The Effect of Regional Temperature on Stunting

Abstract

Global warming has a negative impact on various aspects, including on community nutrition. Indirectly, the impact of extreme hot weather causes food crops to grow well in an area, and will eventually cause a food crisis. This will be worse when stunting occurs in toddlers. Toddlers are a group of people who are the country's hope to be able to build the country in the future. This study uses SDGs indicator data related to stunting and global warming in the country. This study uses the ordinary least square (OLS) method in the same year or periodically. This study shows that global warming has a negative impact on stunting rates. The participation of all countries is needed to prevent more severe global warming, through pro-environmental actions. In addition, world institutions related to food and climate need to mitigate areas that are vulnerable to extreme weather, which will result in a food crisis, especially stunting in toddlers.

Keywords: Temperature, Stunting, Climate Change.

1. Introduction

The era of globalization has caused changes in various dimensions of life, especially regarding temperature (Abbass et al., 2022; Zhang et al., 2022). Increasingly intensive human activities on a global scale, such as industrialization, urbanization, and deforestation, have significantly increased greenhouse gas emissions. This accelerates climate change and causes an increase in the average global temperature. The impacts are felt directly in ecosystems, such as melting polar ice, rising sea levels, and changes in extreme weather patterns. In addition, increasing temperatures also affect agricultural productivity, clean water availability, and human health, especially in areas vulnerable to climate change (Gampe et al., 2021; Moore et al., 2021; Schwaab et al., 2021).

In social and cultural aspects, temperature changes affect the way of life of people in various regions (Etana et al., 2021; Krupocin & Krupocin, 2020; Thiemann et al., 2022). Communities that depend on certain climate patterns, such as farmers and fishermen, must adapt to unpredictable conditions. Changes in planting seasons, reduced harvests, or migration of fish species to cooler waters force communities to find new strategies to survive.

In the political and economic spheres, issues related to temperature are of concern in international agreements such as the Paris Agreement, which aims to limit the increase in global temperatures to below 2 degrees Celsius (Keen, 2022; Malhi et al., 2021; Stern et al., 2022). Countries are working to reduce carbon emissions through renewable energy policies, energy efficiency, and reduced deforestation. However, major challenges remain, especially for developing countries that face a dilemma between economic growth and environmental sustainability.

Global economic activity has changed significantly over the past 20 years, and this has also triggered global climate change. Accelerated industrialization, urbanization, and globalization of trade have massively increased the consumption of fossil-based energy. Greenhouse gas emissions from transportation, manufacturing, and power generation continue to increase, exacerbating the effects of global warming. In addition, the expansion of the agribusiness sector to meet global food and commodity needs often involves massive deforestation, which reduces the ability of forests to absorb carbon dioxide. As a result, climate change is accelerating, with impacts felt around the world.

Economic activities often have negative effects on the condition of natural resources, such as crop failure due to extreme weather (Ahmad et al., 2020; Muhammad et al., 2021; Usman et al., 2022). Massive land exploitation to meet the needs of global agribusiness often ignores the principles of sustainability. The use of chemical fertilizers and pesticides on a large scale can damage soil quality and reduce the carrying capacity of ecosystems, making plants more vulnerable to climate change. Extreme weather, such as floods, droughts, or storms, is becoming more frequent due to global warming triggered by human activities. This condition not only threatens local food security but also disrupts the stability of the global market, which is highly dependent on harvests from key regions.

The impact of economic activity on natural resources is also seen in the loss of biodiversity which plays an important role in supporting agricultural systems (Chopra et al., 2022; Kremsa, 2021; Suchkov et al., 2021). For example, deforestation for agricultural purposes results in the loss of habitat for species that help maintain ecosystem balance, such as natural pollinators. In addition, water pollution from industrial and agricultural waste reduces the quality of water resources needed for irrigation. All of these factors affect crop productivity, increasing the risk of crop failure. For small farmers, these losses often mean the loss of livelihoods, while for the wider community, the impact is felt through increased food prices and the threat of starvation.

One of the impacts of extreme weather is global warming. Global warming can trigger crop failures, where crop failures will cause food insecurity, and can cause stunting. (Hadley et al., 2023; Jolaoso, 2023; Liaqat et al., 2024). Climate change caused by global warming, such as rising temperatures, prolonged droughts, or floods due to extreme rainfall, often disrupts the agricultural cycle. Crops that require specific climate conditions to grow and develop become vulnerable to environmental stress. This results in drastically reduced yields, both in quantity and quality. When food production is disrupted, food supplies in the market become insufficient, leading to increased prices and limited access for people, especially in vulnerable areas, to nutritious food (Khan et al., 2022; Mardones et al., 2020; Savary et al., 2020).

Food insecurity arising from crop failure has a direct impact on the nutritional status of the community, especially vulnerable groups such as children and pregnant women (Algur et al., 2021; Chaudhuri et al., 2021; Piperata & Dufour, 2021). When access to nutritious food is limited, the risk of malnutrition increases, and in the long term, this can lead to stunting in children. Stunting not only hinders physical growth but also cognitive development, thus affecting an individual's future learning ability and productivity. In developing countries, where dependence on subsistence agriculture is high, the impact of global warming on crop yields poses a serious threat to the sustainability of future generations.

There has been much research that reviews the effect of temperature on food production, especially in the context of climate change which affects the yields of major crops such as rice, wheat, and corn (Farooq et al., 2023; Neupane et al., 2022; Rezaei et al., 2023). These studies show that rising global average temperatures can reduce crop productivity due to heat stress, changes in rainfall patterns, and increased attacks by pests and plant diseases. However, there are still limited studies that specifically examine the impact of temperature changes on global stunting rates, even though the two are closely related. Temperature changes that cause reduced crop yields often trigger food insecurity, which leads to less access to nutritious food for communities. In the long term, this can increase the risk of stunting, especially in areas vulnerable to climate change. Given that stunting impacts the quality of human resources in the future, more in-depth and focused studies on this relationship are essential to support effective evidence-based policymaking in addressing global challenges.

2. Data and Methodology

This study uses SDG indicators related to goal 2.2.1, namely the prevalence of stunting in children under the age of five, whose data is taken from the United Nations Statistics Division. This indicator was chosen because of its relevance in describing the nutritional conditions of the community, which is one of the significant impacts of food insecurity. Furthermore, world temperature data was obtained from the World Meteorological Organization (WMO), which provides comprehensive data on global temperature changes over time. These two data sources are integrated to identify the relationship between world temperature changes and stunting levels, thus providing a deeper picture of the impact of climate change on global health.

To analyze the relationship between global temperature and stunting rates, this study used the ordinary least square (OLS) method. This method was chosen because of its ability to measure the influence of independent variables on dependent variables linearly, while providing efficient and unbiased estimates (Craven & Islam, 2011; Dempster et al., 1977). With this regression model, the study attempts to explain the extent to which rising global temperatures can affect the prevalence of stunting in various countries. The analysis was conducted by considering control variables such as per capita income, urbanization rate, and access to health services, to ensure that the results obtained reflect the true relationship between temperature and stunting.

The results of this analysis are expected to provide new insights into the implications of climate change on global health and nutrition, especially for children. These findings are not only relevant for academic research but also have practical implications for policymakers in designing climate change mitigation and adaptation strategies. For example, if a significant relationship between temperature and stunting is identified, efforts to improve food security, nutrition intervention programs, and carbon emission control can be prioritized in addressing the multidimensional impacts of climate change. Thus, this research can contribute to supporting efforts to achieve sustainable development goals (SDGs), especially in terms of ending hunger and improving the health of children around the world.

3. Results and Discussion

Based on the results of the calculations carried out in this study, it is known that the increase in temperature has a positive effect on the level of stunting. These results indicate that any increase in global temperature can contribute to the increasing prevalence of stunting in children under the age of five. Climate change hurts food production, leading to food insecurity and malnutrition. This condition will result in stunting.

Rising temperatures caused by global warming worsen food security, especially in developing countries that rely heavily on agriculture to meet their food needs. Higher temperatures can reduce agricultural yields, increase the frequency of natural disasters such as droughts or floods, and worsen the quality of water used for crop irrigation. When food production is disrupted, affected families struggle to access the nutritious food their children need to grow. As a result, stunting rates among children increase, as they are deprived of adequate nutrition during critical periods of growth.

In addition, extreme temperature changes can affect disease patterns, which in turn contribute to stunting. For example, higher temperatures can increase the prevalence of tropical diseases or sanitation-related infections, which worsen nutritional conditions in children. Children infected with these diseases tend to have impaired nutrient absorption and impaired metabolism, which slows their growth.

Based on table 1 presented, the analysis shows that global temperature has a significant positive effect on stunting rates in 2020, with a consistently positive coefficient for each year tested, from 1990 to 2020. This result indicates that each annual increase in temperature is associated with an increase in stunting rates, with a t value indicating strong statistical significance. The coefficient for 2020, which reached 0.6427016, confirms this positive relationship, although the explanatory contribution to the variation in stunting remains low (R-squared = 0.0992). When compared to previous studies, which also observed the impact of climate change on food security and nutrition, this finding is in line with evidence that climate change risks increasing food insecurity and malnutrition (Dietz, 2020; Mahapatra et al., 2021; Tirado et al., 2022). However, despite the similarities in showing a relationship between temperature and stunting, this study emphasizes that other factors, besides temperature, need to be taken into account more deeply to explain more variation in global stunting rates.

Table 1. The Effect of Temperature Between Times on Stunting Rates in the World in 2020

Independent Variable [Temperature Year]	Coef.	Std. Err.	t	[95% Conf. Interval]		R-squared
2020	0.6427016	0.1341816	4.79	0.3771187	0.9082845	0.0992
2019	0.6650246	0.1325799	5.02	0.4026118	0.9274374	0.1050
2015	0.6579097	0.1303325	5.05	0.3999451	0.9158742	0.1060
2010	0.6954456	0.1192866	5.83	0.459344	0.9315471	0.1275
2005	0.6847058	0.1201963	5.70	0.4468037	0.9226078	0.1246
2000	0.6781824	0.1307146	5.19	0.4194617	0.9369032	0.1119
1995	0.6690296	0.1240181	5.39	0.423563	0.9144962	0.1157
1990	0.6763589	0.1275668	5.30	0.4238685	0.9288494	0.1148

Dependent Variable: Stunting 2020; Sig. 0,000; Prob>F 0,000; Number of Obs. 126.

Table 2. The Effect of Temperature on Global Stunting Rates

Independent Variable [Temperature Year]	Coef.	Std. Err.	t	[95% Conf. Interval]		R-squared
2019	0.6681034	0.1353509	4.94	0.400206	0.9360008	0.1046
2018	0.6850686	0.1368911	5.00	0.4141228	0.9560143	0.1093
2017	0.6722880	0.1339249	5.02	0.4072131	0.9373629	0.1101
2016	0.6852008	0.1355857	5.05	0.4168388	0.9535629	0.1136
2015	0.6613780	0.1466168	4.52	0.3729410	0.9533334	0.1010
2014	0.6594289	0.1495815	4.41	0.3633653	0.9554925	0.0991
2013	0.6847124	0.1504477	4.55	0.3869344	0.9824905	0.1055
2012	0.6632435	0.1539308	4.31	0.3585714	0.9679156	0.0990
2011	0.6787661	0.1571786	4.32	0.3676657	0.9898666	0.0997
2010	0.7073344	0.157067	4.50	0.3964547	1.0182140	0.1068
2009	0.7014657	0.1673133	4.19	0.3703058	1.0326260	0.0983
2008	0.6839881	0.1809981	3.78	0.3257422	1.0422340	0.0854
2007	0.6747515	0.1828405	3.69	0.3128590	1.0366440	0.0828
2006	0.6635087	0.1810065	3.67	0.3052461	1.0217710	0.0810

Independent Variable [Temperature Year]	Coef.	Std. Err.	t	[95% Conf. Interval]		R-squared
2005	0.6685651	0.1808610	3.70	0.3105905	1.0265400	0.0845
2004	0.6652096	0.1852765	3.59	0.2984956	1.0319240	0.0799
2003	0.6247168	0.1867810	3.34	0.2550248	0.9944087	0.0725
2002	0.6328748	0.1955940	3.24	0.2457395	1.0200100	0.0699
2001	0.6294365	0.1966271	3.20	0.2402563	1.0186170	0.0682
2000	0.6275261	0.2058344	3.05	0.2201222	1.0349300	0.0639

Dependent Variable: Stunting Current Year; Sig. 0,000; Prob>F 0,000; Number of Obs. 126.

Based on Table 2 presented, the analysis shows that global temperature has a significant positive effect on stunting rates in the current year, with a positive coefficient in each year tested, from 2000 to 2019. The highest coefficient was recorded in 2019 (0.6681034), which means that every increase in temperature in that year is associated with an increase in stunting rates of 0.668 units. The significant t-values (all above 2) support the conclusion that temperature has a significant effect on stunting prevalence, although the model's contribution to stunting variation is relatively small, with R-squared ranging from 0.0699 to 0.1046. When compared to previous studies, which also examined the effects of climate change on agricultural output and nutrition, these findings are consistent in showing that higher temperatures contribute to food insecurity and malnutrition, which in turn increase the risk of stunting (Agostoni et al., 2023; Randell et al., 2020).

Figure 1. Stunting Rates by Country in 2000

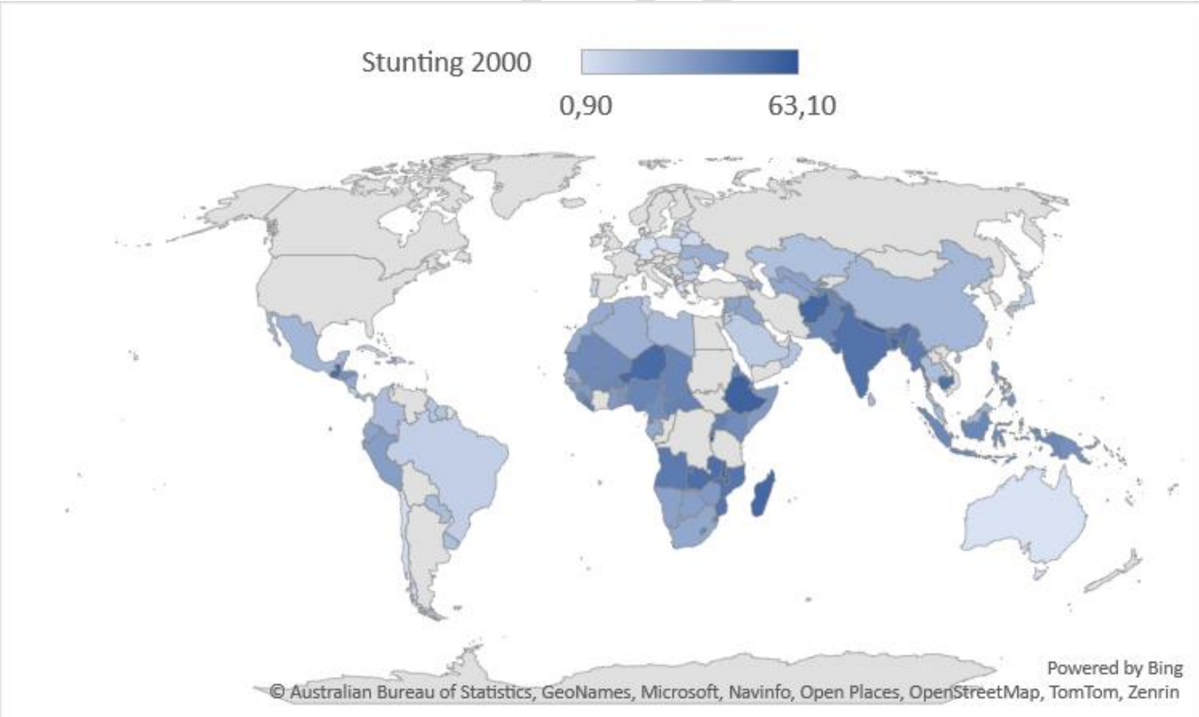
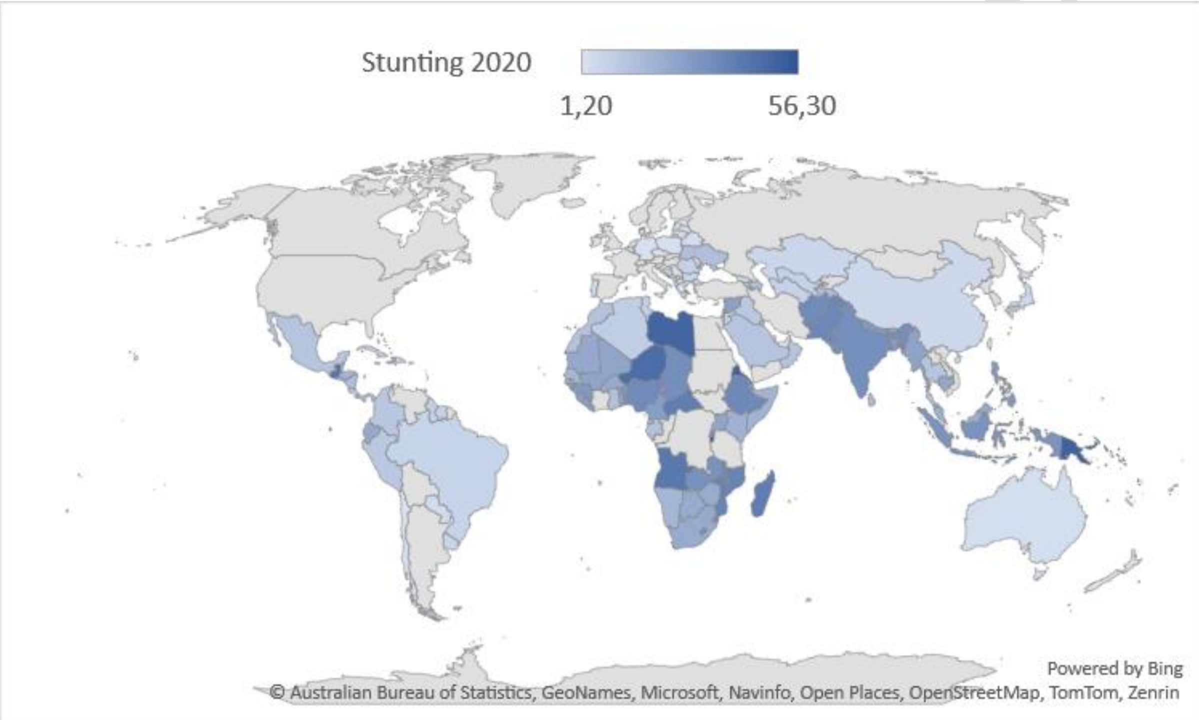


Figure 1 shows the distribution of stunting rates by country in 2000, with darker shades indicating higher stunting prevalence, while lighter shades indicate lower stunting rates. In general, countries in Sub-Saharan Africa and South Asia have very high stunting rates, reaching over 30%, while countries in Europe and North America tend to have very low stunting rates, below 10%. This is in line with previous research findings, which show that global stunting rates are strongly influenced by factors such as malnutrition, poor sanitation, and limited access to health services, which are more prevalent in developing countries (Ali, 2021; Montenegro et al., 2022). The study also emphasized that environmental factors, including climate change, worsen nutritional conditions, which is relevant to the analysis of the relationship between global temperatures and stunting which is increasing in countries with high stunting rates as seen in the map.

Figure 2 shows the distribution of global stunting rates in 2020, with prevalence ranging from 1.2% to 56.3%. Stunting was highest in Sub-Saharan Africa and South Asia, reflecting a pattern consistent with previous reports, such as UNICEF (2019) which also showed that both regions had dominant stunting rates due to economic inequality, food access, and health services.

Figure 2. Stunting Rates by Country in 2020



The global temperature distribution map in 2000 shows an annual mean temperature range of 3.94°C to 28.7°C, with tropical regions such as Sub-Saharan Africa, South Asia, and South America having the highest temperatures. This distribution is consistent with previous studies, which confirmed the dominance of high temperatures in low latitudes due to intensive solar radiation (Akala et al., 2021; Sekar et al., 2023). Compared with more recent data, the global warming trend since 2000 has worsened the previously more moderate temperature disparity between tropical and high latitudes. This increase in temperature underscores the need for climate change mitigation to reduce the impacts on vulnerable populations in hot regions, especially in terms of food security and health.

The 2020 global temperature map shows a temperature range between 3.62°C and 29.3°C, with tropical regions such as Africa, South Asia, and South America still dominating high temperatures. Compared to 2000, there is an increase in global temperature consistent with the IPCC report (2018) which states an increase in the average global temperature of 0.2°C per decade due to human activities. This temperature change emphasizes the trend of global warming, with a more significant impact in the already hot tropical regions. In addition, the temperature distribution pattern remains similar to 2000, but its intensity has increased, indicating the need for more aggressive global action to mitigate climate change to minimize risks to vulnerable ecosystems and populations.

Figure 3. Temperature by Country in 2000

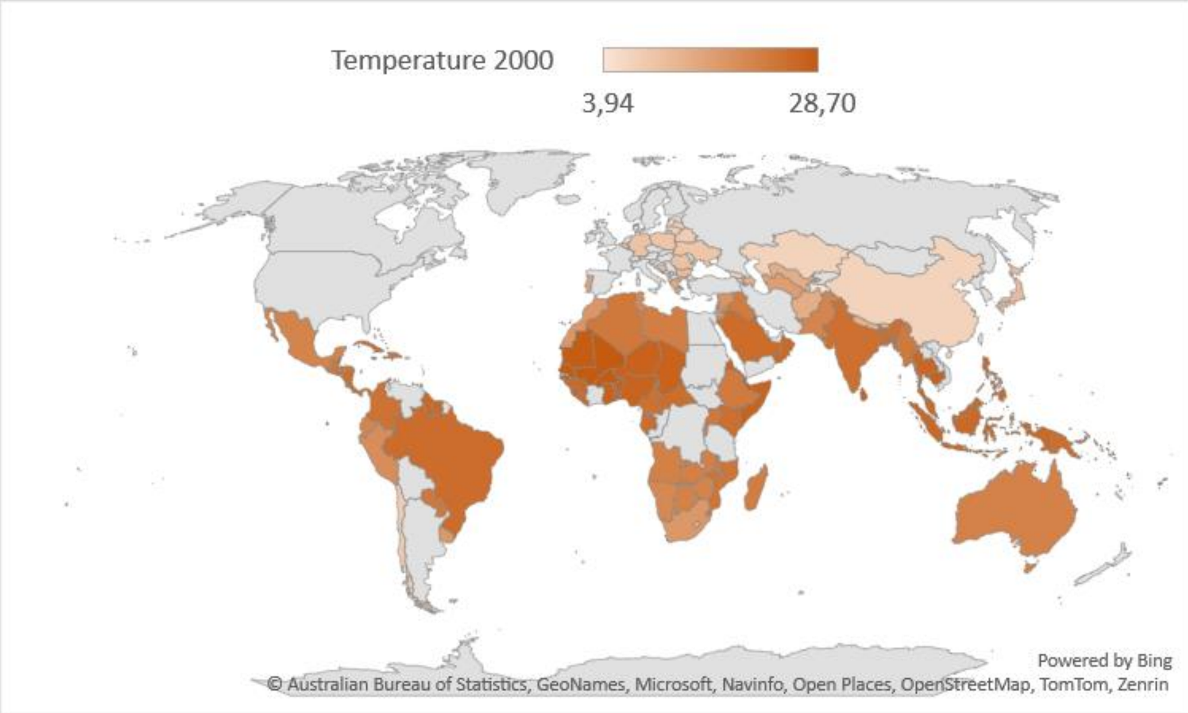
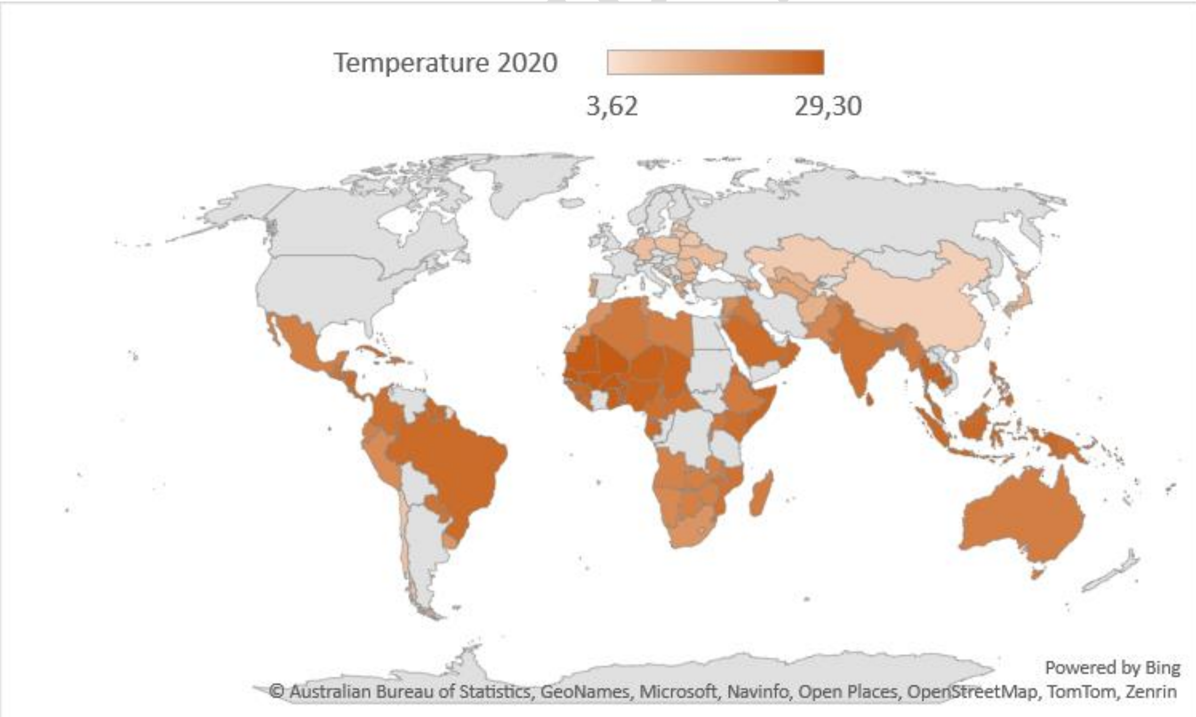


Figure 4. Temperature By Country 2020



To prevent the cascading impacts of temperature, drought, and stunting, comprehensive mitigation and adaptation measures are needed. Developing crop varieties that are resistant to climate change, such as drought or high temperatures, can be a solution to reduce the risk of crop failure. In addition, investment in irrigation infrastructure, efficient water management, and diversification of food sources can improve food security. Government policies that support community access to nutritious food, such as food subsidies and supplementary feeding programs, are also important steps in reducing stunting rates. With an integrated approach, the impact of global warming on food insecurity and stunting can be minimized to create a healthier and more sustainable future.

4. Conclusion

The study concluded that rising global temperatures have a significant impact on increasing stunting rates in children under the age of five. Climate change that increases global temperatures worsens food security, reduces crop yields, and increases the risk of malnutrition due to limited access to nutritious food. These effects are more severe in developing countries that depend on agriculture. In addition, extreme temperatures also trigger disease patterns that negatively impact nutrient absorption, thereby exacerbating the risk of stunting. The importance of climate change mitigation, the development of weather-resistant crop varieties, and evidence-based nutrition policies are key to reducing the multidimensional impacts of global temperature change on children's health.

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