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DEVELOPING METROLOGICAL TOOLS TO MEASURE THE IMPACT OF GREEN SPACES ON HUMAN HEALTH

INTRODUCTION & OBJECTIVES

Vegetation significantly impacts environmental factors that pose a health risk to humans in urban areas. Especially air pollutants such as particulate matter (PM) and ozone (O3), but also thermal stress, are threats being reduced by vegetation [1]. However, representative data supporting this argument to implement green spaces in cities is lacking. This project aims to develop a measurement procedure – a **measurement protocol** – to generate data on the effects of vegetation on these environmental aspects, ultimately affecting human health in the city of Lausanne.

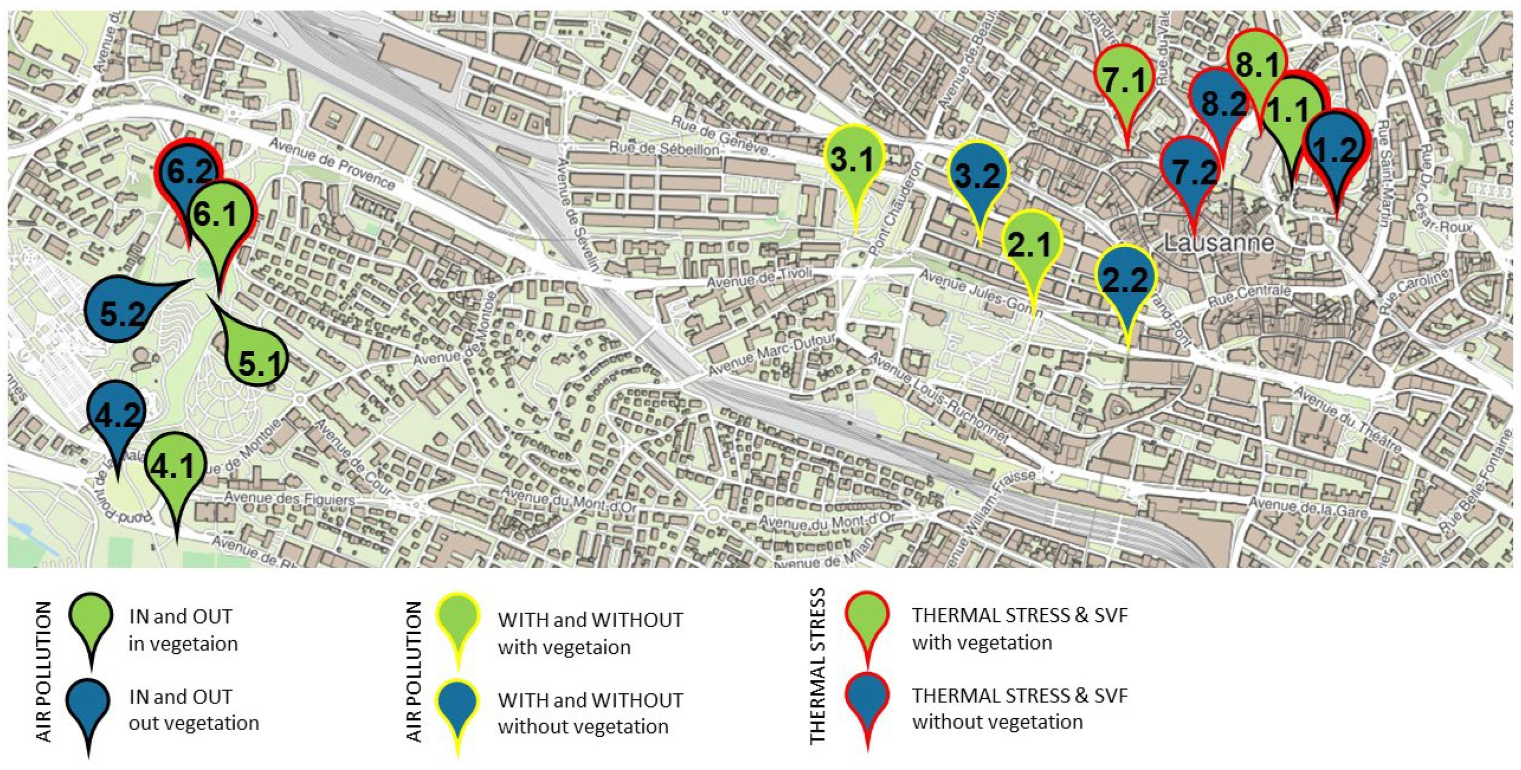


Figure 1: Locations for measurements in the city of Lausanne

DESIGNING A MEASUREMENT PROTOCOL

The measurable parameters PM, O3, and thermal stress depend on meteorological factors and the anthropogenic environment. For example, air mixing might obscure the cooling effect of vegetation when measuring thermal stress. Consequently, the impact of vegetation on the considered health parameters is not directly measurable and is confounded by these factors [2]. Therefore, the proposed method aims to eliminate these **confounding factors** through the design of the measurement procedure and the choice of the measurement locations.

METHODS

AIR POLLUTION

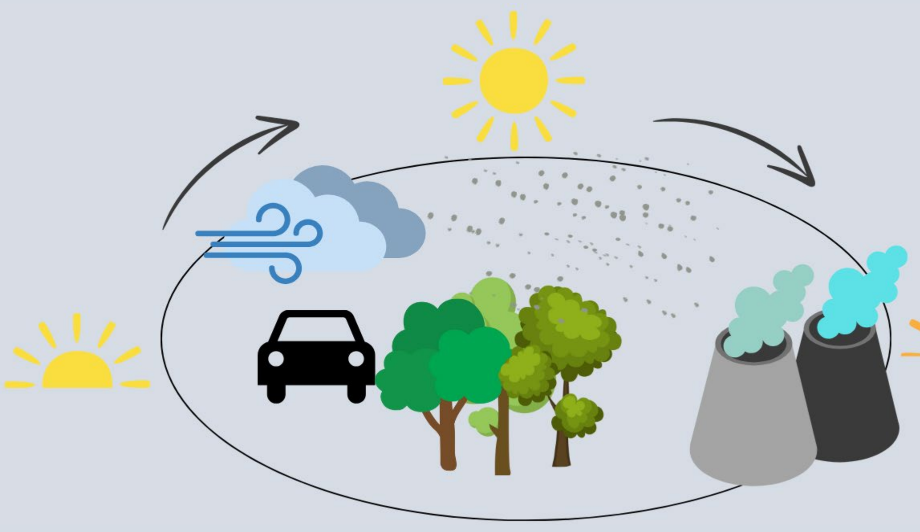


Figure 2: Confounding factors for air pollution measurements

CONFOUNDING FACTORS

- Pollution sources
- Time of the day
- Vegetation type
- Air mixing
- Initial concentration

Method 1: IN and OUT

2 operators measuring simultaneously at the same location [2]:

- 1 operator **inside** vegetation: 1m from tree trunk
- 1 operator **outside** vegetation: at least 10m distance to vegetation
- Distance to source (traffic): at least 30m

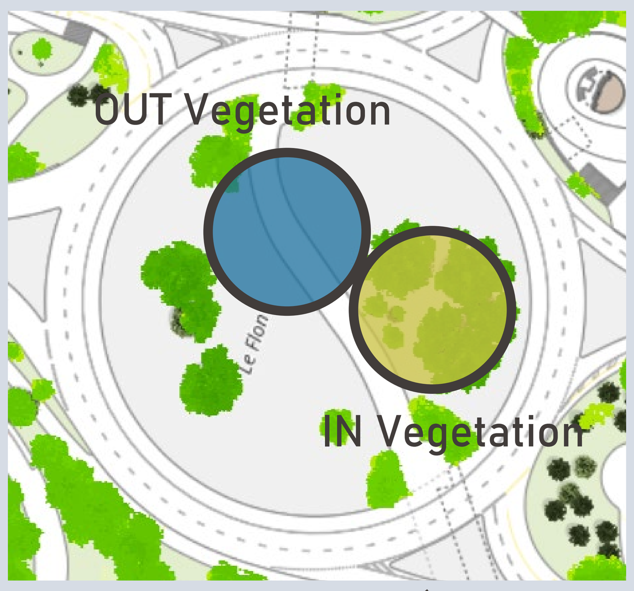


Figure 4: Location 4: «Maladière»

Method 2: WITH – WITHOUT

2 operators measuring simultaneously at different locations with similar characteristics [3]:

- 1 operator **with** vegetation: location with vegetation
- 1 operator **without** vegetation: location without vegetation
- Distance to source (traffic): at least 30m

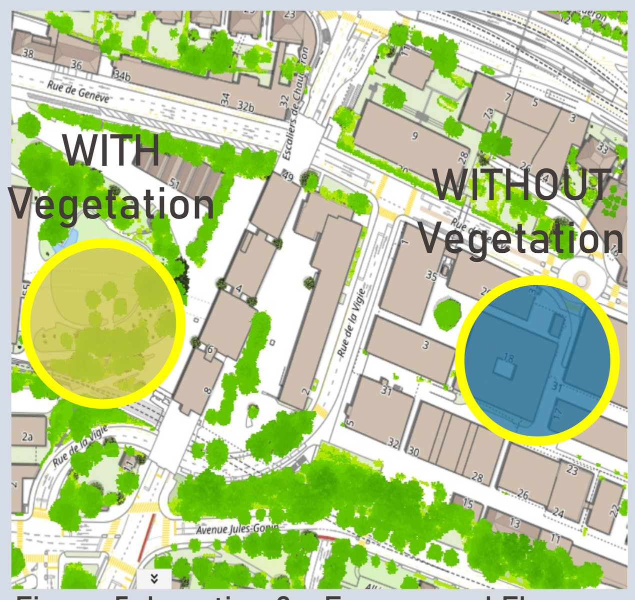


Figure 5: Location 3: «Eracom and Flon»

THERMAL STRESS

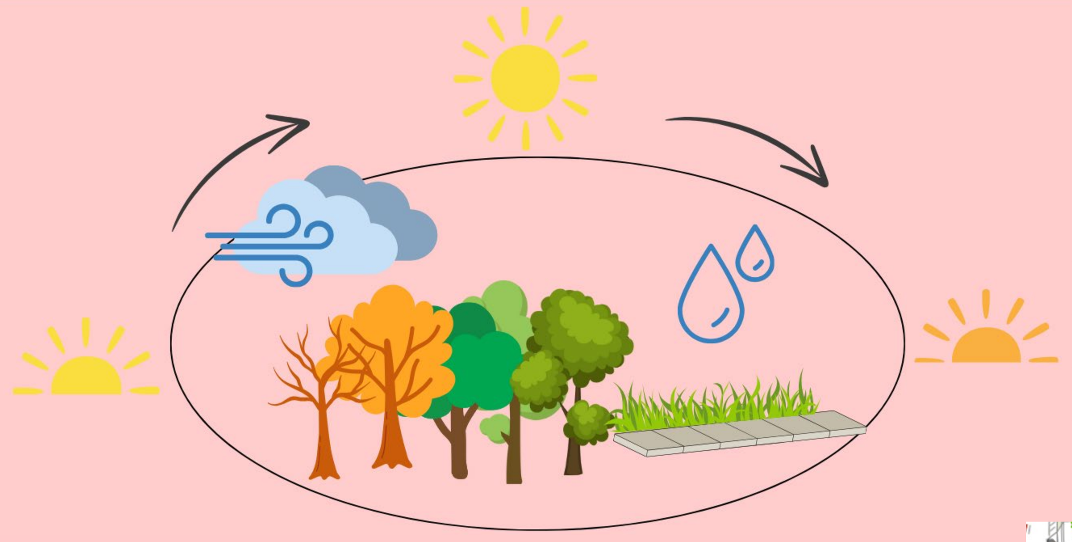


Figure 3: Confounding factors for thermal stress measurements

CONFOUNDING FACTORS

- Time of the day & season
- Vegetation type
- Air mixing
- Humidity
- Ground properties

Method: WITH - WITHOUT

2 operators measuring simultaneously at different locations with similar characteristics [4]:

- 1 operator **with** vegetation: location with vegetation
- 1 operator **without** vegetation: location without vegetation

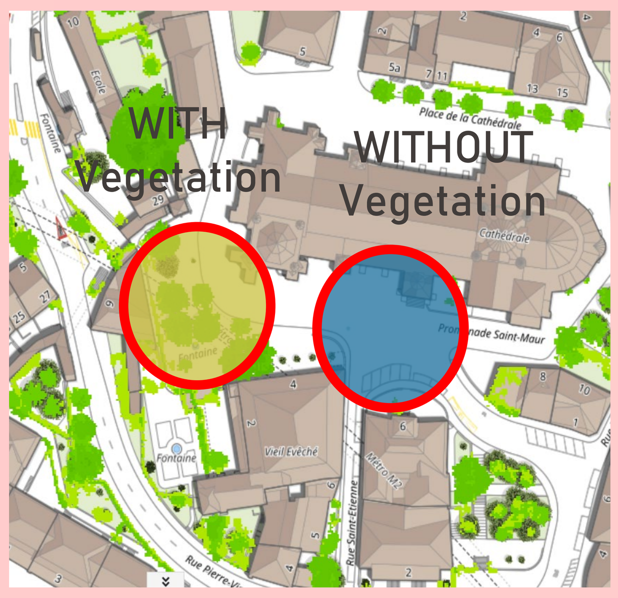
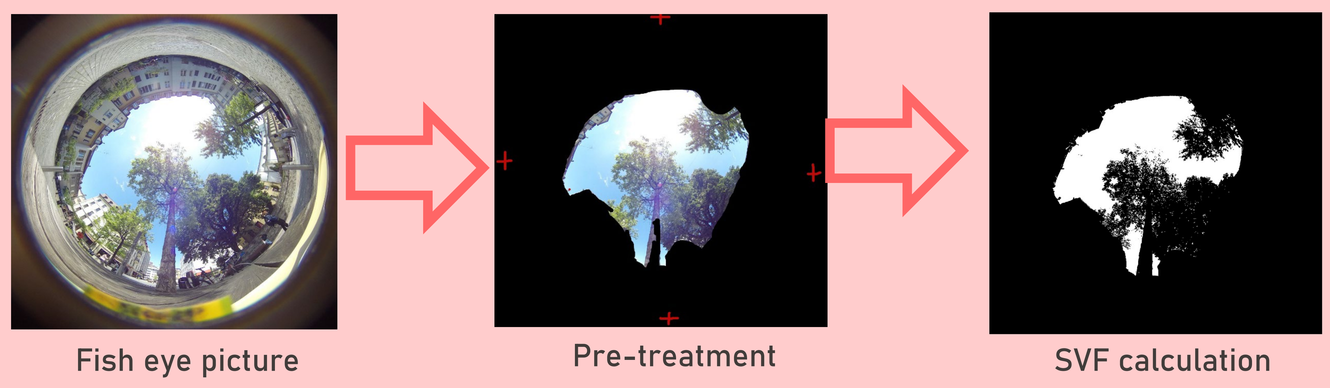


Figure 9 : Location 1: «Cathedral»

Sky View Factor (SVF) calculation

- SVF as explanatory variable for thermal stress: relation to vegetation
- Calculate SVF using the SkyViewFactorCalculator [5] with fisheye photos taken at thermal stress measurement locations



RESULTS

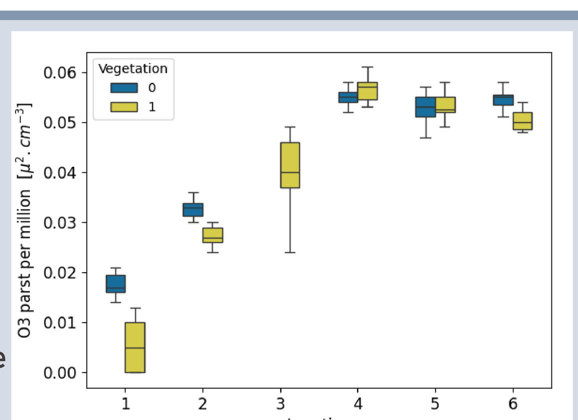


Figure 7: Ozone concentration

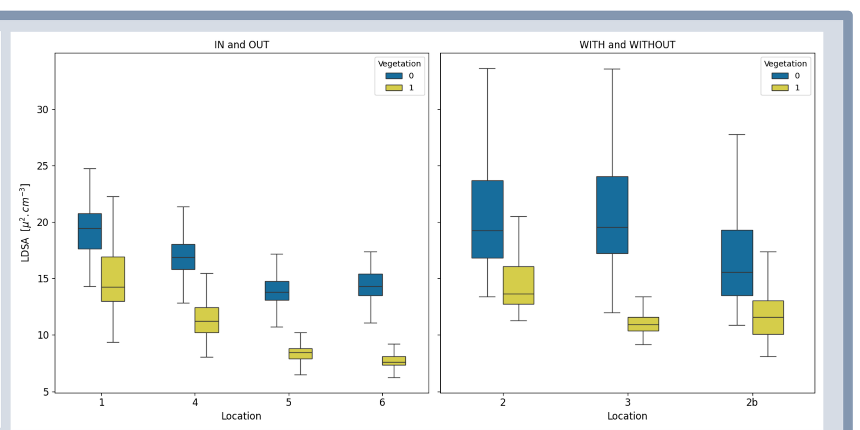


Figure 6: LDSA at each location, method comparison

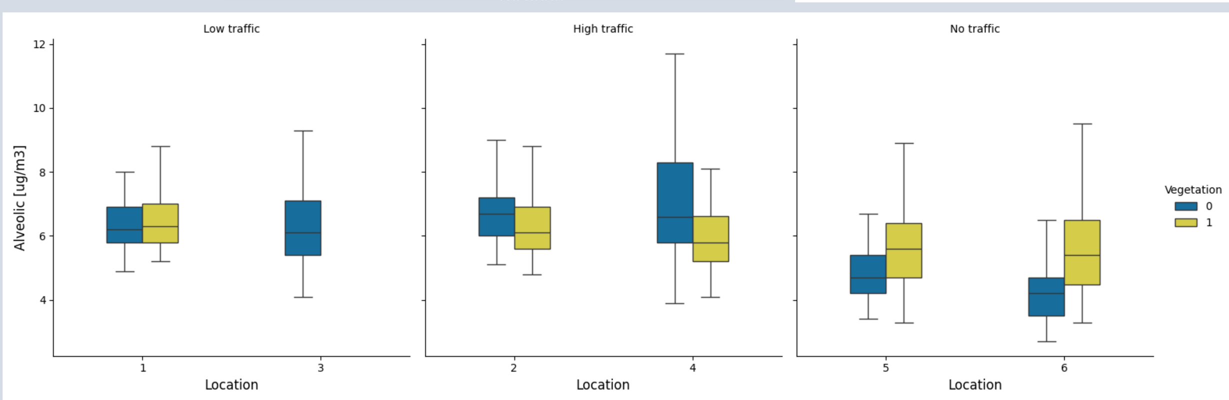


Figure 8: Alveolic particle concentration at each location, traffic influence

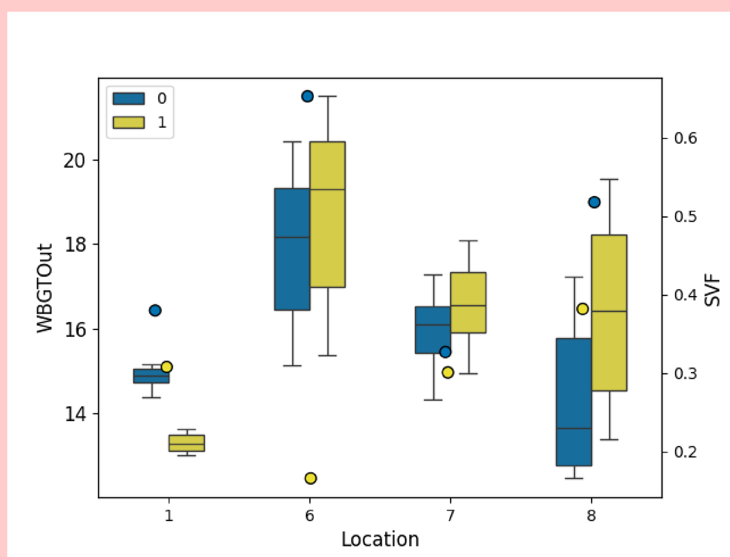


Figure 10: WBGTOut and SVF

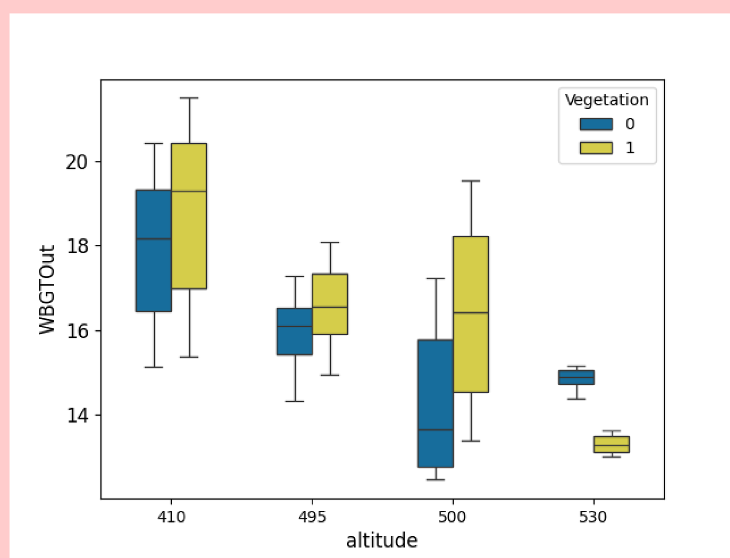


Figure 11: WBGTOut location's altitude influence

DISCUSSION

- ❖ Results from the implemented protocol show an influence of vegetation on LDSA, SVF, and ozone concentration, which are indicators related to human health.
- ❖ Vegetation seems to reduce the concentration of alveolar particles (<4 µm) from traffic that can penetrate deep into the human body.
- ❖ No significant influence of vegetation on thermal stress was observed, probably because heat stress was not high enough at the time of measurement.

CONCLUSION

- ❖ The method IN and OUT is more promising than WITH and WITHOUT
- ❖ High dependency on meteorological factors
- ❖ Sample multiplication by measuring on several days needed
- ❖ Logistics play an important role in the design of the measurement protocol.

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[4] Chen, T., Pan, H., Lu, M., Hang, J., Lam, C. K. C., Yuan, C., and Pearlmutter, D. (2021). Effects of tree plantings and aspect ratios on pedestrian visual and thermal comfort using scaled outdoor experiments. Science of the Total Environment, 801.
[5] Lindberg, F. and Holmer, B. (2012). Sky View Factor Calculator User Manual-Version 1.1

DESIGN PROJECT
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