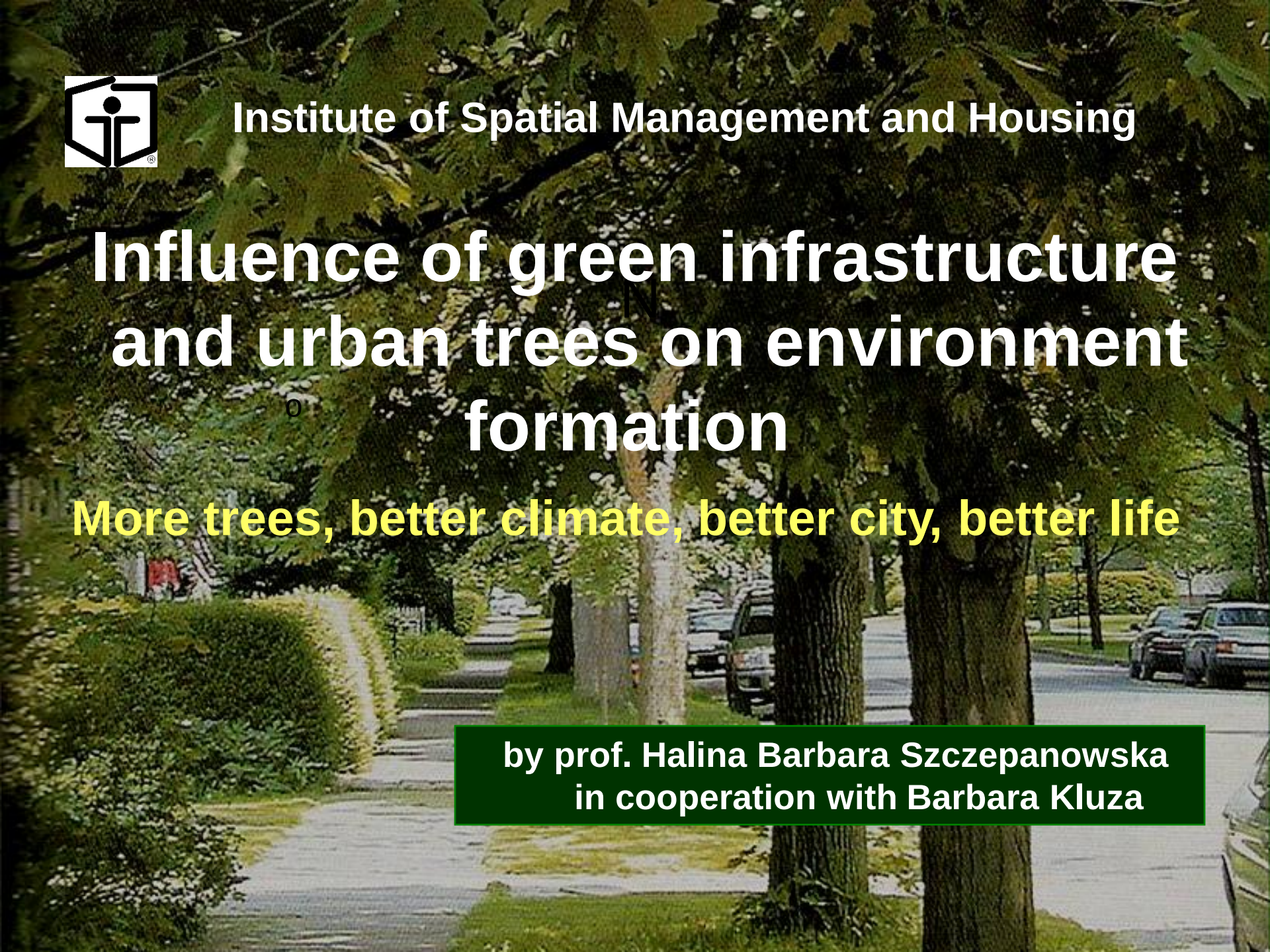


Institute of Spatial Management and Housing

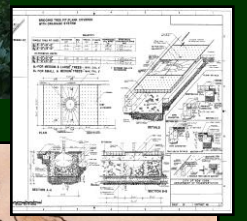
# Influence of green infrastructure and urban trees on environment formation

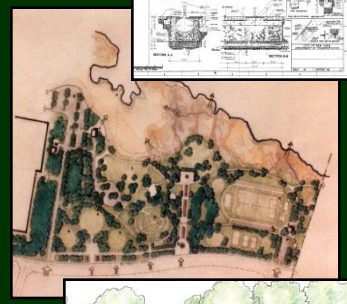
## More trees, better climate, better city, better life

by prof. Halina Barbara Szczepanowska
in cooperation with Barbara Kluza

# *About the author*

- Halina Barbara Szczepanowska - professor of the Institute of Spatial Management and Housing. Landscape architect.
- Many years of experience as a lecturer at Warsaw University of Life Sciences (SGGW).
- In charge of „urban green research laboratory” at the Institute of Environmental Development in Warsaw, as a leader of multidisciplinary research project (the first such in Poland), studying  the effect of green infrastructure on the improvement of the quality of urban environment
- Research of the semi-desert vegetation in the Mediterranean Sea area
- Many years of studies and design (in cooperation with Cornell University and Hunter College) related to trees planting in New York City with elaboration of new standards for tree development.
- Author and co-author of 10 books and 40 scientific and professional articles. Leader of research projects devoted to methods of tree evaluation.



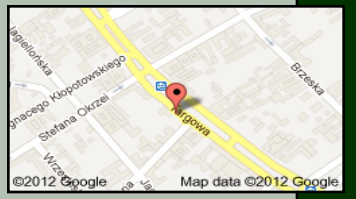


INSTITUTE OF SPATIAL MANAGEMENT AND HOUSING

INSTYTUT GOSPODARKI PRZESTRZENNEJ I MIESZKALNICTWA

- The main area of Institute activities:

  methods and techniques of urban and spatial planning, regional development, trans border co-operation, environment and green infrastructure protection and formation, municipal economy.




- Offers:

  research work, ongoing process monitoring, changes forecasting, urban planning and design, study methodology, legal solution, government administration consulting, standardization and normalization of spatial management and housing issues, real estate and municipal services management issues, environment and green infrastructure protection issues.

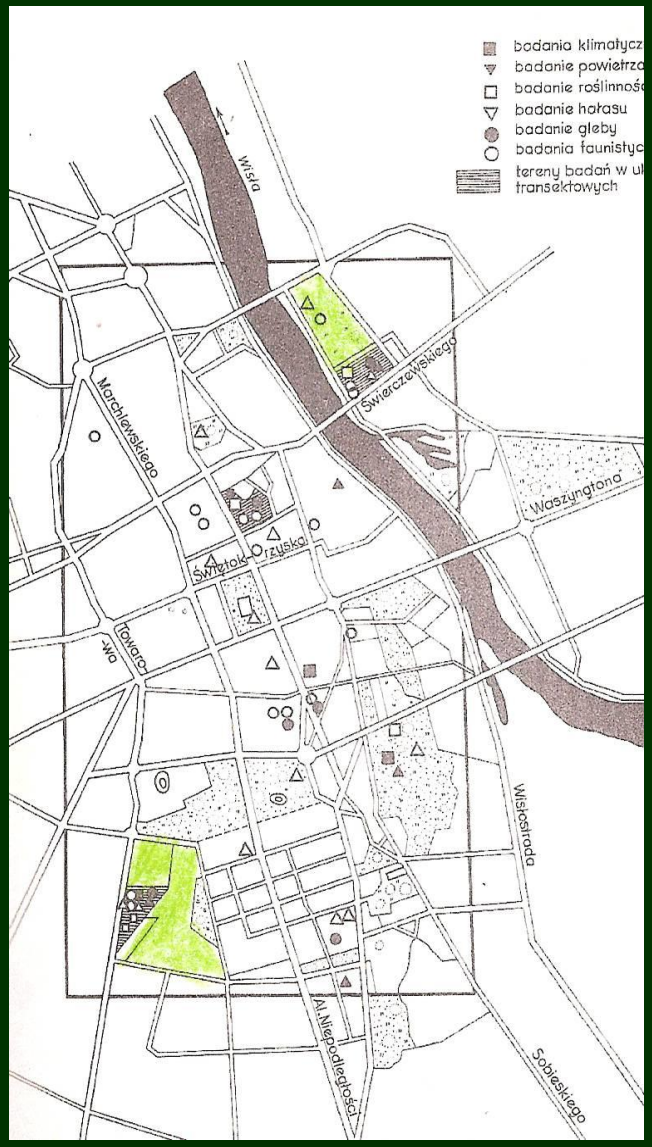
- Hire an experienced and inter-disciplinary team which consists: architects, town planners, landscape architects, foresters, geographers, biologists, economists, sociologists, lawyers and social scientists.

The Institute structure consists of three Departments:

- Spatial Planning Department
- Municipal Transport Department
- Landscape Architecture, Training and Real Estate Management Department

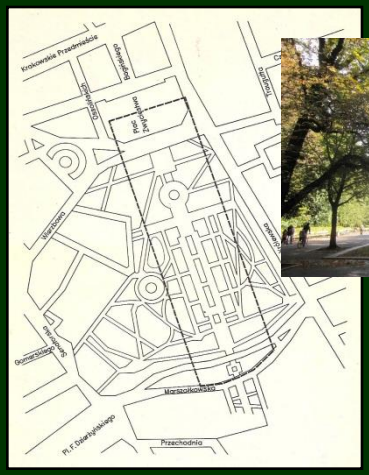
Conducts training in the area of spatial planning, real estate and municipal services management with Leon Kozminski Academy.

# Influence of greens and urban environment formation

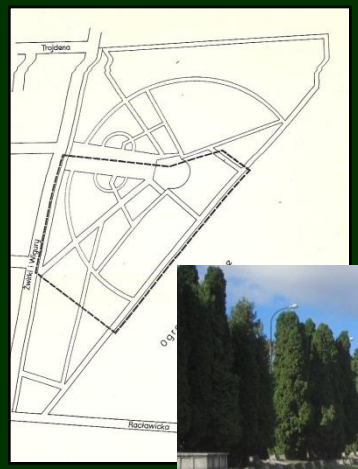



- About forty years ago researchers from Polish Academy of Sciences, University of Warsaw, Warsaw University of Life Sciences (SGGW), Warsaw University of Technology and urban planners attempted multidisciplinary research referring to the influence of green infrastructure on improvement quality city environment and to estimation of degradation level of the natural environment in central parts of city due to urban strains.
- Forty researchers were worked together in twelve different scientific groups to define far-reaching interrelation between various phenomena and obtain measurable factors of f degradation mechanisms occurring in urban environment,

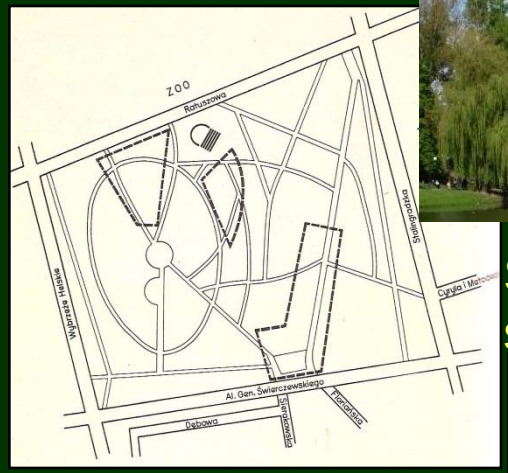
# Influence of greens and urban environment formation - results




Saski Garden

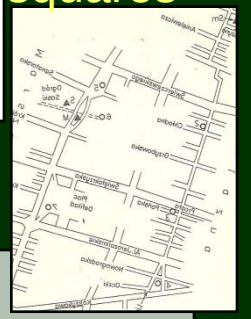



Cemetery - Mausoleum



Praski Park

Streets and squares



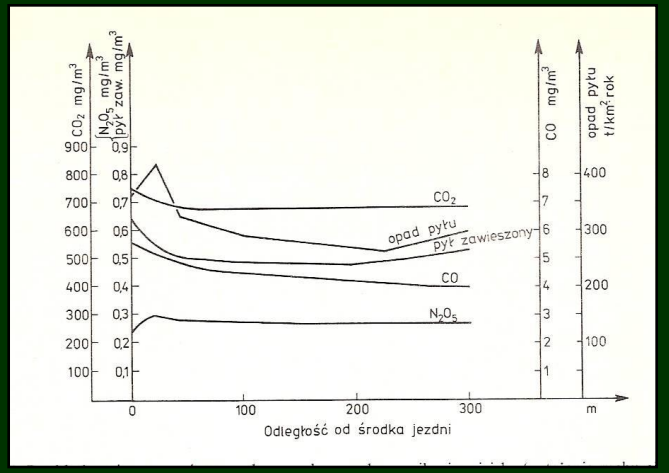
The range of studies included the mainly following problems:

- Influence of green infrastructure on local climate and microclimate;
- Spread of gaseous and particle pollution in atmospheric air at parks and streets;
- Physic-chemical changes of soils in Warsaw green areas;
- Accumulation of heavy metals (mainly zinc and lead) in soil and tree leaves;
- Productivity biomass and $CO_2$ sequestration and tree phenology;
- The role of entomo- and avifauna in green infrastructure in Warsaw;
- Influence of plant covered areas on decrease of noise in urban agglomeration

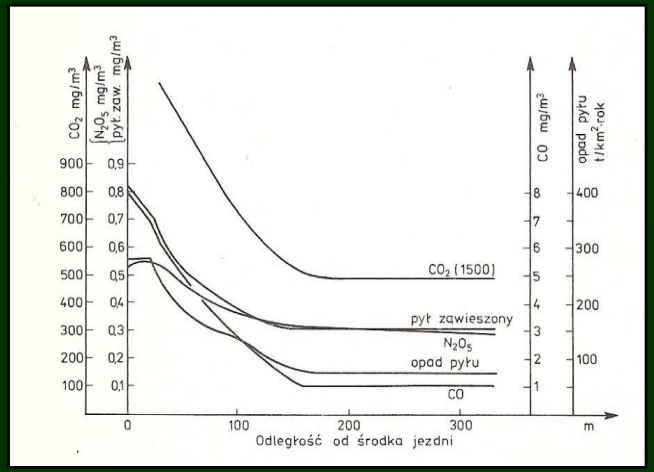
# Influence of greens and urban environment formation - results

- Green areas surrounded by buildings are much less resistant to pollution and less effectively in the influence improvement of environmental parameters, than larger complexes of vegetation areas with mixed vegetation (trees, shrubs, lawns and water *(Kopacz i in. 1984)*)

Saski Garden

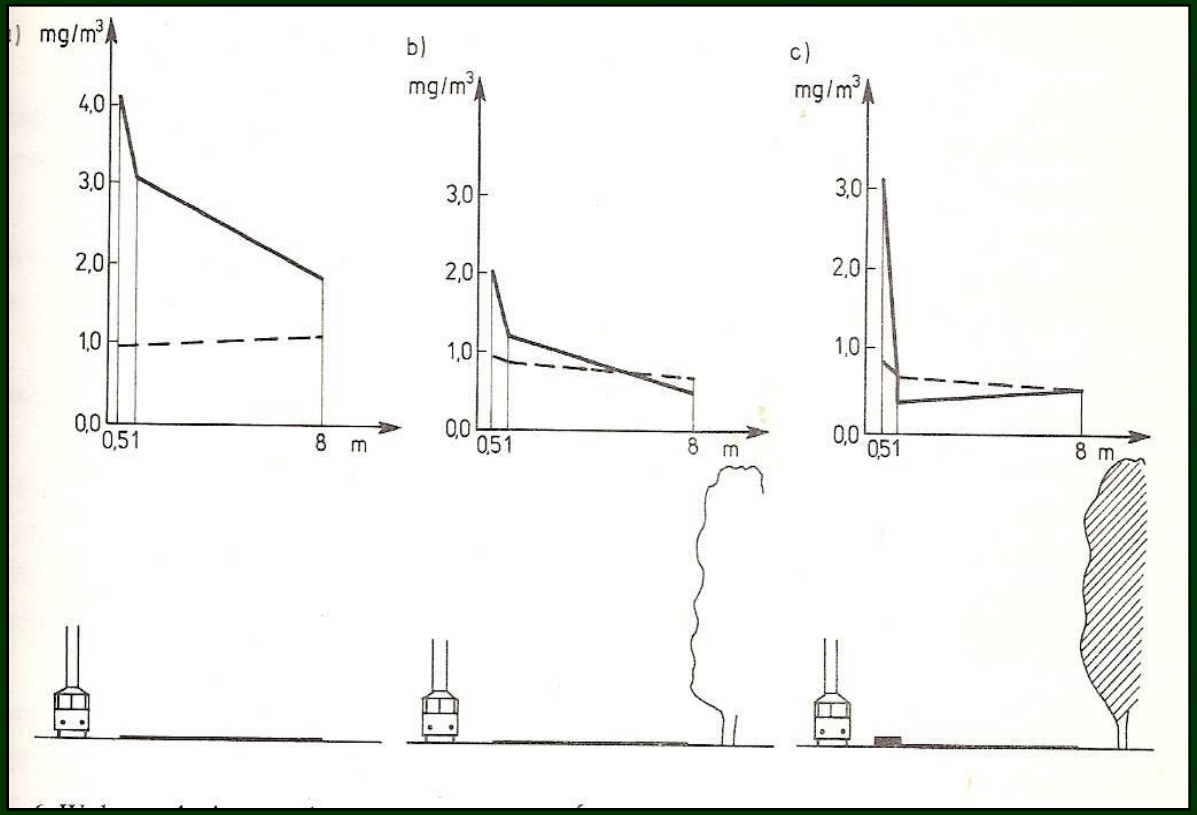



Praski Park

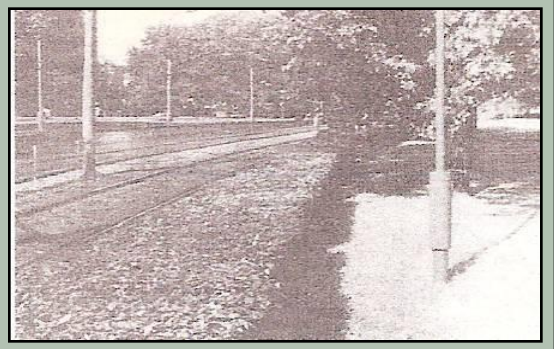


# Influence of greens and urban environment formation - results

- Areas covering up to 30 meters from the big traffic is characterized by high degree of pollution. The negative effect of big traffic was observed within the areas up to 100 -150 meters from street center.
- However, even small 1,0 m x 1,0 m hedge along roadway can significant reduce particle pollution spreading from traffic.

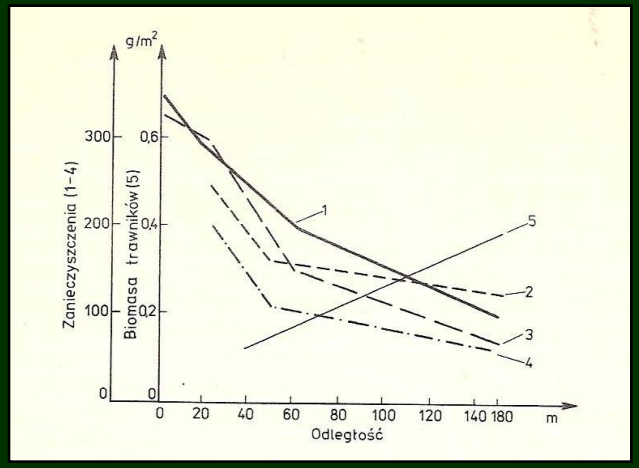



a/ Roadway with pavement
b/ Roadway with strip of lawn and nearby trees
c/ Roadway with strip of hedge and groups of trees. (*Skorupski 1984*)



# Influence of greens and urban environment formation - results

- The minimum area on vegetation effecting microclimatic influence (lowering temperature and increasing humidity) was found to at least 3000 m2 green area or 60 m strip covered with plants. The best results of plant influence to climatic condition is obtained when area is covered with different vegetation as trees, shrubs and lawns mixed with paths and water reservoirs.(*Konacka-Betley 1984)*
- A high degree of correlation was found between the air pollution rate, accumulation of heavy metals in upper soils and decrease of lawn biomass productivity. *(Szczepanowska 1984*)



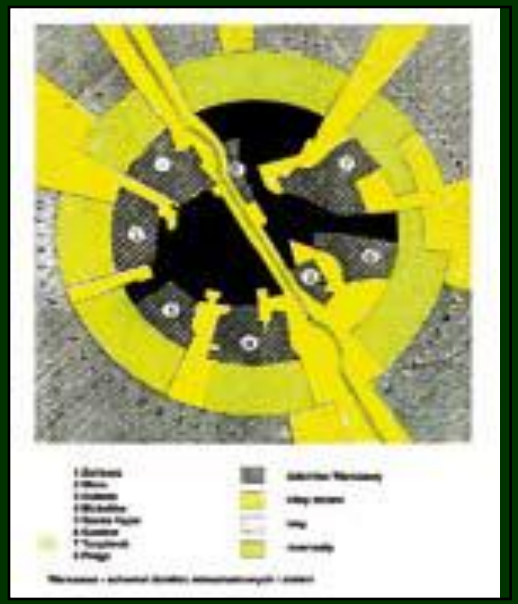

distance from roadway centre in m

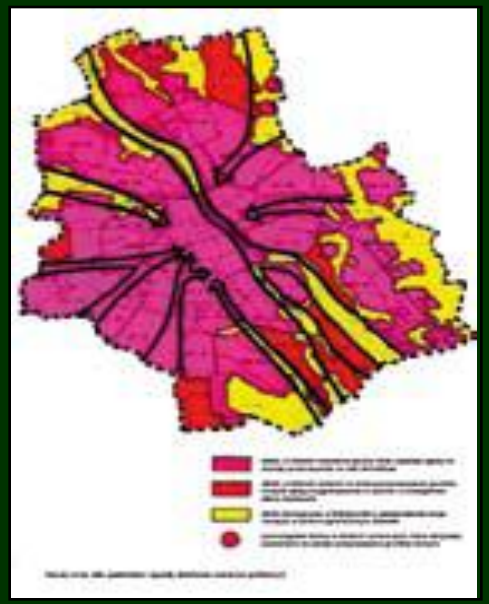
1. fallen particle pollution (dust) t/km2/year
2. suspended particle pollution (dust) mg/m3
3. zinc ppm
4. lead ppm
5. biomass of lawns areas g/m2

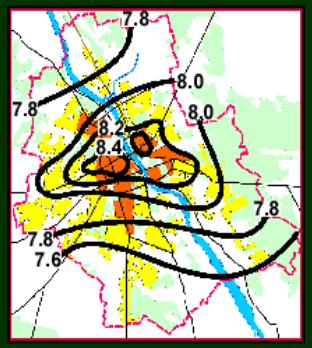
Many others scientific useful information brought these multidisciplinary research.

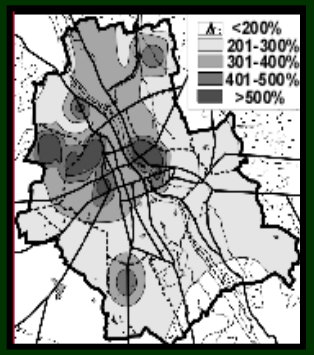
# Changes in urban environment during last decades

plan 1929 **Warsaw** 1999



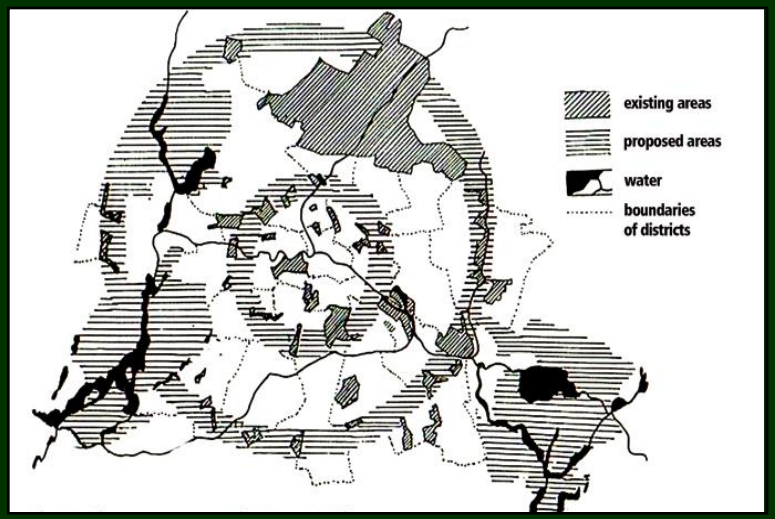





In city centers ‘heat islands’ have formed with the temperature increasing by more than 10°C and great pollution concentration (f.i. lead)

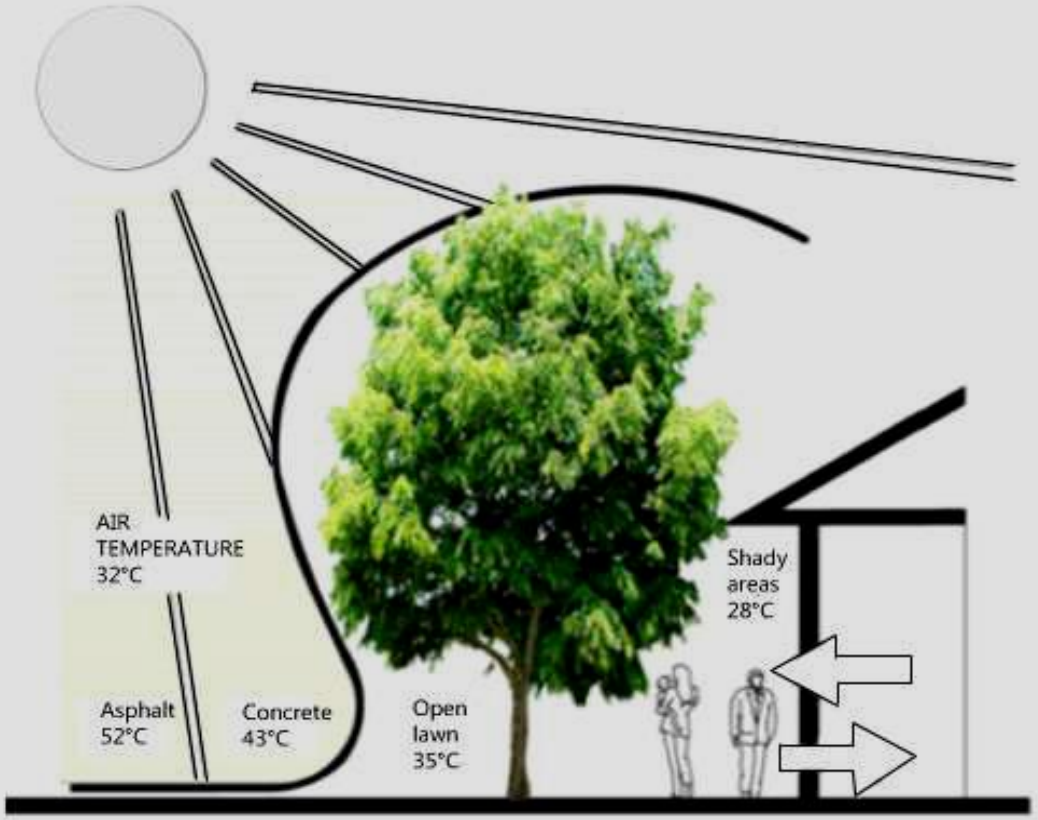
plan 1998




## Berlin

The return to the former concept of city connected with surrounding areas was planned during reconstruction of the metropolitan area of Berlin with a system of two green belts around the city combining forest, water and open areas with zones of parks and other open spaces in the centre (*Mehler 1998*)

# Climatic benefit from trees




A large maple tree on a hot, summer afternoon may evaporate more than 265 liters of water in an hour. Cooling effect resulting from the transpiration of one large tree may be compared to the efficiency of an average sized air-conditioner working about 20 hours a day (Leonard 1972).

A tree-related decrease in temperature is caused by such factors as direct shading and the process of evapotranspiration. In a stretch of street and pavement, the differences in temperatures on unshaded surfaces were compared with shaded locations.
When air temperature reached 32°C, the asphalt surface exposed to the sun heated up to 52°C, and the concrete surface to 43°C. The surface temperature of a neighbouring uncovered lawn was 35°C, while under the crowns of the nearby trees, and when low nearby vegetation was well watered, air temperature was only 28°C. *(Simmonds 1977)*

# Cleaning benefit from trees

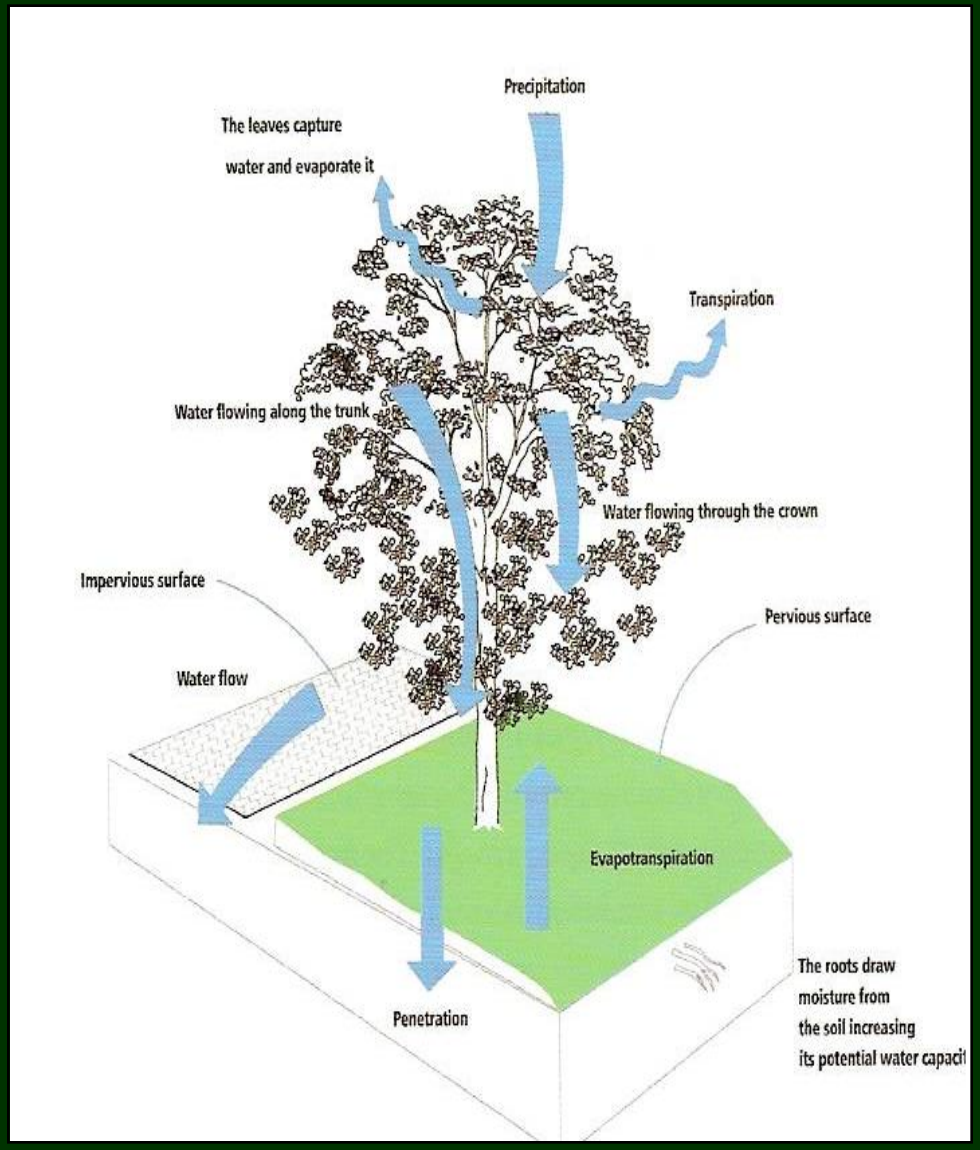
Vegetation in urban areas can absorb annually on average 3.16 kg C/m2, For city Leicester (UK) amounts to 231,000 t/year. 96% were absorbed by urban trees *(Davies 2011).*

Plants, especially trees, improve atmospheric air quality by absorbing gas contaminants (ozone, nitrogen and carbon oxides, sulphur dioxide and others) from the air, intercepting particulate contaminants (e.g. heavy metals), and releasing oxygen while absorbing carbon dioxide during photosynthesis. In locations with heavily polluted air (e.g. in vicinity of streets) trees eliminate even four times more *(McPherson 2002).*

In Chicago (USA) trees eliminate annually from the air: 17 t of carbon monoxide, 93 t of sulphur dioxide, 98 t of nitrogen monoxide and 210 t of ozone, 234 t of suspended solids, and they build 940,000t of carbon into their tissues. The economic value amounted to about 9.2ml USD*(Nowak1984*)

Similar values of tree „works” were obtained as the results of the research in other big cities in USA.

# Hydrological benefit from trees



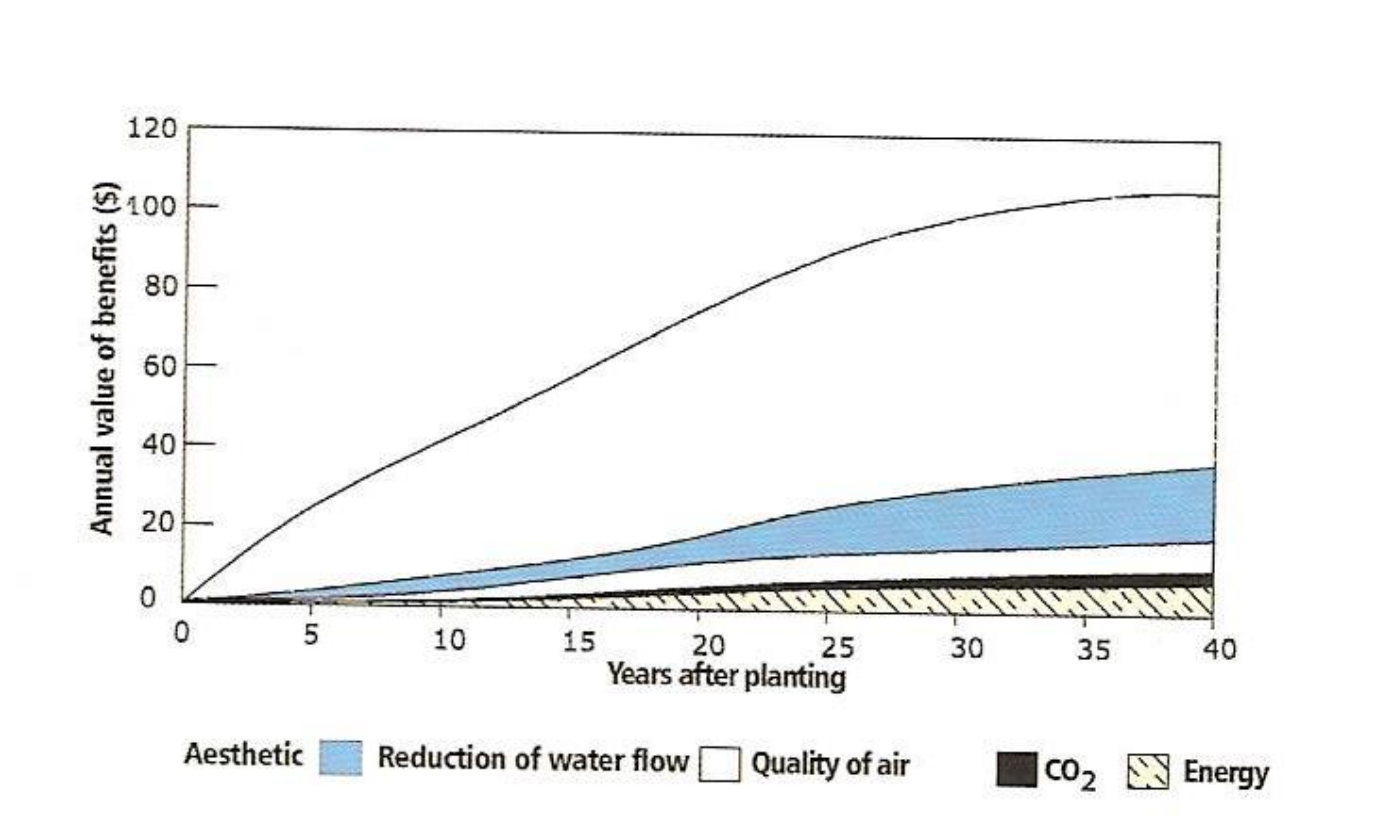

The role of trees and other plants in water management in urban areas is especially significant.

During rainfall, leaves and branches absorb and store water. Roots in soil increase infiltration rate and renewal of groundwater resources and reducing rainwater runoff, thus preventing floods. *(McPherson 2004)*

A large tree can store on average 228 to 455 liters of water within its crown *(Xiao, at al. 2000*).

Trees clear heavy metals and other unfavourable elements *(Gawroński et al. 2001).*

# Monetary benefit from one tree during forty years

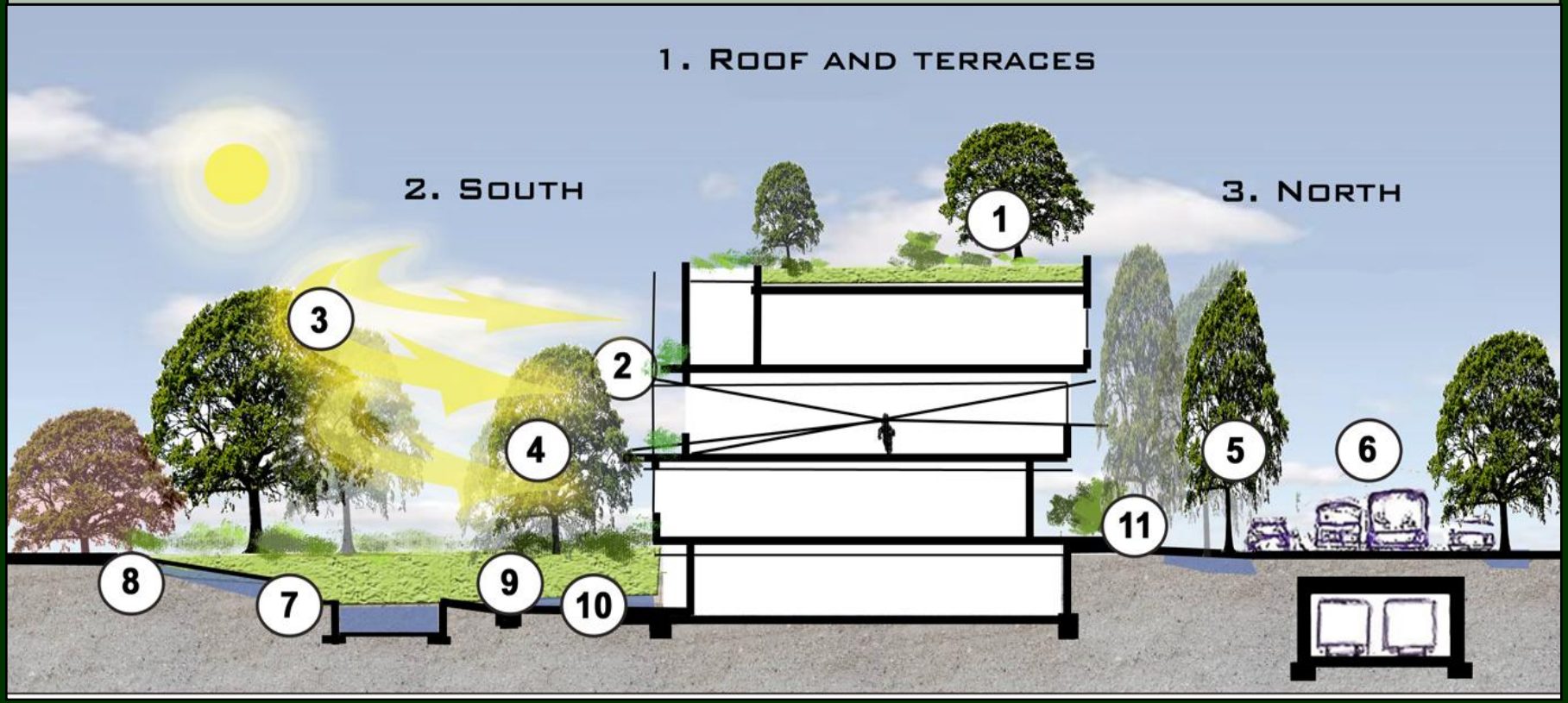



A financial value obtained on the basis of one tree within a period of 40 years:
- social benefits (aesthetic and other) - 65% (2,025 USD)
- reduction in water flow - 15% (476 USD)
- energy savings - 9% (280 USD)
- improvement in air quality – 8% (243 USD),
- reduction in $CO_2$ emissions – 3% (93 USD) *(McPherson 2004)*

**Social value**
**2025 USD**
People are willing to pay
**Physical Value**
**1035 USD**
Environmental Improvement

# Building-site - ecological relationship

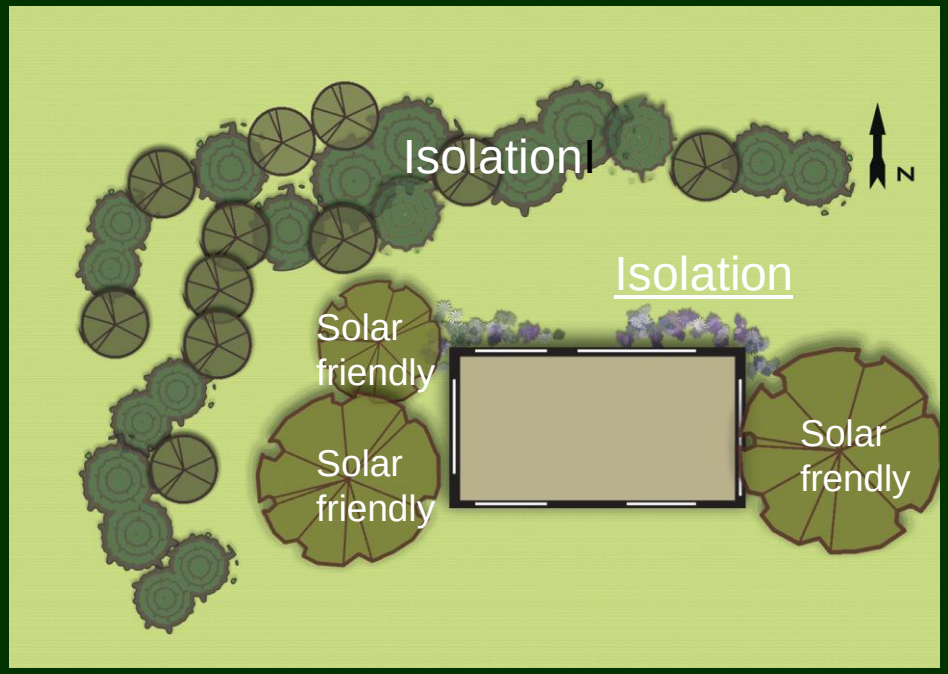
Improvement of mutual relationship between **vegetation-soil-water** in order to create a system which protects local ecology and microclimate



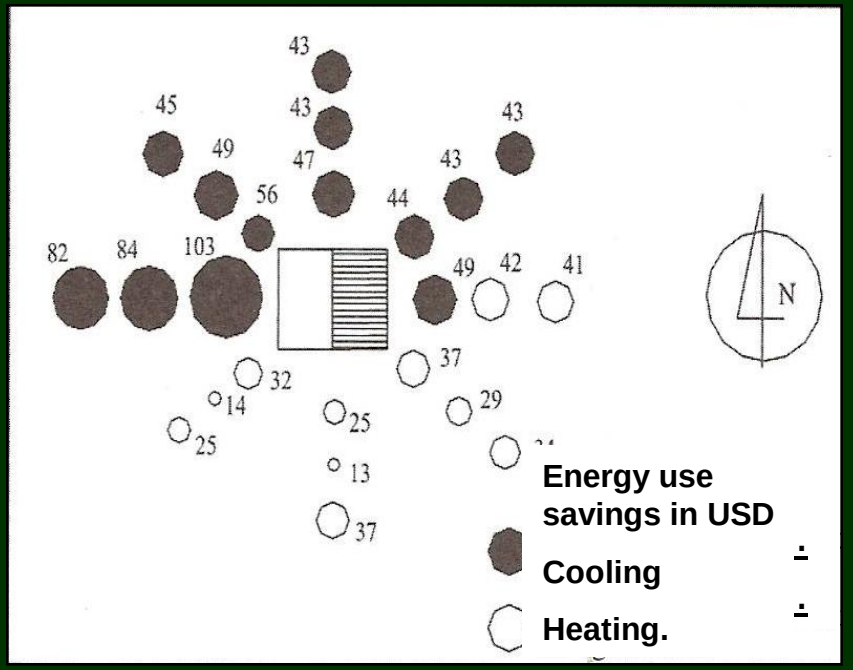

1. **Roof vegetation**
2. **Balcony  terrace and wall vegetation**
3. **Broad-leaves solar friendly trees**
4. **Summer breeze**
5. **Evergreen plant winter-noise protection**
6. **Traffic noise – pollution source**
7. **Plant covered bank-erosion protection**
8. **Increase permeable parking pavement**
9. **Reservoir for stormwater collection**
10. **System for collecting air for conditioning**
11. **Bike lane**

(autor: John Knesel)

# Shading, cooling and isolating effect of trees




**Strategic tree location in temperate climate**




**Energy saving by various located trees**

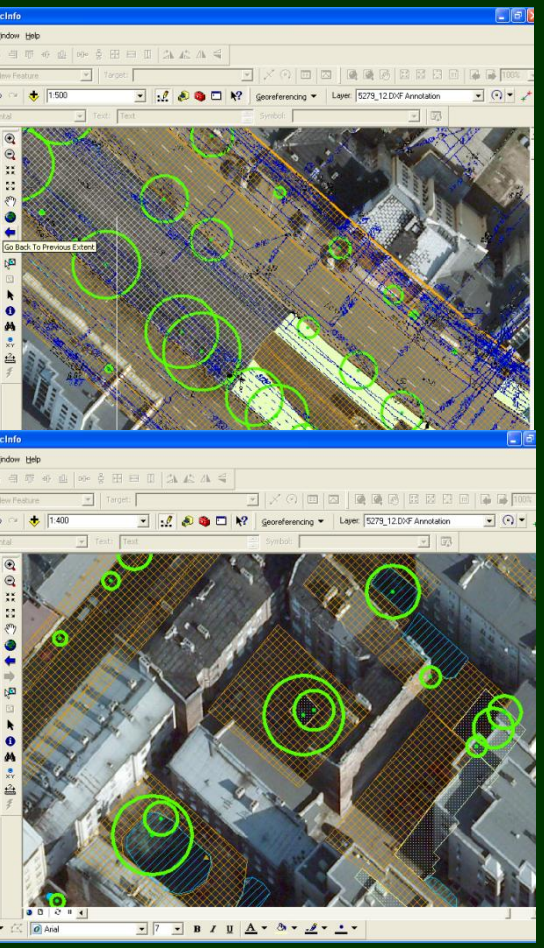
Energy saved by one 12 m high tree growing in different location around one-family house in Detroit was worth yearly from 13 to 103 USD (USA) *(Dwyer at l1992).*

According to theoretical estimation of these authors, by planting 3 „strategic trees" nearby each one-family house (1000 mln trees in USA), energy consum-ption may be worth 2 bln USD/yearly and restricted 9 mln tons of corbon emission to the atmospheric air from power plants.

# Integration of buildings, roadway and vegetation

**Create absorbent landscape**: Minimize impervious pavement area and use pervious pavement, where possible. Plant trees in continuous soil zones. Use structural soil where appropriate. Direct gradients of roadway to catch basin inserts. Use stormwater from roofs of houses for landscape watering by perforated pipe system and bio retention (*Braun, 2005).*

# Current research: Functional evaluation of urban trees and shrubs in relation to technical infrastructure.



**Monitored area: 276 301m2**
**Biological active : 16%**
**Tree crown projection: 10%**
**Vegetation covering: 26%**
**24 trees/ha**

Vegetation and spatial inventory and analysis of the areas of the central parts of Warsaw – Praga District (extreme difficult urban conditions).

The work addresses landscape opportunities associated with urban planning and construction projects in cities. Increase of plant benefits:

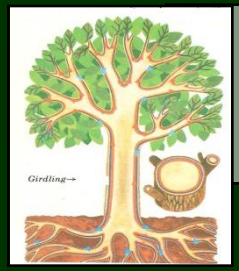
1/ maximize vegetation, especially trees, which are most effective in $CO_2$ sequestration, shading, cooling and decreasing of urban heat islands,

2/ minimizing site/soil disturbances and plant destruction on the construction site by integrated organization and suitable regulations,

3/ techniques of storm water management, water efficient landscaping and increase permeable spaces

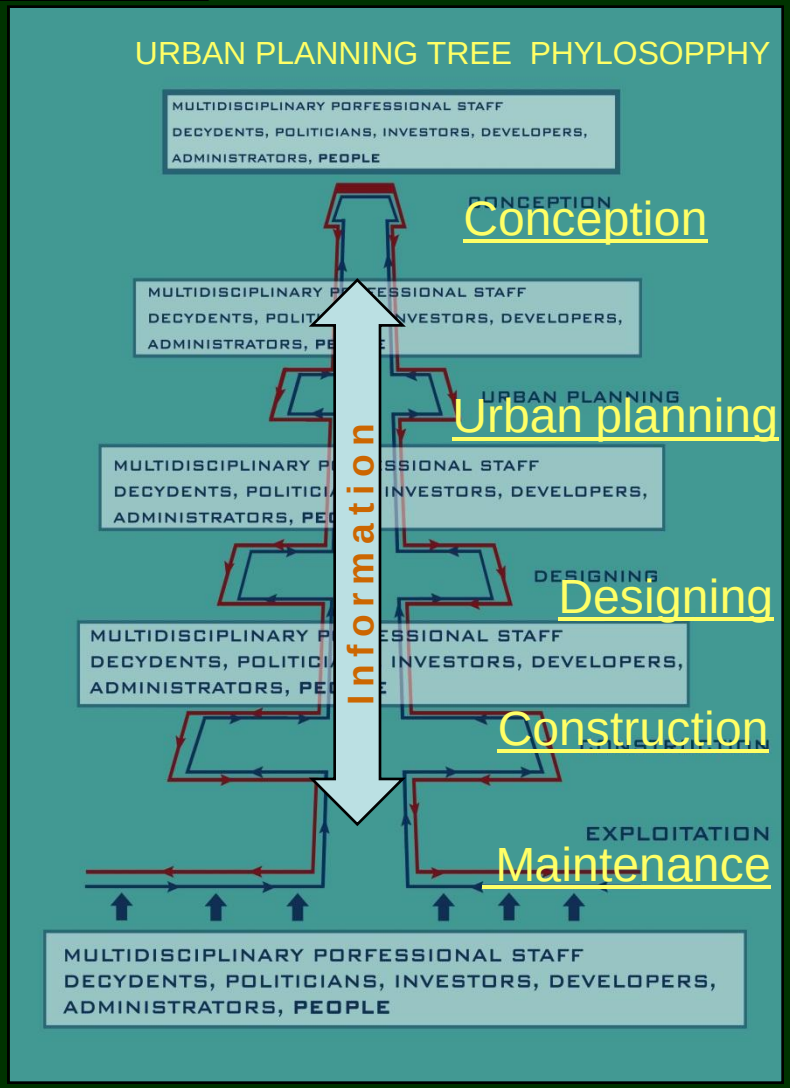
4/ relation between vegetation and technical infrastructure and methods to improve it.

The site inventory is made with GPS method and Excel monitoring system in Excel. Results of this work will be focused on practical recommendation for urban planers, designers, developers, city administrators, NGOs and inhabitants.



# Urban Planning Tree Phylosophy - UPTP

UPTP




**Trees** play a particular role in the vegetation of urban areas. They are a dominant spatial element, both visually and in terms of their effect on climate and cleaning the air. They increase architectural value and create a sense of order.
Tree is a sophisticated organism with large structure and longevity (lasts even thousand years) and constitutes most efficient **integrative systems** and most effective biological mechanism, **which are the strongest and most effective currently available**. (*Moore 2012)*
We should learn from it:
1.Integration
2.Mutual cooperation on each stage of investment process
3.From upper level (conception) – holistic vision of all problems on every maintenance/management level

This Urban Planning Tree Philosophy **leads to investment success.**

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