Ricardo Wurmus

72191 Global Environmental Studies

Assignment 3

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On biodiversity loss and human population pressures

2011 marked the year the global human population reached 7 billion people. Does this mean that the world is overpopulated? To answer this question, it is not enough to calculate the ratio of the world population to the earth's total land area, as some[1] have argued; instead, the competition of different populations for the earth's limited resources and their dependence on vulnerable ecosystem services must be analysed.

The patterns of consumption and production of growing human populations in recent centuries have caused extensive changes to the global biogeochemical cycles, the climate, and the composition, resilience, and distribution of ecosystems. These changes have dramatically accelerated global extinction rates with far-reaching consequences for ecosystems and human economies alike (Chapin III et al., 2000). In 2011 the Western Black Rhinoceros was declared extinct and many other species will likely have the same fate despite conservation efforts (Emslie, 2011).

The problems of increasing population pressures and rapid species loss have varied causes, that I shall discuss below. As these problems have been known for decades, a number of programmes have been proposed, designed to halt the decline of global biodiversity, curb the exponential growth of the world's human population, and address environmental pressures stemming from human activities. I shall review the international efforts to cope with these problems and identify key issues that remain to be addressed.

Human population pressures

Based on estimates aggregated by the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat (2010), the human world population has grown by about 4.5 billion compared to the 1950s. During the same period, the world's economies have grown rapidly, as can be inferred from indicators such as global food production, car production, and global energy consumption (Dearing, Battarbee, Dikau, Larocque, & Oldfield, 2006). While increased affluence in the last century has generally resulted in improved health and better living conditions for the populations of industrialised nations (Kinsella, 1992), increasing individual resource demands multiplied by the size of an exploding world population size have intensified global human-environment interactions and fundamentally altered earth system processes at a scale that prompted Vitousek, Mooney, Lubchenco, and Melillo (1997) to declare the earth a "human-dominated planet"[2].

Although the issue whether poverty is a major driver of environmental degradation or affluence is still subject to scientific enquiry (cf. Duraiappah, 1998), both rapid economic growth as well as poverty have been recognised as threats to global ecosystems. Myers and

[1] See for example the website overpopulationisamyth.com by the non-profit organisation "Population Research Institute".

[2] See figure 1 for an overview of human activities and systemic changes to earth system processes.

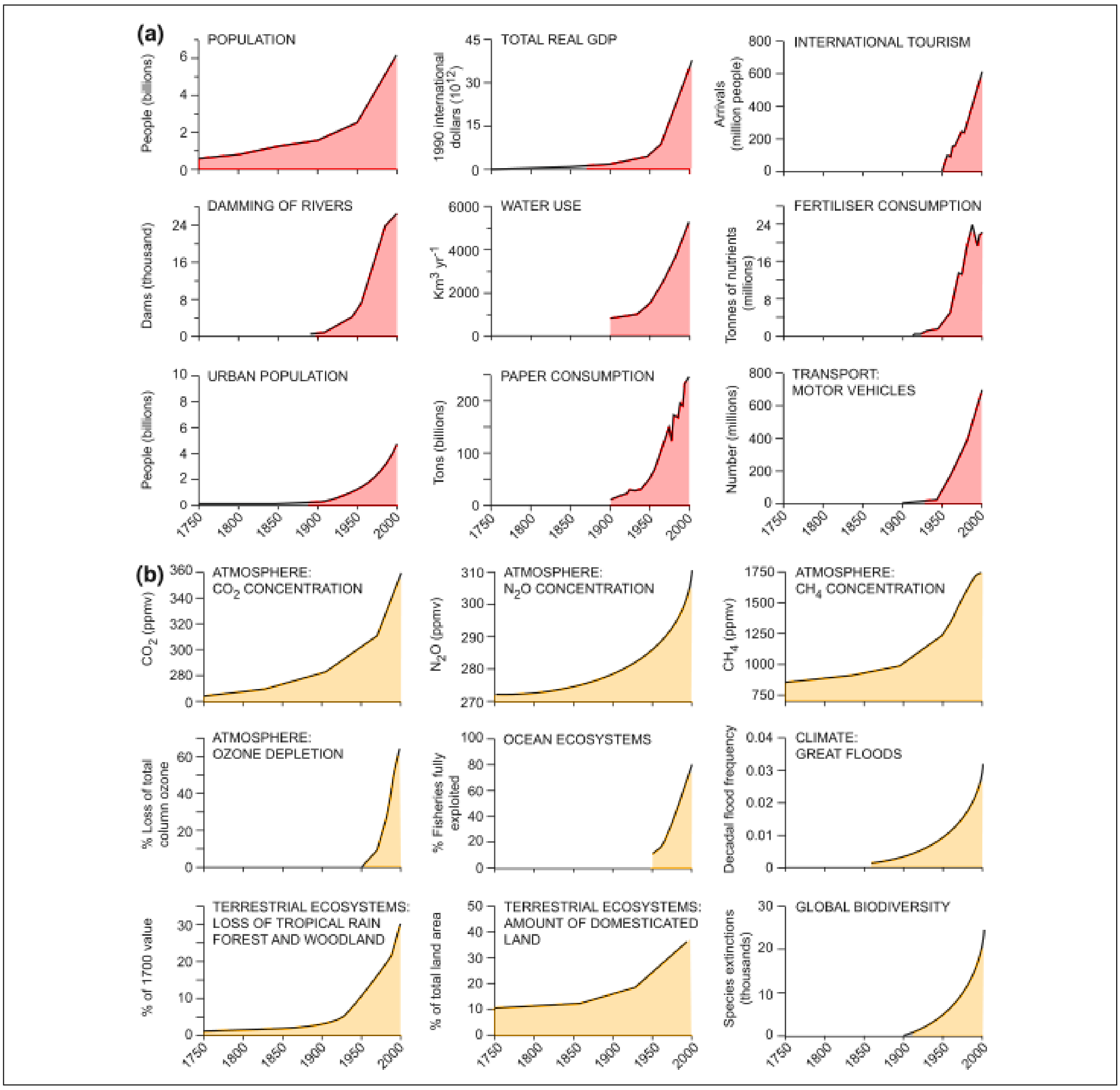

Figure 1: Trends in human activities (a) and global environmental changes (b) over the past 250 years. Reproduced from Dearing et al. (2006).

Kent (2003) identify two activities of increasingly wealthy populations of advanced developing countries that have significant environmental impacts: *(a)* meat-based diets that tremendously increase the demand for grain, resulting in water shortages, deforestation, and other harmful effects of industrialised agricultural practises; and *(b)* rising use of cars, contributing to around 74 percent of global CO_2 emissions.

Populations of poorer countries often rely directly on ecosystem services. At the same time, however, these populations exert tremendous pressure on their environment due to rapid growth (UNFPA, 2001; Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2010). The effects of widespread poverty and population growth on the environment are clearly observable in the example of Mozambique. Around 80 percent of Mozambique's land area is covered with vegetation and the country possesses a number of sites supporting high biodiversity (USAID, 2008). Mozambique has a relatively small population of 21 million people and a fairly low average population density of about 25 people per square kilometer, yet a high population growth rate of 1.8 percent spells an increase of population pressures in the near future (USAID, 2008). Commercial deforestation is well below the sustainable yield, but both poverty and unequal distribution of the population have resulted in severe degradation of forests around urban centres (USAID, 2008). As 85 percent of the country's population (including that in urban areas) rely on wood or charcoal, harvesting firefood results in deforestation at a scale of 250 times that of commercial operations (USAID, 2008, p. 36). More than 70 percent of the population live in poverty and directly depend on ecosystem services for their livelihoods (USAID, 2008, p. 19). As the population grows, the need for agricultural land and forestry products—and thus pressure on forest and wildlife—is intensifying quickly. While population pressures increase, reforestation efforts are minimal despite regulations, making even the current low rate of deforestation unsustainable (USAID, 2008, p. 37).

In their evaluation of population pressures and the global state of biodiversity, Butchart et al. (2010) note that humanity's ecological footprint, i.e. the average demand for land and other resources, has almost doubled since the first evaluation in 1970. The same rising trend applies to nitrogen deposition and the level of overexploitation of fisheries (Butchart et al., 2010). In summary, human population pressures on the environment can be regarded as consequences of an increase in food production and energy consumption: land-use change and unsustainable agricultural practises have lead to deforestation, biodiversity loss, sedimentation, and significant changes to global biogeochemical cycles (Vitousek et al., 1997); the demand for cheap energy from fossil fuels has resulted in excessive emissions of carbon dioxide, the main contributor to anthropogenic climate change (Solomon et al., 2007).

Drivers of biodiversity loss and the impact on human well-being

Human activities represent a major threat to global biodiversity. According to Chapin III et al. (2000), the largest driver of global species loss is land-use change, i.e. the conversion of one biome into another, including the draining of wetlands and the clearing of native vegetation cover for food production (cf. Leadley et al., 2010), followed by climate change and species introductions. Land-use change often results in the destruction of the habitats of most species in the affected area and causes fragmentation of remaining habitats (Foley et al., 2005). Meyer and Turner II (1992) identify the demand for expanded agricultural production as the driving force behind land conversions and list as major proximate sources *(a)* forest clearing, *(b)* tillage technologies on grasslands, *(c)* drainage in wetlands, and *(d)* irrigation in arid lands. Of all of these sources, deforestation is considered to be the top cause of global habitat loss and fragmentation (Leadley et al., 2010, p. 16)

Poaching of threatened animals as a resource, for bush meat, and for use in traditional medicine exerts significant pressure on a few already endangered species, some of which are so-called keystone species (Dinerstein et al., 2007; Alves, Souto, & Barboza, 2010). Keystone species, according to Bond (1994), have a disproportionate effect on other species and play an important role in their environment. Their life processes may create habitat for other species, assist plants by dispersing seeds, or control the population size of other species (Bond, 1994). The extinction of keystone species often leads to the loss of many other directly or indirectly dependent species (Bond, 1994; Díaz, Fargione, Chapin III, & Tilman, 2006). Similarly, the loss of functional groups of more abundant species has a higher impact on ecosystem health than the loss of already rare species of lower functional importance (Díaz et al., 2006).

Other drivers of global biodiversity changes that are either directly or indirectly related to human activities are biological invasions and climate change (Díaz et al., 2006). As with the extinction of a single species, the introduction of a single species can have cascading effects through the food-web with results that are difficult to predict (Díaz et al., 2006). New Zealand is a tragic example for the effect of introduced animals on biodiversity. According to Towns and Daugherty (1994), about 40 percent of New Zealand's fauna has become extinct since the introduction of mammalian predators by human settlers less than 1000 years ago. Holdaway (1999) argues that the introduction of the Pacific rat may have played the biggest part in the extinctions of nearly half of New Zealand's avifauna. A large percentage of the surviving species now occupy very restricted ranges on rat-free offshore islands (Towns & Daugherty, 1994).

Changing biodiversity does not only lead to shifts in native wildlife communities as in New Zealand or cause severe environmental degradation; it can also have considerable detrimental effects on human economies and human health, especially impacting the populations of poor countries (Díaz et al., 2006). According to Díaz et al. (2006), the rural poor and traditional societies with high numbers of subsistance farmers and fishermen rely most directly on ecosystem services for nutrition, medicinal products, fuel and construction materials, and protection from natural disasters. Their lack of economic and political leverage often leaves them, unlike the more wealthy, without alternatives when natural renewable resources are in decline and ecosystem services are degraded. It can thus be said that rapid extinctions and the subsequent degradation of ecosystems accentuate inequality and exacerbate the problem of poverty, which in turn is an important driver of biodiversity loss (Díaz et al., 2006).

Wealthy countries are not exempt from the impacts of biodiversity change. Chapin III et al. (2000) mention the reduction of municipal water supplies in the United States due to the invasion of *Tamarix*. The shrub also traps sediments, narrowing river channels and altering flow and flooding characteristics. The presence of *Tamarix* is estimated to have increased flood damages by as much as 50 million US dollars a year (Chapin III et al., 2000). According to Chapin III et al. (2000), estimates of the overall cost of introduced species in the United States range from 1.1 to 137 billion US dollars.

International response

One of the earliest attempts to model the interactions of human populations with their environment was made in 1971 when Ehrlich and Holdren (1971) proposed the *I=PAT* identity as a means to express the impact (I) of human populations on the environment as a product of population size (P), affluence (A), and technology (T). Although the model involves three variables that are considered main constituents of human population pressures, *I=PAT* is an insufficient method to explain the relations between population and environmental degradation as it disregards the influence of the three factors on one another (Alcott, 2009). The United Nations Population Fund proposes to take into account geographic distribution and socio-economic composition of populations in order to address the different resource demands and contributions to pollution of distinct population groups (UNFPA, 2001). Governments are encouraged to consider demographics and population trends when designing environmental strategies, such as programmes to cope with the effects of climate change (UNFPA, 2011).

In recognition of the interactions between economic development, poverty, and biodiversity loss, the UN developed *Agenda 21*, an action plan to protect the environment, strive towards sustainable economic growth, and to help developing countries in their efforts to fight poverty. This plan was adopted by more than 170 of the parties to the United Nations Conference on Environment and Development (UNCED; also known as the *Rio Summit* or *Earth Summit*) in 1992 (UN Department of Economic and Social Affairs, 2009). The goals to eradicate extreme poverty and strive for environmental sustainability have also been included in the UN Millennium Development Goals (United Nations Development Programme, 2007a, 2007b). In a review over a decade after the Rio Summit, however, Castelló, Gil-González, Diaz, and Hernández-Aguado (2010) have found that there has only been little progress towards the goal of environmental sustainability, because environmental issues are still not treated with sufficient priority in research and politics.

While it is true that there are still gaps in the scientific understanding of species interactions across trophic levels or the classification of organisms according to functional traits and their importance on the ecosystem level, most of the actions to slow down biodiversity loss currently at our disposal depend on government policies (Díaz et al., 2006). The issue of biodiversity loss was specifically targeted by the UNCED Convention on Biological Diversity (CBD) which has since been ratified by more than 160 nations expressing their commitment to reduce the rate of biodiversity loss by 2010[3]. A framework of 22 indicators was adopted in 2006 to assess the effectiveness of biodiversity management, yet by the end of 2009 only a minority of the required measures had been developed well enough to be useful indicators of progress (Walpole et al., 2009). Walpole et al. (2009) criticise that even the few well-developed indicators, such as forest cover, are not necessarily suitable to measure effec-

[3] The United States of America are a notable exception (Secretariat of the Convention on Biological Diversity, 2012).

tiveness of biodiversity policies and to track biodiversity changes, as they were designed as proxies for purposes other than conservation.

According to Butchart et al. (2010), eight out of ten indicators for the state of biodiversity showed negative trends, suggesting continued rapid species loss. At the same time, indicators of population pressures on biodiversity showed positive trends over recent decades. The Conference of the Parties to the Convention on Biological Diversity (2010) recognised the failure to meet the 2010 biodiversity target in a review in October 2010, and adopted the Aichi Biodiversity Targets that are to be achieved by 2020 (Secretariat of the Convention on Biological Diversity, 2010). In June 2012 the United Nations Conference on Sustainable Development (or *Rio+20*) will be held. Just like previous summits, the focus will be on strengthening international environmental governance (United Nations Conference on Sustainable Development, 2011), sustainability, and poverty eradication (Secretariat of the UN CSD, 2011b, 2011a).

Recommendations

The disappointingly slow progress towards slowing down extinction rates and developing sustainable economies calls into question the current approach to environmental policies. Alcott (2009) argues that policies intended to indirectly lower the impact of any of the three right-hand side factors of the *I=PAT* identity are costly and not necessarily effective as other factors may rebound in response. He hence advocates policies that enforce absolute impact caps. An example would be the reduction of the impacts of meat production in developed and emerging nations by removing harmful subsidies, taxing inefficient meat sources, or by introducing full-cost pricing (Myers & Kent, 2003).

Although economical growth has traditionally been considered a requirement for poor societies to develop and act upon environmental concerns, Arrow et al. (1995) argue that the ”inverted-U” relation between per capita income and environmental quality is an oversimplification that *(a)* does not apply to pollution with long-term effects such as toxic waste production and greenhouse gas emissions; *(b)* ignores the feedback of resource stock depletion on environmental quality; *(c)* fails to describe system-wide consequences; and *(d)* that fails to recognise the effects of letting poorer countries and future generations bear the costs of economical growth, resource depletion and pollution. Hence, economical development at all costs is likely to result in a shift of population pressures and even an overall decrease of life quality unless financial mechanisms are implemented to assign value to ecosystem services (Díaz et al., 2006). Díaz et al. (2006) and Turner et al. (2012) see the accounting of ecosystem services as a necessary step in order to assist policy makers in negotiations with different stakeholders. Turner et al. (2012) suggest that beneficiaries of ecosystem services provide financial compensation to resource stewards in a *Payments for Ecosystem Services* model, making the conservation of ecosystem services and biodiversity an effective means to alleviate poverty.

In the meantime, higher priority should be assigned to restore degraded ecosystems and increase the area of protected land in order to create buffer zones that can help avert irreversible tipping points that otherwise would easily be reached as a consequence of the continuing growth of population pressures and resource demands (Leadley et al., 2010, p. 26).

Conclusion

To summarise: current patterns of consumption and production of affluent and poor populations are unsustainable and a threat to biodiversity. Continuing rapid population growth will aggravate population pressures and make it increasingly difficult to cope with environmental degradation, especially for poor countries whose inhabitants depend directly on ecosystem services.

Despite international efforts, global biodiversity is still in decline. The biggest threat to biodiversity continues to stem from processes related to food production and energy consumption. As emergent nations become more affluent their ecological footprint is expected to rise, driving human demands on resources beyond the earth's carrying capacity. As population models indicate, the world population will likely continue to grow to reach 9 billion people by 2050 (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2010). Hence, international efforts must be targeted at reducing the ecological footprints of developed and advanced developing societies, while sustainably developing economies in disadvantaged countries. So far, the goals to slow the rate of biodiversity loss and shift to sustainable development have not been met by the international community. Research suggests that establishing financial mechanisms to account for the value provided by ecosystem services would help both in the struggle for biodiversity conservation and against extreme poverty. Restoring degraded landscapes and legally protecting more of remaining ecosystems might buy humanity enough time before vulnerable ecosystems reach irreversible tipping points that will lead to unpredictable changes to the very ecosystem services that human well-being depends on.

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