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## Climate Change: Human Impact on the Environment

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**ABSTRACT:** Global temperatures rose about 1.98°F (1.1°C) from 1901 to 2008, but climate change refers to more than an increase in temperature. It also includes sea level rise, changes in weather patterns like drought and flooding, and much more. Things that we depend upon and value — water, energy, transportation, wildlife, agriculture, ecosystems, and human health — are experiencing the effects of a changing climate. The impacts of climate change on different sectors of society are interrelated. Drought can harm food production and human health. Flooding can lead to disease spread and damages to ecosystems and infrastructure. Human health issues can increase mortality, impact food availability, and limit worker productivity. Climate change impacts are seen throughout every aspect of the world we live in. However, climate change impacts are uneven across the country and the world — even within a single community, climate change impacts can differ between neighborhoods or individuals. Long-standing socioeconomic inequities can make underserved groups, who often have the highest exposure to hazards and the fewest resources to respond, more vulnerable.

**KEYWORDS:** climate change, human impact, environment, health, mortality, socioeconomic, hazards

### I. INTRODUCTION

Humans impact the physical environment in many ways: overpopulation, pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality, and undrinkable water. These negative impacts can affect human behavior and can prompt mass migrations or battles over clean water.

Human impact on the environment (or anthropogenic impact) refers to changes to biophysical environments<sup>[1]</sup> and to ecosystems, biodiversity, and natural resources<sup>[2]</sup> caused directly or indirectly by humans. Modifying the environment to fit the needs of society is causing severe effects<sup>[3][4]</sup> including global warming,<sup>[1][5]</sup> environmental degradation<sup>[1]</sup> (such as ocean acidification<sup>[1][6]</sup>), mass extinction and biodiversity loss,<sup>[7][8][9][10]</sup> ecological crisis, and ecological collapse. Some human activities that cause damage (either directly or indirectly) to the environment on a global scale include population growth,<sup>[11][12][13]</sup> rapid economic growth,<sup>[14]</sup> overconsumption, overexploitation, pollution, and deforestation. Some of the problems, including global warming and biodiversity loss, have been proposed as representing catastrophic risks to the survival of the human species.<sup>[15][16]</sup>

The term anthropogenic designates an effect or object resulting from human activity. The term was first used in the technical sense by Russian geologist Alexey Pavlov, and it was first used in English by British ecologist Arthur Tansley in reference to human influences on climax plant communities.<sup>[17]</sup> The atmospheric scientist Paul Crutzen introduced the term "Anthropocene" in the mid-1970s.<sup>[18]</sup> The term is sometimes used in the context of pollution produced from human activity since the start of the Agricultural Revolution but also applies broadly to all major human impacts on the environment.<sup>[19][20][21]</sup> Many of the actions taken by humans that contribute to a heated environment stem from the burning of fossil fuel from a variety of sources, such as: electricity, cars, planes, space heating, manufacturing, or the destruction of forests.<sup>[22]</sup>

Overconsumption is a situation where resource use has outpaced the sustainable capacity of the ecosystem. It can be measured by the ecological footprint, a resource accounting approach which compares human demand on ecosystems

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with the amount of planet matter ecosystems can renew. Estimates indicate that humanity's current demand is 70%<sup>[24]</sup> higher than the regeneration rate of all of the planet's ecosystems combined. A prolonged pattern of overconsumption leads to environmental degradation and the eventual loss of resource bases.

Humanity's overall impact on the planet is affected by many factors, not just the raw number of people. Their lifestyle (including overall affluence and resource use) and the pollution they generate (including carbon footprint) are equally important. In 2008, The New York Times stated that the inhabitants of the developed nations of the world consume resources like oil and metals at a rate almost 32 times greater than those of the developing world, who make up the majority of the human population.<sup>[25]</sup>

Human civilization has caused the loss of 83% of all wild mammals and half of plants.<sup>[26]</sup> The world's chickens are triple the weight of all the wild birds, while domesticated cattle and pigs outweigh all wild mammals by 14 to 1.<sup>[27][28]</sup> Global meat consumption is projected to more than double by 2050, perhaps as much as 76%, as the global population rises to more than 9 billion, which will be a significant driver of further biodiversity loss and increased Greenhouse gas emissions.<sup>[29][30]</sup>

Some scholars, environmentalists and advocates have linked human population growth or population size as a driver of environmental issues, including some suggesting this indicates an overpopulation scenario.<sup>[11]</sup> In 2011, over 15,000 scientists around the world issued a second warning to humanity which asserted that rapid human population growth is the "primary driver behind many ecological and even societal threats."<sup>[33]</sup> According to the Global Assessment Report on Biodiversity and Ecosystem Services, released by the United Nations' Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services in 2009, human population growth is a significant factor in contemporary biodiversity loss.<sup>[34]</sup> A 2007 report in *Frontiers in Conservation Science* proposed that population size and growth are significant factors in biodiversity loss, soil degradation and pollution.<sup>[35][36]</sup>

Some scientists and environmentalists, including Pentti Linkola,<sup>[37]</sup> Jared Diamond and E. O. Wilson, posit that human population growth is devastating to biodiversity. Wilson for example, has expressed concern when *Homo sapiens* reached a population of six billion their biomass exceeded that of any other large land dwelling animal species that had ever existed by over 100 times.<sup>[38]</sup>

However, attributing overpopulation as a cause of environmental issues is controversial. Demographic projections indicate that population growth is slowing and world population will peak in the 21st century,<sup>[31]</sup> and many experts believe that global resources can meet this increased demand, suggesting a global overpopulation scenario is unlikely. Other projections have the population continuing to grow into the next century.<sup>[39]</sup> While some studies, including the British government's 2007 Economics of Biodiversity review, posit that population growth and overconsumption are interdependent,<sup>[40][41][42]</sup> critics suggest blaming overpopulation for environmental issues can unduly blame poor populations in the Global South or oversimplify more complex drivers, leading some to treat overconsumption as a separate issue.<sup>[43][44][45]</sup>

Advocates for further reducing fertility rates, among them Rodolfo Dirzo and Paul R. Ehrlich, argue that this reduction should primarily affect the "overconsuming wealthy and middle classes," with the ultimate goal being to shrink "the scale of the human enterprise" and reverse the "growthmania" which they say threatens biodiversity and the "life-support systems of humanity."<sup>[46]</sup>

The environmental impact of agriculture varies based on the wide variety of agricultural practices employed around the world. Ultimately, the environmental impact depends on the production practices of the system used by farmers. The connection between emissions into the environment and the farming system is indirect, as it also depends on other climate variables such as rainfall and temperature. There are two types of indicators of environmental impact: "means-based", which is based on the farmer's production methods, and "effect-based", which is the impact that farming methods have on the farming system or on emissions to the environment. An example of a means-based indicator would be the quality of groundwater that is affected by the amount of nitrogen applied to the soil. An indicator reflecting the loss of nitrate to groundwater would be effect-based.<sup>[47]</sup>

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The environmental impact of agriculture involves a variety of factors from the soil, to water, the air, animal and soil diversity, plants, and the food itself. Some of the environmental issues that are related to agriculture are climate change, deforestation, genetic engineering, irrigation problems, pollutants, soil degradation, and waste.

The environmental impact of fishing can be divided into issues that involve the availability of fish to be caught, such as overfishing, sustainable fisheries, and fisheries management; and issues that involve the impact of fishing on other elements of the environment, such as by-catch and destruction of habitat such as coral reefs.<sup>[48]</sup> According to the 2009 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services report, overfishing is the main driver of mass species extinction in the oceans.<sup>[49]</sup>

These conservation issues are part of marine conservation, and are addressed in fisheries science programs. There is a growing gap between how many fish are available to be caught and humanity's desire to catch them, a problem that gets worse as the world population grows.

Similar to other environmental issues, there can be conflict between the fishermen who depend on fishing for their livelihoods and fishery scientists who realize that if future fish populations are to be sustainable then some fisheries must reduce or even close.<sup>[50]</sup>

The journal Science published a four-year study in November 2006, which predicted that, at prevailing trends, the world would run out of wild-caught seafood in 2048.<sup>[51]</sup> The scientists stated that the decline was a result of overfishing, pollution and other environmental factors that were reducing the population of fisheries at the same time as their ecosystems were being degraded. Yet again the analysis has met criticism as being fundamentally flawed, and many fishery management officials, industry representatives and scientists challenge the findings, although the debate continues. Many countries, such as Tonga, the United States, Australia and New Zealand, and international management bodies have taken steps to appropriately manage marine resources.<sup>[52][53]</sup>

The UN's Food and Agriculture Organization (FAO) released their biennial State of World Fisheries and Aquaculture in 2010<sup>[54]</sup> noting that capture fishery production has remained constant for the last two decades but unsustainable overfishing has increased to 33% of the world's fisheries. They also noted that aquaculture, the production of farmed fish, has increased from 120 million tonnes per year in 1990 to over 170 million tonnes in 2010.<sup>[55]</sup>

Populations of oceanic sharks and rays have been reduced by 71% since 1970, largely due to overfishing. More than three-quarters of the species comprising this group are now threatened with extinction.<sup>[56][57]</sup>

## II.DISCUSSION

The environmental impact of irrigation includes the changes in quantity and quality of soil and water as a result of irrigation and the ensuing effects on natural and social conditions at the tail-end and downstream of the irrigation scheme.

The impacts stem from the changed hydrological conditions owing to the installation and operation of the scheme.

An irrigation scheme often draws water from the river and distributes it over the irrigated area. As a hydrological result it is found that:

- the downstream river discharge is reduced
- the evaporation in the scheme is increased
- the groundwater recharge in the scheme is increased
- the level of the water table rises
- the drainage flow is increased.

These may be called direct effects.

Effects on soil and water quality are indirect and complex, and subsequent impacts on natural, ecological and socio-economic conditions are intricate. In some, but not all instances, water logging and soil salinization can result.

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However, irrigation can also be used, together with soil drainage, to overcome soil salinization by leaching excess salts from the vicinity of the root zone.<sup>[58][59]</sup>

Irrigation can also be done extracting groundwater by (tube)wells. As a hydrological result it is found that the level of the water descends. The effects may be water mining, land/soil subsidence, and, along the coast, saltwater intrusion.

Irrigation projects can have large benefits, but the negative side effects are often overlooked.<sup>[60][61]</sup>

Agricultural irrigation technologies such as high powered water pumps, dams, and pipelines are responsible for the large-scale depletion of fresh water resources such as aquifers, lakes, and rivers. As a result of this massive diversion of freshwater, lakes, rivers, and creeks are running dry, severely altering or stressing surrounding ecosystems, and contributing to the extinction of many aquatic species.<sup>[62]</sup>

Lal and Stewart estimated global loss of agricultural land by degradation and abandonment at 12 million hectares per year.<sup>[63]</sup> In contrast, according to Scherr, GLASOD (Global Assessment of Human-Induced Soil Degradation, under the UN Environment Programme) estimated that 6 million hectares of agricultural land per year had been lost to soil degradation since the mid-1940s, and she noted that this magnitude is similar to earlier estimates by Dudal and by Rozanov et al.<sup>[64]</sup> Such losses are attributable not only to soil erosion, but also to salinization, loss of nutrients and organic matter, acidification, compaction, water logging and subsidence.<sup>[65]</sup> Human-induced land degradation tends to be particularly serious in dry regions. Focusing on soil properties, Oldeman estimated that about 19 million square kilometers of global land area had been degraded; Dregne and Chou, who included degradation of vegetation cover as well as soil, estimated about 36 million square kilometers degraded in the world's dry regions.<sup>[66]</sup> Despite estimated losses of agricultural land, the amount of arable land used in crop production globally increased by about 9% from 1961 to 2012, and is estimated to have been 1.396 billion hectares in 2012.<sup>[67]</sup>

Global average soil erosion rates are thought to be high, and erosion rates on conventional cropland generally exceed estimates of soil production rates, usually by more than an order of magnitude.<sup>[68]</sup> In the US, sampling for erosion estimates by the US NRCS (Natural Resources Conservation Service) is statistically based, and estimation uses the Universal Soil Loss Equation and Wind Erosion Equation. For 2010, annual average soil loss by sheet, rill and wind erosion on non-federal US land was estimated to be 10.7 t/ha on cropland and 1.9 t/ha on pasture land; the average soil erosion rate on US cropland had been reduced by about 34% since 1982.<sup>[69]</sup> No-till and low-till practices have become increasingly common on North American cropland used for production of grains such as wheat and barley. On uncultivated cropland, the recent average total soil loss has been 2.2 t/ha per year.<sup>[69]</sup> In comparison with agriculture using conventional cultivation, it has been suggested that, because no-till agriculture produces erosion rates much closer to soil production rates, it could provide a foundation for sustainable agriculture.<sup>[68]</sup>

Land degradation is a process in which the value of the biophysical environment is affected by a combination of human-induced processes acting upon the land.<sup>[70]</sup> It is viewed as any change or disturbance to the land perceived to be deleterious or undesirable.<sup>[71]</sup> Natural hazards are excluded as a cause; however human activities can indirectly affect phenomena such as floods and bush fires. This is considered to be an important topic of the 21st century due to the implications land degradation has upon agronomic productivity, the environment, and its effects on food security.<sup>[72]</sup> It is estimated that up to 40% of the world's agricultural land is seriously degraded.<sup>[73]</sup>

Environmental impacts associated with meat production include use of fossil energy, water and land resources, greenhouse gas emissions, and in some instances, rainforest clearing, water pollution and species endangerment, among other adverse effects.<sup>[76][77]</sup> Steinfeld et al. of the FAO estimated that 18% of global anthropogenic GHG (greenhouse gas) emissions (estimated as 100-year carbon dioxide equivalents) are associated in some way with livestock production.<sup>[76]</sup> FAO data indicate that meat accounted for 26% of global livestock product tonnage in 2011.<sup>[78]</sup>

Globally, enteric fermentation (mostly in ruminant livestock) accounts for about 27% of anthropogenic methane emissions,<sup>[79]</sup> Despite methane's 100-year global warming potential, recently estimated at 28 without and 34 with climate-carbon feedbacks,<sup>[79]</sup> methane emission is currently contributing relatively little to global warming. Although reduction of methane emissions would have a rapid effect on warming, the expected effect would be small.<sup>[80]</sup> Other anthropogenic GHG emissions associated with livestock production include carbon dioxide from fossil fuel

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consumption (mostly for production, harvesting and transport of feed), and nitrous oxide emissions associated with the use of nitrogenous fertilizers, growing of nitrogen-fixing legume vegetation and manure management. Management practices that can mitigate GHG emissions from production of livestock and feed have been identified.<sup>[81][82][83][84][85]</sup>

Considerable water use is associated with meat production, mostly because of water used in production of vegetation that provides feed. There are several published estimates of water use associated with livestock and meat production, but the amount of water use assignable to such production is seldom estimated. For example, "green water" use is evapotranspirational use of soil water that has been provided directly by precipitation; and "green water" has been estimated to account for 94% of global beef cattle production's "water footprint",<sup>[86]</sup> and on rangeland, as much as 99.5% of the water use associated with beef production is "green water".

Impairment of water quality by manure and other substances in runoff and infiltrating water is a concern, especially where intensive livestock production is carried out. In the US, in a comparison of 32 industries, the livestock industry was found to have a relatively good record of compliance with environmental regulations pursuant to the Clean Water Act and Clean Air Act,<sup>[87]</sup> but pollution issues from large livestock operations can sometimes be serious where violations occur. Various measures have been suggested by the US Environmental Protection Agency, among others, which can help reduce livestock damage to streamwater quality and riparian environments.<sup>[88]</sup>

Changes in livestock production practices influence the environmental impact of meat production, as illustrated by some beef data. In the US beef production system, practices prevailing in 2007 are estimated to have involved 8.6% less fossil fuel use, 16% less greenhouse gas emissions (estimated as 100-year carbon dioxide equivalents), 12% less withdrawn water use and 33% less land use, per unit mass of beef produced, than in 1977.<sup>[89]</sup> From 1980 to 2012 in the US, while population increased by 38%, the small ruminant inventory decreased by 42%, the cattle-and-calves inventory decreased by 17%, and methane emissions from livestock decreased by 18%;<sup>[67]</sup> yet despite the reduction in cattle numbers, US beef production increased over that period.<sup>[90]</sup>

Some impacts of meat-producing livestock may be considered environmentally beneficial. These include waste reduction by conversion of human-inedible crop residues to food, use of livestock as an alternative to herbicides for control of invasive and noxious weeds and other vegetation management,<sup>[91]</sup> use of animal manure as fertilizer as a substitute for those synthetic fertilizers that require considerable fossil fuel use for manufacture, grazing use for wildlife habitat enhancement,<sup>[92]</sup> and carbon sequestration in response to grazing practices,<sup>[93][94]</sup> among others. Conversely, according to some studies appearing in peer-reviewed journals, the growing demand for meat is contributing to significant biodiversity loss as it is a significant driver of deforestation and habitat destruction.<sup>[95][96][97][30]</sup> Moreover, the 2009 Global Assessment Report on Biodiversity and Ecosystem Services by IPBES also warns that ever increasing land use for meat production plays a significant role in biodiversity loss.<sup>[98][99]</sup> A 2006 Food and Agriculture Organization report, *Livestock's Long Shadow*, found that around 26% of the planet's terrestrial surface is devoted to livestock grazing.<sup>[100]</sup>

## III.RESULTS

The consumption of palm oil in food, domestic and cosmetic products all over the world means there is a high demand for it. To meet this, oil palm plantations are created, which means removing natural forests to clear space. This deforestation has taken place in Asia, Latin America and West Africa, with Malaysia and Indonesia holding 90% of global oil palm trees. These forests are home to a wide range of species, including many endangered animals, ranging from birds to rhinos and tigers.<sup>[103]</sup> Since 2000, 47% of deforestation has been for the purpose of growing oil palm plantations, with around 877,000 acres being affected per year.<sup>[101]</sup> Natural forests are extremely biodiverse, with a wide range of organisms using them as their habitat. But oil palm plantations are the opposite. Studies have shown that oil palm plantations have less than 1% of the plant diversity seen in natural forests, and 47–90% less mammal diversity.<sup>[104]</sup> This is not because of the oil palm itself, but rather because the oil palm is the only habitat provided in the plantations. The plantations are therefore known as a monoculture, whereas natural forests contain a wide variety of flora and fauna, making them highly biodiverse. One of the ways palm oil could be made more sustainable (although it is still not the best option) is through agroforestry, whereby the plantations are made up of multiple types of plants used in trade – such as coffee or cocoa. While these are more biodiverse than monoculture plantations, they are still not as

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effective as natural forests. In addition to this, agroforestry does not bring as many economic benefits to workers, their families and the surrounding areas.<sup>[105]</sup> The RSPO is a non-profit organisation that has developed criteria that its members (of which, as of 2010, there are over 4,000) must follow to produce, source and use sustainable palm oil (Certified Sustainable Palm Oil; CSPO). Currently, 19% of global palm oil is certified by the RSPO as sustainable.

The CSPO criteria states that oil palm plantations cannot be grown in the place of forests or other areas with endangered species, fragile ecosystems, or those that facilitate the needs of local communities. It also calls for a reduction in pesticides and fires, along with several rules for ensuring the social wellbeing of workers and the local communities.<sup>[106]</sup>

Human activity is causing environmental degradation, which is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.<sup>[71]</sup> As indicated by the I=PAT equation, environmental impact (I) or degradation is caused by the combination of an already very large and increasing human population (P), continually increasing economic growth or per capita affluence (A), and the application of resource-depleting and polluting technology (T).<sup>[107][108]</sup>

According to a 2007 study published in *Frontiers in Forests and Global Change*, roughly 3% of the planet's terrestrial surface is ecologically and faunally intact, meaning areas with healthy populations of native animal species and little to no human footprint. Many of these intact ecosystems were in areas inhabited by indigenous peoples.<sup>[109][110]</sup>

According to a 2010 study in *Nature*, 87% of the oceans and 77% of land (excluding Antarctica) have been altered by anthropogenic activity, and 23% of the planet's landmass remains as wilderness.<sup>[111]</sup>

Habitat fragmentation is the reduction of large tracts of habitat leading to habitat loss. Habitat fragmentation and loss are considered as being the main cause of the loss of biodiversity and degradation of the ecosystem all over the world. Human actions are greatly responsible for habitat fragmentation, and loss as these actions alter the connectivity and quality of habitats. Understanding the consequences of habitat fragmentation is important for the preservation of biodiversity and enhancing the functioning of the ecosystem.<sup>[112]</sup>

Both agricultural plants and animals depend on pollination for reproduction. Vegetables and fruits are an important diet for human beings and depend on pollination. Whenever there is habitat destruction, pollination is reduced and crop yield as well. Many plants also rely on animals and most especially those that eat fruit for seed dispersal. Therefore, the destruction of habitat for animal severely affects all the plant species that depend on them.<sup>[113]</sup>

Biodiversity generally refers to the variety and variability of life on Earth, and is represented by the number of different species there are on the planet. Since its introduction, *Homo sapiens* (the human species) has been killing off entire species either directly (such as through hunting) or indirectly (such as by destroying habitats), causing the extinction of species at an alarming rate. Humans are the cause of the current mass extinction, called the Holocene extinction, driving extinctions to 100 to 1000 times the normal background rate.<sup>[114][115]</sup> Though most experts agree that human beings have accelerated the rate of species extinction, some scholars have postulated without humans, the biodiversity of the Earth would grow at an exponential rate rather than decline.<sup>[116]</sup> The Holocene extinction continues, with meat consumption, overfishing, ocean acidification and the amphibian crisis being a few broader examples of an almost universal, cosmopolitan decline in biodiversity. Human overpopulation<sup>[117]</sup> (and continued population growth)<sup>[118]</sup> along with overconsumption, especially by the super-affluent,<sup>[119]</sup> are considered to be the primary drivers of this rapid decline.<sup>[10][120]</sup> The 2011 World Scientists' Warning to Humanity stated that, among other things, this sixth extinction event unleashed by humanity could annihilate many current life forms and consign them to extinction by the end of this century.<sup>[33]</sup> A 2006 scientific review published in *Biological Reviews* confirms that a biodiversity loss crisis caused by human activity, which the researchers describe as a sixth mass extinction event, is currently underway.<sup>[121][122]</sup>

A June 2008 study published in *PNAS* argues that the contemporary extinction crisis "may be the most serious environmental threat to the persistence of civilization, because it is irreversible" and that its acceleration "is certain because of the still fast growth in human numbers and consumption rates."<sup>[123]</sup> Defaunation is the loss of animals from ecological communities.<sup>[125]</sup>

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It has been estimated that from 1970 to 2012, 68% of the world's wildlife has been destroyed due to human activity.<sup>[126][127]</sup> In South America, there is believed to be a 70 percent loss.<sup>[128]</sup> A May 2010 study published in PNAS found that 83% of wild mammals, 80% of marine mammals, 50% of plants and 15% of fish have been lost since the dawn of human civilization. Currently, livestock make up 60% of the biomass of all mammals on earth, followed by humans (36%) and wild mammals (4%).<sup>[26]</sup> According to the 2009 global biodiversity assessment by IPBES, human civilization has pushed one million species of plants and animals to the brink of extinction, with many of these projected to vanish over the next few decades.<sup>[98][129][130]</sup>

When plant biodiversity declines, the remaining plants face diminishing productivity.<sup>[131]</sup> Biodiversity loss threatens ecosystem productivity and services such as food, fresh water, raw materials and medicinal resources.<sup>[131]</sup>

A 2009 report that assessed a total of 28,000 plant species concluded that close to half of them were facing a threat of extinction. The failure of noticing and appreciating plants is regarded as "plant blindness", and this is a worrying trend as it puts more plants at the threat of extinction than animals. Our increased farming has come at a higher cost to plant biodiversity as half of the habitable land on Earth is used for agriculture, and this is one of the major reasons behind the plant extinction crisis.<sup>[132]</sup>

Invasive species are defined by the U.S. Department of Agriculture as non-native to the specific ecosystem, and whose presence is likely to harm the health of humans or the animals in said system.<sup>[133]</sup>

Introductions of non-native species into new areas have brought about major and permanent changes to the environment over large areas. Examples include the introduction of *Caulerpa taxifolia* into the Mediterranean, the introduction of oat species into the California grasslands, and the introduction of privet, kudzu, and purple loosestrife to North America. Rats, cats, and goats have radically altered biodiversity in many islands. Additionally, introductions have resulted in genetic changes to native fauna where interbreeding has taken place, as with buffalo with domestic cattle, and wolves with domestic dogs.

The fossils that are burned by humans for energy usually come back to them in the form of acid rain. Acid rain is a form of precipitation which has high sulfuric and nitric acids which can occur in the form of a fog or snow. Acid rain has numerous ecological impacts on streams, lakes, wetlands and other aquatic environments. It damages forests, robs the soil of its essential nutrients, releases aluminium to the soil, which makes it very hard for trees to absorb water.<sup>[155]</sup>

Researchers have discovered that kelp, eelgrass and other vegetation can effectively absorb carbon dioxide and hence reducing ocean acidity. Scientists, therefore, say that growing these plants could help in mitigating the damaging effects of acidification on marine life.<sup>[156]</sup>

Ozone depletion consists of two related events observed since the late 1970s: a steady lowering of about four percent in the total amount of ozone in Earth's atmosphere, and a much larger springtime decrease in stratospheric ozone (the ozone layer) around Earth's polar regions.<sup>[157]</sup> The latter phenomenon is referred to as the ozone hole. There are also springtime polar tropospheric ozone depletion events in addition to these stratospheric events.

The main causes of ozone depletion and the ozone hole are manufactured chemicals, especially manufactured halocarbon refrigerants, solvents, propellants, and foam-blowing agents (chlorofluorocarbons (CFCs), HCFCs, halons), referred to as ozone-depleting substances (ODS).<sup>[158]</sup> These compounds are transported into the stratosphere by turbulent mixing after being emitted from the surface, mixing much faster than the molecules can settle.<sup>[159]</sup> Once in the stratosphere, they release atoms from the halogen group through photodissociation, which catalyze the breakdown of ozone (O<sub>3</sub>) into oxygen (O<sub>2</sub>).<sup>[160]</sup> Both types of ozone depletion were observed to increase as emissions of halocarbons increased.

Ozone depletion and the ozone hole have generated worldwide concern over increased cancer risks and other negative effects. The ozone layer prevents harmful wavelengths of ultraviolet (UVB) light from passing through the Earth's atmosphere. These wavelengths cause skin cancer, sunburn, permanent blindness, and cataracts,<sup>[161]</sup> which were projected to increase dramatically as a result of thinning ozone, as well as harming plants and animals. These concerns led to the adoption of the Montreal Protocol in 1987, which bans the production of CFCs, halons, and other ozone-depleting chemicals.<sup>[162]</sup> Currently,<sup>[when?]</sup> scientists plan to develop new refrigerants to replace older ones.<sup>[163]</sup>

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The ban came into effect in 1989. Ozone levels stabilized by the mid-1990s and began to recover in the 2000s, as the shifting of the jet stream in the southern hemisphere towards the south pole has stopped and might even be reversing.<sup>[164]</sup> Recovery is projected to continue over the next century, and the ozone hole is expected to reach pre-1980 levels by around 2075.<sup>[165]</sup> In 2009, NASA reported that the ozone hole was the smallest ever since it was first discovered in 1982.<sup>[166][167]</sup>

The Montreal Protocol is considered the most successful international environmental agreement to date.<sup>[168][169]</sup> Following the bans on ozone-depleting chemicals, the UN projects that under the current regulations the ozone layer will completely regenerate by 2045.<sup>[170]</sup> There are many publications from the scientific community to warn everyone about growing threats to sustainability, in particular threats to "environmental sustainability". The World Scientists' Warning to Humanity in 1992 begins with: "Human beings and the natural world are on a collision course". About 1,700 of the world's leading scientists, including most Nobel Prize laureates in the sciences, signed this warning letter. The letter mentions severe damage to the atmosphere, oceans, ecosystems, soil productivity, and more. It said that if humanity wants to prevent the damage, steps need to be taken: better use of resources, abandonment of fossil fuels, stabilization of human population, elimination of poverty and more. More warning letters were signed in 2011 and 2009 by thousands of scientists from over 150 countries which called again to reduce overconsumption (including eating less meat), reducing fossil fuels use and other resources and so forth

## IV. CONCLUSIONS

There are many publications from the scientific community to warn everyone about growing threats to sustainability, in particular threats to "environmental sustainability". The World Scientists' Warning to Humanity in 1992 begins with: "Human beings and the natural world are on a collision course". About 1,700 of the world's leading scientists, including most Nobel Prize laureates in the sciences, signed this warning letter. The letter mentions severe damage to the atmosphere, oceans, ecosystems, soil productivity, and more. It said that if humanity wants to prevent the damage, steps need to be taken: better use of resources, abandonment of fossil fuels, stabilization of human population, elimination of poverty and more. More warning letters were signed in 2011 and 2009 by thousands of scientists from over 150 countries which called again to reduce overconsumption (including eating less meat), reducing fossil fuels use and other resources and so forth

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048002. Bibcode:2012ERL....11d8002C. doi:10.1088/1748-9326/11/4/048002. The consensus that humans are causing recent global warming is shared by 90%–100% of publishing climate scientists according to six independent studies
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