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Sub-tropical freshwater storage catchments: major greenhouse gas sinks?

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The relatively unstudied catchments and freshwater storages of the sub-tropics represent a potentially important gap in understanding global greenhouse gas cycling. The low number of studies may bias attempts to include this region's contribution to global greenhouse gas cycling, as very few studies have examined the major drivers behind terrestrial and aquatic greenhouse cycling in such sub-tropical areas. In addition, the uncertainty associated in quantifying greenhouse gas emission rates is relatively unknown. This information is crucial to determine whether freshwater storages and their associated catchments are net sources or sinks of greenhouse gas. Here, we present a greenhouse gas audit of the catchment and freshwater storage of Little Nerang Dam to determine the greenhouse gas status of the system as a whole.

Little Nerang Dam is a sub-tropical freshwater storage located in Southeast Queensland, Australia. The catchment is in a relatively pristine condition with over 85% native forest remaining dominated by carbon dense Eucalypt species trees. Aquatic surface area is approximately 0.5 km2 in contrast to the terrestrial surface area of 35 km2. This system is an ideal model to investigate drivers behind greenhouse cycling in a relatively undisturbed catchment. A comprehensive field survey was conducted to estimate the major pools of carbon including terrestrial above and belowground fractions as well as the aquatic sediment and water column fractions. Greenhouse rates of emissions and sequestration were monitored over an annual cycle; parameters included tree growth rates, soil respiration, forest litter fall rates and aquatic methane and nitrous oxide fluxes.

Results demonstrated the terrestrial carbon pool exceeded the aquatic pool by at least 2 orders of magnitude. When emission and sequestration rates were expressed as CO_2 equivalents per unit area catchment sequestration was approximately double that of catchment and storage emissions. When rates were corrected for total surface area of terrestrial and aquatic zones, annual catchment sequestration rates were more than 2 orders of magnitude higher compared with catchment and storage emissions. These data suggest subtropical forested catchments to be a major sink of greenhouse gas.

Catchment sequestration was dominated by tree trunk growth rates and the major uncertainty associated in quantifying rates was initial tree size with larger size sequestering significantly higher amounts. Catchment and storage emissions were dominated by aquatic methane fluxes when expressed per unit area, however, when corrected for total surface area soil respiration exceeded aquatic methane fluxes by at least one order of magnitude. The major uncertainty associated with aquatic methane fluxes was in identification and intensity of ebullition zones where 2 to 7% of the aquatic surface area emitted over 97% of the total flux. The ebullition zones were consistently found in shallow depositional areas adjacent catchment inflows where substrates were dominated by forest litter. This audit greatly improves our understanding of both the drivers behind greenhouse gas cycling in sub-tropical freshwater storages and catchments as well as identifies the major sources of uncertainty in quantifying greenhouse cycling rates in these systems.