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NYMPHAEA (FM SEI)

Executive summary

Clean water scarcity is one of the main issues of our world, and it is listed among the UN SDG to be reached by 2030. It is particularly severe in Sub-Saharan Africa, the only region in the Earth in which the number of people without safely managed drinking water is increasing, especially in rural and isolated areas.

Several technical solutions that want to bring water in isolated villages have been proposed, but they often missed two crucial requirements: they rely on specialized first-world technologies or supplies of chemicals/filters, which are hard to maintain, repair and resupply in such a context; they are not integrated and accepted in the community in which they are put.

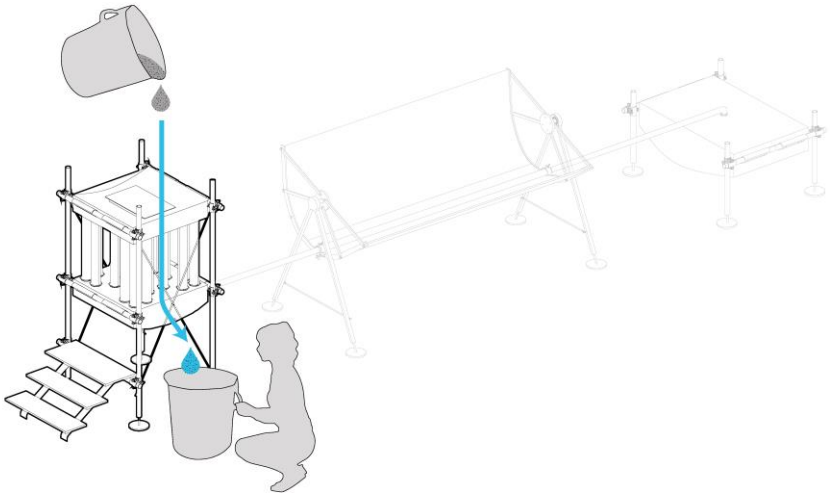
Nymphaea aims to address this problem using a cheap, low-tech solution, with the combination of a sand filter, to remove debris and heavy metals, and a parabolic solar concentrator, to heat up the water and purify it from microbiological contamination. This design requires no electric energy, no chemicals and no supplies for maintenance. The device has been mathematically modelled and a small prototype has been built, demonstrating the technical feasibility of the concept.

Nymphaea is a community-level product, designed to produce 300 l/d of clean water. Its objective is also to be easily introduced and adopted by the end users, the inhabitants of the villages. Creating a network of local entrepreneurs that sell the drinking water at a fair price in their communities, Nymphaea becomes a source of income and local development.

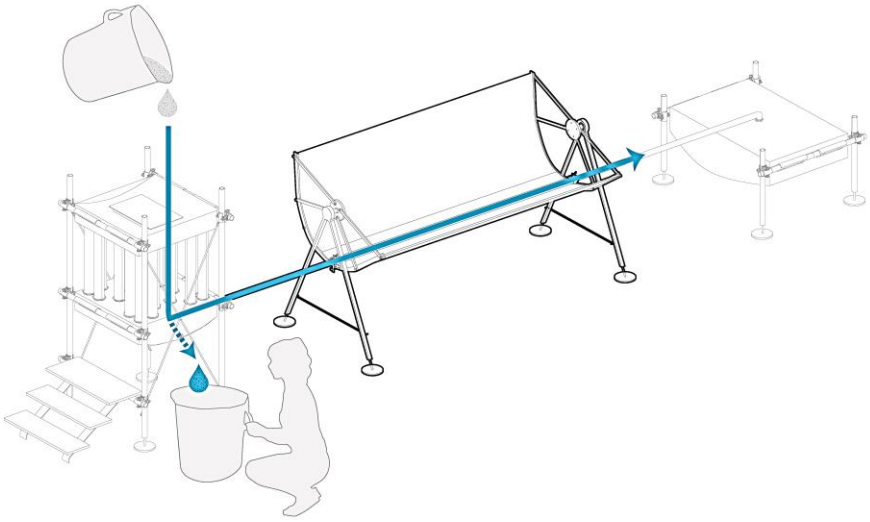
Key Words

water; local development; Africa; sustainability; social innovation

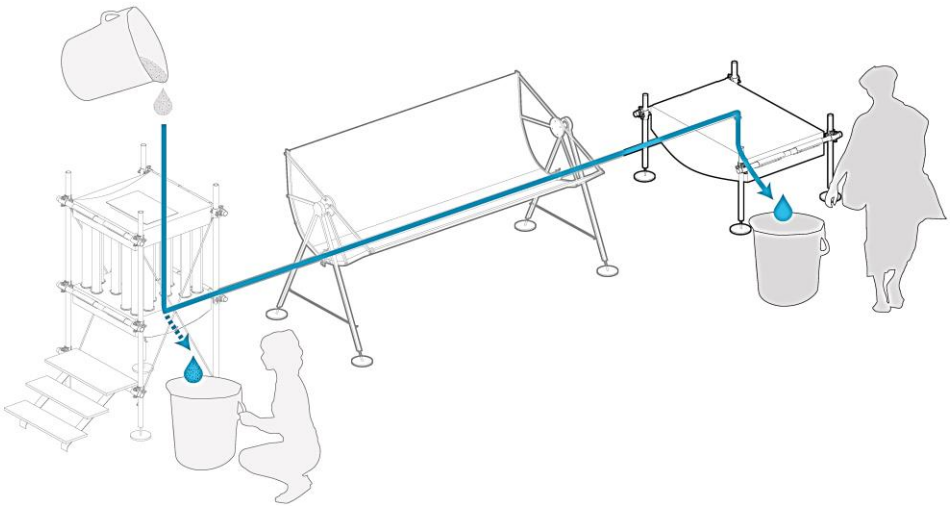
nymphaea



1ST PHASE: FILTRATION



2ND PHASE: SOLAR HEATING



3RD PHASE: STORAGE AND COLLECTION

Project description written by the Principal Academic Tutor

The lack of safely managed drinking water is a problem that still today affects about a third of world population. "Clean Water and Sanitation" is the 6th UN Sustainable Development Goal, and in fact in almost all world's continents the number of people affected by this situation is steadily decreasing. Only in Sub-Saharan Africa the trend is reversed, due to the lack of proper solutions and the rising population. The problem is particularly harsh in the rural areas, where electricity is a scarce resource, the logistics is extremely complicated and hence the use of common first-world products or infrastructures is not effective at all. The people living in this context are estimated to be 200 million.

The ASP Nymphaea (FM SEI) project has addressed this complicated topic by proposing a novel combination of two simple technologies and a new business approach, efficiently combining all the different academic backgrounds of the team members (Energy, Aeronautical, Industrial Production and Transport Engineering, and Architecture). Before doing this, they deeply analysed the environment of Sub-Saharan Africa, of its isolated, rural communities, and of the existing solutions to the problem of drinking water, also directly talking with many different stakeholders and actors with a direct experience in the field.

A solution like the one proposed by Nymphaea can create a new last mile logistics paradigm for water supply in this scenario. As it is happening with renewable energy generation, it is possible to imagine infrastructures built at a very local level whose aim is to purify water, with water storage tanks that connect a plurality of these devices and deliver clean water where is needed.

Team description by skill

Silvia Cosentino: Engineering for Industrial Production @ Politecnico di Torino. Silvia mainly worked on the business model of our project and she was responsible for the communication with the stakeholders.

Francesco Cuzzocrea: Civil Engineering with specialization in Transport Infrastructure @ Politecnico di Milano. Francesco was the Team Controller, and he took in charge the definition of the timeline of the project. He designed and made the project videos and website.

Luca Galli: Building Architecture @ Politecnico di Milano. Luca had a major role in the prototyping phase and on the concept design of our project. He delivered the final pitch in the June 2019 Demo Day.

Alessandro Innocenti: Energy Engineering @ Politecnico di Milano. Alessandro mainly studied the technical feasibility of Nymphaea, and he modelized the water production system to verify its consistency. He contributed to the prototyping phase.

Lucia Miglietta: Architecture for Sustainable Design @ Politecnico di Torino. Lucia investigated the problem of drinking water in the world, and she focused on the relations between the project's stakeholders. She was responsible for the visual communication of the project.

Fabio Giovanni Parisi: Aeronautical Engineering @ Politecnico di Milano. Fabio reviewed the state of the art, comparing the various technologies. He carried out the market and competitor analysis.

Goal

The project started in June 2018, in collaboration with the School of Entrepreneurship & Innovation (SEI). Indeed, Pioneer is one of the main modules of the school that is dedicated to high tech and innovation. It is a 12-month experience which accompanied the team along a complete path of innovative product development: visioning, ideation, user validation, business feasibility, prototyping, presentation to an audience of investors, companies, entrepreneurs and partners. The aim of the program was to launch a startup idea, working with an entrepreneurial approach. The innovation theme pre-established in the program was the one of last mile logistics, which at the end was interpreted by our team as last mile water supply in developing countries and going towards a social innovation solution. The name of Nymphaea was chosen, inspired by the natural water purification properties of water lilies.

Understanding the problem

As reported by the United Nations, 3 out of 10 people in the world lack access to safely managed drinking water services. Besides the appalling consequences of this phenomenon in terms of diseases and deaths, the issue of sanitized water seriously impacts on the growth of developing countries. The hidden costs of polluted water are huge: thus, investing in water sanitation could produce a great economic return in these areas. For this reason, the United Nations have dedicated the sixth objective of the Sustainable Development Goals to the achievement of clean water and sanitation for all citizens of the world.

While in most regions the number of people that lack access to improved water services has been decreasing in the last three decades, this figure has been rising in Sub-Saharan Africa. Most of the population in this region lives in rural areas, where water infrastructure is highly fragmented and inadequate, and electricity is not widely available. The issue of polluted water underlies the persistency of poverty in Sub-Saharan Africa and addressing the problem is the first step in kick-starting the socio-economic development of this region.

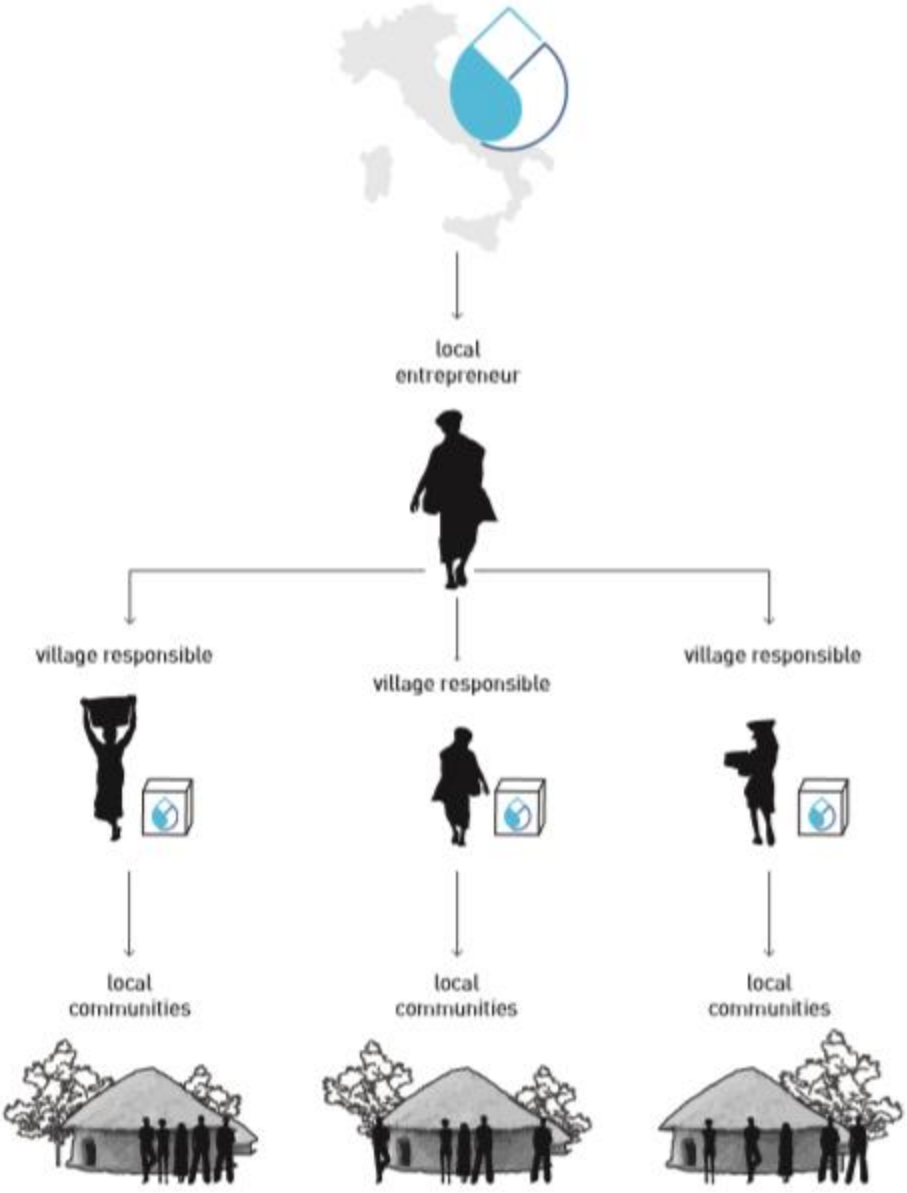
Understanding the complicated stakeholders' network related to this problem has been fundamental. The formulation of the needs and the requirements of these actors helped us in selecting the most suitable solutions for the technology, the design and the business model of Nymphaea.

Exploring the opportunities

Our idea is that development in Sub-Saharan countries must come from the empowerment of local communities. People should not just be passive users of the water sanitation device but should actively capture value from it. The business model of a startup that commercializes a device for cleaning water should be built on a strong ecosystem of customers and stakeholders deeply rooted in the territory. In our proposal, the relationship between the startup and local entrepreneurs of the Sub-Saharan region plays a crucial role.

They rent one or more water sanitation devices at the price of a monthly subscription, that includes training and support from the startup team. Once learnt the basics to run and make the most of the product, the local entrepreneur leans on a village responsible for the operational management of the devices. The village responsibles are in charge of operating the devices within a rural community and selling the clean water produced to the inhabitants of the village. Due to the cost-effectiveness of Nymphaea, it is possible to sell water at a highly competitive price compared to other sellers in the region.

The first beneficiaries are the people from rural areas, who do not only save money, but also time: instead of walking long distances to find a clean water source, it is possible for them to dedicate themselves to other valuables activities. On the other hand, village responsibles reap the benefits of water sales, by retaining a percentage on those. Finally, local entrepreneurs earn a profit on the sales performed by the village responsibles. Thus, Nymphaea will trigger a virtuous circle, by promoting health and generating wealth in local communities.



Generating a solution

All these remarks have been the main drivers for the development of Nymphaea solution, a water sanitation device that has been designed to be implemented in remote regions of the world and to be run at a community level. Although other products have been developed with the same purpose and the same target, Nymphaea presents some features that considerably differentiate it from its competitors. First of all, the product does not need any electricity to work and is only powered by solar radiation. Moreover, it is built with low-tech and low-cost materials that do not require continuous maintenance, that do not require supplies and that guarantee the sustainability of the device throughout its life cycle.

Nymphaea is able to remove debris and heavy metals from polluted water thanks to a sand filter. On top of this, the concentration of sunlight with a parabolic concentrator allow heating the water up to 75-80°C, and subsequently ensures the removal of microbiological contaminants from polluted water. The device is expected to produce on average about 300 l/day of drinkable water, therefore being suitable for serving the needs of a small rural community.

The current configuration of the product, which presents compact dimensions and affordable costs, has been proved to reach the target production of clean water thanks to a feasibility study supported by mathematical models. Nevertheless, Nymphaea needs to be tested on field, not only from the technical point of view but also for what concerns the ecosystem of people that should be involved in the project. The validation of the product and business model should be achieved with a first pilot project.

The pilot is scheduled in 2020 and will target Kenya, which is deemed to offer a favourable environment for the first implementation of the devices. Indeed, it is one of the developing countries with the highest spending power and most stable political situation. The field trial will last about one year and will allow to concretely assess the performance of the product and suggest ideas for further improvements.

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