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Review Article

Effect of Built Environment on Biodiversity

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Abstract

The aim of this paper is to establish a broad overview of the impact which urban areas have on biodiversity and to determine the major impacts that biodiversity loss and ecosystem degradation have and will have on the built environment. Common built environment responses to these impacts will also be studied. Regenerative design that uses the ecosystem services analysis method is proposed as a way of responding to biodiversity loss while simultaneously addressing climate change and adaption in a built environment. This is studied for potential benefits and disadvantages.

Keywords: Biodiversity; Ecology; Environment; Natural Resources

Introduction

Built environment responses to biodiversity loss.

The built environment could contribute to reducing biodiversity loss in at least four main ways.

Figure 1

How is the loss of biodiversity affecting ecosystems:

Ecosystem effects of biodiversity loss could rival impacts of climate change and pollution.

ANN ARBOR—Loss of biodiversity appears to impact ecosystems as much as climate change, pollution and other major forms of environmental stress, according to a new study from an international research team.

The effect of ecosystem destruction are the following: Increased flooding due to the erosion of soil and lack of trees; Rising of the sea levels due to the melting of the glaciers, caused by Global Warming; Disruption of the food chain when the apex predators become extinct.

The Role of Ecology in Our Lives. The many specialties within ecology, such as marine, vegetation, and statistical ecology, provide us with information to better understand the world around us. This information also help us improve our environment, manage our natural resources, and protect human health.

Ecological degradation

In general terms, the cause of ecosystem degradation and loss is often due to a failure to appreciate the full value of beneficial functions provided by such systems. These include: sustaining biodiversity, storage of sediment, flood defense and storm buffering, maintenance of water quality, and support of commercial coastal and marine food chains. Many of the processes and the functioning of estuarine systems have been described in previous chapters of this volume, so we will focus on some of the direct management implications of maintaining and restoring intertidal systems.

Ecosystem Degradation Leads to Four Losses; Restoration Delivers Four Returns

- **Inspirational capital:** People engagement, innovation, awareness, and passion
- **Social capital:** Jobs, income, security, and social cohesion
- **Natural capital:** Fertile soils, hydrology, biodiversity, biomass, and carbon storage
- **Financial capital:** Financial performance (e.g., increases in agriculture, timber, water production) and demonstrable CSR.

Responses to ecosystem degradation in the built environment

Although urban areas cannot alone solve all of the identified causes of biodiversity loss, the way people build and inhabit the built environment contributes to the causes of biodiversity loss and may also potentially begin to address these problems [1]. The urban built environment is the main site of human economic, social and cultural life in terms of both magnitude and significance. More than half of all humans now live in urban built environments, a figure predicted to rise to 60% by 2030 [2]. It is also where nations invest large amounts of money and resources in terms of energy and materials [3]. It is important then that the built environment contributes to the causes of biodiversity but loss 1 it also able to adapt to its impacts.

Typical responses to addressing the loss of biodiversity in a built environment context are:

- Protection or conservation of remnant ecosystems through covenants or nature reserves,
- Provision of connections between remnant habitats to reduce fragmentation,
- Restoration of degraded ecosystems, and
- Management of urban vegetation and/or structure to increase biodiversity.

Actions that target education, policy changes, and economic penalties or rewards can also result in biodiversity benefits but are considered to be outside the scope of this paper.

The relationship between responses to climate change and biodiversity health in a built environment context

Responses to climate change and the loss of biodiversity vary. It is important that responses are complementary rather than antagonistic in addressing these two issues. Site selection and management practices are crucial to determining whether activities related to climate mitigation, such as land-use change, reforestation or conservation, and renewable energy generation, will affect biodiversity positively or negatively [4]. It is important that responses take into account interactions between drivers of change over long time periods, to ensure that actions are beneficial in both reducing climate change and maintaining biodiversity. Management of single drivers is unlikely to be adequate [5], while the effectiveness of strategies can be enhanced when they are part of broader approaches to address other impacts of global change [4]. For example, increases in the production of biofuel can be positive within a climate change mitigation agenda because biofuel can replace fossil fuels in some instances and therefore reduce GHG emissions, but from a biodiversity point of view, increased crop production of a variety of oils and fuels has meant the destruction of existing ecosystems to provide land for the crops [6]. This has had severe negative biodiversity implications for certain places in Asia, for example [7]. In contrast, protecting or regenerating native area on degraded land to provide carbon sinks is likely to have biodiversity benefits if these are considered at the planning stage. However, the creation of carbon sinks does not address the use of fossil fuels, or provide an alternative to their use.

Regenerative design: responding to biodiversity loss and climate change simultaneously

Because there is a synergistic relationship between climate and ecosystems [8-10], additional strategies to address the causes and impacts of climate change may be found by reducing the loss of biodiversity and working to restore the health of ecosystems (Figure). This would at the same time restore or create ecosystem services and can addqresilience [7,11,12].

Many current biodiversity loss and climate change mitigation and adaptation strategies can be described as 'sustainable'. While this is an improvement on design that does not consider environmental impacts at all, 'sustainable' design nevertheless tends to result in negative environmental impact [13]. Sustainable design seeks to minimize pollution rather than achieving clean air, soil and water; it minimizes energy use, rather than using energy from non-damaging renewable sources; it minimizes waste rather than eliminating it altogether by creating positive cycles of resource use; and so on. Within this paradigm, the built environment continues to degrade the ecosystems and climate on which humans are dependent for their well-being, wealth, and basic survival. Currently, most urban environments are built in such a way that the outcome is detrimental to climate, ecosystems, and therefore to people, rather than nearing even approximate 'sustainability' [14].

Relationship between humans, ecosystems and climate

The link between climate change and biodiversity has long been established. Although throughout Earth's history climatic conditions has always changed with ecosystems and species coming and going, rapid climate change affects ecosystems and species ability to adapt and so biodiversity loss increases.

Ecosystem services are the benefits that people obtain from ecosystems. From the availability of adequate food and water, to disease regulation of vectors, pests, and pathogens, human health and well-being depended on these services and conditions from the natural environment.

Natural changes that can affect an ecosystem. Wind, rain, predation and earthquakes are all examples of natural processes which impact an ecosystem. Humans also affect ecosystems by reducing habitat, over-hunting, and spreading pesticides or fertilizers, and other influences.

Climate change not only affects ecosystems and species directly, it also interacts with other human stressors such as development. Although some stressors cause only minor impacts when acting alone, their cumulative impact may lead to dramatic ecological changes.

Healthy ecosystems clean our water, purify our air, maintain our soil, regulate the climate, recycle nutrients and provide us with food. They provide raw materials and resources for medicines and other purposes.

As a society, we depend on healthy ecosystems to do many things; to purify the air so we can breathe properly, sequester carbon for climate regulation, recycling nutrients so we have access to clean drinking water without costly infrastructure, and pollinate our crops so we don't go hungry.

Human activities contribute to climate change by causing changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness. The largest known contribution comes from the burning of fossil fuels, which releases carbon dioxide gas to the atmosphere. Following are the seven aervices2ervices, or bundles of services which are identified as appropriate for inclusion in an ecosystem services analysis methodology:

1. Habitat provision (including genetic information, biological control, fixation of solar energy, and species maintenance);
2. Nutrient cycling (including decomposition, soil building, and raw materials);
3. Purification;
4. Climate regulation;
5. Provision of fuel/energy for human consumption;
6. Provision of fresh water; and
7. Provision of food (including provision of biochemicals)

Conclusion

Addressing the decline in ecosystem health and loss of biodiversity in terms of both scale and scope needs many solutions to fit the vast variety of political, economic, cultural, climatic, and ecological conditions within which humans dwell. Much like climate change, it is an urgent task of great magnitude with uncertain outcome. Strategies that employ the medium of the built environment to effect change could be one such set of solutions. If the dominant economic philosophies and structures of human society and their resulting behaviors do not or cannot change in the short to medium term, it is doubtful that new or existing forms of design thinking and practice, or new technologies will alone be able to create significant change, before humanity is severely affected by the degradation of ecosystems and changes in climate [15,16].

Because of the great variation of impacts in different locations, responses to biodiversity loss should be tailored to specific urban environments. Responses to climate change and to biodiversity issues also need to be considered together so that actions taken are beneficial for both climate and ecosystems, rather than antagonistic. Regenerative design could be investigated further for its ability to enable the built environment to address climate change and biodiversity loss. A shift from a built environment that is degenerating ecosystems to one that regenerates capacity for ecosystems to thrive, will not be a gradual process of improvements, but will require fundamental rethinking of architectural and urban design.

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