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Beyond ninety minutes: Reflections on the FIFA World Cup through an ecotoxicological lens

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ABSTRACT

This reflective commentary examines the FIFA World Cup through the lens of ecotoxicology and ecosystem thinking to evaluate how large-scale human celebrations, consumption patterns, and globalization interact with environmental sustainability and ecological responsibility. Adopting an ecotoxicological and conceptual framework, this paper analyzes mega-sporting events as large-scale anthropogenic disturbances. It examines the cumulative ecological stress generated beyond stadium boundaries by assessing systemic environmental drivers, including transportation, energy demand, waste production, infrastructure use, and resource consumption. While football as a sport is inherently benign, the industrial and commercial scale required to host the tournament generates substantial ecological footprints. These multifaceted environmental pressures introduce pollutants, waste streams, and emissions into surrounding ecosystems, creating local and global ecotoxicological impacts that challenge the ethical framing of global mega-events. The findings highlight a fundamental tension between collective human joy and environmental stewardship. Reconciling the FIFA World Cup with planetary health requires a shift from high-impact commercial expansion toward ecological responsibility and biosphere-conscious planning. Event organizers, host nations, and governing bodies such as FIFA must integrate ecotoxicological risk assessments and strict environmental standards into early-stage tournament planning. Practical measures include mandatory zero-waste policies, reliance on renewable energy networks, strict ecotoxicological standards for supply chains, and localized transport-mitigation strategies. This paper expands the traditional sports management and mega-event literature, which predominantly focuses on socioeconomic and political dimensions by introducing an ecotoxicological perspective. It bridges event management and ecosystem thinking, providing a novel conceptual framework for understanding the cumulative biosphere impacts of global celebrations.

Contribution/Originality: This study contributes to the existing literature by applying an ecotoxicological lens to the FIFA World Cup. Its originality lies in connecting personal reflections from aquatic contamination research with tournament consumption, waste pathways, cumulative environmental pressures, and ecological feedbacks, while distinguishing potential environmental risks from demonstrated toxicity.

1. INTRODUCTION

In June 2026, the United States, Mexico, and Canada jointly hosted the 23rd edition of the FIFA World Cup, marking the first time that football's premier international tournament was staged across three host nations. The tournament began in Mexico City on 11 June 2026, rather than in the United States, with the opening match played

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at the historic Estadio Azteca. For billions of football fans around the world, the long-awaited moment had finally arrived. After four years of anticipation following the 2022 World Cup in Qatar, attention once again turned to the excitement, uncertainty, national pride, and shared emotions that only a World Cup can generate. The 2026 tournament was also historically significant because it was the first World Cup expanded to 48 national teams, transforming the competition into an even larger global sporting event.

Every four years, the FIFA World Cup captures the imagination of billions of people. Streets become quieter during matches, national flags decorate homes, and strangers become friends through a shared passion for football. The World Cup is more than a sporting competition. It represents human emotions, national identity, collective memory, and shared global culture. For many people, football becomes a temporary language of humanity. FIFA has publicly committed to reducing carbon emissions by 50% by 2030 and reaching net zero by 2040 (International Federation of Association Football, 2021), yet the growing scale and geographical expansion of modern football tournaments continue to raise concerns about carbon emissions and environmental sustainability (McCarthy, Bradfield, Butler, & Butler, 2025).

As an ecotoxicologist, however, I have gradually learned that no human activity exists outside the environment. Ecotoxicology teaches us that disturbances may begin from human actions but later travel through air, water, soil, organisms, and food webs (Newman, 2015; Walker, Sibly, Hopkin, & Peakall, 2012). Therefore, while billions celebrate goals and victories, another invisible scoreline must also be considered: the environmental cost behind the celebration. Major sporting events are known to produce environmental externalities associated with tourism, transport, energy use, resource consumption, and waste generation (Collins, Jones, & Munday, 2009; Triantafyllidis & Davakos, 2019).

Importantly, FIFA itself has increasingly acknowledged these environmental responsibilities. The FIFA Climate Strategy established commitments toward climate action and emissions reduction across football activities (International Federation of Association Football, 2021), while the FIFA World Cup 26 Sustainability & Human Rights Strategy further integrates environmental sustainability into the planning and delivery of the 2026 tournament (International Federation of Association Football, 2024). These initiatives are encouraging because they demonstrate that the environmental footprint of global football is no longer peripheral to the organization of mega sporting events, but an issue requiring explicit recognition, measurement, mitigation, and accountability.

The objective of this reflective commentary is to examine the FIFA World Cup from an ecotoxicological perspective and to explore how one of humanity's greatest sporting celebrations is connected to broader ecological processes and environmental consequences. Specifically, this paper aims to reflect on the environmental implications associated with resource consumption, greenhouse gas emissions, waste generation, and cumulative anthropogenic stressors arising from mega sporting events. Through the integration of ecotoxicological principles, ecosystem health concepts, and environmental ethics, this commentary seeks to highlight the interconnectedness between human activities and the biosphere, while emphasizing the importance of balancing collective enjoyment and cultural achievements with ecological sustainability and responsibility.

2. ECOTOXICOLOGICAL THINKING BEYOND CHEMICALS

Figure 1 illustrates the transition from traditional ecotoxicology, which emphasizes exposure, dose, bioaccumulation, toxicity, and biological response, to modern ecosystem-level thinking that considers cumulative and interacting environmental stressors. The FIFA World Cup is conceptualized as a short-duration but high-intensity anthropogenic disturbance involving travel, stadium operations, accommodation, food consumption, broadcasting, security, merchandise, and post-event waste. These activities create geographically dispersed pathways involving carbon emissions, plastic and microplastic transport, resource extraction, manufacturing, and transportation, with potential consequences for air and water quality, soils, biodiversity, vegetation, surface temperature, and habitat conditions. Nevertheless, potential environmental pressure should not be interpreted automatically as demonstrated

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toxicity. Environmental monitoring is required to verify ecological effects, distinguish environmental harm from possible local improvements, and translate sustainability claims into measurable evidence.

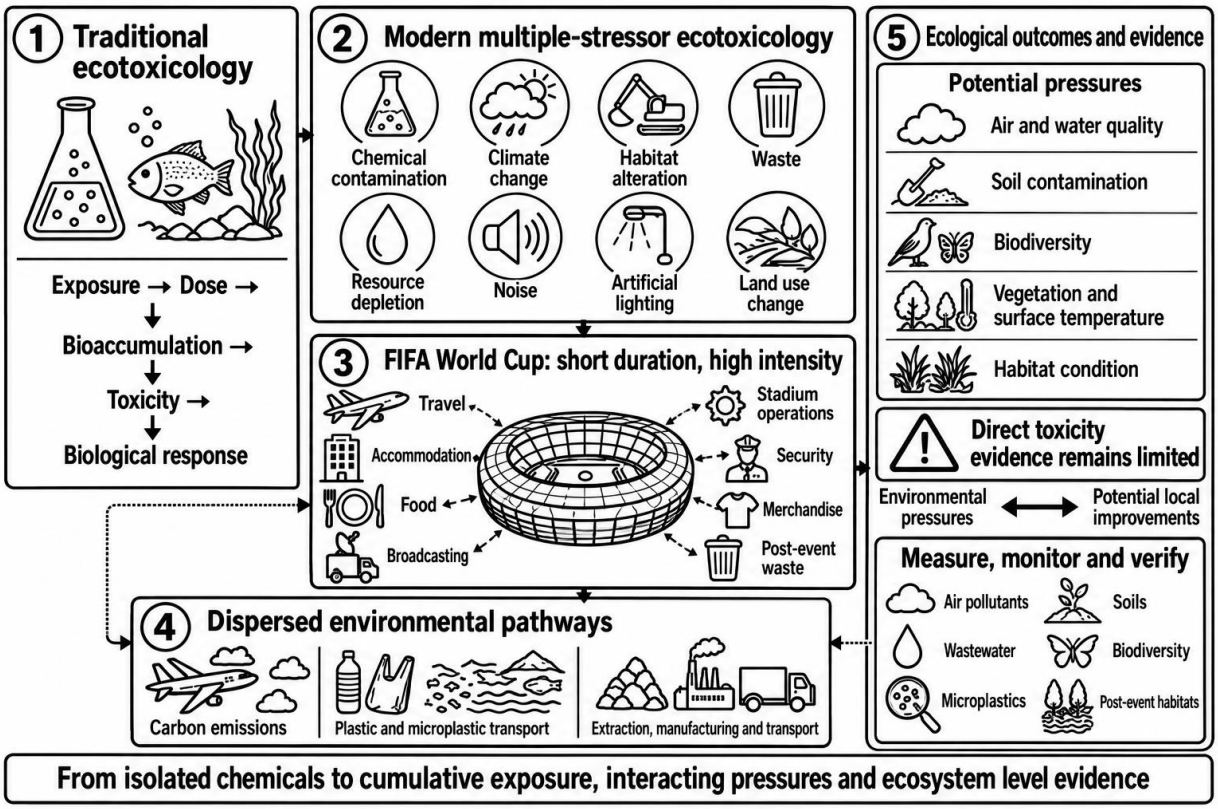


Figure 1. Ecotoxicological thinking beyond chemicals: The FIFA World Cup as a short-duration, high-intensity, multiple stressor ecological episode.

Traditional ecotoxicology focused mainly on toxic chemicals, pollutants, and their adverse effects on organisms. Its familiar questions concerned exposure, dose, bioaccumulation, toxicity, and biological response. Modern ecotoxicology, however, increasingly considers the ecosystem as an interconnected system exposed to several pressures at the same time. Chemical contamination may interact with climate change, habitat alteration, waste generation, resource depletion, noise, artificial lighting, and land use change. These interactions mean that ecological harm cannot always be attributed to one identifiable chemical or one isolated source (Newman, 2015; Walker et al., 2012). This broader interpretation allows the FIFA World Cup to be examined as an ecological episode rather than only as a sporting competition.

From this perspective, the World Cup may be understood as a short-duration but high-intensity anthropogenic disturbance. Stadium operations, international travel, accommodation, food consumption, broadcasting, security, merchandise production, and post-event waste combine within a concentrated period. Each activity may appear manageable when considered alone, but the tournament brings them together at an extraordinary scale. Ecotoxicological thinking is valuable precisely because it examines cumulative exposure and interacting pressures. The relevant question is therefore not whether a football match directly releases a toxic chemical. It is whether the complete system required to stage many matches imposes environmental loads that may eventually affect organisms, habitats, and ecological processes.

The tournament also illustrates how local activities can produce geographically dispersed environmental effects. Carbon emitted by an aircraft does not remain above the airport from which the aircraft departed. Plastic packaging discarded near a stadium may be transported through drainage systems and rivers before reaching coastal waters. Materials used in temporary structures may carry environmental costs originating far from the host city through

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mining, manufacturing, and transportation. Wilby et al. (2023) observed that sport contributes to climate change through its emissions while also possessing considerable cultural influence over public attitudes and sustainability practices. The ecological boundary of the World Cup therefore extends far beyond the stadium fence.

Recent research supports this broader interpretation. Studies of World Cup sustainability discuss carbon footprints, circular construction, waste management, transport, land transformation, and environmental governance rather than limiting environmental evaluation to one class of pollutants (Al-Thani, 2025; Al Sholi et al., 2023; Kucukvar et al., 2021). Urban development associated with stadium construction may also alter vegetation, surface temperature, water demand, and surrounding land use. Liu, Abulibdeh, Pirasteh, Zhang, and Fang (2026), for example, examined changes in vegetation and land surface temperature around seven Qatar World Cup stadiums. Such work shows that a mega event can produce both environmental pressures and potential local improvements, but these outcomes must be measured rather than presumed.

An ecotoxicological reading of the World Cup must therefore remain balanced. It should not claim that every stadium or journey causes measurable toxicity in wildlife. Direct evidence connecting World Cup activities with contaminant concentrations, bioaccumulation, and ecological effects remains limited. Nevertheless, the absence of direct toxicity studies does not mean that there is no ecological risk. It reveals an important research gap. Future assessments should connect event inventories with environmental monitoring, including air pollutants, wastewater quality, microplastics, soil contamination, biodiversity responses, and post-event habitat conditions. Only then can sustainability promises be translated into ecologically meaningful evidence.

3. THE INVISIBLE FOOTPRINT BEHIND THE CELEBRATION

Figure 2 illustrates that football itself is not the direct environmental problem; rather, the ecological footprint arises from the extensive systems required to organize and sustain a modern World Cup. Behind the visible celebration are the movements and needs of spectators, teams, officials, media personnel, workers, and tourists, together with transportation, accommodation, cooling, food, water, security, communication, and broadcasting services. Tournament geography, long-distance air travel, construction, and distant supply chains generate carbon emissions, wastewater, mining waste, resource consumption, habitat disturbance, and environmental exposure extending far beyond host cities. The footprint begins before the tournament through planning, construction, procurement, and travel, continues during the matches through energy and water consumption, transport, food services, and waste generation, and persists afterward through maintenance, demolition, material disposal, and urban land use change. Environmental credentials must therefore be supported by independently verifiable evidence covering air, water, vegetation, waste, material recovery, and the long-term use of infrastructure.

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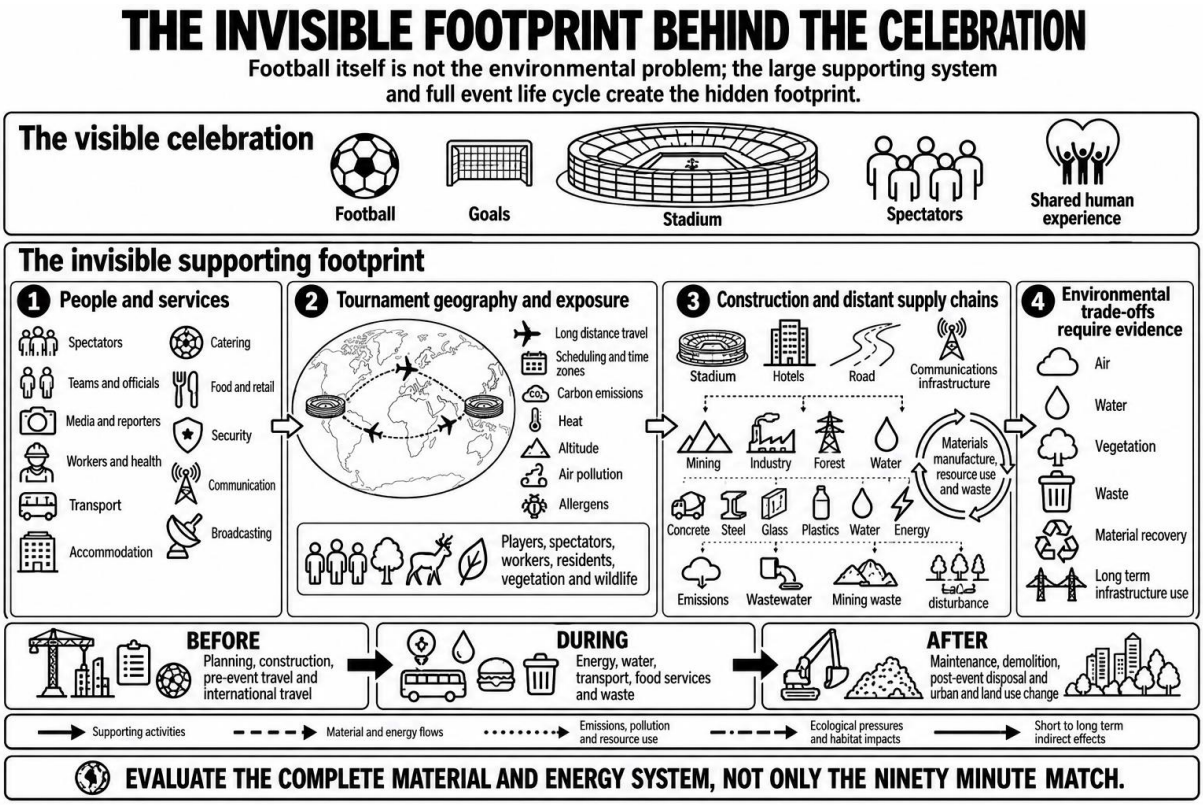


Figure 2. The invisible environmental footprint behind the FIFA World Cup celebration across its supporting systems and event life cycle.

Football itself is not the enemy. A ball rolling across grass does not pollute rivers, acidify oceans, or contaminate sediments. The environmental footprint arises from the scale and supporting structure of the modern tournament. Millions of spectators travel between cities and countries. Teams, officials, journalists, sponsors, workers, and tourists require transportation, accommodation, cooling, food, water, security, and communication services. Broadcasting systems operate continuously across international networks. Seen through an ecotoxicological lens, these activities form a connected web of material and energy flows rather than a collection of unrelated conveniences.

Air travel is one of the most important components of this hidden footprint. McCarthy et al. (2025) examined team travel across 895 matches played in major international football tournaments between 1990 and 2024. Their analysis demonstrates that tournament geography and travel arrangements have substantial consequences for carbon emissions. Hosting matches across several countries and widely separated cities may distribute economic benefits, but it also increases travel distances. The issue is particularly relevant to the expanded 2026 World Cup because matches are distributed across Canada, Mexico, and the United States. Scheduling and team allocation therefore become environmental decisions, even when they are presented primarily as sporting or logistical matters.

The 2026 tournament also introduces environmental exposure concerns for players and spectators. Esh et al. (2026) identified heat, altitude, air pollution, allergens, and extensive travel as important environmental challenges that will vary among host cities. These conditions are normally discussed in relation to player health and performance, but they also reveal the wider ecological condition of host environments. Poor air quality, for example, does not affect athletes alone. It reflects pollutant mixtures to which urban vegetation, animals, outdoor workers, residents, and visitors may also be exposed. Sport therefore becomes a temporary window through which existing environmental inequalities become more visible.

Construction and infrastructure contribute another substantial but less visible burden. Stadiums, transport facilities, hotels, roads, fan zones, and communication networks require concrete, steel, glass, plastics, water, and energy. The extraction and processing of these materials can generate emissions, wastewater, mining waste, and habitat disturbance far from the host city. Kucukvar et al. (2021) argued that modular construction and collaborative

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circular economy practices could reduce some of these impacts by facilitating material recovery and reuse. Such approaches are encouraging, but their value depends on what happens to the materials after the final match, not merely on the environmental language used during construction.

The full footprint must therefore be evaluated across the event's life cycle. It begins before the tournament through planning, construction, procurement, and international travel. It continues during the matches through energy use, water consumption, transport, food services, and waste generation. It persists afterward through infrastructure maintenance, demolition, material disposal, and changes in urban land use. Wang, Hu, Wang, and Zhang (2026) showed that environmental performance involving air, water, vegetation, and waste has become relevant to mega sport event bidding and urban competitiveness. This is an important development, but environmental credentials should be supported by independently verifiable outcomes rather than functioning only as part of a competitive bid.

4. WASTE, CONSUMPTION, AND ECOTOXICOLOGICAL PATHWAYS

Figure 3 illustrates how products entering a football tournament move through extraction, production, transportation, consumption, and disposal before reaching landfills, incinerators, recycling facilities, urban drains, or rivers. Plastic items may undergo fragmentation through sunlight, heat, and abrasion, producing microplastics that move through wastewater systems into rivers, oceans, organisms, and food webs. Plastics and electronic products may also release or transport dyes, plasticizers, flame retardants, stabilizers, metals, and other contaminants whose persistence, mobility, and biological availability influence ecological exposure. Food and beverage services generate additional organic and packaging waste through procurement, refrigeration, preparation, packaging, and consumption. Because individual actions accumulate across millions of spectators, multiple venues, and several weeks, prevention must begin at procurement through reusable systems, deposit schemes, drinking water stations, food donation, accurate purchasing, recyclable materials, and accountable contracting. Independently audited data are therefore required to determine material use, waste generation, recycling quality, food recovery, contamination rates, and final disposal routes, since transferring waste from landfill to incineration does not necessarily represent genuine zero waste.

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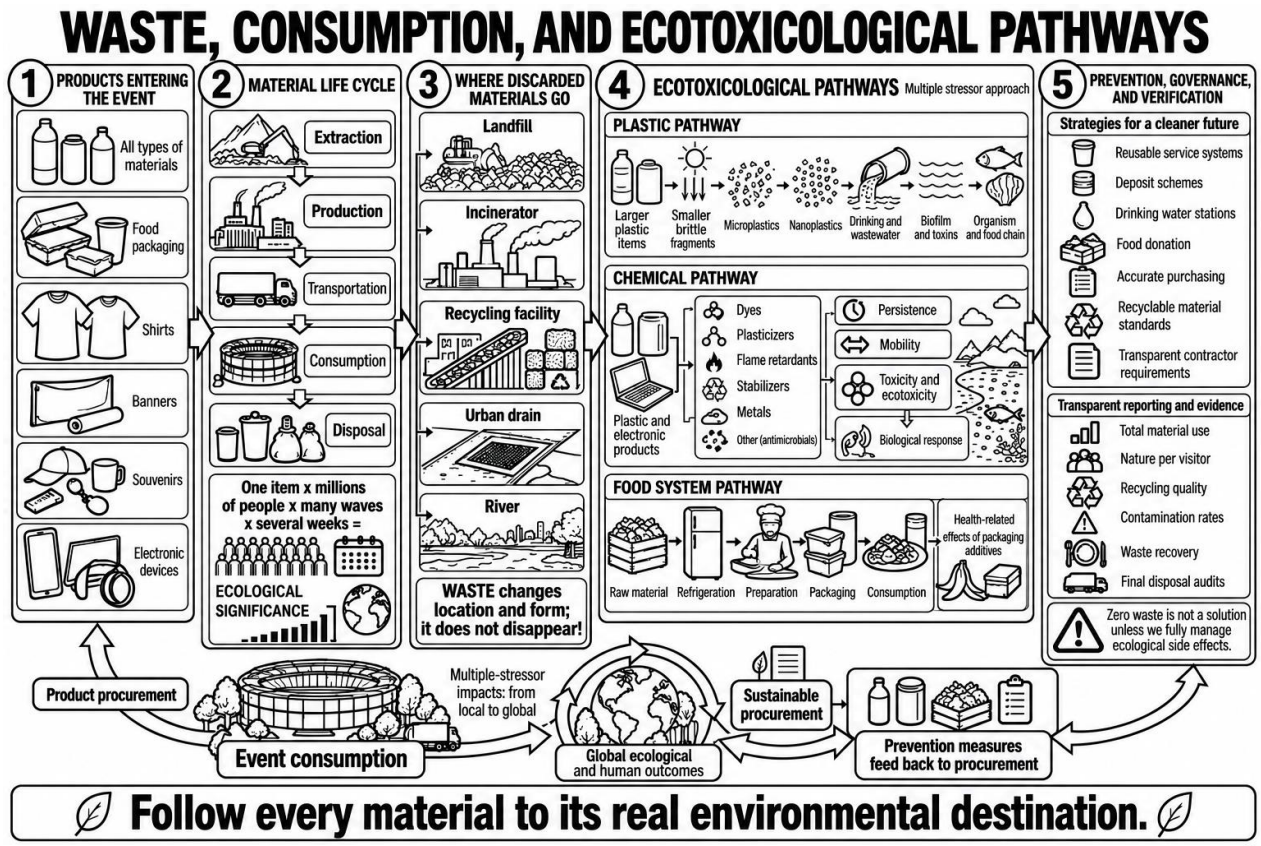


Figure 3. Waste, consumption, and ecotoxicological pathways associated with material use throughout a major football tournament.

Watching supporters celebrate in stadiums and fan zones, I often think about the material remains of the event. Behind every drink container, food package, shirt, banner, souvenir, and electronic device lies a chain of extraction, production, transportation, consumption, and disposal. Ecotoxicology teaches us that waste does not disappear simply because it has left human sight. It changes location and form. A discarded item may enter a landfill, an incinerator, a recycling facility, an urban drain, or a river. Its environmental importance depends not only on its quantity but also on its chemical composition, persistence, mobility, and eventual biological availability.

Plastic waste illustrates this pathway clearly. Larger plastic items can be fragmented by sunlight, heat, abrasion, and mechanical stress into smaller particles. These particles may move through drainage networks and wastewater systems into freshwater and marine environments. Plastics can contain dyes, plasticizers, flame retardants, stabilizers, metals, and other additives, while their surfaces may also carry environmental contaminants. The ecological concern is therefore not limited to litter that looks unpleasant around a stadium. It includes the possibility that persistent materials may enter food webs or interact with organisms long after the tournament has ended.

Food and beverage systems add another dimension. A large tournament requires extensive procurement, refrigeration, preparation, packaging, and transportation. Uneaten food becomes organic waste, while single-use containers, cutlery, bottles, and multilayer packaging create difficult waste streams. Al-Thani (2025) examined the relationships among governance, planning, risk reduction, zero waste, and sustainability in the Qatar 2022 World Cup. The study is valuable because it recognizes that waste management is not simply a cleaning operation after spectators leave. It is a governance responsibility requiring preparation, coordination, measurement, and accountability throughout the event.

The ecological significance of waste lies in accumulation. One plastic cup may appear insignificant. One shirt may appear harmless. One meal discarded at the end of the evening may seem unavoidable. Yet, when these actions are multiplied across millions of people, numerous venues, and several weeks, their combined effect becomes environmentally meaningful. The ecological footprint approach is useful because mega events generate impacts

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through visitor movement, consumption, and resource demand (Collins et al., 2009). Circular economy research on the Qatar World Cup similarly shows that supply chain emissions and material use must be considered alongside waste collected within the event site (Al Sholi et al., 2023).

Waste prevention should therefore begin before a product reaches the spectator. Reusable service systems, deposit schemes, safe drinking water stations, food donation, accurate purchasing, recyclable material standards, and transparent contractor requirements can reduce waste at its source. The environmental success of these measures must be judged through independently audited data, including total material use, waste generated per visitor, recycling quality, contamination rates, food recovery, and final disposal routes. Claims of "zero waste" require particular care because transferring waste from landfill to incineration does not necessarily eliminate emissions or toxic residues. Ecotoxicology demands that we follow the material to its real environmental destination.

5. CLIMATE CHANGE, SPORT, AND THE RETURNING IMPACT

Figure 4 illustrates the circular relationship between tournament activities, greenhouse gas emissions, climate and ecosystem change, and the resulting risks that return to affect sport and society. Transportation, construction, tourism, and energy use contribute to emissions that influence temperature, rainfall, water availability, air quality, and ecosystem functioning. These altered conditions may expose athletes, spectators, workers, and residents to extreme heat, drought, flooding, storms, air pollution, wildfire smoke, travel disruption, infrastructure damage, and match postponement. Environmental conditions may also differ among host cities, creating concerns involving health, occupational protection, social equity, and fair competition. Mitigation measures should reduce avoidable travel, promote low-emission transportation, use existing infrastructure, improve energy efficiency, and provide complete carbon accounts, while adaptation measures should address heat, scheduling, water management, and urban greening. However, greening interventions must be evaluated for their water requirements, chemical inputs, biodiversity value, species suitability, maintenance needs, and long-term survival, because adaptation without meaningful emission reduction allows the underlying environmental pressure to continue.

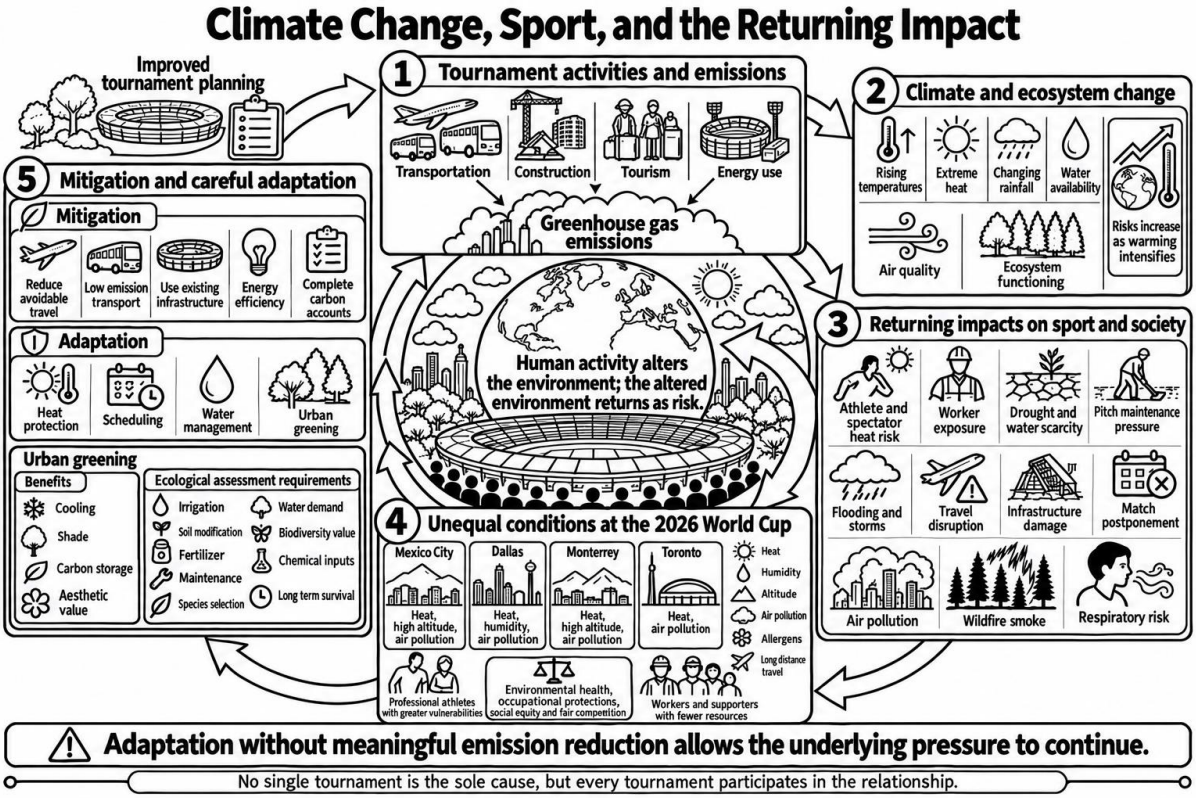


Figure 4. Climate change, sport, and the returning impact: An ecotoxicological feedback pathway linking tournament emissions, environmental change, and risks to football and society.

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A very important ecotoxicological lesson is that pollutants and disturbances often return to affect the society that produced them. Greenhouse gases emitted through transportation, construction, tourism, and energy use do not remain abstract entries in a carbon inventory. They influence climate systems, temperature extremes, rainfall patterns, water availability, air quality, and ecosystem functioning. Climate change is already recognized as a major threat to human and ecological systems, with risks increasing as warming intensifies (Intergovernmental Panel on Climate Change, 2023). The World Cup participates in this global relationship even though no single tournament can be treated as the sole cause.

The irony is that football contributes to emissions while climate change increasingly threatens football itself. Extreme heat may endanger athletes, officials, workers, and spectators. Drought and water scarcity may affect pitch maintenance and urban water supplies. Flooding and storms can disrupt travel, damage infrastructure, and force match postponements. Air pollution and wildfire smoke may create respiratory risks. Orr and Inoue (2019) described this relationship through the climate vulnerability of sport organizations, while Wilby et al. (2023) showed that sport is simultaneously a source of emissions, a climate-vulnerable activity, and a potentially influential agent of behavioural change.

The 2026 World Cup makes this returning impact especially visible. Esh et al. (2026) noted that teams will encounter varying combinations of heat, humidity, altitude, air pollution, allergens, and long-distance travel among host cities. These environmental conditions will not be distributed equally. Some teams may play under more demanding conditions than others, while outdoor workers and supporters may have fewer protective resources than professional athletes. Climate adaptation in sport is therefore not only a performance issue. It is also an issue of environmental health, occupational protection, social equity, and fair competition.

Urban greening offers one possible response, but it also illustrates the need for careful ecological assessment. Liu et al. (2026) found that greening associated with Qatar's stadium developments produced measurable vegetation and land surface temperature changes around the sites. Vegetation can provide cooling, shade, carbon storage, and aesthetic benefits. In an arid environment, however, greening may also require irrigation, soil modification, fertilizer, maintenance, and suitable species selection. An intervention should not be called sustainable merely because it appears green. Its water demand, biodiversity value, chemical inputs, long-term survival, and relationship with native ecosystems should also be evaluated.

This circular relationship resembles an ecotoxicological feedback pathway. Human activity alters environmental conditions, and those altered conditions eventually return as risks to human activity. The lesson is not that football must end. The lesson is that sport cannot continue to behave as though climate stability were an unlimited and free resource. Tournament planning should reduce avoidable travel, favour low-emission transport, use existing infrastructure where possible, improve energy efficiency, and publish complete carbon accounts. Adaptation is necessary, but adaptation without meaningful emission reduction merely allows the underlying pressure to continue.

6. THE PARADOX OF HUMAN GREATNESS

Figure 5 illustrates the World Cup as both an expression of human greatness and a reflection of humanity's ecological contradictions. Football creates beauty, discipline, cooperation, shared rules, cultural understanding, peaceful competition, and unity across national borders. At the same time, the continuing expansion of teams, matches, host cities, flights, sponsorship, merchandise, and broadcasting increases demand for energy, water, land, materials, and the limited capacity of ecosystems to absorb waste. Although successive tournaments have introduced environmental programmes involving resource management, circular construction, urban greening, waste planning, and infrastructure legacy, an important question remains whether sustainability genuinely reshapes tournament decisions or merely surrounds an unchanged model of growth. A more meaningful measure of greatness should therefore include restraint, responsibility, measurable environmental outcomes, long-term infrastructure use, and the prevention of hidden costs to distant communities and future generations. The most advanced tournament is not

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necessarily the largest, but the one that provides the richest human experience with the smallest avoidable ecological burden.

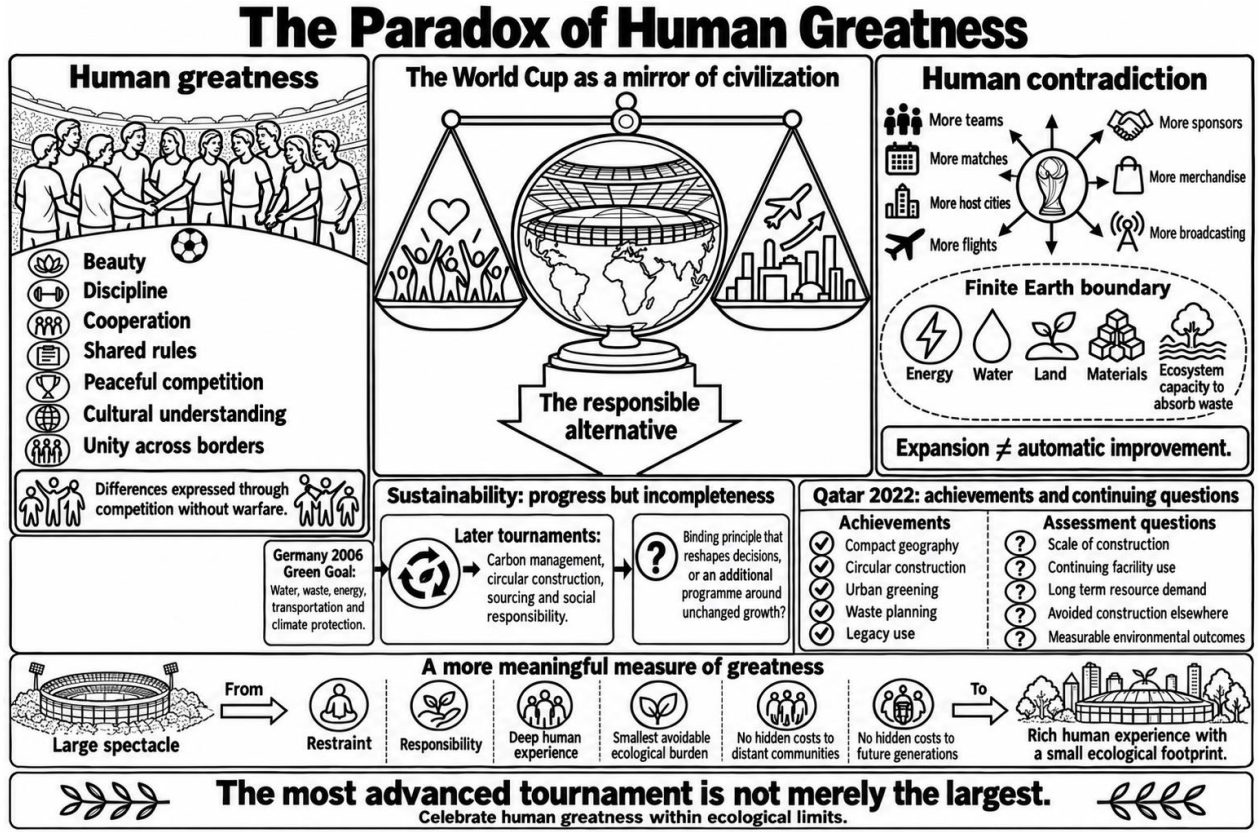


Figure 5. The paradox of human greatness: The FIFA World Cup as a mirror of human unity, continuous expansion, and finite ecological limits.

Perhaps the greatest irony is that the World Cup represents both the greatness and the contradictions of humanity. Human beings can create beauty, discipline, cooperation, and peaceful competition. Nations that disagree politically can still meet on a football field under shared rules. People who cannot speak the same language can understand the meaning of a goal, a save, a loss, or a victory. For ninety minutes, differences of culture, geography, and history may be expressed through competition without warfare. This is not a small achievement, and any environmental reflection should acknowledge the genuine human value of the event.

Yet, the same event also reflects humanity's tendency to equate expansion with improvement. More teams, more matches, more host cities, more flights, more sponsors, more merchandise, and more broadcasting are presented as signs of progress. Ecology teaches a more cautious lesson. Growth within a finite system must eventually encounter limits because energy, water, land, materials, and the capacity of ecosystems to absorb waste are not infinite (Odum & Barrett, 2005). A larger tournament may offer greater inclusion and commercial reach, but it may also multiply environmental pressures unless its structure is fundamentally reconsidered.

The history of World Cup sustainability demonstrates both progress and incompleteness. Germany's 2006 "Green Goal" programme addressed water, waste, energy, transportation, and climate protection, establishing an important precedent for environmental planning in international football (Dolles & Söderman, 2010). Later tournaments expanded sustainability language to include carbon management, circular construction, sourcing, and social responsibility (Orr, Murfree, Anahory, & Edwabne, 2022). These developments show that environmental concern is no longer absent from football governance. The remaining question is whether sustainability has become

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a binding principle that can reshape tournament decisions or remains an additional programme surrounding an unchanged model of growth.

Qatar 2022 further illustrates this contradiction. Circular construction, compact tournament geography, urban greening, waste planning, and legacy use were presented as sustainability achievements (Al-Thani, 2025; Al Sholi et al., 2023; Kucukvar et al., 2021). At the same time, the scale of construction and the environmental claims associated with the tournament generated continuing debate. Elbanna, Talaoui, and Armstrong (2025) emphasized that the tournament's legacy extends beyond immediate financial returns, including infrastructure and broader social changes. From an ecological perspective, however, a legacy must also be judged by the continuing use of facilities, long-term resource demands, avoided construction elsewhere, and measurable environmental outcomes.

The World Cup therefore becomes a mirror of civilization. It shows that humanity can cooperate across borders, but it also exposes our appetite for scale and spectacle. True greatness should not be measured only by the number of spectators reached, revenues generated, or stadiums constructed. It should also be measured by restraint, responsibility, and the ability to celebrate without transferring hidden costs to distant communities and future generations. The most advanced tournament would not merely be the largest. It would be the one that delivers the deepest human experience with the smallest avoidable ecological burden.

7. A PERSONAL REFLECTION

As someone who has spent decades studying pollutants in mussels, sediments, and aquatic ecosystems, I have learned that environmental problems rarely arise from obviously evil intentions. They often emerge from ordinary activities repeated at enormous scales. A person eats, travels, purchases something, or discards a container without intending to harm an ecosystem. Yet, millions of similar decisions can produce contamination, resource depletion, and ecological stress. This is why ecotoxicology is not only a laboratory science concerned with instruments, concentrations, and statistical significance. It is also a way of seeing connections that are normally hidden by distance and convenience.

My work with aquatic organisms has repeatedly shown me that ecosystems retain evidence. Water may carry a pollutant away from its visible source, but the pollutant may accumulate in sediment or enter the tissues of an organism. The absence of visible waste does not prove the absence of environmental burden. I apply the same reasoning when watching the World Cup. The television screen shows skill, colour, music, emotion, and celebration. It does not show the aircraft emissions, construction materials, wastewater, discarded packaging, electricity demand, or ecological disturbances that helped make the spectacle possible.

Football is not the enemy. Joy is not the enemy. Human celebration is not the enemy. The problem begins when celebration becomes detached from ecological responsibility. The biosphere that supports stadiums, cities, food systems, water supplies, and human health is the same biosphere that receives our emissions and wastes. The World Cup is therefore not separate from nature. It is part of the human ecological system. Its environmental impacts are not external side effects. They are consequences generated within the same system that makes the event possible.

I also believe that football possesses unusual power to improve environmental awareness. Few institutions can communicate simultaneously with billions of people across differences of age, language, nationality, religion, and social class. Sustainability messages linked to football could encourage public transport, reusable products, responsible consumption, waste reduction, and respect for local environments. Wilby et al. (2023) noted that sport has cultural influence over sustainability behaviour. That influence should not be reduced to slogans displayed before a match. Players, governing bodies, sponsors, broadcasters, and supporters must demonstrate the behaviours they ask others to adopt.

When billions of people celebrate a goal, another question should enter our minds: can humanity celebrate greatness without increasing the burden on the environment that sustains us? This question does not diminish football. It asks football to become worthy of the unity and hope it represents. Here, ecotoxicology becomes more

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than the study of contaminants. It becomes a philosophy of connection, responsibility, evidence, and humility. Ninety minutes may decide the result of a match, but the ecological consequences of staging that match can remain much longer. Our responsibility therefore begins before kick-off and continues well beyond the final whistle.

8. CONCLUSION

From an ecotoxicological perspective, the FIFA World Cup is far more than a sporting event. It is a global-scale example of how human joy, economics, technology, nationalism, tourism, and consumption interact with ecological systems. The tournament demonstrates the concept of cumulative stressors, where many small actions combine into large environmental consequences. The World Cup has the power to unite humanity. However, true victory in the twenty-first century should not be measured only by goals, trophies, and national pride. It should also be measured by whether humanity can celebrate without damaging the ecological foundations of life. Perhaps the most important lesson is simple: humanity and the environment are not opponents. They are players on the same team. If one loses, eventually both lose.

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