Biodiversity in urban habitats:

diversity of organisms in interaction with one another and feedback on ecosystem functionning for its sustainability

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What is (are) biodiversity(ies)?

➔ the **variability** among living organisms from all sources
different scales : genes, cells, species, populations, communities
biodiversity includes all managed and unmanaged ecosystems (terrestrial, aquatic)

➔ Biodiversity is **functional**: *"Biodiversity forms the foundation of the vast array of ecosystem services that critically contribute to human well-being"* *(Greenfacts.org)*

My own definition: this is a high quantity of **organisms (visible and invisible) in interaction with one another** with :

- different **needs**,
- different **functions**,
- different **tolerance / adaptation** ability to the cocktail of human disturbances (especially in urban habitat: chemical pollution air soil water, climate, artificialization, fragmentation of habitat, soil compaction, noise and light pollution, exotic species introduction...)

Biodiversity is still **moving** through space and time (dispersion, different life cycles, population equilibrium, dynamics, evolutive relationships, ecological community succession..)

Urban habitats: complementary physical, chemical and biological approaches

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Let’s take the time to observe the city...

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Let's take the time to observe the city... as an ecosystem ... or several ecosystems in interaction thanks to corridors...

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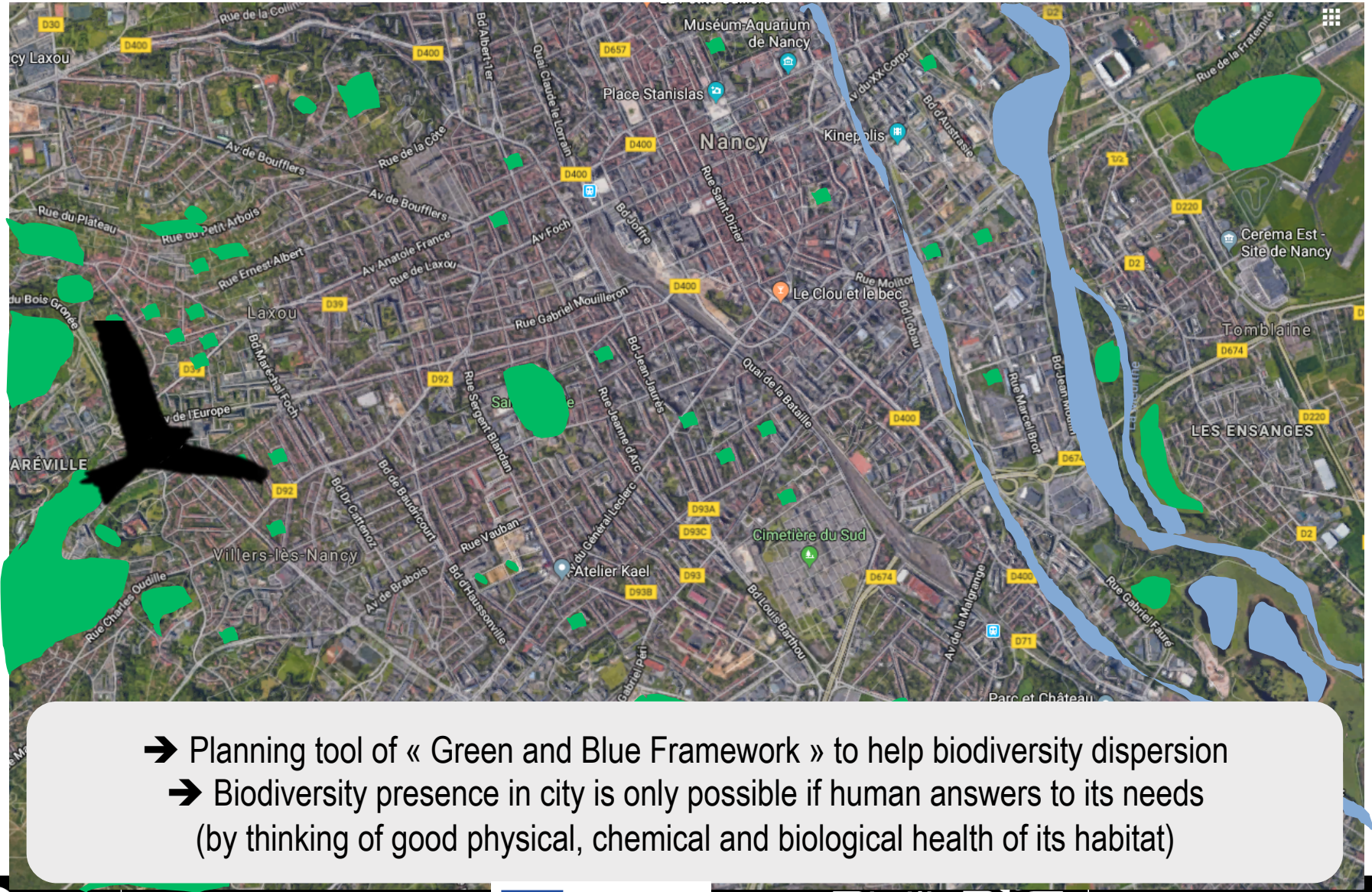

➔ Planning tool of « Green and Blue Framework » to help biodiversity dispersion
➔ Biodiversity presence in city is only possible if human answers to its needs (by thinking of good physical, chemical and biological health of its habitat)

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The living organisms

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What kind of biodiversity in city?

Mosses, lichen, micro-organisms (bacteria, fungi....)

Plants (decorative, crops, weeds, invasive...)

Animals (insects, rats, foxes, birds...)

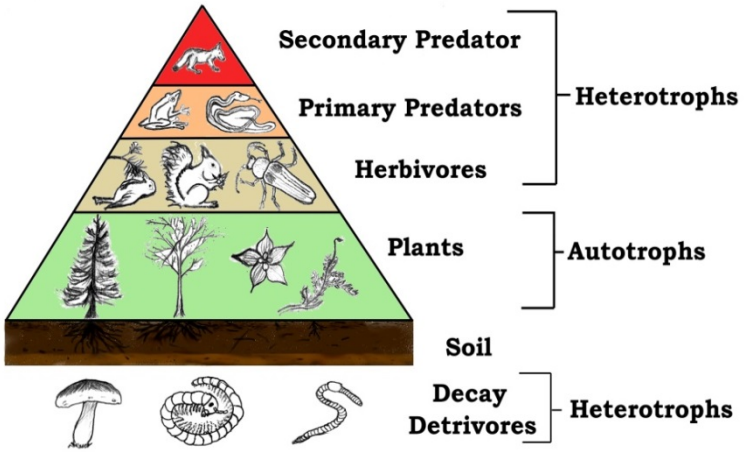
What does biodiversity need?

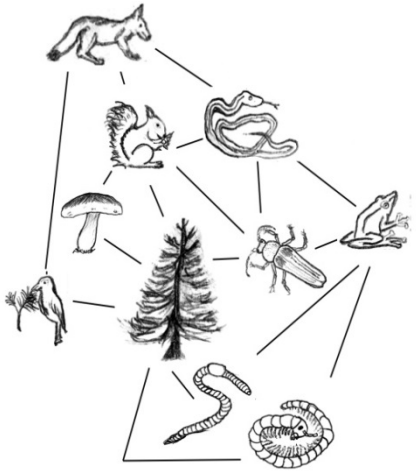
➔ Healthy habitat (good physical and chemical qualities)

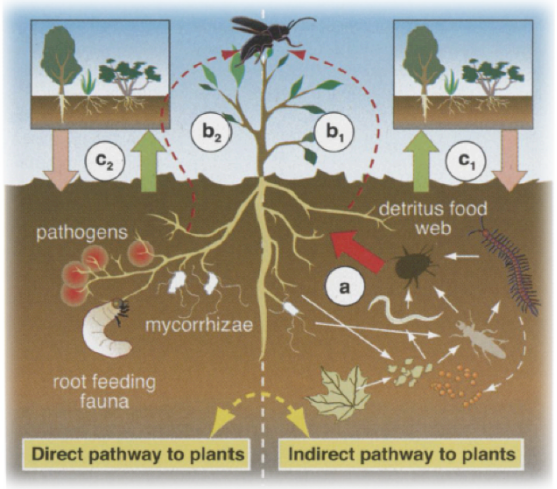
➔ Nutrition quality and quantity (nutrients, food, elements for photosynthesis and respiration)

➔ Movement (active & passive dispersion for finding resources, for reproduction and sustainability of life, avoiding predation and disturbance, long-term survival)

➔ Interaction with other organisms (trophic links, symbiosis, passive dispersion...)







Wardle et al. 2004

What does biodiversity need?

Examples of physico-chemical and biological needs of terrestrial biodiversity to grow, to survive...

niches (micro-ecosystems)

plant

animal

Temperature

sun

$C0_2$

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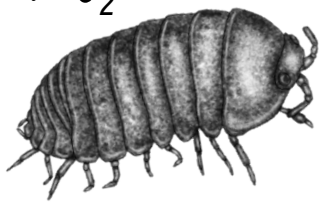
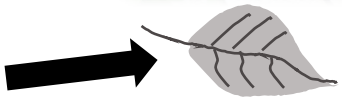
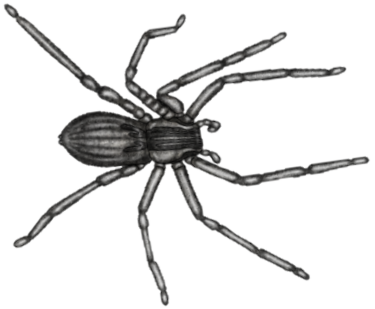
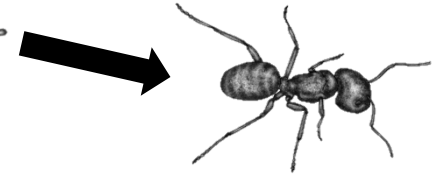




water





water

N, P, K, S, Ca, Mg.... from ***soil***

Low concentration of pollutant, good pH
Uncompacted soil / deep soil...

Interaction with micro-organisms (...like us) and other organisms

The needs of biodiversity are not identical from one species to another

Adaptation ability of biodiversity: examples for city

Rapid evolution of seed dispersal in an urban environment in the weed *Crepis sancta*

dispersing seeds

non-dispersing seeds

« In urban patches, dispersing seeds have a 55% lower chance of settling in their patch compared with nondispersing seeds and, thus, fall on a concrete matrix unsuitable for germination.

The study shows that a high cost of dispersal after recent urban fragmentation causes rapid evolution toward lower dispersal »
Evolution in 5 to 12 generations

Cheptou *et al.*, 2008

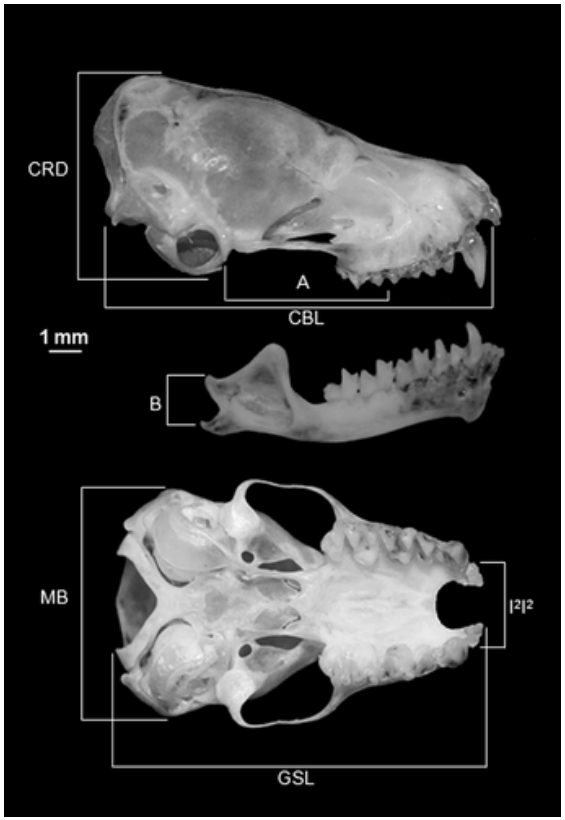
https://www.pnas.org/content/105/10/3796#T1

Adaptation ability of biodiversity: examples for city

Cranial size of a common bat (*Pipistrellus kuhlii*) had changed between 1875 and 2007 in Italian urban zones (climate change and urbanization effect)

➔energetic benefits provided b od concentration at street lamps, w roosts in buildings) will lead to a e increase in *P. kuhlii*

➔ because street lamps impair moth antipredatory manoeuvres, cranial size may have selectively increased as an adaptive response to handle larger prey (moths) in artificially illuminated sites



+ 0.6% to 2.9% of cranial bones size

Tomassini *et al*., 2013
doi:10.1111/jbi.12248

Adaptation ability of biodiversity: examples for city

Micro-climatic urban-heat-island effects on animal body size

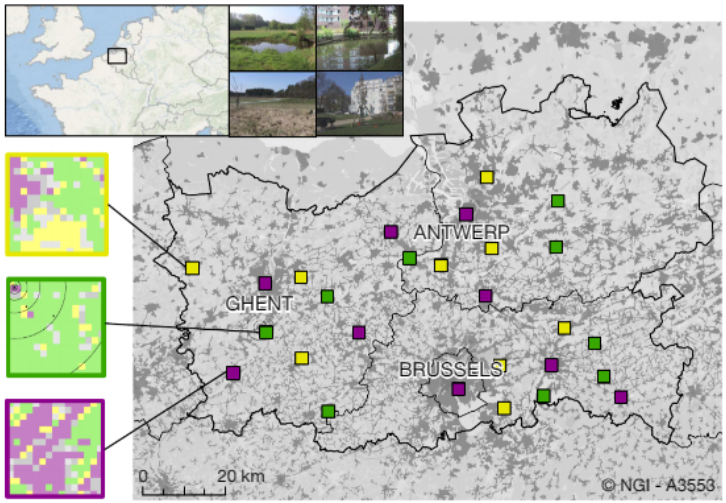
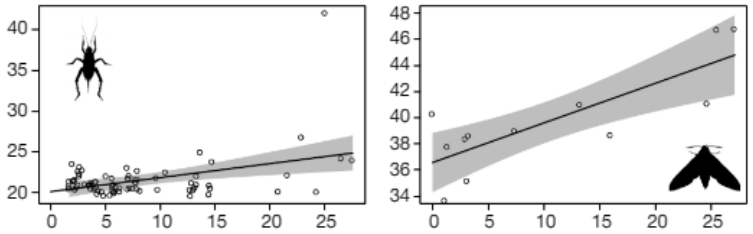
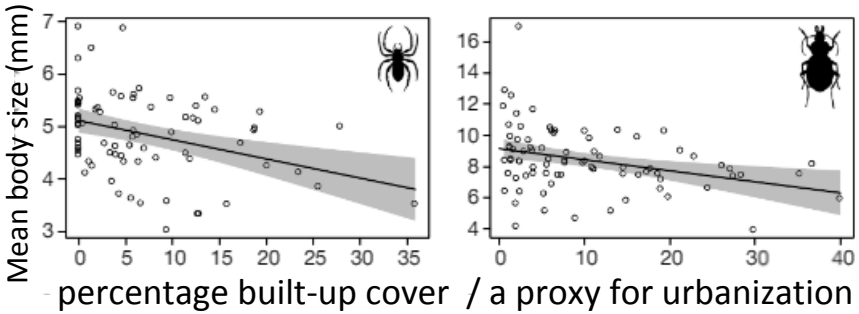


Fig. 1 | Map of the study area. The configuration of 27 landscape-scale sampling plots (nine urban, magenta; nine semi-urban, yellow; nine non-urban, green) on an urbanization background (light and dark corresponds to non-urban and urban gradient, respectively). Solid





Urban-heat-island effect and urban habitat fragmentation are associated with contrasting community-level shifts in body size that critically depend on the association between body size and dispersal. Because body size determines the structure and dynamics of ecological networks , such shifts may affect urban ecosystem function

Merckx *et al.*, 2018

doi.org/10.1038/s41586-018-0140-0

Adaptation ability of biodiversity: examples for city

Urbanization effect on *Parus major* body size

Urban birds had significantly smaller morphological features than their rural counterparts, with a shorter tarsus, lower body mass, and smaller wing and tail lengths relative to their overall body size.

Differences in food resource availability could advance the phenology of urban birds

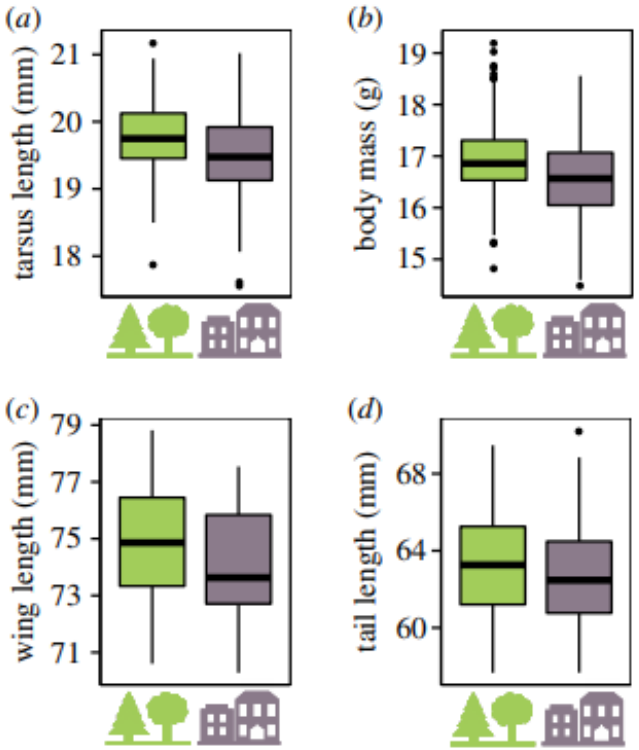


Figure 1. Morphological divergence between forest (green) and urban (purple) great tits for (*a*) tarsus length, (*b*) body mass, (*c*) wing length and (*d*) tail length. Boxplots of predicted data from the best linear mixed models, representing minimum, first quartile, median, third quartile, maximum and outliers (points).

Merckx *et al*., 2018

doi.org/10.1038/s41586-018-0140-0

Functional approaches

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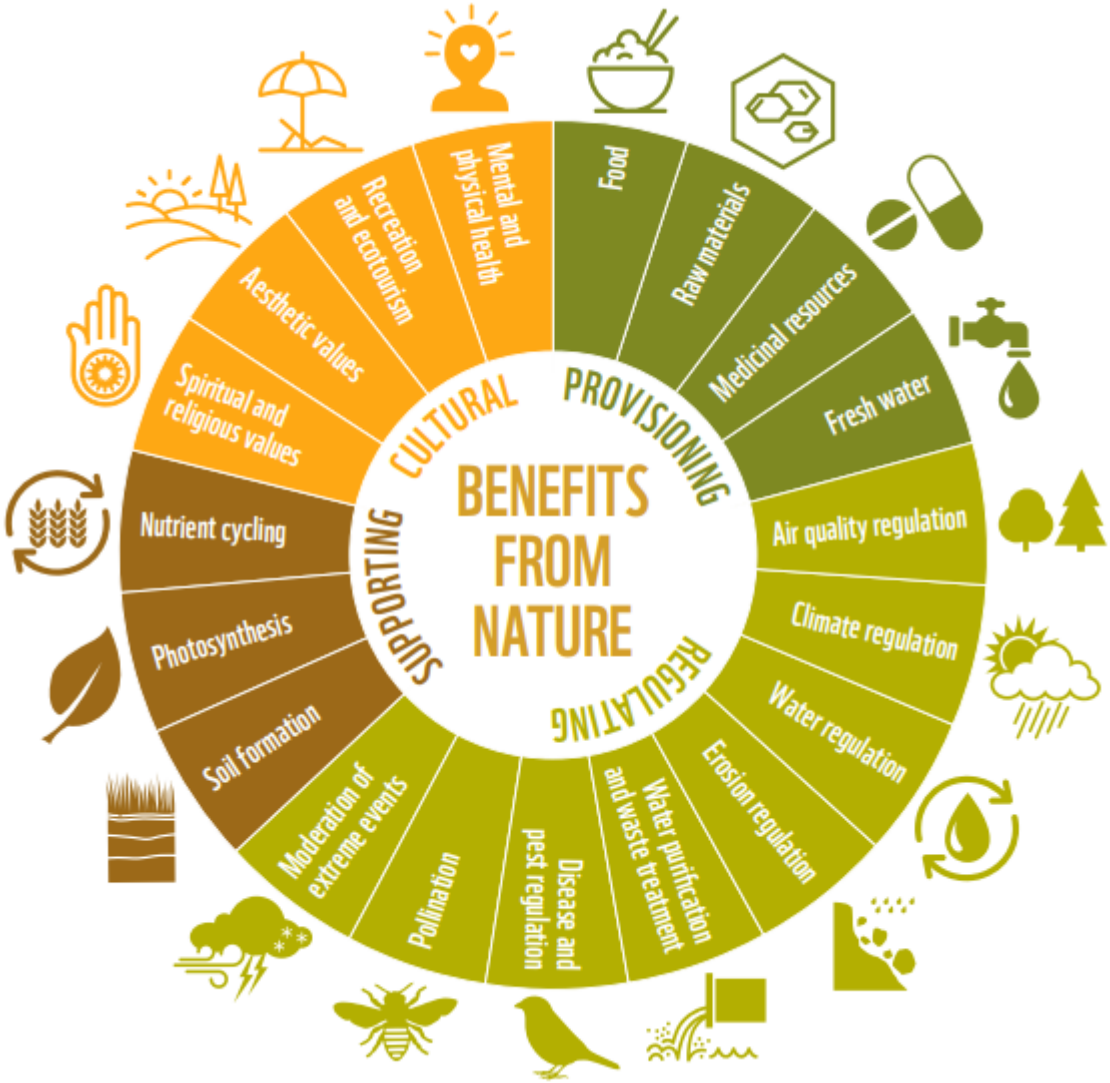
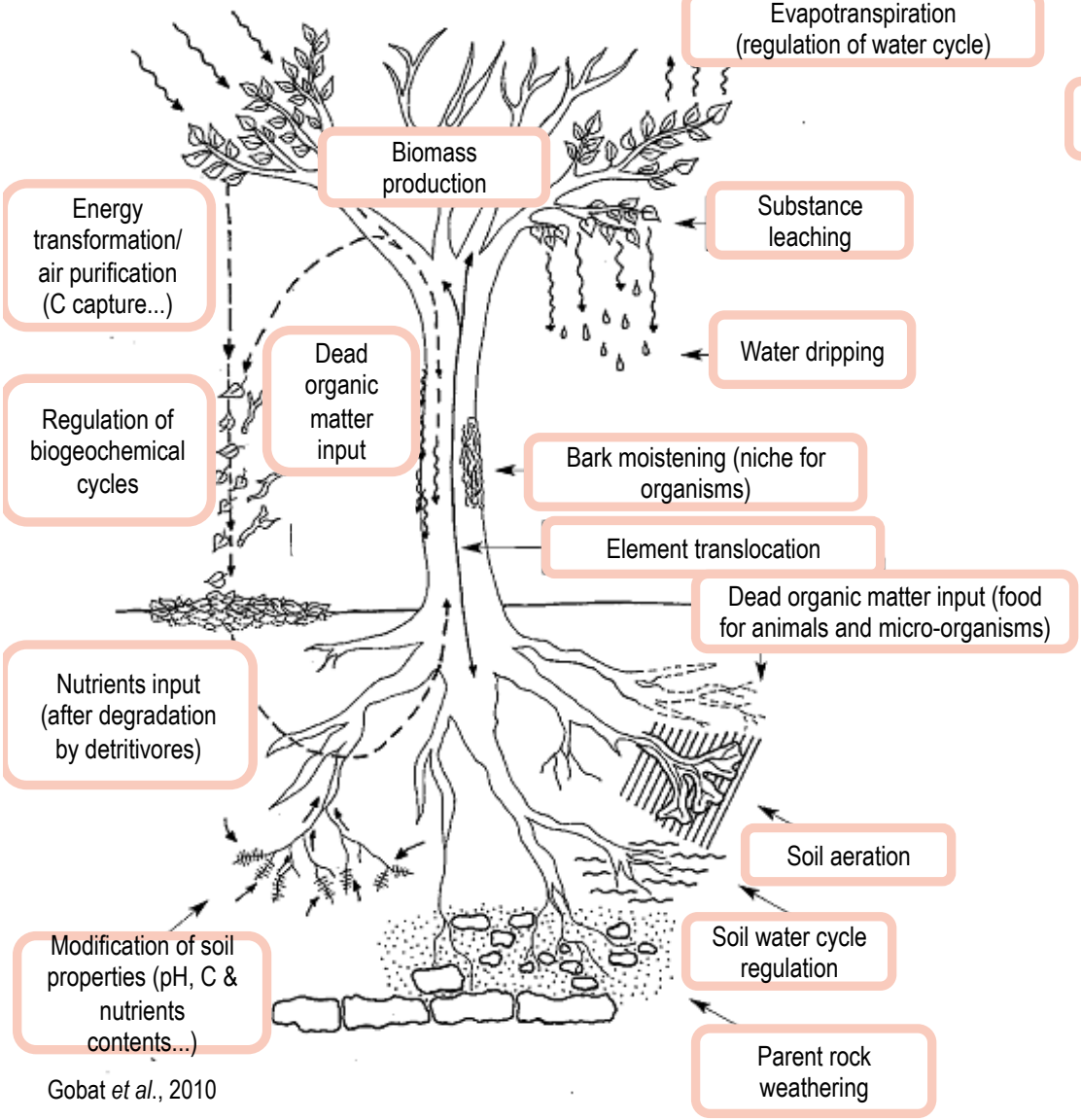
What are the roles/services provided by biodiversity?



WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland

What are the roles of biodiversity?



Gobat *et al.*, 2010

Shadow

Barrier against wind

Support for bird nests...

Example for a plant and its direct and indirect functions – benefits on ecosystem and human

Fruits /wood

Dead organic matter for gardeners

A potential disservice : the pollen

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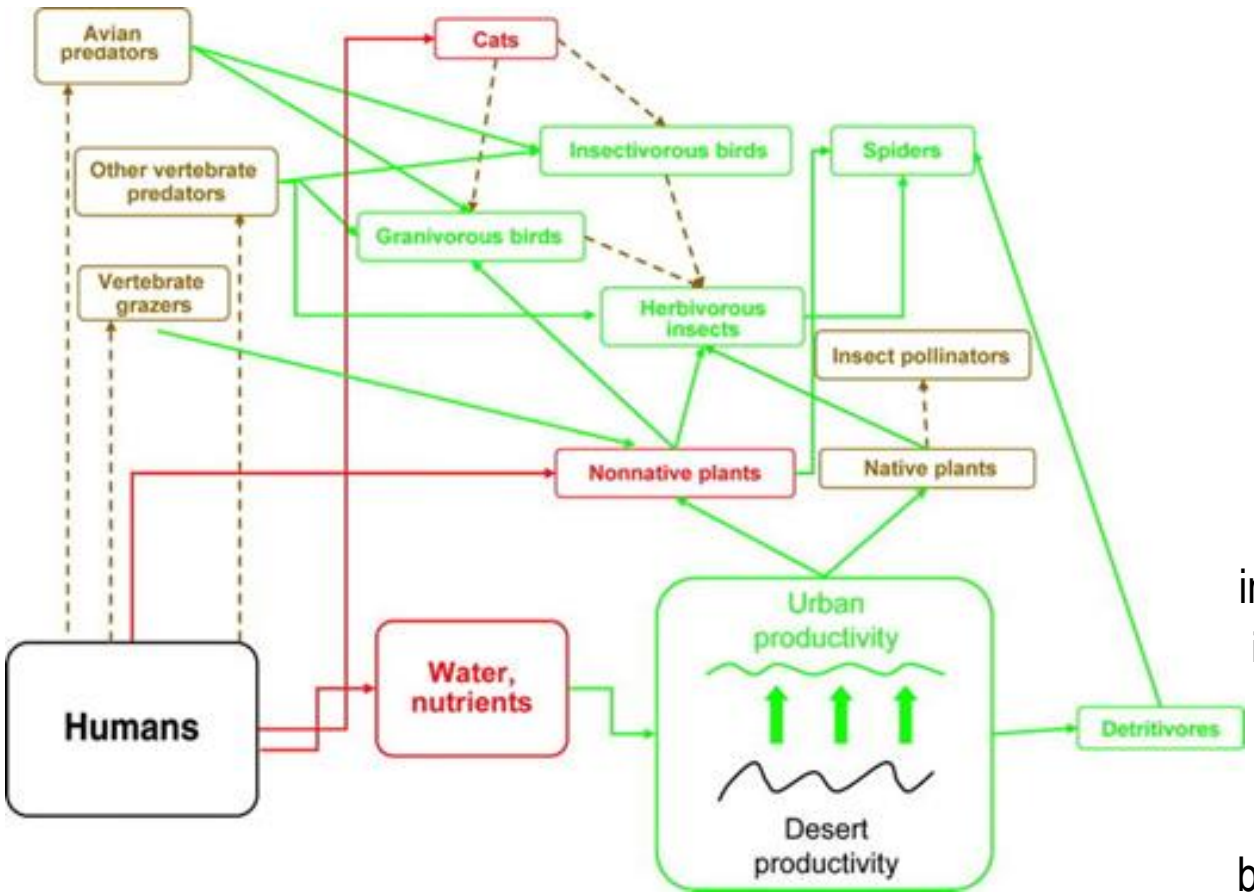
Trophic dynamic in urban communities



Faeth *et al*., 2005

https://academic.oup.com/bioscience/article/55/5/399/225953

The food web in the Phoenix, Arizona, metropolitan area.

Human activity has directly increased available resources, particularly water (shown in red), which has increased and stabilized productivity.

This human activity, coupled with other direct effects, such as the introduction of domestic cats (shown in red), and indirect effects, such as the reduction of other vertebrate predators (shown in brown), has increased the abundance of some biotic groups either directly (red solid arrows) or indirectly (green solid arrows), while decreasing others (brown dashed arrows)

Green technologies need functional ecosystems

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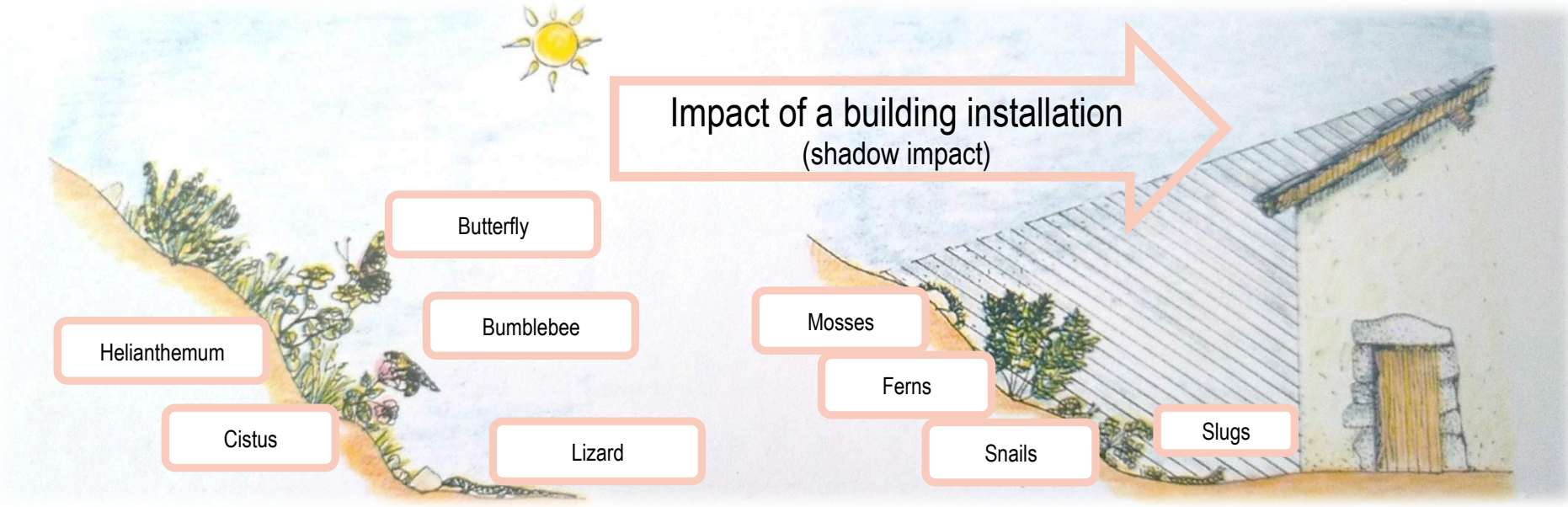
What is a sustainable project?

➔Be aware (a priori) to each **impact** of installation of green technologies on the ecosystem and its biodiversity (make accomodations and before-after tests if necessary)

➔Knowledge of the **complexity** of nature / integration of this complexity in design.



What is a sustainable project?

➔Feel free to **enhance the services** that biodiversity provides, introduce « interesting » biodiversity in technologies, answer to its needs (example: green roof: think about soil invertebrates to enhance the biomass recycling instead of human maintenance: reduction in economical costs)

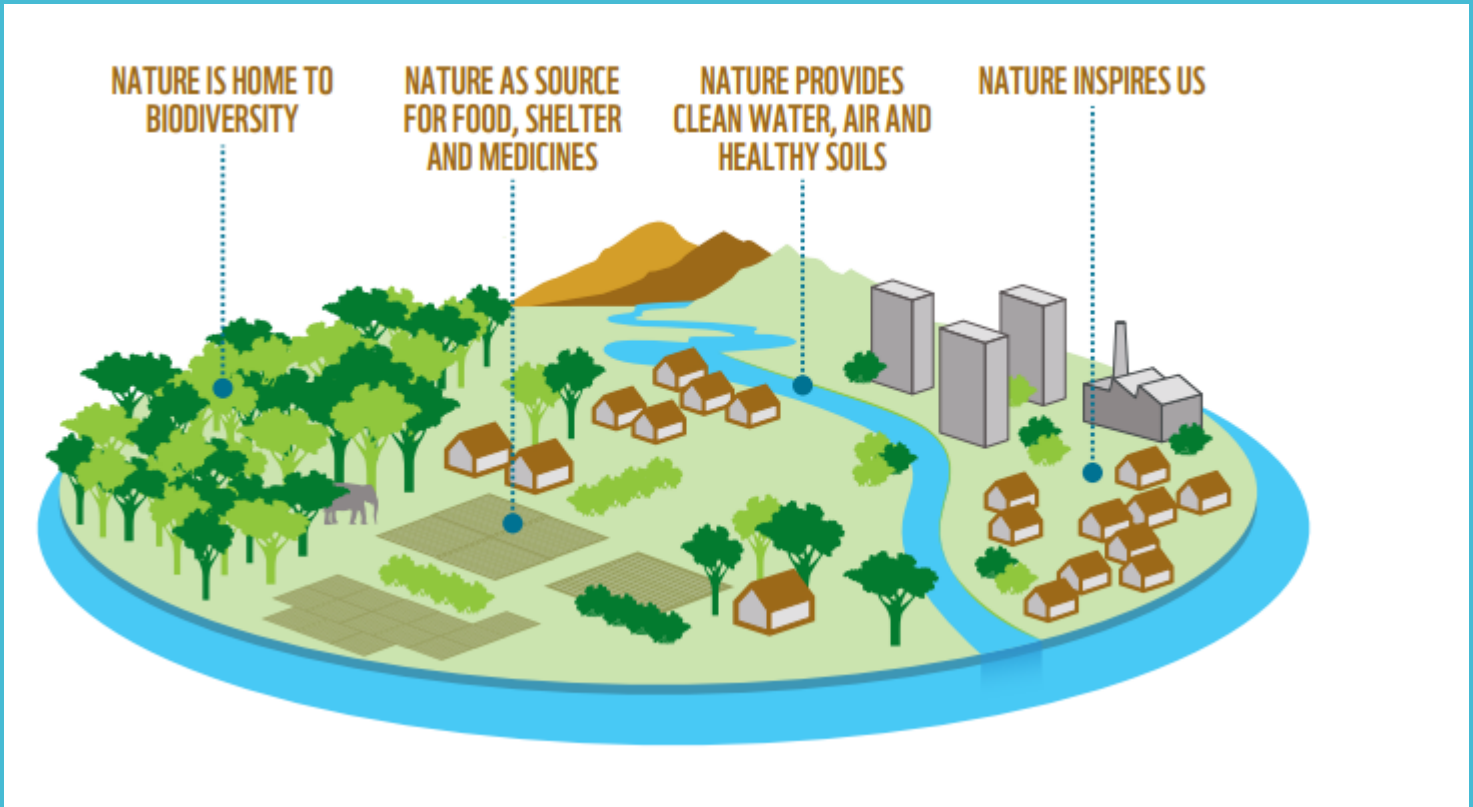
➔Be aware about the **evolution** of the biodiversity, perhaps one day you will have a « new service » provides by a « new species » which colonized your (eco)system. Create a long-term suitable healthy habitat

➔Take the time to **observe** the state of the ecosystem, and use your knowledge from natural ecosystem to create sustainable (eco)system

➔Think about **corridors** through the city to help colonization by different species and help interactions between species and then, sustainability (territorial level) / one system in one part of the city has to be thought in relation with others

➔Do not forget that **human** is part of biodiversity and is living in the urban ecosystem... Take care of it!

Thanks for your attention



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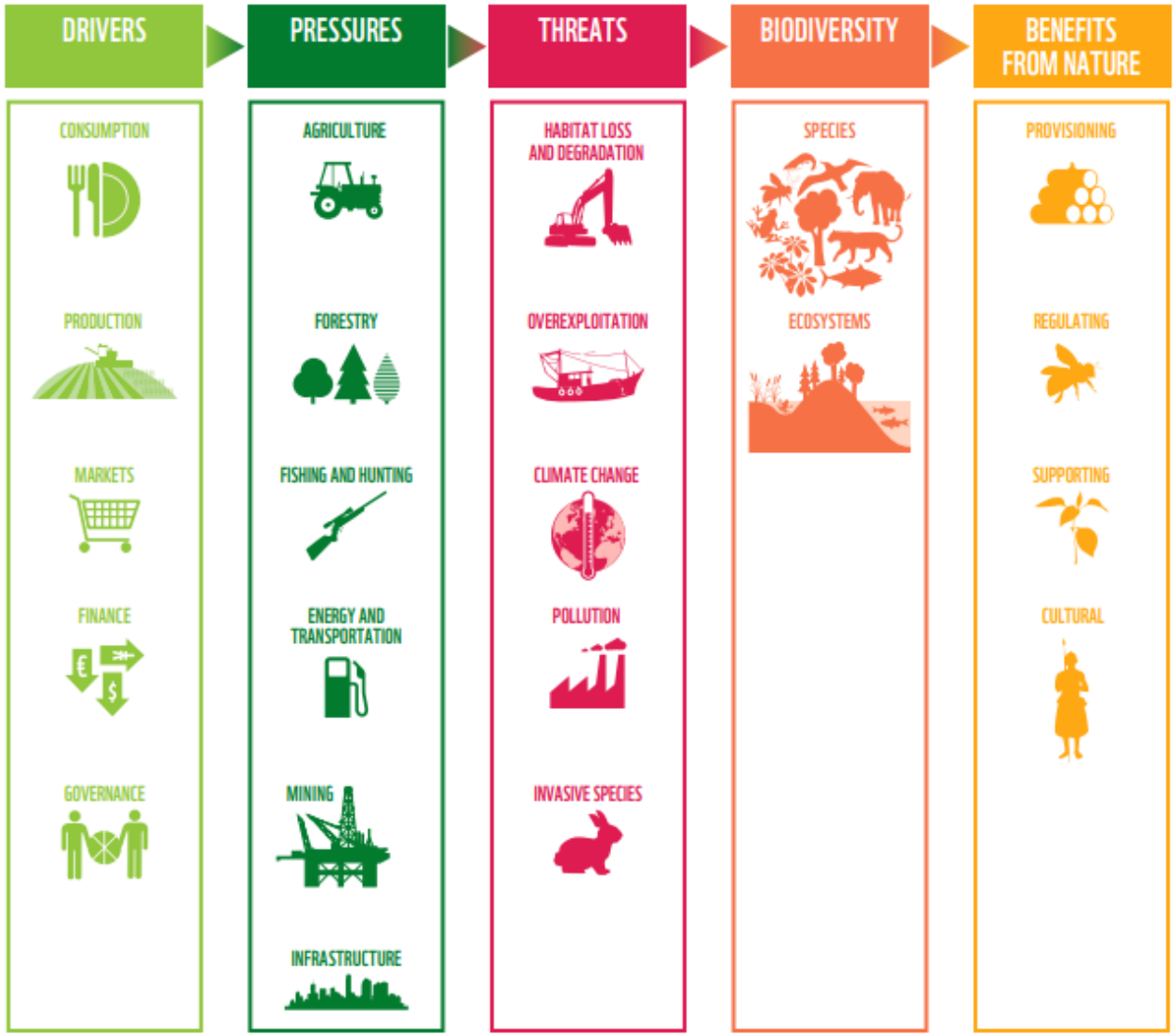
WWF. 2018. Living Planet Report - 2018

Additional slide



WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland

Additional slide

WHY BIODIVERSITY MATTERS

- Our health, food and security depend on biodiversity. From medical treatments to food production, biodiversity is critical to society and people's well-being.
- All our economic activity ultimately depends on nature. It's estimated that, globally, nature provides services worth around US$125 trillion a year.
- Stable planetary systems have enabled modern human society to develop. Without healthy natural systems researchers are asking whether continuing human development is possible.

THREATS AND PRESSURES

- Overexploitation and agricultural activity, driven by our runaway consumption, are still the dominant causes of current species loss.
- Land degradation seriously impacts 75% of terrestrial ecosystems, reducing the welfare of more than 3 billion people, with huge economic costs.
- Bees, other pollinators and our soils – critical for global food security – are under increasing threat.
- Overfishing and plastic pollution are threatening our oceans, while pollution, habitat fragmentation and destruction have led to catastrophic declines in freshwater biodiversity.
- New technologies and big data are helping us to understand and measure these threats and their specific impacts.

BIODIVERSITY IN A CHANGING WORLD

- The Living Planet Index has recorded an overall decline of 60% in species population sizes between 1970 and 2014.
- The Living Planet Index shows species population declines are especially pronounced in the tropics, with South and Central America suffering an 89% loss compared to 1970.
- A Freshwater Living Planet Index shows an 83% decline since 1970.

WWF. 2018. Living Planet Report - 2018: Aiming Higher. Grooten, M. and Almond, R.E.A.(Eds). WWF, Gland, Switzerland

Additional slide: biodiversity and disservices in urban area

BOX 1. Examples of ecosystem disservices in urban areas.

Aesthetic issues

- Areas that are not intensively managed are often considered unpleasant and ugly (e.g. parks with weeds and dense vegetation, brownfield and wasteland).
- Certain sounds, smells and behavior of plants and animals can irritate people. Especially bird and dog excrements are considered as aesthetic and hygiene problem.
- Many species, such as foxes or birds searching food from trash bins can litter the environment.

Safety issues

- Areas with poor management but high biodiversity are often felt unsafe, especially in night-time.
- Wild or semi-wild animals like bats, rats, foxes or deer in larger park areas can cause fear, anxiety and inconvenience.

Security and health issues

- Plants can cause allergic reactions or intoxication. E.g. high concentrations of Mugwort (*Artemisia vulgaris*) pollen cause severe health problems for people with respiratory conditions such as asthma.
- Certain animal species can be vectors of diseases (e.g. avian influenza, rabies).

Economic issues

- Maintaining green areas prevents more profitable use, e.g. for construction.
- Market based direct gains from rich biodiversity often do not exist or they are allocated to other times or places.
- Damage to structures can be caused e.g. by decomposition of construction wood by microbial activity, bird excrements accelerating corrosion, tree roots damaging pavements, or animals digging nesting holes.
- Costs are caused by attempts to remove unwanted species (e.g. weeds, birds nesting in wrong places, invasive species). Presence of protected species can restrict other uses of the area.
- Planting, maintaining and removing plant coverage creates substantial costs. Harmful species can damage those species that are cared for and thus cause economic loss (e.g. animals eating plantations, pests, fungi).

Mobility issues

- Large green or blue areas can obstruct fast and comfortable transportation and moving, especially the use of motorized transportation.
- While trees along streets and roads may increase traffic safety because they make car drivers slow down, plants growing near traffic areas can decrease visibility and increase the risk for traffic accidents. Leaves falling from trees can increase the breaking distances of cars and trams.

Lyytimäki et al., 2008