



The Climate Registry

***State of the Science: GHG Emissions from Hydro Reservoirs
A Dialogue with Experts***

17 September 2009

Hotel Delta Montreal

Montreal, QC



**The UNESCO/IHA GHG Research
GHG Status of Freshwater Reservoirs**



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All human activities have a GHG footprint. Freshwater reservoirs are no exception

Climate change and water management are today among the most important issues for strategic sustainable development.

There is a clear and pressing need to quantify the greenhouse-gas (GHG) footprint of all human activities.

The issue of the GHG status of freshwater reservoirs plays an important role in these discussions.

However, there is currently no scientific consensus on how to measure the GHG status of freshwater reservoirs, which creates a significant problem for water, energy and climate policy.



What do we know from previous work ?

In the last decade, freshwater reservoirs have been investigated as potential sources of GHG (mainly CO₂ and CH₄) emissions to the atmosphere

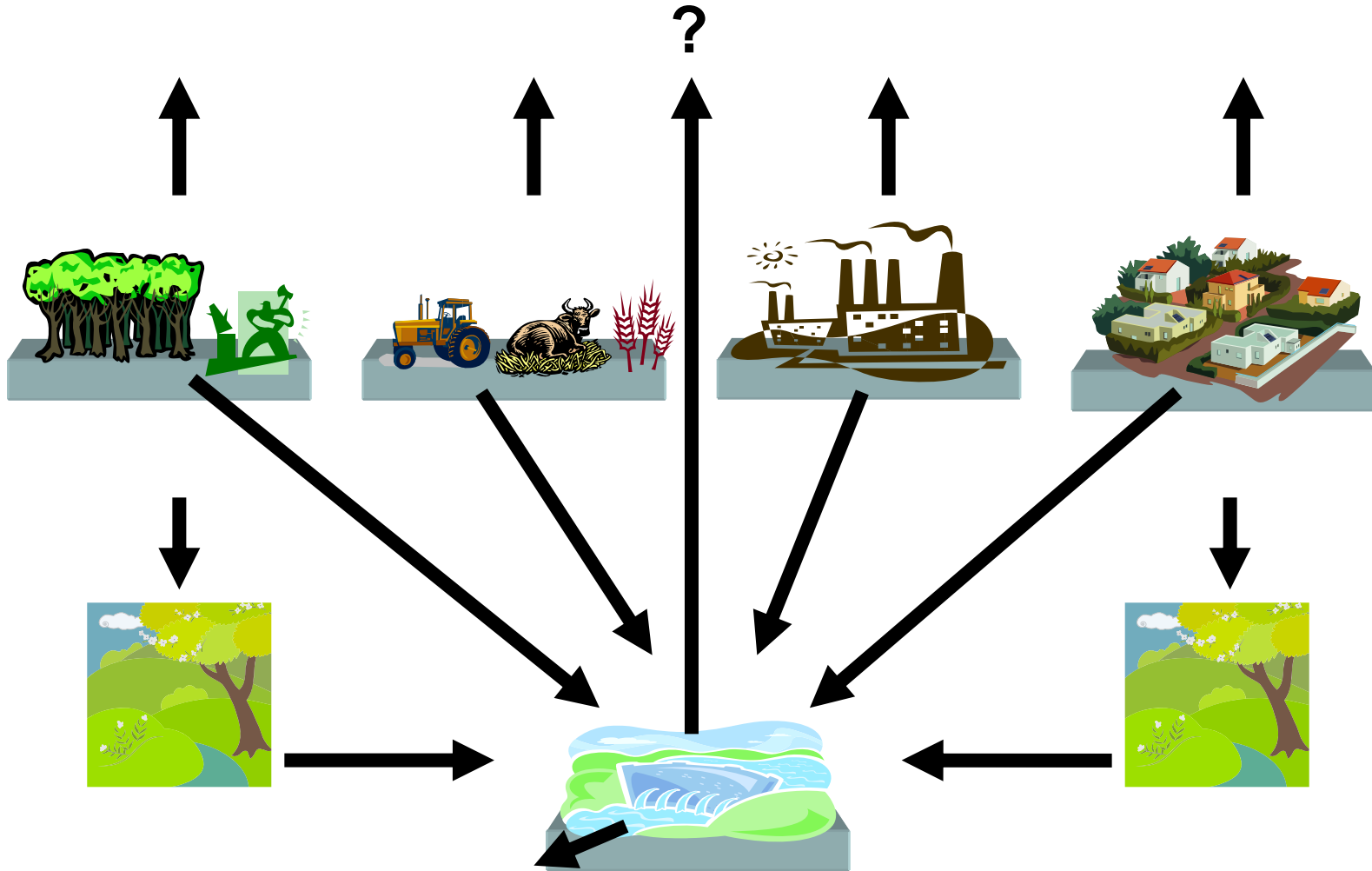
GHG pathway	Boreal & temperate		Tropical	
	CO ₂ mmol m ⁻² d ⁻¹	CH ₄ mmol m ⁻² d ⁻¹	CO ₂ mmol m ⁻² d ⁻¹	CH ₄ mmol m ⁻² d ⁻¹
Diffusive fluxes	-23—145 (107)	-0.3—8 (56)	-19—432 (15)	0.3—51 (14)
Bubbling	0	0—18 (4)	0	0—88 (12)
Degassing [§]	~0.1 (2)	n.a.	4—23 (1)	4—30 (2)
River below the dam	n.a.	n.a.	500—2500 (3)	2—350 (3)

[§]The degassing (generally in Mg d⁻¹) is attributed to the surface of the reservoir and is expressed in the same unit as the other fluxes (mmol m⁻² d⁻¹)

Fluxes of CO₂ and CH₄ have been measured in a limited number of boreal/temperate and tropical reservoirs.

These studies, however, only evaluate gross emissions.

Where is the carbon coming from ? Internal + External Sources



The issue of GHG Status of Freshwater Reservoirs: Definition of NET GHG EMISSIONS

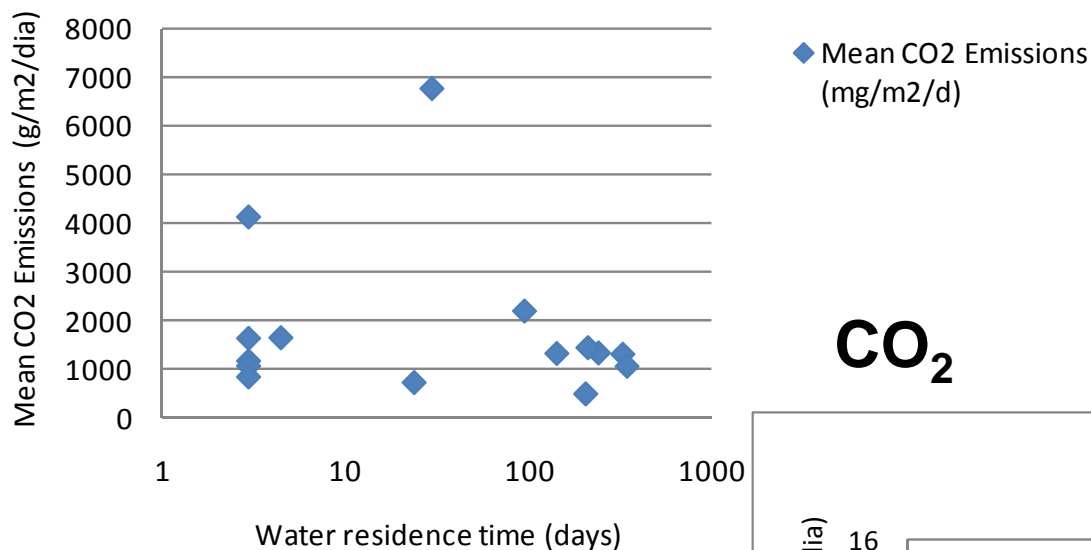
NET GHG EMISSIONS:

change in GHG emissions caused by the creation of a reservoir.

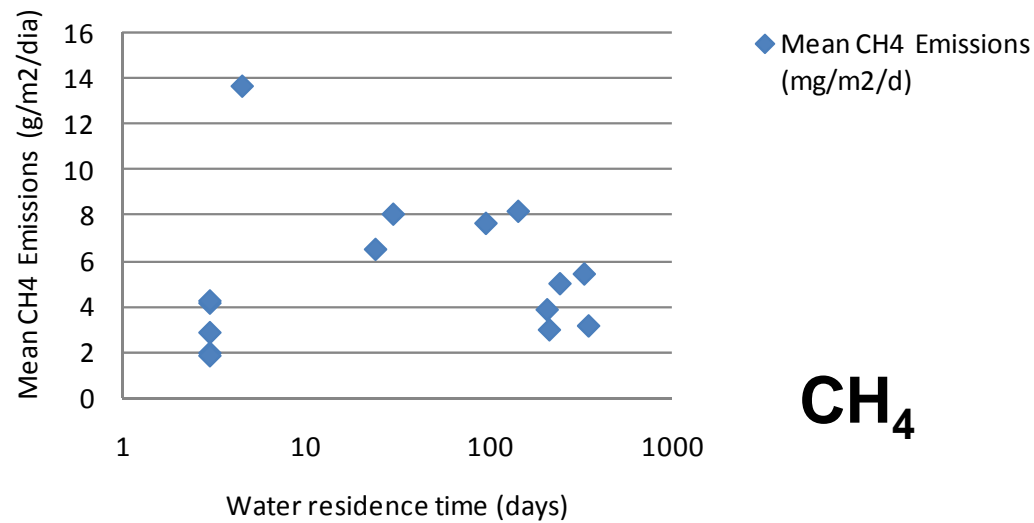
Obtained by the difference between pre- and post-reservoir emissions from the portion of the river basin influenced by the reservoir.

The knowledge issues are not just in the Tropics

Boreal Reservoirs



Boreal Reservoirs



The information in literature is so heterogeneous that it is impossible to pull it together at global level with credibility

Vast majority of studies conducted in young reservoirs (more intense emissions).

Flux measurements at the water-atmosphere or land-atmosphere interface are often the only type of measurements reported in the literature.

Few measurements of material transported into or out of the reservoir have been reported.

Few studies have quantified carbon accumulation in reservoir sediments.

Different methodologies (equipment and procedures) were applied for each study.

Comparisons of these results are not easily obtained, requiring intense data interpretation.



Summary of challenges

The main difficulties at this stage are:

- The existing data have not been obtained in a standard procedure;
- It is still difficult to have a representative sample of the existing and planned reservoirs;
- There is no agreed procedure to estimate the net emissions of reservoirs.

GHG emissions from reservoirs at the global scale are subject to large uncertainties.

To have a robust methodology, there is a need to sharpen our understanding of the processes involved.

PURPOSE

of the UNESCO/IHA Project

The **GHG Research Project**,

performed by

the International Hydropower Association (**IHA**),

in collaboration with the International Hydrological Programme (**IHP**) of **UNESCO**,

aims to **improve understanding on the impact of reservoirs on natural GHG emissions in a river basin**, obtaining a better comprehension on current methodologies and helping to overcome knowledge gaps.



International Hydrological Programme (UNESCO-IHP)



- IHP is UNESCO's international scientific cooperative programme in water research, water resources management, education and capacity-building.

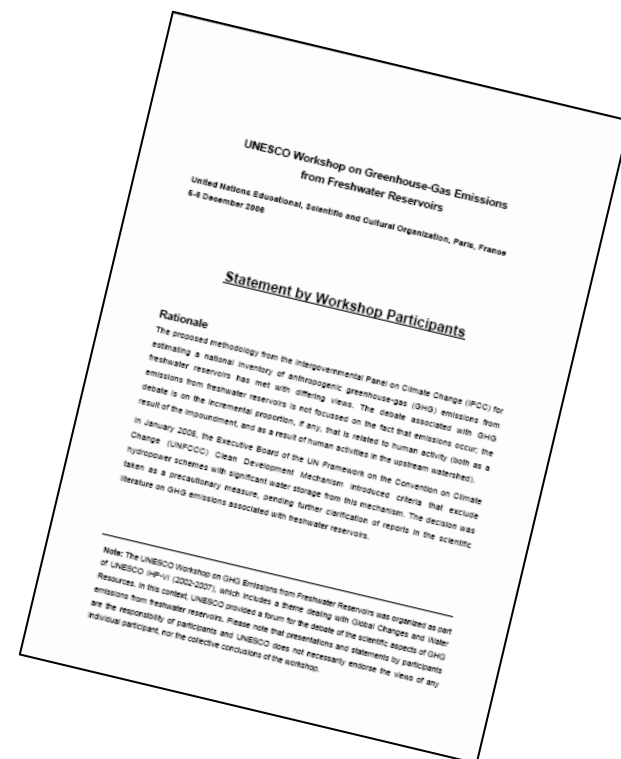
International Hydropower Association (IHA)



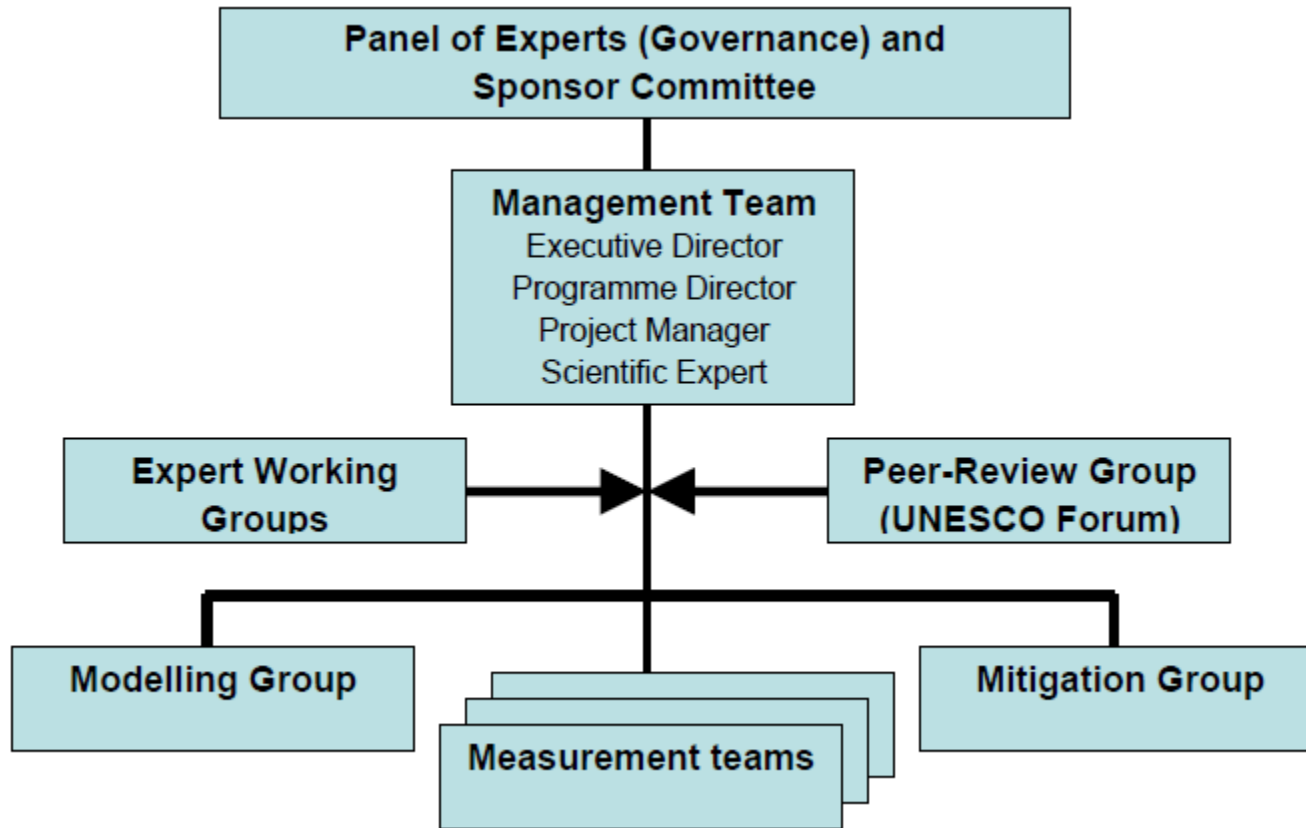
- Non-governmental mutual association of organizations and professionals working or studying in the hydropower sector.
- Founded in 1995, under the auspices of UNESCO, to advance knowledge on all aspects of hydropower and to promote good practice.
- **Mission: Advancing Sustainable Hydropower**
- **Present Membership: total of 107 Corporate Members**

How the Project was created

- 2006 – First International Workshop (Paris, December 2006)
- 2007 – Second International Workshop (Iguassu, November 2007)
- 2008 – Scoping Paper completed by UNESCO Working Group (April 2008)
- 2008 – UNESCO/IHA Project for an initial two-year programme (April 2008)



STRUCTURE of the UNESCO/IHA Project



OBJECTIVES

of the UNESCO/IHA Project

1. develop measurement guidance for net GHG measurements in freshwater reservoirs
2. promote scientifically rigorous measurements and calculate net emissions (the changes in GHG emissions due to a construction of a freshwater reservoir) from a representative set of freshwater reservoirs.
3. develop predictive modelling tools to assess the GHG status of unmonitored reservoirs and potential new reservoir sites
4. develop guidance and assessment tools for mitigation of GHG emissions for vulnerable sites



SCOPE of the UNESCO/IHA Project

The scope of the Project includes data and methodologies to be applied to a representative set of reservoirs **throughout the world.**

This includes field measurements in several countries, including, but not limited to, sites in Africa, Asia and Latin America.



DELIVERABLES of the UNESCO/IHA Project

- a measurement specification to be applied to a representative set of reservoirs
- results database
- an empirical predictive model
- a process-based predictive model
- mitigation measures for vulnerable sites

UNESCO/IHA Initiatives and Products

- 2008 – UNESCO/IHA Measurement Specification Workshop (London, November 2008):
Measurement Specification Guidance
- 2009 – UNESCO/IHA Site Selection and Database Workshop (Sao Paulo, May 2009):
 - Reservoir Site Selection and Criteria
 - Data acquisition, processing, use and publishing
 - Draft agreement on confidentiality and non-disclosure policy
- 2009 – IHA World Congress (Reykjavik, June 2009):
 - Strategic Meeting
 - Sponsors Meeting
 - Seminar on Hydropower and GHG Emissions
- 2009 – UNESCO/IHA Field Measurement and Data Analysis Workshop (Montreal, September/2009):
 - Database Structure
 - Measurement Questionnaire
 - Field Manual
 - Calculations Manual



Workshops

Work schedule (quarters of each fiscal year to 31 March)	Year to 31.03.2009				Year to 31.03.2010				Year to 31.03.2011			
	APR/08 JUN/08	JUL/08 SEP/08	OCT/08 DEC/08	JAN/09 MAR09	APR/09 JUN/09	JUL/09 SEP/09	OCT/09 DEC/09	JAN/10 MAR10	APR/10 JUN/10	JUL/10 SEP/10	OCT/10 DEC/10	JAN/11 MAR11
WORKSHOP WS1 Measurement Specification			WS 1									
WORKSHOP WS2 Site Selection DataBase					WS 2							
WORKSHOP WS3 Field Measurment Data analysis							WS 3					
WORKSHOP WS4 Data Analysis Empirical Model									WS 4			
WORKSHOP WS5 Empirical Model Proc-Based Model Mitigation Guide												WS 5

Products

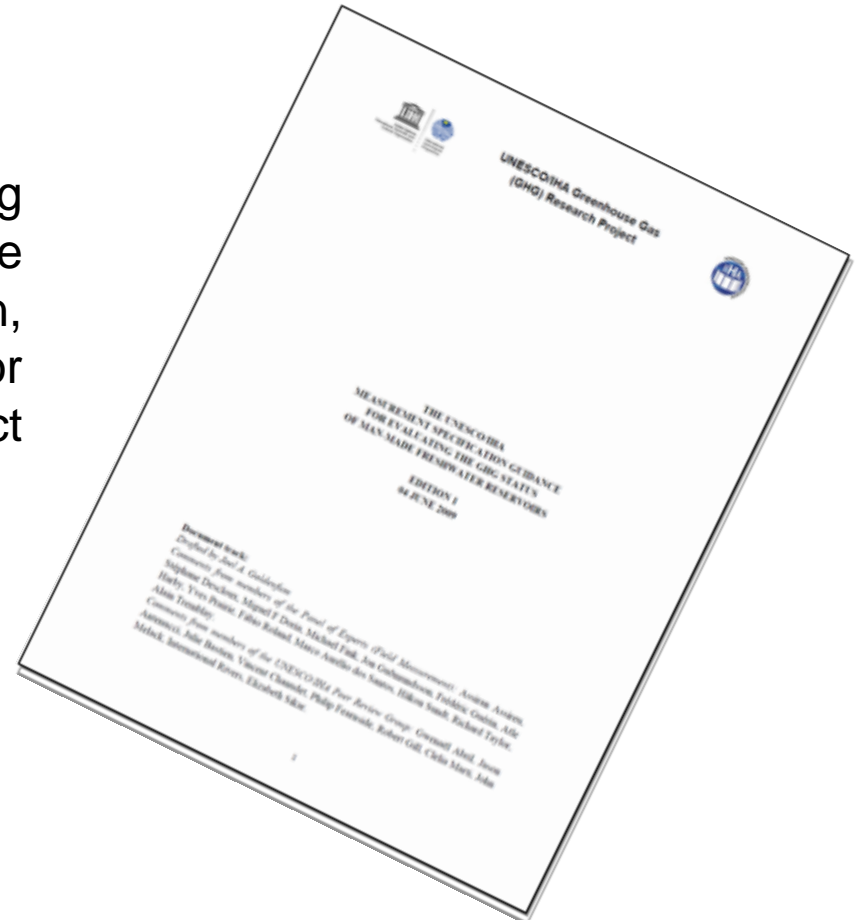
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Assessment methodology	Scoping Paper Version1										Scoping Paper Version2	
Measurement specification (MS)					MS Version 1			MS Version 2				MS Version 3
Field Manual (FM)							FM Version 1					
Calculations Manual (CM)								CM Version 1				
Site selection & supervision (SS)							SS Group1		SS Group2			
Data Base (DB)							DB Version 1		DB Version 2			
Empirical Model (EM)									EM Version 1			EM Version 2
Process Based Model (PB)												PB Version 1
Mitigation guidance (MG)											MG Version 1	

The Measurement Specification Guidance

THE UNESCO/IHA MEASUREMENT SPECIFICATION GUIDANCE FOR EVALUATING THE GHG STATUS OF MAN-MADE FRESHWATER RESERVOIRS

Guidelines for GHG measurements aiming at international standard and objective measurements that will ease comparison, transferability and global use of data, for the purpose of evaluating the GHG impact from the creation of freshwater reservoirs.

Edition 1 – 04 June 2009



The Measurement Specification Guidance

THE UNESCO/IHA MEASUREMENT SPECIFICATION GUIDANCE FOR EVALUATING THE GHG STATUS OF MAN-MADE FRESHWATER RESERVOIRS

I. INTRODUCTION

- I.1. Background
- I.2. Objective and applicability of the guidance

II. GENERAL PRINCIPLES AND DATA

- II.1. Previous work
- II.2. Key processes and parameters
- II.3. Measurements
- II.4. The importance of considering net emissions

III. SPATIAL AND TEMPORAL RESOLUTION

- III.1. Where to measure
- III.2. When to measure

IV. SITE SELECTION

V. METHODS AND EQUIPMENT

- V.1. Procedures for measuring GHG emissions
- V.2. Procedures for measuring carbon mass flow and carbon storage in sediments
- V.3. Procedures for measuring physical and water quality parameters

VI. DATA ANALYSIS

VII. DATABASE

VIII. UPDATING THIS GUIDANCE MANUAL

IX. REFERENCES



The Field Manual

THE UNESCO/IHA FIELD MANUAL FOR MEASURING GHG EMISSIONS TO EVALUATE THE GHG STATUS OF MAN-MADE FRESHWATER RESERVOIRS

Objective and clear instructions of field methods and equipments necessary to estimate GHG emissions, under pre- and post-impoundment conditions, allowing qualified technicians and scientists to have conditions to perform field GHG emission measurements.

Commented Zero-draft: 04 September 2009

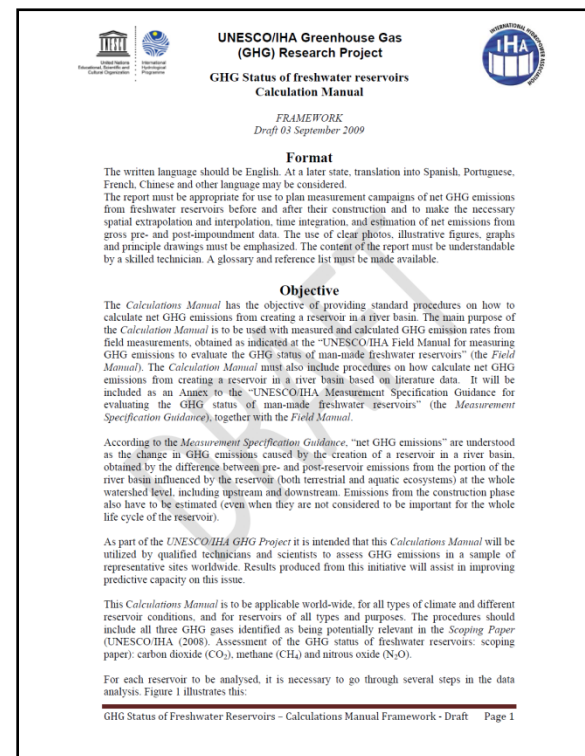


The Calculations Manual

THE UNESCO/IHA CALCULATIONS MANUAL FOR EVALUATING THE GHG STATUS OF MAN-MADE FRESHWATER RESERVOIRS

Standard procedures on how to calculate net GHG emissions from creating a reservoir in a river basin, to be used with measured and calculated GHG emission rates from field measurements, obtained as indicated at the Field Manual.

Framework: 07 September 2009



Next Steps

- **Finish the Field Manual and the Calculations Manual**
- **Ensure application on a representative set of reservoirs**
- **Build a database of results, with emphasis on filling knowledge gaps**
- **Develop an empirical predictive model, define the main concepts for a process-based model, and report**

YOU CAN BE PART OF THIS !



Thank you for your attention!

Any further information, please contact:

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