Water use and resilience in the golf sector 2020

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Environmental Solutions International Ltd

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1.1 Background & capabilities

Tony Hanson is a Member of the Institute of Workplace & Facilities Management (MIWFM), a Practitioner with the Institute of Environmental Management & Assessment (PIEMA) and an Associate Member of the Institution of Civil Engineers (AMICE)

Involved in the Golf and Leisure industry for 35 years, 17 years in environmental management, including 6 years as Property and Environment Director of The Facilities Management Group.

ESi was established in 2009 to work with clients in the Golf, Leisure, Estate and Commercial property sectors, to provide advice and solutions to a range of environmental issues.

Our purpose is to help our clients achieve Net zero emissions through resource efficiency and identifying on-site Carbon sequestration and assist with environmental compliance and environmental enhancement through a combination of formal Environmental Management Systems and specific issue reviews and advice.

In 2012, Tony Hanson was appointed as a Golf Environment Organisation Sustainability Associate to provide verification for the GEO Certified eco-label. Tony has undertaken over 30 Verification surveys for clients applying for GEO Certified status over the past 7 years.

In 2016 Tony Hanson was appointed as a Planet Mark Associate, the Eden Project endorsed environmental certification reducing emissions, energy, water, travel and waste and contributing to Cool Earth protecting endangered rainforests and supported by Her Majesty the Queen and Sir David Attenborough.

With our focus on the golf and leisure sector, ESi offer a single point of contact for the range of in house and external expert consultants required by leisure and estates operators.

Our panel includes specialists and partners cover:

- Ecology and Biodiversity
- Arboriculture
- Water resources – reservoir, land drainage, rain and grey-water
- Waste management
- Universities engaged in research within the golf sector:
  - Cranfield University
  - Imperial College London
  - University of Reading

2.0 Executive summary

2.1 Context

This report has been compiled and updated from the 2018 report to summarise the source, use and issues relating to future supply of water for irrigation and hospitality services for the next 25 years.

The concerns in the golf sector primarily result from variation in rainfall levels, increased population, less reliable winter recharge of groundwater and surface flows, together with increased legislative and regulatory infrastructure affecting the water supply industry.

Esi are continuing to monitor and engage with the Environment Agency and other key stakeholders Regionally, Nationally and Centrally with various Government Parliamentary Groups in Westminster.

Esi research data and this report are Client funded

Esi research data and mapping details the location of English golf facilities against the Environment Agency Catchment Area Management water availability database.

This report has been undertaken by Esi to allow us to advise our Clients of the potential water availability for their sites and to help develop water resilience plans to ensure sustainability for the coming years.

This report has been funded by Esi and their Clients and not by the Governing bodies of the golf industry, subsequently detailed information of facility location and water availability is not provided within the report for general release.

Operators wishing to access more detailed information should contact Tony Hanson at Esi.

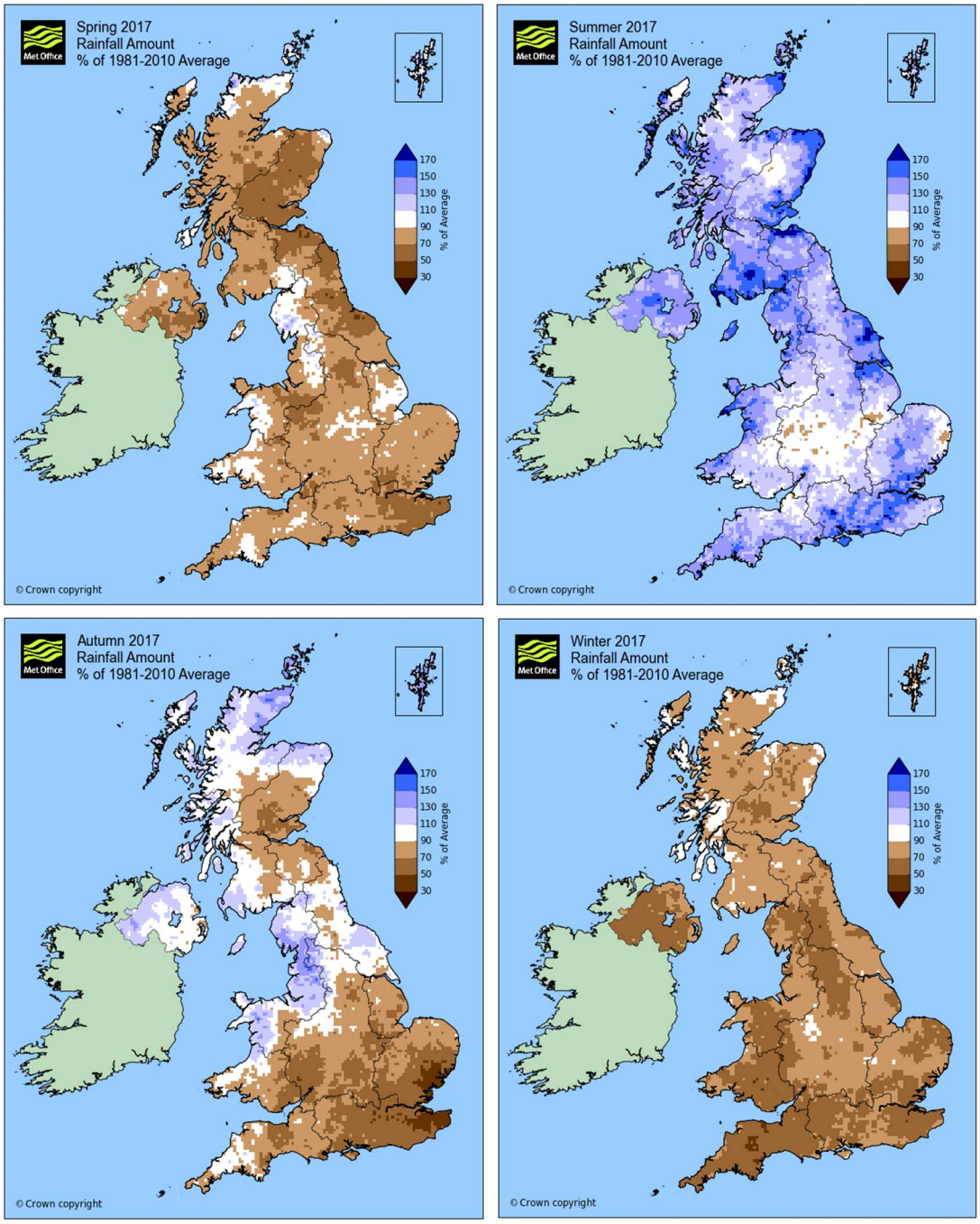
Rainfall – seasonal and geographic distribution

2017 Rainfall

The following maps provide data on the seasonal rainfall totals judged against average rainfall during the period 1981 to 2010.

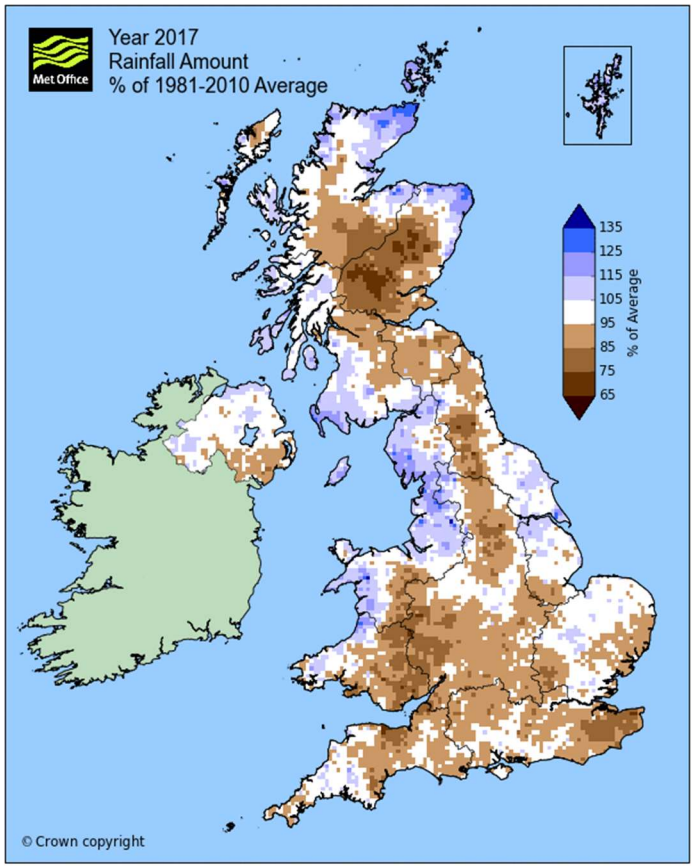
In summary:

- Spring – Nationally - below average
- Summer – Average to above average with the exception small areas of the Midlands
- Autumn – Below average with the exception of the North West
- Winter – Below average Nationally



2017 Annual summary:

Significant areas on the United Kingdom experienced below average rainfall, compounded by the summer rainfall being largely lost to high evaporation, evapotranspiration rates and runoff resulting reducing groundwater recharge rates.



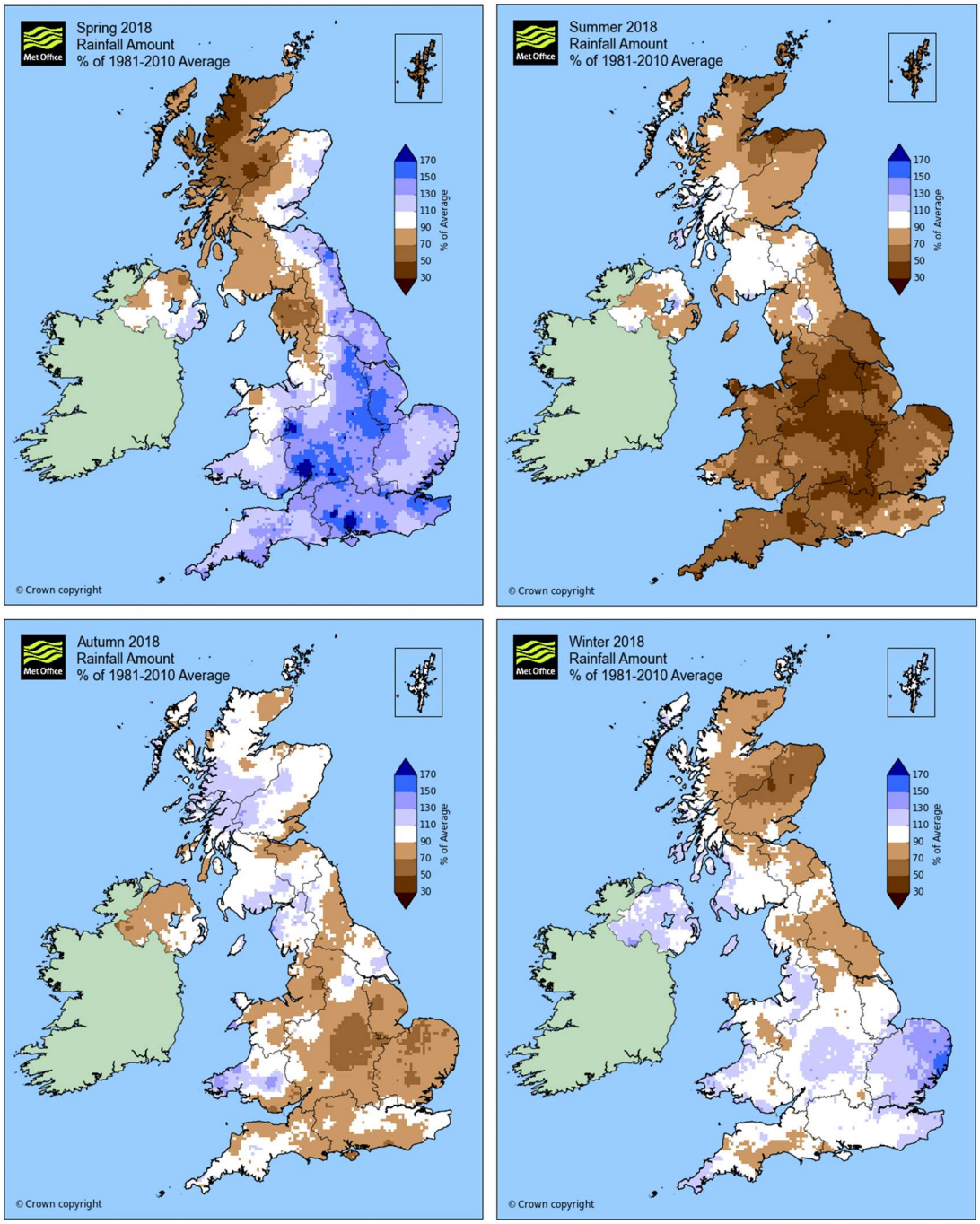
2018 Rainfall

The summer of 2018 was one of the driest on record and the winter period provided little respite with low rainfall totals insufficient to recharge the groundwater levels putting water consumption into deficit through 2018.

The following maps provide data on the seasonal rainfall totals judged against average rainfall during the period 1981 to 2010.

In summary:

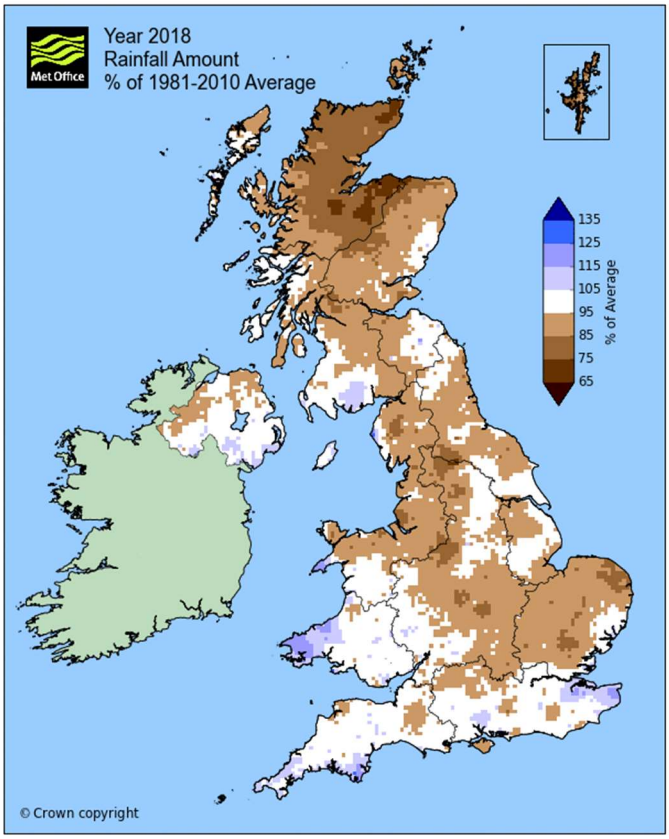
- Spring
  - Above average across the South, Midlands and North East
  - Below average across the North West England and significant parts of Scotland and Northern Ireland
- Summer
  - Below average, with the exception of the Scottish Borders and parts of Western Scotland and Northern Ireland
- Autumn
  - Significant areas of England experienced below average rainfall with small areas of Scotland and Wales receiving greater than the average
- Winter
  - Scotland and the North East experienced below average rainfall with the majority of England and Wales on or above the average



Source Met Office - Rainfall Maps 2018

2018 Annual summary:

Significant areas on the United Kingdom experienced below average rainfall, compounded by the summer rainfall being largely lost to high evaporation, evapotranspiration rates and runoff resulting reducing groundwater recharge rates substantially.



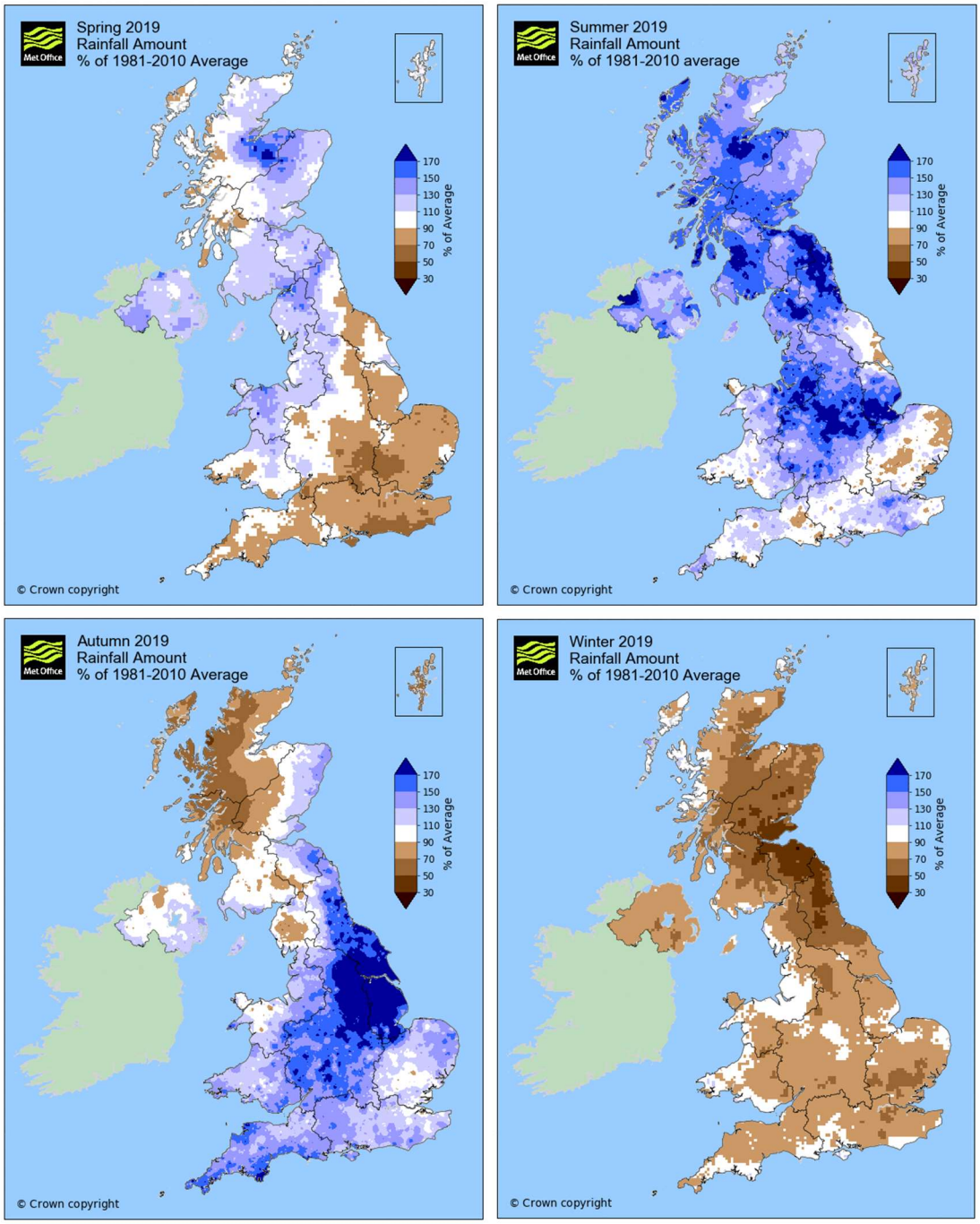
2019 Rainfall

The Summer of 2019 continued the low average rainfall totals, although the patterns of storms and depressions during the summer and into the Winter have resulted in high volume rainfall events over very short periods resulting significant flooding in parts of the United Kingdom.

These heavy short-lived rainfall events appear to be becoming more common and are not reflected in the average rainfall maps. High intensity rainfalls do little to recharge groundwater due to the volume simply overwhelming the soils permeability resulting in surface runoff and frequently localised flooding.

In summary:

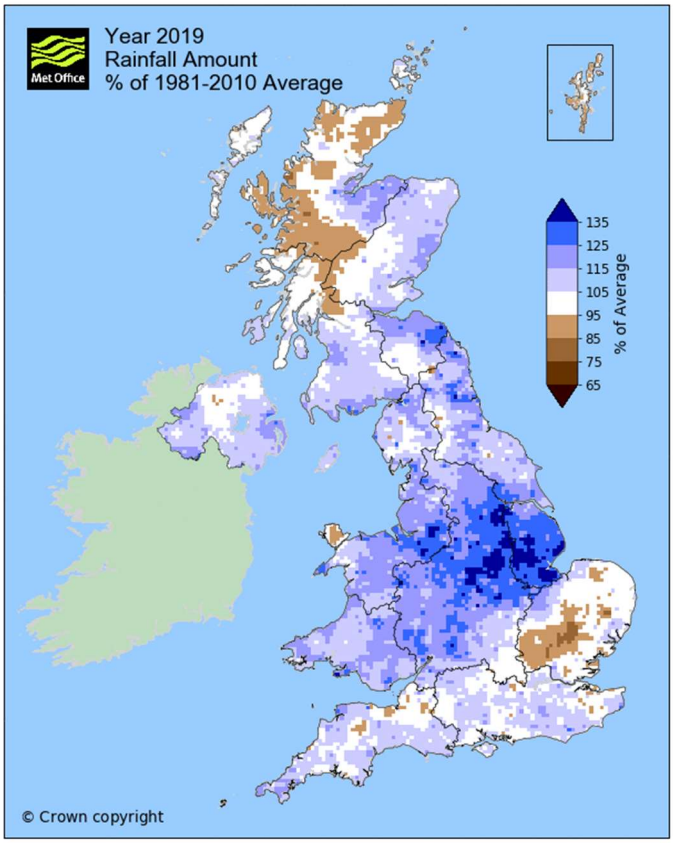
- Spring
  - Below average across the South, Midlands and South West
  - Above average across the North West England and parts of Scotland and Northern Ireland
- Summer
  - Above average North of a line between The Wash and the Bristol Channel
- Autumn
  - Significant areas of England experienced above average rainfall with areas of Scotland and North West England receiving lower than average rainfall.
- Winter
  - Lower than average across the whole of the United Kingdom



Source Met Office - Rainfall maps 2019

2019 Annual Summary

Rainfall totals were significantly higher than the 1981-2010 average across the majority of England, especially in the East Midland to the Welsh Boarders resulting, as we are all aware, of flooding.



Changes to our weather patterns, presumably generated by increasing global temperatures resulting in increasing energy and greater atmospheric moisture capacity, appear to be resulting in heavier more intense rainfall events.

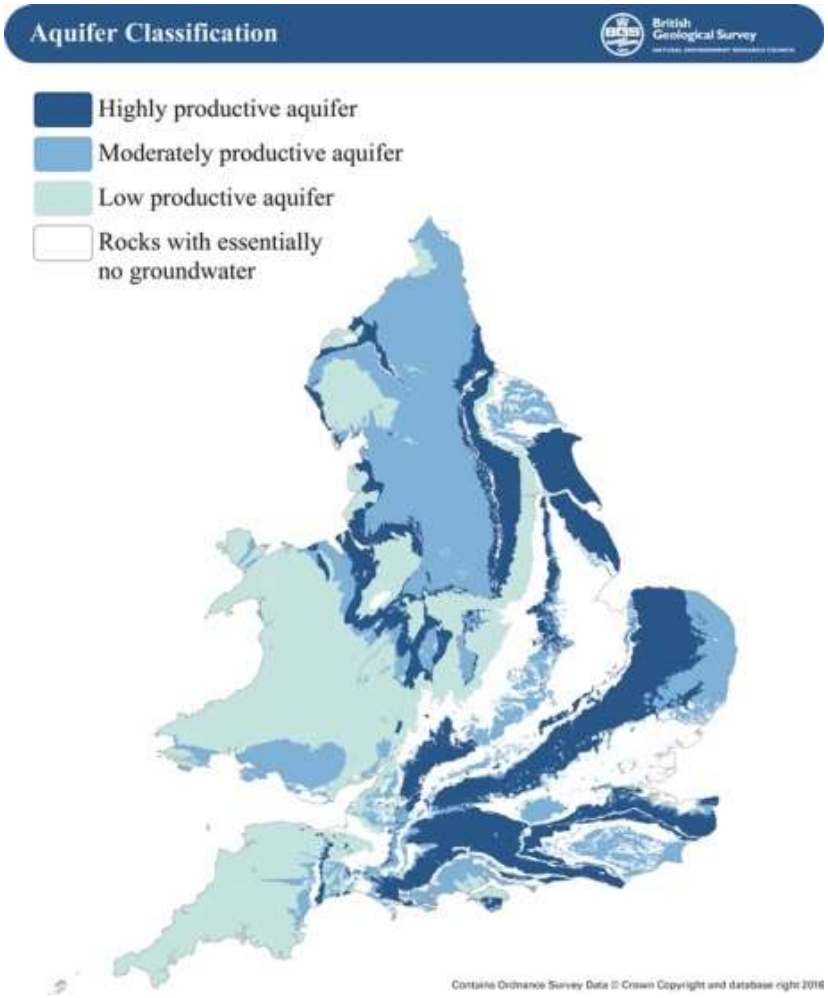
These events and their timing increase the risks of flooding and drought and will demand the need for the golf and leisure sector to develop resilience plans to retain water gluts, helping to reduce flooding and for use in drought periods.

Water sources for potable supply in the UK

As we have seen, we appear to be witnessing more extreme whether events at different periods of the year. This combination over the past few years is resulting in lower infiltration rates and higher surface water flows following rainfall.

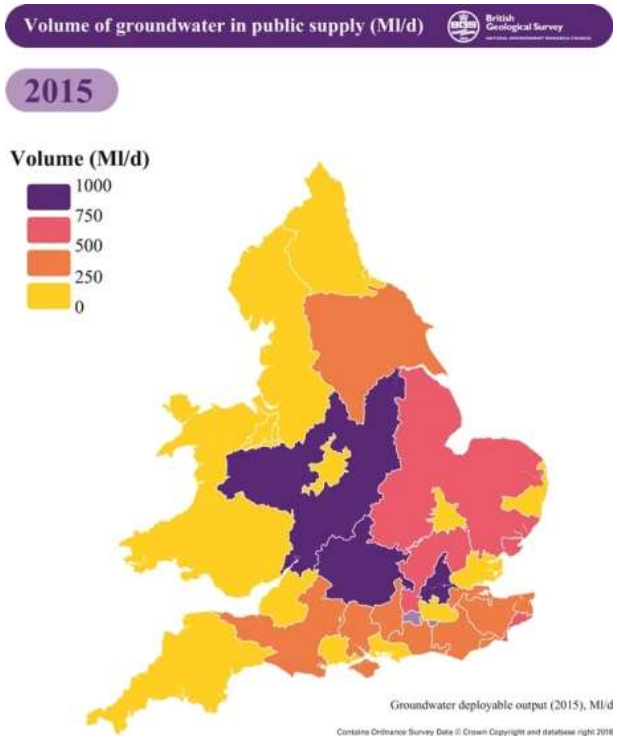
I hate to use the phrase “The wrong type of rain” but that is an apt description, with the result that Ground Water levels remain low and river flows becoming a less reliable source for potential abstraction.

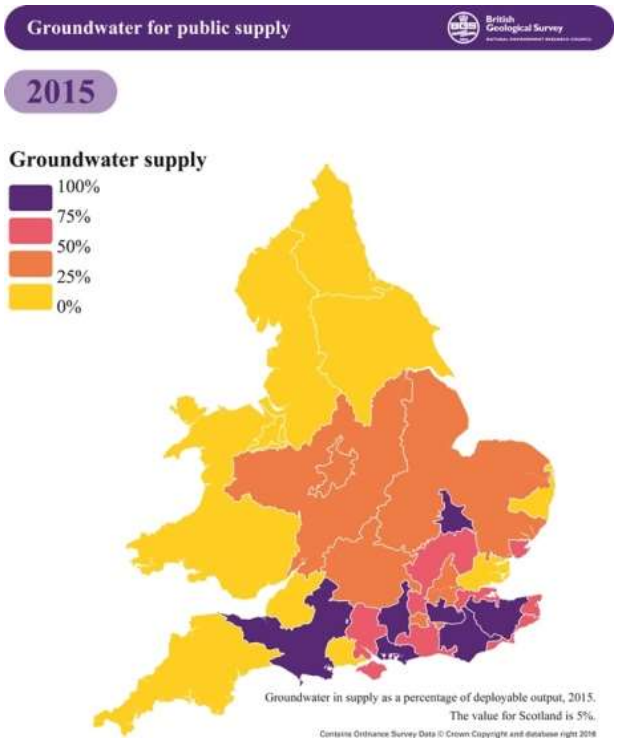
The Aquifer Classification map provides an overview of England and the potential availability of ground water as a source for public supply, although this data is from 2016.



Source: British Geological Survey

The importance of Ground Water for public water supply cannot be under-estimated, and the following image shows the volume (Ml/d) and distribution map, along with the per centage of supply that volume represents.



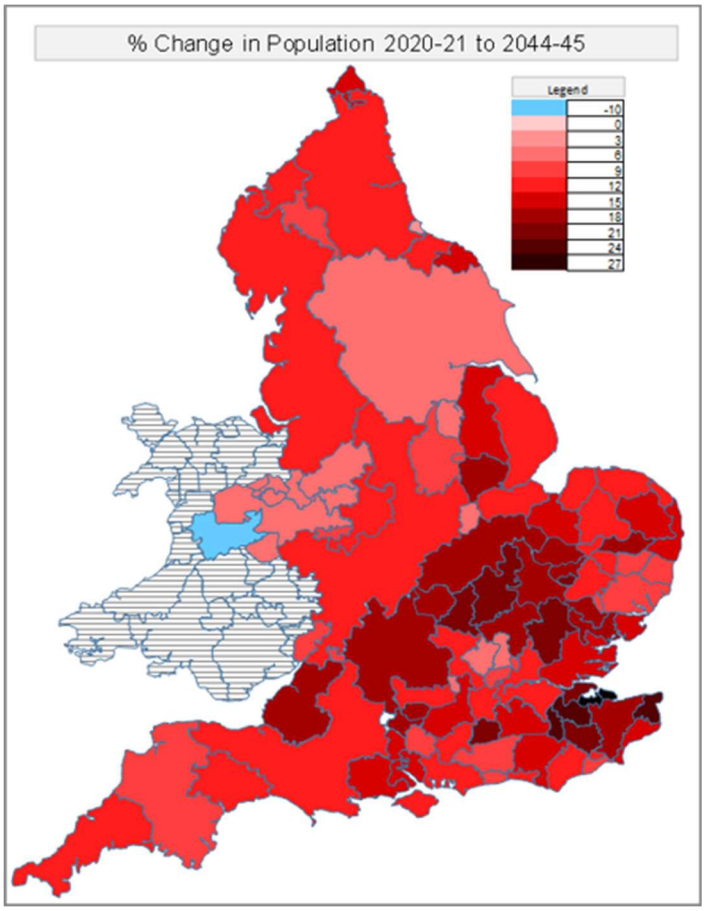


Source: British Geological Survey

A dry Ground water fed pond in Hertfordshire – December 2019

Population distribution and growth

The Ground Water use maps from the BGS indicate overlaid with the population growth map below highlight the conflict we are likely to see over the next 35 years; population growth is predicted in the areas of greatest water stress.



This imbalance of demand and supply has led to the Environment Agency and DEFRA developing National Water Framework Catchment Area Management Groups to engage with major commercial water consumers, water companies and other stakeholders. It has a primary remit to manage abstraction and to understand the likely changes in demand over the next 30 years.

The first meeting was held on the 29th October 2019 in London and Esi were invited to provide a voice and information on water use in the leisure sector and to gain an understanding of the likely demands on water from domestic and commercial abstractors to 2050.

Purpose of the meeting

- Highlight the demands on water abstraction now and projections and forecasts for demand over the next 30 years
- Review the regional variations in demand - volume and use
- Engage with representatives from key industrial/commercial sectors to gain insight to likely changes in demand over the next 30 years
- Introduce the 5 EA Regional Catchment Area Management Groups tasked with catchment management including supply infrastructure and demand management

Discussion summary

- Supply priority – energy sector – takes around 50% of available abstraction supply
- Economic drivers – water allocation should not adversely affect National GDP where possible
- Increasing domestic demand needs have to be met
- Need to meet the requirements to reduce environment and ecological impacts, improve efficiency and waste and ensure drinking water supply to citizens
- Resilience to changing weather patterns – characterised over the last few years by longer dry periods in summer and Atlantic storm systems leading to numerous heavier rainfall events leading to flooding. The result is reduced groundwater recharge over Autumn and Winter and likely reductions in water available for abstraction to 2050.

Results

- Esi have engaged with the EA Water Framework group lead and the 5 EA Regional Water Group leaders – discussing and engaging with the Resilience meetings Esi have been running for the last 2 years and client action.

- Abstraction Licenced volumes will need to be reviewed and adjusted by the EA Regional Water Groups to allow distribution in line with evolving strategic aims.
- Water Management – Golf, along with other commercial users, will have to show verifiable measures to reduce waste, improve efficiency and build resilience for drought and treat winter storm water as a valuable resource rather than design drainage to expedite flow away from the site.

In terms of the source of supply, golf facilities will have to move away from using potable mains but will be unlikely to obtain a bore hole or surface water abstraction licence as an alternative in a number of catchments identified in the Esi research mapping.

Changes in global weather events have been discussed in many loftier reports than this, however predictions and computer models are still evolving as more data becomes available.

One description of global weather evolution that seems to sum up our experience so far is of “Global weirding”, a phrase coined by Dr. Katherine Hayhoe, Director of the Climate Science Center, Texas Tech University. In simple terms the suggestion is that we will experience more and more random and extraordinary weather events as global temperature increases over the coming decades.

2.2 Golf industry

The 2018 report highlighted that the golf industry has traditionally relied on mains potable water for both clubhouse and irrigation use, with estimated annual consumptions of 10,000 M^3 for hospitality services and up to 70,000 M^3 for irrigation.

Since the publication of the 2018 report Esi has been working with partners, the water industry and our clients to identify water sources and use in the golf sector. The BIGGA survey conducted in 2019 provides some excellent data provided by their membership looking specifically at irrigation use.

Industry averages are not currently available, and variations will be considerable, however reliance on mains potable supply for irrigation is clearly not a sustainable use of a valuable resource.

Moving towards alternative sources of supply for irrigation will still be a challenge due to increased general demand. Abstraction license volumes are being reduced at renewal as a matter of course, and new abstraction licences are not easy to obtain.

It is likely that the water required for irrigation will have to be obtained during the winter period and stored on site until required in the summer. The volumes required for irrigation can make it difficult to find enough land area within the golf facility to store the volume of water to provide the bare minimum of 21 days drought or offer the greater annual irrigation requirement.

2.3 Water industry

The water sector is under significant pressure to make provision for secure supply with reserve, for a growing population and during a period of less predictable rainfall events.

The water industry clearly has an obligation to prioritise the maintenance of supply for domestic consumption over leisure sector irrigation. In the event of a drought water companies can use Temporary Use Ban's (TUB's), escalating to Ordinary Drought Order (ODO) or Non-Essential Use (NEU) and Emergency Drought Order's (EDO), bans preventing irrigation use and potentially resulting in the loss of golf greens, and golf courses closing either temporarily or permanently.

The latest Water Resource Management Plans (WRMP 19) required the water supply companies to outline company's strategy to meet DEFRA's water resource plan, and secondly to provide infrastructure and supply costs for Price Review (PR19), ensuring customer service, affordable bills, resilience and innovation.

The key elements arising from the Golf Sustainability Project meeting in September 2016, highlighted a desire of the EA to engage with the golf sector to help balance water use, prevent water quality being adversely affected by golf operations, and to work with golf to ensure resilience.

In 2019 Esi, The EA, Cranfield University and Thames Water collaborated with Waterwise to draft an irrigation guidance document to highlight the risks to water supply and to offer some high-level advice on how to optimise irrigation water. The guidance document is endorsed by BIGGA, IOG and England Golf.

DEFRA and the EA have established and expanded 5 Regional water groups covering England to help engage and create regionally specific Abstraction Management Strategies focussing on the National Guidelines, to allocate water resources and abstraction volumes based on projections of demand and supply. Esi have engaged with these regional groups and will be representing our clients in these regional consultations and discussions of water availability.

2.4 Organisations

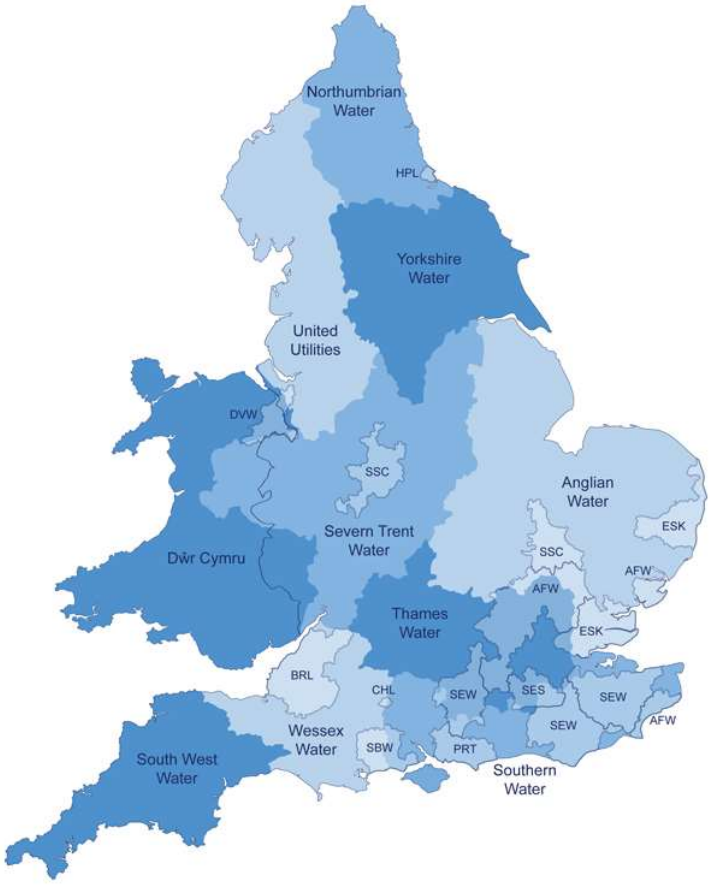
Environment Agency (EA)

Responsibilities include:

- Regulating major industry and waste
- Treatment of contaminated land
- Fisheries,
- Inland rivers, estuaries and harbour navigation
- Conservation and ecology
- Flood management
- Lead local flood authorities
- Water quality and resource.

Water Companies

The 19 English Water companies covering England and Wales:



Source: OFWAT

Responsibilities include:

- Supply and billing water to public and commercial clients
- Wastewater treatment and discharge of "Treated effluent" to watercourse.

Incorporated within this remit is the maintenance/upgrading of the supply network infrastructure, and construction and maintenance of larger supply infrastructure including reservoirs.

Overseen by OFWAT, the water companies have an obligation to provide Water Resource Management Plan's (WRMP) outlining how they will ensure supply balancing supply infrastructure and project demand levels for the medium and long term. Price reviews are submitted for price increases that are reviewed by OFWAT to provide pricing oversight and prevent excessive rates.

OFWAT

Responsibilities are outlined in Section 2 and Section 3, of the Water Industry Act 1991 (WIA91) as amended.

Primarily to act as an economic regulator:

- Protecting the interest of consumers
- Ensure the water companies undertake their statutory obligations (Potable and wastewater)
- Ensure reasonable pricing to consumers allows sufficient income to ensure that capital is available for water companies to maintain their statutory obligations
- Ensure that water and sewerage licensees properly carry out their licensed function
- Further the resilience objective to secure long-term resilience of water companies water supply and wastewater system

Further to these main responsibilities OFWAT aim to:

- Promote economy and efficiency by water companies
- Ensure no undue preference or discrimination by water company's in fixing charges
- Ensure no undue preference or discrimination by water company's in relations to the provision of services by themselves or by water supply or sewerage licensees
- Ensure consumers interests are protected when water companies sell land
- Ensure consumers interests are protected in relation to any unregulated activities by the water companies
- Contribute to the achievement of sustainable development

Waterwise

Water industry funded organisation

Waterwise is an independent, not-for-profit organisation, we are a registered business but reinvest all profits back into our vision that water should be used wisely every day, everywhere.

Waterwise is recognised as the leading UK authority on water efficiency. A powerful brand, Waterwise influences water efficiency policy, regulation, delivery and research, including through ambition and innovation. Waterwise are also a campaigning organisation that want to see a reduction in Per Capita Consumption to below 100 litres per day by 2050.

3.0 Water use in the golf sector

3.1 Overview

The golf sector continues to be hampered by the lack of detailed in terms of a centralised data gathering. The result is that the use of water by the golf sector in this report necessarily relies on limited data and significant extrapolation. In coming years hopefully to data volume will be far greater and accuracy on which future reports draw will allow greater incite.

Data has been drawn from the recent BIGGA survey, Golf Environment Organization (Sustainable Golf), data volunteered by clubs and operators and from Knox et al 2008.

The key areas of consumption in most golf facilities are logically split in to:

1. Hotel services
    a. Water use
        i. Drinking
        ii. Food preparation
        iii. Washing – catering/personal hygiene
        iv. Toilets and urinals
    b. Sewerage mains outgoing
        i. Grey water – Wash water from showers/handbasins/kitchen outflow – dishwashers/kitchen wash water (high in Fats, oils and grease or FOG)
        ii. Black water – Toilet and urinal waste flushed
2. Course maintenance
    a. Water use
        i. Irrigation – systemic/hand watering
    b. Outgoing
        i. Surface run off
        ii. Evaporation

3.2 Source of supply

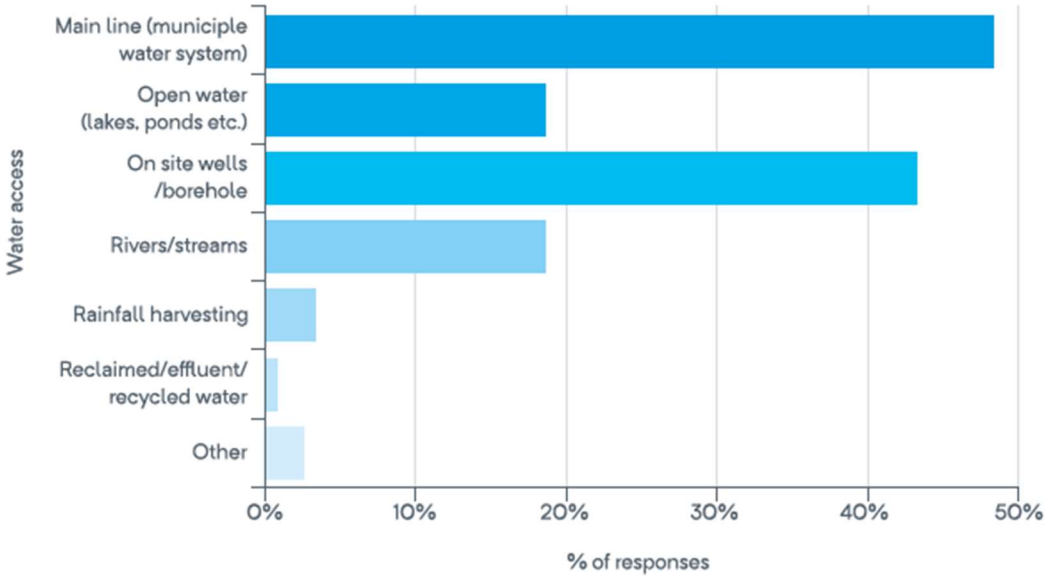
As originally highlighted golf facilities primarily depend on:

1. Mains potable supply
2. Borehole – Licensed volume or 20m3 per day
3. Surface water abstraction – River
4. Reservoir – Rainfall drainage filled/pumped rainfall drainage/mains potable
5. Combination of some, or all the above

The location of the facility, population and the underlying soil and geology are key determining factors for water resources available. The interaction of these factors and rainfall volumes, groundwater levels, demand volumes, evaporation rates, rainfall runoff speed will be instrumental in assessing a golf facilities potential risk factor.

Irrigation water sources disclosed in the BIGGA survey provide the following snapshot.

Water source



Source - BIGGA Irrigation Survey 2019

The primary source of irrigation water for almost 50% of the respondents is mains potable supply, the water industry figure suggests nationwide the figure is closer to 66%.

The significant use of mains supply for irrigation results in a dependence on a resource that is under increasing demand from domestic and commercial use across the United Kingdom.

During the Water Resilience seminars organised by Esi in 2018 much of the discussion related to golf facilities finding alternative sources of supply, often looking to potential groundwater abstraction. During 2018 and 2019 it has become even more clear that both ground water and surface water abstraction headroom (estimated excess of supply over demand) is likely to be insufficient based on current consumption levels and expected increases in demand for electricity as the economy decarbonises as the energy sector accommodate increasing consumption of electricity for vehicles and a host of other uses.

The data on which this report is based, referenced in section 6, will help to provide a strategic but older overview to balance the newer limited data provided by individual golf club in the BIGGA survey.

The 2008 report (Knox et al), identified 2,140 golf facilities in England and Wales and interestingly the geographical distribution was mapped in line with the Environment Agency regions.

The resulting distribution, unsurprisingly, shows a correlation between population and golf facility locations, resulting in a disproportionate incidence in areas of water stress.

Specifically:

- 20% located in the Thames Region
- 14% located in the Midlands
- 13% located in the North West
- 13% located in the North East
- 12% located in the Anglian Region
- 10% located in the Southern Region
- 9% located in the South West Region
- 9% located in the EA Wales region

Distribution of golf courses in England and Wales 2003 – Knox et al 2008

Further refinement of golf course distribution by Catchment Abstraction Management Strategy (CAMS) areas is included in the 2008 report, which further highlights the potential conflict in demand between potable drinking water in high population areas and the golf sector:

- Colne CAMS 51 – Thames North 68 golf facilities
- South London CAMS 56 55 golf facilities
- Wey CAMS 54 – Surrey 54 golf facilities
- Aire and Calder CAMS 11 – North East Region 54 golf facilities
- North London CAMS 50 50 golf facilities

Distribution of golf courses in England and Wales 2003 by CAMS area – Knox et al 2008

It is noted that four of the top five CAMS area golf facility intensity are in and around the London area which is already an area of water stress.

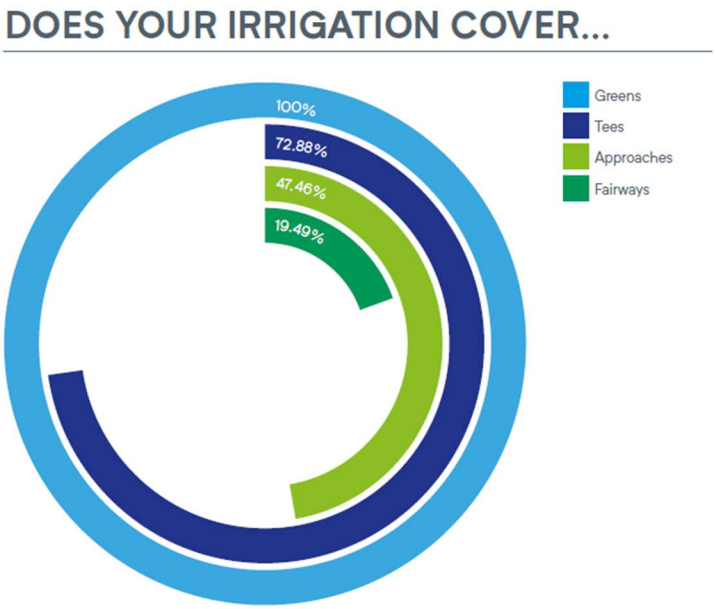
3.3 Consumption and efficiency

As mentioned above, the golf sector is limited in terms of the available water consumption data although the latest information from the recent BIGGA survey has provided some useful information.

The Golf Environment Organization (GEO) website has been updated in October 2019 providing data that maybe used to provide industry averages, and intensity of consumption allowing better understanding and strategic management of water and other resources.

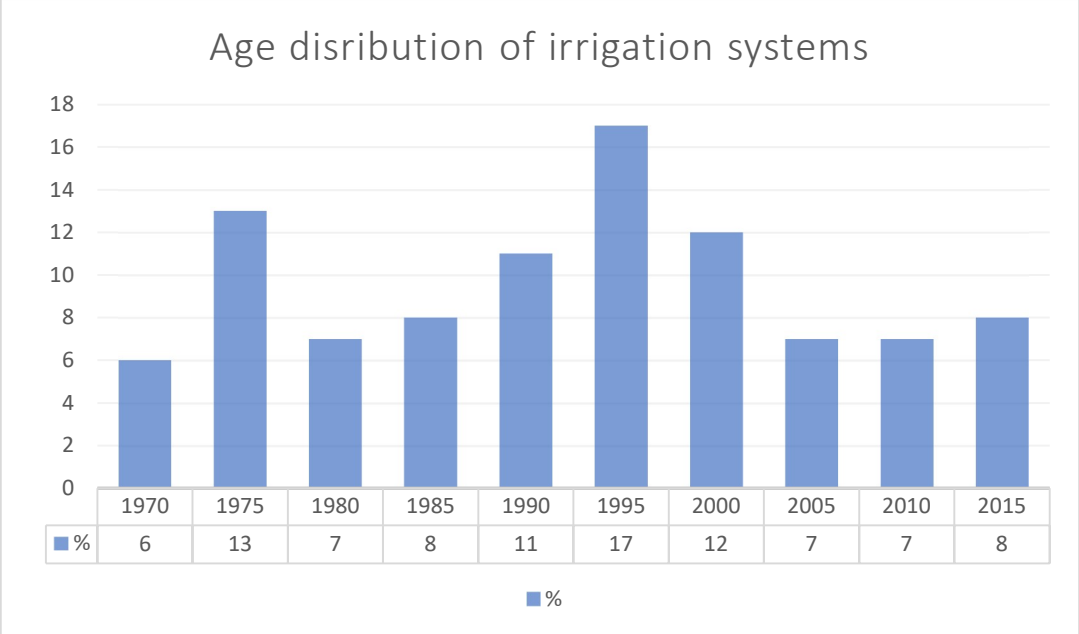
The BIGGA survey outlines two key elements, firstly the areas of the course that are receiving irrigation but, of greater potential interest to the golf sector and to the Environment Agency is the age of irrigation systems.

Areas of the course irrigated



The age of an irrigation system should not be taken as a marker of its efficiency, however as we move in to a period of increasing demand the age, condition and control will no doubt become part of criteria for the granting and renewal of abstraction licences in the coming years.

Irrigation system age



Source: BIGGA Irrigation survey 2019

The cost of replacing an irrigation system is clearly substantial and many golf facilities in England may not have the financial resources to undertake a project potentially totalling hundreds of thousands of pounds.

3.4 Business risk of loss of water supply

The likelihood of a restriction of the use of potable mains water for irrigation in the coming years is almost a certainty. The demand for water resources has been increasing year on year and this is showing no sign of abating in the next 30 years.

Potable supply for the hotel services element of the golf sector operations is much less likely to be affected, the risk to the golf sector is primarily from the loss of water for irrigation in the event of a Temporary Use Ban (TUB), more permanent restriction on the use of potable mains supply and availability of abstracted water.

The impact of a restriction on irrigation for amenity sites during a prolonged period of hot weather, would have an almost instant effect on the greens at every golf club.

In the first few days the greens would be left to grow to help relieve some stress, but within a week the course would be close to unplayable in comparison with an irrigated course.

Over the next week or so the greens would reach a tipping point beyond which it would not be able to recover them with any degree of certainty that the greens would provide the consistency demanded by players at most golf clubs. This would require a complete refurbishment with costs including:

- Loss of revenue/members
- Man hours – to refurbish & re-seed
- Growing in time – 1 year +/-

It may be possible for clubs to introduce temporary greens, either turf or simply cut areas of fairway with hand watering after restriction have been lifted, but membership/players would inevitably see these as a poor alternative.

With restricted footfall, the knock-on effect would also restrict bar and catering income from players and societies, although weddings and non-play related events may be impacted less.

Given the fine margins many golf operators are working with, the reduced income, and increased costs, are likely to result in a significant number of golf facilities closing either temporarily or permanently.

It may be possible for clubs to reduce their costs by reducing payroll commitments, initially through reducing temporary/seasonal staff, cutting hours or reducing salaries. The result may be a loss of some key staff, and the issues surrounding recruitment and the loss of the essential knowledge may well result in a period of less stable operation.

The risks are evenly spread across the industry, however if other local clubs have put water resilience plans in place allowing them to maintain irrigation and playing surfaces, the impacts for the unprepared will be significantly worse.

3.4 Stakeholder engagement

Governing and representative bodies

The Royal and Ancient, Golf Unions, GCMA, CMAE and others have made strides towards sustainability and highlighting issues they will affect their members.

The R&A Golf Course 2030 initiative has identified water as one of the key issues facing the golf sector and funding has been allocated for various additional research projects reporting in the next 6 to 18 months.

Televised tournaments

Televised coverage of golf provides a somewhat utopian image of perfect greens teas and fairways which in the real world is not achievable for most club and this places considerable pressure and stress on Course Managers up and down the Country.

The quality of playing surfaces at televised tournaments is unlikely to change as understandably the Clubs wish to show themselves in the best possible light. providing some coverage to highlight of the level of preparation and the massive resources required would help club players understand the difference.

Golf operators, Clubs and Courses

It is noticeable that the recent UK weather events, both drought and floods, have increased awareness of the vulnerability of the golf sector to water. Esi has certainly experienced increased interest from the golf and leisure sector with numerous projects to build in resilience and make to the most of excess rainfall to effectively store the excess for a dry day.

There is still a broad lack of understanding as to the magnitude and proximity of the problem facing the golf sector. For the majority of clubs this complacency will only be cured when it is too late to react as water restriction come it to place over the coming years.

3.5 Resilience and resource planning

The alternatives to mains potable water include:

- On site
    - abstraction,
    - land drainage
    - grey water
    - rainwater (SuDS)
- Storage system
    - Reservoir - surface or sub-surface
    - Swales/ponds (more naturalised and allowed to dry completely or partially)
- From offsite
    - Local borehole - surplus abstraction supply
    - Treated wastewater – WwTP

At this point it may be useful to outline the potential quantity of water required to support green only for 21 days, historically considered to be a period of reasonable drought resilience, although changing weather patterns may require a revision to this guide.

To work this out we need to make some assumption on areas being watered, temperature/humidity, soil type, time of day to allow a "Ball park" figure to be considered.

If we assume:

- 18 greens covering 1.2 Hectares or 12,000M^2
- Requiring 2mm of water per night
    - Totals 24M^2 per night
- 21 nights
    - Total water 504M^2 or 504,000 litres
    - Requiring a reservoir measuring
        - 10m long x 10m wide x 5m deep

Clearly, the volumes required to irrigate the entire season will be significantly greater than that needed for drought resilience. As an industry the direction of travel will have to be towards onsite storage, but the size of a reservoir or reservoirs providing complete self-sufficiency would be substantial.

The usage of water for irrigation is clearly dependent on numerous factors, not the least of which is rainfall (volume and timing) and temperature. Studies have been conducted previously, and referenced within this document, however the data dates back 10 years or more.

Many clubs have upgraded their irrigation systems resulting in reduced leakage, improved efficiency, reduced pressure variation, better distribution, moisture content analysis and reduced areas of irrigation.

The data available suggests a required volume of around 5,400,000 litres or 5,400 M^3 per year, with storage reservoir with a volume of between 1 and 3 times the annual irrigation use depending on budgets, space available, and how risk averse the club is in terms of operation.

Sources of water used to fill on-site storage include ground and surface water abstraction, mains potable and local land drainage, often with a combination of all these sources, with maximum reservoir levels from winter recharge, in May to provide cover the summer months.

Combination supply is the most likely scenario for most clubs including rainwater, grey water, abstraction and possibly some mains potable, since finding 5,400 M3 of water from a single source, even over a period of months, maybe problematic.

In addition to simply identifying potential supplies of water to maintain current consumption levels, industry organisations, like STERF have already undertaken research to quantify the variation in irrigation requirements for various turf grass species and cultivars. The species preferred by golf facilities will vary with

individual preferences and, I am not qualified to offer an opinion. Clearly it will depend on course soil types, green construction as to what may be considered the optimum sward content, but many facilities appear to maintain high per centages of naturalised species such as perennial ryegrass (Lolium perenne) and annual meadow grass (Poa annua) across greens, tees and fairways.

3.6 Technology

New technology is providing methods to reduce the volume of water used by improving applications to maintain optimum soil moisture levels and the efficacy of the water that is applied.

Forthcoming reports being funded by the R&A Golf Course 2030 programme from STRI and STERFF will no doubt cover these technologies in more detail, but Course Mangers should review:

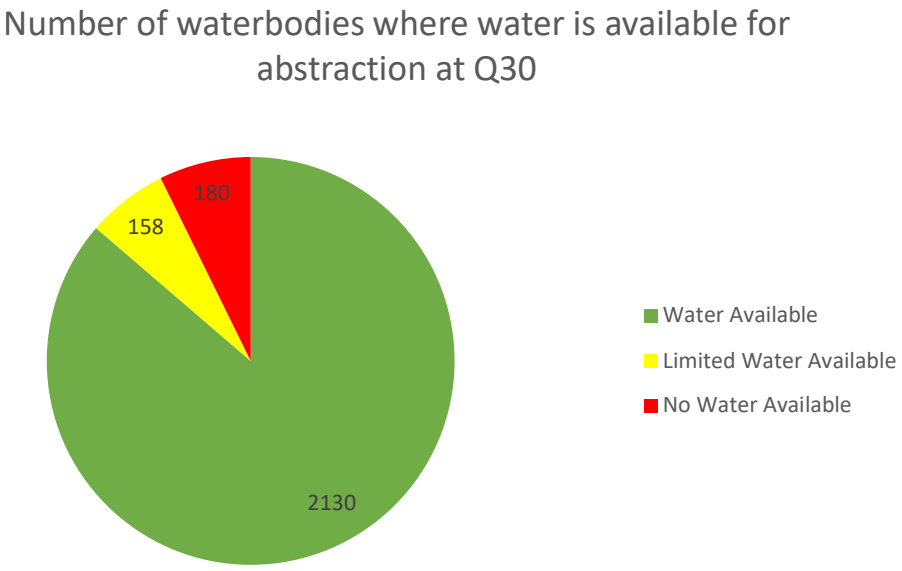
- Computerised irrigation controls
- Moisture monitoring
- Magnetic and other water process

3.7 Golf Facilities at greatest risk of water restriction

Mapping the golf facilities and cross referencing the locations against EA Catchment Management Area and water body proximity allows an understanding of the scale to the problems facing the golf and leisure sector.

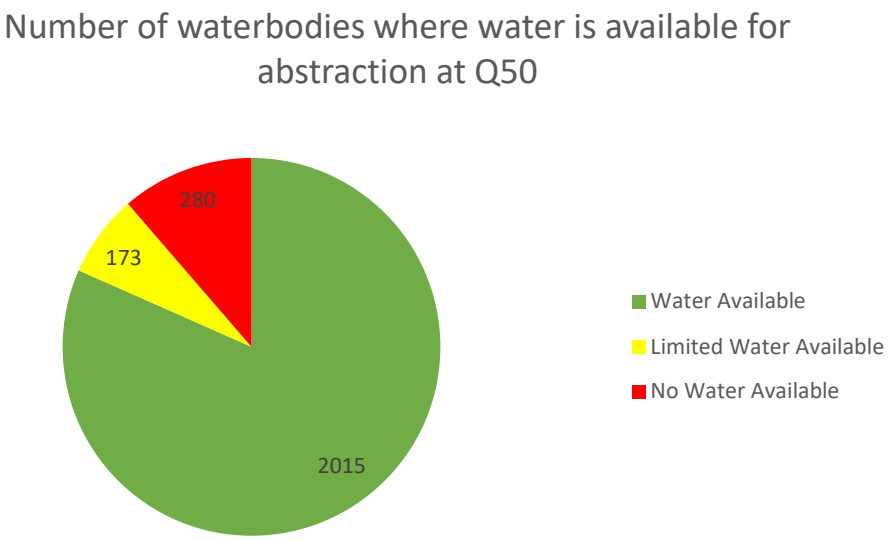
The following tables offer an analysis of the water available for abstraction given varying flow rates and identifies the number of golf facilities falling within each sector.

Q30 refers to a flow rate exceeded for only 30% of recorded flows



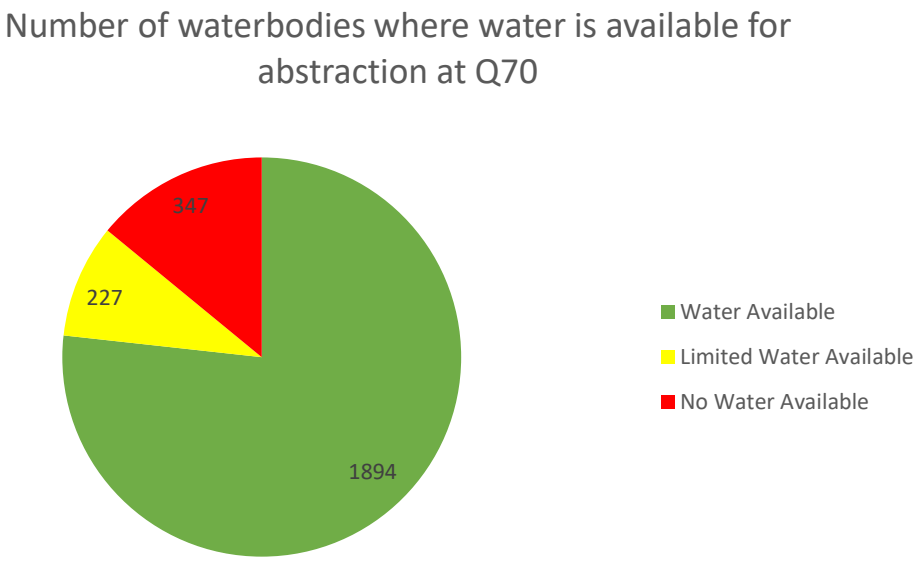
Source – The Environment Agency

Q50 refers to a flow rate exceeded for 50% of recorded flows



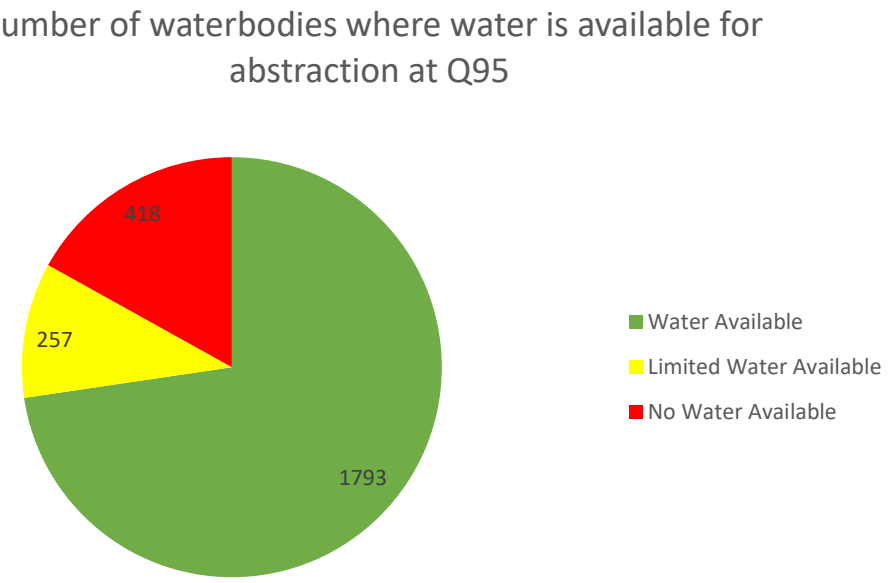
Source - The Environment Agency

Q70 refers to flow rates exceeded for 70% of recorded flows



Source - The Environment Agency

Q95 refers to flow rates exceeded for 95% of recorded flows



Source – The Environment Agency

Q30 flow rates highlight 238 locations with Limited or No water availability
Q50 flow rates highlight 353 locations with Limited or No water availability
Q70 flow rates highlight 574 locations with Limited or No water availability
Q95 flow rates highlight 675 locations with Limited or No water availability

The location of some of the golf facilities falls in to more than one water body catchment resulting in some locations in close proximity to more than one water body appearing in the data sets more than once.

The specific data on the location of golf facilities mapping and catchment location has been effectively funded by our clients and our priority will be to:

1. Continue the process of water resource review and water resilience planning with existing Esi Clients
2. Begin the process of engaging with BIGGA and Course Managers with clubs identified as at greatest risk of water stress.

4.0 Water industry

4.1 Overview

The United Kingdom population has increased from an estimated 58 million in 1995, to an estimated 65.1 million in 2015, and based on the suggested 150 litres per person per day average consumption figure for domestic use, the additional 7.1 million people would use around 1,065,000 M^3 per day (Ref: 6.2)

Variation in population makes planning infrastructure extremely difficult. The 10 yearly Census was abandoned because the figures became irrelevant due to the speed with which population fluctuated as people moved across the European Union.

The likelihood is that a major infrastructure project will take 20 years from initial design through planning and finally to completion. Worryingly, the resulting reservoir may then be in the wrong place by the time it is finished!

Estimated losses, and usage, are equally difficult to assess due to the accuracy of flow meters at pumping stations, and the lack of meters of many domestic properties in the UK.

In addition to increasing or decreasing population, we also must factor in the changes to the climate, and the likely result of more variable weather patterns, rainfall events, and dry periods.

Rainfall in the late spring and summer runs off or evaporates too quickly to help recharge groundwater levels, and are more likely to result in localised flooding, further degrading the quality of river water in the local catchment.

The legislative background

Water industry in the United Kingdom is subject to a number of legal requirements requiring the industry to safeguard water supply in terms of quality and quantity. These requirements primarily result from the Water Industry Act 1991 placing a statutory requirement on the water industry to provide Water Resource Management Plan (WRMP) and drought plans.

This legislation also provides the powers to implement Temporary Use Bans (TUBS) and escalating to Ordinary Use Orders or Non-Essential Use bans as required to ensure domestic potable mains supplies are maintained while maintaining the quality of drinking water supply to their customers.

Within the 1991 Act it is a specific offence to supply water unfit for human consumption. The water companies therefore have very stringent requirements placed on them to ensure compliance under this act.

In November 2012 the European Commission launched the blueprint for safeguarding Europe's water which is designed to ensure supply of good quality water to meet the needs of people, the economy and the environment.

The seventh Environment Action Programme (2013-2020) has several components governing water.

Priority Objective 1, to protect, conserve and enhance the EU natural capital, requires a program to ensure that by 2020 the impact of pressures on transitional, coastal and fresh waters including surface and groundwater, is significantly reduced to achieve, maintain or enhance good status as defined by directive 2000/16/EEC.

Priority objective 2, requires that by 2020 water stress in the EU is prevented or significantly reduced. Specifically, this requires member states to have developed measures and benchmarking methodologies by 2015 for the resource efficiency of water use and improving water efficiency by setting and monitoring targets at river basin level, and by using market mechanisms such as water pricing.

Priority objective 3, requires that by 2020 EU citizens benefit from high standards for safe drinking and bathing waters.

From the water company's perspective, this provides the key outline to their statutory obligations when it comes to the supply of potable water, and treatment of wastewater, on a catchment wide basis while maintaining surface and groundwater quality and viable habitat and biodiversity.

4.2 Sources and supply

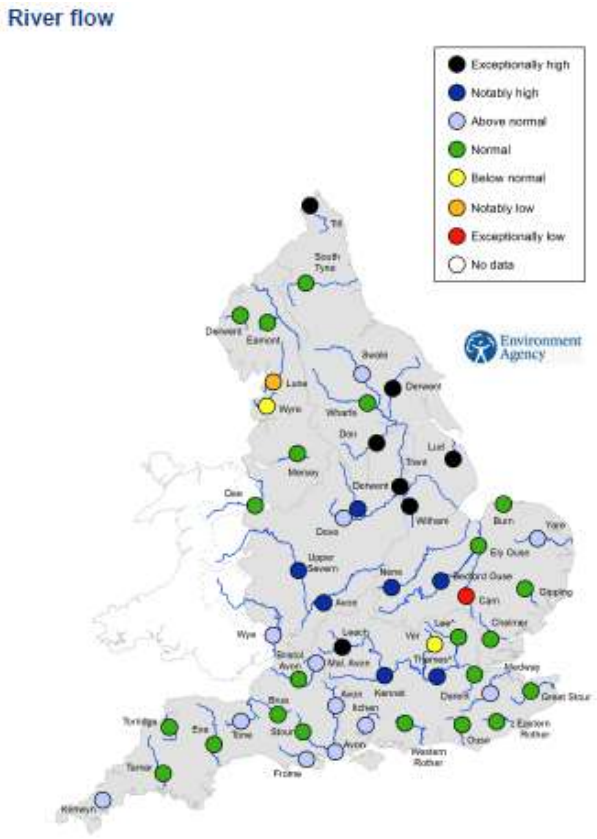
Source of water supply across the majority of the United Kingdom is from either river abstraction, groundwater and, to a limited extent, desalinated sea or brackish water. For our purposes therefore, we are limited in terms of the amount of usable water to rainfall events that may be stored naturally or artificially.

It is not necessarily just the quantity of rainfall through the year, it is also when the rainfall events occur which determine how much of the water is lost to evaporation or run-off, and therefore how much infiltrates into the soil to be retained as groundwater or flow into rivers or reservoirs.

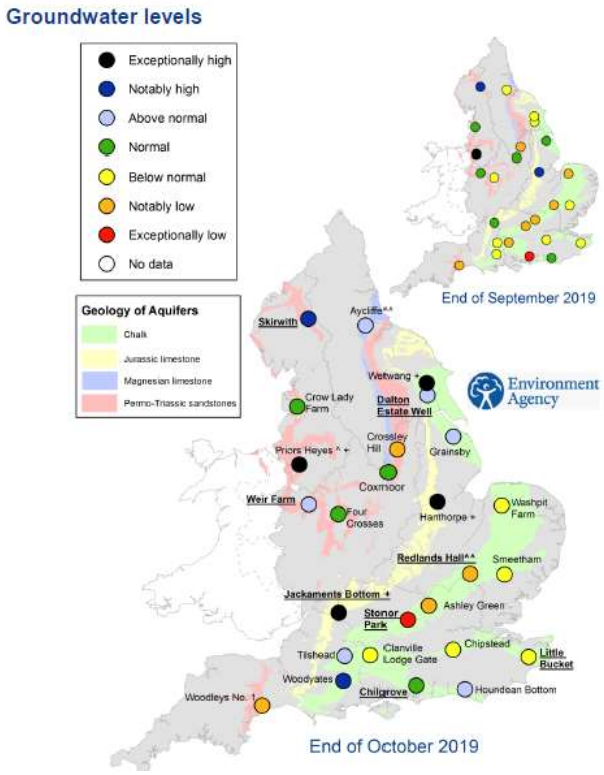
It must be understood that some rainfall events are far less effective in recharging groundwater due to the higher temperatures and increased losses through evaporation run-off and absorption plants and trees. Groundwater recharge is primarily at its optimum through the autumn and winter periods, but once again heavy rainfall events that lead to flooding and swift run-off are lost as surely as summer rainfall on a baked landscape.

Over recent years it does appear that rainfall events seem to be more intense which is a concern from the perspective of potential flooding, and from the loss of potential groundwater to immediate run-off.

Additionally, if these rainfall events fall at different periods of the year than we have seen in previous decades it will require some significant reduction in terms of our use, and improved methods of interception and retention.



River levels at the end of October 2019 – Source the Environment Agency



Groundwater levels end of October 2019 – Source the Environment Agency

We have already noted that changes in population as a key variable in terms of the demand planning process and the 7 million population increase in the last 20 years is significant, critically due to the conception to completion period for a major infrastructure project like reservoirs. We are also in a situation where the population of the United Kingdom is entirely likely to fluctuate as the political situation changes.

In addition to the national population increase, understanding the population distribution and demographics is also key in formulating plans for water supply over a longer time period.

Significant development has been undertaken throughout the South East of England and particularly in London and the surrounding areas where housing demand is particularly high. Unfortunately, this area is also an area of significant water stress at least partly due to the relatively low rainfall levels experienced in the Thames catchment area.

The supply network infrastructure in many areas dates back many decades, which can result in leaks ranging from relatively low volume, to mains failing resulting in highly publicised flooding events. These losses have been highlighted by OFWAT, and a number of other organisations, as a key element in helping to rebalance demand and supply. However, the calculation of leakage will necessarily be based on some significant estimates and extrapolation because of the lack of accuracy of water meters, and the simple fact that many domestic properties still do not have water meters, preventing an accurate assessment of true water use.

The current quoted figures for resilience built into the UK water supply system suggest that we currently have approximately 3,000,000,000 L of additional capacity per day, however the suggested minimum requirement recommended is 4,000,000,000 L per day based on figures provided by the National Infrastructure Commission (NIC) and this level of resilience is to come from a combination of new supply infrastructure, leakage reduction and demand management.

To underline the current situation in the south-east of England, Southern Water had this to say recently:

"Our supplies to customers will remain at risk during the AMP7 period and into AMP 8 until sufficient alternative supplies are delivered. On the basis of environmental conditions we expect to encounter before 2027, we have forecast that we will need to implement Temporary Use Bans in Hampshire, and to apply for drought orders (in some areas)."

The National Infrastructure Commission (NIC) report; Preparing for a Drier Future – England's water infrastructure needs 2018 highlighted the need for available water supply of 4,000,000,000 Litres per day ensured through a combination of increased supply and demand reduction, and made 3 key recommendations to facilitate this:

1. OFWAT should launch a competitive process by the end of 2019, complementing the Price Review, so that by 2030's at least 1,300,000,000 Litres of water per day is provided by:
    a. a national water network
    b. additional supply infrastructure
2. The Department for Environment Food and Rural Affairs (DEFRA) should set

an objective for the water industry to halve leakage by 2050, with OFWAT agreeing 5-year commitments for each company (as part of the regulatory cycle) and reporting on progress

3. The Department for Environment Food and Rural Affairs (DEFRA) should enable companies to implement compulsory metering beyond water stressed areas by the 2030's, by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters as a first step in a concerted campaign to improve water efficiency

The NIC report identifies the possible source of increased supply coming almost equally from 3 areas:

1. Leakage reduction
2. Efficiency and metering
3. Supply infrastructure

4.3 Water Resource Management Plan 19 (WRMP19)

Earlier this year the water companies submitted their most recent draft Water Resource Management Plan 2019 (WRMP19) covering 2020 to 2080, in which they have tried to assess:

- Customer participation
- demand forecast
- supply forecast
- forecast uncertainty
- supply demand balance
- options
- decision-making
- National and regional considerations

These draft WRMP's have been assessed by OFWAT in terms of the statutory duties and obligations including

- Adherence to the requirements of the water resources planning guidelines and DEFRA's guiding principles for water resource planning and
- How the draft plan helps achieve OFWAT's vision of ensuring trust and confidence in the sector through the delivery of key themes for price review 19 which include great customer service, affordability, builds resilience in the round, and innovation.

Part of the purpose of the WRMP, it should be remembered, is to allow a consultation and cooperative approach between water suppliers and consumers to help manage the demand and supply elements of the water balancing act.

4.4 Priority of supply

There is little doubt moving forward over the next 20+ years that the restrictions being placed on the water companies and Environment Agency relating to abstraction and the maintenance of water levels to protect the environment and that there will be an excess of demand over supply which will exceed that we have historically experienced resulting in a prioritisation of water use.

There may be an argument to continue to allow irrigation use for food crops in a country with greater competition for a scarce resource, however it is extremely unlikely that any weight would be given to irrigation for amenity use in a situation where a water company was unable to guarantee supply of potable drinking water for human consumption.

5.0 Summary

5.1 Water use in the golf industry

The golf industry is in the precarious position of requiring a resource for its very survival, which is scarce in supply and under increasing demand. At this point in time we have little empirical data other than a limited number of water consumption figures declared by golf clubs responding to industry surveys or undertaking environmental certification programs, which allows a glimpse of the water use within the golf sector.

Previous studies now date back approximately 10 years, and the most recent figures found for this report were provided by a report drafted by JW Knox at Al in 2008. At this point in time it was more common for golf clubs to undertake irrigation of not only greens, but also tees and fairways, potentially resulting in higher irrigation figures.

The golf industry should undertake a much more detailed survey of the sites across the United Kingdom to understand the use and risks posed, although to gain real insight the response rate needs to be between 50% and 75%. It is certainly the conclusion of this report that a survey of this type is required to get a greater understanding of the consumption of water within the golf industry. The information should also include data for the areas under irrigation to allow an understanding of the intensity of water consumption, and whether or not the industry has now reduced the areas of irrigation to greens and tees only.

Significant work has been undertaken by various organisations to understand the relative demands of different grass species and mixes, and it may be the case that as an industry we need to move away from more traditional coarse grass species such as annual meadow grass (Poa annua) and perennial ryegrass (Lolium perenne) which are commonly seen across many golf courses in the United Kingdom. Finer cultivars have been developed providing greater drought tolerance but also resistance to disease.

5.2 Sources and supply

For the golf industry to survive over the coming decades it will be essential for them to provide their own water, initially during periods of drought and the potential of temporary use bans.

Ultimately the golf sector will have to move away completely from the use of potable mains water supply for irrigation purposes, and probably in to a combination of abstraction from surface or ground waters, rainwater harvesting and grey water from their own site and operate a water storage facility in some form.

5.3 Regulatory framework

With the pressure being applied to the water industry there is likely to be restrictions and controls of water use and supply for amenity use. A strong programme of industry self-regulation and monitoring may prevent a much less flexible regulatory framework being implemented by regulators in the coming years.

6.0 References

6.1 Assessing optimum irrigation water use: Additional agricultural and non-agricultural sectors 2008 by J.W. Knox, E.W. Weatherhead and J.A. Rodriguez-Dias

6.2https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/mar2017

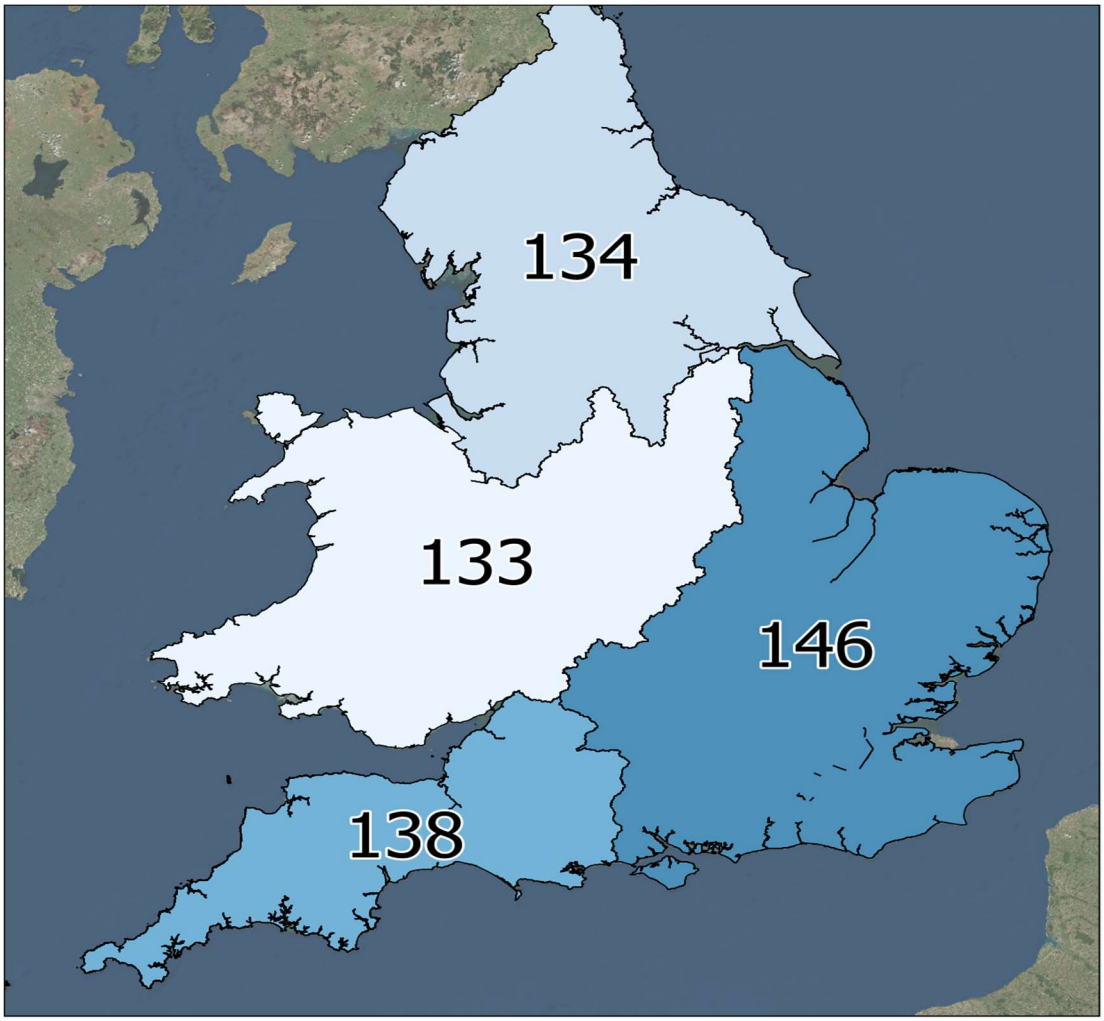
6.3 The National Infrastructure Commission (NIC) report; Preparing for a Drier Future – England's water infrastructure needs 2018
6.4 Environment Agency – Assessing optimum irrigation water use: additional agricultural and non-agricultural sectors – Science report SC040008/SR1

6.4 Environment Agency – Assessing optimum irrigation water use: additional agricultural and non-agricultural sectors – Science report SC040008/SR1

6.5 Water use of various turfgrass species on greens and fairways – By Trygve S. Aamlid, Trond Pettersen and Agnar Kvalbein, Turfgrass Research Group 2012

7.0 Appendices

7.1 Per Capita Water consumption England and Wales – extract from Ofwat report; The long-term potential for deep reductions in household water demand – April 2018 Produced by Artesia Consulting



Highlighting the highest domestic water consumption in the South East of England, the area of greatest water stress and housing demand and development.