

Interrogating the Impact of Climate Change on Multiple Outdoor Sports Activities: A Critical Review

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DOI: <https://dx.doi.org/10.47772/IJRISS.2024.801160>

Received: 16 January 2024; Accepted: 18 January 2024; Published: 17 February 2024

ABSTRACT

Over the years, the multiple outdoor sport activities have relied on the natural environment for critical resources such as energy, water, and the field of play. The relationship between outdoor sports activities and the environment has been primarily examined to understand how outdoor sports activities impact on the natural environment. However, the actual and potential deleterious effects of climate change on sports are under-researched. Yet, climate change impacts individuals' sporting choices, since changing temperatures and precipitation patterns affect the participation of outdoor sports activities. In this paper, we examined the nexus between climate change and multiple outdoor sports on individuals' health outcomes. After evaluating more than 150 publications, the researchers retained 45 articles and analyzed them to answer the research questions: (1) what evidence is available regarding the impacts of climate change on the performance of multiple outdoor sports activities. The research question was built around three themes; (1) nexus between climate change and outdoor sports activities; (2) heat effects on athlete performance; and (3) Mitigation and adaptive measures taken to prevent the impact of climate change on athletes involved in multiple outdoor sports. This review reveals that there is evidence of climate change impacts on multiple sports activities. The paper concludes that the changing heat waves and precipitation patterns affect individual participations in outdoor sports activities, which has direct ramifications for health and wellbeing of individuals participating in sporting activities. It is therefore, recommended that policy makers should be involved in engaging athletes, local leaders and other stakeholders in combating the impacts of climate change on outdoor sports.

Keywords: Outdoor sport, Climate Change, Environment, Kenya

INTRODUCTION

Climate change is defined as long-term shift in the planet's weather patterns or average temperatures (Orr et al. 2022). Unlike hazards, climate vulnerability is more controllable at the organization and industry levels (Orr & Inoue, 2019). Climate change has complex consequences for the environment, society, economy and people's health (Eichinger, 2019; Townsend et al., 2003). From wildfires and typhoons to rising temperatures, natural disasters and severe weather are disrupting sporting events around the world. This impacts both competitive and recreational athletes' ability to participate in many sports and affects people of all ages and backgrounds (Viola, 2021).

On outdoor sport activities, climate change is widespread and intensifying and will have far-reaching implications for human sporting activities.

In this paper, outdoor sports refers to official competitions such as football that take place outdoors (Dee et al. 2022). Climate change directly impacts individuals' sports choices since the changing temperatures and precipitation patterns influence the attractiveness of alternative activities, and these shifts may have

downstream ramifications for health and wellbeing. Climate vulnerability is a function of potential impacts of climate change and adaptive capacity (Adger, 2006; Turner et al., 2003; Weis et al., 2016). Climate change impacts are the scope and severity of the climate hazard, while adaptive capacity refers to the subject's state of readiness and capacity to continue operating with minimal disruptions (Berkhout, 2012; Fussel, 2007).

Evidently, the issue of climate change has received comparatively little attention to date in the fields of sports science. However, it will not only be professional athletes, but also amateurs, spectators and officials who are directly confronted with the adverse implications of climate change on our health in the near future. The historic relationship between sport and the natural environment begins at the origins of nearly every sport. Most outdoor sports were borne of interactions between humans and their environment. For instance, surfing came out of indigenous cultural practices in Polynesia (Warshaw, 2010), golfing originated from the rolling hills in Scotland (Browning, 2011), and cross-country skiing from Scandinavia and Eastern Europe (Huntford, 2009). However, until recently, the conditions of the natural environment surrounding these facilities were taken for granted (Orr & Inoue, 2019), and the impacts of changes to the natural environment were ignored (McCullough et al., 2020).

In this paper we argue that sport is a global commodity (Ziakas & Beacom, 2018), with an estimated annual market value of US\$750–840 billion (Sports Value, 2020). The outdoor sports and the natural environment have a bidirectional relationship. Evidence shows that outdoor sports influence the natural environment and well influenced by the natural environment (McCullough et al., 2020; Orr & Inoue, 2019). The impacts of outdoor sport on the environment particularly on waste production and emissions and efforts to mitigate these impacts through sustainability interventions affect the outdoor sports significantly (Dingle & Stewart, 2018; Orr & Inoue, 2019).

The paucity of empirical work about the possible and actual consequences of climate change for sport is surprising given its global significance, combined with the clear vulnerability of certain sports due to their climate-exposed outdoor settings and climatic demands (Orr & Inoue, 2019). The phenomenon of climate change, its urgency, increasing severity, and associated impacts are well-established (IPCC, 2018). Researchers in disciplines such as atmospheric sciences, oceanography, ecology, geology, and geography have provided abundant evidence that “earth's climate is being affected by human activities (Oreskes, 2018), and this scientific consensus about climate change informs estimates of future climate impacts. As a consequence of the potentially devastating consequences for more vulnerable populations, such as Small Island Developing States (Hoegh-Guldberg et al. 2018), it is argued that over the next two decades, a rapid global transition to sustainable development is necessary (Rogelj et al. 2018).

However, what remains unclear for the sport sector, as in many other sectors, is how best to respond (Orr & Inoue, 2019). Further, a systematic understanding of the nature and extent of climate change's impacts on sport is lacking, as the research examining climate change and sport has been disjointed and published in journals as diverse as the disciplines of the researchers, including sport medicine (Nybo et al., 2020), climate research (Grundstein et al. 2013), and tourism (Scott et al., 2015). For the latter, Steiger et al. (2019) discussed that research on climate change and ski tourism has reached the diversification phase, where there is a wide array of research questions and interdisciplinary collaborations to understand the impacts of climate change on ski tourism. This is an advancement from the growth phase, where the number and scope of relevant studies expanded significantly, as well as the earliest pioneering phase, where only a small number of studies addressed the topic (Steiger et al., 2019). Yet, there has been no focused attempt to illustrate the state of research in relation to climate change's impacts on organized sport (sport competitions and organizations that operate them).

Unlike hazards, climate vulnerability is more controllable at the organization and industry levels (Orr & Inoue, 2019). The natural resources literature conceptualizes climate vulnerability as a function of (a)

potential impacts of climate change and (b) adaptive capacity (Adger, 2006; Turner et al., 2003; Weis et al., 2016). Potential impacts are the scope and severity of the climate hazard on the subject, while adaptive capacity refers to the subject's state of readiness and capacity to continue operating with minimal disruptions (Berkhout, 2012; Fussler, 2007). The researcher is also interested in understanding how can sports be greener? How can sports not leave climate change, an intense carbon footprint?

STATEMENT OF THE PROBLEM

To date, very little research has explicitly examined climate change impact on the outdoor sporting activities (Dingle & Stewart, 2018; Orr & Inoue, 2019). This dearth of research may be attributed to lack of interest and/or lack of awareness. Orr and Inoue, (2019) rightfully identified that until recently, the conditions of the natural environment were largely taken for granted in the sport industry. However, it is also possible that interest and awareness exist, but methodology for identifying hazards and development vulnerability assessments is lacking. Most climate change hazards research occurs in the natural resource sciences (Berkhout, 2012; Hinkel, 2011). Further, vulnerability assessments developed in the natural science and policy domains have been critiqued for being too jargon-filled and complicated, and thus difficult to understand and apply without extensive training in climatology and natural sciences (Hinkel, 2011; Tonmoy, El-Zein & Hinkel, 2014). The development of vulnerability assessments in sport management requires a basic understanding of the hazards to which organizations may be vulnerable. As such, hazards research must precede vulnerability research. This paper attempts to address the dearth of research on climate hazards in the multiple sports literature by adopting a basic scenario-planning method, using secondary data from the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC, 2014). The paper is to examine the impacts of climate change on multiple sport activities, with further attention paid to their adaptation efforts.

RESEARCH METHODOLOGY

The researcher used a scoping review method to identify studies to be included in this paper. Scoping reviews are a type of structured research synthesis intended to map key concepts or existing evidence especially for an emerging research field (Dowling et al. 2020; Peters et al. 2020). As the impact of climate change on sporting activities is a relatively new research topic, no comprehensive understanding exists regarding the extent and nature of evidence that has been produced in the literature. The reviewed literature was presented thematically as shown in the subsequent sections.

FINDINGS AND DISCUSSIONS

The Nexus between Climate Change and Outdoor Sports Activities

A significant number of studies have recently interrogated the impacts of climate change on specific outdoor sports activities. Existing evidence shows that adversative effects of warming on winter recreation and tourism (Morris and Walls 2009; Damm et al. 2017; Parthum and Christensen 2022), losses in the value of beach going from rising seas (Pendleton et al. 2011), mixed results for recreational fishing (Dundas and von Haefen 2021), and potential increases in warm-weather activities (Chan and Wichman 2020). What is considered healthy/safe limits for outdoor sports activity from mid-21st century? Survey results reveal a general understanding and acceptance of climate change and a need for adjustments in accordance with more dangerous heat-related events. Enhancing climate change and health communication may promote important changes to sports programs including timing, duration, intensity, and location of practices that should be made in accordance with increasingly dangerous temperatures and weather conditions.

Health Impacts on Outdoor Sports Activities

The influence of the outdoor sports activities on climate change has been of many concerns especially to the participants (Formayer & Kromp-Kolb, 2009; Veit, 2002). The World Health Organization has said heat stress linked to climate change effects is likely to cause 38,000 extra deaths a year worldwide between 2030 and 2050, as it worsens existing health problems and provokes heat stroke and exhaustion.

In the UK for instance, when heavy storms hit the country in 2015-16, the cricket board spent about a million pounds (\$1.25 million) in 2016, and 1.6 million pounds in 2017 to fix facilities and to support affected clubs. Extreme weather due to climate change effects also caused the cancellation of 25 Football League fixtures during the 2015-16 season. Major national football leagues offered about 750,000 pounds to help flood-affected clubs that season, while the Football Association, Britain's soccer body, spent 48 million pounds to weather-proof pitches across the country (Reuters, 2015).

The Climate Coalition, of 130 non-governmental groups in Britain underscored that warming threatens sports beyond those dependent on snow and ice on display. From the foregoing, to avoid further health problems in heated waters, water monitoring and corresponding communication to the sports participants is of particular importance. Tobias et al. (2019) found that at FIFA Men's World Cup events, the number of penalty shoot-outs during the round of 16 is strongly positively correlated ($r = 0.82$) with anomalous high temperatures. Nybo et al. (2020) went one step further and showed that heat, specifically, had detrimental effects on endurance performance of football (soccer) players: in hot temperatures athletes' core body temperatures can rise as much as 1.5°C above normal, putting them within range of a low-grade fever, and sweat loss can decrease by 50%, leading to overheating and slower pace of play.

Tipton et al. (2019) raised similar concerns related to heat impacting athlete performance and suggested that the adoption of heat policies is appropriate as a measure not just for protecting the health of the athletes, but also for preserving the competitiveness and quality of play. This concern was echoed in a case study of the Texas Rangers baseball franchise, which proposed a new facility with a roof and air conditioning capacities to address heat (Kellison & Orr, 2020).

One important note is that many studies in our review referenced heat exposure research, as it relates to athletic performance (including among game officials). However, the majority of heat exposure studies did not link heat to climate change and thus were not included in this review.

Adaptive Measures Taken in Sport

While there is no single standard definition of a heat waves, these are a series of days/nights with maximum/minimum temperatures above a particular high percentile threshold, usually the 90th and 99th percentiles of the daily temperature distribution (Keellings et al., 2018). Heat policies are advanced in this literature as a possible tool for managing the incidence of heat-related illness among athletes and spectators (Australian Conservation Foundation, 2020; Grundstein et al., 2013; Grundstein et al., Grundstein et al., 2020). Though not as common as other weather-related policies like Lightning Policy (Cheung, 2018), heat policies are adaptive measures that allow sport organizations and sportspeople to respond quickly to high temperatures and protect the health and well-being of athletes and spectators (Grundstein et al., 2013). Heat policies typically include a temperature threshold that triggers a predetermined action, such as a pause for a water break, a change in attire to reduce the number of layers worn (Grundstein et al., 2013), or offering athletes access to a cooling agent such as cooling towel, mist showers (Kakamu et al., 2017).

Some adaptive measures are not linked to any specific hazard, but were proposed as a precaution to overall health and performance issues linked to climate. These include increasing the amount of time afforded to

athletes to acclimatize to new climate conditions before competing (Honjo et al., 2018; Nybo et al., 2020) and choosing host cities for competitions based on favourable weather and environmental conditions (Scott et al., 2019), thereby reducing the need to build new facilities or worry about extreme conditions. Infrastructural upgrades and equipment changes were also commonly invoked as an adaptive strategy that may help sport organizations to manage the impacts of heat (Kellison & Orr, 2020; Orr, 2020; Sofotasiou et al., 2015), storms (Goggins et al., 2018; Orr, 2020), and sea level rise (Kellison & Orr, 2020). The infrastructural changes differ based on the hazard, but range from adding shade or fans along the course of a marathon route (Vanos et al., 2019), to installing outdoor cooling technologies for open-air stadiums (Sofotasiou et al., 2015), to building brand new facilities (Kellison & Orr, 2020).

Sports-specific Risks Caused by Climate Change

The risks are differentiated between direct and indirect health-related effects (Eis, Helm, Laubmann, & Stark, 2010; Mucke & Matzarakis, 2019). Direct consequences are primarily caused by extreme temperature and other weather conditions (heatwaves, extreme weather events, ultraviolet (UV) radiation), while indirect consequences are a result of climate-induced changes to our ecosystem (air pollutants, allergens, viruses and bacteria as well as the associated vectors and natural reservoirs) (Mucke & Matzarakis, 2019).

Benchmarking and Parameters for Safe Playing Conditions

As an emerging literature, the most consistent thread across the studies is the importance of benchmarking past and current conditions for sport and setting parameters around what is considered safe playing conditions for competition. These parameters, once established through further research centered on the health and safety of players and spectators (Grundstein et al., 2013; Kakamu et al., 2017; Olya, 2019), will impact adaptation requirements and innovation (Dingle & Stewart, 2018; Goggins et al., 2018; Kellison & Orr, 2020; Orr, 2020) and the selection of host cities for events (Scott et al., 2019). They could also impact the general organizing principles of sport. Though this theme was addressed differently across the articles we reviewed, benchmarking and setting boundary conditions was raised as an implication or a next step in nearly every study.

Climate Adaptation Strategies

From the preceding discussions in this paper, in addition to temperature, definite humidity increases with global warming following the Clausius-Clapeyron relationship. This will further exacerbate climate change by reducing sweating efficiency. The higher humidity reduces the skin-air difference in moisture that eventually leads to less evaporative cooling (Buzan & Huber, 2020). Studies such as Ruttly et al. (2014) argue that various climatic adaptation strategies such as transition of some competitions to indoor venues, snowmaking and advanced weather forecasting can help manage weather risk during outdoor sports activities. The need for weather risk management strategies is paramount since weather conditions keep changing (Willwerth et al., 2023).

The IPCC (2013) pose that human influence on the climate system is clear is dominated by the observed warming since the mid-20th century. It emphasizes that human-caused global climate change has just begun, and depending on future greenhouse gas (GHG) emissions, additional warming of global average surface temperatures of 0.3–4.8°C (relative to 1986–2005) is likely to occur by end of the twenty-first century. Critically, IPCC (2013) anticipates that additional warming in the winter months will cause a further decrease in Northern Hemisphere snow cover and ice extent. Several studies have demonstrated the potential negative impact of future climate change on outdoor winter sports (see Scott, Hall, & Gosling, 2012), but the implications of a warmer world for the outdoor sports remains uncertain.

EMERGING ISSUES AND CRITICAL REFLECTIONS

Climate change presents a significant and growing challenge to the sport industry, especially outdoor sports. While this review demonstrates that outdoor sport and climate change research is at an early stage of development, there is great scope for growth. It is revealing that the link between sport and climate change has not been actively researched, as reflected by an absence of strong publication record, until the last 10 years. This likely reflects a number of issues, including a lack of awareness about climate change impacts by the sport sector in general, a lack of connection between sports academics and climate researchers that has likely not linked the two areas as being of interest.

The small number of sport and climate studies is consistent with research in the disciplines of business and management demonstrating that academic journals, especially the most prestigious ones, can be slow to respond to climate change and sports (Goodall, 2008; Linnenluecke et al. 2013). Based on the findings and the centrality of the subject matter, we argue that some adaptations, including the implementation of sport and climate related policies will change aspects of the game that sports managers will have to take account of. This can be viewed especially when they may also be feeling the effects of increased heat. It is necessary that event managers understand and track potential future climate change hazards by way of risk assessment procedures, and proactively adopt strategies that protect athlete, staff, and spectator health and safety and the quality of play.

CONCLUSION

From the forgoing discussion, the concern about global climate change has increased worldwide and continues to feature prominently in high-profile international policy debates. The policy goal of restricting global warming to below 2°C is increasingly unlikely and the trajectory is towards a warming of +4°C or greater by the end of the twenty-first century. Although the consequences of climate change will vary geographically, it is inevitable that all nations and economic sectors will have to adapt to additional climatic change in the decades ahead. This has led to an explosion of interest in climate change impacts and adaptation research (Adger, Arnell & Tompkins, 2005; Janssen, Schoon, Ke, & Borner, 2006; Stehr & von Storch, 2010).

There is no shortage of opportunity to study climate impacts on outdoor sports activities. What is strikingly evident from the forgoing is that there is relatively limited literature on outdoor sports activities and climate change. The relative paucity of studies examining the impact of outdoor sports on climate change can be explained, in part, by the narrow focus of academic research conducted by sport researchers, and may not necessarily feel they have the expertise to extensively conduct such research.

IMPLICATIONS AND FUTURE RESEARCH

Despite the clear trend toward increasingly dangerous climatic conditions, people engaged in outdoor sports activities still do not acknowledge the changing climate and its implications for individual health. Climate change communication is needed to initiate changes to sports policies to mitigate the risks of climate change for individuals engaged in outdoor sports. The theoretical implication of this paper is to understand the nexus between climate change and sports with management capacity concepts within the context of outdoor sports and climate change by placing the constructs of potential impact and adaptive capacity on a shared framework as shared by Doherty et al. (2014) and Edwards (2015). Future research and interventions should aim at enhancing climate projections to more rigorously model physiological response to heat stress while exercising and could explore how educating athletes and staff involved about climate change projections and awareness.

RECOMMENDATIONS

Given an already vast and growing body of climate literature that indicates a strong nexus between climate change and sports, there is need for different stakeholders involved in the sports industry to prepare well and address growing health-related concerns for the safety of individuals involved in sports. Further outreach is required to establish, educate about, and enforce local policies and public health interventions to reduce risk. Additionally, health-related policies should advocate for the implementation of interventions that protect athletes' health and ensure the longevity and continued economic and cultural value of sports programs in Kenya and beyond.

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ACKNOWLEDGEMENT

This work was supported by the Kenya Academy of Sports, P.O. Box 9056-00200 Nairobi, Kenya