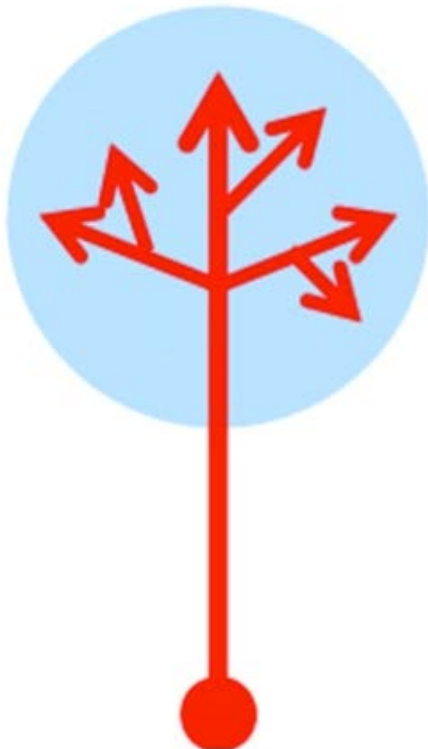


Arbor-ization: what's going on in the world of arboriculture and urban forestry

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Arborization: any branching, tree-like shape or formation thresholds for human well-being

Currently, more than half of the world's population lives in an urban environment. Urbanization has been both a gradual and cyclical process since the beginning of human civilization. However the rate of urbanization increased dramatically during the industrial revolution and evolved into "overflowing settlements" in the second part of the 20th Century. During this time, the post-World War II population boom in developing countries was largely absorbed by the cities. As a result, more than 50% of the world population now lives in the urban areas. This percentage is even higher in Europe where more than 70% of the population is "urbanized". This is why Arboriculture and Urban Forestry must have a prominent role in the management of urbanization and establishment of habitable cities. All greenspaces, from flowerbeds to periurban (outlying) forests offer a "concept of nature," and fulfill a paramount function in improving quality of life. Have you ever imagined what the world would be like without trees? I have not, and can't even think about it! Greenspaces help cities to reach the minimal thresholds for human well-being. We desperately need them in our concrete jungle (the definition of this idiomatic word is "an urban or other populated area containing a high



density of buildings constructed of concrete or similar materials, especially one which lacks greenery and which seems unattractive, harsh, or unsafe" http://en.wiktionary.org/wiki/concrete_jungle). Many view greenspaces simply as an outlet for recreation and don't even think about what they can offer to improve citizens' quality of life. These benefits have been the subject of numerous research projects, including European COST studies, the Horizon 2020 Programme for Research and

Innovation, LIFE Programme, etc. The European Commission identifies that urban areas are the source of many of today's environmental challenges – not surprisingly, since, as said, two out of three Europeans live in towns and cities. Local governments and authorities can provide the commitment and innovation needed to tackle and resolve many of these

problems. In the new EU budget 2014-2020, at least 5% of the European Regional Development Fund will have to be used for sustainable urban development. Cities can take advantage of the Structural Funds, for example, by forming a thematic urban network under URBACT II or by making use of the European Urban Knowledge Network. Some noteworthy funding programs are as follows; LIFE+, URBACT, INTERREG IVC, Horizon 2020, Smart Cities and Communities European Innovation Partnership, EU Cities Adapt.

EU recognizes that green areas in inner cities are invaluable for improving the urban climate. They play a very important role in mitigating temperature extremes, managing stormwater, reducing gaseous and particulate matter pollution, which is urgently needed, particularly in densely populated areas and in areas with dense transport networks. Therefore, the inclusion of appropriate research activities in the new Horizon 2020 framework program for research and innovation appears to be an important contribution towards studying the interaction between the biosphere and human health, the management of ground and surface water in inner cities, sustainable urban development and, in general, addressing climate change.

An interesting COST action¹ related to trees in the urban environment is now running (FPS COST Action FP1204) "Green Infrastructure (GI) approach: linking environmental with social aspects in studying and managing urban forests (UF)". A COST Action on this topic is crucial because of the diversity of GI and UF approaches at European level and because of the need to create a structured interaction among scientists, citizens, policy makers and managers. The COST Action aims to: 1) increase the understanding of the role of UF in the context of GI from a scientific and a socio-economic perspective, in terms of the ecosystem services provided to people and to the urban environment; 2) to identify priorities and challenges for future research in the field; 3) to provide indicators and/or thresholds to be included by policy makers in local, national or international regulations about GI and UF; 4) to develop guidelines for GI planners and managers on how to implement GI approaches with an emphasis on linking the environmental and social services of UF (http://www.cost.eu/COST_Actions/fps/Actions/FP1204 or <http://www.greeninurbs.com/>).

LIFE is the EU's financial instrument supporting environmental, nature conservation and climate action projects throughout the EU. Since 1992, LIFE has co-financed some 4.171 projects, contributing approximately €3.4 billion euros to the protection of the environment and climate. The LIFE Program for the Environment and Climate Change 2014-2020 is divided into two sub-programs: **climate action and environment**.

LIFE sub-program Climate Action will support projects in the development of innovative ways to respond to the challenges of climate change in Europe.

Life sub-program Environment will support efforts for the better implementation and integration of environmental objectives in the following areas:

Environment and Resource Efficiency, which will focus on implementation of environment policy and exclude market replication-oriented innovation;

Nature and Biodiversity, which will develop best practices for wider biodiversity challenges, while keeping its focus on Natura 2000;

Environmental Governance and Information, which will promote knowledge sharing, dissemination of best practices, and better compliance, in addition to awareness raising campaigns.

The sub-programme for Environment will have a budget of approximately EUR 2.6 billion over the duration of the Programme (or 75% of the overall LIFE budget 2014-2020).

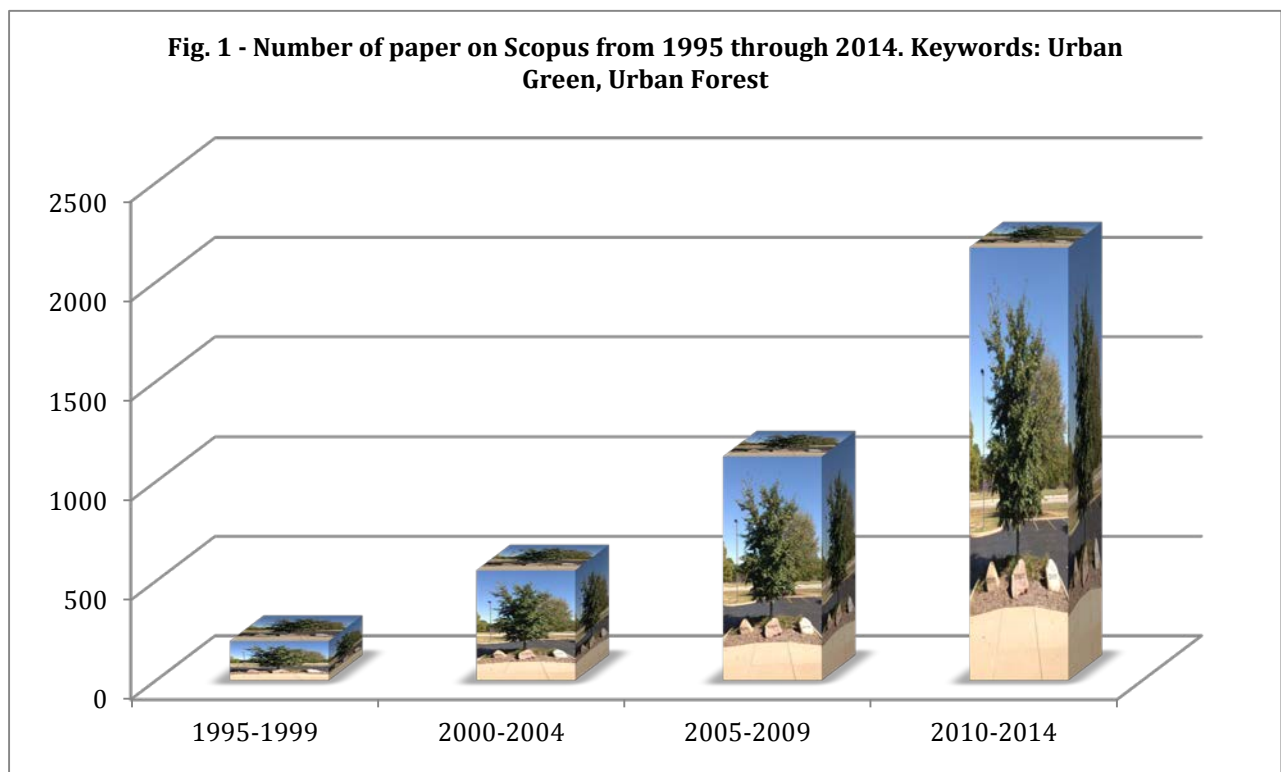
Developing countries will also play an increasingly important role in global environmental

¹ COST (European Cooperation in Science and Technology) is one of the longest-running European frameworks supporting cooperation among scientists and researchers across Europe.

issues as their major cities are growing much faster and often in a less sustainable way than those in the most developed countries.

This said the aim of this paper is to summarize future arboricultural challenges identified at conferences and meetings held all over the world in the last years and what emerges from databases, questionnaires, survey, etc. from all over the world. A particular focus will be on the ISA activities and program to become more and more international and to realize the “*arborization of the world*”.

It doesn't surprise that the recognized qualities of the trees have helped to increase the awareness of their fundamental importance and sensitivity towards them and, consequently, the need to manage them as a priceless heritage in different countries. The study of urban arboriculture is therefore growing at a very fast pace and it is difficult to keep up with the amount of scientific literature produced worldwide, as evidenced by the number of papers indexed in Scopus (www.scopus.com), relating to keywords "Urban Green" and "Urban Forest", grown from about 150 in the five years from 1995 to 1999 to over 2,000 in the 2010-



2014 (see Fig. 1, as of 25th of March).

The stimuli at the base of this growing interest towards these topics are varied and interconnected. A substantial part of the research is related to the aspects of pollution and of climate change and the potential that the green areas, and trees in particular, offer in limiting their effects. As a matter of fact a large proportion of reports was then given to the study and quantification of the benefits from green areas and specifically trees, to the quality of life in the urban environment.

In Table 1 you can see the different distribution of the papers (even though some of them can be found in more than one category). It's not surprisingly to see that a much lower number of scientific research is dedicated to the management issues because working with trees in a very complex environment is difficult and time consuming. The all four stages of research need to be carefully planned and they all take time:

- Designing the study can take a while sometimes, but usually it's not too time consuming. However an experimental design is the structure of any scientific work. It gives direction and systematizes the research. The method chosen will affect results and how to conclude the

findings. Results from studies which are not correctly planned may not be reliable and should be looked upon with skepticism.

- Data collection can take years. Sometimes you have to wait for the trees to grow and then collect data for at least three growing seasons to get reliable results. Further the shorter is the time, the more replicates (and then more trees) you need to get consistent data and this means raising research costs a lot.

- Analyzing the data collected involves examining it in ways that reveal the relationships, patterns, trends, etc., that can be found within the research. That may mean subjecting them to statistical operations that can tell not only what kinds of relationships seem to exist among variables, but also to what level the answers found are trustable.

- Finally, researchers should describe their results clearly, and in a way that other researchers can compare them with their own results. They should also analyze the results, using appropriate statistical methods to try to determine the probability that they may have been chance findings, and may not be replicable in larger studies. But this is not enough. Results need to be interpreted in an objective and critical way, before assessing their implications and before drawing conclusions. It may mean comparing the obtained information to that from other research to help to better understand the overall situation and to draw some conclusions from the data.

Tab. 1 – Number of papers cited in Scopus using different keywords matching (as of 25th of March)

Key words	Number of papers
“Arboriculture and Urban Forestry” (AUF)	2174
AUF+pollution	584
AUF+benefits	502
AUF+climate change	282
AUF+tree perception	145
AUF+human health	132
AUF+tree planting and management	127
AUF+tree mature	53
AUF+tree physiology	37
AUF+pests and disease	25

In Tab. 2 are shown the results obtained using the same keywords in Google (not Google Scholar). As it can be seen the ranking is quite different. Scopus covers a wider journal range, but it is currently limited to recent articles (published after 1995). Google, as for the Web in general, can help in the retrieval of even the most obscure information, but its use is blemished by inadequate, less often updated, citation information. Being not selective, Google shows everything that is published and it presents all the benefits and drawbacks of the web. It sometimes offers unique options in the scientific field, information is ample, but access is often uncontrolled.

I speculate that this disparity is due to the fact that a vast number of papers is published by the extension services of US Universities which, even if they contain reliable and science-based information, are not indexed in any scientific database. These publications (indeed sometimes very similar with some “carbon-copy” versions of the same main article) are mainly directed to describe the problems which arise in the field of arboriculture and urban forestry and to give suggestions to face them in a practical way. They instruct people who, at different levels, deal with trees through an educational process that uses research-based knowledge focused on issues and needs.

So, even though research-based information on tree planting and management, including pests and disease, is limited, there is plenty of information on these topic because of their importance in maintaining a healthy urban forest.

Tab. 2 - Number of results in Google using different keywords matching (as of 25th of March)

Key words on Google	Number of papers
"Arboriculture and Urban Forestry" (AUF)	13.800
"AUF" +pests and disease	7230
"AUF" +tree planting and management	6810
"AUF" + pollution reduction	5410
"AUF" + Tree benefits	5360
"AUF" +tree perception	2960
"AUF" +tree physiology and biochemistry	2850
"AUF" + climate change	2680
"AUF" +human health	2560
"AUF" +tree mature	2490

ISA has also conducted a survey (TREE Fund Research Needs Assessment) among its member about

- Employment and experience profile of respondents
- Research area preferences
- Donor status and future donation plans
- Personal research topics of interest

The goal of the ISA and TREE Fund Research Needs Assessment survey was to examine the needs and interests of the arboriculture community and provide the insight needed to create a proactive research program that will prepare ISA and TREE Fund for long-term success within the profession.

The key finding are that ISA has a diverse membership and, accordingly, members' research interests span a variety of topics influenced by their position, employment area, and experience. According to the top-ranked responses, members believe ISA and the TREE Fund should focus on: tree benefits and public awareness; tree risk assessment and management; plant health care; urban and community forestry; and mature tree care and preservation. Yet, each of the dozen areas listed generated a notable amount of interest from respondents, with even the lowest-ranking research field still an area of concern for close to one-third of this survey sample. This indicates that ISA and TREE Fund serve a broad audience that has complex needs.

To get information about the topic of the presentation, I also circulated via email and/or using Facebook pages four main questions:

- 1) What do you think are and will be the main challenges for Arboriculture and Urban Forestry?
- 2) How research helps and will help ISA growth?
- 3) Do you feel that the field of Arboriculture and Urban Forestry and the professionalism of the people are undervalued?
- 4) How do you think research findings should be transferred to tree workers?

Several feedbacks were received and from them it emerges what follows.

Question n. 1 What do you think are and will be the main challenges for Arboriculture and Urban Forestry?

The analysis of the answers received shows that the main challenge will be climate change in all its aspects. The urban tree population we currently have may not be the best to future conditions. Climate change plus globalization are bringing and will bring risks of new pests and diseases which already can be seen. New dangerous pests are already arriving from Asia to Europe and North America as well as between American and European continents. Native species as well as exotics we are now planting in urban areas face new risks they are not “prepared” against in natural evolution.

The biggest professional challenges in arboriculture are thus related to the intensification of the research at all levels, from tree benefits (not only related the microclimate improvement in the cities), to the reduction of the concentrations of greenhouse gases in the atmosphere which are linked with the increased risk of global climate change.

ISA role is to help people and not just members to understand that planning and management of green areas have expanded from the notion of municipal street tree management to urban ecosystem management and why having healthy, fast-growing trees provide great benefits is fundamental for our life. Trees need to be in good health to maximize gas exchange and wood biomass production, the main CO₂ storage site in the long term. At the same time trees are very vulnerable to the stresses induced by climate change. As complex and long-lived organisms they experience climatic impacts over a long time, sometimes centuries, and any impacts of the benefits or injuries imposed by long term climate changes or short term fluctuations in the weather, will be reflected with compound interest as time passes. Therefore tree protection from the adverse effects of climate change must lie in developing long-term management and replacement programs.

Question n. 2 How research helps and will help ISA growth?

There is a substantial agreement that research must be highly practical, so it may easily be used out in the field. It should also provide tools for future conditions like the things mentioned above. It's perceived that research is essential for the progress of the field of Arboriculture and Urban Forestry, but has to be presented to and accepted by practitioners. The TREE Fund has made great progress but the number of sources for funding and size of grants is only a fraction of what is available to researchers in other areas. This is the driving force for attracting the best researchers and making their work possible. Discovery of new knowledge is important for ISA's growth but the most important role is professionalism in the industry (e.g. credentialing)(Fountain, pers. Comm.).

ISA will and must have a prominent role from a scientific, technical and practical standpoint in addressing public administrations (from national to the community) and all those interested in trees (including tree lovers, NGO, etc.) to:

- Increase the number of healthy trees (this increases pollution removal and C sequestration).
- Sustain existing tree cover (maintains current C storage and levels of pollution removal).
- Sustain large, healthy trees (large trees have greatest per-tree effects).
- Plant long-lived species and use wood for long-term products (forestalls C emissions from decomposition).
- Use low-maintenance, urban-adapted trees (reduces pollution emissions from maintenance activities).
- Minimize the use of fossil fuels in maintaining vegetation (reduces pollution emissions).

- Plant trees in energy-conserving locations and use tree materials for energy production (reduces pollution emissions from power plants).
- Plant trees to shade parked cars (reduces vehicular VOCs emissions).
- Plant trees in polluted and/or heavily populated areas (maximizes tree effects).
- Select and plant trees with a high performance in reducing the levels of particulate matter. (Nowak, D.J., D.E. Crane, J.C. Stevens, and M. Ibarra. 2002. Brooklyn's Urban Forest. General Technical Report NE-290, U.S. Department of Agriculture, Forest Service, Northeastern Research Station, Newtown Square, PA. 107 pp.)

Last but not least, ISA will have a fundamental role in issuing standard procedures for any arboriculture practice and in increasing the number of certified arborists while improving their preparation level.

Question n. 3 Do you feel that the field of Arboriculture and Urban Forestry and the professionalism of the people are undervalued?

Every respondent said that the professionalism of the people involved in the field of Arboriculture and Urban Forestry is definitely undervalued and there is reason for that: both in practical application and in the theoretical area of arboriculture far too many bad things happen because of poor education and/or other interests. As long as a significant part of arboriculture is not really professional, this profession will not be regarded and accepted as a real profession. Arborists feel to be undervalued but state that is mainly for their own fault for trying to undercut their own businesses. Too many companies don't know their own costs and bid work too cheaply. They give work away to keep busy and don't really know their expenses and what it costs to do business. They also undervalue their own knowledge.

Also most university administrators fail to have an appreciation for the disciplines that do not involve row crops and the animal sciences. A profession that is the hobby of 80% of the US population (Gallop Poll) is not going to have the same level of professional respect (Fountain, pers. Comm.). This is also a cause of the limited number of students who prefer to go into a more lucrative profession where they are more valued. The positive face of this is that those who choose to get their degree in this field are really passionate.

My personal think is that people who work with trees should know that they have a profession not just a job. Jobs are activities that are performed in exchange of a monetary value. A job is often short-term and only done as a person requires money to live. A profession is, instead, a vocation that is based on specialized educational training.

Question n. 4 How do you think research findings should be transferred to tree workers?

Also in this case there is almost a unanimity that transmission of research findings to workers is through education. Good seminars, workshops, conferences etc. are needed to provide the latest news. Chapters must be helped to deliver the latest news to tree workers.

There is no doubt that research results need to be conveyed to technicians, practitioners, municipal arborists, urban forester and so on. An analysis on the transfer of knowledge from research to practice in fields other than education suggests that transfer is complex and dependent on particular conditions that may not be easily met in education; Research can be sometimes difficult to transfer to practice because its findings may vary with context, or they may be interpreted differently, or they may contradict policy directions. In this particular scenario the critical role of practitioners in the process of knowledge transfer in education needs to be recognized and developed. Current developments linking research to policy and practice pay insufficient attention to the complexity of relationships between policy-makers, researchers and practitioners and the extent to which they pursue different agendas.

Conclusion

The 21st century will be characterized by an intensification of the urbanization, especially in some developing cities, which will strongly affect the green areas and trees in particular. The other enormous challenge, which is somewhat related to the urbanization, is global change (above all global warming). Thus research is strongly needed and must be planned keeping in mind that trees are long-lived beings and accordingly to the limited degree to which adoption to changes can occur, it will be increasingly necessary to consider the impact of changes in urban trees and urban forest management plans, including species and site selection. Apart from improving site condition through a precise assessment of the intrinsic and extrinsic factors, it is important to take into account all the possible changes to be expected in the future.

Increased emphasis should be placed on selection and/or breeding trees for environmental stress tolerance, such as drought and temperature stress. Tolerance or resistance of trees to environmental stress will result in healthier trees that are not only able to resist disease, but will notably improving the quality of the urban environment.

It is my opinion that the main strategy for protecting trees from the adverse effects of climate change and for maximizing their benefits on the urban environment and on human well-being, consists in developing long term management and replacement programs which will ensure a balanced age range and a good tree health.

Decision makers, policy makers, city planners as well as stakeholders should be aware of the impacts that global change will have in our life and the paramount importance of urban vegetation to mitigate these impacts and to improve the quality of our cities.

To this regard is important to remember that ISA is an old but mentally young organization with great opportunities, which will determine a clear sense of future direction and focus.

We are living in a rapidly changing time and ISA has big opportunities and competitive advantages not only to maintain but also to improve its leader position in the field of Arboriculture and Urban Forestry thus having significant impact on our urban environment (and not only) over the next 20-30 years. Looking at political, economic, technological, social, lifestyle, demographic, competitive, regulatory and broad philanthropic trends, we can determine which changes are opportunities for us (for example, opportunities to grow) and which could be threats to us in some way (trends that can keep us from being successful).