

Bio-Regenerative Building Design

(Indoor Ecosystem Services contribution to SDGs)

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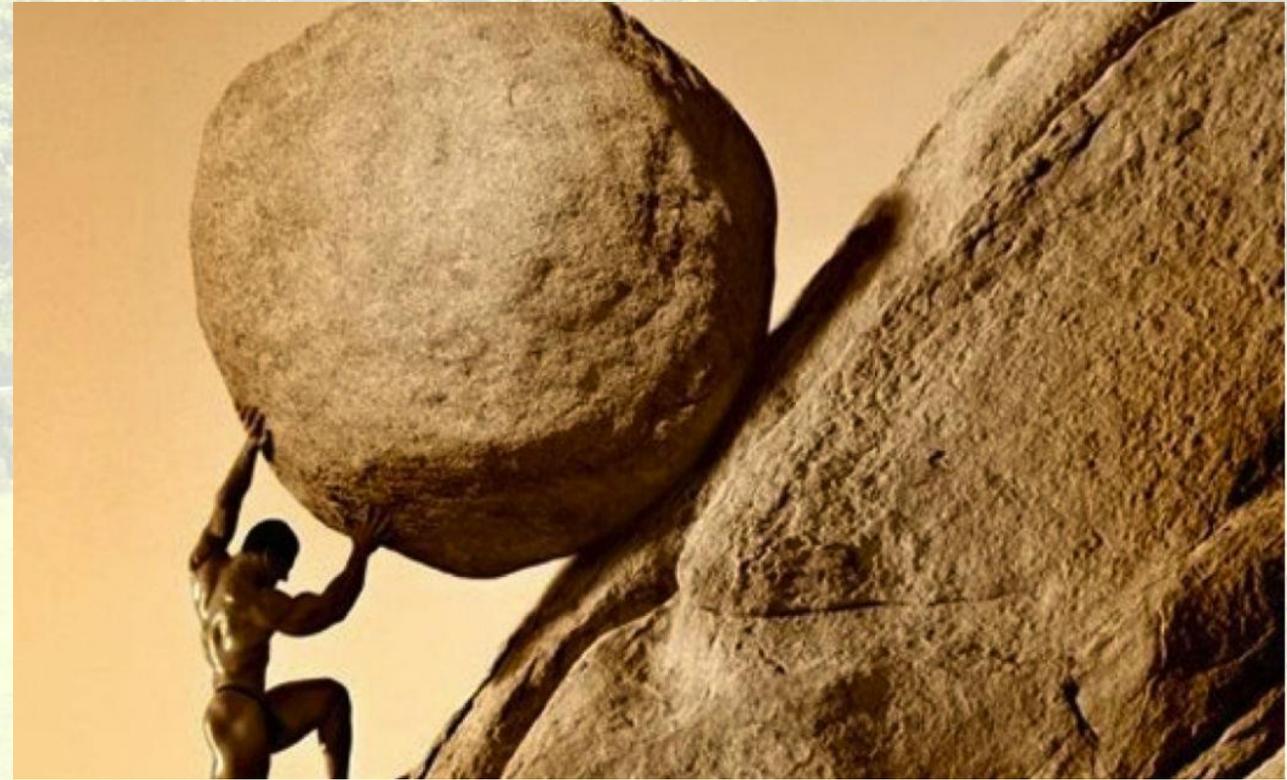


HUMBER

Faculty of Applied Sciences & Technology

Global Challenges Facing Humanity

1. Climate Change
2. Natural Resource Depletion
3. Health Risk
4. Social Inequality

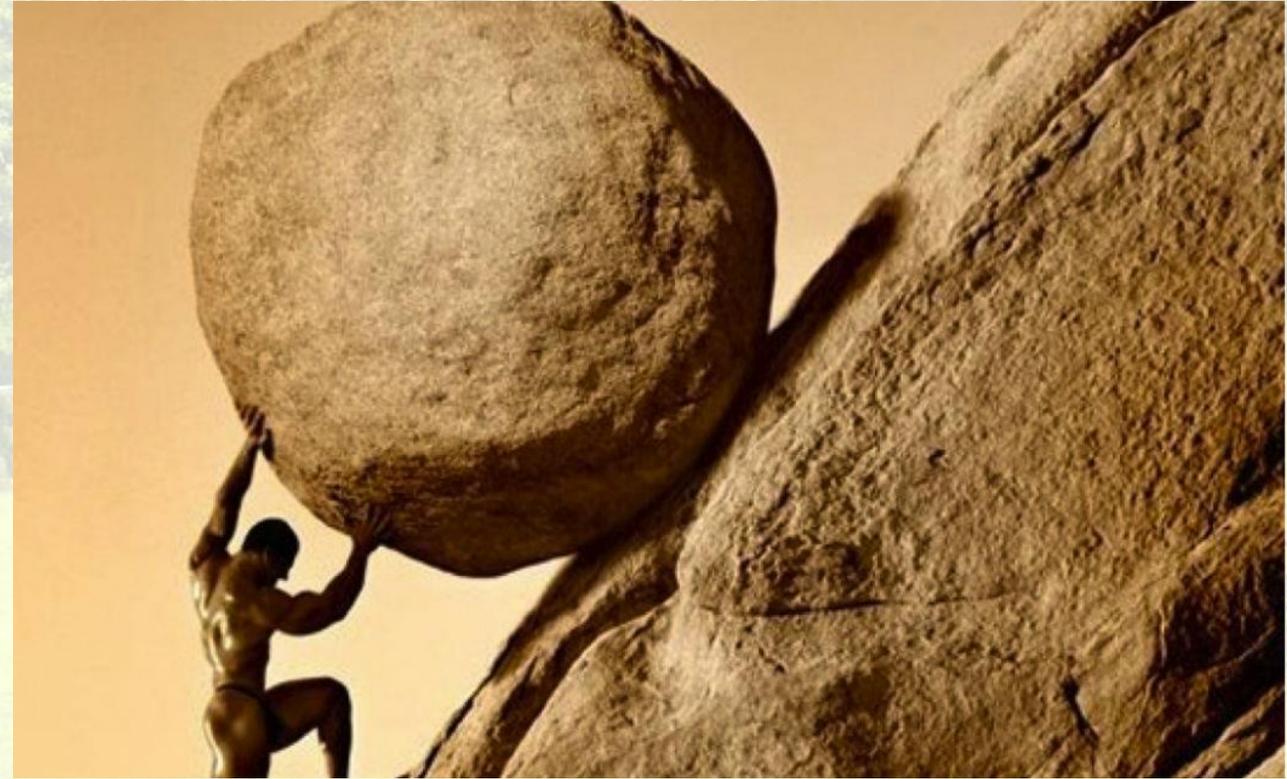


<https://climate.nasa.gov/solutions/adaptation-mitigation/>

Global Challenges Facing Humanity

To mitigate these global challenges, the build environment shall:

1. reduce carbon footprint
2. minimize resources consumption
3. be conducive to occupants health
4. contribute to the SDGs



<https://climate.nasa.gov/solutions/adaptation-mitigation/>



Millennium Ecosystem Assessment

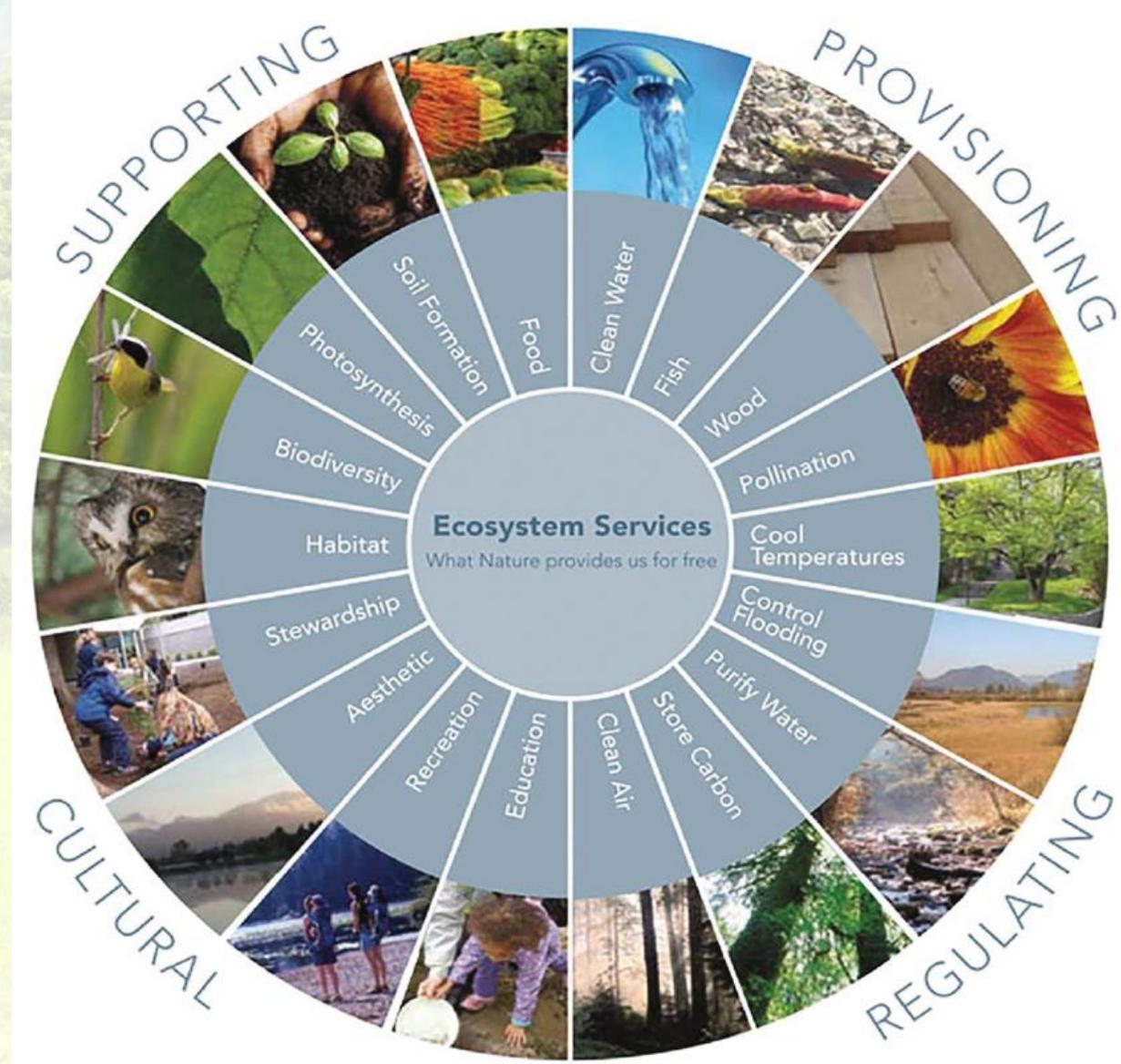
Millennium Ecosystem Assessment

Commissioned by the United Nations Secretary –
General in 2000, and completed in 2005.

www.millenniumassessment.org | Strengthening Capacity to Manage Ecosystems Sustainably for Human Well-Being

UN Millennium Ecosystem Assessment

- The objective was to assess the consequences of ecosystem change to human well-being.
- The findings provide a scientific basis for action needed to enhance the restoration, conservation, and sustainable use of those ecosystems and their contribution to human well-being.



Ecosystem Services

- Ecosystem services are the many and varied benefits to humans provided by the natural environment and healthy ecosystems.

Provisioning	Regulating	Cultural
<p>Products humans obtain from ecosystems:</p> <ul style="list-style-type: none">• Food• Raw Materials e.g. wood, fuel, fibre• Medicine• Fresh Water	<p>Services nature provides that regulate the environment:</p> <ul style="list-style-type: none">• Air Quality• Climate• Water Purification• Waste Treatment• Disease and Pest Control• Pollination• Extreme Events Moderation	<p>Non-material benefits of nature for humans:</p> <ul style="list-style-type: none">• Recreation e.g. tourism• Aesthetic Values• Religious and Spiritual Values• Mental and Physical Health• Education
Supporting		
<p>The underpinning services that enable all other services to function – encompasses both human and ecosystem needs:</p> <ul style="list-style-type: none">• Photosynthesis• Nutrient Cycling• Soil Formation		

Source: <https://www.greenelement.co.uk/blog/ecosystem-services-the-fundamentals-part-i/>

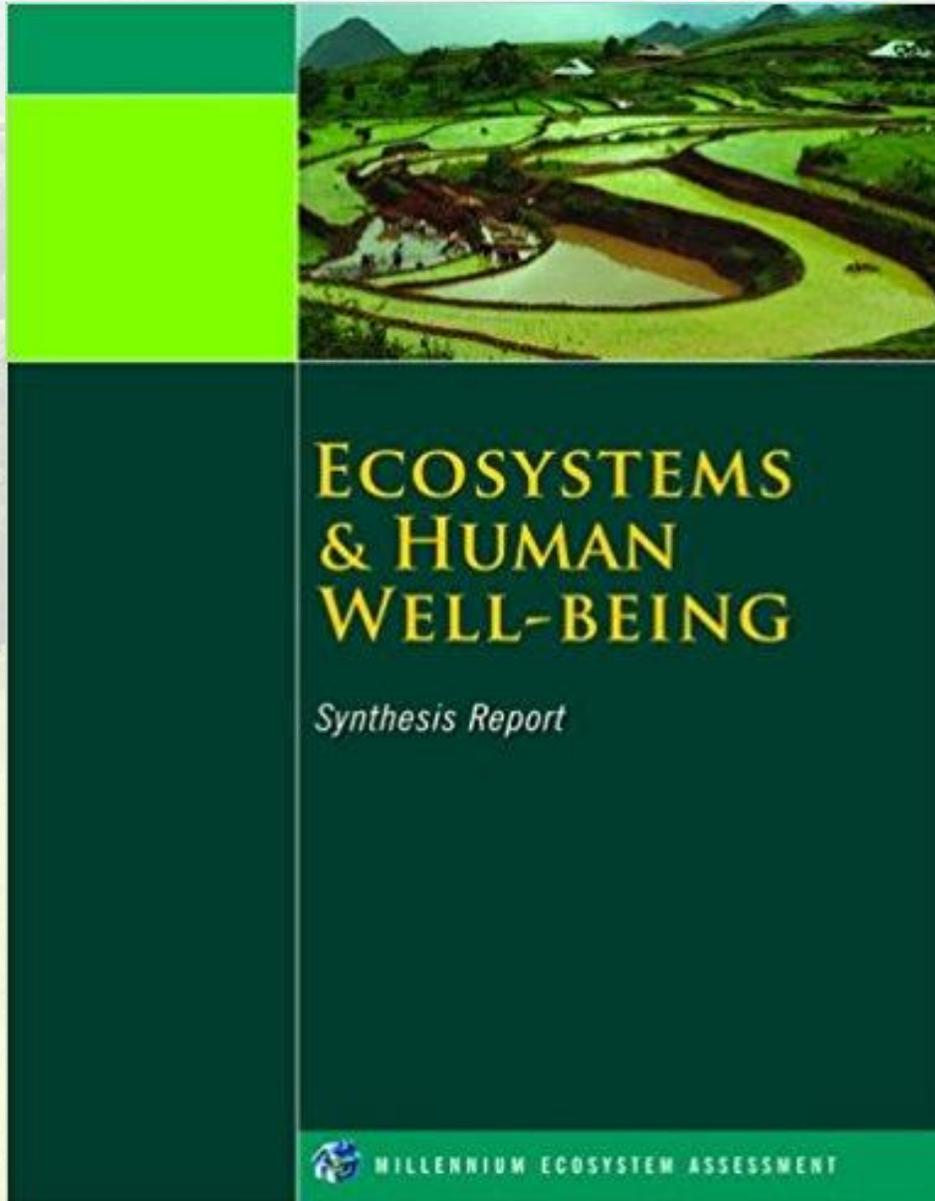
Ecosystem Services

1. Climate Change
 - ~ reduce carbon footprint
2. Natural Resource Depletion
 - ~ minimize resources consumption
3. Health Risk
 - ~ be conducive to occupants health
4. Social Inequality
 - ~ contribute to the SDGs

Provisioning	Regulating	Cultural
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UN Millennium Ecosystem Assessment



ECOSYSTEMS AND HUMAN WELL-BEING

OUR HUMAN PLANET



Summary for Decision Makers

MILLENNIUM ECOSYSTEM ASSESSMENT

UN Millennium Ecosystem Assessment

- The 2005 Millennium Ecosystem Assessment (MA), identified a problem, in addition to energy efficiency and climate change, which is seldom addressed by the built environment – the degradation of ecosystems and their constituent ecosystem functions .
- The MA identified that out of the 24 ecosystem services examined for the report, 15 are being degraded over time as a direct result of unsustainable resource and land uses.

UN Millennium Ecosystem Assessment

Services	Ecosystems	Agro ecosystems	Forests	Grasslands	Heath and scrubs	Wetlands	Lakes and rivers
Provisioning							
Crops/timber		↓	↑			↓	
Livestock		↓	=	=	=	↓	
Wild Foods		=	↓	↓		=	
Wood fuel			=		=		
Capture fisheries						=	=
Aquaculture						↓	↓
Genetic		=	↓	↓	=	=	
Fresh water			↓			↑	↑
Regulating							
Pollination		↑	↓	=			
Climate regulation			↑		=	=	=
Pest regulation		↑		=			
Erosion regulation			=	=	=		
Water regulation			=		↑	↑	=
Water purification						=	=
Hazard regulation						=	=
Cultural							
Recreation		↑	=	↓	↑	↑	=
Aesthetic		↑	=	=	=	↑	=

Status for period 1990–present ■ Degraded ■ Mixed ■ Enhanced ■ Unknown Not applicable

Trend between periods



Positive change between the periods 1950–1990 and 1990 to present



Negative change between the periods 1950–1990 and 1990 to present



No change between the two periods

Source: <https://www.eea.europa.eu/themes/biodiversity/where-we-stand/ecosystem-services-in-the-eu>

UN Millennium Ecosystem Assessment

Four Main Findings

1. Over the 50 years (1950-2000), humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber, and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.



UN Millennium Ecosystem Assessment

Four Main Findings

2. The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services and the aggravation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.



Source: <https://www.socialworker.com/extras/social-work-month-2018/social-work-advocacy-for-our-future-generations/>

UN Millennium Ecosystem Assessment

Four Main Findings

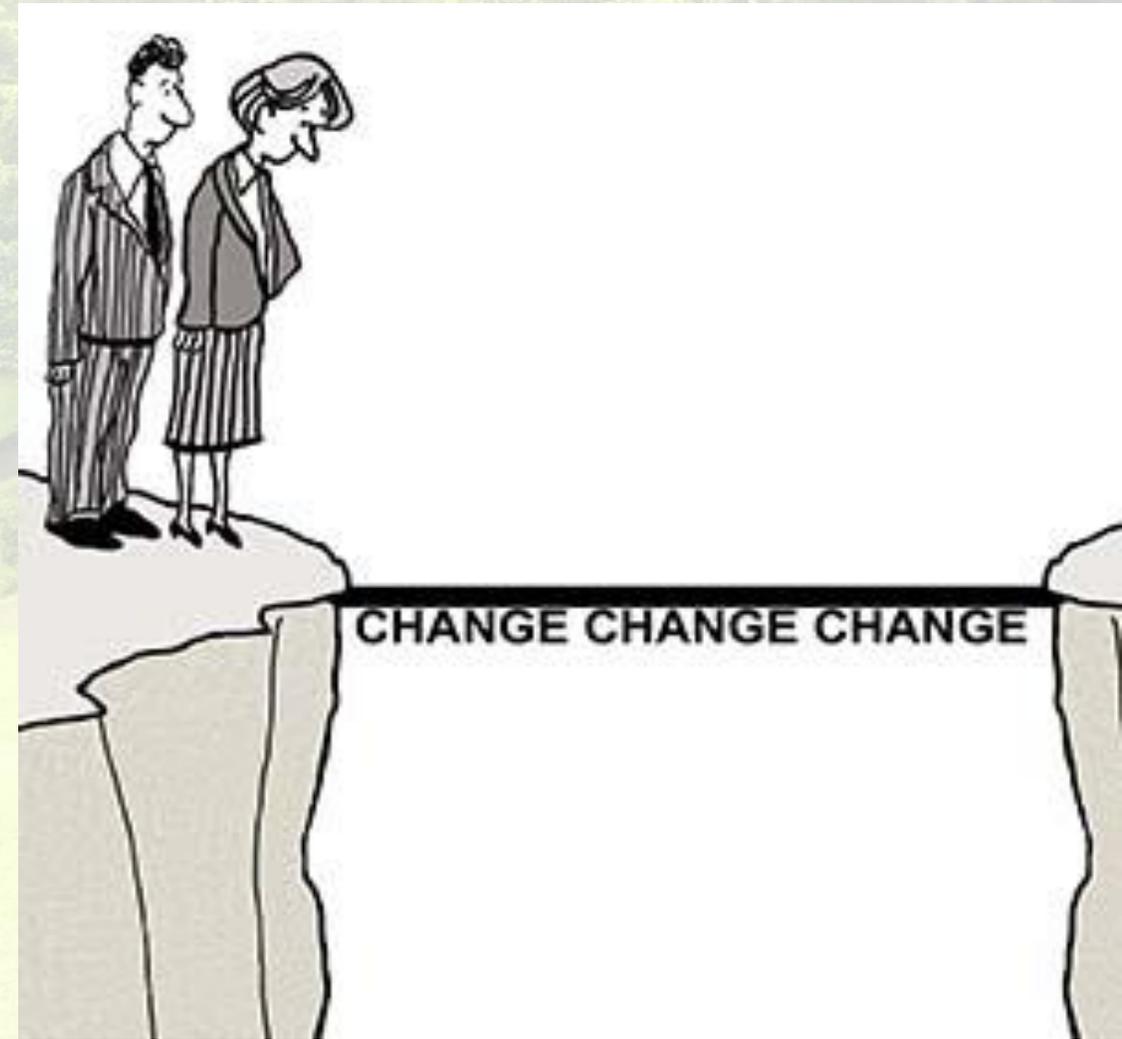
3. The degradation of ecosystem services could grow significantly worse during the first half of this century (2000 – 2050) and is a barrier to achieving the Millennium Development Goals.



UN Millennium Ecosystem Assessment

Four Main Findings

4. The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the MA has considered, but these involve significant changes in policies, institutions, and practices that are **NOT** currently under way.

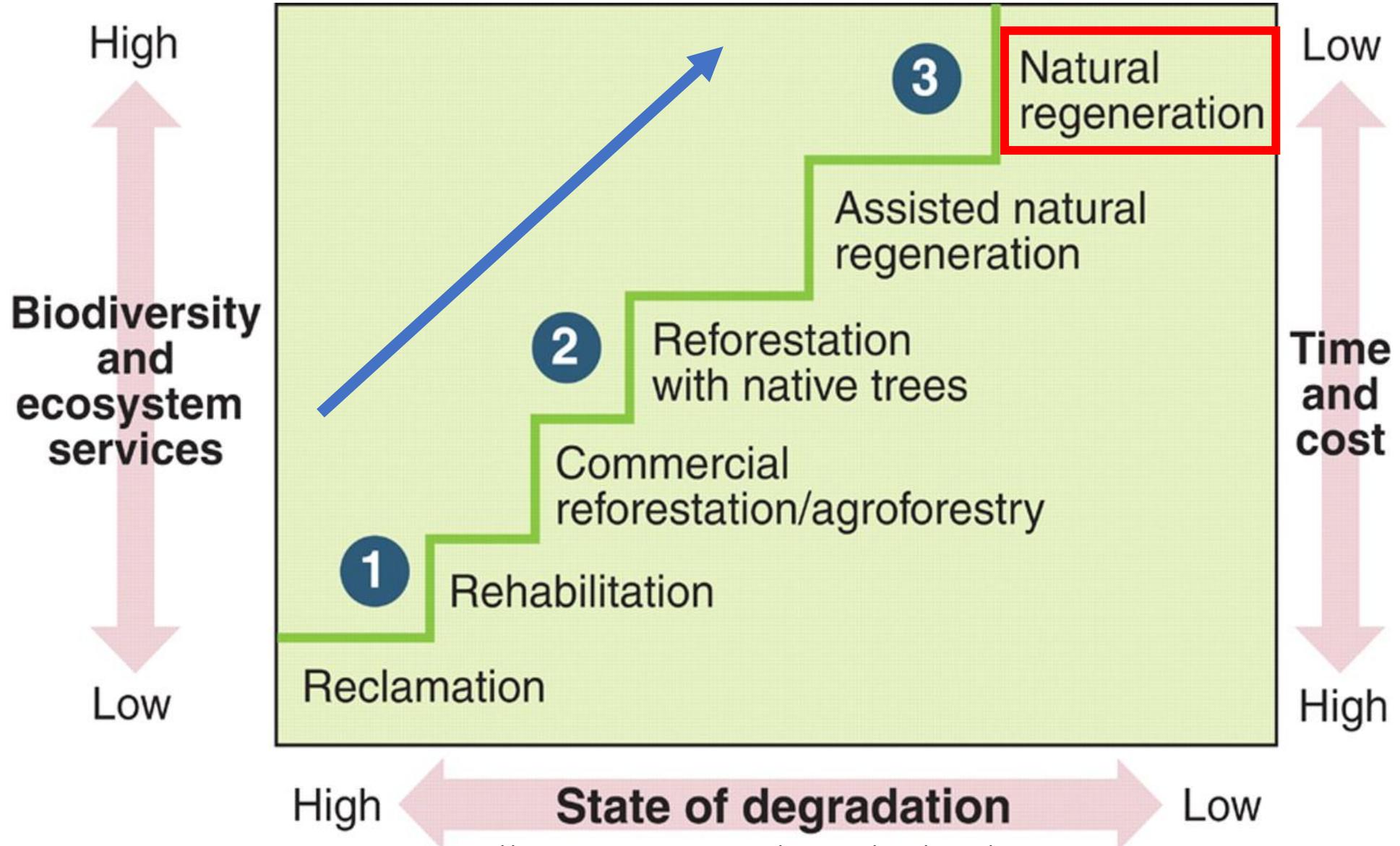


Source: <https://www.nichq.org/insight/what-comes-first-policy-or-change-0>

UN Millennium Ecosystem Assessment

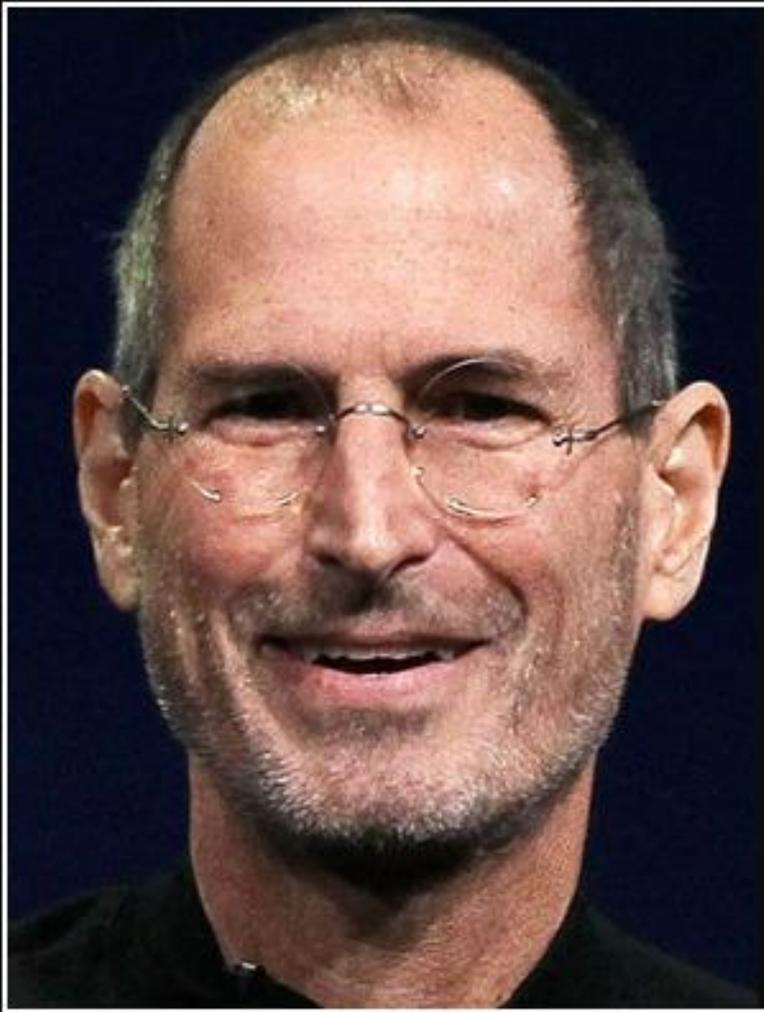
- There are options existed to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.
- One way to reduce or to possibly reverse the negative environmental impact of the built environment could be to create new developments or redesign existing buildings and urban areas so that they provide or support ecosystem services.
- If the built environment can provide some of its own ecosystem services, pressure is potentially decreased on local and distant ecosystems. And the degraded ecosystem functions may be able to begin to regenerate and therefore be able to support more species.

UN Millennium Ecosystem Assessment



Source: <http://science.sciencemag.org/content/320/5882/1458>

A Visionary Statement



I think the biggest innovations of the 21st century will be at the intersection of biology and technology. A new era is beginning.

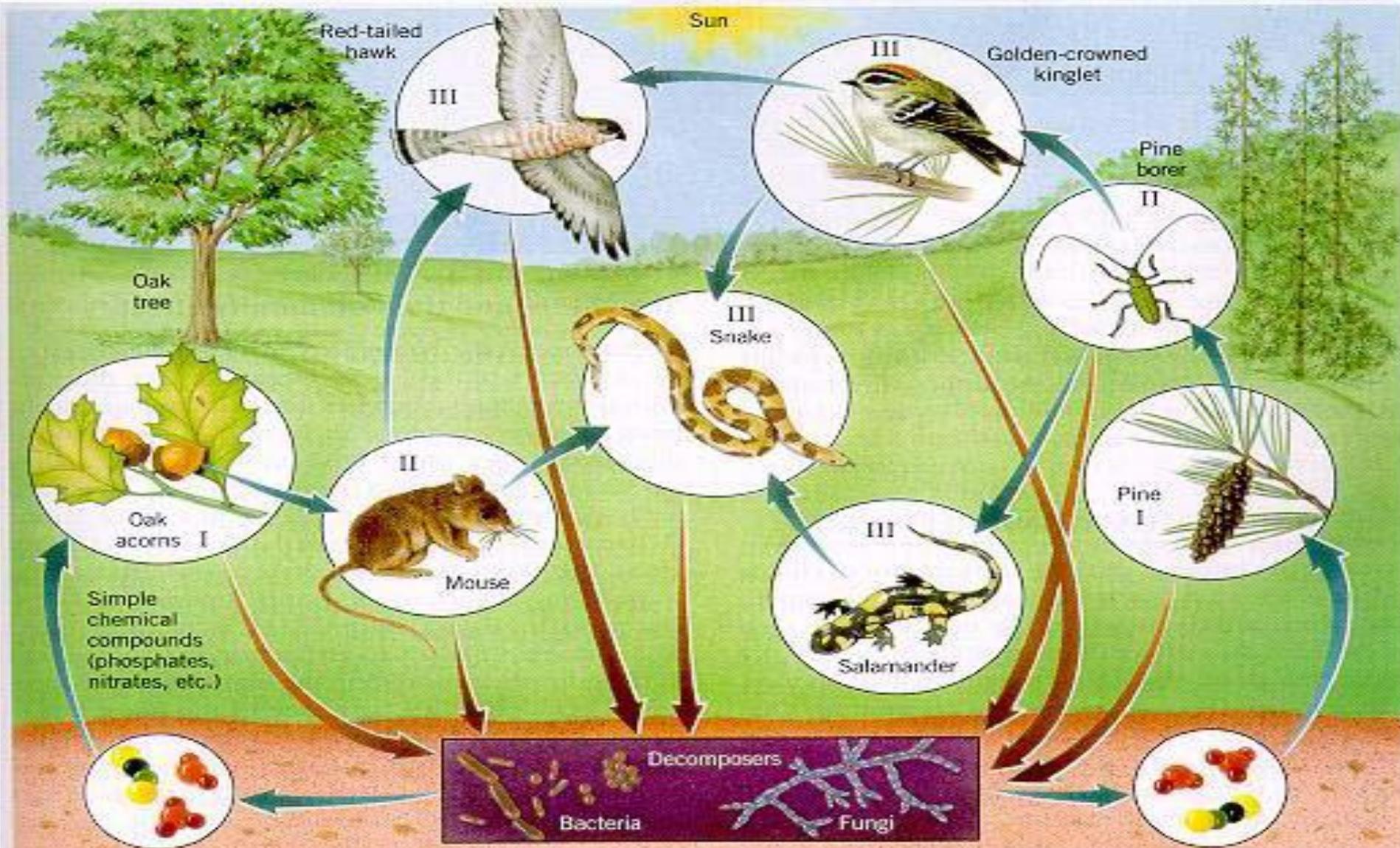
— *Steve Jobs* —

A Missional Statement

“I think the biggest innovation and design of the 21st century is at the intersection of natural science (nature) and engineering.”

(Phil Fung, 2021)

Nature's design solutions have been tested for 3.8 billion of years and are sustainable and harmonized with the ecosystem.



Ecosystems are resilient and utilize existing relationships for symbiotic advantage. They adapt to disturbance and create conditions conducive to ongoing life.



How does Nature operate and survive?

- Nature utilizes local natural resources to build.
- Nature recycled, reused and renewed all materials constantly.
- Nature uses only resources it needs and relies on.
- Nature produces neither permanent garbage nor toxic to harm their living environment.
- Nature is resilient to unforeseeable changes to the environment.
- Nature optimizes rather than maximizes ~ biodiversity.
- Nature rewards cooperation – symbiotic relationship.
- Nature runs on information-feedback loops.
- Nature operates on close-loop systems.
- Nature is adaptive and responsive.

Nature-Inspired Design (Bio-Design)

Natural Science

Engineering

Biology
Chemistry
Physics
Geography
Environmental Science
etc...

**Multidisciplinary
Nature-Inspired
Design**

Mechanical
Electrical
Structural
Civil
Environmental
Energy
etc...

Nature-Inspired Design (Bio- Design)

RECONNECT WITH
NATURE
BIOPHILIC DESIGN

Nature-Inspired Design (Bio- Design)

- Biophilia evolved from within the fields of biology and psychology, and relate to the desire for a (re)connection with nature and natural systems.

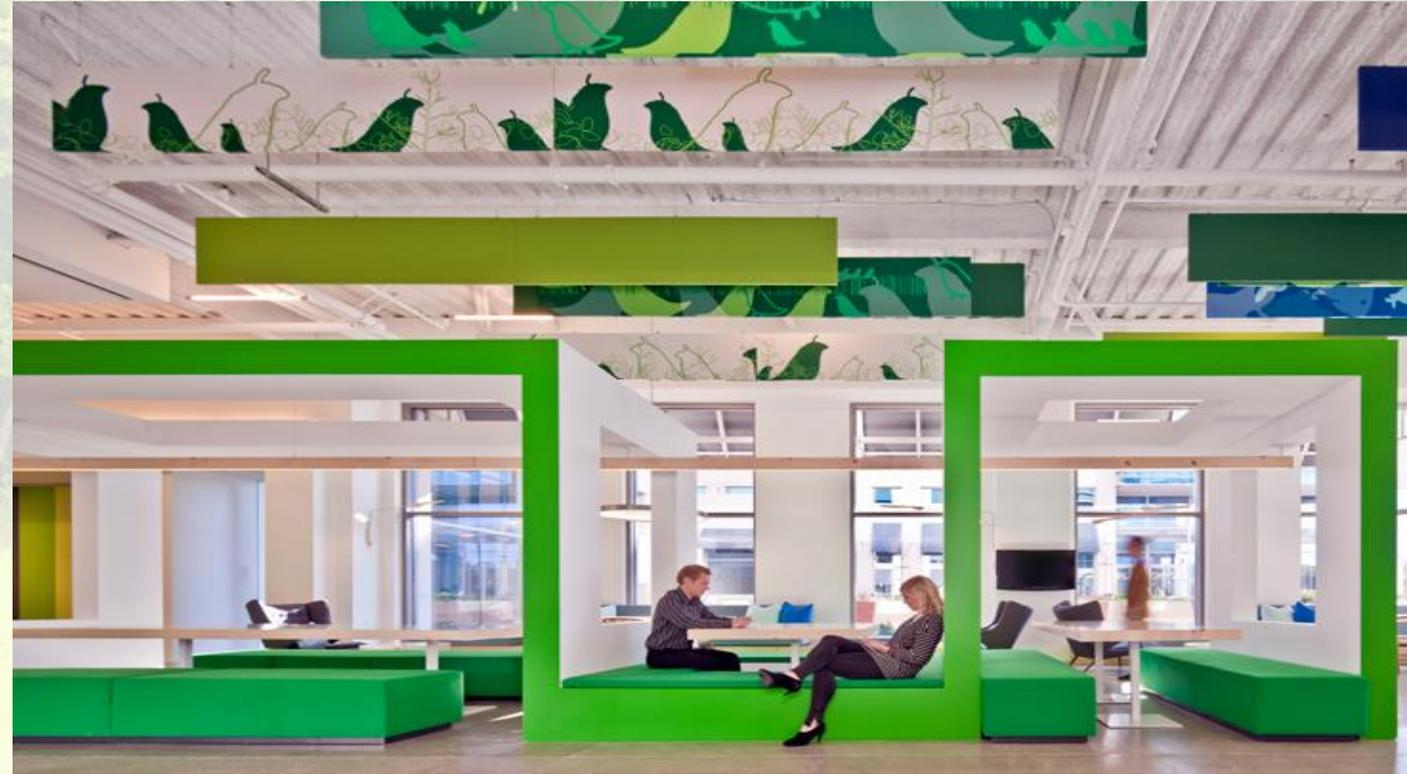
Biophilia

Psychology or Biology?



Nature-Inspired Design (Bio- Design)

- Biophilic design provides people opportunities to live and work in healthy places and spaces with less stress and greater overall health and well-being.



Nature-Inspired Design (Bio-Design)

WATER

MATERIALS

LEARN FROM
NATURE

**BIOMIMETIC
DESIGN**

RESILIENCE

ENERGY

Nature-Inspired Design (Bio- Design)

- Biomimicry comes from the Greek words bios, meaning life, and mimesis, meaning to imitate.



Nature-Inspired Design (Bio- Design)

- Biomimetic design is the adaptation of biological principles into modern technology to address a variety of human needs.



STORING CARBON



CLEANSING AIR



PURIFYING WATER

Every ecosystem provides ecosystem services.
If we emulate nature's genius, cities can too.

Biomimicry 3.8 | Biomimicry.net

Nature-Inspired Design (Bio-Design)



sunlight and air



water

UTILIZE
NATURE
**BIO-SYNERGISTIC
DESIGN**



soil



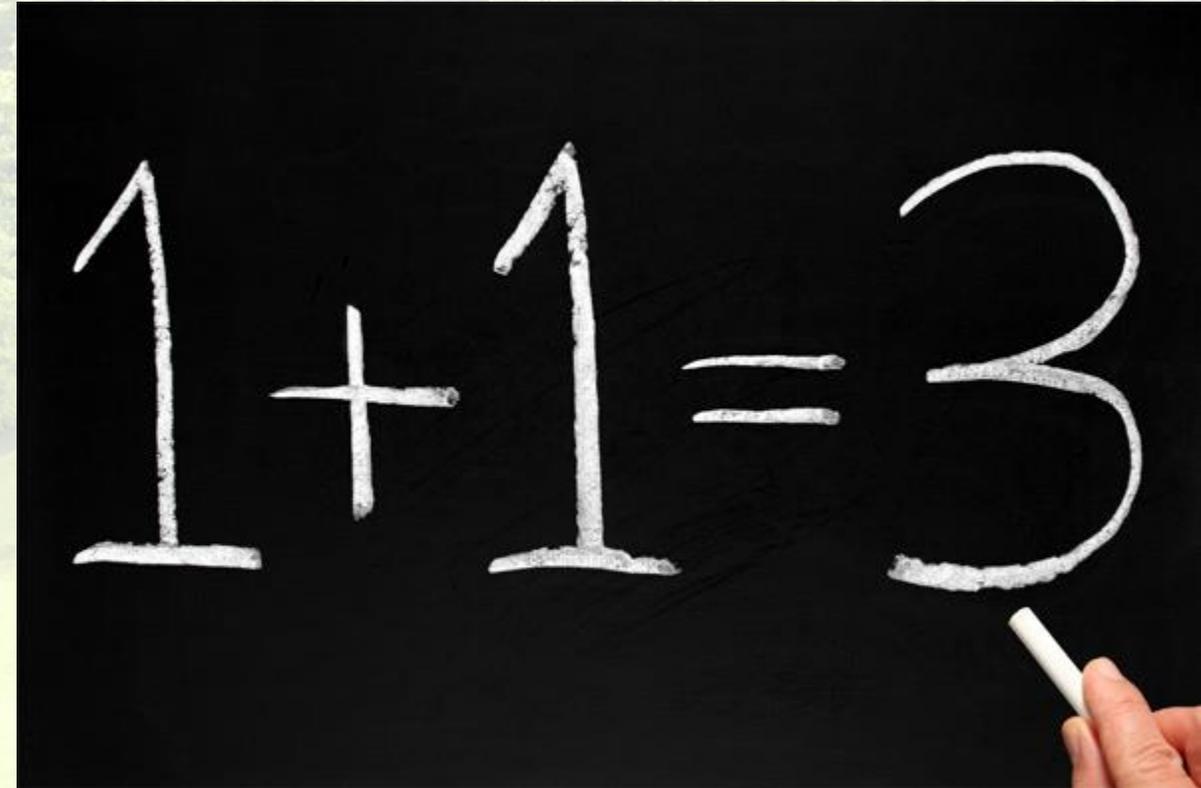
plants



animals

Nature-Inspired Design (Bio- Design)

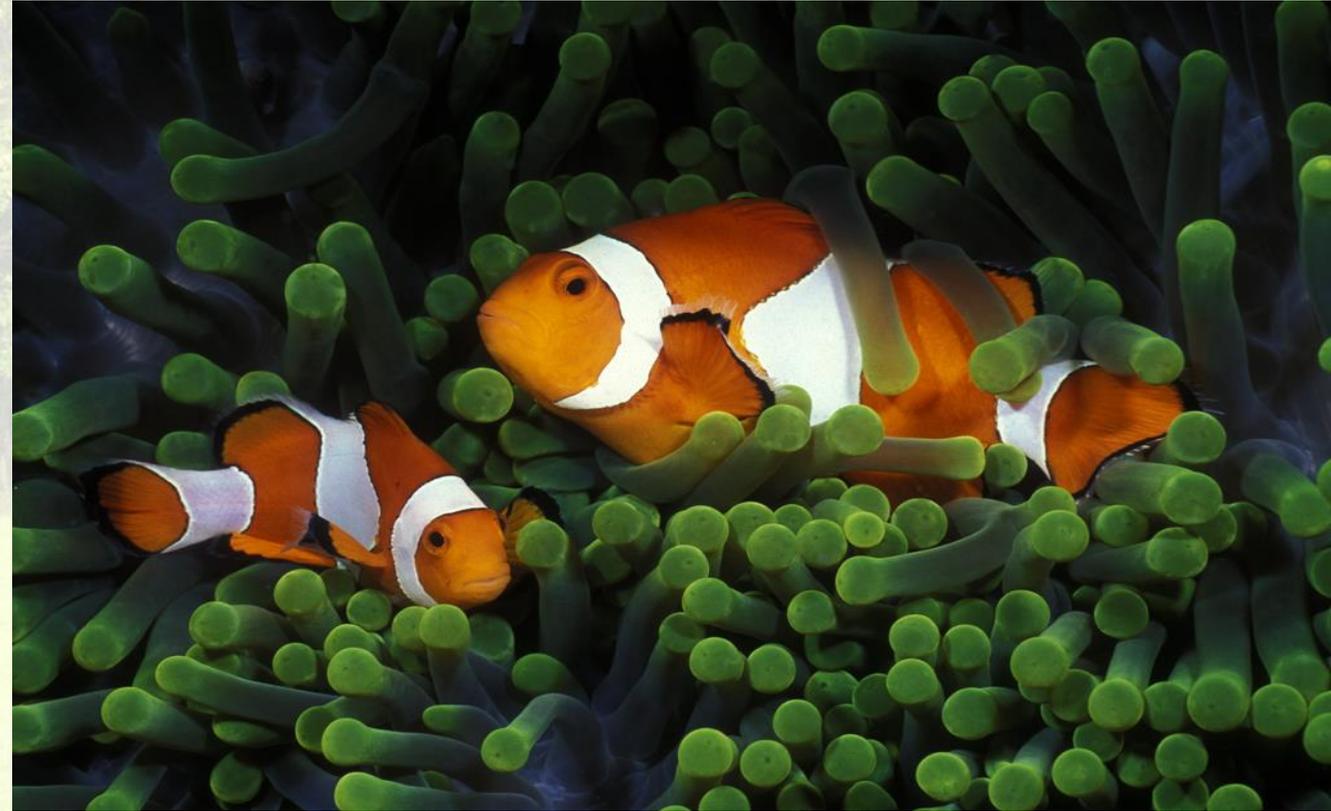
- Bio-Synergy is broadly defined as the combined effects of two or more organisms to produce a greater result than each would achieve individually.



Nature-Inspired Design (Bio- Design)

- Bio-Synthetic Design ~
Facultative Mutualism

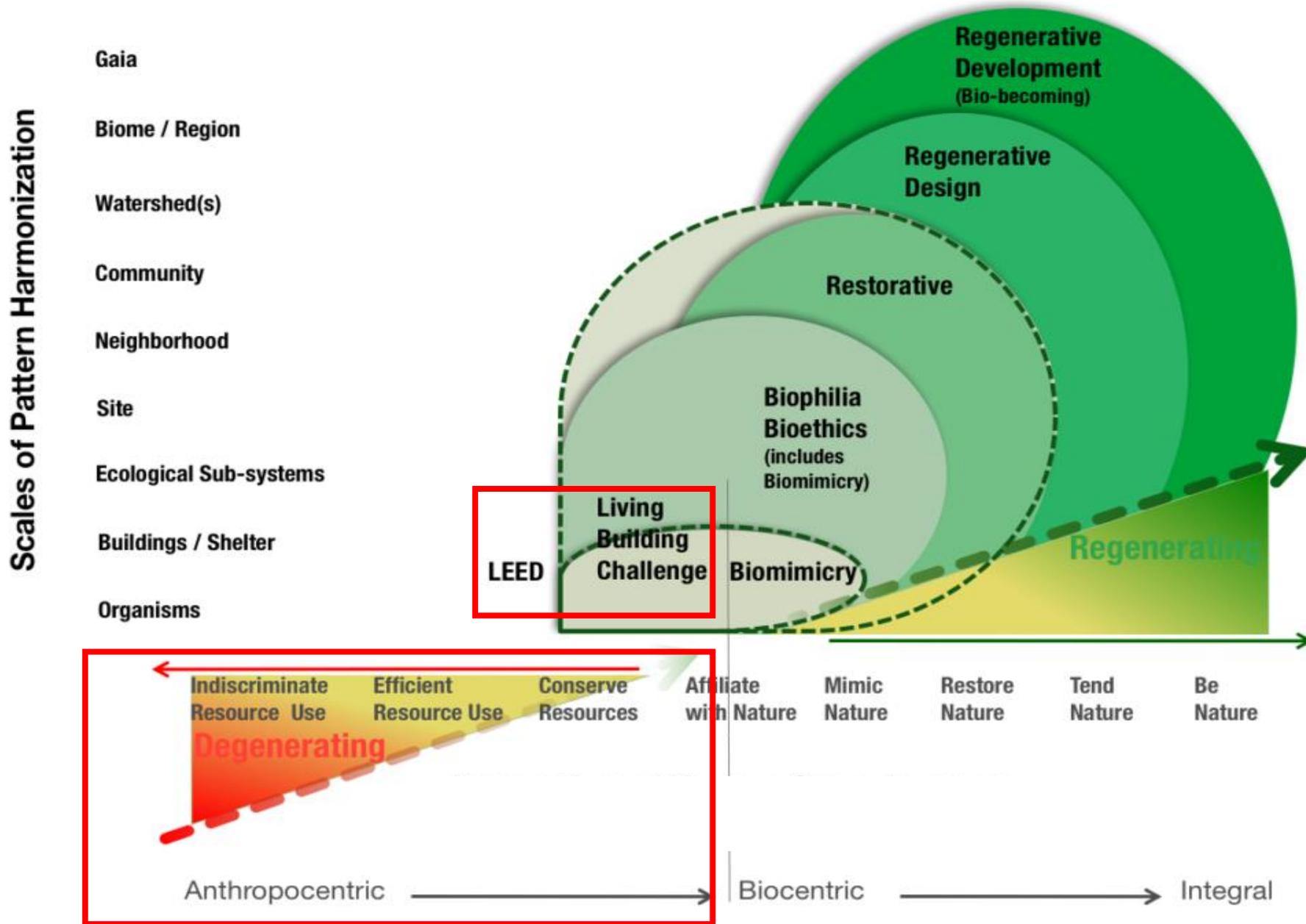
Organisms benefit from the interaction but are not dependent upon their survival.



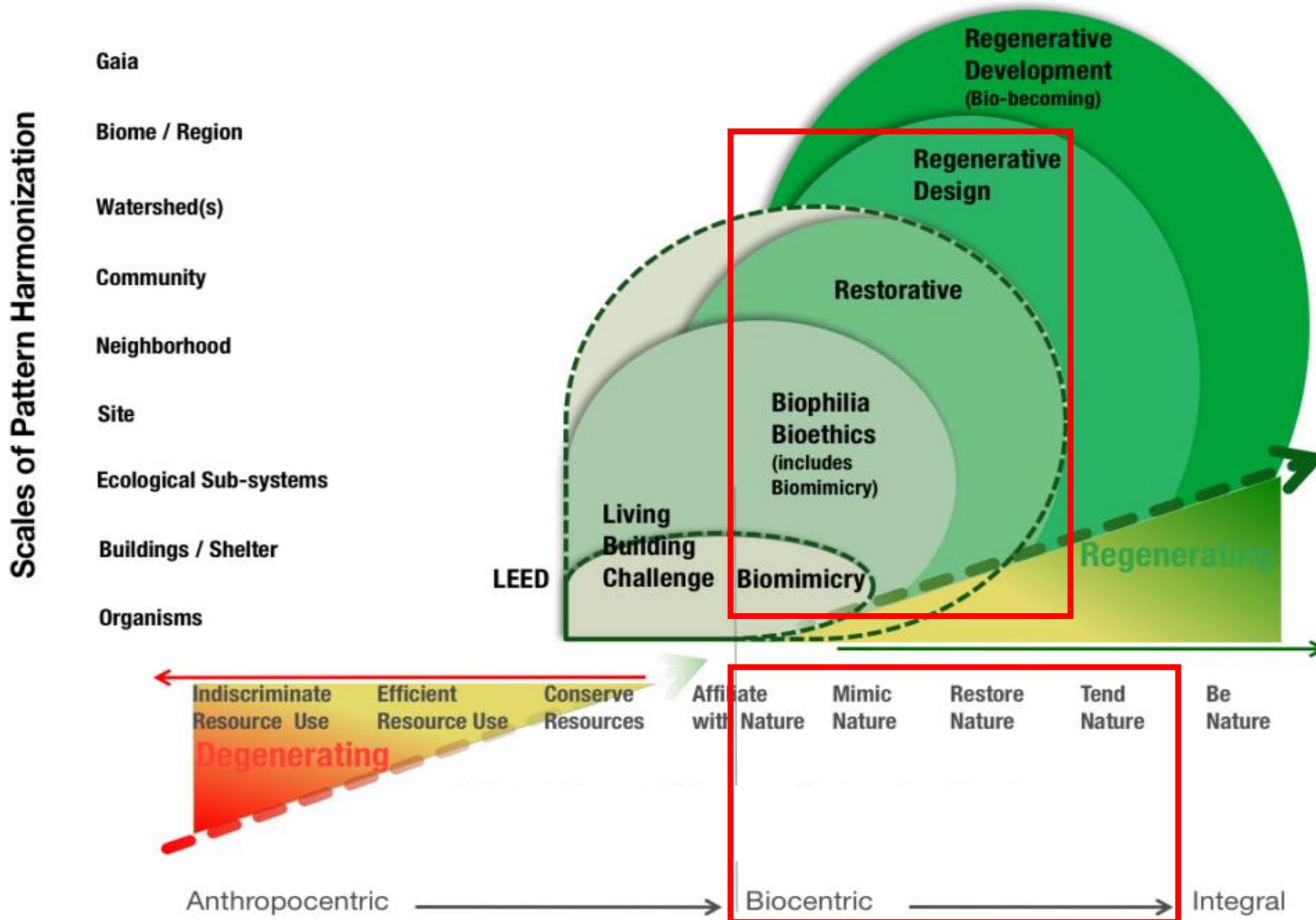
Regenerative Design & Sustainable Design

- Sustainable design implies something that endures over time without degrading, but it does not regenerate itself or create anything new.
- Regenerative design looks to sustainability practices as the starting point and builds on them in order to increase ecosystem health.
- Sustainable design aims to provide for fundamental human needs; regenerative design plans for the future co-existence of humans and other species (nature).
- Success in sustainable design is measured by performance of building and development. Whereas regenerative design is measured by the improvements in health and wellbeing for humans, other living beings and ecosystems as a whole.



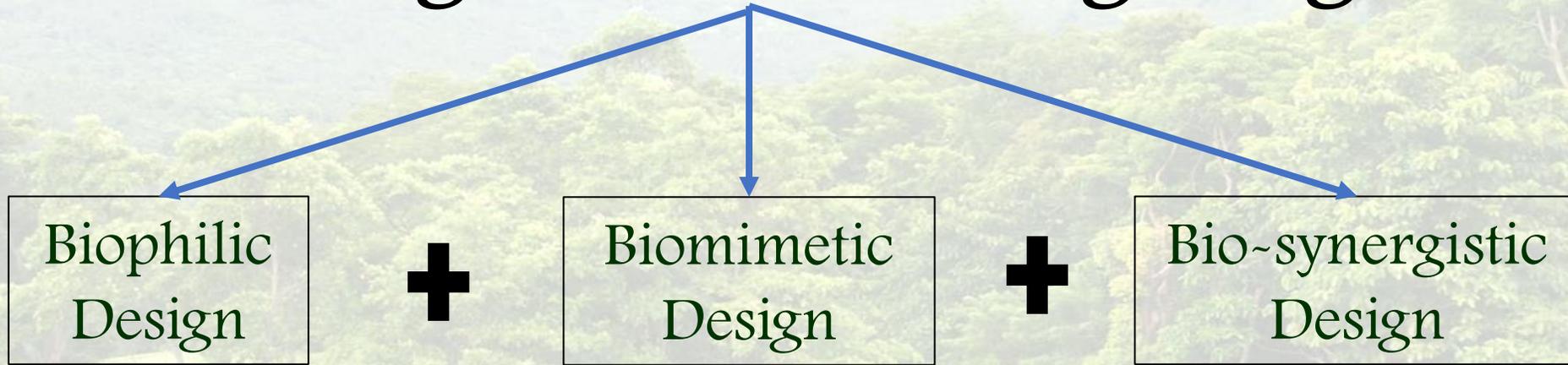


Source: <https://biomimicry.org/learning-nature-designing-nature-regenerative-cultures-create-conditions-conducive-life/>



Source: <https://biomimicry.org/learning-nature-designing-nature-regenerative-cultures-create-conditions-conducive-life/>

Bio-Regenerative Building Design



Bio-Regenerative Engineered Ecosystems

Building Ecosystem Services



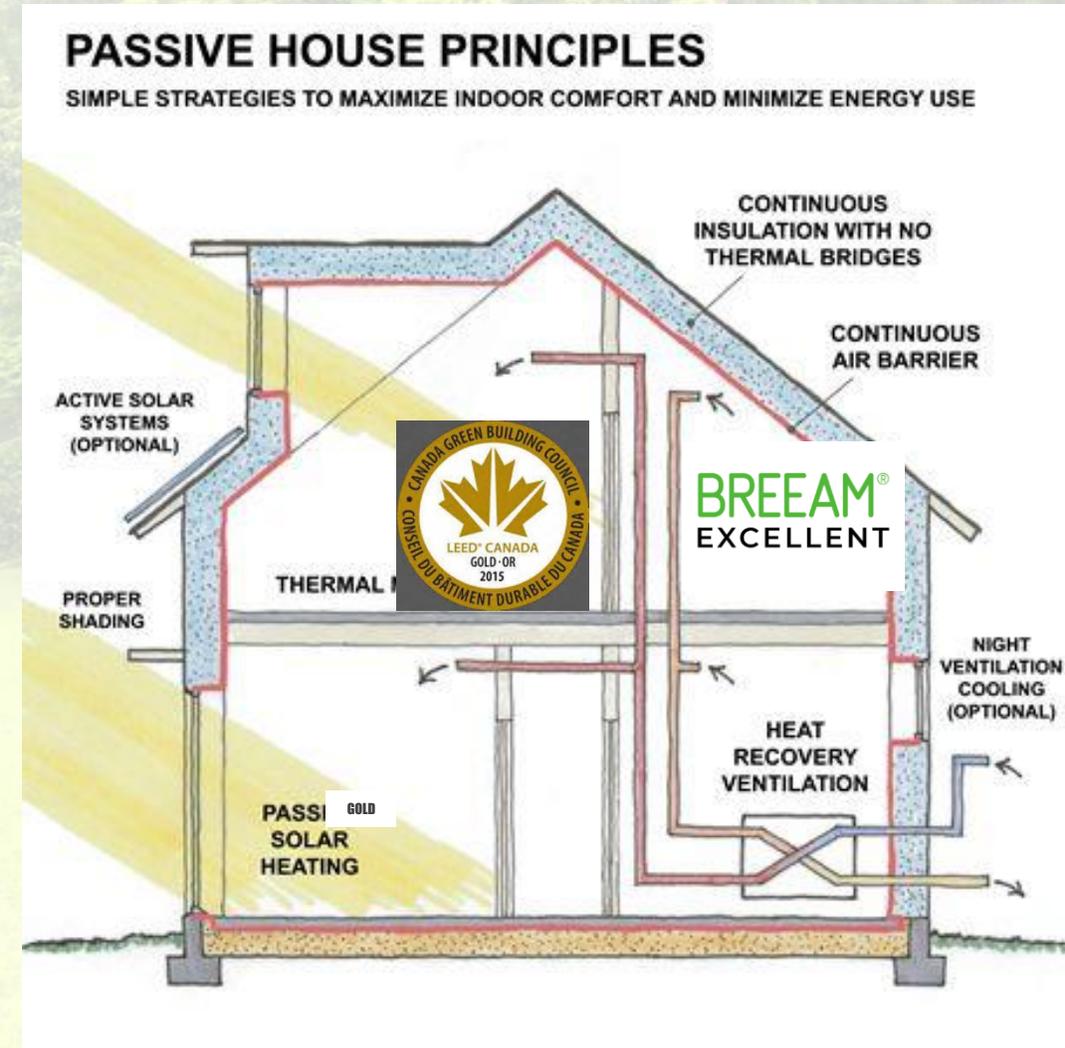
Bio~Regenerative Building Design

Sustainable Building design:

- ICF/SIP Shell
- Passive House Standard Envelope
- LEED Gold/BREEAM Excellent attributes

Bio~Regenerative Building design:

- Food Ecosystem Services
- Wellbeing Ecosystem Services
- Energy Ecosystem Services
- Air Ecosystem Services
- Carbon Ecosystem Services



Design Principle

Nature is our mentor and model.

Community is like a forest; buildings are the trees.



Research Projects

A scenic view of a golf course with rolling green hills, a dense line of trees, and a blue flag on a green in the distance.

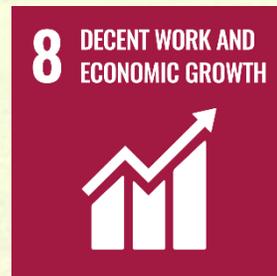
Bio-Regenerative Building Design

Food Ecosystem Services

How does nature grow organic food with natural inputs?



SDGs



Design Principle

Aquaponics + Hydroponics + Soil
(organic) (natural) (organic)



Food Diversity

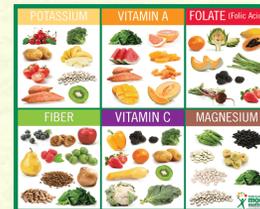
Food Safety

Food Security

*Diversified Crops
(3 growing platforms)*

High Quality Crops
(Certified Canadian Organic)

*Optimized Crops Yield
(3 pH platforms)*



Community
Distributed
Food
System



Food
Sovereignty

Bio-Regenerative Building Design

Wellbeing Ecosystem Services

How does nature nurture human well-being?



SDGs



Bio~Regenerative Building Design

Wellbeing Ecosystem Services

'Nature therapy' program offered as
new medical prescription to
Canadians

March 2021

“More than 500 health-care
workers across Canada have signed
up to participate in the Park
Prescriptions program.”



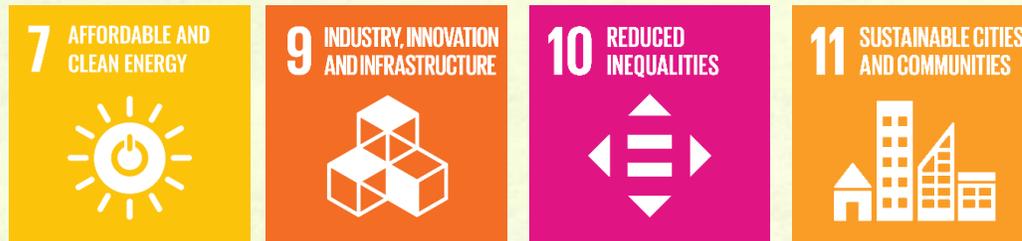
Bio~Regenerative Building Design

Energy Ecosystem Services

What are the functions of trees in nature?



SDGs



Bio~Regenerative Building Design

Energy Ecosystem Services

- Regulator (AC & DC – renewable energy supply)
- Distributor (AC & DC)
- AC/DC Hybrid House
- Battery Storage (stand-by)
- AI Director (energy and peak management)
- Communicator (micro grid)



Bio~Regenerative Building Design

Air Ecosystem Services

How does nature purify air?



SDGs

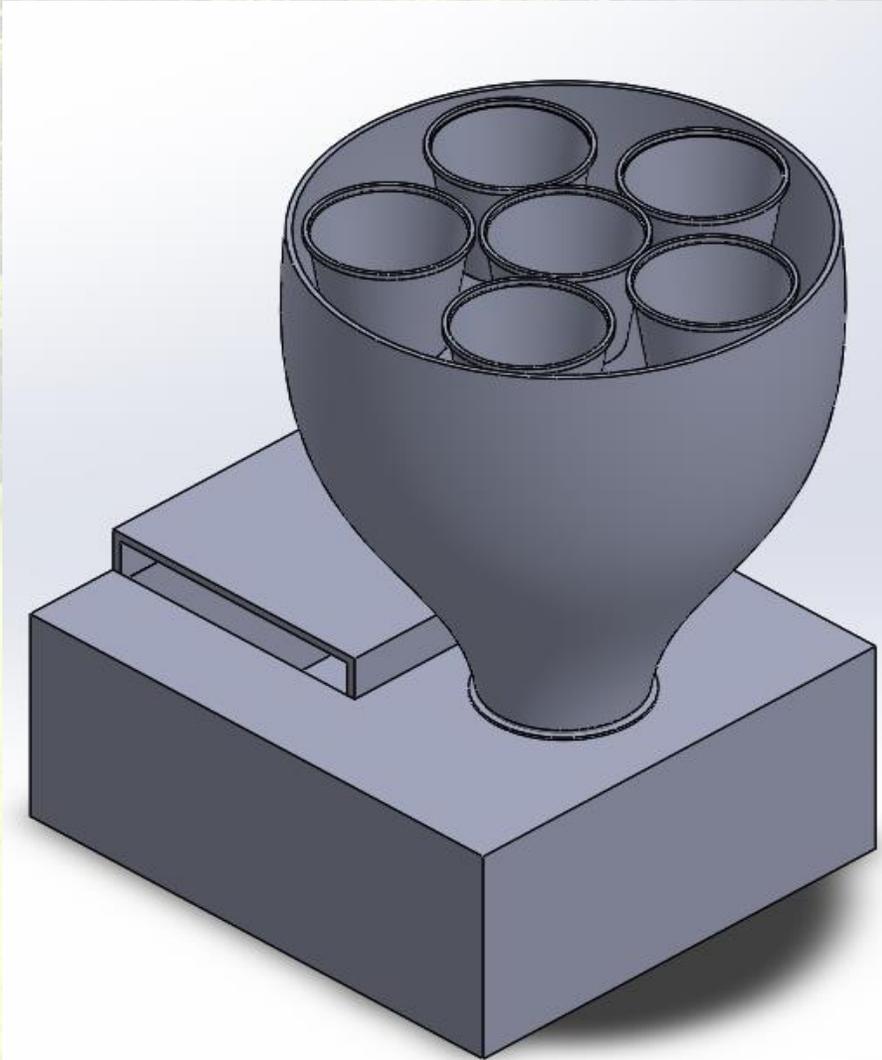
3 GOOD HEALTH AND WELL-BEING 	15 LIFE ON LAND 	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 
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Bio~Regenerative Building Design

Air Ecosystem Services

Air Regeneration – Triple~Filtration

- Absorption ~ Plants
- Adsorption ~ Biochar
- Bio~degradation ~ Microbes



Bio~Regenerative Building Design

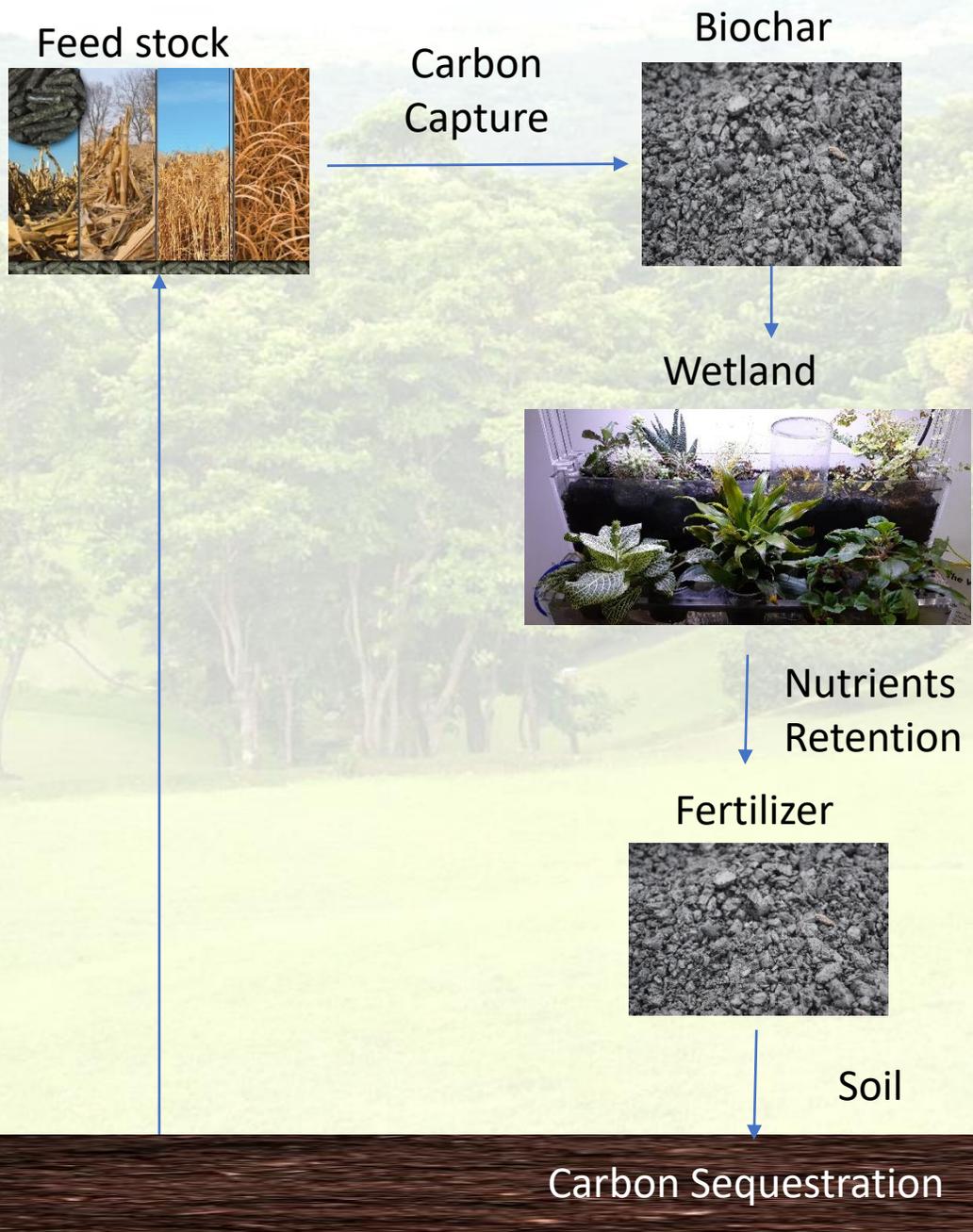
Carbon Ecosystem Services

How does nature perform carbon sequestration?



SDGs





A lush green landscape with rolling hills, dense trees, and a golf course in the foreground. The scene is bright and clear, with a mix of vibrant green grass and deep green foliage. The text 'Commercial Projects' is centered in a dark green, serif font.

Commercial Projects

Off-Grid Food Shed City of Brampton

We “**build**” a  to feed your **community** year round

Solar PV Off-Grid Food Shed





Country Heritage Park Milton



Hydroponics + Soil

Tilapia Aquaponics +
Hydroponics + Soil

Rainbow Trout
Aquaponics

Tilapia Breeding
& Fingerlings
Tank

Rainbow Trout
Breeding &
Fingerlings Tank



St. James Town Co-op Housing Toronto

Food Hub



Food Shelf

Gold Fish Aquaponics

Hydroponics
with Worm Tea

Soil





**Nature
Therapy
delivers**

**CALMNESS
&
PEACE**





105 Gibson Center Indoor Farm Markham



Indoor Farm

Education



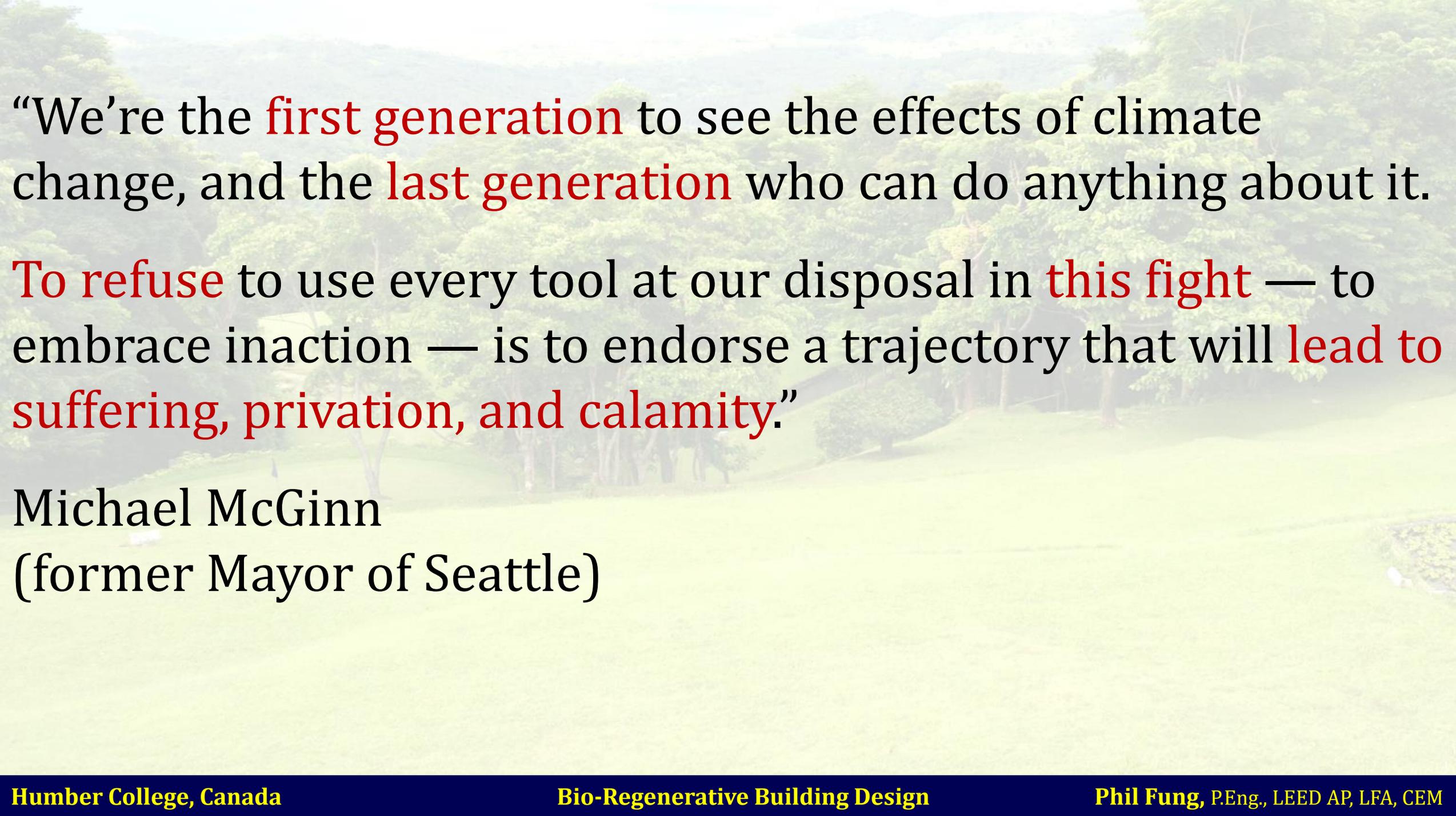
Community Engagement



A lush green landscape with rolling hills, dense trees, and a golf course in the foreground. The scene is bright and vibrant, with a clear sky and a dense forest of tall trees in the background. The foreground shows a well-maintained golf course with a green and a flag visible on the left side.

Office Nature Room Markham





“We’re the **first generation** to see the effects of climate change, and the **last generation** who can do anything about it.

To refuse to use every tool at our disposal in **this fight** — to embrace inaction — is to endorse a trajectory that will **lead to suffering, privation, and calamity.**”

Michael McGinn
(former Mayor of Seattle)



Bio-Regenerative Building Design

(Indoor Ecosystem Services contribution to SDGs)

THANK YOU

Q&A

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