Impact of Sea-Level Change In Hudson Bay on Local Animals

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Abstract. The melting of the Laurentian ice cap and subsequent foreshore collapse caused a drop in sea-level in Hudson Bay. This has had a significant impact on the local ecosystem. Strategies are urgently needed to mitigate the effects of sea-level fall and to develop strategies to help native organisms adapt to the changing environment. Potential impacts of sea-level change in Hudson Bay on coastal ecosystems include impacts on native organisms that rely on sea ice for hunting and breeding, thus causing flooding in low-lying areas, which in turn leads to habitat change and fragmentation and rapid environmental change. This range of impacts affects organisms employing K-strategy reproductive strategies as well as changes in local food chains. This paper aims to raise the public's awareness of areas affected by climate change but received little attention, and explores the impacts of sea-level fall on wildlife and possible mitigation measures using Hudson Bay as an example.

Keywords: Hudson Bay; Coastal Environment; Sea-level Change; Wildlife Preservation.

1. Introduction

Since the Anthropocene's beginning, human impact on the Earth's environment has gradually increased, even on the Earth's climate. In the context of climate change, sea-level change is a global issue. However, sea-level change has been the most discussed regarding sea-level rise, while sea-level fall is an under-discussed topic. Hudson Bay is an example of a sea-level drop. Unlike sea-level rise, which is influenced by eustatic factors, Hudson Bay's sea-level drop is generally an isostatic event. Although eustatic factors such as tides and ocean thermal expansion impact the sea-level in Hudson Bay, changes in land elevation appear to be the dominant factor. Over the last 8000 years, the elevation of Hudson bay's coastal area has risen 100-300 meters, a trend that increased after the Anthropocene. The reason for this is the melting of the Laurentide Ice Sheet. The massive Laurentide Ice Sheet initially exerted tremendous pressure on the underlying tectonic plate. This pressure squeezed the land plate southward, leading to a glacial forebulge. The Laurentide Ice Sheet gradually melted in the context of the rising local temperature in Hudson Bay. With a lower weight, the pressure Laurentide Ice Sheet applied to the tectonic plate reduced, which led to forebulge collapse. Changes in plate motion, or the modulation of the lithosphere, rearranged ocean waters, leading to the Hudson Bay sea-level drop. And in the Anthropocene, the further warming of local temperatures caused by human activity may have accelerated this process [1].

The hazards of sea-level drop are less intuitive than those of sea-level rise. However, it still has a considerable impact on the environment as well as on humans. Hudson Bay is covered by the massive Laurentide Ice Sheet, which could change the local climate. The huge ice sheet causes a delayed spring, extensive permafrost, and a slight temperature difference between the ocean and land in winter. Countless species have long been familiar with this unique climate. The drop in sea-level has led to a series of knock-on effects. First, the permafrost area is shrinking, so many local species' habitats are gradually shrinking. Also, melting the ice cap has led to a climate change that is difficult for local species to adapt to. For example, polar bears originally relied on sea ice to hunt seals in winter to gain weight and survive periods of food deprivation. But now, the reduction in sea ice has made it more difficult for polar bears to hunt, and climate change is causing periods of food abundance or scarcity to change. Although few humans live along Hudson Bay, the drop in the sea-level has also impacted the local population. Firstly, the geological activity caused by the forebulge collapse may cause harm to the local population. Secondly, most of the humans living along Hudson Bay are local Inuit. Hunting is an essential matter for them. The harm to local species caused by the sea-level drop will

make hunting difficult for local human residents. And in addition to the difficulty in obtaining food, cultural impacts are also important to consider [2].

Although the sea-level fall in Hudson Bay results from a combination of factors, this study will focus on analyzing the Impact of sea-level change in Hudson Bay on local animals. The enhanced greenhouse effect caused by greenhouse gas emissions after the Anthropocene can lead to glacial melting and intensify the process of forebay collapse. This study reveals what is happening in Hudson Bay. And these impacts brought by the sea-level change will be exacerbated if the Enhanced Greenhouse Effect is not mitigated in the future.

The sea-level fall in Hudson Bay has significantly impacted the local ecosystem. The melting of the Laurentian ice cap and subsequent foreshore collapse are the primary causes of sea-level fall. The increased greenhouse effect of the Anthropocene exacerbates this process. Sea-level fall has led to habitat change and fragmentation, changes in local food chains. Moreover, reduced sea ice made hunting more difficult for local organisms, including polar bears and seals. Several actions, including reducing greenhouse gas emissions, must be addressed to mitigate the effects of sea-level fall on Hudson Bay and other areas of the globe. Strategies are necessary to help native organisms adapt to the changing environment and protect biodiversity. This paper aims to raise awareness of the effects of sea-level fall on wildlife in Hudson Bay. This paper aims to highlight specific cases in Hudson Bay to demonstrate the significant impacts of sea-level fall on Arctic organisms and discuss possible solutions to mitigate the effects of sea-level fall on wildlife. The ultimate goal is to encourage more research and action to address the issue of sea-level drop and its impacts on biodiversity in different parts of the world.

2. Analysis

Sea-level changes can significantly impact coastal ecosystems, including habitat changes, fragmentation, competition from new competitors entering the hunt, and changes in sea ice, making hunting difficult. Sea-level changes in Hudson Bay can significantly impact coastal habitats, leading to habitat changes and fragmentation of native organisms, especially for those living in low-lying areas and permafrost. First of all, in low-lying areas, flooding due to the simultaneous melting of glaciers brought about by sea-level fall can be catastrophic for the organisms in the area. Changes in low-lying areas could also lead to habitat fragmentation for some animals with larger territories, such as polar bears. Such changes can make it more difficult for species to move and disperse, leading to a decline in genetic diversity. This reduction in biodiversity also means that local ecosystems are more vulnerable to environmental change.

At the same time, the impact of the sea-level drop represents a dramatic change in the local environment, which is not good news for the polar life living in Hudson Bay. This is because the reproductive strategies of most polar organisms make it difficult for them to adapt to the rapidly changing environment. The two types of reproductive strategies are s-strategy and k-strategy. S-strategy refers to reproductive strategies that are highly fertile, short-lived, small in size, and have low rearing costs. S-strategy is represented by rodents such as rats. K-strategy is a reproductive strategy with low fertility, long life span, large size, and high rearing cost, often adopted by higher trophic levels in the food chain. The polar regions have more limited resources, and polar organisms often need to concentrate on a period of abundant resources for concentrated reproduction [3].

Such a strategy is usually characteristic of the K-strategy, which allows species to survive in harsh environmental conditions and maintain the stability of their population size. Species like emperor penguins are known for this reproductive strategy. In Hudson Bay, creatures such as polar bears, beluga whales, and seals, for example, have adopted the K-strategy. This strategy is suitable for species to achieve a stable population in a stable environment with stable resources, but this is different now. The K-strategy is no longer appropriate for Hudson Bay because of the dramatic changes in local rings caused by the sea-level fall. In a rapidly changing environment, species need to adapt quickly and are under great stress. Since species using the K-strategy tend to have smaller

populations and slow population turnover, this represents an inability for these organisms to adapt quickly to their environment [3]. The death of these organisms due to their failure to adapt would have a catastrophic effect on the entire population.

Another critical effect of the sea-level drop is the change in the local food chain. In Hudson Bay, there are two scenarios. One is that some organisms lower in many trophic levels will be affected due to changes in local hydrological conditions. This includes habitat changes, habitat changes, population declines, etc. For example, as a baseline sentinel specie, scallops are very sensitive to changes in the living environment. Water temperature, seawater salinity, and other factors affected by sea-level drop will change the scallop's situation. Scallops are an essential food source for many Hudson Bay predators, such as seals. In other words, the sea-level fall will directly or indirectly affect all parts of the Hudson Bay food chain [4].

A more specific example is the beluga whales and capelin at Churchill River estuary, which initially gathered at Churchill River estuary in Hudson Bay during the summer migration when the sea ice melted to feed on capelin for sufficient energy and reproduction [5]. Now, however, the capelin's habits have changed. Sea-level changes due to climate change are causing the estuary to become deeper. Combined with changes in sea ice that have caused a shift in the timing and extent of capelin migration, capelin will now move farther from shore in the summer—making it more difficult for the whales to get enough energy for the breeding season, with the Churchill River estuary as an important habitat for beluga whales, such a change could devastate the local beluga population [5].

In another scenario, unlike most, the impact of sea-level drop on the local food chain would start with some organisms at the highest end of the trophic level. Here it is a top-down change. With the redistribution of local waters and the change of coastline brought about by sea-level fall, areas where far offshore predators were active, now have the potential to overlap with areas where Hudson bay's coastal predators are active. For example, sharks and tuna can directly compete with polar bears. This rare or unlikely event may become increasingly common as sea-levels drop. Such a situation leads to increased competition for food, and the consequences of top-down food chain changes are often difficult to encounter. Even minimal population changes can have dramatic effects on local ecology [6].

For local organisms in Hudson Bay, declining sea-level means more competition. At the same time, sea ice changes can significantly impact the hunting of marine mammals native to Hudson Bay. Polar bears and seals, for example, rely on sea ice for hunting and breeding.

When polar bears capture seals and other prey, they need to use the sea ice as a platform. Between hunts, they need to rest on the sea ice to recover. They also need a stable, standing platform to eat their prey. The role of sea ice is similar for creatures like seals. After feeding on invertebrates and fish, they need a platform to rest. Conserving energy in a resource-limited environment is important for creatures that survive in polar regions. For them, sea ice is an important platform for energy conservation. However, the quality of sea ice is closely related to the survival of polar organisms. As the sea ice recedes, these species may need more physical effort to hunt, which could be fatal for arctic creatures. They will also face more incredible difficulty finding food and shelter, thus reducing reproductive success and population decline [6].

A specific example is the comparison between the population trends of seals in James Bay and those in Hudson Bay, where the population of ringed seals ranged from approximately 55,000 to 106,000 from 1977 to 1992. In the next decade, between 1993 and 2003, the population of ringed seals in Hudson Bay increased to between 107,000 and 182,000. On the other hand, the James Bay population of ringed seals remained almost unchanged at about 11,000 and 19,000 [7]. Several factors are involved, but differences in sea ice quality may be a fundamental factor. Along the James Bay coast, the sea ice is "poor stable ice," while along the Hudson Bay coast, there is "good stable ice," and even a large area of "good stable ice" in the eastern part of Hudson Bay stretches to the center of the water. Regarding sea ice quality for local organisms, Hudson Bay is a more conducive habitat for survival and reproduction, and the data seem to confirm this.

Overall, sea-level fall has the potential to significantly impact Hudson Bay's coastal ecosystems and the species that depend on them. Ongoing research is needed to understand better and address these impacts. And decision-makers need to rapidly and aggressively develop policies to mitigate and adapt to the effects of sea-level fall on local organisms.

3. Suggestions

The impacts of sea-level change and climate change on native organisms in Hudson Bay are indisputable. To mitigate these impacts, decision-makers need to respond quickly. This paper makes recommendations in the following. When it comes to protecting animal populations as well as preserving local biodiversity, establishing protected areas is the first option. Establishing a suitably protected area in Hudson Bay requires considering multiple factors. The most popular terrestrial reserve strategies are 1. single large, 2. several small, and 3. wildlife corridor. Organisms known to live on coastal land in Hudson Bay often require large habitats because of the scarcity of resources and their dispersed distribution. Then, three strategies are discussed in the following [8]. This strategy can provide large amounts of habitat and protect various species. However, the disadvantage is that large reserves often require more funding and resources to establish and manage and need more risk-weighting [5]. For Hudson Bay, this approach would meet the need for larger habitat areas for local organisms. And its funding and resource needs are relatively modern drawbacks because of the local climate. However, the coastal topography could be more suitable for establishing single large reserves. And the ecology of the polar regions is inherently fragile, and a single disaster could have a devastating impact on the entire single large reserve ecosystem [9].

The second strategy, several small, is not feasible for Hudson Bay coastal organisms. Because of the scarcity of resources, some local organisms have larger habitats, such as polar bears, to obtain sufficient resources. Several small reserves are unsuitable for artic survival strategies and may even increase habitat fragmentation for local organisms [8]. A third strategy, the wildlife corridor, seems more appropriate along the Hudson Bay coast. A wildlife corridor is a narrow land strip connecting two or more protected areas. The first is topographically more suitable for the coastal area of Hudson Bay [7]. Secondly, linking several smaller reserves is an area that can accommodate the larger habitats needed by some local polar organisms or their migratory survival strategies to avoid the impact of human activities. And as mentioned above, the ecology of polar regions is inherently fragile, and one of the advantages of wildlife corridors is that they are linked by multiple small habitats, which can maintain the genetic connectivity and ecological integrity of populations while avoiding the devastating effects of a single disaster on the entire reserve [10].

Because many of the organisms living along the Hudson Bay coast participate in both terrestrial and marine environments, such as polar bears and seals, it is also necessary for marine protected areas (MPAs) to be established. Unlike protected areas on land, the strategies needed for MPAs need to be discussed in a new light. First of all, promoting sustainable fisheries in Hudson Bay is necessary. While changes in sea-level are more minor for species caught from human fishing activity, often at lower trophic levels in the food chain, as mentioned earlier, the hunting activities of predators such as polar bears or seals in the original Hudson Bay are impacted in multiple ways [4]. So the human impact on their food must be reduced to a minimum level. At the same time, to minimize conflicts between different marine uses, MPAs can be designed to include various levels of protection, such as no-take zones, seasonal exclusion zones, and habitat protection zones [7].

Out of the above adaptation or mitigation strategies, reducing carbon emissions is a solution that can solve the problem from the root. Excessive carbon emissions are the root cause of the sea-level fall in Hudson Bay [11]. This can be achieved through various measures such as increasing the use of renewable energy, improving energy efficiency, and promoting sustainable transportation and land use practices. In addition, carbon capture and storage technologies can be explored to reduce greenhouse gas emissions from large-point sources. However, even if carbon emissions return to pre-Anthropocene levels, the Hudson Bay situation will likely continue to deteriorate. One reason for this

is the permafrost melting along Hudson Bay as local temperatures rise due to the enhanced greenhouse effect. As the permafrost melts, the prehistoric carbon dioxide, which was initially trapped in the permafrost, returns to the atmosphere from the lithosphere, again exacerbating the greenhouse effect and creating a positive feedback loop [12].

4. Conclusion

Overall, the specific case of Hudson Bay provides ample evidence of the impact of sea-level fall on wildlife. Several aspects, such as habitat destruction, changes in the local food chain, and deterioration of sea ice quality, have dramatically impacted the arctic life in Hudson Bay. While natural factors are undoubtedly present, the post-human impact is of even more significant concern. Today, humans are aware of the damage their actions have caused to nature, and it is worth discussing how to repair the damage caused to nature by human errors. In Hudson Bay, several possible suggestions exist to mitigate the effects of sea-level fall on wildlife. For example, the establishment of wildlife sanctuaries and the selection of appropriate strategies for arctic life to reduce the input of resources and at the same time be able to help the local wildlife better. There are also proposals to establish marine protected areas to limit fisheries. Or to address the root cause of the problem by reducing anthropogenic carbon emissions and slowing the rate of sea-level fall. This paper aims to raise the public's awareness of areas affected by climate change but received little attention. Over the past few decades, sea-level rise has been widely discussed, while sea-level fall has not. However, organisms in Hudson Bay are equally affected by climate change in a dramatic way. Since this paper is about something other than a very popular topic, there needs to be more data available, and much of the data was collected decades ago. In the future, this study could be followed up on various aspects. First, the use of the latest local technologies can be explored. For example, collecting paleoclimate records to understand local sea-level changes and local biological populations under different conditions. In addition, pilot trials of the suggestions mentioned in the previous paragraph could be carried out to verify their feasibility. For example, observe the impact of protected areas or compare local biological populations in waters with different fisheries restrictions.

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