7.1.1 Natural Resources, Natural Capital, and Natural Income

Definitions

- **Natural resources**
  - Raw materials and sources of energy that humans utilize to support life and economic activity.
- **Natural capital**
  - The stock of natural resources available on Earth that possess value to human societies. The terms *natural resource* and *natural capital* are often used interchangeably.
- **Natural income**
  - The yield, harvest, or flow of services derived from natural capital.

Contemporary Definitions

Historically, economists regarded capital as the products of manufacturing, distinct from land and labor. However, contemporary understanding recognizes capital as encompassing:

- Goods
  - Tangible natural resources that possess direct value to humans, such as forests, soil, water, living organisms, and mineral ores.
- Services
  - Natural processes that sustain life, including flood and erosion control by forests, oxygen production through photosynthesis, and the maintenance of ecosystem health.

Contemporary Definitions

- Natural capital encompasses both goods and services that are not manufactured but nonetheless hold value for human societies.
- These goods and services arise from the physical, chemical, and biological functions of ecosystems.
- Natural capital can be enhanced or degraded and, with some difficulty, assigned a monetary value.
- Example:
  - mining for metals
  - converting trees into timber

Economic Capital

- Economic capital yields economic income, natural capital yields natural income—the renewable output or services derived from natural systems without depleting the underlying stock.
- Examples include:
  - Cherry trees producing fruit
  - The water cycle providing fresh water
  - Forests supplying timber

Economic Capital

- The true wealth of a nation therefore includes its natural capital, such as mineral resources, forests, and water systems.
- High-income countries (HICs) often add value to natural income through manufacturing, whereas low-income countries (LICs) may possess greater stocks of unprocessed natural capital.
- The World Bank now incorporates natural resource extraction rates and ecological damage (including carbon dioxide emissions) into its calculations of national wealth.

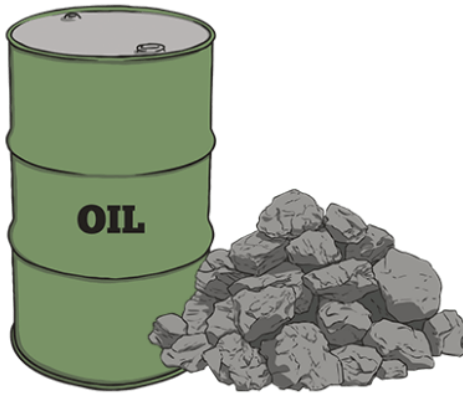
Classification of Natural Capital

Natural capital can be classified along a continuum based on the time required for renewal relative to the rate of human use. Ultimately, all natural resources are finite.

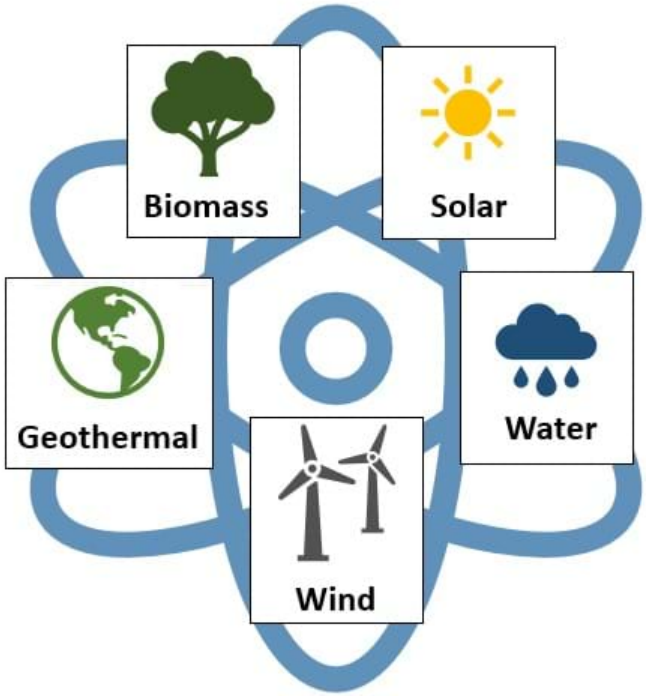
Renewable Vs Non-renewable

Non-Renewable Natural Capital

- Non-renewable natural capital:
  - •Exists in finite quantities on Earth
  - Cannot be renewed or replaced within a human timescale
  - Regenerates only over geological time periods
  - Includes resources such as minerals, fossil fuels, soil, and groundwater stored in aquifers
- As these resources are extracted and consumed, stocks are depleted, necessitating the discovery of new sources or the development of alternatives.



Renewable Natural Capital



- Renewable natural capital has the capacity to regenerate naturally through biological growth or recurring physical processes.
- However, overexploitation can render even renewable resources unsustainable. Renewable natural capital includes:
  - Living species and ecosystems dependent on solar energy and photosynthesis
  - Non-living systems such as groundwater and the ozone layer

Exploited Renewable Natural Capital

- If renewable natural capital is exploited beyond its natural income, the use becomes unsustainable.
  - Extraction, transportation, and processing activities often degrade renewable natural capital, undermining its sustainability.
- For example, water can function as either renewable or non-renewable natural capital depending on local conditions:
  - In regions with abundant rainfall, where surface water is replenished frequently, water represents renewable natural capital.
  - In arid regions with slowly recharging aquifers, water constitutes non-renewable natural capital.

Types of Resources

Types of resources

- Recyclable
- Fish
- Forest
- Life-support
- Services from vegetation

Recyclable Resources

- Some non-renewable resources, such as iron ore, can yield recyclable materials.
- Although iron ore itself is non-renewable, the iron extracted from it can be reused indefinitely.
- For instance, approximately 65% of a car is composed of iron or steel, which can be recovered, remanufactured, and repurposed.
- Thus, while the ore is finite, the derived metal becomes a recyclable resource.
- The same principle applies to other metals such as aluminum.

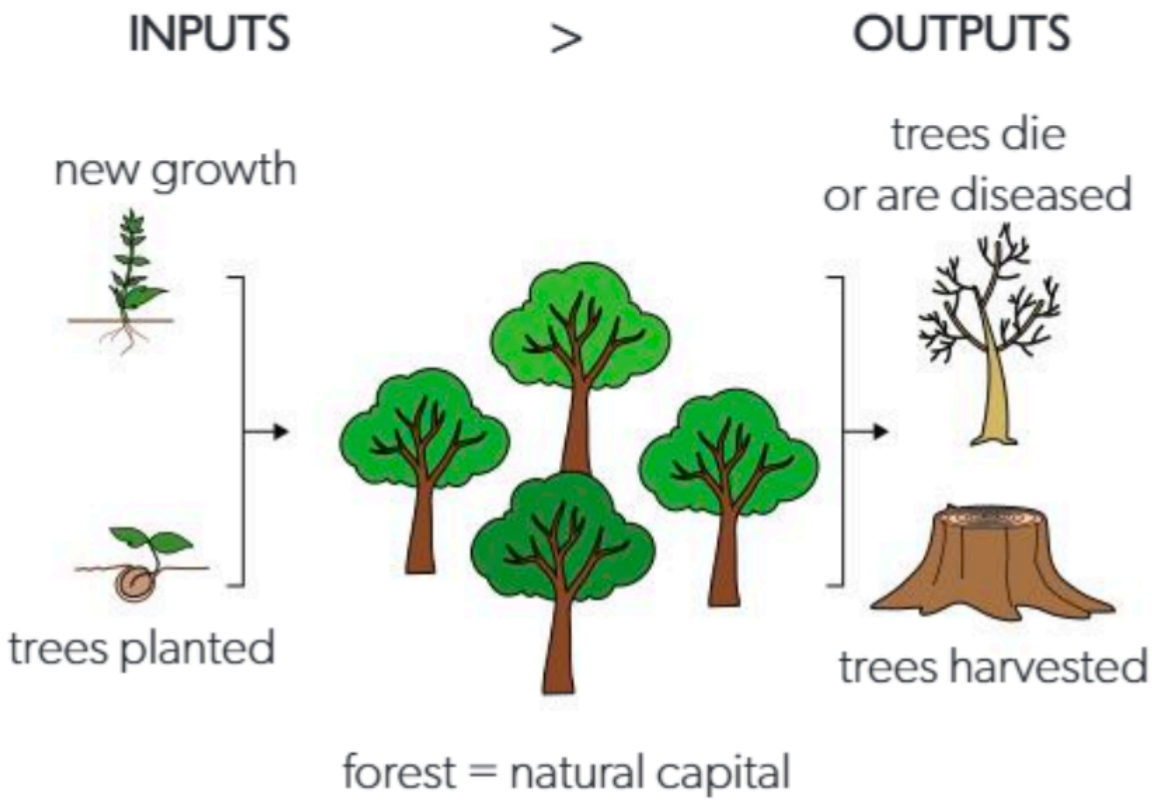
Forests as Natural Capital and Natural Income

- A forest represents a stock of natural capital that yields the natural income of timber. Sustainable forest management requires harvesting at a rate that:
  - Allows for natural regeneration
  - Minimizes harm to ecosystems, watersheds, and wildlife
  - Ensures sufficient standing stock for reproduction and ecosystem balance

Forests as Natural Capital and Natural Income

- In sustainable systems, the inputs to the forest (for example, regrowth) must equal or exceed outputs (for example, harvest).
- Unsustainable logging practices—particularly clear-felling—lead to a range of environmental and social impacts, including:
  - Changes in temperature and humidity
  - Soil erosion and increased flooding
  - Habitat loss and species extinction
  - Displacement of Indigenous communities and social conflict

Forests as Natural Capital and Natural Income



Fish as Natural Capital and Natural Income

- Fish populations represent a critical form of renewable natural capital; however, many have been severely overexploited.
- Unsustainable fishing practices have led to drastic declines in fish stocks, threatening food security and biodiversity.
- For example, the bluefin tuna population in 2023 was estimated at only 30% of its 1970 level, primarily due to technological advances in fishing and increasing global demand.

Life-Support Ecosystem Services

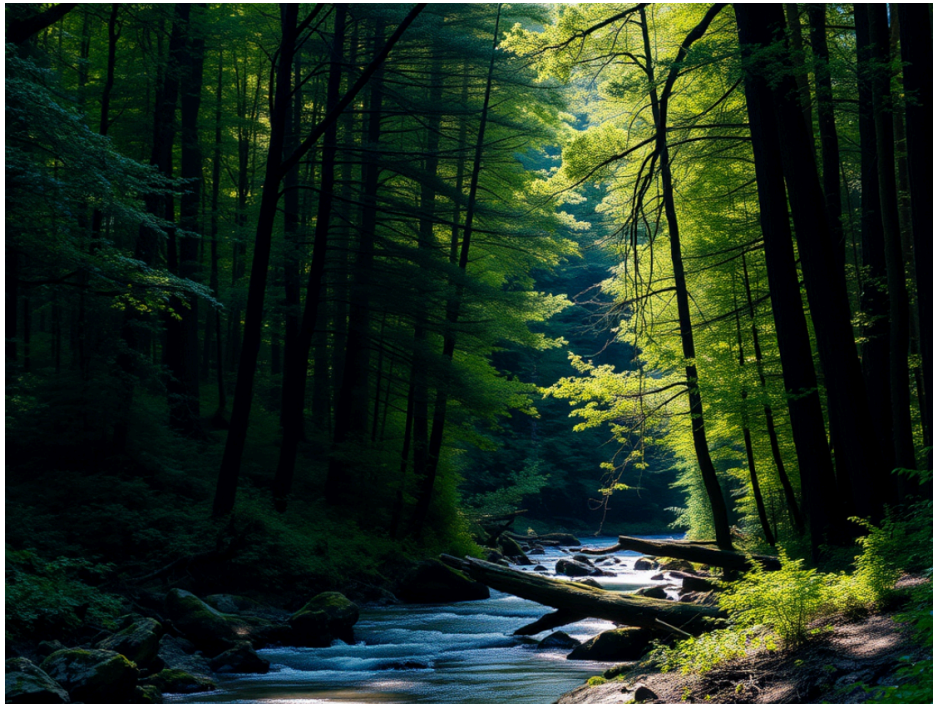
- Many ecosystem services are intangible and therefore difficult to quantify in traditional economic terms.
- While they may not produce tangible goods, these services are essential for maintaining life-supporting systems on Earth.
- If managed sustainably, such services are renewable; if degraded, they can become effectively non-renewable.

Life-Support Ecosystem Services

- Between 2001 and 2005, the Millennium Ecosystem Assessment (MEA), sponsored by the United Nations, sought to:
  - Evaluate the consequences of human-induced ecosystem changes
  - Assess the impacts of these changes on human well-being
  - Strengthen conservation strategies based on scientific evidence
  - Promote sustainable ecosystem management

Supporting Services

- Constitute the foundational ecological processes upon which all other ecosystem services depend.
- Maintain ecological stability and enable the Earth to sustain life.
- Key examples include:
  - Nutrient cycling
  - Soil formation
  - Photosynthesis
  - Regulation of the water cycle



Regulating Services

- Encompass essential ecological processes that ensure the stability and functionality of ecosystems.
- Maintain clean, resilient, and sustainable environments.
- Include processes such as:
  - Carbon sequestration and storage
  - Climate regulation
  - Decomposition of organic matter
  - Control of erosion and flooding
  - Pollination of plants
  - Purification of water

Cultural Services

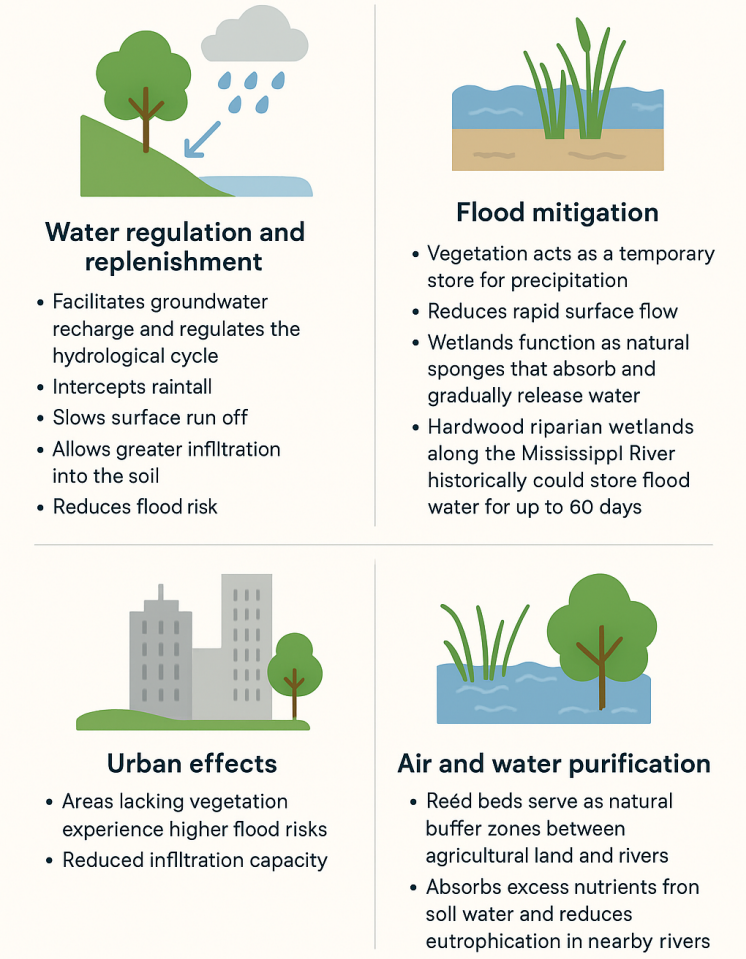
- Arise from interactions between humans and the natural environment across historical and contemporary contexts.
- Provide non-material benefits that foster human development and cultural enrichment.
- Facilitate the generation of knowledge, dissemination of ideas, and cultivation of cultural expressions.
- Influence artistic, architectural, musical, and recreational practices at local, national, and global levels.

Provisioning Services

- Refer to the tangible products and resources that humans obtain from ecosystems.
- Provide essential materials for human survival and well-being.
- Examples include:
  - Plants for food, medicine, and clothing
  - Oils and biogas for cooking and fuel
  - Timber for construction and manufacturing
  - Water for drinking and domestic use

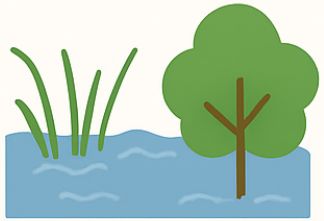
Services Provided by Vegetation

- Vegetation provides both tangible goods and essential life-support services.
- Tangible goods include:
  - Food
  - Fiber
  - Medicine



Urban effects

- Areas lacking vegetation experience higher flood risks
- Reduced infllltration capacity

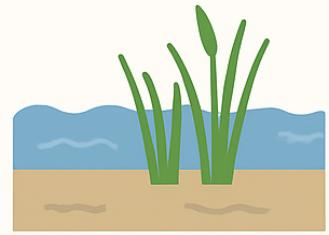


Air and water purification

- Reéd beds serve as natural buffer zones between agricultural land and rivers
- Absorbs excess nutrients fron soll water and reduces eutrophication in nearby rivers

Water regulation and replenishment

- Facilitates groundwater recharge and regulates the hydrological cycle
- Intercepts raintall
- Slows surface run off
- Allows greater infllltration into the soil
- Reduces flood risk



Flood mitigation

- Vegetation acts as a temporary store for precipitation
- Reduces rapid surface flow
- Wetlands function as natural sponges that absorb and gradually release water
- Hardwood riparian wetlands along the Mississippl River historically could store flood water for up to 60 days

Valuing Natural Capital

Valuing Natural Capital

- There are multiple approaches to valuing natural capital, depending on how the term “value” is defined.
  - Value may refer to:
    - The financial worth of a resource or asset;
    - The importance or utility of something;
    - An ethical perspective concerning what is right or wrong.
- Natural capital can be evaluated using different valuation frameworks. One common method distinguishes between use valuation and non-use valuation:
  - Use valuation refers to elements of natural capital that can be assigned a market price, such as goods and services with direct economic value.
  - Non-use valuation applies to aspects of natural capital that are difficult or impossible to quantify in monetary terms, including:
    - Intrinsic ecological rights;
    - Potential sources of future knowledge;
    - Value preserved for future generations.

Valuing Natural Capital

- Some scholars argue that assigning monetary value to non-use aspects of natural capital can help raise awareness of their importance.
  - However, others contend that such monetization risks encouraging the exploitation and commodification of natural resources.
- Assessing whether a resource can be used sustainably is essential for long-term environmental management.
  - Agriculture is often perceived as sustainable because crops are replanted after harvest.
  - True agricultural sustainability depends on:
    - Maintaining soil fertility and structure;
    - Preventing environmental degradation;
    - Preserving biodiversity.
  - If biodiversity is lost due to agricultural practices, the sustainability of agriculture itself becomes questionable.

Valuing Natural Capital

- Traditional practices such as slash-and-burn cultivation (shifting cultivation) and sporadic logging in virgin forests may be sustainable only if ecosystems are given sufficient time to recover.
  - Their sustainability depends on low human population densities and adequate recovery periods for the environment.
- Since the early 1980s, the United Nations Environment Programme (UNEP) has promoted the System of Environmental-Economic Accounting (SEEA), which integrates environmental and economic data to:
  - Evaluate natural capital;
  - Monitor resource depletion;
  - Reflect the environmental costs of degradation.
  - Including environmental degradation in national economic indicators (e.g., Gross National Product) would provide a more accurate measure of a nation's real wealth and sustainability.
- The 1992 United Nations Earth Summit in Rio de Janeiro introduced Agenda 21, a comprehensive global plan for sustainable development.
  - As part of Agenda 21, local councils were encouraged to engage with communities to develop localized sustainability strategies, collectively known as Local Agenda 21.