

Net Greenhouse Gas Emissions from Reservoirs – New Guidance for Measurements and Modeling

Jukka Alm

Finnish Forest Research Institute

Possible reasons for high emissions

- Availability of nutrients and organic matter, hypoxia, high temperature

 – CH₄
- Excess nitrogen, e.g. from agriculture or community sewage
 - $-N_2O$
- Availability of organic (or inorganic) carbon $-CO_2$

Land use change – What the atmosphere sees?

- Impoundment of a landscape replaces terrestrial GHG fluxes with aquatic fluxes
- Managed land \rightarrow Reservoir
 - Forest
 - Cropland
 - Settlement
 - peat extraction
- Unmanaged land \rightarrow Reservoir
 - River, lake, wetland,

An example of pre-impoundment: A planned reservoir







Evaluate both GHG emissions and removals

- Managed forest is a CO₂ sink, but
 - Peatland forest soil is a source of CO₂, N₂O?, and DOC, POC
 - Drainage ditches are sources of CH_4 , DOC and POC
- Peat extraction area is a source of CO_2 , CH_4 , and N_2O
- Undrained peatland is a CH₄ source, CO₂ sink
- Croplands and grasslands can be a source of $\rm CO_2$ and $\rm N_2O$
- Lakes (and rivers?) are CO₂, CH₄ (N₂O?) sources

Reservoir may also be GHG neutral, or net sink of GHG's

- Possible removals
 - Carbon burial in sediment
- Reductions in landscape GHG emissions
 - Natural wetlands (CH_4 emissions, but also CO_2 sink)
- Channelling terrestrial fluxes similarly than natural watercourses
 - Net heterotrophic, emit CO₂ released by decomposition in upstream ecosystems

Help in determining the reservoir net GHG emissions?

- A full-scale research GHG-measurement programme is very expensive
- Reservoirs or new projects with high potential to GHG emissions should be identified
 - In order to efficiently manage the high emission situations
 - Low emission potential projects reguire less intensive assessment

Guidance for field measurements and the net emission approach

 IHA: GHG Measurement Guidelines for Freshwater Reservoirs

http://www.hydropower.org/ghg/guidelines/

 IEA: Guidelines for Quantitative Analysis of Net GHG Emissions from Reservoirs

 Volume 1

http://www.ieahydro.org/

IEA/Hydro-Guidelines and the Brazilian project (measurements and modeling)



Measuring gross emissions



The concept: Net emissions

- NET = POST PRE impoundment emissions
 Makes the situation even more complicated
- But, are all emissions due to reservoir management?
 - Other anthropogenic emissions should be accounted to the causing activity. Thus,

• NET = POST – PRE – UAS (Unrelated Anthropogenic Sources)

All relevant gases are considered

- Carbon dioxide, CO₂
- Methane, CH₄
- Nitrous oxide, N₂O

• Not all of them might be important in all cases

System boundaries include both upstream watershed and downstream reach



Unrelated Anthropogenic Sources?



Catchment scale assessment

- Upstream watershed contributes to fluxes of nutrients and organic matter
 - Influence in GHG formation in the reservoir
 - May be product of other human activity
- Extra emissions should be accounted to the producer
- In some cases the reservoir may facilitate the emissions together with UAS!
 - When hypoxic conditions are created in artificial but not in natural watercourses

Modeling of GHG emissions

New Guidelines in development

– IEA/Hydro and IHA collaborate

- Guidelines for Quantitative Analysis of Net GHG Emissions from Reservoirs
 - Volume 2, Modeling

Exploration



Forest KNOWLEDGE Well-being KNOWLEDGE

Thank you