Temporal Variation in Golf Course Soil Chemistry: Case Studies from the Arid Southwest

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Temporal Variation

- Measurement of changes over time
- This study focuses on temporal variation in soil chemistry on irrigated golf courses in the Western U.S.
- Illustrates how temporal data can be used to provide important monitoring, predictive and diagnostic tools for turf managers

Parameters monitored:

- Soil salinity
- Soil phosphorous
- Soil moisture

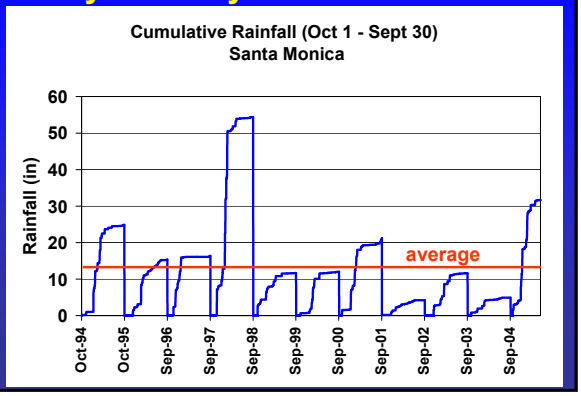
Time frames evaluated:

- Multiple years
- Within one year
- Within a few days

Tools used:

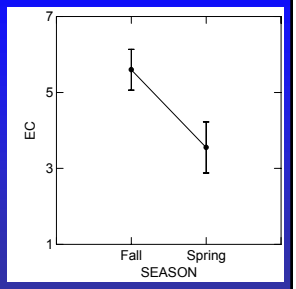
- Soil chemical analysis
- Mobile sensors (soil moisture, turf quality)

Multi-year analysis: rain vs. soil EC

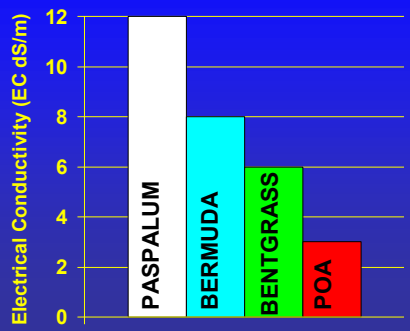


Multi-year analysis: rain vs. soil EC

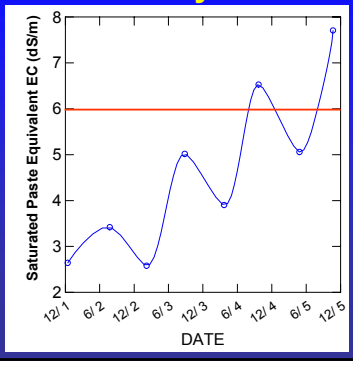
- Soil EC (dS/m or mmhos/cm) is salinity measure
- Salinity increases when dry, decreases when wet
- Periods of salinity-induced turf stress can be predicted, preventively managed



Turfgrass Tolerance to Soil Salinity (dS/m)



Monitoring and forecasting: salinity accumulation

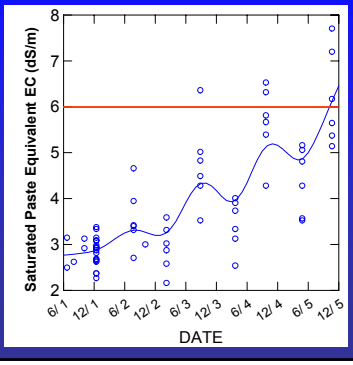


Los Lagos GC
San Jose, CA

Alan Andreasen, superintendent

Fairway 18 ryegrass recycled water

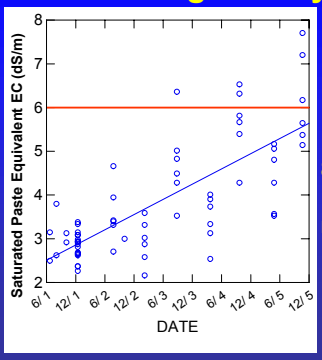
Monitoring and forecasting: salinity accumulation



Los Lagos GC
San Jose, CA

Multiple fairways

Forecasting salinity accumulation



Regression:
EC = 0.019 * days - 68

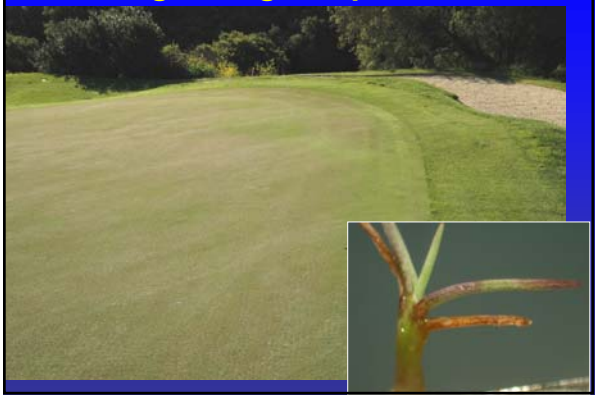
Date to 6 dS/m = 8/18/2006

r^2= 0.57 p<0.001

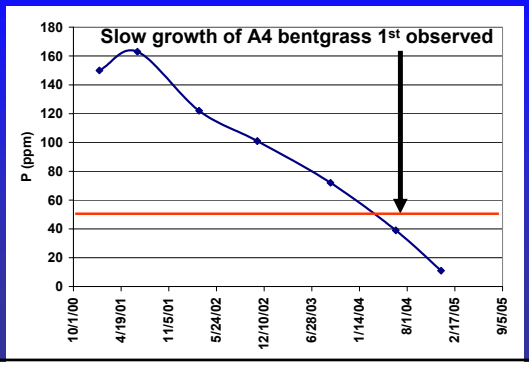
Days counted from 1/1/1900

Los Lagos GC

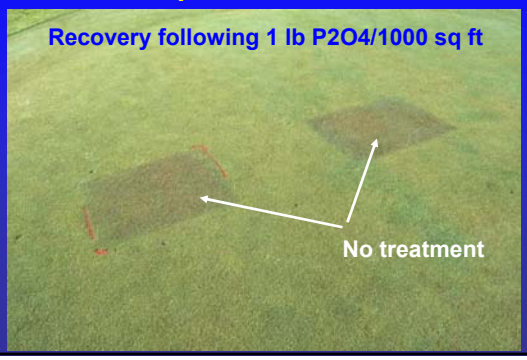
Diagnosing turf problems



Temporal changes in soil phosphorous Talega GC San Clemente, CA



Low P confirmed as culprit in replicated trials



Temporal-Spatial Variation:

Effect of irrigation on soil moisture levels, soil moisture distribution and turf quality

Barona Creek Inn Golf Club
Lakeside, CA Sandy Clark, CGCS

Temporal-Spatial Variation

Equipment:

- Geonics EM38 sensor (soil moisture)
- NTech NDVI red sensor (turf quality)

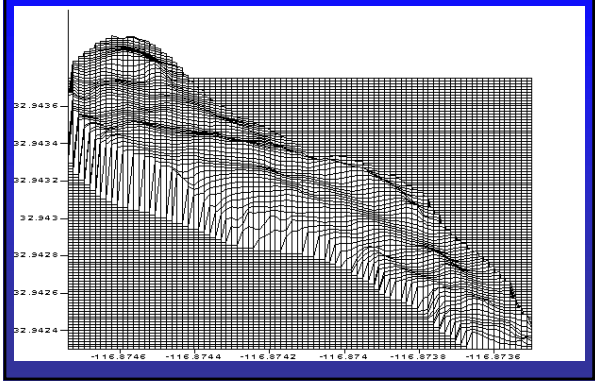
NDVI sensors for turf quality

- LED light sources
- Modulated a high frequencies
- Allows sensors to ignore ambient light
- NIR 770 nm
  Red 656 nm
  Green 525 nm

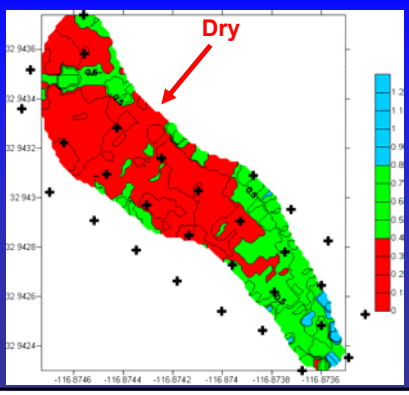
Temporal-Spatial Variation
Barona Creek Inn

- Three fairways evaluated
  - F 2: 20% less than standard irrigation (8 minutes)
  - F 8: normal irrigation - 70% of ETo (10 minutes)
  - F 9: 120% more than normal irrigation (12 minutes)

Altitude variations, Fairway 9



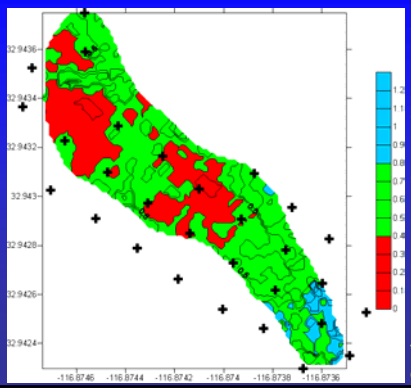
F9 soil moisture (dS/m) before irrigation



- Soil moisture variability
- Irrigation distribution patterns
- Effect of altitude on water movement

Geonics EM 38

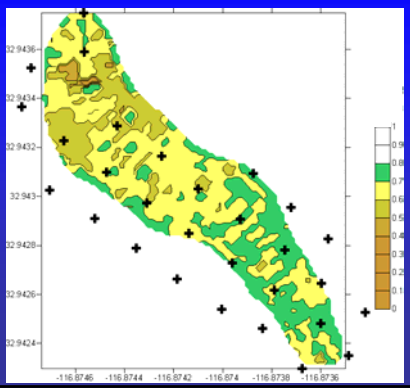
F9 soil moisture (dS/m) after irrigation*



- Overall increase in soil moisture
- Variability still high
- Irrigation management requires site-specific tune-up

*Two 12 minute cycles

F9 turf quality after irrigation* with NDVI-Red



- Turf quality correlates moderately with soil moisture
- Other factors (salinity, compaction) may be involved

*Two 12 minute cycles

Conclusions

- Monitoring temporal and spatial changes provides a powerful tool for turf managers
- Can help prevent accumulation of detrimental factors and deficits of essential nutrients
- Identifies irrigation, soil moisture issues
- Pinpoints location of stressed turf
- Allows site-specific diagnosis and alteration of management practices before turf damage results

The Future: Precision Management Practices

- Smart golf course equipment will aid superintendents in precision management of temporal & spatial variation
- Mobile sensors on mowers, other equipment will deliver powerful data
- Will allow water, fertility, cultural and pest management to be optimized
- New strategies for data management and interpretation will be needed

Cooperators

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Survey

- Soil kits are sent to golf course superintendents who collect and ship the samples to the lab.
- Eight ¾ - 1 inch cores to a depth of 4 inches are combined into a bulk sample for each area of the course sampled
- Historical results for each course are retained for future analysis and those results were used in this summary
- The database contains about 10,000 sample results by location and date

Analytical

- Soil analyses were conducted at Brookside Laboratories, New Knoxville, OH
- Sulfur and major cations/anions determined using Mehlich III extraction and ICP analysis Chloride was extracted using a 1:10 soil:water dilution analyzed using a Cl electrode and the potentiometric known addition method.
- Electrical conductivity was determined using a 1:2 soil:water extract

EC Conversion

- Soil salinity values are based upon a 1:2 water:soil dilution.
- Approximate saturated paste equivalent values were determined by comparing 1:2 values vs. saturated paste values and developing a regression equation:

Saturated paste equivalent = 2.1*(1:2 dS/m) + 0.5

$r^2 = 0.76, p<0.001$

- All EC values reported have been converted to saturated paste equivalents

Spatial-Temporal tools

- Soil electrical Conductivity evaluated using a Geonics EM38
- Turfgrass quality evaluated using an NTech NDVI (red) meter
- Spatial data collected using a Trimble AgGPS132 sub-meter GPS receiver
- B&B Electronics RS232 multiplexer used for interface with Tripod Data Systems Recon pocket PC
- Data acquisition and graphics using HGIS and ESRI ArcMap and Surfer software