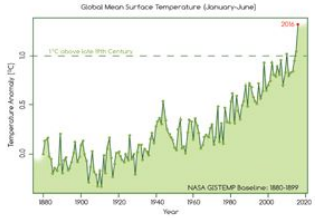
Adaptation to Climate Change:

Urban Green Areas as Cooling Safeguards

Introduction

Weather observations both in Ukraine and abroad demonstrate the tendency to a warmer Earth, which will lead to the increase of hot and dry patterns. Consequences of global warming will be more explicit in big cities due to limited air ventilation, larger areas covered by heat absorbing structures (such as buildings and asphalt roads), and smaller green spaces. The temperature in certain Kyiv districts raised by 7 - 10 °C in 2003 - 2011 (Stankevich, Filipovich, 2013). According to the WHO, 155,000 deaths annually (or 19% of the overall mortality) are caused by preventable environmental impact in Ukraine.



Project idea: to develop a scientific basis for further strategic planning on urban green zones and citizens adaptation to climate change impact in Ukraine.

Project location and duration: Kyiv city, April – August 2016

Project goals: to improve adaptability of the urban green areas to drought and overheating; to increase effectiveness of green areas in adaptation of citizens to extreme temperatures, CO_2 elevation, and direct sunlight; to estimate and raise the readiness of the Ukrainian legal framework to deal with climate change threats.

Project team & partners:

Ukrainian Ecological Club "Green Wave"

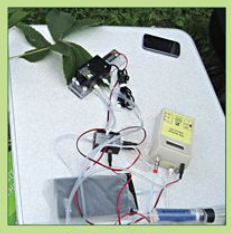
National University of Kyiv-Mohyla Academy

State Centre for Aerospace Research of the Earth

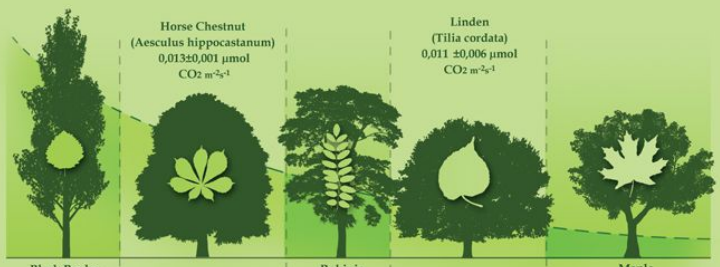
Drone.ua

National Ecological Centre of Ukraine

Financial support of Small grants program Climate Forum East II



Measurements of CO_2 absorption by tree leafs

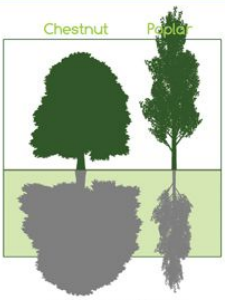


Leaf level

OBJECTIVE: to compare **tolerance of tree** urban species in Kyiv city to **heat waves (>30 - 35 °C)** by measuring the intensity of **leaf CO_2 exchange.**

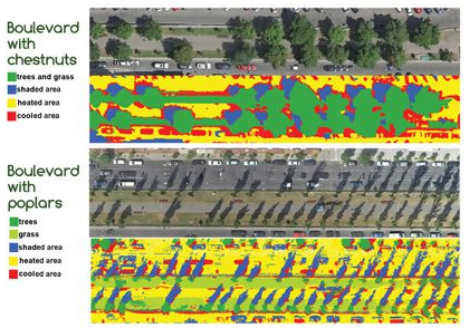
METHOD: usage of **infrared gas analyzer** (CO650 Plant CO_2 Analysis Package, Qubit Systems) to measure CO_2 absorption by tree leaves.

RESULTS: among the species studied, the most **active CO_2 absorbers** (hence resistant to heat stress) are Black Poplar **(Populus nigra)** and Horse Chestnut **(Aesculus hippocastanum).** The **lowest level of CO_2** absorption and thus the least heat tolerance was revealed by Maple **(Acer platanoides).**



The most effective shadowing provides the Horse Chestnut

Drone launch for thermal mapping



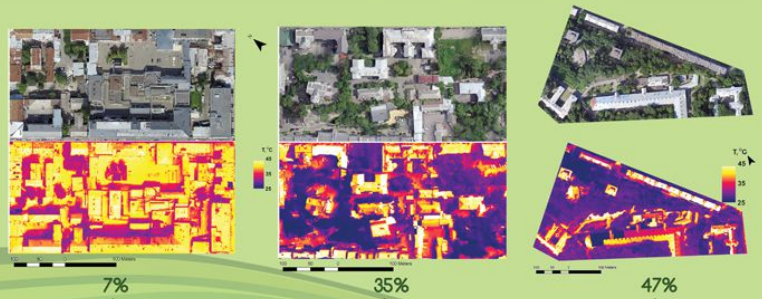
Street level

OBJECTIVE: to assess the effectiveness of street shading by different types of trees.

METHOD: thermal mapping with **Flir Vue Pro thermal camera** mount on **DJI Inspire-1** drone; altitude **100m**, spatial resolution **2 - 5 cm.**

RESULTS:
- **Chestnut** trees with **8 - 12 m crown size** planted with frequency **1 tree/15 m** provide **68%** ground covering that is enough for **uniform cooling of street** or boulevard.
- Due to pyramidal shape, **Black Poplar does not provide** sufficient shading of ground: under density **1 tree / 7.5 m**, only **10 - 30 %** of ground is cooled.

The most effective greening coverage is 35 % and more



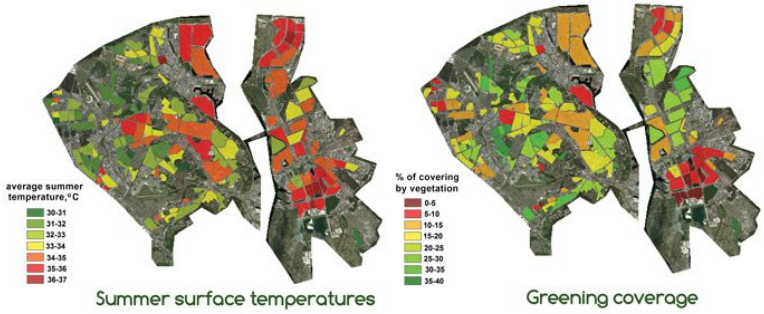
District level

OBJECTIVE: to assess temperature distribution around various urban objects (buildings, trees, flowerbeds) in districts with different levels of planting.

METHOD: thermal mapping with **Flir Vue Pro thermal camera** mount on **DJI Inspire-1** drone; altitude **100m**, spatial resolution **2 - 5 cm.**

RESULTS:
- During heat wave the **asphalt temperature** exceeds **45 °C →** the **vegetation surface** is not warmer than **25 - 30 °C.**
- The **trees are cooler** than the **lawns.**
- The vegetation can reduce surface temperature **even outside of shaded areas**: near shadows there is a small area, in which the surface temperature is lower for **3 - 5 °C** compared to other surface under the sun.
- The effective level of greening area is **35 %.**

The normative greening level is 25 % for living areas. In Kyiv new-built districts it is less.



Summer surface temperatures

Greening coverage

City level

OBJECTIVE: to study the relationship between the percentage of urban greening and average surface temperature within different districts.

METHOD: analysis of Landsat-8 thermal and multispectral satellite images of Kyiv for 2013-2015.

RESULTS:
In many districts, the **actual level** of greening is **much lower** than the level specified by current legislation **(25 % for living areas).** This leads to essential overheating of these districts. There is a clear **relationship** between the greening level and average summer surface temperature:
- The lowest greening: **0 - 10 %** → average summer surface temperature **35 - 37 °C** (Troyeshchyna, Poznyaki districts).
- The level of greening **10 - 15 %** → average summer surface temperature **34 - 35 °C** (Obolon district, city center).
- The highest level of greening: **20 - 40 %** → surface temperature of **30 - 33 °C** (Golosiyivo, Borschagivka, Syrets, and Svyatoshino districts).

Analysis of legislation:

1. **Neither city planning laws**, nor **urban development regulations** account for **adaptation of green areas** to global climate change;

2. Although the **Kyiv City Development Rules** are well-conceived, control over rules' execution is imposed on a body that is the main administrator of both green spaces and vegetation. Hence, it is necessary to introduce a **mechanism of external control** over implementation of the Rules.

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