



Review Paper

Biodiversity loss and its economic costs: a global perspective

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Abstract

This article reviews the economic costs of global biodiversity loss using existing literature. Biodiversity loss poses a major threat to the global economy, with estimated annual costs in the trillions of dollars. These costs primarily result from the loss of ecosystem services, such as food and water provision, carbon sequestration, regulation of climate, pests, and diseases. For example, Honeybee extinction from habitat loss and pesticide use may have significant economic consequences. They play a vital role in pollinating crops, supporting the global food supply and agricultural economy. Bee pollination is valued at \$235-\$577 billion globally and around \$15 billion to the US agricultural sector per year. The article also highlights that developing countries bear most of the economic costs associated with biodiversity loss. The conclusion emphasizes the urgent need for global action through targeted policies, regulations, public awareness, education, investment in conservation and restoration efforts to preserve ecosystem services. In this article we suggest that addressing biodiversity loss and resolving this issue with preservation and other means will not only benefit the environment but also promote sustainable economic growth and human well-being.

Keywords: Global biodiversity loss, Economic costs, Ecosystem services, Honeybee extinction, Conservation and restoration efforts.

Introduction

The variety of living things on Earth, such as plants, animals, and microorganisms, is known as biodiversity, as well as the ecosystems they inhabit. It is a fundamental component of the natural world, and it plays an essential role in sustaining the planet's ecological balance. Biodiversity provides numerous benefits to human society, including food, medicine, raw materials, and cultural and recreational opportunities. In order to maintain ecosystem services including pollination, water purification, carbon sequestration, and climate regulation, biodiversity is crucial. One of the biggest dangers to biodiversity is human activities, such as deforestation, overfishing, pollution, and climate change. These activities are causing unprecedented rates of biodiversity loss worldwide. Over one million species are at risk of extinction, many within the next few decades, according to a report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). This loss of biodiversity poses a major threat to the global economy, with estimated annual costs in the trillions of dollars¹.

The loss of biodiversity can impact numerous sectors of the economy, including agriculture, forestry, fisheries, and tourism. For example, the absence of pollinators like bees and butterflies can have a considerable negative influence on agricultural output. Many crops depend on pollinators to reproduce, and the absence of these species can result in lower yields, reduced

quality, and higher costs for farmers. In addition, the loss of biodiversity can lead to reduced water quality, soil erosion and the spread of invasive species, all of which can impact agriculture and other industries. Forests, another crucial component of biodiversity, provide numerous services of ecosystem, which includes water regulation, carbon sequestration, the provision of timber and other forest products. However, deforestation, driven by agricultural expansion, logging, and other human activities, is causing significant losses in forest biodiversity. This loss of biodiversity can lead to decreased forest productivity, increased carbon emissions, and reduced water quality, among other impacts. Biodiversity loss also has significant impacts on the marine environment. Overfishing, habitat destruction, and pollution are causing declines in marine biodiversity, with potentially catastrophic consequences for the global economy².

According to the World Wildlife Fund report, the world's fish stocks could collapse by 2048, resulting in significant economic losses for the numerous communities that rely on the fishing sector for their livelihoods. The loss of coral reefs, which provide numerous ecosystem services, including fisheries, coastal protection, and tourism, could result in economic losses of up to \$1 trillion per year by 2100. Biodiversity loss also poses a significant threat to human health. Many medicines and other pharmaceutical products are derived from natural sources, and the loss of biodiversity can limit our ability to discover new treatments and cures³.

The risk of infectious diseases and other health issues can rise if ecosystem services like disease control and water filtration disappear. Developing countries, in particular, bear a disproportionate burden of the economic costs associated with biodiversity loss. These countries often rely heavily on natural resources for their economic development, and the loss of biodiversity can have significant impacts on their economies and societies. For example, a decline in forest biodiversity may result in lower productivity and greater sensitivity to climate change, both of which can impact the livelihoods of millions of people. Therefore, preserving ecosystem services and biodiversity it provides is crucial for sustaining economic growth and human well-being, both now and in the future. There are many strategies for preserving biodiversity, including protected areas, ecosystem restoration, sustainable agriculture, and the conservation of endangered species. In addition, promoting public awareness and education on biodiversity conservation⁴.

Objectives: The objective of the article are as follows: i. To provide a comprehensive review of the existing literature on the economic costs of global biodiversity loss and its impact on the global economy. ii. To examine the causes of biodiversity loss and the associated economic costs, focusing on the ecosystem services loss. iii. To highlight the economic significance of specific examples of biodiversity loss, such as the decline of honeybees and its effect on agriculture and global food supply. iv. To analyse the distribution of economic costs associated with biodiversity loss, with a particular focus on the disproportionate impact on developing countries. v. To emphasize the need for targeted policies, regulations, public awareness, education, and investment in conservation and restoration efforts to preserve ecosystem services and mitigate the economic costs of biodiversity loss. vi. To illustrate the potential benefits of addressing biodiversity loss, including the promotion of sustainable economic growth and human well-being⁵.

This piece attempts to increase public awareness of the financial implications associated with the loss of biodiversity worldwide and the immediate need for action to protect ecosystem services. By providing a comprehensive review of the existing literature, examining specific examples, and analysing the distribution of economic costs, we hope to contribute to the development of effective policies and strategies to mitigate the negative impacts of biodiversity loss and promote sustainable economic growth.

Economic costs of biodiversity loss

Biodiversity loss refers to the decline or extinction of species and ecosystems that provide various services to humans, such as food, medicine, and tourism. The economic costs of biodiversity loss are the negative impacts on the economy, society, and human well-being caused by the loss of biodiversity. The large and varied literature on the monetary costs of biodiversity loss covers a wide range of topics and points of view.

The evaluation of ecosystem services and biodiversity is a crucial field of research. This involves assessing the economic value of natural resources and ecosystems, such as forests, wetlands, and coral reefs, based on their contribution to human well-being. According to studies, the economic worth of biodiversity and ecosystem services can reach trillions of dollars or even surpass the world's gross domestic product⁶. The effects of biodiversity loss on many economic sectors are a crucial field for investigation. In agriculture, for example, the loss of pollinators like bees can have a large financial impact because it lowers crop yields and raises the price of pollination services. The loss of fisheries can also have significant economic impacts, as it reduces the availability of fish for consumption and commercial purposes.

The literature also covers the indirect economic impacts of biodiversity loss, such as the effects on human health, cultural values, tourism. For example, the loss of biodiversity can increase the spread of infectious diseases, reduce the attractiveness of natural areas for tourism, and erode cultural traditions and practices that rely on biodiversity. Moreover, the literature also explores the economic and policy instruments that can be used to address biodiversity loss. These instruments include of both regulated and unregulated methods, such as protected areas and species-specific conservation programmes, such as payments for ecosystem services and biodiversity offsets⁷.

Ecosystem services and their economic value

The advantages that come from natural ecosystems to humans are called ecosystem services. These services include the control of climate and natural disasters, the provision of clean air and water, fertile soil, crop pollination, and more. Ecosystem services are essential to human welfare and the operation of our economies, despite the fact that they are commonly taken for granted. The economic value of ecosystem services is the monetary or market value of these benefits. The cost of the crops that bees pollinate, like blueberries or almonds, could be used as a proxy for the pollination services provided by bees. The importance of the economic value of ecosystem services lies in the fact that it aids in our comprehension of the worth of protecting natural ecosystems and guiding our usage decisions⁸. There are numerous techniques to determine the economic worth of ecosystem services. Utilising market-based techniques, such as determining the value of fisheries or timber, is one typical strategy. Another tactic is to use non-market valuation methods that gauge how much individuals value ecosystem services based on their willingness to pay for them or the expense of accessing them. These methods include contingent valuation and trip cost analysis. Understanding the economic value of ecosystem services is crucial for making informed decisions about land use, conservation, and development. It can help policymakers and businesses to prioritize conservation efforts and make more sustainable decisions that balance economic development with the protection of natural resources⁹.

Here are some examples of ecosystem services lost due to biodiversity loss and their estimated economic costs:

Pollination: Pollinators such as bees, butterflies, and birds play a crucial role in plant reproduction and the production of many crops that we rely on. It's estimated that pollinators contribute \$235 to \$577 billion in global crop output annually. However, due to biodiversity loss, populations of some pollinator species are declining, which could lead to lower crop yields and higher food prices.

Water purification: Wetlands, forests, and other natural ecosystems filter and purify water, making it safe for human consumption. The cost of water treatment to replace this service is estimated to be \$2.2 trillion annually¹⁰.

Climate regulation: Natural ecosystems such as forests, oceans, and wetlands help regulate the Earth's climate by storing carbon and producing oxygen. However, as biodiversity is lost, the ability of these ecosystems to store carbon decreases. It's estimated that the cost of climate change caused by deforestation and other land-use changes could reach \$3.3 trillion annually by 2030.

Soil fertility: Biodiversity loss can lead to soil degradation, reducing its fertility and agricultural productivity. The cost of soil erosion and degradation is estimated to be \$300 billion annually.

Disease regulation: Biodiversity loss can increase the risk of zoonotic diseases (diseases that spread from animals to humans). For example, habitat loss and deforestation can bring people and wild animals closer together, raising the risk of disease transmission. Zoonotic disease epidemics can have significant financial and health consequences for people. For instance, the COVID-19 epidemic is thought to have cost trillions of dollars¹⁰.

Table-1: Ecosystem services and their economic value¹⁰.

Ecosystem Service	Example	Estimated Economic Cost
Pollination	Declining populations of pollinators	\$235 to \$577 billion annually in global crop output
Water purification	Loss of wetlands and other natural filters	\$2.2 trillion annually for water treatment
Climate regulation	Deforestation and land-use changes	Up to \$3.3 trillion annually by 2030 for climate change
Soil fertility	Soil degradation and reduced agricultural productivity	\$300 billion annually

These are just a few examples of ecosystem services lost due to biodiversity loss and their estimated economic costs. The true cost of biodiversity loss is difficult to quantify, but it's clear that the economic impacts are significant and far-reaching. Protecting biodiversity and the ecosystems that support it is essential for both ecological and economic reasons. In Table-1 Ecosystem services and their economic values are explained.

The disproportionate impact of biodiversity loss on developing countries

Biodiversity loss affects all countries; developing countries are often disproportionately impacted due to a variety of factors. Firstly, many developing countries rely heavily on natural resources such as forests, oceans, and wetlands for their livelihoods, including food, medicine, and building materials. As biodiversity is lost, the capacity of these ecosystems to support human needs is reduced, often leading to economic and social impacts. Secondly, many developing countries have less capacity to adapt to the impacts of biodiversity loss, such as changes in weather patterns, water availability, and food production. These countries may have less access to technology and resources to adapt and mitigate the negative effects of biodiversity loss¹¹. Thirdly, biodiversity loss can exacerbate existing inequalities within developing countries, particularly for marginalized communities who depend on natural resources for their survival. As these resources become scarce or degraded, these communities may face increased food insecurity, poverty, and health risks. Overall, the disproportionate impact of biodiversity loss on developing countries underscores the importance of global efforts to protect and conserve biodiversity, including reducing greenhouse gas emissions, protecting critical ecosystems, and promoting sustainable development practices that support biodiversity conservation and equitable economic growth¹¹.

Case study: Honeybee extinction and its economic consequences

One case study of the importance of honeybees in pollinating crops and supporting the global food supply and agricultural economy can be seen in the almond industry in California, which is the world's biggest producer of almonds. Almonds are entirely dependent on honeybees for pollination, and each year over one million honeybee colonies are brought to California specifically to pollinate the almond trees during the bloom period. This equates to about 80% of the world's honeybee population being brought to California for this purpose¹². Without honeybees, almond trees would not produce any nuts, and the almond industry would collapse. This would have significant economic impacts, as the almond industry in California alone contributes over \$11 billion to the state's economy and creates over 100,000 jobs. Honeybees also play a critical role in pollinating many other crops, including apples, cherries, blueberries, and cucumbers, among others.

Without honeybees, these crops would be unable to reproduce, leading to reduced yields and potentially even crop failures. As a result, there can be a lack of food supply, increased food costs, less economic growth, and fewer jobs in the agricultural industry¹³. The importance of honeybees in pollinating crops and supporting the global food supply and agricultural economy is further highlighted by their role in supporting wild plant and animal populations. Honeybees are an important part of many ecosystems, providing pollination services to a wide range of plants. Their loss could result in decreased biodiversity and ecosystem stability, as well as impacts on other pollinators and wildlife that depend on honeybees for food. To address the threats facing honeybees and support their critical role in pollinating crops and supporting the global food supply and agricultural economy, it is important to promote sustainable land use practices, protect natural habitats that support honeybee populations, and reduce the use of harmful pesticides. By taking steps to safeguard honeybees and their habitats, we can make sure that our agricultural systems and ecosystems remain healthy and productive¹⁴.

Causes and Consequences of Honeybee Extinction

The honeybee extinction crisis is a growing concern in recent years due to the important role that honeybees play in pollination, which is essential for food production and the overall health of ecosystems. There are many factors that contribute to honeybee extinction, including habitat loss and pesticide use. Habitat loss is a biggest cause of honeybee extinction, as it reduces the amount of available forage for bees. This is particularly problematic for honeybees because they require a variety of flowers to provide them with the nectar and pollen they need to survive. As urbanization and agricultural expansion continue to increase, honeybee habitats are being destroyed at an alarming rate, leaving fewer areas for bees to feed and reproduce¹⁵. Pesticide use is another major cause of honeybee extinction, as many chemicals used to control pests and weeds are toxic to bees. These substances have the potential to harm bees directly or compromise their immune systems, leaving them more vulnerable to illness and other environmental stresses. So, pesticides can contaminate the nectar and pollen that bees collect, which can have negative effects on their health and behaviour¹⁶. Colony Collapse Disorder (CCD), a phenomenon that has been seen over the globe since the early 2000s, serves as a case study for the disappearance of honeybees. The unexpected disappearance of entire bee colonies, leaving only a few worker bees and a queen behind, is the hallmark of CCD. Climate change, pesticide use, disease, and habitat loss are among of the causes that researchers think contribute to CCD¹⁷. The effects of honeybee loss are profound and widespread. Many of the most significant crops in the world, such as fruits, vegetables, and nuts, are pollinated by honeybees. Food production would suffer greatly without honeybees, possibly resulting in scarcities, price increases, and unstable economies. Honeybees are essential for the production of food, but they are also essential for the maintenance of

healthy ecosystems because they pollinate wildflowers and other plants that serve as habitat for other creatures. So, the extinction of honeybees is a serious concern with far-reaching consequences. The loss of these important pollinators can have a significant impact on food production, ecosystem health, and global economies. To address this issue, it is important to reduce habitat loss, minimize pesticide use, and promote sustainable agricultural practices that support healthy honeybee populations¹⁸.

Estimating economic costs of honeybee extinction: A Global and National Perspective

At the global level, the estimated economic cost of honeybee extinction is in the range of \$235 billion to \$577 billion annually. This cost includes the loss of pollination services provided by honeybees, which would result in reduced crop yields and higher food prices. The cost also includes the loss of honey and other bee products, as well as the cost of replacing honeybees with alternative pollinators or pollination methods¹⁹. At the national level, the economic costs of honeybee extinction can vary depending on the country's agricultural dependence on pollination services. For example, in the United States, the economic value of honeybee pollination services is estimated to be around \$15 billion annually, with crops such as almonds, apples, and blueberries heavily dependent on bee pollination. The loss of honeybee pollination services could lead to reduced crop yields and higher food prices, as well as job losses and economic instability in rural areas. So, the economic costs of honeybee extinction are significant and should not be overlooked. The use of pesticides should be reduced, honeybee habitats should be protected, and sustainable farming practices should be promoted in order to address the decline in honeybee populations. A greater knowledge of these costs can guide policy decisions and encourage these activities²⁰.

Overview of existing policies and initiatives aimed at preserving biodiversity and ecosystem services

There are a variety of policies and initiatives that have been developed to address biodiversity loss and ecosystem degradation. Some of the key examples include:

Protected areas: These are designated areas where natural resources are conserved and protected. Protected areas can include national parks, wilderness areas, and wildlife refuges, among others. These areas can help preserve biodiversity and ecosystem services by providing a safe haven for species and ecosystems²¹.

Ecosystem restoration: This involves the process of returning degraded ecosystems to a healthier and more functional state. This can include efforts to restore wetlands, forests, and other ecosystems that have been impacted by human activity.

Sustainable agriculture: This involves practices that promote sustainable land use and protect biodiversity. This can include techniques like crop rotation, agroforestry, and integrated pest management²².

International agreements: Objectives of international agreements like the Convention on Biological Diversity and the Paris Agreement on climate change include the protection of ecosystems and global biodiversity.

Sustainable development goals: The Sustainable Development Goals (SDGs) of the United Nations include a variety of targets relating to biodiversity conservation, such as goals to safeguard terrestrial and aquatic ecosystems, expand protected areas, and advance sustainable agriculture.

Payments for ecosystem services: This involves compensating landowners and communities for the ecological services their land provides, such as carbon sequestration, water filtration, and wildlife habitat²³.

Evaluation of policy effectiveness in reducing economic costs of Biodiversity loss

The effectiveness of policies and initiatives aimed at preserving biodiversity and ecosystem services can vary depending on various factors such as implementation, enforcement, and stakeholder engagement. However, studies have shown that over time, these initiatives and policies can lower the financial costs of biodiversity loss.

For instance, it has been discovered that protected areas offer a variety of ecosystem services, such as carbon sequestration and water purification, which can significantly boost local economies and communities. Similarly, ecosystem restoration can improve the productivity and resilience of ecosystems, leading to increased economic benefits such as increased crop yields and reduced flooding²⁴.

Sustainable agriculture practices can also lead to improved soil health, reduced use of chemical inputs, and increased biodiversity, which can reduce long-term economic costs associated with soil degradation and loss of pollinators. International agreements and sustainable development goals can help promote coordinated action at a global level, which is crucial for addressing the drivers of biodiversity loss, such as climate change and unsustainable resource use²⁵.

Payments for ecosystem services can incentivize landowners and communities to protect and restore ecosystems, while also generating economic benefits for those who provide the services. So, even though policies and initiatives to protect biodiversity and ecosystem services may or may not be effective, they have the potential to lower long-term economic costs associated with biodiversity loss while also encouraging sustainable use of natural resources for future generations²⁶.

Challenges and Opportunities for Biodiversity Conservation Policies and Awareness

There are several challenges and opportunities for implementing effective policies and promoting public awareness and education on biodiversity conservation.

Challenges: Limited funding: Lack of funding is a major challenge in implementing effective policies and initiatives. It can limit the capacity of organizations and governments to implement conservation measures²⁷.

Resistance to change: Resistance to change is another challenge, as many people and organizations may be reluctant to alter their behavior or practices that contribute to biodiversity loss.

Complex issues: Biodiversity conservation is a complex issue that involves multiple stakeholders and requires a multidisciplinary approach. This can make it difficult to develop and implement effective policies²⁸.

Opportunities: Public awareness and education: Raising public awareness and educating people about the importance of biodiversity conservation can create opportunities for engagement and support for conservation measures²⁹.

Innovation and technology: Advances in technology and innovation can provide new opportunities for conservation, such as using drones and satellite imagery for monitoring ecosystems and using artificial intelligence to predict and prevent biodiversity loss³⁰.

Collaboration and partnerships: Collaboration and partnerships between governments, NGOs, and the private sector can facilitate the development and implementation of effective policies and initiatives.

Incentives: Providing incentives for conservation, such as tax breaks or subsidies, can encourage individuals and organizations to take action to protect biodiversity³¹.

So, addressing the challenges and taking advantage of opportunities can help to promote effective policies and initiatives for biodiversity conservation, while also increasing public awareness and support for conservation measures.

Conclusion

The current rate of biodiversity loss is unprecedented in human history and poses a significant threat to the well-being of our planet and its inhabitants. Ecosystem services that are vital for human survival, such as clean air and water, food and fiber production, and climate regulation, are being compromised as a result of this loss. The decline of species and ecosystems, combined with other global issues such as climate change, poses significant challenges to human societies and economies.

Global effort is urgently required to combat biodiversity loss and maintain ecological services. All individuals, groups, organisations, and governments must work together to accomplish this. In order to support the preservation and sustainable use of biological diversity, the United Nations recognised this need and founded the Convention on Biological Diversity (CBD). Protecting and restoring natural ecosystems is one of the most important steps that must be taken to address biodiversity loss. By creating protected areas, employing sustainable land-use methods, and restoring harmed ecosystems, this can be accomplished. Additionally, it is crucial to lessen and mitigate the effects of human activities like habitat destruction, excessive resource use, and pollution. Increasing public understanding of the significance of biodiversity and ecosystem services is another crucial effort. This may encourage people to act in their daily lives and advance a culture of conservation. Encouraging sustainable consumption patterns and supporting local and sustainable food production can also contribute to the conservation of biodiversity. Furthermore, international cooperation is essential in addressing biodiversity loss.

Governments need to work together to establish and implement effective policies and strategies to protect biodiversity and promote sustainable development. Funding for conservation and research needs to be increased, and technology and innovation should be used to support conservation efforts. The deterioration of ecosystem services and loss of biodiversity are serious problems that demand immediate attention and urgent worldwide response. The protection and restoration of natural habitats, public education and awareness, sustainable consumption, and international cooperation are all essential components of addressing this challenge. By taking collective action, we can mitigate the negative impacts of biodiversity loss and ensure a healthy and resilient planet for future generations. In conclusion, biodiversity conservation can provide numerous benefits for sustainable economic growth and human well-being.

Conservation activities can encourage the wise use of natural resources, improve ecosystems' resistance to environmental change, and support the preservation of the benefits that these resources offer to human communities. Biodiversity also provides direct economic benefits, such as the production of food, medicines, and other goods, and supports industries such as tourism and recreation. Conserving biodiversity can therefore contribute to economic growth and development by promoting sustainable use and management of these resources. In addition to economic benefits, conservation of biodiversity can also have significant positive impacts on human well-being. Natural ecosystems provide a range of services such as clean air and water, climate regulation, and protection against natural disasters, all of which are essential for human survival and health.

Conservation efforts can therefore contribute to improved human health and well-being, particularly for marginalized communities who are often the most reliant on ecosystem services. Furthermore, the protection and restoration of biodiversity can also have cultural and spiritual significance for many societies, contributing to a sense of identity and connection to the natural world. Conserving biodiversity can also support traditional knowledge and practices that have been developed over generations. In summary, the conservation of biodiversity can provide a range of benefits for sustainable economic growth and human well-being. It is essential that we recognize and prioritize these benefits in our efforts to address biodiversity loss and promote sustainable development. By conserving biodiversity, we can create a more sustainable and equitable future for all.

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