

# CO-DESIGNING INTERVENTIONS TO CREATE AWARENESS AND RESHAPE THE FUTURE IN A MEXICAN SEMIARID AGRICULTURAL COMMUNITY

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## ABSTRACT

The agricultural territory of Nuevas Delicias (Chihuahua, Mexico –29.071248, –106.251566), belonging to the Rio Bravo basin, is experiencing an important water crisis due to the worsening of the extreme climate in this semi-arid region as well as the unsustainable exploitation of the aquifer. While the older generations see this climate challenge as a last condition for agriculture and livestock farming in the region, the new generations seem interested in discovering new ways of experiencing the territory and making it productive, without bowing to the destiny of migration towards the metropolitan area of Chihuahua. Starting from this problematic but hopeful background, the ‘Design for Vulnerables – Technology Challenge’ research group promoted a series of participatory design activities with the community of Nuevas Delicias, for the generation of new practices of agriculture and livestock farming. The co-design process was carried out with five main actors (elementary, middle and high schools, ‘grandparents club’ and the local Agricultural and Livestock Union) and has been structured in six sequential phases: (1) semi-structured interviews; (2) walk around the community; (3) mapping; (4) definition of indicators and vulnerabilities; (5) development of shared strategy; and (6) definition of tech-based project. This paper aims to describe these six phases and their result: an ‘agricultural hub’, which is being implemented with interventions related to composting, urban vegetable gardens, vegetable gardens in smart greenhouses, rainwater collection, generation of electricity via solar panels, measurement of the quality of water, soil and climate, and drones for the control of cattle waterers. Beyond presenting methodology and results, this paper aims to highlight how the co-design process contributes (1) to creating awareness about existing vulnerabilities and possible solutions; and (2) to imagine a new future, where local and global threats are contained by new ways of living the territory. *Keywords: vulnerabilities, semi-arid region, water crisis, agriculture, participatory design, co-design process, technology adaptation, digital divide, urban gardens, architecture.*

## 1 INTRODUCTION

In a society where technological resources are increasingly widespread and have an ever-increasing role in everyone’s life, it is important to understand how we can take advantage of this strong presence to develop interventions aimed at reducing vulnerabilities and the digital divide [1]–[4]. Mexico is a country with great wealth, but with important socio-economic inequalities that contribute to generating conditions of socio-ecological vulnerability and computer illiteracy [5]–[7]. This article describes how an urban-architectural project was implemented in a village in the semi-arid area of the Chihuahuan desert, with the aim of facilitating the introduction of accessible technological resources and reducing conditions of vulnerability.

### 1.1 The arid zone of the Chihuahua desert

Nuevas Delicias (Chihuahua, Mexico –29.071248, –106.251566) is a recent community, founded after the Mexican revolution, with a strong vocation for agriculture and livestock.



Even if it is part of the Chihuahua municipality, the activities are substantially autonomous from the capital of the Mexican state and there are many socioeconomic activities that take place in this village. In particular, Nuevas Delicias is a key centre for educational activities in the region, hosting installations for all three school cycles (elementary, middle and high school) serving villages up to 35 km away.

#### 1.1.1 Basin and aquifer

Nuevas Delicias (Fig. 1) is located in the central part of the state of Chihuahua and, from the point of view of water resources, is part of the 'Rio Grande' basin and contributes to the 'El Sauz-Encinillas' aquifer (SIGMAS – 0807 of the CONAGUA) which has an area of 2,743 km<sup>2</sup>. This region has a temperate semi-dry climate that presents rains in summer with a percentage of winter precipitation between 5 and 10.2 mm [8]. According to the configuration of the depth to the static level for the year 2009 the values vary from 5 to 120 m [8]. If in this context the water quality has satisfactory levels, there is a very relevant problem in terms of aquifer recharge: extractions are much more relevant than recharges (vertical and horizontal). It is estimated that in 2022 (last year available) the extraction estimate was 120.5 hm<sup>3</sup>/year, against an average annual recharge of indicatively 62 hm<sup>3</sup>/year. This is partly due to contributions to the city of Chihuahua from the consumption of drinking water (together with two other aquifers the 'El Sauz-Encinillas' aquifer covers 97% of urban needs) and partly to local needs for agriculture and livestock. All this generates an annual deficit of 58 hm<sup>3</sup> [8].



Figure 1: The community of Nuevas Delicias (Chihuahua, Mexico), with agricultural vocation. Several fields of walnut trees can be seen.

#### 1.1.2 Agricultural system

This deficit puts two things at risk: (1) on the one hand, the quality of life of the residents of Nueva Delicias, who will be able to count on less availability of water (currently they already suffer numerous daily cuts); and (2) the development of productive activities. This paper presents exactly an intervention approach on this last issue. Currently, the main agricultural production of this region is focused on alfalfa (for livestock) and walnut trees (for selling

directly – without value-added processes). Both productions require large amounts of water. Considering the high deficit (and the consequent implications in the growing difficulties in finding water) and the current climate changes (with increasingly longer drought seasons), the community of farmers and ranchers has expressed several times the intention to stop these productive activities and not pushing new generations to follow in the footsteps of their parents, preferring jobs in the city's industries.

### 1.2 The 'Design for Vulnerables – Technology Challenge' research project

For these reasons, the community has been considered to participate in the research project 'Design for Vulnerables – Technology Challenge' that aims to understand how architectural design can facilitate the introduction of technological resources in vulnerable communities. The project is structured with a multidisciplinary team to facilitate a deeper interpretation of the contexts and reaches out to the communities in which it intervenes with a detailed and prolonged listening and co-design process.

### 1.3 Awareness and imagination of a new future: a research question

In previous years, the research team has approached studies of socio-ecological vulnerabilities, observing how the main issue that is connected to these conditions of vulnerability is often related to the awareness that exists in the context about the specific issues [9]–[12]. For this reason, 'Design for Vulnerables – Technology Challenge' wants to define in detail how a design process can not only favour the implementation of an intervention in the built environment but can also provide a process of deep awareness among members of the community itself. Aware of the radical changes in contemporary society and the consequent (also radical) changes in architectural practice [13], these studios want to find new ways to strengthen design processes, so that awareness, empowerment and the ability to imagine new futures are regenerative in the communities in which they intervene. Taking advantage of the great presence of technological resources in society today, 'Design for Vulnerables' requires going beyond traditional co-design processes and technological resources to innovative design processes to deeply impact the most vulnerable communities, through interventions and awareness.

## 2 METHODOLOGY

In line with the research methodology of 'research by design' [14] and considering the well-structured and documented design process as a research process that leads to the generation of scientific knowledge, the research group structured the research process with the following stages.

### 2.1 Approach to the community

Nuevas Delicias is one of the four communities in which the 'Design for Vulnerables – Technology Challenge' project is currently active. These four communities have been defined according to: (1) situations of notable vulnerabilities and potentials; (2) relative proximity to the university campus (within 4 hours of travel); (3) existing contacts with a member of the community; (4) possibility of covering urban, peri-urban, agricultural and forestry contexts. In this context of Nuevas Delicias, the initial approach was with the 'grandparents' club' with whom there was a previous relationship. From this first contact, before beginning the 'six phases' process, contact was made with four other local actors (elementary, secondary, high-school, and agricultural and livestock society).



## 2.2 A multidisciplinary approach

Aware that a single discipline cannot favour the deep reading and interpretation of a territory, we sought from the beginning to structure the work team with experts from different areas. Those involved have been from the following areas: architecture, urban design, design, ecology, medicine, mechatronic engineering, transportation engineering, business, humanities, social sciences, climate change and governance. During the course of the project, experts in the areas of nutrition and agriculture also joined.

## 2.3 The six phases

The methodological structure of the project definition process conformed to six subsequent steps which allowed the objectives set at the beginning of the path to be achieved: (1) building a relationship of trust with the community with which we were working for the first time; (2) generate critical discussions about the conditions of vulnerability existing in the territory; (3) define an urban-architectural intervention based on accessible technology; (4) organize collaborative work between the five actors for project management after execution; (5) a collective vision for a new regenerative agricultural system, in Nuevas Delicias. This process lasted 8 months.

### 2.3.1 Semi-structured interviews

To get closer to the individual residents of the community, semi-structured interviews were carried out to reflect on what were the main issues that were dear to the residents. This first phase of interviews took place entirely in the community, in common spaces (without accessing private residences) and involved only people of age and involved with the five main actors. The maximum number of assistants for a single interview was three people.

### 2.3.2 Walk around the neighbourhood

Once having received an introduction on personal experiences and perceptions, walks were carried out around the community, trying to involve all participants, so that a description of the territory was generated precisely in the context described. This facilitated the interpretation of the environment and the relationships between actors.

### 2.3.3 Co-mapping the community

Subsequently, discussions were organized in which the discussions that had occurred previously were mapped out together with the community: the stories, episodes and main concerns of the community were mapped. In addition to knowing reality more deeply, this exercise had the aim of making residents reflect on the existence and territoriality of phenomena that are often normalized in everyday life.

### 2.3.4 Co-defining the indicators for vulnerabilities

A further exercise to get to know the community more deeply and make residents reflect on local phenomena was a participatory definition of the indicators to be considered for the evaluation of the vulnerability levels of the territory. This exercise allowed the first themes on which to focus the design attention to quantitatively emerge.

### 2.3.5 Co-imagining a solution

Thanks to the previous reflection, in the following months various meetings were held with community actors to define what visions could be hoped for the community in the coming years. These exercises have allowed us to give shape to the 'hub' that we want to promote at



Nuevas Delicias: a place where we can experiment collectively with a new way to promote sustainable agriculture.

### 2.3.6 Co-design the interventions

Starting from this vision of a 'hub', a proposal has been developed for the implementation of some interventions that facilitate collaboration between actors and the development of collective awareness that allows the co-imagined solution to be created.

## 3 RESULTS

The design process contributed directly and indirectly to the implementation of: (1) interventions that modified the community space (in particular schools) and created new skills (drone handling); and (2) training activities born precisely from a new spirit of enabling knowledge and activities around the interventions carried out. Both implementations had the importance of bringing out new considerations about the future of the colony and the possibilities for an agricultural system that is productive, regenerative and resilient to the changes of the near future.

For reasons of space available, this article only presents the results in terms of interventions, leaving out the broader analysis of perceptions of vulnerability, use of technologies and project development.

### 3.1 Interventions

The interventions that were carried out jointly between academic experts, private companies and the community are presented below. Most are located in the village area (Fig. 2). Clearly, the interventions were preceded by projects designed by the research group (Fig. 3).



Figure 2: Map representing the different installations carried out in the village.



Figure 3: Architectural representation of the greenhouse installation project.

### 3.1.1 Drone

To facilitate the overhaul of water troughs and water channels to prevent major leaks, a drone was provided to the local group of farmers who, thanks to this technology, can save hours of work, gasoline, and the dangers of being in these areas for so long and alone (Fig. 4).

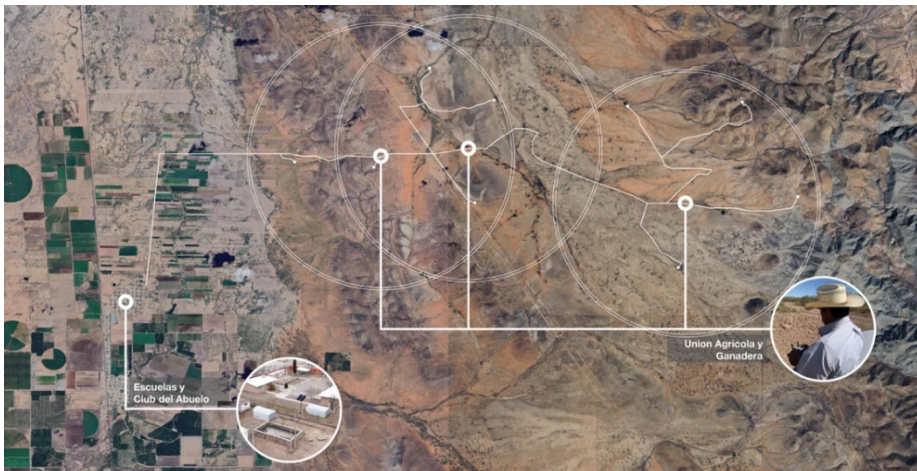


Figure 4: Free livestock area and drone coverage: instead to ride to check all the watering holes, with a drone, the farmers can save time and dangers.

### 3.1.2 Greenhouses

To grow vegetables and fruits within a controlled and sustainable environment, these greenhouses have a wet wall system and an extractor fan to control the climate inside it. The energy required for this system is provided by solar panels; the water comes from rain catchment from the classroom roof. For irrigation, a drip irrigation system was installed that works through solar panels and a water tank that is taken from the rainwater harvesting storage (Fig. 5).

### 3.1.3 Cactus field and drip irrigation

A drip irrigation system was installed for a nopales field at the high school. The energy required for irrigation is generated by solar panels. These nopales are mainly used as cattle feed (Fig. 6).

### 3.1.4 Compost

Since the elementary school has a lunchroom, a composting machine was installed. The idea is to take advantage of the organic waste generated by the cafeteria, converting it into compost that can be used for planting nopales and greenhouses in middle and high school.



Figure 5: Intervention in the high-school and grandparents' club with greenhouses, rainwater harvesting and solar panels.



Figure 6: Cactus garden and irrigation drip in the secondary school.

### 3.1.5 Climatic station

A climatological station was installed at the high school for students to obtain rainfall measurements, temperature, relative humidity, radiation, and wind speed and direction. All this to have comparable data at different times of the year.

### 3.2 Emerging activities

The most interesting thing in this process is that, thanks to the support given from the beginning, all the persons involved at the beginning of the project are still actively participating in the interventions and are taking to promote new activities related to the 'agricultural hub'. These activities are carried out around the physical system that has been built. For example, a series of workshops was organized with urban agriculture experts to learn the appropriate techniques for cultivating self-sustainable home gardens. But activities have also been carried out to improve schools to have new spaces in which to experiment with the technology offered and new forms of agricultural production.

### 3.3 Perception for the future

A further fact that we consider very important and which emerged during the final phases of implementation of the emerging projects and activities is that a large number of students have begun to become passionate about these new agricultural practices. In fact, many students have repeatedly expressed the desire to experiment with new solutions so that agriculture in Nuevas Delicias can evolve to be sustainable again and thus offer a valid alternative to migration towards urban industry. Indeed, this new perception towards a possible sustainable (and regenerative) future of agriculture measures well with the activities that the students themselves carry out to manage the projects they have started: from tending the vegetable garden to experiments with technologies. Even among adults, the grey vision of an uncertain future has begun to change: farmers see the use of drones as an aid (including economic) to their work. Furthermore, we are starting to seriously reflect on the possibility of scaling the secondary cactus garden to an agricultural field, to experiment with this cultivation, combined with drip irrigation technology, on a production scale.

## 4 CONCLUSIONS

The interventions allowed the emergence of a new positive vision for the future and various considerations on possible improvements in the agricultural processes of Nuevas Delicias. It is clear that the main objective in implementing projects that intervene in vulnerable communities is the ability to generate a change in the perception of the vulnerability itself that exists in the social context. The projects must allow the community to break away from normalized processes and visions, in order to collaboratively develop solutions that would otherwise be unthinkable. From this perspective, the objective of governmental and philanthropic initiatives that want to resolve problems in the most vulnerable contexts must be projects capable of creating awareness and allowing communities to reshape their future. In this panorama, some aspects must be highlighted that highlight the importance of the architectural discipline, namely that the design process allows this impact to be greater thanks to:

- Readings of the territory and the context, aided by a multidisciplinary vision, but with a sensitivity specific to the architectural discipline.
- Participation process in which listening and interpreting thoughts can take on a territorial and spatial dimension.
- Reflection, together with the user, to transform ideas and visions into architectural spaces in which community collaboration dynamics can be activated.
- Creation of interventions, in this case based on technology, which are carried out together with the local community, so that they feel completely involved in the process and master the intervention.

The project has already been implemented and the degree of community acceptance is being assessed. This further study will be able to provide more detailed information on specific aspects of the process and understand more deeply the positive and negative aspects of the adopted methodology. Furthermore, as time passes, the actual impacts in the communities and the transformations implemented to materialize the hoped-for image of the future will become increasingly clear.

In the meantime, the research group will study the impact of the project carried out more thoroughly and comparison studies will be carried out with other projects implemented in other contexts ([www.designforvulnerables.com](http://www.designforvulnerables.com)) [15]. Furthermore, it is considered to initiate





new interventions based on the methodology described in similar communities in the semi-arid context of the Chihuahuan Desert.

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