



A. TREMBLAY · L. VARFALVY  
C. ROEHM · M. GARNEAU  
Editors

# Greenhouse Gas Emissions – Fluxes and Processes

Hydroelectric Reservoirs  
and Natural Environments

 Springer

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# Greenhouse Gas Emissions - Fluxes and Processes

Hydroelectric Reservoirs and Natural  
Environments

With 200 Figures

 Springer

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## Foreword

In a time when an unquestionable link between anthropogenic emissions of greenhouse gases and climatic changes has finally been acknowledged and widely documented through IPCC\* reports, the need for precise estimates of greenhouse gas (GHG) production rates and emissions from natural as well as managed ecosystems has risen to a critical level. Future agreements between nations concerning the reduction of their GHG emissions will depend upon precise estimates of the present level of these emissions in both natural and managed terrestrial and aquatic environments.

From this viewpoint, the present volume should prove to a benchmark contribution because it provides very carefully assessed values for GHG emissions or exchanges between critical climatic zones in aquatic environments and the atmosphere. It also provides unique information on the biases of different measurement methods that may account for some of the contradictory results that have been published recently in the literature on this subject. Not only has a large array of current measurement methods been tested concurrently here, but a few new approaches have also been developed, notably laser measurements of atmospheric CO<sub>2</sub> concentration gradients. Another highly useful feature of this book is the addition of monitoring and process studies as well as modeling.

Indeed, the prospect of mitigation measures and of better management practices of aquatic environments requires an in-depth knowledge of processes governing GHG production and an exhaustive knowledge of those involved in the global carbon cycle. Here again, the present volume provides new information and highly original research projects on the carbon fate in aquatic systems. Most compartments of the carbon cycle in such systems have been investigated using state-of-the-art methodologies. The roles of primary production and of the bacterial and photochemical degradation of organic matter are carefully addressed as well as the fate of soil-derived dissolved organic carbon (DOC) in the aquatic environments. The degradation site and rates of DOC seem to be key elements in this respect.

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\* International Panel on Climate Change (see [http:// www.ipcc.ch](http://www.ipcc.ch))

As illustrated in the volume, the present state of knowledge does not permit the unequivocal conversion of "gross GHG emissions" of impounded basins into "net GHG emissions," mainly due to uncertainties concerning the fate of terrestrially derived DOC and of soil-atmosphere budgets. In other words, GHG emissions resulting strictly from the impoundment of terrestrial and aquatic ecosystems, particularly in high latitude environments, are certainly lower than the measured emissions, but are still difficult to assess.

As a matter of fact, the focus on the boreal forest and equatorial systems described here is interesting in the way that it provides information on the two end-members of large aquatic bodies with respect to their GHG emissions into the atmosphere, from primarily CO<sub>2</sub>-emitters in the Boreal domain to primarily CH<sub>4</sub>-emitters in the equatorial forest domain. More concern, indeed, arises from the role of the latter in the capture of atmospheric CO<sub>2</sub> through primary production and its replacement by the much longer residence time of CH<sub>4</sub>.

Nevertheless, despite the contributions of nearly 60 co-authors, this volume has well-balanced content and a coherent view of GHG production and emissions in terrestrial water bodies. The efforts of the editorial committee have been instrumental in this respect. However, one specific advantage of the involvement of such a large group of scientists in such a hotly debated topic cannot be ignored: a consensus among so many specialists is likely to provide ground for policy decisions.

It is very much to the credit of Hydro-Québec and its partners that supported most of the studies illustrated in the present volume that they have devoted so much time and effort to studying GHG emissions from hydroelectric reservoirs. Indeed, from the strict viewpoint of Hydro-Québec, this problem is relatively less serious than for many other energy producers, since hydropower from boreal forest reservoirs remains one of the most cost-effective processes with respect to GHG emissions.

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## Glossary

nm:	nanometer
UV:	Ultra-violet light
DOM:	Dissolved organic matter
DOC:	Dissolved organic carbon
DIC:	Dissolved inorganic carbon
Gross emission:	The gross emissions are those measured at the water-air interface or soil-air interface or soil-water interface.
Net emission:	The net reservoir emissions are gross emissions minus pre-impoundment natural emission (both terrestrial and aquatic ecosystems) at the whole watershed level, including downstream and estuary.
NDIR:	None-dispersive Infrared
FTIR:	Fourier Transform Infrared
CO <sub>2</sub> :	Carbon dioxide (44 g per mole, 1 mmole of CO <sub>2</sub> = 44 mg of CO <sub>2</sub> )
CH <sub>4</sub> :	Methane (16 g per mole, 1 mmole of CH <sub>4</sub> = 16 mg of CH <sub>4</sub> )
N <sub>2</sub> O:	Nitrous oxide
mg·m <sup>-2</sup> ·d <sup>-1</sup> :	milligram per square meter per day (mg/m <sup>2</sup> /d)

## Résumé-Synthèse

Alain Tremblay, Louis Varfalvy, Charlotte Roehm et Michelle Garneau

Ce chapitre a pour but de faire le point sur l'état des connaissances et d'identifier les lacunes relatives à la problématique de l'émission de gaz à effet de serre (GES) par les réservoirs hydroélectriques et les écosystèmes naturels. Il est devenu essentiel d'intégrer nos connaissances du cycle du carbone à des échelles temporelles et spatiales plus vastes de façon à mieux définir l'ampleur des flux de GES associés aux réservoirs<sup>1</sup> et aux écosystèmes naturels. Les données disponibles proviennent d'études à petite échelle et de courte durée (1 à 10 ans), effectuées surtout en région boréale, mais aussi en régions semi-aride et tropicale. La variabilité naturelle des flux de GES due à des variations climatiques régionales et leurs impacts sur la production biologique globale est plus importante que celle des méthodes de mesures. Il faut donc garder à l'esprit que les incertitudes concernant les flux de GES sont avant tout le résultat de variations spatiales et temporelles naturelles des flux, et non pas des techniques de mesure disponibles. La présente synthèse se base sur les résultats de plus de dix ans de suivis obtenus par différentes équipes de recherche de plusieurs universités, institutions gouvernementales et compagnies d'électricité.

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<sup>1</sup> Pour évaluer l'ampleur des flux de GES, nous avons calculé les émissions brutes et les émissions nettes. Les émissions brutes sont celles mesurées à l'interface eau-air. Les émissions nettes des réservoirs correspondent à la différence entre les émissions brutes et les émissions naturelles des écosystèmes terrestres et aquatiques avant la mise en eau, pour l'ensemble du bassin versant, incluant la portion aval et l'estuaire. Ces définitions sont celles de WCD (2000).

