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A survey on the effect of global warming in Canada

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A B S T R A C T

During the past four decades, there have been tremendous changes on earth due to climate change. Humankind has increasingly used fossil fuels such as coal, oil, etc. and increased the green gas effect on this planet. Nowadays, most scientists believe there must be some actions to prevent global warming to rescue the next generation from the irreversible consequences of climate change. This paper studies the recent studies on the effects of global warming in Canada. The study reviews the recent efforts on the effects of global warming on forests, lakes, etc.

1. Introduction

Global warming has become a critical issue among scientists these days. According to NASA's Goddard Institute for Space Studies (GISS), the earth's mean temperature has been upped by about 1.1° Celsius since 1880. Most of the warming has appeared during the past 50 years, at a rate of approximately 0.15 to 0.20°C per decade. It is important to understand the effect of temperature increase on our planet (Marquis et al., 2022). In fact, a one-degree change in temperature globally means it takes a significant amount of heat to warm all the existing oceans, the atmosphere, and the land masses by that much. A massive climate change can cause different catastrophic incidents such as severe thunderstorms, floods, etc. Many regions in the world would be expected to go under water if this trend continues. Many wild animals will disappear from the habitants and the world will face a new ecosystem which would not be desirable for human beings.

During the past two decades, there have been some efforts to reduce the burden of global warming. Canada has committed to lower its greenhouse gas emissions to 30% below 2005 levels by 2030 (Jacob, 2021). However, it is still unclear on how the country could possibly manage to reach its Paris target. According to Pekkarinen (2020), Canada is responsible for only 1.6% of total global warming, however, many argue countries like the United States or China must play the major role on reducing global warming since they are responsible for the most important portion of gas emission. Nevertheless, to fight climate change everyone must feel responsible in making meaningful change, regardless of the scale of the contribution.

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2. The effect of global warming on Sea-level

Walker et al. (2022) performed a survey on Sea-level in Canada. They indicated that Sea-level rise would be an important indicator of broader climate changes, and the time schedule could be considered to determine when modern rates of sea-level rise emerged above background variability. They explained that globally, it is quite possible that rates of sea-level could rise emerged above pre-industrial rates by 1863 CE (P = 0.9; range of 1825 [P = 0.66] to 1873 CE [P = 0.95]), which is almost the same in timing to evidence for early ocean warming and glacier melt (Walker et al., 2022). The time of emergence in the North Atlantic in their survey disclosed a distinct spatial pattern, happening earliest in the mid-Atlantic region (1872–1894 CE) and later in Canada and Europe (1930–1964 CE) (Walker et al., 2022). Regional and local sea-level changes happening over various time periods drive the spatial pattern in emergence, recommending regional processes underlie centennial-timescale sea-level variability over the Common Era (Walker et al., 2022).

3. Weather whiplash

Many people have demonstrated an increasing interest in quickly changing weather, colloquially termed “weather whiplash” events. Lee (2022) investigated the variability of trends in seasonally standardized short-term temperature ranges in the world. He measured trends for three various “range windows”: 7-day ranges, 1-day departure, and diurnal (24-hr) temperature ranges. The study demonstrated that globally, over the 70-year period of record 7- and 1-day ranges were increasing significantly in all seasons, while diurnal trends were only decreasing substantially only in boreal autumn. Since 1985, nevertheless, ranges at all three-time windows increased substantially (Lee, 2022). The most widespread changes were happening as substantial increases in these ranges in the Southern Ocean, Africa, and South America and in regions of coastal upwelling. Significant decreases in these ranges are noted mostly at the Arctic Ocean confluence with the Pacific and Atlantic Oceans, especially in the Greenland, Iceland, and Norwegian Seas, and more recently, in northeastern Canada.

4. Renewable energies

There is no doubt that alternative energies such as sun farms, wind resources, thermos, etc. may play essential roles as replacement alternatives for traditional fuel energies such as oil and gas (Alzamil & Hamed, 2019). In fact, the high-resolution regional climate model could be considered as an alternative tool for forecasting wind power changes. Ma et al. (2022) implemented a pair of 4-km convection-permitting Weather Research Forecasting (WRF) simulations over southern Canada to investigate the wind energy. Ma et al. (2022) report that the wind energy potential over different areas of Canada may decrease, while the changes over present wind farms, placed in efficient locations, could be less significant.

According to Panda and Nayak (2022), global warming, which is the most important issue, causes severe environmental consequences like increase in temperature and declining water supplies. The implementation of renewable energy (RE) or related technologies is a good countermeasure to global warming. Hence, Panda and Nayak (2022) in a study considered optimal capacities of solar based Distributed Generation (DG) to acknowledge the transmission network's N-1 contingency scenario. They presented a multi-objective framework utilizing the Grey Wolf Optimizer (GWO) to reach the exact size of solar DG by minimizing the costs, voltage deviations and power losses of the network concurrently. Their results emphasized the significance of their method in terms of expenses, voltages and losses. Heydari et al. (2019) also studied the effects of the renewable energy’s generation and carbon dioxide emission forecasting in microgrids and national grids using GRNN-GWO methodology.

According to Çakmak and Acar (2022), despite the known effects of fossil fuel consumption, oil-producing countries are reluctant to use renewable energy sources because of financial concerns, which could increase the effects of global warming. Çakmak and Acar (2022) studies the relationship between economic growth, renewable energy consumption, and ecological footprint in the oil-producing USA, Russia, Saudi Arabia, Canada, China, Brazil, Kuwait, and Nigeria for 1999–2017 by applying a dynamic panel data analysis and panel causality analysis. They aimed to show the oil-producing countries' growing ecological footprint/environmental contamination and the effect on global warming by analyzing how economic growth and renewable energy consumption could influence the ecological footprint in oil production countries. They reported a substantial effect of economic growth on ecological footprint, endorsing the Pollution Haven Hypothesis and no significant impact of renewable energy consumption on ecological footprint. In their study, they showed that a 1% increase in economic growth could increase the ecological footprint by 0.02828%.

Demirezen and Fung (2021) performed an investigation on using different sources of energies in the city of Toronto, Canada using some tests conducted at the Toronto and Region Conservation Authority's (TRCA) Archetype Sustainable Houses. A hybrid residential space heating system with a supervisory controller was considered to study its performance and effectiveness for the heating season. A high efficiency natural gas furnace (NGF) and an electric air source heat pump (ASHP) were coupled together to reach the space heating demand of the house in the survey. The integrated cloud based Smart Dual Fuel Switching System (SDFSS) considered time-of-use (TOU) pricing, fuel cost, short-term weather forecast, and equipment efficiencies and capacities. This multi-variable decision-making process defined an optimal schedule for the hybrid system to run more cost effectively. The SDFSS systems demonstrated lower operating expenses with respect to the furnace or the ASHP system alone with various carbon tax (CT) levels from $0 to $250/tone of CT with an increment of $10/tone

of CT simulated, along with a substantial GHG emission reduction relative to the conventional heating systems. They claimed, with these technologies, Canada's residential sector could potentially meet Canada's Paris Agreement goals.

Farjana et al. (2020) emphasized on the importance to increase renewable energy usage in the industrial, residential, and commercial to reduce the effects of fossil fuels effects. They concentrated on the modelling and optimization of solar industrial process heating systems using a flat plate collector and evacuated tube collector integrated into lead mining processes for 7 different lead miner countries of the world: Australia, Canada, Indonesia, China, Peru, Russia, USA. Comparative analysis among seven miner countries was performed by investigating different cases based on solar industrial process heating system design. To study the reduction potential of environmental burdens, life cycle assessment of lead mining process was carried out based on the global average dataset. They reported that environmental effects could be substantially reduced in global warming, human toxicity, and fossil fuel scarcity through the solar process heat integration. According to Farjana et al. (2020), the evacuated-tube collector based solar process heating system with solar loop heat exchanger could have the highest efficiency and solar fraction and any increase in the number of solar collector installations could possibly yield a higher solar fraction and capital cost.

According to Haine and Blumberga (2020), advanced urban planning is encountering severe troubles because of the fast increase in the population, which leads to having some fast strategies to meet their energy needs. Since the 1980s, in a context marked by increasing development in energy expenditure and global warming. They have steadily mobilized to better control their energies and reduce the environmental footprint. Haine and Blumberga (2020) tried to learn more about the effects of modern urban strategy on the application of solar urban planning. The study showed the important role of solar electricity integration used in detecting the urban solar potential in four studied regions located on three different continents: Africa, Europe and North America, in the cities of Ibenbadis (Constantine, Algeria), Saint-Hugues (Quebec, Canada), Saint-Malo (France) and Ambolobozobe (Madagascar). The results showed the effects of reducing carbon dioxide as well as a comparison of solar energy costs on three continents.

5. Human health and ecosystem impacts

Global warming mitigation strategies are believed to significantly influence human health and biodiversity through diverse cause-effect actions. Fernández Astudillo et al. (2019) analyzed these impacts by applying a methodology to link TIMES energy models with life cycle assessment. They applied a cutoff to determine the most relevant processes. These processes had their own efficiencies, fuel mixes, and emission factors updated to be consistent with the TIMES model. The method was implemented to evaluate the potential impacts of deploying low-carbon technologies to make a reduction on combustion emissions in the province of Quebec (Canada). In the case of Quebec, the reduction of combustion emissions was obtained through electrification of energy services. Global warming mitigation efforts are reported to be able to reduce the effects on human health and ecosystem quality, primarily due to lower global warming, water scarcity, and metal contamination impacts.

6. Summary

There is no doubt that the current trend of global warming may have irreversible effects on our planet and there must be some action plans to reduce the green gas effects. Our survey indicates that countries like the United States and China are responsible for most of the green gas emissions. Canada as part of G-7 countries is also committed to reduce the green gas effects within the next few decades and brings it to zero level. Nevertheless, any attempts to reduce the green gas effect may cause severe costs and this may be the most important factor for not reaching the zero-level green gas effect by 2050. Within the next few years, our planet will face more severe climate change and the new generation may face more natural disasters such as floods, shortage of clean water, etc. We hope this paper could bring more awareness for the Canadian society to place more efforts and commitment for a better future.

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