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Review Article

Environmental and Ecological Economics

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Abstract

Environmental economics is a concentration within the traditional field of economics that focuses on modern environmental issues. Economics is about finding the right balance between how many products can be sold and how much products and services should cost (supply and demand); environmental economics is about trying to balance the needs people have for products and services with the necessity of protecting natural resources and the environment. Many environmental economists today are taking a more ecological and holistic approach to traditional economic theories, creating two different fields in this subset of economics: environmental economics and ecological economics.

Environmental issues have broad social, cultural, and political implications beyond those found in standard economic theory. Environmental economists take these complex and inter-related issues into account when making economic policy with concern for more than basic supply, demand, and profit-maximisation. Environmental and ecological economists consider the exhaustibility of natural resources, the environmental and health benefits of alternative fuels, and the long-term costs of remediation in economic equations. They hope to make decisions that are sustainable, ecologically and socially sound.

One distinction that may be made between environmental and ecological economics is the notion of "value": environmental economists tend to focus on human preferences (demand-side), while ecological economists tend to focus on the science and environmental consequences of economic decisions (supply-side). Whilst environmental economists are concerned with the efficient allocation of natural resources, ecological economists figure out the cost-benefit of preserving or protecting natural resources.

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The Academic Requirements

While environmental and/or ecological economics is a fairly common course to find in most interdisciplinary environmental programmes, degrees and certificates in the field are not as easy to come by. However, by most accounts, it is a growing field which is becoming more and more acknowledged by academic institutions, with new programmes and courses sprouting up every year. Requirements will vary, but you can expect a firm basis in economics, ecology, environmental science, management, and quantitative methods. Classes may include mathematics, modelling, business, and other economics classes, as well as ecology, environmental science, and ecological design.

The Bureau of Labour Statistics (BLS) states that "graduate education is required for many private sector economist and market and survey research jobs and for advancement to more responsible positions". Further, the BLS states that "aspiring economists and market and survey researchers should gain experience gathering and analysing data, conducting interviews or surveys, and writing reports on their findings while in college. Those considering careers as economists or market and survey researchers should be able to pay attention to details because much time is spent on precise data analysis".

Environmental and Ecological Economics

The following are summarised:

- Dynamic modelling of ecological and economic systems
- Integrated modelling of industrial and ecological systems
- Economics of sustainability
- Green accounting
- Economics of renewable natural resources
- Natural resource policy
- Environmental policy
- Land use planning and policy
- Developing sustainable communities
- Microeconomic theory with applications to natural resources
- Risk assessment
- The environment, sustainable development, and business
- International relations and the environment

Professional Outlook

Environmental economists do the same jobs as traditional economists, except that they focus specifically on environmental issues. They try to integrate aspects of the economy that are not traditionally valued in the market; for example, the value of pristine wilderness vs. developed land, or the value of biodiversity in a forest vs. a tree plantation. They work to minimise the impact of human activities on the environment. Environmental economists address issues in many areas, including; public and private land use, soil conservation, air and water pollution control, endangered species protection, and ocean resources. Economists are usually involved in research for their company or organisation; they apply economic principles to current company policy and advise the company. They then prepare and present a report – presenting statistical information in a concise, simple manner is especially important.

Environmental economics graduates find jobs in the business, non-profit, government, and educational fields. There is certainly a need for more ecologically-minded economists in the field of education. Graduates are also needed in the policy-making and government fields, helping to make important decisions regarding resource allocation, wildlife management, and pollution control, to name a few pressing issues. Non-profit companies are also hiring environmental economists to help with sustainable development, sometimes in poor rural areas in other countries, where resource-allocation decisions are becoming a political issue for the first time. Also, consideration of environmental economics is becoming more and more important in traditional scientific fields, including jobs in parks and recreation, wildlife management, species conservation, and environmental planning.

Private businesses employ about 90% of economists, with the government employing most of the remaining 10%. The main government employers are the Departments of Agriculture, Labour and Commerce. Some work for international organisation, such as the United Nations (UN) and World Bank (WB).

Here are some job titles that we have seen, including some of the organisations that offer them, all of which included a requirement for experience in environmental or ecological economics:

- Agricultural economist
- Interdisciplinary economist
- Senior experimental economist (Commonwealth Scientific and Industrial Research Organisation)
- Environmental protection economist
- Marine resource economist
- Restorative business manager (Silva Forest Foundation)
- Senior practice leader (Stratus Consultants)
- Resource economists
- Junior professional officer (The World Conservation Union)
- Environmental economist (World Bank)
- Environmental specialists
- Staff attorney (Earth-Law)
- Plan formulator/economist (USA Army Corps of Engineers)
- Environmental/natural resource economist
- Senior/associate programme development position (The Scale Project)

Environmental Economics

Environmental Economics is a sub-field of economics that is concerned with environmental issues. Quoting from the National Bureau of Economic Research Environmental Economics Programme: **"**Environmental Economics undertakes theoretical or empirical studies of the economic effects of national or local environmental policies around the world. Particular issues include the costs and benefits of alternative environmental policies to deal with air pollution, water quality, toxic substances, solid waste, and global warming**"**.

Environmental economics is distinguished from ecological economics in that ecological economics emphasises the economy as a subsystem of the ecosystem with its focus upon preserving natural capital. One survey of German economists found that ecological and environmental economics are different schools of economic thought, with ecological economists emphasising "strong" sustainability and rejecting the proposition that natural capital can be substituted by human-made capital.

Engineering Connections

Engineers adapt designs for housing, cities and many types of buildings to specific environments and ecosystems. They use their environment, knowledge of the biosphere and the concept of ecosystems to inform their designs and shape the human-built environment. Engineers and scientists use biodomes to study ecosystems and model how living and nonliving things interact in those natural environments. They also collaborate to use this information to predict the availability of water for communities.

Introduction/Motivation

What are environments and ecosystems and why do we need to understand them? An *environment* is the surrounding area in which an organism lives, including the air, water, food and energy required for that organism to survive. An *ecosystem* includes all the living organisms and the nonliving things in an area that are linked together through the flow of nutrients and energy. On our planet, there are many different environments where organisms can live. There are mountains, valleys, trees, snow, and water environments, as well as hot and cold *climate* environments. (Conduct a class discussion [see the Pre-Lesson Assessment activities described in the Assessment section] to explore with students various types of environments and ecosystems [such as tropical rain forest, tundra, etc.] and their characteristics [climates, plants, animals, soils, weather, etc.]).

Animals, plants and other organisms have different physical *characteristics* that make them more adapted to a particular environment. However, different types of organisms can live together in similar environments. Birds have hollow bones (making them lighter) and feathers that help them to fly. Large animals need support and bone structure to walk; as a result, they have backbones and legs. Still, both of these animals might live in a forest.

Some physical characteristics make an organism less adapted for other environments. For example, whales have blubber so they can withstand cold temperatures and other mammals have thick fur, which protects them from the cold. Because of these characteristics, these animals would not survive very well in a hot desert environment. Also, some animals can adapt to changes in their environment by changing their physical characteristics or changing their surroundings. What are some things that protect us from the climate and/

or weather that we experience? (Possible answers: Warm clothing homes/buildings with heating or air conditioning; homes/buildings that can withstand wind, snow, rain or other more severe weather conditions such as earthquakes or hurricanes). *Engineers* help us design most of the things I just named! All organisms have a place in this world and are adapted to a specific *niche* or role within their environment.

Let us imagine that we are travelling through different environments on a mission to collect information about the plants, animals, weather and climate. All of these things make up the earth's *biosphere*, which contains both living and nonliving components, such as air, soil, water and sunlight (Table 1). The biosphere is the portion of the earth where life is found. It is made up of all the different environments and ecosystems. Some examples of environments found in the biosphere include tropical rain forests, deserts, other forest types (such as deciduous or coniferous), grassland prairie and arctic climates.

Ecosystem	Plants	Animals	Soil
Rain Forest	Vines Cypress trees Banana plants Liana Rubber	Monkey Jaguar Frog Anaconda	Heavy clay
Arctic tundra	Limited dwarf trees Small shrubs	Bear Lemming Mice Goats	Permafrost
Temperature	Deciduous trees Coniferous trees Agricultural products	Seagull Chipmunk	Permeable loan
Desert	Cactus Mesquite trees Sagebrush	Lizard	Sand

Table 1: Example plants, animals and soil found in different ecosystems.

Do you know what a *biodome* is? It is something that people make to *model* a particular environment and the community of organisms that live there. Engineers and scientists use *biodomes* to study ecosystems and model how living and nonliving things interact in those natural environments. Can you think of other reasons why studying the environment, climates and ecosystems, might be important to an engineer? (Possible answers: To learn how to better design structures to withstand hurricanes, earthquakes or tsunamis, as well as snow loads, flood prevention, etc.).

In this section, we are going to become engineers who create model ecosystems. We will design and create our own biodomes and watch what happens to the living and nonliving things we place in them. We will have to learn as much as possible about the environment, though, so we can design and build successful biodomes!

Vocabulary/Definitions

Biodome: A human-made, closed environment containing plants and animals existing in equilibrium.

Biome: An area with a certain set of ecological characteristics, including a specific climate, plants and animals living in it.

Biosphere: The part of the earth's atmosphere that is capable of supporting life and includes both living and non-living things.

Biotic: Pertaining to life or living organisms.

Characteristic: A distinguishing feature or quality.

Climate: The average weather, usually over a 30-year time period, for a particular region and time period. Climate is not the same as weather; it is the average pattern of weather for a particular region. Weather describes the short-term state of the atmosphere. Climatic elements include precipitation, temperature, humidity, sunshine, and wind velocity, phenomena such as fog, frost and hailstorms.

Ecosystem: A functional unit consisting of all the living organisms (plants, animals and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow. An ecosystem can be of any size — a log, pond, field, forest or the earth's biosphere — but it always functions as a whole unit.

Engineer: A person who applies scientific and mathematical principles to creative and practical ends such as the design, manufacture and operation of efficient and economical structures, machines, processes and systems.

Environment: The surroundings in which an organism lives, including air, water, land, natural resources, flora, fauna, humans, and their interrelationships. (Examples: Tundra, coniferous forest, deciduous forest, grassland prairie, mountains and rain forest.).

Equilibrium: A stable condition of being in balance.

Habitat*:* The natural home of a plant or animal.

Homeostatis: Equilibrium of an internal environment.

Model: (verb) to simulate, make or construct something to help visualize or learn about something else (as the living human body, a process or an ecosystem) that cannot be directly observed or experimented upon. (noun) a representation of something, sometimes on a smaller scale.

Niche: A unique ecological role that an organism plays in an ecosystem.

Energy Engineering or Energy Systems

Energy engineering or Energy systems is a broad field of engineering dealing with energy efficiency, energy services, facility management, plant engineering, environmental compliance and alternative energy technologies. Energy engineering is one of the more recent engineering disciplines to emerge. Energy engineering combines knowledge from the fields of physics, mathematics and chemistry with economic and environmental engineering practices. Energy engineers apply their skills to increase efficiency and further develop renewable sources of energy. The main job of energy engineers is to find the most efficient and sustainable ways to operate buildings and manufacturing processes. Energy engineers audit the use of energy in those processes and suggest ways to improve the systems. This means suggesting advanced lighting, better insulation, more efficient heating and cooling properties of buildings. Although an energy engineer is concerned about obtaining and using energy in the most environmentally friendly ways, their field is not limited to strictly renewable energy like hydro, solar, biomass, or geothermal. Energy engineers are also employed by the fields of oil and natural gas extraction.

Although sustainable development is defined in multiple ways, the most often cited definition of the term comes from the Bruntland Report titled, “Our Common Future”. According to the report, sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. From this particular definition, sustainable development can be reduced to two key concepts: needs and limitations. Needs refers to those in need—the world’s poor. The limitations are those “imposed by the state of technology and social organisation on the environment’s ability to meet present and future needs”.

The following are five examples of sustainable development that meet both those needs and limitations.

Solar Energy

The greatest advantages of solar energy are that it is completely free and is available in a limitless supply. Both of these factors provide a huge benefit to consumers and help reduce pollution. Replacing non-renewable energy with this type of energy is both environmentally and financially effective [1].

Wind Energy

Wind energy is another readily available energy source. Harnessing the power of wind energy necessitates the use of windmills; however, due to construction cost and finding a suitable location, this kind of energy is meant to service more than just the individual. Wind energy can supplement or even replace the cost of grid power, and therefore may be a good investment and remains a great example of sustainable development.

Crop Rotation

The online dictionary defines crop rotation as “the successive planting of different crops on the same land to improve soil fertility and help control insects and diseases”. This farming practice is beneficial in several ways, most notably because it is chemical-free. Crop rotation has been proven to maximise the growth potential of land, while also preventing disease and insects in the soil. Not only can this form of development benefit commercial farmers, but it can also aid those who garden at home [2].

Efficient Water Fixtures

Replacing current construction practices and supporting the installation of efficient shower heads, toilets and other water appliances can conserve one of earth’s most precious resources: water. Examples of efficient fixtures include products from the Environmental Protection Agency (EPA’s) Water Sense Programme, as well as dual-flush and composting toilets. According to the EPA, it takes a lot of energy to produce and transport water and to process waste water, and since less than one percent of the earth’s available water supply is fresh water, it is important that sustainable water use is employed at the individual and societal level [3].

Green Space

Green spaces include parks and other areas where plants and wildlife are encouraged to thrive. These spaces also offer the public great opportunities to enjoy outdoor recreation, especially in dense, and urban areas. According to the University of Wisconsin (UW) -Madison Department of Urban and Regional Planning, advantages of green spaces include, “helping regulate air quality and climate … reducing energy consumption by countering the warming effects of paved surfaces … recharging groundwater supplies and protecting lakes and streams from polluted runoff”. Research conducted in the UK. By the University of Exeter Medical School also found that moving to a greener area could lead to significant and lasting improvements to an individual’s mental health.

Here are many different origins and definitions of the term sustainable development but in 1987 the World Commission on Environment and Development’s report called the Bruntland Report is by far the best and is now one of the most widely recognised definitions.

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- The concept of ‘needs’, in particular the essential needs of the world’s poor, to which overriding priority should be given; and
- The idea of limitations imposed by the state of technology and social organisation on the environment’s ability to meet present and future needs”.

So this is all sounds great. Nice and scientific but what does this mean and what needs for our current and future life conditions are needed in order to accomplish this? Let us think out loud for a moment shall we? We need clean air to breathe and for plant life to exist. We need transportation as well. For the most part these “needs” will conflict and this is a decision that we have to make. Now take your conflicting needs and multiply them by your town/city, state, country, and world! How about a specific example? Japan’s (and most countries) need for energy relies on using nuclear power yet there is a risk to the people’s safety (and other countries) of those countries [4].

How do we as a society decide whose needs are met first? By economic status? Citizens or immigrants? People living in urban or in the rural areas? People first world countries over third world countries? You or your neighbours? The environment or the corporation? This generation or the next generation? When there has to be a trade off, whose needs should go first? These are very complex questions to answer and really they are just the tip of the iceberg when it comes to the questions that we need.

Scheme of sustainable development: at the confluence of three constituent parts. (2006) – en.wikipedia.org/wiki/Sustainable development.

To ask ourselves about sustainable development: People concerned about sustainable development suggest that meeting the needs of the future depends on how well we balance social, economic, and environmental objectives–or needs–when making decisions today.

It is amazing to see how so many things conflict with each other in the short-term yet in the long-term it works out for the best. For example, third world growth might conflict with preserving natural resources. Yet, in the long run, the responsible use of these natural resources will help ensure that there are resources available for sustained growth of these third world countries into the future [5].

So if you look at the diagram above (Figure 1) you can see that it raises a number of difficult questions. For example, can the long-term economic objective of sustained agricultural growth be met if the ecological objective of preserving biodiversity is not? What happens to the environment in the long-term if a large number of people cannot afford to meet their basic household needs today? If you did not have access to safe water, and therefore needed wood to boil drinking water so that you and your children would not get sick, would you worry about causing deforestation? Or, if you had to drive a long distance to get to work each day, would you be willing to move or get a new job to avoid polluting the air with your car exhaust? If we do not balance our social, economic, and environmental objectives in the short-term, how can we expect to sustain our development in the long-term?.

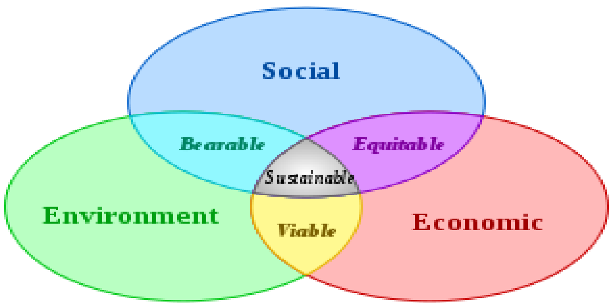

Figure 1: Sustainable development and environment.

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