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## **Hybrid Green Corridors in Arid Northern Mexico: Design for a Balance between Ecological and Non-Motorized Mobility Networks**

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### **Introduction**

Urban planning in Mexico has been going through intensive updating by the hand of the recently created Municipal Planning Institutes (IMPLANES). These institutes have emerged in the XXI century as a response to the inability to implement medium to long term planning efforts derived from an urban administration model determined by three year municipal government terms with no reelection as an option. Before the emergence of IMPLANES, decisions pertaining urban infrastructure were determined by mayors trying to leverage brief periods of time in the scale of urban administration and planning. IMPLANES have spent a significant part of their efforts updating the aged and conceptually obsolete –largely based on XX century zoning practices- urban plans of medium to large cities in the country.

One of the frequent components added, as innovations, to the urban plans are green corridors and non-motorized mobility networks conceived as devices to structure what often are highly fragmented urban fabrics. Green corridors are planned on creeks, dry rivers, and rivers. Non-motorized mobility networks are planned on existing streets of various hierarchies. These 2 types of networks, are often planned as separate systems. The green corridors are associated to the production of public space/green areas and the non-motorized systems are related to mobility plans which typically include pedestrian, bicycle, and public transportation alternatives.

The separation of green corridor and non-motorized mobility systems results in plans with complete spatial coverage for non-motorized mobility. But, it also results in plans which have proven to be unrealistic towards implementation. After some years of planning there are very few bicycle lanes built today. As bicycle transportation is slowly being accepted by the population, particularly young people, public budgets continue to be sucked away by expensive traditional car-oriented infrastructure.

The intention of this paper is to propose that a hybrid network composed of integrated green corridors and non-motorized mobility can be more effective as a strategy towards implementation. While the spatial coverage might not be as extensive as the planned non-motorized networks on retrofitted streets, it is a coverage which can be targeted and centered on green corridors which, complemented by complete streets, can both deliver mobility, public space, and ecosystem services.

This paper is the result of the design exploration of hybrid networks in applied academic studios. The inquiry is led by urban studies on 4 northern Mexico cities, 3 of which were supported by design studios in collaboration with the local IMPLANES. These studios fill the gap created by the lack of educational programs in landscape architecture and urban design in Mexico; while serving as an opportunity to learn by serving communities.

The four cities were selected because of two different characteristics in their green corridor capacities: Chihuahua and Los Cabos possess networks already planned on natural drainage ways; Hermosillo and Mexicali have mostly artificial drainage ways found on irrigation and storm water management canals.

All these four cities also share 2 other critical conditions relevant to the production of hybrid corridors: these are all semi-arid and arid cities. According to their urban plans, their average rainfall rates are 262.7 millimeters for Los Cabos; 427.2 mm for Chihuahua; 348 mm for Hermosillo; and 36 mm for Mexicali. Their natural landscapes are mostly composed of grasslands and desert scrub with the presence of trees only on intermittent riparian corridors and on mountain slopes. These corridors and massifs contain spatial and environmental quality but are threatened, destroyed, or polluted by urbanization. The four cities have insufficient green areas. According to recommendations by the World Health Organization, used as indicator by their urban plans, city dwellers need 9 square meters of green areas: Los Cabos has only 4 m<sup>2</sup> per person; Chihuahua 3.7 m<sup>2</sup>; Hermosillo 6.19 m<sup>2</sup>; and Mexicali 2.1 m<sup>2</sup>.

## **Background**

Urban planning in northern Mexico is a recent practice. In Chihuahua, for example, the first urban plan was developed in 1982, with a second update in 1994, and, since then, there has been a more frequent practice of updating of the plan which mirrors the emergence of an interest in urban planning and its newly minted and decentralized institutions such as IMPLAN. Green corridors as open public spaces and green areas have been part of urban plans since the beginning. But even with this, the rivers and creeks have not been integrated into public budgets for implementation. It was until the XXI century when non-motorized mobility became a fixture component of urban plans. But the cities have struggled to implement bicycle lane networks due to a lack of culture, local skepticism, and lukewarm political support. In Chihuahua City, for example, of the original 16.8 kilometers of bicycle lanes built on retrofitted streets during 2007-13, only less than 9 km. exist today.

One important consideration for the implementation of green corridors is the fact that in Mexico, creeks and rivers are within federal control; not local. Any kind of infrastructure to be built within the corridor limits established by the federal government has to be approved by the National Water Commission (CONAGUA). The procedure to obtain permissions from the federal government to do any kind of public work prevents local municipalities from investing in these spaces. CONAGUA is an institution that has historically invested in hard infrastructure –concrete channels- on creeks and rivers directed at the mitigation of flooding caused by excessive urbanization and the lack of prevention measures to maintain capacity. This, paired with an inefficient urban administration that allowed construction, of mostly low income settlements, on creeks and rivers, adds to the complexity to create green corridors.

In this context and for the purposes of this paper, the study, and the studios, the main sources of information have been accessed through the local IMPLANES via the study of the available urban plans of the four cities. In the case of Chihuahua City, a sustainable mobility plan, an urban risks atlas, and a water management plan were additional studies to the urban plan. In Los Cabos and Mexicali the study was mainly focused on the urban plan. In Hermosillo the study had access to the urban plan and a water management study.

Recent literature on greenway design and planning was employed as reference during the design processes.

### **Goals and objectives**

Implementing green corridor and non-motorized mobility networks as separate systems results in a planning approach which produces more linear kilometers of corridors than if compared with a hybrid system which integrates both in relationship to origin-destination, urban structure, and environmental recovery or protection. The modeling by design of these hybrid networks in these 4 cities intends to demonstrate how the savings on linear kilometers of corridors can be reflected on more feasible budgets for the implementation of these networks. As these cities have the physical natural and urban infrastructure which facilitates the implementation of a hybrid network it is also important to consider how the cities can benefit from a shared conceptual approach to a sustainable mobility where not only urban connectivity is delivered, but also public space of quality –in arid or semi-arid cities with little green cover and shade- while positively impacting local culture by placing people closer to nature. The infiltration of green corridors into the urban mantle is the opportunity to improve both environmental and public health.

## **Method(s)**

The design studios followed a conventional design methodology where site inventory was completed first, then it was synthesized into a site analysis. Conceptual design and schematic design were included in the final reports. No construction documents were produced as the projects are intended to deliver design concepts which refine the ideas included in the urban plans of these cities. All studios took advantage of previous site visits and documentation inventory by the author. The studio groups visited the cities as well, and engaged with interviews and presentations with the local IMPLANES, their boards of directors which include local developers, practitioners of architecture, urban design and planning, and educators.

The methods of design had variations determined by each one of the project briefs requested by the local IMPLANES. Los Cabos and Chihuahua requested designs for specific natural drainage ways on a creek and a section of a river. Hermosillo and Mexicali were interested on the exploration of extensive networks including both artificial and natural drainage ways. Both groups were analyzed by design embracing the concept of hybrid corridors.

Generally, the studios analyzed the historical development of the cities and its planning in relationship to their drainage ways. A detailed analysis of the existing plans was performed. The studios employed GIS and CAD tools to study the accessibility and connectivity of green corridors and non-motorized plans in relationship to pedestrian and bicycle ranges, and in relationship to elements of the urban structure which determine areas of origin –housing- and destination –commercial and service centers, industrial areas, and educational areas-. Once the separate systems were analyzed, the overlaying of both was done in order to study where there were redundancies in the networks.

## **Design constraints and findings**

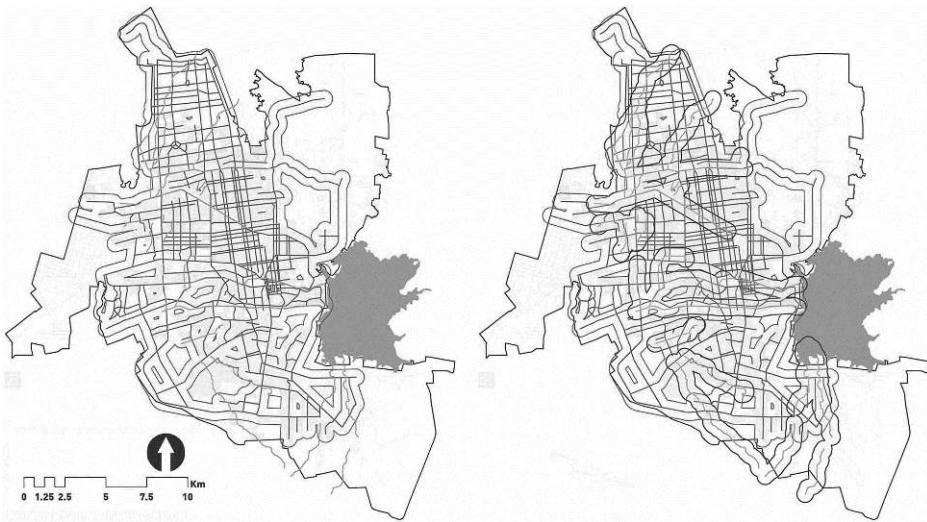
The most recent update of the urban plan of Los Cabos is one of the most explicit in its intent to employ natural corridors as main components of the urban structure for both San Jose del Cabo and Cabo San Lucas, twin cities administered within the same municipal government separated by a 20 mile long stretch of a tourist resort corridor. The studio project worked in San Jose del Cabo, a city of 100,000 people occupying the valley of the Arroyo San Jose. The city from the coast to the north along the western bank of the Arroyo San Jose. The tributaries to the Arroyo San Jose spill down from the mountains to the west, traversing the city at almost regular intervals.

The urban plan of Los Cabos integrates a non-motorized network in a hybrid composition: locating pedestrian friendly and bicycle corridors both on retrofitted streets and on creeks and the river. The studio project was therefore approached as a demonstration project on one creek –the El Zacatal- running through a very low income area of the city. The main concept of the project dealt with how a basin can be divided and programmed by micro-basins delivering smaller projects feasible for implementation.

Chihuahua's project is on the eastern urban stretch of the Chuiscar River, the foundational river of the city since 1709. This section, as opposed to the west section, is not channelized and its riverbed occupied by agriculture irrigated from the river waters. Most of the water in the river is treated water delivered back by two water treatment plants. This 20 kilometer long corridor is in an area with vast territorial reserves for housing and other land uses it is therefore subject to significant urbanization pressure.

The main strategies of the project included the connectivity of the agricultural villages along the river activating agricultural access roads retrofitted as recreational and non-motorized roads; and connectivity to the non-motorized corridors proposed in the urban plan. These river corridor roads were also designed as green infrastructure elements mitigating erosion and pollution coming into the river. Finally, the agricultural areas were preserved as protection against flooding.

Hermosillo's green corridor network was composed by the existing system of storm water management which captures and diverts water from the city to its wester periphery following the slope defined by the Hermosillo river (now a concrete channel through the city center). These corridors are narrow, ranging from 20 to 60 meter in width, including circulation lanes, bike lanes, pedestrian paths, and the drainage ditch. Today, these canals are already informally used by the population as part of their daily mobility networks. The designs visualized three basic corridor types defined by urbanization stages: downtown/core, infill/consolidation areas, and peripheries. The network sought to integrate with large natural elements in the landscape such as mountain ranges, the river, and the created greenery (by diversion of urban runoff via the canals) on the western periphery.



**Figure 1. Comparison between spatial coverage of proposed bicycle network in Hermosillo by its urban plan (left) against an overlay of the spatial coverage provided by green corridors (right). Source: Gabriel Diaz Montemayor and Lauramaria Pedraza Sanchez**

In Mexicali there are very few significant natural drainage ways but a large presence of irrigation canals. There are two different types of canals: one is to distribute irrigation water to agricultural parcels and the other is for the collection of runoff from the agricultural parcels after irrigation. This is a critical difference for making these corridors accessible as the runoff canals contain nutrient and fertilizer rich polluted waters which pose a public health threat. While in the center of the city most of the canals have already been decommissioned, filled, and buried; in the periphery, where the available land for urban growth is, the canals provide with very significant spatial coverage. This spatial distribution makes it feasible to conceive a non-motorized network which can be based in the canal network in the periphery; and based on the retrofit of streets at the urban core.

## Discussion

As hybrid corridor networks as a mobility and ecological strategy are yet to be implemented in the region it is important to note some additional factors.

Los Cabos and Chihuahua, have projects which have a capacity to be re-conceptualized and developed as polyvalent components which can lock in into larger systems from where hybridization can spread into the rest of the network. Hermosillo and Mexicali have projects which exist in extensive

territorial grids, therefore require a comprehensive planning and design approach as multiple programs –urban and environmental- coexist in relatively narrow corridors within complex urban fabrics.

All four cities have, in general, more obvious spatial opportunities on stretches of corridors laying on areas with large vacancies or in the periphery. These peripheries contain low income populations whose needs go beyond hybrid corridors. But this also means that the existing corridors in the periphery are recoverable and more likely to be integrated to the urban structure of future urban growth. A hybrid network with integral spatial coverage can extend from the fringes to the center in a centripetal direction. As the Mexican Federal Government strives to remediate the urban sprawl of the first 12 years of the XXI century –by the hand of the construction of millions of low income housing units scattered in peripheral subdivisions- the time is ripe to leverage federal efforts which are currently proposing higher subsidies for housing in central areas of the city. As the federal government is in control of rivers and creeks, this may be a unique opportunity to pair subsidies with the construction of hybrid infrastructures and networks such as the ones proposed by these 4 studies and projects.

## **Conclusion**

The projects included in this study date back to just 2 years ago (Los Cabos and Chihuahua from 2014, and Hermosillo and Mexicali from 2015). All these were responsive to the local IMPLANES and their interest on finding ways to advance innovative planning ideas towards implementation. To this day none of the projects has progressed beyond the design phase. The Chihuahua project is the one which has at least been presented to the local public. The three others remain in control of the IMPLANES. Beyond the proposition of hybrid corridors, these projects represent one way to attract the interest of stakeholders and decision takers to accept and invest on new urban infrastructures. The impact of the projects and subsequent phases is yet to be seen. This paper is one of the efforts towards implementation.

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