Ten years of recycled water use at Big Canyon Country Club, Newport Beach, California

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Summary

To study the effects of recycled water on turf quality and management, we conducted a 10 year monitoring program on bermudagrass fairways and ryegrass roughs at Big Canyon Country Club. Recycled water was used on 14 fairways and roughs, and domestic water was used on 4. We found that:

- Monitoring soil chemistry on a regular basis was a powerful tool for identifying and addressing potentially hazardous changes.
- Significant increases in soil salinity, nitrogen and organic matter were the most important trends observed in areas irrigated with recycled water.
- To reverse these trends, these mangement practices were instituted:
  1. Periodic leaching to limit soil salts to less than 6 dS/m
  2. Switch to higher quality domestic water during the summer months to mitigate build-up of salts and nitrogen
  3. Aerification and sand topdressing to dilute organic matter and to allow increased leaching without loss of soil integrity
  4. Re-surfacing of fairways to remove excess organic matter
  5. Decreased rates of nitrogen fertilizer to accomodate the high levels of N delivered in irrigation water
- Although the focus is frequently on the quality of the recycled water, soil chemistry, soil physical characteristics and rainfall patterns were equally important in the successful use of recycled water on golf courses.
- A contract with the water provider should define water quality limits and delivery guarantees, and should cover the cost of management programs (cultivation, amendments, monitoring programs) adopted to prevent soil and plant damage from long-term use of recycled water.

Figure 1. Trends in accumulation of potentially damaging soil salts, 1999 - 2008. Green shaded areas represent desired values. With the exception of sodium, salts were kept below damaging levels through leaching programs and application of gypsum. Higher than desired sodium levels in both the recycled and domestic water areas indicates that additional gypsum applications and leaching will be required.

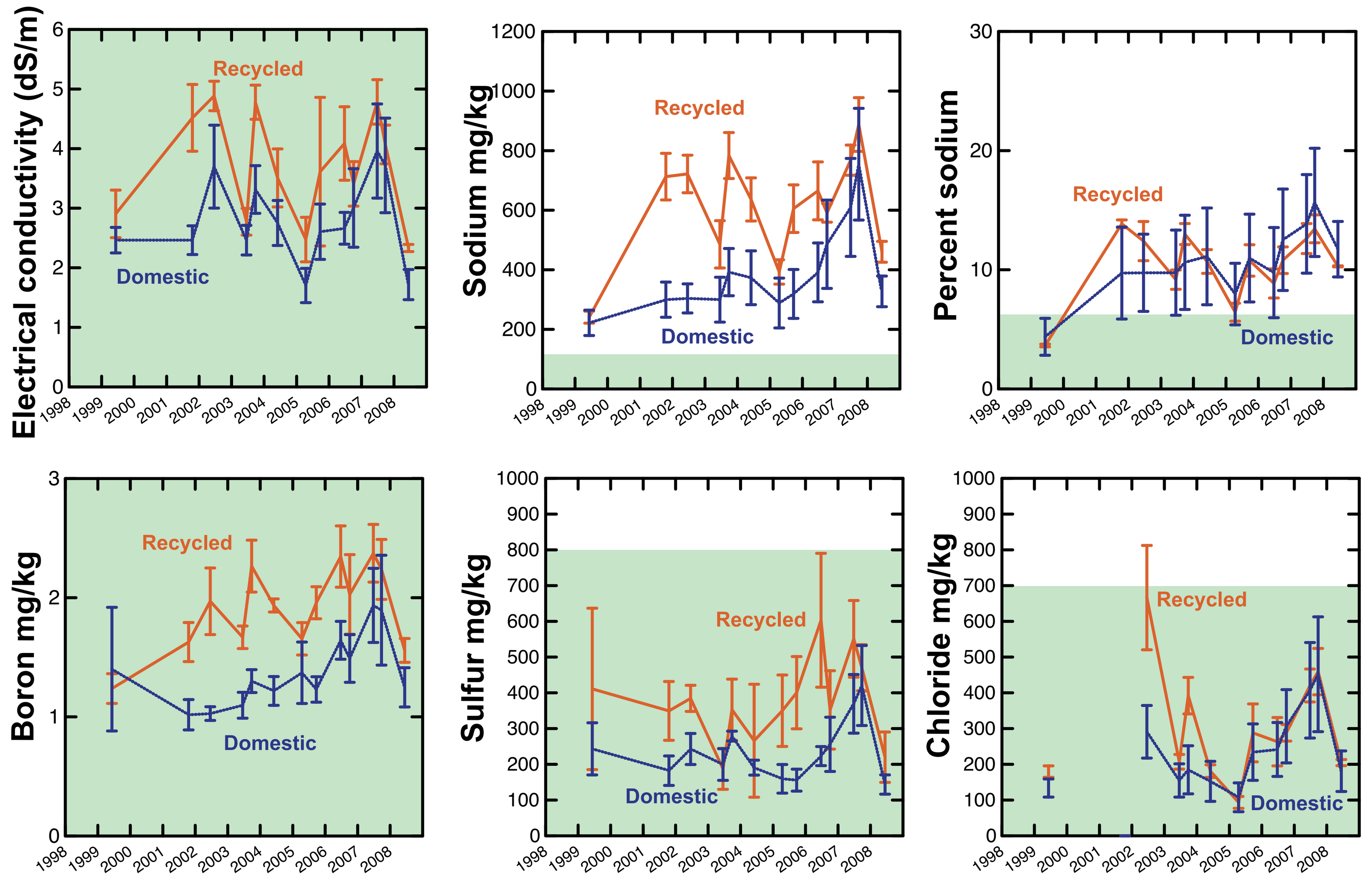


Figure 2. Trends in accumulation of nitrogen and organic matter, 1999 - 2008. Green shaded areas represent desired values. High levels of nitrogen in the recycled water (Table 1) led to excessive soil nitrogen and organic matter accumulation, and to damage to ryegrass roughs (Figure 3). This trend was reversed, beginning in 2004, through decreased use of nitrogen fertilizer, increased sand topdressing, and use of domestic water, with its almost negligible nitrogen levels, during the summer months.

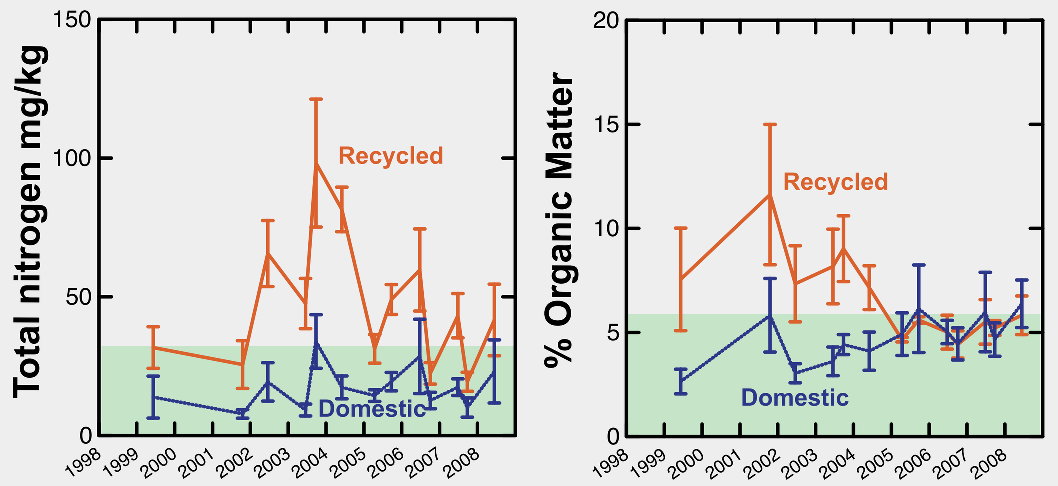


Figure 3. Turf damage due to high soil nitrogen levels. Damage to ryegrass roughs (lower left) was investigated by analyzing soil samples that varied in quality from 1 (dead turf) to 5 (moderate quality). There was a strong negative correlation between turf quality and soil nitrogen, with the highest quality turf exhibiting the lowest (<20 mg/kg) N levels, and the lowest quality turf exhibiting the highest (>140 mg/kg) N levels.

Figure 4. Trends in other soil chemistry factors, 1999 - 2008. Green shaded areas represent desired values.

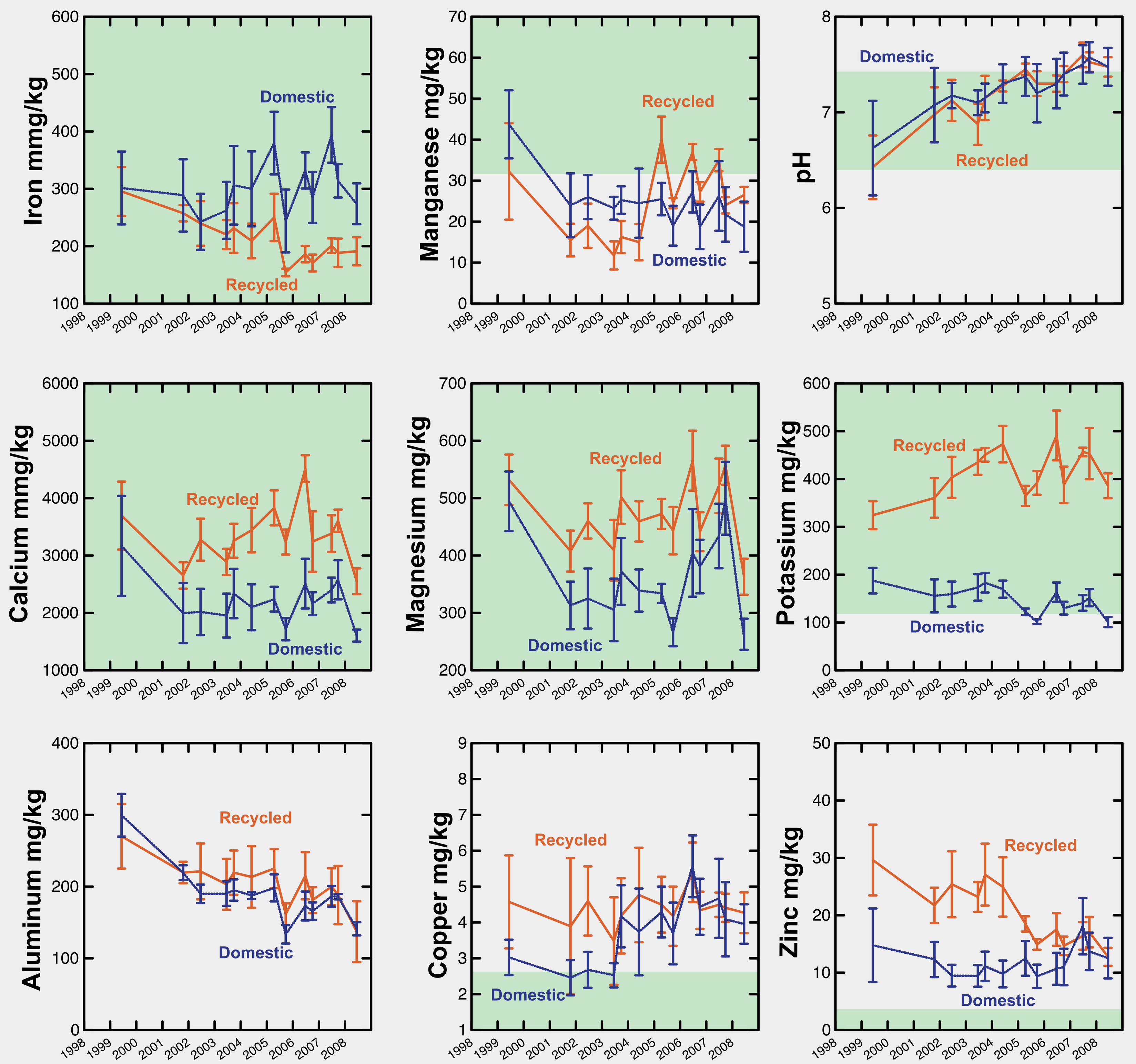


Table 1. Recycled water quality from Green Acres Treatment Plant, Orange County, CA. Note that contract limits were frequently exceeded (noted in red type), especially for bicarbonate levels. Nitrogen levels were not part of the original contract, but the 8.0 mg/L limit shown below represents our general guideline limit for irrigation water. It was also frequently exceeded.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Contract Limits	Domestic Water
Bicarbonate (HCO_3) mg/L	260	237	274	252	259	288	283	265	235	304	250	156
Total nitrogen mg/L	18.6	18.7	17.3	14.1	20.3	24.4	22.5	19.2	15.0	17.4	Not set (8.0)	0.2
Sodium absorption ratio (SAR)	5.0	4.9	5.7	5.3	5.4	5.1	5.2	5.6	5.6	5.5	5.7	2.4
Total dissolved salts (TDS) mg/L	844	780	842	757	839	758	730	805	628	725	900	625
Phosphate (PO_4-P) mg/L	1.5	1.3	1.2	0.9	1.0	0.3	0.3	0.1	0.2	0.8	Not set	0.1

Figure 5. Trends in the potential for phosphorus run-off, 1999 - 2008, as measured by phosphorus saturation index (PSI). Green shaded areas represent desired values. PSI=P mmol/kg/(Al mmol/kg+Fe mmol/kg), with all values determined by Mehlich III extraction.

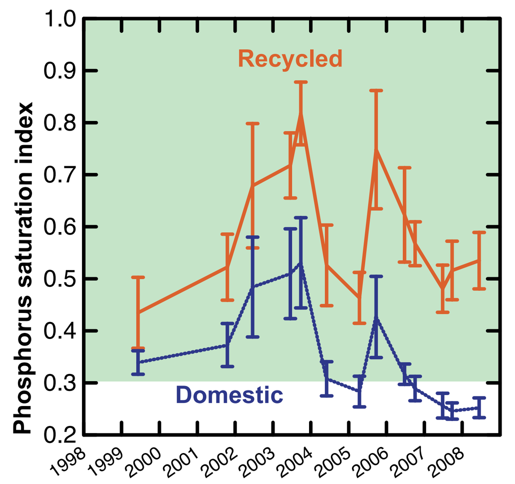
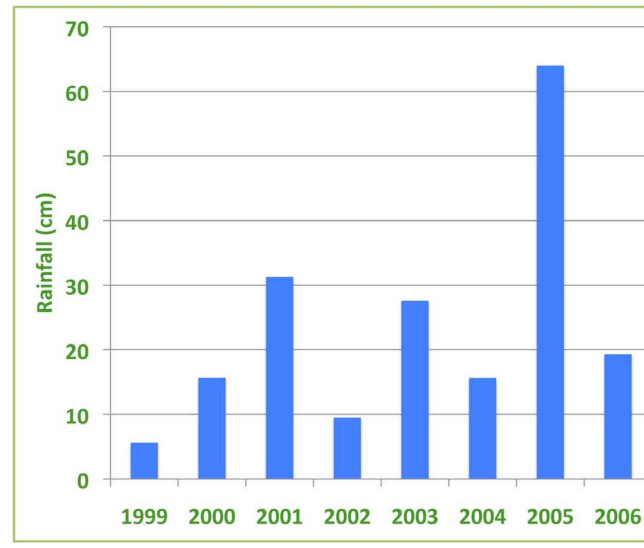


Figure 6. Rainfall for Newport Beach, CA, 1999 - 2008. Values shown are accumulations for the rainy season, which runs from September through May of the year indicated below. The timing and volume of the winter/spring rains are the driving force behind the zig-zag trends illustrated in the soil chemistry graphs shown here.



Methods

- On each sampling date, 8 soil samples were collected per fairway, to a depth of 10.2 cm, using a 3.2 cm diameter soil auger. These samples were combined to form one composite sample for each fairway.
- Water and soil analyses were conducted by Brookside Laboratories, New Knoxville, OH. Soil nitrogen was analyzed using 1M KCl extraction and a Lachat Quick Chem 8000 flow injection analyzer. Other elements were analyzed using Mehlich III extraction and ICP, and electrical conductivity was measured using a 1:2 soil:water dilution.

Acknowledgements

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