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THE NATIONAL ACADEMY OF SCIENCES
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ENV PRO

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Department: ENVIRONMENTAL PROTECTION AND NATURE MANAGMENT

Subject: URBAN ECOLOGY

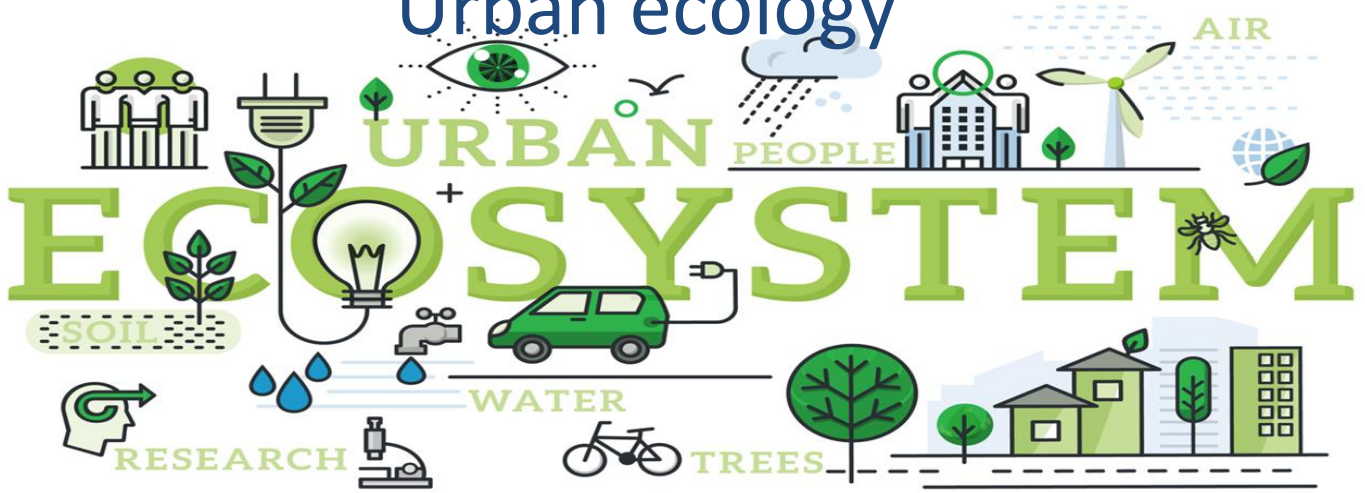
Lecturer: Dr. GAYANE NERSISYAN

The Environmental Science Education for Sustainable Human Health

6 – 13 September 2021

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA · GIRAF PM · NAS RA INTERNATIONAL SCIENTIFIC EDUCATIONAL CENTER · MARTIN-LUTHER-UNIVERSITÄT HALLE-WITTENBERG · UNIVERSITY OF GEORGIA · TÉCNICO LISBOA · GRENA GEORGIAN RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION

Urban ecology



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Summary

•Urban Ecology is a subfield of ecology that deals with the interactions of plants and animals (including humans) within urban and suburban environments and study of how urban communities and other high-population developments affect the natural resources and ecosystems around them. Or Urban ecology studies the conditions for the survival of human society in a unique ecosystem, a city with man-made infrastructure that is simultaneously connected to natural components.

•**Course goal:** This course intended for students is developing a science-based ecological perception, acquiring a comprehensive knowledge in building an environmentally friendly habitat, gaining relevant decision making skills.

•**Key issues:** Addressed include the status of urban geo-sociosystem and forecasting the ways of its development as a whole, interaction of its compartments, the influence of urban environment on adjacent sites and their ecosystems.

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Yerevan, 2021

MENV PRO

- City and urban ecology

Main role of the cities:

-industrial,
-educational,
-administrative,
-scientific,
-cultural

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Development or evolution of cities:

1st stage: 16-17 centuries, Citizens use local and feed resources, water and wind energy, horses and other domestic animals. *Environmental problems were*: wastewater and infectious diseases.

2nd phases / up to 19 centuries. transport and roads are developing, heat energy is being used, cities and their population grow.

3th rounds: beginning of the 19th century. Industrial Revolution and a *dramatic increase in environmental impact*: The first urbanized country (1900) Great Britain.

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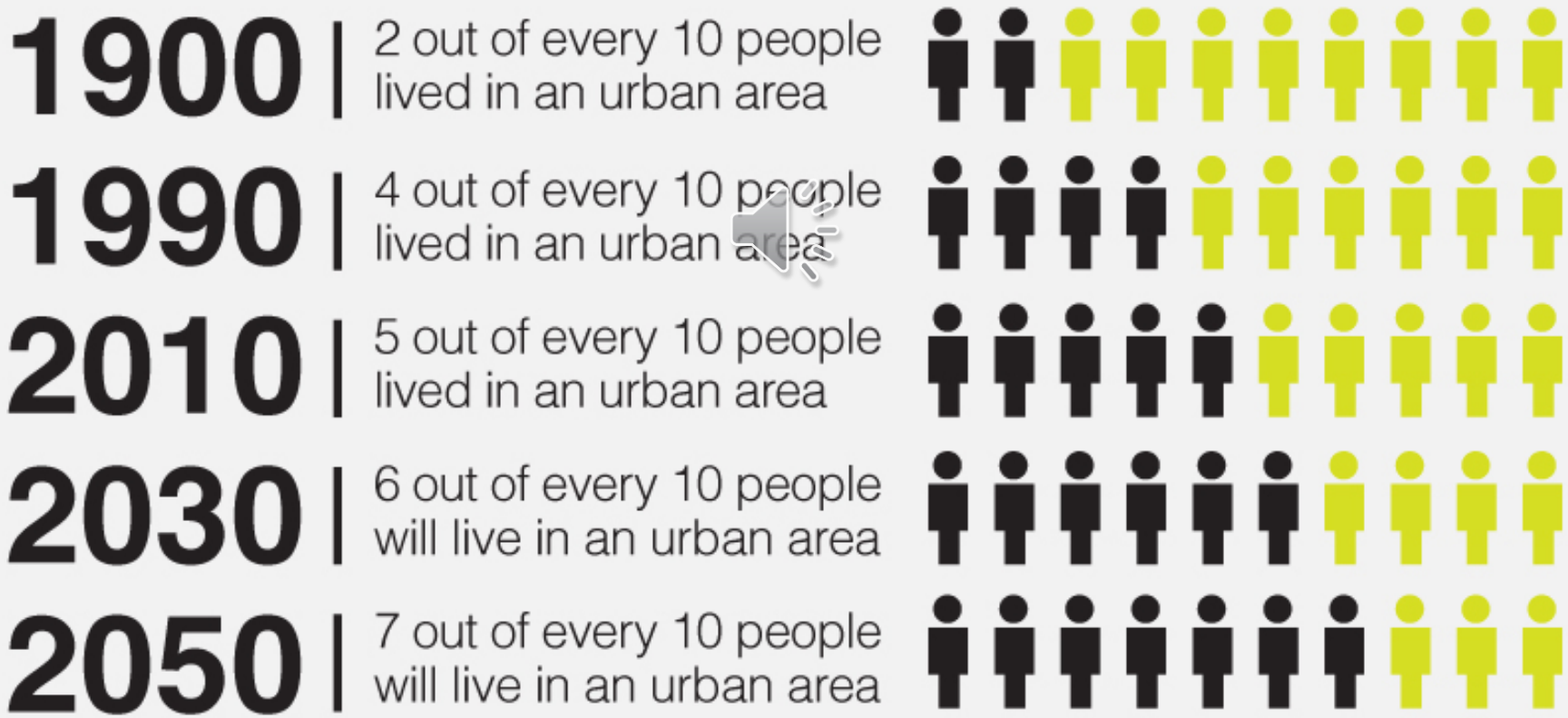
Urbanization



Defined by UN HABITAT as a city with a population of more than 10 million

Ecological peculiarities of the city.

There are active anthropogenic processes in it:
- industrial and economic activity,
-construction,
- the increasing number of vehicles,

all of which are permanent factors affecting urban environment as well as landscapes.

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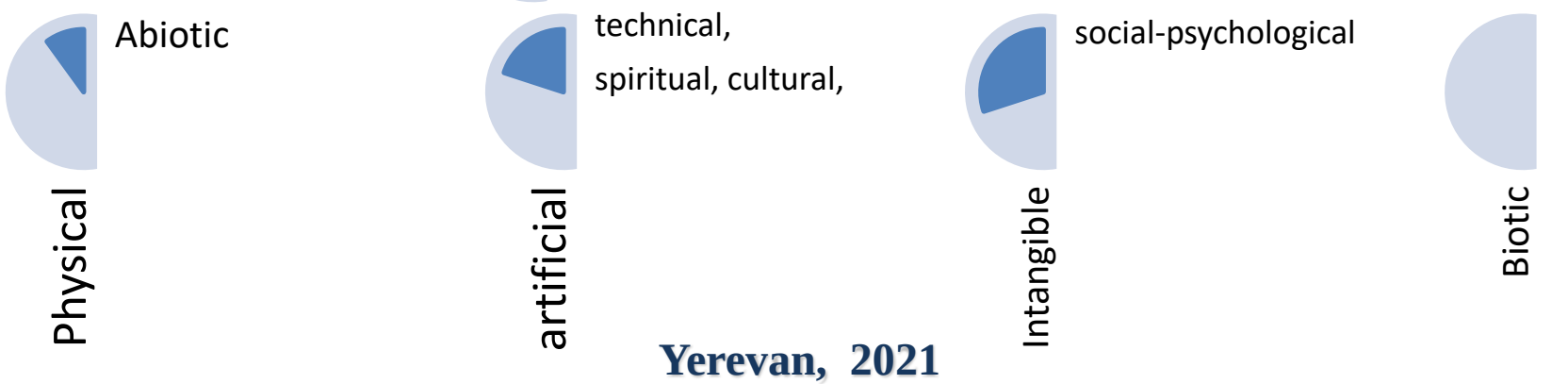
What is Urban environment

It is a part of the geographical layer, which is limited to the areas of the city, suburban parts, engineering-transport structures.

Urban environment devided

1. physical : abiotic,
2. biotics,
3. artificial technical and
4. artificil spiritual, cultural, socio-psychological environments.

All these ingredients are interrelated



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Ecological issues of cities

- changing relief and geological structure, composition of surface and ground water, climate, soil cover and vegetation / tens to hundreds of meters in the communications, tunnels, subway stations, pipes, cables

Landscape degradation

- large-scale using of natural resources, their development and toxic residues;

Economic problems

- with the health of the urban population.

Anthropoecological problems

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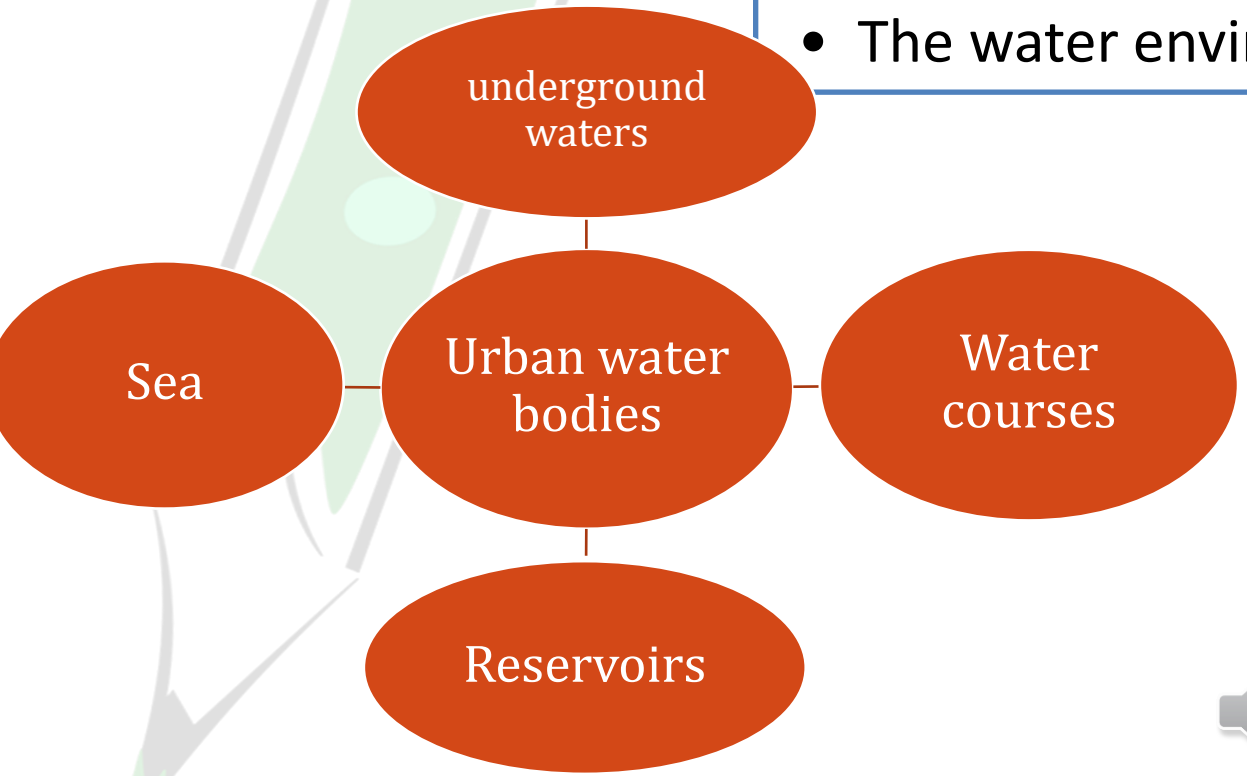
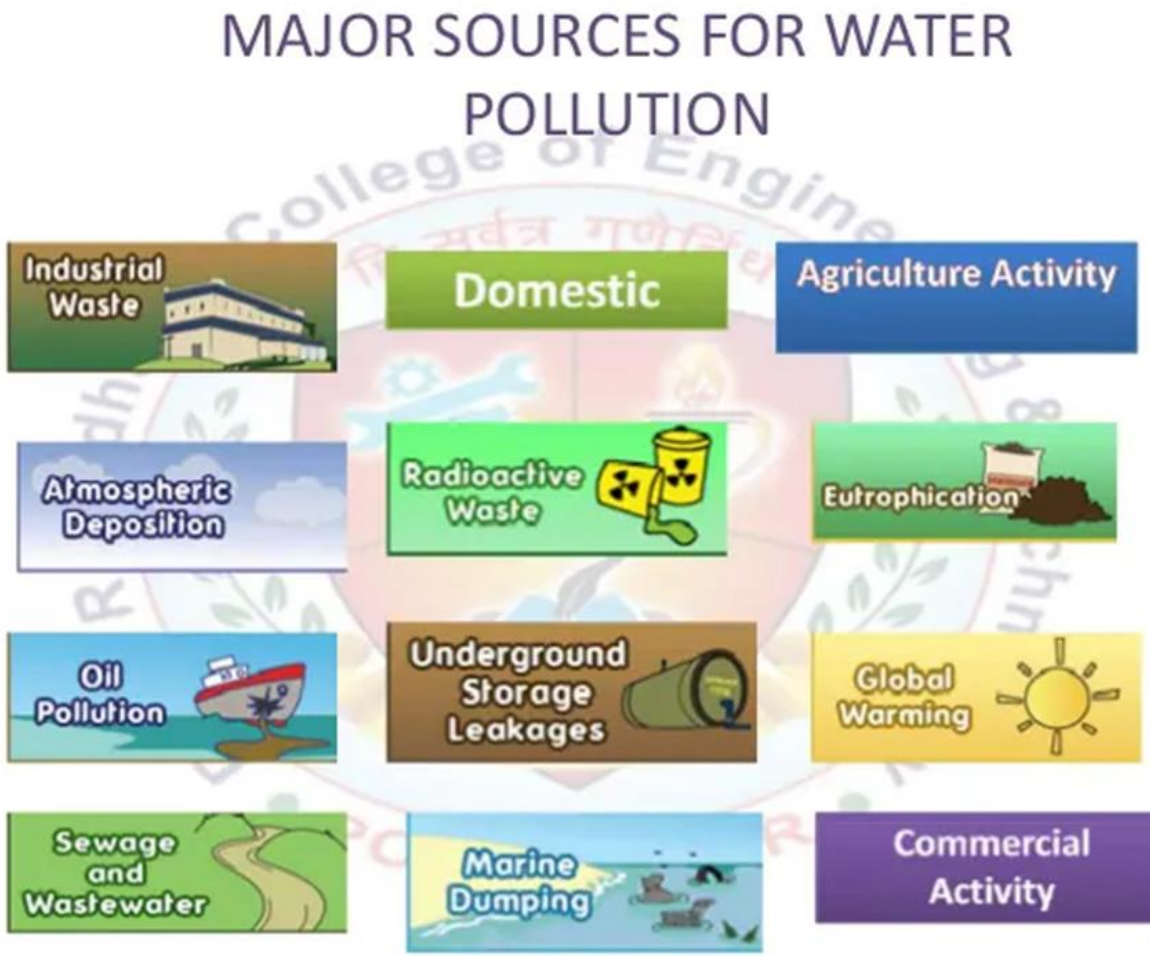
- The water environment of the city





Water pollution is the penetration, formation and accumulation of physical, chemical and biological pollutants that have a negative impact on environmental conditions, human health.

The sources of water pollution are as follows:

- Domestic wastewater (biomaterials or biogenic substances, nitrogen-phosphorus compounds),
- Industrial effluents (with petroleum products, phenols, heavy metals (lead, cadmium, copper, zinc, etc.)
- complex organic compounds (synthetic detergents, paints, fats),
- Moved from landslides during heavy rains pesticides
- Harmful substances from habitats,
- Pollutants released from the atmosphere by snow.

Water quality indicators

- Biological: algae, bacteria
- Physical: temperature, turbidity and clarity, color, salinity, suspended solids, dissolved solids, sediment
- Chemical: pH, dissolved oxygen, biological oxygen demand, nutrients (including nitrogen and phosphorus), organic and inorganic compounds (including toxicants)
- Aesthetic: odors, taints, color, floating matter
- Radioactive: alpha, beta and gamma radiation emitters.

WATER CODE OF THE REPUBLIC OF ARMENIA (Adopted by the National Assembly of the Republic of Armenia on June 4, 2002)

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INTRODUCTION

Urban greening

Phytoremediation is defined as:

Use of higher plants
to remove pollutants from the environment
or to render them harmless

Salt *et al.* 1998. Ann. Rev. Plant Physiol. & Mol. Biol.

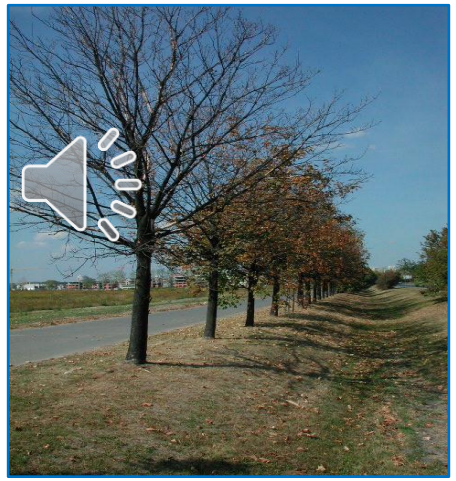
'**Phytoremediation**' derives from a Greek word '***phyto***' meaning 'plant', and Latin word '***remedium***' which means a tool against negative impact

So, PHYTOREMEDIATION, restore environmental balance through use of plants



brown fields





urban areas



indoor

Pollutants in urban areas:

- ✓ Particulate matters (10μm, 2.5 and 0.2μm)
- ✓ Gases (NO_2, NO, CO, O_3)
- ✓ Heavy metals (Pb, Cd, Mn, Zn)
- ✓ Polycyclic aromatic hydrocarbons (PAHs)
- ✓ Chlorinated biphenols (PCB)
- ✓ Noble metals (Pt, Pd, Rd)
- ✓ Salinity (de-icing salt, over 90 % NaCl)

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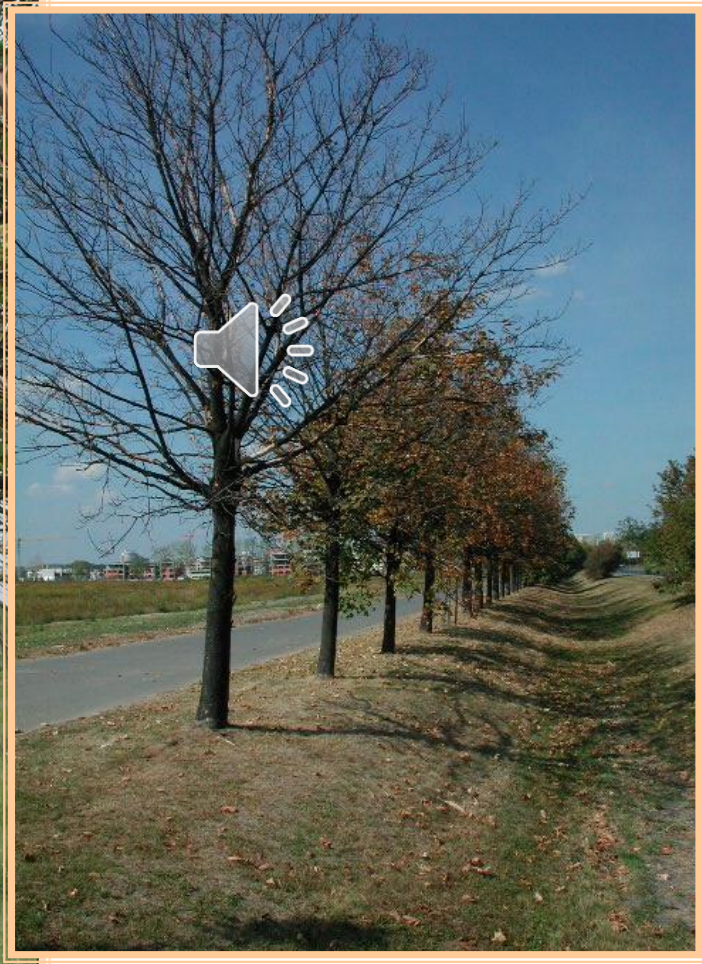
www.atmosphere.mpg.de/media/archive/2898.jpg

Efect of de-icing salt during winter on trees, pictures taken: June 2006 (1), and August 2006 (2,3.)



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Some species tolerate air pollutants better than others

Yerevan, 2021

Some species tolerate air pollutants better than others

Yerevan, 2021

Yeravan - Armenia's capital

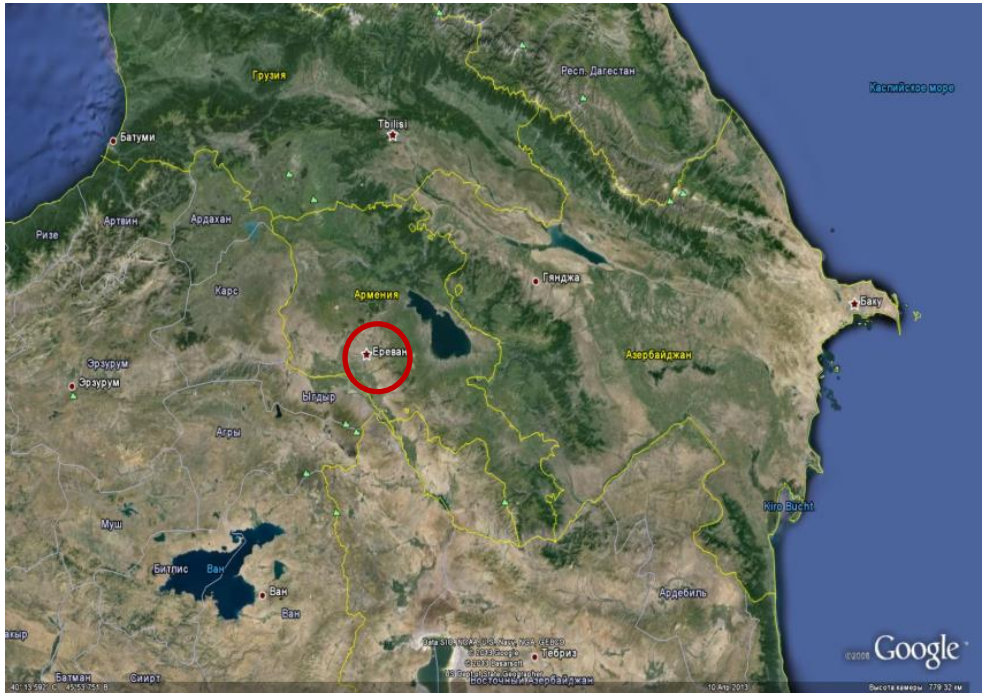
Population: 1,068 mil.

Total area: 223 sq. km

Total area of green spaces 6758.5 ha

Climate: sharply continental

Republic of Armenia – *a landlock country located in the South Caucasus*



95 %

5 %

Negative impact on the Yerevan's environment are:

- Traffic,
- Industrial enterprises,
- Construction,
- Power and heat generating facilities,
- Housing and communal facilities.

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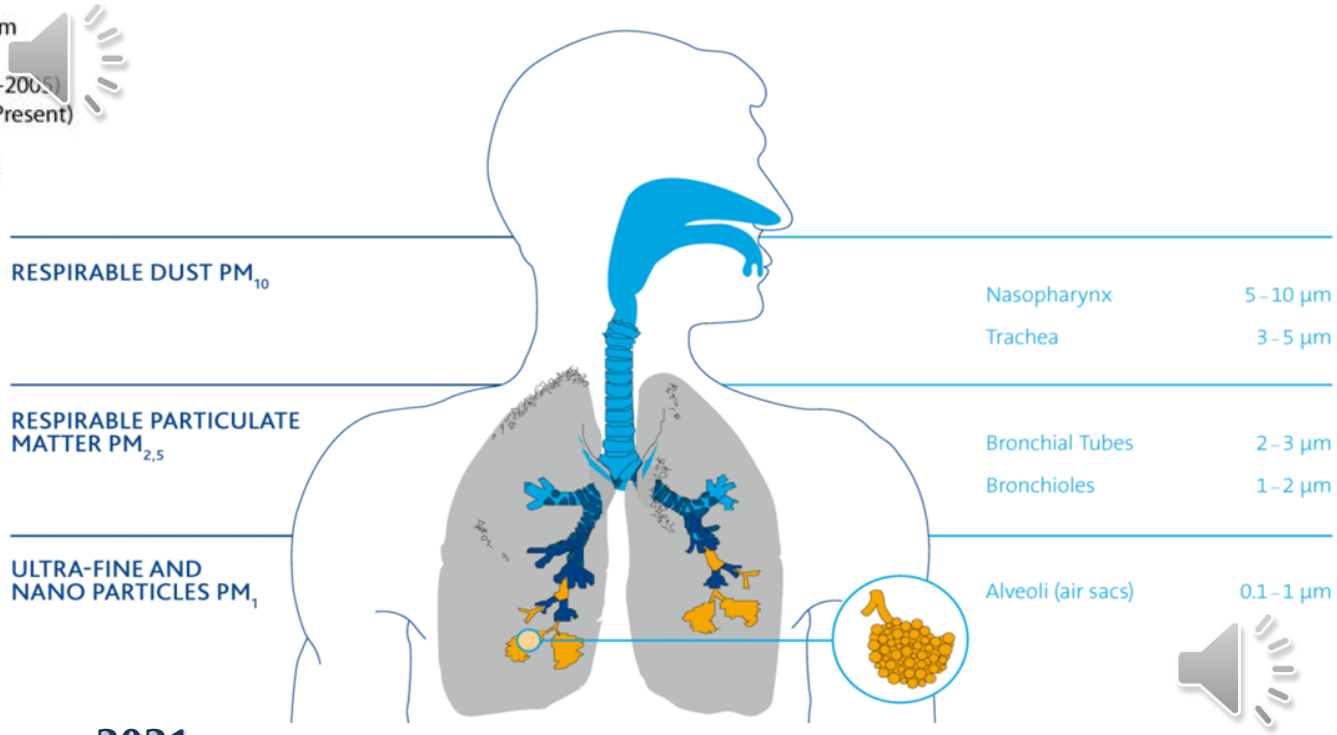
Fine Particle Regulations

Name	Total Suspended Particle (TSP)	PM_{10}	$PM_{2.5}$
Dates	1970-1987	1983-Present	1999-Present
Regulated Size	30µm	10µm	2.5µm
Daily Standard	260	150	65 (1999-2006) 35 (2006-Present)
Annual Standard	75	50	15

*µm = micrograms



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10 Parks and Squares

20 Streets

The research period: 2007 - 2017.

The research goal: providing indicator parameters of ecological tolerance of trees and selection of tree species with phytofiltration properties appropriate for Yerevan greening.

The research was implemented by stages employing a complex method of ecological assessment of plants developed by us:

- Studying the biodiversity of urban plants,
- Plant condition assessment,
- Geochemical investigations,
- Selection of tolerant tree species for urban greening

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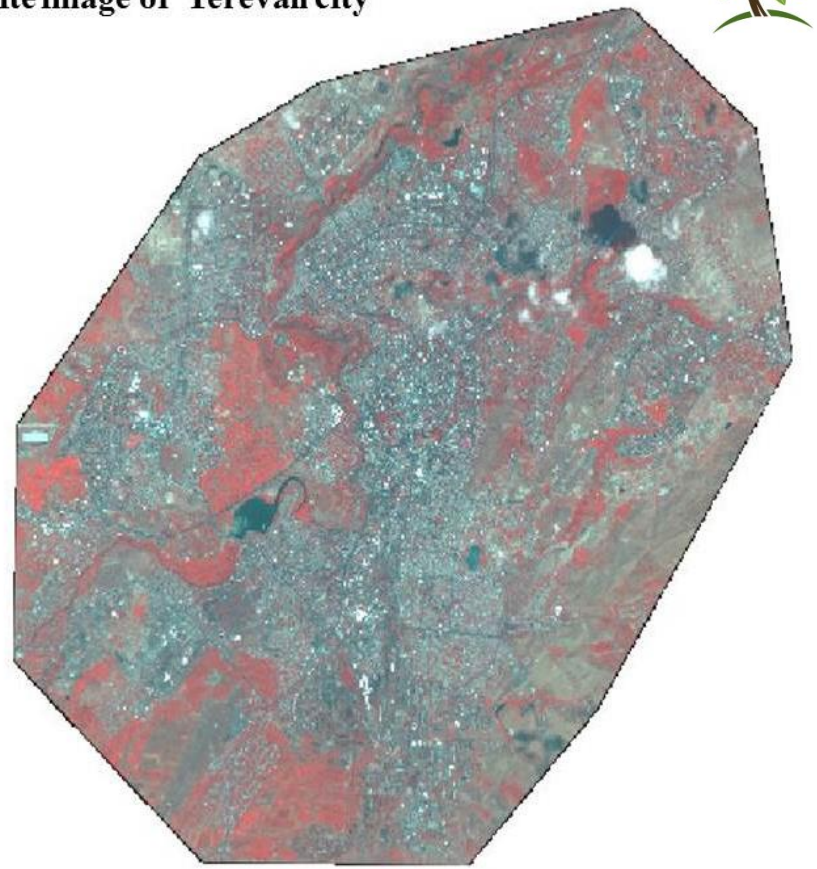
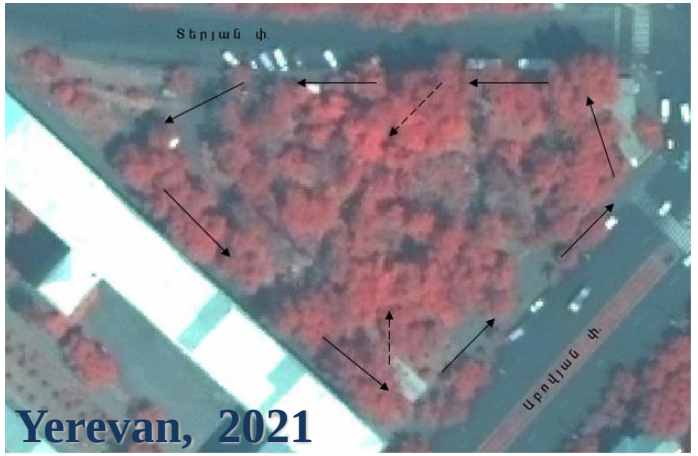
Satellite image of Yerevan city





Satellite images of parks and squares

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1. Assessment of ecological status of plants.

Assessing condition of trees

I - *excellent,*
II - *good,*
III - *poor,*
IV - *extremely poor,*
V - *dead:*

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2. SAMPLE COLLECTION

SAMPLE TREATMENT

- washing,
- air drying,
- chopping into small pieces,

Krakow 2019

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3. SAMPLE ANALYSIS

The Central Analytical Experimental Laboratory CENS

Cu, Pb, Mn, Mo, Ni, Zn, Hg

Atomic-absorption spectrometer:
AAnalyst 800 (Perkin Elmer, USA)

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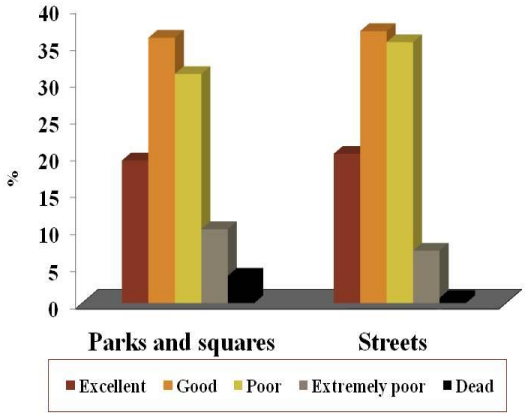

Fig. 2. Assessing condition of trees growing in Yerevan parks and squares

Fig. 3. Visible foliar injuries in polluted

OBTAINED RESULTS

Parks and Squares	
Ash tree	*Fraxinus excelsior*
Green Ash	*Fraxinus pensilvanica*
Robinia	*Robinia pseudoacacia L.*
Marple tree	*Acer negundo L.*
Golden rain tree	*Koelreuteria paniculata*
Ailanthus	*Alianthus altissima swingle*

Streets	
Marple tree	*Acer negundo*
Ailanthus	*Alianthus altissima swingle*
Ash tree	*Fraxinus excelsior*
Green Ash	*Fraxinus pensilvanica*
Poplar	*Populus alba*
White morus	*Morus alba*

1. Robinia - *Robinia pseudoacacia L.*
2. Ash tree - *Fraxinus excelsior L.*
3. Green Ash – *Fraxinus pensilvanica Marsh.*
4. Poplar – *Populus alba L.*
5. Golden rain tree – *Koelreuteria paniculata Laxm.*

A basic assortments of tree species planted in Yerevan parks and squares

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Tab. 1. Mean contents of heavy metals in Yerevan soils and plants (mg/kg)(2007-2008).

Elements	Soil		Plant	
	MAC* (mg/kg)	Observed conc. (mg/kg)	Normal conc.* (mg/kg)	Observed conc. (mg/kg)
Cu	55	88.8	3-40	21.11
Mn	1500	786	15-150	75.8
Pb	32	39	0.1-5.0	4.31
Ni	85	118.5	0.1-1.0	5.3
Mo	4	4	0.2-1.0	1.82
Zn	100	116.7	15-150	31.7

* **Kabata-Pendias A., Trace elements in soils and plants. – Warszawa, 2001, 432 pp.**

* ***Baker D.E., Chestin L.*** **Chemical monitoring of soil for environmental anality and animal and human health. – Advances in Agronomy, 1975, №27, p. 906-360.**

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Normal conc. (mg/kg)	Max. conc. (mg/kg)
0,001-0,01	0,04

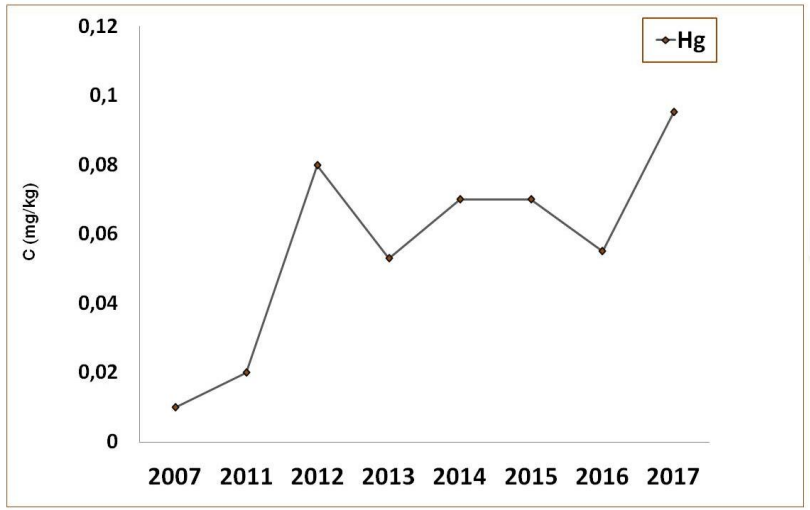

Fig. 4. The dynamics of changes in mean content of mercury
in tree species planted in Yerevan

Element	Normal conc. (mg/kg)*
Pb	0,1-5,0
Mo	0,2-1,0
Ni	0,1-1,0

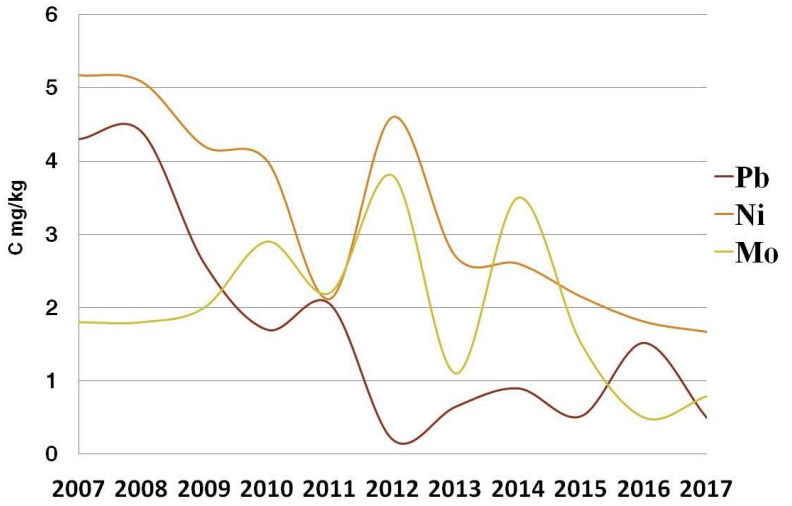

Fig. 5. The dynamics of change in mean contents of heavy metals in the foliage of Yerevan trees

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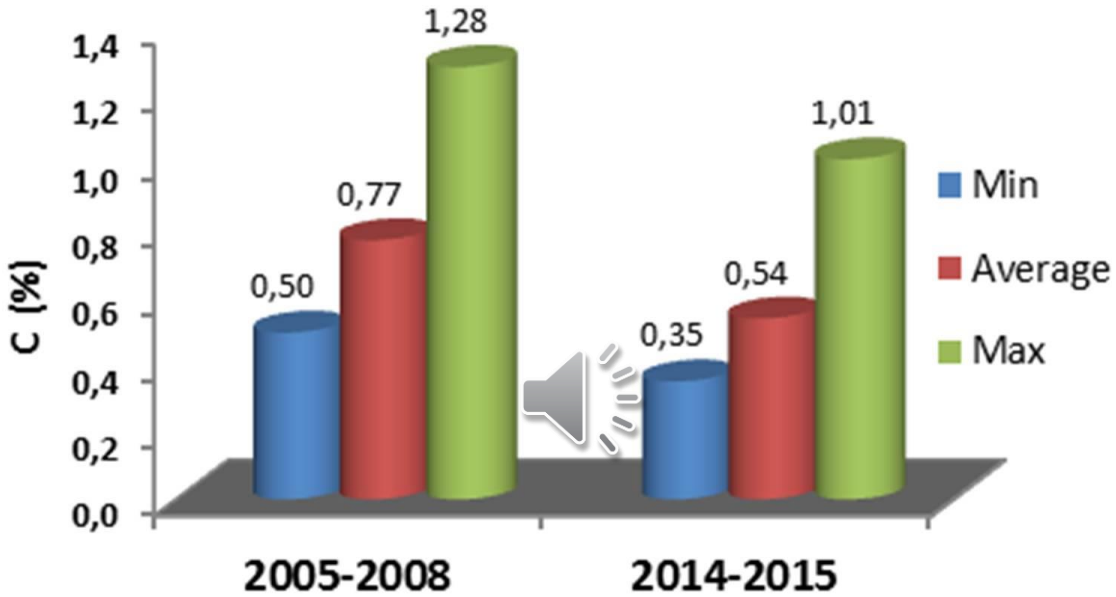

Fig. 6. Collation of monitoring data on chlorine concentrations in the leaves of Fraxinus excelsior L.

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Tree species	Variant	N/Cu	N/Mo	N/Zn	$N/\sum_{T.M}$
Robinia pseudoacacia	Background	1870	32258	840	176
	Pollution site	917.1	10645	614	145
	Strong pollution site*	330	4954	461	96.5
Fraxinus excelsior	Background	949	50000	631	126.5
	Pollution site	846.7	7022	775	130
	Strong pollution site*	259.5	5105	327	79.59
Populus alba	Background	833	36585	559.7	121
	Pollution site	670	7414	533.5	111.6
	Strong pollution site*	624	6496	364	113.9

* - a strongly polluted site with visible injuries of plants

Table 2. Values of relations between nitrogen/metal and nitrogen/chlorine in the leaves of plants growing on polluted sites

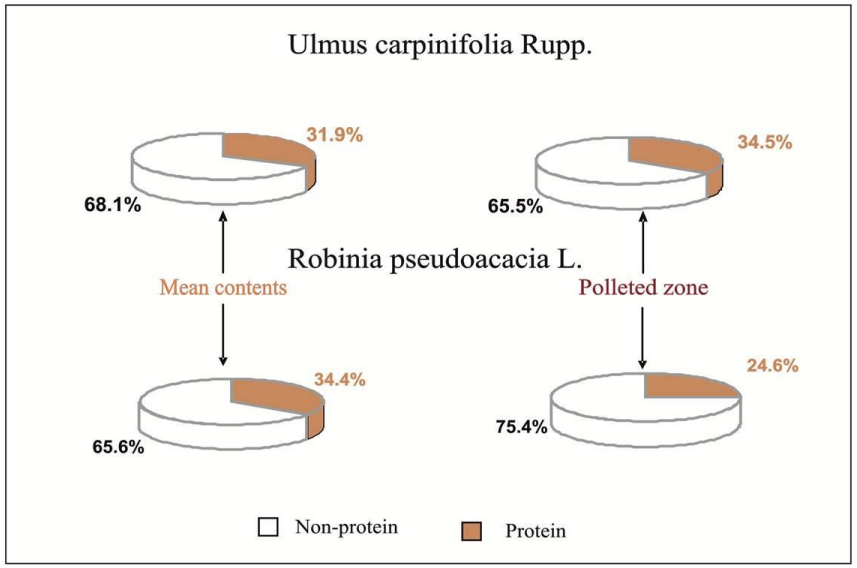

Fig. 7. Protein and non-protein nitrogen in different trees

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The obtained research results support the following conclusions:

- The assortment of tree growing in Yerevan parks and squares and strees includes some 50 and 30 species, respectively.
- The selected ecologically tolerant tree species having good phytofiltration properties include *Robinia pseudoacacia L.*, *Fraxinus excelsior L.*, *Fraxinus pennsilvanica March.*, *Populus alba L.* and *Koelreuteria paniculata*.
- The concentrations of trace elements exceed the accepted norms in Yerevan soils and plants.
- The best chlorine absorption and phytomelioration property as well as ecological tolerance under conditions of chlorine pollution is typical of Robinia pseudoacacia L., Fraxinus excelsior L., Platanus orientalis L.,
- Recent researches have indicated Pb, Mo, Ni and Hg in Yerevan plants.
- Within strongly polluted zones nitrogen/ metals correlation values dramatically decreased.
- In tolerant species under the impact of toxicants, an increase in protein nitrogen and in intolerant species – accumulation of non-protein forms of nitrogen is detectable.

Thus, our research continues in this direction, which allows us to choose the most sustainable species having best phytopiltration properties for urban greening sites.

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A set of tree and shrub species recommended for sites with different pollution level

Low pollution zone	Mean pollution zone	High pollution zone
Juniperus virginiana L. *Malus domestica L.* *Pyrus communis Borkh.* *Picea pungens Engelm* *Picea abies (L.) Karst.* *Kochiana Klotzsch ex C Koch* *Pinus pallasiana D.Don* *Philadelphus caucasicus* *Forsythia intermedia* *Acer tataricum L.* *Acer campestre L.* *Acer platanoides L.* *Morus alba L.* *Styphnolobium japonicum (L.) Schott* *Aesculus hippocastanum L.* *Populus alba L.* *Populus nigra L.* *Populus gracilis Grossh.* *Juglans nigra L.* *Salix alba L.* *et. st.*	*Sorbus domestica L.* *Acer tataricum L.* *Robinia pseudoacacia L.* *Aesculus hippocastanum L.* *Populus nigra L.* *Acer campestre L.* *Acer platanoides L.* *Morus alba L.* *Morus nigra L.* *Juglans nigra L.* *Salix alba L.* *Acer pseudoplatanus L.* *Tilia cordata Mill.* *Styphnolobium japonicum (L.) Schott* *Gleditcshia triacanthos L.* *Thuja occidentalis L.* *Elaeagnus angustifolia L.* *Hedera helix L.* *Lonicera tatarica L.*	*Fraxinus excelsior L.* *Fraxinus lanceolata Borkh.* *Platanus orientalis L.* *Populus alba L.* *Quercus L.* *Acer negundo L.* *Juniperus communis Ulmus L.* *Rosa canina L.* *Ailanthus altissima (Mill.) Swingle* *Syringa vulgaris L.* *Buxus sempervirens L.* *Parthenocissus quinguefolia L.*

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Thank you for your kind attention!

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