

Golf Course Water Use and Costs – Past, Present and Future

A sustainable water supply is vital to all golf courses. The 2014 survey, “[Water Use and Conservation Practices on U.S. Golf Courses](#)” found that 67 percent of the nearly 2,000 responding golf courses use lakes, ponds, rivers, streams, canals and wells for their irrigation supply, while an additional 8 percent use municipal drinking water. Unpredictable weather and growing demand for water have placed increasing strain on all those sources. As a result, water costs are rising and usage restrictions are becoming more common. The goal of this report is to provide an overview of water use, the cost of water, and water use regulations in the past, present and future.

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1. Historical Perspective

Annual water use, the cost of water, and water use regulations are highly variable. The amount of water a given golf course will need depends largely on the variables below:

- Turfgrass species
- Climate
- Irrigated acreage
- Soil conditions
- Overall use and traffic

While these key variables determine the amount of water a golf course needs, annual water use rates are not static year after year. Droughts followed by periods of excessive rainfall have impacted water use for decades and will continue to do so in the future. Unfortunately, historical information related to golf course water use, cost and regulations are limited. However, understanding the evolution of golf course irrigation does provide insights into the overall water use trends throughout the past 100 years.

Automatic pop-up sprinklers were invented in the early [1920s](#), but it took many years before this technology became commonplace on golf courses. Between the 1930s and 1960s, a [quick-coupler system](#) was the most common type of irrigation system installed on golf courses (Labban and Witteveen, 2002). Quick-coupler systems controlled the amount water a golf course could use in given year simply because the design had limited pumping capacity. However, by the end of the 1970s, irrigation system capabilities had increased from approximately 500 GPM to 1,500 GPM (Labban and Witteveen, 2002), resulting in increased water use on many golf courses. Double- and even triple-row systems were being installed that allowed for more uniform coverage for the fairways (Labban and Witteveen, 2002), but also increases in overall water use.

Information related to the cost of water over time is very limited. In the 1934 book *The Spirit of St Andrews*, Alister MacKenzie wrote that Cypress Point had the finest fairways anywhere, but the water bill was enormous. The article, "[Water Management](#)" written in a 1956 issue of *Golfdom* magazine discussed how the average water cost in the Los Angeles area was \$7,000 annually, roughly 10 percent of the average budget for an 18-hole course. Ultimately, the use and cost of water has gone up at golf courses around the world and more detailed analysis of the current state of the industry is provided below.

2. Present

Along with their maintenance budget surveys, in 2014 the GCSAA published a report that outlined U.S. water-use trends in 2005 and 2013. To provide an accurate depiction of regional trends, the U.S. was divided into seven agronomic regions based on location and climate. These agronomic regions are limited to the U.S. However, the United States Department of Agriculture has divided North America into 11 different plant hardiness zones, which influence the grass species selected for a golf course and to some extent the overall water use. The majority of golf courses located outside of North America likely will fall within one of the 11 plant hardiness zones and agronomic regions defined below (Figure 1 and Figure 2). Thus, it is possible to extrapolate some U.S. water-use trends onto golf courses throughout the world.

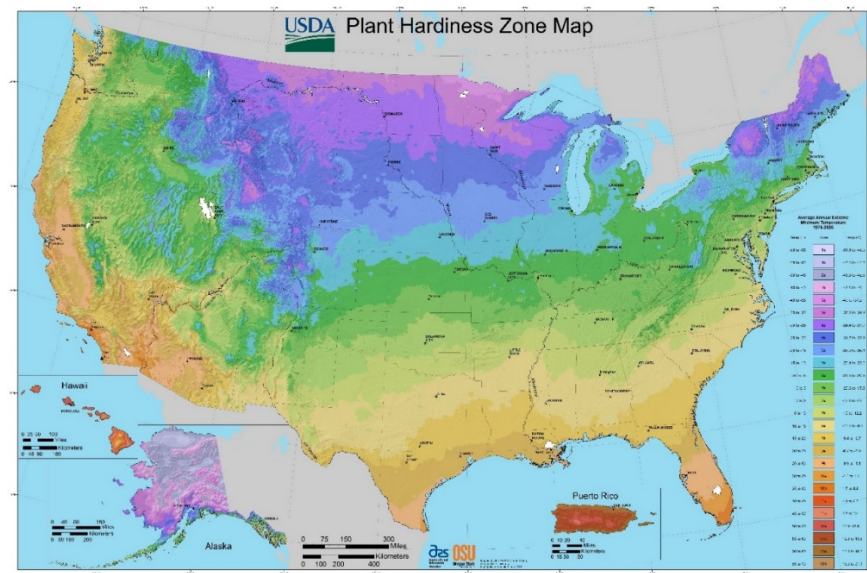


Figure 1 USDA Plant Hardiness Zone Map (Source: United States Department of Agriculture)

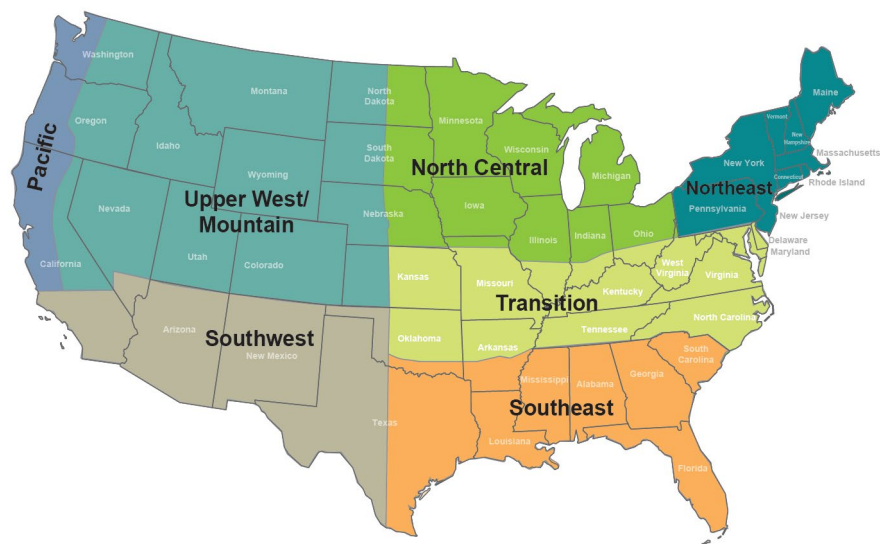


Figure 2 Agronomic regions within the United States. Source GCSAA.

There are many interesting findings from the 2014 GCSAA water-use survey, but median water use, water cost per 18-hole course, and median cost of water per acre-foot are the primary focus of this report.

Between 2005 and 2013, median water use declined in all regions except for the Southwest and Pacific. The reduction in water use is attributed to water conservation practices, voluntary reduction in irrigated acres and a reduction in the number of golf facilities. Regions with year-round turf growing seasons – e.g., Southeast and Southwest – have the highest water use, while regions with the shortest growing seasons – e.g., Northeast and North Central – have much lower water use patterns. These trends also align with average annual rainfall data in Figure 3.

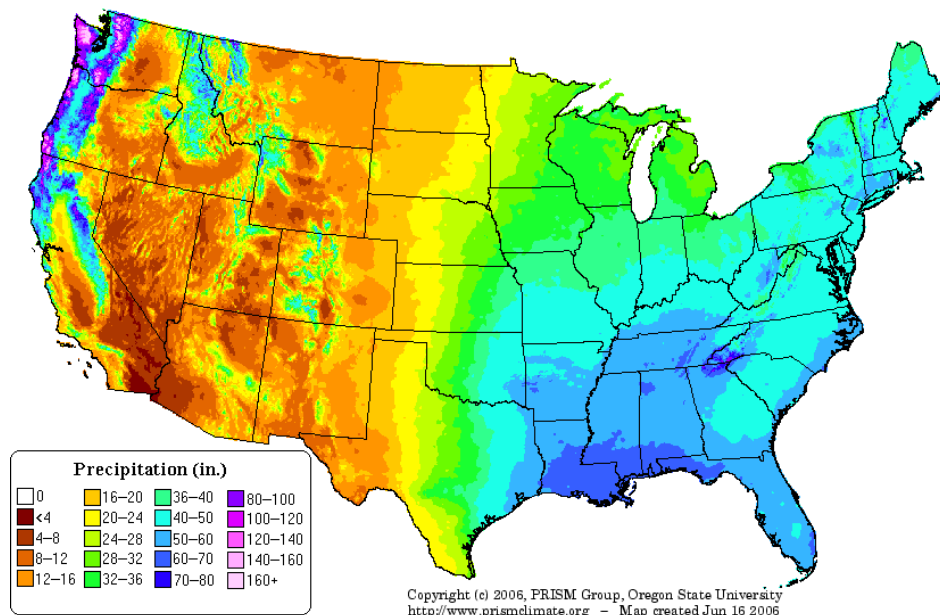


Figure 3 Average precipitation throughout the U.S.

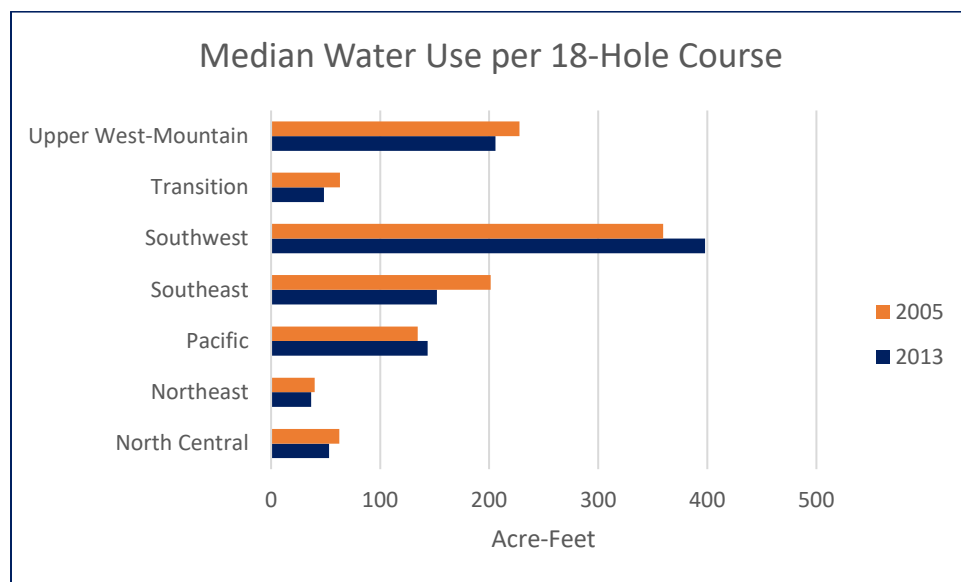


Figure 4 Median water use for an 18-hole course in acre-feet by region. Source GCSAA.

In addition to variations in water use (Figure 4), the cost of water also varies by region. Figure 5 illustrates that between 2005 and 2013, median water costs have statistically increased in all regions except the North Central, Northeast and Upper West-Mountain. Water costs were the lowest in the North Central region, which is also the only region that had a statistically significant reduction in median water cost between 2005 and 2013.

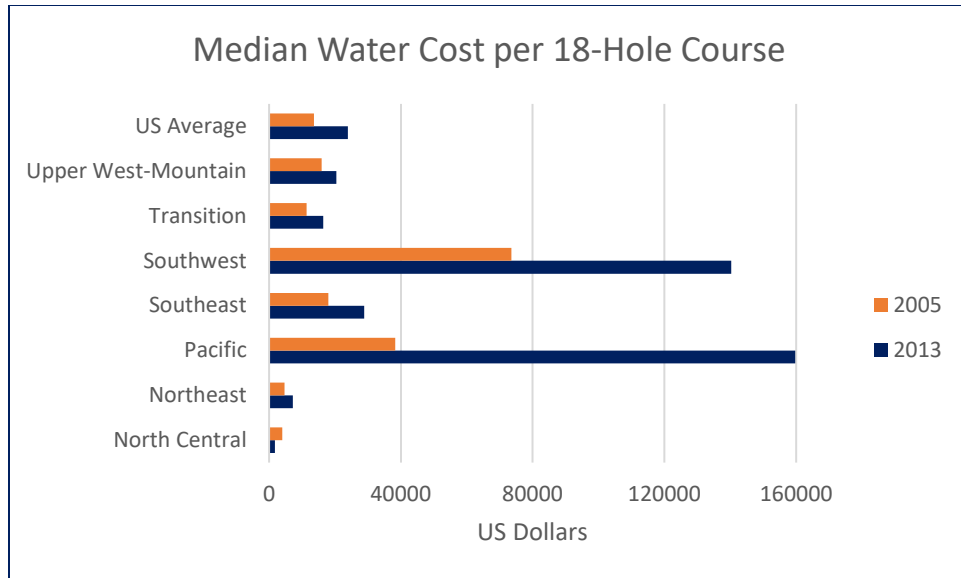


Figure 5 Median water cost by region in 2005 vs. 2013. Source GCSAA.

The large differences between regional water use and the variability in the cost of water are important because it illustrates the effects on golf course maintenance budgets. Water costs are regionally specific, but all regions except the North Central experienced an increase in cost per acre-foot of water between 2005 and 2013 (Figure 6). In total, median U.S. water costs increased by 46 percent between 2005 and 2013. In the Pacific and Northeast, the median water cost increased by more than 160 percent.

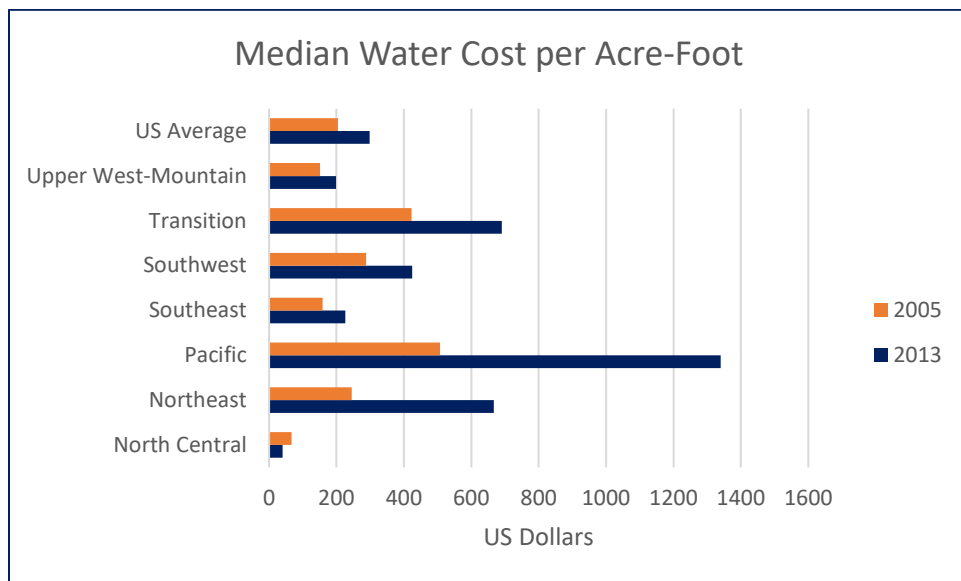


Figure 6 Median cost of water per acre-foot in 2005 vs. 2013. Source GCSAA.

3. Water Use by Golf Course Playing Area

In the U.S., the GCSAA water use survey reported that 49 percent of the total area of 18-hole golf courses are irrigated – i.e., 74 acres. Within the 74 acres of irrigated turf, overall water use is not evenly

distributed throughout a golf course. The total amount of irrigated golf course acreage in the U.S. is included Table 1.

Table 1 Median acreage of irrigated turf on 18-hole facilities in the U.S.

Greens	Tees	Fairways	Rough	Practice Areas	Nursery	Grounds
Irrigated Acres						
3.2	3.05	28.8	34.5	5	0.86	1.3

The average amount of water used for an 18-hole course was not divided by golf course area in the GCSAA water-use survey. However, fairway and rough irrigated acreage made up 83 percent of the total irrigated acreage on U.S. golf courses in 2015 so these features receive the highest total volume of water annually.

Water budgets are used to estimate the amount of water a golf course needs in a given year. A water budget is a theoretical model, but it provides superintendents with the ability to forecast water needs based on the average temperature, rainfall and grass species – i.e., cool season vs. warm-season. Water budgets account for monthly evapotranspiration (ET), average rainfall, effective rainfall, grass species crop coefficients and total irrigated area. Superintendents create water budgets for their entire course and specific features within the course. Tables 2, 3, 4, 5, 6, 7, and 8 provides summary of the water budgets for golf courses that have the median size putting greens, tees and fairways in seven cities throughout the U.S.

Table 2 Water budgets for the U.S. median size putting greens, tees and fairways in Los Angeles, California.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i>	Fairways (28.8 A) <i>Warm Season</i>	Total
acre-feet				
Los Angeles, CA	8	7.5	61.6	77.1

Table 3 Water budgets for the U.S. median size putting greens, tees and fairways in Seattle, Washington.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i>	Fairways (28.8 A) <i>Cool Season</i>	Total
Seattle, WA	3.8	3.6	34	41.4

Table 4 Water budgets for the U.S. median size putting greens, tees and fairways in Chicago, Illinois.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i>	Fairways (28.8 A) <i>Cool Season</i>	Total
acre-feet				
Chicago, IL	2.9	2.8	26.2	31.9

Table 5 Water budgets for the U.S. median size putting greens, tees and fairways in Dallas, Texas.

	Putting Greens (3.2 A)	Tees (3.05 A)	Fairways (28.8 A)	Total
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	<i>Warm Season</i>	<i>Warm Season</i> acre-feet	<i>Warm Season</i>	
Dallas, TX	4.5	4.3	40	48.8

Table 6 Water budgets for the U.S. median size putting greens, tees and fairways in Atlanta, Georgia.

	Putting Greens (3.2 A) <i>Warm Season</i>	Tees (3.05 A) <i>Warm Season</i> acre-feet	Fairways (28.8 A) <i>Warm Season</i>	Total
Atlanta, GA	2.4	2.3	21.4	26.1

Table 7 Water budgets for the U.S. median size putting greens, tees and fairways in Boston, Massachusetts.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i> acre-feet	Fairways (28.8 A) <i>Cool Season</i>	Total
Boston, MA	2.7	2.6	24	29.3

Tables 2 through 7 illustrate that fairways require the most amount of water amongst the primary playing areas. Tables 8 and 9 illustrate the water use reductions possible when switching from cool-season grass fairways to warm-season grass fairways. The USGA article "[Warm-Season Grasses: Less Water, Better Turf](#)" highlights how courses are saving a significant amount of water by switching to grasses that use less water.

Table 8 Water budgets for the U.S. median size putting greens, tees and fairways in Washington DC using cool-season grasses for greens, tees and fairways.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i> acre-feet	Fairways (28.8 A) <i>Cool Season</i>	Total
Washington D.C.	3.7	3.5	32.8	40

Table 9 Water budgets for the U.S. median size putting greens, tees and fairways in Washington DC using cool-season grasses for greens and tees but warm-season grasses for fairways.

	Putting Greens (3.2 A) <i>Cool Season</i>	Tees (3.05 A) <i>Cool Season</i> acre-feet	Fairways (28.8 A) <i>Warm Season</i>	Total
Washington D.C.	2.4	2.3	23.8	28.5

Roughs make up a largest total irrigated area on U.S. golf courses, but the percentage of maintained rough that is irrigated varies significantly between regions. In the North Central, it is estimated that 40 percent of the maintained rough is irrigated. In the Southwest, it is estimated that 99 percent of the maintained rough is irrigated. Given the large regional differences in irrigated acreage, water budgets were not developed for rough.

4. Water Use of non-U.S. Golf Courses.

The median annual water use for an 18-hole golf course in the U.S. is 148.3 acre-feet. In Spain, the average annual water use for golf courses with fewer than 18-holes is 81 acre-feet. Golf courses with 18-holes or more in Spain are reported to use more than 162 acre-feet annually (Use of Water on Golf Courses in Spain, 2018).

In France, the average 18-hole golf courses is reported to use 3176 m³/ha/an (French Water Charter, 2006). On average, 40 percent of the total area of golf courses are irrigated according to The French Water Charter. This data also shows that putting greens represented 10 percent of the total volume of water consumed. The total water consumed for tees on golf courses in France was 23 percent. Consistent with U.S. data in Table 1, golf course fairways and roughs in France represent the largest amount of total water use. Fairways and roughs are reported to make up 62 percent of the total volume of water used on golf courses.

In Denmark, average annual water use is not reported. However, Tobren Kastrup Petersen of the Danish Golf Union believes that approximately 20 percent of the golf courses in Denmark have fairway irrigation. In the U.S. 96 percent of the golf courses have fairway irrigation (GCSAA Land-Use Survey, 2015). Given that fairways typically make up more than 35 percent of the maintained turf areas, it is very likely that golf courses in Denmark use far less water than golf courses in other parts of the world.

Within golf courses and regions, the amount of irrigated acreage varies significantly. In the U.S., the average golf course irrigates 76 percent of its total maintained turf. In the Southwest and Upper West/Mountain regions, more than 96 percent of the maintained turf areas are irrigated (GCSAA Land-Use Survey, 2015).

5. Water Use Regulations

In many parts of the U.S. and other parts of the world, local, state or provincial governments regulate the amount of water that can be used on golf courses. In the U.S. many states limit the amount of water a golf course can use in a given day, month or year. However, these regulations are not always consistent within each area. For instance, the New Jersey Department of Environmental Protection allocated 9.2 acre-feet of water each month to a 36-hole golf course. Meanwhile, a 27-hole golf course located only 20 miles away, with very similar features and grasses, was allocated 159 acre-feet annually.

Mount Vernon Country Club in Virginia is another example of a course with a monthly allotment of water, which is challenging because of extreme conditions in the summer. [Mount Vernon Country Club is allocated 12.2 acre-feet per month.](#)

Cape Cod National in Massachusetts also has water-use regulations that impact their course. While other courses have annual or monthly water allocations, Cape Cod National is only allocated [100,000 gallons per day](#) – i.e., 0.31 acre-feet per day. This limit makes it very difficult to maintain healthy putting greens, tees, fairways and rough during hot and dry periods. A drought was simulated using the Water Budget Calculator to determine the amount of water that would be needed during the month of July. In

this simulation, actual monthly rainfall is adjusted to be 75 percent lower than the average rainfall. Table 10 illustrates the water shortfall that can be expected when a significant drought impacts Cape Cod National.

Table 10 The July water budget for putting greens, tees and fairways at Cape Cod National based on average rainfall of 2.5 inches and a simulated drought with a total of 0.5 inches.

Cape Cod National July Water Budget		
Average Rain - 2.5 inches	Simulated Drought - 0.5 inches	Monthly Water Allocation
	acre-feet	
7.6	10.8	9.5

The daily water allocation of 0.3 acre-feet per day and simulated drought illustrate that Cape Cod National will be forced to reduce overall water use by more than 14 percent. To reduce overall water use, Cape Cod National converted 15 acres of irrigated rough to non-irrigated natural areas.

In Arizona, arguably one of the most arid parts of the U.S., water regulations for golf courses do not yet exist. However, regulations require that any new golf course built in key areas of the state must not exceed 90 acres of irrigated turf for the entire golf course or 5 acres per hole. The size limits are in place to limit overall water use for golf courses.

During periods of drought, local and state governments implement mandatory water use regulations for golf courses. Arguably the most significant water-use regulations occurred during the [severe drought in California](#) between 2013 and 2015. In 2015, both San Diego and Los Angeles imposed a 15 percent mandatory reduction in water use along with restrictions on days and times golf courses can irrigate. The City of Santa Cruz experienced the most significant restriction, where a 28 percent mandatory cutback was imposed. During these mandatory restrictions, courses eliminated irrigation in the rough and practice facilities, while also reducing overall use to fairways. In some situations, some golf courses simply ran out of water and were forced to eliminate water use on their fairways.



Figure 7 During the severe drought in California between 2013 and 2015, this golf course was forced to eliminate irrigation to their fairways because they could not gain access to a reliable supply of water.

Water regulations are prominent in many non-U.S. countries as well. In Denmark, local municipalities allocate a specific amount of water that can be used for each golf course (Tobren Kastrup Petersen of the Danish Golf Union, personal communication).

France has created a three-tiered water restriction policy that predetermines the mandatory percent reductions in water based on the golf course feature. If level one drought occurs, golf courses must reduce between 15 to 30 percent of water used each week. Level two drought restrictions require a reduction of weekly water use by 50 percent including a ban on irrigating fairways. If a drought persists to level three, French golf courses are only allowed water putting greens (The French Water Charter, 2006).

6. Summary and Future Implications

Water is one of the most precious resources used to maintain golf courses around the world. There are certainly some golf courses that can maintain quality playing conditions without supplemental irrigation. Eighty-one percent of the world's golf facilities are located within the United States, United Kingdom, Japan, Canada, Australia, Germany, France, Sweden, South Africa and South Korea (NGF Golf Industry Report, 2018 Edition). Within these countries, most golf courses rely on supplemental irrigation to maintain quality playing conditions.

Projecting into the future, the cost of water expected to continue to rise. The availability of water is also expected to be a challenge. As a result, there will be golf courses that cannot afford to purchase water, secure reliable access to water, or both. In arid regions like the Southwestern U.S. and other parts of the world, the rising costs for water combined with an increase in overall use is particularly concerning.

Selecting the best turf species for the climate in which it will be grown is critical to water conservation. Influencing golfer perceptions on the value of playing conditions compared to aesthetics is also important. Simply reducing the amount of water applied to a given golf course will reduce water consumption, but this must be done carefully to ensure the turf remains healthy. If playing conditions deteriorate as a result of extreme conservation practices, overall revenue is likely to be negatively impacted. Thus, reducing water use on golf courses needs to be viewed as a long-term goal with incremental improvements over time. Many facilities are already making great strides with water conservation as evidenced by the reduction in overall water use at U.S. courses between 2005 and 2013. This trend is expected to continue in the future.

Water is an interconnected resource; communities, business and individual users depend on one another to ensure there is a sustainable supply for everyone. As golf courses work to develop sustainable water supplies, they not only improve their own viability, they are also playing their part in the societal effort to use water responsibly.

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