CONTRIBUTION OF EVAPOTRANSPIRATION TO CLIMATE BENEFITS OF A RECENTLY UNSEALED AND REHABILITATED SITE

Antoine MOREL[1], Sophie HERPIN[2], Lydia BRIALIX[2], Dominique LEMESLE[3], David RAMIER[3], Adeline BULOT[4], Laure VIDAL-BEAUDET[5]

1. Institut Agro EPHOR, Institut Agro BAGAP, IRSTV FR CNRS 2488, 2 rue André le Notre 49100 Angers, antoine.morel@agrocampus-ouest.fr
2. Institut Agro EPHOR, IRSTV FR CNRS 2488, 2 rue André le Notre 49100 Angers, sophie.herpin@agrocampus-ouest.fr, lydia.brialix@agrocampus-ouest.fr, dominique.lemesle@agrocampus-ouest.fr
3. Cerema Team, 12 rue Teisserenc de Bort 78190 TRAPPES, david.ramier@cerema.fr
4. Institut Agro EPHOR, Institut Agro BAGAP, 2 rue André le Notre 49100 Angers, adeline.bulot@agrocampus-ouest.fr
5. Institut Agro EPHOR, IRSTV FR CNRS 2488, 2 rue André le Notre 49100 Angers, laure.beaudet@agrocampus-ouest.fr

Contribution de l'évapotranspiration aux bénéfices climatiques d'un site récemment descellé et réhabilité

Mots-clés : descellement, végétalisation, évapotranspiration, microclimat urbain
Keywords: unsealing, revegetation, evapotranspiration, urban microclimate

Introduction

Soil artificialization in urban areas induces an increase of thermal stress of inhabitants and a loss of biodiversity. In order to address these issues, more and more desealing and renaturation projects are being undertaken by cities stakeholders, but their impact on local microclimate still needs to be understood and quantified. In this contribution, we propose to study the evapotranspiration and microclimate of a recently unsealed site, with different conditions of revegetation.

1. Description of the unsealed site and revegetation process

The studied site is located in a parking lot near Angers, western France. A surface of 64 m² was unsealed in October 2022: the upper layer (20 cm thick) of asphalt and gravel was removed and replaced by topsoil, and the deeper soil (down to a depth of 110 cm), mainly composed of stones and sand, was partly reused after being decompacted and completed with topsoil down to a depth of 70 cm (proportions 50/50). This unsealed site will be referred to as the "Oasis" hereafter. Four indigenous trees (*Sorbus torminalis*) were planted in December 2022 and herbaceous species were sown in April 2023 on certain sections of the Oasis. The Oasis was indeed divided into 12 sections of 3 to 5 m², in order to compare two combinations of herbaceous species (a first mix, called "dicots", composed of 11 dicotyledonous species and a second one, called "dicots-grass", composed of the same 11 dicot species plus three grass species) along with a control condition (unsown), each with four replicates. The seeds were sown at high densities.

We assumed that deliberately sowing seeds, rather than relying on spontaneous colonization, could result in a more substantial vegetation cover ratio. Specifically, we hypothesized that the introduction of grass species would accentuate and accelerate this process, leading to a higher vegetation cover ratio. Consequently, the surface would evapotranspirate more, thus enhancing the cooling effect of the Oasis. We also made the hypothesis that the evapotranspiration of the Oasis would be limited by the fact that the vegetation was only recently installed, and that the soil was made of a significant number of coarse elements, in comparison with a large meadow, with full vegetation cover and a mature rooting system with better access to water.

2. Measurement methods

To address these hypotheses, an evapotranspiration (ET) chamber (Ramier *et al.,* 2015; Versini *et al.,* 2023) was used to evaluate the latent heat flux both in the Oasis surface (Fig. 1) and in a meadow located 220 meters from the studied site, before and after mowing. The measurements were made on the 13th of June 2023, two days after a rain event of 18 mm. Weather conditions were sunny and stable throughout the day.

The latent heat flux (LE) was non-dimensionnalized with respect to net radiation (RN). The vegetation cover rate of each of the 12 sections of the unsealed site was evaluated using ImageJ according to Xiong *et al.* (2019) method, and the soil volumetric water content (VWC) was monitored with TDR probes at 20 cm depth. Meteorological stations recording air temperature, relative humidity, globe temperature, global radiation and wind

speed and direction were installed in the meadow, in the Oasis, as well as in a sealed reference site in order to evaluate the cooling effects of the Oasis.

Figure 1. Measurement with the chamber on the Oasis on 13/06/2023

3. Results

Around solar noon, in the Oasis, the ratio LE/RN in the dicots-grass sections (0.21) is significantly higher than in the control (non-sowed) sections (0.17), but no significant difference was found between the control and the dicots only sections. These findings are consistent with the fact that the vegetation cover rate in the dicots-grass sections (51%) is significantly higher than in the control sections (17%), but that no significant difference was found in the cover rate between the dicot only and the control sections. Also, the ratio LE/RN was always higher in the non-mowed meadow (0.29) compared to the Oasis, for the two sowing and the control conditions. Finally, the mowed meadow ratio (0.22) was only significantly higher than the one of control sections: no difference was found between the mowed meadow and the sown sections. These differences can be attributed to differences in cover rates, vegetation heights and soil water contents (VWC=11.8% for the Meadow, VWC=7.9% on average for the Oasis).

In the Oasis, the lower ratio LE/RN is associated with a higher surface temperature (27°C versus 24°C), a lower air absolute humidity (11.3 versus 12.2 g of water/kg of dry air) but a slightly lower air temperature (27.2 versus 27.9°C) compared to the meadow, where the grass is not mown. The sealed reference has an intermediate situation regarding air temperature (27.6°C) and air absolute humidity (11.6 g/kg). Shashua- Bar *et al.* (2011) already showed that well irrigated grass could reduce the thermal stress during the day compared to a sealed surface. If the air temperature was not reduced itself, surface temperature and long waves emissions were both reduced.

Conclusion

This experiment shows that densely sowing after desealing has a significant impact on evapotranspiration. Furthermore, soil water content is a limiting factor of that effect, as well as the mowing management.

Bibliography

Ramier, D., Chollet, J., Berthier, E., Sabre, M., Tétard, Y., Flori, J.-P., Bouyer, J., Lanher, A., Bouzouidja, R., Claverie, R., 2015 : Mesure de l'évapotranspiration à petite échelle spatiale : applications aux toitures végétalisées. *Journée Scientifique SIRTA.*

Shashua-Bar, L., Pearlmutter, D., Erell, E., 2011 : The influence of trees and grass on outdoor thermal comfort in a hot- arid environment. *International Journal of Climatology*, **31**, 1498–1506.

Versini, P.-A., Castellanos-Diaz, L.A., Ramier, D., Tchiguirinskaia, I., 2023 : Evapotranspiration evaluation by 3 different protocols on a large green roof in the greater Paris area. Earth System Science Data. [preprint]

Xiong, Y., West, C.P., Brown, C.P., Green, P.E., 2019 : Digital Image Analysis of Old World Bluestem Cover to Estimate Canopy Development. *Agronomy Journal*, **111**, 1247–1253.