GOLF COURSE IRRIGATION

A NEW STUDY

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This study, undertaken over 1991-3 by the Department of Economics at the University of Leicester to assess the possible implications of climate change for the demand for water, concerns itself with both the public water supply (PWS) and direct abstractions (DA's), concentrating on those demands thought to be especially sensitive to climate.

Mr John Shildrick of the BTLIA helped in the compilation and distribution of a questionnaire to a sample of members of BIGGA, and five NRA regions in the south and east of England (Anglian, Southern, South West, Thames and Wessex) were targeted as the area most susceptible to water scarcity problems. A questionnaire was produced, the objectives of which were:

- to gain a factual picture of present golf course irrigation in terms of quantities, sources, uses and timing;
- to assemble information about annual water costs;
- to ascertain the possible response to a hypothetical doubling of water prices, from both PWS and DA's;
- to invite comments about the possible implications of global warming for course water use.

The questionnaire was sent to 298 BIGGA members and there were 89 returns (30%), covering irrigation activities on 114 golf courses: 95 18-hole (83%) and 19 9-hole (17%). The consensus estimate is that there were about 1600 golf courses in England and Wales in 1992. Assuming that half of these, 800, were located in the five NRA regions, returns represented 14% of courses in the south and east. The returns were from 21 counties, from Cornwall across to Lincolnshire; of these 35% came from Hertfordshire, Kent and Surrey.

Size of Golf Course Complexes

One of the 89 responses gave information about a 64-hole complex (14000 yards, in Surrey), one for a 39-hole complex (15000 yards, in East Sussex), nine for 36-hole complexes, and twelve for 27 holes. Of the remainder, six were for 9-hole courses and sixty for 18 holes. 18-hole courses ranged from 5300 to 7100 yards. Numbers of rounds played per year ranged from 2500 to 80000. The 44 18-hole courses providing use information revealed an average of 44250 rounds per year.

Irrigation Systems and Uses

Virtually all courses provided information of the type of irrigation system used. 76% made use of automatic systems with pop-ups, 12% had manual installations (with sprinklers working from hose-points), and 11% had mixed automatic and manual systems. Just one course had no fixed installation at all, and two reported travelling sprinklers in addition to an automatic system. As recently as 1987 it was reported in Turf Management that as many as 11% of courses had no form of irrigation system. However, the regional breakdown of that 11% is unknown.

Most courses (56%) irrigated both greens and tees in a climatically average year; a further 27% watered greens only, 7% irrigated greens, tees and approaches, and the remaining 10% watered fairways in addition.

Sources of Water

We obtained information on sources of irrigation water for 100 'courses', a course sometimes defined as a 27-hole or larger complex. 33 courses reported more than one type of source, 'types' being defined as • PWS (direct) • PWS (into storage first) •DA's (direct) •DA's (into own storage first).

The various possible source combinations are best summarised in the Venn diagram shown as Figure 1.

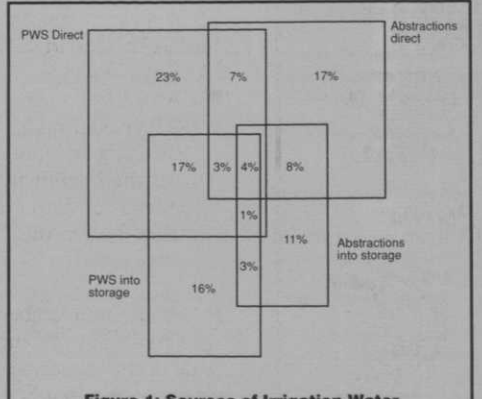

Figure 1: Sources of Irrigation Water for 100 Courses

This shows that 64% of courses made use of mains water (= PWS); of these 30% used PWS only directly, 19% PWS only for storage and 15% a mixture of directly and for storage. 54% of courses made use of direct abstractions; of these 24% used DA's only directly, 15% only for storage and 15% a mixture. 47% of courses used only direct supplies, of one sort or another, while 30% irrigated only from storage and 23% used a mixture of the two. Of the 39 courses using abstractions directly, 58% abstracted from boreholes and 42% from a river or lake.

Quantities of Water Used for Irrigation

We sought information from courses concerning the quantities of water used for irrigation over the years 1990, 1991 and 1992. Table 1 shows the resulting average figures. (In Table 1 and throughout this section we have omitted the data from two new courses which each reported using 10 million gallons in 1992.)

	No of courses[3]	1990	1991	1992
PWS-only courses				
Information for all three years (Q6)	16	3.97	3.77	2.85
1992 information only (Q6 & Q7)	39	*3.76*[4]		2.70
DAs-only courses				
Information for all three years (Q6)	9	3.32	2.86	2.23
1992 information only (Q6 & Q7)	27	*5.42*[4]		3.64
All courses				
Information for all three years (Q6)	40	6.36	5.07	3.79
1992 information only (Q6 & Q7)	84	*5.42*[4]		3.23

Table 1: Average Water Quantities Used on Courses[1] (Megalitres[2]/year)

Notes

(1) Strictly speaking data refer to responses received and therefore to complexes rather than courses. Virtually nothing is known about irrigation of separate components of > 18-hole complexes; we therefore apply our water use averages to courses, although average course use will be lower than the average complex use data listed in the table.

(2) To convert data to millions of gallons per year, divide figures by 4.546.

(3) Number of courses providing this information < 100% of sample.

(4) As explained in the text, the 1990 estimate in italics is derived by multiplying ➡ 8

the average 1992 course use (derived from the much larger number of courses reporting 1992 information only) by the 1990/1992 ratio for the courses reporting information for all three years. In this way, we make maximum use of the available information.

(5) Q.6 and Q.7 refer to question 6 and question 7 in the questionnaire.

Averages for 1992 were lower than earlier data for two reasons: the wetter weather in many parts of the south and east from June onwards, plus some restrictions on watering in earlier months. Without further study it is impossible to establish the extent to which the 1992 averages reflect restrictions-suppressed and therefore less than 'true' demands. We are thus inclined to label the '1992 information only' figures for 1992 as demands relating to a climatically 'average' year, and those for 1990 (in italics) as our best estimates for a 'hot, dry' year. 1990 estimates have been calculated by applying '1992 information only' to 1992 averages, the 1990/1992 relativity factors established from courses providing data for all three years.

Results: courses using only mains water reported using an average of 2.70 Ml (about 600,000 gallons) in 1992; we estimate the corresponding average for 1990 to be 3.76 Ml, 39% higher. Courses using only direct abstractions (from borehole, river or lake) irrigated an average of 3.64 Ml (800,000 gallons) per course in 1992, and 49% more than this in 1990. For all courses for which we have information, however, the estimated averages were 3.23 Ml (710,000 gallons) in 1992, and 68% more than this in 1990. For courses using both mains water and direct abstractions, the average quantity irrigated was higher: 5.50 Ml (1,210,000 gallons) in 1992. Based on the responses of only eight courses providing the relevant information, 53% of this was from the PWS and 47% from direct abstractions.

These average figures hide very skewed distributions; for all categories of courses the most frequently reported irrigation use was in 1992 between 200,000 and 400,000 gallons (0.91 to 1.82 megalitres).

If our sample of 114 courses is typical of the 800 estimated in the south and east, it is possible to estimate that total golf course water use in 1990 in the five NRA regions was 1601 megalitres from the PWS and 1618 megalitres from DA's (assuming that water taken from courses' own storage in that year was balanced by new water drawn from piped supplies or from abstractions). In other work undertaken for the DoE we have estimated total PWS industrial and commercial use in the south and east to be 1939 Ml/day in 1991 and total abstractions for all spray irrigation at 170 Ml/day. This therefore suggests that golf course irrigation use represented 0.23% of the PWS and 2.6% of total spray irrigation in 1990.

These percentage shares of course take no account of seasonal distribution. Because of the concentration of irrigation in May to August, golf course use may represent nearly 1% of total PWS industrial and commercial use over this period of the year.

Costs and Timing of Water Use

60% of respondents provided information on costs, and, as would be expected, water costs are significantly higher when there is reliance on the PWS. Annual costs for 24 PWS-only courses ranged from £400 to £5000, with an average of £2100; for 15 courses using only direct abstractions, costs ranged from £34 to £2350, with an average of £308. All 49 courses reporting cost data revealed average 1992 water costs of £1582. Turf Management had reported a 1986 figure of £645, suggesting an increase of nearly 150% over the last six years (although the regional difference in the surveys should be noted).

All 89 responses gave information on water use timing. Only ten clubs claimed to use water in April, and even then it was generally only 5% of annual use. 44 clubs used water in May (mostly l0% of annual use), but 80 watered in June and 87 in July. 68 irrigated in August and only l6 in September. The most common pattern was to use 10% of water in May, followed by 30% in June, 40% in July and 20% in August.

What if the Price of Water Were to Double?

It is likely, whether or not global warming occurs as predicted, that the real price of water will continue to increase significantly over the next decade. For PWS's this trend is already very clear, while for DA's incentive-based charging schemes are now the subject of public debate. We wished to sound out those responsible for course irrigation management as to their responses to a large increase in the price of water, and so we hypothesised a doubling of real price and presented various possible reactions for checking.

	No of courses responding	Yes	Maybe	No
Reduce water application (with existing techniques and resources)?				
PWS-only courses	37	30%	27%	43%
DAs-only courses	27	26%	19%	55%
Mixed courses	15	20%	27%	53%
All courses	79	27%	24%	49%
Construct more storage capacity?				
Courses with no storage	37	38%	27%	35%
Courses with some storage	44	39%	32%	29%
Courses with PWS and DAs	16	69%	31%	0%
All courses	81	38%	30%	32%
(Average water costs of 'all courses' groups)	(44)	(£2320)	(£1650)	(£1250)
Change irrigation technique/ technology?				
Present technology: automatic	62	40%	36%	24%
Present technology: manual + hose points	7	71%	29%	0%
Present technology: mixed	6	50%	17%	33%
All courses	75	44%	33%	23%
(Average water costs of 'all courses' groups)	(40)	(£1880)	(£2030)	(£810)

Table 2: Responses to Water Price Doubling in Real Terms

'Two respondents complained about recent trends towards sandy top dressings on greens and tees, with one complaining this had probably doubled water use on a particular course in the last seven years.'

The first question, about application (would a doubling in price 'affect the amount of water you apply with existing techniques and sources'?), is essentially about a short-run decision, implicitly assuming irrigation technique and equipment to remain unchanged. Only a quarter said they would cut back water use. Another quarter might, but half thought they definitely would not. These results are unsurprising; when courses are locked' into a certain irrigation system, there may well be only limited scope for economies in use. There were no significant differences in the average annual water costs of courses answering yes, maybe and no.

On the question of more storage, involving a once-and-for-all investment (and therefore a longer-term) decision, there was more interest. Overall, nearly 40% of the 81 courses responding thought they would be induced to construct more storage by a doubling of water prices and only one third thought they would not. Significantly, the present average annual water costs of 15 courses saying 'yes; more storage' were nearly double those of the 14 courses responding negatively. This accords with what economic analysis would predict. On the other hand, it was surprising that courses with no storage at present seemed no more interested in additional future storage than those already having storage facilities. Courses with mixed supplies, perhaps already alive to the dangers of water scarcity, were particularly interested in adding storage in the event of a large price increase.

Even more interest was expressed in changing irrigation techniques and technology if the price was to double in real terms. Nearly half of all courses registered a definite 'yes', and

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less than a quarter ruled this out. Again, economic factors seem to be at work here: the courses answering 'yes' or 'maybe' have at present average water costs more than twice as large as those registering a firm 'no'.

Further Information about Water Use

We invited greenkeepers to offer other relevant comments or information about course water use, especially in relation to the possibility of global warming, and 34 (38%) responded to this request.

Reactions covered a wide variety of aspects of course irrigation, with most frequent mention being made of the need to produce and encourage more drought-resistant grasses for a warmer climate and of current and future plans to construct reservoirs for on-course storage. Typically these provide storage of between 1.5–2.5 million gallons (7 to 11 megalitres), and one current application was described for a licence for two borehole abstractions, to fill two large course water hazards which would also serve as reservoirs for use when mains water was restricted or became too expensive.

Two respondents complained about recent trends towards sandy top dressings on greens and tees, with one complaining this had probably doubled water use on a particular course in the last seven years. Two more drew attention to greater use of courses leading to compaction and hence greater run-off and therefore even more water being needed. As though in response, another two reactions drew attention to the usefulness of tining turf regularly in the peak summer season to assist water penetration.

Two clubs pointed out the usefulness of misting irrigation in very hot weather and two more saw great virtue in the use of wetting agents (one recorded a 'dramatic reduction' in water use after using a 'hand hose with wetting agent gun plus a monthly blanket wetting agent').

The influx of U.S. irrigation technology was criticised ('different conditions and different budgets there'), but another respondent was pursuing US style plans to treat the effluent from the clubhouse and an associated hotel, hopefully to supply up to 4000 gallons (18000 litres) per day for course watering.

Other comments covered supply restrictions and the need to modify the game itself as well as balls and clubs for warmer conditions. Finally, three East Anglian greenkeepers claimed they would be unlikely to lose sleep over future water shortages induced by climate change since the same phenomenon would most likely ensure their courses were completely submerged by rising sea water!

■ **This is an abridged version of the document 'Golf Course Water Use', a 16 page study document by Paul Herrington and Martina Hoschatt. Copies are available from the University of Leicester, Economics Department, Leicester LE1 7RH, price £1.50 including postage – cheques, made payable to The University of Leicester, should be sent with order.**