**Sport Versus Climate: Introducing the Climate Vulnerability of Sport Organizations Framework**

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**Abstract**

Climate change presents a significant and growing challenge to the sport industry, especially outdoor and winter sports. The authors present a conceptual framework that elucidates the varying states of climate vulnerability a sport organization may face, so practitioners may better understand the risks of climate change. The authors developed the Climate Vulnerability of Sport Organizations (CVSO) framework by building on—and linking—concepts of climate vulnerability, exposure, sensitivity, and adaptive capacity in the context of sport organizations. By placing potential impact on one axis and organizational climate capacity on the other, the authors present four quadrants representing four types of climate vulnerability: the Problem State, the Redundant State, the Responsive State, and the Fortified State. Positioning organizations within the CVSO framework facilitates a better understanding of the effort and resources needed to address climate-related risks. Though not all sport organizations will be equally impacted by climate change, all must be prepared to identify the risks to their organizations.

**Keywords**

Adaptation, Climate change, Sustainability, Vulnerability, Organizational capacity

## 1. Introduction

Some of the most memorable images of the 2010 Vancouver Olympics were weather-related: rain and green mountains in the middle of winter. During the first days of the event, under the scrutiny of global media, organizers sourced snow from neighboring areas so the freestyle ski and snowboard events could be held in Vancouver (Goldenburg, 2010). This makeshift solution was costly and inefficient, but not uncommon. The problem of insufficient snow has become so ubiquitous in winter sport events that it is hardly surprising when events get canceled due to warm weather. Recent examples include the January 2017 cancellations of the American Birkebeiner Challenge, North America's largest cross-country skiing event, and the cancellation of the St. Moritz Para Alpine Skiing World Cup in Switzerland in December 2017. The acceleration of undesirable climate conditions for events is not unique to winter sports: organizers canceled the 2017 Cycle Oregon, a prominent Pacific Northwest cycling event, because of the forest fires that ravaged California, Oregon, and Washington State. Later that year, organizers canceled the Rock'n'Roll Marathon in Montreal because of unseasonably hot temperatures and high humidity in late September. Each cancellation carried economic and social consequences for the sport organizations and the communities in which they operate (Govind, 2018). Despite the growing awareness of climate change and the related actions taken around the world (Hunt & Watkiss, 2011), most sport organizations remain ill-equipped to proactively assess and manage the risks of the climate challenge.

The potential consequences of climate change for sport organizations include lowered revenues (Kay & Vamplew, 2006), damage and destruction of facilities (Elsasser & Burki, 2002), event delays and cancelations (Fairley, Ruhanen & Lovegrove, 2015; Filo, Cuskelly & Wicker, 2015), and an overall decline in interest in a sport (Dawson, Scott & Havitz, 2013). Examples of such consequences include the Major League Baseball and National Football

League cancelations during Hurricane Harvey in 2017 (Winkler, 2017) and the Australian Open delays in 2014 due to high temperatures (Govind, 2018). Given these climate-related effects, it is important for sport managers to understand the potential impacts of climate change on their organizations. In addition, beyond simply engendering understanding the potential impacts, discussions about climate change must include an acknowledgement of people's capacity for response in order to avoid being disempowering and patronizing (Wisner & Fordham, 2014). Many sport organizations are dynamic entities with considerable agency to change their circumstances and operations. Conceptualizing the adaptive capacity of sport organizations is therefore necessary for a holistic understanding of climate vulnerability in this context.

The relationship between sport and the natural environment is bidirectional. In one direction, sport organizations impact the natural environment through, for example, waste production (Chard & Mallen, 2012; Trendafilova, Babiak, & Heinze, 2013). In the other direction, the environment impacts sport by providing natural resources such as fields of play and weather conditions (Kay & Vamplew, 2006). Consequently, if the conditions of the natural environment change, sport events will be impacted, along with the associated sport organizations. Yet this latter direction and subsequent effects of the sport–natural environment relationship remains underexplored in the sport management literature. This lack of conceptualization is problematic because the natural environment offers a central resource to sport organizations, either directly (e.g., as a field of play) or indirectly (e.g., through the provision of water and oil to power and maintain sport facilities). As the examples of event cancellations indicate, utility of the natural environment for sports is no longer a given. The increasing speed and severity of climate change (Pearce, Brown, Nerlich, & Koteyko, 2015)

presents a need for sport organizations to monitor and manage the natural environment from which they derive key resources with some degree of urgency.

This paper serves a twofold purpose: first, to identify and define key constructs that address the relationship between sport and the natural environment; and second, to advance a conceptual framework that elucidates the varying states of climate vulnerability a sport organization may face, so risks may be better understood and managed by practitioners. The key contribution of this paper is a conceptual illustration of the relationship between climate change and sport organizations, accomplished by focusing on the interaction of climate change impacts and organizational climate capacity.

## 2. Literature review

### *2.1 Sport and the natural environment*

Since the 1990s, sport management scholars have explored ways the sport industry impacts the natural environment. They have done so through the lenses of sport sustainability (Kellison & Hong, 2015; Mallen, Adams, Stevens, & Thompson, 2010; Mallen & Chard, 2012; Mallen, Stevens, Adams, & McRoberts 2010; Sartore-Baldwin & McCullough, 2018), corporate social responsibility (Casper, Pfahl, & McSherry, 2012; Ioakimidis, Stergioulas & Tripolitsioti, 2006; Inoue & Kent, 2012a, 2012b; Trendafilova, Babiak, & Heinze, 2013), and sport industry influence on pro-environmental behaviors (Casper, Pfahl, & McCullough, 2017; Chard & Mallen, 2012; Dolf & Teehan, 2015; Kellison & Kim, 2014; McCullough, 2011; McCullough & Cunningham, 2013). However, this literature addresses only half of the sport–environment relationship. The natural environment also has an impact on sports. For example, skiing relies on tenable snow conditions, pond hockey requires a certain depth and strength of ice, and sailing is most competitive in windy conditions. It follows, then, that if conditions of the natural

environment change, sport will be impacted in terms of both opportunities to participate and consume sport (supply) and interest in participating and consuming (demand). Environmental change will carry subsequent implications for marketing, financing, and sustaining sport organizations.

The academic disciplines of tourism, recreation, and leisure have taken great steps in identifying this issue and creating frameworks to understand it in the context of their respective domains (Gössling, Scott, Hall, Ceron, & Dubois 2012; Scott, 2006, 2011; Wells, Ponting, & Peattie, 2011). Because of the sport industry's unique characteristics (Gyōri & Balogh, 2017), such as the central roles of managing competition (Trail, Anderson, & Fink, 2000) and spectatorship (Funk & James, 2001; James, Walker, & Kuminka, 2009), sport management also requires discipline-specific frameworks and strategies for assessing and managing climate change impacts.

To date, there have been only nine publications in the sport management literature that explicitly discuss the natural environment's impact on sport (Fairley, Ruhanen & Lovegrove, 2015; Filo, Cuskelly & Wicker, 2015; Leopkey & Parent, 2009; Mallen & Chard, 2011; Petrass, 2016; Phillips & Turner, 2014; Ponting & O'Brien, 2015; Salome & Van Bottenburg, 2012; Watanabe, Wicker & Yan, 2017). We identified these articles through a keyword-based literature review among the nine journals listed as "General Sport Management Literature" on the North American Society for Sport Management (NASSM) website (NASSM, 2015). Keywords were *environment*, *climate*, *green*, *sustainable*, and derivatives thereof (e.g., *environmentalism*, *climate change*, *greening*, and *sustainability*). We retained only those articles that discuss a relationship between the natural environment and sport, and specifically, impacts of the natural environment on sport.

Of the nine publications, only two dealt specifically with climate change response and resilience: Fairley et al. (2015) presented a case study on the management implications of deteriorating ice conditions that are rendering pond hockey tournaments impossible, and Filo et al. (2015) discussed resilience and recovery of sport clubs in the aftermath of disasters. These two articles offered empirical evidence of the impacts of climate; however, neither offered a conceptualization for *how* climate (and specifically, climate change) impacts sport. The dearth of research related to climate change in sport management may be due to the fact that scientists only reached consensus on climate change in 2001 (Oreskes, 2005). Nonetheless, this gap has left sport management practitioners largely underequipped to address the growing challenge of climate change, as evidenced by the many event cancellations in 2017 that resulted in net economic and opportunity losses.

In the following sections, we introduce the concepts of climate change and climate vulnerability, with close attention paid to key dimensions of climate vulnerability: exposure to climate hazards, sensitivity to climate hazards, and adaptive capacity.

### *2.2 Climate change*

The Intergovernmental Panel on Climate Change defines climate change as "any change in climate over time whether due to natural variability or as a result of human activity" (Pielke, 2004, p. 515). For several decades, the definition of climate change has been a topic of contentious debate, due to political and scientific uncertainty over the role that humans play in the changing climate. Scholars have generally accepted this particular definition, as it acknowledges both human-induced and natural variability in climate (Pielke, 2004). In the early 2000s, the scientific community reached a consensus on the existence and observability of climate change (Oreskes, 2005). The causes, speed, severity, and implications of climate change

remain salient topics of research in nearly every discipline (Gilmore, 2017; Moss et al. 2010; Stern, 2008).

A 2004 report by the United Nations International Strategy for Disaster Reduction (UNISDR) separates climate change risk into two related concepts: hazard (geographic location, intensity, and probability of negative occurrence) and vulnerability (susceptibility to experience the hazard, and capacity to respond or recover). Hazard cannot be addressed through primary research in the discipline of sport management, because such research requires intimate knowledge of climate prediction models, geography, and natural resource science that is best addressed by specialists in those disciplines. In contrast, vulnerability is well within the scope of sport scholars' expertise and is an important area for future research within the discipline of sport management. Research on vulnerability centers on the interaction of external forces (e.g., rainfall, temperature, political environment) and internal forces (e.g., knowledge, resources), both of which are accessible and measurable by sport managers. Additionally, climate vulnerability offers insights into the management actions that can reduce overall climate risk.

### *2.3 Climate vulnerability*

The concept of vulnerability originated in natural resource research, but researchers have expanded it to denote the degrees and points of weaknesses and exposure to threats in fields as diverse as ecology, public health, political science, and agriculture (Fussel, 2007). Researchers define and theorize vulnerability differently across disciplines. For instance, applied scientists use the term descriptively, while social scientists and management scholars tend to use the term within explanatory models (O'Brien, Eriksen, Schjolen & Nygaard, 2004; Fussel, 2007). Sport management scholars apply the concept of vulnerability to describe financial weakness (Cordery, Sim & Baskerville, 2013), shortcomings of performance regimes (Sam & Macris, 2014), and issues relating to abuse and harassment against women, queer, and disabled populations in sport

organizations (Kirby, Demers & Parent, 2008)—but not yet to climate or environment. This research examines another application of the concept of vulnerability in sport management: climate vulnerability.

The UNISDR framework and the natural resources and policy literatures conceptualize climate vulnerability as a function of (a) potential impact of climate change and (b) adaptive capacity (Adger, 2006; Turner et al., 2003; Weis, Agostini, Roth, Gilmer, Schill, Knowles & Blyther, 2016). Potential impact is the scope and severity of impact that climate change hazards will have on a given unit of observation. The Intergovernmental Panel for Climate Change (IPCC) breaks down the concept of potential impact into two constructs: *exposure* (which measures the probability of facing the climate hazard) and sensitivity (which refers to the potential severity of the damages and disruptions due to climate hazards; IPCC, 2001). Exposure and sensitivity are further defined below, followed by a definition and description of adaptive capacity.

Exposure is the likelihood of the observational unit experiencing a negative impact or hazard (Smit & Wandel, 2006), which in the case of climate vulnerability refers to any climate change-related hazard such as extreme heat, flooding, drought, hurricane, and so on. Exposure is best illustrated as a response to the question: what is the probability of experiencing climate hazards? Sensitivity, meanwhile, refers to the internal or external physical, social, and economic features of an observational unit that influence its sensitivity to climate change (Smit & Wandel, 2006). The natural resources literature addresses sensitivity using the following question: to what degree would the natural or social system be directly or indirectly affected by the climate hazard? (Hinkel, 2011; Smit & Wandel, 2006, Wisner & Fordham, 2014). By these definitions, exposure and sensitivity are inextricably linked as complimentary factors of vulnerability, with

the former explaining the likelihood experiencing climate hazards, and the latter detailing the scope and severity of damages caused by those hazards. Sensitivity and exposure relate to adaptive capacity: many of the features of an observational unit that determine its sensitivity are similar to—or indeed the same as—the features that constrain a system's adaptive capacity (Smit & Wandel, 2006).

The IPCC (2001, p. 982) defined adaptive capacity as "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (see also Brooks, Adger & Kelly, 2005). It is a concept derived from the term adaptation, which originated in the natural sciences to describe the shifts in behavioral or genetic characteristics that enable living beings or systems to cope with change (Smit & Wandel, 2006). The common purposes of adaptive capacity research are to assess the extent to which potential impacts of climate change can be offset by adaptation to the impact (Parry, 2002), and to determine the relative adaptive capacity of different geographical or political units (e.g., countries, cities, neighborhoods; Brooks et al., 2005). The most common application of adaptive capacity research is to determine where systems can best direct their efforts to reduce overall vulnerability.

There remains no consensus for a universal model of the relationships among climate vulnerability, adaptive capacity, and the potential impacts of climate change (Hinkel, 2011). Exposure and sensitivity, as two constructs of potential impacts of climate change, and adaptive capacity, are applied differently across disciplines, as the relative weighting of exposure and sensitivity, and the scope of adaptive capacity, vary by discipline (Smit & Wandel, 2006). Regardless of context, however, environmental and social forces determine exposure and sensitivity, and the social, cultural, political, and economic circumstances of the observational unit influence adaptive capacity (Smit

& Wandel, 2006). Additionally, climate vulnerability may be linked to other forms of vulnerability, including economic or social vulnerability. However, the possible relationships between climate vulnerability and economic vulnerability or social vulnerability remain unstudied in the context of sport, tourism, or recreation.

The most common critique of vulnerability research is that the measures used to analyze exposure, sensitivity, and vulnerability are too broad and unspecific; hence they have low generalizability and lack specific applications (Hinkel, 2011). Indeed, vulnerability is a theoretical concept that eludes the possibility of precise measurement, given that it is not an observable phenomenon (Hinkel, 2011; Moss et al., 2001). Still, the IPCC estimates vulnerability through the use of statistical models (IPCC, 2001). Understanding and operationalizing the concept of climate vulnerability is critical, as it denotes a pressing risk for society. We advance a framework to address climate vulnerability in a way specific to sport organizations, to be both industry-relative and directly applicable.

## 3. Conceptualizing climate vulnerability in sport

Researchers can address climate vulnerability in sport at several levels: the industry level, the institutional level, the organizational level, and the individual level. We explore climate vulnerability at the organizational level using the conceptual revision methodology detailed by MacInnis (2011). This methodology involves adopting and rewriting or reconfiguring an existing concept to suit the particularities of the discipline where the concept is adopted (MacInnis, 2011). Contributions made through conceptual revision explain the need for the revision and the relative benefits of the new work compared with previous literature (MacInnis, 2011). In this case, we borrow the concepts of climate change, climate vulnerability, exposure, sensitivity, and adaptive capacity from the domain of natural resource and policy research, and adapt each

concept to suit the needs and interests of sport management scholars. Table 1 includes all definitions before and after revision. The result is a conceptual framework that applies the constructs of potential impact and adaptive capacity to the sport organization context. As described in Section 3.1, when we revised potential impact and adaptive capacity for the sport context, they became climate impacts on organization and organizational climate capacity.

Table 1. Definitions for Climate Vulnerability among Sport Organizations

| Construct name | Definition based on Intergovernmental Panel on Climate Change Third Assessment Report (2001b) | Revised construct name | Revised definition for Climate Vulnerability of Sport Organizations framework |
|---|---|---|---|
| Climate vulnerability | Bu | (no name change) | (no definition change) |
| Potential Impact | "All impacts that may occur given a projected change in climate, without considering adaptation" (p. 375) | Climate impact on organizations (CIO) | The probability and consequences of climate change impacts affecting the sport organization, as the organization presently exists and operates. |
| Exposure | "The nature and degree to which a system is exposed to significant climatic variations" (p. 373). | (no name change) | The susceptibility of the sport organization to experience climate hazards. |
| Sensitivity | "The degree to which a system is affected… by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to *sea-level rise*)" (p. 384). | (no name change) | The severity of climate change-related consequences for the sport organization. |
| Adaptive Capacity | "The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (p. 365). | Organizational climate capacity (OCC) | A sport organization's capacity to accommodate changes in climate with minimal disruptions or additional costs. |

Following the revision of the key concepts involved in climate vulnerability, delineation (MacInnis, 2011) was used to depict the relationships between CIO and OCC. Delineation

involves “detailing, articulating, charting, describing, or depicting an entity” (MacInnis, 2011, p. 144). Delineation requires an articulation and explanation of ideas and relationships, but emphasizes generalities and abstractions; researchers tease out the details through subsequent empirical research (MacInnis, 2011). The delineation process for this paper resulted in a new discipline-specific framework that illustrates the various states of climate vulnerability for sport organizations. The framework, including a discussion of its features and limitations, is shown in Section 3.2 and Section 4.

### *3.1 Revising potential impact and adaptive capacity*

Initially defined and conceptualized as the scope and severity of negative impacts on an observational unit, and thus a hazard requiring mitigation (Hinkel, 2011), we revised potential impact for the context of sport organizations to CIO (climate impact on organization). CIO encompasses the probability and consequences of climate change impacts affecting a given sport organization as the organization presently exists and operates, and is the aggregate of exposure and sensitivity. In addition, CIO does not take adaptive capacity into consideration, but rather solely describes potential negative impacts on the organization. The implication for practice is that managers should mitigate and reduce CIO.

The particular climate change impacts of concern may include warmer weather, higher or lower precipitation, higher or lower winds, storms and extreme weather, drought, and changing tides (IPCC, 2014). These hazards are specific to the geographic area in which a sport takes place, the environmental demands of the sport; the existing organizational infrastructure; and the severity of the lost opportunities, revenues, and reputation due to climate hazards. In assessing CIO, the probability and consequences of the hazard are considered at the time the assessment takes place. As such, potential future developments of the organization cannot be considered when assessing CIO; rather these would be included in a revised future assessment. The present

operations, products, relationships, and potential losses are the only considerations in CIO; adaptive capacity, which includes future projections, is assessed separately as discussed below.

Sensitivity, the first factor informing CIO, denotes how severe the impact would be for an organization if climate change worsened. In traditional vulnerability research, observational units commonly consist of nations and other political entities (Smit & Wandel, 2006), wherein the mission of leaders is to serve the people and provide for the prosperity and wellbeing of people and space. In contrast, the mission of a sport organization likely includes successful seasonal operations aimed at turning profits and serving a specific subset of the community (Higham & Hinch, 2002; Smith & Steward, 2010), and giving stakeholders (e.g., athletes, staff, spectators, suppliers, sponsors) access to a sport that may have very particular demands on the natural environment such as the need for ice in hockey, or wind for sailing.

Sensitivity in the context of sport organizations should therefore consider the climate sensitivity of each of the following: athlete experiences, staff experiences (including coaches and administrators), spectator experiences, finances (revenues and expenses), facilities and equipment, supply chains, partnerships and sponsorships, outreach (including marketing and public relations), and type of sport played.

Exposure, the second factor of CIO, denotes the susceptibility of the organization to experience climate hazards. It is determined by both geographic and organizational indicators (Adger, 2006; Smit & Wandel, 2006). Geographic indicators relate to current climate conditions and forecasted climate conditions in the region where the organization operates, and organizational indicators entail the degree to which the organization is reliant on stability and on specific climate conditions.

Examples of geographic indicators for exposure include latitude, altitude, average precipitation, wind, and recent storm activity (Hinkel, 2011). This information can generally be found on government-run climate and environment websites, such as Environment Canada, the National Centers for Environmental Information in the United States, Meteo France, and the World Meteorological Organization. Additional resources exist to examine projected storm activity and climate change, such as the report *States at Risk: Climate Preparedness Report Card* (Yu et al., 2015). Examples of the organizational indicators for exposure include the degree to which sport organizations rely on stable weather as well as their extent of use of natural spaces (e.g., golf courses, ski mountains, frozen ponds, trails; Verbos & Brownlee, 2017).

The concept of adaptive capacity is borrowed from natural resource and policy research and is revised based on literature dealing with organizational capacity for change **(**Heckman, Steger & Dowling, 2016; Judge & Douglas, 2009; Judge & Elenkov, 2005). The resulting concept of organizational climate capacity is specific to sport organizations in the context of climate change. OCC is defined as the awareness, skill, know-how, and resourcefulness that allow organizations to adapt their operations to new threats and to proactively develop new capabilities to insulate the organization from potential future threats (Judge & Elenkov, 2005). Based on this definition, OCC refers to the sport organization's capacity to accommodate changes in climate with minimal disruptions or additional costs.

Management researchers conceptualize adaptive capacity as positive (Engle, 2011) and consider organizational capacity a strategic necessity for the 21st century (Judge & Douglas, 2009), OCC is both positive and imperative for sport organizations. Thus, organizations should seek to improve and increase their adaptive capacity as a key strategy for mitigating climate

vulnerability. OCC is influenced by social, political, economic, and infrastructural forces, some of which are internal to the organization and some of which are not.

OCC is conceptualized similarly to organizational capacity in the literature of both management science and sport management (e.g., Doherty, Misener & Cuskelly, 2014; Edwards, 2015; Judge & Douglas, 2009). In particular, previous researchers who focused on organizational capacity in sport, specifically in the contexts of nonprofit sport organizations (Balduck, Lucidarme, Marlier & Willem, 2015; Doherty et al., 2014; Misener & Doherty, 2009, 2013; Wicker & Breuer, 2013) and sport for development (Svensson & Hambrick, 2016), measured organizational capacity based on dimensions such as human resources (e.g., experience and knowledge), financial resources (e.g., income and financial stability), infrastructure, cultural resources, and external relationships (Doherty & Misener, 2014; Wicker & Breuer, 2013). These dimensions can be adapted for the assessment of OCC to reflect the unique challenges of climate change, including infrastructure and operations; environmental technology; human resources; financial and other core resources; and networks and external relationships.

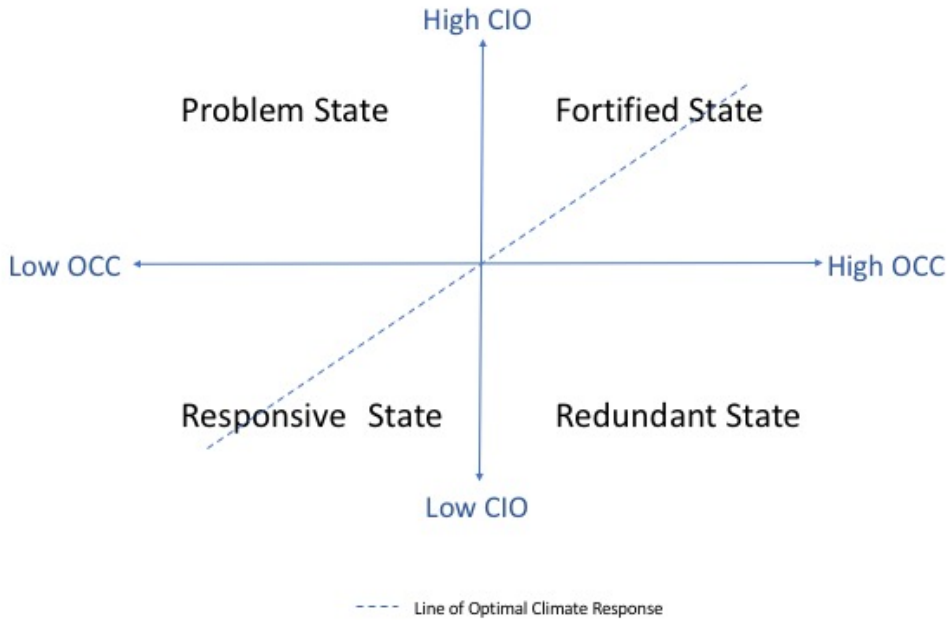
Some indicators of OCC may include type of facility and status of facility maintenance (for infrastructure and operations); storm readiness (for environmental technology); experience with recent storms and staff knowledge about extreme weather and natural disaster recovery (for human resources); access to finances for climate preparedness initiatives such as staff trainings, renovations, and storm recovery efforts (for financial resources); and networks that include climate specialists or climate organizations, and political support for climate initiatives (for networks and external resources). Given that OCC can only be determined based on the specific CIO of the organization, we conceptualize CIO as exogenous to OCC.

*3.2 Delineating climate vulnerability in sport*

If climate vulnerability is a function of potential impact and adaptive capacity, as discussed in the natural resource and in policy literature (Fussel, 2007; Hinkel, 2011), then CIO and OCC are likely related to each other and to the assessment of climate vulnerability of sport organizations. CIO and OCC exist concurrently within each organization, and can be low or high, on a continuum. High CIO would mean that exposure is high and sensitivity is severe, reflecting many climate-related risks and high potential for the organization to experience disruption and loss as a result of climate change. Low CIO indicates low exposure and sensitivity, suggesting relative stability where climate change does not present a high risk to the organization. High OCC indicates a sport organization's high ability to assess and respond to climate impacts on the organization based on available resources, knowledge, and experience. Low OCC suggests a lack of resources, knowledge, and experience needed to respond to the climate impacts on the organization.

Assuming the climate vulnerability of sport organizations is a function of climate impacts and organizations' adaptive capacity, then a bi-dimensional framework can be drawn with OCC on the *x* axis and CIO on the *y* axis (Figure 1). The resulting framework is the Climate Vulnerability of Sport Organizations framework, discussed in the next section.

Figure 1. Climate Vulnerability of Sport Organizations (CVSO) Framework




## 4. The Climate Vulnerability of Sport Organizations Framework

The CVSO framework reflects the reality that there are no exceptions to climate risk; it is always present, to varying degrees (as indicated by the open arrows on the axes in Figure 1). However, given the agency of sport organizations to respond to risks (Cuskelly, 1989), the CVSO includes constructs that are controllable (OCC and CIO's sensitivity factor).

The CVSO is not focused on CIO or OCC as singular constructs, but rather on the interaction between the two. Thus, the focus of the framework is the four quadrants, not the axes. The purpose of the CVSO is to offer insights into the types of climate vulnerability that sport organizations may face (represented by the quadrants), and the resulting management implications. This framework is intended to inform researchers of the risk that climate change presents to sport, and to inspire research on *how* organizations can minimize their vulnerability. The descriptions of each quadrant and the implications of the framework are discussed below.

*4.1 Problem state*

The worst-case scenario for an organization is to have high potential impact and low organizational climate capacity, which we refer to as the Problem State. The Problem State is the state of gravest climate vulnerability, and sport organizations in this state are at risk for disruptions, damages, and losses due to climate hazards. An example of an organization in this quadrant is Hume Tennis and Community Club, located in Melbourne, Australia. The extreme heat conditions at the 2014, 2016 and 2018 Australian Open events held in Melbourne suggest that this region of Southern Australia, and the sport of tennis specifically, will be a test case for climate change and summer sport (Govind, 2018). Melbourne is likely to face the impacts of shifts in temperature, heightened UV strength, prolonged drought, and other climate-related changes that will prevent tennis from being played, or at least significantly alter the experience for athletes, staff, and spectators (Chalmers & Jay, 2018; Murphy & Timbal, 2007; Smith, Reid, Kovalchik, Woods & Duffield, 2018). Each of these changes could be devastating. To compound the high exposure and sensitivity, a tennis facility that operates entirely in the high-impact space may also have little capacity to change their circumstances, for example by funding new infrastructure to buffer the vulnerability (Doherty et al., 2014). The climate vulnerability of this organization is therefore high.

Another example of an organization in the Problem State is the iconic Idatarod sled dog race, an annual event in Anchorage, Alaska. This region has faced significant shifts in precipitation patterns and temperature in recent years, forcing the organization to move the event's start line further north in 2015 (Hagenstad, Burakowski & Hill, 2018; Stubberud & Ruud, 2017). However, moving the start line further North is untenable, without compromising the distance of the course, or participation and interest due to lack of access. Indeed, even a move to an alternate location may not be sufficient to keep climate risks at bay: in the coming years the

whole region of southern Alaska is expecting higher temperatures that would make sledding unsafe and a long-distance race event untenable (Stubberud & Ruud, 2017; Yu et al., 2015).

In the Problem State, the organization faces high climate risk, so managers will be under pressure to lessen their sensitivity and exposure or increase their capacity. Within the Problem State, the management goal is to move into the Responsive or Fortified State, wherein organizations are adequately adaptable.

*4.2 Redundant state*

The best-case scenario for an organization, seemingly, is to have low CIO and high OCC (the Redundant State), as climate change would then present a negligible concern. However, this scenario is only ideal if the organization has unlimited resources and few constraints to spending. Given the law of scarcity, this is not the best quadrant for managers to strategically aim for, as it means spending more resources on addressing climate vulnerability than is necessary (i.e., implementing more adaptive measures than are needed to meet the immediate climate impacts, such as building storm gutters in the desert).

A better use of limited resources would be to match an organization's adaptive capacity to the level of potential impact, such that organizations expend a sufficient amount of resources for the organization to be responsive and adaptable in the face of climate change, without exceeding those needs and wasting resources on unnecessary additional responses. Thus, the ideal scenario, given limited resources, is to be in the Responsive State or the Fortified State.

*4.3 Responsive state*

An organization in the Responsive State experiences low climate impacts and has low organizational climate capacity. Organizations in this state have matched their OCC to the current CIO and are thus responsive to current climate risks, making this the most efficient scenario. In this state, managers must be vigilant and conduct regular assessments of OCC to

ensure that any changes to the climate are matched with adequate changes to OCC. An example of an organization in the Responsive State is an outdoor sport facility in a moderate climate region that is relatively stable, meaning that it is expected to face few storms and little flux in temperature, and to see little change to climate conditions in coming years. One such example is Heinz Field, home of the Pittsburgh Steelers, an outdoor facility in a relatively consistent climate zone, especially during the fall season when the facility is operational as a football field (IPCC, 2014; Yu et al., 2015). Another would be Memorial Stadium at the University of North Dakota, which is also in a region largely unaffected by climate change during the fall college football season, as most of the severe consequences of climate change in this area occur in summer and winter (IPCC, 2014; Yu et al., 2015). The operations of these facilities experience limited exposure and have little sensitivity, considering that football can be usually played in heat and rain and spectators will still attend. Thus, little climate preparedness (i.e., OCC) is required, especially for the main operational season (Yu et al., 2015). Low CIO does not exclude the possibility that these organizations may experience some impacts of climate change such as lowered attendance from out-of-town fans who may experience severe weather conditions, complications with team travel, and game schedule changes to accommodate other teams from regions that are more susceptible. However, for the most part, these organizations' main operations, namely hosting football games, are likely to be insulated from the worst possible impacts of climate change.

*4.4 Fortified state*

When an organization faces high CIO and has high OCC, the organization is in the Fortified State. Organizations in this state devote significant resources to improve preparedness and responsiveness toward current potential impacts and future potential impacts that may become more severe or more likely to occur. In this state, organizations must demonstrate

innovation and proactivity, requiring targeted management approaches. An example of an organization in the Fortified State is the Miami Marlins, who operate in a high-risk region for hurricanes and torrential rains that negatively impact baseball games (IPCC, 2014). In response to this high CIO, the Marlins have developed high OCC, including building a hurricane-resistant stadium (completed in 2012; Gould, Vega, & Sheppard, 2012) and training their operations and events staff in storm-response protocol. The organization's facility and storm-response protocols were pretested in 2008 by engineers (Gould et al., 2012), then tested again by Hurricane Irma in 2017, when they withstood the storm with minimal superficial damage to the roof and no flooding or water damage **(**Frisaro, 2017).

*4.5 Classifying an organization into a state*

The classification of an organization into one of the four states reflects its sensitivity, exposure, and adaptive capacity. As noted, some examples of indicators for climate change impacts (sensitivity and exposure) include the type of sport played, degree to which sport organizations rely on stable weather, the use of natural spaces (e.g., golf courses, ski mountains, frozen ponds, trails; Verbos & Brownlee, 2017), precipitation patterns, and frequency of extreme weather events (Hinkel, 2011). Some indicators of adaptive capacity include experience and knowledge (human resources), income and financial stability (financial resources), infrastructure, cultural resources, and external relationships (Doherty et al., 2014). In instances where the climate change impacts are greater than the adaptive capacity, the organization is at risk and falls in the Problem State. When adaptive capacity outweighs the climate change impacts, the organization is relatively safe and can be classified in the Redundant State. When the climate change impact and adaptive capacity are relatively equal, the organization is either in the Responsive State (low CIO, low OCC) or the Fortified State (high CIO, high OCC). There exists, theoretically, a line that runs through the CVSO and cuts diagonally across the Responsive and

Fortified States, representing the perfect match of climate impact with adaptive capacity. This is the *Line of Optimal Climate Response* (dotted line in Figure 1).

*4.6 Shifting between states*

The CVSO framework presents a benefit for managers by confirming their agency regarding climate vulnerability. The fact of climate change does not automatically predestine sport organizations to negative consequences. However, as indicated by the discussion and examples above, climate change does present a set of actual and potential risks for organizations that should be assessed and addressed, where appropriate. The expected application of this framework is thus to assist sport organizations with identifying their points of vulnerability and directing their efforts towards those areas with the biggest exposure, greatest sensitivity, or least capacity. Management actions may shift an organization's position in this framework, meaning that managers have the capacity to influence the outcomes of climate change for their organization.

For example, managers can shift on organization from the Problem State to the Fortified State, as in the case of Buck Hill ski mountain in Minnesota. In the winter of 2012-13, Buck Hill experienced low snowfall and consequently had to close the ski area a few weeks earlier than usual. This resulted in significant financial and social losses for the mountain, a competitive disadvantage for the athletes who train at the mountain regularly, and a decrease in winter tourism in the region. In response, the managers at Buck Hill invested in over four acres worth of artificial snow sheets (Daher, 2016). This innovation allows Buck Hill to operate year-round, offering skiing and snowboarding regardless of climate conditions (Buck Hill, n.d.). Further, the managers opted to diversify the venue's offerings by hosting mountain biking events the following summer, ushering in a new segment of the sport industry and a set of secondary operations. In two years, the mountain developed a high OCC using new infrastructure, new

environmental technologies (snowmaking and artificial landscaping), and new operations that have low potential climate impact.

Given the potential for organizations to shift in the CVSO framework, the concept of organizational learning is useful to explore the process through which organizations can understand their climate vulnerability, increase their OCC, and mitigate their CIO. Organizational learning is defined as the process by which individuals participate in collective discourse and training that advances organizational knowledge and experience (Popova-Nowak & Cseh, 2015). The first step in organizational learning is knowledge acquisition (Huber, 1991), and in this respect, the CVSO framework provides new insights into the types of climate vulnerability faced by sport organizations, with the aim of increased awareness among sport management scholars and practitioners regarding climate change risks for this industry. A full exploration of the organizational learning process is beyond the scope of the present paper; however, this is an avenue for future research.

## 5. Implications and future research

The theoretical implications of this paper are manifold. First, we take steps to bridge risk concepts with organizational capacity concepts within the context of sport and climate change by placing the constructs of potential impact and adaptive capacity on a shared framework. This application of organizational capacity extends its use in the sport management literature by Doherty et al. (2014) and Edwards (2015) by considering capacity in a new context: environment. We also integrate a more recent understanding of organizational capacity by examining it in relation to climate impacts, and extending it as a variable influencing vulnerability.

Second, we present interdisciplinary concepts from natural resources, geography, management, and sport management, which Doherty (2011) has suggested is the necessary approach to address gaps in the literature relating to complex issues such as climate change. We contribute to interdisciplinary work in sport management by highlighting the utility of MacInnis's (2011) revision and delineation methods for not only borrowing theories from other disciplines, but blending theories from diverse disciplines.

Moreover, we add to the broader management literature that focuses on addressing grand societal challenges (Berrone, Gelabert, Massa-Saluzzo, & Rousseau, 2016; George, Howard-Grenville, Joshi & Tihanyi, 2016; Howard-Grenville, Buckle, Hoskins, & George, 2014). The interdisciplinary and grand challenge orientation will make it possible for the CVSO framework to support a wide array of socially relevant research in sport management, and will facilitate cooperation between sport management scholars and those from other disciplines. At the same time, this framework benefits specific research on sport organizations, as it is based on constructs of climate vulnerability adapted for sport organizations: climate impacts on organizations and organizational climate capacity.

For practitioners, an operationalization of this framework could entail a climate-specific risk assessment that would be indispensable for sport managers to proactively address the climate risks associated with their operations. This framework can aid in the risk assessment of climate-change related hazards and assist mangers in determining how highly to prioritize this risk, and how many resources to dedicate to addressing climate vulnerability. For instance, an organization could use this framework to consider what types of impacts it might face regarding climate change (e.g., increased precipitation, extreme heat, rising sea level) and what capacities they possess to respond and act (e.g., moving indoors, relocating, establishing more robust rain

plans, increasing availability of water to rehydrate athletes in extreme heat). By considering both the potential impacts and climate capacity, organizations can assess their climate vulnerability and determine what types of actions should be taken to improve. Familiarizing the staff of an organization with the CVSO framework through this paper would be a step towards organizational learning, as reading contributes to knowledge acquisition (Huber, 1991), and awareness is part of adaptive capacity.

A limitation of our framework is that it does not explore the possibility of a directional or causal relationship between CIO and OCC. Previous researchers have suggested that vulnerability can be represented by the following equation: vulnerability = potential impact – adaptive capacity (Brooks et al., 2005; Smit & Wandel, 2006). However, this may not be true for the adapted constructs of CIO and OCC, or it may be more complicated in the sport context.

Another limitation of the CVSO framework is that it is static, whereas climate change and organizational climate capacity are both dynamic, changing regularly and sometimes unpredictably. Therefore, this framework derives its utility from regular reassessment of the organization's CIO and OCC, and repositioning on the framework to track progress towards the line of optimal response; organizations must periodically reassess the potential impacts of climate change and adaptive capacity. This periodic reassessment might involve revisiting analysis of the indicators mentioned in section 3.1 to see if any changes in precipitation, winds, natural disasters, finances, facilities, human capital, experience with recent storms or natural hazards, or other related factors have shifted the organization's OCC or CIO. As such an assessment likely requires substantial knowledge and experience, sport organizations may benefit from working with agencies, nonprofit organizations, and research institutions that

specialize in climate change assessments to determine their exposure, sensitivity, and adaptive capacity.

This framework remains untested; it is a reconceptualization of existing concepts adopted from natural resource science, geography, and policy research, among others. The precise dimensions and operationalization of each construct (CIO and OCC) should be discussed and refined in future research to render this framework more useful to managers. For instance, as with previous sport management research that developed measures of a newly proposed concept (e.g., Uhrich & Benkenstein, 2010), a Delphi study could be conducted with experts in related areas (e.g., sport sustainability, environmental management, climate science) to identify a comprehensive list of indicators for CIO and OCC. Subsequently, an index consisting of the identified indicators could be administered via a survey to a sample of managers in sports that are likely to be susceptible to climate change, such as baseball and skiing, to refine the scale and determine its reliability and validity. The resultant index, validated through the initial survey data, can be then implemented with a range of sport organizations and events that operate in various contexts to obtain further evidence to increase its accessibility and usefulness to sport managers.

In addition to the development of an index, the CVSO framework lends itself to future research in many other ways. For instance, case studies can be conducted to illustrate the utility of the framework to inform response strategies of sport organizations that need to address climate change, such as the 2020 Tokyo Olympics and Paralympics and their efforts to develop a response strategy for extreme heat conditions (The Japan Times, 2018). Future studies might also use organizational learning theories (Popova-Nowak & Cseh, 2015) and qualitative methods, such as action research (Chalip, 1997) to determine precisely how organizations can shift

between states. Organizations that are classified into the Problem State are best suited to action research studies that explore the process of shifting between states, as there is the greatest urgency to improve OCC and lower CIO. As the observational unit of this research is sport organizations, future research might also explore the applicability of this framework to climate vulnerability at the individual, institutional, or industry levels.

If climate change progresses in scope and severity as predicted, resources are needed to assist sport managers in the assessment of and response to climate risks. The valence of this paper lies in its conceptualization of the climate vulnerability of sport organizations and its potential to inspire future research and interest in this domain. Climate change will not impact all organizations equally, and some may barely notice any effect. However, it is important for organization to have the tools to identify the risks and understand their vulnerabilities.

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