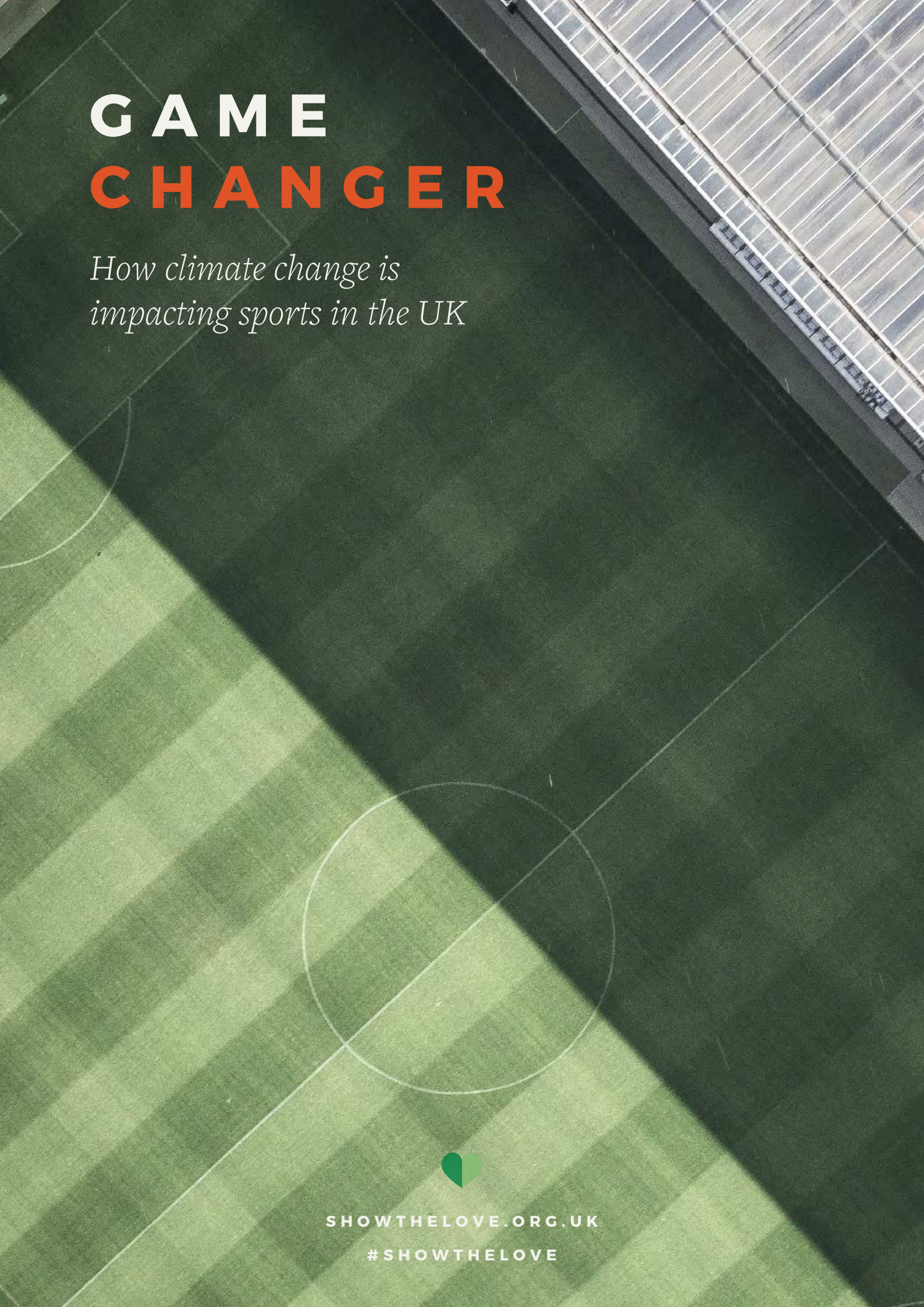

GAME CHANGER

How climate change is impacting sports in the UK

SHOWTHELOVE.ORG.UK

#SHOWTHELOVE

THE CLIMATE COALITION

This report marks the launch of the The Climate Coalition's annual Show The Love campaign which aims to raise awareness of climate change and all it threatens, and encourage people to show their support for action to address it.

The Climate Coalition is the UK's largest group of people dedicated to action on climate change and limiting its impact on the people, places and life we love at home in the UK and around the world, including the world's poorest countries. The coalition is made up of over 130 organisations with a combined supporter base of 15 million, including WWF, National Trust, RSPB, Christian Aid, CAFOD, The Women's Institute and Oxfam. Together, we want a world powered by clean and secure energy within a generation.

Find out more at showthelove.org.uk

PRIESTLEY INTERNATIONAL CENTRE FOR CLIMATE

Providing research to underpin robust and timely climate solutions is the USP of the Priestley International Centre for Climate. The University of Leeds centre is unique in bringing together world leading expertise in all the key strands of climate change research.

One of the University's flagship strategic investments, the Priestley Centre aims to provide international solutions to the global challenge of climate change through new interdisciplinary research partnerships that better link our physical, technological, economic and social understanding of climate change with strategies for mitigation and adaptation.

Find out more at climate.leeds.ac.uk

ACKNOWLEDGEMENTS

Editorial and production team:

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Thanks to:

James Boyle, Pete Chalkley, Dan Cherry, Mike Childs, Matt Chilton, Robin Clegg, Jess Coffin, Helen Collinson, Steve Cornelius, Darren Crossman, Adam Dayson, Fiona Dear, Emma Elliott, Patricia Espinosa, Emma Fidler, Dominic Foster, Aimee Fuller, John Gawthorpe, Katherine Grainger, Ryan Henson, Steve Isaac, Ed King, Robert Lingard, Michael Lloyd, George McCaffrey, Luke Morgan, Andrew Murray, Friederike Otto, Tom Pitchon, Claire Poole, Rosie Shannon, Russell Seymour, John Shiels, The Sport and Recreation Alliance, Alex Stafford, Neil Thorns, Tom Viita, Elliot Ward, David Warrilow, Terry Watson, Chris Whittaker, Richard Windows

Special thanks to the British Association for Sustainable Sport (***BASIS***)

CONTENTS

INTRODUCTION

Sport is central to our national culture, providing enjoyment, boosting health and a source of passion and delight for millions. The triumph and tragedy of great sporting moments at St Andrews, the Principality Stadium or Wembley sit atop a hive of grassroots sports clubs which are woven into the fabric of our nations.

But some of the UK's best loved sports are facing an unexpected threat. Climate change, and the changing risks of extreme weather that it brings, is already affecting sports across the country. The experiences of sports clubs and players in this report, backed up by the scientific expertise of the Priestley International Centre for Climate, provide a snapshot of the problem.

This report focuses on three sports with hundreds of years of history between them: golf, football and cricket. And with the report's launch coinciding with the Winter Olympic Games in PyeongChang, South Korea, it also looks at winter sports, which are among the hardest hit by climate change as higher temperatures drive the snow line higher up the mountains.

This report reveals the impacts of extreme weather, but also showcases how sport is starting to play a part in tackling climate change by cutting emissions and by taking a lead, inspiring others to follow. We are far from being powerless to act. In the sporting spirit of aiming to win, there are clear actions we can all take to get the right result:

1.

Sports clubs and governing bodies all need to reduce carbon emissions and other environmental impacts. The British Association of Sustainable Sport (BASIS) can provide resources and expertise to help sports better understand the impacts of climate change and share best practice in how to become more resilient and environmentally sustainable, and in doing so encourage their millions of fans to do the same.

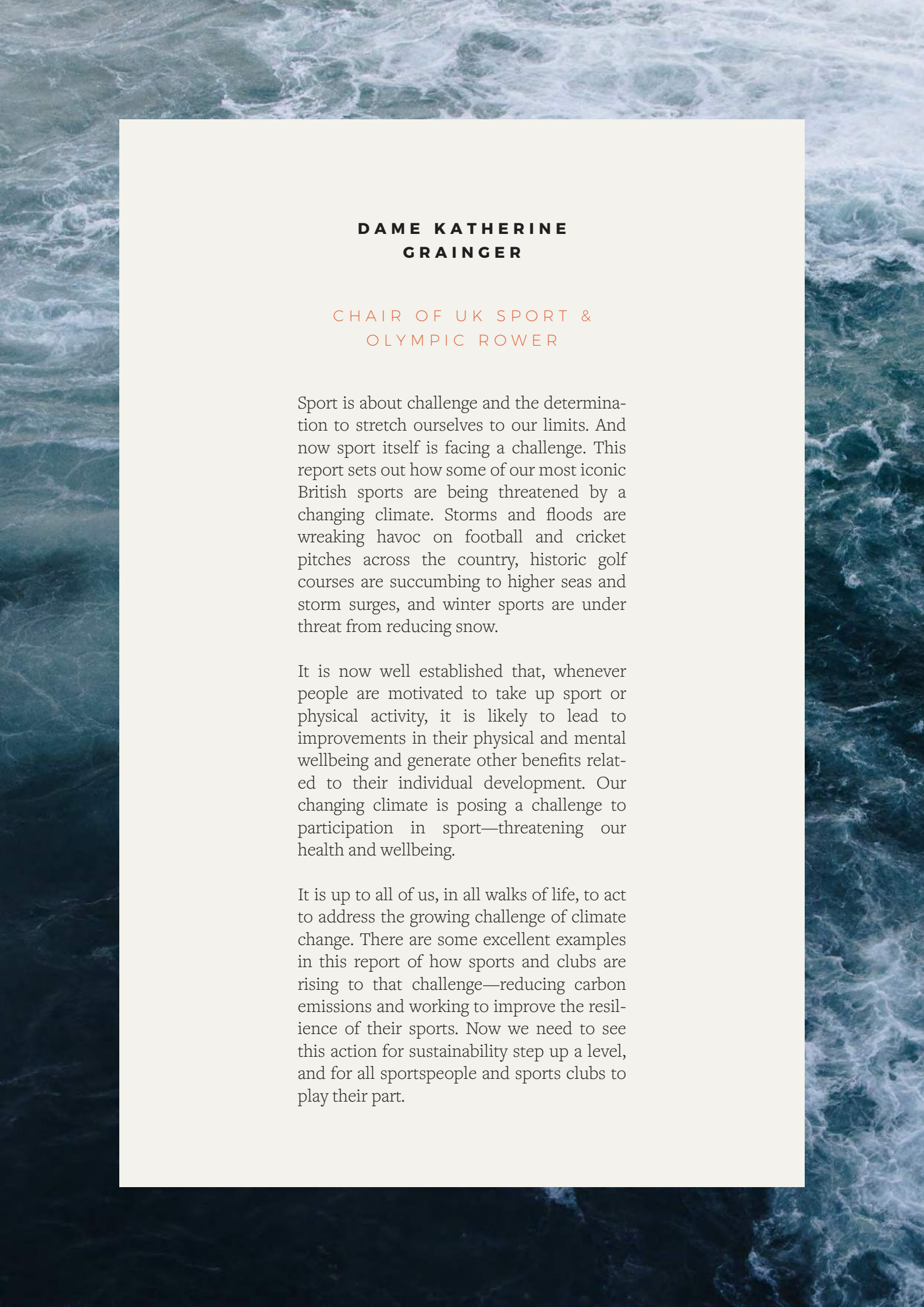
2.

Governments across the UK need to help us all live more sustainably by driving down greenhouse gas emissions. To achieve the ambition of the Climate Change Act we need a big acceleration in energy from the sun, wind and waves; warm, efficient, healthy homes; and increased uptake of clean electric cars, walking, cycling and public transport.

3.

Signed by 196 countries, the Paris Climate Agreement signals to the world that companies, governments and institutions must act to stop temperatures from rising more than 1.5°C and help poorer countries adapt to the impacts they are already seeing. A new UNFCCC dialogue on sport and the environment is underway – British sport should engage fully in this and play their part.

If climate change affects something as central to our lives as sport, then it's a strong sign that wherever we look across society we'll find similar stories and impacts. The Show the Love campaign aims to highlight these unexpected and everyday impacts of climate change, as it's these that have the potential to wake us all up to the new reality.



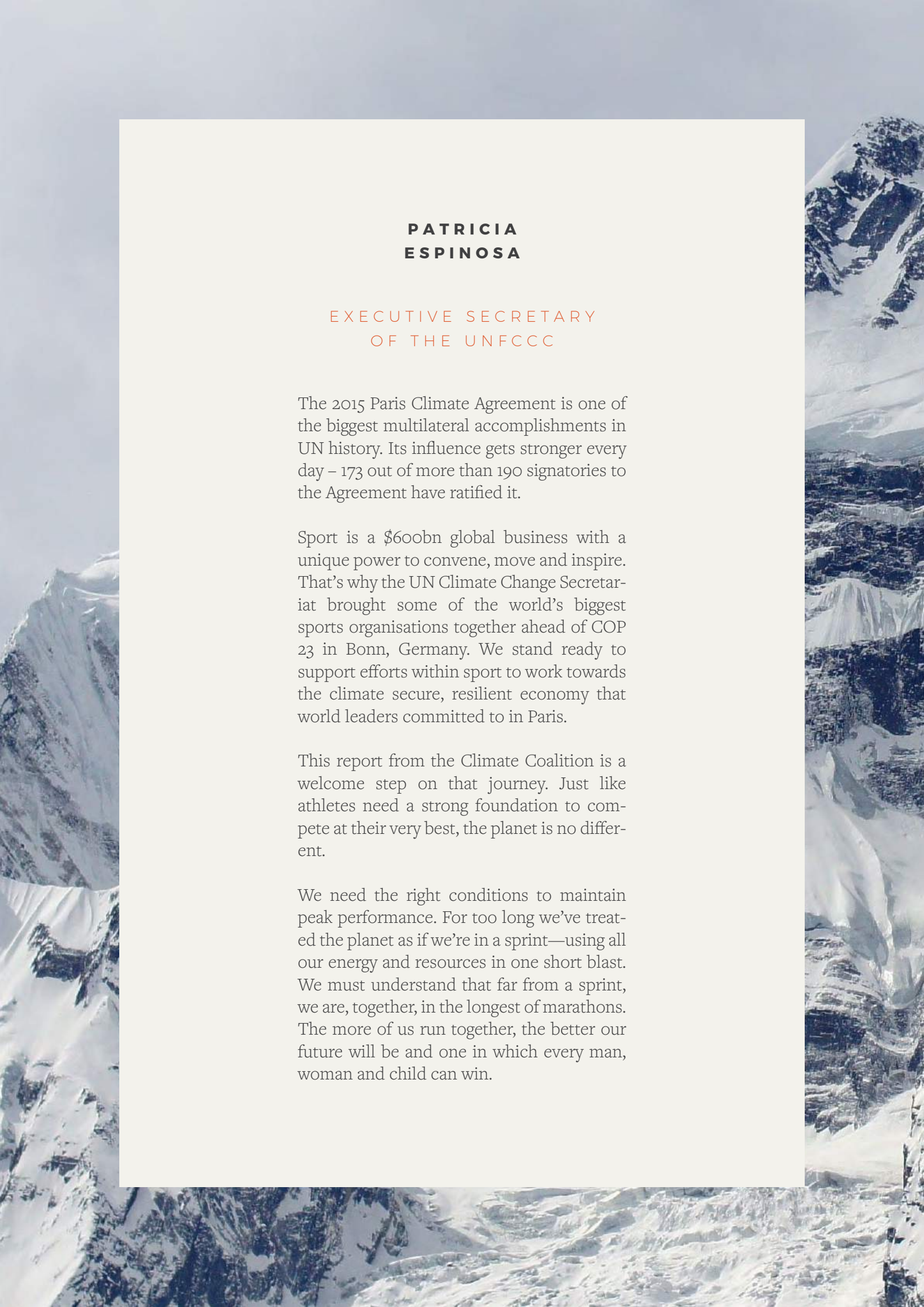
DAME KATHERINE GRAINGER

CHAIR OF UK SPORT & OLYMPIC ROWER

Sport is about challenge and the determination to stretch ourselves to our limits. And now sport itself is facing a challenge. This report sets out how some of our most iconic British sports are being threatened by a changing climate. Storms and floods are wreaking havoc on football and cricket pitches across the country, historic golf courses are succumbing to higher seas and storm surges, and winter sports are under threat from reducing snow.

It is now well established that, whenever people are motivated to take up sport or physical activity, it is likely to lead to improvements in their physical and mental wellbeing and generate other benefits related to their individual development. Our changing climate is posing a challenge to participation in sport—threatening our health and wellbeing.

It is up to all of us, in all walks of life, to act to address the growing challenge of climate change. There are some excellent examples in this report of how sports and clubs are rising to that challenge—reducing carbon emissions and working to improve the resilience of their sports. Now we need to see this action for sustainability step up a level, and for all sportspeople and sports clubs to play their part.



PATRICIA ESPINOSA

EXECUTIVE SECRETARY OF THE UNFCCC

The 2015 Paris Climate Agreement is one of the biggest multilateral accomplishments in UN history. Its influence gets stronger every day – 173 out of more than 190 signatories to the Agreement have ratified it.

Sport is a $600bn global business with a unique power to convene, move and inspire. That's why the UN Climate Change Secretariat brought some of the world's biggest sports organisations together ahead of COP 23 in Bonn, Germany. We stand ready to support efforts within sport to work towards the climate secure, resilient economy that world leaders committed to in Paris.

This report from the Climate Coalition is a welcome step on that journey. Just like athletes need a strong foundation to compete at their very best, the planet is no different.

We need the right conditions to maintain peak performance. For too long we've treated the planet as if we're in a sprint—using all our energy and resources in one short blast. We must understand that far from a sprint, we are, together, in the longest of marathons. The more of us run together, the better our future will be and one in which every man, woman and child can win.

CLIMATE IMPACT ON SPORTS: WHAT THE SCIENCE TELLS US

KATE SAMBROOK & PIERS FORSTER
PRIESTLEY INTERNATIONAL CENTRE FOR CLIMATE

Cancelled football matches, flooded cricket grounds and golf courses crumbling into the sea: climate change is already impacting our ability to play and watch the sports we love.

On a global scale, the science is settled: human emissions of greenhouse gases have led to a rise in global average surface temperature of over 1°C[1], with impacts on rainfall patterns, climate and ecosystems all over the world[2].Through careful scientific analysis and data recording by the Met Office and others, a clearer picture of the effects of climate change on the UK is beginning to emerge[3].

WATER WATER EVERYWHERE

There is growing evidence that the UK is becoming warmer and wetter. The laws of physics tell us that a warmer atmosphere can hold more moisture, increasing the frequency and strength of extreme rainfall events[4]. During the last 20-30 years, the UK has experienced a rapid increase in extreme weather events such as heavy rainfall, bringing severe flooding in many areas[5-6]. Six out of the seven wettest years in our history have occurred since 2000 (see figure 1).

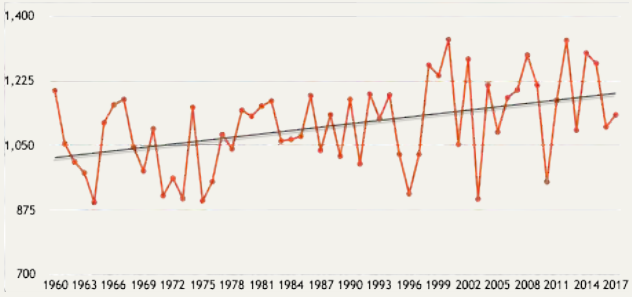


Figure 1: Annual rainfall (mm) for the UK, 1960 to 2016. (Source: Met Office, 2017).

Seasonal differences in rainfall mean that different sports are affected in different ways. For football, with fixtures throughout the winter, the main concern is the 26% increase in winter rainfall since 1900[7-10]. The recent winters of 2013-2014 and 2015-2016 were notable for their record-breaking rainfall, with over 150% more rainfall than normal[11]. The resulting flooding affected sports facilities across the country. In a recent study researchers found that climate change made the UK's record December rainfall in 2015 59% more likely[12].

Future projections by the Met Office indicate that winter rainfall could increase by 70-100% by the 2080s. While there will still be drier years, this suggests that wet winters like the ones we have experienced lately could become more common in the future[13], increasing the risk of further damaging floods in the UK.

DRY BUT STORMY SUMMERS

Climate change is having different impacts in different parts of the country. Despite a small overall increase in summer rainfall in England[5], the south-east has seen a decrease[14]. This is likely to get worse in future, with a projected 40% decrease in summer rainfall in this region by the 2080s, along with an increase in average summer temperatures of up to 4.2°C[15].

Alongside drier weather comes a trend for more summer thunderstorms, with a significant increase in storms observed between 1960 and 2016[7,16]. Climate scientists predict from well-tested physical theories that, despite a substantial reduction in future average summer rainfall, by the 2080s extreme rainfall events will become more frequent in a warmer, moister environment[17].

CRUMBLING COURSES

The effects of climate change on the UK will involve more than changing rainfall patterns. Our coastline is also at risk from rising sea levels and storm surges. For some of the UK's most iconic golf courses, coastal erosion is becoming a real problem.

The impacts on the coastline are twofold. Firstly, since 1900, sea levels have risen by an average of 15-20cm around the UK[18]. Sea-level rise is driven by climate change through the melting of glaciers and ice sheets, and because the volume of the water in the oceans increases as it warms, a process known as thermal expansion[17]. Using satellite measurements of ice changes on Greenland and Antarctica, simulations have shown that sea levels could rise by a further 50-100cm by 2100[18]. Secondly, the rate of coastal erosion is likely to increase as a result of rising sea levels, more intense storms and increases in intense rainfall[19].

This report provides a snapshot of how the changing climate is already affecting some of the country's most popular sports. The extreme weather being experienced by sportspeople today is in line with what climate scientists expect and have predicted, and these trends are only set to continue unless we collectively act, both nationally and globally, to reduce our carbon emissions.

GOLF

Golf is inextricably linked to the natural environment. The location, condition, playability, quality and presentation of golf courses is shaped by the climate. "A golf course... that works with nature rather than against it is normally more interesting and challenging," says European Ryder Cup-winning captain Colin Montgomerie, who describes golf as "a test against the hazards that nature provided[20]."

The increase in heavy rainfall and bad weather which has affected golf clubs in the Glasgow area is typical of the increase in extreme rainfall we have seen in recent years. As temperatures increase, warmer air holds more moisture, meaning that we are very likely to see continued increases in heavy rain and more powerful storms, with a continued impact on golf courses across the country.

We will also see more damaging storm surges which, combined with rising sea levels, are likely to worsen the coastal erosion already being experienced by Montrose and other historic golf courses. Climate change is putting these historic links courses in the birthplace of golf at risk.

—Kate Sambrook, Priestley International Centre for Climate

Now climate change is providing another hazard. Increased rainfall, more extreme weather events, coastal erosion and rising sea levels pose huge challenges to the game, and are already having an impact on the health of many clubs in Britain[21]. Unchecked, the impacts of climate change could significantly affect the sport over the long term, particularly in Scotland.

Sea-level rise poses the greatest long-term threat to golf in the UK. More than one in six of Scotland's 600 golf courses are located on the coast – including the Old Course at St Andrews, Royal Troon and Montrose Golf Links in Angus. 'Links' are the oldest type of golf courses, developed in Scotland, and located on the coast on 'links land' – characterised by dunes, sandy soil and fine-textured grassland. The R&A, the governing body for golf outside the USA and Mexico, recognises the risk, while only a small increase in sea-level rise would imperil all of the world's links courses before the end of the century.

Along with the damage they can do to course playability, increased rainfall and storms – exacerbated by climate change – are posing participation challenges.

"It [climate change] is certainly becoming a factor" said Steve Isaac, Director of Sustainability at The R&A. "Golf is impacted by climate change more than most other sports. Trends associated with climate change are resulting in periods of course closures, even during summer, with disruption seen to some professional tournaments. We are witnessing different types and timings of disease, pest and weed outbreaks. The future threats are very real, with course managers having to show adaptation if we are to maintain current standards of course condition. It is something we take very seriously."

MORE THAN 1 IN 6 OF SCOTLAND'S GOLF COURSES ARE LOCATED ON THE COAST

Nationwide statistics on course closures in recreational golf are not collected centrally, but those at the sharp end recognise an increasing trend with potential long-term impacts on the game. Across England and Scotland there has been a 20% decline in golf club membership since 2005[22]. Of course we can't lay all the blame on bad weather but sports administrators believe it is a contributing factor.

"It is a fact that increased rainfall and extreme events are causing more disruption in recreational golf," says Richard Windows of the Sports Turf Research Institute (STRI).

"Course closure means reduced revenue from visitor and clubhouse income at a time when additional investment into course maintenance and infrastructure is required to combat the effects of extreme weather. It can trap clubs in a vicious cycle that isn't their fault and it could potentially be a factor in membership decline."

The disruption caused by increased rainfall and more extreme weather has seen more courses closed more often and for longer periods of time. The years 2016/17 saw as much as 20% less playing time at courses across the Greater Glasgow area than 2006/7[23-24].

> *I started playing golf as a 10 year old at Didsbury Golf Club. I have never known in the 50 years of being associated, the course being so wet for so long. Our playing season is decreasing in time whilst the playing surfaces are the poorer for it even when its dry overhead. I'm frightened for the future of my home club and many like it!"*
>
> ***—Andrew Murray, PGA professional, former European Open champion & BBC commentator***

PARTICIPATION	*977, 300*[25]
VIEWING FIGURES	*600 million worldwide watched the Open at Royal Troon in 2016 and 1.1 million people in the UK watched the final day*[26]
ECONOMIC BENEFIT	*£4 billion is spent annually by UK golfers on their sport*[27]

IN FOCUS : CLIMATE IMPACT ON GREENS

Research led by the STRI[23-24], which underpins the sport's adaptation drive and sustainability initiatives, predicts a comprehensive range of impacts on greens, fairways, tees, rough and bunkers, with huge implications for the way golf courses are managed.

PREDICTION	IMPACT
Wetter autumns and winters	*Softer surfaces, green closures, muddy conditions, more pitch marks, poorer spring condition, more turf disease, and greater time for greens to reach summer condition.*
Milder autumns and winters	*More disruption to surfaces from disease scars, more wear, more pest and disease activity, greater variety of disease and more severe attacks, more thatch accumulation, more wear.*
Drier summers	*Reduction in uniformity and quality of surface from drought, more turf stress, more irrigation required, more signs of wear.*

Erosion at Montrose

Montrose is one of the five oldest golf courses in the world. The first reference to golf being played here dates back to 1562, and the course has been attended by such legendary golf architects Old Tom Morris, Willie Park Jr and Harry Colt. But more than 450 years of golfing history is at risk of being washed away by rising seas and coastal erosion linked to climate change.

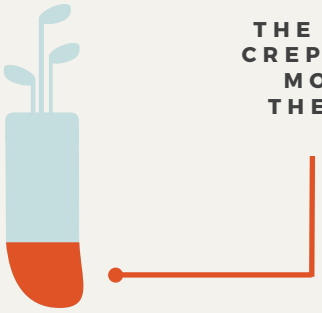
> *As the sea rises and the coast falls away, we're left with nowhere to go. Climate change is often seen as tomorrow's problem, but it's already eating away at our course.*

Research published in 2016 by Dundee University showed that the North Sea has crept 70 metres towards Montrose within the last 30 years[28].The combination of rising sea levels and reducing sediment is moving the shoreline further inland, effectively reversing the conditions that originally created the beaches and dunes. This poses a costly threat to the iconic Montrose Links.

"As the sea rises and the coast falls away, we're left with nowhere to go. Climate change is often seen as tomorrow's problem, but it's already eating away at our course," says Chris Curnin, Director at Montrose Golf Links.

"Last year we reached a critical point, the rock armour protecting our second tee and first green was no longer sufficient and we were in real danger of losing them. In a perfect storm we could lose 5-10 metres over just a couple of days and that could happen at pretty much any point. It was decided along with help from Angus Council that we would sacrifice our third tee (which is one of the iconic holes) by moving the rocks from there to bolster the rocks at the second2nd tee and first1st green. We are pinning our hopes on being included in the next round of funding for coastal protection."

If Montrose do not receive government funding to protect the dunes, we would have to dramatically move the course inland, which mean losing a slice of golfing history we won't ever get back. Protection for the golf course would also prevent the town of Montrose flooding.



THE NORTH SEA HAS CREPT 70M TOWARDS MONTROSE WITHIN THE LAST 30 YEARS

Golf doesn't always have the best press when it comes to its own environmental impact. However, the reality of climate change affecting the sport, plus a growing awareness of the range of environmental and ecological impacts that golf can have is leading to improvements. The R&A, the European Tour, Scottish Golf, the GEO Foundation and the STRI have all developed initiatives to equip courses to adapt to the impacts of climate change and help the sport become more sustainable.

Through the Green Links programme, the R&A aims to make The Open Championship one of the world's most sustainable sporting events. Launched ahead of the 145th Open at Royal Troon in 2016, Green Links aims to protect the environment, conserve natural resources and bring value to local communities.

> *A great deal of innovation is taking place on these Open venues. Solar power, rainwater harvesting, electric and hybrid machinery and partnering with local environmental and community groups are just some of those.*

The Green Links programme involves venues meeting a set of criteria across the categories of nature, water, energy, supply chain, pollution control and community, while working closely with ecology experts to enhance the habitat for a wide range of wildlife. These criteria are assessed under the GEO Certified® scheme, administered by the Golf Environment Organisation (GEO), a not-for-profit group dedicated to sustainability in the golf industry.

St Andrews was the first venue to achieve the standard, followed by the Old Course at Carnoustie, host of The 147th Open in 2018, Muirfield, Royal Troon, Turnberry, Royal Birkdale, Royal Liverpool, Royal St George's and Royal Lytham & St Annes. Most recently, Royal Portrush's certification means that all ten Open Championship venues have achieved GEO Certified.

On Portrush's certification, R&A Chief Executive Martin Slumbers said: "We are delighted that all ten host venues have demonstrated a long-term commitment to sustainability best practices by achieving GEO Certified ® status. This is very much in line with The R&A approach to sustainability and is certainly a key priority for us in the years to come."

"This is a fantastic achievement and an impressive show of leadership from the ten Open venues and The R&A," said Jonathan Smith, Chief Executive of GEO. "A great deal of innovation is taking place on these Open venues. Solar power, rainwater harvesting, electric and hybrid machinery and partnering with local environmental and community groups are just some of those. This announcement is symbolic of growing momentum in the advancement of sustainability through golf."

FOOTBALL

Football is one of our nation's greatest creations. The sport that started in the 18th century with entire villages engaged in brutal battles against each other now touches every nation, reaches across every divide, and brings unprecedented numbers of people together. More people watched the last FIFA World Cup Final than any other event that year[29].

Top players may be global superstars, but they represent only the tip of the pyramid. Grassroots football remains the lifeblood of the game, providing challenge, friendship, fitness and joy for millions, and the platform for success for those with the skills to make it in the professional game. Yet participation in grassroots football is in decline: in December 2016 Sport England reported a 180,000 drop in the number of people playing weekly, compared to a decade earlier[30].

The devastation of Carlisle United FC's home ground was a result of flooding caused by Storm Desmond in December 2015. Climate modelling has found that climate change made this storm 59% more likely. The biggest clubs are acting to reduce their carbon footprint because they know that if we reduce emissions we'll start to reduce the risk of a future where this record breaking rainfall, and the resulting flooding will become the norm.

—Kate Sambrook, Priestley International Centre for Climate

Increased rainfall and more extreme weather events associated with climate change may be a defining factor in the viability of grassroots football. The last comprehensive survey of grassroots football found that, on average, grassroots clubs lose five weeks every season due to bad weather – with more than a third losing between two and three months. Some 84% of these clubs highlight facilities as the most pressing issue facing the grassroots game[31].

While the impacts of weather trends linked to climate change may be felt most at the game's grassroots, football at a higher level is also exposed. Extreme weather events caused the cancellation of 25 Football League fixtures during the 2015/16 season[32], with Carlisle United's Brunton Park the most prominent example. The League One side was forced out of its home ground for 49 days by Storm Desmond at a cost of nearly £200,000.

In response to the floods of 2015/16, the FA, the Premier League and Sport England made £750,000 available to support affected clubs. Longer term, the FA will invest £48m in hundreds of new all-weather and specially adapted turf pitches across the country, including new dedicated facilities in 30 cities, in addition to upgrading more than 200 existing pitches nationwide[33].

The impacts of climate change on football are one of the drivers towards greater sustainability in the game. Manchester City and Manchester United are celebrated further in this chapter for their achievements, but they are just two examples of some of the Premier League's leading clubs who are taking significant action to reduce environmental impact and improve sustainability.

PARTICIPATION	2,299,700[34]
VIEWING FIGURES	*The total domestic TV audience across the 2016/17 FA Cup season was at least 82.5 million*[35]
NUMBER OF CLUBS	*37,000 grassroots football clubs in England*[36]
ECONOMIC BENEFIT	*In the 2013/14 season, the Premier League and clubs paid £2.4 billion in tax and added £3.4 billion to the UK's GDP*[37]

CASE STUDY : BROMLEY HEATH UNITED

Bromley Heath United Football Club, founded in 1966, is the oldest junior football club in Bristol. Over 350 young footballers, from 6 to 18 years of age, regularly play at their home ground of Pomphrey Hill, five miles from the centre of Bristol. The club is a feeder for academies affiliated to professional football clubs including Bristol City and Southampton.

> *[A decade ago] you would maybe get one or two matches cancelled, but for the past four years we have had have to cancel matches for a minimum of a month.*

"I've noticed that the kids aren't able to play as many matches per season as they were when I first got involved with the club over a decade ago," says club chairman Jamie Andrews-Britton. "Then you would maybe get one or two matches cancelled because of excessive rain but that's changed significantly. For the past four years we have had have to cancel matches for a minimum of a month during the season."

The 2015-16 season was particularly bad for the club with matches called off for 12 weeks due to unsatisfactory playing conditions. This affects the economic health of the club. When the pitches are unplayable the club is unable to collect the vital revenue needed for the upkeep of the grounds.

"Over the course of the winter there were so many matches called off because the pitches were unplayable that we saw a massive impact on the revenue we were able to earn from the bar and food facilities we usually supply," Jamie added. "During that period alone we lost £15,000 in revenue. We are trying to do community and private events to try and make up the shortfall and are just about breaking even at the moment."

He sees implications beyond the club as well: "If we're not supplying children for the club academies because they're not able to play regularly over the season then eventually we won't see the players feeding through to bigger clubs and the national squad."

KICKING OFF SUSTAINABILITY

CITY FOOTBALL ACADEMY

Izzy Christiansen Shows The Love

Manchester City's City Football Academy is one of the world's premier elite sports development facilities, providing up to 400 young players with coaching as well as fitness, accommodation and education facilities.

But footballing sustainability is not only watchword, with the club putting a high priority on environmental sustainability. While the stars of the future seek awards on the field, the City Football Academy has already won a Gold Standard award from Leadership in Energy and Environmental Design (LEED).

More than 30 hectares of post-industrial wasteland has been transformed into a world-class facility at the heart of the community. Through the creation of extensive wildflower meadows, grasses and wetland, once toxic land is now home to various types of moths, butterflies and bats, while 2,000 trees provide cover and nesting places for various birds, including kestrels.

Each hectare of the academy's turfgrass absorbs 6.5-8.5 tonnes of CO_2. Recycling and reuse means zero waste is sent to landfill, while 80-100% of the club's irrigation water is gathered onsite through harvesting and storage.

MANCHESTER UNITED

Old Trafford – the Theatre of Dreams – is one of the most iconic stadiums in the world. Along with United's Trafford Training Ground, it is also the focus of the club's environmental efforts.

The journey began with the training ground's construction on an environmentally sensitive site in 2000. A nature reserve (maintained in partnership with the Cheshire Wildlife Trust) was created, with grassland and ponds providing important habitats for wildlife: red admiral butterflies, meadow pipits and grey partridges have all made their home there. Two lagoons are also used as part of the wastewater treatment system,

Good sustainability practices include harvesting and recycling rainwater to irrigate and maintain the pitch and an extensive recycling and reuse programme. Non-recyclable waste is used to generate energy, including through anaerobic digestion of food waste.

Sergio Romero Shows The Love
Image credit: Man United Foundation

The club demands high environmental standards throughout its supply chain, engaging more than 70 suppliers over a five-year period, including through initiatives like 'ReUSE-A-Shoe', which recycled worn-out trainers into premium sports surfaces for football, tennis, basketball and running tracks. The Education Team in the Manchester United Museum also delivers lessons on sustainability to local schools.

CRICKET

Of all the major pitch sports, cricket will be hardest hit by climate change. Whether Mumbai, Melbourne, Antigua or Lancashire, cricket is defined almost entirely by the climatic conditions. If they change, so does the essence of the game.

Marylebone Cricket Club's (MCC) Russell Seymour – also chair of the British Association for Sustainable Sport (BASIS) – is English cricket's only dedicated sustainability manager, and he is more than worried: "Matches can hinge on changes in the weather," he says.

"It's usually easier to bat in sunny, dry conditions because it's harder for the bowlers to get unpredictable movement in dry air. Overcast conditions increase humidity, and the ball is more likely to swing making it more difficult for batters. A rain shower can change conditions again. English weather can change numerous times in a four or five day match. Climate change will amplify these changes. Over time we will also see changes to soil-moisture levels, and higher temperatures will bring drier air, then drier pitches and a drier outfield, changing all features of the game."

> *"Clubs like Glamorgan are feeling the day-to-day, match-by-match impact of increasing rainfall and more frequent heavy rain, with the knock-on increase in playing time lost to bad weather. This increase is in line with nationwide trends in rainfall, and is only set to get worse if climate change continues unchecked."*
>
> ***—Piers Forster, Priestley International Centre for Climate***

Increased rainfall and more extreme weather events are already a factor. Wetter winters and more intense summer downpours are disrupting the game at every level. According to Dan Musson, the England and Wales Cricket Board's (ECB) National Participation Manager, "there is clear evidence that climate change has had a huge impact on the game in the form of general wet weather and extreme weather events[38]."

In international cricket, 27% of England's home One Day Internationals since 2000 have been played with reduced overs because of rain disruptions. Of these, 62% have used DLS (formerly known as the Duckworth–Lewis Method, the mathematical calculation used to define the second innings target in a match with significant disruption). The rate of rain-affected matches has more than doubled since 2011; 5% of matches during that time have been abandoned completely[39].

County cricket clubs like Glamorgan are increasingly aware of the impact of our changing environment on the sport. The recreational game is most exposed, with fixture disruption and damage to facilities across the country.

"I've been at the ECB since 2006 and we have had to implement flood relief efforts on half a dozen occasions," says Dan Musson. "Wet weather has caused a significant loss of fixtures every year in the last five at recreational level and significant flooding in six of the last ten years. In season, the worst year was 2007, with flooding in the Midlands and the Thames Valley. Out of season the worst was 2015/16, when Storms Desmond and Eva badly affected more than 50 community clubs[40]."

PARTICIPATION	*347,300*[41]
VIEWING FIGURES	*1.3 million watched the final Test Match of the 2015 Ashes*[42]
ECONOMIC BENEFIT	*The 2013 Ashes at Lord's were worth £15.6 million to the Westminster economy*[43]

Supporting clubs to get back on their feet and restore their facilities cost the ECB £1m in emergency grants during 2016 and £1.6m in 2017. This trend has forced the governing body to set aside £2.5m a year for small grants to help recreational clubs keep the game on. The ECB is also conducting research to identify flood risk, and producing guidance for clubs on climate-related risks.

The ultimate risk to the game, however, is that increasingly disrupted cricket will lead people to eventually give up and do something else. Indeed, nearly 40,000 fewer people played cricket in 2015/6 than in 2005/6, a fall of almost a fifth[44].

Dan Cherry, Director of Operations, Glamorgan Cricket Club, says the weather is definitely a factor in participation decline: "The impact is becoming more obvious. If fewer people play the game, the whole sport will suffer."

CASE STUDY : GLAMORGAN CRICKET CLUB

In recent years, this Cardiff-based club has been seriously affected by high levels of rainfall and extreme weather. Since 2000, they have lost more than 1300 hours of cricket – equivalent to 217 days or at least 20,000 overs. Across the whole County Championship, at least 175 days - around 16,000 overs - have been lost in five of the last ten years[44].

> *Climate change is becoming a huge factor. If we don't take it seriously, it will fundamentally change the game.*

"Losing so much cricket is a county's worst nightmare – it affects the club at every level," says Dan Cherry, Head of Operations and a former first-class batsman who represented England at under-18 level. "Our experience is becoming the norm for almost every club and it's difficult even for first-class counties to be commercially viable with such an impact. It's been worst in recent years – during the 2017 season five of our seven T20 Blast fixtures were badly affected by rain, with three being totally abandoned. T20 Blast is a great way to get new people through the gates and into cricket, but they won't come back if this keeps happening, and it's damaged the club to the tune of £1m. It's also bad for Cardiff as the club adds tens of millions to the local economy during its busiest years."

Image credit: Huw Evans Agency

Glamorgan Cricket Club in the rain

"Climate change is becoming a huge factor. If we don't take it seriously, it will fundamentally change the game. It's simple: the less cricket we play at every level the fewer people will watch it, the less they will come to the ground and pay to enter, the less chance there is for young people to be inspired to take up the game."

For Glamorgan, taking climate change seriously means serious action to reduce its own environmental impact. Following a full inspection and analysis of its operations, the club has taken measures to improve sustainability across suppliers and caterers, electricity and gas use, water and waste management, and away-day travel.

Since 2013, Glamorgan has achieved a 10-15% reduction in electricity use and a similar reduction in gas use and emissions related to away-day travel. Measures ranging from new appliances and fittings to staff training have helped deliver an overall reduction of 137 tonnes of CO_2 in the first two years of their sustainability programme. Impressively, this has been achieved while spending has remained stable and revenues have increased[45].

GREENING THE HOME OF CRICKET

Marylebone Cricket Club has helped to pioneer environmental sustainability in professional sport. Lord's was the first national venue to employ a sustainability manager, and its energy and waste policies are now becoming the norm for major stadia.

Some of the sustainability measures introduced by MCC include:

100% of the ground's energy needs are sourced from wind power, with additional solar PV, solar thermal and ground-source heat pump options in the new Warner Stand

Essential machinery such as leaf blowers, and buggies are all electric, eliminating polluting equipment

All new equipment inside the ground is low-energy rating, and motion sensor technology is used in areas such as bathrooms, corridors, kitchens and small rooms

Staff contribute to a more sustainable culture through sustainable printing initiatives, segregated bins and limiting single-use plastic

With one of the most comprehensive recycling systems of any national sporting venue, Lord's delivers zero waste to landfill

Unused edible food – always seasonal and as locally sourced as possible – is delivered to those who need it in the surrounding community via local charities, with food waste segregated and dispatched for anaerobic digestion

WINTER SPORTS

As the latest Winter Olympics gets under way in South Korea in February 2018, the future of many winter sports is in jeopardy.

Rising temperatures are already having an impact on snowfall and glaciers in mountainous regions. Temperatures in the Alps have risen by just under 2°C over the past 120 years, almost twice as much as the global average[46]. This has led to a 15-25% decline in rain, snow and sleet, a 10-50% reduction in average winter snow depth and a shortening of the ski season at all elevations of 5-15% over the 1931-2010 period[47].

In future, winter temperatures in the Alps are projected to increase by a further 2-4°C towards the end of the 21st century, with snow cover expected to decrease by 70-100% at elevations below 1500m[48]. In Scotland, a 2-4°C increase in temperature could cause a 60% reduction in winter snowfall rates by the 2080s[49].

SKIING

The Met Office has warned that the Scottish skiing industry could collapse within as little as 50 years as winters become too mild for regular snowfall. Continuous decreases in snow cover have already been observed over the last 40 years, with three of Scotland's main resorts spending more than half their operating budgets on artificial snow factories after a particularly bad 2016/17 season[50].

If these trends continue, disaster looms, with potentially devastating consequences for local economies in the Scottish mountains[51].

In Europe, there are big concerns, particularly for ski resorts under 1000 metres. As a rule of thumb, with every 1°C temperature increase the snowline elevation will rise by 150m[52-55]. As a result, less snow will accumulate at low elevations and the ski season may start up to a month later and finish up to three months earlier, due to the lack of snow. Nearly half of all ski resorts in Switzerland, and even more in Germany, Austriaand the Pyrenees, will face difficulties in attracting tourists and winter sport enthusiasts in the future[56].

PARTICIPATION	*1.1 million recreational skiers and snowboarders in the UK*[57]
VIEWING FIGURES	*The FIS Alpine Ski championships received an average TV audience of 6.5 million*[58]
ECONOMIC BENEFIT	*The Scottish ski industry adds ~£700m to the UK economy per year and supports more than 20,000 jobs*[59]

> *"Retreating glaciers, and the disappearance of ice on mountain climbing routes, as documented by the athletes in this chapter, are in line with climate models which predict the effects of a warming world on mountainous areas. As temperatures rise, the snowline will retreat, making winter sports increasingly vulnerable to climate change."*
>
> ***—Piers Forster, Priestley International Centre for Climate***

"I've been visiting the Alps in winter since my first trip as a toddler in 1967." Matt Chilton is an Alpine skiing commentator for Eurosport and BBC Sport. He says: "As a travel and media professional my Alpine work began in 1984, and the changes I have witnessed since then have been remarkable. No two winters are the same in the mountains. Across much of the Alps, snow depths are currently high, but this is largely restricted to high altitude resorts. Lower lying, previously snow-sure ski areas are losing operational capacity, and livelihoods are at risk as each ski season seems to bring warmer temperatures and fewer snowy days.

Matt Chilton

"Many glacier ski areas where we played in the eighties and nineties have now changed beyond recognition. Resorts which once offered skiing 365 days of the year no longer make these claims. Increasingly, skiing and snowboarding in November, December and even into January is reliant on artificial snow, which is itself dependent upon low temperatures, water and electricity. The future of the entire ski and snowboard industry, at both recreational and elite competition levels is under pressure. We need snow and low temperatures. We need winter."

Image credit: Thierry Gregorius

Glen Shee, skiing off season

Tourism of any kind is extremely weather sensitive, and weather variability will have a significant impact on the ski tourism industry: while warmer weather and less snow can be expected across the whole season, the loss of guaranteed good snow at particular times of year is just as significant. Although the current season is unusually good, with a further 2°C increase in temperature the Alpine tourism industry is predicted to lose up to 10.1 million overnight stays across the winter season, due to variable weather conditions and a lack of certainty around good skiing conditions[60].

WINTER OLYMPICS

The Winter Olympics hasn't escaped the changing climate. A recent study from the University of Waterloo, California, shows that, by the middle of the century, if greenhouse gas emissions continue to grow, almost half of the past Winter Olympics host cities would be too warm for outdoor Alpine sports. As few as 6 of the previous 19 venues are likely to be cold enough to host the games by the end of the century[61].

The last Winter Games in Sochi, Russia saw temperatures as high as 16°C, more akin to a Summer Olympics. The warm weather was above normal for Sochi, where average February temperatures are around 10°C. The poor snow conditions caused delays, injuries and athlete complaints in a number of disciplines including the men's snowboard halfpipe, the women's ski jump and the men's downhill.

This follows a trend of warmer weather for the Winter Olympics, from 3.1°C in the 1960-90s, to 7.8°C in the games held in the 21st century[62].

Meanwhile, athletes training for the Winter Olympics are being affected by increasingly scarce summer and autumn training sites[63].

BY THE MIDDLE OF THE CENTURY ALMOST HALF OF THE PAST WINTER OLYMPICS HOST CITIES WOULD BE TOO WARM FOR OUTDOOR ALPINE SPORTS

"I have been snowboarding for 10 years and I have seen first hand the glacier receding year by year," says Aimee Fuller, Olympic Snowboarder for Team GB.

Image credit: ROXY
Image location Absolut Park Flachauwinkl

Aimee Fuller

"In that time I have been making an almost annual trip to the Saas-Fee Glacier in Switzerland, it was one of the first resorts I ever visited and they have one of the best snow parks in Europe. Now you can physically see it getting smaller with huge chunks of glacier breaking and cracking off. Snowboarding is really susceptible to the impact of climate change and we can see the impact on our sport in the mountains on a daily basis. This is a large scale, ongoing issue that we all need to be aware of and get behind. Within the snowboard community you see a growing level of awareness on the issue which is great, but we can all make a difference. No matter how big or small, little adjustments can make a world of difference that can help to protect the mountains that we get so much pleasure from. We want to make sure future generations get to enjoy these incredible places in the same way we have."

CASE STUDY: LES DEUX ALPES

"I've dedicated my teenage years and adult life to freestyle skiing," says Dean Harris. "Conditions were just not like this five years ago. This is my concern for the future of the mountains and my sport."

> *By us all doing our little bit then perhaps we can prevent snow-free mountains becoming the only option.*

Dean has been coming to Les Deux Alpes for years. The French alpine resort offers some of the world's best summer skiing on its high altitude glacier, and the best freestyle skiers and snowboarders come here to train.

"Just a few years ago you could pretty much step out of the gondola and into your skis," says Dean. "Now it's a hike. The training sessions are short: bullet hard conditions first thing are not favourable for heavy landings, by lunchtime you are in slush and the day is done. It's on the way back where the effects of the 'big melt' are most noticeable – crevasses and more significantly rivers of water pouring down the ice.

"I get that people may think that skiers and snowboarders are hypocritical because we travel around the world, but there is a movement within the scene to make change."

Dean Harris

Dean runs a project called Envirojam to educate people about climate change. "We got an amazing response with people seeing the value in sharing cars, getting the train and thinking about how to make small changes," he says. "It's not total, I get that, but it's a start. By us all doing our little bit then perhaps we can prevent snow-free mountains becoming the only option."

CONCLUSION

This report has documented the impacts that extreme weather and coastal erosion are having on some of the UK's most popular sports. As the evidence from the Priestley International Centre for Climate shows, these impacts are in line with climate trends that will continue if we don't act to reduce greenhouse gas emissions.

The worst effects of climate change on sport, and on the whole of society, can still be avoided:

Internationally, companies, governments, financial institutions and the sporting industry must act to reduce emissions in line with the ambition of the Paris Agreement, to prevent global temperatures from rising more that 1.5°C.

Nationally, governments across the UK must introduce policies to ensure we meet or exceed the targets set out in the Climate Change Act.

Sports bodies should follow the lead of the pioneering clubs showcased in this report, and work to reduce their own carbon emissions and other environmental impacts.

Show The Love is an annual celebration of all that we love but could lose to climate change. Each February since 2015, organisations, institutions, and millions of people have harnessed the power of green hearts to show they care about climate change and its impacts on the things we care about. Every one of us can be part of this movement.

The Show the Love campaign aims to get people talking about how the things we love are affected by climate change. We can all contribute to making action on climate change as much of an everyday activity as playing sports. Start by starting conversations about the findings in this report. Talk about your own experiences of being affected by increasingly extreme weather. Talk about what you care about and how it will be affected by climate change. Talk about this at half time in a football match, or while out for a run with a friend and help make climate change a part of the national conversation. Then together we can work to find and call for the steps that will help to get our climate back in balance.

Show The Love 2018 will build on the momentum of the last three years. Green hearts will kick off conversations about the things we love and the future we want for our children - one powered by clean and secure energy. From The WI crafternoons to Premier League football matches, from pubs to primary school playgrounds, we can all show that we care.

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