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ВЛИЯНИЕ АНТРОПОГЕННЫХ ФАКТОРОВ НА АНТАРКТИДУ

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HOW ANTHROPOGENIC FACTORS INFLUENCE ANTARCTICA

АННОТАЦИЯ. Данная статья рассматривает антропогенные факторы воздействия на Антарктиду, а именно на ее окружающую среду. Выделяются различные виды загрязнения и его источники. Представлены международные протоколы по защите окружающей среды.

ABSTRACT. This article considers the anthropogenic factors affecting Antarctica, namely its environment. There are various types of pollution in the Antarctic region and its sources. The article presents different international protocols of the environmental protection.

КЛЮЧЕВЫЕ СЛОВА: Антарктида, антропогенные факторы, загрязнение, окружающая среда, климат, континент, лёд.

KEY WORDS: Antarctica, anthropogenic factors, pollution, environment, climate, continent, ice.

As we know, Antarctica is Earth's southernmost continent. It contains the geographic South Pole and is situated in the Antarctic region of the Southern Hemisphere, almost entirely south of the Antarctic Circle, and is surrounded by the Southern Ocean. At 14,000,000 square kilometres, it is the fifth-largest continent. For comparison, Antarctica is nearly twice the size of Australia. In fact, about 98% of Antarctica is covered by ice that averages 1.9 km in thickness, which extends to all but the northernmost reaches of the Antarctic Peninsula. Antarctica, on average, is the coldest, driest, and windiest continent, and has the highest average elevation of all the continents. Indeed, Antarctica is a desert, with annual precipitation of only 200 mm along the coast and far less inland. The temperature in Antarctica has reached −89.2 °C, though the average for the third quarter (the coldest part of the year) is −63 °C. Anywhere from 1,000 to 5,000 people reside throughout the year at the research stations scattered across the continent. Clearly, organisms native to Antarctica include many types of algae, bacteria, fungi, plants, protista, and certain animals, such as mites, nematodes, penguins, seals and tardigrades. Vegetation, where it occurs, is tundra.

Of course, Sub-Antarctic islands share many similarities in their history of human interaction and impacts before the mid-twentieth century. Large impacts on land were associated with marine exploitation industries of sealing and whaling. Their onshore activities involved significant construction and pollution in many accessible landing bays, inevitably destroying large areas of coastal terrestrial habitat. Needless to say, considerable transfer of nutrients to terrestrial environments will have been associated with scavengers utilizing large carrion supplies. Attempted establishment of agricultural industries, particularly the introduction of grazing mammals, took place on several islands and, although rarely proving economically viable, often resulted in the long-term creation of feral populations. These were accompanied by introductions of other alien vertebrates, plants and invertebrates to most sub-Antarctic islands, although precise records of entry events, or subsequent biological studies in this period, largely do not exist. Thus, exploitation industries in this region inevitably led to considerable alterations and impacts to terrestrial ecosystems almost from the outset of human contact with the islands. In the absence of baseline ecological and biodiversity studies, the true magnitude of many of these impacts is difficult to assess, although their legacy continues to the provide day. Indeed, the nearly complete removal of fur seals may have allowed coastal vegetation to become more extensive and lush than hitherto, paradoxically now regarded as "typical" and threatened by recovery of seal populations.

Unfortunately, Antarctica is plagued by anthropogenic pollution, but curiously the continent is devoid of permanent human settlement as the region is inhabitable by people. Ozone degradation, heightened CO2 levels, increased lead

concentrations, and tangible human waste litter the Antarctic region. Of course, the degradation in the Antarctic region is a result of internal, yet mostly external anthropogenic activities from international agents. Spikes in pollutants around the region directly correspond to the international use of pollutants such as lead, fossil fuels, and Chlorofluorocarbons (CFCs). Whether it be the documented increase in lead concentrations that fluctuated with the industrial revolution, or the growing hole in the Ozone Layer that has been a proven outcome of international CFC usage, the contamination in Antarctica is mostly a result of external works from several nations. In 1959, Antarctica was mounted as an international area dedicated to science and research. Thus, several nations including Argentina, France, Japan, the United Kingdom, and the United States signed the Antarctic Treaty. It specifically states that the continent "shall continue forever to be used exclusively for peaceful goal and shall not become the scene or object of international discord. The arrangement contains 14 articles which establish key elements essential to peaceful international coordination on the continent. Some examples include a ban on military intervention, peaceful scientific study, international information exchange from research on the continent, no territorial sovereignty, and the application of the treaty to all areas south of the 60 degree latitude line in the southern hemisphere. It created a continent that disregards sovereignty, and dedicates an area to international coordination and scientific progress.

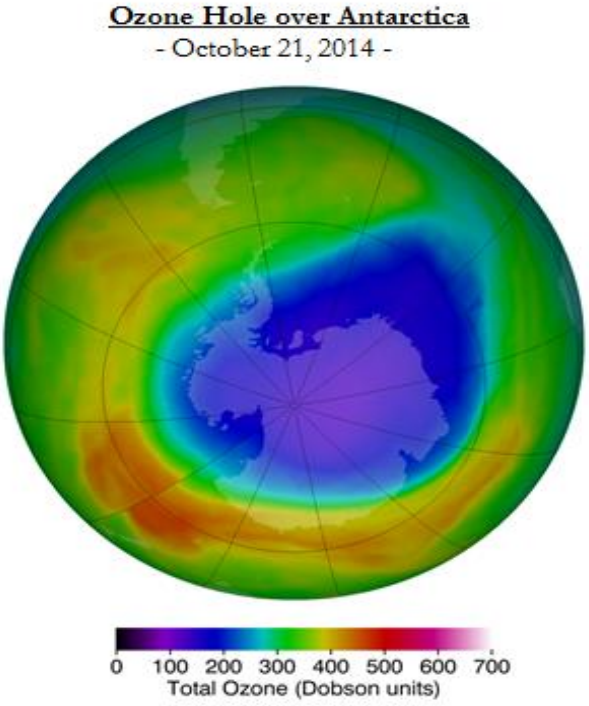
Incidentally, the Antarctic Treaty of 1959 further illustrates that Antarctic pollution observed internally is the result of external international agents. The documentation of littered oil drums, sewage, and discarded human pollutants are the result of temporary human occupation on the continent from international organizations. Thus, the internal pollution in the Antarctic region is the result of not just one nation, but those nations that are conducting research in the area. The

Protocol on Environmental Protection to the Antarctic Treaty was instated in 1991. Needless to say, the contract accompanied the Antarctic Treaty and was signed by multiple nations. The document asks the international community to cooperate in activities upheld in Antarctica such that the effects of those activities do not further degrade the continent and its environment. It states that if an activity degrades the Antarctic environment, the country responsible would be responsible for the needed clean up. The document also established the Committee for Environmental Protection to Antarctica. International cooperation and compliance is needed to sustain Antarctica. Before the 1991 Protocol on Environmental Protection, the Montreal Protocol mounted necessary international regulations that would serve to be beneficial to the Antarctic environment. CFCs and other aerosols would be limited in use internationally under the Montreal protocol in 1987. The agreement's mission was to eliminate ozone depletion through reducing the usage of substances that facilitated the ozone hole over Antarctica. Not every nation agreed to the deal, but after the implementation of the contract in 1989, CFC and other aerosol usage lessened to a great extent. In addition, the 2001 Stockholm Convention created international guidelines that would limit international usage of persistent organic pollutants (POPs). POPs are chemicals that are dispersed internationally, and pose a significant threat to human and environmental health. The Stockholm Convention provided provisions to its signatories to eliminate/prohibit the usage of POPs in any sector. Actually, the convention further went to state that each party signing the protocol agrees to search out sites of potential POPs and reduce the risk of exposure. POPs effect Antarctica to a large extent due to the global distillation process called the "grasshopper effect".

In general, there are many environmental problems such as warming up, hole in the Ozone Layer, Antarctic Oil Spill, Exacerbation from the Grasshopper Effect, lead pollution, plastic pollution, International Efforts for Antarctic Sustainability. Particularly strong warming has been noted on the Antarctic Peninsula. A study by Eric Steig published in 2009 noted for the first time that the continent-wide average surface temperature trend of Antarctica is slightly positive at >0.05 °C per decade from 1957 to 2006. Also, this research also noted that West Antarctica has warmed by more than 0.1 °C per decade in the last 50 years, and this warming is strongest in winter and spring. This is partly offset by autumn cooling in East Antarctica. Eventually, there is evidence from one study that Antarctica is warming as a result of human carbon dioxide emissions, but this remains ambiguous. Needless to say, the amount of surface warming in West Antarctica, while large, has not led to appreciable melting at the surface, and is not directly affecting the West Antarctic Ice Sheet's contribution to sea level. Instead the recent increases in glacier outflow

are believed to be due to an inflow of warm water from the deep ocean, just off the continental shelf. Likewise, the net contribution to sea level from the Antarctic Peninsula is more likely to be a direct outcome of the much greater atmospheric warming there. For example, in 2002 the Antarctic Peninsula's Larsen-B ice shelf collapsed. Between 28 February and 8 March 2008, about 570 km2 of ice from the Wilkins Ice Shelf on the southwest part of the peninsula collapsed, putting the remaining 15,000 km2 of the ice shelf at risk. The ice was being held back by a "thread" of ice about 6 km wide, prior to its collapse on 5 April 2009.According to NASA, the most widespread Antarctic surface melting of the past 30 years occurred in 2005, when an area of ice comparable in size to California briefly melted and refroze; this may have resulted from temperatures rising to as high as 5°C. A research published in Nature Geoscience in 2013 identified central West Antarctica as one of the fastest-warming regions on Earth. The scientists demonstrate a complete temperature record from Antarctica's Byrd Station and assert that it "reveals a linear increase in annual temperature between 1958 and 2010 by 2.4±1.2 °C".

In consideration, another problem is the Ozone Layer is a stratospheric layer of O_3 around the earth which has been depleted. As we know, the Ozone Layer provides the earth with protection from harmful ultra violet radiation. Unfortunately, within the past few decades, researchers have found a decreased concentration of ozone above Antarctica. The National Science Foundation in the United States gives information and background on the science behind the Ozone Layer and its depletion. Accordingly, the ozone layer is affected by small particulates such as CFCs and other aerosols. The thing is, these particulates destroy ozone during cold Antarctic winters when stratospheric clouds form, harboring small particulates, which are mostly human induced. By the way, where stratospheric ozone protects the earth from UV rays, tropospheric ozone is an agent in photochemical smog. According to information provided by the US Environmental Protection Agency, CFCs were heavily used worldwide during the 20^{th} century. CFCs could be found in refrigerants, hairsprays, and Styrofoam; they were known as a “wonder”. Until they were found to be detrimental to the Ozone Layer in the 1980s, they were frequently used. NASA is concurrently monitoring the hole in the ozone layer that has manifested. Identically, the hole has varied in size, shape, and thinness. According to the data ensured by NASA, the monitoring began in 1979 and stretches to today. The ozone hole was recorded at its lowest recorded level where it occupied an area of 1.1 million km^2. Today the hole is recorded as occupying an area of 24 million km^2. The hole is projected to continue fluctuating until air pollutant levels degrade over time.



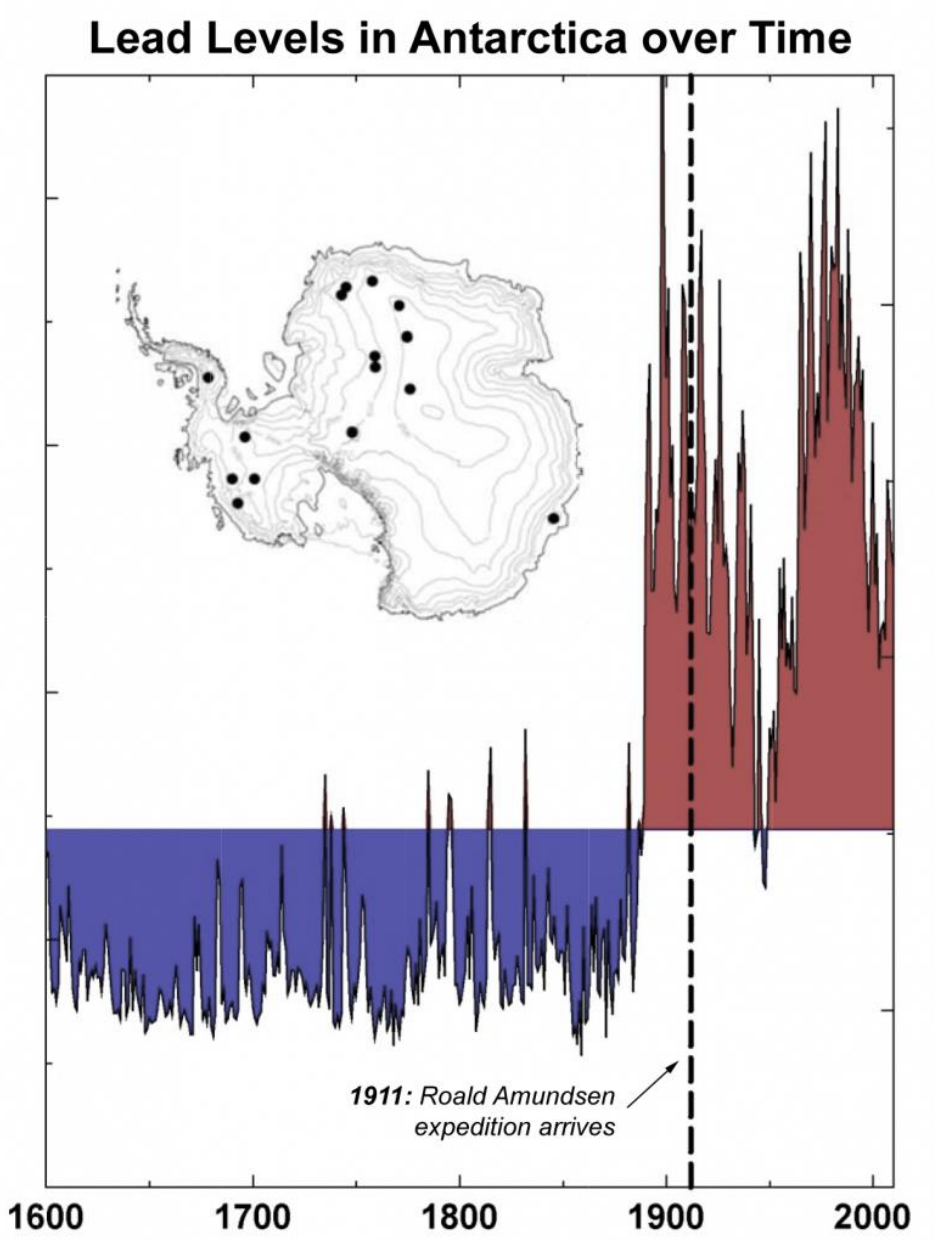
(NASA, 2014)

Currently, oil spills harm cold climates more than others because oil globules can be retained in ice for long periods of time, and at low temperatures microbes take a far longer to degrade oil. Local resources were not as readily available to address the impact of this spill either. The environmental impacts of the spill were later documented. Identically, the effects took time and varied, though seabirds were those most affected. Regrettably, following the spill, Adelie penguins were documents as losing an extra 16% of their population, Comorant chicks saw a nearly 100% mortality rate following the spill, and in years following the spill, Comorant nests lessened by 85%. These fluctuations in species populations could lead to other indirect impacts on the environment that may be more difficult to quantify. Eventually, these statistics show the effects that anthropogenic pollution may have on other species.

In fact, the "grasshopper effect" exacerbates the pollution that makes its way to Antarctica. The grasshopper effect moves pollutants, typically persistent organic pollutants (POPs), from warmer climates to colder Polar Regions. Molecules are evaporated at warmer climates, and settle back to the ground at colder climates where the molecules can condense out. Undoubtedly, this process leads to greater concentrations of POPs and other pollutants in polar climates. Although this system harms the Arctic region more than the Antarctic, the grasshopper effect still has the potential to move pollutants arising from the southern hemisphere to the Antarctic region. The POPs that make their way to Antarctica have the potential to harm the

wildlife, plant life, and humans on and around the region. POPs that make their way to Antarctica are consumed by several species, and the effects are exacerbated by bioaccumulation. This means species higher in the food chain are most exposed to these pollutants because they consume organisms lower on the food chain that may already store the POPs in their fat or tissue.

Generally speaking, lead pollution arrived to Antarctica far before any humans made it to the South Pole. Sixteen ice core samples were obtained by Antarctic researchers that contained lead. In fact, high levels of lead appeared to manifest in Antarctica around two decades before humans arrived on the continent. This time line coincides with the Industrial Revolution. According to the study ensured, 660 tons of lead made its way to Antarctica before any human laid foot on the continent. As a matter of fact, the *Sydney Morning Herald* touches on Australia's contribution to the lead pollution in Antarctica. The item provides a synopsis of the research conducted by Joe McConnel. Thus, the article continues to claim that most of the lead impurity found in Antarctica comes from Australian lead mining. The topic gives a timeline to the contamination levels claiming it started around 1900, and continued to rise with various fluctuations until it leveled off around 1990. Equally important, the article ties external anthropogenic activity with the lead concentration levels over time in Antarctica.



Unfortunately, plastic pollution is suffocating the ocean and the animals that call it home. Researchers estimate there are now more than 5.25 trillion pieces of plastic in the ocean and the number grows every day. This pollution is ravaging our marine ecosystems, entangling and choking wildlife such as seabirds, dolphins, fish and turtles. Identically, plastic never biodegrades, it only spreads and it's now polluting every part of the ocean—from beaches, reefs and deep ocean trenches to the frigid waters of the Arctic. Solving a question of this magnitude will be neither easy nor simple. However, a variety of approaches are needed to address the threat, including public education, product innovation and industry leadership. While recycling is important, less than 10 percent of plastic consumed since 1950 has actually been recycled. As recycling delays the final disposal of the material, it is ultimately useful for reducing the amount of new plastic that is produced. The

solution to the plastics crisis depends on tackling the problem at the source: We must stop consuming plastics at current rates.

In fact, several nations have implemented sustainable practices domestically, as well as within Antarctica. The United Kingdom, the United States, and Australia have not only signed the Protocol for Environmental Protection to the Antarctic Treaty, they mandate specific rules for activities within their countries as well as on Antarctica. In the first place, their efforts aim to sustain the Antarctic environment. The British Antarctic Survey (BAS) is a United Kingdom based organization dedicated to Antarctic research. To maintain the Antarctic environment, the organization provides several measures for sustainable analysis on the continent. In addition, all waste that is produced by the organization on Antarctica, except for sewage and food waste, is removed from the continent in a timely manner. The Environmental Protocol allows sewage and food waste to be discharged into the ocean surrounding Antarctica, but BAS has installed a biological waste treatment plant on the continent. BAS also incinerates the food waste as well as the sludge the treatment plant creates. The two ships the organization owns also protect the continent's environment by utilizing special waste disposal equipment. The United States' Antarctic Program, American NGOs, and tourists abide to measures within international Antarctic policies, as well as extra US policies to further sustain the continent. Moreover, the National Science Foundation requires all US organizations conducting research on Antarctica to provide a detailed analysis of the environmental impacts of the proposed research. The US reiterates the penalties for not following such measures to ensure proper study on the continent. On top of this, the US is aiming to reduce fossil fuel usage in analysis conducted on the continent. There are current projects underway that use renewable energy sources such as solar

and wind power at field camps. Australia, a continent in close proximity to Antarctica, provides extra laws for research on the continent. Although the 1959 Antarctic Treaty bans sovereignty over any part of the continent, Australia lays claim to its own territory on the continent accompanied by environmental laws. In general, the country has several acts created to protect the environment such as the Environment Protection and Biodiversity Conservation Act 1999, the Environment Protection and Biodiversity Conservation Regulations 2000, and the Protection of the Sea (Prevention of Pollution from Ships) Act 1983. On top of these regulations, the country has established the Heard Islands and McDonald Islands Marine Reserve.

In conclusion, we can say that Antarctic pollution is the outcome of human occupation on earth. Of course, the pollution currently degrading the Antarctic environment affects not just the continent, but the world as a whole. But if Antarctic ice sheets were to melt, the United States and the rest of the world would be inundated with water. Not just would coastlines be eliminated, currents would change, temperatures would fluctuate, and entire species would go extinct. Although humans should realize that anthropogenic pollution is detrimental to earth as a whole, many nations neglect their contribution to international pollution. Hopefully, as sea levels continue to rise, the world will aim to lessen the pollution that it creates. Luckily, the international community has come to recognize this fact and is promoting measures to lessen and eventually end the pollution.