SHORT TERM SCIENTIFIC MISSION (STSM)
SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17107
STSM title: Smart textiles for sustainable water collection from fog
STSM start and end date: 29/08/2021 to 20/10/2021
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PURPOSE OF THE STSM:

This STSM purpose is to understand which are the characteristics that make a fog collection textile efficient. The “Raschel” is the textile that has been used in fog collection projects worldwide until now; this is not due to its good performance, instead, because it is cheap and easy to find in commerce. In order to understand the collection properties of different kind of meshes, several test have been developed during the period of the mission, under different climatic conditions. A first test campaign was developed in Tenerife in April and May, there some bidimensional meshes and a tridimensional have been tested. Since the results of this first campaign showed the most efficient behavior in the 3D mesh, it has been decided that the second STSM test campaign was going to be focused on 3D meshes.The hypothesis is that all the mashes tested are more appropriated for fog water collection then the Raschel mesh; therefore the results of collection efficiency, of the alternative meshes have been compared with the ones of the Raschel as a benchmark, during both test campaigns. The aim was to find the features that make a mesh more efficient, as weight, base/height hole’s ratio, shading effect and air permeability between others. Moreover the data collected are useful to understand the climatic conditions of this fog oases and replicate the experiment in the lab. Finally the results of these tests can direct the path line for the design of the optimal fog harvesting project depending on the conditions. This envisioning smart textile can be used in building and living applications, in order to make constructions water self-sufficient and achieve Net Zero Energy Buildings; moreover, it can be also employed in several different application fields, as agriculture, industry water recovering or emergency camps.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

The first step carried out starting the STSM, was the installation of the three Standard Fog Collector, used to test the selected meshes. The structures were designed, produced and installed in April, during the first STSM; after that, they were uninstalled and stored. Therefore, for the second STSM test campaign the structures have just been installed again in the same position in the same location, in order to have comparable results. The selected location is again Tenerife, specifically El Gaitero, at 1690 masl, in a protected area. The location of those fog collectors relates to the context, the presence and disposition of vegetation, the slope and the wind direction. So, a site visit was essential to understand the right disposition of the installation, in order to have reliable results of fog water collection from the three structures. It is important to underline that the fog formation changes along the year, changing its altituded depending on the seasons. The first campaign was developed during spring, while the second during autumn, these period are supposed to present similar conditions. In order to install the structures, the Grantee and the representative of the host institution, asked the permission to occupy public soil from the town council.

The experiment had the purpose of determining the efficiency of each mesh compared with the common one (Raschel), proving that we can find in commerce many performative mehses and understand which are the features that determine their efficiency. The Raschel mesh, has been applied to the first structure and it remaind there during all the mission. The other meshes have been applied in succession, on the others two structures, in order to compare them with the standard mesh and then select the more performative. For each round of tests the two selected meshes had similar characteristics, in order to have a more accurate comparison; for example same pattern but with different width, or same pattern with different orientation, or one mesh made of numerous chains and the other made of monofilaments.
The duration period of each test depends on climatic conditions.
During the time of the tests, some climatic analysis have been developed, thanks to the data elaborated by the climatic station of "El Gaitero". In order to better understand the results of the water collected by each mesh some studies have been carried out taking in account some factors as: precipitation, the percentage of relative humidity, wind speed, and direction. In particular it's important to get the distinction between the water collected from rain and the one collected from fog. The percentage of relative humidity relates with the timing, in fact fog is formed from 90% RH but it will take more time to collect a litter of water in 95%RH conditions than 100%RH. The droplets suspended in the air are deposited on the mesh thanks to the winds that carry them, more wind speed means more collection, but too high speed can push the droplets out of the gutter and make the structure or the mesh broke. The impact angle of the droplets determines also the collection. Some climatic graphs have been designed.
Finally the three structures have been dismantled.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

RESULTS
During the test campaign eight experiments have been carried out and a total of twelve meshes have been tested, bidimensional and ten tridimensional.

To sum up it emerged that all the meshes that have been tested during this STSM are more efficient then the Raschel mesh, so the hypothesis has been proved. Furthermore, the results of the first test campaign on bidimensional meshes have been verified: the Honeycomb resulted in a collection efficiency of [+177,27%] respect to the Raschel mesh, while the Iride multi pro-extra showed [+35%]. Moreover, the test campaign on 3D meshes showd that the third dimension is really important; in fact, the collection factor average of 3D meshes is higher than the one of bidimensional meshes, tested during the first campaign. Although, it seems to be important up to 10mm width, after that there is no much improvement in harvesting potential. Moreover it emerged that the orientation of internal filaments is relevant. In fact, convex orientation resulted as more performative than concave. This can be due to the fact that in convex orientation the drops tend to form where the internal filaments are connected to the external surfaces, so, when they reach a certain weight the flow down adhering on the surface, collecting also all the other smaller droplets that have been formed. On the other hand, in concave orientation of the filaments, the droplets are formed in the lower part of the center, and when they reach a certain weight they directly flow down to the gutter whitout following a determined path; this means that they are less probable to intersect other droplets and also they can flow away easily because of strong winds.

FUTURE COLLABORATIONS (if applicable)

The future steps of this research can be divided in three aspects, thanks to the creation of an international networking, those are: replicability of measures; validation of data in lab and in others sites; and finally smart mesh design and its validation. In order to have reliable datas it is important to replicate the same tests and validate the results, as the confrontation of the first and second campaign results demonstrates. In fact, since we are working with almost unpredictable climatic aspects, it's essential to conduct the same test under several conditions.

First, it would interesting to conduct a direct confrontation test campaign, where the most performative meshes will be tested simultaneously several times, to verify the efficiency with different climatical conditions, as a means to compare them through more reliable results. Moreover a second phase of tests should be carried out analysing the meshes with a different pattern's orientation (chains in horizontal and vertical). Moreover, the test of one last 3D mesh, that has been used for some specific projects of fog harvesting, could be really interesting. In fact, it can be verified its efficiency in comparison to the 3D

meshes that have already been tested, taking into consideration also the economic aspect.

In addition, thanks to the results obtained during this period of experiments, and the following ones in the lab, using climatic chamber and wind tunnel, the most efficient mesh will be determined. A future step is the test of these nets in another context, as Italy and Portugal. The resulting mesh can differ, or not, from the one determined as the most efficient in lab or in Canary Islands.

Once these analyses have been completed, it would be interesting to design a new structure for building textile façades, as mean to archive constructions water self-sufficient and achieve Net Zero Energy Buildings.