ECOSYSTEM ADAPTATION TO GLOBAL WARMING

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Abstract

The potentially catastrophic impacts of climate change may be reduced by preserving ecological equilibrium. For instance, coastal ecosystems such as mangroves offer natural flood defences, well-protected lakes preserve water supplies even during droughts, and healthy forests reduce the probability of devastating wildfires occurring. The process that takes use of these ecosystem services as a component of an adaptation strategy that is more extensive is referred to as ecosystem-based adaptation, or EbA for short. EbA protects vulnerable people from the consequences of severe weather while also offering a range of benefits that are vital for human well-being, such as clean water and food. EbA also protects vulnerable people against the effects of climate change. These advantages are often accomplished via the use of win-win situations.

keywords: *Ecosystem, Global, Warming*

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) came to the conclusion that the costs of stabilising greenhouse gas concentrations will gradually increase as mitigation efforts move atmospheric concentrations of carbon dioxide (CO_2) from 650 ppm to 550 ppm, and that these costs will increase more sharply as concentrations decrease even further, from 550 ppm to 450 ppm (Metz et al., 2001). This was the conclusion that was reached by the IPCC. One of the most significant questions to ask is how the marginal benefits, also known as the losses that may be averted, linked with climate control change depending on the precise degrees of mitigation. In other words, what are the expected advantages of lowering atmospheric concentrations of greenhouse gases to progressively lower levels, as well as the harms that will be averted as a result of this reduction?1 There have been a few research that attempt to answer this topic. The researchers Smith et al. (2001) determined approximate climatic thresholds beyond which worldwide detrimental consequences would occur. However, they did not identify how marginal damages or benefits might vary with changing climate. Several research, such as have sought to quantify the advantages of reversing the effects of climate change. These studies often represent the benefits in terms of a standard measure, which is frequently monetary value. They developed algorithms reflecting the link between climate change (usually quantified in terms of change in global mean temperature) and effects by, for the most part, surveying the relevant literature and relying on the assessment of subject matter experts. The effects are typically given a monetary value, which enables a direct comparison of the advantages of managing the climate to the costs of reducing greenhouse gas emissions. However, selecting a single measure to use throughout is one of the most significant challenges presented by this method. It is possible that dollars are an adequate unit for quantifying the effects on market systems such as agriculture and forestry; however, it is possible that dollars are not as good a unit for enumerating the effects on other sectors. In addition, if you base your evaluation on a measure such as dollars, you give more weight to the effects that have an effect on individuals who have more financial resources than those who have less financial resources. Other numeraires, such as the number of persons impacted or changes in land use or categorization, are typical possibilities; however, these options come with their own set of constraints. Counting the number of persons impacted, for instance, does not take into account the extent to which they are affected or the kind of danger they may be exposed to, and it might result in duplicate counting. It is therefore not always obvious whether people who "win," in the sense of benefiting in some manner from climate change, should compensate for those who stand to lose in the aggregate. Changes in land use or categorization, on the other hand, do not assess the degree of effect and might lead to duplicate counting. In this work, we make an effort to determine the marginal gains that are linked with varying degrees of climate change. We come to this conclusion based on a review of a variety of research, the majority of which are focused on specific industries and have sought to estimate the worldwide implications of climate change. We have decided to not convert the impacts to a standard metric such as dollars but rather to keep the various metrics that were presented by the authors. Clearly, because of this, we are unable to aggregate our results across different industries. Our objective is not to produce a unified calculation of the global benefits across all industries. Instead, the goal is to investigate the connections that exist between climate change and the effects it has on certain industries in order to identify any overarching trends. It is crucial to emphasise that there is more than one approach to discover key marginal consequences of climate change; a complete assessment of the effects of climate change is not the only way to do so. This should be acknowledged. In their study, Smith et al. (2001) came up with five "reasons for concern." Two of the "reasons for concern" are the aggregate implications, which are discussed in this article, and the distributional impacts, which are discussed, to a certain extent, in this article. The other three are risks to unique and threatened systems, risks stemming from increasing extreme weather events, and risks of triggering large-scale single events such as the breakup of the West Antarctic Ice Sheet. Loss or substantial damage to a valued system is an example of a risk to unique and threatened systems. These three "reasons for concern" are the only ones that are not addressed in this particular piece of writing. To the best of our knowledge, no global impact studies have been conducted with any of these three topics as the primary emphasis. Another difficult problem to solve is determining which index should be used to quantify the degree to which the climate is changing. Smith et al. (2001) contains a substantial conversation on this topic across its pages. In a perfect world, the indicator of choice would be either emissions of greenhouse gases or atmospheric concentrations of those gases. This is due to the fact that the utilisation of either one would make it possible to make a pretty direct comparison of the benefits connected with managing the climate to the expenses associated with a specific degree of mitigation effort. There is a wide range of uncertainty about how climate will change given any rate of emissions or concentration (in fact, there is ambiguity over the atmospheric concentration that will arise from a certain emissions rate; see Box 19-1 in Smith et al.). The difficulty with these metrics is that there is uncertainty about how climate will change given any rate of emissions or concentration. The global mean temperature (GMT) serves as the index that we employ in order to measure the global mean climate change that is related with the consequences that are mentioned in the research that we analyse. Unquestionably, a wide range of simultaneous changes occur in the world's precipitation and in a variety of other meteorological indicators whenever the GMT is adjusted. The hydrological cycle is accelerated when the mean temperature rises, which results in an increase in global precipitation. There is a large variety of potential regional patterns of climate change connected with a specific shift in GMT as well. The degree to which these regional patterns vary can have a significant bearing not just on the affects felt locally but also on the net global implications. Therefore, it is reasonable to anticipate that an investigation of the kind that we are conducting will provide a wide variety of potential effects for any particular GMT. However, it is important to keep in mind that GMT has some limits and that we use it because it is the most practical gauge of climatic change. The investigation is largely geared on illuminating the phenomenon's worldwide effects. In order to drive home the idea that regional repercussions frequently have only a passing resemblance to those of the world at large, the discussion of regional impacts is kept to a minimum. The repercussions felt on a regional scale are not portrayed in this study in a manner that is comprehensive. Determining the overall form of the damage curve, which statistically describes this relationship, is an essential initial step in the process of characterising the link that exists between climate change and the consequences of this change. For example, do the repercussions start to occur when there is just a little bit of warming, and do they get worse when there is more warmth? If this is the case, how do the impacts develop over time? Do they rise steadily to a certain level (increase asymptotically, i.e., decreasing additional impacts for each successive degree of warming), or do they rise exponentially (following a concave path, i.e., increasing impacts for each successive degree of warming)? If they stabilise at a certain level, do they increase asymptotically, then? Exist cutoff points below which there is no evidence of influence, and cutoff points above which there is evidence of impact? The last association would seem to indicate that moderate amounts of climate change might very certainly have no significant effects at all. Or, does the link between effects and climate change follow a parabolic shape, so that there may be advantages associated with lower levels of climate change, but beyond a certain point, the benefits begin to decline, and finally, there are downsides associated with high enough levels of climate change?2 The answers to these questions are significant because they indicate whether there are advantages associated with lower GMT and whether those benefits remain the same, diminish, or grow as GMT increases. These benefits are important because they determine whether there are benefits associated with lower GMT. Given the limited number of data points that are provided by the majority of research, really explaining this link can be a challenge at times. In situations like these, we rely on our understanding of the fundamental biophysical interactions in order to provide support for our judgements regarding the contours of damage curves.

Adaptation services

According to Doswald et al. (2014) and Pramova et al. (2012)b, ecosystems that are well-managed and provide a variety of ecosystem services are able to assist societies in their adaptation to present climate dangers as well as future climate change. This article will focus on reviewing six important issues.

Products and local communities

According to Innes and Hickey (2006), the provisioning services that are offered to rural populations, particularly in developing nations, have an essential impact in the coping and adapting techniques that are implemented. Many rural populations rely on forest products as a buffer against the negative effects of environmental pressures, such as a lack of agricultural productivity brought on by drought. Collecting forest wild goods has been shown to be an effective method of coping with natural disasters such as floods in Peru (Takasaki et al., 2004) and droughts in Tanzania (Enfors and Gordon, 2008). According to McSweeney (2005), the recovery of Honduran families was aided by the gathering and sale of items derived from the country's forests. Diversification of livelihoods is an adaptive and anticipatory approach that minimises the vulnerability of households and communities to fluctuations in climate. Both timber and non-timber forest products, such as firewood, wild fruits, mushrooms, and feed, contribute to diversification of livelihoods. In Bolivia (Robledo et al., 2004) or Cameroon (Bele et al., 2011), for example, several studies have established the significance of ecosystem provisioning services for the diversification and resilience of livelihoods. According to Paavola (2008), the most common tactic used by rural people in Morogoro, Tanzania, to manage the effects of climate change is to diversify their sources of income, in part by selling firewood or fruits. For instance, in Mali (Djoudi et al., 2013) and Bangladesh (Rahman et al., 2012), complex cropping systems, which include numerous kinds of crops, fodder, and trees, allow for a continual harvest of goods despite differences in climate. Due to the absence of alternatives and the modest needs in terms of financial, physical, or human assets for collecting these goods, the coping and adapting strategies of the poorest or most vulnerable families frequently rely significantly on ecosystem products. This is because the requirements for collecting these items are minimal. During a flood in Peru (Takasaki et al., 2004), this dependence was seen in young and poor households with limited access to land. During droughts in Malawi (Fisher et al., 2010), it was seen in households with low income or headed by older and less-educated individuals. In Indonesia (Liswanti et al., 2011), it was seen in the poorest and least-educated people after a flood. As a consequence of this, farmers and pastoralists in Kenya who have restricted access to forest products are more susceptible to variations in rainfall than other people in the country (Owuor et al., 2005). Similarly, in the Philippines, where poor coastal communities lack access to mangrove resources, their vulnerability is increased (Walton etal., 2006). According to Pattanayak and Sills (2001), the use of provisioning services for the purpose of coping with pressures frequently stems from a lack of other options; hence, it may be considered a symptom of poverty rather than a solution for adaptation. According to Levang et al. (2005), using ecosystem services as a safety net can be a trap that leads to poverty. This is especially true in situations when there is a limited supply of resources, a big population is in need, and there are few other options.

Local climate regulation in agriculture

As a result of the fact that trees located in or close to agricultural fields provide regulating services that lessen the susceptibility of cropping systems to changes in climate, the incorporation of trees into agricultural practises, such as in agroforestry and silvopastoralist systems, is seen as an effective adaptation approach. During times of drought, the deep exploration of soil by tree roots for water and nutrients is beneficial to crop production. According to Verchot et al. (2007), trees increase the organic content, porosity, infiltration, and soil cover of soils, which in turn improves soil fertility and protects soils from erosion. Research conducted in Malawi and Zambia, for instance (Garrity et al., 2010), shown that nitrogen-fixing trees improve the quality of soil nutrients and increase water penetration, two factors that lead to increased crop resilience in the face of drought. According to research by Sendzimir et al. (2011), areas of Niger with tree regeneration saw less of an impact from previous droughts on wheat output. The resilience of coffee and chocolate production may be improved by planting shade trees, which not only regulate temperature and humidity but also shield crops from the effects of storms and winds (Lin, 2010). One country that could benefit from this is Mexico. Research on agroforestry systems provide information on the trade-offs involved. For instance, a high tree cover might boost soil protection, but it can also decrease the amount of light that is accessible to crops growing in the understory. Because of this, it is necessary to determine the situation-appropriate tree cover that will maximise the advantages of agroforestry. There are also other trade-offs that arise between average yields and resilience. For example, tree cover can protect crops against the negative effects of climate change; but, it can reduce average yields even when there is no climate change. Agroforestry may contribute differently to crop adaptation to climate change depending on climate scenarios and production systems (Verchot et al., 2007). Despite the benefits of agroforestry, its expansion has been constrained by policies promoting intensive agriculture systems that exclude trees or, in some cases, induce deforestation (Morton et al., 2008). Despite the benefits of agroforestry, its expansion has been constrained by policies promoting intensive agriculture systems that exclude trees. Other methods are conceivable, including those in which agricultural intensification takes place in conjunction with the planting of trees with the purpose of securing both environmental services and incomes (Steffan-Dewenter et al., 2007). According to Fischer et al. (2008), the social and biophysical context is what determines how land-use and agricultural policies strike a balance between land sparing (the maximisation of agricultural production in some areas and the conservation of natural ecosystems in others) and land sharing (the integration of conservation and production in heterogeneous landscapes).

Local climate regulation in cities

The regulation of temperatures (through shade and evaporative cooling) and water (through rain interception and infiltration) by urban forests and trees is one way that cities may adapt to the variable and changing environment. Cities are susceptible to floods because their surfaces are impermeable; however, the presence of urban parks or trees helps lessen runoff by allowing more water to soak into the ground. The effects of urban heat islands, which enhance the health implications of heat waves, can be reduced by green cover, as was shown, for instance, in Manchester, United Kingdom (Gill et al., 2007). In metropolitan areas, ecosystem-based adaptation calls for a solid knowledge of landscape ecology and the ability of green infrastructure to improve the wellbeing of vulnerable people, as was the case in Durban, South Africa (Roberts et al., 2012). This is especially important in the case of Durban. Additionally, adaptation must be developed at several scales, including ecosystem management outside of urban areas and preservation of higher watersheds. For instance, in Beijing, China, three stages are recommended for a green infrastructure: at the regional scale (forest belts), in the city (urban parks and green corridors), and in communities (road and vertical greening). These sizes include the regional scale, the city scale, and the neighbourhood scale. However, urban ecosystem-based adaptation raises issues about high opportunity costs of land and probable management limits. For instance, during droughts, the precious water that is spent to sustain trees may be needed for other uses. This presents a dilemma for urban planners.

Protection of coastal areas

Coastal ecosystems, such as mangroves, can safeguard coastal regions from the hazards that are caused by climate change, such as tropical storms, rising sea levels, floods, and erosion. They do this by stabilising the soil and absorbing and dispersing the energy that is carried by waves. It was clear after a hurricane in Orissa, India that mangroves provide protection from storms (Das and Vincent, 2009), and coastal residents in Bangladesh are aware of the benefits that mangroves offer in this regard. For example, in Zanzibar, Tanzania, it has been suggested that coastal forest management may be used to minimise beach erosion caused by future sea level rise. According to Adger (1999), the maintenance expenses of sea dykes created for the purpose of defending coastal towns in Vietnam are reduced when mangroves are planted. It is unknown how much mangrove forest must be present in order to lessen the susceptibility of a coastal area to a variety of dangers, nor is it known how the protective role of mangroves is affected by factors such as topography, bathymetry, or the quantity and type of mangroves. The minimum width required for a particular area is contingent not only on the type and structure of mangroves but also on the width of the mangroves themselves. A solid comprehension of the dynamics of coastal areas and the function of mangroves have to serve as the foundation for any plans. Coastal ecosystems should also be included in a more comprehensive plan for reducing the risk of natural disasters and adapting to their effects because they cannot provide absolute security against catastrophic events.

Protection of watersheds

The hydrological processes that occur inside watersheds are affected by the ecosystems within those watersheds because of the contributions that ecosystems make to the processes of rainfall interception, evapotranspiration, water infiltration, and groundwater recharge. This influence has the potential to lessen the effects that climate change will have on downstream populations. For instance, ecosystems have the potential to maintain base flows during dry seasons if they contribute to groundwater recharge; conversely, ecosystems have the potential to lower peak flows or floods during rainfall events if they contribute to rainfall interception and infiltration. Both of these benefits can be realised if ecosystems are allowed to contribute to rainfall interception and infiltration. In addition, ecosystems have the ability to lessen the risks of landslides and soil erosion, both of which are partly influenced by climate. In Flores, Indonesia, farming villages located further downstream felt less of the effects of droughts as a result of higher base flows in wooded watersheds. Natural forest regeneration in Bolivia enhanced water supplies to farmers during protracted dry times, stabilised slopes, and decreased the damage to communities caused by soil erosion and landslides. Even while hydrological research on forests and water might provide insight into decisions about adaptation, very few of them deal with extreme occurrences and the societal sensitivity to hazards associated to water and soil. In addition, there is much discussion over the impact that trees have on floods. Even if trees can lessen storm flow because of their increased infiltration, this impact is questionable in the case of major rainfall events after the soils are saturated with water. This is because forests are often located in areas that are prone to flooding. In spite of the fact that such debates exist, it is important not to discount the part that forests play in the floods that occur on a more frequent and medium-scale. A similar debate can be seen about the influence that forests have on base flow. This is due to the fact that base flow is the product of two ecosystem processes that compete with one another: in forests, high transpiration lowers base flow, but high infiltration raises soil water recharge and base flow. The hydrological literature supports that surface erosion is typically minimal in forests; yet, concerns persist concerning the function of forests in the prevention of landslides, especially when high rainfall intensity overwhelms the effect of roots in stabilising soils. Soil erosion and landslides are both a concern.

Climate regulation at regional and continental scale

At both the regional and continental scales, ecosystems have a hand in the process of recycling precipitation and producing new fluxes of water vapour in the atmosphere. Even if the amount of water that flows through a watershed is decreased as a result of evapotranspiration by trees, this process also pumps water back into the atmosphere, which can result in an increase in the amount of precipitation that falls in the area. There is some speculation about whether or not woods have a significant influence in hydrological processes at the regional scale. One possible function of forests is that they serve as a "pump" for atmospheric moisture, drawing humid air inland from coastal areas. Despite its significance, for example, in reducing droughts impacts due to global climate change, the role of forests and trees in regulating atmospheric water and regional rainfall has been disregarded by scientific evaluations on ecosystems and climate change. This is despite the fact that forests and trees have a role in regulating atmospheric water and regional rainfall.

Climate threats on ecosystem services

Even under the low- and medium-range projections of global warming, the majority of ecosystems will be negatively impacted by climate change. They are likely to be affected by gradual variations in temperature or precipitation, as well as climate-related disturbances (for example, floods, drought, and wildfire), in conjunction with other risks (for example, changes in land use, pollution, and overexploitation of resources). Because of these changes and disruptions, the structure and function of ecosystems, as well as the ecological interactions among species and the geographic ranges of species, will be altered, which will have an effect on both biodiversity and the services provided by ecosystems. The fragility of ecosystems can have an effect on the temperature of the entire planet. If changes and disturbances cause carbon to be released into the atmosphere, the feedback loop between vegetation and climate will make global warming worse. Climate change may also have an effect on ecosystem services that are local and regional in scope, such as the management of water or the production of lumber, which might have direct repercussions for civilizations that are dependent on these services. Multiple elements, such as the structure of the landscape, the number of species that live there, and their richness and variety, all play a role in determining an ecosystem's capacity to withstand the effects of climate change. Nutrient cycling and primary production are crucial components that contribute to the functioning, resistance, and resilience of the ecosystem. We need to have a deeper understanding of the ecological mechanisms that permit the maintenance and adaptation of ecosystem services during times of change so that we may better manage these challenges. In areas of management where the risk of short-term or non-climatic threats to ecosystems has been reduced to an acceptable level, specialised methods for adapting to climate change can be introduced. The capacity of ecosystems and species to adapt may be increased via management, which can simultaneously lower the hazards associated with climate change. It is possible for actions to act as a buffer for ecosystems against disturbances, such as via the control of fire or pests, or as a facilitator for biological responses to changing climates, such as through the reduction of landscape fragmentation in order to make it easier for species to migrate. The process of adaptation, on the other hand, must be an ongoing one rather than one that aims to either preserve the status quo or achieve a new equilibrium.

Existing policy instruments

The use of ecosystems as a tool in climate change mitigation has recently gained recognition in international accords and policy tools. For instance, the contribution of tropical afforestation and reforestation is recognised in the Clean Development Mechanism (CDM) of the Kyoto Protocol, and various plantation projects are rewarded through either this mechanism or voluntary carbon agreements. This acknowledges the positive impact that these activities have on the environment. REDD+, which stands for "Reducing Emissions from Deforestation and forest Degradation," is another effort that intends to preserve carbon stocks by providing financial incentives to protect forests from deforestation and degradation, as well as increase carbon stocks via sustainable forest management. REDD+'s primary focus is on maintaining carbon stocks in developing countries. Although the role of ecosystem-based methods in international conversations regarding adaptation is not as obvious as it is in discussions concerning mitigation, several efforts have been launched at both the national and local stages. More than half of the least developed nations that had submitted National Adaptation Programmes of Action (NAPAs) to the United Nations Framework Convention on Climate Change (UNFCCC) by the middle of 2010 acknowledged the significance of ecosystem services. The NAPAs incorporated ecosystem management activities in around 25 percent of their adaptation programmes. These activities aimed to improve human well-being and adaptation through the implementation of measures such as soil restoration, erosion control, and water regulation.

Ecosystem-based approaches to climate change: the way forward

Although they seldom take into account both adaptation and mitigation measures, several initiatives and programmes are making important contributions to the development of effective mitigation and adaptation strategies through the preservation of biodiversity and the services provided by ecosystems. An all-encompassing strategy ought to include the following three components: ecosystem-based mitigation, ecosystem-based adaptation, and adaptation for ecosystems (Figure 38. 3). The management of ecosystems must, as a first step, decrease present risks to ecosystem services, such as deforestation and forest degradation, in order to guarantee that ecosystems attenuate climate change and assist humans in adapting to its effects. In addition to this, it should create adaptation strategies in order to meet future dangers. 'Adaptation for ecosystems' is therefore required in ecosystem-based responses to climate change in order to guarantee that ecosystem-based adaptation and mitigation work over the long run. When, for instance, the regional distributions of carbon, hydrological services, or biodiversity are positively associated, the management of ecosystem services can provide combined advantages for both adaptation and mitigation. For instance, the preservation and regeneration of mangrove forests contribute simultaneously to the protection of coastal regions as well as the storage of significant amounts of carbon. The adaptability of local livelihoods can be improved by forest conservation programmes for mitigation, such as REDD+ projects, which can increase the provision of local regulating ecosystem services to communities, therefore shielding them from fluctuations in hydrological conditions. They are also able to contribute to the diversification of incomes and economic activities through the use of provisioning services such as non-timber forest products, which may be found in forests. The reduction of anthropogenic stresses on forests, the enhancement of connectivity across forest regions, and the preservation of biodiversity hotspots are all examples of ways in which REDD+ programmes might help enable ecological resilience to climate change.

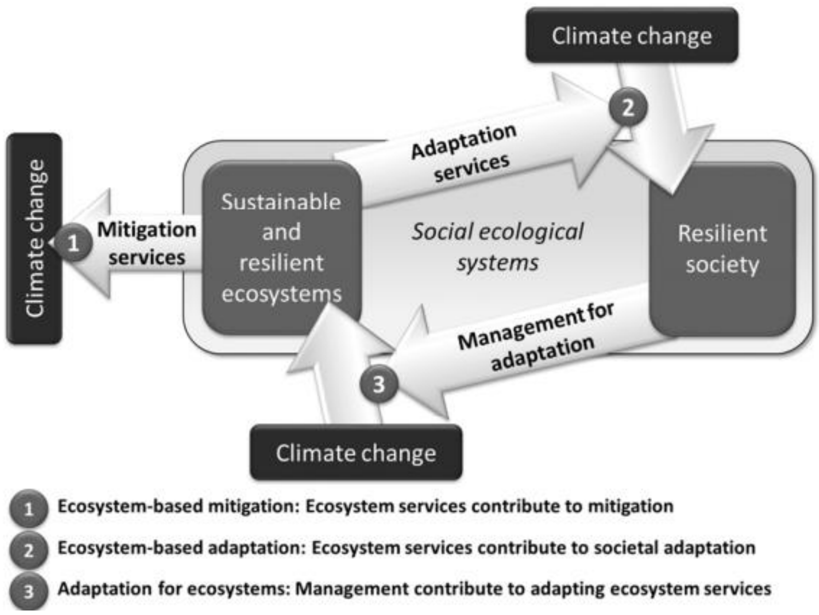

Figure 1 The three pillars that support ecosystem-based strategies for combating climate change

However, adaptation and mitigation can sometimes conflict with one another. Adaptation can result in an increase in emissions; for instance, if the goal of ecosystem management is to improve water balance for the purpose of helping water users adapt to climate change, the best results may in some cases be achieved through ecosystems that have a low carbon content; for example, grasslands rather than forests (Locatelli and Vignola, 2009). On the other hand, mitigation could make a situation more vulnerable. For instance, a monoculture that makes use of species that have a fast growth rate and a high water consumption rate might perform well in terms of carbon storage and mitigation, but it can also generate downstream water shortages and biodiversity losses, which can ultimately exacerbate societal and ecological vulnerability to climate change. The Intergovernmental Panel on Climate Change (IPCC) has issued a warning that the extensive alteration of ecosystems for the purpose of mitigating climate change, such as planting fast-growing tree species or bioenergy plantations, would have a severe impact on biodiversity and ecosystems. If a REDD+ project limits the rights and access of local people to the forest provisioning services that forests provide, this might make it more difficult for people to maintain their livelihoods. It is becoming increasingly necessary to pursue adaptation and mitigation together, despite the fact that adaptation and mitigation show substantial distinctions, notably in their aims, regional dimensions, and temporal scales. Given that ecosystems are capable of simultaneously providing services related to climate change adaptation and mitigation, policies and local efforts connected to ecosystem management have the potential to combine both adaptation and mitigation measures while avoiding trade-offs between the two. Beyond the integration of adaptation and mitigation, there is a need to mainstream climate change in the policy areas of ecosystem management and rural development. Adaptation and mitigation are only two sides of the same coin.

Causes of Global Warming

Green House Gases

- Greenhouse gases are the primary contributors to the current state of global warming.
- At the present moment, greenhouse gases such as carbon dioxide, methane, and nitrous oxide are playing a role in the creation of risks.
- These greenhouse gases cause the earth's temperature to rise because they prevent heat from escaping from the atmosphere and hence trap heat there.
- The release of an abnormally high amount of these gases into the atmosphere is the primary driver of climate change.

Figure 2 demonstrates that industrial activities are the second largest source of greenhouse gas emissions, following power plants as the principal source. The lowest level of emissions of greenhouse gases is found in the industry that is responsible for the disposal of rubbish and the treatment of waste. The phenomenon known as "global warming," which refers to a major warming of both the land and the ocean, is caused by an increase in the concentration of greenhouse gases, the most notable of which is carbon dioxide. This rise in concentration of greenhouse gases was caused by human activity.

Power Plants

The major sources of carbon dioxide emissions into the atmosphere are power plants. Because the generation of electricity involves the burning of fossil fuels, power plants are responsible for a considerable portion of the carbon dioxide that is emitted into the atmosphere. These power plants generate the majority of their energy by using coal as their primary source of fuel. Coal creates roughly 1.7 times the amount of carbon dioxide per unit of energy that is generated by natural gas, while oil generates around 1.25 times the amount of carbon dioxide per unit of energy.

Pollution

Because of the burning of biomass in the northwestern part of India and the air pollution from large industrial centres in the northern part of India, there is frequently a concentration of a thick haze and smoke inside the Ganges basin. This is owing to the fact that the basin is located within India. Dust and black carbon that are blown towards higher altitudes by winds at the southern faces of the Himalayas are able to absorb shortwave radiation and heat the air above the Tibetan plateau. This phenomenon is caused by the fact that dust and black carbon are pushed towards higher elevations by the southern faces of the Himalayas. The winds that blow on the southern sides of the Himalayas are the source of this phenomena. This causes the air to warm up and rise, which in turn increases the amount of moisture in the mid-troposphere and generates a positive feedback loop that supports the further heating of aerosols (Lau, 2006). The net warming of the atmosphere that is generated by the absorption of aerosols causes the air to warm up and rise.

Deforestation

The primary cause of deforestation, which is responsible for the emission of almost one quarter of all carbon dioxide into the atmosphere, is the cutting down and burning of around 34 million acres of trees each year. Cutting down trees is one of the biggest contributors to the growing amounts of carbon dioxide in the atmosphere, and it's also one of the most destructive human activities. Greater urbanisation, the demand for land to accommodate companies and structures, and the want for timber are all factors that lead to deforestation, which in turn adds to the phenomenon of global warming.

Transport

Another important factor that contributes to the overall amount of carbon dioxide in the atmosphere is the exhaust produced by vehicles and other types of transportation. It is estimated that around twenty percent of the carbon dioxide that is emitted into the atmosphere comes from the burning of petrol that occurs in automotive engines. When navigating the streets of a city, it is almost always best to be behind the wheel of a car that was designed from the ground up with city driving in mind. Table 1 displays, according to Guardian (2007), the top five countries in terms of production of carbon dioxide.

Effects of Global warming

Effect on the economy

According to the findings of a study conducted by the Indira Gandhi Institute of Development Research, climate-related factors have the potential to bring about a reduction of up to nine percent of India's gross domestic product (GDP). According to the findings of research that was conducted by Smith et al. (2007), if the average temperature of the planet were to rise by merely 2 degrees Celsius, about seven million people would be required to migrate as a result of a range of different conditions, such as the flooding of districts in Mumbai and Chennai. The inhabitants of Meghalaya, which is a state located in the north-eastern region of India, are concerned that the rising sea level may force the low-lying neighbouring nation of Bangladesh to be flooded, which will result in an influx of refugees into Meghalaya. Meghalaya is located in the northeastern section of India. According to research conducted by Ahmad et al. (2006), in the event that there are major adjustments in the climate of the entire planet, Bangladesh would experience a loss of land along its coastline.

Table 1 Major CO2 emitting countries

Country	CO_2 Emissions (in billion tones)
USA	5.9
CHINA	4.7
RUSSIA	1.7
JAPAN	1.3
INDIA	1.1

Effect on environment

Since the beginning of the industrial revolution in the latter half of the 18th century, there has been as much as a 33 percent growth in the levels of pollution that may be found in the atmosphere. This rise is mostly attributable to the increased production of harmful substances such as carbon monoxide and other greenhouse gases. Flooding, coastal erosion, droughts, salt water intrusion into soils, unusually high levels of tropical storms and cyclones, and enormous amounts of rainfall are some of the consequences that have been observed in various regions of the world over the past several years and have been attributed to an increase in the global average temperature. This phenomenon has been attributed to an increase in the amount of greenhouse gases that are being released into the atmosphere. As a consequence of rising sea levels, flooding is occurring in a great deal of the world's land and water areas. According to the findings of a study that was carried out by Anup et al. (2006), the rise in sea level over the course of the last century may be attributed to global warming. The rise in sea level is estimated to have been about one metre.

Extreme weather

There is a possibility that the warming of the globe is to blame for some trends that have been noticed in natural disasters such as extreme weather in the past. There will be an increase in the number of tropical cyclones as well as an increase in their intensity. The findings of Stefan et al. (2007) indicate that the frequency of occurrences of sea levels that are extraordinarily high will continue to rise.

Conclusion

It is an urgent necessity for nations that are already affluent as well as those that are rapidly developing to collaborate in the development of strategies that would cut emissions of greenhouse gases. Countries that are quickening the pace of their economic progress have to also think about the prospect of adopting cutting-edge technology that reduce energy use. It is imperative that a substantial quantity of reforestation be carried out as soon as possible. In addition to this, there is an increased emphasis being placed on the use of renewable energy sources such as the sun and the wind. There is a need for a reduction in the quantity of fertiliser that is used.

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