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Fog and Dew Harvesting: Italy and Chile in Comparison

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Abstract:
Climate change is the 21st century emergency, including the water issue in the first place, not only for developing countries, but also for Italy, as reported by the European Environment Agency (EEA, 2012).
According to this premise, the purpose of the report is to analyze fog and dew harvesting systems for dealing with drought, which are used in various oasis de niebla around the world, in particular in Chile, and verify whether they are also applicable in the Italian context.
The study areas correspond to Chañaral (Chile) and Milan (Italy): the two cities belong to completely different climatic regions, one extremely arid and the other continental moderate, but both are subjected to intense fogs especially in winter, although these phenomena have very different characteristics in the two continents.
While in Chile, investigations have been developed thanks to the existing experiments concerning fog; in Italy, having no researches to refer to, this study carried out the analyses of climate data related to dew. The meteorological data of air temperature, relative humidity and wind of the city of Milan will be taken in exam and processed, to verify, at least on a theoretical simplified level, whether and how much water is possible to condense and harvest from the air in Milan.
This investigation allows a first comparison of the efficiency of the phenomena in the two contexts, and possibly suggest a new innovative, economic and environmentally responsible way in which water resources are obtained in Po's Valley.

Keywords: *Fog harvesting, Dew harvesting, Camanchaca, Po's Valley's Fog, innovative-renewable water resource*

1. Introduction

1.1. Water Security

Water scarcity is one of the most important issue of 21st century, it is a result of climate change and the increase in water demand, because of the development of the industry, the urbanization phenomena and changes in lifestyle, among other factors *(EEA, 2012)*. A fundamental element of climate change is the impact on the hydric cycle, which continuously distributes water from seas to the atmosphere, the soil, rivers and lakes, for finally returns to seas and oceans. The levels of steam in the atmosphere are increasing and causing heat-amplifying effect, moreover the melting of glaciers results in the fall of seas temperature, thus generating changes in currents, that determine cyclones and anticyclones. These phenomena are altering water cycle, they can lead to storms accompanied by more intense rainfall in some areas, while other may face more severe drought conditions, especially during the summer period, therefore making water availability less predictable (Catalano de Sousa, 2016).

Drought is a natural event characterized by a temporal reduction of hydric availability, defined as deviation of average climate condition of a determined site. One of the most immediate consequences of water shortages is desertification, climate change is doubling the extent of the earth's deserts. Desertification implies in arid, semi-arid and sub-humid areas, soil degradation, this phenomenon is the result of climatic and anthropic factors, which in the capacity of ecosystems to support flora and fauna subsistence.

Currently, 3.6 billion people live in areas where water is scarce for at least one month a year, and the data is set to rise because the world population could number 10.2 billion by the middle of the century. Today are used about 4,600 cubic km of water: 70% is for agriculture, 20% for industrial activities and 10% for household consumption. However, a faster demand grow is expected: in the last 100 years it has increased six times, and every year it rises by 1% (Watts, 2018).

Therefore is estimated that almost 80% of world population is dealing with water security, defined as 'the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human wellbeing and socio-economic development, for ensuring protection against water-borne pollution and water related disasters, and for preserving ecosystem in a climate of peace and political stability' (United Nations, 2013).

1.2. Water Issue in Chile

In Chile, the Atacama Desert, the most arid in the world, is also facing climate changes. First of all, its growth, the desert located in the northern regions of Chile and the south of Peru, has been reaching the centrals regions of the state, including the capital Santiago, in the last decade. Another notable effect in Atacama are floods, many cities in the costal desert have been affected by destructive floods coming from the Bolivian Altiplano, during rainy season.

Despite its national water availability potential of 53'000 m^3/person/year, much more of the world average, limited at 6'600 m^3/person/year, the northern regions of Chile just have access to 800 m^3/person/year, taking in consideration that the estimated minimum for a sustainable development is 2'000 m^3/person/year. Due to this issue, the exploration of alternative and complementary sources of fresh water in northern Chile is necessary (Domen, 2014).

1.3. Water Issue in Italy

Italy too is dealing with climate effects, in recent years it has been increasingly difficult to cope water demand, due both to the weather, which has led to particularly dry years, and to the increase in demand in the civil sector, which has made water supply difficult for the agricultural sector. The lack of rainfall results in a reduction in the level of groundwater, therefor these basins are not recharged and the demand is increasing (Corona 2009).

In the last century the average global temperatures have risen by 1.5 degrees Celsius, in the Po Valley by 2.5 degrees Celsius. So even Po basin, which is known for its abundance of water and predisposition to agriculture, is now one of the global warming hotspots, like the Alps. In northern Italy rising temperatures means drought: critical phases have become more frequent, compromising the agricultural system and threatening biodiversity. (FAO, 2008)

To handle this problem are needed immediate solutions on the territory, that combine the protection of biological wealth with a truly sustainable agriculture that does not affect the environmental balance: «Climate change must be taken into account in the agricultural planning of the Po Valley», said Barbara Meggetto, president of Legambiente Lombardia.

1.4. Objectives of the Study

This increase stress upon water resources challenges a search for alternative methods for the supply of drinking water. Water scarcity creates environmental struggle due to the loss of biodiversity, so we must promote measures to protect the biodiversity in relation to the ones to combat desertification.

The study's purpose is to analyze the two above-mentioned regions, which belong to completely different climatic areas, one extremely arid and the other Mediterranean, but both are subjected to intense fogs especially during the winter period, these particular locations are defined *oasis de niebla* form the study department of Centro de Atacama, de la Universidad Católica de Chile. Dealing with the hydric issue, this specific feature leads to fog harvesting, this technology appears to be, in these regions, a powerful and efficient alternative to manage water accessibility, through a tensile membrane structure.

However, this phenomenon results in very different characteristics in the two continents, therefore the study aims to analyze fog and dew formation conditions, considering their physic aspect in both regions. Moreover, Po Valley meteorological calculations have been developed; in fact, while in Chile, fog phenomenon and fog harvesting have been studied and verified thanks to on site investigation, in Italy there are no experimentations to refer to, for this reason has been analyzed theoretically the potential of water collection from the Italian fog.

2. Fog and Dew Phenomena

2.1. Fog

Fog is a hydrometeor, a stratified cloud produced by the condensation of water vapour, consisting of tiny droplets of liquid water small enough to stay in suspension in the atmosphere, of the order of 1 μm and up to 40 μm in diameter , which can change the optical properties of the air (reducing visibility) or, it can be made by ice crystals suspended in the air. Fog is characterized by three parameters: the size distribution of droplets, their concentration and their content in condensed water. These parameters depend, mainly, on the formation process and also on the temperature, the altitude and the duration. (Schemenauer and Cereceda, 1994)

Fog phenomenon begins to form when the relative humidity of a mass of air reaches 100%, which is when the humid air reaches the saturation conditions UR=100%. There are, however, different mechanisms and conditions for achieving this state, for which it is necessary to distinguish fog in: radiation fog, advection fog, orographic fog and evaporation fog.

According to the World Meteorological Organization, the expression fog (denoted FG, by the English 'fog') applies when the visibility is less than 1000 meters. For visibility from 1000 to 5000 meters we use, instead, the term mist (marked BR, from the French 'brume').

2.2. Dew

Dew is a physical phenomenon whereby direct condensation of the water vapor contained in the air, droplets of water are formed on cooler surfaces, when the temperature of the soil or any other surface drops down to trigger the phase transition of water vapor, contained in the layer of air above, in the liquid state. Often after a cool and serene night, ground and vegetation sparkle in the sun. Fog originates from the same mechanism and it is indeed difficult to predict if the phenomena will form simultaneously, in fact there can be dew without fog but never the opposite.

The air can only contain defined amounts of water vapour that vary depending on the temperature, so the warmer the air, the greater the amount of steam that can be stored. When the air is no longer able to retain any more steam, it has reached the 'saturation point'. The water vapour will then begin to return to the liquid state by condensation. The temperature at which the steam begins to condense is called 'dew point'. If condensation occurs close to the ground the water molecules will tend to regroup on objects and plants giving rise to do, if instead the temperature is lower than the freezing point, or dew point less than 0°C, the water vapor will immediately turn into ice crystals, forming frost. (Matsumoto, 2005)

The absence of clouds facilitates the rapid dispersion of heat stored during the day and thus condensation, which will only affect the surface of the ground or objects if the wet air layer is thin; thicker wet layers cause the fog. Dew is formed as the droplets of water aggregate more easily on solid surfaces rather than in the air, where they tend to remain suspended without meeting; it is typical of plains and valley floor less windy.

2.3. Camanchaca, Chilean Fog

Fog is a frequent phenomenon in many areas of the world, in Chile there is a particular fog, camanchaca, that forms over the ocean and is carried to the coast by the winds. The camanchaca is present in several *oasis de niebla* along the coast of northern Chile, Peru and Ecuador, for the climatic and geographical conditions, in this area the Anticyclone of the Southeast Pacific produces a thermal reversal, that is descending air from the upper atmosphere that is heated by compression. This is due to adiabatic heating of the central atmosphere layers, caused by the downward movement of the high-pressure centers.

Camanchaca is the source of sustenance for many plant species in arid climates, which capture water droplets through the thorns or outer shell of the plant. At national level, the study of this phenomenon led to the establishment of the Atacama Desert Center (CDA PUC), that lead to studies related to the management of natural resources and landscape, measurements of the efficiency of fog harvesting, moreover has determined the records and locations of various oasis de niebla, but above all promoting strategies for the creation of fog as social capital (Klemm, 2012).

Camanchaca forms at altitudes of about 500-1000 mslm, depending on the geographical position, with a layer about 300-400m thick, and is composed of two types: orographic and advection fog. Advection fog is formed on seas and oceans by the sliding of a cold front on a warm one. The presence of the Humbolt current, characterized by cold water, in contrast with the warm air of the high pressure (heated by the presence of the desert) causes an evaporation thus creating condensation (fog), that is pushed by the winds towards the coast, dissipating as entering the hinterland. Moreover, when advection fog, thanks to the winds, collides on the coastal mountain front the phenomenon intensifies for the generation of the orographic fog. The orographic fog is formed when a moist and warm air mass is pushed towards a mountainous front. These mountains are obstacles that force the air mass to rise and cool by expansion, condense the water vapour and then form the fog. Camanchaca is formed at night and remains until dawn, slowly disappearing due to the effect of solar radiation that causes evaporation; the most intense phenomena are registered during winter. The amount of water in fog depends on many factors, such as temperature, humidity, height, period of year and climate zone. (Schemenauer, 2015).

Different investigations at the Falda Verde site (Chañaral, Atacama desert) yielded to different results, in 1985 it was possible to harvest 69,7 liters of water per month per square meter (2.3 l/m2/d) of Rachel mesh (35% of shading) , according to another study between 1998 and 2000 it was possible to harvest 1,43 l/m2/d. Falda Verde is one of the oasis de niebla where water in fog is less abundant, therefore, for its capture it is needed of a greater instrumentation, but unlike Alto Patache (oasis with copious presence of fog, where the Centro de Atacama is located) the collection is constant in Falda Verde, in fact fog water can be collected also during the summer season, therefore, with a correct collection system, fog harvesting in this place can be very efficient. (Larrain, 2001)

In this sense, due to its aesthetic, ecological and social qualities the camanchaca presents optimal characteristics for landscape architecture projects in the oasis of fog.

2.4. Po's Valley fog and dew

Milan, city in the Po Valley, is part of the area most affected by the presence of fog, precisely radiation fog. In most cases fog forms during periods dominated by high pressure, which tends to compress the underlying layer, where there is cold air (cold air cushion), and the valpadana is the ideal place where this phenomenon occurs. The high pressure usually contains warm air that is lighter than the cold one, but hot air of high pressure is predominantly dry, and dry air is heavier than wet air because it contains a higher percentage of nitrogen (in fact the Nitrogen weighs more than Water). (Mariani, 2009)

Other characteristics that defined the Po Valley as an ideal place for the development of the phenomenon are:

- Great availability of water in the subsurface (which made the soil wet),
- Permeability of the soil
- Protection from the winds, due to the orography of the soil that generates a valley,
- Presence of pollutants (sulphur dioxide concentrations, steam catalyst),
- Low temperatures during winter nights (the temperature must fall below or coincide with the dew point);

This phenomenon, however, due to climate change and man-made action is slowly disappearing, let's analyze why. Throughout the Po Valley fog has become an increasingly rare phenomenon: in 2014 a study by the Institute of Atmosphere and Climate Science of the National Research Council (isac-cnr) of Bologna had noted that since the early nineties fog formations had fallen by 47%. According to the study, the main cause has to do with climate change, which in recent years has made winters more rainy (turning fog into precipitations) and ventilated (preventing radiation), as well as with the general rise in temperatures, it is not by chance that freeze, formation of ice or frost on the ground during the coldest nights, have also become less frequent. Another important factor is the urban heat island effect (increasing in Milan) due in particular to the waterproofing of the ground, in fact if the water vapor contained in the earth cannot get released (it is retained by the cement layers) there is no fog formation; moreover another factor that faster fog formations are the particulates present in the air. (Giulianelli, 2014)

In the '60 (and also before), times in which there were intense thick fogs, some pollutants were on very high levels, considering that the heating systems worked with diesel, nowadays, these levels can be found in metropolitan areas of South East Asia. That period was characterized by the industrial boom, in fact, for decades factories were spreading fumes in the air with all kinds of substances, generating pollution that today would be much more than illegal.

The pollutants promote the aggregation of water vapour, and therefore fog. With the reduction of pollution, but still present with levels that are among the highest in Europe, the conditions for fog formations have diminished.

However, fog is not destined to disappear, if climate change is handled, limiting the island of heat, thus avoiding cement and gases emissions that cause the greenhouse effect, although there won't be longer pollutants that hold the fog, this would continue to form for natural processes.

2.5. Comparison

In Chile, research on this phenomenon is developed both theoretically and experimentally, although there is a limited number of application projects. However, in Italy, the research concerning fog and dew formation is still very modest; therefore, it was not possible to rely on data derived from experiments, but a theoretical evaluation of fog presence or absence, with calculations has been made, based on data provided by the ARPA for the year 2018 and a 'year' composed by the typical months (from 1984 to 1996), without being able to derive the intensity of the phenomenon.

Camanchaca (Chilean fog) and Po's Valley fog are different in many respects, both for their physical characteristics and for the way the water is extracted, as already explained. In Chile as in Italy, fog after its formation remains stable for several hours due to the presence of the anticilon, that is high pressure, which acts as a 'cover' for the fog. When solar radiation comes into play, yet the temperature rises, exceeding the dew point and then the liquid water contained in the humid air evaporates.

Due to the presence of intense winds, the capture of fog water in Chile is purely mechanical, it occurs in condensation conditions (verified by the experiments carried out on site), the condensed vapour droplets are deposited on the mesh where they are intercepted by the filaments and flow by gravity towards the collecting channel and are then stored. The efficiency of the collection therefore depends on the presence of the winds, and on the diameter of the droplets, the diameter of the filaments and the percentage of shading of the mesh, it has been verified that the optimal conditions occur with a diameter of the droplet about 11 μm and with a wind speed between 3,5 and 6,5 m/s (Schemenauer, 2015). In Milan, however, the speed of the winds is much lower, with an annual average of about 2 m/s, besides the size of the condensate droplets is not documented.

Based on that, for this study, the capture depends only on the formation of dew on the mesh, and in order to appear, the temperature of the mesh must be lower than dew point; while in Chile the particles of water are already present in the air and are captured because are dragged by the wind and collide to the mesh. To find out if dew capture is possible, we have analyzed some meteorological data that will be explained.

3. Methodology

In order to verify the possibility to apply the dew harvesting system in Milan, at Piazza d'Armi, a simplified physical model for a dew harvesting vertical mesh was developed. On the one side climatic data were processed in order to determine the dew point temperature during the year. On the other side an energy balance equation for the mesh was set, in order to evaluate the surface temperature. Whenever the mesh temperature was found to be lower than the dew point temperature, condensation on the fabric was considered occurring. In this case the condensation rate was roughly estimated from the wind speed.

Night hours are the ones taken into consideration, because the presence of solar radiation causes the temperature rise and therefore the dew point is more probably exceeded. At first the months taken in examination correspond to the winter season (October- March) because colder, in which the temperature can easily drop below the dew point and so inclined at dew formation. Subsequently, as favorable results were noted also in March and October, the analysis has been extended throughout the year.

The yearly weather data taken into considerations are of two types: the first is a typical meteorological year for Milan, namely composed of months considered 'typical' for their characteristics, and derives from an analysis that goes from 1984 to 1996; the second year corresponds to 2018 data from ARPA station in Milan, Zavattari. It has been chosen to analyze also a more recent period to notice variations due to climate change, in any case, irrefutable results cannot be achieved because of unpredictable alterations in climatic conditions.

3.1. Psychrometric calculations

To verify the presence of dew it is necessary to analyze the status of the humid air. The Carrier Diagram (also called psychrometric diagram or Grosvenor diagram) is frequently used for the determination of the properties of a water-air mixture at constant pressure. We can consider the diagram as a graphic representation of state equations. The diagram is used to estimate graphically the characteristic of the mixture (dry air + steam) subjected to a thermodynamic transformation, with constant pressure. In the psychrometric diagram the line of saturation (that corresponds to 100%

relative humidity), which separates the 'fog zone' (where the system consists of air saturated of water and liquid water dispersed in it, in the form of tiny drops or aerosols) to the area of unsaturated air (where the system consists in a mixture of dry air and water vapour). The X-axis corresponds to dry air conditions (TBS), while the Y-axis to specific humidity.
The graphic procedure indicated by the psychrometric diagram has been translated into formulas to speed up the verification process. The determination of the dew point temperature allows the detection of the temperature (Tx) at which the mesh should be in order to have condensation (temperature below dew point).
In this section the process is described; the calculations have been developed with the Excel program, based on UNI EN 13786.

Firstly, the saturated vapour pressure p_{vs} [Pa] is calculated. It is the maximum pressure achievable for vapour at a given temperature; in this situation the liquid substance is in equilibrium with its vapour independently of the air pressure, because its molecules do not interact with those of the steam.

In addition, the saturated vapour pressure increases in relation to temperature increasing. In fact, as the temperature rises, molecules acquire higher kinetic energy and are more likely to evaporate. The following empirical equations from UNI EN 13786 relating p_{vs} with the dry bulb temperature T_{DB} are used:

If T_{DB}>0°C: $p_{vs}\ (T_{DB}) = 610.5e^{\frac{17.269*T_{BS}}{237.3+T_{BS}}}$ (1)

If T_{DB}<0°C: $p_{vs}\ (T_{DB}) = 610.5e^{\frac{21.875*T_{BS}}{265.5+T_{BS}}}$ (2)

From the relative humidity RH [%] and the saturated vapour pressure p_{vs} the vapor pressure p_v [Pa] is calculated as:

$$pv = RH * psv_{(TBS)} \qquad (3)$$

Then the dew point temperatureT_{DP} [°C] is obtained by reversing equations (1) or (2):.

$$Tdp = \frac{-237.3}{\left(1-\frac{17.263}{\ln\left(\frac{pv}{610.5}\right)}\right)} \qquad (4)$$

3.2. Energy balance equation for the mesh

As depicted in Figure 1, the mesh is modelled as a vertical plane exchanging heat by convection with the air and by radiation with the sky and the ground. We remark that the balance is performed during the night, therefore there is no solar radiation. Then, the mesh temperature (T_X) is determined as a function of the air temperature (T_{DB}), the sky temperature (T_{SKY}) and the ground temperature (T_{GR}).
The sky temperature [K] is calculated according to the following correlation:

$$T_{SKY} = 0.0552 * (T_{BS} + 273.15)^{\frac{3}{2}} \qquad (5)$$

while for the sake of simplicity the ground temperature is assumed equal to the air temperature.

The energy balance equation at the equilibrium is an algebraic equation of the 4th degree, where the three heat flows are balanced to zero):

$$\sum_K \varphi_K = 0 \qquad (6)$$
$$\varphi_{CONV} + \varphi_{RAD,SKY} + \varphi_{RAD,GR} = 0 \qquad (7)$$
$$h_{cv}(T_X - T_{BS}) + \varepsilon\sigma F_{X,SKY}(T_X^4 - T_{SKY}^4) + \varepsilon\sigma F_{X,GR}(T_X^4 - T_{GR}^4) = 0 \qquad (8)$$

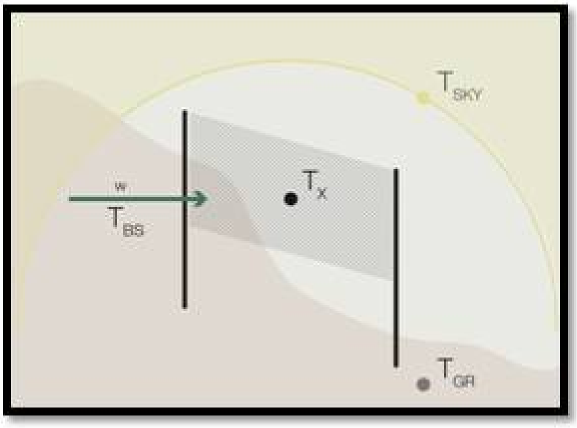

Figure 1: Exchanging Flows between the Mesh and the Environment

In equation (8):

- h_{cv} is the convective coefficient [W/(m^2.K)], which can be calculated from the wind speed w [m/s] with the following correlation:

$$h_{cv} = (4 + 4) * w \quad (9)$$

- ▯ is the mesh emissivity, equal to 0,9;
- σ is the constant of Stefan-Boltzmann equal to 5,67·10^{-8} W/(m^2.K^4);
- $F_{X,SKY}$ and $F_{X,GR}$ are the mesh to sky and mesh to ground view factors respectively; the view factor can vary from 0 to 1; in this case due to the vertical orientation of the mesh, the factors are both equal to 0,5.

Equation (8) can be simplified to:

$$AT_x^4+BT_x+C=0 \quad (10)$$

where:

$$A = \varepsilon\sigma\left(F_{X,SKY} + F_{X,GR}\right) \quad (11)$$

$$B = h_{cv} \quad (12)$$

$$C = -h_{cv}T_{BS} - \varepsilon\sigma\left[F_{X,SKY} * {T_{SKY}}^4 + F_{X,GR} * T_{GR}^4\right] \quad (13)$$

3.3. Condensation rate

Once the presence of condensation has been identified, that is when 0 <$T_X < Tr$, also setting T_X> 0°C to exclude frost phenomena that would lead to mesh properties reduction therefore annul the harvest, the condensed flow per unit mesh surface m_c [kg/s/m^2] is calculated assuming that unsaturated air enters the mesh at the wind velocity and leaves it in saturated conditions, namely:

$$\dot{m}_c = \dot{m} * (x_A - x_X) \quad (14)$$

where:

- m is the air flow across the unit mesh surface roughly estimated assuming that the wind flows perpendicular to the mesh through the pores

- $\dot{m}=\rho*w$ (15)

with ▯ the air density, taken equal to 1,2 kg/m^3;

- x_A and x_X indicate the air specific humidity and saturated air specific humidity calculated as:

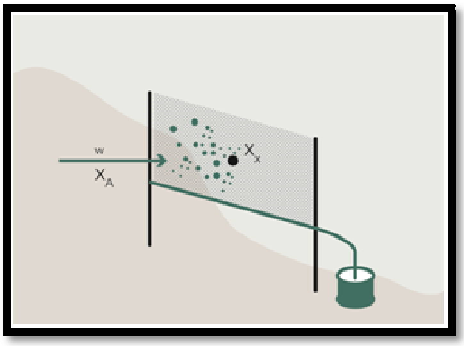

Figure 2: Condensation Process

$$x_A = 0.622 * \frac{pv}{(p-pv)} \quad (16)$$

$$x_X = 0.622 * \frac{pvs}{(p-pvs)} \quad (17)$$

with p indicating the atmospheric pressure corresponding to 101325 Pa.

4. Results and discussion

The results obtain in Figure 3 show that by the equations (1-13) has been verified the primary condition: the temperature of the mesh cannot be higher than the air temperature, nor less than the sky temperature. And in Figure 4 the temperature of the mesh and the dew point are in comparison, dew collection can be obtained when the temperature of the mesh is lower than the dew point, therefore winter season is the most favorable.

In the Figures following are shown just the analysis that outcome from the year 2018, that is due to a doubtful result in the calculations of the ‘typical year’, in fact it has demonstrated optimal results also during summer period, and that is a very unlikely condition. These results, in both years perhaps depend on an excessive simplification of the methodology, for sure more likely results will be registered with the on-site empirical investigation.

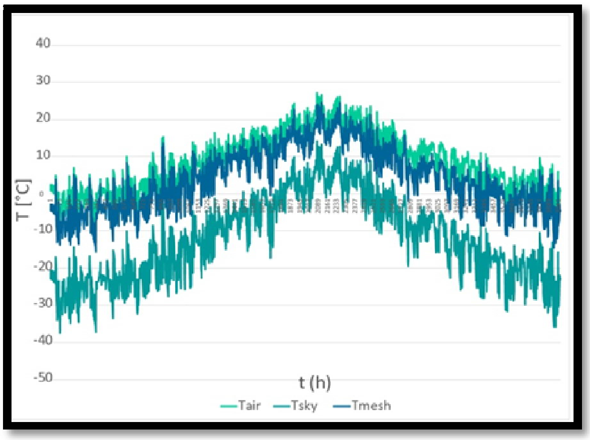

Figure 3: Comparison of Temperatures

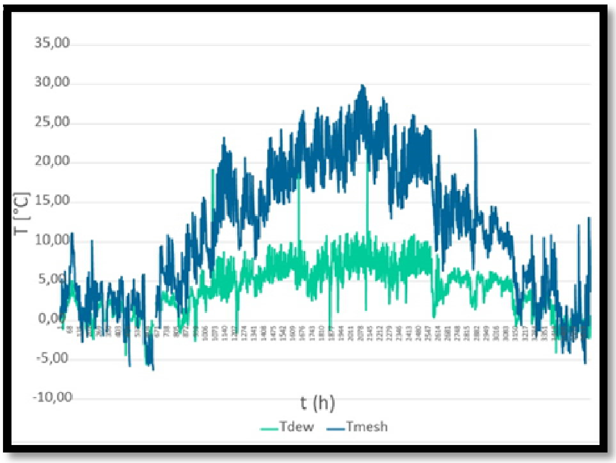

Figure 4: Dew Formation

The results obtained in 2018 (Figure 6) show an annual water collection capacity of about 600 kg/m², this result from the equations (14-17) was compared with the amount of fog water collected in Chile annually, that is 550 kg/m² (Figure 5) (Larrain et al., 2001). Although the study areas belong to completely different climatic and social contexts, both have demonstrated the potential for the operation of vapour harvesting systems, for the capture of fog water in the Chilean case and dew water in the case of Milan.

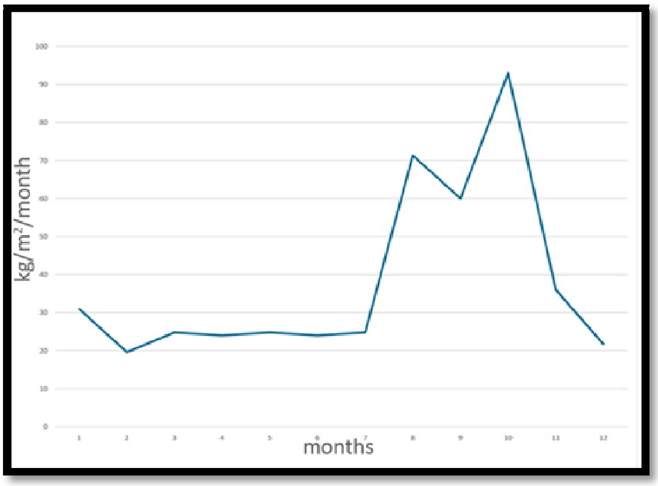

Figure 5: Camanchaca Formation during the Year (Chañaral)

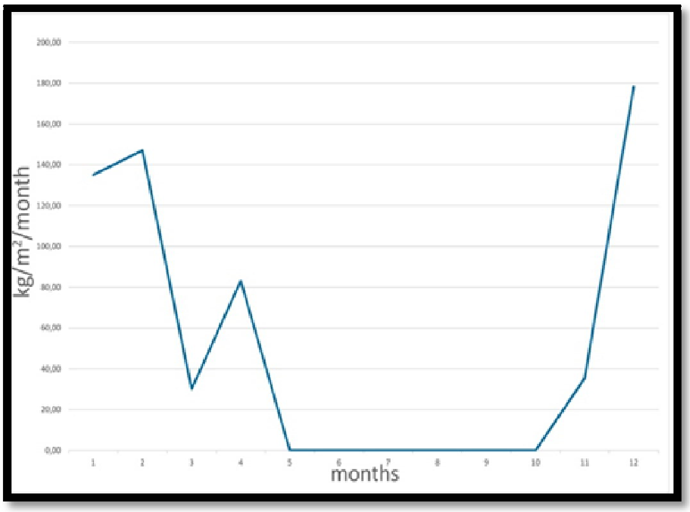

Figure 6: Dew Formation during the Year (Milan)

Is also interesting to note that the two formations have different origins and one is present throughout the year, with a more or less constant collection (Atacama), while the other (Milan) presents the phenomenon only during winter and in particular conditions, therefore the harvest is limited only to a season of the year, which unfortunately corresponds to that which has less need of water, therefore presenting seasonal peaks of harvest much higher than those of Chile.

Factor to take into account is the necessity, in fact, while in Chile there is a desert, polluted, which depends on 100% of external supplements for water and food, in addition to social and ecological problems, in Milan the situation is opposite, it is a territory that used to abound in water and historically agricultural, belonging to the Agricultural Park Milano Sud. Even if the climate issue, is changing this state, the conditions of the two areas are quite different. So, we can deduce that, nowadays the *camanchaca* water is a fundamental source, while in Milan is still not.

However, a new source of clean water should not be discarded due to the unpredictable water situation. So even if it is minimum, it would be interesting to be able to collect this dew water perhaps for the irrigation of some urban gardens, or domestic use, this system can determine the way water resource are managed in cities and rural areas.

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