CliSeTiCS

Project title: Quantifying and modelling Climatic Services provided by Trees inside a Canyon Street

Acronym: CliSeTiCS

Project duration: 36 months – Start date: 01/10/2018 End date: 30/09/2021

Key-words: Water, soil, plant, agronomy, urban, ecosystem services, heat island, modelling, transpiration

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Summary:

Context
More than half of the world population lives in cities, thus maintaining well-being in cities appears as a critical point. Plants are a key element in urban planning, given the ecosystem services they provide, especially the role they play in heat island mitigation and refreshment. Within the next decades, however, with the climate change and global warming, extreme events will occur more frequently (heat waves, drought). In this context, the competition for water usage will increase, and keeping plants in a good ecophysiological state will thus become a challenge not only to warranty their sustainability, but also to maintain their ecosystem services cited above. Given this context, stakeholders request tools adapted to the specificity of urban conditions in order to plan greening for towns of tomorrow.

Goals
The project aims at better understanding and quantify the climatic ecosystem services provided by trees in cities in terms of refreshment and shading under different climatic conditions and at evaluating the consequences of water restriction on these services. For the purpose of the project, trees grown inside a canyon street will be considered. Indeed, the canyon street infrastructure is a typical urban configuration in many towns and the simplicity of its geometry will facilitate the modelling stages. The PhD thesis will focus on the quantification of water transfers through the substrate-plant-atmosphere continuum under urban conditions, and on the heat transfers between the trees and their environment for different water regimes.

Methodology
To reach this goal the project will include:
(i) a characterization of the physical processes involved in water and energy transfers through the soil-plant-atmosphere continuum on the basis of a state-of-the-art review, and from an analysis of data recorded in urban conditions,
(ii) the quantification of these processes from experiments conducted on a reduced-scale model (canyon street scale 1:5) with well-watered trees and/or trees under water restriction. The question of how these results can be transposed to the real urban scale will be analyzed at that stage,
(iii) a modelling of the dynamics of those transfers and of their consequence on the climatic ecosystem services provided by trees when grown under water comfort or water restriction conditions. A global model on the one hand and a distributed climate model on the other hand (based on a Computational Fluid Dynamics-CFD tool) will be used, a validation against measured data will be performed.
(iv) the simulation of different climates and water inputs scenarios in order to assess the ability of trees to provide the expected climatic ecosystem services for a range of climatic and environmental conditions.