

ITRI-Carbon

Pathways to a climate positive future for golf

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Popular Scientific Articles
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ITRI Carbon: Pathways to a climate positive future for golf

Climate change is the most urgent environmental crisis of our time, and the golf industry, as with all sectors of society, has a role and responsibility to address this crisis. In March 2026 a 3-year STERF, R&A and USGA funded project began to benchmark golf course soil carbon stocks and understand maintenance emission through life cycle assessment. This ITRI project will improve understanding of the overall carbon balance of golf courses, and establish if they have a positive or negative environmental impact.

The International Turfgrass Research Initiative (ITRI) aims to support projects with global significance. Therefore, it is exciting that this project will include golf courses from seven climatic regions: New Mexico (USA), Scotland, Germany, Sweden, Japan, Brisbane (Australia) and Cairns (Australia). Soil samples will be taken from two golf courses in each region and analysed for soil organic carbon (SOC). We will use this to calculate the current SOC stock of the golf courses, and es-

The International Turfgrass Research Initiative, ITRI, is a cooperative effort by STERF, The R&A and USGA to fund globally relevant research that will advance scientific knowledge and turfgrass management. Research priorities are: Integrated Pest Management, Water Conservation, Climate (Carbon Balances) and Biodiversity and Landscape Perspective.



Figure 1. Soil sampling at Östersund-Frösö Golf Club. Photo: Robert Kempster



Figure 2. Soil core assessment at Östersund-Frösö Golf Club. Photo: Elisabeth K. Larsen

timate likely sequestration rates using the estimated soil carbon change from the previous land use. The project aims to encourage golf course managers to measure their soil carbon to understand their own carbon balance by developing a robust soil sampling method.

We will also conduct life cycle analysis, or carbon foot printing, of the golf course maintenance emissions through annual surveys. These surveys will include questions on energy, fuel, pesticide, water and fertiliser use, as well as maintenance activity and waste management. As it can be difficult and time consuming to collet this type of data annually, we hope to develop data collection methods to improve the accuracy and ease of recording emissions in various ways. This includes fuel and machine tracking (Figure 3) in association with The Toro Company and "as-it-happens" data entry supported by Reddibo. The aim is to use this data to help us identify the most effective strategies and provide recommendations to reduce golf maintenance emissions.



Figure 3. The Toro Company fuel tracking system. Photo: Josh Friell

Why measure soil carbon?

Golf course turfgrass surfaces sequester or capture carbon from the atmosphere through photosynthesis and assimilate this carbon into its plant tissues (leaves and roots). Turf continuously sheds material over time, and this is broken down by soil microbes. Some of this carbon is returned to the atmosphere (CO_2) and some is turned into more stable organic compounds that remain in the soil as soil organic matter. Soil organic carbon (SOC) is the carbon part, approximately 50-60%, of this soil organic matter. We want to benchmark SOC golf turfgrass stocks so that we can return a number of years later and calculate actual SOC sequestration on golf courses.

Golf course superintendents around the world are increasingly enquiring about the sequestration value of their turfgrass, often asking, how much carbon does my golf course sequester? Unfortunately, this question can currently only be answered with a low degree of confidence due to the methods used. There are various methods to estimate soil carbon sequestration, but previous methods rely on many assumptions, meaning our current understanding is insufficient. The geographical range of these studies is also limited and will be expanded through this project (Figure 4). The longitudinally method is considered the most reliable and gives actual carbon sequestration by taking two samples at the same location at two time points, at least 5 years apart. However, to date there are no studies that estimate golf course SOC sequestration using the longitudinal method, likely due to the time required. SOC stocks on golf courses are not only a function of age but also of soil texture and the site's initial SOC stock prior to golf course construction. Therefore, it is important to measure these soil characteristics and repeat future sampling in the same locations.

How to calculate golf emissions?

Golf courses also emit greenhouse gases (GHGs) through both direct and indirect energy consumption used for maintenance. Indeed, previous research indicates that GHG emissions are more important in determining the overall carbon balance of a golf facility than SOC sequestration (Bekken and Soldat, 2021). However, accurately estimating GHG emissions from golf course maintenance is chal-

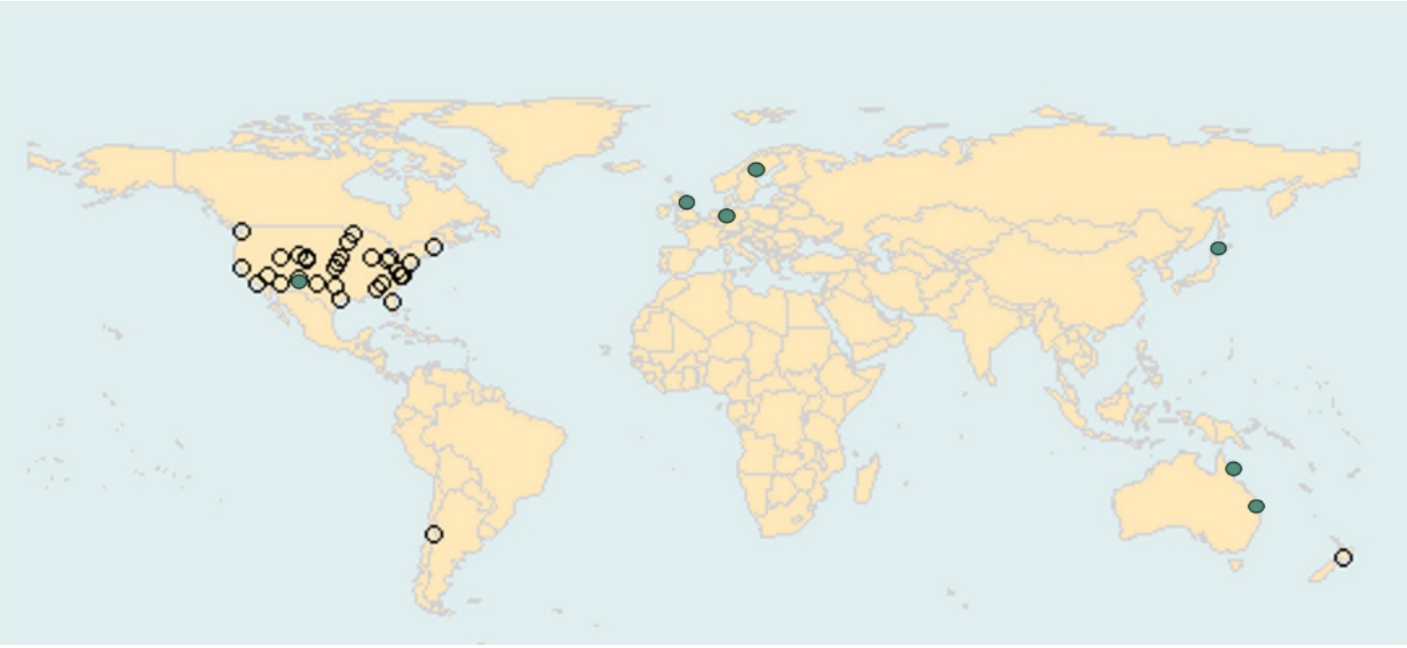


Figure 4. Expanding the geographical range of turf grass carbon sequestration data. Adapted from Phillips et al., 2023. ITRI carbon golf course locations shown as green dots, previous turf soil carbon studies shown with black circles.

lenging. In addition to direct emissions on golf courses, such as machine use, golf courses use a wide variety of resources and materials, which emit different amounts of GHGs based on how they are produced, transported to the facility, and used on the golf course. Previous attempts to estimate golf emissions do not always capture the full range of emission sources and are geographically limited. The key to accurately calculating emissions are the conversion factors used to standardise relative impacts from different sources. Previous studies often use outdated emissions factors, meaning that our current estimates of golf course GHG emissions could be significantly improved.

Progress so far...

We have worked to develop a soil sampling protocol that is optimised for golf courses. A network of sampling equipment has also been established in America, Europe and Australia that can be used for future SOC sampling. Soil sampling has already taken place at 10 of the 14 golf courses on the project. These samples are now being analysed for different forms of soil carbon, texture, pH and nitrogen. This will allow us to benchmark current golf course carbon stocks and estimate likely carbon sequestration since construction.

A detailed life cycle analysis survey has been developed and distributed to the golf courses, and data will continue to come in. The project team has been working with a leading LCA consultant for an in-depth overview of current emissions factors relevant to golf maintenance.

The Toro company data trackers have been installed at two golf courses in Minnesota and Bris-



Figure 5: Soil sampling at Glasgow Golf Club. Photo: Robert Kempster

bane, and we are continuing to monitor this data remotely, with almost 2000 hours of machine time logged. The Reddibo team have begun work on the advanced tracking application that improves the ease and accuracy of emissions data collection.

References

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Phillips, C. L., Wang, R., Mattox, C., Trammell, T. L. E., Young, J., & Kowalewski, A. (2023). High soil carbon sequestration rates persist several decades in turfgrass systems: A meta-analysis. Science of the Total Environment, 858, 159974. https://doi.org/10.1016/j.scitotenv.2022.15997

ITRI-Carbon:

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Period:

2026 to 2028

Objective:

Deliver a globally validated soil sampling protocol for golf course SOC stock determination. Deliver next generation LCA model for quantifying GHG emissions in golf course maintenance and provide a clear guide for the most effective GHG emission reduction pathways for golf course maintenance operations.

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