

Urban Ecology

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Master Study Program Urban Agriculture Teaching Material/ 2021

URBAN ECOLOGY

MSC.

Mandatory

First year/First Semester

2+1

4 ECTS

Course description

- The course introduces students to subject field, concepts and definitions related to urban ecology. Furthermore, the course describes basic information of ecology, relationship between plant and other living organisms.
- The ecological factors and their mechanism of action as well and sustainable development, social aspects which lead to a harmonised development in economic and ecological aspect.

Course goals

- The course objective is to describe the basic information for the urban ecology. Also for the main local and international legislation for the environment and impact of agriculture.

Expected Learning outcomes:

After successfully completing the module, the student will be able to:

- Describe the urban ecological issues;
- Evaluate the impacts of humans in the urban environment;

- Describe the link between cities and biodiversity;
- Argue about UA advantages besides production;
- Identify functions and services from UA;
- Evaluate factors of UA sustainability;
- Plan and manage ecological agricultural systems.

Teaching methods

- The teaching methodology is based on a lecture, exercises, evaluation tests (2) and work seminar.

Assesment methods

- Student evaluation is based on student's attendance of lectures and their participation in theoretical and practical lectures, success on mid-evaluation, final exam. Attendance

(90-100% =5 points; 80-90% =4 points; 70-80%= 3 points
<70% = dropout 5

Activities	15
Colloquium class	20
Homework and essays	20
Final exam	40

- In the past most of population have not lived in cities.
- In 1800, only 3% of the global population lived in cities and only 1 city had more than 1 million inhabitants.
- Later on 1900, 14% of the global population lived in cities and 15 cities had more than 1 million inhabitants.

- In 1950 about 30% of population lived in cities and 83 cities had more than 1 million inhabitants.
- Later on 2008, the ration of urban and rural population was 50% vs 50% and more than 400 cities had more than 1 million inhabitants.
- However, now days 74% of people in industrialized countries live in urban area, and in developing countries 44% live in urban area.

- The growing population of urban centers necessitates the study of interaction between living organisms and urban environment, which is defined as the environment surrounded by man-made structures, such as residential and commercial buildings, paved surfaces etc.
- Within this scope, urban ecology developed as a branch of ecology in the last few decades.
- As the ecological processes in urban environment are comparable to those outside the urban context, the methods and studies at urban ecology are similar to ecology, in general. Urban ecology dictates that local-scale dynamic interactions between socioeconomic and biophysical forces leading to development of a concept called city.

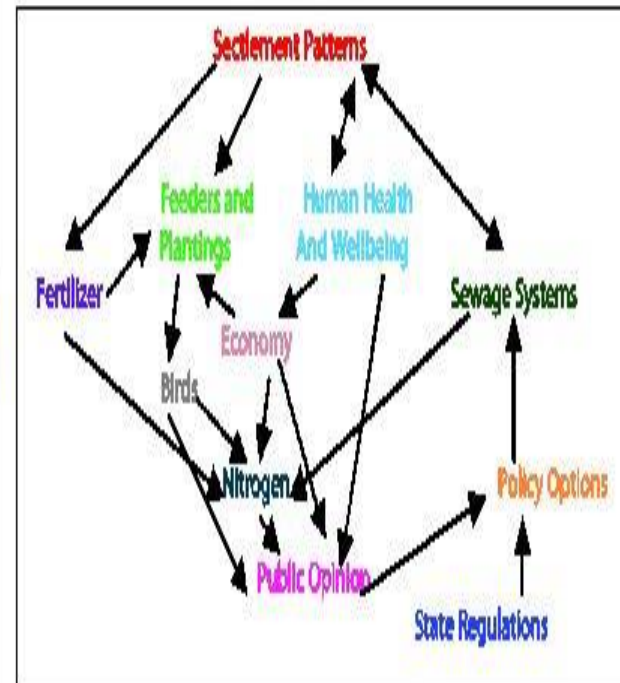
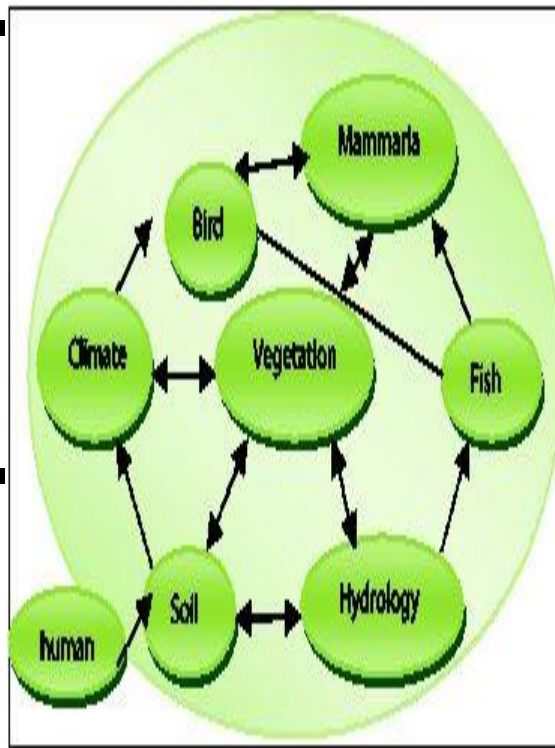
- Inherently, urban ecology is an interdisciplinary field of study. The examination of complex interactions between humans and their surrounding, such as construction, production, housing, transport etc., necessitates the involvement of natural and social sciences as well as humanities and engineering.
- The direct consequence of this interdisciplinary nature is that urban ecology can be used not only for understanding the urban systems but also for improving the conditions of urban environments.
- For example, it is required to comprehend how the urban system functions and in which extent it is affected from the global and local processes so that we can analyze how to maintain the water cycle working in a region and which factors, such as the use of landscape, the effect of green spaces, climate conditions, the coexistence of species etc., affect this.

- Similarly, the study of urban ecology is vital if we would like to understand where and how human activity harms the urban environment or in which way we could improve the living conditions of humans without giving any damage to the urban environment.
- While traditional lines of urban ecology still have a close connection to the scientific and social context of their time as well as to the respective urban structures [4], today's urban ecology differs widely from its beginnings.

- Urban ecology studies the relations of mankind with each other and their surroundings including cities and urbanizing landscapes. This recent and interdisciplinary field tries to understand the coexistence of human and ecological processes in urban environment and help humans to build more sustainable living.
- It is a subfield of ecology and it has strong connections with many disciplines like sociology, geography, urban planning, landscape architecture, engineering, economics, anthropology, climatology and public health.
- Therefore, urban ecology is used to define the study of humans in urban environment, of nature in cities, and of the relationships between humans and nature [5].

- Urban ecology basically concerns the relationship between the spatio-temporal patterns of urbanization and ecological processes [8].
- There is a mutual interaction between cities and ecological processes such that both are affecting to each other. This is true not only within the boundaries of the cities but also beyond them.
- As a result of this strong interaction, it is not possible and even useful to insulate human and natural components of urban ecological studies

- Urban ecology basically concerns the relationship between the spatio-temporal patterns of urbanization and ecological processes [8].



- Based on the definition of cities, i.e. complex phenomena emerged by human activity, new approaches are necessary to comprehend their properties [5], which can be outlined as:
 1. The complex structure of the cities, a social and biophysical phenomenon, could be defined by simpler and definable structures, functions and processes.
 2. The effects of the cities on the ecological and environmental processes should be well studied.
 3. While the tremendous amounts of requirements of the cities, such as energy and food, use the natural resources, the emissions and wastes produced by them are disposed to the country regions.
 4. As a result of this strong interaction, it is highly probable that the ecological processes in the Earth are strongly affected by the cities, which has not been studied yet.
 5. In fact, there is a possibility to conserve the natural resources and reduce the negative impacts of human activity on the environment with the help of the concepts emerged by the cities.

- Marzluff et al. [5] pointed out that urban ecology can be viewed from three points:

(1) ecology and evolution of living organisms residing in city boundaries;

(2) biological, political, economic, and cultural ecology of humans in urban landscape;

(3) cities resultant of the coupled relations of humans and natural processes. According to them, the third view in which human and nature are observed as interacting forces shaping the measurable patterns and processes should be followed by the field.

Human factors and naturel systems with biotic and abiotic factors are coupled together since they both drive and are affected by the patterns and processes they create.

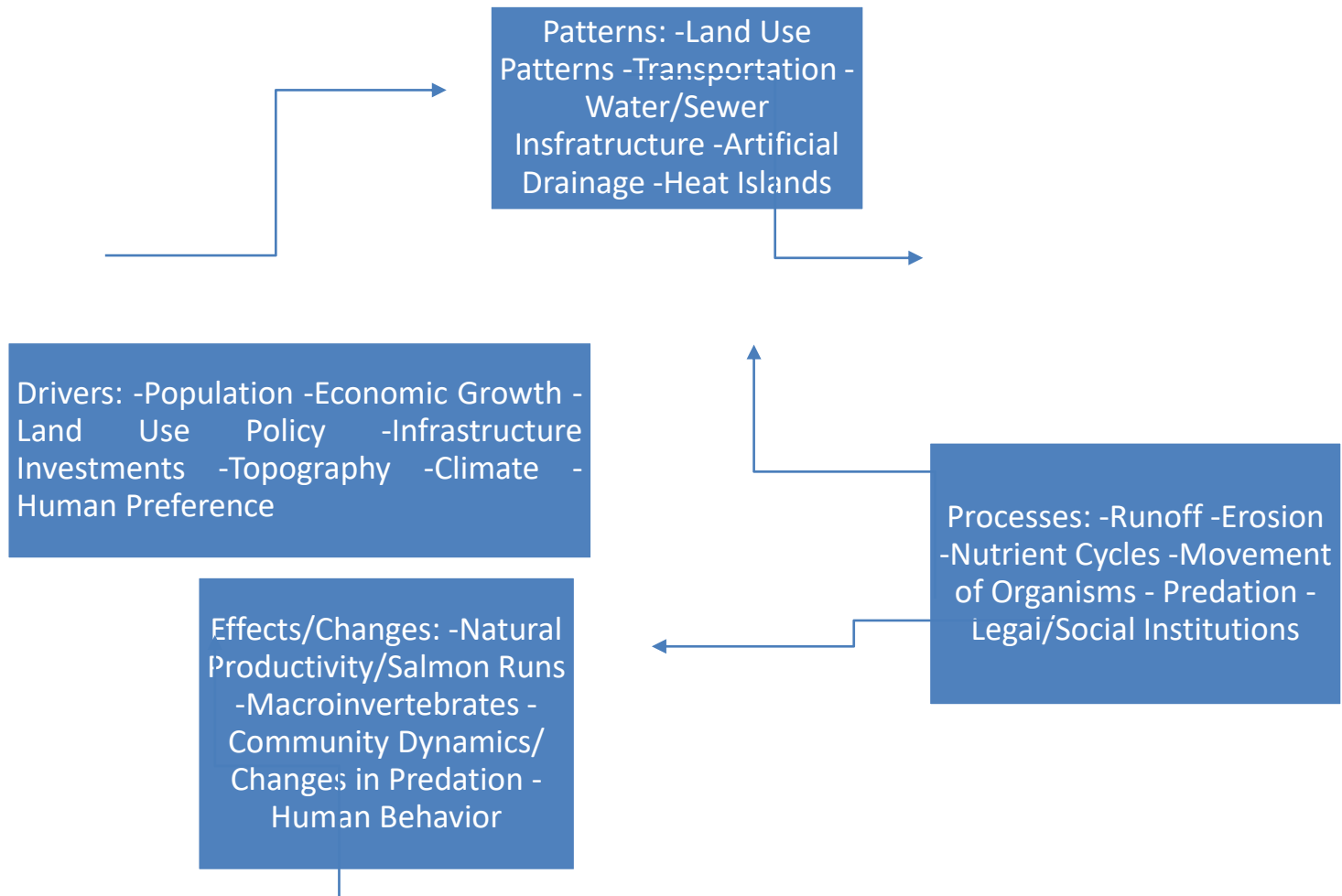


Figure 2. A scheme of urban ecology showing the relationships between humans and natural drivers which are influenced by the patterns and processes of abiotic and biotic drivers [5].

Urban ecosystems

- According to Moll and Petit [9], “a set of interacting species and their local environment working cooperatively to stay alive” is called as ecosystem.
- In urban environments, it could be difficult to distinguish different forms of ecosystems.
- In fact, one can define the whole city as a single ecosystem, while it is also possible to consider a city is a collection of many individual ecosystems, such as parks, lakes [10], urban forests, cultivated lands, wetlands, sea and streams [10].

- The second approach is preferred which covers all natural green and blue areas in the city. Based on this definition, street and ponds should be considered as individual ecosystems, while actually, Bolund and Hunhammar [11] states that they are very small and could only be defined as the elements of a larger ecosystem.
- According to Marzluff et al. [5], regardless of the approaches mentioned above, the whole ecosystem in a city is called urban ecosystem which includes abiotic spheres (the atmosphere, hydrosphere, lithosphere, and soil or pedosphere) and biotic spheres (often viewed as an interacting biosphere of urban plants and animals plus the socio-economic world of people, the anthroposphere).

Urbanization

- Big cities, highly dense population and maximum-imperviousness are local- and regional scale environmental effects of urbanization, which are caused by million-plus, core-oriented, high-rise concentrations [12].
- Urban regions are continuing- will most probably continue in future- to be attraction centers for a number of people [8].
- Accordingly, in Europe 75 % of the population live in big cities, 80% will be so by the year 2020 [13]. Repercussions of the issue have yet to be grasped within society as a whole.
- On the other hand, how natural resources are understood, connected and used is profoundly affected by the phenomenon of urbanization.

- For the great majority of population, various types of urban landscape are 'familiar' environments, and it is expected to be so in future [8].
- Landscape is turned into a complex structure by urbanization in terms of forms, materials and activities, which are different characteristics compared to rural landscape [14].
- Human populations living in urban areas cause dramatic effects on the Earth, even though those urbanized parts cover small areas on Earth's surface.
- The most critical point is that urbanization affects global biodiversity and ecosystems, yet this is not understood adequately.
- Although there is an increasing interest in urban ecological research, and the understanding of biotic effects of urbanization is better grasped, still, the efforts to bring these issues on the agenda of policy, governance, and planning is lacking [8]

- Ecologists did not study urban areas for the first half of the twentieth century, which is worth noting especially considering the concerns of urbanites regarding the future of urban plants and animals [16].
- Sukkop [17] claimed that a systematic approach to urban ecological research started after the World War II.
- Central Europe and the UK can be considered as the pioneers of the oldest urban ecological research tradition.
- In Berlin, for example, the topic has long been studied (since 1950s) [8].
- Now that, as Alberti [18] mentions, the focus on urban ecology studies has augmented, different arguments on dynamics of urban ecosystems are accrued.
- It is of vital importance to offer a common action that includes comprehensible definition of ecological conditions inside and outside of cities all around the world [8].

- One should take into account several urban dynamics in order to understand the relationship between urban sites and biodiversity, and develop a concept satisfying their needs [13]:
- Urbanity stands for city's life quality and character; it refers to the particular pattern of functional, structural, socio-economic and cultural interplay in urban sites.
- Although many enjoy urbanity, still they prefer to live near nature when they need to make a decision.
- In this sense, urban revitalization is an attempt to combine nature and city, especially in popular public sites.

- Urbanization is a general term for urban population increase, urban densification and/or expansion and fragmentation of urban sites.
- It usually leads to increase in a city's ecological footprint, and affects biodiversity and environment as a whole.
- On the other hand, the nature of footprint depends on the shape and structure of urbanization.
- Urban design is about describing cities' location, physical shape and the construction; therefore, it makes a number of functionalities and life styles possible.
- In this sense, through a successful urban design additional urban land-take and fragmentation can be reduced.
- What is more, urban design can provide green areas, and support biodiversity in cities.
- Additional green areas, recreating brown fields, promoting 'green' roofs and walls, and keeping the density and compactness in urban areas will maximize ecosystem activities and ecological footprint in big cities.
- In point of fact, by providing convenient pattern and activity plan, urban area can become more environmentally friendly areas; rather than mere threats to biodiversity.

- It is important to highlight the need for an international frame of thought regarding urbanization, which has recently been experienced as a massive, unplanned course of action in landscape change in the world.
- Urbanization offers a diversity of altered types of land covers in residential, commercial, and industrial areas; they are generally interconnected by roads and railways, on which special green spaces are allocated.

- This diversity and similar structures are common all around the world; yet; how they affect biodiversity and ecosystem processes has yet to be determined.
- What is more, international and comparative research attempts are essential in order to develop the understanding of ecological effects of urbanization [8].
- Sustainability of future can be maintained only if an ecosystem oriented approach is adopted in terms of urban planning; this approach should include equitable access to ecosystem services and proper planning [8].

The necessity of the ecological areas in the urban landscapes

- The biodiversity in the cities are very much influenced by the presence of green spaces, green roofs and walls along with tree-lined streets.
- In order to maintain the different ecosystem services including wildlife and human populations, existence of landscapes with sufficient size, diversity and distribution is essential.
- The green infrastructure in the urban landscape consists of recreation parks and gardens, unmanaged natural open spaces, wetlands and rural lands.
- According to EEA [13], the quality of life for most urban dwellers is closely related to the amount of green areas where they live.
- Since these areas provide people with opportunities for social relations, recreation and experiencing nature which affect them both emotionally and physically.

- The structure of green spaces and biodiversity are quite different from each other in rural and urban areas as in Europe.
- Although different countries have different green zone policies, it is accepted that nature affects humans in a very positive way by reducing blood pressure, improving cognitive abilities and increasing happiness.
- Meanwhile, green areas and biodiversity are also beneficial in filtering particles, purifying water, reducing noise, and buffering climate extremes like heat waves.
- This means that the green areas in the cities help to reduce the temperatures which are especially important in adopting the future climate changes for the landscapes which are likely to experience high temperatures and heat waves [13].
- The English Garden in Munich, Germany is a good sample for this subject (Fig 3-4).



The English Garden in Munich, Germany is a good sample for this subject

- The presence of natural flora in the cities, the establishment of habitats suitable to the animals adapted to the urban conditions and ecological studies for the protection and development of ecosystems are considered as environmentally ethical studies, as they protect the natural resources.
- Meanwhile, these areas are places which are increasing the quality of life in the city and allowing the social interaction of the residents [20].
- Ecological studies and designs are significantly important for the sustainability of the mankind and natural environment.
- The ecological studies carried out for the establishment of the sustainability in the urban areas as well as the for the protection of the resources involve not only the construction-scale efforts performed in the urban areas but also the works conducted in the rural areas.
- In the construction-scale, the studies comprise efforts such as taking precautions for the extensive use of solar energy, recycling of the domestic waste etc [20].

Urban climate

- The examination of the climatic conditions for lands differ from that of water.
- The complex combination of the elements of the lands, such as topography, land form, water and plants, strongly influences the climatic conditions related with solar radiation, wind precipitation, temperature and humidity.
- For example, the movement of air masses are strongly influenced by land forms and their topography, which are basically considered as obstacles (when they are tall) or routers (when they are in the valley-shaped) for air flow.
- A variety of air flow dynamics, from simple to complex, could be observed in many circumstances.
- Not only airflow but also humidity, temperature and absorption of solar energy are strongly affected by the properties of landscapes

- The windward and leeward sides of hills affect the humidity, while height of the landscapes strongly influences the temperature.
- Additionally, higher levels of solar energy are absorbed at the south-facing slopes, giving small microvariations in the climate and changing the vegetation patterns [24].
- Cities are generally warmer than open lands and forests as walls and roofs of the buildings and asphalt pavements have higher radiation surface than open lands yielding higher amount of solar energy absorbed.
- Meanwhile, the precipitation falls into the cities flow away to the sewage system through asphalt roads and squares quickly.
- As a result of this, the solar radiation is more effective on these surfaces than humid ground in the open lands and heat up more yielding higher degree of warming.

- As the terrestrial radiative heat loss from these city structures is slower, the temperature of the cities is higher.
- Meanwhile, evaporation of the water in the open lands also results in energy loss.
- For these reasons, in calm weather and invariable weather conditions, the temperature of a city could be 0.5-1.5 °C higher than that of its surrounding landscape.
- This difference could reach to 4-5°C in the night period and even up to 10 °C in the first few hours of the winter nights.
- Additionally the minimum temperature values could be 0.8 – 1.5°C higher than what is observed in the rural landscape. As a result of this a city can be termed as heat island.
- The number of frost and icy days are lower for cities.
- The warmer climatic conditions of the cities allow a long vegetation period for vegetables and reduce the freezing damages especially observed in the frozen nights.

- For this reason, the plants that do not grow normally in the climatic conditions of the open land of that region could grow in the city.
- The heat production in the cities and being warmer compared to their surroundings produce a low pressure region in the atmosphere.
- This causes a continuous flow of a wind from rural areas to the urban ones.
- The amounts of the dust and artificial gases in the atmosphere present on the cities are much higher than those present on the open lands and forests.
- Thus, these artificial materials hinder the sunshine arriving to the city. It was determined that the polluted air reduces the solar radiation by 15- 20 %.
- When the plantation is performed in the cities, the level of solar radiation increases as trees filter the polluted air and dust is partially captured by the long trees [22].

- The effects of the elements present in the urban areas on the flow of the energy.
- As depicted above, a city can be considered as a hot-spot or heat island compared to its surrounding rural landscape.
- In fact, the climatic characteristics of a city can be considered for smaller scales, such that the effect of each element in the city, e.g., streets, buildings, parks etc., could be evaluated individually.



According to Marsh [14], the following factors affect the temperature of the urban areas:

1. The man-made solid-structures, walls, roofs, roads, paved areas etc., have higher heat conductivities, heat capacities and reflection capabilities than natural soils.
2. The surface area of these structures with vertical faces increases the total surface area of the landscape giving higher degree of energy, mass and momentum conversion.
3. The heat is continuously produced by equipments, such as machinery, vehicles, heating and cooling systems.
4. The amount of evaporation and the energy used for that process decreases in the cities effecting the humidity and heat of the urban areas.
5. Exposure to long-wave radiation varies due to the pollutants and dusts are given off to the atmosphere by human activity.

- Urban landscapes change the direction and speed of the winds coming from surrounding.
- For that reason, differences occur between air flow on the cities and on the forests as well as open fields.
- The buildings in cities which are much taller than the average height increase the number of the calm days in the city and worsen the ventilation.
- These tall structures are the sources of the calm air, increased temperature and vapor pressure.
- In fact, this has a negative effect on the living conditions of the city resident.
- However, tall buildings do not always reduce the speed of the winds, on the contrary, it is stated that they may improve the circulation of the wind.
- For this, the large brows (facades) of the buildings should be perpendicular and their narrow brows should be parallel to the direction of the wind.
- Meanwhile, the distance between buildings should be long enough so that they do not block the motion of the wind [22]

Urban biodiversity

- Biodiversity provides an ecosystem system, on which the standard of living on European citizens depends, urban setting proves this successfully.
- Urbanites benefit from recreational, social and inspirational services of the nature, both inside and outside of cities.
- Yet, ecosystems are also crucial in terms of basic living conditions in cities.
- Thanks to its positive climatic effects, urban greenery will play an important role in adapting strategies to deal with climate change, which is expected to intensify or alter the specific urban climatic conditions.
- Urban greenery makes cities attraction centers; it prevents urban sprawl and saves space for biodiversity.
- In addition, as in-city services increase, the city's footprint is decreased; as a result, potential negative effects on biodiversity and environment is destroyed [13]

- In addition to ecologic services, green areas –in which biologic diversity is supported- are also gaining favor in terms of public health, maintaining social cohesion, economic benefit (like the increase in real estate market thanks to the green areas), and low maintenance cost (less irrigation and fertilization by creating ecologically sustainable urban designs) [34].
- Local and regional authorities have the legal power to designate conservation areas; to advocate EU's Natura 2000 networks; and, to bring biodiversity concerns urban and spatial planning agendas.
- Cities share the responsibility to select Natura 2000 sites.

- The scale of public commitment can be traced in Local Agenda 21 processes, which aim to establish sustainable societies identifying biodiversity as a precondition to build resilient cities.
- European Union supports advanced commitment and increased awareness by honoring the most sustainable cities, the European Green Capital Award (see the box below), and establishing a legal framework to protect biodiversity through, Natura 2000 network under the EU Habitats and Birds Directives, Air Quality Directives, the Water Framework Directive and the development of a Soil Directive [13].
- Cities are crucial in terms of sheltering some rare and endangered species and habitats, which are considered to be important at the European level as well.

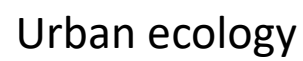
- There are a total of 97 Natura 200 sites are located in 32 major European cities.
- Of these cities, sixteen are capitals (for example, London, Paris, Prague, Rome and Tallinn).
- In addition, one or more harbors in more than half of the EU's capitals are Natura 2000 sites.
- Although Berlin has 15 Natura 2000 sites, most of the others have one or two.
- A new City Biodiversity Index (CBI) has been developed by favor of Convention on Biological Diversity (CBD) and contributions of Governments for Sustainability (ICLEI) [13].
- In cities, the value of biodiversity is closely related to societies' cultural and social preferences.
- Biodiversity not only offers quite an amount of ecosystem services to urbanites, it also modifies negative perceptions created by cities [35].

- As Walker and Salt [36] put, it is possible to perceive urban diversity within the framework of response diversity, which is the case when species and ecosystems respond differently to external interventions, even though they function collectively.
- For instance, urban trees intercept large amounts of precipitation, and prevent flooding; therefore, tree diversity contributes to precipitation interception's response diversity function [37]. As a result, strong biodiversity guarantees lower risk for the entire function, despite local extinction.
- As the cities continue to face the effects of climate change, response diversity will be an important capacity building factor in terms of resistance [37].

- From the perspective of urban planning, protection of biodiversity in cities is a high-priority for both stakeholders and decision-makers.
- Still, when it comes to put the issue at the top priority list during the planning process, it is left behind of anthropocentric objectives such as economic development, transportation, land use and recreation [37].
- Extensive use of native species is essential for the sake of urban biodiversity.
- By doing so it could be possible to carry out more successful landscape projects with minimum maintenance work and cost.
- Furthermore, a breeding and feeding environment can be created through increasing biodiversity and by using native species.
- Regarding sustainable cities, floristic diversity is an important topic [38].
- Biotic, physical and social factors along with processes are related to biodiversity in urban ecosystems.
- On the other hand, ecology itself is insufficient to delineate urban ecosystems.
- As a result, it is advised to establish an interdisciplinary approach, including natural and social sciences, that will discuss ecology-related inputs in terms of urban planning [38].

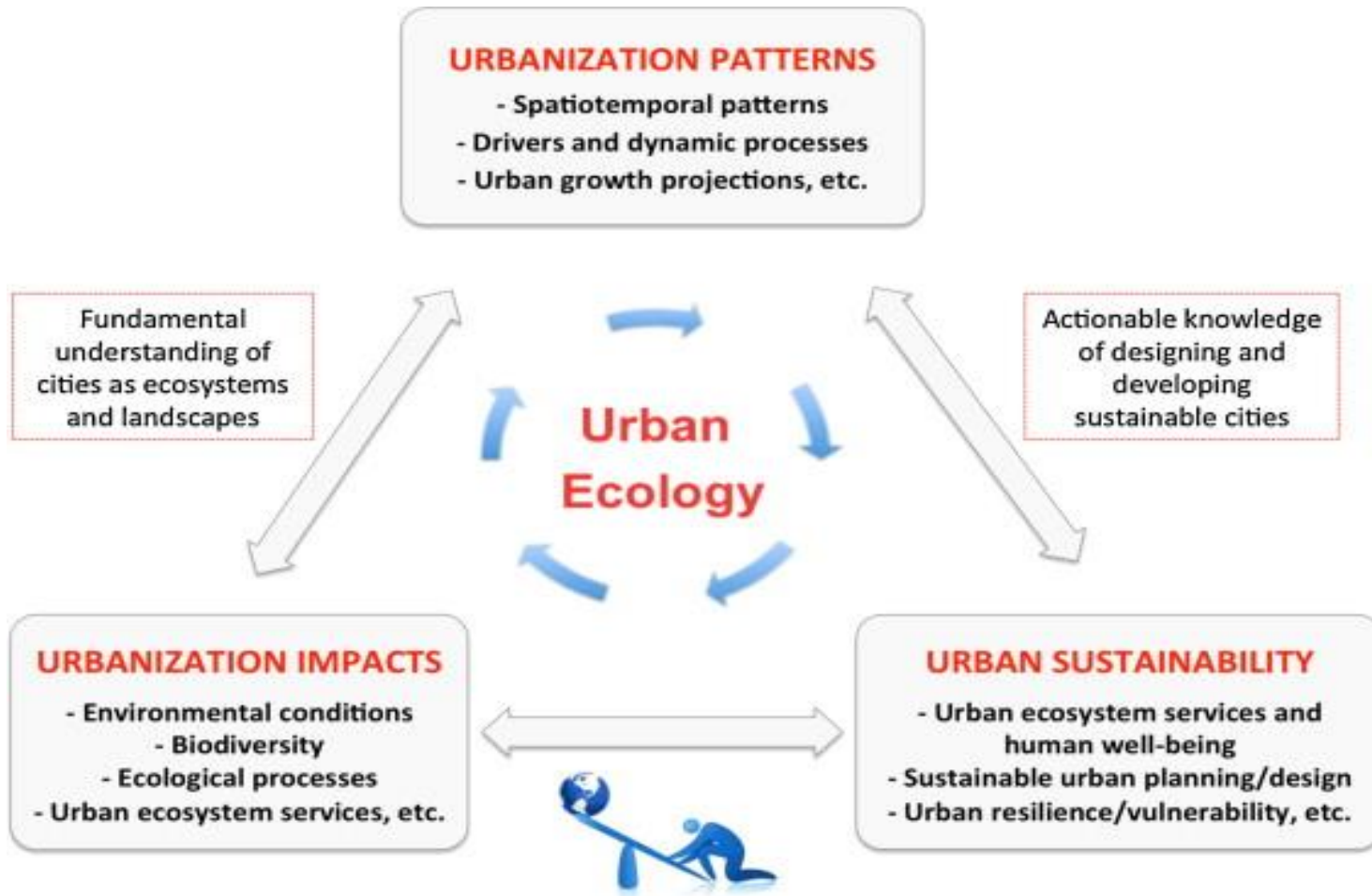


Urban research





Urban ecology

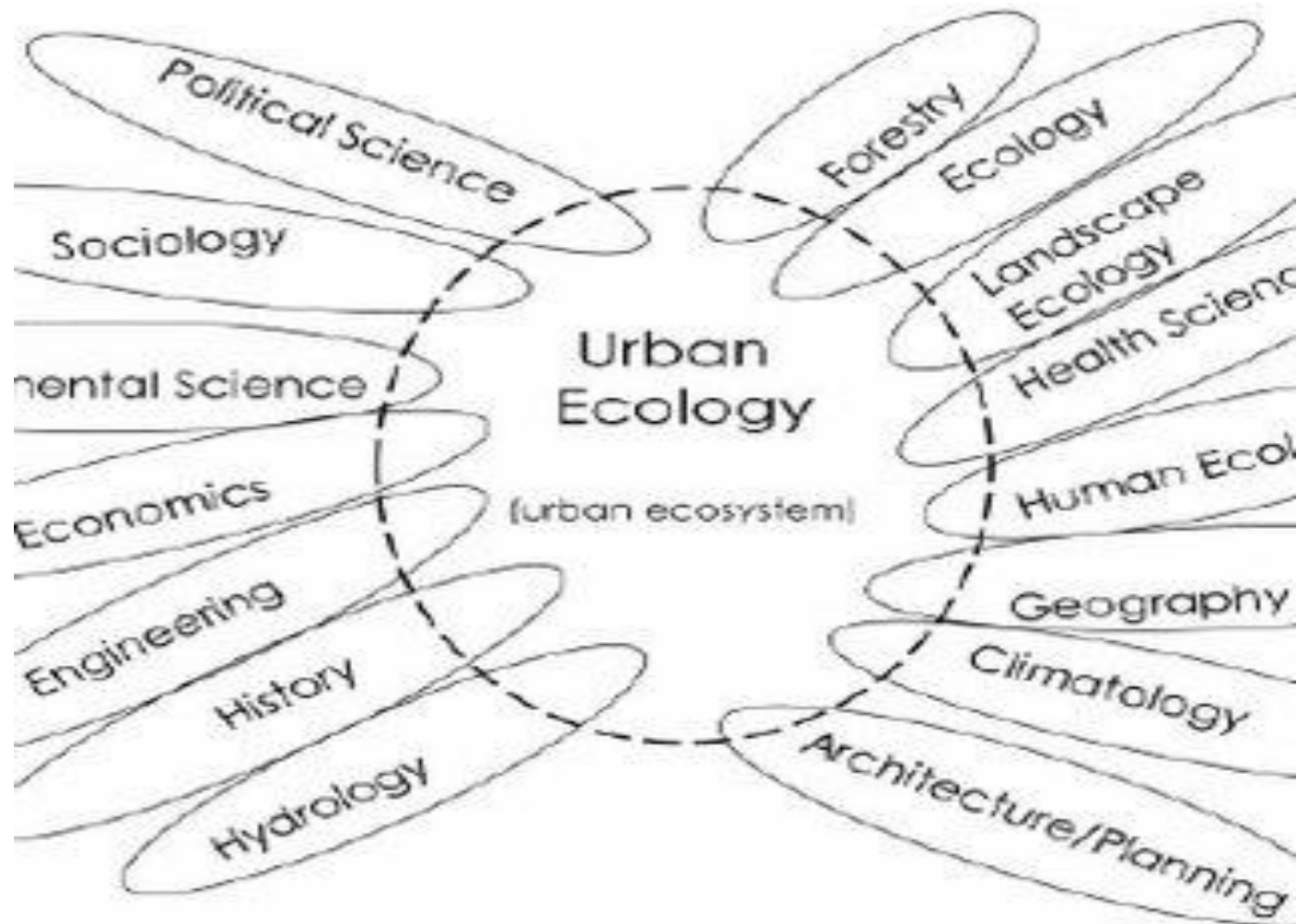


Urban ecology

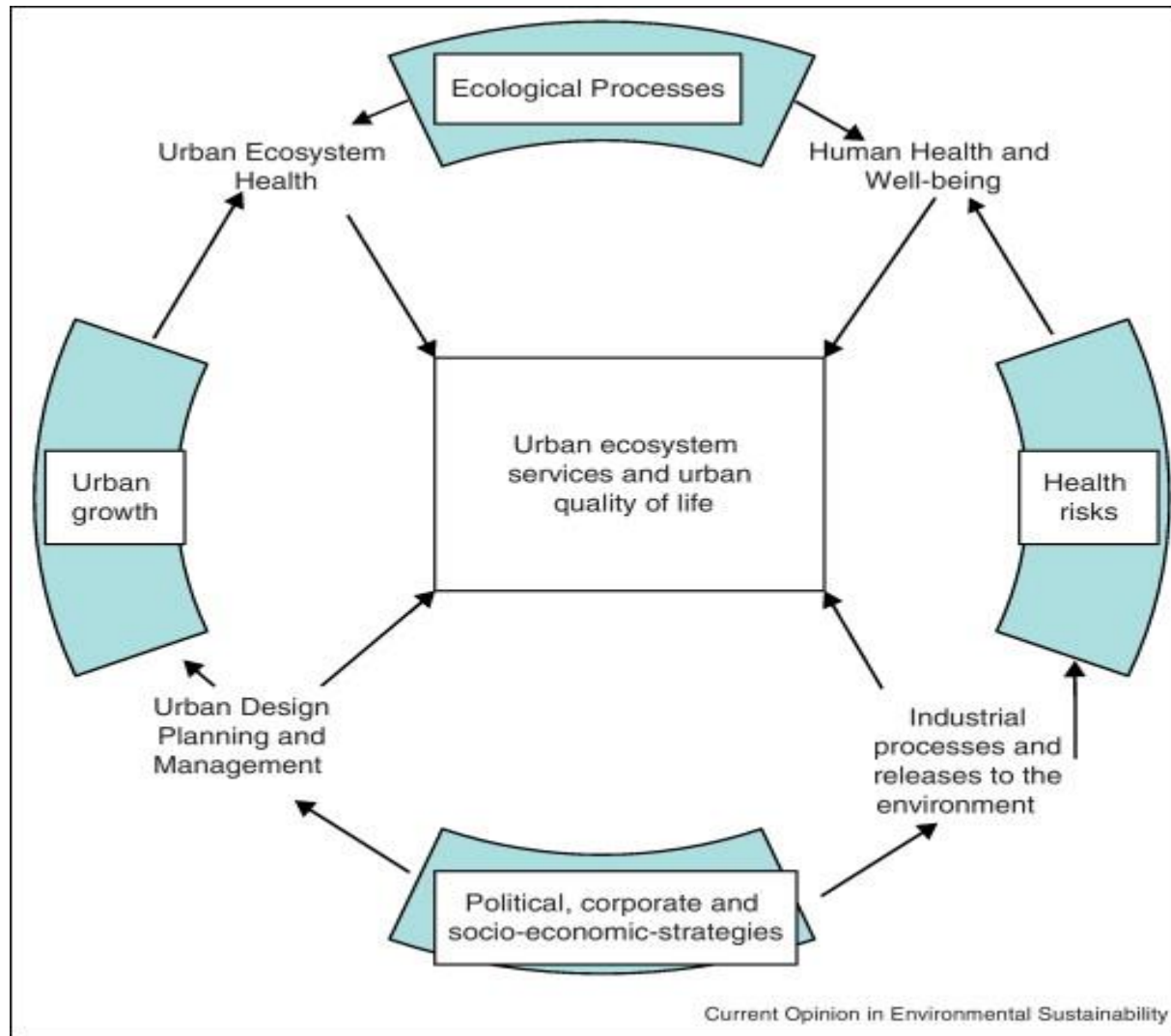
The unprecedented rates of urban population growth over the past century have occurred on <3% of the global terrestrial surface, yet the impact has been global, with 78% of carbon emissions, 60% of residential water use, and 76% of wood used for industrial purposes attributed to cities.

Land use change directly associated with building cities as well as supporting the demands of urban populations drives many other types of environmental change.

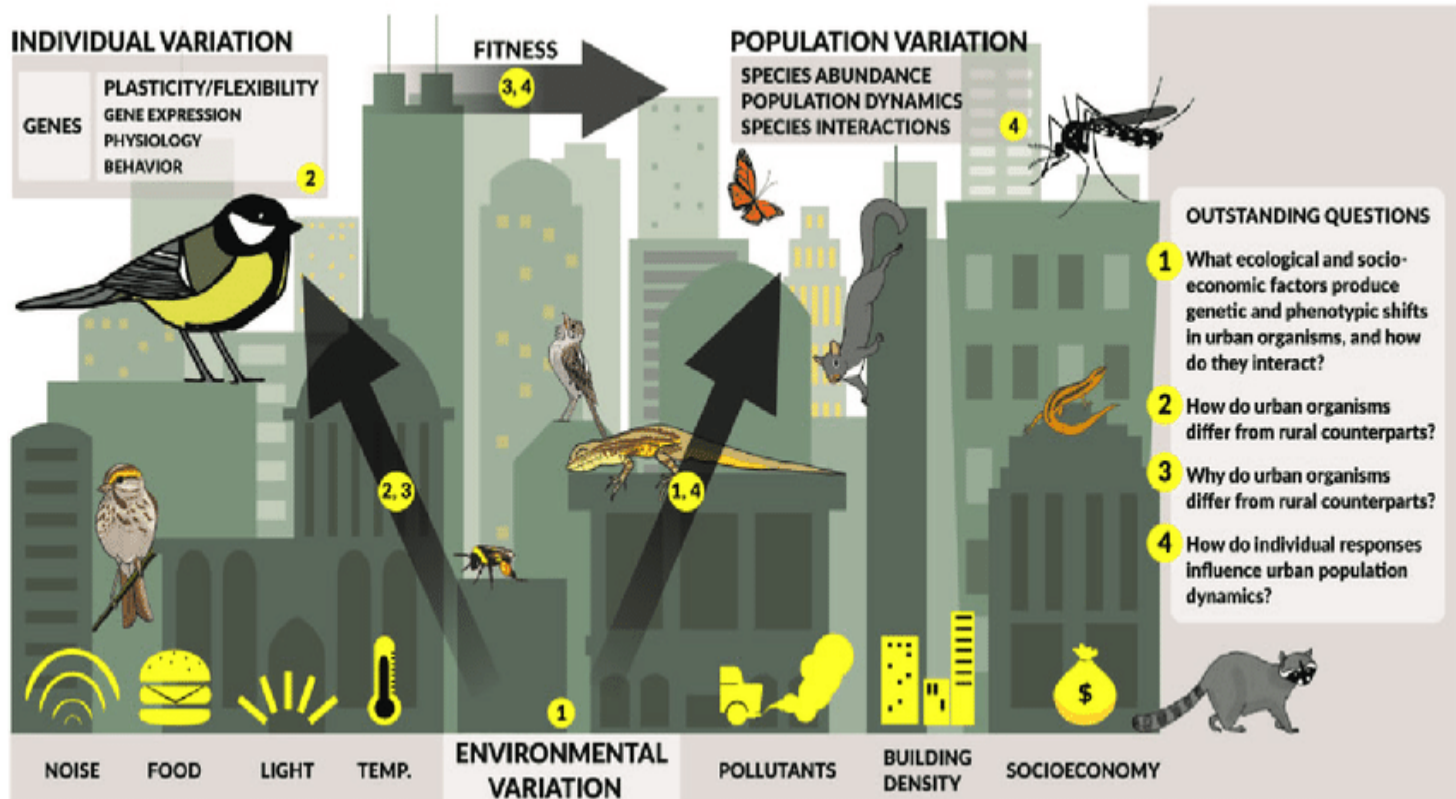
(Grimm et al., 2008)



Urban ecology



Urban ecology



Outstanding questions for urban ecology (1-4) in the context of environmental, individual, and population variation.

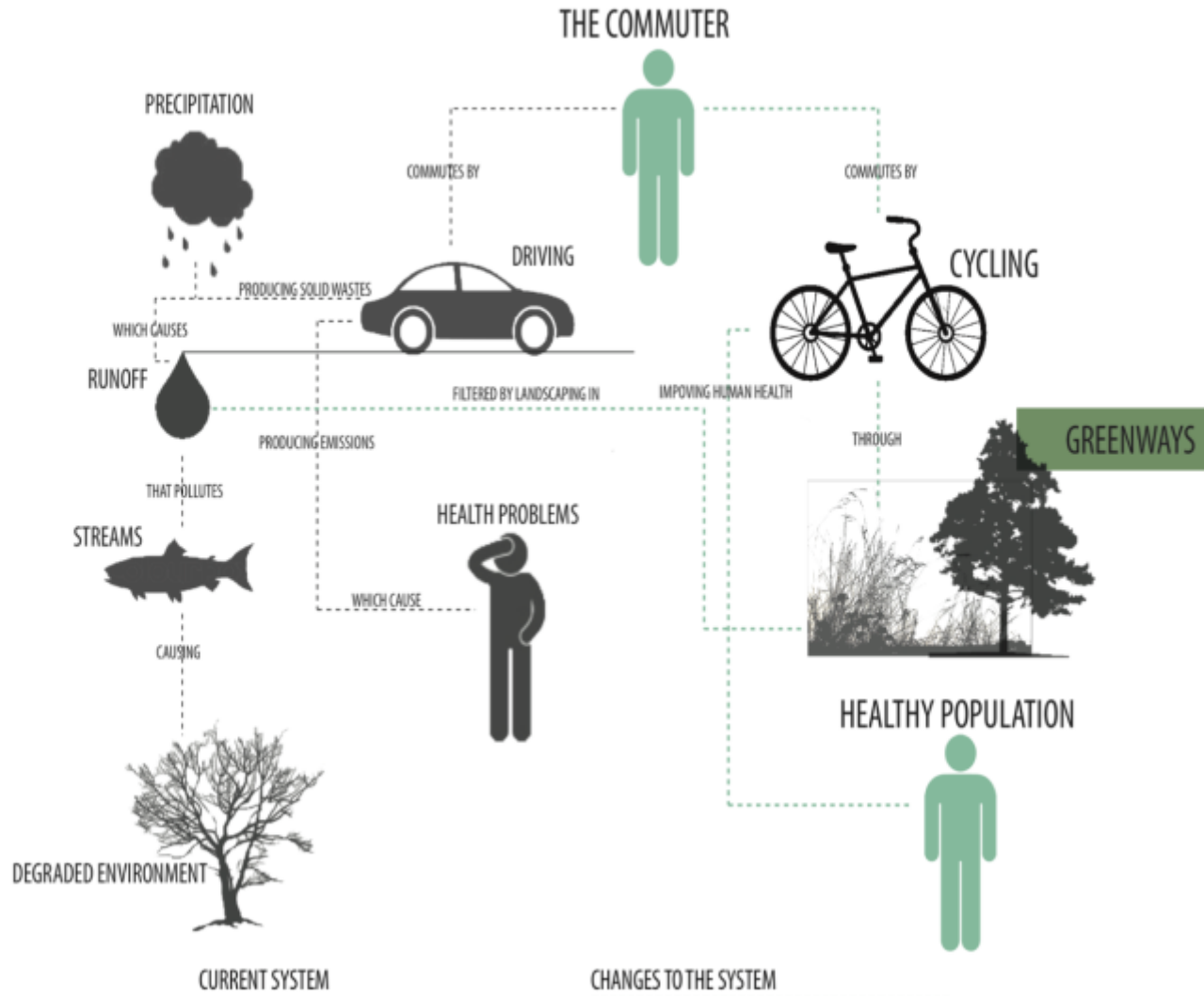
Some representative common animals found in cities around the globe are pictured.

Environmental variation can affect individual and population-level variation.

Individual variation affects individual fitness which then can lead to changes at the population-level.

THE COMMUTER

THIS DIAGRAM PRESENTS THE EFFECTS ON HUMAN HEALTH OF COMMUTING BY CAR VERSUS BIKE. THE LEFT SIDE DEPICTS THE NEGATIVE HEALTH EFFECTS OF DRIVING, WHICH DEGRADE HUMAN HEALTH. THE RIGHT SIDE OF THE DIAGRAM SHOWS HOW THE DESIGN PROPOSAL OF GREENWAYS CAN RESPOND TO THE NEGATIVE EFFECTS OF COMMUTING BY CAR TO CREATE A HEALTHIER POPULATION.



Urban ecology

For most of the 20th century, most ecologists ignored urban areas with the result that ecological knowledge contributed little to solving urban environmental problems.

Recently, however, ecologists have begun collaborating with other scientists, planners, and engineers to understand and even redesign urban ecosystems.

With the advent 10 years ago of National Science Foundation–funded urban research programs in the United States, urban ecology also has begun to change the discipline of ecology.

(Grimm et al., 2008)

Bring written answers to the following questions to class tomorrow.

1) The review of Gimme Green at the following link:

<http://www.gimmegreen.com/media%20articles/Newsleader.htm>

includes an interesting quote towards the end – “Some documentaries “fall on the preachy side (and) turn people off... Others antagonize and attempt to make people look foolish. That’s not my style at all”. **What do you think? Does the film avoid getting preachy? Does the film avoid antagonizing/making people look foolish?**

2) **Overall, do you think this review does a good job of capturing the essence of the film? Discuss your answer.**

3) **Spend a little time looking at the Gimme Green website <http://www.gimmegreen.com/> Describe a few interesting things you learned specifically from the website.**

4) Did you think the film was humorous? If so, comment on some of the more humorous moments in the film.

5) Do you know anyone who is obsessed with their lawn or at least is very committed to maintaining a nice looking lawn? If so, briefly discuss this person's relationship with their lawn and how you think they would respond if they watched the film Gimme Green. If not, describe how you think one of the specific people interviewed in the film would react to the film.

6) Considering the negative environmental impact of intensively managed lawns, do you think there should be public policies to discourage lawns or encourage alternatives to lawns?

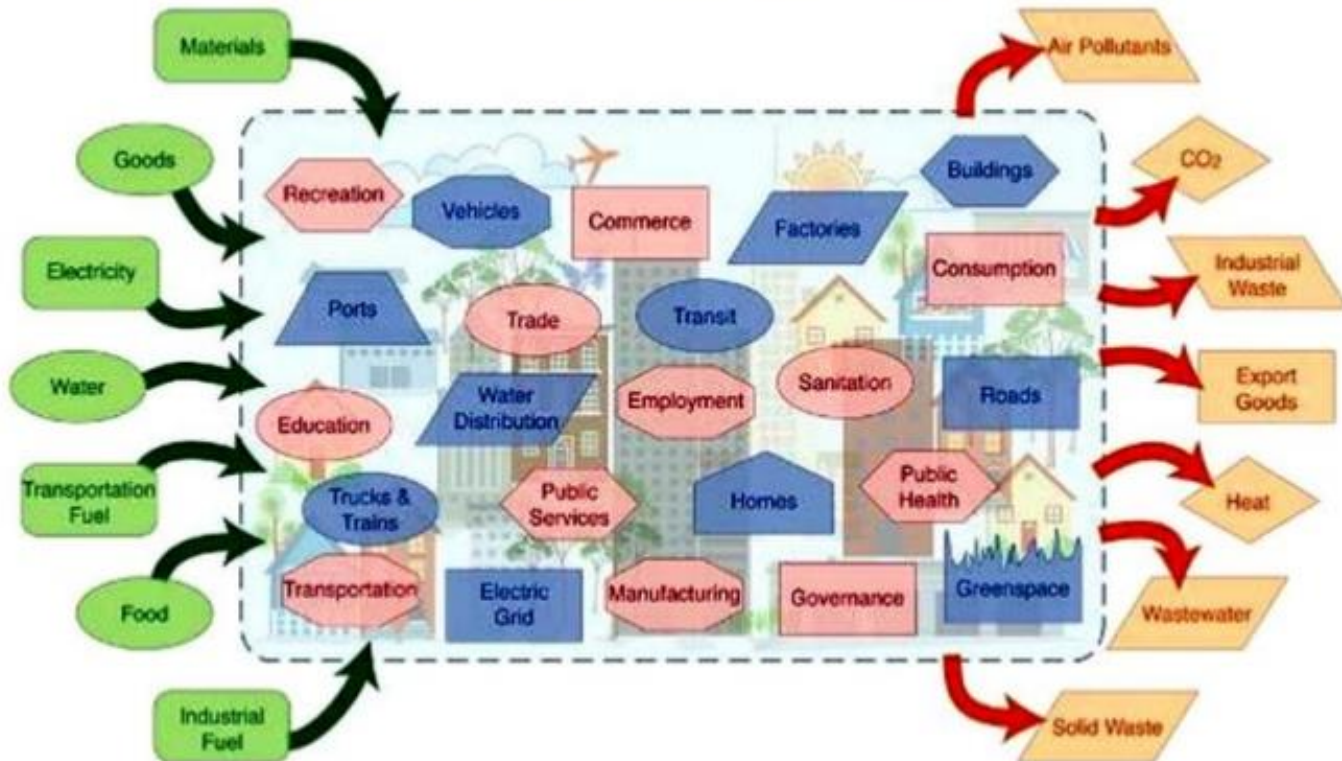
7) Has your perspective on lawns changed at all as a result of watching the film? Explain.

What is urban metabolism?

A key concept within the discipline of urban ecology is **urban metabolism** which compares the flows of energy and materials in and out of cities and the transformation and accumulation of energy and materials within cities to biological metabolism.

Some scientists debate the appropriateness of the metabolism analogy but interest in urban metabolism has led to informative analysis of long-term trends in the flow of energy, paper, plastics, metals and food stuffs in, out and within cities.

Urban Metabolism



Materials flow into cities and waste is emitted.

Paul Bunje 2010



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