WaLi Water for Life

Exploring Urban Landscapes for Water Harvesting with New Technologies

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TensiNet Association | Eu network for all parties interested in tensioned membrane construction (Brussels)
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PROJECT DESCRIPTION

Water resources are the core of any sustainable development, but they have been highly affected by unsustainable development and lack of appropriate government policies, and that brought the constantly increasing demand for fresh water. If the balance between demand and availability of a limited resource will not be restored, the world will have to cope with a dangerous global shortage of water.

The aim of WaLi project is to propose an alternative solution to the increasing problems of water scarcity, through fog harvesting technologies, therefore taking inspiration from nature, and demonstrate that this solution could be applied at the urban scale for different purposes.

The main goal of the project is to create an alternative, innovative solution to conventional fog harvesting devices. The project investigates a wide range of relevant cases of Fog Water Harvesting, in order to establish parameters to identify urban and regional contexts where to define design strategies. It defines the framework of social and economic feasibility of fog harvesting technology integration into urban context, and the study of the most promising textile materials. The result includes the development of novel concepts of integration of fog water harvesting elements into and collective spaces, the definition of scenarios on the expected effects of the project in terms of regeneration, activation of places, raising awareness and possible consequences.

If in developing contexts the availability of water profoundly changed social relations, in the developed one it is expected to rather create a “green” conscience in the wider public and start a network of sustainable approaches to resource extraction and replenishment.

Also noteworthy is the landscape and cultural impact of such devices. The design idea developed is also meant to become relevant in specific contexts, thanks to multiple functions, offering locals designed and customized urban furniture, a place to have leisure time and creating a landmark, one that can rather become distinctive, promoting its image worldwide as a sustainability model.

TASKS AND SKILLS

Lucas Bandeira Calixto - state of the art research (fog water harvesting, case studies), problem detailing (location selection, stakeholders), design solution(location)

Runze Li - state of the art research (fog collector components), problem detailing (location selection), design solution (elements of the design, business model canvas, framework of social and economic feasibility)

Federico Lorenzon - state of the art research (fog collectors morphology), problem detailing (stakeholders), graphics

Sara Miladinovic - state of the art research (fog water harvesting, case studies), problem detailing (scenario identification), design solution

Gloria Morichi - field of research, state of the art research (fog collectors morphology), problem detailing (scenario identification), design solution

ABSTRACT

Water is critical for the sustainable development of our society, regarding social, economic and environmental progress. However, water resources are limited, especially the fresh water. And, the global water demand is anticipated to increase by 55% by 2050, because of population growth, urbanization, food and energy security policies and climate change. Moreover, different regions in the world face with various water problems and degree of severity and are already in need of some efficient alternatives.

One of the most promising solutions is fog water collection and in order to understand its functioning, different fog forming processes are studied, as well as efficiency, determining factors for its success and the typical and most common design and construction of the devices.

Further on, five fields of study (agriculture, urban design, building components, domestic use and outdoor activities), where fog harvesting techniques could be applied, have been considered. We also took into consideration different parameters, such as economic benefits, possibility of mass production, life cycle, market attractiveness and sustainability, for each scenario both in European countries and non-European ones. After a SWOT analysis, urban design field was chosen and a pilot project location was proposed among eight places from four continents.

Then, in the design phase, a modular hexagonal structure is considered. It is multifunctional and can be combined into complex structure, customizable according to different functions and users, being able to meet requirements of different contexts. While detailing design specifications, a business model was elaborated, to show the relationship among activities, partners, customers and revenues and a promotion strategy was presented to increase the customer segment, attract investors and increase water issues knowledge. In the end, socio-economic feasibility and sustainability of the project are also analyzed.

In conclusion, the implementation of fog harvesting technology into urban design devices is a new idea that, even if the requirements for its application differ in relation to the context, have high chance of improvement and large possibility of generating a positive impact on urban water resource management. Since in European context, water scarcity is not perceived as a problem yet, a possible perspective of lack of citizen's interest in the project pushed the design towards a solution mostly aimed at attracting people with an interactive and multifunctional proposal.

UNDERSTANDING THE PROBLEM

The term 'water scarcity' can be defined as a lack of water quantity. Climate change is a central external driver that affects both water and demands for all uses directly. In this context, fog has the potential to provide an alternative source of freshwater in many dry regions. Fog can be defined as thick cloud of tiny water vapor condensed into small water droplets suspended in the atmosphere at or near the earth's surface. The small water droplets present in the fog precipitate when they come in contact with objects.

Fog collection is essentially any activity that collects water condensed out of atmospheric water vapor. Numerous plants and animals use textural as well as chemical features on their surfaces to harvest this precious resource.

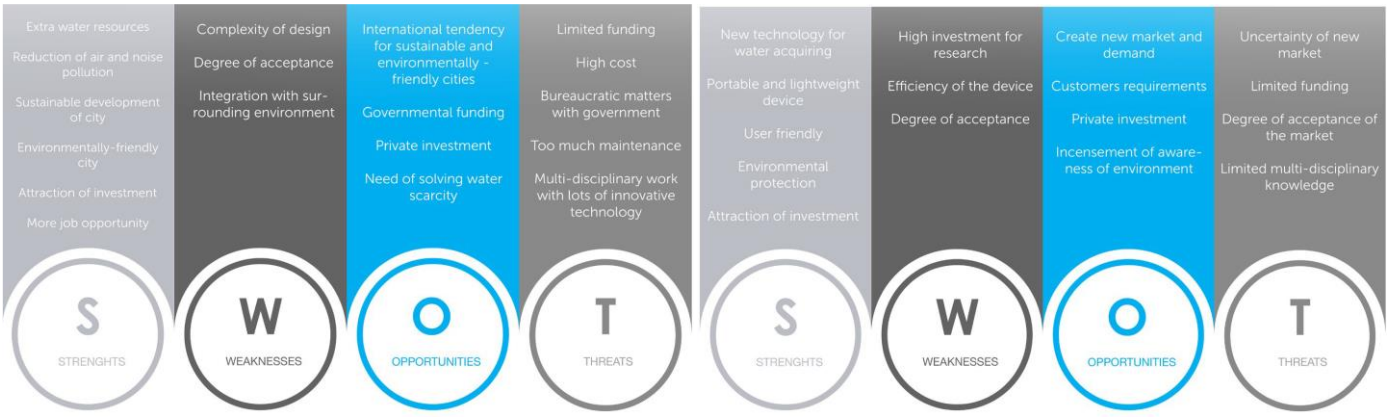
The amount of water that can be collected by a fog collector is directly related to the fog liquid water content (LWC) and the wind speed. The LWC values typically encountered in fog collection projects range from 0.1 to $0.7 g/m^3$, with $0.2 g/m^3$ being a representative value. Practical wind speeds for projects range from 2 to 12m/s. A typical wind speed is 6m/s. In addition, the number of hours per day with fog can vary from 0 to 24. A typical value would be 6 h/day. The combination of these typical values would produce about 5 L of water from a square meter of mesh per day.

Regarding the device, full-scale fog collectors could be a simple, flat, rectangular nets of nylon supported by a post at either end and arranged perpendicular to the direction of the prevailing wind. Alternatively, the collectors may be more complex structures, made up of a series of such collection panels joined together. Physically, a plastic mesh is stretched facing the prevailing wind direction and thus part of the fog droplets are intercepted as the air passes through the mesh. Minute fog droplets coalesce and form larger water droplets on the mesh fabric and trickle down into an attached gutter. The collected water can then flow to a sedimentation tank through gravity, and ultimately to a domestic water supply and/or irrigation system.

EXPLORING THE OPPORTUNITIES

According to the previous research, few fields in which fog harvesting technique can be successfully implemented were evaluated: agriculture, urban design, private/domestic use, building components and outdoor activities.

For the evaluation of all the possible scenarios, we took into consideration different variables, such as economic impact for production, social benefits, improve in sustainability, market attractiveness, and after the results were weighted, urban design and outdoor activities scenario emerged as the most promising ones.



After SWOT analysis, urban design (figure 1) emerged as the best field for fog harvesting technology implementation. The major factor that led to this choice was the goal of the present work, which aimed to reach the widest public possible and, above all, have the highest positive impact on environment and improve people's attitude towards water management practice.

Fog harvesting technique implemented into urban design project is a solution that can achieve positive results both in terms of fog water collection itself and of raising attractiveness of the technique for companies, and raising awareness for citizens.

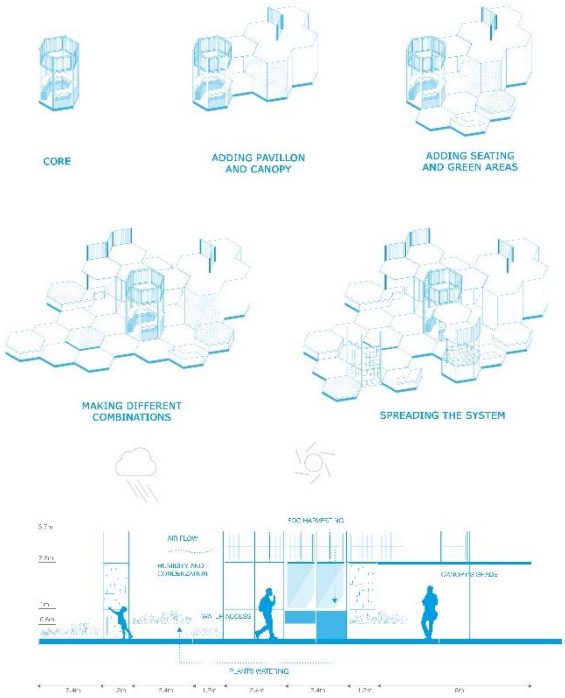
Regarding the project location, a study on climatic, social and economic condition in different cities was made. Tenerife scored the highest grade among the location considered. In Tenerife, fresh water is less abundant than in mainland Spain, as the island relies mostly on cloud water. The usage of fog harvesting devices could contribute not only to the local agriculture, but also to reduce the stress on hydric resources currently exploited, especially during high tourism seasons.

Among the other locations considered, Lima and Milan emerged as possible adequate options. Lima's hilly periphery makes it especially difficult for the construction of piping water distribution infrastructure, and so fog water harvesting is a promising way of supplying the city with its fresh water needs. Any fog water harvesting projects would not be big enough to supply the whole metropolitan area with fresh water. However, smaller scale projects placed in specific areas of the city could show some improvements

Milan represents a typical European metropolitan area, that is not currently jeopardized by water scarcity. It is moving towards a sustainable city model, therefore any innovative strategy of water management is a step closer to this goal. It would attract people and investments into the city, as well as raise awareness on water scarcity issue.

GENERATING A SOLUTION

The design process mostly consisted of literature review and analysis of existing fog harvesting techniques. New design alternatives should not be based on complicated shapes because the strength of the fog collection technique lays on the simplicity and adaptability of the system. Starting from a hexagonal footprint (inspired by the honeycomb structure), and extruding it to vary in its height, we came up with three - dimensional modules that seem the most efficient way to response climatically to fog water capture aspects.



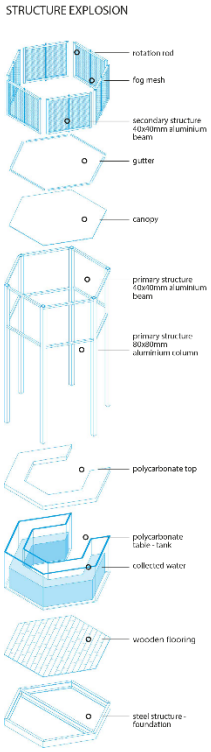
Various configurations may be arranged. An element always present in each configuration is the core, that represents the main fog collector. With every single hexagon module, we wanted to include different functions, so they correspond to individual users.

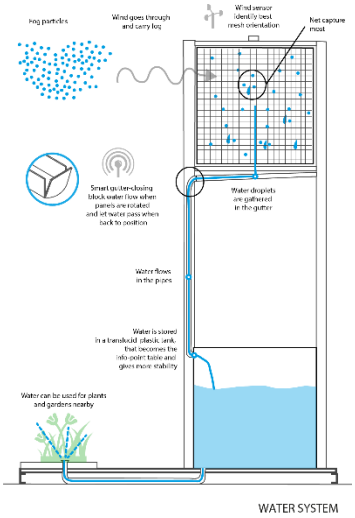
The design is easily customizable and it is suitable to a wide range of given conditions.

As for the functioning, the fog cloud passes through the net, which captures small water particles and creates water droplets. The water falls to the gutter and to the pipes, being collected in the plastic table/ tank and then stored to be used in different ways. Sensors are placed in the top of FHD to choose the best orientation for the mesh while a smart system with water level sensors decides the timing to put the panel back to the original position.

The elements of the design used in the project are:

- The foundation - temporary structure, integrated with the upper structure.
- Lightweight structure - aluminum (square hollow sections 80mm×80mm for columns and 40mm×40mm for beams).
- Mesh - 3D polyester textile FogHa-TiN mesh, highly efficient and wind resistant.
- Sensor - an anemometer to measure wind speed and a vane to measure wind direction. This enables the mechanical system, to turn the net to face optimal direction to collect water efficiently.
- Distribution system - PVC pipes with a diameter of 60mm, that convey the water into water tank.
- Storage system - a water tank, integrated as a part of the core. Besides, it could also perform as an additional foundation, improving the stability of the structure.
- Smart screen - a database and interactive platform.





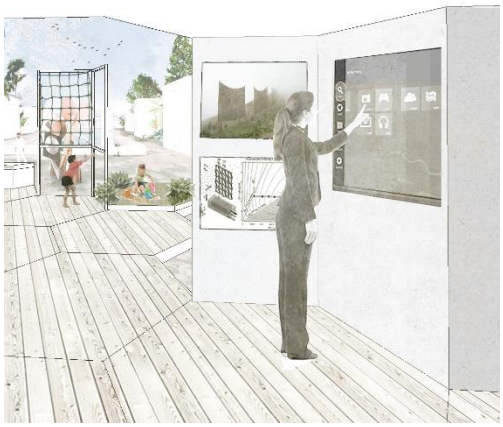
WATER SYSTEM

A promotion strategy is a fundamental way of getting closer to the public, in order to increase awareness about the water issues, as well as to draw attention of the possible future development and investment. Education can be a key to success. For this reason, our solution has an educational emphasis not only in the initial stage but maintains it throughout the entire project. A design made of nature-based principles can shift the way in thinking towards a more competitive, resource efficient and greener economy.

From a future perspective, this solution avoids consuming environmental resources and it could cut maintenance costs for green areas and water resources, offering a new alternative to improve water management. By

introducing this new topic of urban fog harvesting, the educational goal will possibly result in a positive economical outcome, so that this water management technique will become a common and widespread tool.

As architects and planners our task will be re-engineering cities, developing systems, networks and technologies to reduce water scarcity. Urban Fog Harvesting is one those systems (flexible, adaptable, responsive, scalable, and non-linear), which works as interface with the environment, trying to address or mitigate it operating at the scale of an area within the city.



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TAGS

#Sustainability #WaterManagement #EnviromentalDesign #FogHarvesting