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The Industrial-Level Effects of Climate Change: Evidence from the Health Industry, Wheat Industry, Potatoes Industry, and Corns Industry

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Abstract. Climate change has broad and multifaceted impacts on various industrial sectors, and global and regional effects are becoming increasingly evident. This article focuses on the health, grain, wheat, and corn industries among different regions to illustrate the performances of climate change at the industry level. Rising temperatures, changing precipitation, and increasing extreme weather events disrupt agricultural productivity and pose significant challenges to the grain, wheat, and corn industries. Changes in crop yields and the geographic distribution of cropland can lead to food supply instability, higher production costs, and potential long-term economic impacts. Similarly, the healthcare industry is under increasing pressure due to the far-reaching health impacts of climate-related diseases, environmental stress, food insecurity, and malnutrition. By reviewing the latest data and industry-specific case studies, this article highlights the urgency of mitigating the adverse impacts of climate change on these industries and developing adaptation strategies to protect global economic stability and people's welfare.

Keywords: climate change, healthcare cost, insurance, moral hazard, U.S. Wheat, Canada Wheat, Russia potatoes, U.S. Corn, precipitation, temperature, heat waves, harvest area, food security

1. Introduction

Climate change significantly impacts ecosystems, public health, and even the economy. For example, the Intergovernmental Panel on Climate Change (IPCC) reports that rising temperatures will lead to more extreme weather events, affecting food security [1] and water resources [2]. Organisations such as the World Wildlife Fund (WWF) advocate for conservation and sustainable practices to mitigate these impacts. A clear example is the increase in wildfires in California; climate change has increased the profitability of the number of wildfires and has caused devastating effects on biodiversity and communities. Facing and solving climate change is ultimately essential for a sustainable future. Figure 1 shows the number of fires in California in 2023 and 2024; it is obvious that the number of wildfires increased from 5407 to 6422.

CAL FIRE TOTAL INCIDENT RESPONSES: 2024 YTD

WILDLAND FIRES	STRUCTURE FIRES	FIRE, OTHER	MEDICAL	HAZMAT	LAW ENFORCEMENT	PUBLIC SERVICE	TOTAL
6,422	3,289	39,128	323,864	10,424	3,490	56,331	448,744

CALIFORNIA TOTAL WILDLAND FIRE STATS YTD

Year-To-Date (YTD) is for current year, last year, and 5-year average, as of the "Updated" date indicated above.

INTERVAL	WILDLAND FIRES	ACRES
2024 Combined YTD (CALFIRE & US Forest Service)	6,422	996,00
2023 Combined YTD (CALFIRE & US Forest Service)	5,407	284,84
5-Year Average (same interval)	6,261	1,059,07

Figure 1. Number of California fire total incident responses in 2024 and number of California total fires in 2023 and 2024 [3]

Climate change greatly changes the way farmers farm when it comes to producing food for their communities and hence the money they bring in, specifically in regions that rely a lot on agriculture that is sensitive to climate. More than one study has been carried out to discover how increased temperatures, as well as changing precipitation patterns, are likely to affect the level of agricultural productivity. High temperatures and changing rainfall might directly impact crop yields as they affect the life cycle or other crop characteristics in the wrong manner. The impact of climate change on agriculture has exacerbated water scarcity in arid and semi-arid areas and led to an increased frequency of temperature extremes, which reduce farm productivity and, hence, the farmers' income [4].

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Moreover, the rise in the frequency of abnormal atmospheric precipitations, such as floods and droughts, hinders agricultural functioning even more and increases economic risk for farmers [5].

To ensure that these impacts do not cause undue damage, mitigation strategies like acquiring cereals that are tolerant to drought and better water management are recommended to curb the effects of climate change on agriculture [6]. Although there is a lot of literature and research on wheat markets in different countries and regions on the website, very little focuses on Canada and relates wheat to precipitation, temperature, and farmers' income. Instead of focusing on the variables of climate change and farmers' income, it can be more pure and focused on climate research. Of course, it also includes that extreme weather and natural disasters are uncontrollable and cannot be accurately predicted. Such research can better respond to and analyse Canadian agriculture's challenges by exploring climate change to predict the wheat yield in Canada.

2. Literature review

2.1. Definition, influence factor, and consequences of climate change

When Earth's temperature changes greatly and long-lastingly, mainly due to burning fossil fuels, deforestation, and industrial production, these human activities will produce climate change.

When human activities like burning fossil fuels for energy and transportation processes release greenhouse gases like carbon dioxide (CO_2) and methane (CH_4) into the atmosphere, which will increase the concentration of greenhouse gases in the air; additionally, deforestation plays a crucial role, due to the development of agriculture and urban areas, people need more spare space to do their planning, which means the environment will face more trees being cut, and it will reduce the amount of CO_2 absorption, a further exacerbating problem will exist. Industrial productions also contribute to emissions of GHGs and other pollutants. These factors create a feedback loop that intensifies climate change, making urgent action necessary to mitigate its impacts [7].

The consequences of climate risks are always far-reaching and have a significant influence on both ecosystems and our human societies. Increasing global temperature causes a higher frequency of severe extreme weather events, such as hurricanes, droughts, and heavy rainfall, which will devastate infrastructure, agriculture, and even livelihoods. And melting polar ice and seawater thermal expansion will cause sea level rise, threatening coastal communities, and millions of people will lose their homes [8]. Although many species are trying to adapt to the current changing climate, the ecosystem faces destruction, leading to biodiversity loss and changes in their homes. Climate change also poses great risks to people's health, increasing the prevalence of heat-related illnesses, vector-borne diseases, and food insecurity [9]. Finally, all these consequences state that we need to take thorough actions to slow down all the effects made by climate change.

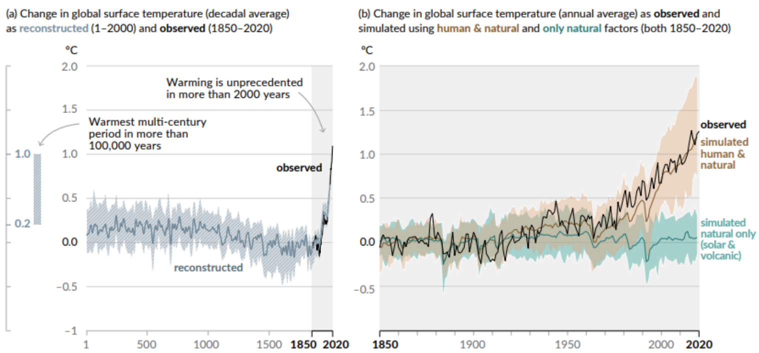

Figure 2. Global temperature rise

Figure 2 is from SPM.1, the Intergovernmental Panel on Climate Change (IPCC). Sixth Assessment Report: The Physical Science Basis. From this essay’s A.1.6, A.1.8, and A.2.2, we got the graph showing the increase in global temperatures over the past century, highlighting the sharp rise post-1970.

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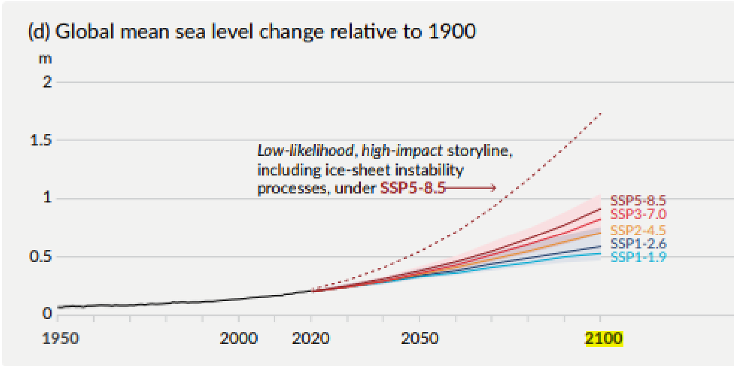

Figure 3. Sea level rise

Figure 3 from SPM.8 illustrates different scenarios for sea-level rise by 2100 based on varying emissions levels.

Table SPM.2 | Estimates of historical carbon dioxide (CO_2) emissions and remaining carbon budgets. Estimated remaining carbon budgets are calculated from the beginning of 2020 and extend until global net zero CO_2 emissions are reached. They refer to CO_2 emissions, while accounting for the global warming effect of non-CO_2 emissions. Global warming in this table refers to human-induced global surface temperature increase, which excludes the impact of natural variability on global temperatures in individual years.
{Table 3.1, 5.5.1, 5.5.2, Box 5.2, Table 5.1, Table 5.7, Table 5.8, Table TS.3}

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

Figure 4. Atmospheric CO_2 rise

Figure 4 from SPM.2 depicts the historical and projected rise in atmospheric CO_2 levels.

This article will illustrate different industries in different regions to analyze the consequences of climate risks and give more new aspects.

2.2. Health industry

Climate risks refer to the potential negative influence of climate change on the environment, societies, and economic systems. This includes physical risks (e.g., severe extreme weather events, rising sea levels, and long-term changes in climate patterns like precipitation) and transition risks (economic and policy shifts aimed at reducing carbon emissions). These risks affect global health by exacerbating health issues, such as infectious diseases, heat-related illnesses, and respiratory conditions [10].

The health economy encompasses producing, distributing, and consuming health services and goods. Climate change can impose significant burdens on health systems by increasing the frequency and severity of health conditions, straining resources, and necessitating greater spending on healthcare infrastructure, disaster response, and public health measures. Figure 5 illustrates several consequences of climate risks on health risks and health outcomes aspects.

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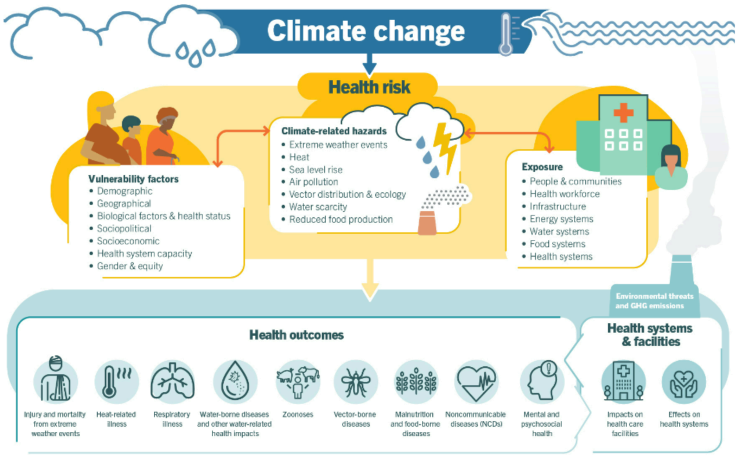

Figure 5. Health risks and health outcomes made by climate change [11]

In the context of climate risks, moral hazard arises when individuals, corporations, or governments engage in riskier behaviours because they are insulated from the consequences, often due to safety nets such as insurance, disaster relief, or publicly funded healthcare systems. For instance, if companies rely on government bailouts or insurance to cover the costs related to damages—such as floods, heatwaves, or storms—they may be less motivated to reduce their carbon emissions or invest in sustainable infrastructure [12]. Similarly, individuals with health insurance covering the costs of respiratory illnesses caused by air pollution may feel less urgent to adopt greener lifestyle practices [13]. This disconnect between the party causing the risk and the one bearing the cost leads to continued risky behaviour, perpetuating climate risks and increasing long-term societal costs [14]. Without internalising the true cost of climate impacts, moral hazard can delay crucial adaptation and mitigation efforts needed to address climate change effectively [15].

2.3. Wheat industry

A simple search reveals that wheat is one of the most important crops in the world. It is also one of the three major crops for more than 50% of global production. They are wheat, rice, and maize. Canada is not a big wheat producer but a big wheat exporter. China has a large population, so the demand for wheat is particularly large. Although China is already a large wheat producer, the supply still exceeds the demand. Canada produces enough wheat to cover domestic demand, so the surplus can be exported to China for international trade.

1. Shakoor et al. [4]: This study focuses on the results of changes in net agricultural returns, and focuses on climate change in the arid region of Rawalpindi, Pakistan, and provides some strategies to mitigate the negative impacts of climate change on agriculture, which can help policymakers and agricultural regulators to better understand the local market and how to respond.
2. Tubiello et al. [5]: This study mainly focuses on the impact of greenhouse gases on wheat agriculture and conducts a very comprehensive and complete analysis. Appropriate strategies should be formulated to mitigate the negative impact of greenhouse gases on wheat agriculture, which will make significant discoveries and help develop sustainable agriculture.
3. FAO (2021): As we all know, wheat is a crop sensitive to climate change, so the impact of climate change on wheat is significant and worthy of attention. FAO mainly comprehensively summarised the status and influence of wheat in global agriculture, which should attract great attention, and also conducted a comprehensive analysis of wheat import and export trade and food safety.

This literature analyzed the wheat industry and climate change from different perspectives, regions and focuses, the negative impacts of extreme weather, and how to deal with and solve such a global concern for strategic support and mitigation measures.

2.4. Trends and challenges in U.S. wheat production

Growing wheat is a staple of American agriculture and has long been vital to global food security. Numerous studies and data analyses, including those from FAOSTAT, have clarified variable trends in wheat production and the causes behind these changes throughout time. This review of the literature will examine the main studies and reports regarding the declining harvested area, output variability, and the potential long-term effects of these trends.

The steady decline in wheat-harvested land in the United States over the past few decades is a major problem in the literature. According to Shoemaker et al., farmers have been forced to reallocate land from wheat cultivation due to changes in agricultural subsidies, market dynamics, and the increased profitability of alternative crops. Schlenker and Roberts [16] investigate how climate-related hazards and crop insurance programs encourage farmers to reduce their wheat acreage. According to these studies, as farmers adapt to changing environmental and economic conditions, the decline in wheat acreage is anticipated to continue.

On the other hand, because of technological improvements, production levels have not decreased in tandem with the reduction in harvested area. According to USDA, improvements in precision agriculture technologies, fertilizers, and seed genetics have helped to maintain and, in some cases, increase yields per unit of land. Because of these developments, the decrease in acreage has been momentarily offset by an increase in wheat production per hectare. However, scientists like Lobell [17] warn that when environmental stressors like climate change worsen, this reliance on technology may eventually become unsustainable.

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Climate change is significantly influencing wheat production. Several studies emphasize that rising temperatures and unpredictable weather have led to increased yield unpredictability. Extreme weather events, such as droughts and floods, are increasingly responsible for yield losses, according to Tack et al. The growing frequency of these occurrences is projected to present more challenges to the stability of wheat output.

Numerous economic and agricultural papers have addressed the future ramifications of these tendencies. The FAO's global food security report warns that diminishing wheat production in key exporters such as the U.S. may impact global food costs and availability. Other academics contend that without substantial alterations in policy and agricultural practices, the risks of food insecurity may escalate nationally and internationally.

The literature highlights economic, technological, and environmental issues that have influenced U.S. wheat output in recent decades. Although technical advancements have momentarily mitigated the constraints of diminished land utilization, the escalating effects of climate change and the persistent evolution of agricultural objectives indicate that U.S. wheat production will encounter considerable hurdles ahead.

This review synthesizes multiple research and papers, highlighting the primary topics and academic viewpoints about developments in U.S. wheat output. This can be modified according to any particular publications or studies you consider.

2.5. US corn industry

The U.S. corn industry, a cornerstone of American agriculture and a critical component of the global food supply faces significant consequences due to climate change. This literature review delves into the effects of changing climate conditions on corn yield and economic stability.

Research indicates that rising temperatures and altered precipitation patterns can directly impact corn yield. According to the article [17], a 1°C increase in temperature during the growing season can lead to a 5-10% reduction in yield. This phenomenon is exacerbated by extreme weather events, such as droughts and heavy rainfall, which disrupt planting and harvesting schedules [16]. Moreover, studies suggest that traditionally suitable for corn cultivation regions may become less viable, pushing farmers to adapt their practices or abandon corn altogether.

The economic implications of these yield reductions are profound. The U.S. corn industry feeds millions and supports a vast agricultural economy, including the processing and transportation sectors. According to the USDA, corn accounted for approximately $50 billion in cash receipts in 2020, making it the largest single crop in the U.S. (USDA, 2021). A decrease in yield translates directly to reduced revenue for farmers and can ripple through the economy, affecting prices, employment, and local communities.

In addition to immediate yield impacts, climate change poses long-term risks to the corn industry’s economic sustainability. Adaptation strategies, such as shifting planting dates and adopting drought-resistant corn varieties, can mitigate some adverse effects [16]. However, these adaptations often require substantial investment in research and development, posing financial challenges for smaller farms. Furthermore, uncertainties in future climate conditions make it difficult for farmers to make informed decisions, potentially leading to increased volatility in the market [16].

In conclusion, the U.S. corn industry is at a critical juncture as climate change increasingly impacts yield and economic stability. Continued research and policy initiatives are essential to equip farmers with the tools they need to adapt to a changing climate, ensuring the resilience of this vital industry for future generations. The interplay between yield reductions, economic ramifications, and global food security underscores the urgent need for concerted action in the face of climate challenges.

3. Research design

3.1. Health industry

To prove there is evidence of moral hazard between climate risk and health economy, we need to explore the data and research that can show how moral hazard occurs.

3.1.1. Healthcare spending related to climate events

There is well-documented evidence that heatwaves, floods, and hurricanes like these disasters related to health costs are still rising. For example, a 2018 report from the Lancet Countdown on Health and Climate Change highlighted that heat-related mortality increased by 53% from 2000 to 2017. In response, health systems worldwide have had to expand emergency response and healthcare provision, leading to greater costs [18].

U.S. National Institutes of Health (NIH) reports show that healthcare spending spikes during extreme weather events. For example, the costs related to healthcare treatments following hurricanes like Katrina (2005) and Harvey (2017) exceeded billions of dollars [19]. From Figure 6, the mortality increased heavily, as we all know that Katarina 2005 brought huge damage in the USA and also more deaths. Figure 7 shows that in 2017, annual spending per person was over 5000 dollars, and the USA suffered from Harvey at that time, which was also a financial burden for them to cover.

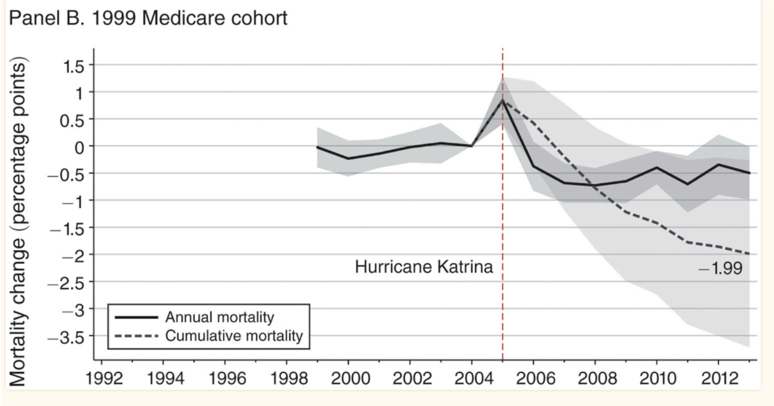

Figure 6. Mortality rate from 1992 to 2012 in the USA [20]

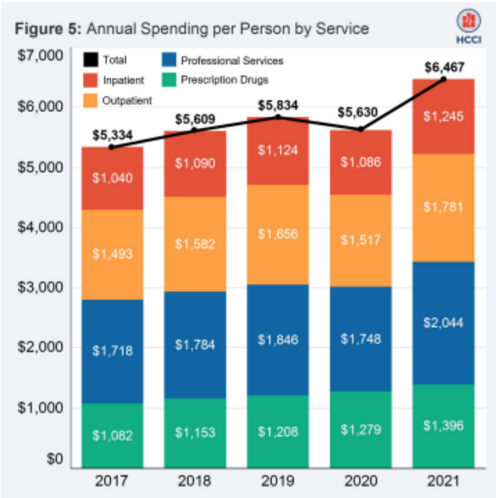

Figure 7. Annual spending per person by service [21]

When governments and health systems bear the majority of the costs of these disasters, individuals and corporations may not feel compelled to reduce climate risks (such as by cutting emissions or relocating away from high-risk areas), perpetuating the risk.

3.1.2. Insurance data on climate events

The Insurance Information Institute and reinsurance companies like Munich Re provide data showing the financial losses from climate-related events. Munich Re's 2022 report indicated that climate-related disasters caused more than $270 billion in damages globally, with only 42% of that covered by insurance [22].

Insurance companies often cover the medical costs of climate events, especially health-related claims (heat stroke, respiratory illness, etc.). For example, health claims in Europe spiked during the 2003 heatwave, when over 30,000 people died, according to the Britannica [23].

Insurance companies' extensive coverage of damages can create a moral hazard for individuals and businesses. If they know they will be covered by insurance, they may not adopt climate mitigation strategies (like green infrastructure investments), which results in continued exposure to climate risks.

3.1.3. Government subsidies and disaster relief data

Governments often provide relief and subsidies after climate disasters. For example, the U.S. government allocated $121.7 billion in disaster relief after Hurricane Katrina and the 2018 Hurricane. A study by the National Bureau of Economic Research (NBER) found that this kind of disaster relief, while critical for recovery, also has unintended consequences in encouraging rebuilding in high-risk areas [24].

Generous disaster relief programs may discourage regions from investing in resilience (such as flood defenses, heatwave shelters, or early warning systems) because they expect financial support after disasters.

3.1.4. Carbon-intensive industries and healthcare impacts

Studies from the Global Burden of Disease (GBD) show that carbon-intensive industries mainly cause air pollution, leading to millions of premature deaths worldwide each year. Despite existing health effects, some industries like coal and oil are still under government subsidies. Figure 8 represents the data for different regions' people's deaths under different reasons; for example, the number of East Asian deaths under remaining emissions is nearly 800,000. Figure 9 represents different types of global fossil subsidies. A report from the International Monetary Fund (IMF) estimates global fossil fuel subsidies at $7 trillion in 2022.

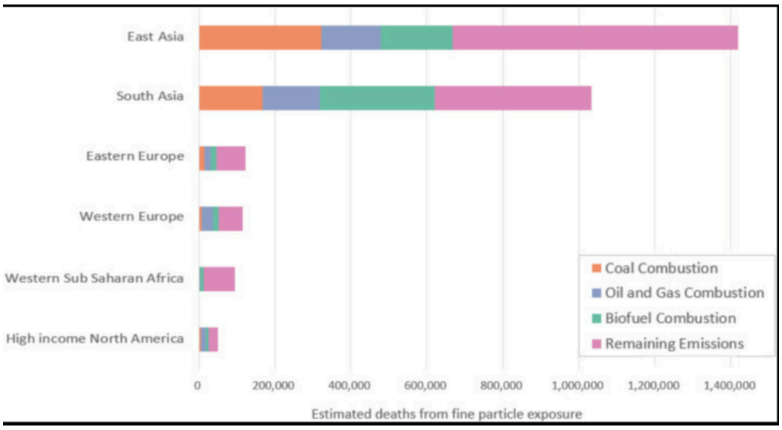

Figure 8. Estimated deaths from fine particle exposure [25]

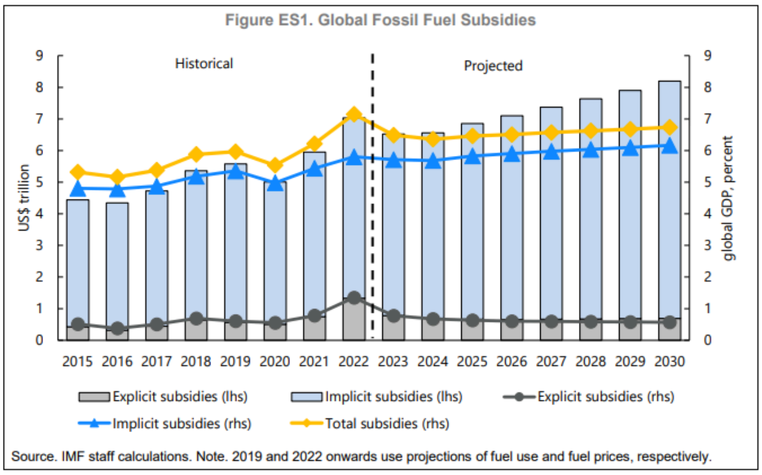

Figure 9. Global fossil fuel subsidies from 2015 to 2030 [26]

The subsidization of carbon-intensive industries creates a moral hazard by insulating these industries from the health and environmental costs they generate. Without financial penalties for pollution (such as carbon pricing), companies lack incentives to shift to cleaner practices, exacerbating health burdens linked to climate change (e.g., respiratory and cardiovascular diseases).

3.1.5. Preventive measures and healthcare expenditures

Preventive measures such as investments in climate adaptation infrastructure (e.g., green spaces to reduce urban heat, improved building codes, and renewable energy sources) can significantly reduce health burdens from climate change [27]. Studies from the European Environment Agency (EEA) show that urban areas that adopted green infrastructure saw a reduction in heat-related illnesses.

Countries that have taken proactive measures in climate mitigation and adaptation, such as the Netherlands, with its extensive flood defense systems, have seen a reduction in total expenditure costs related to climate impacts, and the healthcare costs related to it will decrease proportionally [28].

Suppose healthcare systems or governments focus mainly on treating climate-related health impacts without addressing the root causes (e.g., emissions). In that case, it perpetuates a cycle of rising costs and growing health burdens. This leads to higher healthcare expenditures, diverting funds from long-term climate adaptation strategies that could reduce the health burden in the future.

Data from healthcare spending, insurance claims, government subsidies, and studies on carbon-intensive industries provide clear evidence that moral hazard exists in the relationship between climate risk and the health economy. There is a cost externality tendency; whether through insurance, government subsidies, or reliefs, it still has disincentives for climate slow-down and adaptation. To break up this cycle, we must have more efficient strategies, to combine reducing climate risk and health consequences.

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3.2. Canada wheat

3.2.1. Data source

Table 1 illustrates the data for this study is derived from several reliable sources, covering key variables related to climate and agriculture in Canada from 2000 to 2020.

Table 1. Annual surface temperature, average precipitation, Canada wheat production, and net farm income total from 2000 to 2020

year	Annual surface temperature (degreecelsius)	Average Precipitation (Mm)	Canada Wheat Production by Year (1000MT)	Net farm income total (x1,000)
2000	-4.4	540.72	26536	2435594
2001	-3.4	537.61	20630	2673780
2002	-4.6	530.26	15961	1511642
2003	-4	543.83	23049	2775036
2004	-5.1	545.6	24796	4026406
2005	-3.5	579.59	25748	2578616
2006	-2.6	548.47	25265	251391
2007	-4.3	564.94	20090	1129856
2008	-4.4	567.25	28619	7013941
2009	-4.2	545.93	26950	2846841
2010	-2	559.58	23300	2439153
2011	-3.7	552.42	25288	6137918
2012	-3.2	541.48	27246	6654653
2013	-4.3	541.69	37589	12222417
2014	-4.4	556.75	29442	4374972
2015	-3.9	532.91	27647	6895810
2016	-3	551.06	32140	8119888
2017	-3.5	550.58	30377	7969053
2018	-4.5	532.45	32352	3960397
2019	-3.9	539.6	32670	4142259
2020	-3.8	536.14	35437	6053791

1. Temperature Data: This data is the statistics of the average temperature in Canada from 2000 to 2020. The data is authoritative and is an indispensable key factor in this study. Source: IEA Temperature in Canada, 2000-2020.

2. Precipitation Data: This data is the annual average of total precipitation in Canada from 2000 to 2020, which comprehensively summarises the changes of precipitation in Canada in these years and the fluctuations caused by extreme weather, which is very important for this research. Source: Trading Economics Precipitation Data.

3. Wheat Production: This data summarises wheat production in Canada between 2000 and 2020, which is one of the main agricultural aspects studied in this paper and is the decisive factor. Having this data allows for further investigation by regression analysis with other data. Source: Statistics Canada Wheat Production Data.

4. Net Farm Income: This data covers the net income of farmers in the wheat industry of Canada from 2000 to 2020, which greatly complements the data of economic research designed in this paper. Adding this factor makes the data more complete and the analysis more comprehensive. Source: Statistics Canada Net Farm Income Data.

This study uses these variables to analyse the relationship between climate variability (temperature and precipitation) and agricultural outputs, specifically focusing on wheat production and farmer incomes over a 20-year period.

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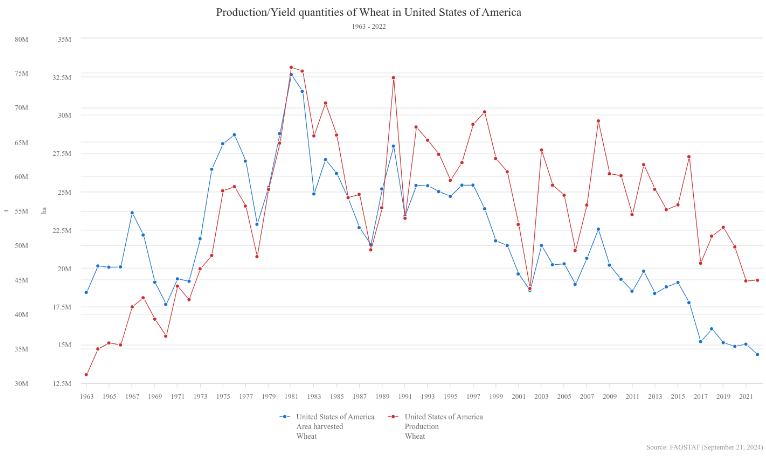

Figure 10. Production/ yield quantities of wheat in the United States of America 1063-2022

Source: https://www.fao.org/faostat

Figure 10 analysis examines the patterns in wheat output and harvested area in the United States from 1963 to 2022, as depicted in the graphic.

1. Variations in Production (red line) and Cultivated Area (blue line): Wheat production and harvested area demonstrate considerable variability, particularly in the 1970s and 1990s. Despite some coordination between the two, the extent of fluctuations is not consistently uniform.

2. Decreasing Harvested Area: Since the 2000s, the harvested area for wheat has exhibited a persistent decline. In 2022, the harvested area attained its nadir within the examined timeframe, indicating a decline in land allocated for wheat cultivation.

3. Production Consistency Notwithstanding the reduced harvested land, wheat output has remained comparatively consistent despite minor fluctuations. This may indicate progress in agricultural technology, which has resulted in increased yields per unit of land, enabling stable production despite a reduction in harvested area.

3.2.2. Possible future consequences

1. Impact on Food Security: The ongoing reduction in harvested area, despite stable production levels, may lead to a future loss in wheat output if yield improvements do not persist, hence exerting pressure on domestic food supply and worldwide wheat markets.

2. Alterations in Agricultural Composition: Land resources may be reallocating towards more lucrative or climate-resilient crops, potentially resulting in a diminished proportion of wheat within the U.S. agricultural framework.

3. Effects of Climate Change: Climate change may be a significant contributor to the diminished harvested area and production instability. In the future, severe weather occurrences may further affect the stability of wheat output.

U.S. wheat production confronts difficulties due to diminishing harvested acreage and output instability. Future dependence may be on technological advancements, climate-resilient agriculture, and modifications in global food markets to provide stability.

4. Main findings

4.1. Health cost & insurance

In the health economy, systems, and insurance companies can afford and cover the costs related to climate health impacts; the governments [29], companies, and individuals' reduction cause the climate risks action motivation will decrease. For example, if the healthcare system initially covers the costs related to air pollution of respiratory illness, other industries will face less pressure on emissions [30], as the polluter hasn't made all the consequences on human health internally [31].

Insurance companies usually cover the health impacts related to climate, like heatwaves, diseases, and injuries caused by natural disasters [32]. Suppose individuals and companies overly rely on insurance. In that case, the motivations for taking and preventing actions will decrease, like investing in infrastructure to reduce climate risk or taking more eco-friendly actions. The availability of health insurance may decrease the responsibilities of personal hard work [33], which makes the risk exist for a long time and increases the whole society's costs.

Governments will meet moral hazards when they solve climate risks. Suppose governments know that international aid or financial funds will cover disasters of climate related to health and economic impact [34]. In that case, they may prioritize the short-term economic benefits of carbon-intensive industries instead of long-term adaptation strategies [35]. This behaviour can lead to delayed or insufficient action on climate change, exacerbating health and economic costs in the future.

In some cases, healthcare spending might increase due to climate impacts [36], creating a short-term solution to the immediate health crisis without addressing the underlying climate risks. This reactive approach may signal moral hazard, as resources are funnelled into treating symptoms (health problems) rather than preventing the root cause (climate change). Such behaviour can perpetuate a cycle where health costs and climate risks continue to rise.

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A small exact example among these analyses, according to the National Weather Service, heat-related deaths are the main reason for weather-related deaths in the U.S. Over the past decade, an average of 702 heat-related deaths occurred annually. This number is expected to rise as temperatures increase due to climate change. Then, the US government has to pay more on government spending like healthcare costs of doctors, hospitals, and patients. Many costs of infrastructure, and there is also a need to care about all the other audiences' frankness, like all these steps the government has to do. We cannot predict whether it is good or bad. We can only support the government and protect ourselves. The policymakers will have more experience and do more preparation for all of us.

4.2. Canada wheat

The wheat industry is highly sensitive to climate variability, particularly changes in temperature and precipitation. Based on the regression model used in this study, the findings support the hypothesis that rising temperatures negatively impact wheat yields, reducing farmers' incomes. The temperature coefficient in the model was -31.94, indicating that for every 1°C increase in temperature, wheat production decreases by approximately 31.94 thousand metric tons. Due to the limited data and the small sample size, this result is not significant. The result shows that high temperature has a negative impact on wheat yield. High temperatures will reduce wheat yield and accelerate water evaporation, thus affecting wheat yield.

Temperature also affects farmers' income. Regression analysis shows that the temperature coefficient of farmers' net income is -184749.81, which indicates that for every 1℃ increase in temperature, farmers' net income decreases by about 184749.81 CAD. This is a high value and proves that temperature also has a very significant effect on farmer income. It can be seen that how much farmers' income depends on the climate, especially in extreme weather; it is easy to directly reduce the profits for the whole year, which is undoubtedly devastating for farmers, so we should timely analyze and formulate coping strategies and mitigation measures.

The impact of climate change on the wheat industry is profound. First of all, wheat is a highly temperature-sensitive crop. If production declines this year, it may lead to higher prices, but it will reduce total profits, and neither farmers nor consumers are willing to see such a situation. In addition, such a situation needs to be dealt with in time and cannot be sustained, which will have a devastating impact on the entire agricultural economy of Canada. As Canada is a large wheat exporter, this will also greatly blow the global trade of wheat in Canada. Therefore, it is necessary to focus on the wheat agricultural market.

4.3. Russian potatoes

4.3.1. Impact of climate change on Russian agriculture

4.3.1.1. Rising temperatures

The agricultural landscape of Russia is changing as global temperatures rise. The northern regions are gradually becoming more suitable for crop cultivation due to the warming climate, which is leading to a longer growing season. But the negative impact of this temperature rise on the traditional agricultural regions in the south cannot be ignored, with extreme weather events such as droughts and heat waves occurring frequently, directly threatening crop yields. For example, climate change-induced fluctuations in production are particularly evident in Russian cereal production data, where total cereal production peaked at 130.94 Mt in 2017, compared to just 117.42 Mt in 2016 got from figure 11.

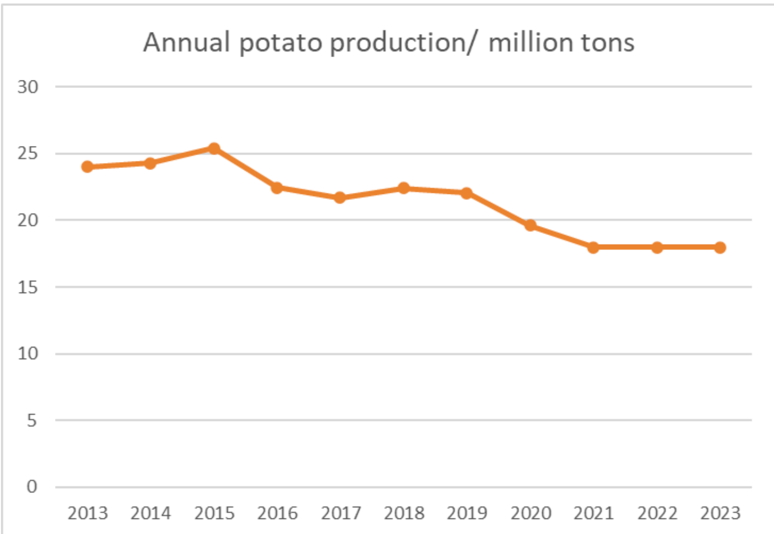

Figure 11. Annual potato production [37]

4.3.1.2. Soil degradation

Prolonged droughts and extreme climatic conditions have led to a loss of soil fertility in some areas, which is more pronounced in the steppe and semi-arid regions. Climate change has accelerated the process of soil erosion and desertification, making the sustainability of agriculture in these areas a serious challenge. Overuse and climatic deterioration of land in some of the main crop-producing regions in the south are making it increasingly difficult to sustain high yields, directly affecting the long-term development of Russian agriculture.

4.3.2. Economic impacts of climate change on agriculture

4.3.2.1. Direct costs of poor harvests and reduced food supply

At the economic level, the direct costs of climate change are reflected in crop failures and reduced food supply. Cereals, a core part of Russian agriculture, have experienced significant fluctuations in production due to climate instability. For example, from 2013 to 2017, Russian cereal production increased from 90.09 Mt to 130.94 Mt. However, this increase hides significant climatic stresses, with extreme weather events causing significantly lower than average yields in some years. In potato production, there was a significant decline from 24.02 Mt in 2013 to 21.71 Mt in 2017 shown in figure 12, demonstrating the multifaceted impact of climate change on agricultural production.

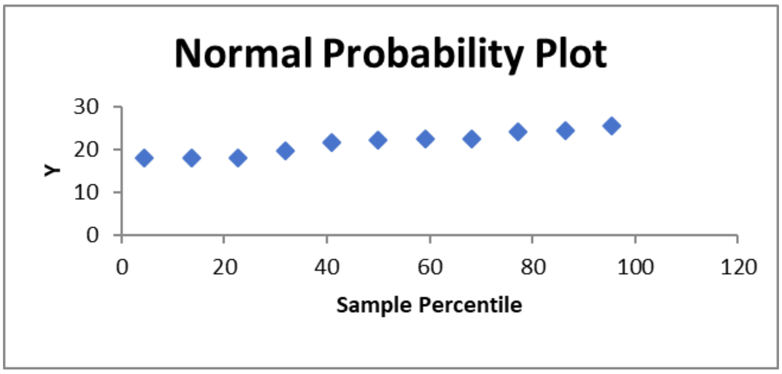

Figure 12. Normal probability plot [38]

4.3.2.2. Cereal production volatility affects Russia's position as a global grain exporter

Fluctuations in grain yields lead to export instability, affecting Russia's competitiveness in the global grain market. As climatic conditions become more unpredictable, Russia faces the risk of reduced grain supply and export capacity. If extreme weather events become frequent in the future, Russia may not be able to maintain its current level of global grain exports. This would not only have a direct impact on the Russian economy but could also trigger volatility in international grain markets.

4.3.3. Solutions and coping strategies

4.3.3.1. Developing drought-resistant crop varieties

Drought-resistant crops can effectively reduce agriculture's dependence on water resources while improving crop yield stability in response to frequent droughts. With the continuous advancement of agricultural technology, Russia is gradually promoting heat—and drought-resistant crop varieties to cope with the increasingly severe challenges of climate change.

4.3.3.2. Policy introduction of regulations and policies to promote sustainable agriculture

The government has begun to introduce regulations and policies to promote sustainable agriculture, with the aim of legally protecting farmland from soil degradation and guiding farmers to adopt more environmentally friendly agricultural technologies and management practices. Government financial subsidies also support farmers in implementing climate-resilient agricultural practices, helping to make the sector more resilient in the face of climate change.

4.4. US corn industry

4.4.1. Definition of US corn industry

The U.S. corn industry occupies a central role in the structure of the agricultural economy of the United States. Corn is cultivated in many of the geographical belt, including the Midwest (often called the "Corn Belt") with states such as Iowa, Illinois, Nebraska, and Indiana. The crop is, in turn, processed mostly into three areas:

Animal Feed: The United States produces the most feed for livestock, including cattle, hogs, and poultry. In this context, feed is especially crucial for the meat and dairy industries, further highlighting corn's importance in food processing.

Ethanol Production: Corn is one of the major U.S. crops that are modified for ethanol, which contributes to the generation of renewable energy and influences domestic fuel markets and agricultural policies.

Exports: The U.S. has been a major producer of corn and supplies its worldwide markets, using it in food production, feed, and industrial applications.

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Considering the size and importance of the industry, Fluctuations in U.S. corn production can have a major influence on domestic and foreign markets. Nevertheless, the entire sector is highly integrated with the environmental dimension, particularly climate, making it vulnerable. No less serious than many others, the challenge of climate change for the industry's future lies in the center. Higher temperatures, modified precipitation trends, and increased frequency of extreme weather conditions are predicted to affect corn production levels and related profits greatly. It will be not only the US, but also the whole food and fuel markets worldwide that will face the consequences of the invisible outcomes. Over the past years, climate change has increasingly attracted the attention of the U.S. agricultural sector. Among all crops, including corn production, new environmental risks such as temperature, precipitation patterns, and more frequent droughts and floods have direct and great impacts on yields, economic returns, and the future sustainability of this vital sector.

4.4.2. Methodology

The prepared data for the study is low dated corn production and climate projections. This can be achieved by looking at the history of corn production over the last few decades and analyzing it with historical climate data to form an informed conclusion regarding the relationship between environmental conditions and agricultural output. The economic models can be developed further to calculate the change in corn yield with climate change; this can be done by considering various scenarios with different levels of global temperature rise.

4.4.2.1. Yields reductions consequences of climate changes

Climate change impacts a multitude of areas of the U.S. corn industry, for instance, yields, production expenses, and market fluctuations. These factors also affect the crop quality and the productivity of the agricultural land as well.

Temperature: The additional heating of the planet during the polling and grain filling stages threatens corn yield as it can produce a significant loss of crop at those points. Corn production suffers from heat stress due to hot temperatures, particularly when it is compounded with drought conditions. Elevated temperatures result in a loss of crops and a rise in prices, which simultaneously complicates the corn market. Research shows that for every 1 degree Celsius temperature rise, corn production is expected to decrease by 6-10% [39].

Precipitation: Farming corn involves a lot of reliance on routine and sufficient water. Droughts, rapidly becoming a part of our lives because of climatic conditions, present a major problem for corn production. In 1983, the United States saw the worst drought in a century, and production levels that year were only half of the previous year's amount. Water scarcity causes crops to fail, which results in low yields, leading to high irrigation costs for the farmers. However, in addition, too much rainy weather and floods have the same effects on crop yields, especially during sowing and reproductive stages when the crops are just planted or too young.

Extreme Weather Events: The increasing frequency of extreme weather events like storms, hurricanes, and heat waves is compounding the problems faced by the corn industry. These events can result in crop destruction, delays in the planting and harvesting process, and soil erosion. Such consequences further reduce crop yields and hike production costs. Additionally, the impact of extreme weather may also disrupt the supply chain, which may affect the availability of corn for domestic use and export.

4.4.2.2. Economic consequences of climate changes

Not only does the U.S. corn industry feel the effect of declining yields, but the result is far-reaching to the economy. These include:

Increased Production Costs: Should farmers respond to the changing weather patterns, it may increase production costs. Finances in terms of irrigation systems, climate-resilient varieties, and advanced farming technologies that are expected to combat climate change undoubtedly build up early-stage costs. Moreover, in pastoral farming, the use of fertilizers and pesticides is likely to increase due to the challenges associated with climate-induced pest and disease outbreaks.

Market Volatility: Climate variability will cause lower and less secure yields for corn, consequently raising the risk of more volatile corn prices. This may jeopardize everyone's business and cause doubts in consumers. Though some farmers selling at high prices may make a decent profit at times, the whole industry would suffer from economic instability in the long run.

Global Trade and Food Security: As one of the largest exporters of corn, any decline in U.S. corn production may upend food markets around the globe. Countries heavily dependent on U.S. corn are expected to have shortages or price hikes, which will lead to food insecurity. Moreover, a shortage of U.S. exports might become a chance for other corn-producing countries, which would, therefore, result in changes to the global food industry.

5. Conclusion

This study explores the impact of climate change, specifically on the Health Industry, Canadian wheat industry, US Wheat industry, Russian potatoes, and US corn industry. By analysing many different industries with different approaches, we found many different results. We are here to combine all these consequences together to observe the interesting impact of climate risks and to have more expectations to solve and protect our environment. For the health industry, we have found a lot of data related to the healthcare costs and insurance costs related to government actions, while we still need to observe more on human well-being. For the part of agriculture, although statistical significance wasn't fully achieved, the results are consistent with broader research on climate impacts. The study emphasises the need for adaptive strategies, such as improving water management and introducing climate-resilient crops, to safeguard the wheat industry against worsening climate conditions. We will still focus on any data related to the industries and keep a positive attitude to face all the climate risks that we will have. At that time, we will have full preparation based on our work.

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