**Ethics & Environmental degradation**

Ethics are norms for conduct that distinguish between acceptable and unacceptable behavior. It is concerned with what is right or wrong, good or bad, fair or unfair, responsible or irresponsible, obligatory or permissible, praiseworthy or blameworthy.

**Environmental degradation** is the deterioration of the [environment](https://en.wikipedia.org/wiki/Environment_%28biophysical%29) through [depletion of resources](https://en.wikipedia.org/wiki/Depletion_of_resources) such as [air](https://en.wikipedia.org/wiki/Air), [water](https://en.wikipedia.org/wiki/Water) and [soil](https://en.wikipedia.org/wiki/Soil); the destruction of [ecosystems](https://en.wikipedia.org/wiki/Ecosystems); [habitat destruction](https://en.wikipedia.org/wiki/Habitat_destruction); the [extinction](https://en.wikipedia.org/wiki/Extinction) of [wildlife](https://en.wikipedia.org/wiki/Wildlife); and [pollution](https://en.wikipedia.org/wiki/Pollution). It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable.[[1]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-1) As indicated by the [I=PAT](https://en.wikipedia.org/wiki/I%3DPAT) 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](https://en.wikipedia.org/wiki/Economic_growth) or per capita affluence (A), and the application of resource-depleting and polluting technology (T).[[2]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-2)[[3]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-3)

Environmental degradation is one of the ten threats officially cautioned by the [High-level Panel on Threats, Challenges and Change](https://en.wikipedia.org/wiki/High-level_Panel_on_Threats%2C_Challenges_and_Change) of the [United Nations](https://en.wikipedia.org/wiki/United_Nations). The [United Nations International Strategy for Disaster Reduction](https://en.wikipedia.org/wiki/United_Nations_International_Strategy_for_Disaster_Reduction) defines environmental degradation as "the reduction of the capacity of the environment to meet social and ecological objectives, and needs".[[4]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-4) Environmental degradation is of many types. When [natural habitats are destroyed](https://en.wikipedia.org/wiki/Habitat_destruction) or natural resources are depleted, the environment is degraded. Efforts to counteract this problem include [environmental protection](https://en.wikipedia.org/wiki/Environmental_protection) and [environmental resources management](https://en.wikipedia.org/wiki/Environmental_resources_management).

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**Water degradation**

One major component of environmental degradation is the depletion of the resource of fresh water on Earth. Approximately only 2.5% of all of the water on Earth is fresh water, with the rest being salt water. 69% of fresh water is frozen in [ice caps](https://en.wikipedia.org/wiki/Ice_caps) located on Antarctica and Greenland, so only 30% of the 2.5% of fresh water is available for consumption.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5) Fresh water is an exceptionally important resource, since life on Earth is ultimately dependent on it. Water transports nutrients, minerals and chemicals within the [biosphere](https://en.wikipedia.org/wiki/Biosphere) to all forms of life, sustains both plants and animals, and moulds the surface of the Earth with transportation and deposition of materials.[[6]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-issues-6)

The current top three uses of fresh water account for 95% of its consumption; approximately 85% is used for [irrigation](https://en.wikipedia.org/wiki/Irrigation) of farmland, golf courses, and parks, 6% is used for domestic purposes such as indoor bathing uses and outdoor garden and lawn use, and 4% is used for industrial purposes such as processing, washing, and cooling in manufacturing centers.[[7]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-change-7) It is estimated that one in three people over the entire globe are already facing water shortages, almost one-fifth of the [world population](https://en.wikipedia.org/wiki/World_population) live in areas of [physical water scarcity](https://en.wikipedia.org/wiki/Physical_water_scarcity), and almost one quarter of the world's population live in a [developing country](https://en.wikipedia.org/wiki/Developing_country) that lacks the necessary infrastructure to use water from available rivers and aquifers. Water scarcity is an increasing problem due to many foreseen issues in the future, including population growth, increased urbanization, higher standards of living, and climate change.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5)

**Climate change and temperature**

[Climate change](https://en.wikipedia.org/wiki/Climate_change) affects the Earth's water supply in a large number of ways. It is predicted that the mean global temperature will rise in the coming years due to a number of forces affecting the climate, the amount of [atmospheric carbon dioxide (CO2)](https://en.wikipedia.org/wiki/Atmospheric_CO2) will rise, and both of these will influence water resources; [evaporation](https://en.wikipedia.org/wiki/Evaporation) depends strongly on temperature and moisture availability, which can ultimately affect the amount of water available to replenish [groundwater](https://en.wikipedia.org/wiki/Groundwater) supplies.

[Transpiration](https://en.wikipedia.org/wiki/Transpiration) from plants can be affected by a rise in atmospheric CO2, which can decrease their use of water, but can also raise their use of water from possible increases of leaf area. Temperature rise can reduce the snow season in the winter and increase the intensity of the melting snow leading to peak runoff of this, affecting soil moisture, flood and drought risks, and storage capacities depending on the area.[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8)

Warmer winter temperatures cause a decrease in [snowpack](https://en.wikipedia.org/wiki/Snowpack), which can result in diminished water resources during summer. This is especially important at mid-latitudes and in mountain regions that depend on glacial runoff to replenish their river systems and groundwater supplies, making these areas increasingly vulnerable to water shortages over time; an increase in temperature will initially result in a rapid rise in water melting from [glaciers](https://en.wikipedia.org/wiki/Glaciers) in the summer, followed by a retreat in glaciers and a decrease in the melt and consequently the water supply every year as the size of these glaciers get smaller and smaller.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5)

[Thermal expansion](https://en.wikipedia.org/wiki/Thermal_expansion) of water and increased melting of oceanic glaciers from an increase in temperature gives way to a rise in sea level, which can affect the fresh water supply of coastal areas as well; as river mouths and deltas with higher [salinity](https://en.wikipedia.org/wiki/Salinity) get pushed further inland, an intrusion of saltwater results in an increase of salinity in reservoirs and aquifers.[[7]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-change-7) Sea-level rise may also consequently be caused by a depletion of groundwater,[[9]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-groundwater-9) as climate change can affect the [hydrologic cycle](https://en.wikipedia.org/wiki/Hydrologic_cycle) in a number of ways. Uneven distributions of increased temperatures and increased precipitation around the globe results in water surpluses and deficits,[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) but a global decrease in groundwater suggests a rise in sea level, even after [meltwater](https://en.wikipedia.org/wiki/Meltwater) and thermal expansion were accounted for,[[9]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-groundwater-9) which can provide a [positive feedback](https://en.wikipedia.org/wiki/Positive_feedback) to the problems sea-level rise causes to fresh-water supply.

A rise in air temperature results in a rise in water temperature, which is also very significant in water degradation, as the water would become more susceptible to [bacterial growth](https://en.wikipedia.org/wiki/Bacterial_growth). An increase in water temperature can also affect [ecosystems](https://en.wikipedia.org/wiki/Ecosystems) greatly because of a species' sensitivity to temperature, and also by inducing changes in a body of water's self-purification system from decreased amounts of dissolved oxygen in the water due to rises in temperature.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5)

**Climate change and precipitation**

A rise in global temperatures is also predicted to correlate with an increase in global precipitation, but because of increased runoff, floods, increased rates of [soil erosion](https://en.wikipedia.org/wiki/Soil_erosion), and mass movement of land, a decline in [water quality](https://en.wikipedia.org/wiki/Water_quality) is probable, while water will carry more nutrients, it will also carry more contaminants.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5) While most of the attention about climate change is directed towards global warming and [greenhouse effect](https://en.wikipedia.org/wiki/Greenhouse_effect), some of the most severe effects of climate change are likely to be from changes in precipitation, [evapotranspiration](https://en.wikipedia.org/wiki/Evapotranspiration), runoff, and soil moisture. It is generally expected that, on average, global precipitation will increase, with some areas receiving increases and some decreases.

[Climate models](https://en.wikipedia.org/wiki/Climate_model) show that while some regions should expect an increase in precipitation,[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) such as in the tropics and higher latitudes, other areas are expected to see a decrease, such as in the subtropics; this will ultimately cause a latitudinal variation in water distribution.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5) The areas receiving more precipitation are also expected to receive this increase during their winter and actually become drier during their summer,[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) creating even more of a variation of precipitation distribution. Naturally, the distribution of precipitation across the planet is very uneven, causing constant variations in water availability in respective locations.

Changes in precipitation affect the timing and magnitude of floods and droughts, shift runoff processes, and alter groundwater recharge rates. Vegetation patterns and growth rates will be directly affected by shifts in precipitation amount and distribution, which will in turn affect agriculture as well as natural ecosystems. Decreased precipitation will deprive areas of water, causing water tables to fall and reservoirs and wetlands, rivers, and lakes to empty,[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) and possibly an increase in evaporation and evapotranspiration, depending on the accompanied rise in temperature.[[7]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-change-7) Groundwater reserves will be depleted, and the remaining water has a greater chance of being of poor quality from saline or contaminants on the land surface.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5)

**Population growth**

[The human population on Earth is expanding rapidly](https://en.wikipedia.org/wiki/Human_population_growth) which goes hand in hand with the degradation of the environment at large measures. Humanity's appetite for needs is disarranging the environment's natural equilibrium. Production industries are venting smoke and discharging chemicals that are polluting water resources. The smoke that is emitted into the atmosphere holds detrimental gases such as carbon monoxide and sulfur dioxide. The high levels of pollution in the atmosphere form layers that are eventually absorbed into the atmosphere. Organic compounds such as chlorofluorocarbons (CFC’s) have generated an unwanted opening in the ozone layer, which emits higher levels of ultraviolet radiation putting the globe at large threat.

The available fresh water being affected by the climate is also being stretched across an ever-increasing global population. It is estimated that almost a quarter of the global population is living in an area that is using more than 20% of their renewable water supply; water use will rise with population while the water supply is also being aggravated by decreases in streamflow and groundwater caused by climate change. Even though some areas may see an increase in freshwater supply from an uneven distribution of precipitation increase, an increased use of water supply is expected.[[10]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-armed-10)

An increased population means increased withdrawals from the water supply for domestic, agricultural, and industrial uses, the largest of these being agriculture,[[11]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-sustain-11) believed to be the major non-climate driver of environmental change and water deterioration. The next 50 years will likely be the last period of rapid [agricultural expansion](https://en.wikipedia.org/wiki/Agricultural_expansion), but the larger and wealthier population over this time will demand more agriculture.[[12]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-agriculture-12)

Population increase over the last two decades, at least in the United States, has also been accompanied by a shift to an increase in urban areas from rural areas,[[13]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-human-13) which concentrates the demand for water into certain areas, and puts stress on the fresh water supply from industrial and human contaminants.[[5]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-water-5) [Urbanization](https://en.wikipedia.org/wiki/Urbanization) causes overcrowding and increasingly unsanitary living conditions, especially in developing countries, which in turn exposes an increasingly number of people to disease. About 79% of the world's population is in developing countries, which lack access to sanitary water and sewer systems, giving rises to disease and deaths from contaminated water and increased numbers of disease-carrying insects.[[14]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-disease-14)

**Agriculture**

Agriculture is dependent on available soil moisture, which is directly affected by climate dynamics, with precipitation being the input in this system and various processes being the output, such as evapotranspiration, [surface runoff](https://en.wikipedia.org/wiki/Surface_runoff), drainage, and percolation into groundwater. Changes in climate, especially the changes in precipitation and evapotranspiration predicted by climate models, will directly affect soil moisture, surface runoff, and groundwater recharge.

In areas with decreasing precipitation as predicted by the climate models, soil moisture may be substantially reduced.[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) With this in mind, agriculture in most areas needs irrigation already, which depletes fresh water supplies both by the physical use of the water and the degradation agriculture causes to the water. Irrigation increases salt and nutrient content in areas that would not normally be affected, and damages streams and rivers from damming and removal of water. Fertilizer enters both human and livestock waste streams that eventually enter groundwater, while nitrogen, phosphorus, and other chemicals from fertilizer can acidify both soils and water. Certain agricultural demands may increase more than others with an increasingly wealthier global population, and meat is one commodity expected to double global food demand by 2050,[[12]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-agriculture-12) which directly affects the global supply of fresh water. Cows need water to drink, more if the temperature is high and humidity is low, and more if the production system the cow is in is extensive, since finding food takes more effort. Water is needed in processing of the meat, and also in the production of feed for the livestock. Manure can contaminate bodies of freshwater, and slaughterhouses, depending on how well they are managed, contribute waste such as blood, fat, hair, and other bodily contents to supplies of fresh water.[[15]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-meat-15)

The transfer of water from agricultural to urban and suburban use raises concerns about agricultural sustainability, rural socioeconomic decline, food security, an increased [carbon footprint](https://en.wikipedia.org/wiki/Carbon_footprint) from imported food, and decreased foreign trade balance.[[11]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-sustain-11) The depletion of fresh water, as applied to more specific and populated areas, increases fresh water scarcity among the population and also makes populations susceptible to economic, social, and political conflict in a number of ways; rising sea levels forces [migration](https://en.wikipedia.org/wiki/Human_migration) from coastal areas to other areas farther inland, pushing populations closer together breaching borders and other geographical patterns, and agricultural surpluses and deficits from the availability of water induce trade problems and economies of certain areas.[[10]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-armed-10) Climate change is an important cause of involuntary migration and forced displacement[[16]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-16) According to the [Food and Agriculture Organization](https://en.wikipedia.org/wiki/Food_and_Agriculture_Organization) of the United Nations, global greenhouse gas emissions from animal agriculture exceeds that of transportation.[[17]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-17)

**Water management**

The issue of the depletion of fresh water can be met by increased efforts in water management.[[6]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-issues-6) While water management systems are often flexible, adaptation to new hydrologic conditions may be very costly.[[8]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-arid-8) Preventative approaches are necessary to avoid high costs of inefficiency and the need for rehabilitation of [water supplies](https://en.wikipedia.org/wiki/Water_supply),[[6]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-issues-6) and innovations to decrease overall demand may be important in planning water sustainability.[[11]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-sustain-11)

Water supply systems, as they exist now, were based on the assumptions of the current climate, and built to accommodate existing river flows and flood frequencies. Reservoirs are operated based on past hydrologic records, and [irrigation](https://en.wikipedia.org/wiki/Irrigation) systems on historical temperature, water availability, and crop water requirements; these may not be a reliable guide to the future. Re-examining engineering designs, operations, optimizations, and planning, as well as re-evaluating legal, technical, and economic approaches to manage water resources are very important for the future of water management in response to water degradation. Another approach is water privatization; despite its economic and cultural effects, service quality and overall quality of the water can be more easily controlled and distributed. Rationality and [sustainability](https://en.wikipedia.org/wiki/Sustainability) is appropriate, and requires limits to [overexploitation](https://en.wikipedia.org/wiki/Overexploitation) and pollution, and efforts in conservation.[[6]](https://en.wikipedia.org/wiki/Environmental_degradation#cite_note-issues-6)

Ecological Degradation and the Evolution of World-Systems

by

Christopher Chase-Dunn

In this chapter we summarize and build upon our work in comparative world-systems analysis (Chase-Dunn and Hall 1997, 2000, 2002) to explore the roles played by anthropogenic ecological degradation in the evolution of world-systems over the past one hundred thousand years. Our analysis builds on work by anthropologists on population pressure and ecological degradation. Among other things, we find that the expanding spatial scale of sedentary world-systems corresponds to the expanding scale of ecological degradation. Thus in the long run, more complex and hierarchical systems face the same problems that smaller and simpler systems faced, despite the effects of institutional developments that temporarily overcome the constraints of demography and ecology. Processes of ecological depletion have long been central in the evolution of social structures and human institutions, and are likely to continue to be so in the future.

We begin by summarizing our general approach, highlighting the role of ecological processes, especially environmental degradation, in systemic social evolution. Many geo-scientists have focused on the problem of the extent to which changes in climate, soil, and biosphere over the last two hundred years have been caused by human action. A few social scientists have begun doing formal comparative research on the causal connections between world-systemic developmental processes and changes in the biosphere (e.g. Grimes and Roberts 1995; Kick *et al* 1996, and the other chapters in this volume). It is helpful to place such work in the context of the roles that ecological factors and anthropogenic ecological degradation have played in the evolution of world-systems over the past 100,000 years.

I. World-System Evolution: Basic Concepts

Because we wish to study systemic transformations, we maximize the range of possible cases by including both nomadic and sedentary human groups. In our earlier work (Hall and Chase-Dunn 1997) we began with sedentism, but now we have realized that that same principles that influenced the expansion of sedentary world-systems were operating long before the first peoples began living in hamlets and villages. Indeed it was the search for new resources that motivated our species to migrate out of Africa and to populate the whole Earth. Chase-Dunn and Hall (1997) argued that we should begin world-systems analysis with the emergence of sedentism. But nomads do not wander aimlessly across space and so it does make sense to study world-systems composed solely of nomads. The yearly migration cycles of nomads reflect both the seasonal location of resources and interactions with other groups of humans. The sequence in which larger yearly migration routes become gradually smaller, and the emergence of regional differences in Paleolithic toolkits shows that the same processes of growing population density that affect sedentary peoples are also operating on nomads.

We define world-systems as **intersocietal networks in which the interactions (e.g., trade, warfare, intermarriage, information) are important for the reproduction of the internal structures of the composite units and importantly affect changes that occur in these local structures** (Chase-Dunn and Hall 1997). Because the boundaries of non-state social groups (e.g., "bands" or "tribes") are often empirically fuzzy, and because the term "society" can too easily imply a clearly bounded social group, we use the term "composite units" in our definition.

World-systems are fundamentally socially structured interaction networks that include different cultural groups and polities within them. As social structures they are based on biological and ecological substrata, but they are analytically separate from, and different from, biological and ecological systems. The key difference is due to culture -- the invention by humans of synthesized symbolic systems of representation and communication. We begin with an already-formed human institutional process based on linguistically constructed social roles, relationships and normative structures that had been developed by nomadic foragers since the emergence of oral language. World-systems involve interactions among culturally different groups, and this idea can usefully be applied to nomadic hunter-gatherers of the Paleolithic age. Sedentary world-systems began when diviersified foragers (hunter-gatherers) first began living most of the year in villages and they interacted with their still-nomadic neighbors. With sedentism concepts of territoriality and control of access to natural resources intensified. This intensification was motivated by a desire to mitigate the effects of over-exploitation of resources. Thus, concern with human-caused ecological depletion coincides with the development of world-systems. The importance of deforestation and other types of ecological depletion as factors in long-term social change have long been recognized by social scientists (e.g. Chew 2000, 2001). What we add is an extension to before the time of the invention of the emergence of states.

But what is a world-system, and where are its boundaries?

A. Spatial Boundaries: A Multicriteria Approach

Spatially bounding world-systems necessarily must proceed from a specific locale. While all human societies, even nomadic hunter-gatherers, interact with neighboring societies, not all intersocietal interactions have had global consequences. Here we use “world” in “world-system” in the way Wallerstein (1974a, 1974v) originally intended, as a self-contained system, not necessarily global (Earth-wide) in extent. We use the notion of "fall-off" of effects over space to bound the networks of interaction that importantly impinge upon any focal locale. The world-system of which any locality is a part includes those peoples whose actions in production, communication, warfare, alliance and trade have a large and interactive impact on that locality. Interactions must be **two-way and regularized** to be systemic. One-shot deals do not a system make. From this perspective world-systems were small regional affairs that gradually became larger as long-distance transportation and communications technology developed.

Clearly, economic forms of interaction are important in all world-systems. Of these, bulk-goods exchanges that form an intersocietal division of labor are constitutive forms of interconnection (Wallerstein 1974a, 1974b). However, we also agree with Jane Schneider (1977) that luxury goods can be very important for the reproduction of power structures. Prestige goods networks typically are much larger than bulk goods networks. Clearly, too, regularized political-military conflicts and/or alliances are important in all systems. The political/military network is typically intermediate in spatial size between the bulk and prestige goods networks. Finally, we note that networks of information flows including such intangibles as ideology, religion, technical information, and culture can be an important from of systemic interaction. Thus, we propose four types of interaction for spatially bounding world-systems:

       bulk goods exchange network (BGN)

       prestige goods exchange network (PGN)

       political/military exchange network (PMN)

       information exchange network (IN)

Figure 1 gives a graphic representation of typical nested relations among these networks. Occasionally, as in both the modern global world-system and some earlier geographically isolated systems (e.g., the Hawaiian Islands), these four networks converge to become of similar spatial scale.

B. Core/Periphery Relations

We divide potential core/periphery relations into two aspectss: (1) core/periphery **differentiation** exists when two societies are in systemic interaction with one another and one of these has higher population density and/or greater complexity than the other; (2) core/periphery **hierarchy**, exists when one society dominates or exploits another. While these two aspects often go together, but there are important instances of reversal. We make this analytical distinction to facilitate empirical investigations of actual intersocietal relations. We also note that the question of core/periphery relations **needs to be asked at each level of network interaction**.

Core/periphery relations can be quite complex. Mitchell Allen (1996: Chapter 1) developed the concept of a "contested periphery," a peripheral region for which two non-contiguous core regions compete. He finds that once an area has been incorporated into one world-system it can more easily be moved into another world-system than if it were being incorporated for the first time. Not surprisingly, contested peripheries have more leverage in responding to core demands. Furthermore, what is peripheral in one world-system can become semiperipheral in another. A semiperipheral region may be:

1.      one that mixes both core and peripheral forms of organization;

2.      spatially located between two or more competing core regions;

3.      mediate activities between core and peripheral areas;

4.      one in which institutional features are in some ways intermediate between those forms found in core and peripheral regions.

5.      recently founded societies that are located near the edge of an older core region.

All world-systems do no necessarily have a semiperiphery, and some may have several different kinds. We leave the existence, number, and types of intermediate levels as an empirical problem in need of further investigation.

C. Semiperipheral Development

World-systems have gotten larger in terms of population size, population density, territorial extent, absolute and *per capita* productivity. Growth necessarily entails absorption of formerly external areas, the incorporation of new peoples and territories and/or the merger of formerly autonomous world-systems. Throughout these processes no one core area remains a core area indefinitely. Development is uneven. Old cores are replaced, often by formerly semiperipheral societies.

The semiperiphery is fertile ground for social, organizational, and technical innovation and has an advantageous location for the establishment of new centers of power (Chase-Dunn and Hall 1997, Ch. 5). In particular, secondary state-formation on the marches of empires has frequently been recognized as a semiperipheral phenomenon that is related to the rise and fall of empires and the shift of hegemony within interstate systems (e.g. Mann 1986). A broadly similar phenomenon occurs among chiefdoms (e.g. Kirch 1984:204).

City-states, many of which engage in merchant capitalism and production capitalism, are one special type of semiperipheral society. They often mediated trade between the core and peripheral regions. Sometimes they manipulated this position in order to maintain political and economic autonomy, although they were often swallowed up by imperial expansion (Frankenstein 1979). Some important examples are: e.g. Dilmun, Old Assur, Byblos, Tyre, Sidon, Carthage, Malacca, Venice, Florence, Genoa, Antwerp, and the cities of the Hanseatic League. Frequently they were agents of commodification and commercialization within the predominantly tributary world-systems.

II. World-Systems Evolution

We see world-systemic evolution as open-ended and path dependent. That is, it occurs within the context of specific historical legacies and conditions. Important bifurcations and discontinuities of development, rapid transformations, and instances of devolution are normal characteristics of social change (see Sanderson 1990). A world-system is composed of the **totality** of interactions that constitute the social, economic, cultural, and political system. Thus, world-systems analysis must attend to the complex dialectics that link social change within composite units with the entire system. Causality can run from the system to the parts, but also from the parts to the system.

World-systemic evolution has three major elements:

1. semiperipheral development;

2. an "iteration" model that involves demographic and ecological variables as causes of hierarchy formation, economic intensification and technological change; and

3. transformations of modes of accumulation.

The main long-term forces of world-systemic evolution are population growth, ecological degradation, and population pressure. **Population growth**, other things equal, causes the decline of natural resources -- **ecological degradation** because more people use more natural resources. The type and scale of ecological degradation varies with the nature of production technology and the scale of the exploitation of natural resources. **Population pressure** results when resource scarcities require people to increase the amount of effort necessary to meet their needs, e.g. as a resource becomes depleted it take more labor to produce the same amount of a needed product. It is not necessary for resources to be completely destroyed to promote change. Rather, it is only necessary that more effort becomes necessary to obtain the same return. Yet, people usually prefer to continue in the way that they know as long as the increase in effort is not too great, what George Zipf (1949) called the **principle of least effort.**

More production leads to greater environmental degradation. This occurs because more resources are extracted, and because of the polluting consequences of production and consumption activities. Nomadic hunter-gatherers depleted the herds of big game and Polynesian horticulturalists deforested many a Pacific island. Environmental degradation is not a new phenomenon. Only its global scale is new.



Figure 2: Basic Iteration Model of World-System Evolution

When increased effort fails or becomes too costly in terms of labor time or other expenditures, emigration can be an attractive alternative. Sometimes, however, suitable new locations are not available, either due to a lack of desireable new sites or because of effective resistance from existing occupants of desirable sites. In such cases of social and/or environmental c**ircumscription** (Carneiro 1970) people cannot easily migrate to solve these problems and so competition for resources within and between societies increases. This usually leads to increased **conflict.** Sometimes endemic warfare functions as a demographic regulator by reducing the population density and alleviating (temporarily) population pressure. But in other cases new hierarchies and/or larger polities emerge (**hierarchy formation**) to regulate the use of resources (e.g. property, law), and/or the invention and implementation of new technologies of production (e.g. horticulture, irrigation, manufacturing, etc.) that allow larger numbers of people to live within a given area. Even where such solutions are found, eventually population grows and causes the same problems to reemerge on a larger scale. Hence, the process is "iterative." In regions in which no solution is emerges the system may cycle around the lower conflictive end of the iteration model. Semiperipheral actors are usually the agents of political expansion, hierarchy formation and technological development. Competition, conflict and semiperipheral development are world-systemic processes, not societal ones.

As Jared Diamond (1998) points out, all continents around the world did not start with the same animal and plant resources. In Western Asia both plants (barley and wheat) and animals (sheep, goats, cows, and oxen) were more easily domesticated than the plants and animals of Africa and the New World. Since domesticated plants and animals can more easily diffuse lattitudinally (East and West) than longitudinally (North and South), these inventions spread more quickly to Europe and East Asia than they did to Africa. These exogenous factors of zoological and botanical capital affected the timing and speed of hierarchy formation and technological development. As well, climate change and geographical obstacles and opportunities affected the development of transportation and communications technologies. Many analysts content that the early large state that emerged on the Nile was greatly facilitated by the ease of controlling transportation and communications in that linear environment, while the more complicated geography of Mesopotamia stabilized the system of city-states and slowed the emergence of a core-wide empire. Patrick Kirch (1984) contends that it was the difficult geography of the Marquesas Island (short steep valleys separated by high mountains and treacherous coasts) that prevented the emergence of island-wide paramount chiefdoms, and kept the Marquesas in the “nasty bottom” of the iteration model.

This model, illustrated in Figure 2 above, involves complex feedback loops, and by no means is meant to imply that bigger hierarchies or technological development inevitably occur in each region. Primary (or pristine) states emerged in interaction with other states. Virtually all of them occurred in a context that had already experienced the formation of complex chiefdoms. Thus, as with ecological succession in the biosphere, higher orders of complexity can only emerge once the soil of institutional development has been brought to a certain level of complexity by earlier development. But this kind of succession does not reoccur in the same place. If it did Iraq would still be the center of the world-system. Rather it is uneven in space, with the semiperipheries out on the edge performing the greatest leaps in the creation of new high levels of complexity and techniques of power.

Ecology structures the economics of least effort because it limits available resources and potential alternative resources. As world-systems become more complex and hierarchical these ecological limits and potentials change their spatial scale because of changes in social organization and technology. The comparative world-systems perspective allows us to see that the scale of ecological constraints grows with the expanding scale of intersocietal networks and intensification. Thus, continental and global ecological constraints become more important as world-systems increased in size. Contrary to what some social evolutionists have argued (e.g. Lenski and Nolan 2004); complex societies do not transcend ecological constraints. As the scale of ecological constraints expands, their importance as intermittent constraints on social change does not diminish overall (for detailed history for these processes among states see Chew 2003).

Technological innovations act back on population growth by increasing the number of people who can be fed and sheltered within a given amount of land. This stimulates population increase, or more typically reduces the incentives to maintain cultural and social regulations on population growth. So population density tends to increase to the point where resources are again pressed. Then the whole cycle goes around again. As systems become larger, and especially as they become more diversified, regulation or maintenance of the overall system becomes more complex. Those systems that develop hierarchical structures are generally better able to manage these complexities. We are **not** proposing a teleological process. Increasing complexity does not cause hierarchy formation or extension. Rather, among systems that face complex regulation, those that develop hierarchical systems tend to survive more often than systems that do not. But the notion of semiperipheral development provides an important gloss on this generalization.

How and when does a high level of conflict created by population pressure and ecological degradation in a circumscribed setting result in the emergence of a new level of hierarchy? We note that hierarchy-formation by conquest occurred most frequently when a semiperipheral polity conquered an old core. The iteration model combines core-periphery hierarchy with considerations of "internal" stratification and class struggle. Semiperipheral polities in precapitalist world-systems generally **had less internal stratification than older core polities**. Older core regions developed greater internal inequalities as well as greater divisions among different factions in the ruling elites. Semiperipheral marcher states (and semiperipheral marcher chiefdoms) usually had less class inequality, more solidarity among elites and more solidarity between leaders and followers. This gave them an important military advantage over older core regions and allowed them to conquer entire core regions and construct larger polities.[[1]](#footnote-2)[1] Because semiperipheral polities often occupied regions that were less ecologically desirable than those occupied by older core regions (e.g., Kirch 1984), the application of core techniques of production reached their ecological limitations more quickly. This motivated polities in stressed regions to take the risks associated with attempts to conquer the older core chiefdoms and/or to experiment with new technologies.

This model does not explain the exact kind of social change that takes place. Nor does it explain where or exactly when social change takes place. But it does provide a processual backdrop for explaining the most general features of human social change -- increasing population density, scale, and hierarchy of social organization. Just as earlier hierarchies and technological changes were responses to the problems created by ecological degradation, population pressure and intensified conflict, larger empires, greater long-distance economic integration and the development of commodified goods, labor, land and wealth were also responses to these same problems.

The difference is that in the iteration model the institutional inventions -- larger empires, larger markets, and capitalism -- temporarily altered the way in which the iteration model worked. This was especially true during periods of expansion. The development of these institutional structures allowed population pressure to temporarily affect hierarchy formation and technological development directly rather than through the path of circumscription and intensified conflict. The demographic and ecological constraints reappear in periods of contractions, and especially in those extreme contractions that Tainter (1988) calls collapse.

This modifies the model in Figure 2 by adding positive arrows directly from population pressure to both hierarchy formation and technological change (see Figure 3). When market mechanisms articulate growing scarcities (e.g. deforestation in England), they provide incentives for new kinds of production (e.g. the coal industry). These institutional inventions are responses to the constraints and opportunities created by ecological degradation and population pressure. They allow for greater population growth and density by temporarily bypassing the conflictive path in the iteration model. We say this is temporary because eventually population pressures reemerge to create problems on a scale that the new institutional structures cannot handle. This leads to a return to the conflictive lower section of the iteration model.



Figure.3:Iteration Model with Shortcutting Institutions

Similarly, in some cases ecological degradation operated directly on technological intensification rather than by means of increasing conflict. Once the market mechanism is working, resource scarcities may provoke substitutions avoiding the disruptive processes of conflict and violent competition.

Rapid population growth also causes disruption in modern societies. Jack Goldstone (1991) demonstrates that both reform movements and revolutions originate in the effects of rapid population growth and a consequent increase in state expenditures beyond revenues. He argues that, as the revenue gap increases, the state must either raise new taxes or curtail expenditures. The growth of elite population (which is often greater than among the non-elite population) heightens competition for resources and positions. Rising grain prices create new wealth holders who, if blocked by traditional or new barriers, become marginal elites. Population growth increases the proportion of young persons, who due to un- or under-employment become an impoverished group with high potential for mass action. The increase in poverty further strains state resources. As conditions deteriorate, elites and commoners lose confidence in the state and elites struggle for control and promote reform. If a formerly marginal elite seizes power and if the prevailing culture has an eschatological tradition, reform radicalizes into revolution. If any of these components is absent or very weak, reform or regime collapse are typical results.

Goldstone's demographic analysis is congruent with the iteration model. However, we disagree with his claim that world-system processes do not affect state crises. The East Asian and West Asian/Mediterranean regions he studies had been linked by long-distance trade into a single PGN at least as early as 400 BCE (see Chase-Dunn and Hall 1997:Chapter 8). In the first few centuries of the common era this linkage became sufficiently strong to transmit pathogens from Central Asia to China and Rome, unleashing epidemics in both (McNeill 1976). This recurred in the century after the Mongols temporarily merged Afroeurasia into a single PMN when the Black Death swept through Europe and epidemics occurred in China.

Goldstone acknowledges that the severe population losses brought by the Black Death set the conditions for a rather spectacular population increase a couple of centuries later when European populations had built up immunities and climate changes favored increased agricultural production. But Goldstone does not acknowledge that the pathways along which the pathogens spread were precisely those by which the Eurasian PGN was linked. That is, the occurrence of epidemics was not an exogenous, or randomly induced, change, but one that worked along predictable world-systemic pathways. Now when we add to this the linkages implied by the correlation of urban and empire growth/decline phases in the Mediterranean/West Asian and East Asian PMNs (Chase-Dunn, Manning, and Hall 2000; Chase-Dunn and Manning 2002), the synchronies of the revolutions Goldstone examined are very likely produced by larger system-wide processes.

Rather than abandoning the basic iteration model for completely different explanations of how transformations take place in complex and hierarchical systems, we explain why the iteration model moves back stage to geopolitical and capitalist dynamics only to come forth again during periods of collapse and crisis. The basic demographic, economic, and ecological constraints posited in the iteration model do not become irrelevant. Rather, institutional superstructures such as states and capitalist accumulation temporarily overcome these constraints by raising the pace of spatial expansion and technological development.[[2]](#footnote-3)[2] But eventually even these institutional mechanisms run into limitations posed by the material substratum of demographic, economic, and ecological factors. These operate somewhat differently in the different transformations, but they do not ever completely transcend the basic iteration model.

To recapitulate, population pressure affects hierarchy formation and technological change directly once states and commodities have come into existence rather than through the mechanisms of conflict and circumscription. But the path of causality that goes through conflict and circumscription is yet again important even in the presence of states and commodities during periods of institutional breakdown and systemic collapse. In this sense there is a single underlying model of transformations, though it works somewhat differently once states and markets have become widespread social forms.

III.               East/West synchrony of urban and empire growth/decline phases

We have demonstrated that city growth and empire growth and decline phases occur synchronously in the Central (West Asian and Mediterranean) and the East Asian PMNs (Chase-Dunn, Manning, and Hall 2000; Chase-Dunn and Manning 2002). Figure 4 shows the territorial sizes of the largest empires in the Central and East Asian PMNs from 1500 BCE to 1750 CE are temporally correlated. We also found that the intermediate Indic PMN did not experience a similar sequence of growth and decline phases.

# What are the negative effects of environmental degradation?

Environmental degradation is the deterioration of the environment through depletion of resources such as air, water and soil.

Air pollution pollutes the air that we breathe which causes health issues. Land pollution results in degradation of earth's surface as a result of human activities.

***Effects of Environmental Degradation***

**Impact on Human Health:** Human health might be at the receiving end as a result of the environmental degradation. Areas exposed to toxic air pollutants can cause respiratory problems

**Loss of Biodiversity:**

Deforestation, global warming, overpopulation and pollution are few of the major causes for loss of biodiversity.

**Ozone Layer Depletion:**

As it will deplete, it will emit harmful radiations back to the earth.

**Economic Impact:** The huge cost that a country may have to borne due to environmental degradation can have big economic impact in terms of restoration of green cover, cleaning up of landfills and protection of endangered species. The economic impact can also be in terms of loss of tourism industry.

We can, however, take action to stop it and take care of the world that we live in by providing environmental education to the people which will help them pick familiarity with their surroundings that will enable to take care of environmental concerns thus making it more useful and protected for our children and other future generations.

Source: ([Causes and Effects of Environmental Degradation - Conserve Energy Future](https://www.conserve-energy-future.com/causes-and-effects-of-environmental-degradation.php))

#### Global Warming and Its Effects

[**Global warming**](http://www.omicsonline.org/scholarly/global-warming-journals-articles-ppts-list.php) which is also referred to as **climate change**, is the observed rise in the average temperature of the Earth's climate system  the global surface temperature is likely to rise a further 0.3 to 1.7 °C  in the lowest emissions scenario, and 2.6 to 4.8 °C in the highest emissions scenario .These readings have been recorded by the “national science academies of the major industrialized nations”. Future climate change and impacts will differ from region to region. Expected effects include increase in global temperatures, rising sea levels, changing [precipitation](http://www.omicsonline.org/scholarly/precipitation-journals-articles-ppts-list.php), and expansion of deserts.

####

**Causes:**

Global warming is a serious environmental issues. The causes are divided into two categories include "natural" and "human influences" of global warming.

#### Natural Causes of Global Warming:

* rotation of the sun that changes the intensity of sunlight and moving closer to the earth
* greenhouse gases
* Volcanic eruption.

#### ****Human Influences on Global Warming****:

* industrial revolution
* Mining
* Deforestation

#### ****Effects****:

* heat waves,
* droughts,
* heavy rainfall with floods,
* heavy snowfall ,
* ocean acidification,
* species extinctions due to shifting temperature regimes

#### ****solutions:****

* To reduce [**gasoline**](http://www.omicsonline.org/scholarly/gasoline-journals-articles-ppts-list.php) means we have to choose a hybrid car that reduce using gasoline. However, petrol prices are increasing. If a person everyday drives to work they need to pump petrol after 3 days and causes carbon dioxide. Yet other way to reduce gasoline is take public transport or carpool to work. It can help reduce carbon dioxide and save cost as well.
* **Recycle** can reduce garbage by reusing plastic bags, bottles, papers or glass. for an example  buy food, and use our own containers instead of plastic bags. Another example is after  drinking water from  bottle; we can reuse it or use our own bottle. If all this is being reuse,it can help upto great extend to eradicate global warming
* Finally, human should stop **open burning** such as burning dry leafs or burning garbage. It will release carbon dioxide if its burnt with garbage and plastic.
* Besides, government should reduce **deforestation** because the earth temperatures is increasing. Trees will help to improve the temperature on earth
* Ozone depletion
* ocean acidification
* species extinctions due to shifting temperature regimes
* Deforestation
* Volcanic eruption

**The planet is warming,** from North Pole to South Pole. Since 1906, the global average surface temperature has [increased](http://earthobservatory.nasa.gov/Features/GlobalWarming/page2.php) between 1.1 and 1.6 degrees Fahrenheit (0.6 to 0.9 degrees Celsius)–even more in sensitive polar regions. And the effects of rising temperatures aren’t waiting for some far-flung future–signs of the effects of global warming are appearing right now. The heat is melting glaciers and sea ice, shifting precipitation patterns, and setting [animals on the move](http://news.nationalgeographic.com/news/2014/03/140331-global-warming-climate-change-ipcc-animals-science-environment/).

The planet is already suffering from some impacts of global warming.

* Ice is melting worldwide, especially at the Earth’s poles. This includes mountain glaciers, ice sheets covering West Antarctica and Greenland, and Arctic sea ice.
* Many species have been impacted by rising temperatures. For example, researcher Bill Fraser has tracked the decline of the Adélie penguins on Antarctica, where their numbers have fallen from 32,000 breeding pairs to 11,000 in 30 years.
* The sea level has been rising more quickly over the last century.
* Some butterflies, foxes, and alpine plants have moved farther north or to higher, cooler areas.
* Precipitation (rain and snowfall) has increased across the globe, on average.
* Some invasive species are thriving. For example, spruce bark [beetles have boomed](https://ngm.nationalgeographic.com/2015/04/pine-beetles/rosner-text) in Alaska thanks to 20 years of warm summers. The insects have chewed up 4 million acres of spruce trees.

Other effects could take place later this century, if warming continues.

* [Sea levels](https://news.nationalgeographic.com/2016/04/160401-climate-change-sea-level-antarctica-ice-melt-physics/) are expected to rise between 7 and 23 inches (18 and 59 centimeters) by the end of the century, and continued melting at the poles could add between 4 and 8 inches (10 to 20 centimeters).
* Hurricanes and other storms are likely to become stronger.
* Floods and droughts will become more common. Rainfall in Ethiopia, where droughts are already common, could decline by 10 percent over the next 50 years.
* Less fresh water will be available. If the [Quelccaya ice cap](https://environment.nationalgeographic.com/environment/global-warming/big-thaw/) in Peru continues to melt at its current rate, it will be gone by 2100, leaving thousands of people who rely on it for drinking water and electricity without a source of either.
* Some diseases will spread, such as mosquito-borne malaria (and the 2016 resurgence of the [Zika virus](https://news.nationalgeographic.com/2016/01/160128-zika-virus-birth-defects-brian-damage-history-science/)). Ecosystems will change: Some species will move farther north or become more successful; others won’t be able to move and could become extinct.
* Wildlife research scientist Martyn Obbard has found that since the mid-1980s, with less ice on which to live and fish for food, polar bears have gotten considerably skinnier. Polar bear biologist Ian Stirling has found a similar pattern in Hudson Bay. He fears that if sea ice disappears, the [polar bears will as well.](https://news.nationalgeographic.com/2015/09/150904-polar-bears-dolphins-seals-climate-change/)

# What is global warming?

Global warming is the current increase in temperature of the Earth's surface (both land and water) as well as it's atmosphere. Average temperatures around the world have risen by 0.75°C (1.4°F) over the last 100 years about two thirds of this increase has occurred since 1975.[1](https://whatsyourimpact.org/global-warming#footnote1_d6ac8xg) [2](https://whatsyourimpact.org/global-warming#footnote2_t3q9ahb) In the past, when the Earth experienced increases in temperature it was the result of natural causes but today it is being caused by the accumulation of greenhouse gases in the atmosphere produced by human activities.[3](https://whatsyourimpact.org/global-warming#footnote3_17h03wk)

The natural greenhouse effect maintains the Earth's temperature at a safe level making it possible for humans and many other lifeforms to exist.[4](https://whatsyourimpact.org/global-warming#footnote4_0foyujk) However, since the Industrial Revolution human activities have significantly enhanced the greenhouse effect causing the Earth's average temperature to rise by almost 1°C. This is creating the global warming we see today. To put this increase in perspective it is important to understand that during the last ice age, a period of massive climate change, the average temperature change around the globe was only about 5°C.[5](https://whatsyourimpact.org/global-warming#footnote5_qj8ue8x) [6](https://whatsyourimpact.org/global-warming#footnote6_bu4wmju)



A long series of scientific research and international studies has shown, with more than 90% certainty, that this increase in overall temperatures is due to the greenhouse gases produced by humans.[7](https://whatsyourimpact.org/global-warming#footnote7_mrxdo5c) Activities such as deforestation and the burning of fossil fuels are the main sources of these emissions. These findings are recognized by the national science academies of all the major industrialized countries.[8](https://whatsyourimpact.org/global-warming#footnote8_gqngw45)

Global warming is affecting many places around the world. It is accelerating the melting of ice sheets, permafrost and glaciers which is causing average sea levels to rise.[9](https://whatsyourimpact.org/global-warming#footnote9_hceylci) [10](https://whatsyourimpact.org/global-warming#footnote10_q06stye) It is also changing precipitation and weather patterns in many different places, making some places dryer, with more intense periods of drought and at the same time making other places wetter, with stronger storms and increased flooding.[11](https://whatsyourimpact.org/global-warming#footnote11_891kqmn) [12](https://whatsyourimpact.org/global-warming#footnote12_6hqbz6h) These changes have affected both nature as well as human society and will continue to have increasingly worse effects if greenhouse gas emissions continue to grow at the same pace as today.

### [What causes global warming?](https://whatsyourimpact.org/global-warming%22%20%5Cl%20%22causes)



The cause of global warming is the increasing quantity of greenhouse gases in the our atmosphere produced by human activities, like the burning of fossil fuels or deforestation. These activities produce large amounts of greenhouse gas emissions which is causing global warming.[7](https://whatsyourimpact.org/global-warming#footnote7_mrxdo5c) Greenhouse gases trap heat in the Earth's atmosphere to keep the planet warm enough to sustain life, this process is called the greenhouse effect.[3](https://whatsyourimpact.org/global-warming#footnote3_17h03wk) It is a natural process and without these gases, the Earth would be too cold for humans, plants and other creatures to live.

The natural greenhouse effect exists due to the balance of the major types of greenhouse gases. However, when abnormally high levels of these gases accumulate in the air, more heat starts getting trapped and leads to the enhancement of the greenhouse effect. Human-caused emissions have been increasing greenhouse levels which is raising worldwide temperatures and driving global warming.[3](https://whatsyourimpact.org/global-warming#footnote3_17h03wk)

#### Greenhouse gas emissions and the enhanced greenhouse effect

Greenhouse gases are produced both naturally and through human activities. Unfortunately, greenhouse gases generated by human activities are being added to the atmosphere at a much faster rate than any natural process can remove them.

Global levels of greenhouse gases have increased dramatically since the dawn of the Industrial Revolution in the 1750s.[7](https://whatsyourimpact.org/global-warming#footnote7_mrxdo5c) Only a small group of human activities are causing the concentration of the main greenhouse gases (carbon dioxide, methane, nitrous oxide and fluorinated gases) to rise:

* The majority of man-made carbon dioxide emissions is from the burning of fossil fuels such as coal and oil so that humans can power various vehicles, machinery, keep warm and create electricity. Other important sources come from land-use changes (ex: deforestation) and industry (ex: cement production).[13](https://whatsyourimpact.org/global-warming#footnote13_i3tsqwb)
* Methane is created by humans during fossil fuel production and use, livestock and rice farming, as well as landfills.[14](https://whatsyourimpact.org/global-warming#footnote14_i4hlcw7)
* Nitrous oxide emissions are mainly caused by the use of synthetic fertilizers for agriculture, fossil fuel combustion and livestock manure management.[15](https://whatsyourimpact.org/global-warming#footnote15_m70f6h8)
* Fluorinated gases are used mainly in refrigeration, cooling and manufacturing applications.[16](https://whatsyourimpact.org/global-warming#footnote16_4g0iror)

#### Deforestation

Deforestation has become a massive undertaking by humans and transforming forests into farms has a significant number of impacts as far as greenhouse gas emissions are concerned. For centuries, people have burned and cut down forests to clear land for agriculture. This has a double effect on the atmosphere both emiting carbon dioxide into the atmosphere and simultaneously reducing the number of trees that can remove carbon dioxide from the air.

When forested land is cleared, soil disturbance and increased rates of decomposition in converted soils both create carbon dioxide emissions.[17](https://whatsyourimpact.org/global-warming#footnote17_bl4jem4) This also increases soil erosion and nutrient leaching which can further reduces the area's ability to act as a carbon sink.

### [What are the effects of global warming?](https://whatsyourimpact.org/global-warming%22%20%5Cl%20%22effects)

Global warming is damaging the Earth's climate as well as the physical environment. One of the most visible effects of global warming can be seen in the Arctic as glaciers, permafrost and sea ice are melting rapidly. Global warming is harming the environment in several ways including:

* Desertification
* Increased melting of snow and ice
* Sea level rise
* Stronger hurricanes and cyclones

#### Desertification



Increasing temperatures around the world are making arid and semi-arid areas even more dry than before. Current research is also showing that the water cycle is changing and rainfall patterns are shifting to make areas that are already dry even drier. This is causing water shortages and an intense amount of distress to the over 2.5 million people in dry regions which are degrading into desert.[18](https://whatsyourimpact.org/global-warming#footnote18_u9553bf) This process is called desertification.

#### Increased melting of snow and ice



Around the world, snow and ice is melting at a much faster pace than in the past. This has been seen in the Alps, Himalayas, Andes, Rockies, Alaska and Africa but is particularly true at the Earth's poles.

Perennial ice cover in the Arctic is melting at the rate of 11.5% per decade and the thickness of the Arctic ice has decreased by 48% since the 1960s.[19](https://whatsyourimpact.org/global-warming#footnote19_6ychubn) During the past 30 years, more than a million square miles of sea ice has vanished, an area equivalent to the size of Norway, Denmark and Sweden combined.[20](https://whatsyourimpact.org/global-warming#footnote20_qjkjpjs) The continent of Antarctica has been losing more than 100 cubic kilometers (24 cubic miles) of ice per year since 2002.[21](https://whatsyourimpact.org/global-warming#footnote21_9za0b5j) Since 2010, the Antarctic ice melt rate has doubled.[22](https://whatsyourimpact.org/global-warming#footnote22_fgc2f7u)

#### Sea level rise



The Earth's sea level has risen by 21 cm (8 inches) since 1880.[23](https://whatsyourimpact.org/global-warming#footnote23_9924w4b) The rate of rise is accelerating and is now at a pace that has not been seen for at least 5000 years.[24](https://whatsyourimpact.org/global-warming#footnote24_g6oye19) Global warming has caused this by affecting the oceans in two ways: warmer average temperatures cause ocean waters to expand (thermal expansion) and the accelerated melting of ice and glaciers increase the amount of water in the oceans.

#### Stronger hurricanes and cyclones



Tropical cyclone activity has seen an obvious upswing trend since the early 1970s.[25](https://whatsyourimpact.org/global-warming#footnote25_uaqszqs) Interestingly, this matches directly with an observed rise in the oceans' temperature over the same period of time. Since then, the Power Dissipation Index which measures the destructive power of tropical cyclones has increased in the Pacific by 35% and in the Atlantic it has nearly doubled.[26](https://whatsyourimpact.org/global-warming#footnote26_2k37r6y) Global warming also increases the frequency of strong cyclones. Every 1 degree C increase in sea surface temperature results in a 31% increase in the global frequency of category 4 and 5 storms.[27](https://whatsyourimpact.org/global-warming#footnote27_x2iw1ao)

# Effects of global warming on humans

From Wikipedia, the free encyclopedia

See also: [Global warming](https://en.wikipedia.org/wiki/Global_warming) and [Effects of global warming](https://en.wikipedia.org/wiki/Effects_of_global_warming)

Climate change has brought about possibly permanent alterations to [Earth's](https://en.wikipedia.org/wiki/Earth) geological, biological and [ecological systems](https://en.wikipedia.org/wiki/Ecosystem).[[1]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-AmericasClimateChoices-2011-FullReport-1) These changes have led to the emergence of a not so large-scale [environmental hazards to human health](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_human_health), such as [extreme weather](https://en.wikipedia.org/wiki/Extreme_weather),[[2]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-2) [ozone depletion](https://en.wikipedia.org/wiki/Ozone_depletion), increased danger of wildland fires,[[3]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-fire-3) [loss of biodiversity](https://en.wikipedia.org/wiki/Biodiversity_loss),[[4]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-SahneyBentonFerry2010LinksDiversityVertebrates-4) stresses to food-producing systems and the [global spread of infectious diseases](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_human_health#Impact_on_infectious_diseases).[[5]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-story-5) The [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) (WHO) estimates that 160,000 deaths, since 1950, are directly attributable to climate change.

To date, a neglected aspect of the [climate change debate](https://en.wikipedia.org/wiki/Climate_change_debate), much less research has been conducted on the impacts of climate change on health, food supply, [economic growth](https://en.wikipedia.org/wiki/Economic_growth), [migration](https://en.wikipedia.org/wiki/Environmental_migrant), security, societal change, and [public goods](https://en.wikipedia.org/wiki/Public_good), such as [drinking water](https://en.wikipedia.org/wiki/Drinking_water), than on the [geophysical](https://en.wikipedia.org/wiki/Geophysical) changes related to [global warming](https://en.wikipedia.org/wiki/Global_warming). Human impacts can be both negative and positive. Climatic changes in [Siberia](https://en.wikipedia.org/wiki/Siberia), for instance, are expected to improve food production and local economic activity, at least in the short to medium term. Numerous studies suggest, however, that the [current and future impacts of climate change](https://en.wikipedia.org/wiki/Effects_of_global_warming) on human society are and will continue to be overwhelmingly negative.[[6]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-6)[[7]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-7)

The majority of the adverse effects of climate change are experienced by poor and low-income communities around the world, who have much higher levels of vulnerability to environmental determinants of health, [wealth](https://en.wikipedia.org/wiki/Wealth) and other factors, and much lower levels of capacity available for coping with environmental change. A report on the global human impact of climate change published by the [Global Humanitarian Forum](https://en.wikipedia.org/wiki/Global_Humanitarian_Forum) in 2009, estimated more than 300,000 deaths and about $125 billion in economic losses each year, and indicating that most climate change induced mortality is due to worsening floods and droughts in [developing countries](https://en.wikipedia.org/wiki/Developing_countries).[[8]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-8)

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## Key vulnerabilities

Most of the key vulnerabilities to climate change are related to climate phenomena that exceed thresholds for adaptation; such as extreme weather events or abrupt climate change, as well as limited access to resources (financial, technical, human, institutional) to cope. In 2007, the IPCC published a report of key vulnerabilities of industry, settlements, and society to climate change.[[9]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-wilbanks-9) This assessment included a level of confidence for each key vulnerability:

* **Very high confidence**: Interactions between climate change and urbanization: this is most notable in developing countries, where urbanization is often focused in vulnerable coastal areas.
* **High confidence**:
	+ Interactions between climate change and global economic growth: Stresses due to climate change are not only linked to the impacts of climate change, but also to the impacts of climate change policies. For example, these policies might affect development paths by requiring high cost fuel choices.
	+ Fixed physical infrastructures that are important in meeting human needs: These include infrastructures that are susceptible to damage from extreme weather events or sea level rise, and infrastructures that are already close to being inadequate.
* **Medium confidence**: Interactions with governmental and social cultural structures that already face other pressures, e.g., limited economic resources.

## Health

Main article: [Effects of climate change on human health](https://en.wikipedia.org/wiki/Effects_of_climate_change_on_human_health)

Climate change poses a wide range of risks to population health – risks that will increase in future decades, often to critical levels, if global climate change continues on its current trajectory.[[10]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Lancet-10) The three main categories of health risks include: (i) direct-acting effects (e.g. due to [heat waves](https://en.wikipedia.org/wiki/Heat_wave), amplified [air pollution](https://en.wikipedia.org/wiki/Air_pollution), and physical weather disasters), (ii) impacts mediated via climate-related changes in ecological systems and relationships (e.g. crop yields, [mosquito](https://en.wikipedia.org/wiki/Mosquito) ecology, marine productivity), and (iii) the more diffuse (indirect) consequences relating to impoverishment, displacement, resource conflicts (e.g. water), and post-disaster mental health problems.

Climate change thus threatens to slow, halt or reverse international progress towards reducing child under-nutrition, deaths from [diarrheal diseases](https://en.wikipedia.org/wiki/Diarrheal_disease) and the spread of other [infectious diseases](https://en.wikipedia.org/wiki/Infectious_diseases). Climate change acts predominantly by exacerbating the existing, often enormous, health problems, especially in the poorer parts of the world. Current variations in weather conditions already have many adverse impacts on the health of poor people in developing nations,[[11]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-11) and these too are likely to be 'multiplied' by the added stresses of climate change.

A changing climate thus affects the prerequisites of population health: clean air and water, sufficient food, natural constraints on infectious disease agents, and the adequacy and security of shelter. A warmer and more variable climate leads to higher levels of some [air pollutants](https://en.wikipedia.org/wiki/Air_pollutant). It increases the rates and ranges of transmission of infectious diseases through unclean water and contaminated food, and by affecting [vector](https://en.wikipedia.org/wiki/Vector_%28epidemiology%29) organisms (such as [mosquitoes](https://en.wikipedia.org/wiki/Mosquitoes)) and intermediate or reservoir host species that harbour the infectious agent (such as cattle,[[12]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-LundeLindtjorn_2013CattleClimate-12) [bats](https://en.wikipedia.org/wiki/Bat) and [rodents](https://en.wikipedia.org/wiki/Rodents)). Changes in temperature, rainfall and seasonality compromise agricultural production in many regions, including some of the least developed countries, thus jeopardising child health and growth and the overall health and functional capacity of adults. As warming proceeds, the severity (and perhaps frequency) of weather-related disasters will increase – and appears to have done so in a number of regions of the world over the past several decades.[[13]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-13) Therefore, in summary, global warming, together with resultant changes in food and water supplies, can indirectly cause increases in a range of adverse health outcomes, including [malnutrition](https://en.wikipedia.org/wiki/Malnutrition), [diarrhea](https://en.wikipedia.org/wiki/Diarrhea), [injuries](https://en.wikipedia.org/wiki/Injuries), [cardiovascular](https://en.wikipedia.org/wiki/Cardiovascular_disease) and [respiratory diseases](https://en.wikipedia.org/wiki/Respiratory_disease), and water-borne and insect-transmitted diseases.

Health equity and climate change have a major impact on human health and quality of life, and are interlinked in a number of ways. The report of the WHO Commission on Social Determinants of Health points out that disadvantaged communities are likely to shoulder a disproportionate share of the burden of climate change because of their increased exposure and vulnerability to health threats. Over 90 percent of [malaria](https://en.wikipedia.org/wiki/Malaria) and diarrhea deaths are borne by children aged 5 years or younger, mostly in developing countries.[[14]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-who.int-14) Other severely affected population groups include women, the elderly and people living in [small island developing states](https://en.wikipedia.org/wiki/Small_Island_Developing_States) and other coastal regions, mega-cities or mountainous areas.[[15]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-hdr.undp.org-15)

### Psychological impacts

Further information: [Effects of global warming on human health § Mental health](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_human_health#Mental_health)

A 2011 article in the [*American Psychologist*](https://en.wikipedia.org/wiki/American_Psychologist) identified three classes of psychological impacts from global climate change:[[16]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Doherty-16)

* Direct - "Acute or traumatic effects of extreme weather events and a changed environment"
* Indirect - "Threats to emotional well-being based on observation of impacts and concern or uncertainty about future risks"
* Psychosocial – "Chronic social and community effects of heat, drought, migrations, and climate-related conﬂicts, and postdisaster adjustment" A psychological impact is shown through peoples behaviours and how they act towards the actual situation. The topic of climate change is very complex and difficult for people to understand, which effects how they act upon it. It is shown by Ranney and Clark(2016)[[17]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-17) that by informing people to make them understand the topic of climate science clearly, it promotes the change in behaviour towards mitigation of climate change.

### Extreme weather events

Further information: [Extreme weather](https://en.wikipedia.org/wiki/Extreme_weather)

This trend towards more variability and fluctuation is perhaps more important, in terms of its impact on human health, than that of a gradual and long-term trend towards higher average temperature.[[18]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Epstein-18) Infectious disease often accompanies [extreme weather](https://en.wikipedia.org/wiki/Extreme_weather) events, such as floods, earthquakes and drought.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)] These local epidemics occur due to loss of infrastructure, such as hospitals and sanitation services, but also because of changes in local ecology and environment.

### Diseases

Further information: [Effects of global warming on infectious diseases](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_infectious_diseases)

Climate change may lead to dramatic increases in prevalence of a variety of infectious diseases. Beginning in the mid-'70s, there has been an “emergence, resurgence and redistribution of infectious diseases”.[[18]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Epstein-18) Reasons for this are likely multicausal, dependent on a variety of social, environmental and climatic factors, however, many argue that the “volatility of infectious disease may be one of the earliest biological expressions of climate instability”.[[18]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Epstein-18) Though many infectious diseases are affected by changes in climate, vector-borne diseases, such as malaria, [dengue fever](https://en.wikipedia.org/wiki/Dengue_fever) and leishmaniasis, present the strongest [causal relationship](https://en.wikipedia.org/wiki/Causality). Observation and research detect a shift of pests and pathogens in the distribution away from the equator and towards Earth's poles.[[19]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-19)

#### Malaria

Increased [precipitation](https://en.wikipedia.org/wiki/Precipitation) like [rain](https://en.wikipedia.org/wiki/Rain) could increase the number of [mosquitos](https://en.wikipedia.org/wiki/Mosquito) indirectly by expanding larval habitat and food supply. Malaria kills approximately 300,000 children (under age 5) annually, poses an [imminent threat](https://en.wikipedia.org/wiki/Imminent_threat) through temperature increase .[[20]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-malaria-20) Models suggest, conservatively, that risk of malaria will increase 5-15% by 2100 due to climate change.[[21]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Bhattacharya-21) In Africa alone, according to the MARA Project (Mapping Malaria Risk in Africa),[[22]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-mara-22) there is a projected increase of 16–28% in person-month exposures to malaria by 2100.[[23]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-23)

#### Non-climatic determinants

Sociodemographic factors include, but are not limited to: patterns of [human migration](https://en.wikipedia.org/wiki/Human_migration) and travel, effectiveness of [public health](https://en.wikipedia.org/wiki/Public_health) and medical infrastructure in controlling and treating disease, the extent of [anti-malarial](https://en.wikipedia.org/wiki/Malaria) [drug resistance](https://en.wikipedia.org/wiki/Drug_resistance) and the underlying health status of the population at hand.[[24]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-infectious-24) Environmental factors include: changes in [land-use](https://en.wikipedia.org/wiki/Land_use) (e.g. deforestation), expansion of agricultural and water development projects (which tend to increase mosquito breeding habitat), and the overall trend towards urbanization (i.e. increased concentration of human hosts). Patz and Olson argue that these changes in landscape can alter local weather more than long term climate change.[[20]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-malaria-20) For example, the [deforestation](https://en.wikipedia.org/wiki/Deforestation) and cultivation of natural swamps in the African highlands has created conditions favourable for the survival of mosquito larvae, and has, in part, led to the increasing incidence of malaria.[[20]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-malaria-20) The effects of these non-climatic factors complicate things and make a direct causal relationship between climate change and malaria difficult to confirm. It is highly unlikely that climate exerts an isolated effect.

## Environment

Climate change may dramatically impact [habitat loss](https://en.wikipedia.org/wiki/Habitat_loss), for example, [arid](https://en.wikipedia.org/wiki/Arid) conditions may cause the [deforestation](https://en.wikipedia.org/wiki/Deforestation) of [rainforests](https://en.wikipedia.org/wiki/Rainforest), as has occurred in the past.[[25]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-SahneyBentonFalconLang_2010RainforestCollapse-25)

### Temperature

A sustained [wet-bulb temperature](https://en.wikipedia.org/wiki/Wet-bulb_temperature) exceeding 35° is a threshold at which the resilience of human systems is no longer able to adequately cool the skin. A study by NOAA from 2013 concluded that heat stress will reduce labor capacity considerably under current emissions scenarios.[[26]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-26) There is evidence to show that high temperatures can increase mortality rates among fetuses and children[[27]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-27) Although the main focus is often on the health impacts and risks of higher temperatures, it should be remembered that they also reduce learning and worker productivity, which can impact a country's economy and development.

### Water

See also: [Water crisis](https://en.wikipedia.org/wiki/Water_crisis)

The [freshwater](https://en.wikipedia.org/wiki/Freshwater) resources that humans rely on are highly sensitive to variations in weather and climate. In 2007, the IPCC reported with high confidence that climate change has a net negative impact on water resources and freshwater ecosystems in all regions.[[28]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ipcc2007-28) The IPCC also found with very high confidence that arid and semi-arid areas are particularly exposed to freshwater impacts.[[28]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ipcc2007-28)

As the climate warms, it changes the nature of global rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality. Specific impacts include:

* Warmer water temperatures affect water quality and accelerate [water pollution](https://en.wikipedia.org/wiki/Water_pollution).[[29]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ISSE-29)
* Sea level rise is projected to increase salt-water intrusion into [groundwater](https://en.wikipedia.org/wiki/Groundwater) in some regions. This reduces the amount of freshwater available for drinking and farming.[[29]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ISSE-29)[[30]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-30)
* In some areas, shrinking glaciers and snow deposits threaten the water supply.[[31]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-31) Areas that depend on melted water runoff will likely see that runoff depleted, with less flow in the late summer and spring peaks occurring earlier.[[29]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ISSE-29) This can affect the ability to [irrigate](https://en.wikipedia.org/wiki/Irrigation) crops. (This situation is particularly acute for irrigation in South America,[[32]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-peru2-32) for irrigation and drinking supplies in Central Asia, and for hydropower in Norway, the Alps, and the Pacific Northwest of North America.)
* Increased extreme weather means more water falls on hardened ground unable to absorb it, leading to flash floods instead of a replenishment of soil moisture or groundwater levels.[[33]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-33)
* Increased evaporation will reduce the effectiveness of reservoirs.
* At the same time, human demand for water will grow for the purposes of cooling and hydration.

## Displacement and migration

Climate change causes displacement of people in several ways, the most obvious—and dramatic—being through the increased number and severity of weather-related disasters which destroy homes and habitats causing people to seek shelter or livelihoods elsewhere. Effects of climate change such as [desertification](https://en.wikipedia.org/wiki/Desertification) and [rising sea levels](https://en.wikipedia.org/wiki/Rising_sea_levels) gradually erode livelihood and force communities to abandon traditional homelands for more accommodating environments. This is currently happening in areas of Africa’s [Sahel](https://en.wikipedia.org/wiki/Sahel), the semi-arid belt that spans the continent just below its northern deserts. Deteriorating environments triggered by climate change can also lead to increased conflict over resources which in turn can displace people.[[34]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-34)

The [IPCC](https://en.wikipedia.org/wiki/IPCC) has estimated that 150 million environmental migrants will exist by the year 2050, due mainly to the effects of coastal flooding, shoreline erosion and agricultural disruption.[[35]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-35) However, the IPCC also cautions that it is extremely difficult to measure the extent of environmental migration due to the complexity of the issue and a lack of data.[[9]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-wilbanks-9)

According to the Internal Displacement Monitoring Centre, more than 42 million people were displaced in Asia and the Pacific during 2010 and 2011, more than twice the population of Sri Lanka. This figure includes those displaced by storms, floods, and heat and cold waves. Still others were displaced drought and sea-level rise. Most of those compelled to leave their homes eventually returned when conditions improved, but an undetermined number became migrants, usually within their country, but also across national borders.[[36]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-36)

Asia and the Pacific is the global area most prone to natural disasters, both in terms of the absolute number of disasters and of populations affected. It is highly exposed to climate impacts, and is home to highly vulnerable population groups, who are disproportionately poor and marginalized. A recent Asian Development Bank report highlights “environmental hot spots” that are particular risk of flooding, [cyclones](https://en.wikipedia.org/wiki/Cyclones), [typhoons](https://en.wikipedia.org/wiki/Typhoons), and water stress.[[37]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-beta.adb.org-37)

Some Pacific Ocean island nations, such as [Tuvalu](https://en.wikipedia.org/wiki/Tuvalu), [Kiribati](https://en.wikipedia.org/wiki/Kiribati), and the [Maldives](https://en.wikipedia.org/wiki/Maldives),[[38]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-38) are considering the eventual possibility of evacuation, as flood defense may become economically unrealistic. Tuvalu already has an ad hoc agreement with New Zealand to allow phased relocation.[[39]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-39) However, for some islanders relocation is not an option. They are not willing to leave their homes, land and families. Some simply don’t know the threat that climate change has on their island and this is mainly down to the lack of awareness that climate change even exists. In Vutia on Viti Levu, Fiji’s main island, half the respondents to a survey had not heard of climate change (Lata and Nuun 2012). Even where there is awareness many believe that it is a problem caused by developed countries and should therefore be solved by developed countries.[[40]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-40)

Governments have considered various approaches to reduce migration compelled by environmental conditions in at-risk communities, including programs of social protection, livelihoods development, basic urban infrastructure development, and disaster risk management. Some experts even support migration as an appropriate way for people to cope with environmental changes. However, this is controversial because migrants – particularly low-skilled ones – are among the most vulnerable people in society and are often denied basic protections and access to services.[[37]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-beta.adb.org-37)

Climate change is only one factor that may contribute to a household's decision to migrate; other factors may include [poverty](https://en.wikipedia.org/wiki/Poverty), [population growth](https://en.wikipedia.org/wiki/Population_growth) or [employment](https://en.wikipedia.org/wiki/Employment) options.[[41]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-41) For this reason, it is difficult to classify [environmental migrants](https://en.wikipedia.org/wiki/Environmental_migrant) as actual "refugees" as legally defined by the [UNHCR](https://en.wikipedia.org/wiki/UNHCR).[[42]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-UNHCR_on_environmental_migration_terminology-42) Neither the [UN Framework Convention on Climate Change](https://en.wikipedia.org/wiki/UN_Framework_Convention_on_Climate_Change) nor its [Kyoto Protocol](https://en.wikipedia.org/wiki/Kyoto_Protocol), an international agreement on climate change, includes any provisions concerning specific assistance or protection for those who will be directly affected by climate change.[[43]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-43)

In small islands and [megadeltas](https://en.wikipedia.org/wiki/River_delta), [inundation](https://en.wikipedia.org/wiki/Inundation) as a result of [sea level rise](https://en.wikipedia.org/wiki/Sea_level_rise) is expected to threaten vital infrastructure and human settlements.[[44]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-44)[[45]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-45) This could lead to issues of [statelessness](https://en.wikipedia.org/wiki/Statelessness) for populations in countries such as the [Maldives](https://en.wikipedia.org/wiki/Maldives) and [Tuvalu](https://en.wikipedia.org/wiki/Tuvalu)[[46]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-46) and [homelessness](https://en.wikipedia.org/wiki/Climate_refugee) in countries with low-lying areas such as [Bangladesh](https://en.wikipedia.org/wiki/Bangladesh).

The World Bank predicts that a “severe hit” will spur conflict and migration across the [Middle East](https://en.wikipedia.org/wiki/Middle_East), [Central Asia](https://en.wikipedia.org/wiki/Central_Asia), and [Africa](https://en.wikipedia.org/wiki/Africa).[[47]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-47)

## Security

Climate change has the potential to exacerbate existing tensions or create new ones — serving as a threat multiplier. It can be a catalyst for violent conflict and a threat to international security.[[48]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-48)[[49]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-49) A meta-analysis of over 50 quantitative studies that examine the link between climate and conflict found that "for each 1 standard deviation (1σ) change in climate toward warmer temperatures or more extreme rainfall, median estimates indicate that the frequency of interpersonal violence rises 4% and the frequency of intergroup conflict rises 14%".[[50]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-50)[[51]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-51) The IPCC has suggested that the disruption of [environmental migration](https://en.wikipedia.org/wiki/Environmental_migrant) may serve to exacerbate conflicts,[[52]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-52) though they are less confident of the role of increased resource scarcity.[[9]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-wilbanks-9) Of course, climate change does not always lead to violence, and conflicts are often caused by multiple interconnected factors.[[53]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-:0-53)

A variety of experts have warned that climate change may lead to increased conflict. The [Military Advisory Board](https://en.wikipedia.org/wiki/Military_Advisory_Board), a panel of retired U.S. generals and admirals, predicted that global warming will serve as a "threat multiplier" in already volatile regions.[[54]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-54) The [Center for Strategic and International Studies](https://en.wikipedia.org/wiki/Center_for_Strategic_and_International_Studies) and the [Center for a New American Security](https://en.wikipedia.org/wiki/Center_for_a_New_American_Security), two Washington think tanks, have reported that flooding "has the potential to challenge regional and even national identities," leading to "armed conflict over resources." They indicate that the greatest threat would come from "large-scale migrations of people — both inside nations and across existing national borders."[[55]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-55) However, other researchers have been more skeptical: One study found no statistically meaningful relationship between climate and conflict using data from Europe between the years 1000 and 2000.[[56]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-56)

The link between climate change and security is a concern for authorities across the world, including [United Nations Security Council](https://en.wikipedia.org/wiki/United_Nations_Security_Council) and the [G77](https://en.wikipedia.org/wiki/Group_of_77) group of developing nations. Climate change's impact as a security threat is expected to hit developing nations particularly hard. In Britain, [Foreign Secretary](https://en.wikipedia.org/wiki/Secretary_of_State_for_Foreign_and_Commonwealth_Affairs) [Margaret Beckett](https://en.wikipedia.org/wiki/Margaret_Beckett) has argued that "An unstable climate will exacerbate some of the core drivers of conflict, such as migratory pressures and competition for resources."[[57]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-57) The links between the human impact of climate change and the threat of violence and armed conflict are particularly important because multiple destabilizing conditions are affected simultaneously.

Experts have suggested links to climate change in several major conflicts:

* [War in Darfur](https://en.wikipedia.org/wiki/War_in_Darfur), where sustained drought encouraged conflict between herders and farmers[[58]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-58)[[59]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-59)[[60]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-60)
* [Syrian Civil War](https://en.wikipedia.org/wiki/Syrian_Civil_War), preceded by the displacement of 1.5 million people due to drought-induced crop and livestock failure[[61]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-61)[[62]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-62)[[63]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-63)
* [Islamist insurgency in Nigeria](https://en.wikipedia.org/wiki/Islamist_insurgency_in_Nigeria), which exploited natural resource shortages to fuel anti-government sentiment[[64]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-64)[[65]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-65)
* [Somali Civil War](https://en.wikipedia.org/wiki/Somali_Civil_War), in which droughts and extreme high temperatures have been linked to violence[[66]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-66)[[67]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-67)

Additionally, researchers studying ancient climate patterns ([paleoclimatology](https://en.wikipedia.org/wiki/Paleoclimatology)) have shown that long-term fluctuations of war frequency and population changes have followed cycles of temperature change since the preindustrial era.[[68]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-68) A 2016 study finds that "drought can contribute to sustaining conflict, especially for agriculturally dependent groups and politically excluded groups in very poor countries. These results suggest a reciprocal nature–society interaction in which violent conflict and environmental shock constitute a vicious circle, each phenomenon increasing the group’s vulnerability to the other."[[69]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-69)

## Social impacts

See also: [Climate change and gender](https://en.wikipedia.org/wiki/Climate_change_and_gender)

The consequences of [climate change and poverty](https://en.wikipedia.org/wiki/Climate_change_and_poverty) are not distributed uniformly within communities. Individual and social factors such as gender, age, education, ethnicity, geography and language lead to differential [vulnerability](https://en.wikipedia.org/wiki/Vulnerability) and capacity to adapt to the effects of climate change. Climate change effects such as hunger, poverty and diseases like diarrhea and malaria, disproportionately impact children; about 90 percent of malaria and diarrhea deaths are among young children. Children are also 14–44 percent more likely to die from environmental factors,[[70]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-70) again leaving them the most vulnerable.Those in urban areas will be affected by lower air quality and overcrowding, and will struggle the most to better their situation.[[14]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-who.int-14)

### Social effects of extreme weather

See also: [List of costliest Atlantic hurricanes](https://en.wikipedia.org/wiki/List_of_costliest_Atlantic_hurricanes) and [Physical impacts of climate change](https://en.wikipedia.org/wiki/Physical_impacts_of_climate_change)

As the [World Meteorological Organization](https://en.wikipedia.org/wiki/World_Meteorological_Organization) explains, "recent increase in societal impact from tropical cyclones has largely been caused by rising concentrations of population and infrastructure in coastal regions."[[71]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-71) Pielke *et al.* (2008) normalized mainland U.S. hurricane damage from 1900 to 2005 to 2005 values and found no remaining trend of increasing absolute damage. The 1970s and 1980s were notable because of the extremely low amounts of damage compared to other decades. The decade 1996–2005 has the second most damage among the past 11 decades, with only the decade 1926–1935 surpassing its costs. The most damaging single storm is the [1926 Miami hurricane](https://en.wikipedia.org/wiki/1926_Miami_hurricane), with $157 billion of normalized damage.[[72]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-72)

The American *Insurance Journal* predicted that "catastrophe losses should be expected to double roughly every 10 years because of increases in construction costs, increases in the number of structures and changes in their characteristics."[[73]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-73) The Association of British Insurers has stated that limiting carbon emissions would avoid 80% of the projected additional annual cost of tropical cyclones by the 2080s. The cost is also increasing partly because of building in exposed areas such as coasts and floodplains. The ABI claims that reduction of the vulnerability to some inevitable effects of climate change, for example through more resilient buildings and improved flood defences, could also result in considerable cost-savings in the longterm.[[74]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-74)

## Human settlement

Further information: [Sea level rise](https://en.wikipedia.org/wiki/Sea_level_rise) and [Future sea level](https://en.wikipedia.org/wiki/Future_sea_level)

A major challenge for human settlements is [sea level rise](https://en.wikipedia.org/wiki/Sea_level_rise), indicated by ongoing observation and research of rapid declines in ice-mass balance from both Greenland and Antarctica. Estimates for 2100 are at least twice as large as previously estimated by IPCC AR4, with an upper limit of about two meters.[[75]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Copenhagen_Diagnosis-75) Depending on regional changes, increased precipitation patterns can cause more flooding or extended drought stresses water resources.

### Coasts and low-lying areas

For historical reasons to do with [trade](https://en.wikipedia.org/wiki/Trade), many of the world's largest and most prosperous cities are on the [coast](https://en.wikipedia.org/wiki/Coast). In developing countries, the poorest often live on [floodplains](https://en.wikipedia.org/wiki/Floodplain), because it is the only available space, or fertile agricultural land. These settlements often lack infrastructure such as [dykes](https://en.wikipedia.org/wiki/Levee) and early warning systems. Poorer communities also tend to lack the insurance, savings, or access to credit needed to recover from disasters.

In a journal paper, Nicholls and [Tol](https://en.wikipedia.org/wiki/Richard_Tol) (2006) considered the effects of sea level rise:[[76]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-76)

The most vulnerable future worlds to sea-level rise appear to be the A2 and B2 [IPCC] [scenarios](https://en.wikipedia.org/wiki/Special_Report_on_Emissions_Scenarios), which primarily reflects differences in the [socio-economic](https://en.wikipedia.org/wiki/Socio-economic) situation (coastal population, [Gross Domestic Product](https://en.wikipedia.org/wiki/Gross_Domestic_Product) (GDP) and GDP/capita), rather than the magnitude of sea-level rise. Small islands and deltaic settings stand out as being more vulnerable as shown in many earlier analyses. Collectively, these results suggest that human societies will have more choice in how they respond to sea-level rise than is often assumed. However, this conclusion needs to be tempered by recognition that we still do not understand these choices and significant impacts remain possible.

The IPCC reported that socioeconomic impacts of climate change in coastal and low-lying areas would be overwhelmingly adverse. The following impacts were projected with very high confidence:[[77]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-77)

* Coastal and low-lying areas would be exposed to increasing risks including coastal erosion due to climate change and sea level rise.
* By the 2080s, millions of people would experience floods every year due to sea level rise. The numbers affected were projected to be largest in the densely populated and low-lying mega-deltas of Asia and Africa; and smaller islands were judged to be especially vulnerable.

A study in the April 2007 issue of *Environment and Urbanization* reports that 634 million people live in coastal areas within 30 feet (9.1 m) of sea level.[[78]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-78) The study also reported that about two thirds of the world's cities with over five million people are located in these low-lying coastal areas.

## Energy sector

### Oil, coal and natural gas

Oil and natural gas infrastructure is vulnerable to the effects of climate change and the increased risk[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia%3ACitation_needed)] of disasters such as [storm](https://en.wikipedia.org/wiki/Storm), [cyclones](https://en.wikipedia.org/wiki/Cyclone), [flooding](https://en.wikipedia.org/wiki/Flooding) and long-term [increases in sea level](https://en.wikipedia.org/wiki/Sea_level_rise). Minimising these risks by building in less disaster prone areas, can be expensive and impossible in countries with coastal locations or [island states](https://en.wikipedia.org/wiki/Island_state). All [thermal power stations](https://en.wikipedia.org/wiki/Thermal_power_station) depend on water to cool them. Not only is there increased demand for fresh water, but climate change can increase the likelihood of [drought](https://en.wikipedia.org/wiki/Drought) and [fresh water shortages](https://en.wikipedia.org/wiki/Water_shortage). Another impact for thermal power plants, is that increasing the temperatures in which they operate reduces their efficiency and hence their output. The source of oil often comes from areas prone to high natural disaster risks; such as tropical storms, hurricanes, cyclones, and floods. An example is [Hurricane Katrina](https://en.wikipedia.org/wiki/Hurricane_Katrina)'s impact on oil extraction in the [Gulf of Mexico](https://en.wikipedia.org/wiki/Gulf_of_Mexico), as it destroyed 126 oil and gas platforms and damaged 183 more.[[79]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ODI1-79)

However, previously pristine arctic areas will now be available for [resource extraction](https://en.wikipedia.org/wiki/Oil_spill)[[80]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-80)

### Nuclear

Climate change, along with extreme weather and natural disasters can affect nuclear power plants in a similar way to those using oil, coal, and natural gas. However, the impact of water shortages on nuclear power plants cooled by rivers will be greater than on other thermal power plants. This is because old reactor designs with water-cooled cores must run at lower internal temperatures and thus, paradoxically, must dump more heat to the environment to produce a given amount of electricity. This situation has forced some nuclear reactors to be shut down and will do so again unless the cooling systems of these plants are enhanced to provide more capacity. Nuclear power supply was diminished by low river ﬂow rates and droughts, which meant rivers had reached the maximum temperatures for cooling. Such shutdowns happened in France during the 2003 and 2006 heat waves. During the heat waves, 17 reactors had to limit output or shut down. 77% of French electricity is produced by nuclear power; and in 2009 a similar situation created a 8GW shortage, and forced the French government to import electricity. Other Cases have been reported from Germany, where extreme temperatures have reduced nuclear power production 9 times due to high temperatures between 1979 and 2007. In particular:

* The [Unterweser nuclear power plant](https://en.wikipedia.org/wiki/Unterweser_Nuclear_Power_Plant) reduced output by 90% between June and September 2003.
* The [Isar nuclear power plant](https://en.wikipedia.org/wiki/Isar_Nuclear_Power_Plant) cut production by 60% for 14 days due to excess river temperatures and low stream ﬂow in the river Isar in 2006.

Similar events have happened elsewhere in Europe during those same hot summers. Many scientists agree that if [global warming](https://en.wikipedia.org/wiki/Global_warming) continues, this disruption is likely to increase.[[79]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ODI1-79)

### Hydroelectricity

Changes in the amount of river flow will correlate with the amount of energy produced by a dam. Lower river flows because of drought, climate change, or upstream dams and diversions, will reduce the amount of live storage in a reservoir; therefore reducing the amount of water that can be used for hydroelectricity. The result of diminished river flow can be a power shortage in areas that depend heavily on hydroelectric power. The risk of flow shortage may increase as a result of [climate change](https://en.wikipedia.org/wiki/Climate_change). Studies from the [Colorado River](https://en.wikipedia.org/wiki/Colorado_River) in the United States suggests that modest climate changes (such as a 2 degree change in Celsius that could result in a 10% decline in precipitation), might reduce river run-off by up to 40%. [Brazil](https://en.wikipedia.org/wiki/Brazil) in particular, is vulnerable due to its having reliance on hydroelectricity as increasing temperatures, lower water ﬂow, and alterations in the rainfall regime, could reduce total energy production by 7% annually by the end of the century.[[79]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-ODI1-79)

## Cost

The scientific evidence for links between global warming and the increasing cost of natural disasters due to weather events[[81]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-fivethirtyeight032114-81) is weak, but, nevertheless, prominent mainstream environmental spokesmen such as Barack Obama and Al Gore have emphasized the possible connection.[[82]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Peilke6-82) For the most part increased costs due to events such as [Hurricane Sandy](https://en.wikipedia.org/wiki/Hurricane_Sandy)[[83]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-fivethirtyeight031915-83) are due to increased exposure to loss resulting from building insured facilities in vulnerable locations.[[84]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-Peilke21-84) This information has been denounced by [Paul Krugman](https://en.wikipedia.org/wiki/Paul_Krugman)[[85]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-NYT032314-85) and [ThinkProgress](https://en.wikipedia.org/wiki/ThinkProgress) as [climate change denial](https://en.wikipedia.org/wiki/Climate_change_denial).[[86]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-thinkprogress031914-86)

### Insurance

An industry directly affected by the risks of climate change is the [insurance](https://en.wikipedia.org/wiki/Insurance) industry.[[87]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-87) According to a 2005 report from the Association of British Insurers, limiting carbon emissions could avoid 80% of the projected additional annual cost of tropical cyclones by the 2080s.[[88]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-88) A June 2004 report by the Association of British Insurers declared "Climate change is not a remote issue for future generations to deal with; it is, in various forms here already, impacting on insurers' businesses now."[[89]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-89) The report noted that weather-related risks for households and property were already increasing by 2–4% per year due to the changing weather conditions, and claims for storm and flood damages in the UK had doubled to over £6 billion over the period from 1998–2003 compared to the previous five years. The results are rising insurance premiums, and the risk that in some areas [flood insurance](https://en.wikipedia.org/wiki/Flood_insurance) will become unaffordable for those in the lower income brackets.

Financial institutions, including the world's two largest insurance companies: [Munich Re](https://en.wikipedia.org/wiki/Munich_Re) and [Swiss Re](https://en.wikipedia.org/wiki/Swiss_Re), warned in a 2002 study that "the increasing frequency of severe climatic events, coupled with social trends could cost almost 150 billion [US$](https://en.wikipedia.org/wiki/United_States_dollar) each year in the next decade".[[90]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-90) These costs would burden customers, taxpayers, and the insurance industry, with increased costs related to insurance and disaster relief.

In the United States, insurance losses have also greatly increased. It has been shown that a 1% climb in annual precipitation can increase catastrophe loss by as much as 2.8%.[[91]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-choifisher-91) Gross increases are mostly attributed to increased population and property values in [vulnerable](https://en.wikipedia.org/wiki/Vulnerability) coastal areas; though there was also an increase in frequency of weather-related events like heavy rainfalls since the 1950s.[[92]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-92)

## Transport

Roads, airport runways, railway lines and pipelines, (including [oil pipelines](https://en.wikipedia.org/wiki/Oil_pipeline), [sewers](https://en.wikipedia.org/wiki/Sanitary_sewer), [water mains](https://en.wikipedia.org/wiki/Water_main) etc.) may require increased maintenance and renewal as they become subject to greater temperature variation. Regions already adversely affected include areas of [permafrost](https://en.wikipedia.org/wiki/Permafrost), which are subject to high levels of [subsidence](https://en.wikipedia.org/wiki/Subsidence), resulting in buckling roads, sunken foundations, and severely cracked runways.[[93]](https://en.wikipedia.org/wiki/Effects_of_global_warming_on_humans#cite_note-93)

# What are the effects of industrialization on the environment?

[Invest in top mutual fund portfolios for 2018 created by experts.](https://www.upwardly.in/build-wealth/advanced-equity-investing-1?utm_medium=quora&utm_campaign=AdvEqInv_2" \t "_blank)

[These funds have doubled investments in 2.5 years. Start an SIP or lumpsum.](https://www.upwardly.in/build-wealth/advanced-equity-investing-1?utm_medium=quora&utm_campaign=AdvEqInv_2" \t "_blank)

I’ll sum this up in a few points, just to add to the other answers out there. These are the effects of industrialization on the environment:

1. **Pollution**. Industrialization normally adds to pollution in air, water, soil, due to the waste products it produces.
2. **Extraction**. Industrialization makes use of resources - raw materials from the land, water, perhaps wood and plants, fossil fuels, etc. This has an effect on the environment, since demand for all these goes up, and more quantities are extracted from the land.
3. **Urbanization**. Industrialization needs people to work in factories. So, people move from rural/agricultural areas, that are spread out, to industrialized cities, that are concentrated. A higher population puts added pressure on the local environment.
4. **Waste material**. Industrialization produces a greater amount of waste, both directly as a result of production of goods, as well as the disposal of those goods once their purpose has been served. For example, if a factory makes plastic furniture, it produces waste plastic … and once the plastic furniture is worn, it is added to the rubbish pile too.
5. Finally, there is a **possible long term beneficial impact.** Industrialization adds to the wealth of society, and makes a greater quantity of goods available at lower cost, thus uplifting the lives of many. If managed properly, with ill effects kept limited, this will allow humanity to have the resources to better manage the environment while having a high standard of living.

## What is the Impact of Industrialization on the Environment?

Since the ages of industrial and technological revolutions, economic growth has been regarded as the major fundamental of the world’s growth.  Industrial growth has started to affect the entire environment with its severe downside problems. The formation of massive pollution making industries are the result of the constant need and greed of the human being.  These industries include, transportation and manufacturing, which are  exhausting the earth’s resources, but also causing tremendous stress on the environment and the ecological system. The productiveness of industries generally depends on the natural resources available. The **impact of industrialization on the environment** has led the way with certain positive and large negative outcomes, with progressive rates and inventions. There are quite a number of resourceful natural elements like, water, air, soil and  fisheries, which are considered to be positive and fertile assets. The pollution of water, soil and air, are defined as the by-product of economical development in industry and city life. Global warming and greenhouse effects are the result, which is a massive *impact of industrialization on the environment*.   The degradation of the entire environment and ecological system, is inclined to become permanent and tends to cause several negative effects on the economy, by causing human losses, ill health of the employees at large costs to governments, manufacturing and society.

 Constant air and water pollution are affecting the quality of human lives with its harmful pollutants. The rapid growth of industries are leaving harmful effects on the human life, by polluting water and air.  The air and water pollution are, thus, the main problems in the environment. The establishment of more industries increase the major difficulties of degrading the water and soil.

[Impact of Industrialization On The Environment](http://environmentinsider.com/impact-of-mining-on-environment/)

The impact of industrialization on the environment needs to be emphasized with more intensity and feeling as the world is quietly but surely facing destruction from man-made follies. For example, did you know that in three Pennsylvania river basins, there is a growing population of mutated fish? Male fish have female parts and vice versa, open sores, and unusual blotches on their bodies and it doesn’t make national news. This is because extreme animal mutations, tons of dead birds, farm animals, and fishes have become a common occurrence around the world in the past 5 years. It’s no longer headlines news because it’s become “commonplace.”

Before you assume that these events are caused by prophetic stories from way back in history, there is a more logical reason: unhampered or merciless industrialization.

### ****Estrogenic Compounds: Mankind’s Friend, Environment’s Foe****

Scientists have traced the cause of mutation in fish to be from estrogenic compounds in the water. While there are natural estrogenic compounds found in soy, urine, and manure most come from synthetic sources like chemicals, birth control pills, BPA plastics, and pesticides – all of which come from the efforts and successes of industrialized farming. They end up in waterways and rivers because of farm irrigation. More alarming is that exposure to estrogenic compounds is not limited to the fish in the rivers of Pennsylvania. They are seen everywhere including big cities and provincial towns. For example, in an effort to ease menstrual cramps and prevent premature labor, a synthetic drug commonly referred to as DES was developed which eventually led to cervical and breast cancer. It was also used on cattle right before slaughter to fatten them and researchers believed it is a significant factor in the spike in cancer patients and low male sperm production.

Whatever consumers are putting in the land will eventually end up in the water not just because of natural flow of water but because of increased flooding, erosion, and human sewage. Scientists estimate that 90% of estrogenic compounds come from industrialized farming not because farmers are using chemicals in animal feeds but from herbicides, pesticides, and the urine and waste of livestock. On the other hand, human waste from the cities can end up in the waterways that will flow out into rivers and seas. The bottom line is: the waste has to go somewhere and most likely into the land or into the waters.

Impact of Industrialization On The Environment

### ****The Great Barrier Reef: Progress and Higher Tax Collection?****

Halfway across the world is the Great Barrier Reef and due to the impact of industrialization on the environment, it is slowly falling into a sad state because over half of the coral reef is gone. Initially, the cause was natural forces but now even the protected areas are being threatened because of industrialization. For instance there are plans for the port to be expanded to facilitate coal mining activities. The Australian Federal Government approved the Abbot Point coal port expansion which involves dumping 3 million square meters of waste and dredge spoils into the reef waters. After a massive campaign to stop the plan, changes were made but only with regards to where the dredge spoils would be dumped. The expansion of the coal port will proceed.

Unfortunately the second option as a dumping site is the Caley Valley Wetlands which is the natural habitat of the shorebird. It is also a breeding ground for fish and a filter for the water that runs into the Great Barrier Reef. This means the dredge spoils sediments will eventually make it way to the Great Barrier Reef not to mention that by dumping this amount of spoils, the wetlands will flood and increase the amount of greenhouse gases.

**Impact of Industrialization On The Environment**

According to the CEO of the Australian Conservation Foundation, Don Henry, coal ships will increase in the area from 1,700 to more than 10,000. It’s progress, yes but with it comes oil spills, potential for collision, increased marine pests, damage of reefs by anchors, groundings, and chemical spills. Marine life is going to be severely challenged. However, the new coal port, when finished, will create thousands of new jobs and increase tax collection by as much as $22 billion. For these reasons – a.k.a. progress and industrialization – Greenpeace has been described as being “hysterical.”

Around the world, these 2 scenarios are duplicated as proponents of growth and development battle with environmentalists on how to find the middle ground and lessen the impact of industrialization on the environment. The debate and fight will never end because for earth-friendly advocates, there is no middle ground. The environment must be protected.

## Conferences and Reports on the Environment

UN activity in the field of environment has been driven by major conferences and reports.

* UN Conference on the Human Environment (1972)
* World Commission on Environment and Development (1987)
* United Nations Conference on Environment and Development (1992)
* General Assembly Special Session on the Environment (1997)
* World Summit on Sustainable Development (2002)
* UN Conference on Sustainable Development (2012)
* UN Sustainable Development Summit (2015)

## UN Conference on the Human Environment (1972)

* Economic and Social Council resolution [1346 (XLV)](http://www.un.org/en/ga/search/view_doc.asp?symbol=e/res/1346%28XLV%29) of 30 July 1968 recommended the General Assembly consider convening a UN conference on problems of the human environment.
* Conference convened by General Assembly resolution [2398 (XXIII)](http://www.un.org/en/ga/search/view_doc.asp?symbol=a/res/2398%28XXIII%29)of 3 December 1968
* Held in **Stockholm,**5-16 June 1972
* Led to the **establishment of the United Nations Environment Programme** (UNEP)
* Outcome document: [A/CONF.48/14/Rev.1](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.48/14/Rev.1)

## World Commission on Environment and Development (1987)

* Established by General Assembly resolution [38/161](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/38/161) of 19 December 1983
* Prepared a report for General Assembly in 1987
	+ Based on a four-year study
	+ Transmitted by [A/42/427](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/42/427)
	+ Entitled ***Our Common Future***, also known as the **Brundtland** **report**
	+ Developed the theme of **sustainable development**

## United Nations Conference on Environment and Development (1992)

* Convened by General Assembly resolution [44/228](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/44/228) of 20 December 1988
* Held in **Rio de Janeiro**, 3-14 June 1992
* Known at the time as the **Earth Summit**
* Later came to be called the **Rio Conference**
* Led to the establishment of the Commission on Sustainable Development
* Outcome document in 3 volumes: **A/CONF.151/26/Rev.1**
	+ [Vol.I](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.I%29) + [Corr.1](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.I%29/Corr.1): Resolutions adopted by the Conference
	+ [Vol.II](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.II%29): Proceedings of the Conference
	+ [Vol.III](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.III%29) + [Corr.1](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.III%29/Corr.1): Statements made by Heads of State or Government at the summit segment of the Conference
* Three major agreements adopted (found in [Vol.I](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.I%29) + [Corr.1](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.151/26/Rev.1%28Vol.I%29/Corr.1)):
	+ **Rio Declaration** on Environment and Development, a series of principles defining the rights and responsibilities of States
	+ **Agenda 21**, a global plan of action to promote sustainable development
	+ Statement of Forest Principles, a set of principles to underpin the sustainable management of forests worldwide
* Two multilateral treaties were opened for signature:
	+ United Nations Framework Convention on Climate Change (UNFCCC)
	+ Convention on Biological Diversity
* Called for several major initiatives in other key areas of sustainable development, such as, a global conference on Small Island Developing States; negotiations began for a Convention to Combat Desertification, and for an agreement on highly migratory and straddling fish stocks.

## General Assembly Special Session on the Environment (1997)

* Called for by General Assembly resolutions [47/190](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/47/190) and [51/181](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/51/181)
* Known as the Earth Summit +5
* 19th special session of the General Assembly
* Held in New York, 23-27 June 1997
* **Review** of the implementation of Agenda 21
* Outcome document: General Assembly resolution [S-19/2](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/S-19/2) of 27 June 1997, Programme for the Further Implementation of Agenda 21.

## World Summit on Sustainable Development (2002)

* Convened by General Assembly resolution [55/199](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/res/55/199) of 20 December 2000
* Also known as Rio +10
* Held in **Johannesburg**, 26 August - 4 September 2002
* **Reviewed** progress in the implementation of Agenda 21 since its adoption in 1992
* [WSSD website](http://www.un.org/events/wssd/) still available
* Outcome document: [A/CONF.199/20](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.199/20) + [Corr.1](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.199/20/Corr.1), includes:
	+ Johannesburg Declaration on Sustainable Development
	+ Plan of Implementation

## UN Conference on Sustainable Development (2012)

* Called for by General Assembly resolution [66/197](http://www.un.org/en/ga/search/view_doc.asp?symbol=a/res/66/197)
* Known as Rio+20
* Held in Rio de Janeiro, 20-22 June 2012
* [Rio +20](https://sustainabledevelopment.un.org/rio20.html) website
* Outcome document [A/CONF.216/16](http://www.un.org/en/ga/search/view_doc.asp?symbol=A/CONF.216/16), includes "**The future we want**"

## UN Sustainable Development Summit (2015)

* Convened as a high-level plenary meeting of the General Assembly
* New York, 25 - 27 September 2015

**BMC (SEMESTER – V)**

**What is pollution?**

* Pollution is the introduction of harmful substances or products into the environment
* We will be examining 3 main parts of pollution
	+ Water Pollution
	+ Air Pollution
	+ Land Pollution

**Causes of Water Pollution**

* Factors that contribute to water pollution can be categorized into two different groups
	+ Point sources
	+ Non-point sources
* Point sources are the easiest to identify and control
* Non point sources are ambiguously defined and harder to control

Point Sources

* Some point sources of water pollution include
	+ Waste products from factories
	+ Waste from sewage system
	+ Waste from power plants
	+ Waste from underground coalmines
	+ Waste from oil wells
* They are called point sources because they are direct sources of water pollution and can be reduced and monitored

Non-point Sources

* The term non-point source encompasses a large range of sources such as:
	+ when rain or snow moves through the ground and picks up pollutants as it moves towards a major body of water
	+ the runoff of fertilizers from farm animals and crop land
	+ air pollutants getting washed or deposited to earth
	+ storm water drainage from lawns, parking lots, and streets

**Air Pollution**

**Causes of Air Pollution**

* One of the main causes of air pollution is the release of carbon dioxide into the atmosphere, this happens because of Deforestation and fossil fuel burning
* Sulfur dioxide is another air polluter and is released into the atmosphere by the burning of sulfur containing compounds of fossil fuels. Sulfur oxides are very dangerous to humans at a high concentration. Sulfur in the atmosphere is responsible for acid rain

More causes of air pollution: CFCs

* Chlorofluorocarbons (CFCs) also contribute to air pollution by reducing the amount of ozone the stratosphere. CFCs come from a variety of places such as:
	+ the burning of plastic foam items
	+ leaking refrigerator equipment
	+ spray cans

**Natural Air Pollutants**

* Natural air pollutants can include:
	+ Smoke from wild fires
	+ Methane released from live stock
	+ Volcanic eruptions

**Six primary or “criteria” air pollutants**

* Carbon monoxide (CO)
* Ozone (O3)
* Nitrogen dioxide (NO2)
* Sulfur oxides (SOx)
* PM2.5 and PM10
* Lead (Pb)

**Consequences of Air Pollution**

* CO2 is a good transmitter of sunlight, but it also partially restricts infrared radiation going back from the earth into space, which produces the so-called greenhouse effect that prevents a drastic cooling of the Earth during the night
* Increasing the amount of CO2 in the atmosphere reinforces this effect and is expected to result in a warming of the Earth's surface
* CO2 in atmosphere🡪GLOBAL WARMING

**Acid Rain**

* When emissions of sulfur dioxide and nitric oxide from stationary sources are transported long distances by winds, they form secondary pollutants such as nitrogen dioxide, nitric acid vapor, and droplets containing solutions of sulfuric acid, sulfate, and nitrate salts
* These chemicals descend to the earth's surface in wet form as rain or snow and in dry form as a gases fog, dew, or solid particles, it is known as acid rain or acid deposition

**Smog**

* With the introduction of petroleum to replace coal economies in countries, photochemical smog has become predominant in many cities, which are located in sunny, warm, and dry climates with many motor vehicles
* Worst episodes of photochemical smog tends to occur in summer

**Other consequences**

* Sulfur dioxide, nitrogen oxides, ozone and peroxyacl nitrates (PANs), cause direct damage to leaves of crop plants and trees when they enter leaf pores (stomates)
* Chronic exposure of leaves and needles to air pollutants can also break down the waxy coating that helps prevent excessive water loss and damage from diseases, pests, drought and frost
* "In the midwestern United States crop losses of wheat, corn, soybeans, and peanuts from damage by ozone and acid deposition amount to about $5 billion a year". (Miller 498)

**Land Pollution**

Causes of **Land Pollution**

* Four Main causes of land pollution
	+ Construction
	+ Agriculture
	+ Domestic waste
	+ Industrial Waste

**Construction**

* Buildings take up resources and land, the trees are chopped down and used to make buildings
	+ - Takes away from places for animals and other organisms to live

**Agriculture**

* + - As there are more and more people inhabiting the earth, food is in higher demand and so forests are chopped down and turned into farmland
		- In addition, herbicides, pesticides, artificial fertilizers, animal manure (poop) are washed into the soil and pollute it

**Domestic Waste**

* Tons of domestic waste is dumped every day. Some waste from homes, offices and industries can be recycled or burnt in incinerators
* There is still a lot of garbage, such as refrigerators and washing machines that are dumped in landfills simply because they cannot be reused in anyway, nor recycled

**Industrial Waste**

* Plastics factories, chemical plants, oil refineries, nuclear waste disposal activity, large animal farms, coal-fired power plants, metals production factories and other heavy industry all contribute to land pollution

**Consequences of Land Pollution**

* Land pollution exterminates wild life
* Acid rain kills trees and other plants
* The vegetation that provides food and shelter is destroyed
* Land pollution can seriously disrupt the balance of nature, and, in extreme cases, can cause human fatalities
* Pesticides can damage crops; kill vegetation; and poison birds, animals, and fish. Most pesticides kill or damage life forms other than those intended. For example, pesticides used in an effort to control or destroy undesirable vegetation and insects often destroy birds and small animals. Some life forms develop immunity to pesticides used to destroy them

**WAYS TO STOP POLLUTION**

* You can help to reduce global air pollution and climate change by:
	+ Driving a car that gets at least 35 mpg
	+ Walking, biking, and using public transportation
	+ Using CFL bulbs over incandescent bulbs
	+ Buying only energy efficient appliances
	+ Recycling newspaper, aluminum, and others
	+ Planting trees!
	+ Avoid purchasing products that contain CFCs
	+ Supporting much stricter clean air laws and enforcement of international treaties to reduce ozone depletion and slow global warming
* **Every unit of electricity (kWh) used generates 0.82 kg of CO2 at the power station**
* Replace just one 100W bulb (incandescent lamp) with a 20W Compact Fluorescent Lamp (CFL)
* Reduce annual CO2 emissions by 84 kg
* Reduce annual electricity bills\* by ` 409

**If you were to just change 100 bulbs in your office to CFLs**

* 8400 kg of CO2 less per year

Switch off unnecessary lights and fans

Replace old desktops with laptops

Every small car that goes off the road reduces:

* Annual CO2 emissions by 1321 kg
* Annual fuel cost by ` 29352

**Switch off ignition at traffic signals and when you are in a traffic**

1. [↑](#footnote-ref-2)
2. [↑](#footnote-ref-3)