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Jack Kimmel International Grant Application

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Relevant citations authored

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Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	
Previous TREE Fund awards	

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Relevant citations authored	PETRALLI M., MASSETTI L., ORLANDINI S. (2011). Five years of thermal intra-urban monitoring in Florence (Italy) and application of climatological indices. Theoretical Applied Climatology, 104, 3: 349-356, DOI 10.1007/s00704-010-0349-9.

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Journal of Environmental Quality 45 (1), 90-96. doi:10.2134/jeq2014.12.0521

Has this investigator previously received funding from the TREE Fund?	No
If yes, was the funding for this project?	
Previous TREE Fund awards	

Students/Interns (if applicable)

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Department or major

Status

Student/Intern 2

Name

Department or major

Status

Student/Intern 3

Name

Department or major

Status

Project

Project title	Effect of topping on microclimate condition and human comfort
Research area	Plant health care Urban forestry
Project summary	Urban trees create many benefits in terms of thermal comfort and Urban Heat Island (UHI) mitigation during the summer season. These benefits are strictly linked to tree canopy, but the management of the trees in the urban environment includes pruning activities. The aim of this work is to evaluate the effects of topping on microclimate conditions in the area where tree are planted. We hypothesized that topping can affect temperature of air and soil and air relative humidity. Thus, we want to test the hypothesis that topping do not only depress tree health, but also directly reduces thermal comfort and human well being in cities. The experiment will be conducted using 96 15-year-old maple (Acer spp.) and linden (Tilia spp.) trees. Half of them will be topped in late winter, while the remaining half will be left unpruned, according to a randomized block statistical design with 4 replicates. Sensors for measuring air temperature and relative humidity during the summer season have been placed in early summer 2016 in the area of research. After topping tree growth and physiology will be checked and air and soil temperature, and air relative humidity will be continuously monitored

for two years and the effect on human comfort will be calculated by applying biometeorological indices.

Statement of problem

Trees growing in the urban environment require periodic pruning to provide clearance and improve view (i.e. trees along roadsides), to reduce conflicts with buildings and infrastructures, to thin dense canopies and decrease wind resistance, and to improve safety by removing structural defects and by reducing canopy area exposed to wind load.
Unfortunately the bad practice of topping trees is widely spread all over the world. Topping shortens the growing axis by cutting the distal portion of the branch in the internode or in between consecutive lateral branches, without preserving the leader shoot of the branch required for sound canopy growth. This affects canopy size, density and morphology, key determinants of the amount of shade casted and of water transpired. Most research on pruning of urban trees, however, focused on pruning dose and timing on tree response to wounding, on compartimentalization of wood decay fungi, on tree response in the wind, whereas to our knowledge, nobody has investigated the effects of pruning method on microclimate conditions and, as a consequence, on human thermal comfort.
Previous studies discovered the role of green areas in mitigating the UHI effect in warm cities. In those studies, the air temperature across the city was reduced between 1 and 4 °C by the presence of green areas. According to the type of green area (with trees or covered only by grass), densely forested parks are generally warmer than parks without trees at night, and 1-4 °C cooler during the day. This is probably due to the canopy effect of trees that prevents radiation cooling during the night and soil heating by the solar radiation during the day. Even more dramatically, the temperature difference between shaded and non-shaded ground can be as much as 20°C (36 F), based on some studies described below. While the studies measured temperature of the ground surface, heating differences also occur at the surface of an animal’s fur or a person’s skin.
Urban temperatures and thermal comfort affects human health and wellbeing: the perception and the sensation of thermal comfort are vital in urban form, thus further study on what settings should be provided in various types of urban from is important to sustain the urban life.
Urban forests can help keep cities within a healthy temperature range, although the exact temperature reduction from urban forests is difficult to measure. The extent of the effect varies in space and in time, but management techniques, including pruning, play a key role. How do we affect urban microclimate when we improperly prune a tree? How much shading and transpirational cooling are lost along with topped branches? How long does it take to recover the pre-topping environmental benefits? Microclimatic benefits of urban trees have been widely described, but very little attention has been paid, up to date, on how they may be affected by improper management techniques, such as topping.

Significance of your proposed project as it relates to the

This project is related to urban forestry as it investigates the effect of tree topping on air temperature, relative humidity and human

profession of arboriculture or urban forestry	thermal comfort (HTC). Tree topping is unfortunately one of the techniques widely used all over the World to prune trees in urban environment. The aims of the study will be (1) to quantify the effects of topping street trees on some air parameters (mainly relative humidity and temperature) and (2) to quantify the HTC after tree topping. As such, this is a unique study that will be capable of observing not only the effect of topping on tree growth and physiology, but also the negative feedback determined on human comfort and health. To our knowledge there are no studies that have been undertaken representing neither in warm nor in temperate areas, and we are aware that many temperate cities may experience such warm summer conditions and heat events under projected climatic changes.
Description of what is currently known about proposed project area	Cities are frequently warmer than surrounding rural areas. Described as the 'urban heat island' (UHI), this phenomenon has been reported for cities worldwide. The UHI is an artefact of the complex built environment, the lack of cooling vegetation and the high density of human activities in urban areas, and is a result of differences in the energy balances of urban and rural environments. During the day, cities and the countryside receive energy from the sun and from human activities. This energy is reflected or absorbed and stored for release when the temperature of the surrounding environment drops, most notably at night-time. Differences in where the heat is stored, the amount of heat stored, the rate and extent of energy release and what happens to emitted energy combine to create the UHI. In this scenario we know that green areas have an important role in UHI mitigation: according to a variety of variables, such as the magnitude of green area, the hour of the day, the height of buildings in the surroundings, the type of green area (with trees or grass), the air temperature reduction can vary usually between 1 to 4 °C. It has been demonstrated that even a single tree or a single cluster of trees can already have positive effects on the urban thermal environment. Urban street trees can have positive effects on city air temperature and HTC although this is highly localized and variable, depending on tree cover, geometry, and prevailing meteorological conditions. The cooling benefit of street tree canopies increases as street geometry shallows and broadens and can be very different in urban plazas which are defined as open public areas that are usually near city buildings and that often have trees and bushes and places to sit, walk, and shop. Usually these areas in summertime are hit by the sun during the whole day and air and ground temperature can reach values well over the threshold of discomfort. Street trees can also help reduce high urban temperature through key vegetative processes of shading and transpiration. Shading combats the UHI in three complementary and additive ways. Firstly, by limiting solar penetration shading restricts energy storage and the heating of the local environment that subsequently occurs. Secondly, shading reduces the direct gain of energy through windows and the subsequent 'internal' greenhouse effect. Lowering air-conditioning demand leads to energy and cost savings and reduces the emission of waste heat energy. Finally, shading shelters people from direct exposure to the sun, which is important as thermal discomfort has been suggested to relate more to higher radiation exposure than

higher air temperatures. The magnitude of cooling from a shade tree depends upon crown shape (broad being best) and density. Dense trees block more incoming solar radiation, reducing solar warming. Magnitude of cooling also depends on tree growth rate and longevity, and placement of the trees relative to the building to be shaded. It has been calculated the value of shading can be as 2.5 times greater than that of evapotranspiration cooling. However, in temperate climates the role of shading and evapotranspiration are approximately equal.
Several studies suggest that an increase in vegetation can help mitigate the urban heat island (UHI), while others promote vegetation as a way of modifying urban microclimates and human thermal comfort (HTC). However urban street trees face significant challenges including development and infrastructure pressures, maintenance issues, and poor water availability at times that can compromise their ability to mitigate urban heat and improve HTC. Topping is an improper pruning technique that is, unfortunately, still widely used in cities worldwide. Despite it is long known that topping enhances decay, and it has been recently pointed out that it depresses stress tolerance, short-term economic considerations still prevail over proper tree care, and trees are then topped. In this project, we assume that topping can have negative effect also on urban microclimate and on human thermal comfort: the main benefits that urban trees produce are linked to tree canopy, that is completely removed with topping. New evidences that the negative effects of topping are not limited to the tree itself, but have consequences on human well being, may act as deterrent to topping and may assist the appraisal of topping damage to trees.

Summary of project goals	The project will provide useful information to be used to convince municipality and private owners not to top trees and how bad this practice can be for trees but also for human well-being. In particular, this project aims to: - quantify the effect of topping on air and soil temperature and air relative humidity - quantify the effects of topping on thermal comfort - measure the effects of topping on three growth and physiology - compare tree growth and physiology between topped and non topped trees - compare the effect of topping on microclimate and human thermal comfort between topped and non topped trees - determine how much time is needed to restore pre-topping conditions
Description of measurable outcomes expected	- Increase/reduction of temperature - Knowledge on tree growth and physiology after topping - Management guidelines to improve/maintain thermal comfort and human health.
Project plan including design, hypotheses, methodology and analyses	96 15-years old Norway maples (Acer platanoides), mountain maple (Acer pseudoplatanus), and linden (Tilia spp.) have been selected in an experimental plot near Milan (North of Italy). 10-12 cm (4-5 in.) circumference. Trees were planted in 2005, in mixed stands, spaced 6 m in-row and 3.5 m between the rows. Plants have been grown for

	several years in the field, are uniform in size, and reached full canopy closure in 2013. The experimental field was divided into 300 m2 plots, each planted with 12 mixed maple and linden trees, according to a randomized block design with 4 blocks. Plots will be either topped or left unpruned. In topped plots, all plants will be topped by chainsaw cutting of primary branches. Branches will be pruned close to the crotch as unfortunately is often done by municipalities and private owners. The remaining half trees will be left unpruned as a control. Sensors to measure air temperature and relative humidity have been placed around the trees in late spring 2016 to monitor the microclimate around the trees during the summer season before topping. These sensors were all located at the same distance from tree trunks and at 1,5 m height, in order to collect air temperature and relative humidity at pedestrian level. Growth in topped and unpruned trees will be determined through measurement of shoot growth, stem diameter growth, and canopy size. To estimate transpirational cooling, leaf gas exchange will be measured, with a particular reference to daily trends of transpiration per unit leaf area. This value, integrated over the whole leaf area (calculated from crown projection measurements and leaf area index), allows the calculation of water transpired by trees over the day and, by consequence, of the consequent cooling benefit. Leaf gas exchange will be measured monthly during the growing season using an infra-red gas analyzer. We showed in a previous experiment that leaf characteristics and leaf temperature are affected by topping. Because these traits are correlated to the emission of Volatile Organic Compounds (VOCs), which important pollutants in cities, VOC emission will be determined in topped and unpruned plants. This will allow to evaluate a side effect that topping may have on human health
Description of plan for disseminating the results of this project	The results of this project will be disseminated through presentations at professional meetings that include both academic and industry scientists and publications in peer-reviewed and industry publications, this will include reports and other documents. We plan to organize meetings with stakeholders to present the results of this study. The dissemination will be also done through workshops, national and international conferences and through the most important social networks (online discussion lists, tweets, Facebook posts, photos, etc.).
Project start date	03/01/2017
Project completion date	02/28/2019
Geographic range of project	USA & Canada Latin America Europe & North Eurasia Asia & Pacific Middle East Africa

Budget

Compensation/Stipend

Proposed project budget	10000
Requesting from TREE Fund	5000
Funding from other sources	5000
Value of in-kind support from other sources	0

Employee Benefits

Proposed project budget	0
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	0

Travel (> 50 miles)

Proposed project budget	6000
Requesting from TREE Fund	2000
Funding from other sources	4000
Value of in-kind support from other sources	0

Local Transportation (< 50 miles)

Proposed project budget	0
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	0

Equipment (vehicles, growth chambers, etc.)

Proposed project budget	7000
Requesting from TREE Fund	2000
Funding from other sources	5000
Value of in-kind support from other sources	0

Supplies (paper, ink, toner, etc.)

Proposed project budget	0
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	0

Contract Labor (contractor, speaker, etc.)

Proposed project budget	0
Requesting from TREE Fund	0
Funding from other sources	0
Value of in-kind support from other sources	0

Other/Misc.

Proposed project budget	2000
Requesting from TREE Fund	1000
Funding from other sources	1000
Value of in-kind support from other sources	0
Description of other/misc. expenses	Cost of publication Production of informative leaflets

Total

Proposed project budget	25000
Requesting from TREE Fund	10000
Funding from other sources	15000
Value of in-kind support from other sources	0

Funds already received from other sources	0
Funds pending from other sources	15000

Value of in-kind support already received from other sources	0
Value of in-kind support pending from other sources	0

How did you hear about this grant?	TREE Fund website TREE Fund newsletter TREE Fund conference booth Social media (Facebook, LinkedIn)

Applications will be scored on the following scale:

- Applicant is qualified (10 points)
- Applicant has experience (10 points)
- Project directly meets one or all TREE Fund priorities (10 points)
- Project has clearly stated need (10 points)
- Project is clearly linked to arboriculture and/or urban forestry (10 points)
- Research has practical application (10 points)
- Methods are clear (10 points)
- Objectives are achievable within proposed time frame (10 points)
- Objectives are achievable within proposed budget (10 points)
- Requested funds are matched with at least 10% cash or in-kind (10 points)

Your application will not be available for editing after it has been submitted.
Please review your application for completion before submission.