Water Plus

From informal to water-sustainable, from water-sustainable to water-provider

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ABSTRACT: Mexico City is situated on an elevated valley surrounded by a ring of mountains within an endhoreic basin. The urban area continues to claim land from an ancient lake and the surrounding foothills. Major infrastructure has been built overtime to extract seasonal rainfall and sewage out of the valley that has caused severe flooding through the centuries. Even larger infrastructure has been introduced to import water from adjacent basins to complete the insufficient and over-exploited aquifer extraction. However, the city is still unable to satisfy the needs of its over 20 million population, thus creating the paradox of this increasingly thirsty metropolis, developing within a flood plain: Its simultaneous lack and excess of water.

Rainwater falling on the surrounding hills infiltrates the soil, to refill the aquifers, and runs through streams that go into the sewage system when entering the urban area. Informal-settlements grow on these foothills, occupying former co-opted lands. They have gradually consolidated, progressively achieving basic urban infrastructure and legal ownership of the land, but they still face acute water scarcity and have a negative influence on water running downstream.

This project conducts a study of one of these communities. It analyses its water balance and its physical and socio-economical conditions in order to produce alternative solutions. First, one where water needs can be provided through rainwater harvesting and water reuse: Water Zero. A second one, where the negative influence on water running out reverts to become a clean water source for downstream communities: Water Plus.

A non-governmental organisation (Isla Urbana) working within the community, has developed and installed appropriate rainwater harvesting systems. Through the evaluation of its vision, methods and performance, this project aims to produce a community action project methodology that can provoke the community's evolution towards water sustainability.

Keywords: Sustainable Water Use, Informal Settlements, Mexico City, Sustainable Urban Ecosystems, Community-Action Project Methodology

INTRODUCTION

Mexico City's water infrastructure is not large enough to provide drinking water to its almost 20 million people and it is not up to the task of evacuating the enormous volume of seasonal rainfall.

Mexico City's valley is situated 2240 meters above the sea level. Its original lake has been artificially drained to provide growing space to one of the world's largest cities. From Tenochtitlan, the Aztec lake city, to today's megalopolis it has gone through several very different growth phases. In the 1970's population increased by a factor 4 times in just ten years. That growth spurt was so severe that the city has been struggling and failing to provide needed infrastructure ever since.

People outside the formal real-estate market have developed informal settlements on any free land they have found: land without basic urban services, often in risky areas or within environmental protection zones. These slums have developed at high speed in Mexico City's periphery and have undergone alternating periods of repression and tolerance from the city's authorities.

Many of these settlements have by now acquired basic services like a water distribution network, paved streets, schools and small clinics through community organizing, but some still lack these most basic features. The installation of water networks does not mean people have running water in their homes. The service is intermittent at best, and weeks can go by without water coming out of their faucets.

District authorities or «Delegaciones» truck water tankers up to these areas and people store water in plastic containers. But not even this municipal supply is enough and neighbours have to organize and privately buy additional water to satisfy their needs, consequently paying the highest price per litre of water in the metropolitan area.

The mountains that surround Mexico City's valley are covered with forests through which springs and rivers run: a precious source of clean fresh water that feeds the lake system. Like other cities around the world, Mexico city grew swallowing its rivers, transforming them into sewage, eventually covering them up for hygienic

reasons and to give way to avenues and freeways that ease urban traffic.

The sewage filled pipes that replaced the original rivers are emptied through an opening that exits the water basin. They feed an artificially created irrigation district in the neighbouring state of Hidalgo, from where they flow into the gulf of Mexico.

Many of the Informal settlements have developed on the foothills of the valley's surrounding mountains, colonising forests where rainfall is more abundant. Evidently, this has had a detrimental influence on the environment; waterproofing precious water infiltration land, accelerating and expanding storm water flow to the central city, polluting the springs and rivers that still run downstream.

According to Mexico City's Land Management and Environmental Attorney (PAOT), Mexico City's urban sprawl has swallowed one hectare of forest per day through the las 60 years. In the two decades between 1980 and 2000, 76% of the new houses were built on "Conservation lands".

This "Conservation Land" is a protected natural reserve that belongs to the "Corredor Biológico Ajusco-Chichinautzin" one of the world's primary nature conservation regions for it houses 2% of the world's biodiversity and provides almost two thirds of the water used in Mexico City's Metropolitan Area. Ancient Mexicans clearly understood the importance of this forest, naming it "Ajusco" from the Nahuatl word *Axosco* which means "where water springs" or "water forest" [1].

It's clear that continuing colonisation of forest lands would be disastrous and the Informal City spread needs to stop, but even if it did, future development and growth of existing communities is a fact we need to address as architects and urban planners.

As planners we are looking for opportunities that can trigger alternative ways of development. We want to find ways to help our cities become sustainable. Around the world, the need to develop models that guarantee a satisfactory quality of life for everyone within the natural limits of our planet, has inspired the conception of new neighbourhoods. Newly recovered railroad or industrial brown-field lands in different European cities are providing urban opportunities within downtown districts. Many of these opportunities have given way to sustainable urban developments. In the Mexico City Metropolitan Region (ZMCM, for its Spanish initials) communities whose infrastructure problems need an immediate solution, the need for clean fresh water can be the engine for evolution to an alternative sustainable way of using water and can provide this urban opportunity.

Understanding that these communities are fertile soil for sustainable urban development in Mexico City and for all the people living at the margins of the global south's emerging cities, this project aims to find how we can empower a particular community and accompany it towards an alternative sustainable water management. This management incorporates rainwater harvesting and storage, local storm-water management and water treatment, reverting the negative influence on the springs flowing downstream to provide the full community's water needs and to become a fresh water provider through clean down flowing streams: Water Plus.

This paper proposes a Community Action Project Methodology where an interdsiciplinary team can co-develop the technologies and projects that can be appropiated by and become part of the future users' culture.

INFORMAL SETTLEMENTS IN MEXICO CITY

« A slum is not merely an area of decrepit buildings. It is a social fact» [2]. «More than a billion people live in informal cities in today's world; and a billion more are expected to move in» [3]. Informal settlements occupy 40% of the total ZMCM's territory and form 52% of its housing zones. They are between 10 and 22 years old (Environment Secretary SME Environmental Protection Program for the Federal District 2002-2006) and 20% of them are estimated to occupy high-risk zones on cliffs or riverbeds. 68% of these irregular settlements are on three Delegations: Tlalpan, Cuajimalpa and Xochimilco [4]. All three delegations are mostly on "Conservation Land"

Different attitudes to the sprawl of Informal Settlements have produced different reactions from the city authorities. They have been considered an urban sickness, leading to "bulldozer" action, but they have also been acknowledged as a complementary counterpart to the formal economy in developing countries. For Abrams (1964, 1966) informal settlements have to be understood as the result of people's struggle for housing, a struggle that should not be ignored on the contrary it should be capitalized [5]. This later vision has led to

regularization and urban infrastructure introduction programs for illegal settlements. The World Bank and the United Nations have promoted and financed these kinds of policies.

Resilience is the ability of a system to absorb disturbance and still retain its basic function and structure. In a world threatened by economic crisis, depleition of natural resources, diminishing biodiversity and climate change, sustainability depends on resilience [6].

Informal settlement's resilience is based on an enormous capacity of self-construction after disasters. Being deprived of the most basic tenure of their premises, the poor of global slums have hardly any rights, yet they live in an ecosystem where nothing is wasted, nobody is unemployed and things somehow work. Their study and the lessons to be learnt to improve their needs in security, health, energy, food, water, might be essential in determining the resilience of our future urban ecosystems [6].

In Mexico City's foothills, informal settlements on "Conservation Land" affect the entire ZMCM's access to vital resources. There are not many options when trying to find a balance between the needs of all the citizens. Are their alternatives to the informal settlements' repression and eradication if we want to reduce their impact on the natural balance of the forestlands?

In the ZMCM, eight million residents (40% of the total population) suffer from inadequate water supply, many of them waiting weeks or months for a single drop of water to fall from the faucet [8].

Need drives action, action drives learning, creating community leadership which can affect positive change. Communities within the informal city have developed grassroots initiatives that have been able to obtain official ownership of the land for their residents. After organising and obtaining some basic services they have kept on working to become a place where the next generation can expect a better quality of life.

The rational use of resources is already part of the Informal Settlements' culture. These settlements have understood before others that water resources are limited and have adapted by adopting rational water use habits. In order to be able to become a Water Zero community it is primordial to acknowledge the scarcity and preciousness of clean water. This consciousness is part of the Informal City culture.

Understandably, the detrimental influence of these communities on the basin's water resources is not yet a source of preoccupation for people whose priority is still surviving everyday. One way to change this attitude can be to reward them for their positive influence on their urban context. Rewards can take the form of "Environmental Services Payments" or even the creation of jobs related to water harvesting, treatment and reuse. Creating a purification and distribution of bottled drinking water could also become an interesting source of income for them.

We can learn from informal settlements, from this non-official unplanned processes or "Emergent Urbanism". Emergent urbanism contrasts, or at least complements conventional urban planning. The "emergent" surges mostly in a self-organized way and as a consequence of interaction and collaboration of diverse human groups. Citizen participation is an engine of the whole process, starting as debate and deliberation and more importantly turning into direct action to build the city [8].

WATER ZERO AND WATER PLUS COMMUNITIES

Communities throughout the world are using more than their Renewable Water Resources, they are consuming their *Fossil Water Resources*. Many of these communities in the developing world are still not being able to supply potable water to their entire population. Our cities' water systems were conceived in a different historical moment, in an era where resources seemed unlimited. Deep changes are taking part today. Further changes are expected with climate change: rising global temperatures are expected to deepen water scarcity problems that already exist throughout the globe.

Today's urban metabolisms have increasing resource needs and produce more and more excreta. We need to radically change the way we conceive our urban systems in order to keep our urban ecosystem resource needs within renewable source limits.

Water Zero and Water Plus communities' water management paradigm starts with the acknowledgement of the scarcity of potable water: Rainwater is no longer overlooked as a primary water source. All the water that can be caught on clean surfaces is harvested and stored. Water falling on streets and other impermeable surfaces

does not run-off downstream to join other communities' storm-water in the city's sewage system. Run-off water stays in appropriate spaces where it can infiltrate naturally into the aquifers before it gets polluted while travelling through miles of streets down to the sewage. The community understands the environmental service it can give to the entire water basin by stopping this rainwater from flowing into the sewage and by letting it refill the underground water sources because it gets remunerated for it.

By being conscious of the big benefits rainwater can bring to the community, the way used-water is looked upon changes as well. Treating and re-using water has a very important freshwater saving potential. Awareness of the real value of clean water makes people realise they don't want it for activities where treated water is perfectly efficient. High demand water uses like garden irrigation or toilet flushing can be perfectly covered with appropriately treated water.

Within Water Zero and Water Plus communities, resource needs are reduced and fulfilled using renewable sources. Excreta are reduced to zero through treatment and re-use.

WORKING WITHIN THE COMMUNITY

«Design and technologies for sustainable development have to be effectively appropriated whilst responding to the social needs and the realities of the beneficiaries» states the Cooperation and Development Center of the E.P.F.L. [10]. Complex urban strategies cannot be created in-vitro in a laboratory without the direct participation of the future users. Being an "agent" of change and not an isolated "product creator" is crucial to the product's future acceptance and appropriation by its final user, and this is the architect's or designer's role in the «Design Thinking» methodology. Developed by Tim Brown, this methodology uses the «designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable economical strategy can convert into an appropriate product» [11]. It is a human-centered collaborative methodological model based on successive divergence and convergence cycles where simple prototypes are iteratively produced and evaluated.

According to Freire (2009), the "Design Thinking" methodology can be a good tool to create the conditions where «Emergent Urbanism» can flourish. He states that in order to obtain the best results we should design the contexts within which social interactions, individual and collective work can thrive through the creation of innovative and resilient organizations [8].

Isla Urbana is a Non-Profit Organization that works within the informal settlements on the Ajusco's foothills in Mexico City. Isla Urbana's team has developed a low cost, easy-to-install rainwater harvesting system which is installed on individual households. These RWH systems provide a family with about 50% of their annual water need. They are developing a method of widespread implementation of rainwater harvesting in Mexico City. This implementation method includes training local plumbers, using only local materials, and working closely with the beneficiaries to train them on the maintenance and use of their system. Isla Urbana's RWH systems are low-cost, are installed in about one day, are easy to maintain, and provide clean water for all household uses.

The non-profit organisation is a multidisciplinary team of designers, engineers, urbanists, and sociologists who work closely with the community, local businesses, non-profits, non-governemental organisations, and the Mexico City government to facilitate the widespread adoption of rainwater harvesting as a viable solution to the water crisis [7].

Through Isla Urbana's presence and methods « Water Zero » and « Water Plus » strategies will be developed using « Design Thinking » processes. Opportunites will be deeply documented in-situ in order to co-develop prototypes that will be validated and corrected with the beneficiaries. This working methodology itself will be tuned and validated throughout the project.

OPPORTUNITIES

The strategic key to sustainable development resides on a culture of environmental resource value within the citizens, and not on some supplementary technical protheses [12]. We believe that only citizen participation and understanding will permit sustainable water management in informal communities. With a set of possible solutions or «seeds» we will approach the community to understand which of these technologies are pertinent and how they can be adapted to answer to its specific needs and capabilities.

A preliminary water-balance analysis of a small community within the informal settlements on "Conservation Land" of the Ajusco foothills indicates

that the entire water needs of the population can be provided through rainwater harvesting alone from June to November. The community for this preliminar study area is a neighborhood called «Colonia Bosques» (Fig.1). It is located close to the limit of the non-urbanised «Conservation Land», on the higher and steeper areas within the Ajusco foothill's informal settlements. The preliminar water-balance of one typical block in «Colonia Bosques» shows that if we additionally include reuse of treated water for toilet flushing, exterior cleaning and watering, rainwater alone can cover the community's full water needs all year round (Reduced Water Supply). (Fig.2)

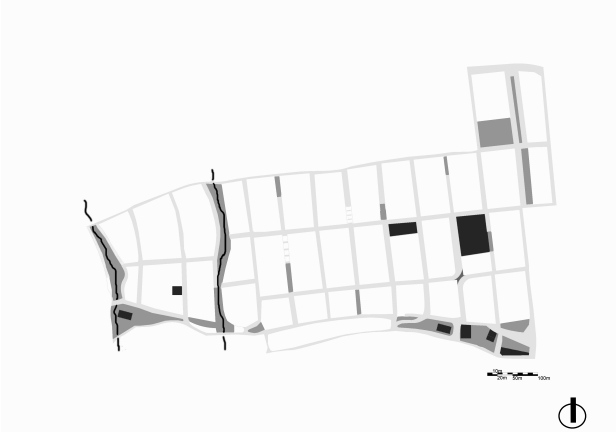

Figure 1: «Colonia Bosques»:Open green areas are marked in gray, community services and buildings are marked in black. On the left, two intermittent streams flow down towards the valley and the city.

This preliminary balance was obtained using available data: Water needs are 120lt./person/day, Tlalpan's yearly average rainfall is 944mm (The local rainfall should be higher). Water use is supposed based on studies done by WWF in Belgium: 35% for showers, 35% for toilet flushing, 14% for clothes-washing, 7% for dishwashing, 2.5% for drinking and cooking, 6.5% for other uses: cleaning, watering. Urban surfaces were calculated using information found in public GIS and geo-referenced pictures made available by the National Statistic and Geography Institute of Mexico (INEGI for its spanish initials). Demographic information comes from the same source. These data has to be validated with that obtained through fieldwork but it already suggests interesting opportunities.

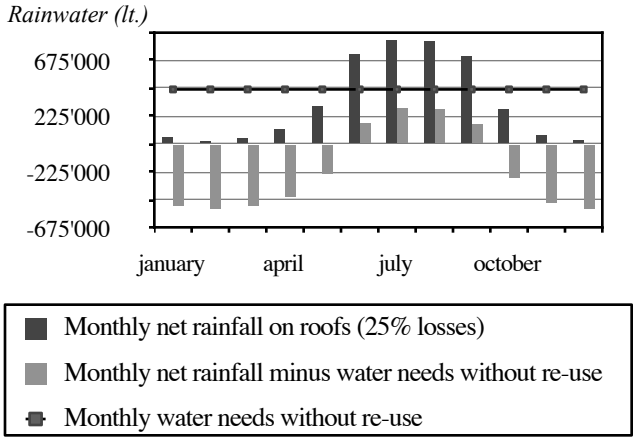

*Figure 2: **Rainwater harvesting potential and water needs.** Without the re-use of water, even if all the rainwater was harvested and stocked, year-round needs wouldn't be fulfilled. Rain harvesting alone can provide enough water through the rainy season. Stockage volumes only need to be enough to last the few days with no rain.*

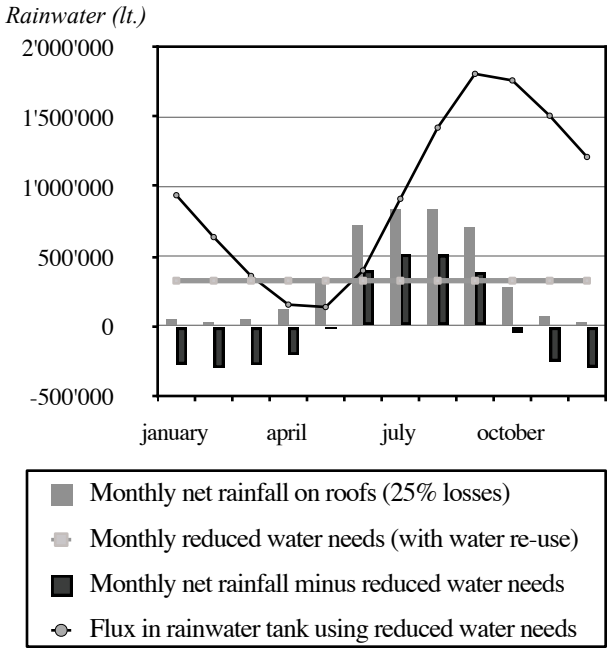

*Figure 3: **Rainwater harvesting potential with water re-use.** When water is re-used for suitable activities, rainwater is enough to supply the the community's needs throughout the year. The water stockage volumes become very large to last through the dry season.*

COMMUNITY ACTION PROJECT METHODOLOGY

Urban Think Tank, a urban design laboratory that has been successfully developing strategies in slums

advocates for users, agents of change. This change must be accomplished thoughtfully and carefully, one step at a time, so as to be viable and sustainable» [9].

Informal settlements will become Water Zero and Water Plus communities one step at a time. Hypotheses or preliminar possibilities for each step will be proved via community workshops and provide for the first prototypes. Theses prototypes or possible water management options will be developed, then tested, modified and made better continously. In these workshops stakeholders from the community, environmental protection institutions, City Authority representatives and other organisations will sit together with the designers to define the appropriate strategies.

The first step is the introduction of individual roof rainwater harvesting and stock. This first stage is already happening through Isla Urbana's action within the community. This first step is already providing water for its users throughout the rainy season (June to September). Rainwater is enough to provide the full year's water needs but its seasonal concentration makes individual complete stock impossible. The second step is the development of community year round stocks that will receive individual stock overflows on the most humid months. These stocks can take the form of reservoirs under successive stairs and squares on streets that are too steep for cars, or they can be dug under basketball courts or school playgrounds. The adequate solution can only come from the community workshops. With this enhanced rainwater reserves, the community will be able to provide its water needs for 6 months. The third step is the development and implementation of water re-use technologies within households that will permit using adequately filtered wastewater for toilet flushing, watering and exterior cleaning. At this stage, the community's full year water needs can be fulfilled with rainwater.

Having solved the access to the water needed, now the community has to revert its negative influence. The fourth step will be to find the adequate community remuneration system that can provoke incentives to deliver clean water to streams flowing down. This incentives should at least be enough to afford suitable run-off water ways and infiltration spaces. The last step will be the introduction of water-treatment systems that will empty bio-compatible treated waters into streams and other bodies of water.

CONCLUSION

"Territory is a work of art. Maybe the most noble and the most collective work of art humanity has ever made… Territory is the product of a dialog between living entities, humankind and nature through history" [12].

This paper notes that the presence of informal settlements in the Ajusco foothills creates significant resource problems that need to be addressed to arrive at a sustainable solution, and that such a solution will only come about through a holistic approach that involves the inhabitants themselves and their power to influence their own urban environment.

Reciprocal learning takes place, we learn from the settlement's resilience, organisation and self-building capacity and the community enhances its awareness on its influence on the natural and urban contexts within which it exists. Very interesting affordable technology co-development reside within this reciprocal approach.

Houses in Mexico City's informal settlements are not built to comply with building codes and without getting any sort of building permit, and yet, the basic building module, a 4m. by 4m., 3m. high room is put together with the proper columns and beams for adequate earthquake resistance. We assume such earthquake building know-how is passed by word of mouth by the many construction workers that inhabit and self-build the settlements. This knowledge is now part of the informal settlement's culture and houses will continue to be built this way without any need of external intervention.

And this is exactly the goal of the Community Action Project Methodology we're proposing, to work holistically with the community to get to a point, a day when without knowing who, how or when these "ways of using water" were introduced, they will reproduce themselves sustainably and durably, adapting to new times and uses.

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