Lecture 13: Ecosystem Services

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This lecture will talk about what ecosystem services are the ideas and the key points around them. The next lecture will talk more practically about valuing ecosystem services or natural capital as it is now.

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The learning outcomes: we should be able to name the four types of ecosystem services.

We should understand how the Millennium Ecosystem Assessment shaped current understanding of the importance of ecosystem services.

We should understand the relevance to the sustainable development goals. And finally, we should be able to define multifunctionality and explain why it is important in meeting environmental goals.

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Loss of ecosystems has been widespread and incredibly damaging, resulting in changes in land use to meet rapidly increasing requirements for food, water, space and fuel. Over the last century, there has been an incredibly rapid change in human wellbeing and economic development, but the costs to biodiversity are increasing leading to global alarm. There is a huge challenge in reversing ecosystem degradation, while still meeting the needs of the people who live there. This balancing act is possible, but may result in significant changes in policies institutions and practices. By 1990, more than two thirds of the area of two biomes and over half of four more had been converted.

The dark parts of the bars are the projections for 2050 but note that this paper came out in 2005. I can't find any updated graphs like this one. So these estimates may be a bit off. I also want you to notice that projected increase in temperate woodland by 2050. This is probably due to efforts to create new natural forest and also the widespread plantations for forest products.

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The tragedy of the commons is a concept coined by Hardin in 1968. He noted that the human population was growing at an enormous, apparently exponential rate, according to the principles of Malthus. Hardin’s example is a field that is open to everybody. You would expect each herdsman to try to keep as many cows as possible on the field. He will ask, what is the cost-benefit to keeping one more cow on the land? The benefit is the profit from one more cow. He will get all of this profit. The cost is a function of the additional overgrazing by one more animal. But this cost is shared between all the herdsmen. So the cost to our first herdsmen is less than the benefit. Each herdsman will think the same thing. So all will keep adding cows, they will keep on until the resource is ruined.

Essentially this principle can be applied to the entire Earth. The use of our natural resources needs to be regulated and used sustainably, and governments and non-governmental organizations have been trying to achieve this for many years. A good example is greenhouse gas regulation. Repeated world summits have resulted in virtually no action and missed targets. Governments argue over whose responsibility it is to reduce greenhouse gas emissions and whose economy can afford to shrink in the pursuit of this reduction. The result is very little change.

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In order to begin to assess how to preserve ecosystems and to know if they have been degraded, we need to put in place a framework. Ecosystem services are defined as the benefits people get from ecosystems. These are closely linked with human wellbeing. We are viewing the services through the lens of what we need to survive, but also what we need to have a good quality of life. And this includes culture, spirituality and our enjoyment of the natural world.

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Energy and material inputs originate from the sun. Ecosystem services are underpinned by the ecosystem, such as air, water, soil and so on and natural processes, also known as ecosystem functions which are things like nutrient cycling, production of biomass and so on.

Ecosystem services are things that people derive a direct benefit from like pollinating crops, pest control, growth of crops and livestock. There are those types of services that we can get a clear economic value from, and others that are less easy to find you, where we get wellbeing benefits. These are just as important as the economic benefits.

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We can divide ecosystem services into four types. The first is provisioning services and this is things like food, water, clean air and so on. The second is regulating services. This is regulation of ecosystem processes such as pollination and climate regulation. The third is cultural services. This is the one that is quite hard to value it is things like recreation, aesthetic experience and spiritual enrichment. The fourth supporting services and these will help us gain all of the other benefits and this is things like soil formation and nutrient cycling.

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I will talk more about valuing ecosystem services in the next lecture. But for now, the importance of each type of service has traditionally been viewed through their market value or some kind of obvious benefit to people, like heritage sites or tourist spots. Increasingly, people are realizing that there are benefits to these ecosystem services that are maybe not appreciated until they are gone. Collapse of bee populations is a good example. These pollinate a lot of our food plants, but they are declining in numbers due to widespread use of neonictinoid pesticides. In some areas, these have been banned, but some large companies are seeking legal challenges. There is often a lack of long term thinking which contributes to the tragedy of the commons.

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These are the other two types of ecosystem service just to complete the set. There is a problem with decision making. Generally, that it tends to be very short term. This could be for many reasons. For example, in many countries political parties change often, and so the decisions may change when the next group comes to power. Many land practices are grant or project based and so only have a certain lifetime. This can cause problems for long term effective changes to be made and the benefits to be seen. Remember how the lynx and the snowshoe hare had an eight to 11 year cycle, and Krebs needed to do an experiment that was eight years long to see the cycle. Well, many projects or initiatives are only a few years- if that had been the case Krebs would never have seen the results that he did.

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The Millennium Ecosystem Assessment in 2005 was designed to be the largest assessment of the health of our world ecosystems. It was called for by the UN in the year 2000 and was a partnership between UN agencies, governments, businesses and many other groups. It was prepared by over 1000 experts from 95 countries and was extensively and rigorously reviewed. It was intended to evaluate, not only the state of the environment, but also what we knew about the consequence of ecosystem changes for human wellbeing.

The main highlights were that over the last half of the 20th century, humans have made enormous and irreversible changes to natural ecosystems and that there was substantial loss to life on Earth. There were also very important points about trade-offs between ecosystem services, and that if we focus too much on the ecosystem service with the most obvious and immediate value to us, we risk suddenly losing others that we didn't even know we needed. Therefore, we need to direct our efforts and resources into maintaining as many ecosystem services as possible at the same time.

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The Millennium Ecosystem Assessment also highlighted that extinction rates of animals have been up to 1000 times what the background rate would be based on the fossil record. The y axis is a logarithmic scale. So it really is very high. But that's not all - future extinctions could go up another 10 times.

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The good news is that the changes we have made to ecosystems have improved human wellbeing all over the world. We have a hugely increased population and have produced more food, fuel and power to be able to accommodate it. Quality of life has vastly improved in almost every way. But we need to be aware that much of this is unsustainable and that measures need to be taken to use ecosystems well, so that future generations do not experience a loss of quality of life. 60% of ecosystem services evaluated are used unsustainably.

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Degradation of ecosystem services has impact at a range of scales from local to global and over different time frames. Traditionally national economic figures do not account for depletion of natural assets or degradation of ecosystems. If a country depleted its fisheries, this would appear as a gain in gross domestic product because of the profits, without taking into account that loss from the unsustainable practice of overfishing.

I'm going to talk a little bit about frameworks put in place at international scales. This is the framework the Millennium Ecosystem Assessment presented, which you can look at at leisure, but it aimed to encapsulate the main factors acting on human wellbeing and poverty reduction at different scales, and identify the points where interventions may be possible to reduce the impact of these changes. The direct drivers of change are likely to be quite straightforward to quantify and to change. Indirect ones are a lot more ambiguous.

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Moving on to the ecosystem approach, this is a conceptual framework devised by the Convention on Biological Diversity. The ecosystem approach is intended to meet the three objectives of the Convention. These are conservation, sustainable use and fair sharing of benefits from using genetic resources.

The ecosystem approach has 12 principles that aim to increase the knowledge and wellbeing of everybody, value nature and reward good practice. In Asia, the ecosystem approach has been adopted and one of the main areas is fisheries. Many Asian Pacific nations have signed up to agreements for sustainable use of fisheries, although I cannot see if Myanmar has signed the agreements.

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The IUCN came up with five steps to implement the ecosystem approach.

The first one is to find who the stakeholders are and define the ecosystem area, and then define the relationship between these.

We must then look at the structure and the function of the ecosystem. What is the best way to manage this and keep all the stakeholders happy?

We then think about what are the important economic issues.

Then we consider the impact of the ecosystem in question on adjacent ecosystems, so those nearby.

We then think about long term goals and flexible strategies.

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This is an example of the strategy in the UK, presented by the Ecosystems Knowledge Network, it aims to integrate local people, natural capital, which are ecosystem assets, and natural solutions. In the UK, there are a range of projects that investigate payments for ecosystem services modelling services such as flood mitigation and creating tools to assess ecosystem service provision.

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Moving on to the sustainable development goals, these were implemented more recently by the UN and have a timeframe of 2015 to 2030. There is a big focus on human wellbeing but it comes with an understanding that development must be built on good ecosystem management. The Sustainable Development Goals build on the Millennium Development Goals, which had a fair amount of success, but still more to do. Southeast Asia was the most successful region in Asia and the Pacific and the idea for the sustainable development goals up to 2030 is to take these successes and extend them, taking action at the global, regional and sub regional level. I had a look at the most recent report by the UN Economic and Social commission for Asia and the Pacific and the key goal in Myanmar is to improve connectivity of people through roads and transport infrastructure but I saw nothing about ecology or ecosystem service delivery.

There are goal targets for each of these 17 goals, I urge you to take a look at the website here. There are lots of tips for how to help meet the goals, how to communicate the importance and what the targets are.

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I'm going to shift focus now back to ecosystem services themselves and talk about multifunctionality. Now, through this lecture, I have referred to the fact that these initiatives to improve our world take an integrated view of ecosystem services and people's needs. Increasingly ecologists have tried to create statistical methods that can group ecosystems functions together to get an overall understanding of the function of an ecosystem, particularly in response to change. The grouping of many types of ecosystem function is called multifunctionality. Multifunctionality is intended to make it easier to recognize if an ecosystem is becoming degraded or improved. By providing a multifunctionality metric this will make it easier to meet ecosystem approach or Sustainable Development Goals. There is a lot of debate over how to measure multifunctionality. Two of the main methods to measure multifunctionality include the z-score and the threshold approach.

The z-score of each function is taken. This means for each function you scale it so the value is zero and the highest is one and the lowest was minus one. This means that they are all kept within the same range and you can average them. This technique has some criticisms, but it is still widely used. One criticism is that all functions are assumed to be equally important so weighting does not occur. The use of mean values also means that more functions are added than it is less likely you can get a high score of multifunctionality, simply due to the mathematical properties of the score.

The threshold approach counts the number of functions that have passed a certain threshold. The threshold is usually some proportion of the highest function value.

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Multifunctionality has been used to answer questions of ecosystems. In this example Pascari and colleagues attempt to look at the old question of does increasing species freshness also increase multifunctionality. They used the z-score approach to look at this relationship over different scales.

You remember how we looked at alpha and beta diversity. Well, for the big landscape scale analyses we are most interested in beta diversity. In this analysis, we see that there is a positive relationship between alpha diversity and multifunctionality and gamma diversity and multifunctionality. So alpha is at the local scale of species richness, and gamma is species richness at the regional scale- a large scale. If we remember beta diversity is the number of communities in an area. So it's slightly different to alpha and gamma diversity, and we do not see a very strong positive relationship between beta diversity and multifunctionality. But what we do see is that the variance decreases as you increase in numbers of communities. So we can see that when we're looking at multifunctionality species richness is more important than community richness.

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Here is an applied example using the threshold approach to look at Forest data in Germany. Different groups of people have different priorities for the land. So here we are looking at public land, land owned by environmental groups and owned by a private owner. Their priorities were found from a consultation meeting. They were asked which one most important out of these ecosystem services. So there were four ecosystem services: timber production, biodiversity, water supply and carbon sequestration. Out of these four the three different groups were asked, which was most important to them. They found that generally if you add more conifers, which are evergreen trees as you increase these on the x axis, ecosystem multifunctionality also increases across all scenarios. But there's a slight difference for the different groups. And this graph in the top right, the slope of the public and private owners is quite steep showing that from the perspective of the stakeholders more conifers mean more benefits and these benefits increase fast as you increase the number of conifers. But from the environmental groups’ perspective, there is a non-significant effect of conifer planting on multifunctionality. So the environmental group does not care about numbers of conifers in terms of delivering the ecosystem services that are important to them. Their priorities are different. And with more conifers their needs are not met. This kind of analysis is useful to assess the effect of making changes to an ecosystem on the needs and priorities of different groups of people.

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In summary, ecosystem services are the benefits that people get from ecosystems.

There are four groups: provisioning, regulating, cultural and supporting.

There are many global initiatives to maintain or improve ecosystems to deliver ecosystem services.

And finally, different people have different needs and priorities. So we need to find ways to assess multifunctionality of ecosystem services so that we can make effective decisions of what to do with demand.