Forests for Urban Landscapes

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Urban (and peri-urban) forestry

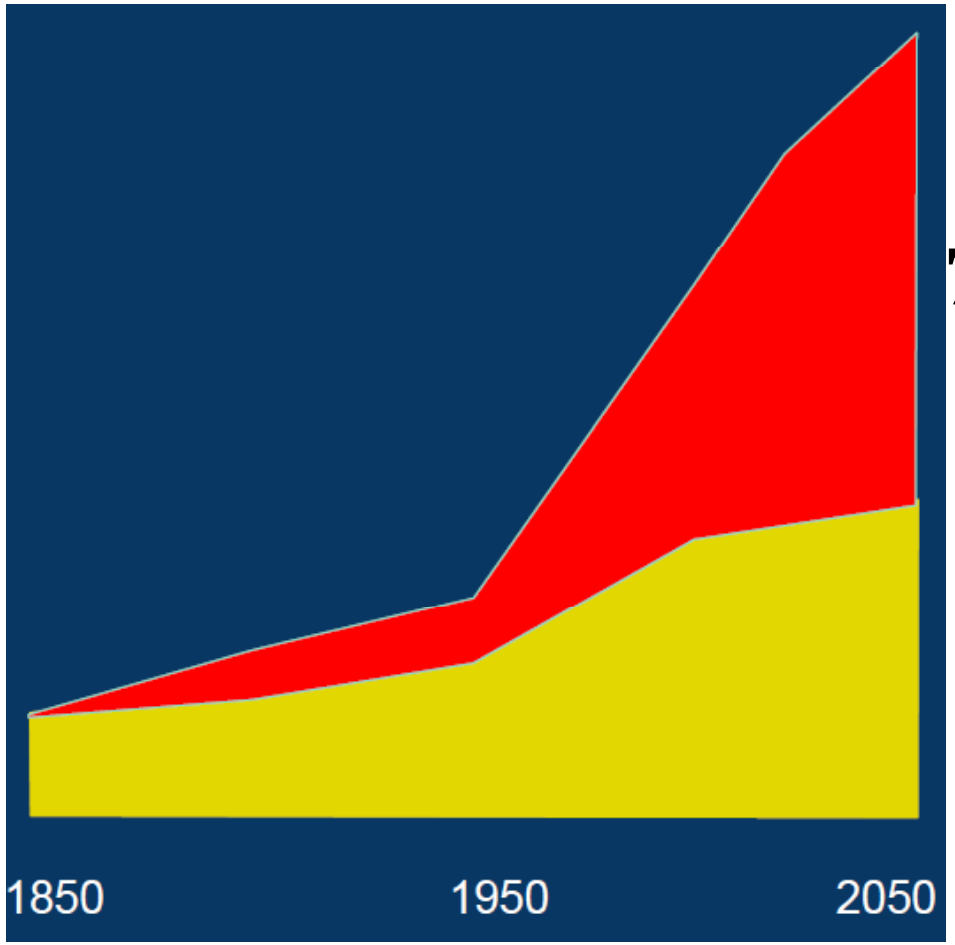
- Trees in streets, squares, parking areas and other “grey spaces” with sealed surfaces.

- Trees in parks and other green spaces such as yards, gardens, and commercial areas.

- Stands of trees that are often referred to as “woodlands” or “woods”.

Randrup et al., 2005

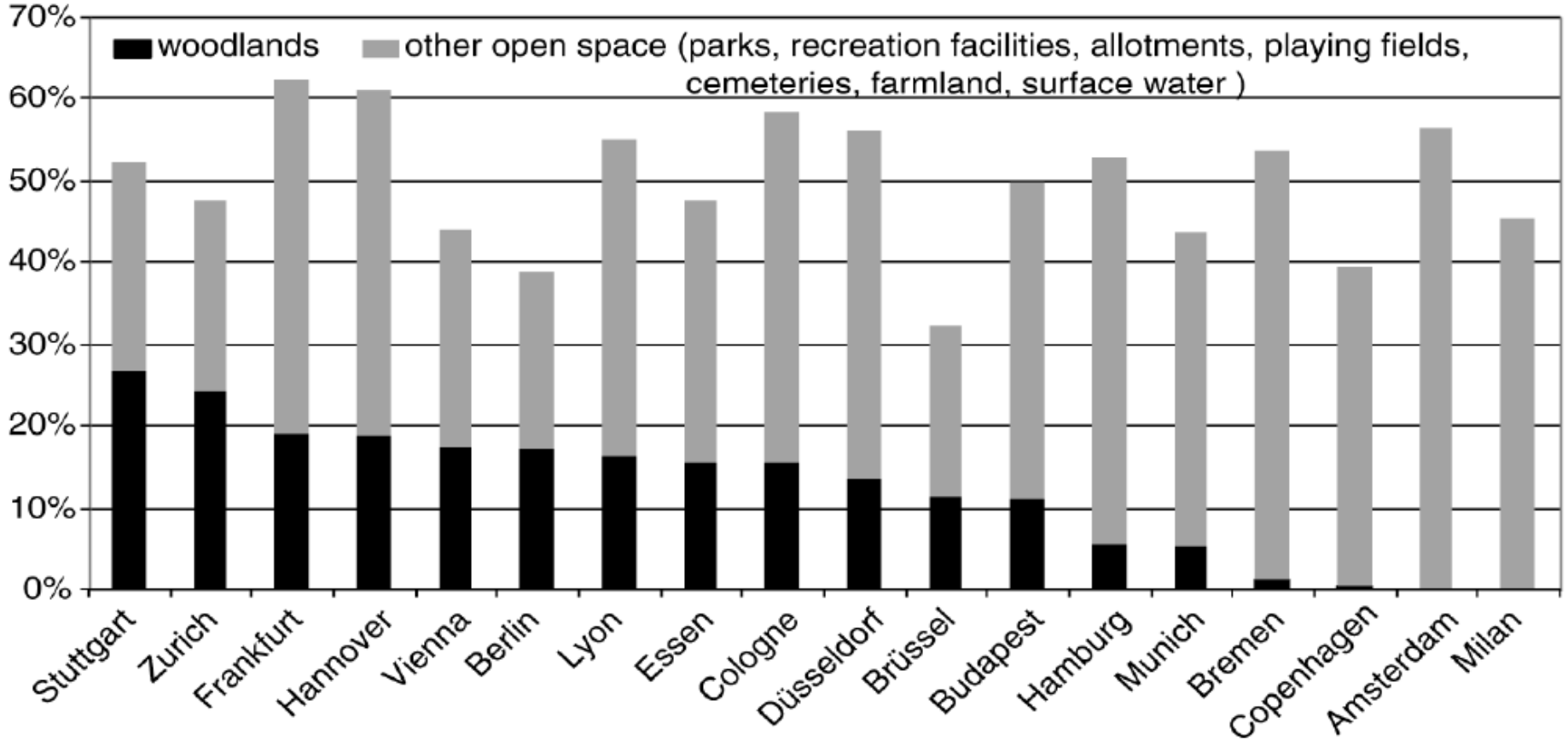
Urban population



70 million annual increase
2 billion new residents

UN-HABITAT, Financing Urban Shelter: Global Report on Human Settlements 2005, pp.4-5.

Urban green in Europe



From Pauleit et al. 2005

June 2010

Green infrastructure

EN Nature

Nature in peri-urban areas is important for landscape connectivity

nature

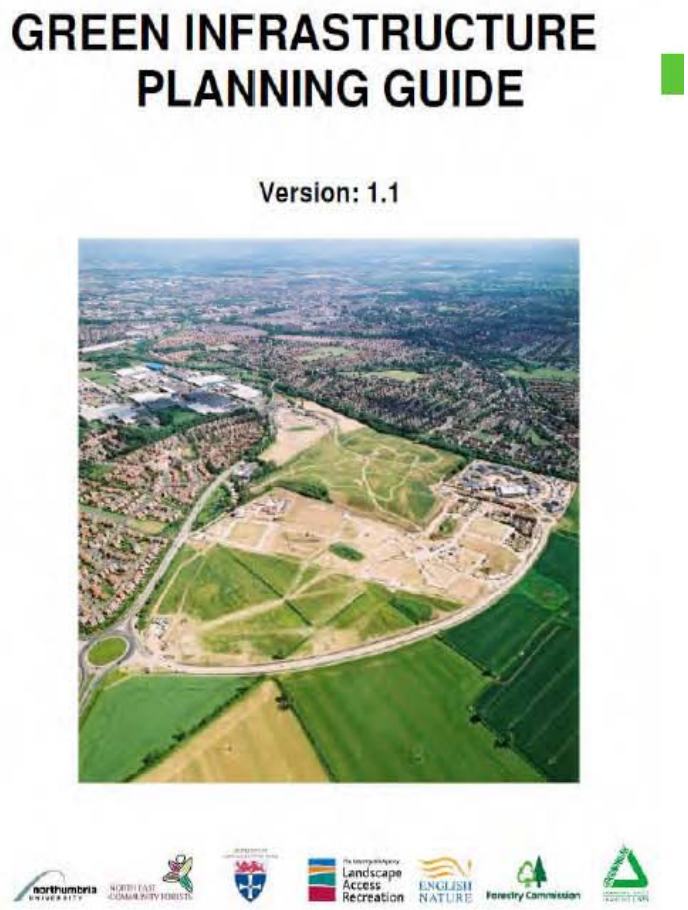
EUROPEAN COMMISSION

environment

GREEN INFRASTRUCTURE

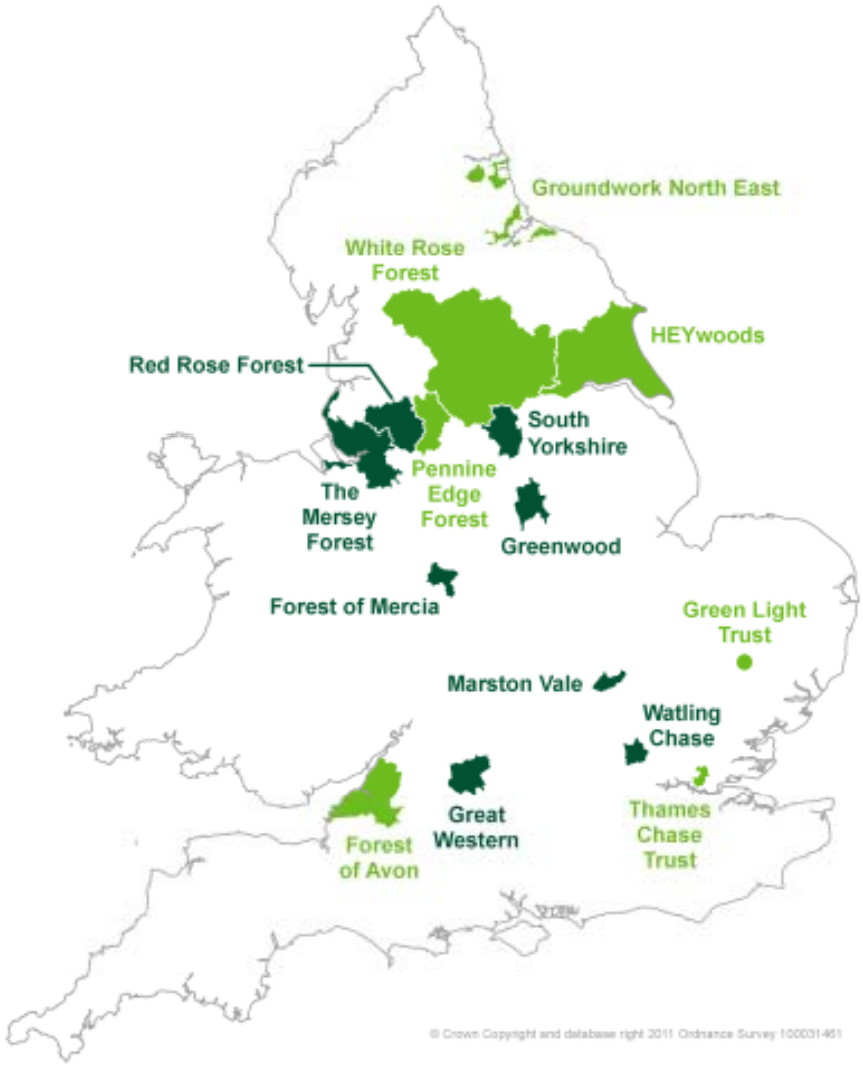
- Network of multi-functional open spaces, including parks, gardens, woodlands, green corridors, waterways, street trees and open
- It comprises all environmental resources, and thus a green infrastructure approach also contributes towards sustainable resource management.

Davies et al. 2006



Courtesy R. LaFortezza

The Community Forests in UK



1 Forestry for rural development

2 Forestry for economic regeneration

3 Forestry for recreation, access and tourism

4 Forestry for the environment and conservation

Within these four programmes the England Forestry Strategy identifies certain key priorities relevant to England's Community Forests:

- The creation of a network of woodlands on the urban fringe
- The creation of larger woodlands, where they can bring enhanced social benefits
- The restoration of former industrial land
- Reversing the fragmentation of ancient woodlands
- Gaining public confidence and support for the benefits of well-managed woodlands and forests
- Enhancing the economic value of forest resources
- Encouraging and facilitating public access to woodlands
- Greening of major transport corridors
- Creating a robust and sustainable framework for future investment

Urban Forestry in the USA

Long-term Research Initiatives. Multi-year projects recognize the importance of natural resource management in cities, and embrace urban ecology, stewardship, and ecological literacy to support ecosystem management and human well-being.

Knowledge Sharing. The Urban Field Station conducts comparative research and disseminates knowledge throughout other metropolitan regions in the United States and links to a growing of network federal scientists, facilities and university cooperators focused on urban research.

Expanding Networks. The Urban Field Station has engaged over100 non-profit, academic, and government partners in workshops and symposia, technical consultations, peer-reviewed publications, databases, and tools that support urban ecosystem management and sustainability planning efforts such as PlaNYC.

Urban Forestry in the USA

Trees in Our City

Center for Urban Forest Research

http://www.fs.fed.us/psw/programs/cufr/TreesInOurCity/

Trees Pay Us Back.

100 Trees Over 40 Years...

Benefits = $193,000

Energy

Air Quality

Real Estate

Costs = $66,000

Planting - Pruning

Removal/Disposal

Pest and Disease

Irrigation - Clean up

Sidewalk Repair

Legal - Admin

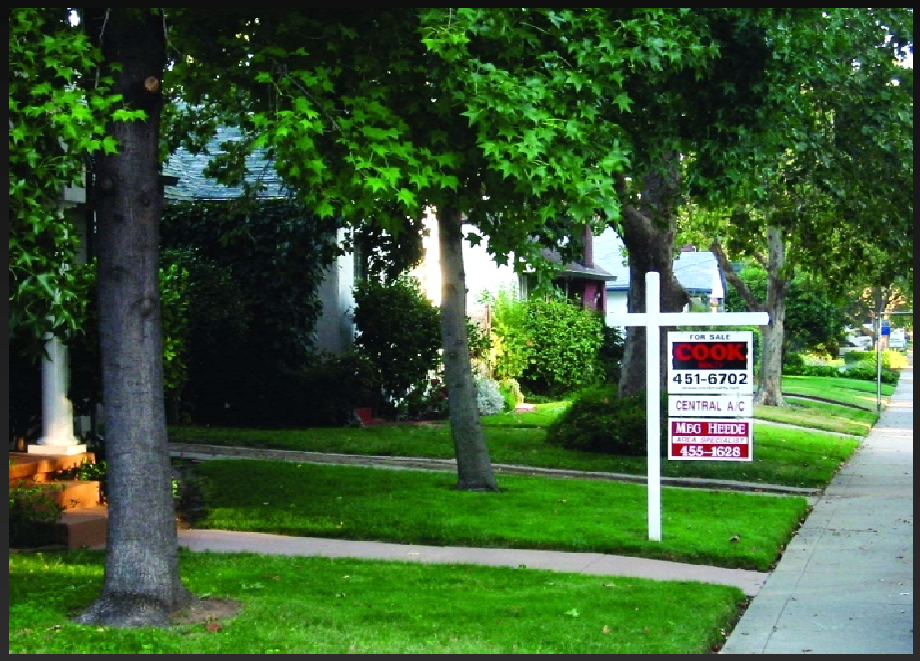
Pay Off: $127,000

Trees Mean Better Business.

In tree-lined commercial districts…

- More frequent shopping
- Longer shopping trips
- Shoppers spend more for parking
- Shoppers spend 12% more for goods

Trees Sell Houses. (At higher prices.)



- Each large front yard tree adds
  1% to sales price
- Large specimen trees can add
  10%, or more, to property values.

Trees. Important to Human Health.

- 100 trees remove 14 tons of CO_2/year
- 100 trees remove 1014 lbs of pollutants per year, including:
  - 428 lbs of ozone
  - 313 lbs of particulates

What is MillionTreesNYC ?

- An initiative to plant one million new trees in New York City's public and private spaces over the next ten years

- An important part of PlaNYC: Open Space and Air Quality sections

- An innovative partnership of NYC Department of Parks & Recreation and the New York Restoration Project (NYRP)

- A program with core initiative elements including stewardship, education, community outreach, marketing and public relations, public policy and advocacy, and research and evaluation

milliontrees NYC
A PLANYC INITIATIVE WITH NYC PARKS AND NEW YORK RESTORATION PROJECT

NYRP
NewYorkRestoration Project

Urban Forests' benefits

Save Money

Modify Urban Microclimate

Save Energy

Benefits society

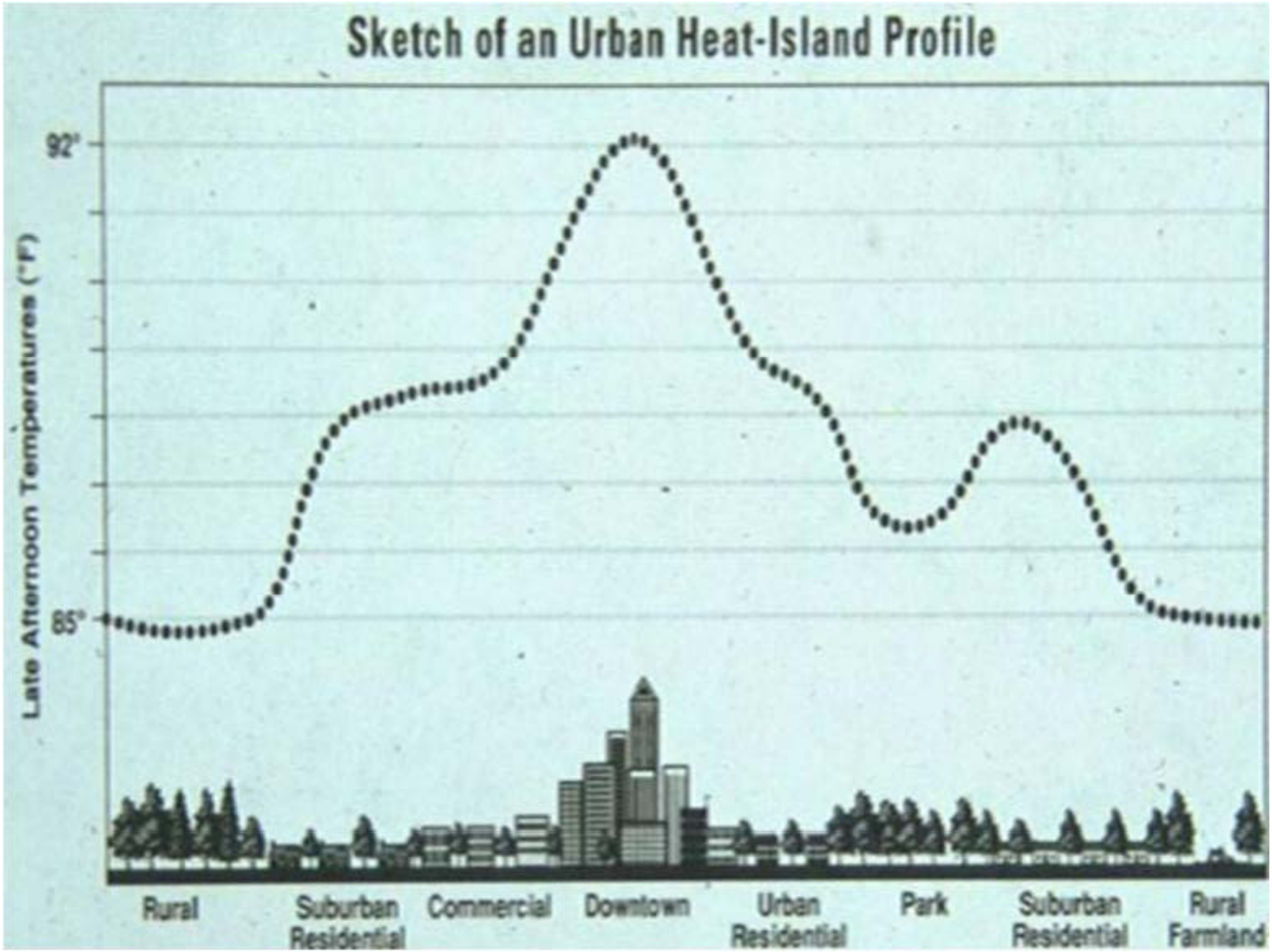
Reduce Runoff

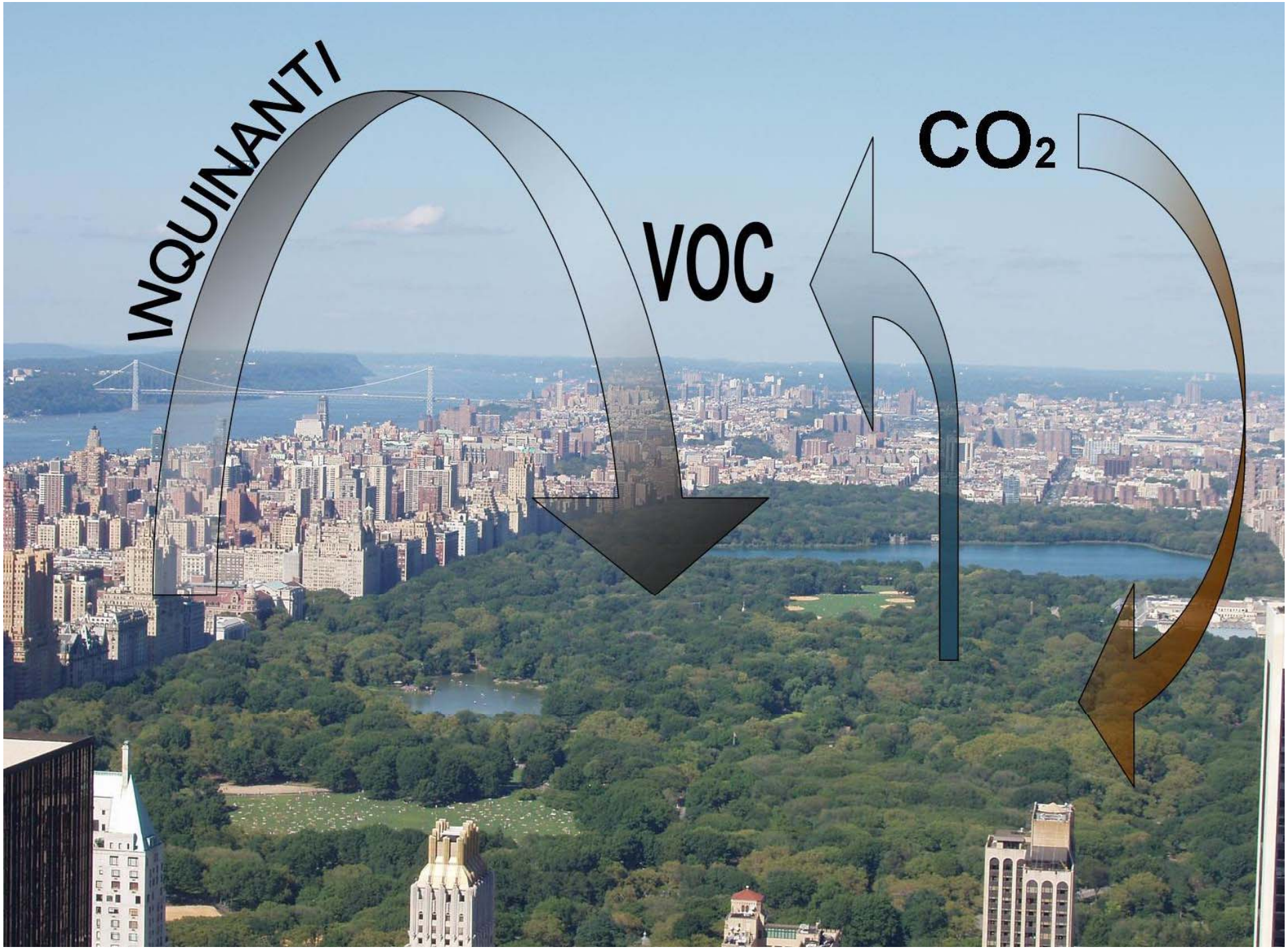
Reduce Noise

Reduce Soil Erosion

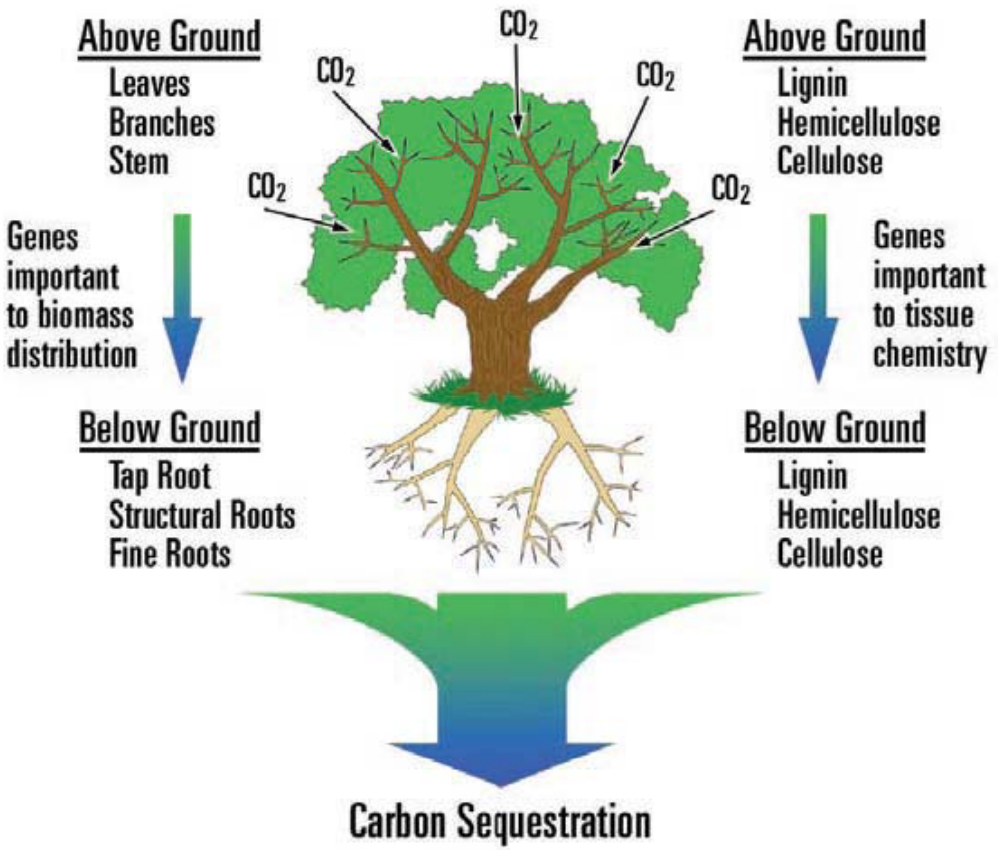
Ecological functions

Improve Air Quality


Sketch of an Urban Heat-Island Profile
92°
85°
Late Afternoon Temperatures (°F)
Rural
Suburban Residential
Commercial
Downtown
Urban Residential
Park
Suburban Residential
Rural Farmland


INQUINANTI
VOC
CO_2

Carbon Storage & Sequestration



Carbon Storage
carbon stored in plant tissues (roots, stem and branches)

Carbon Sequestration
carbon annually removed from trees and from soil

Important to increase our knowledge on soil carbon sequestration capacity

INCREASED ATTENTION TOWARDS CO2 REDUCTIONS THROUGH URBAN FORESTRY

- On 29 January 2008, the European Commission launched the Covenant of Mayors to oblige European cities to establish an Action Plan to reduce their CO2 emissions by over 20% through activities and practices including the addition of more trees in urban areas and the sustainable management of the green spaces
- FAO Guidelines in preparation for Policy and Decision Making promoting Urban and Peri-urban Forestry – specific issue on climate change and CO2 reductions

COMUNE DI FIRENZE

Carlo Calfapietra, Arianna Morani,
Gregorio Sgrigna, Francesco Loreto

E con il contributo di Francesco Ferrini

LA FORESTA URBANA PER L'ABBATTIMENTO DI CO_2

AGENDE 21 LOCALI AREA FIORENTINA

Linee guida per un regolamento del verde

Indirect CO_2 SAVING

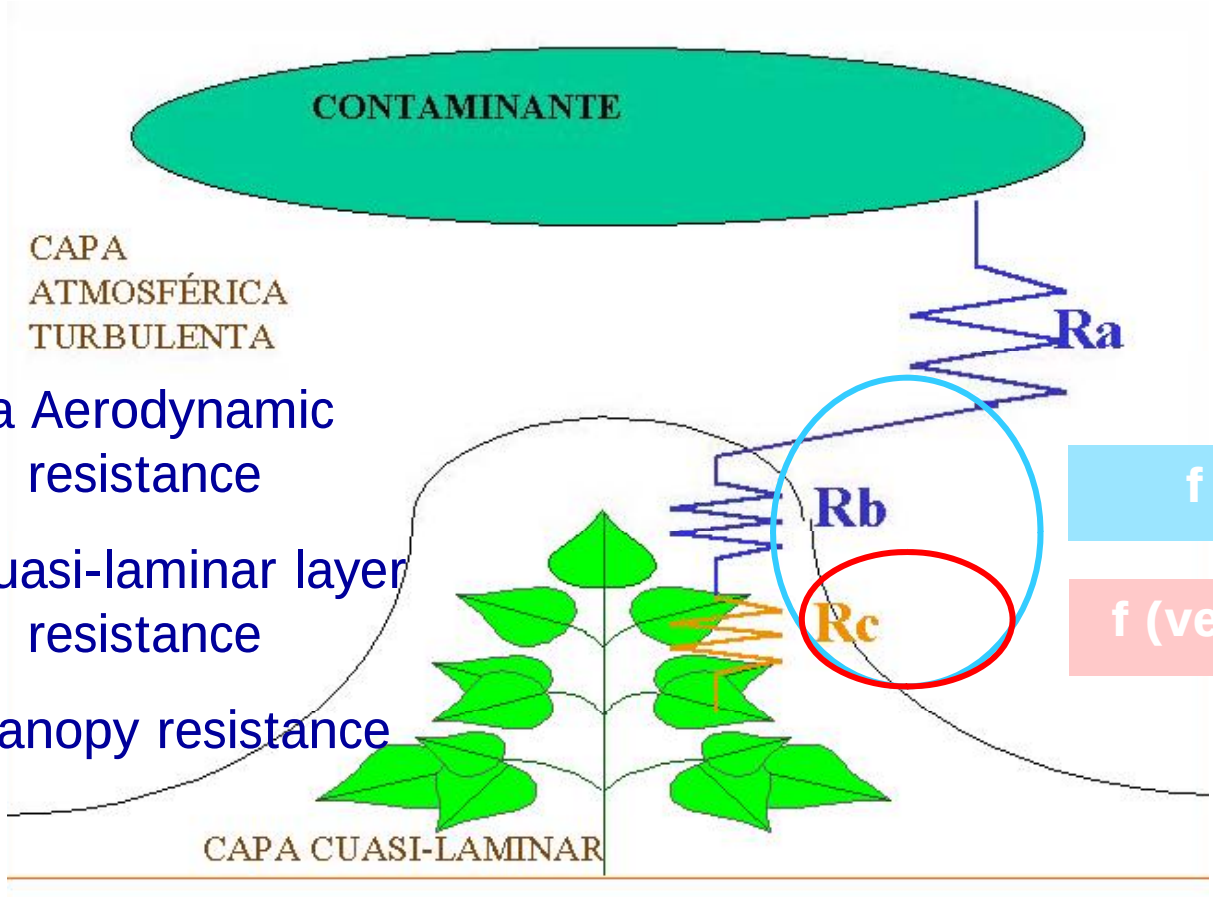
Trees in the cities reduce CO_2 emissions through energy saving

	kWh/a saved per tree	Reduction in Kg C/a
1) Energy saving	92	15
a) Shading	60	10
b) Evapotranspiration	32	5
2) Carbon sequestration	n/a	4.5

Los Angeles

Rosenfeld et al., 1998

Dry Deposition of air pollutants



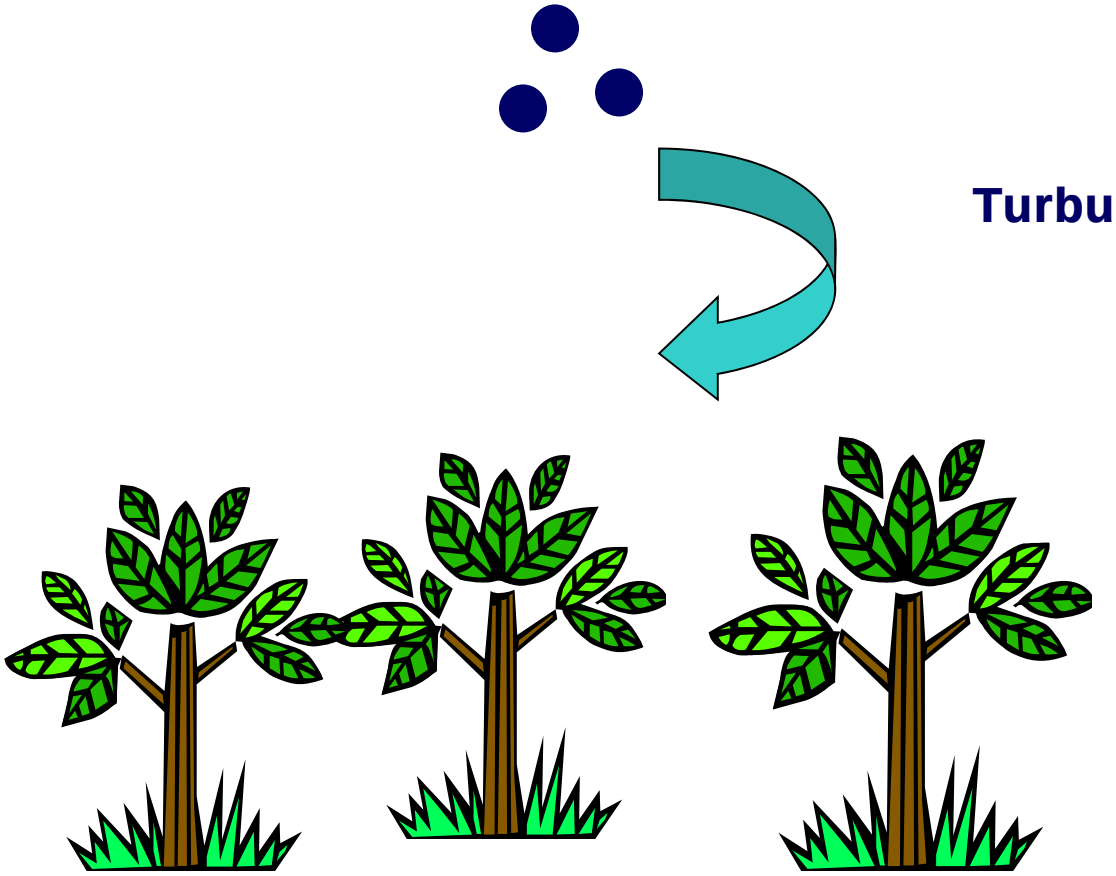
Ra Aerodynamic resistance

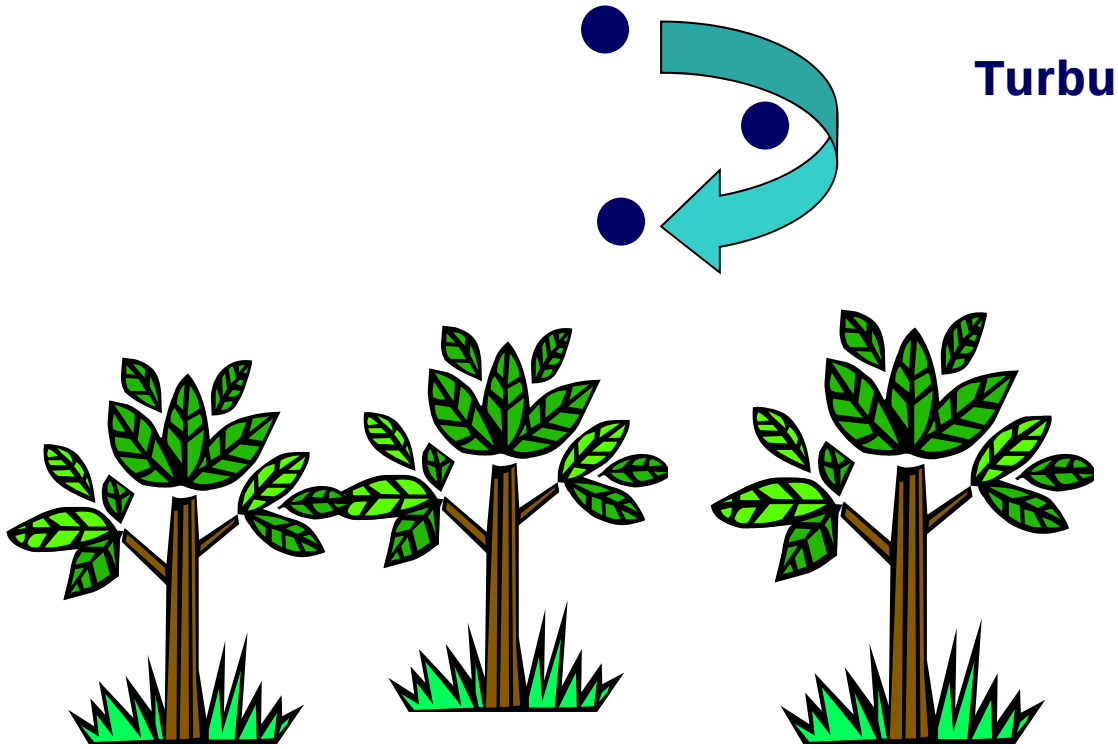
Rb quasi-laminar layer resistance

Rc canopy resistance

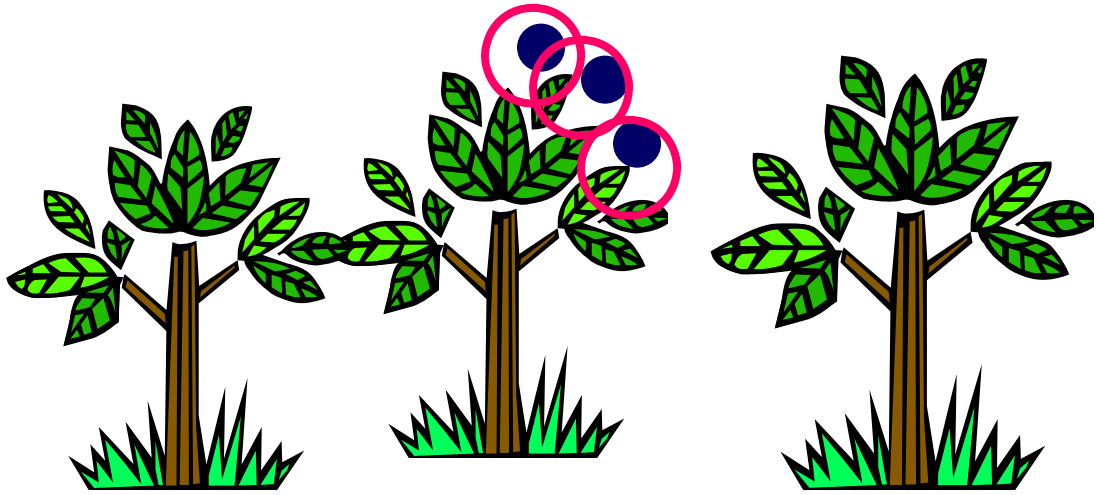
f (pollutant)

f (vegetal species)

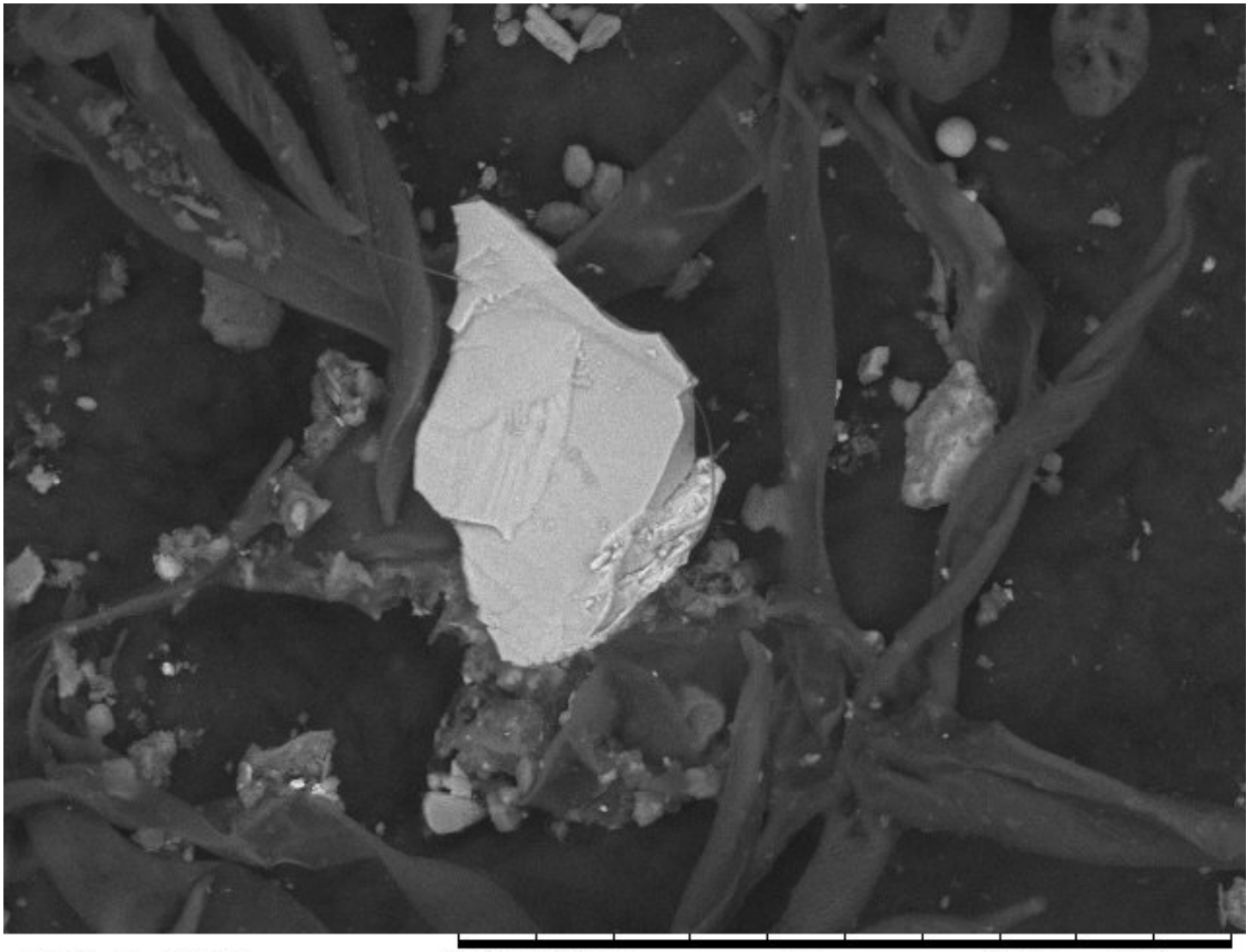

Turbulence


Turbulence

Surface capture



Terni: Quercus ilex leaf in a park close to steelworks

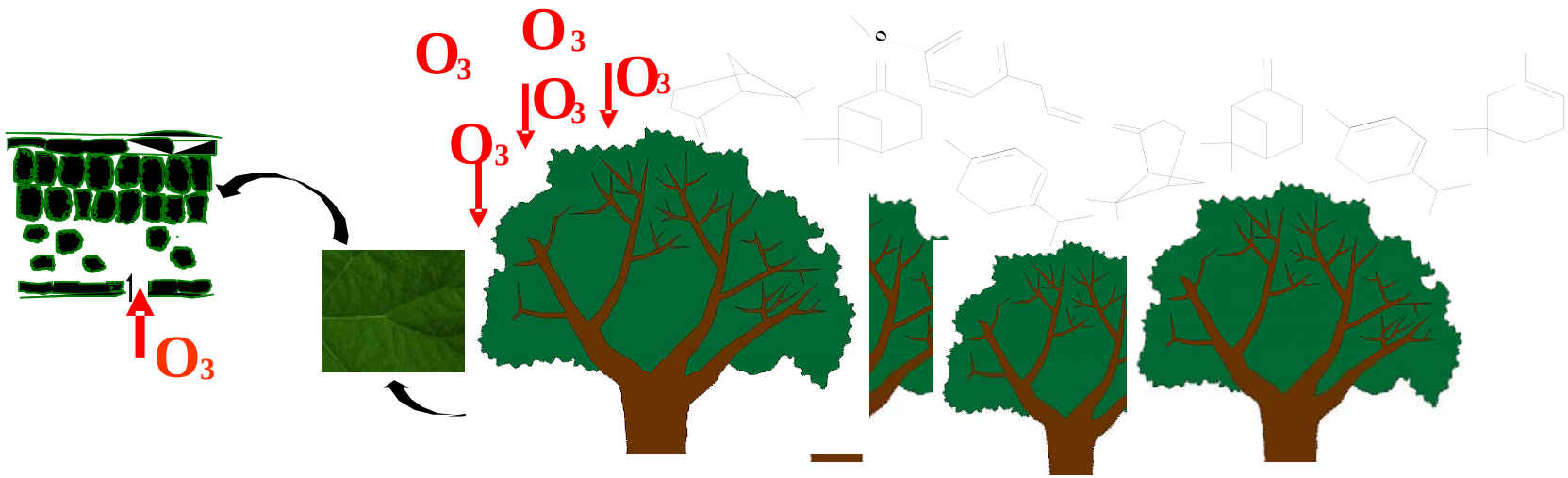


PM removal

City	Country	PM_{10} removed annually (1994) Average (g m^{-2})	PM_{10} removed annually (1994) range (g m^{-2})	Reference
Indianapolis	USA	4.5	1.1-5.7	Nowak et al., 2006
Los Angeles	USA	6.9	1.0-7.1	Nowak et al., 2006
Miami	USA	5.5	1.3-6.4	Nowak et al., 2006
New York	USA	3.7	0.9-4.7	Nowak et al., 2006
Newark	USA	3.6	0.8-4.7	Nowak et al., 2006
New Orleans	USA	4.8	1.1-6.0	Nowak et al., 2006
Philadelphia	USA	3.8	1.0-5.0	Nowak et al., 2006
San Diego	USA	7.6	1.5-8.4	Nowak et al., 2006
Washington	USA	3.9	0.9-5.1	Nowak et al., 2006
Pechino	CHINA	16.7	--------	Yang et al., 2005 mod.
Santiago	CHILE	14.3	--------	Escobedo et al., in press, mod.

from Giuntoli, 2007

Ozone is taken up by plants



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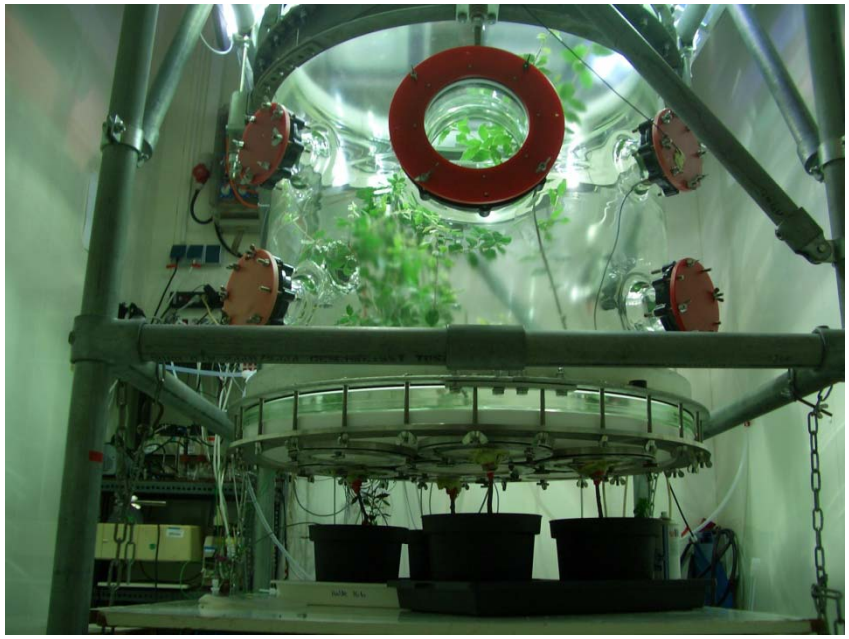
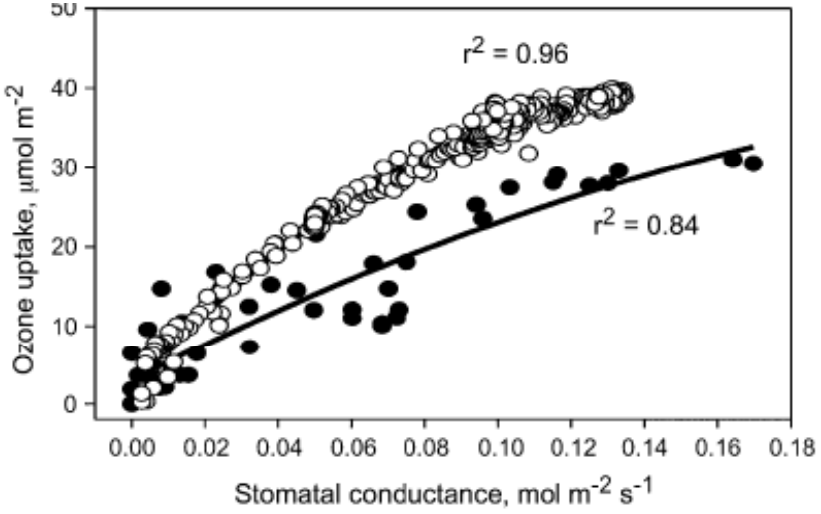
Journal of Experimental Botany
www.jxb.oxfordjournals.org



OPINION PAPER

Determinants of ozone fluxes and metrics for ozone risk assessment in plants

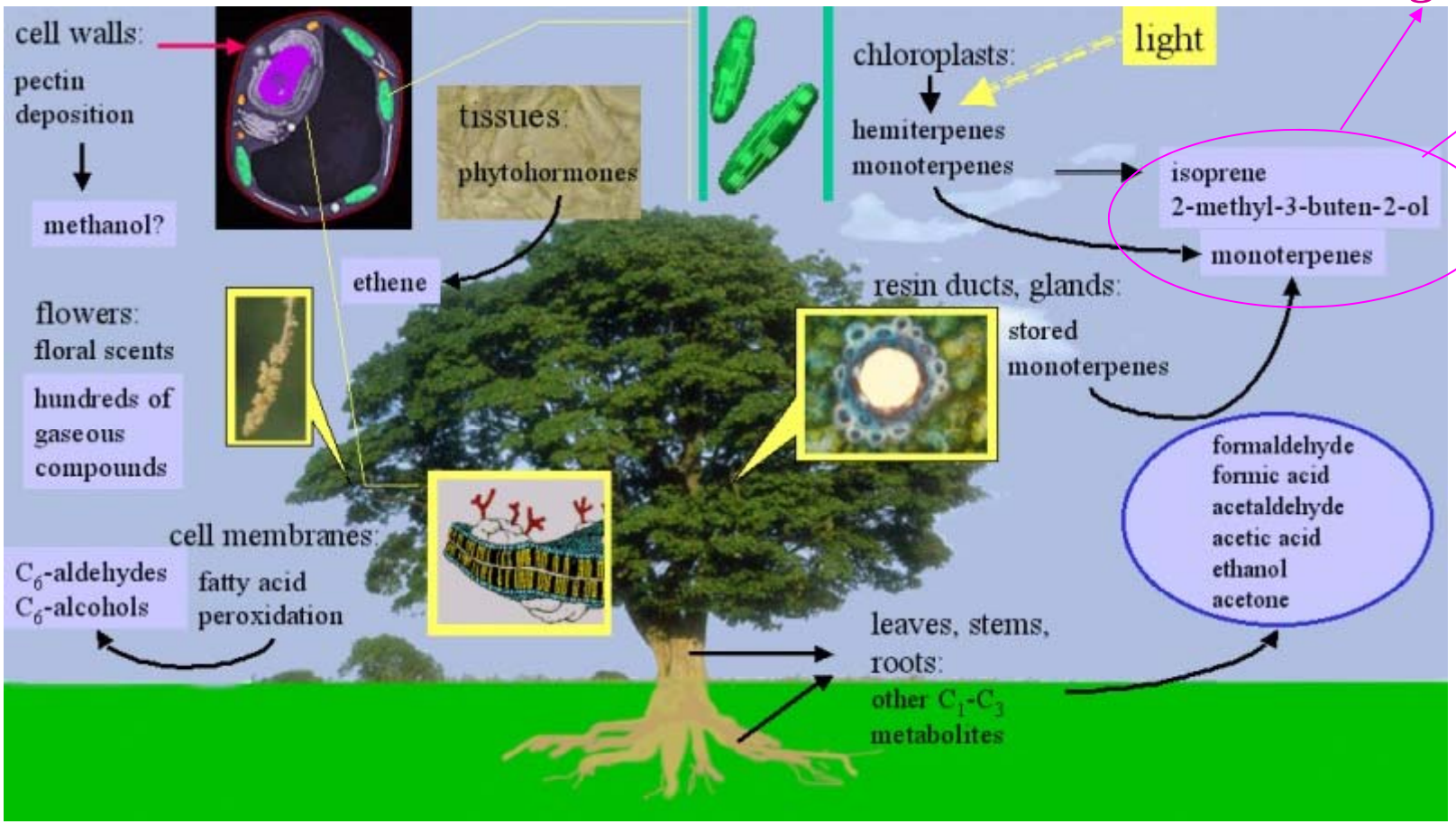
Silvano Fares[1,2,*], Allen Goldstein[2] and Francesco Loreto[3]



The BVOC family (> 1000 Tg C y^{-1})

> 500 Tg C y^{-1}

1-10% of C fixed



VOC and ozone formation

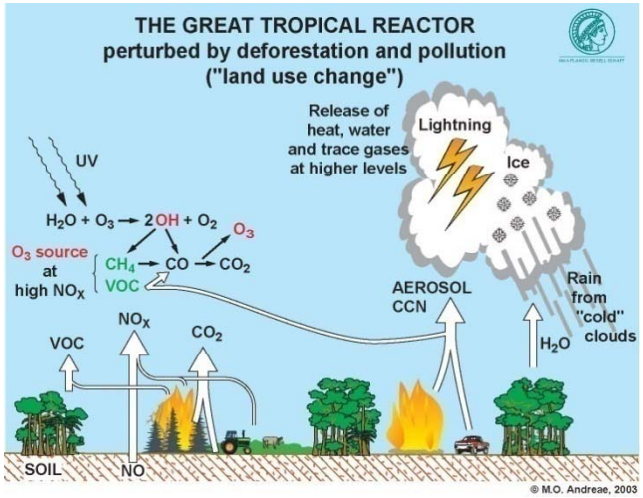
NO_2+ sunlight → NO + O

O + O_2 → O_3

At the meantime

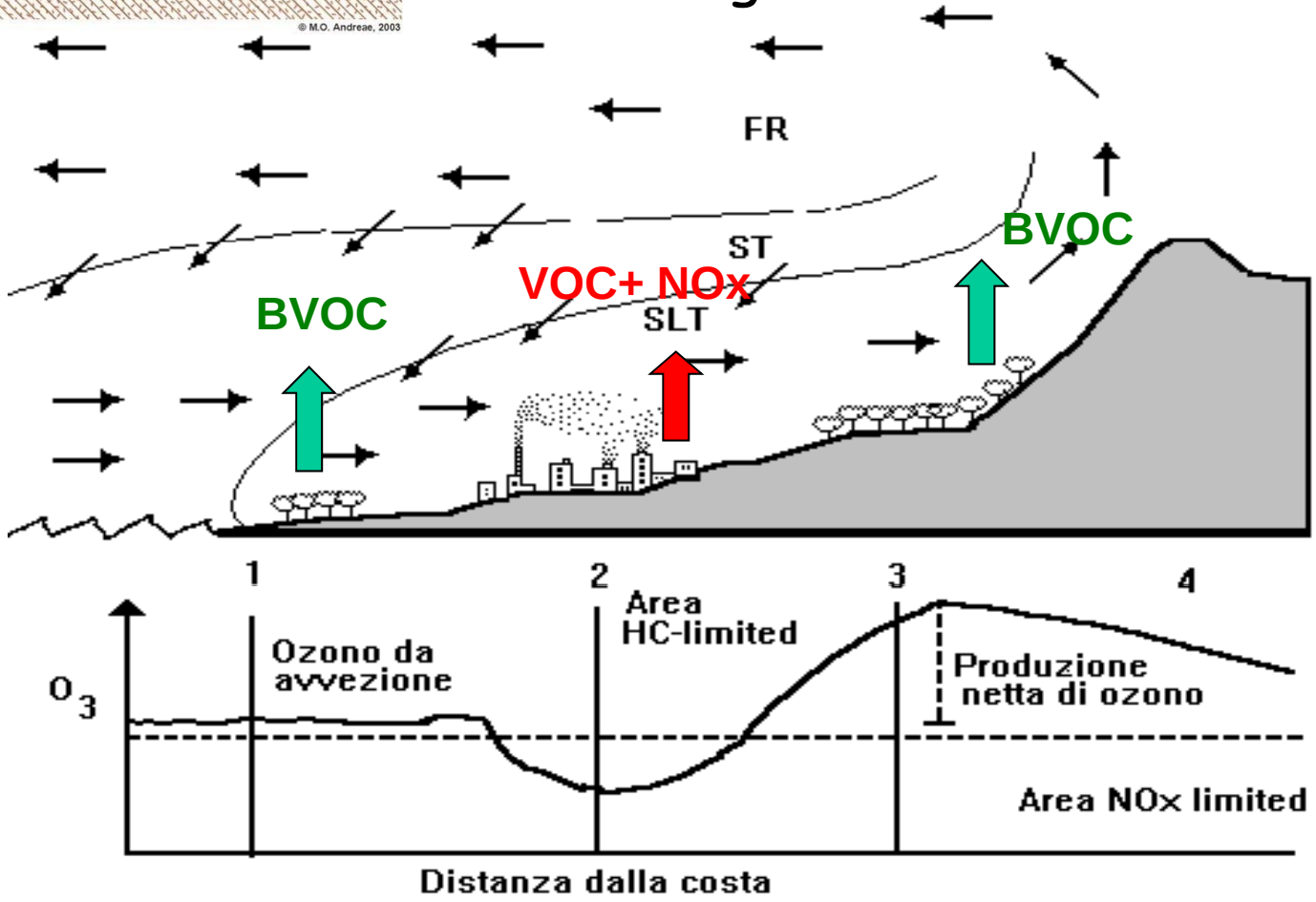
O_3+ NO → NO_2+ O_2

The hydrocarbons (such as VOCs), through reactions with the radicals OH, induce an increase of NO_2 to the detriment of NO, with consequent increase of ozone concentration



why the Mediterranean is a "hot spot" for BVOC and photochemical pollution……

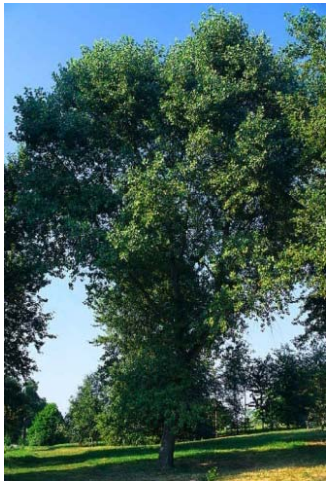
….along the coasts



High BVOC-emitters

Quercus spp.

Platanus spp



Populus spp

Salix spp.

Reeds (Phragmites, Arundo….)

Eucalyptus spp.

The Urban Forest Effects (UFORE)

<u>UFORE is a computer model developed</u>:

- To quantify urban forest structure
- To estimate urban forest's benefits
- To calculate energy and emission savings
- To help city managers and policy makers

UFORE methods: an overview

- UFORE-A:Anatomy of the Urban Forest
- UFORE-B: Biogenic Volatile Organic Compound (VOC) Emission
- UFORE-C: Carbon Storage and Sequestration
- UFORE-D: Dry Deposition of Air Pollution
- UFORE-E: Energy Conservation

I. City totals, trees only

City	% Tree cover	Number of trees	Carbon storage (tons)	Carbon sequestration (tons/yr)	Pollution removal (tons/yr)	Pollution value U.S. $
Calgary, Canada[a]	7.2	11,889,000	445,000	21,400	326	1,611,000
Atlanta, GA[b]	36.7	9,415,000	1,344,000	46,400	1,663	8,321,000
Toronto, Canada[c]	20.5	7,542,000	992,000	40,300	1,212	6,105,000
New York, NY[b]	20.9	5,212,000	1,350,000	42,300	1,677	8,071,000
Baltimore, MD[d]	21.0	2,627,000	597,000	16,200	430	2,129,000
Philadelphia, PA[b]	15.7	2,113,000	530,000	16,100	576	2,826,000
Washington, DC[e]	28.6	1,928,000	526,000	16,200	418	1,956,000
Boston, MA[b]	22.3	1,183,000	319,000	10,500	284	1,426,000
Woodbridge, NJ[f]	29.5	986,000	160,000	5,560	210	1,037,000
Minneapolis, MN[g]	26.4	979,000	250,000	8,900	306	1,527,000
Syracuse, NY[d]	23.1	876,000	173,000	5,420	109	568,000
San Francisco, CA[a]	11.9	668,000	194,000	5,100	141	693,000
Morgantown, WV[h]	35.5	658,000	93,000	2,890	72	333,000
Moorestown, NJ[f]	28.0	583,000	117,000	3,760	118	576,000
Jersey City, NJ[f]	11.5	136,000	21,000	890	41	196,000
Freehold, NJ[f]	34.4	48,000	20,000	545	22	110,000

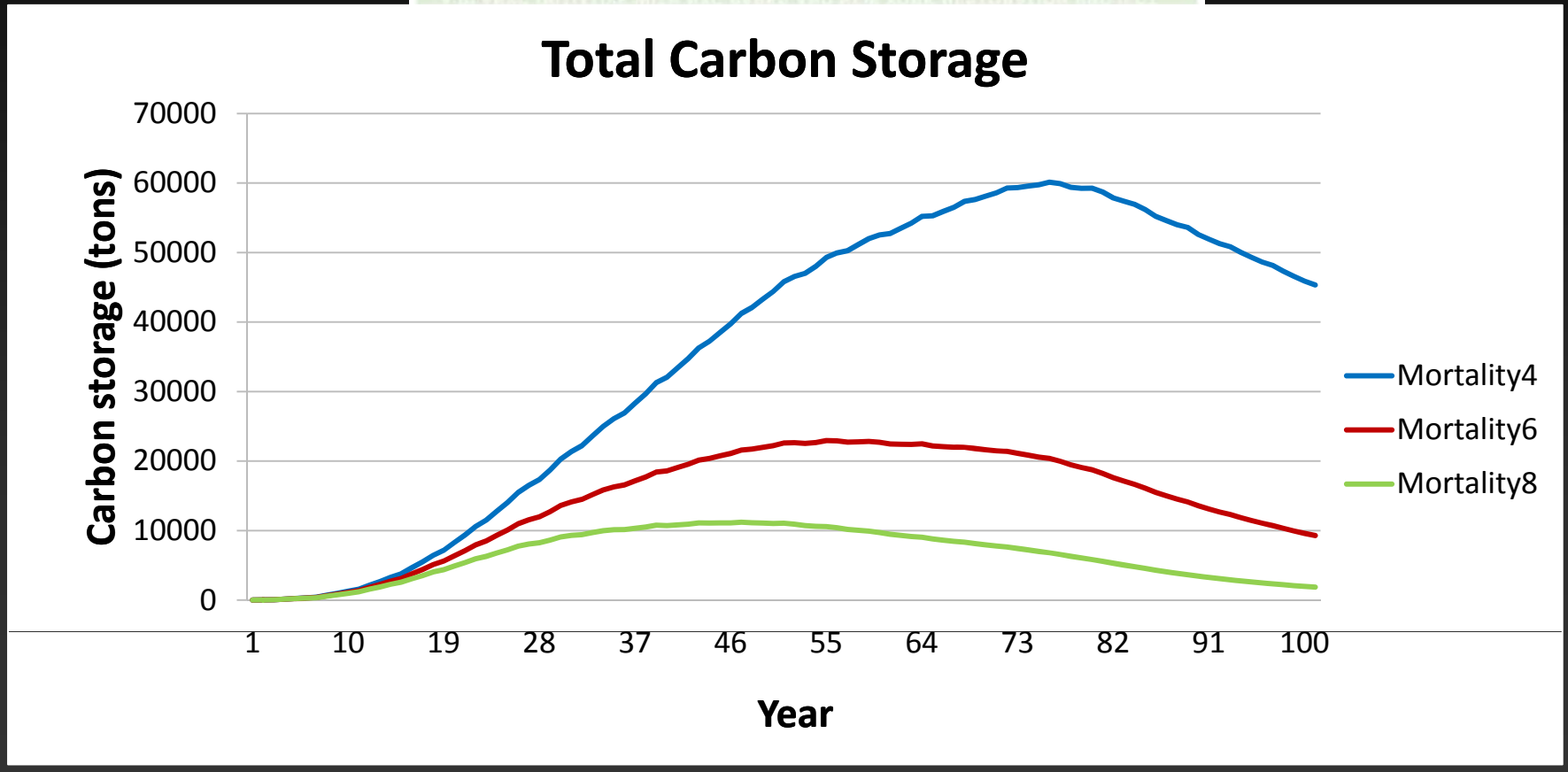
USDA, 2007

Table 3. Air pollution removal and value for all urban trees in the coterminous United States

Pollutant	Removal (t)	Value ($ × 10^6)
O_3	305,100	2,060
	(75,000–390,200)	(506–2635)
PM_{10}	214,900	969
	(84,000–335,800)	(378–1514)
NO_2	97,800	660
	(42,800–119,100)	(289–804)
SO_2	70,900	117
	(32,200–111,100)	(53–184)
CO	22,600	22
	na	Na
Total	711,300	3828
	(256,600–978,800)	(1,249–5158)

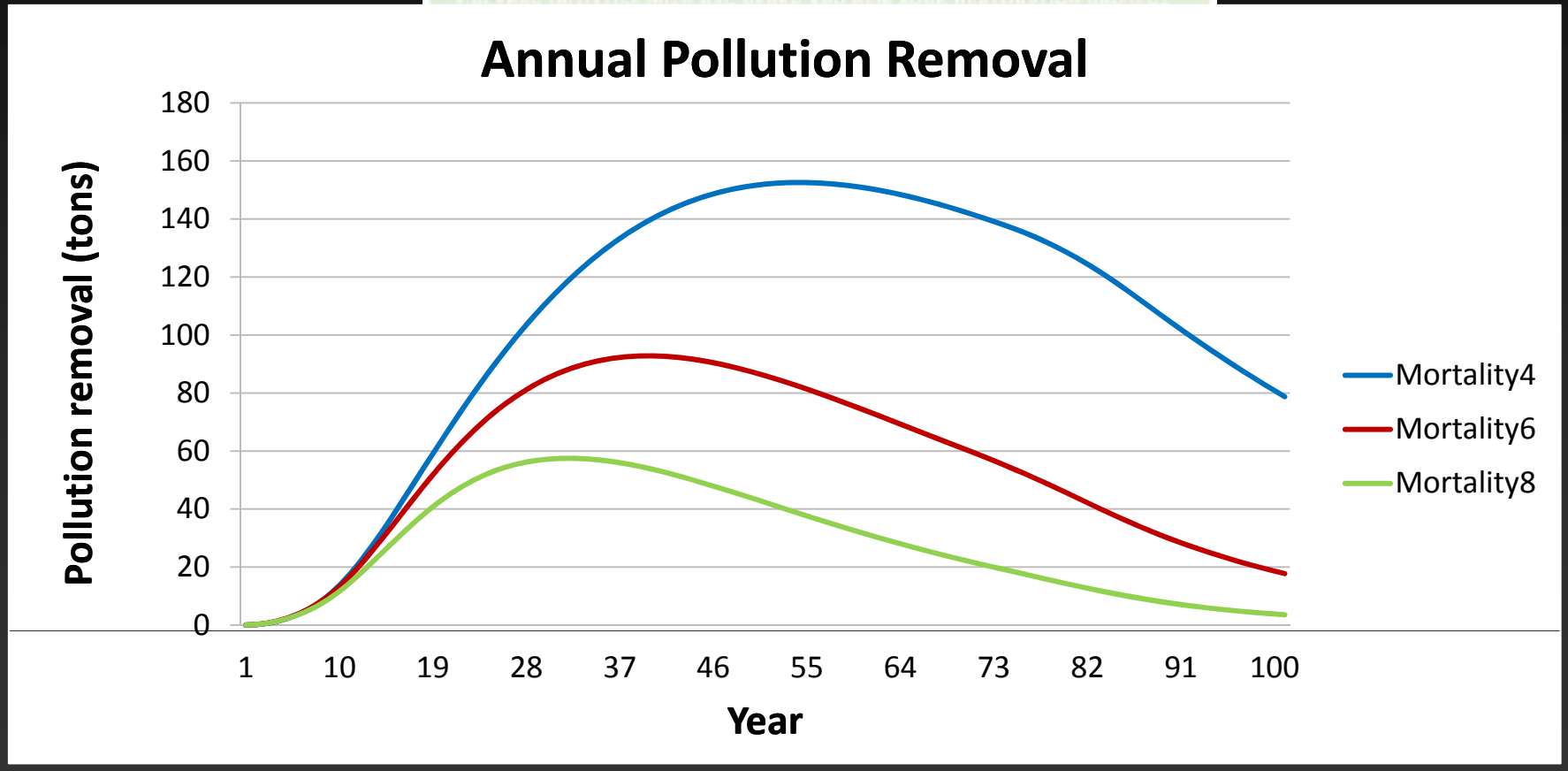
Estimates are given for ozone (O_3), particulate matter less than 10 μm (PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO). The monetary value of pollution removal by trees is estimated using the median externality values for the United States for each pollutant (Murray et al., 1994). Externality values for O_3 were set to equal the value for NO_2. Bounds of total tree removal of O_3, NO_2, SO_2, and PM_{10} were estimated using the typical range of published in-leaf dry deposition velocities (Lovett, 1994).

Results: UFORE Population Projector



Morani et al. 2011, Environmental Pollution

Results: UFORE Population Projector



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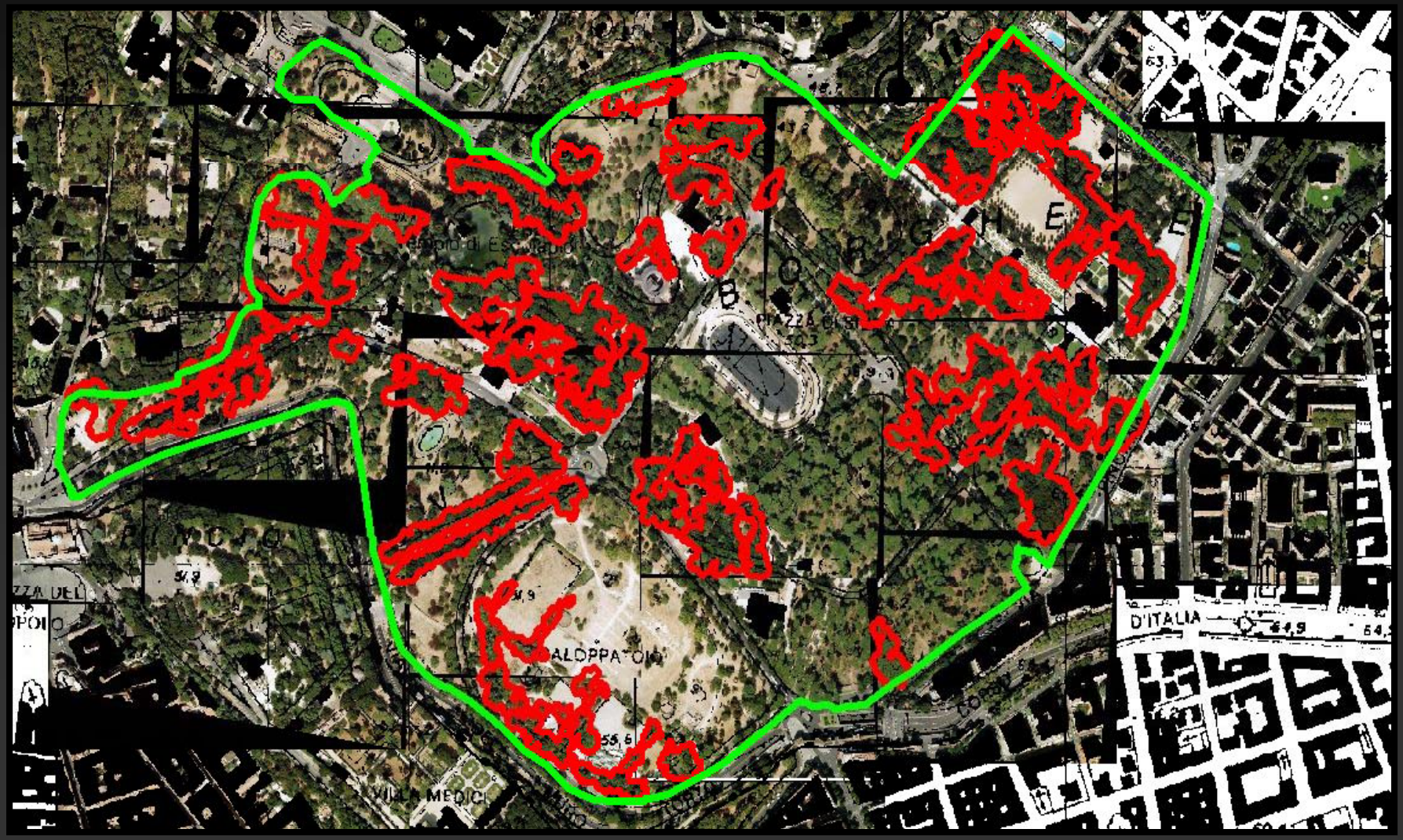
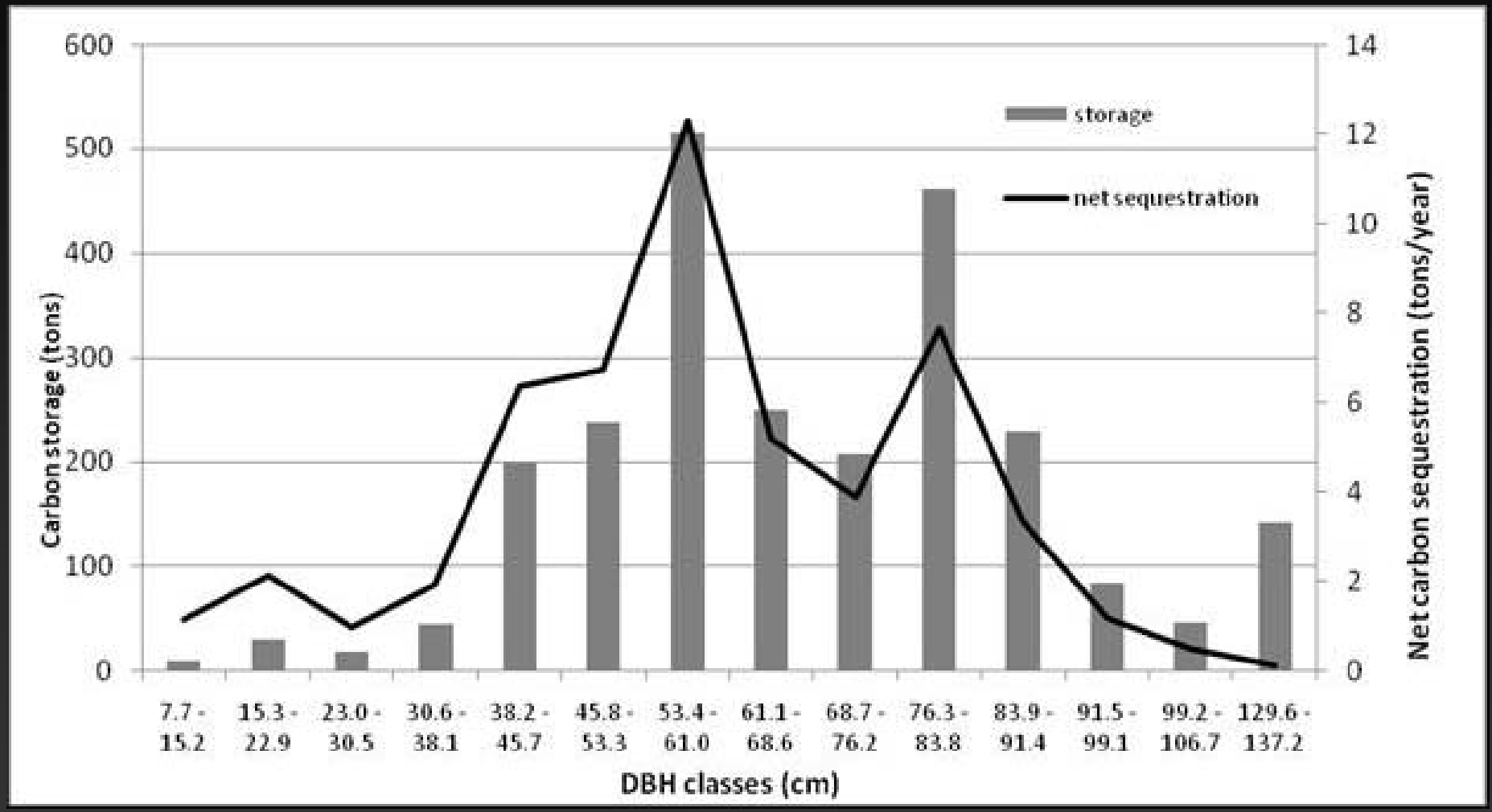
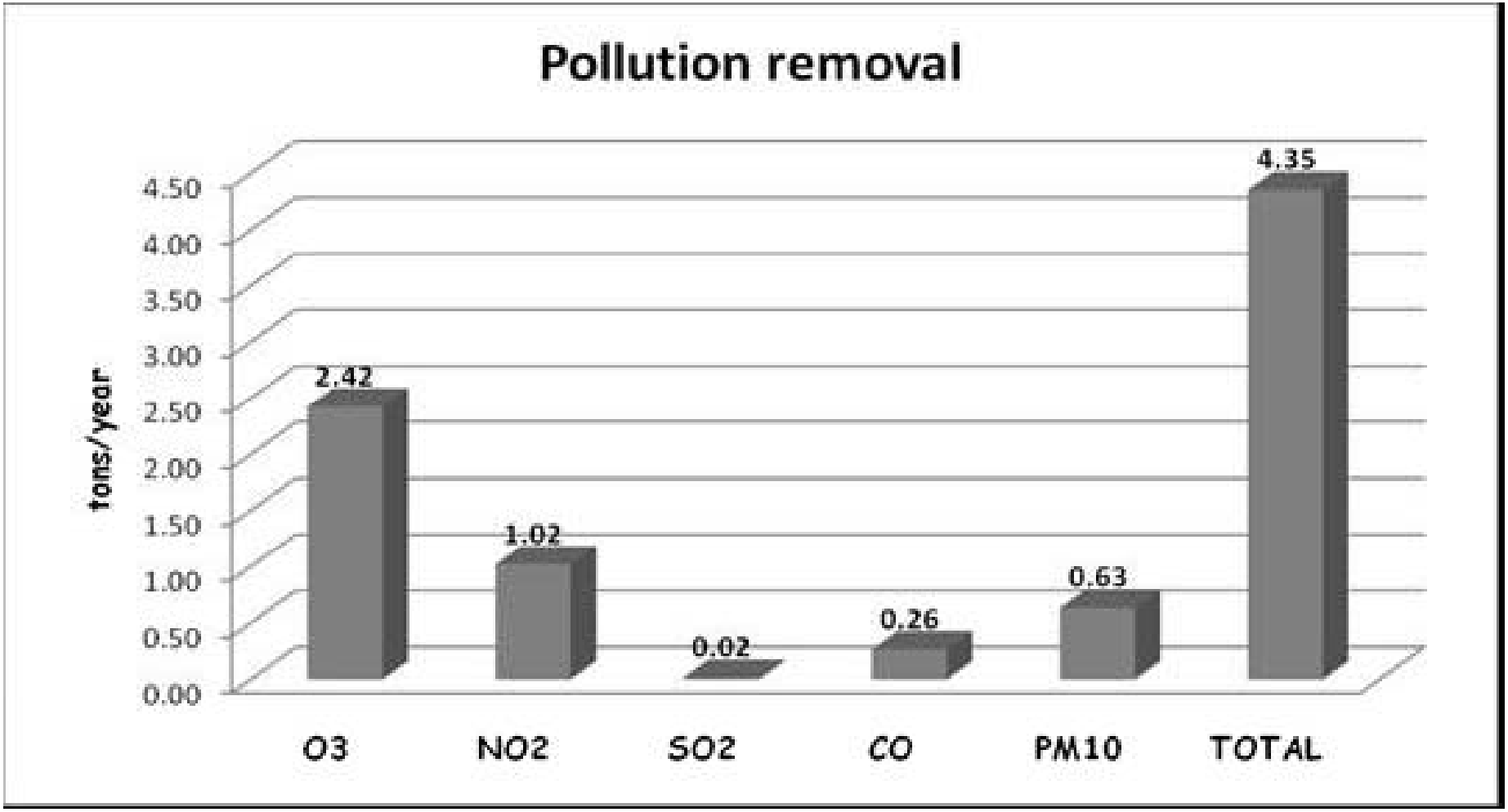
Villa Borghese



Villa Borghese



Villa Borghese



Scientific Gaps

-Better Understanding of CO_2 sequestration capacity by urban forestry (particularly soil and by indirect effect)

-Measuring effective uptake of air pollutants by urban trees to validate models

-Assessing air pollutant uptake by urban vegetation with air quality improvements

-Relating air quality improvements by urban forests with human health

Other Gaps

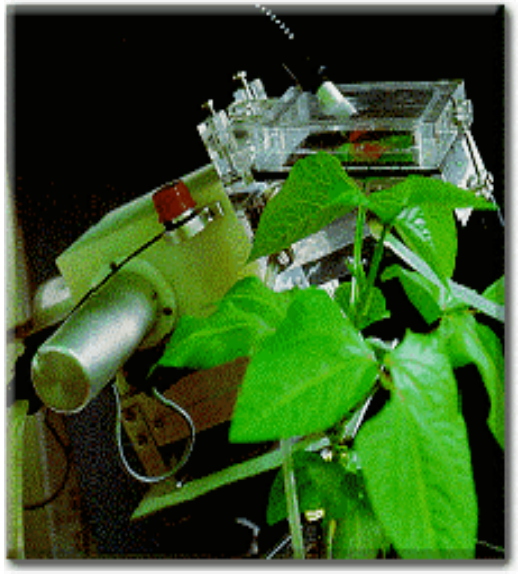
-Carbon stored in urban forests is not accounted for carbon sink inventories in most countries

-Urban forests are not covered in national forest health surveys

-Planning and management of urban forest does not usually takes into account environmental issues

NEW FRONTIERS

MEASUREMENTS OF POLLUTANT UPTAKE BY VEGETATION



NEW FRONTIERS

LINKING URBAN FORESTRY WITH AIR POLLUTION AND HUMAN HEALTH

-HEREPLUS aims at detecting and analyzing Health Risk of Environmental Pollution Levels in Urban Systems and the mitigation potential by urban forestry


The right tree, in the right place, managed in the right way
THANK YOU
The great challenge!