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The net GHG (CO_2, CH_4 and N_2O) footprint of a newly impounded subtropical hydroelectric reservoir: Nam Theun 2

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There is a rising concern over the contribution of hydroelectric reservoirs to global anthropogenic greenhouse gases (GHGs) emissions. We present here the first comprehensive assessment of GHGs footprint associated with the creation of the Nam Theun 2 (NT2) hydroelectric reservoir in subtropical region of the Lao People's Democratic Republic. This assessment is the results of a monthly monitoring that have been conducted over 4 year (2008-to date). The carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) sources and sinks were quantified before and after impoundment, which began in May 2008.

Before impoundment, the landscape to be flooded was a sink of carbon dioxide (-73 $\pm$ 225 Gg CO_2eq yr^{-1}), roughly neutral in terms of methane (7 $\pm$ 11 Gg CO_2eq yr^{-1}), and a source of nitrous oxide (345 $\pm$ 158 Gg CO_2eq yr^{-1}). After impoundment, total CO_2 and CH_4 emissions increased and N_2O emissions decreased. For the year 2010, CO_2 (791 $\pm$ 54 Gg CO_2eq yr^{-1}) and CH_4 (644 $\pm$ 124 Gg CO_2eq yr^{-1}) contributed equally to the total gross GHG emissions from NT2 (54 and 43% for CO_2 and CH_4, respectively) whereas N_2O contributed only 3% (47 $\pm$ 29 Gg CO_2eq yr^{-1}). The GHG emissions remained constant in 2011. Our results indicate that most of the GHG (around 90%) were emitted from reservoir water surface and the drawdown area, and only 10% were emitted by degassing at the turbines and from diffusive emissions downstream of the turbines and the dam, a percentage lower than reported for other hydroelectric reservoirs.

With a total emissions of 1482 $\pm$ 207 and 1298 $\pm$ 200 Gg CO_2eq yr^{-1} for year 2010 and 2011, gross NT2 emissions are about an order of magnitude higher than pre-impoundment emissions (276 $\pm$ 393 Gg CO_2eq yr^{-1}). With a net GHG emissions of 1203 $\pm$ 601 (2010) and 1022 $\pm$ 594 (2011) Gg CO_2eq yr^{-1}, and an annual power generation of about 6 TWh, GHG emission factor equal to 0.20 (2010) and 0.17 (2011) Mg CO_2eq MWh^{-1} for NT2 which is up to five times lower than the emission factor of a thermal power plant (ranging from 0.44 to 1.05 Mg CO_2eq MWh^{-1}). Since emissions are supposed to decrease with the age of the reservoir, 2010 emission factor probably corresponds to the maximum value that would be reached for this reservoir. Work is in progress to predict the trends of GHG emissions over the projected life span (e.g. 100 years) of the reservoir. Integration of net GHG emissions at this time scale will allow a better comparison of emission factor of hydropower generation with other alternate energy sources.

Keywords: Net GHG emissions, subtropical hydroelectric reservoir, Nam Theun 2