have moved center-staged both ethically and politically" [36 p.p. 3]. A lot of political energy invested into promoting, protecting, and articulating their significance in the construction of a better world. Though, for the most part these concepts are understood as individualistic and property-based and, as such, "do nothing to challenge hegemonic liberal and neoliberal market logics, or neoliberal modes of legality and state action. We live in a world, after all, where the rights of private property and the profit rate trump all other notions of rights one can think of" [idem]. Still, the question of what kind of city we want is intimately related to the question of what kind of people we want to be, what kind of social networks we wish to

construct, what is our relation regarding the nature, what kind of life style do we seek and what values we hold [idem].

“The right to the city is, therefore, far more than a right of individual or group access to the resources that the city embodies: it is a right to change and reinvent the city more after our hearts' desire. It is, moreover, a collective rather than an individual right, since reinventing the city inevitably depends upon the exercise of a collective power over the processes of urbanization” [p.p. 4].

3. An approach to modern land tenure system in Mexico

3.1 From haciendas to agrarian Reform

At the end of Colonial period in 1821, when Mexico achieved independence from the Kingdom of Spain, the new country inherited a complex-land-tenure-system:

- The communal land – pre-Hispanic *ejido* and *Altépetl*² system.
- Public land – owned by the Spanish Crown.
- Private land – owned by the Church and property owners or *hacendados*, as the new upper-middle-agrarian class.

During the 19th Century, Mexico took its first steps towards regulating the colonial system through land reforms. Wilkie & Hammond [37] consider 1853 as the year modern land policy was initiated. This marked the beginning of the new function of the federal government as the National land administrator. President Benito Juárez introduced the policy from 1855 to 1861, when the Catholic Church's property, including *haciendas* and communal land from native groups, was confiscated to be used as small agrarian holdings.

The industrialization of the country in the 19th century boosted the monopolization of land and water resources for industrial production by *hacendados*, endorsed by the dictatorship of President Porfirio Díaz established in 1876. Wilkie & Hammond (Ibid.) observe that, in comparison with former tenure policies, Porfirio Díaz radically changed land ownership from individual and communal properties to massive estates for proprietors and infrastructure development. Mining concessions, extensive farmland and more than 20,000 km of railways built during the dictatorship by foreign companies – mainly from the USA and the UK – were made possible by expropriation due to an ineffective land tenure policy [38].

The routing of the railway over rural land was based on connecting production with trading centers, that is to say, *haciendas* and industries being linked to cities by infrastructure. For this reason, the importance of *haciendas* in Mexico is twofold: on the one hand, the *haciendas* represented an unfair-socioeconomic and labor-exploitation system; on the other hand, the *haciendas* catalyzed modern agrarian production in Mexico. Some important features of the industrialization of the agrarian sector are shown in Table 1. Although relatively small groups of *hacendados* controlled these features, most of the communal and native land suffered land-tenure insecurity due to private appropriation and government expropriation.

² *Altépetl*, from the Nahuatl language “Water-mountain”; was a complex socio-spatial and political system that gave order to former Mesoamerican cities. Each *Altépetl* had their own government as City-state and own communal land outside the cores for agricultural purposes. This was the primordial land tenure system in Mesoamerica and one of the influences for the modern *ejido* implementation.

AGRARIAN SYSTEM FEATURES	Hacienda System 19th Century	Agrarian Reform 20th Century	Post- NAFTA 21th Century
Land tenure	<ul style="list-style-type: none">- Large estates- Ancestral communal land- Population concentration in small villages and towns	<ul style="list-style-type: none">- <i>Ejido</i>, land distribution policies- Small private properties- Restrictions from <i>ejidos</i> for open-land market	<ul style="list-style-type: none">- Private ownership for communal and <i>ejido</i> land- Periurbanization over <i>ejido</i> land
Capital	<ul style="list-style-type: none">- Agro-industrial production- Landlords investment- International exportation of agricultural commodities	<ul style="list-style-type: none">- Public capital, subsidy policies to <i>ejidos</i>, public loans- Protection of National market- Rise and fall of agrarian productivity- Beginning of importation of grains and goods from the USA	<ul style="list-style-type: none">- Subsidies to the agrarian sector- International and private investment for agrarian industry- Consolidation on importation on corn, grains and agricultural commodities from the USA and other countries
Labor	<ul style="list-style-type: none">- Cheap farmers and peasants labor for <i>Haciendas</i>- “Wage slavery” system	<ul style="list-style-type: none">- Self-consumption and individual production- Rural-urban migration	<ul style="list-style-type: none">- Agro-industrial production, self-production- Rural labor migration to the USA- Abandonment of agricultural activities in Mexico
Technology	<ul style="list-style-type: none">- <i>Hacienda</i>’s technology for agro-industrialization	<ul style="list-style-type: none">- Free distribution of farm equipment, livestock, and farm goods to <i>ejidatarios</i> by subsidies- Technical training from the State to <i>ejidatarios</i>	<ul style="list-style-type: none">- Private development for agro-companies- Distribution of farm goods from the State to small farmers- Subsidy through rural and agricultural development projects
Organization	<ul style="list-style-type: none">- Landlords controlled economy, commerce, transportation and labor structure.	<ul style="list-style-type: none">- Rural collectives- Family labor organization inside and outside the <i>ejidos</i> for survival- <i>Ejidatarios</i>’ labor unions	<ul style="list-style-type: none">- Rural-local collectives, small producers- Association of small producers and rural cooperatives with big agro-industries- “Employees in their own land” through a Neo-Latifundium system based on private investment and development. Peasants and farmers produce for big companies

TABLE 1. AGRARIAN CHANGE IN MEXICO. SOURCE: MELISSA SCHUMACHER & TEODORO SCHUMACHER (2019)

Unable to make a living and in view of the imminent threat of their lands either being grabbed by *hacendados* or expropriated by the Government, in 1910, farmers, workers and peasants came together to resist them in what was to become the Mexican Revolution. This social movement, spearheaded by farmers’ and peasants’ leaders such as Emiliano Zapata, who fought for the restitution of lands to their original owners, sought for democracy and social justice under the banners of “Land and Liberty” and “The land belongs to those who work it with their hands”.

It should be noted that the development of the Mexican Revolution was different in the North and the South of Mexico. According to Katz [39], the social movement in the northern states was

guided mainly by a rural middle class, a working class, and *hacendados*³ that stood against the political system. The government of Porfirio Díaz favored foreign companies in the development of mining, railroads, livestock, and industrial agriculture in Mexican territory. In the south-center of the country, the revolution had a strong ideology based on political change, social justice for peasants and the restitution of ancient lands to their original owners⁴. In contrast to the North, *hacendados* did not join the revolutionary forces, where peasants were incited to fight against *hacendados*, supported by intellectuals, workers, and local leaders.

With the aim of fulfilling the Mexican Revolution's land demands, the drafting of the Mexican Constitution of 1917 was the basis for a National land policy through the Article 27, which guarantees:

*"Ownership of the lands and waters within the boundaries of the national territory is vested originally in the Nation, which has had, and has the right to transfer title thereof to private persons, thereby constituting private property"*⁵ [40].

Meaning that national ownership of water and territory grants the state the right to secure tenure and private property and recognized three types of tenure: public, private and communal. With the stabilization of democracy, the Agrarian Reform (1920-1934) was launched as the modern land policy in the wake of the Mexican Revolution. The aim of the new land policy was to enable land distribution through the conversion of *haciendas* into a type of communal land called *ejido*. Widely used since pre-Hispanic times, the modern *ejido* system grants *ejidatarios* the right to be communal landowners. According to Assenatto & de León [41], the *ejido* is a communal land tenure system that ensures: the right to use farmland, conduct collective activities and establish rural settlements. However, one of the main drawbacks of the legal framework of *ejidos* was the lack of private ownership. As a type of communal land, the owner of an *ejido* right was not able to sell it, the land was transferred to the next generation or divided among family members by inheritance.

With the Agrarian Reform, the Agrarian Law was created as a National land policy that ensured communal land tenure through *ejidos* and was an axiom of Mexican Revolution's ideals during the 20th Century [42]. However, the beneficent intentions of a land policy based on fair distribution of agricultural land did not improve the agrarian economy nor conditions for the rural population, as presented in Table 1. While the *ejido* system did amend land tenure security for peasants and indigenous people; the government subsidies did not result in a reform of labor conditions or upgrading of agrarian technology for small producers.

Agrarian reforms continuously reshape the distribution of land, for example, the 7,000 *ejidos* that existed in 1935, multiplied to 29,983 agrarian nuclei by 1991 at the end of agrarian distribution. However, they decreased to 29,942 on 2007, after the neoliberal socioeconomic change. [43]

In the 60 years of Agrarian Reform history, Warman's [42] studies from the 20th century's agrarian census observed that 50% of Mexican territory was distributed among more than 30,000 *ejidos* for 3.5 million of *ejidatarios*. And yet the revolution's promise of land justice and land rights was not fulfilled, as the lack of governmental capacity to improve the agricultural economy and the constant socioeconomic struggle in rural areas triggered a simultaneous migration of rural inhabitants to big cities and the U.S. as a permanent feature of 20th century urban growth. This situation has deteriorated further since 1992 after the liberalization of *ejido* land and the negotiation of NAFTA⁶.

The modification and liberalization of land policies was justified by the Federal government first as a necessary measure for improving tenure security and allowing "privatization of communal resources" [44]; and second, to regulate informal settlements that were developed in periurban *ejido*

³ Most of the generals in the North were small and big owners of rural land, but not the famous General Pancho Villa, who was a former *hacienda* worker and outlaw.

⁴ For example, old *Altépetl* communal land and territories.

⁵ Official translation of the Political Constitution of the United Mexican States by Carlos Pérez Vázquez, in the 2005 edition by the Institute of Juridical Research, UNAM.

⁶ North American Free Trade Agreement

territories. The reform of Article 27 from the Mexican Constitution that gave private ownership to *ejidos* had the following consequences:

- a) *Urbanization of ejidos* – Many rural localities located in the outskirts of cities were transformed when urban development reached former *ejido* land. Private ownership made expropriation and selling of rural land easier.
- b) *Privatization of ejidos* – Private investors bought thousands of hectares of former *ejido* land. This action developed massive social housing projects as part of a national housing policy which aimed to fulfill the needs of an increasing urban population.
- c) *Land-use change* – Former productive agricultural land was transformed into massive social housing and residential projects.
- d) *Migration to the United States* – According to Vereza [45], “the undocumented population in the U.S. tripled during the NAFTA era”; in 1994 there were about 3.8 million illegal Mexicans, peaking in 2007 with 12.2 million. This phenomenon is associated with the introduction of subsidies for foreign farm products, against which small scale farmers were not able to compete.

As Torres-Mazuera [7] points out, two components of land policy gave cohesion to Mexican rurality: the *ejido* and the municipality with its town council. Both institutions have had different influences in the evolution of modern land policies in Mexico, especially during the past 60 years, as summarized in Table 2.

It is important to clarify the differences within *ejido* tenure systems. According to the National Agrarian Law[46], due to its function as a social tenure system, the *ejido* used to be divided in: land for human settlements close to urban population, communal lands protected by the community, and agricultural plots that were the base for *ejido* tenure rights. Therefore, the *ejidatario* was granted the rights to use the land, but not the legal ownership, because all *ejido* land is considered a National good.

Formerly, in order to acquire *ejidal* rights, the candidate should inhabit and be registered in the rural community. Through a community assembly supported by a technical committee, a commission evaluated the request. After three assemblies, the candidate could be recognized as an *ejidatario* and the candidate was granted circa 8.8 hectares, varying from one geographic location to other, depending on the availability of fertile land.

After the reforms to the Article 27, the process for recognizing private property to *ejidatarios* was accountability of the local assemblies based on Article 56 of the National Agrarian Law. This legal change transformed the legal protection of *ejidos* as untouchable and indissociably goods, thus assemblies were the entity to grant private ownership to *ejidatarios*. The Certification Program for *Ejido* Rights (PROCEDE) was the responsible Federal program for the described procedure.

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Year	Promoter	Land Policies	Features
1853	Antonio López de Santa Anna (President)	<i>"Primera Reforma Agraria"</i> (First Agrarian Reform). Legislation over public, informal and communal tenure system.	-First attempt to improve the Colonial land tenure system
1855-1861	Benito Juárez (President)	<i>"Leyes de Reforma"</i> (Reform Laws). Political separation of State and Church, confiscation of private and communal land, transformed into public land.	-Catholic Church possessed large portions of land, estates and properties. - Creation of civil records.
1876	Porfirio Díaz (President)	<i>"Enajenación de bienes"</i> (Alienation of goods). Transformation of small properties, communal and public land into big estates and <i>haciendas</i> .	-Large portions of land were in the hand of few proprietors. -Industrialization of agriculture through <i>haciendas</i> .
1910	Emiliano Zapata (Social leader)	<i>"Plan de Ayala"</i> (Ayala Plan). Devolution of communal land to original farmers and peasants that were grasped by <i>hacendados</i> .	-Mexican Revolution, fight for democracy, land rights and land tenure.
1917	Venustiano Carranza (President)	<i>"Ley Agraria: Artículo 27"</i> (Agrarian Law: Article 27). Land distribution for farmers and peasants, constitutional consolidation of <i>ejido</i> tenure system.	-Land policy established in the Mexican Constitution. -Land consolidation was a responsibility of the Federal Government.
1973	Luis Echeverría (President)	<i>"CORETT"</i> (Comisión para la regularización de la Tenencia de la Tierra) creation by presidential agreement. Public organization for land tenure regularization in informal settlements over <i>ejido</i> and public land.	-Land management instrument focused on tenure regularization of informal settlements. -Key institution for expropriation when land ownership was granted.
1920-1934 (main period) until 1990	Federal Government	<i>"Reforma Agraria"</i> (Agrarian Reform). Land distribution of <i>ejidos</i> , creation of Ministry of Agrarian Reform, organization of agrarian workers union, credits for <i>ejidatarios</i> , and subsidies for agro-products. Creation of CORETT (Commission for Land Tenure Regularization)	-10,000,000 hectares of land (50% of Mexican territory) distributed to farmers and peasants as a legal right for <i>"ejidatarios"</i> . -Creation of 30,000 <i>ejidos</i> . -Decline in agricultural production. - CORETT was the responsible institution for regularization of informal urban settlements over <i>ejido</i> land.
1992	Carlos Salinas de Gortari (President)	<i>"Liberalización del ejido"</i> (Liberalization of <i>ejido</i>). Major changes on article 27, <i>ejido</i> tenure system opened to private ownership.	-End of land distribution and <i>ejidos</i> , crisis on the rural world. -Negotiation of NAFTA. -Informal urban growth over <i>ejido</i> land. -Social programs for farmers: <i>Oportunidades</i> and <i>Procampo</i>
2016	Enrique Peña Nieto (President)	INSU <i>"Instituto Nacional del Suelo Sustentable"</i> (National Institute for Sustainable Land) Public institution created to replace CORETT	-Mechanism for land readjustment and land regularization based on the instrument PRAH <i>Programa para Regularizar Asentamientos Humanos</i> (regularization for informal settlements). -Institution regulated by SEDATU Ministry of Agrarian, Territorial and Urban Development.

TABLE 2. SUMMARY OF MEXICAN LAND POLICIES. SOURCE: MELISSA SCHUMACHER & EDUARDO GUTIÉRREZ-REYES (2019), ADAPTED FROM WILKIE & HAMMOND (1998), WARMAN (2003), PROCURADURÍA AGRARIA

As exemplary cases of the listed features and consequences of *ejido* transformation into urban land, there are two municipalities that stand out in particular: San Andrés Cholula and Ocoyucan, former rural towns in the region of Cholula and located in the Metropolitan Area of Puebla-Tlaxcala. The first municipality was part of an ambitious master plan – PROTA *Plan Angelópolis* – formulated by Puebla’s State Government to shape urban growth through land expropriation. The second municipality is exemplary of how private development and planning shapes urban growth through land-use changes.

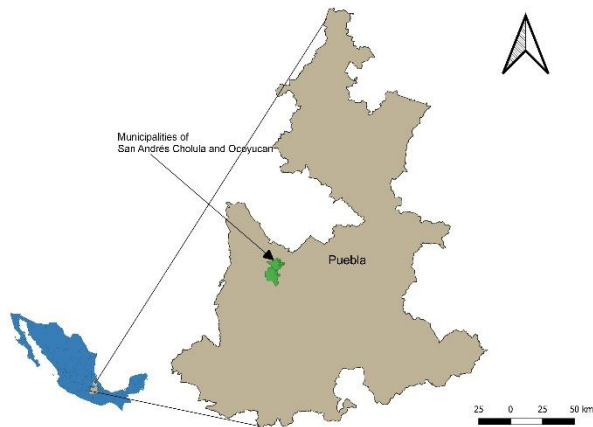


FIGURE 1. LOCATION MAP OF CASE STUDIES IN MEXICO. ELABORATED BY DAVID A. GONZÁLEZ-RIVAS (2019)

Due to its conurbation to Puebla City and the development of the commercial and residential area of Lomas de Angelópolis, San Andrés Cholula, has lost a great amount of its Natural areas in the past few years. Currently, 62% of the territory has been transformed into urban areas, while the remaining 38% is used for agriculture. According to the latest censuses conducted by the National Institute of Statistics and Geography (INEGI) [47], the number of inhabitants increased from 45,872 in 1995 to 80,118 in 2005. For the first time in history, San Andrés Cholula reached a population of over 100,000 inhabitants in 2010. As a result, the type of population is heterogeneous, because while the number of the original inhabitants still reside in the territory, the spatial growth beyond municipalities’ administrative boundaries, the location of universities and the increase of services and tertiary activities, has led to a population growth in which the groups of residents do not always relate in terms of community or social activities.

Bordering to the North with San Andrés Cholula, Santa Clara Ocoyucan is located in Ocoyucan, one of the 217 municipalities that conform the state of Puebla. Out of the 4,871 inhabitants registered in the census of 2010 by INEGI [47], 7.31% was indigenous population and 2.42% spoke an indigenous language. Santa Clara Ocoyucan’s economy is mainly dependant on agriculture and livestock, however, the residential area Lomas de Angelópolis has expanded over the farm plots, exceeding the policies and guidelines traced in the urban development plan of the municipality.

3.2 Land tenure change: PROTA/PDRA (Plan Angelópolis)

In Mexico, every planning instrument or mechanism is based on the National Planning Law[48], updated in 2015. This law provides the guidelines for the elaboration of national development plans and establishes different categories and planning scales that should be aligned with the National Plan. Normally, this plan is valid for 6 years during every president period.

Other two key planning instruments are the National Urban Development Plan and the Human Settlements, Spatial Planning and Urban Development Law[49] which guide spatial planning and urban development.

The ministry responsible for supporting those key instruments is the Ministry for Agrarian Land and Urban Development (SEDATU), which works with other organisms to create and modify plans. Sub-ministries and agencies also proposes plans together with regional governments. At a local level,

municipalities are responsible for planning and regulating their territories and their plans should be aligned with regional and national development plans.

At a regional and municipal level, urban development plans are the most important implementation instrument. Thereupon, plans are useless without operative programs, especially at a local level as the plans should contend with construction regulations, land uses, density, zoning and cadaster included in the municipal urban development programs.

Such was the case for PROTA, a regional plan that managed urban growth in the metropolitan area of Puebla-Tlaxcala, and its operative program was the PSDUM, a program that was main guideline for local urban plans in Cholula.

The Metropolitan Area of Puebla-Tlaxcala is located 120 km west of Mexico City; its major urban core is the City of Puebla, a former textile industry center. In 1960, the modernization of the city began with federal projects in the 1960s and 1970s following the establishment of production facilities by the German car manufacturer Volkswagen. This action transformed Puebla and its surroundings into an important industrial hub between the capital of the country and the Port of Veracruz.

Despite industrial growth, no holistic urban planning existed until 1990. Due to the liberalization of *ejido* land, Puebla's Government created a metropolitan plan first called *Programa Regional de Ordenamiento Territorial Angelópolis PROTA* and then updated as *Programa de Desarrollo Regional Angelópolis PDRA*. As part of this plan, the land reserve "*Reserva Territorial Atlixcáyotl-Quetzalcóatl*" was created through a sub-regional implementation plan *Programa Sub-regional de Desarrollo Urbano de los Municipios de Cuautlancingo, Puebla, San Andrés Cholula y San Pedro Cholula PSDUM*. This sub-regional plan managed future urban growth for several municipalities and promoted housing development to fulfil immediate population needs.

For the creation of the land reserve, 1,092 Hectares of *ejido* land from the region of Cholula – the municipalities of Cuautlancingo, San Pedro Cholula and San Andrés Cholula – were expropriated [50][51][52]. In addition to the mentioned municipalities, the master plan included 33 other localities with the purpose of generating the first integrated metropolitan development plan through the PROTA [53]. Locally, the urban development plan was carried out through the PSDUM[54] in which, for the first time, the urban context was considered as a whole. This plan included an all-encompassing outlook for mobility systems, urban infrastructure, wastewater treatment plants, peripheral ring roads and a vast ecological reserve of green belts along a – polluted – river crossing the urban territory, the Atoyac. Puebla's Governor at the time, Manuel Bartlett (1993-1999), invited international architectural firms to collaborate on the re-engineering of the city and develop the plan, as local bureaus did not share Bartlett's progressive mentality and did not have the economic nor human capital to compete with international firms. Among the firms involved were the North American architects and urban consultants HKS Architects, Sasaki & Associates and McKinley & Co.[12]. They proposed commodifying the historic center through investment in touristic infrastructure and expanding the metropolitan area towards the newly created land reserve. The PROTA master plan had an exclusive automobile-planning rather than an inclusive development focus to assess the needs of rural and urban population. PROTA proposed a zoning land-use, retail and residential areas, entertainment, and services. In addition to PROTA, the PSDUM was the framework for land expropriations that had been taking place at a continuous pace since 1992. The PROTA was in place until 1999 but it did not survive the subsequent two state governments, and the holistic metropolitan plan was shelved.

The idea of an integral spatial planning was no longer addressed in the political agenda until 2011 with the government of Rafael Moreno Valle (2011-2017). Moreno Valle shared Bartlett's idea of attracting international investment to Puebla and providing resources to carry out iconic projects. During this period, the exploitation of the land reserve for commercial and residential ends expanded at an accelerated rate. The updating of PSDMU was an urban and re-engineering intervention for programming urban land through hybrid zoning of mixed land-use in order to create groupings of economically interesting investment projects that would generate commercial benefits. PSDMU was updated five times in 1997, 1998, 2000, 2005, and 2011, but as noted by Garrido Alfonso, the creation of this plan and the land reserve did not fulfil the public purpose for which it was created [56].

During Bartlett’s period, urban development was based on the idea of doing business through benefit and profit from urban land uses. Thus, the real estate developers defined the rhythm and the shape of urban growth focused on construction of gated communities, residential towers, amenities, and shopping centers aimed at middle and upper-middle class consumers seeking for commodities and a high-end life-style. This was the consequence of a neo-liberal trend in urban development, where private developers were responsible for urban planning rather than local authorities, who behaved rather flexibly in the enforcement of regulations regarding land uses [19].

4. How much *ejido* land was transformed into urban?

The municipalities of San Andrés Cholula and Ocoyucan are part of the Metropolitan Area of Puebla-Tlaxcala, they share physical conurbation with the city of Puebla and had a largely agricultural economy until the late 20th Century. In 1995, San Andrés Cholula began its urban metropolization process with the implementation of the PDRA and Ocoyucan, mainly from 2010 when private developers bought cheap *ejido* land in order to push urban development. The name and size of *ejidos* from both municipalities is presented in Table 4.

The *ejidos* from San Andrés, as part of a planning speculative strategy, detonated sprawl and urbanization based on real estate market and cheap rural land for investment, as exemplified by *ejidos* San Bernardino Tlaxcalancingo and Santa Clara Ocoyucan.

Nowadays both locations present a modern urban image with luxury residential areas and towers, gated communities and several shopping and entertainment centers. Although Ocoyucan was not considered as part of PDRA implementation and urban growth, housing market demand turned the area into a new pole for residential development due to the flexibility of urban regulations – a legacy of its status as a former rural municipality. Table 3 shows the population growth in our case studies in order to visualize to what extent both municipalities have been developed in comparison to the main urban core, Puebla, and the whole Metropolitan Area of Puebla-Tlaxcala. The latest statistics are based on the National Census of 2010, Metropolitan Statistics from CONAPO [57], and National Polls from 2015 [58], however it would be worthwhile monitoring the results from the next National Census of 2020.

MUNICIPALITY	1990	2000	2010	2015	POPULATION GROWTH	DENSITY
San Andrés Cholula (77.182 Km²)	37,788	56,066	100,439	137,290	1990-2000:2.5% 2000-2010:5.8% 2010-2015: 7%	2171.7 pop/Km²
Ocoyucan (120.165 Km²)	17,708	23,619	25,720	28,220	1990-2000:2.9% 2000-2010: 0.8% 2010-2015: 2.0%	214 pop/Km²
Puebla (Capital) (548.889 Km²)	1,057,454	1,346,916	1,539,819	1,576,259	1990-2000:2.5% 2000-2010:1.3% 2010-2015: 0.6%	2805.34 pop/Km²
Metropolitan Area of Puebla-Tlaxcala (2,394.4 Km²)	1,776,884	2,269,995	2,728,790	2,941,989	1990-2000:2.5% 2000-2010: 1.8% 2010-2015: 1.6%	76.6 pop/Ha

TABLE 3. POPULATION GROWTH AND DENSITY, SOURCE: INEGI (2010, 2015), CONAPO (2018)

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MUNICIPALITY	Ejidos before 1995	Total Hectares of Ejidos in 1995	Urban development after 1995	Total Hectares of urban development from 1995 to 2018
San Andrés Cholula	Ejido San Andrés Cholula	1,986.00	Land Reserve Atlixcáyotl - PSDMU	1,222.00
	Ejido San Bernardino Tlaxcalancingo		Several gated communities, high-towers and retail areas	
Ocoyucan	Ejido Emilio Portes Gil	3,614.50		
	Ejido La Pastora			
	Ejido San Bernardino Chalchihuapan			
	Ejido Santa Clara Ocoyucan		Lomas de Angelópolis (gated community developed by Grupo Proyecta)	4,204.00
	Ejido Santa María Malacatepec			
	Ejido Santa Martha Hidalgo			
	Ejido Santiago Coloctzingo			

TABLE 4. NAME AND SIZE OF EJIDOS IN SAN ANDRÉS CHOLULA AND OCOYUCAN. SOURCE: VII CENSO EJIDAL INEGI

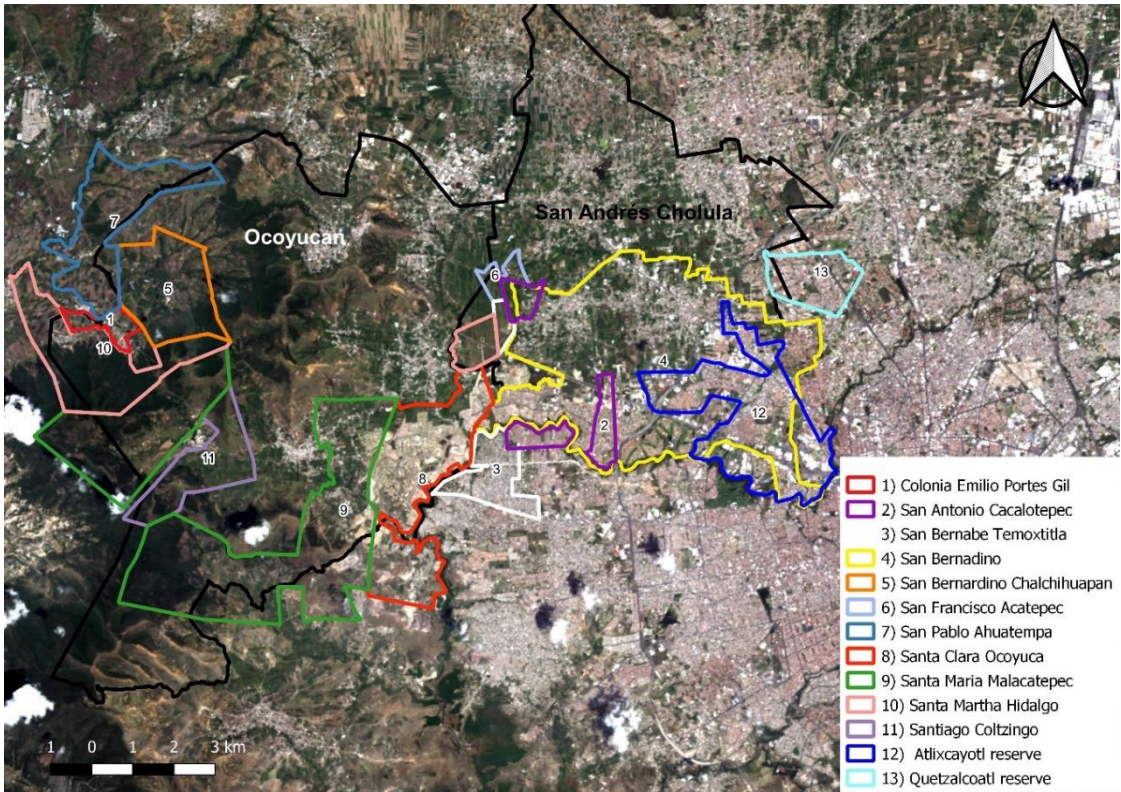


FIGURE 2. DISTRIBUTION OF EJIDOS BELONGING TO THE MUNICIPALITIES OF SAN ANDRÉS CHOLULA AND OCOYUCAN BASED ON A FALSE COLORED IMAGE LANDSAT 2018. ELABORATED BY DAVID A. GONZÁLEZ-RIVAS (2019)

How much of San Andrés Cholula and Ocoyucan rural territory is now urban? As shown in Table 4, data from INEGI records the exponential population growth of San Andrés Cholula and Ocoyucan compared to other areas, which demonstrates that both municipalities are attractive places for new incomers.

In order to visualize the urban growth in the case studies, we made use of satellite images of the urban settlements. We used images from satellites Landsat 5 and Landsat 8 from dates corresponding to summer of 1995 and 2018 to measure the urbanization of *ejido* and rural land and to determine the total area used.

The digital level values of all the images were converted to Top of Atmosphere Radiance (TOAR). The Dark Object Subtraction (DOS1) method in QGIS 2.18 was necessary to correct the atmospheric effects. To obtain the total farmed area and urban area per year, as well as its geographical location, we used a supervised classification – maximum likelihood algorithm of GRASS GIS 7.4 – and categorized each of the images into four groups: cultivation area, urban area, soil area and vegetation area.

We applied the method developed by Olofsson et al. [60] to validate the classification and estimation area of each category. The method includes calculating the sample size and assigning it to the categories of coverage types based on the best result of five hypothetical assignments. Moreover, to assign land-use of reference coverage we performed a visual inspection of each of the sample units using a set of Landsat images together with Google Earth™ images with a difference of 3 months per 2018 image. 1995 Google Earth™ satellite images were available. Following Olofsson et al. [60], after the visual inspection, we calculated the estimation area and error through pixel precision using the confusion matrix relative to the confidence intervals. This procedure was followed for both images from the total area of the study area, and for each of the sub-areas previously determined, using a confidence interval of 95% and standard error of 0.015 for the sample size calculation.

Five possible "allocations" were constructed for each year, with an average of 800 samples, distributed over four classes per year, based on the confusion matrix suggested by Ofofsson et al. (2014). As a result, we obtained for each class the total estimated area and a 95% confidence interval as described in Table 5 and Figure 2.

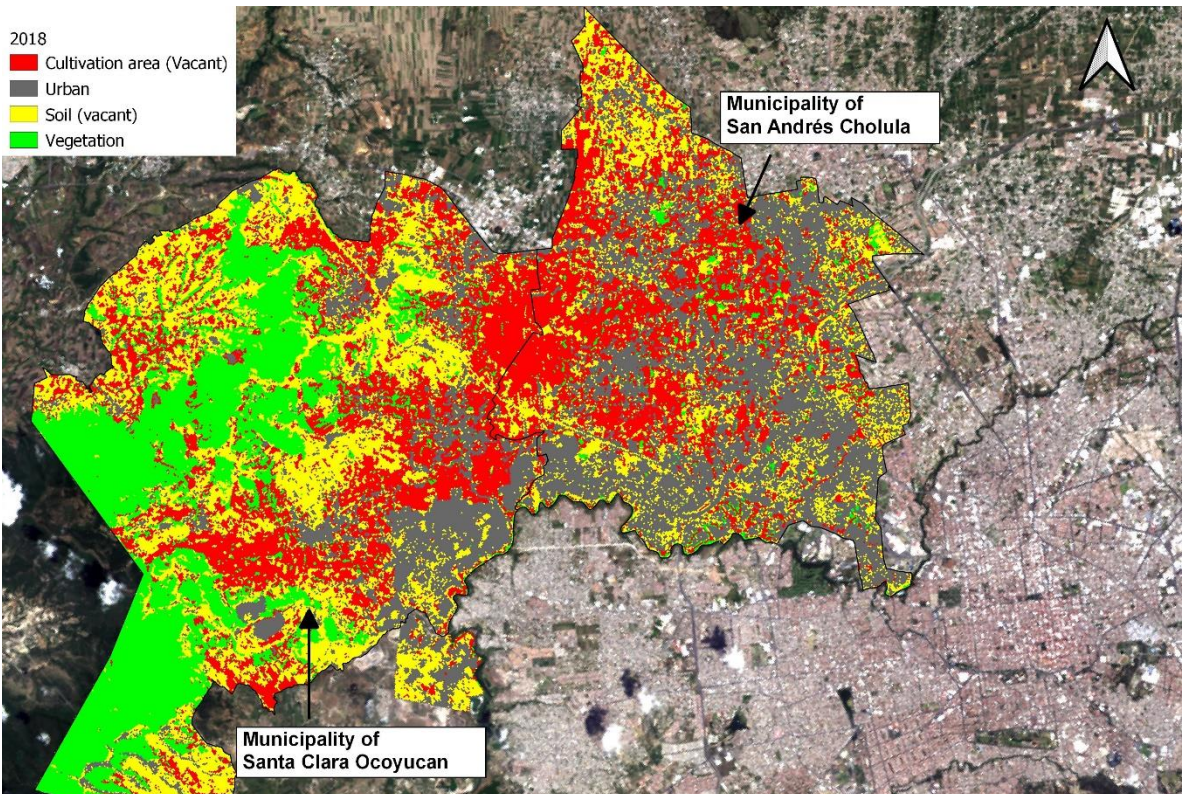
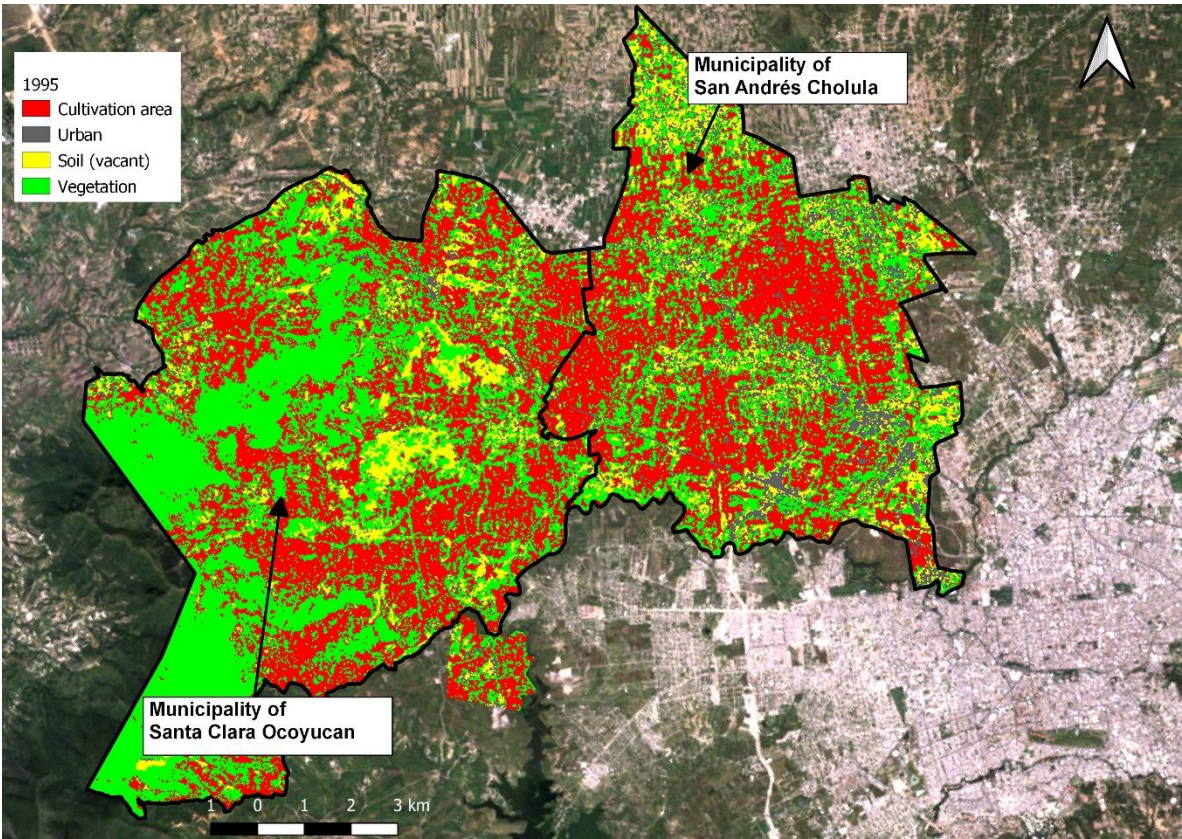


FIGURE 3. LAND USE CLASSIFICATION DATA IN 1995 AND 2018. SOURCE: ELABORATED BY DAVID A. GONZÁLEZ-RIVAS (2019)

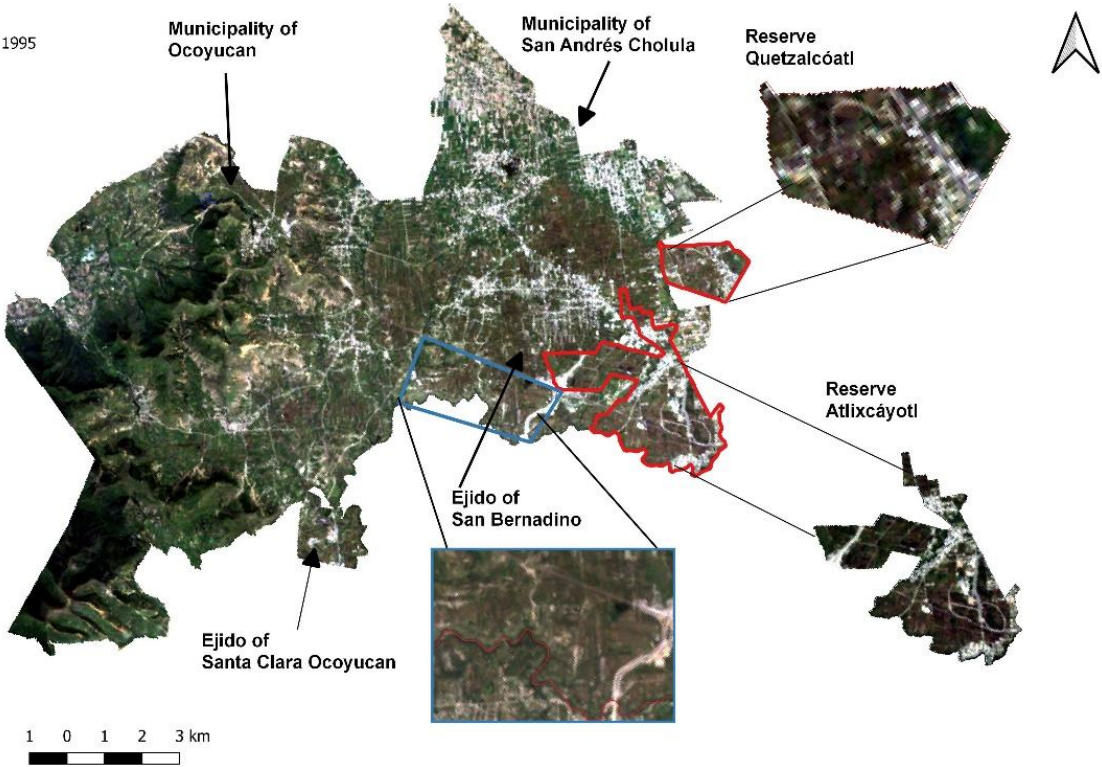
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Ejido Santa Clara Ocoyucan 1995				
STRATA	Hectares	Land use development (Overall Average)	95% confidence interval in Hectares	95% confidence interval in percentage
Cultivation area	6,665	41.70%	562	8%
Urban	1,230	7.7%	203	16%
Soil (vacant)	1,756	11%	234	13%
Vegetation	6,336	39.63%	563	9%
TOTAL	15,987	100%		
Ejido Santa Clara Ocoyucan 2018				
Cultivation area	4,012	25%	255	6%
Urban	4,204	26.30%	343	8%
Soil (vacant)	1,032	6.5%	264	26%
Vegetation	6,739	42.20%	383	6%
TOTAL	15,987	100%		
Atlixáyotl-Quetzalcóatl Land Reserve 1995				
Strata	Hectares		95% confidence interval in Hectares	95% confidence interval in percentage
Cultivation area	811	66%	31	4%
Urban	410	33%	31	7%
TOTAL	1,222	100%		
Atlixáyotl-Quetzalcóatl Land Reserve 2018				
Vacant land (former cultivation area)	447	36%	46	10%
Urban	775	63%	46	6%
TOTAL	1,222	100%		

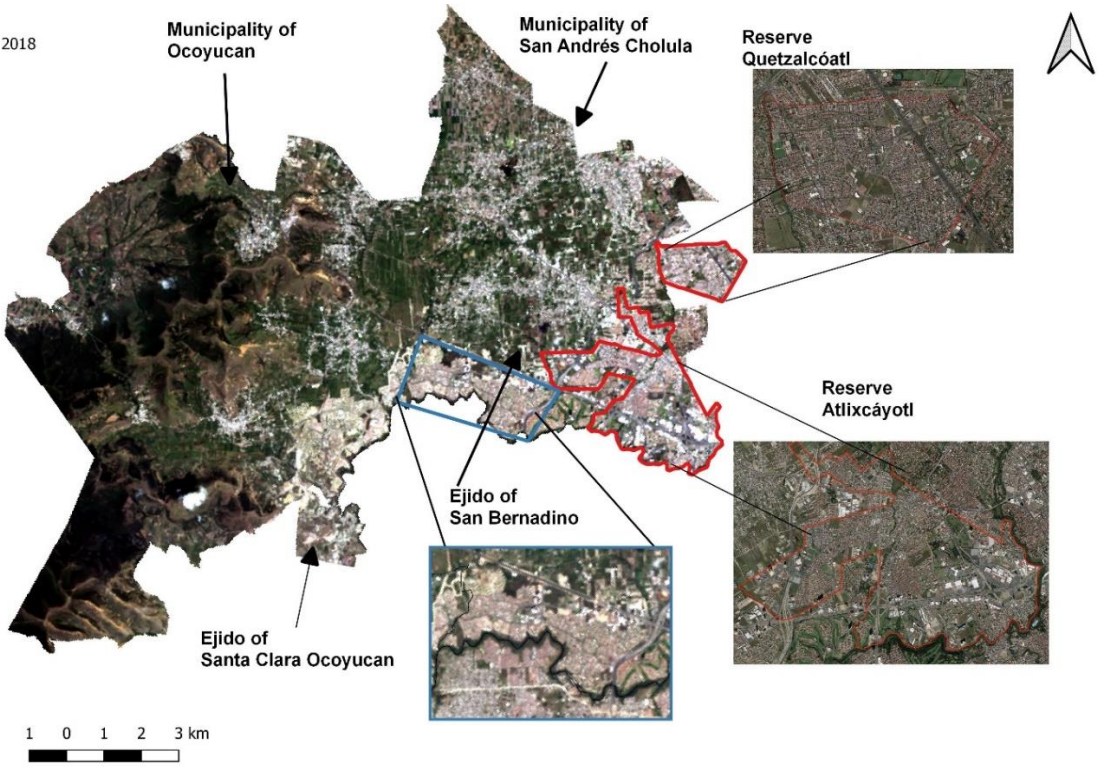
TABLE 5. SAMPLING SIZE CALCULATION FOR THE CASE STUDIES ACCORDING TO OLOFSSON’S METHOD. SOURCE: ELABORATED BY DAVID A. GONZÁLEZ-RIVAS (2019)

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FIGURE 4. SPATIAL DEVELOPMENT IN 1995 AND 2018. SOURCE: LANDSAT, ELABORATED BY DAVID A. GONZÁLEZ-RIVAS (2019)

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5. Results

Through the comparison of the images taken by Landsat 5 and Landsat 8 satellites over a span of 23 years, we observed the land-use changes in the forest areas and agrarian zones of Ocoyucan and San Andrés Cholula.

According to Figures 2 and 3 and Table 5⁷, the land-uses of the aforementioned *ejidos* changed radically. The Santa Clara Ocoyucan *ejido* devoted 41.7% of its territory to farming in 1995, but this had decreased to 25% by 2018. Its urban area, which accounted for only 7.7% of the territory in 1995, increased to 26.3% by 2018 due to the construction of the “Lomas de Angelópolis” gated-community.

In 1995, 33% of the land reserve Atlixcáyotl-Quetzalcóatl⁸ in San Andrés Cholula was classified as urban and 66% as farmland. By contrast, in 2018 63% of the land reserve was classified as urban while the remaining 36% of farmland changed its land-use to vacant land for development. In addition, the Atoyac River was the natural border between San Andrés Cholula and the city of Puebla. However, the cession of 38,100 Hectares of San Andrés Cholula’s land reserve to the city of Puebla in 2014 by the Local Congress [37], changed the territory in shape and value, as the ceded territory in 2019 is one of the most lucrative and expensive areas in terms of taxes and cadastral values [62].

In Figure 2, the land reserve Atlixcáyotl-Quetzalcóatl at the moment of expropriation in 1995 is indicated in blue. According to PSDUM, this land reserve shares boundaries between San Andrés Cholula, San Pedro Cholula, Cuautlancingo and the conurbation with the City of Puebla. The two other main *ejidos* from San Andrés Cholula and Ocoyucan, the *ejido* of San Bernardino Tlaxcalancingo and the *ejido* of Santa Clara Ocoyucan, are delineated in red.

Figures 3 and 4 show the spatial development for the *ejidos* and rural areas in San Andrés Cholula until 2018. It is striking that the land reserve is almost completely built up and developed. For Ocoyucan, the *ejido* demarcated in red is completely urbanized by the “Lomas de Ángelópolis” gated community. In the satellite image, Ocoyucan shows up as a rural municipality with small urban cores, however, this municipality was not part of the PROTA or PSDUM plans, but it was progressively urbanized as a crossing municipality to the city of Atlixco.

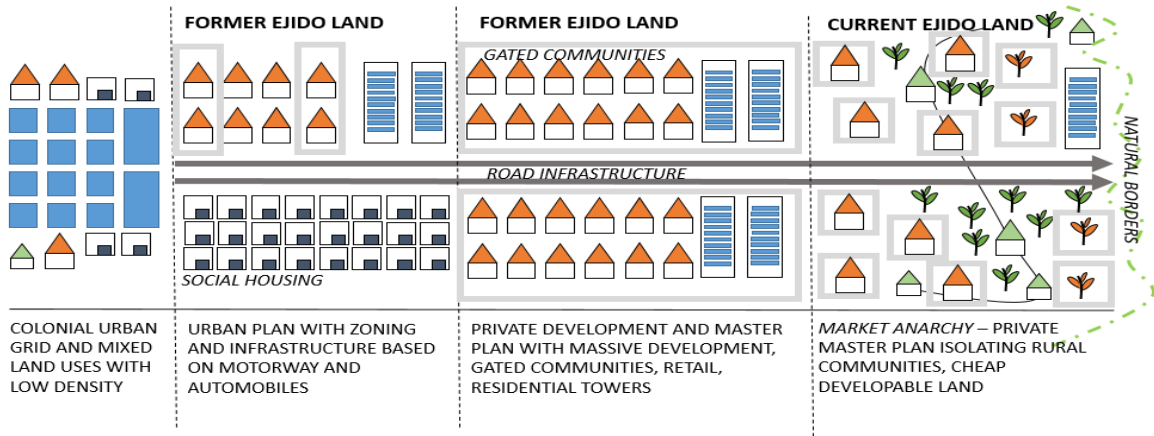


FIGURE 5: SEGREGATION AND URBANIZATION MODEL OVER FORMER EJIDO LAND. SOURCE: MELISSA SCHUMACHER (2019)

The motorway crosses the land reserve from north to south and the “Periférico” crosses from north-west to south-east the Metropolitan Area. Both the “Periférico” and the Puebla-Atlixco

⁷ In Table 5 we counted 1,222 Hectares rather than 1,092 because some selected plots correspond to the Atoyac River as a boundary for the land reserve.

⁸ Shared with San Pedro Cholula and Cuautlancingo municipalities

⁹ The “Periférico” is the peripheral ring or beltway.

motorway were poles for urban development, and most of the master plan and regulations of PSDMU were traced following these two urban thoroughfares. In 1995, Cholula's region did not have a strong physical conurbation with the city of Puebla, as its urban core was encircled by *ejidos*, which acted as buffers for urban growth. However, the creation of the land reserve led to the conurbation through massive social housing projects that finally reached the urban core of Cholula.

The *ejidos* of San Andrés Cholula and Ocoyucan are case studies displaying planned versus private sector development over former communal land tenure. Additionally, the motorway to Atlixco acts as a pole of urban growth, while the natural reserve "Sierra del Tenzo" is the border that prevents gated communities from being conurbated with Atlixco. Despite this, the "Lomas de Angelópolis" gated community is reaching Santa Clara Ocoyucan as displayed in Figure 3.

The Atoyac River is an urban-rural fringe with the municipality of Puebla, which serves as a natural border at the east of the land reserve and "Lomas de Angelópolis". As shown in Figures 2 and 3, this border territory became highly dense and the border that corresponds to "Lomas de Angelópolis" has many informal settlements with low-income socioeconomic groups. By contrast, "Lomas de Angelópolis" corresponds to middle- to higher-income groups.

The Atoyac River runs parallel to the Motorway Puebla-Atlixco and most urban growth follows this sprawl path. Another growth pole is located at north of the metropolitan area following the Puebla-Mexico City Motorway, where the Volkswagen plant is located.

The mixed morphology of the urban fringe comes from the imposition of the urban pattern while the rural parcels succumb to the urban growth pressure. Hence, the process of privatization of *ejidos* is shaping five different morphologies for urban growth, as seen on Table 6.

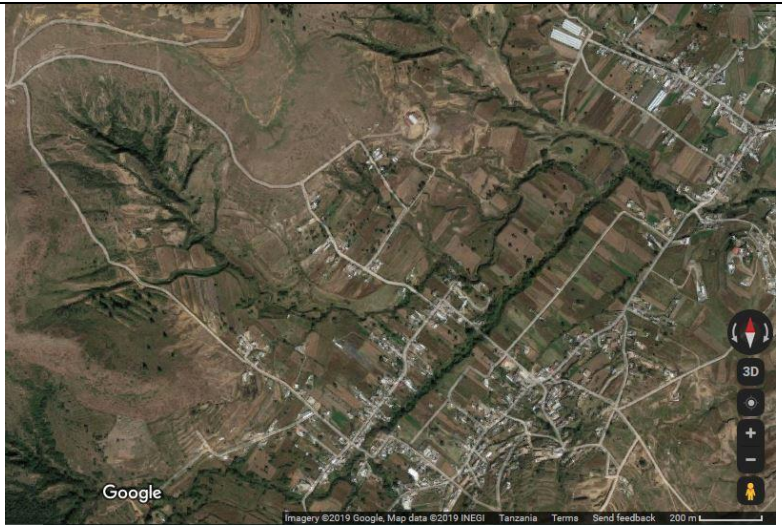

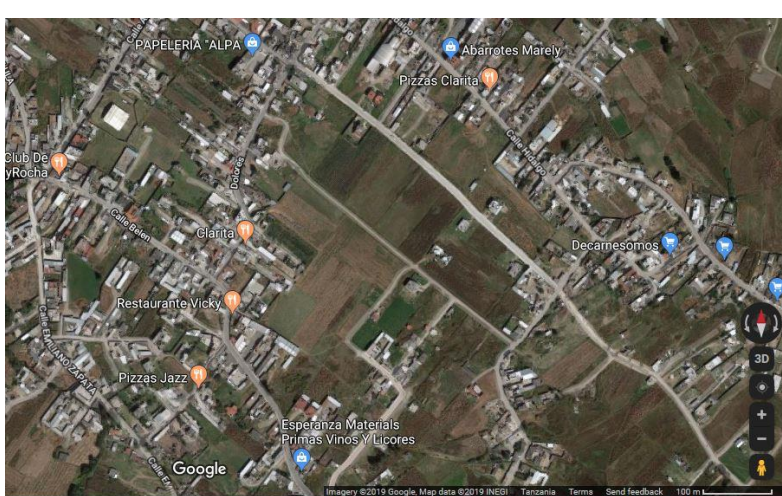
In the *ejido* of Santa Clara Ocoyucan, the rural parcels align in a linear grid network perpendicular to water streams, adapting to the contour lines of the topography. In *ejido* tenure, edification in the productive farmland is not allowed, as a result, rural settlements tend to follow a PE¹⁰ [63] pattern in a linear tree network from a livestock road that delimits the cultivation area of the parcels and encircles the rhithron of the runoffs. The densification of the rural core occurs following a corridor cellular pattern in an organic manner, as in type 1.

When an *ejido* is regularized, the urban growth reaches it and the former livestock roads transform into urban infrastructures activating the edification of single family housing over the farmland plots in a U+P+E pattern, as seen on type 2. As the growth by polarization materialize, the plot is densified with further edification of informal single family houses, typically inhabited by the extended family of the farmer. This marginal urbanization P+E pattern respects the size, shape and orientation of the parcels although it is not necessarily aligned to the roads, thus it follows a free corridor matrix within the boundaries of the plots, as in type 3.

The regularization of *ejidos* catalyzes a land use change from rural to urban. In cases as San Andrés Cholula where *ejido* land of Atlixcáyotl was part of the land reserve for further urban housing, the extension of infrastructures triggered an ordered grid urban growth usually radiating from the different highways and ring roads that fracture the territory and overlap with the rural parcels, thus the edifications tend to be middle-class housing aligned to the parcels and roads in order to occupy most of the surface of the plot. This morphology follows a suburban U+P+E pattern, and could either shape an axial lattice or cell strands depending on the urban clusters and its public spaces, as seen on type 4.

In the case of Ocoyucan, the urban pressure on Ocoyucan from the gated community of Lomas de Angelópolis coming from the west is evident, as the urbanization model UP+E with branched cul-de-sac and crescents street types of the garden city is outlined over the rural land, regardless of the orientation, size or shape of the rural plots of the original *ejido*. As seen in Picture 5, the traced streets of Lomas de Angelópolis remain open for further development over *ejido* land. This shape is archetypal of private tenure, as in type 5.

¹⁰ According to Solà-Morales, U is for Urbanization, meaning the introduction of urban services, furnaces and infrastructures; P is for Parcelation, denoting the subdivision of the land; and E is for Edification of buildings.

Type	Use	Tenure	Image
1	Rural-Farmland	Communal land <i>ejido</i>	 <p>PICTURE 1. EJIDO OF SANTA CLARA OCOYUCAN. GOOGLE MAPS 2019 [ONLINE: ACCESSED 23.07.2019]</p>
2	Rural-Farmland	Communal land <i>ejido</i>	 <p>PICTURE 2. BUILT EJIDO LAND IN SANTA CLARA OCOYUCAN. GOOGLE MAPS 2019 [ONLINE: ACCESSED 23.07.2019]</p>
3	Rural- Informal	Regularized <i>ejido</i>	 <p>PICTURE 3. INFORMAL HOUSING IN EJIDO SANTA CLARA OCOYUCAN. GOOGLE MAPS 2019 [ONLINE: ACCESSED 23.07.2019]</p>

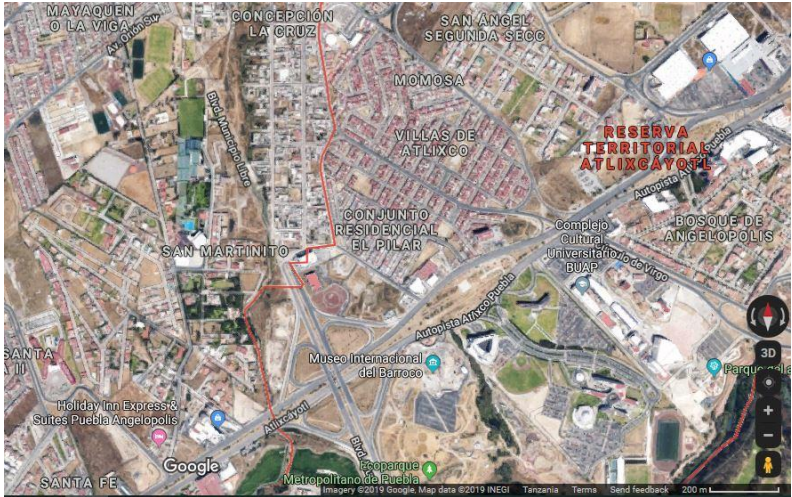
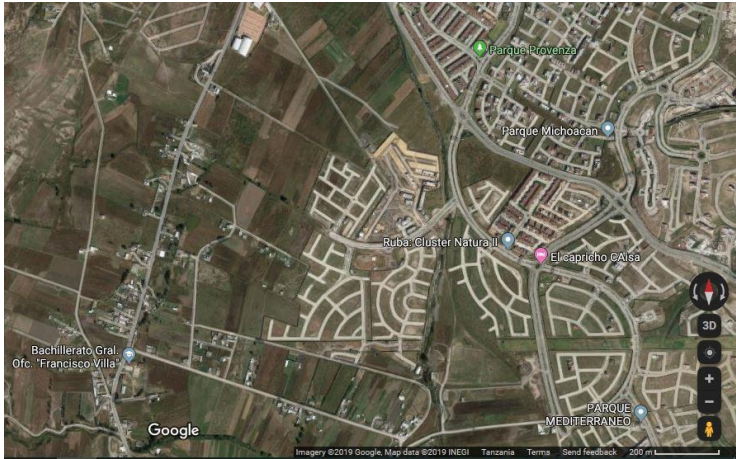
4	Urban-Middle class housing	Regularized <i>ejido</i>	 <p>PICTURE 4. MIDDLE CLASS HOUSING IN ATLIXCÁYTŁ. GOOGLE MAPS 2019 [ONLINE: ACCESSED 23.07.2019]</p>
5	Urban-Gated community	Private	 <p>PICTURE 5. LOMAS DE ANGELÓPOLIS ENGULFING OCOYUCAN. GOOGLE MAPS 2019 [ONLINE: ACCESSED 23.07.2019]</p>

TABLE 6. TYPE OF URBAN GROWTH ACCORDING TO TYPE OF TENURE. ELABORATED BY PAMELA DURAN-DIAZ (2019)

In summary, after the analysis of satellite images, we found that urban growth over expropriated and privatized ejidos engenders sprawl, land speculation and isolation of the original communities.

6. Discussion

6.1 Ecological implications

The current literature suggests severe ecological implications resulting from the urbanization of rural areas and *ejidos*. The rapid urban development of the case studies of Ocoyucan and San Andrés Cholula is linked to land-use changes from rural to urban areas, involves a drastic transformation in the ecology of the landscape and the soil. This has severe ecological repercussions with serious loss of biological diversity in the agricultural areas, including loss of small mammals, birds, reptiles, insects, and plant species associated with different types of crops[64][65].

Similarly, Grimm et al.[66] specify the environmental effects of urban development such as water pollution, air, and soil loss and contamination, either by the use of hydrocarbons or compaction of the substrate for construction, which creates severe changes in the landscape [67]. The population’s health problems are associated with these anthropogenic pressures on the environment,

particularly in respect of water or air pollution [68]. Moreover, the rapid transformation of agricultural and forest areas to urban areas could raise the risk of floods and generate heat islands [69].

6.2 Private Sector Planning vs Rural Fragmentation

Salas Luévano [70] states that the Mexican economy radically changed after the introduction of neoliberalism in 1980. During this period, the traditional model of government regulations, low imports, and an internal market fell into crisis. In the pursuit of a competitive economy on global markets, the Federal Government radically changed public policies through the privatization of government goods, land and enterprises such as banks, telecommunications, services, and communally-based territory such as *ejidos*.

At the time, a neoliberal policy was regarded as the means to improve agrarian productivity through private capital investment. The impacts, however, were both positive and negative on Mexican rurality. Salas Luévano [17] (p.62) quotes Nava Tablada [71] to describe four main impacts on *ejido* land and agricultural economy:

- a) *Reform of Article 27* – *Ejido* tenure system relinquished to private ownership, massive agricultural production, and big national and international capital investment.
- b) *Credit organizations* – Privatization of public credits for the agrarian sector.
- c) *Subsidy policy* – Withdrawal of public subsidies for agrarian products and implementation of social care programs for poor peasants.
- d) *Exportation* – Boost of agricultural products for international markets.
- e) *Social programs* – Poor peasants were excluded from the new economic model, hence had to be supported through welfare.

The implementation of NAFTA in 1994 between Mexico, USA and Canada exacerbated the effects of the four impacts described above. NAFTA agreement should have been an opportunity for the Mexican Government to improve agrarian productivity and reach North American markets. However, as Weisbrot et al [72] demonstrate, the consequences of NAFTA for Mexico show the opposite, since, despite increments in the exportation of agrarian goods from Mexico and international capital investment, NAFTA represented the end of agricultural independence and food security. According to Katz, “family farms in Mexico would not be able to compete with subsidized U.S. production” [19] (p.14). This was the beginning of farmers and peasant’s exodus to other Mexican cities and the USA, and the ensuing abandonment of agricultural activities.

Although the *ejido* system was intended to improve agricultural productivity while upgrading socioeconomic conditions of farmers, the lack of effective policies, tools, technology, reinvestment and government abandonment have pushed the *ejidos* to a financial collapse with and the attendant socio-spatial consequences. The harsh conditions of the agricultural sector worsened in 1992 after NAFTA and a land policy readjustment that transformed Mexican rurality through the implementation of a new land reform, in the name of the ‘liberalization’ of *ejido* land.

Such land reform policy challenged the tenure system in Mexico, perceived as a “critical mediating role in the inter-relationship between humans and the environment” [73]. Article 27 of Mexican Constitution ensured the role of communal land tenure and rural culture among Mexican farmers. This restricted communal tenure facilitated private ownership of *ejido* land, justified by the recognition of tenure rights to *ejido* farmers, the regularization of informal settlements over agricultural land with the aim of adding it to urban land, and the improvement of economic development ensured by NAFTA in 1994. After this year, as Chomsky [74] observed, modern neoliberalism promoted a “private economy”, in which corporations had control of international economy, while influencing the structure of public policies. This trend meant that governments had less influence and control over the market.

As a consequence, an “irreversible urbanization process” [42] was triggered by the privatization of *ejido* land and the subsequent immiseration of many Mexican farmers. This jeopardized agrarian sector survival and merged new socio-spatial processes. Nonetheless, Barnes [73] considers that *ejido*

and rural communities are some of the most resilient communities in the world, for they have been able to adapt and transform their identity and economy.

Joel Garreau [75] points out that this phenomenon prompts the emergence of “edge cities” as a result of decentralization of urban activities together with large housing projects. This view is shared by Robert E. Lang [32] (p.152) in his description of an urban territory that does not present a physical limit; these are extremely dispersed and amorphous territories that have absorbed entire regions with low density and sprawl. What is worrisome is that these new urban and periurban territories represent a socio-spatial struggle when upper socioeconomic groups marginalize lower classes and native communities [33].

The phenomenon that Lang calls “edgeless city”, appears in the galaxy-like urban periphery of Puebla in which constant conflicts between traditional land owners, and real estate developers and local government take place. The evidence of this struggle is the clash between agricultural land and practices and extension of commercial and residential land uses that make the urban border diffuse- where does the urbanization end and where does the rural landscape begin? When the first expropriations began in 1989 in Lomas de Angelópolis area, the price paid for agricultural land by the government was that of 0.90 Mexican Pesos per m². Later on, in 1993-1994, and after the protests by the population of the local rural communities, the price went up to 21.00 Mexican Pesos per m². State government then sold the land to private developers making some profit. Private developers, in turn, were already re-selling the same land extensions as residential lots in 9,500 Mexican Pesos (500 US dollars) per m² [76]. The cadastral values of the land occupied by the real estate business in Angelópolis area had reached in 2017 the price of minimum of 8,044.00 Mexican Pesos per m² in the commercial zone, and 6,002.00 Mexican Pesos per m² in the residential area [77].

Regarding the commercial value, the current real estate advertisements reveal that to date, the best located commercial land in this zone is sold in 19,178.95 Mexican Pesos (1000 US dollars) per m², and in the residential are from 7,000.00 Mexican Pesos per m² to up to 18,000.00 Mexican Pesos per m² [78].What have the local communities profited from this increment of land value? They have simply traded their lands and its usufruct for a ridiculously low amount of money while the private sector is profiting from *ejidatarios*’ loss. As the economic interests are constantly menacing the coexistence between the rural and the urban worlds, socio-economic conflicts arise in the border areas between the different cells of the urban “galaxy”, where the threat for more expropriations is latent.

This condition is observed in the Atlixcáyotl-Quetzalcóatl Land Reserve and in the Ocoyucan municipality, where the upper classes confined themselves inside gated communities to protect themselves from security threats. J. Blakely and Mary Gail Snyder [79] (pp. 153-156) classified three types of these separatist communities: focused on certain life-style, related to free time and entertainment activities, and communities of prestige of people staging their environment to transmit the idea of a certain social status. As a consequence of *ejido* urbanization and land privatization, groups of landowners impose ethical, aesthetic, life-style, and racial limitations inside residential ghettos. Former *ejidatarios* and peasants are forced to sell their lands, leave their rural communities, and abandon agricultural activities to work in services for new householders and landowners. Table 6 is a summary of the positive and negative aspects of the urbanization of *ejidos* in our case studies.

KEY ASPECTS	SAN ANDRÉS CHOLULA		OCOYUCAN	
	Positive aspects	Negative aspects	Positive aspects	Negative aspects
PSDMU (urban plan)	Plan that managed urban growth	Did not consider local needs	New urban land uses that improved tax collection.	Urban plan made to benefit urban developers and urban sprawl beyond land reserve
		Regulations are updated according private development		

Private master plans	National investment	Land-use change to benefit land speculation	Local and National investment in infrastructure and housing	Construction of gated communities and luxury buildings that isolate local communities
Cadastral and market values	Higher market values, more taxation	Speculation with land market values	Added value through land-use change	Cheap ejido and rural land in the borders
Rural communities	Added value to land	Expropriation, migration to the USA and abandonment of agricultural activities Socio-spatial segregation	Added value to land	Land speculation and intimidation by developers Abandonment of agricultural activities Socio-spatial segregation
New incomers	Modern areas to live and work in with private security	Very expensive area to buy or live in	Residential areas with new houses, parks, schools, leisure and entertainment with private security	Not integrated to local communities

TABLE 7. POSITIVE AND NEGATIVE ASPECTS OF URBANIZATION OF EJIDOS IN CASE STUDIES. SOURCE: MELISSA SCHUMACHER

6.3 New urbanization model: private planning and gated communities

As illustrated in Figure 4 and based on the results of the case studies new territorial dynamics are driven by different schemes of land tenure, which means that a strong trend in private urbanization is driving hyper-speculation practices that are leading to an exponential growth of gated communities and urban developments with flexible construction regulations and no local planning.

This leads us to question whether gated communities benefit or jeopardize land management. The logic behind any closed community – regardless of its scale – goes against the principles of a healthy urban tissue. In other words, the mixture of people and land-uses are threatened by the private sector, which is unconcerned with the socio-spatial. Furthermore, this new model implies the arrival of a new urban population and often generates null integration and instead leads to local population diaspora. The collapse of rural identity and the loss of agricultural land, bio-cultural traditions, and the landscape generates what is known as *l'esprit de lieu*.

Urban growth activated by the private sector over former ejido land is a trend initiated by flexible local policies, which enabled land privatization and the transformation of agricultural land into urban. **The role of the public sector and local administrations in this process is highly questionable.** Historically, land tenure was based on the common good for rural communities after the Mexican Revolution, but through the neoliberal economic reforms, land tenure was key for economic development and urban growth. These changes caused the loss of good urban-rural public space as an element that contributes to the construction of a healthy urban or rural-urban fabric [80], as in our case studies. If this common public space is not considered for new land tenure schemes, territories are condemned to the disappearance of public areas as spaces for community and identity construction. Jeopardizing these features entails the loss of socio-cultural cohesion.

7. Conclusions and recommendations

Regarding the recent urban development in Cholula and Puebla, we conclude that the urban expansion of Puebla transgressed municipal boundaries and state limits with the neighboring State of Tlaxcala, reflecting the phenomenon that García Vázquez [30] calls “liquid city”. The notion of a dominating urban core is lost in these gigantic but fragmented and polycentric urban regions. Moreover, as we can see in the case of Puebla, the capital city is no longer expanding through dilatation but by phagocytosis, engulfing existing localities into its metropolitan area. The result is a

series of discontinuities in a galaxy-like system responding to market demands rather than to human needs, as seen in cases such as San Andrés Cholula and Ocoyucan. The resulting fractured urban territory is heterogeneous with alternating urban developments, agricultural zones and nature reserves [14] (p.p. 141, 142).

In answer to our research questions, we conclude this paper with the following statements:

- a) Land tenure change is shaping urban growth and is driven by market pressure and private investment.
- b) Local urban plans benefit private investment based on zoning and urban infrastructure.
- c) *Ejidatarios* are forced to sell due to scattered conditions of agriculture, as their land is transformed to cadastral-based urban land.

Both investors and local land policies are creating a new urbanization model ruled by the **private sector and market forces, who decide where, how, and when land will be developed**. This has its origin in the liberalization and expropriation of *ejido* land 30 years ago and entails no boundaries between formal and informal periurbanization. The trend shows that for local and regional authorities, all rural and *ejido* land is sooner or later developable [19]. This makes creating a productive landscape with desirable mixture of agricultural and urban land uses in a territory with strong rural features almost impossible.

The fracture of socio-spatial fabric because of gated and private spaces precludes encounter and coexistence among communities and contributes to spatial segregation. The geo-analysis and evaluation of both municipalities reflects the dramatic change in land tenure and land distribution for urban purposes, and the satellite diagnoses reaffirm what is observable on the ground. The new urban model is physically represented in the gated-community “Lomas de Angelópolis”. This residential-services project perfectly portrays how real estate operations correspond to business logics that play with an aspirational culture concerned with security issues but eager to improve their life-style. Moreover, this gated-community as an urban model has completely devoured *ejido* land and made it virtually impossible to generate a balance between urban housing demand and periurban and rural communities.

The planning operations carried out by PROTA seem to have contemplated only the participation of the private sector, following an economic-developmental logic valid only for investment. However, the excessive participation of the sector has not only led to *ejido* extinction, also put at risk small rural communities that become isolated in their own territory.

In order to protect rural and *ejido* land from being engulfed by private sector urbanizations, we recommend to reinforce an integrated land policy based on three main areas: planning, implementation and management, where stakeholders are key to improve spatial development and to monitor the implementation of local regulations [19]. Contrary to the traditional linear planning system, we recommend to have the planning as an iterative process with feedback loops. This approach enables the constant evaluation of the municipal plans and programs, while allowing stakeholders and local agencies to participate in the planning. Therefore, circle organizations are necessary to empower citizens to pressure local authorities' accountability and transparency. Without empowering locals, weaker community groups such as *ejidatarios* and farmers will be condemned to marginalization and migration to the USA. Along the same lines, Iracheta [81] (p.254) advises to improve land governance making use of administrative accountability, participatory mechanisms, municipal participation and coordination structures. In Mexico, however, these land management mechanisms are hindered by the lack of liability of municipal authorities that allow flexible regulations.

For this reason, **participatory planning**, in which the different stakeholders take part in making the decisions that would transform their land, is crucial. We thus agree with Schumacher's [17] (p.166) key procedures to integrate land-use and land tenure changes in periurban areas in Latin American countries. First, to implement **priority planning** as an instrument proven useful to protect vulnerable land-uses. Second, the creation of a **socio-spatial unit network** that would integrate rural settlements, gated communities and different stakeholders sharing a collective space. And third, to avoid socioeconomic and spatial segregation through strengthening the **sense of community**, making use of integral actions that recognize local knowledge as an essential and valuable asset.

One of the limitations of this research was the narrow diversity of available official geo-data and sources regarding *ejidos*. Therefore, a recommendation for further research of interest to our research group is to map the evolution of urbanization of *ejidos* in Mexico. Although there are notable examples at regional and local levels of this process, we consider it would be an interesting challenge to crisscross the official geo-data of INEGI, the Agrarian National Registry and the National Institute for Sustainable Land in one map for further analysis.

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