College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

Università degli Studi di Padova

DAFNAE
Department of Agronomy Food Natural resources Animals Environment

Diurnal greenhouse gas emissions and substrate temperatures from blue-green roofs in north-eastern Italy during the summer season

Authors: Alexandra Lugo-Arroyo[1-2], Giampaolo Zanin[1], Aaron Thompson[2], Maurizio Borin[1], Carmelo Maucieri[1]

[1]Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE) - University of Padvoa, Agripolis Campus, Viale dell'Università 16, 35020 — Legnaro (PD), Italy.
[2]Department of Crop and Soil Sciences — University of Georgia, Athens Campus, 30602 —Athens, Georgia (GA), United States.

1. Objective

Evaluate the effect of substrate depth, vegetation type, and irrigation level applied on greenhouse gas (CO_2, CH_4, and N_2O) (GHG) emissions and substrate temperatures from blue-green roofs (GR).

2. Background

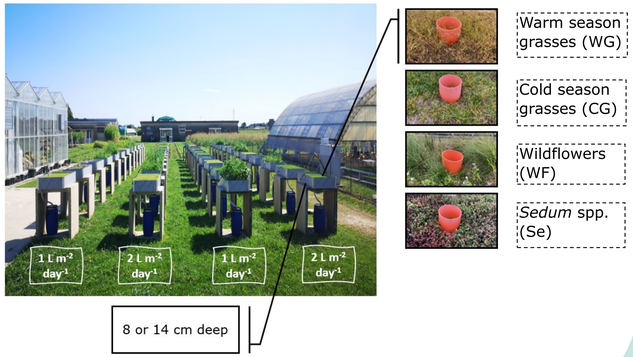
- Increasing urbanization highlights the negative effects of climate change.
- GRs can link sustainable urban development with climate change adaptation in cities through the provision of ecosystem services.
- Ecosystem services of GRs include reduction of GHG emissions and cooling of the building microclimate.

GHG fluxes → *Sink = photosynthesis + methane oxidation. *Source = leaching + respiration.

Microclimate → *GRs cool microclimate through plant evapotranspiration + lower roof albedo.

3. Materials and Methods

1. GHG fluxes: Fourier Transform Infrared Spectroscopy (FTIR) (The Gasmet™ DX4040).
2. Substrate temperature: Handheld soil thermometer (x3 per day.
3. Irrigation: Manual, 1-2 times per week.



4. Results

A. Controls on GHG Fluxes.

Figure 1: Vegetation species (*Sedum* spp., Se; warm season grasses, WG; cold season grasses, CG; and wildflowers, WF) as a control for GHG emissions [(a) CO_2, (b) CH_4, and (c) N_2O] from GRs.

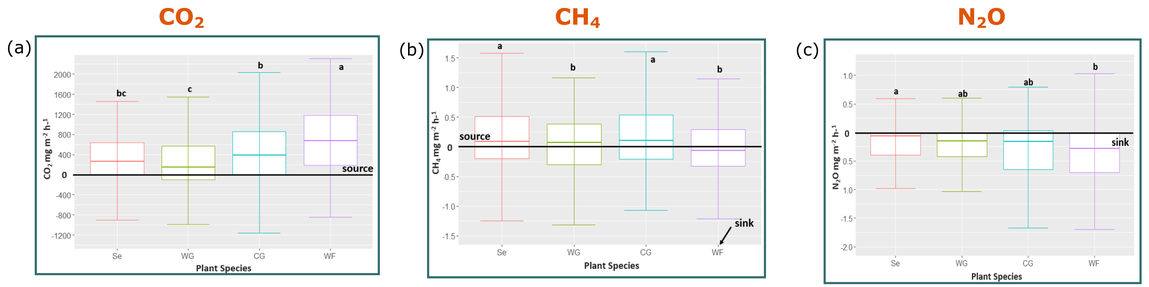
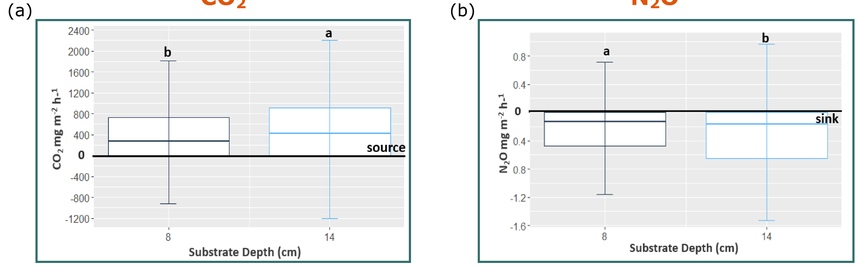
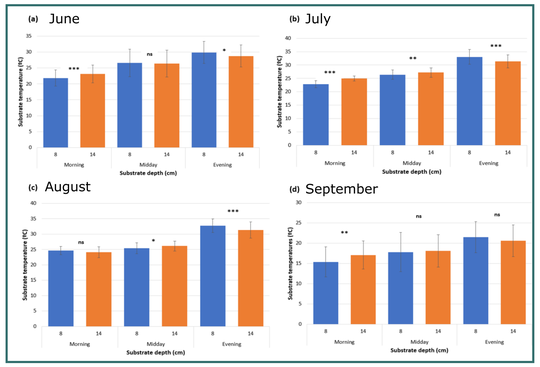


Figure 2: Substrate depth (8 or 14 cm) as a control for GHG emissions [(a) CO_2 and (b) N_2O] from GRs.



B. Controls on Substrate Temperature.

Figure 3: Substrate depth (8 or 14 cm) as a control for substrate temperatures during the summer months [(a) June, (b) July, (c) August, (d) September].



5. Conclusion and Discussion

Take-home messages

*The GRs ecosystem services evaluated are significantly affected by vegetation type and substrate depth.

*Overall, GRs were a source of GHGs (regulated by both plant type and depth) except for N_2O (net sink).

*Deeper substrate depths served as a buffer for substrate temperature, reducing the jump from min. to max. temperatures.

*The lack of rain and moisture during our sampling season highlighted the potential for GRs to serve as N_2O sinks in dry conditions.

A. Vegetation type as a control for GHG emissions

*Net emission of CO_2 across all vegetation types, with WF being the highest emitter, and only slight differences across *Sedum* spp. and grass species.
*All treatments, excluding WF, were net sources of CH_4, suggesting that, in dry conditions, GRs can be a significant source of CH_4.
*We found all treatments to be a net sink of N_2O, signaling a novel potential ecosystem service of GRs in dry climates.
*N_2O emissions were probably limited by a lack of soil moisture, restricting microbial activity.

B. Substrate depth as a control for GHG emissions

*Net emission of CO_2 + net capture of N_2O across both substrate depths.
*CO_2 fluxes increase with substrate depth due to increased capacity for organic matter accumulation.
*Substrate depth can alter N_2O fluxes by affecting N cycling dynamics, relating to substrate moisture and temperature, the amount of leachable material, and microbial habitat.

C. Substrate depth as a control for substrate temperature

*Shallower substrate depths dry faster + produce higher temperature fluctuations.
*Although it was statistically significant in all months, the effect was more marked during the hotter and dryer months (July and August).