An aerial photograph of a cricket field. The central green pitch is visible, with several players in various colored uniforms positioned on it. The outfield is a mix of green grass and brown, dry-looking grass. The title 'HIT FOR SIX' is overlaid in large white letters on the right side of the image. The word 'SIX' is particularly large, with a cricket bat integrated into the letter 'I'.

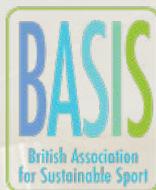
# HIT FOR SIX

THE IMPACT OF CLIMATE CHANGE ON CRICKET

# HIT FOR SIX

This report was produced by:

  
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Priestley International  
Centre for Climate



  
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## FOREWORD



BY RUSSELL SEYMOUR

Cricket is a sport where natural systems (sunlight, temperature, rainfall, soil, etc.) significantly influence the playing surface, and the conditions on the day can alter the balance of the game. Sunny, dry conditions may favour batting, while overcast, humid conditions may be more helpful to a skilful bowler. Conditions can change many times during a four- or five-day match. Imagine that variability multiplied by the predictions of climate change.

To be clear, it would be a mistake to think that climate change is something that may happen at some point in the future. The consensus of the vast majority of scientists is that, while the effects of climate change will increase in years to come, its impacts are with us now, as this important report explains. This report is unprecedented in its breadth, not only discussing the large-scale infrastructure impacts already felt by cricket-playing nations but, for the first time, examining how expected changes might influence the physiological and psychological responses of individual athletes, and the welfare-related policy reforms that may be required to mitigate these effects.

At Lord's Cricket Ground, as in the rest of England, we will see higher summer temperatures with less rainfall, perhaps fundamentally altering the management of the pitch and the playing conditions. Will seed germination rates change? How will root and leaf growth respond? Will we need to change the seed mixes used? Or deal with different and unusual pests and diseases? Weather conditions will be less stable and, likely, more dangerous, whether through the risks of extreme heat and humidity to players and spectators, or more severe storms, floods and droughts, impacting communities, facilities and finances.

In particular, this report underlines the dangers of increasing heat to players at all levels of the game, but especially to young players. The recent "School Strike for Climate" protests across the world demonstrate that many young people feel that their future is being put at risk. We may fail a generation of cricket players if we fail to act on the timely recommendations of this report.

Climate change is a problem that sport can help to fix, with cricket well placed to take a lead. The Game Changer report, published by the Climate Coalition in 2018, noted "of all the major pitch sports, cricket will be the hardest hit by climate change", therefore climate change should appear high on the risk register of cricket bodies. In response, these organisations should, firstly, review their actions and reduce their impacts (following the recommendations in this report will go a long way to accomplishing that goal). Secondly, they should act as trusted ambassadors to discuss, openly, the future impacts of climate change, and other sustainability issues, on the sport loved by many and what can be done to help.

There's a misconception that clubs, venues and governing bodies have to be perfect examples of sustainability, with their impacts managed and minimised, before they engage in the conversation. Ultimately it is a genuine commitment to take action that is needed, and that commitment needs to come soon. Cricket, indeed any sport, can speak about sustainability, with confidence, from a position of strength and responsibility, due to the significant effects that will be felt by the game.

Sport has taken a strong stance before, actively addressing social issues such as racism, sexism, obesity and, most recently, mental health. The time has come for sport to speak out on the environment, an issue that will encompass us all.

So what can be done? We can reduce greenhouse gas emissions, minimise waste, cut out single-use plastics, and use water sustainably. Typically, sustainability equates with efficiency, so we can do all of this and save money.

Lord's is now powered by 100% wind-generated electricity, sends no waste directly to landfill and has cut the use of single-use plastic by more than half (with more actions being taken). Other BASIS members, including venues, governing bodies, broadcasters and suppliers, are also taking the urgent action needed and creating a better experience for spectators, staff and players.

This report represents a huge step forward. Its focus is on cricket, but it could be replicated for every sport as we will all be affected. BASIS exists with three goals in mind: to develop best practice and integrate sustainability into the sports sector; to encourage action and collaboration; and to use the influence of sport to educate our participants and fans. Put simply, our task is to build knowledge, confidence and momentum and transform it into action. In doing so, we may insulate the sports we love from the worst impacts of climate change and make a real contribution to solving humanity's most pressing challenge.

*Dr Russell Seymour is Sustainability Manager for Marylebone Cricket Club at Lord's Cricket Ground, London.*

*He is also the Founder and Chief Executive of BASIS (the British Association for Sustainable Sport).*

*BASIS is a group of like-minded individuals, organisations, partners and providers from various organisations and a diversity of sports. Our vision is to nurture and promote sustainability and sustainable development in all aspects of sport through providing high quality support, resources and events. We recognise sustainability in the broadest terms to include economic activity, environmental responsibility and social progress. We welcome new members to be part of this exciting group whose common desire is to manage our sporting activities in a more sustainable way.*

[www.basis.org](http://www.basis.org)

## FOREWORDS



BARONESS SCOTLAND,  
COMMONWEALTH SECRETARY GENERAL

*The Commonwealth is a family of nations with shared history, shared challenges  
and shared passions.*

Cricket is chief among those passions – all the major cricketing nations are Commonwealth countries. Love of cricket is a characteristic that is shared across many of the 2.4 billion people who live within our 53 nations.

Without doubt, climate change is the dominant challenge we all share. The threats to our health, livelihoods, food security, water supply, human security, and economic growth are very real. Heightened threats to biodiversity and ecosystems, including species loss and extinction both on land and sea, are also expected if current trends continue.

Commonwealth countries range from industrial to developing, from the highest mountains to the lowest-lying islands. No country in our family remains untouched. We now need to do more – faster and better – to win the race against time and save our Common Earth.

This report is timely and welcome. It shows not only how our biggest shared challenge is affecting our pastime, but offers a window into the threat climate changes poses Commonwealth countries. Higher temperatures across the board; extremes of flooding and drought; more frequent, intense storms and rising seas; pressure on natural resources including food and water; political instability and the threat of conflict.

One of my fondest childhood memories is standing on a homemade pitch, cricket bat in hand, heart pounding with excitement, praying to hit a six. And through the years, I have witnessed for myself how the capacity for cricket and sports in general to be unifying force, bringing people together and to break down barriers.

This report frames a clear choice: allow climate to continue changing unchecked, and in doing so allow our economic choices to damage the things we love; or take action – in every industry, every sector, every pastime, everything we do – to protect the things we love by taking better care of the planet we all share.

That starts by understanding the impact of climate change, which this report helps us to do, and by cutting our emissions, which this report inspires us to do – and which we have already agreed to do. By endorsing this report, I renew the a clear commitment I have made to help the countries covered in it, and all other members of the commonwealth, to keep the promises made in the Paris Climate Accords.

## FOREWORDS



KEITH C. MITCHELL, PH.D.  
PRIME MINISTER, GRENADA

“The cricket fraternity must heed the call to drive climate awareness and action to address the scourge of climate change. Climate change is an existential threat for the West Indian community as the team seeks to re-establish itself at the pinnacle of the cricketing pyramid. Climate change is real. It’s as simple as that. Every ball bowled at us is currently a bouncer. We’re ducking so much we’re struggling to build an innings that will ensure a safe, secure and sustainable future for our people. We are all impacted by climate change: there’s not a country in the world that can afford to ignore the clear warnings from climate scientists. There is not a sport that can turn a blind eye to the devastating impacts of climate change. Cricket cannot afford to ignore the incontestable climate science.”



OVAIS SARMA, D,  
DEPUTY EXECUTIVE SECRETARY, UNFCCC SECRETARIAT

“No one is safe from the impacts of climate change and sport organizations and sporting communities are already being affected. Climate action is therefore urgent. Cricket teams, associations and anyone who loves the game of cricket, as I do, now have the opportunity and the imperative to raise awareness about climate change challenge that we are all facing, to encourage action, and to lead by example. This report is an excellent contribution to raise awareness about climate change and encourage concrete and proactive climate action by the sporting communities.”

## 2 - EXECUTIVE SUMMARY



*Cricket is already feeling the effects of a planet that is heating up. Scientific studies have shown the fingerprints of climate change on the heatwave that in 2017/2018 impacted youth matches in Australia, Storm Desmond in 2015-16 that [washed away](#) 'Appleby and Eden Cricket Club in Cumbria, England and the drought that plagued Cape Town during the 2017/2018 Indian cricket tour of South Africa.*

*And the science says the impacts will worsen significantly.*

For the first time this report brings together the expertise of climate scientists with the science of sports physiology to explore the current and future impacts of our changing climate on the world's second most followed sport. Leading institutions from their respective fields, the Priestley International Centre for Climate and the Extreme Environments Laboratory at the University of Portsmouth, have combined their knowledge to see how, in particular, the extremes of heat driven by climate change are already affecting the game now and could challenge it in the future.

As the 'heat' chapter of this report lays out, a hot, still, sunny day of 30°C and 35% humidity could push players beyond the 'black flag' level at which that the American College of Sports Medicine recommends cancelling any continuous exercise. For the first time the report reveals how a professional batsman generates the same amount of heat as a runner travelling at 8 km/hr – equivalent to a marathon over a day of batting. The human body has limits to the heat and humidity it can withstand, especially when exercising and particularly when clothing, such as batting pads and helmet, restrict the ability to evaporate sweat.

A chapter exploring the climate impacts in some of the world's great cricket-playing

regions (India, Australia, South Africa, England and the West Indies) reminds us that the mercury in Visakhapatnam, Andhra Pradesh, which recently hosted a one day international between India and Australia, hits 37 °C on a much more frequent basis and large regions of India are set to get hotter still.

It's clear that change is coming. This report's recommendations point to the lead that Cricket Australia has taken in laying out heat rules. Other countries must surely now follow. Clothing could have to change to allow particularly batsman to evaporate sweat more easily. The political risk coming from the increasing competition for water resources, to keep playing fields green, but also sustain populations, must be navigated. And young people, more susceptible to heat, will need special care and attention when playing the game.

Beyond this cricket will need to ask itself if it is doing enough to help halt climate change. Early moves from MCC which installed solar panels and runs Lord's on 100% renewable energy will need to be followed worldwide. Many of cricket's two billion fans and legion of amateur players are on the frontline of climate change, facing the extreme heat of India or the hurricanes of the Caribbean. Their wellbeing and livelihoods are intertwined with the future of the game.



## RISK 1: HEAT

While cricket is not commonly regarded as active a sport as football or rugby, data from University of Portsmouth reveals the heat production of an international batsman is equivalent to an individual running at about 8 km.h<sup>-1</sup>. Those metrics indicate a day at the crease can be compared to running a marathon wearing helmet, gloves and pads. And when air temperature is higher than skin temperature – typically around 33-35°C – only sweat can stop the body heating up. Protective clothing and high humidity make this less effective

Cricket is a game that requires its players to have a wide range of physical and mental skills. Concentration and agility must be maintained at the highest level over the course of often long periods, but they are affected by heat and high body temperatures. The science tells us climate change is already leading to more extreme heatwaves. Implications for cricket include:

- More games being postponed, rearranged to cooler times of the day
- Poorer performance due to the heat-influenced cognitive deterioration

- Increased likelihood of heat exhaustion and other heat illnesses
- Increased likelihood of heat stroke resulting in the need for medical intervention.

New guidelines will need to be put in place to protect players at all levels and abilities. Cricket authorities may consider allowing players to wear shorts under extreme conditions, while major kit and equipment manufacturers would be advised to accelerate testing of helmets, gloves and protective padding that enhance air-flow and keep players cool.

These impacts are not limited to players. The decision by Lord's in 2018 to temporarily relax dress codes for members due to the summer heatwave was unusual. But in time this will become commonplace as temperatures rise. More direct sunlight and heat increases the chance of hyperthermia, heat syncope (faint) and sunburn.

## SUMMARY OF IMPACTS



### RISK 2: DROUGHT

Cricket is typically played on grass. Without adequate water grass dies. This is obvious, yet cricket authorities in India and South Africa faced calls in the past two years to minimise their water use due to droughts afflicting both countries.

Access to water is likely to become increasingly contested as climate impacts multiply, and fresh water sources come under

increasing stress. During future prolonged droughts, governments may decide to prioritise food and drinking water supplies over sport.

Cricket authorities across the globe will need to work proactively to avoid future conflicts, and also invest in water efficiency initiatives to minimise the game's drain on regional and national water resources.



### RISK 3: EXTREME STORMS

Hurricanes Irma and Maria delivered knock-out blows to much of the Caribbean in September 2017, leaving towns, businesses and dreams in ruins. While much remains to be discovered about the links between climate and hurricanes, scientists agree that warming oceans energise super-storms, and rising sea levels exacerbate their impact on landfall.

Sri Lanka, India and the West Indies are at greatest risk of extreme storms, with West Indies still suffering from the devastation of the 2017 storm season. At stake is nothing less than the future sustainability of West Indies cricket - the sport can survive but unless steps

are taken to protect infrastructure and people it will be steadily degraded.

Windward Islands cricketer Liam Sebastien, who was caught in Dominica when Maria hit in 2017, told this report "some playing fields are no longer of use" due to the storms, while other players have left the islands in search of work. He calls on the International Cricket Council (ICC) to set up a climate disaster fund that can help support vulnerable regions when they're hit by extreme conditions. "they need to take a closer look - the West Indies is important to the ICC due to its global brand and the flair the players bring," he said.

### 3 - CLIMATE CHANGE – THE SCIENCE

KATE SAMBROOK,  
PRIESTLEY INTERNATIONAL CENTRE FOR CLIMATE

*Scientists are very clear that human activities, such as burning fossil fuels like coal and oil in power stations and vehicles, are pushing our climate out of balance.*

*Greenhouse gases released into the atmosphere trap more of the sun's heat, causing the planet's lands and oceans to warm. While the climate has always been affected by a range of natural factors such as solar radiation and volcanic eruptions, the rate of change since the 1950s is the concern, and societies and the natural world are struggling to adapt.*

And while it might sound as if the increase in temperatures isn't huge – 1°C globally so far since the industrial revolution – many land areas have warmed much more, destabilizing the climate and increasing weather extremes. While weather has always been changeable, climate change loads the dice towards extremes of heat, rainfall and drought, affecting different parts of the planet in different ways and to different extents.

The latest major scientific report from the UN <sup>2</sup> has warned that the “temperature rise to date has already resulted in profound alterations to human and natural systems”. The report concludes that if we could restrict the global temperature increase to 1.5°C (which could be reached by 2040 <sup>3</sup>) instead of 2°C it would make a big difference, with around 420 million fewer people frequently exposed to extreme heatwaves.

Under the 2015 Paris climate agreement <sup>4</sup> world leaders committed to limit temperature rise to 2°C, but also to aim for no more than 1.5°C and to review their pledges at a summit in 2020. However, current government pledges to cut emissions would see temperatures rise by about 3°C <sup>5</sup> by the end of the century.

Limiting temperature rise to 1.5°C by 2100 means immediate and significant cuts in

global emissions <sup>6</sup>. If the world warms beyond 1.5°C, the risk of breaching ‘tipping points’ increases and the greater the risk that we lose the ability to halt climate change. The irreversible ice sheet loss in Greenland and the Antarctic would increase sea level, as a result flooding the world's great coastal cricket grounds.



Image: pixabay

Because of the delay between the release of greenhouse gases and the warming of the oceans the world is already locked into temperature changes in the future from current emissions, but these will only get worse if more greenhouse gases are added to the atmosphere.

### **Rising heat:**

The world is already experiencing the effects of a global 1°C<sup>7</sup> temperature rise. In today's climate the average African region experiences<sup>8</sup> one to three heatwaves a year<sup>9</sup>. In a world set for just 1.5°C warming the frequency of these could more than double<sup>10</sup> by 2050. In 2015 for example, a heatwave in Karachi, Pakistan, killed 1300 people<sup>11</sup>. According to future projections, a 1.5°C temperature rise would mean the city would experience the same temperature about once every 3.6 years<sup>12</sup>.

### **Water shortages in vulnerable regions:**

One fundamental concern for cricket grounds is the impact of climate change on water supply. The amount of freshwater available in rivers and lakes could decrease by 10% in Australia as a result of a 1.5°C global temperature rise<sup>13</sup>. Glaciers in the high mountains of Asia play an important role<sup>14</sup> in the water supply of millions of people living downstream including the Indian sub-continent. 800 million people<sup>15</sup> are at least partly dependent on meltwater from these glaciers. Even in a world where temperature increases are limited to 1.5°C, around a third<sup>16</sup> of the ice stored in these glaciers would be lost by the end of the century.

### **Rising sea levels displace people:**

Climate change drives sea level rise in two ways<sup>17</sup>: (1) through the expansion of water as it warms (i.e. thermal expansion); and (2) by the melting of ice sheets and glaciers, which adds water to the oceans. 46 million people<sup>18</sup> currently live in areas that are at risk of permanent inundation from sea level rise if temperatures rise by 1.5°C, with around half residing in China, Vietnam and Japan<sup>19</sup>. This is equivalent to about 70% of the number<sup>20</sup> of people currently displaced from their homes globally by war, instability or human rights violations.

### **Food production suffers:**

Rising temperatures, drought and unstable weather patterns have serious implications for global food production. Every degree of global temperature rise reduces<sup>21</sup> global yields of wheat by 6%, rice by 3.2%, maize by 7.4%, and soybean by 3.1%. Some regions are more affected than others – in West Africa, wheat yields could fall by up to 25% if temperatures rise to 1.5°C. Fishing will also be affected. Every year, around 82 million tonnes of fish<sup>22</sup> are caught in the sea. For every degree of warming, this could decrease<sup>23</sup> by 3 million tonnes. If the potential impact of coral reef collapse, ocean acidification and/or overfishing on fish populations were also considered, the decrease is likely to be even greater.

### **Nearly all coral reefs lost:**

Between 2014 and 2017, 21 of the 29 reefs listed as World Heritage Sites suffered<sup>24</sup> from heat stress as a result of rising ocean temperatures. With 2°C of warming, virtually all (more than 99%) of coral reefs would be lost, this would be reduced to between 70-90% if that is limited to 1.5°C<sup>25</sup>. Coral reefs provide a natural barrier<sup>26</sup> to protect the shoreline from waves, storms and floods, helping to prevent damage to cricket grounds situated along the coast.

### **Tropical storms even more destructive:**

The full category-five force of Hurricanes Irma and Maria devastated parts of the Eastern Caribbean and caused significant damage<sup>27</sup> to essential cricket grounds. The frequency of similar storms (category 4 and 5) are projected to increase under higher levels of global warming (3°C-4°C). These storms will be associated with higher wind speeds and rainfall rates<sup>28</sup>, which will mean more destruction to cricket grounds and community facilities.

## 4 - HEAT & CRICKET

BY PROFESSOR MICHAEL TIPTON,  
EXTREME ENVIRONMENTS LABORATORY,  
UNIVERSITY OF PORTSMOUTH

*Rising atmospheric concentrations of greenhouse gases (GHGs) over the last 150 years (and especially the last 50) 'trap' long wavelength radiation and add energy to our atmosphere. Global average surface temperatures have already risen 1°C as a result. However, this is an average - and temperatures over land, and where people live and play sport, have risen far more. Perhaps more importantly, the addition of excess energy drives more frequent and more extreme weather events - and the addition of excess energy thus drives more frequent and more extreme weather events. Finally, such changes in the weather and temperatures to which humans are exposed are not evenly distributed: some areas are affected far more than others.*

It is thus not a change in global average temperature, but changes in local weather which are likely to impact the sport of cricket. This will occur through the impact of extreme weather events on ground conditions and crowd attendance (flooded or baked wickets, weather unsuitable for match attendance, or disrupted transport).

The major factors determining the likelihood of heat-related problems for cricketers in addition to the duration of exposure, relate to:

- Environmental conditions (temperature, humidity, solar load);
- Intensity and duration of exercise – about 80% of the energy used exercising is released as heat;
- Clothing worn - clothing provides insulation and a barrier to heat exchange with the environment, it absorbs sweat reducing evaporation next to the skin and increases clothing weight.

These factors are highly relevant to cricket as it is played in the summer, often in hot climates, involves a range of exercise from near rest (e.g. slip fielding) to intense exercise (e.g. bowling, running when batting) and a range of clothing (from light everyday clothing to significant padding and head protection). This means that the risk of heat-related issues, and the nature of the problems likely to be encountered in cricket varies from location to location, from day to day and from player to player.

It has already been established that in hot conditions cricket players can suffer heat-related illness. Two separate studies from Australia have found links between hospitalisation due to heat-related illness and the playing of cricket<sup>29</sup>. It is interesting to note that the sports resulting in heat-related hospitalisation include those with both high (marathon running) and low (bowls) levels of metabolic heat production. The reasons for this are addressed in the following section.

## HOW THE BODY DEALS WITH HEAT – THE BASICS

The body has a number of ways of responding to either internal (generated through exercise) or external (environmental) heating – the responses are known as the ‘heat loss effector mechanisms’. These include increasing skin blood flow (vasodilatation) to deliver heat to the surface of the body to be lost to the outside world, and sweating, which enables evaporation at the surface of the skin thereby cooling the blood flowing through the skin and consequently the body. These effector systems work best when unclothed, at rest in low humidity air at about 26-28°C,

or colder (~10°C) if exercising. When air temperature is higher than skin temperature (which is normally about 33-35°C) heat is gained, not lost, from the environment by non-evaporative routes and the only route for the body to lose heat is through the evaporation of sweat, which is less effective in high humidity environments. Additionally, the body can react to heat with behavioural responses such as reducing physical activity - the drive to do this increases as body temperature increases.

## CONSEQUENCES OF OVER-HEATING

Over-heating can have both a psychological and physiological impact on the body.

### The Psychological Responses

Increases in body temperature can negatively affect not only the physical functioning of the body but the brain too. Simple cognitive tasks (such as basic arithmetic and how long it takes to make a decision) are less vulnerable to heat stress than more complex tasks<sup>30</sup> such as vigilance (the ability to maintain attention, for example, when batting), short-term/working memory (for example a bowler remembering how the ball bounced off the pitch) and dual tasks (for example, a batter keeping an eye on an incoming delivery while simultaneously manoeuvring to take a shot).

Heat stress adversely affects comfort, mood-state, vigour and fatigue. The perception of feeling hot (e.g. hot “flushed” face) or the body’s responses associated with heat (e.g. facial sweating) can be distracting, affect concentration and thereby performance when focus and attention are required. For cricket this could be bowling, batting and fielding.

*I've suffered in the heat before. Running in and bowling can be so tough on the leg and the lungs. It's hard to stay sharp and fully on it. When I was young I had to acclimatise to my first West Indies tour by running through thick sand at the hottest point in the day to replicate what it feels like when all your energy has gone. I remember one game in India when [Andrew] Strauss was captain and had to retire hurt because he was cramping up so much in the heat. They had drips ready after the game in case anyone went over the edge. We were all exhausted.”*

**Liam Plunkett**  
Surrey and England fast bowler;  
2019 Cricket World Cup winner



## The Physiological Responses

The negative physiological responses to heat range from performance threatening to life-threatening (Figure 1), they include:

- Heat cramps.** These usually occur in those muscles being exercised due to dehydration and alterations in electrolyte concentration, and low energy stores. Deep body temperature remains in normal range.
- Heat exhaustion.** The most common form of heat illness, defined as the inability to continue exercising in the heat. Usually seen in unacclimatised individuals i.e. those not used to the conditions or who haven't had enough time for their bodies to get used to them. It is caused by the body not sufficiently adjusting to the hot conditions and dehydration (reduced blood volume) and is characterised by breathlessness, hyperventilation, weak and rapid pulse, low blood pressure, light-headedness/dizziness, headache, flushed skin, nausea, paradoxical chills (goose bumps and shivering in high temperatures), irritability, lethargy and general weakness. Deep body temperature is raised, but not excessively, sweating persists and there is no organ damage.
- Heat stroke.** This is a medical emergency resulting from failure of the thermoregulatory system as a result of deep body temperature rising to more than 40.5°C compared to normal body temperature of around 37°C. It is characterised by confusion, central nervous system dysfunction, diminished coordination, absence of sweating, hot and dry skin, circulatory instability. If not treated by immediate cooling, it results in death from circulatory collapse, increased gut permeability, inflammation and multi-organ failure. Aggressive steps should be taken to cool the casualty as mortality is related to the degree and duration of hyperthermia.

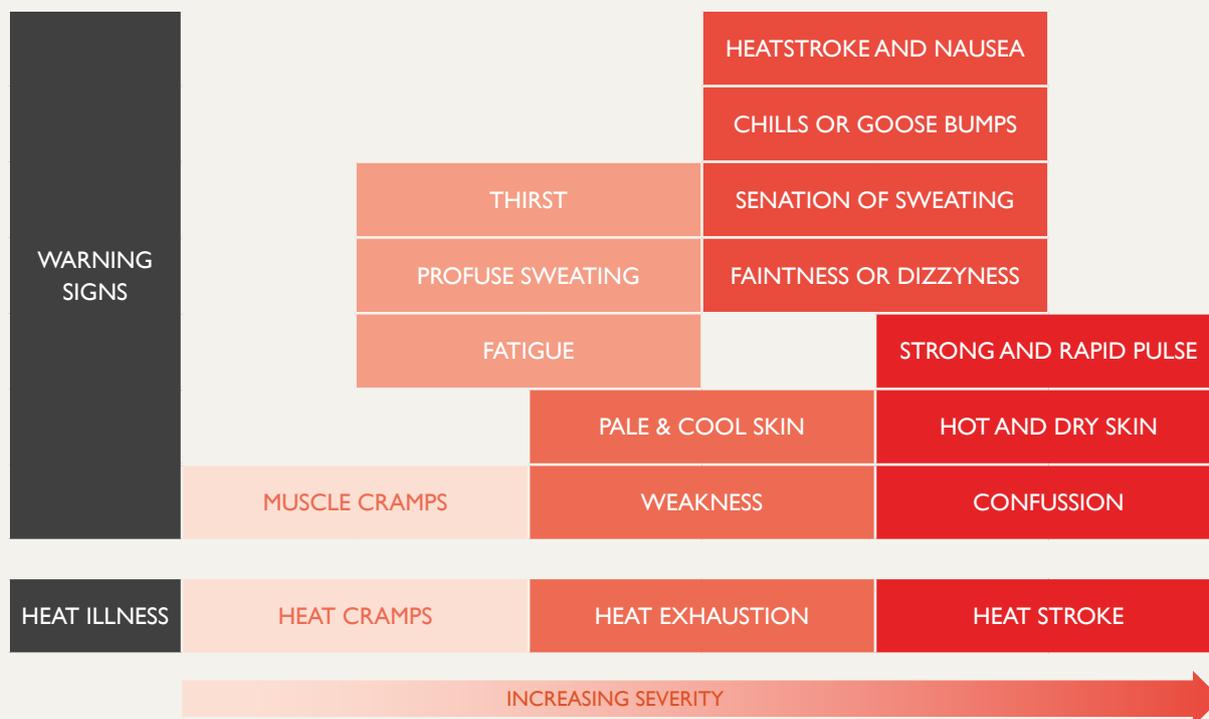


Figure 1. The warning signs of heat-related illness.



MEDICAL EMERGENCY

HEATSTROKE AND NAUSEA

SENSATION OF SWEATING

FAINTNESS OR DIZZINESS

WEAKNESS

THIRST

PROFUSE SWEATING

FATIGUE

**STRONG AND RAPID PULSE**

**HOT AND DRY SKIN**

**CHILLS OR GOOSE BUMPS**

**PALE AND COOL SKIN**

**MUSCLE CRAMPS**

**HEAT CRAMPS**  
These usually occur in those muscles being exercised due to dehydration and alterations in electrolyte concentration, and low energy stores.

**HEAT EXHAUSTION**  
The most common form of heat illness, defined as the inability to continue exercising in the heat. Usually seen in unacclimatised individuals

**HEAT STROKE**  
This is a medical emergency resulting from failure of the thermoregulatory system as a result of deep body temperature rising to more than 40.5°C

## Contributing factors

The impact of high ambient temperatures and humidity on performance and risk of heat-related illness can vary significantly from person to person depending on a wide range of chronic and acute individual factors that include:

- Air temperature, humidity, movement, radiant heat load
- Body size (mass, body surface area, skinfold thickness)
- State of training/sudden increase in training
- Degree of acclimatisation
- Hydration status
- Heat production (exercise intensity/duration)
- Clothing worn (vapour permeability, fit, colour, weight)
- State of health (e.g. fever – viral illness, cold, flu; diabetes mellitus, cardiovascular disease, gastro-enteritis/diarrhoea)
- Genetic disorders (e.g. mutations for cystic fibrosis, malignant hyperthermia)
- Skin disorders (including sunburn over 5% of body surface area)
- Use of medication (e.g. diuretics; antihistamines; ergogenic stimulants)
- Sweat gland dysfunction (e.g. prickly heat)
- Salt depletion
- Age
- Sleep deprivation
- Glycogen or glucose depletion
- Acute/chronic alcohol/drug abuse

Because some of these factors can be temporary in nature, a player can suffer heat illness in circumstances in which they were previously unaffected.

Acclimatisation to heat is generally regarded as the most effective way of reducing the

risk of heat-related performance impairment and illness with benefits including: greater cardiovascular stability; improved salt balance; better thermoregulation; and improved work capacity.

## IMPACT ON PERFORMANCE

Performance impairment due to heat occurs via two main mechanisms, both of which can occur during exercise:

**1.** The direct effects of high deep body temperatures on cellular, central nervous system and organ function. This is usually seen when intense exercise results in the body producing large amounts of heat, or lower levels of heat production but when wearing clothing or protective equipment (which inhibit heat loss) in warm, humid or hot conditions.

**2.** The indirect effects of skin blood flow (vasodilatation), sweating, dehydration and consequent compromised cardiovascular function (ability of the circulation to cope with demands placed upon it) (Figure 2) resulting in overheating, low blood sugar and impaired performance of the cardiovascular system.

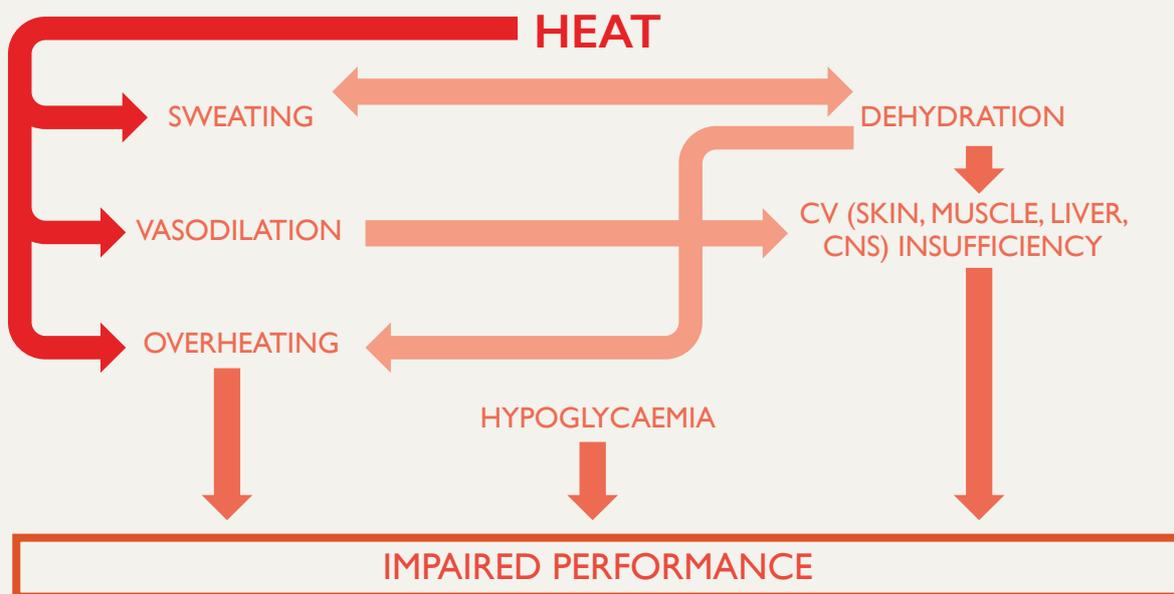


Figure 2. Mechanism of indirect, cardiovascular-related, performance impairment in the heat. CV is cardiovascular; CNS is central nervous system, hypoglycaemia is low blood sugar

It is likely that people playing less intense sports (so generating less heat themselves), but in high temperatures out in the sunshine (a high radiant heat load) will experience the indirect effects of heat with modest increases in deep body temperature but large increases in skin blood flow, and associated dehydration and cardiovascular problems (e.g. heat-related hypotension, light-headedness and fainting).

With more intense sports which see the body generate high levels of heat, problems are more likely to come from direct effects of increasing deep body temperature resulting in hyperthermia and heat stroke.

The important point is that cricketers, depending on what they are doing (bowling, batting, fielding) are susceptible to both these heat-related problems.

Both mechanisms, and therefore heat-related illness, are made more likely by dehydration. During exercise body fluid loss, primarily due to sweating, depends on several factors including external temperature, fitness, level of acclimatisation, intensity and duration of the activity. An athlete competing all day in a hot climate may require 4–12 litres of fluid. Without adequate fluid replacement, athletes can lose body fluid equivalent to 3–10% of their body mass while exercising. Dehydration equivalent to losing just 1–5% of body mass can impair cognitive and physical performance in the heat, resulting in significant reductions in performance and increases in deep body temperature due to reduced heat loss from sweating and skin blood flow. Dehydration of 4.3% of body mass can reduce endurance by 22–48% and maximum aerobic exercising capacity by 10–22%.

## THE BATSMAN AND WICKETKEEPER

The cricketers at greatest risk of heat-related performance impairment or illness are wicketkeepers and batsmen, required to exercise wearing protective clothing and who may be on the pitch in hot conditions and no shade for long periods.

A study published last year of Australian male cricketers playing first-class cricket found that batsmen experienced a greater rise in deep body temperature compared with fielders and so have a greater risk of heat illness<sup>31</sup>. Interestingly, the hotter the batters got the harder they perceived they had to work.

Cricket fans witnessed first-hand the problems heat can create for players when England captain Joe Root retired hurt batting in hot conditions in the fifth Ashes Test in Sydney in 2017-18. The ambient temperature at weather

stations near the ground recorded reached 43.7°C. It is likely that he was suffering from a gastro-intestinal infection and consequent dehydration- both of which, as noted, increase the likelihood of experiencing heat-related problems.

Tests were conducted by some of the contributors to this report on an international batsman recreating his highest score in County cricket (300 not out) by exactly matching his scorecard (balls received and runs scored) in the indoor nets. The batsman ran the length of pitch as required (depending on score achieved on each ball) for a day consisting of 92 overs. The amount of exercise done by the batsman (assessed via the amount of oxygen consumed) and the heat produced by that exercise are shown in Table 1.

SESSION	MEAN OXYGEN CONSUMPTION (L.min <sup>-1</sup> )	ESTIMATED MEAN HEAT PRODUCTION (kJ.min <sup>-1</sup> / W.m <sup>2</sup> )	PEAK OXYGEN CONSUMPTION (L.min <sup>-1</sup> )	ESTIMATED PEAK HEAT PRODUCTION (kJ.min <sup>-1</sup> / W.m <sup>2</sup> )
1ST MORNING	1.51	27 / 216	3.79	69 / 543
2ND AFTER LUNCH	1.78	32 / 255	3.78	69 / 541
3RD AFTER TEA	2.70	49 / 387	4.37	79 / 626

*Oxygen consumption and heat production of an international batsman during the re-creation of an innings. Data recorded at the Rose Bowl, Hampshire. The temperature at the indoor nets was 15°C.*

It is interesting to note from Table 1 how the heat production of the batsman increases in each of the sessions as he “accelerates” his scoring. The overall average level of heat production (36 kJ.min<sup>-1</sup> / 286 W.m<sup>-1</sup>) is surprisingly high, being equivalent to an individual running continuously at about 8 km.h<sup>-1</sup> (in cricket clothing with padding, helmet and bat).

While heat acclimatized players may be better at staying cool, and top class batsmen will rely on good “instincts” (predictive motor programmes) that carry them through, eventually, rising body temperature without thermoregulation impacts the performance of all.

## HOW HOT IS TOO HOT?

The most widely used measure of hot environments is the “Wet Bulb Globe Temperature” (WBGT) index; it is regarded by many as the criterion standard for the assessment of thermal stress during physical activity. The index combines dry (T<sub>db</sub>) and wet bulb (T<sub>wb</sub>) air temperature<sup>32</sup> with radiant (T<sub>g</sub> e.g. sunlight) temperature in the following formula:

$$\text{WBGT} = 0.1T_{db} + 0.7T_{wb} + 0.2T_g$$

The high weighting for ‘wet bulb’ (which related to the humidity [water vapour pressure] in the environment) emphasises the large impact humidity has on the body’s ability to evaporate sweat and the importance of sweating in avoiding heat stress.

A few examples should help demonstrate why measuring WBGT is more important than measuring just air temperature. Taking a fixed air temperature of 30°C and wind speed of 0.5 metres per second in all cases:

<b>Example 1:</b>	<b>Example 2:</b>	<b>Example 3:</b>
Cloudy day (no sun), relative humidity 50 percent,	Sunny day, relative humidity 35 percent,	Light cloud cover, humid day (relative humidity 90 percent),
<b>WBGT = 25.9°C</b>	<b>WBGT = 29.5°C</b>	<b>WBGT = 32.0°C</b>

These examples demonstrate that WBGT does not equal air temperature - they are different measurements; while air temperature alone provides relatively little information about the potential heat strain faced by players<sup>33</sup>. They also emphasise that high humidity limits sweat evaporation and therefore the ability to control body temperature (sweating serves no function [other than dehydrating] unless the sweat produced can evaporate).

But how can WBGT be used? The American College of Sports Medicine has developed the following WBGT recommendations for avoiding heat-related injury during continuous activities such as running and cycling\*.

WBGT	ACTION
>28° C	BLACK FLAG: CANCEL OR RECOMMEND VOLUNTARY WITHDRAWAL. (RACES THAT ARE ALWAYS HELD IN THESE CONDITIONS SHOULD ACKNOWLEDGE THE EXTREME HEAT RISK TO THE POORLY ACCLIMATED AND NON-RESIDENT COMPETITORS IN THE PRE-RACE LITERATURE AND THE PRE-RACE ANNOUNCEMENTS)
23° C – 28°C	RED FLAG: RECOMMEND PARTICIPANTS AT INCREASED RISK FOR HEAT COLLAPSE WITHDRAW FROM RACE AND OTHERS SLOW PACE TO MATCH CONDITIONS.
18° C – 22°C	YELLOW FLAG: RECOMMEND PARTICIPANTS AT INCREASED RISK FOR HEAT COLLAPSE SLOW PACE. WARN ENTRANTS OF INCREASED RISK OF HEAT COLLAPSE.
<18°C	GREEN FLAG: COLLAPSE CAN STILL OCCUR. DECREASED RISK OF HYPERTHERMIC AND HYPOTHERMIC COLLAPSE.
<10°C	WHITE FLAG: INCREASED RISK OF HYPOTHERMIC COLLAPSE

Table 1. The American College of Sports Medicine WBGT recommendations for continuous activities

*(\*Although cricketers are usually not considered as engaging in “continuous activity”, the example presented earlier in this report suggest that the heat production of an international batsman is equivalent to an individual running at about 8 km/h<sup>-1</sup>).*

These recommendations relate to lightly-clothed “road race” athletes so for cricketers wearing heavier clothing or protective padding (which add to work performed, and can limit radiative or evaporative heat loss), the lower temperature in each range should be used. However specific WBGT guidelines for cricket are not widespread; Australian cricket have introduced a [heat policy](#).

Clearly, any increases in ambient air temperature, humidity and solar radiation will increase the likelihood of climate impacting on cricket.

## POSSIBLE IMPLICATIONS FOR CRICKET

Cricket is a game that requires its players to have a wide range of physical and psychomotor skills including concentration, hand-eye co-ordination, agility, fast decision making, fast reaction times, sprinting and endurance. These technical skills, cognitive and physiological capabilities must be maintained at the highest of levels over the course of often long periods. Many of them are adversely affected by the heat and high body temperatures.

The implications for cricket of matches being played in very hot conditions are many and varied. They include:

- On the basis of safety-related heat stress indices, more games being postponed, rearranged to cooler times of the day, due to high ambient temperatures.
- Poorer performance due to the deteriorating cognitive function resulting in more errors, shorter innings and lower skill levels.
- Decreased motivation (“central fatigue”) to perform at a high intensity be that fielding, fast bowling or running between the wickets.

- Increased likelihood of heat exhaustion and other heat illnesses leading to performance decrement and retirement.
- Increased likelihood of heat stroke resulting in the need for medical intervention.

The impact of the occasional very high temperatures associated with climate change will not be limited to players. Similar impairments of cognitive function could be seen in overheating umpires leading to more errors and a greater reliance on technology. Spectators will be exposed to higher temperatures, more direct sunlight increasing the chance of hyperthermia, heat syncope (faint) and sunburn.

Young people have different physiological responses to heat and a generally lower tolerance of hotter conditions. Particular care should be taken for young cricket players to ensure these lower tolerances are taken into account when considering what extra facilities, guidance or rules are required. Where the game is played at the grassroots level at any age, consideration should be given to the facilities and expertise available; unlike at the elite level, cooling strategies and access to proper medical attention might not be immediately on hand.

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## 5 - COUNTRY IMPACTS

*Over the past 50 years South Asia has witnessed increasing numbers of hot days, hot nights and heatwaves<sup>34</sup> and the science tells us things are set to get worse with the duration, frequency and intensity of heatwaves likely to grow<sup>35</sup>. Rising temperatures will boost humidity levels over most of South Asia, including north eastern India, Bangladesh and northern Sri Lanka<sup>36</sup>. The human body struggles to cool itself in very hot, humid conditions and the combination of rising temperatures and rising humidity will affect not only the ability to play cricket but the everyday health of people living in the region<sup>37</sup>. In this part of the world extreme heat is a killer.*

*Record-breaking temperatures during the final 2017-2018 Ashes Test saw fans at the Sydney Cricket Ground searching for cover amid blistering heat.  
Credit: Twitter/@Will\_Mccloy*



## INDIA

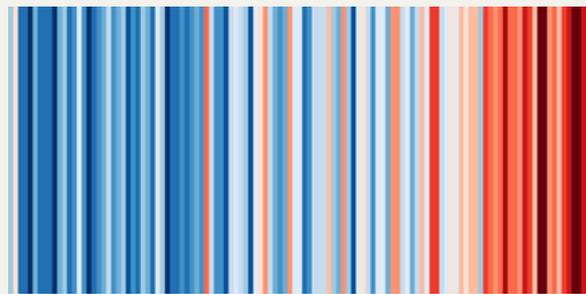
*In September 2017, Australia and India met at Eden Gardens, Kolkata in what Australia bowler Pat Cummins [described as](#)<sup>38</sup> the “hottest one-day game anyone said they had played”. High levels of humidity led to reports of the ‘apparent (“feels like”) temperature’ (arising from air temperature, humidity, wind and radiation from the sun) hitting 42°C. Cummins and fellow fast bowlers Kane Richardson and Nathan Coulter-Nile left the field of play after four-over spells to cool down, while match reports indicate wicketkeeper Matthew Wade and all-rounder Hilton Cartwright required on-field medical attention.*

The Indian domestic cricket leagues run between August and May. It gets particularly hot towards the end of the season – summer in India is April to June. The average maximum temperature for days in April and May has increased by 1-2°C since the 1970s, currently ranging from 40-42°C (Figure 1), and during recent heatwaves temperatures have jumped to more than 45°C<sup>39</sup> in most areas, with an all-time record high temperature of 51°C recorded in Rajasthan in May 2016<sup>40</sup>.

There has been a steep increase in the number of ‘hot temperature’ days (above 37°C) in some of the cities with important cricket grounds. These include New Delhi, where they have been increasing (during the 1990s and early 2000s: 1991– 2013) at a rate of six more every decade; Chennai and Jaipur had eight more. Unusually hot days above 37°C in Visakhapatnam, Andhra Pradesh, which recently hosted an ODI between India and Australia, are now averaging 18 per year<sup>41</sup>.

Since the 1950s, most heatwaves in India have occurred in the month of May. The average relative humidity ranges from 50-70% during the bulk of the cricket season (October-May), with the highest values recorded in

coastal regions such as Mumbai, Chennai and Kolkata<sup>42, 43</sup>.



*These ‘warming stripe’ graphics are visual representations of the change in temperature as measured in India over the past 100+ years. Each stripe represents the temperature in that country averaged over a year. Source: <https://showyourstripes.info>*

Professor Mike Tipton sees these conditions as challenging: “It’s the extremes of temperature that present the problems for cricket, particularly when combined with high levels of humidity that also appear to be on the rise. A batsman in full protective gear exercising during an Indian heatwave where relative humidity rises and the temperature exceeds 37°C will struggle to control body temperature; it’s just not possible to evaporate sweat at the rate required to control body temperature. Heat and humidity isn’t new to India, but for every degree the temperature rises, the harder it is for the body to regulate. If the extreme hot periods are lasting longer,

there are questions as to whether we will see unplayable parts of the season, particularly towards the end of May.”

Extreme heat is not the only manifestation of climate change that is challenging cricket in India. India’s rainfall is expected to become more erratic as the planet warms. Climate scientists expect an [increase in more intense precipitation](#) <sup>44</sup>, and also an increase in prolonged spells of drought.

In May 2016, 13 Indian Premier League (IPL) cricket matches scheduled to be played in the state of Maharashtra [were ordered to be relocated](#) <sup>45</sup> due to the severe drought that hit the nation. This is the type of event that scientists say [will become more common](#) <sup>46</sup> as the climate warms.

Games that did go ahead were also impacted, with the CEO of Delhi Daredevils Hemant Dua and Hyderabad Cricket Association committee member Vikram Mansingh blaming temperatures for low attendances. “If it wasn’t for the heat, we would have seen more crowds at the stadium, especially because the city did not get any T20 World Cup game,” he told [the Economic Times](#) <sup>47</sup>.

In March 2019, Indian water conservation charity Aam Yuva Jan Kalyan Sanstha filed a petition with the National Green Tribunal, asking the government to assess water use by the country’s flagship IPL cricket league. The charity said that in a time of drought, they are concerned at “serious concerns on the wastage of water in the IPL matches and seeks directions to stop it.”

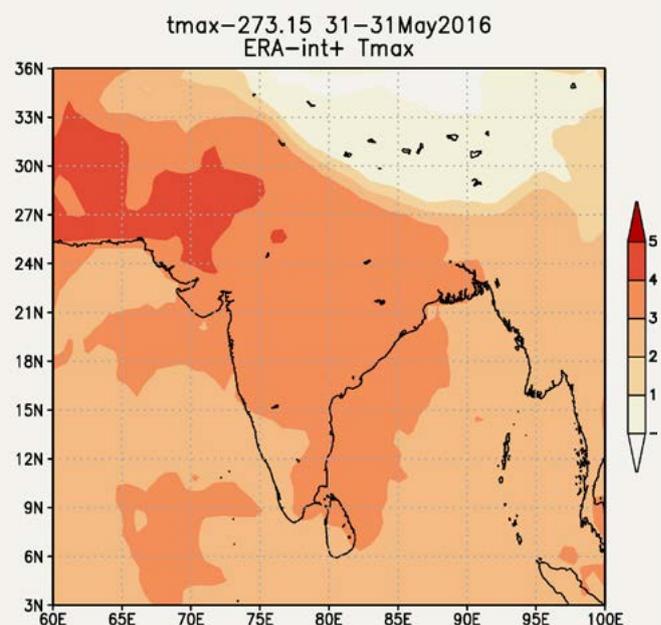
The NGT case is a microcosm of a larger problem that is set to get worse.

In August 2018, in the middle of India’s warmest year [since records began in 1901](#) <sup>48</sup>, devastating floods hit the southern state of Kerala. The rains left over 400 dead and displaced more than a million people. The state’s 14 main cricket grounds were all

affected, with [Greenfields Stadium](#) <sup>49</sup> in Thiruvananthapuram - which hosts ODIs - requiring thousands of pounds of repairs to the outfield, sight-screens and other equipment. India cricket captain Virat Kohli [dedicated his side’s Test win over England](#) <sup>50</sup> at Trent Bridge to the state and those who died.

Kate Sambrook of the Priestley International Centre for Climate puts these challenges in context: “Climate change doesn’t impact regions of the world evenly and it’s fair to say that India is feeling the effects in multiple ways. Starting out as a hot and humid country, additional heat makes things very difficult for its inhabitants. India is heavily dependent on the monsoon and as this is impacted what has been taken for granted in the country becomes more erratic and unpredictable.”

Be it from extremes of rainfall, lack of rainfall or heat, the impact of climate change on India’s most loved sport is only set to increase.



Map showing highest daily maximum temperatures of May 2016, based on data from [ECMWF operational analyses and forecasts](#) <sup>51</sup>. Red shading indicates the hottest temperatures. Produced by Ed King via the KNMI Climate Explorer.



## SRI LANKA

*The heat and humidity of Sri Lanka has long made it a challenging place for touring teams.*

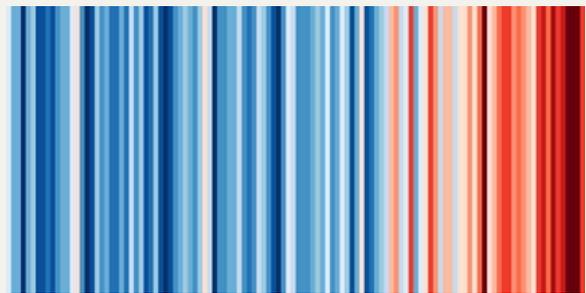
*According to former England wicket-keeper Matt Prior, these extremes make Sri Lanka one of the toughest places to play cricket. Speaking ahead of England's 2018 Test series, Prior revealed he once lost 4.5kg in weight<sup>52</sup> while batting during a morning session despite drinking.*

Galle, one of the main Test venues in Sri Lanka, is typically “hot, steamy and debilitating” according to Times cricket correspondent Mike Atherton. Cricket365's Joe McDougall described the heat<sup>53</sup> in the third Test between Sri Lanka and England in Colombo December 2018 as “paralysing”.

According to the Sri Lankan government “atmospheric temperature is gradually rising almost every-where in the country” while “intensity and the frequency of the extreme events such as floods and droughts have increased during recent times.” Rising temperatures will boost humidity levels over northern Sri Lanka<sup>54</sup>.

A March 2019 paper published in the BMJ Open Sport & Exercise Medicine journal<sup>55</sup> highlighted the mixed levels of understanding of heat-associated risks among junior cricketers in Sri Lanka which could “potentially place them at higher risk” of illness from playing in hot and humid conditions.

Visiting fans will also need to take note in coming decades. In its 2016 climate plan submitted to the UN, Sri Lanka's government signaled fears that malaria, dengue fever and other diseases linked to weather changes could be on the increase.



*These 'warming stripe' graphics are visual representations of the change in temperature as measured in Sri Lanka over the past 100+ years. Each stripe represents the temperature in that country averaged over a year.*

*Source: <https://showyourstripes.info>*

*‘Even with regular drinking, the sweat rate in the Sri Lankan climate is challenging to combat. I would say our biggest challenge in SL is the ability to consistently do good quality conditioning work. Due to the heat, doing conditioning work past 9/10am means we are asking players to perform high-intensity exercise in temperatures well above 30 degrees with up to 90/95% humidity. In order for the conditioning be effective, we schedule it for 730am in the morning, but this limits the volume we can do in one day, as asking players to then do a second session in the midday heat after skills training is often unrealistic without heavily affecting the next day's training.’*

**Rob Chave, Sri Lanka Cricket Physical Preparation Manager**





## SOUTH AFRICA

*When India's cricket team landed in Cape Town in January 2018 during their tour of South Africa they were asked to keep their showers to no more than two minutes<sup>56</sup> to conserve water. The likelihood of the drought occurring was tripled by climate change, according to a study released in mid-2018<sup>57</sup>.*

While the cricketers faced a minor inconvenience of shorter showers, Cape Town as a city faced an existential crisis, described as “a point of no return” by the city’s Mayor, Patricia de Lille. Residents’ water allowance was effectively rationed to 50 litres a day, with queues outside boreholes, municipal water trucks and supermarkets selling water a common sight.

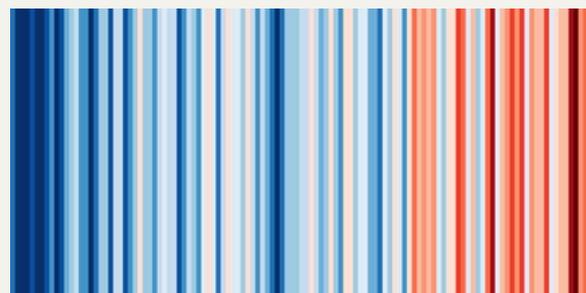
On the field, the drought forced Newlands chief groundsman to use water from the ground’s own borehole to keep the wicket and outfield playable. The outfield was ‘a lot drier and a lot thinner than you’d usually like it for Test cricket,’ due to city restrictions on water use, groundsman Evan Flint told SABC. ‘Test cricket a guy should hit the ball in the middle of the bat to get four, so it will probably be a little quicker than I would have liked,’ he added.

Away from the Test, the drought had wider impacts. According to the BBC<sup>58</sup>, club and school cricket across the region were cancelled from the end of January until the end of the 2018 season.

Cricket South Africa recognised the challenges water shortages place on the domestic game in its 2017-2018 annual report<sup>59</sup>, noting it is ‘even more important to source alternative water sources for the grounds’ upkeep’ and outlining plans to sink boreholes near cricket stadia.

There is good evidence to expect similar, possibly more severe, and more frequent droughts in South African cities. If global warming passes the 2C average global temperature danger limit<sup>60</sup>, a further threefold increase in the risk of severe drought is projected<sup>61</sup>.

In yet another sign of the damage erratic weather patterns can have on the sport, the 2018 Momentum One-Day Cup due to be held in Durban was shared between the Hollywoodbets Dolphins and the Warriors after heavy rain for consecutive days<sup>62</sup> saw the final cancelled.



*These ‘warming stripe’ graphics are visual representations of the change in temperature as measured in South Africa over the past 100+ years. Each stripe represents the temperature in that country averaged over a year. Source: <https://showyourstripes.info>*



## AUSTRALIA

*At the end of a debilitating 2017-2018 Ashes series, Joe Root's hospitalisation after a day batting at the Sydney Cricket Ground seemed emblematic of an England challenge that too often wilted in Test match heat. Suffering from a viral gastroenteritis bug, Root struggled in temperatures that at one stage were reported to hit 47.3°C. In the stands, fans stripped off and according to [one report](#)<sup>63</sup> - as the heat built - retreated to any part of the stadium where they could find shade.*



*Record-breaking temperatures during the final 2017-2018 Ashes Test saw fans at the Sydney Cricket Ground searching for cover amid blistering heat. Credit: Twitter/@Will\_McCloy*

Former Australian batsman turned commentator Dean Jones tweeted that cricket should not be played if temperatures exceeded 41°C. 'After speaking to a couple of doctors this morning... in my opinion cricket should be called off after 41°C,' [he said](#)<sup>64</sup>. Tony Irish, head of the Federation of International Cricketers' Association (FICA), warned authorities they needed to take the heat issue far more seriously: 'What will it take – a player to collapse on the field? I don't know what it's going to take for the ICC to take action,' [he said](#)<sup>65</sup>.

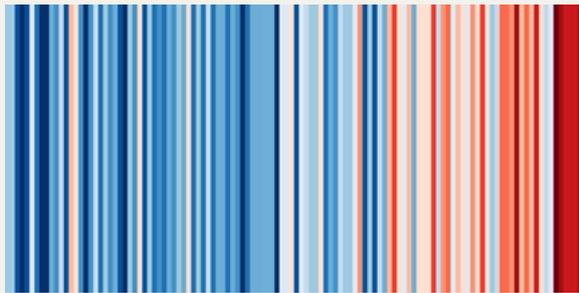
Since Root's collapse Cricket Australia, the national governing body for the game, has [updated its heat policy](#)<sup>66</sup>. It recommends that

on hot days, on-site cold immersion facilities and air-conditioned changing rooms should be available, and advice to players on clothing should be given to ensure they do not over-heat.

Summers in Australia have always been warm - but in recent years temperatures have hit new heights - in what climate scientists say are the [hallmarks of a warming planet](#)<sup>67</sup>. Eight out of the ten warmest years in Australia's history have occurred since 2005. Relative humidity typically ranges from 50-80% October to March with highest levels observed in south-eastern regions<sup>68,69</sup>.

In 2017, intense and persistent heat led to all of Sydney's senior club games (formerly known as Sydney Grade Cricket and now NSW Premier Cricket) being called off for the first time in history<sup>70</sup>. "My main concern is that grade cricket does not have the infrastructure in place to safely monitor and manage heat stroke", Cricket Australia and New South Wales doctor John Orchard told the [Daily Telegraph](#)<sup>71</sup>. According to a scientific [assessment](#)<sup>72</sup>, the 2017 New South Wales heatwave "can be linked directly to climate change." The team of scientists found a 50-fold increase in the likelihood of the NSW hot summer compared to a century ago.

Over 200 temperature records were broken in just over 90 days during 2018-2019 with a peak of 49.3°C in what was Australia's hottest ever summer <sup>73,74</sup>. Cricket Australia ordered games at its under-15 National Championships to be shortened due to the intense heat. One official [told ABC](#) <sup>75</sup> there had been concerns over the dehydration of teenagers due to their inability to regulate body temperature as well as adults.



These 'warming stripe' graphics are visual representations of the change in temperature as measured in Australia over the past 100+ years. Each stripe represents the temperature in that country averaged over a year.  
Source: <https://showyourstripes.info>

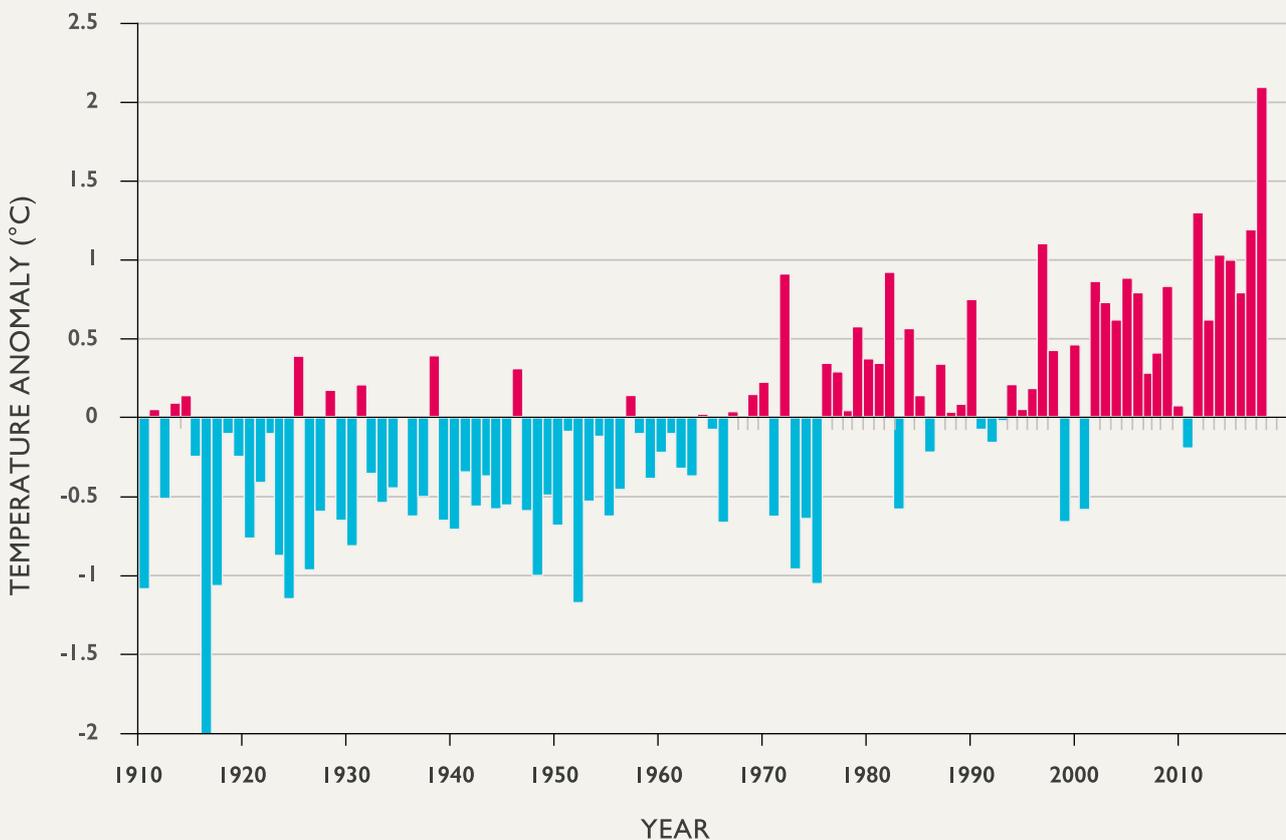
And the heat isn't going away. Projections suggest that if greenhouse gases continue to increase, there will be a noticeable rise in days where the mercury tops 40°C by 2030. For both Adelaide and Perth that would mean a 60% increase in days over 40°C <sup>76</sup> in 2030 (as compared to 1981-2010). What is more, recent research has shown that sites within major Australian cities, such as Sydney and Melbourne, could see unprecedented summer temperatures of 50°C.

**Mike Tipton sees problems occurring when high temperatures mix with humidity and exercise:**

*“High air temperature on its own isn't necessarily a show-stopper, but if days with extreme heat are more frequent and coincide with a reasonable degree of humidity (in the atmosphere or under clothing/padding) and obligatory exercise, that's when the problems arise and you would have to think about calling a game off.”*



**AUSTRALIAN SUMMER MEAN TEMPERATURE**



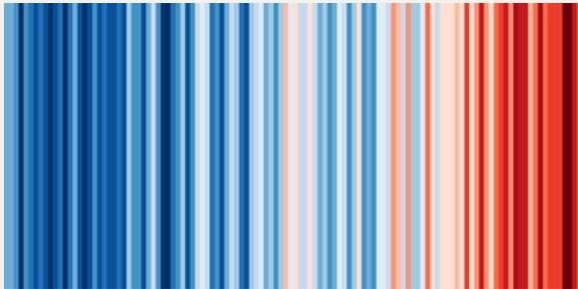
Australia has experienced increasingly hot summers in recent years, which scientists say is linked to climate change. (Credit: Climate Council /The Angriest Summer)



## WEST INDIES

*Small island states like those in the Caribbean have long been identified as being among the most vulnerable to climate change and climate extremes. Sea level rise and more intense hurricanes are all consequences of a warming planet according to the UN's <sup>77</sup> latest climate science [report](#) <sup>78</sup>*

In May 2018 the Hurricane Relief T20 Challenge match took place at Lord's Cricket Ground, London, between the West Indies and a World XI. The aim was to raise money to repair Ronald Webster Park in Anguilla, Dominica's Windsor Park and Sir Viv Richards Stadium in Antigua, which were damaged or converted to host refugees when Hurricane Irma and Hurricane Maria blasted through the Caribbean in September 2017.



*These 'warming stripe' graphics are visual representations of the change in temperature as measured in the West Indies over the past 100+ years. Each stripe represents the temperature in that country averaged over a year. Source: <https://showyourstripes.info>*

An estimated 200 people sheltered at the [Sir Vivian Richards Stadium](#) <sup>79</sup> when the storm hit. According to a [report in The Cricket Monthly](#) <sup>80</sup>, "Every possible space, including both dressing rooms, the rooms designated for umpires, physiotherapists and the media, was utilised to house people". Richards - a hurricane and cricket veteran - told the same publication the winds were the toughest he had ever experienced: "category five, that is pretty strong," he said. On [Instagram](#) <sup>81</sup>

West Indies great Brian Lara spoke of his devastation at the "battering" some islands received from the storms.

Those storms were powered up by oceans that are warmer as a consequence of absorbing heat from the atmosphere, according to a 2018 study [in the journal Nature](#) <sup>82</sup> "...relative to pre-industrial conditions, climate change so far has enhanced the average and extreme rainfall of hurricanes Katrina, Irma and Maria."

The 2017 hurricane season was one of the most devastating in recent memory. Leading insurers Lloyds of London reported a £2 billion loss in its 2017 annual report due to the extraordinary level of damage incurred. According to scientists, high sea surface temperatures in the Atlantic - [likely caused by climate change](#) <sup>83</sup> - played a significant role in powering up the hurricanes.

According to the UN's [1.5C IPCC climate science study](#) <sup>84</sup>, warmer global temperatures will likely fuel hurricanes to greater intensities and lead to heavier rainfall. Storms may whip up sea levels and inundate coastal communities: 'extreme sea levels for small islands, particularly in the Caribbean, are linked to tropical cyclone occurrence' while drought is also likely to be a longer-term factor small islands have to contend with, as rainfall patterns become more erratic.



## HIT FOR SIX BY HURRICANE MARIA

**Liam Sebastian, who plays first-class cricket for the Windward Islands within the West Indies, lived through Hurricane Maria hitting the islands in September 2017:**

*“...it left a long-term impact. It will take us a while to move past the damage. In the next 5-10 years you will still see an impact because of damaged houses and many different impacts. It may not be permanent but it will be long term. It has left a lasting impact on people who now seek out insurance for houses and vehicles... to go the distance to ensure their livelihood is safe. What we saw and experienced is something anyone there would never forget.”*

**Many of the islands’ cricket pitches were damaged and some cricketers left the islands as a result of the impacts:**

*“The facilities were damaged - a lot. Some playing fields are no longer of use at this stage because of soil erosion, water damage. There are some back up and running where we can play cricket. There is cricket going on but it’s not on a large scale. Some players migrated because they suffered damage to their house - it was difficult and it has impacted every aspect of life.”*



Image: pixabay

**Life on the islands was heavily disrupted:**

*“We all had to fend for ourselves not knowing where the next meal would come from. Supermarkets were damaged, banks were not working so people could not access their funds. It was an experience...I never want to go through again.”*

**Looking to the future Liam is concerned:**

*“Bearing in mind experts say it will get worse it can only be worse - it is a very big worry for me and a lot of people. We can only try and do what we can but I don’t think we can ever be fully prepared because of what we saw.*

*“It is real - and as much as we don’t like it - we are heading to the hurricane season in near future and not everyone is prepared for what is to come because of what happened almost two years ago.”*

**Liam suggests there could be a role for the International Cricket Council (ICC) in providing assistance:**

*“ICC maybe needs to start setting up funding for vulnerable teams such as West Indies and to an extent others which can suffer from severe disasters...the ICC needs to put things in place so in case another hurricane hits...it can get players and people back quicker than it has been done before.”*



## ENGLAND & WALES

*On 27 July 2018, the Marylebone Cricket Club (MCC) allowed members to enter its historic pavilion at Lords cricket ground without jackets due to “[abnormally warm temperatures](#)”<sup>85</sup>.”*

*According to the [UK Met Office](#)<sup>86</sup>, climate change made the 2018 UK summer heatwave “30 times more likely” than without climate change, and by mid-century heatwaves where temperatures frequently rises above 35°C could happen “50% of the time”. 2018 was the joint hottest summer on record for the UK (tied with those of 1976, 2003 and 2006) and the hottest ever for England since records began in 1910<sup>87</sup>.*

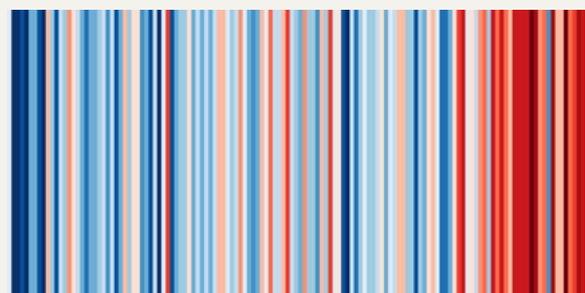
Impacts on cricket were not limited to the stands. India’s warm-up match with England in Essex was [cut short by a day](#)<sup>88</sup>, with the Board of Control for Cricket in India (BCCI) citing “current high temperatures”. Hot conditions also meant extra hours at the crease for England’s army of groundsmen and women, many who resorted to [watering their pitches at night](#)<sup>89</sup>, when conditions were cooler.

According to the Environment Agency’s drought meetings in [March](#)<sup>90</sup> and [June](#)<sup>91</sup> poor rainfall levels in winter and spring “are putting particular pressure on the environment and agriculture. It will be some time before conditions can return to normal. By the 2030s, average daily maximum summer temperatures could be up to 4°C warmer than the 1981-2000 average and up to 5°C warmer by the 2050s<sup>92</sup>.”

Mike Tipton doesn’t see the same level of threat from heat in the UK as compared with India or Australia but says it would still impact the game in England: “England doesn’t see the same heat and humidity as India, so even higher temperatures won’t have the same physiological impact on cricketers. That said, a still day with bright sunshine and high temperatures could still be troubling for a batter who is not acclimatised to heat and

struggling to evaporate sweat under heavy protective clothing.”

If climate change means hotter summers, the science tells us it also means more erratic and heavier rainfall patterns. As revealed in last year’s [Game Changer](#)<sup>93</sup> report of 2018 on climate change impacts on UK sport, more than a quarter of England’s home one-day internationals since 2000 have been truncated because of rain and at Glamorgan, 13,000 hours of cricket have been lost in the same time. In and out of season, wet weather has caused a significant loss of cricket fixtures. In 2015/2016, Storm Desmond and Eva caused severe flooding at more than 50 community clubs. Analysis by climate scientists has found that climate change made storm Desmond 59% more likely<sup>94, 95, 96</sup>.



*These ‘warming stripe’ graphics are visual representations of the change in temperature as measured in the UK over the past 100+ years. Each stripe represents the temperature in that country averaged over a year.*

*Source: <https://showyourstripes.info>*

## 6 – KEY RECOMMENDATIONS

*Climate change does not pose a single, uniform challenge to cricket. Risks will vary depending on locations and seasons, and may increase sharply depending on the speed at which temperatures rise and ecosystems respond in the coming decades. Acting now will ensure cricket can prepare as best it can for the impacts we now know are inevitable and locked into the global climate.*

**Heat rules:** rising global temperatures pose risks to players, umpires and spectators. Leading cricket associations should follow Cricket Australia and adopt guidelines to ensure the safety of all participants [see page 9].

**Hydration breaks:** cricket authorities need to integrate more hydration and cooling breaks into match schedules at all levels where Wet Bulb Globe Temperature [explanation on p.20] exceeds 25°C<sup>97</sup>. Water, hydration liquids and cooling facilities must be mandatory in hot climates.

**Specific youth player guidelines:** young players are less able to regulate body temperatures and may feel less able to refuse to play in hot / humid conditions. Cricket authorities should roll out monitoring programmes to assess the climatic conditions (WBGT) and health of young players in hot conditions.

**Player testing:** performance of players varies considerably in hot conditions. Cricket boards at elite levels may want to consider testing players' ability to compete in hotter temperatures and make selections based on new heat-resilience criteria. The use of heat acclimatisation programmes is recommended to help performance and safety. In particular cricket authorities should consider re-instating longer tours to aid acclimatisation.

**Shorts and clothing:** cricket authorities may consider allowing players to wear shorts where the WBGT is above 25°C in order to help keep body temperatures to safe levels. Major kit and equipment manufacturers should accelerate testing of helmets, gloves and protective padding that enhance air-flow and keep players cool.

**Participation levels monitoring:** Building on [ECB concerns](#)<sup>98</sup> that climate has already had a “huge impact” on the game, cricket authorities should start collecting data on global participation of cricket at all levels, with particular focus on climate-vulnerable regions at risk from intense heat, extreme storms and erratic rain.

**Political risk management:** access to water is likely to become increasingly contested as climate impacts multiply. Cricket in India, Australia and South Africa has already been impacted by water shortages. The sport should proactively work on water efficiency programmes worldwide to avoid future conflicts with authorities.

**Air pollution monitoring:** While air pollution has not been a focus of this report, it is a growing environmental and health threat around the world, underlined by the [smog masks worn by Sri Lanka players](#)<sup>99</sup> during their December 2017 Test with India in Delhi. Cricket grounds at all levels of the game could consider testing air quality during playing time. Playing areas near busy roads should consider the impact of air pollution on the health of players – especially youth teams.

**Cricket infrastructure review:** cricket authorities should review infrastructure in the light of sea level rise, storm surges, and flooding and consider its responsibility to protect spectators from heat and – where possible – invest in clean sources of energy.

**ICC global climate disaster fund:** given the increased likelihood of global climate disasters globally, authorities could consider creating a climate disaster fund which could support communities in vulnerable regions impacted by storms, flooding and heatwaves.

## 7 - ADVICE FOR GOVERNING BODIES

### **Full Country By Country Analysis of Climate Change Risk and Action Plans**

- a. National Cricket Boards from each Test-playing nation to commission a detailed risk-based analysis of the impact of climate change on players, umpires & spectators, facilities, and finances of cricket. Analysis should be country-specific but based on a shared framework / Terms of Reference defined by the ICC.
- b. National Cricket Boards to use analysis to develop country-specific Climate for Cricket Action Plan. Climate for Cricket Actions Plans should include:
  - i. Firm science-based policies to protect players, umpires and spectators from the risks of extreme heat. This includes clear thresholds for match officials to increase the number of lengths of drinks breaks, shorten sessions and suspend play
  - ii. Transparency dialogue and agreement with local and national authorities on how cricket venues should respond to drought conditions to give cricket the best possible conditions for play while prioritising the wellbeing of the wider population
  - iii. Strategies and funding to better-protect facilities and equipment from flood damage

### **Eliminate Cricket's Contribution to Climate Change – make the sport a clean energy contributor, water neutral and waste neutral by 2027 World Cup**

- a. ICC and WCC to upgrade policies to require cricket boards and international venues to introduce and uphold the highest sustainability standards. This includes:
  - i. Minimum sustainability standards for ICC competitions
  - ii. The requirement for all commercial partnerships in international cricket to have environmental sustainability at their heart – including sponsorship, equipment/kit manufacturing and supply, and broadcasting
- b. ICC joins the UNFCCC Sport For Climate Action programme and encourages National Cricket Boards to do the same 3
- c. National Cricket Boards from Test-playing nations to commission a detailed analysis of the environmental impact of cricket in their country, including carbon usage, water usage and waste management – and develop an associated Environmental Action Plan. Actions Plans should:
  - i. Analyse the sustainability potential for each international venue
  - ii. Initiate a comprehensive facilities upgrade programme – specifically a clear outline of the dates at which their venues will be a) powered by renewable energy, b) send no waste to landfill, and c) achieve fully sustainable management of water
  - iii. Outline best-practice and financial support for sustainability measures in development and recreational cricket
  - iv. Appoint a sustainability / environment lead for cricket in each country

## **Climate Change Education Programme – for players, administrators, supporters and commercial partners to ensure long-term protection of cricket**

- a. Annual workshops for players, administrators and commercial partners to understand climate risks to cricket and their role in mitigation
- b. In-stadium and direct communication education campaign for supporters about how they can help cricket become the world's most environmentally friendly sport



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# HIT FOR SIX

