

Effects of global climate changes on sports and athletes

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Abstract. Climate changes occurred due to reasons such as uncontrolled population growth, economic development, destruction of forests and air pollution. These changes have various effects on sports and athletes. The study aimed to examine the effects of global climate change on sports and athletes in the light of literature and some data and to point out possible future results. Method: This study was qualitative research. This research performed with a literature survey model. Since the effects of global climate change on sports and athletes examined by very few people, it was performed with a literature scanning model in order to contribute to the literature on this issue. *Results.* In the study, the negative effects of global climate changes on sports and athletes were explained with examples of sports performed in cold weather and sports in hot weather. The sports sector, which was affected by climate changes, started to spend a lot of money. Athletes affected by the increasing temperature, cold, storm and typhoons were facing danger. Sports fields and facilities were faced with various dangers as a result of global warming. If measures are not taken in 2030-2050, some sports can be in danger. 194 countries signed the Paris climate agreement in 2016. However, this agreement was ineffective in practice.

Key words: *global climate change, sport, athlete, environment.*

Introduction

The global climate is changing rapidly in the world, this change is proven by the data. As a result of global climate changes, all systems in the world are more or less affected by this situation. As long as global climate change continues to affect our world, it is predicted that sports, sports facilities and athletes will be negatively affected by this situation. Therefore, it is important to scientifically demonstrate the effects of climate change on sports and athletes. Scientific observations on our planet show that human activities have contributed to a significant change in the Earth's Atmosphere, including carbon dioxide and other greenhouse gases that trap heat (1). The sports sector is one of the sectors affected by this situation. In this study, the effects of global climate changes on sports and athletes were examined according to the literature.

The most important reason for the change in the global climate is that it is directly made by the human. There is a consensus that human increases the increase in greenhouse gases in the atmosphere day by day (2-7). The uncontrolled population growth, land-use changes and economic development cause human beings to create numerous threats on the world climate (8). Climate change creates various effects that are not normal in the world. As a result of the release of greenhouse gases to the atmosphere, the air temperature increases day by day. The term "weather" refers to atmospheric conditions determined by certain factors. Temperature, precipitation and wind in a particular place and in a short time the term "climate" refer to a typology determined by the long-term means of such conditions (1).

Abnormal increases and decreases in climate affect both sports and athletes at different levels. The rapid warming of the earth causes seasonal changes as the glaciers in the North Pole rapidly melt. Sports organizations depending on weather conditions can be postponed or not organized. The global average temperature has increased by approximately 0.6 - 1° C in the last 100 years (9). The years in the late 90s were the hottest years of the last centuries. Global temperature will increase even faster in the future. Of course, there are many uncertainties and various scenarios. A temperature increase of 1.4 to 5.8° C is predicted, which will be considered in the future. There is a measured increase in the retreat of glaciers around the world. Since 1850, Switzerland has lost more than a quarter of its glacial surfaces. It is estimated that between 20-70% of Swiss glaciers will disappear in 2030 (10). Loss of glaciers due to the increasing effect of greenhouse gases, unexpected accidents and losses may occur in sports and recreation facilities. In recent years, as a result of climate change, many facilities, including 36 chair lifts, 4 ski lifts and 1 funicular, have been damaged in ski resorts. The avalanche winter in 1999 probably caused losses in excess of US \$130 million.

Mountain rail companies had to spend 77% more on snow removal. In previous years, approximately 25% more money was spent to secure the ski slopes compared to normal winters (11). In recent years, landslide floods in summer, avalanches and extreme snowstorms in winter await those who have been doing recreational sports activities in the mountains in open areas. In some winters, the sports facilities established for recreational purposes and the tourism sector will be adversely affected as a result of no snowfall (12).

To learn how climate change might affect the snow reliability of Australian ski resorts, the areas and the effects of different regional climate scenarios on the number of days covered with snow were studied (13). Winter and summer skiing on glacier slopes will not be available at most facilities until 2100. There are some people who think that mountain winter tourism and winter sports cannot be done in natural snow in the global warming land surface and in the northern hemisphere. If no prevention is taken, the risks to be experienced by climate fragility will increase. Sports organization practitioners will have to consider more risks (14).

Material and Method

This research was conducted with qualitative research method. Quantitative research, which is a research, is a systematic research with each stage planned in advance. In this study, the effects of global climate change on sports and athletes were examined by making a literature review. It was tried to be predicted by scanning the literature on how global climate change affects sports and athletes in the world and what their current and future effects might be. The researchers tried to find out to what extent global climate changes affect sports and athletes by scanning the literature. Within the framework of existing data, it was questioned whether climate change is a threat for sports and athletes. The research relies heavily on the evaluation of the literature on this subject. In addition, the observations of the researchers were also evaluated. In addition, numerical secondary data obtained from national and international organizations and scientific publications were evaluated and interpreted with an analytical approach. Due to the scarcity of publications on this subject, it is thought that the study will contribute to the literature.

Climate Change and Sport

While our world was rapidly warming up, an issue that was often overlooked was the impact of climate change on sports and athletes. Extreme weather conditions continued to affect human life negatively. The impact on the sport was increasingly common, although not as much as other vital sectors. Athletes were uniquely aware of the link between health and performance and how conditions affect health. When athletes pushed their bodies to the limit, they won or broke records. This led them to be more sensitive to changing environments. Global climate changes negatively affected the sports industry. The marathon was taken to Sapporo, 800 kilometres north, as it will be very hot at the Tokyo Olympics, which was postponed to 2021 (12). Climate impact research conducted on the winter tourism industry in various countries. Canada, USA, Australia, New Zealand, Austria, Switzerland, France and England wanted to move their winter sports facilities to higher altitudes due to the decrease in snowfall (15, 11). All these studies showed serious implications that if climate change occurs, danger bells ring for the winter tourism industry (16).

We are going through the COVID-19 pandemic that started in late 2019 and still continues, and many professional leagues had to return to the empty stadium. Is the era of longer mass sports crowds over? Climate change touched sports and athletes in every aspect. Human life and global sports were no exception. Sports and athletes tried to cope with climatic conditions. In 2019 the Rugby World Cup was hit by the unprecedented pacific storm, and typhoons shook the world. The Australian opened in tennis in early 2020 was affected by ongoing bushfires and smoke. Long-distance runs for the Tokyo 2020 Olympics moved to other cities (12).

The 2014 Australian Open tennis tournament was played in the midst of severe heat, four days in a row, with heat waves above 41° C, tennis players had to play very hard matches (17).

Global climate changes gave us big signs. This change in temperatures was already paying its price. It tells us that we need to review what we do, the scale of global sports and risks, and the challenges ahead. The sports industry is dying. Heatwaves and heat are pulses expose players to harsh conditions. Stadiums flood due to extreme weather changes, the playgrounds were underwater due to the rise of sea level, and the football fields were left alone with golf courses that were dehydrated. The sport was not only the victim of change but by realizing the importance of this work, the IOC was recently adopted a more environmentally friendly approach, emphasizing the presence of carbon footprint (12).

The sports tourism industry was also affected by global climate changes. The profitability of tourism investors, hotels and other businesses decreased due to the fact that those who practice ski sports for recreational purposes in the winter months did not get enough snow. The snow made through artificial snow machines was both costly and not meeting the needs adequately. Sudden changing weather temperatures created effects other than those expected from the seasons. Excessive floods, winds, storms and tornadoes adversely affected open and closed sports facilities. This new situation should now be taken into account in the planning of sports facilities. It was a fact that athletes can be adversely affected by temperature changes that did not go in the normal course of winter and summer. While some sports branches continued throughout the year, some sports continued mainly in winter and some in summer. Due to this situation, we examined sports performed in cold and hot weather separately in terms of climate changes.

In terms of Cold Weather Sports. Cold weather sports employed more than 200,000 people and adding at least \$ 12 billion a year to the US economy. Considering the winter and summer recreational sports users of the mountains, it emerged as an important sector in the world. There now appears to be a rapidly increasing sensitivity among professional winter sports athletes and ski industry professionals to talk about the risks of global warming. US Cross-Country Skier Andrew Newell launched the "Athletes for Action" campaign to promote climate change solutions, collecting signatures from more than 100 leading winter athletes. The National Ski Areas Association created the Climate Challenge. A program dedicated to helping ski areas reduce greenhouse gas emissions and increase energy efficiency was proposed. Olympic medallists in skiing and snowboarding sent a letter to President Obama urging him to take stronger steps in mitigating climate change and promoting clean energy (18).

Warming conditions also affected the cost of winter sports. Temperature changes, which were not normal due to climate changes, cause winter to be experienced like summer and winter. It was easier for athletes to get injured by being affected by external conditions while doing sports under these conditions (19).

Russia spent \$ 50 billion for the Sochi Winter Games. This led them to the most expensive Olympics ever. An unreported portion of this cost was spent making and preserving hundreds of thousands of cubic meters of artificial snow. Ski resorts in the US often used 50 per cent or more of their annual energy budget for snowmaking.

Alaska experienced one of the mildest winters on record in 2016. February 29 was the first February in the history recorded without snow in Anchorage, the most profitable time of the year. It's so hot that Alaska officials had to haul snow-filled wagons for the inaugural ceremony of the state's iconic Iditarod dog sled race.

Ice hockey was at risk of being an endangered sport, especially as it was played outdoors. Recent reports warn that open-air runways in Canada were over, where average temperatures rose 4.5 degrees between 1951 and 2005. At that time, many regions of Canada saw a 20 per cent drop in outdoor hockey season. This period, which fell to 58 days between 1972 and 2013, is down by five days every ten years. It is estimated that there will be only 28 days in 2090.

In Sochi, Russia, which hosted the 2014 Winter Olympic Games, the temperature reached 61 °F and felt more like the Summer Games. Warm weather was above normal for Sochi with a mean temperature of around 50°F in February. Poor snow conditions caused delays, injuries, and athlete complaints at many Olympic events, including the men's snowboarding halfpipe competition, women's ski jumping and men's downhill.

In Fall 2018, the Intergovernmental Panel on Climate Change (IPCC) published a report on its results as "Keeping warming below 1.5 degrees Celsius in the report; increasing climate change, above pre-industrial temperature". The urgency of climate change mitigation and the related risk management (20) report was prepared. The change will be felt in all sectors and there is no exception in Sport. The sports sector will also be one of the most affected by climate change (14). And yet, a limited number of climate change mentioned the dangers for sports and athletes (21).

Many sports, especially nature sports, affected everywhere arising from unique socio-ecological interactions. For example, the source of surfing in the Polynesia Pacific was known for its breathtaking tides, and indigenous customs were closely related to the island landscape (22). Another example was cross-country skiing. In Scandinavia, there were problems in winter sports, as the large areas covered with snow in winter, which arose from the need to transition, were replaced by winters without snow (23). Indeed, the natural environment provided many of the critical resources needed for sports: wind and water provided conditions

for sailing, snow for skiing, ice for hockey, tennis. While conducting sports businesses, planning and changes should be made in accordance with these conditions (24).

This was the latest example of the increasingly hot weather trend for the Winter Olympics since the 1998 Games in Nagano, Japan. This trend was partly due to the Olympic organizers choosing warmer cities for the Winter Games in recent years, but it was also affected by climate change. Among all cities that hosted the Winter Games since its inception in 1924, Sochi's mountainous region lies in average ranges for latitude (43° N) and elevation (7,000 feet above sea level). This indicated that the threat of warmer conditions can continue to affect the Winter Games.

Hot Air Sports.

Tennis. The Climate Institute published a report on the threat of climate change to sports in Australia. A particularly striking example was the Australian Open, which revised its heat policy for 2015 and set an upward limit on ambient temperatures that athletes can play after the extreme heat of 2014 became a serious health issue, causing hallucinations, vomiting, and fainting. Chinese player Peng Shuai vomited before having cramps. The shoes of one player and the water bottle of another player melted and Jelena Jankovic passed out on an open-top sofa (12). At the 2015 US Open, athletes competed in temperatures exceeding 90 degrees with 40 per cent humidity in the first round, the US Open was the latest in a series of US athletic events that face unusual and dangerous climatic conditions. US Open participant Roger Federer said "heat shouldn't matter," but John Isner said, "It's not a fitness issue, it's a big, big mistake." (12). If you look at science, Isner is right. In very dry conditions, people can be physically active outside at temperatures up to 35° F, but in humid conditions, the limit falls below 32°F because it was more difficult for the body to cool itself through perspiration and evaporation. Continuous exposure to heat causes heat sickness when the combination of heat and humidity gets too high. As climate change raises temperatures and makes heat waves more frequent, we can expect athletes from professionals to amateurs to be more at risk. It is necessary for the health of the athletes to make tennis tournaments under more suitable conditions by using the weather forecast data.

Football. Footballers were particularly at risk of overheating due to severe heat. It was recommended that making transportation with service vehicles to encourage people to leave their cars at home in order to develop more environmentally friendly stadiums, environmental sustainability of sporting events, and improve the public's environmental awareness. The global sport will face massive disruptions from climate change in the coming decades, according to a new analysis. By 2050, it was estimated that nearly one in every four fields of the English football league will be flooded each year. However, the author says tennis, rugby, athletics, and winter sports will also face serious difficulties due to the effects of rising temperatures. Reveals that sports leaders do not take the issue seriously (13). While the Covid-19 outbreak has disrupted sport as much as other aspects of social life, many experts believe this was just a dress rehearsal for the long-term effects on the sport of a very hot world. Extreme weather events associated with rising temperatures have already affected some of the world's highest-profile sports in recent years. (25)

It was unknown what steps was taken by local football clubs in an attempt to gain an opinion voluntarily (26). This meant that players cannot train during the hottest part of the day. A study found that heat deaths tripled in high school players between 1994 and 2009 compared to the previous 15 years. Droughts, such as in Texas in 2011, made lawns difficult and expensive to maintain. In very hot weather, the situation of interrupting football players in the game under the name of water break was a new situation to prevent injuries from loss of fluid from heat stroke (26).

It is recommended to postpone the game in very hot conditions and to increase the liquid intake in hot weather. In addition, a few minutes of rest during water breaks can increase recovery and prevent injury.

Golf. Golf was another sport that is extremely vulnerable to changing weather conditions. In 2013, high temperatures and drought made some greens at the British Open Championship almost unplayable. A historic flood in West Virginia in July 2016 swept through an entire course and forced Professional Golfers Association to cancel the Greenbrier Classic Tournament. The food washed away by heavy rain and more areas will be susceptible to erosion, especially near the coast. According to a study, more than a thousand golf courses in the United States were reported to have an altitude of less than two meters above sea level, and more than half were vulnerable to disappearance by the end of this century (13). Golf courses were already adapting to the changing climate. Drainage systems were being redesigned for more efficient use of even recycled water.

Run/Marathon. Heat can have a noticeable effect on long-distance running events. Marathon durations were typically 2 minutes slower for every 10 ° F as the temperature rises. The Los Angeles Marathon was traditionally held on the third weekend of March, but the temperature reached 90 ° F which was a race record, nearly 200 runners needed medical attention and more than 30 runners were taken to hospital. The event was moved to February for the first time in 2016 when athletes were able to qualify for the Summer Olympic Games but temperatures were still 20 ° F above average (27).

The 2012 Boston Marathon was a sweltering 89 ° F, just one degree less than its all-time high. Win durations were approximately 10 minutes slower than in the previous year when the race day was a warm 57 ° F The starting time of the race was changed in the early hours to beat the heat in 2006. Making snow is an integral part of the Ski industry and the results show that ski areas can remain operational. The economic impact of making additional snowmaking continues to be a significant uncertainty for requirements. The case study in Canada predicted that the mean ski season in the ski area (Lakelands tourism region) would decrease by 0-16% in the 2020s, 7-32%- 11-50% in the 2050s. All branches will be affected by climate change economically and socially.

Results

If global climate changes continue at this pace and no action is taken, snow production in the 2080s will decrease by 37-57% in the winter season. The 2050s Simultaneously with the predicted ski season losses, the estimated amount of artificial snow production required increased by 36-144% in the scenarios for the 2020s. Required snowmaking amounts are increased. In the scenarios of the 2050s, the natural snow will decrease by 48-187%. The ability of individual ski slopes to absorb additional snow-making costs can be an important factor in staying economically viable (29). Climate change represents a new challenge for tourism and winter tourism in particular. However, recreational sports and tourism will be affected by this situation (16). Today, 85% of Switzerland's 230 ski resorts can be considered reliable in terms of snow. However, even today many ski resorts in Prealps are not reliable in terms of snow. If the snow reliability line rises to 1,500 m between 2030 and 2050 as a result of climate change, snowy ski resorts are predicted to decrease to 63%. The Alps in the Friborg cantons, Jura, Eastern and Central Switzerland, Ticino, and Vaud will be particularly endangered on a global scale. There are almost no major problems in the Valais and Graubünden ski areas. Since the average altitude of the cable car terminals in these regions is more than 2500 m, it is considerably higher than sea level. If the reliability line in snow rises to 1800 m, a possible scenario, more severe deterioration in conditions is predicted there. Only 44% of the ski areas are determined to be resistant to snow. Most ski resorts will no longer be reliable in the snow even the cantons of Grisons and Valais (30).

To address the industry's contribution to climate change, it was important to consider reducing tourism's carbon footprint, threatening climate change, life on the planet and where tourism depended. From lush tropical islands to snowy mountain peaks, your favourite resorts may be at risk. As the planet warms, sea levels rise, extreme weather and rising temperatures are affecting ecosystems and communities around the world. Beaches are getting smaller, coral reefs are getting white, and mountain resorts stay snowless and dry. If we want to save our planet and protect these special places, it is the duty of each of us to reduce the impact that is causing this situation (31).

Winter tourism depends on good snow conditions and it is very sensitive to the lack of snow. Winters climate research results showed that there can be an increase in the number of winters. It was expected due to climate change that there can be snow. (32). Tourism representatives will not only lean back but will be obliged to take new measures against climate change. Technical measures to protect skiing, especially artificial snowmaking, are at the forefront of tourism. Tourists demand good snow conditions and these conditions will therefore be offered by ski resorts. In any case, the effects of climate change are beginning to be seen.

For families close to these towns, cheap ski lifts will be destroyed and changed due to the climate. Although indoor skiing is a growing industry in European cities, it is uncertain. Indoor ski domes can replace small ski resorts for beginners on the slopes. As a sector seriously affected by climate change, the need for tourism requires more focus on reduction strategies in its own benefits. Environmental compatibility can also be achieved by climate compatibility. It is an agreement that aims to reduce greenhouse gas emissions within the framework of the United Nations Framework Convention on Climate Change. The agreement, which was opened for signature on 22 April 2016, entered into force as of 4 November 2016 with the signatures of 196 countries.

The agreement aimed follow aspects. In the long run, the global temperature increase to remain below 2 degrees compared to the pre-industrial period. Greenhouse gas emissions to be reduced globally. Since the agreement comes into force, all kinds of measures to reduce greenhouse gas emissions should be put into effect in a short time by using all the possibilities of science. What another thing to be known is that the states that signed the treaty do not face a penalty if they withdraw. However, the president of USA withdrew from this treaty. The countries that affect climate change most have not taken concrete steps to comply with the treaty signed so far.

Discussion

Global climate changes affected sports and sports sectors as well as all sectors. When the literature was examined, this issue was studied by a few researchers in terms of its effects on sports and athletes. As a result of the release of greenhouse gases, the world was warming rapidly and glaciers were melting in the North Pole. The world temperature increased by 1 ° in the last century. It was estimated that there can be a temperature increase of 1.4 to 5.8 ° C, and future warming can be quite large. There was a measured increase in the melting of glaciers around the world. Since 1850, Switzerland lost more than a quarter of its glacial surfaces. It was estimated that between 20 and 70% of Swiss glaciers will disappear in 2030 (11, 3). In recent years, landslides, floods in summer, avalanches, and extreme snowstorms in winter await those who did recreational sports activities in the mountains in open areas (32). Climate changes started to cause various problems in every part of the world. In countries such as Canada, USA, Australia, New Zealand, Austria, Switzerland, France, and England, winter sports facilities were moved to higher altitudes as a result of the decrease in snowfall (12). The serious implications of all these studies show that if climate change occurs, danger bells ring for the winter tourism industry (11). In 2007, before the climate meeting in Bali, Rajendra Pachauri, chairman of the Intergovernmental Panel on Climate Change (IPCC), said, "If there is no action before 2012, it's too late." and said, "This is the defining moment that will determine our future what we will do in the next two to three years." Some experts consider the IPCC to be too optimistic. In the Fall of 2018, the Intergovernmental Panel on Climate Change (IPCC) released a report on climate change consequences, emphasized that climate change, which increased by 1.5 ° C above the pre-industrial temperature, had the urgency of climate change mitigation and according to the results of the risk management report, climate change has consequences. There will be a decrease in snowfall and the duration of the snow season will shorten when the temperature increases (15). It has been stated in many studies in the literature that ski facilities in low-altitude regions will be affected more than those in high-altitude regions and will sooner or later withdraw from the sector (10,15,11,1,2). In addition, increasing temperatures and extreme weather events will increase the frequency of avalanches. The change will be felt in all sectors (36). There was no exception in sports, the sports sector was one of the sectors that will be most affected by this climate change. Also, limited studies mention the dangers of climate change for sports and athletes (21). Athletes were negatively affected by temperature changes (37). If there was no made a provision on a global scale in the near future, some sports can no longer be practiced because the necessary conditions were not met. Some sports cannot be done widely and may be limited to certain areas. The rapid warming of the world and the increase in ocean temperatures can cause great damage to existing sports fields and Sustainability disappears (35). The sports opportunities that we have today may be a dream for future generations. Nowadays, pushing the limits of athletes in terms of heat in sports performed in hot climates can cause their performance to deteriorate, and lose their health. The best proof of this was what cricket players experienced in England in January 2018. UK cricket captain Joe Root was finally hospitalized due to the temperature rising above 41 degrees in 2018 in England. During the women's World Cup in France and the African Cup of Nations in Egypt, additional water breaks appeared in sweltering conditions in matches. Normally, it was not possible to do sports when it was reached 33-35 degrees. The problems experienced by tennis players in Australia and the fact that the 2020 marathon run in Tokyo was taken to Sapporo, 800 meters north of Tokyo, were important evidence that global warming negatively affects athlete health.

The recreational tourism sector in the cold climate suffers a lot of economic losses and the sports sector was negatively affected (33). Winter tourism and winter sports were affected by adverse conditions caused by the lack of snow or too many storms. Making artificial snow as a result of not snowing was both costly and not environmentally friendly in terms of water resources.

In 1982, the Executive Director of UNEP Mostafa Tolba warned delegates from more than 100 countries that the lack of urgent action would bring an environmental disaster at the turn of the century and as complete

and irreversible destruction as any nuclear disaster (33). The report showed that the Himalayan ice will disappear by 2035. Since climatic changes will cause not only warming of the earth but also cooling, human beings will be negatively affected by this (34). If the world continues to warm at this rate, the scenarios in the 2050s look dark for sports and athletes.

As a result of the research, global climate change affects sports and athletes. This situation will cause some sports branches to become impossible in the coming years due to circumstances. But, it is possible that the situation can be prevented. The solution of global climate change can again be achieved through a global joint effort. A sustainable ecosystem should become the top priority all over the world. Even if the system is broken by human hand, it can be corrected by human hand. The universal climate agreement can be implemented urgently. Scientists from all local and general sports federations of the world should be warned about the effects of global climate change on sports.

Applicable Remarks. In the announcement of this situation, this work should be announced more in their countries and around the world with campaigns such as Andrew Newell's "Athletes for Action" campaign, and it can ensure that governments comply with the Paris climate agreement they have signed and they can save the world. Elite athletes can be made aware of this issue and can influence the managers of their countries to comply with the agreement. Much more than the disasters experienced today, the greatest danger for both sports and athletes was global climate change.

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