Considering Carbon Emissions and Sequestration in Turf Grass and Amenity Management

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CO_2 TURF GRASS OVERVIEW, SUSTAINABLE LANDSCAPE MANAGEMENT, CARBON AUDIT;

Introduction

The carbon cycle, greenhouse effect and carbon sequestration, are terms that are becoming part of our day to day vocabulary. What bearing do they have on the amenity market and how can we as amenity managers reduce the effects that our activity has on the environment. The aim of this study is to explain and clarify the terminology that is used and to give to the industry a common basis for further discussion. It also shows how that the use of turf grass can also have a positive effect on the environment in sequestering as much CO_2 as trees. With carbon taxes just around the corner, the industry needs to quantify and compare its sequestration - emission ratios. Different grass seed production methods can also effect the carbon footprint of the activity.

Trees and grasses as with all other chlorophyll based plants use photosynthesis to convert $C0_2$ into organic compounds (sugars, lignin's …) using sunlight. In trees, the carbon is locked in the trunks as lignin with a ratio of 75 : 25 above ground to below ground biomass for hardwoods, 80 : 20 for conifers. (IPCC 2003), whereas in grasses the woody parts of the plants are the fibrous roots, underground and invisible. Grass captures the carbon (mostly in the roots) and the soil stocks it. Denser, deeper, faster growing grass root systems will produce more organic matter and hence more carbon.
The above ground to below ground biomass of turf grasses is the opposite of forests with only 10 – 30% above ground and 70 %- 90% in the soil, the variability being accounted for according to the height of cut.

How do tree and grass species vary in their capacity to sequester carbon? And how do grass varieties also vary ?

The Tufts University has published figures for carbon capture in forests. It shows a range of 2 – 11 tons CO_2 / ha. yr depending on age and species[1].

HOW MUCH CO_2 IS CAPTURED & SEQUESTERED BY GRASSES?

Turf grass leaves contain 3.5 – 6 Mg / ha. when cut at 5 cm. depending upon the species. (Topgreen 2009). They also contribute to the soil organic content when clippings are not removed.

On the basis 1,5kg of dry root mass per m² Stypinski P. Mastalerczuk G. (2002),; 26.95 Mg of CO_2 eq. is stocked in the roots in meadows.. The IPCC - Intergovernmental Panel on Climate Change - uses a default conversion figure or dry organic matter to carbon of 0.49. Other figures quoted in research papers quote a slightly higher conversion figure of 0.55.

Research data undertaken by Topgreen on turf grasses indicates a fourfold difference for root carbon content in five different amenity grass species varying from 11.5 to 47 Mg CO_2 /ha. eq

We can best visualise the root mass of grasses as a reservoir of carbon with a probable maximum content after which the carbon overflows into the soil where it is decomposed into humus. In addition to roots, grass clippings and leaves are also transformed to humus.

Carbon sequestration into the soil is thought to increase annually and stabilise after about 50 years although it may not have a maximum holding capacity in certain climatic conditions. If the organic matter does not decompose it may build up as peat deposits, this is what happens on moorland. The build up of thatch on sports grounds which are subject to compaction, sterile and anaerobic conditions is a parallel non biodegradable process whose rapid formation is easily observable.

Research relating to meadow and pasture grassland for soil carbon sequestration has compared different management regimes. The use of improved grass species is rated favourably with up to 12.33 Mg CO_2 /h./ yr. being sequestered into the soil, Conant et al. (2001)

Can we assume managed turf grass to be denser with a greater root biomass? How much carbon can be sequestered into the soil.?

Research show annual sequestration rates of 4.7 – 20.5 Mg / CO_2 / ha. year (Topgreen 2009) depending on the turf grass species, but how different soil textures interrelate with carbon sequestration for a particular variety is not yet known.

So when we compare grass based carbon sequestration to forest carbon sequestration it appears that grasses perform just as well if not better. So, why aren't grasses and soil equal to trees regarding international carbon credit financing following the Kyoto protocol negotiations of 1997 and made operational through the UNFCC (United Nations Framework Convention on Climate Change)?
The answer for the moment appears to be related to:

- Monitoring and verification procedures are simpler for trees,

Soil organic matter is not considered as stable as trees[2]
A sceptic may well compare the risk of forest fires compared to accidentally ploughing up a park !!

CARBON EMISSIONS

Current work being undertaken by the Société Française de Gazons in Paris is looking at the emissions side of different amenity grass maintenance regimes, golf courses, football pitches, parks, motorway embankments etc. in a national wide study (Commissionne Carbone – Empreinte Carbone des Gazons durant leurs Phases d'Entretien).

As an agricultural crop, grass seed production emits CO_2 through the energy that is consumed; it needs to be fertilised, harvested, dried, cleaned, processed, packaged and transported. In order to reduce its environmental impact DLF Trifolium in Denmark produces its grass seed with 5 year rotational cycles alternating 3 years of grass seed harvesting with nitrogen fixing clover and a wheat crop, thereby reducing fertiliser and pesticide requirements, (H. Wood 2009).

Reasearch by R. Sahu (2008) indicates that the net benefit of sequestration is approximately four times greater than the emissions due to mowing. Whilst the later is may not be representative of a full carbon footprint of a turf grass maintenance (which should include life cycle assessments of machinery, seed production, Green House Gas emissions through fertiliser production etc.,) it is an encouraging indication that turf grass may be a net 'sequesterer' of carbon.

The selective use of grass varieties for carbon sequestration is about to become an environmental factor to be taken into consideration when choosing a grass mixture alongside disease resistance, wear and drought tolerance, perennity, etc.

The potential environmental gains of carbon sequestration in selected grass varieties also indicate exciting times ahead for seed breeders and landscape managers. By comparing the sequestration of carbon through grasses with the emissions related to grounds and landscape maintenance, amenity managers can now optimise their practices, by taking carbon into account. Whereas most human activities (industry,

transport, agriculture…) can only measure carbon emissions, the turf grass industry can quantify its carbon sequestration and perhaps offset future carbon taxes.

The results on carbon sequestration may be the start for orientating more research on grass roots. One can imagine grass varieties being bred and selected for other environmental benefits, such as drought resistance through root depth or water storage capacity, fibrous root matting for erosion control, micro-clover grass mixes for symbiotic nutrient supply reducing the need for nitrogen fertilisers, soil - root matrixes for increased soil biodiversity, surface water filtering or the breakdown of urban pollutants…

The research work on Carbon in grasses has been financed by Topgreen SAS, Les Alleuds, France.

References

[1] http://sustainability.tufts.edu/?pid=74
[2] Forwarded internet correspondence, originating from Professor Jacqueline Rowarth, Massey University, N.Z. 30/11/09
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