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Timothy Kellison

Georgia State University, tkellison@gsu.edu

Madeleine Orr

SUNY Cortland, madeleine.orr@cortland.edu

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Climate Vulnerability as a Catalyst for Early Stadium Replacement

Timothy Kellison

Georgia State University

Madeleine Orr

SUNY Cortland

Correspondence should be addressed to: Timothy Kellison, Georgia State University, Center for Sport and Urban Policy, PO Box 3975, Atlanta, GA USA 30302, phone: +1 404-413-8363, email: tkellison@gsu.edu

Abstract

Purpose:

Severe hazards associated with climate change are threatening human settlements, thereby requiring global cities to implement comprehensive climate adaptation strategies. For sports organizations, adaptive measures may include designing and constructing new stadiums. In this study, we explore climate change as a vehicle for urban transformation, particularly as it relates to the replacement of existing stadiums with new, more sustainable and resilient venues.

Design/methodology/approach:

We employed a collective case study approach focusing on three recent cases of stadium replacement: Globe Life Field in Arlington, Texas; Oakland Ballpark in Oakland, California; and Marlins Park in Miami, Florida. These cases were selected because an official representative of each team made explicit references to some form of climate adaptation, though each ballpark faces a distinctive climate-related threat.

Findings:

Each of the cases illustrates the various ways in which climate vulnerability may be deployed by teams and policymakers to replace professional sports stadiums. Although all three examples involved the replacement of an existing ballpark, only in the Texas case was climate adaptation cited explicitly as the primary reason for stadium replacement. Still, ballpark-replacement plans in Oakland and Miami included significant and costly design features to protect the stadiums from extreme weather events.

Originality:

This study applies the concept of climate vulnerability to illustrate a potential strategy to justify stadium replacement. As cities and metropolitan regions continue to grapple with the grand

challenge of climate change, the associated vulnerability of large public assembly facilities like major sports stadiums—particularly those prominently situated in urban centers—can no longer be ignored.

Keywords: sport ecology, politics, public finance, organizational climate capacity, climate impacts on organizations

Climate Vulnerability as a Catalyst for Early Stadium Replacement

Introduction

Between 1991–2010, the replacement rate of North American professional sports venues exceeded 90 percent (Long, 2013), and stadium lifespans have continued to decline in the years since (McLeod and Holden, 2018). Stadiums are often replaced for reasons other than functional or structural deficiencies. For example, while Major League Baseball's (MLB) two oldest parks opened in the 1910s, its two newest venues replaced stadiums built in the 1990s. In 2017, the Atlanta Braves moved approximately 22 km from their downtown location, citing the strategic decision to make the stadium more accessible to its fanbase, the majority of whom lived in the city's northern suburbs (McGehee *et al.*, in press). Then, in 2020, the Texas Rangers replaced their open-air venue with an enclosable, air-conditioned ballpark to provide spectators with a more hospitable environment for watching baseball in the hot Texas summer (Formby, 2016).

Taken together, these cases illustrate one aspect of the interrelationship between sport and the natural environment (McCullough *et al.*, in press). The former case provides an example of the impact stadium location can have on the environment, as the Braves' relocation to a site nearer to the majority of their fans could reduce the overall carbon emissions associated with spectator travel. The latter example demonstrates the potential impact of the environment on stadium design, as calls for a new stadium were prompted by worsening climatic conditions. The Rangers' replacement stadium is particularly noteworthy given the age of the team's existing ballpark and the high public cost of both venues (Mosier and Brumfield, 2016).

The Rangers' case is a microcosm of climate adaptations taking place in cities and urban spaces around the world. Extreme weather events associated with climate change are expected to continue to threaten human settlements (IPCC, 2014), forcing urban planners and public

policymakers to develop robust systems of climate adaptation (Dhar and Khirfan, 2017). It is estimated that up to 75 percent of global cities are engaged in both climate mitigation and adaptation strategies (Aylett, 2014). Approaches to climate adaptation include ecosystem protection in Durban, the management of low-income settlements in Indore, and spatial and territorial planning in Medellin (Chu *et al.*, 2017).

This study explores climate change as a vehicle for urban transformation, particularly as it is used to catalyze the replacement of existing stadiums with more sustainable and resilient venues. In some cases, facility replacement may be justified from several perspectives, including the comfort of fans; the health and wellness of athletes, spectators, and personnel; the performance of competitors and match officials; and the financial security of organizations and event operators. In other instances, officials may exploit the predicted effects of climate change to hasten venue replacement, a process that itself carries heavy environmental costs. As discussed further below, regardless of whether its effects are already felt or anticipated well into the future, climate change may presage significant changes to urban spaces, infrastructure, and policy through the construction of new, publicly funded sports stadiums.

Literature Review

Stadium replacement

Historically, organizations appealing for a new stadium have leveraged their supposed public value to attract the support of policymakers, fans, and the wider community. In general, stadium-subsidy advocates argue that a professional sports team yields positive tangible (e.g., increase in regional income and tax revenues, job creation, accelerated development) and intangible (e.g., civic pride, development of social capital) externalities (Matheson, 2019; Propheter, 2019). These apparent benefits validate the team's existence, a keystone when

lobbying for a new (or significantly renovated) facility. Additionally, pro-subsidy advocates may argue stadium projects—especially those intended to anchor a more extensive development or district—will “attract more retail, commercial, and residential investment back to a city’s downtown core, ...reinforce a city’s reputation, signify a city’s return to prominence, and/or provide evidence of a city’s ascendance or arrival among a group of peer cities” (Mason *et al.*, 2015, p. 540). As observed by deMause and Cagan (2008), an organization may claim that its existing venue is drifting toward obsolescence and failing to meet the needs of the team (e.g., lack of premium seating necessary to maintain fiscal viability) and fans (e.g., technological deficiencies, poor user amenities). Moreover, without an upgraded stadium, the team argues, it will suffer both financially and in the league standings.

In the absence of a clear path to stadium replacement, team owners may employ the threat of relocation, often with great effect (Hyatt, 2007). As Mondello and Kellison (2016) argued, when a stadium-subsidy decision is made by the public via a referendum or initiative, the perceived threat of team relocation can contribute to their favorable or opposing vote. Voters may also be influenced by well-funded campaigns organized by the teams themselves (e.g., Norman *et al.*, 2015) or local growth coalitions (Misener and Mason, 2008) that emphasize a stadium’s ability to drive economic activity and revitalize neighborhoods (Propheter, 2019; Sapotichne, 2012; van Holm, 2018).

As part of a robust strategy to attract local support for a new stadium, organizations may focus not only on a proposed facility’s positive impact on the community but also on noteworthy features of the venue design itself. Areas of emphasis may include improved seat comfort and sightlines, larger video displays, more attractive food and beverage offerings, wider concourses, and more reliable wireless connectivity. To maximize community support, organizations may

also appeal to members of the broader public, including those who might not typically be characterized as sports consumers. One strategy for connecting to those traditionally considered non-users might be to emphasize a proposed stadium project's pro-environmental design, as contended by Kellison and Mondello (2012): "The integration of sustainable elements into the facility's plan promotes a straightforward indication of the organisation's environmental legitimacy" (p. 407). Based on this premise, they hypothesized that "a sport organisation seeking public funding for a new facility will receive greater public support by incorporating pro-environmental features into the facility's design" (p. 407). This argument suggests that voters may be attracted to a forward-thinking facility design.

Previous research has illustrated the multifaceted approach taken by pro-subsidy advocates to garner support to replace an existing professional sports stadium. Although some public resistance to a stadium subsidy could be expected in any case, such opposition may be especially pronounced for projects proposed to replace stadiums perceived to be structurally sound and aesthetically sufficient (as well as those viewed as historic; Pfleegor *et al.*, 2013)—in other words, those facilities not yet at the end of their useful lifespan. To rationalize the replacement of these stadiums, pro-subsidy advocates may begin exploring alternative justifications. One such argument that has not received attention in the literature, but one that may begin to emerge in stadium-replacement campaigns (indirectly or directly) is the necessity of addressing an organization's climate vulnerability. This concept is discussed in further detail in the next section.

Climate vulnerability

The Intergovernmental Panel on Climate Change (IPCC, 2014) applies the concept of climate vulnerability to denote the degree to which a social system (e.g., a business, a city) is

susceptible to the negative impacts of climate change. Vulnerability is composed of two complementary constructs: potential impacts and adaptive capacity (Hinkel, 2011; Smit and Wandel, 2006). Potential impact refers to the sum of all potential consequences of current or future climate hazards when adaptation is not considered (IPCC, 2014). Adaptive capacity is the ability of a system to moderate potential damages, take advantage of opportunities, and cope with the consequences of climate (IPCC, 2014; Smit and Wandel, 2006). The management literature has specified that social systems have different climate vulnerabilities—that is, varying degrees of exposure and sensitivity to climate change-related hazards—as well as different capacities to respond (Berkhout, 2011).

To suit the particularities of the sports context and address critiques of vagueness in the vulnerability literature, Orr and Inoue (2019) revised the constructs of adaptive capacity and potential impact to fit the context of sports organizations. The constructs that emerged from this sport-specific revision were organizational climate capacity (OCC) for adaptive capacity and climate impacts on organizations (CIO) for potential impact. CIO refers to “the probability and consequences of climate change impacts affecting the sports organization, as the organization presently exists and operates” (p. 455), and OCC is defined as “a sport organization’s capacity to accommodate changes in climate with minimal disruptions or additional costs,” (p. 455). Both CIO and OCC exist on spectrums, so all sports organizations have some degree of CIO and some degree of OCC.

In their Climate Vulnerability of Sport Organizations (CVSO) framework, Orr and Inoue (2019) identified four possible states of climate vulnerability: Problem, Redundant, Responsive, and Fortified. The worst-case for an organization is the Problem state, in which it faces high CIO (i.e., high climate risk) and low OCC. In the Problem state, sport organizations are at risk for

disruptions, damages, and losses due to climate hazards, so managers must either lessen their sensitivity and exposure or increase their capacity. Ideally, managers of organizations in the Problem state would aim to move into the Responsive or Fortified states. Contrastingly, the best circumstance for an organization, seemingly, is to have low CIO and high OCC, which land it in the Redundant state. In the Redundant state, climate change and its associated extreme weather impacts present a minor or negligible concern and therefore, the organization does not need to spend additional resources on adaptation efforts. In the Responsive state, an organization experiences low CIO and has low OCC, effectively matching its available adaptive resources to the threat of climate hazards. When an organization faces high CIO and has high OCC, the organization is in the Fortified state. It is important for organizations in either the Responsive or Fortified state to remain vigilant and attentive to any changes in CIO, such that they can adapt and increase their OCC accordingly. These two states represent the most efficient use of resources and most appropriate state of readiness for climate hazards.

To ensure an organization remains prepared and ready for climate hazards, it must regularly reassess CIO and OCC, making adjustments to their OCC where possible. Importantly, sport organizations have limited control over CIO, since sport managers are unlikely to be able to control weather or exposure to severe climate hazards such as wildfires or floods. However, OCC *is* controllable: managers can cultivate, organize, and deploy their resources in such a way that increases their preparedness to respond to climate hazards and challenges. While many sports organizations are responding to climate change retroactively (i.e., waiting to be directly impacted by a hazard before acting), others are preemptively building and strengthening their OCC.

For a typical sports organization, the vast majority of its operations occur within the physical structure of the stadium. Therefore, much of the organization's OCC is contingent upon the facility's readiness to withstand extreme weather events. When such capability is in question, the organization has several options: ignore, modify (i.e., by retrofitting or renovating the existing stadium), or replace. These options vary in their potential short-term savings and long-term costs, and an organization's ability to fund (either privately or with subsidies) a renovation or complete stadium replacement is a principal factor in its decision-making process. As suggested in the previous section, the availability of public funding for a major stadium project may be based in large part on the strength of the organization's argument that a new stadium is needed in the first place. Though not yet a recurrent talking point among organizations lobbying for public stadium funding, climate vulnerability is applied to several recent stadium-replacement cases in this study, the purpose of which is to illustrate how professional sports organizations may employ the concepts of OCC and CIO to substantiate the need for stadium replacement. As cities and metropolitan regions continue to grapple with the grand challenge of climate change, the associated vulnerability of large public assembly facilities like major sports stadiums—particularly those prominently situated in urban centers—cannot be ignored much longer.

Method

To illustrate how an organization's (and city's) perceived climate vulnerability can trigger the pursuit of a replacement stadium, a collective case study approach was utilized (Creswell and Poth, 2018; Schwandt and Gates, 2018). This approach enables researchers “to explore cross-case comparisons and draw generalizations from the entire collection to understand the phenomenon deeply from a variety of perspectives” (Goddard, 2010, p. 165). Three recent

cases of stadium replacement were selected, all of which were tied to Major League Baseball teams: (1) Globe Life Field in Arlington, Texas; (2) Oakland Ballpark at Jack London Square in Oakland, California; and (3) Marlins Park in Miami, Florida. All cases satisfied a necessary condition to be included in the study: an explicit reference to some form of climate adaptation had to be made publicly by an official representative of the team. Additionally, in each case, climate adaptation was a prominent consideration in its design, though each ballpark is faced with a distinctive climate-related threat (i.e., extreme heat, sea-level rise, and hurricanes, respectively).

Public statements related to each ballpark's climate adaptivity were identified by scouring news reports in each city's most widely circulated publications. To ensure the interpretation of empirical material was consistent with the general themes, material collected from news reports was triangulated by cross-referencing it with official and internal documents (e.g., official team statements, public meeting minutes, city ordinance proposals, county resolutions) and other media reports.

Given the illustrative purpose of this study, analysis of the application of climate vulnerability as a justification for stadium replacement is provided for each case. This analysis is based on data from the 2018 IPCC special report *Global Warming of 1.5°C*. Additionally, evaluation of the cases is grounded in Orr and Inoue's (2019) CVSO framework, which was "intended to inform researchers of the risk that climate change presents to sport, and to inspire research on how organizations can minimize their vulnerability" (p. 457). Specifically, the immediacy and urgency of current climate hazards (e.g., heat in Texas, flooding in Miami) are compared to the organization's current capacity to respond (i.e., pre-new build) to determine which state of the CVSO framework best serves as a starting point. Then, the same comparison

was completed to determine whether the new stadium build would effectively shift the organization to a new and more desirable position within the CVSO framework, or whether the new stadium had minimal impact on the organization's overall vulnerability.

Results and Discussion

A summary of the three cases examined in this study are provided in Table I. Each case is discussed in turn below.

[Insert Table I about here]

Arlington, Texas

As referenced in this study's introduction, the Texas Rangers were set to debut MLB's newest ballpark, Globe Life Field, in Arlington in 2020. The stadium replaced the similarly named Globe Life Park, which opened in 1994. Although it was MLB's 11th oldest park, Globe Life Park was nevertheless structurally sound and featured modern design characteristics. As Madden (2016) observed, however, it was missing one essential feature:

[Globe Field Park] still enjoys a reputation for providing baseball fans the nostalgia of classic understated architecture combined with modern restrooms, concessions and luxury boxes. The ballpark has undergone several renovations and improvements over recent years, which has kept the park from feeling out-of-date. The only thing it lacks is air conditioning. (para. 9)

Based on both official and media reports, the stadium's inability to regulate air temperature was a significant constraint factor among spectators (Stevenson, 2016). It also posed health- and performance-related issues for players and staff, and these problems were expected to worsen in the future.

In Dallas, average summer temperatures have climbed since the opening of Globe Life Park, and the trend is expected to continue in the future (Fox, 2019). Cullen (2016) reported that by 2060, Dallas is predicted to record 55 days above 100 °F, compared to an average of 15 days above 100 °F between 1991–2010. This expected rise in temperature will not be spread evenly across the summer; rather, these higher averages reflect an increased frequency and duration of extreme heat events (IPCC, 2018), which creates an uncomfortable setting for fans and dangerous playing conditions for athletes. Further, extreme heat events can impact performance in baseball by slowing the speed of the ball and over-drying the field. These conditions can lead to harder ground surfaces and a dustier diamond, which can impact running speed (Orr, 2020). As Grant (2019) reported, the game-time temperature at Globe Life Park exceeded 90 °F (32.2 °C) more than 750 times across the 26 seasons it was in use, a sum more than double that of the stadium with the second-highest total. On the business side, Rangers co-owner Ray Davis argued Globe Life Park’s lack of climate control “made it difficult to play games during inclement weather and prevented the stadium from attracting concerts, special events and the ‘jewel’ of professional baseball, the All-Star game” (Richter and Francis, 2016, p. 12). For these reasons, this case illustrates an example of an organization in the Problem state of the CVSO framework (Orr and Inoue, 2019) before the new stadium was built, as the heat presented a threat to on-field performance, business, and human health, especially among athletes.

The solution to these heat-related issues, the Rangers proposed, was to replace Globe Life Park with a new, climate-controlled stadium enabled, in part, by a retractable roof. It was not the first time an enclosed (or enclosable) ballpark was considered. When Tom Schieffer, part of the Rangers’ 16-member ownership group led by George W. Bush and Rusty Rose, was appointed to oversee the development of Globe Life Park in 1990, he weighed the pros and cons of a stadium

capable of being cooled in the hot Texas summer. Although some players expressed the desire for the Rangers to build a domed stadium (Bohls, 1991), as Schieffer explained, “We thought baseball should be played outdoors. ... The great ballparks are not domed” (Sherrington, 2019, paras. 21, 23). Furthermore, at the time, MLB’s only retractable-roof stadium was the Toronto Blue Jays’ SkyDome (now Rogers Centre), which opened in 1989 at the cost of US\$600 million, a figure that likely would have been met with opposition from Arlington voters. Instead, Globe Life Park would be designed with some shade for spectators, and, as Bush predicted, “a lot of unique sightlines and nooks and crannies that will carry a lot of tradition” (Freeman, 1992, p. E3). In the years after Globe Life Park opened, the Rangers commissioned at least two studies to determine the costs of retrofitting the stadium: In 2007, HKS Architects estimated it would cost \$325 million to add a movable roof to the existing structure, and in 2014, a study led by Populous projected it would cost \$80 million to install a metal canopy that would provide cover for at least 75 percent of spectators (Baker, 2016). Ultimately, the Rangers decided, short of adding a roof, they had “done what they [could]...to create more air flow and more climate-controlled areas in the ballpark. They have added some shade spots, created more air-conditioned clubs and enlarged portals behind home plate that allow air to better circulate” (Grant, 2014, para. 17).

In May 2016, the Rangers released their plan for the \$1-billion ballpark-replacement project. In the proposal, the Rangers pledged \$500 million (plus any cost overruns) and the City of Arlington would be responsible for the other \$500 million, to be funded by extending a half-cent sales tax originally approved by voters to finance a football stadium for the Dallas Cowboys (Richter and Francis, 2016). Based on polling on the proposed ballpark’s design, Rob Matwick, Executive Vice President of Business Operations for the Rangers, acknowledged most fans were

satisfied with the existing facility but also noted their view that air conditioning would be a welcome and necessary improvement (Brumfield, 2017a). The campaign for the new stadium was supported by Arlington Mayor Jeff Williams, who contended “a new ballpark featuring a retractable roof and air conditioning to protect our fans from the summer heat” would “continue to attract visitors to our city and grow our economy for another 30 years” (“A Ballpark Overview”, 2017, p. 5). Additionally, the stadium-replacement effort was bolstered by a well-funded and well-organized campaign called Keep the Rangers, which outspent the Save Our Stadium opposition group 254-to-1. Keep the Rangers also utilized more than 300 volunteers; recognizing the summer heat that motivated the pro-stadium campaign in the first place, volunteer organizer Becky Cowan noted, “We had them walking in June, which is hard to do in Texas” (Brumfield, 2017b, para. 51). In November 2016, Arlington voters approved the stadium proposal (60% *for*, 40% *against*; Center for Sport and Urban Policy, 2020a).

The Rangers’ successful stadium replacement campaign suggests the proposal, which centered largely around a retractable roof and climate control, was justified in order to satisfy existing fans and attract new spectators who might have otherwise avoided ballgames in an outdoor stadium during the hot Texas summer. Moreover, from player-performance and safety standpoints, this proposal may be further defensible. In past seasons, hot-weather conditions forced Rangers’ management to make pregame batting practices optional or cancel them altogether (Grant, 2019). They also provided players with elective pregame IVs to prevent dehydration. As Rangers’ shortstop Elvis Andrus admitted, “It is so hard to play physically in that kind of heat. But it takes so much out of you mentally, too. ...I think god for the new stadium. It’s a blessing” (para. 8). As the Rangers built a new stadium to specifically address

these concerns and the central climate hazard of heat, the organization moved from the Problem state to the Fortified state in the CVSO framework (Orr and Inoue, 2019).

To date, this case is exceptional, as climate adaptation was the clear thrust of the team's argument that a new, publicly funded stadium was necessary for both spectator comfort and team performance. In other recent examples, climate adaptation may be a less apparent rationale for stadium replacement. Nevertheless, they provide a glimpse of what could come as the effects of climate change become more pronounced.

Oakland, California

For at least the past 15 years, the Oakland A's have publicly lobbied to replace their current stadium, the Oakland Coliseum (Dickey, 2005). Before the Oakland Raiders relocated to Las Vegas for the 2020 National Football League (NFL) season, the Coliseum was the last of the multi-purpose stadiums used for both professional baseball and football. As Nicas (2019) wrote in a *New York Times* essay, "The Beauty of America's Ugliest Ballpark", the A's ballpark has been plagued by persistent and wide-ranging issues:

When the Oakland Coliseum opened in 1966, it was hailed as a Brutalist gem that could house two sports in an elegantly simple, circular design.

A half-century later, it is perhaps America's most hated sports stadium. Players and coaches deride it. The Oakland Raiders are fleeing it. The lights are breaking, mice are dying in the soda machines, and the sewage that sometimes floods the dugouts has its own Twitter account. (p. B10)

Although various proposals for a new A's stadium have made their rounds in the past, the current plan calls for a 34,000-seat, privately financed venue to be constructed at Howard Terminal, a waterfront site located near Jack London Square in West Oakland, in time for the 2023 MLB

season. The A's have argued that a new ballpark is necessary to reenergize existing fans and drive new ticket sales (Matier and Ross, 2018). Several key Oakland officials support the plan, including Mayor Libby Schaaf and Board of Port Commissioners President Ces Butner. In a co-authored editorial published in the *San Francisco Chronicle*, they declared, "A guiding principle during the conversations between the port, the A's and the city is to strengthen the port and maritime industry, add to the vibrancy of our waterfront, and create jobs". They continued, "The final deal will ensure everyone—the city, the port and the A's—is able to continue to thrive" (Shaaf and Butner, 2019, para. 8).

Supporters of the stadium-replacement plan have argued that in addition to the expected benefits of a new ballpark to the A's bottom line, it would also yield significant positive benefits for Oaklanders living near Howard Terminal, as the project would first necessitate a robust and costly environmental remediation of the site. After years of heavy industrial use, 4–30-inches of asphalt was used to cap the environmental waste from the oil tanks, coal tramway, and manufactured gas, briquette, and asphalt plants that used to exist on the proposed ballpark site (Veklerov, 2019). As Boltuch (2019) highlighted, West Oakland residents face greater cancer risks and report higher rates of asthma, cardiovascular disease, and premature death than other urban residents in the Bay Area, and the environmental cleanup associated with the A's proposal may have a profound effect on reducing these disparities.

The Jack London Square Ballpark plan contains several elements of sustainable design (e.g., meeting LEED Gold standards, reducing vehicular traffic). Furthermore, A's President Dave Kaval has stated the organization is "doing everything we can to make sure this project has a very strong environmental and sustainability focus", including designing "the ballpark with sea level rise in mind" (DeBolt, 2019, paras. 15–16). Based on the latest IPCC estimates and the

typical lifespan of a stadium, however, designing a stadium to control for coastal flooding at this stage could be premature, or “Redundant” using Orr and Inoue’s (2019) CVSO framework. Still, implementing facility design features that would increase the lifespan of the facility and offer strong ventilation, shaded areas for fans, and cooling rooms for athletes may be entirely appropriate under the circumstances.

On the other hand, Kaval has expressed the A’s desire to use the ballpark to secure the team’s place in Oakland “for another 50 or 100 years or really basically forever” (McCauley, 2018, para. 4). If Kaval’s claim is genuine, the stadium could face serious environmental challenges associated with predicted sea-level rise. In addition to the increased frequency, severity, and smoke effect of wildfires anticipated in the next 50 years, by 2100, western California is expected to see a sea-level rise that will be significant enough to trigger coastal flooding episodes in the Bay Area, where most infrastructure is built at low altitude and in flood zones (Orr, 2020). Maese (2019) expanded on this point, noting that the threat of sea-level rise was a central consideration in the stadium-replacement proposal:

How do you maintain operations in areas vulnerable to climate change? How do you sustain facilities and retain fans? How do you make it all economically viable when threats such as sea level rise are inevitable?

...The Athletics’ ambitious stadium proposal highlights many of the problems posed by rising sea levels and some of the creative solutions teams and leagues might consider to address them. In targeting a site that the city of Oakland says sits six feet above sea level, Kaval said the team had no choice but to acknowledge the potential impacts of climate change. (paras. 5, 10)

Beyond recognizing the threat of sea-level rise, some have argued the A's mitigation plan might not wholly consider the proposed site's hydrogeology (Peterson, 2018). That is, because "groundwater under the site floats on top of sea water" (Hickey, 2018, para. 8), sea-level rise could come from multiple directions, including from below the ballpark itself. Moreover, if rising seas pushed the groundwater up, it could inadvertently release dangerous contaminants discussed previously. From a climate vulnerability perspective, a new stadium for the Oakland A's would do little presently to mitigate and address the concerns of rising sea levels within the next 30 years (IPCC, 2018), leaving the organization in the Redundant state of the CVSO framework (Orr and Inoue, 2019). However, as the climate emergency evolves, it is possible the threat of rising seas will worsen (IPCC, 2018) and thus, if the A's truly intend to keep the new facility "basically forever," the new stadium may be appropriate.

The A's plan is expected to be voted on by the Oakland City Council in 2020, a timeline reinforced by state legislation passed in 2018 that requires any legal challenges to the project's environmental review to be adjudicated in 270 days or less (Levi, 2018). Recently, a lawsuit was filed against the stadium project, claiming the A's had circumvented the environmental review process (Coffey and Berman, 2020). Additional criticisms raised against the Jack London Square Ballpark plan include the fear that dense crowds and heavy traffic associated with stadium events will hurt business and operations at the Port of Oakland (Matier, 2020).

Miami, Florida

As an MLB expansion team in 1993, the Miami Marlins (then the Florida Marlins) shared a stadium with the NFL's Miami Dolphins, and founding owner H. Wayne Huizenga immediately began to pursue public funding for the Marlins' own, enclosable ballpark (Reynolds, 2007). After failing to secure enough support from the Florida Legislature, Huizenga

sold the team to John Henry, who eventually “sold the team in frustration after failing to reach a deal” (para. 8). Despite changes in ownership, the Marlins’ argument for a new stadium were relatively consistent: a retractable-roof stadium designed for baseball would allow the team to play through the heavy rain showers and unpredictable thunderstorms prevalent in the South Florida summer. In turn, the Marlins would enjoy “better attendance, increased revenue and a higher payroll, ensuring a competitive team for the future” (Wine, 2005, para. 10). Despite these appeals, the Marlins’ struggles to gain public support for a replacement stadium continued into the 2000s, when five proposals were rejected by state legislators in six years (Wine, 2006).

Following these rejections, two public officials from Weston, a suburban community located just northwest of Miami, suggested a new strategy to make the public funding of a professional sports stadium more palatable: construct a ballpark capable of providing Miamians with safe refuge during a catastrophic tropical cyclone. Elmore (2005) summarized the proposal further:

The Marlins would pay for the baseball portion of a retractable-roof stadium.

Government would pay for a hurricane shelter much better designed than the New Orleans Superdome, the scene of much misery after Hurricane Katrina. The facility would be built to withstand a Category 5 storm and shelter its victims. It would be stocked with generators, showers and extra restrooms. It would serve as a staging area for relief efforts during a serious storm, when the Marlins could not play anyway. (p. 1C)

The proposal never gained traction with Marlins’ leadership. Still, when a ballpark proposal was eventually approved, building engineers had to reckon with the inevitability of a major hurricane making landfall in Miami.

In 2009, the Marlins reached an agreement with the City of Miami and Miami-Dade County to construct a \$645-million ballpark in the city's Little Havana neighborhood (Belson, 2009). The public cost of the stadium was \$488 million (Center for Sport and Urban Policy, 2020b). As Orr and Inoue (2019) explained, the Marlins “developed high [organizational climate capacity], including building a hurricane-resistant stadium...and training their operations and events staff in storm-response protocol” (p. 459). A key innovation of the ballpark's design was its retractable roof, which consisted of three independent panels capable of protecting occupants in severe weather, including windstorms and hurricanes. Both threats offered unusual challenges for engineers, as explained by building consultant firm RWDI:

Whereas Miami usually receives ample notice of approaching hurricanes, such weather is less severe but still potentially dangerous as high winds can develop with very little warning. This meant that in some cases, there would not be time to execute a storm preparation protocol and move the roof into optimal position before a storm. We had to design a roof that would withstand severe weather in an open, closed, and partially open position. (RWDI, 2020, para. 5)

Whenever a hurricane threatened Miami, the stadium's roof could be arranged in another configuration, in which the panels would shift into a “gapped” position that would allow air to flow in and out of the building, reducing the danger of pressure buildup.

Marlins Park opened in 2012, and its roof has been tested several times in its initial years of operation. In 2017, Hurricane Irma damaged approximately 6% of the roof's protective membrane, which required replacement after the season. This damage was deemed to be relatively minor, and the Marlins reported, “The building performed extremely well considering the intensity of the hurricane ... The ballpark did not experience any flooding or water damage”

(Richards and Jackson, 2017, para. 11). Two years later, the threat of Hurricane Dorian prompted the Marlins to initiate emergency readiness measures; similar to their planning for Hurricane Irma, building managers prepared to arrange the roof in the gapped position and secure it using 56 steel anchors (Dusenbury, 2019).

Coastal flooding and an increase in summer season precipitation (i.e., 3% by 2065, an additional 3% by 2100) are critical considerations for new builds in South Florida (Orr, 2020). A recent report by Raimi *et al.* (2020) noted that “Miami is one of the world’s most at-risk cities from coastal flooding” and “by one measure, it faces the largest risk of any major coastal city” (p. 26). In some ways, these impacts are already visible: Florida has seen three 500-year storms in the last five years, and flooding rates have increased due to storms and sea-level rise. Based on these threats, the design features of Marlins Park served to shift the Marlins from the Problem state to the Fortified state of the CVSO framework (Orr and Inoue, 2019).

Concluding Remarks

Each of the cases summarized above illustrates the various ways in which professional sports stadiums may be replaced as a result of their climate vulnerability (whether that vulnerability is superficial, perceived, or genuine). Although all three examples involved the replacement of an existing ballpark, only in the case of the Texas Rangers’ Globe Life Field was climate adaptation cited explicitly as the primary reason for stadium replacement. Still, ballpark-replacement plans for both the Oakland A’s and Miami Marlins included significant and costly design features to protect the stadiums from climate hazards (i.e., sea-level rise and hurricanes, respectively). Given the dire predictions of climate scientists, stadium replacements like the examples studied above are expected to become more common.

The ballparks in Arlington and Miami were both funded through public–private partnerships, and these cases offer a glimpse of how the growth in climate-related stadium replacements may be accelerated as cities increase their investments in climate mitigation and adaptation infrastructure. The results of this study build on the work of Kellison and Mondello (2012), who considered how a proposed stadium’s environmental design could improve the likelihood of the project receiving public funding. Nearly all major sports stadiums in North America receive some public funding, and decisions to subsidize stadium projects are almost entirely made by elected legislators rather than via popular referendum (Kellison and Mondello, 2014). As global cities around the world increase climate adaptation expenditures (Georgeson *et al.*, 2016), politicking club owners may lobby for new stadiums to be included in their cities’ robust spending packages. Such a strategy was proposed in the Miami case, though it was largely dismissed at the time (e.g., deMause, 2005). However, as major sports stadiums continue to serve the public in times of national or international crises (e.g., as shelters following Hurricane Katrina, as testing sites and emergency staging areas during the coronavirus pandemic), the case that publicly funded stadiums are, in fact, community buildings may further legitimize team owners’ contentions that any urban climate plan should include funding for sporting infrastructure.

To a lesser extent, stadium retrofits may also grow in response to the threat of climate vulnerability. Seismic codes in California, for example, already exist to protect building occupants during earthquakes. Today, the California state legislature is exploring options to enhance building codes that would mandate better air handlers capable of filtering heavy smoke produced by wildfires (State of California, 2019). Thus, in the future, climate-resilient stadium

designs may be mandated by local, state, or federal governments—particularly if funding for a facility is part of a city’s larger climate plan.

This study has several limitations that may inform future studies. First, as discussed previously, the cities in this case study were selected to illustrate the potential links between stadium infrastructure, climate vulnerability, and urban transformation. While the authors anticipate these links will strengthen in the future, the cases appearing in this study currently only reflect a small number of stadiums in North America. Second, this study’s cases represent MLB stadiums located in the United States. Subsequent studies may be extended beyond professional baseball and North America to examine how climate vulnerability is impacting stadium design in other global cities and regions (e.g., Dingle and Stewart, 2018). One example is Qatar, whose preparation for the 2022 FIFA Men’s World Cup has included climate adaptation in both stadium design and event delivery. Air-conditioning systems have been developed to cool spectators in open-air stadiums; meanwhile, to protect both athletes and spectators, the entire tournament is scheduled for play in November, during Qatar’s mild winter season (Mufson, 2019).

Studies of sport and climate vulnerability have only recently appeared in the literature, so additional empirical work is necessary to expand both theoretical and practical knowledge. In future work, researchers may consider interview- or survey-based research with organizations that are using climate-change impacts to justify new stadium builds. This line of research may provide insight where organizations get their information on climate impacts and how they arrive at the decision to pursue a new facility. That is, are organization decisions driven by owners’ financial interests, whereby stadium-replacement campaigns are just loosely couched in climate change, or are they legitimately motivated by climate concern? Additionally, these organizations

could be asked whether they implemented any climate adaptation techniques (e.g., new heat policies, rain delay protocols, new irrigation systems for existing facilities, new air handler retrofits) before taking the step to build a new facility.

Additionally, researchers may consider how sports franchises located in comparable locations address the same climate vulnerability issues. For example, in the context of this study, the San Francisco 49ers and Miami Dolphins are football analogs to the A's and Marlins, respectively, and they both compete in outdoor stadiums. The NFL season occurs largely in the fall, when the risk of wildfires in California and hurricanes in Florida is more urgent. Researchers may evaluate whether these organizations are responding to climate-related concerns. Furthermore, researchers may inquire whether there are opportunities for knowledge-sharing across clubs and leagues, and when possible, prescribe recommendations for improving their OCC.

As demonstrated in this study, the threat of climate change may be leveraged—in many cases, legitimately—to drive urban transformation through the construction of new, environmentally and structurally advanced stadiums capable of enduring climate-related threats like extreme heat, sea-level rise, and hurricanes. The perceived vulnerability of major stadiums situated in the urban core is unlikely to be ignored as cities design robust climate mitigation and adaptation strategies, and the public value of these facilities may be underscored to hasten stadium replacement and receive public money. Thus, efforts from urban planners and stadium designers to integrate sustainable and resilient stadiums in a city's larger environmental plan are expected to intensify with the threat of climate change impacts.

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Table I.

Summary of cases examined

Ballpark	City	Date completed	Total cost	Public cost	Age of venue replaced	Environmental design enhancements	CVSO state
Globe Life Field	Arlington, Texas	2020	\$1,100	\$500	26	Retractable roof Climate control	Fortified
Jack London Square Ballpark*	Oakland, California	2023*	TBD	\$0	57	Site remediation Flood mitigation plan	Redundant
Marlins Ballpark	Miami, Florida	2012	\$645	\$488	25	Retractable roof Climate control Wind resistance	Fortified

Note. Cost in US\$ millions. Age in years. CVSO = Climate Vulnerability of Sport Organizations (Orr and Inoue, 2018)

* Date completed, total cost, public cost, and age of venue replacement based on current projections provided by the Oakland A's.