ipcc

INTERGOVERNMENTAL PANEL ON climate change

Task Force on National Greenhouse Gas Inventories (TFI)

IPCC Expert Meeting on HWP, Wetlands and Soil N_2O
WMO Geneva
19-21 October 2010

GHG emissions from reservoirs - where is the truth ?

JOEL A. GOLDENFUM (IHA) - Project Manager

The UNESCO/IHA GHG Research

GHG Status of Freshwater Reservoirs

United Nations Educational, Scientific and Cultural Organization

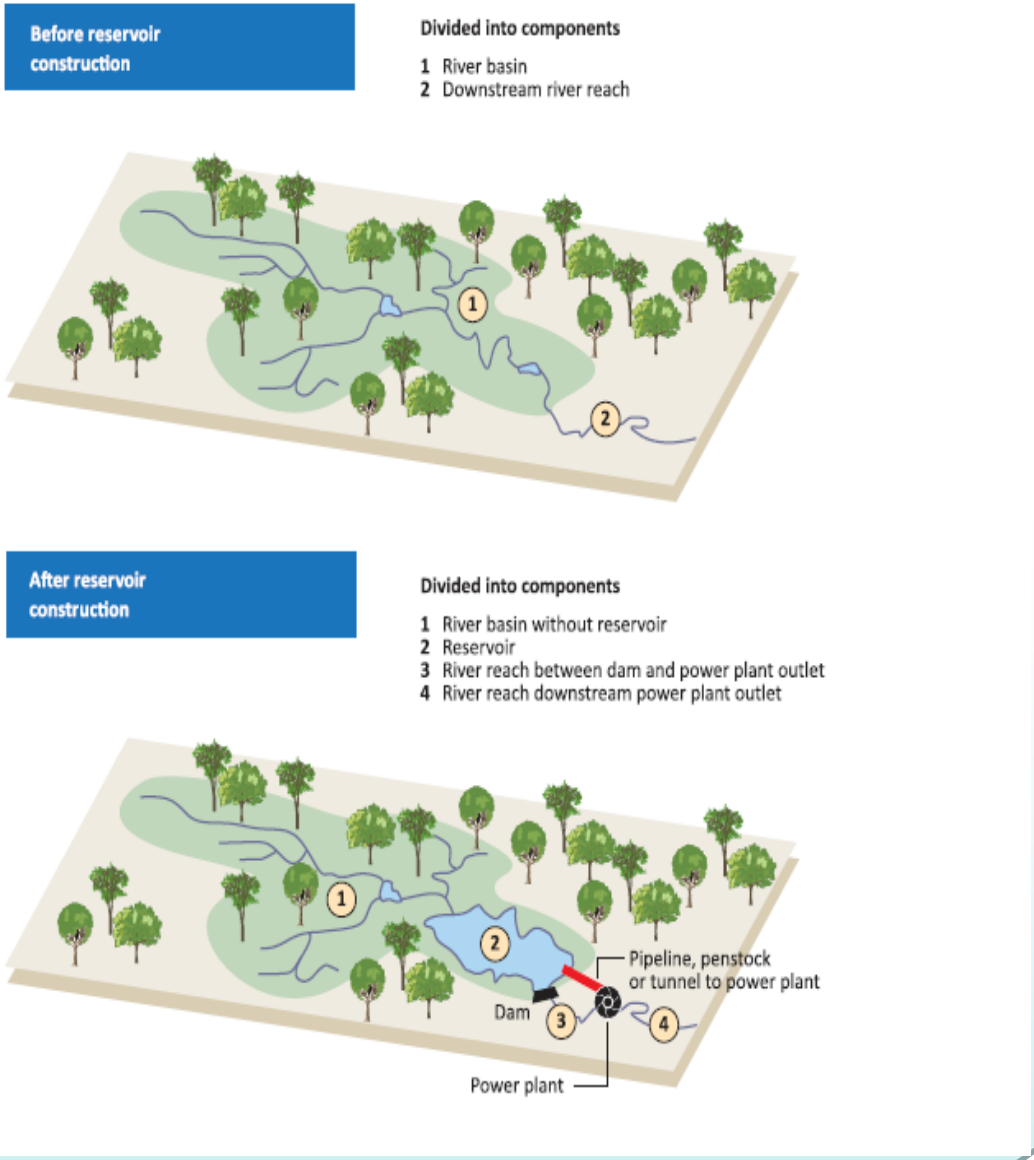
International Hydrological Programme

The concept of NET GHG EMISSIONS

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

Difference between WITH and WITHOUT the reservoir

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



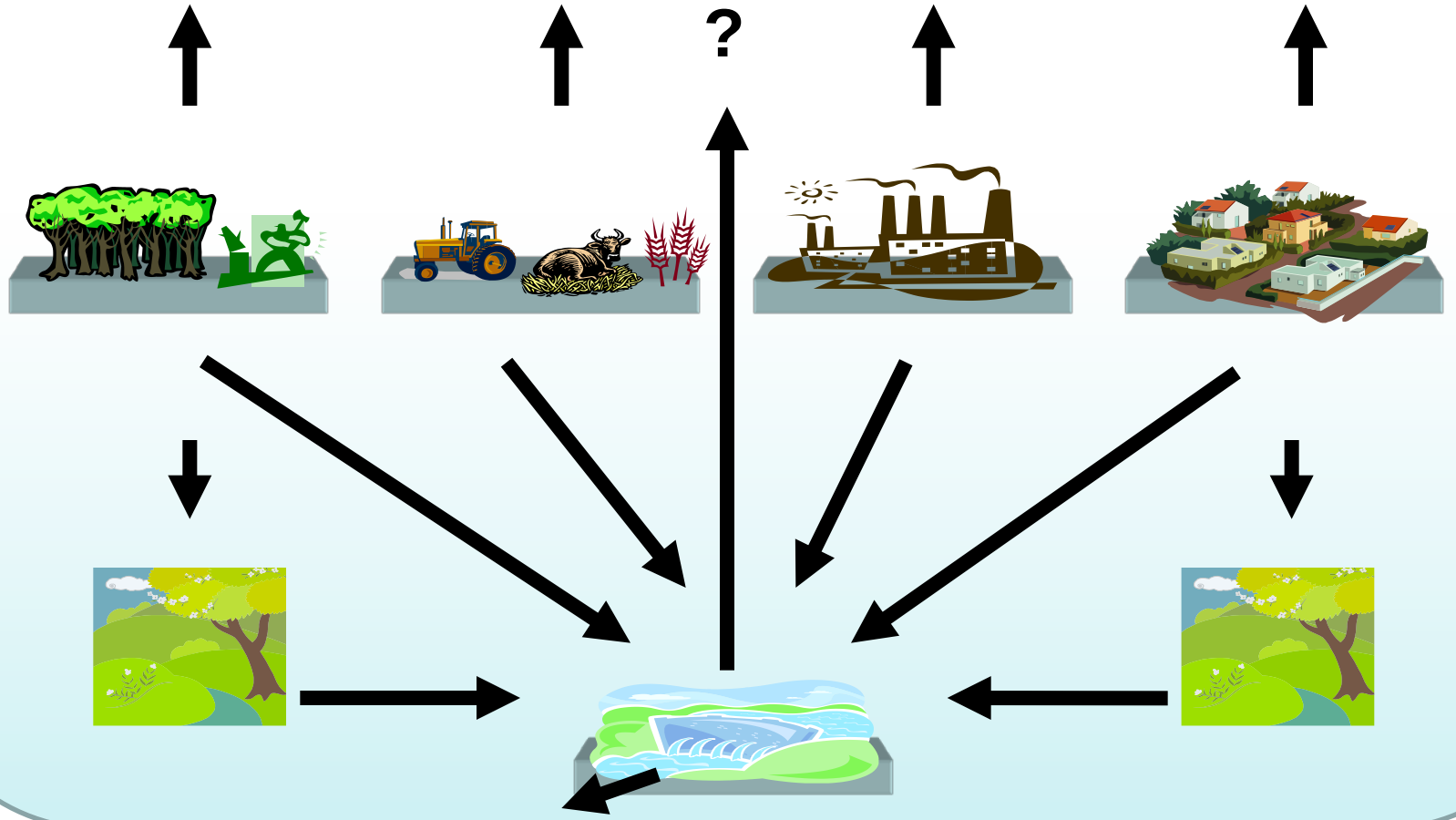
Different objectives – similar issues

IPCC National GHG Inventories:
factors governing emissions and removals
Anthropogenic (direct and indirect) **or Natural**

NET GHG EMISSIONS:
change in GHG emissions
caused by the creation of **a reservoir.**

Where is the carbon coming from ?
Internal + External Sources

IPCC: Avoid double counting
NET GHG EMISSIONS: identify reservoir effects



How to interpret field data results ?

Extreme Methane Emissions from a Swiss Hydropower Reservoir: Contribution from Bubbling Sediments

TONYA DELSONTRO,*,†,⊥
DANIEL F. MCGINNIS,‡
SEBASTIAN SOBEK,†,⊥,§
ILIA OSTROVSKY,∥ AND
BERNHARD WEHRLI†,⊥

Environ. Sci. Technol. **2010**, *44*, 2419–2425

EAWAG bulletin, 11 October 2010

Reservoirs: a neglected source of methane emissions
www.eawag.ch/medien/bulletin/20101011/index_EN

Substantial amounts of the greenhouse gas methane are released not only from large tropical reservoirs but also from run-of-the-river reservoirs in Switzerland:

a finding which slightly tarnishes the reputation of hydropower as a climate-neutral way of generating electricity.

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High organic carbon load coming from several sources:

(1)passage of the Aare River through Bern, including input from several wastewater treatment plants;

(2)drainage of the large Alpine and agricultural river basin yielding terrigenous carbon; and

(3)input from two large Prealpine lakes.

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NET GHG EMISSIONS:

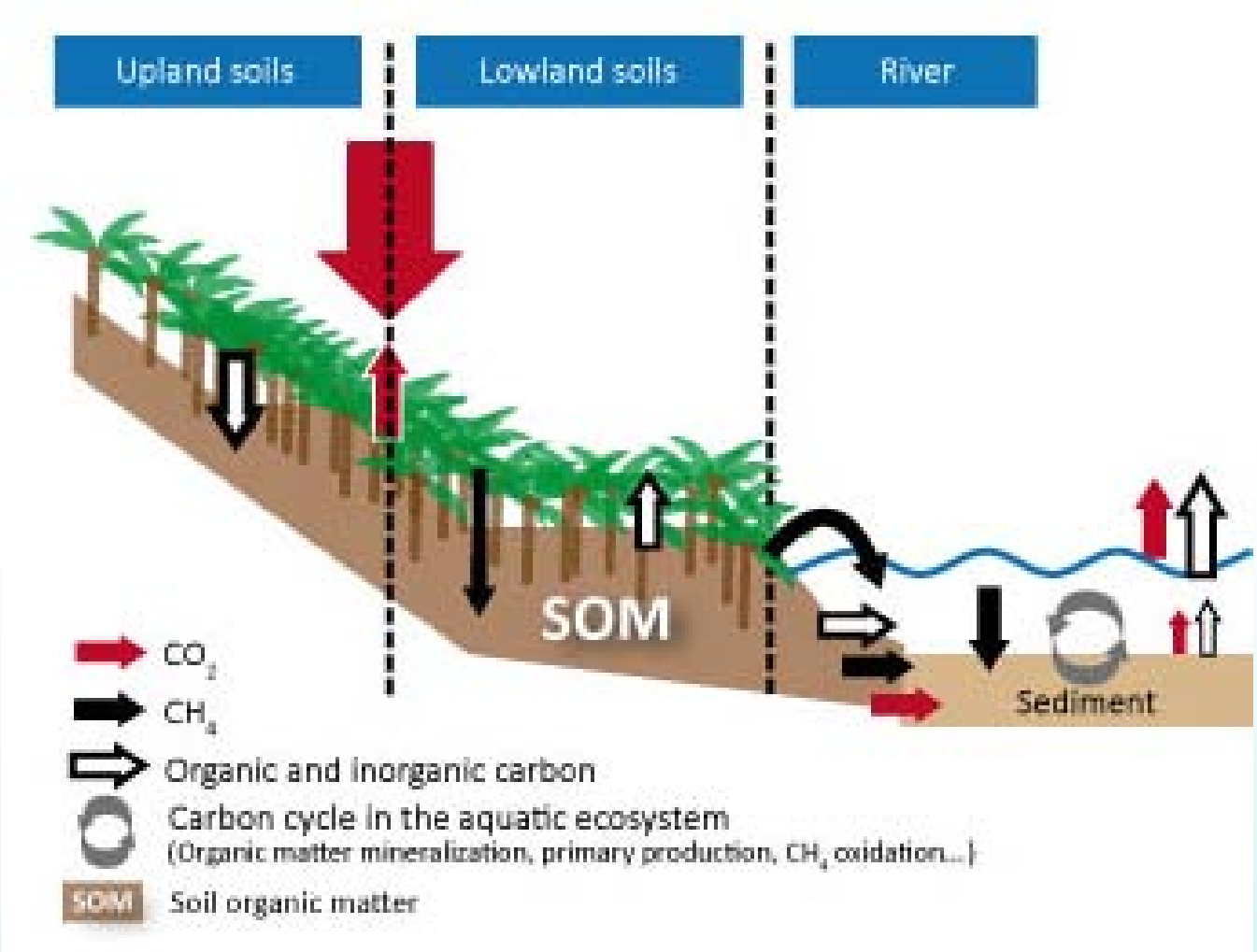
How much of this CH4 would be emitted if the reservoir were not there?

Difference of the emissions with and without the reservoir:
real effect of the dam.

lateral transfer of C and nutrients to the reservoir

DOUBLE COUNTING

Complexity of the processes involved



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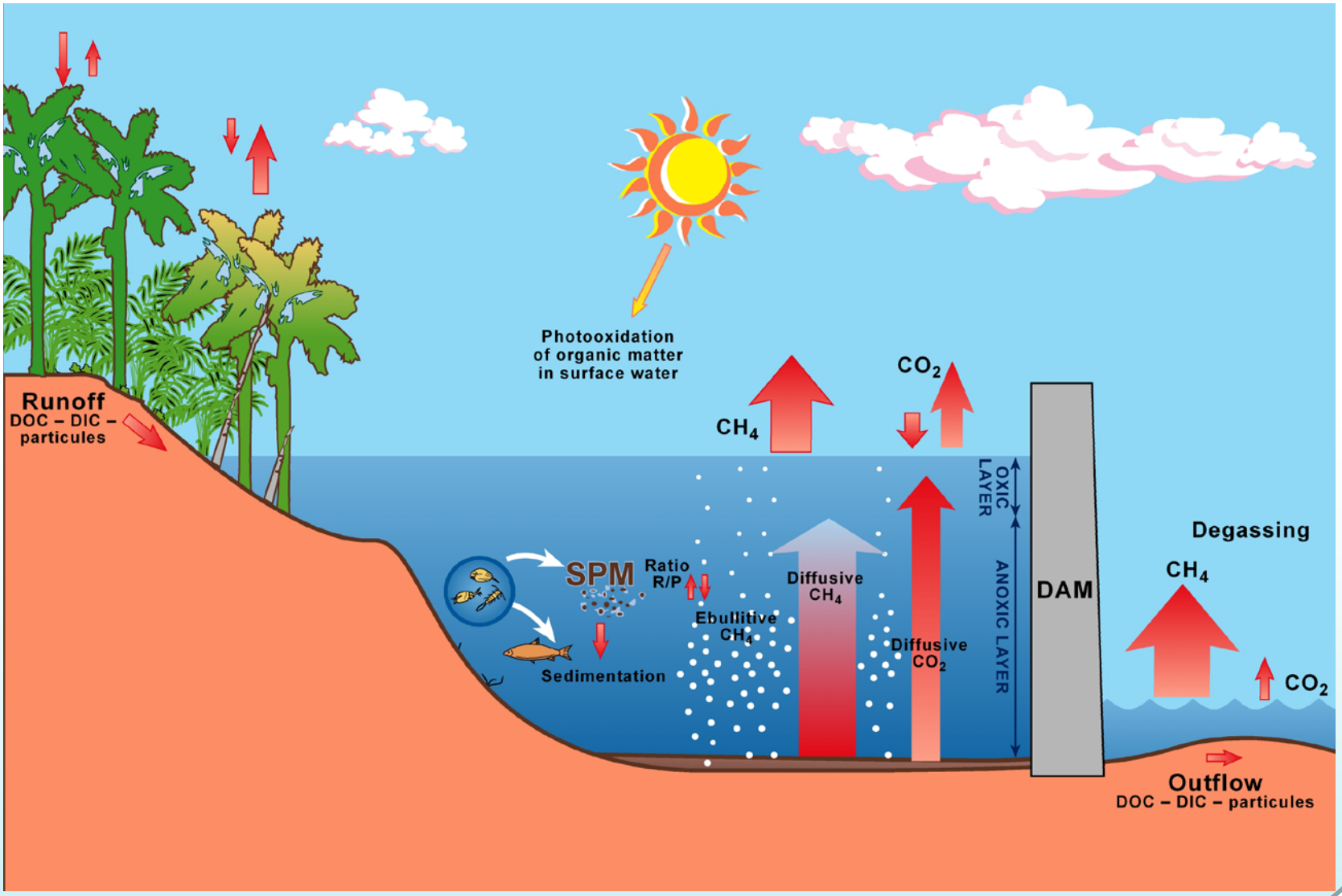


What do we know from previous work ?

In the last decade, freshwater reservoirs have been investigated as potential sources of GHG (mainly CO_2 and CH_4) emissions to the atmosphere

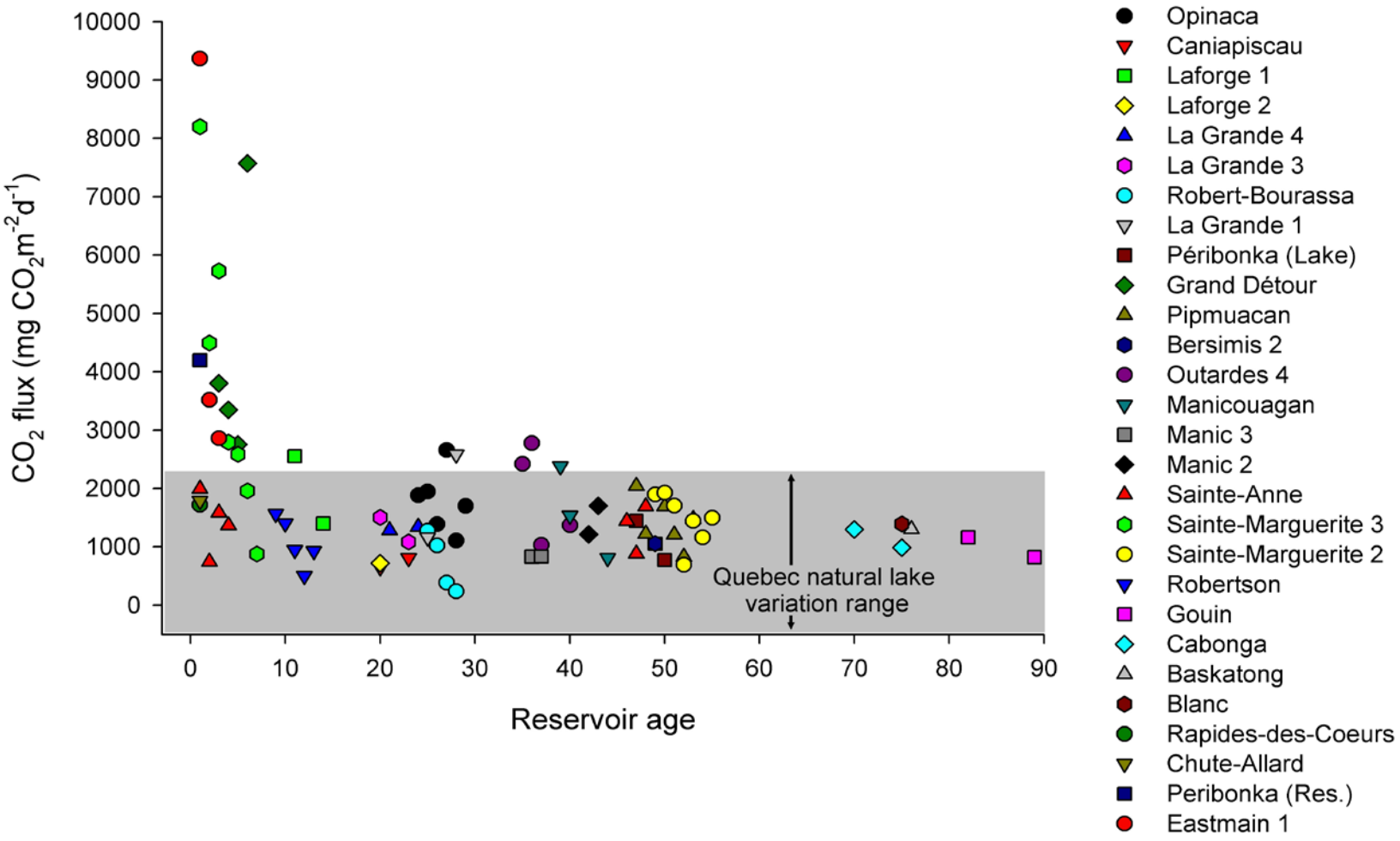
GHG pathway	Boreal & temperate		Tropical	
	CO_2	CH_4	CO_2	CH_4
	mmol m^{-2} d^{-1}	mmol m^{-2} d^{-1}	mmol m^{-2} d^{-1}	mmol m^{-2} d^{-1}
Diffusive fluxes	-23—145 (107)	-0.3—8 (56)	-19—432 (15)	0.3—51 (14)
Bubbling	0	0—18 (4)	0	0—88 (12)
Degassing[$]	~0.1 (2)	n.a.	4—23 (1)	4—30 (2)
River below the 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})

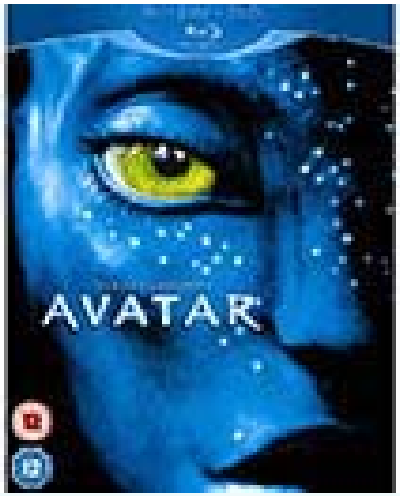
These studies, however, only evaluate gross emissions,

Fluxes of CO_2 and CH_4 have been measured in a limited number of boreal/temperate and tropical reservoirs

What do we know from previous work ?



Negative perception on Hydro



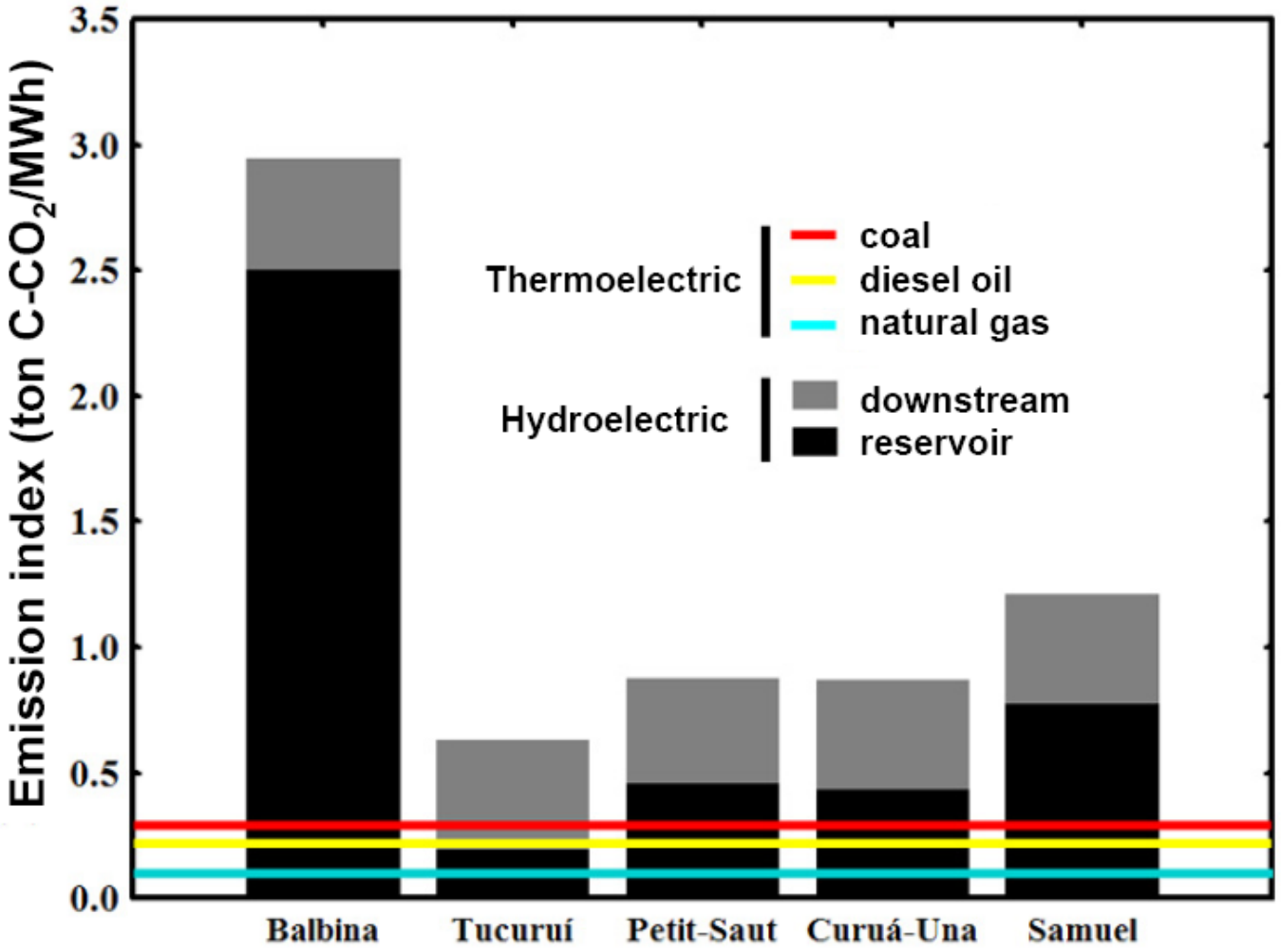
21/04/10 - James Cameron, director of Avatar, has stated that his film was based on controversies surrounding indigenous rights issues in Brazil in relation to hydropower.

"As these trees become inundated by these upstream reservoirs, they die and they release their carbon that they've been sequestering for hundreds, if not thousands of years," he said.

"They release it back into the atmosphere. So we're talking about millions of tons of carbon being released as methane."

(http://edition.cnn.com/2010/SHOWBIZ/04/20/james.cameron.rain.forest/index.html)

Extreme statements

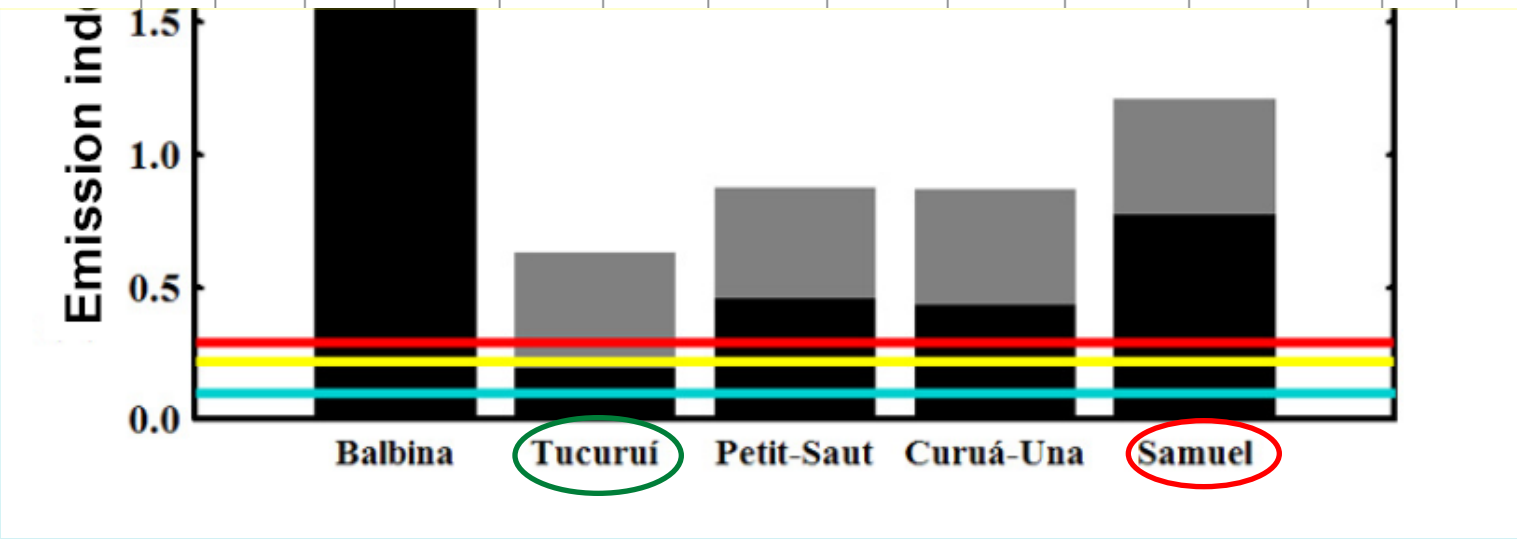


Alexandre Kemenes
Bruce Forsberg
John Melack

Not all studies tell the same story

Brazilian National Inventory, 2006

Hidrelétrica	Área	Latitude	Potência	Média das duas campanhas: Índice de Emissão de CH_4	Média das duas campanhas: Índice de Emissão de CO_2	Média das duas campanhas: Emissão da hidrelétrica[1]	Emissões da Termelétrica Equivalente[2]: Carvão[3] ciclo simples	Óleo[4] ciclo simples	Diesel[5] ciclo simples	Gás[6] ciclo simples	Gás[7] ciclo combinado	Mérito - RI (Emis. Termelétrica / Emis. hidrelétrica): Carvão c. simples	Óleo c. simples	Diesel c. simples	Gás c. simples	Gás c. comb.
	km²		MW	kg/km²/dia	kg/km²/dia	tC/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano					
Tucuruí	2.430	3°45'S	4.240	109,4	8.475	2.602.945	4.661.873	4.702.228	4.501.659	4.330.284	2.598.170	1,79	1,81	1,73	1,66	1,00
Samuel	559	8°45'S	216	104,0	7.448	535.407	237.492	239.547	229.330	220.599	132.360	0,44	0,45	0,43	0,41	0,25



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Samuel	559	8°45'S	216	104,0	7.448	535.407	237.492	239.547	229.330	220.599	132.360	0,44	0,45	0,43	0,41	0,25
Xingó	60	9°37'S	3.000	40,1	6.138	41.668	3.298.495	3.327.048	3.185.136	3.063.880	1.838.328	79,16	79,85	76,44	73,53	44,12
Serra da Mesa	1.784	13°50'S	1.275	51,1	3.973	895.373	1.401.860	1.413.995	1.353.683	1.302.149	781.289	1,57	1,58	1,51	1,45	0,87
Três Marias	1.040	18°13'S	396	196,3	1.117	540.335	435.401	439.170	420.438	404.432	242.659	0,81	0,81	0,78	0,75	0,45
Miranda	50,6	18°55'S	390	154,2	4.388	38.332	428.804	432.516	414.068	398.304	238.983	1,19	1,28	0,80	0,39	6,23
Barra Bonita	312	22°31'S	140,76	20,9	3.985	137.341	154.765	156.105	149.447	143.757	86.254	1,13	1,14	1,09	1,05	0,63
Itaipu	1.549	25°26'S	12.600	20,8	171	93.269	13.853.680	13.973.602	13.377.571	12.868.296	7.720.978	48,54	49,82	143,43	37,97	82,78
Segredo	82	25°47'S	1.260	8,8	2.695	23.497	1.385.368	1.397.360	1.337.757	1.286.830	772.098	58,96	59,47	56,93	54,77	32,86

Not all studies tell the same story

Brazilian National Inventory, 2006

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	km²		MW	kg/km²/dia	kg/km²/dia	tC/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano	tC-CO_2/ano					
Conjunto das 9			23.518			4.908.166	25.857.739	26.081.572	24.969.088	24.018.532	14.411.119	5,27	5,31	5,09	4,89	2,94

What are the reasons for this bad perception ?

In most of the cases, this happens because :

- the worst cases used to obtain generalized conclusions
- the great majority of the available literature data are:
  - large gross emissions from tropical young reservoirs,
  - including natural and unrelated anthropogenic sources,
  - conducting to overestimates of the GHG emissions.
- As a consequence, a misunderstanding and a bad perception of the real role of freshwater reservoirs over climate change is obtained.

Summary of challenges

The main difficulties at this stage are:

•data have not been obtained in a standard procedure;

•difficult to have a representative sample of 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.

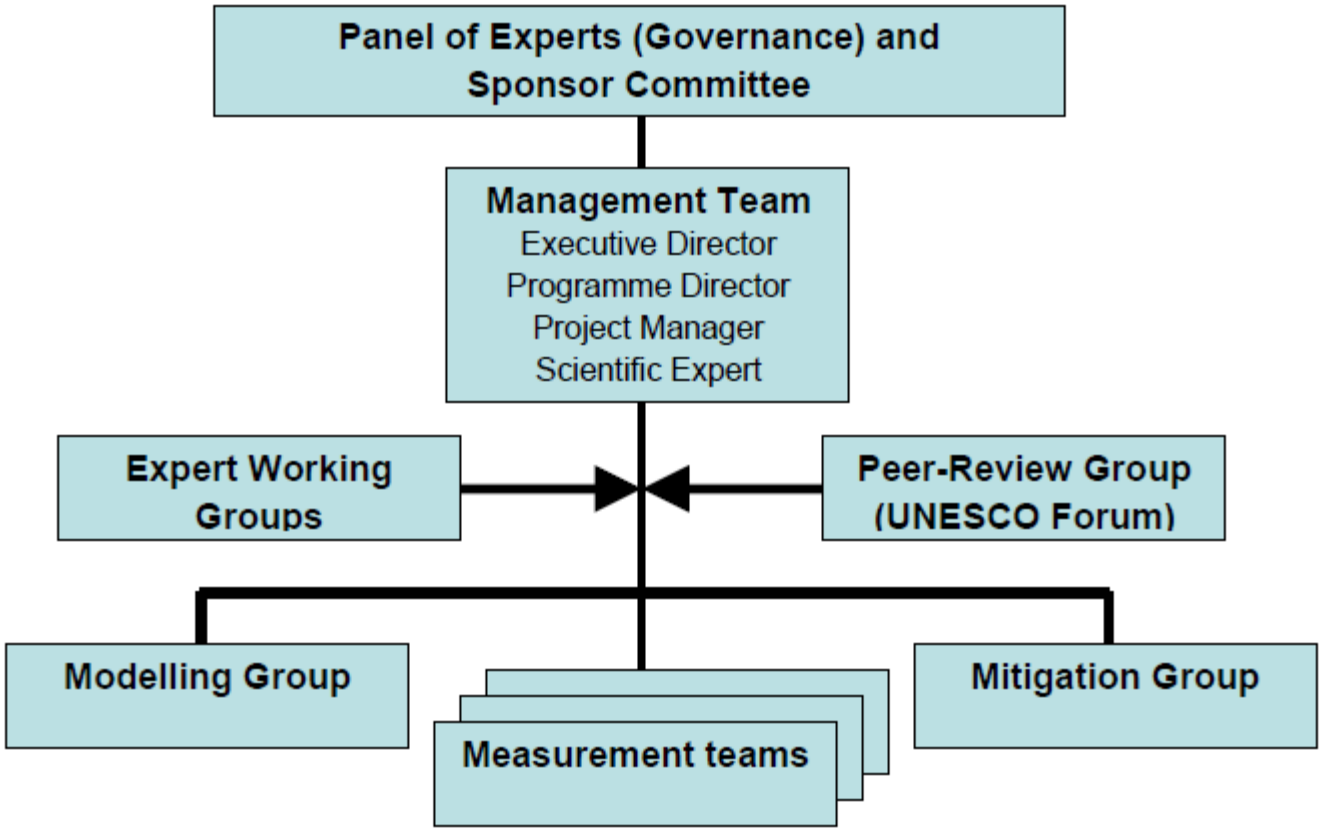
The UNESCO/IHA Project

The UNESCO/IHA GHG Status of Freshwater Reservoirs 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

STRUCTURE
of the UNESCO/IHA Project



OBJECTIVES
of the UNESCO/IHA Project

1. develop measurement guidance for net GHG estimations in freshwater reservoirs

2. promote scientifically rigorous measurements and calculate net emissions from a representative set of freshwater reservoirs.

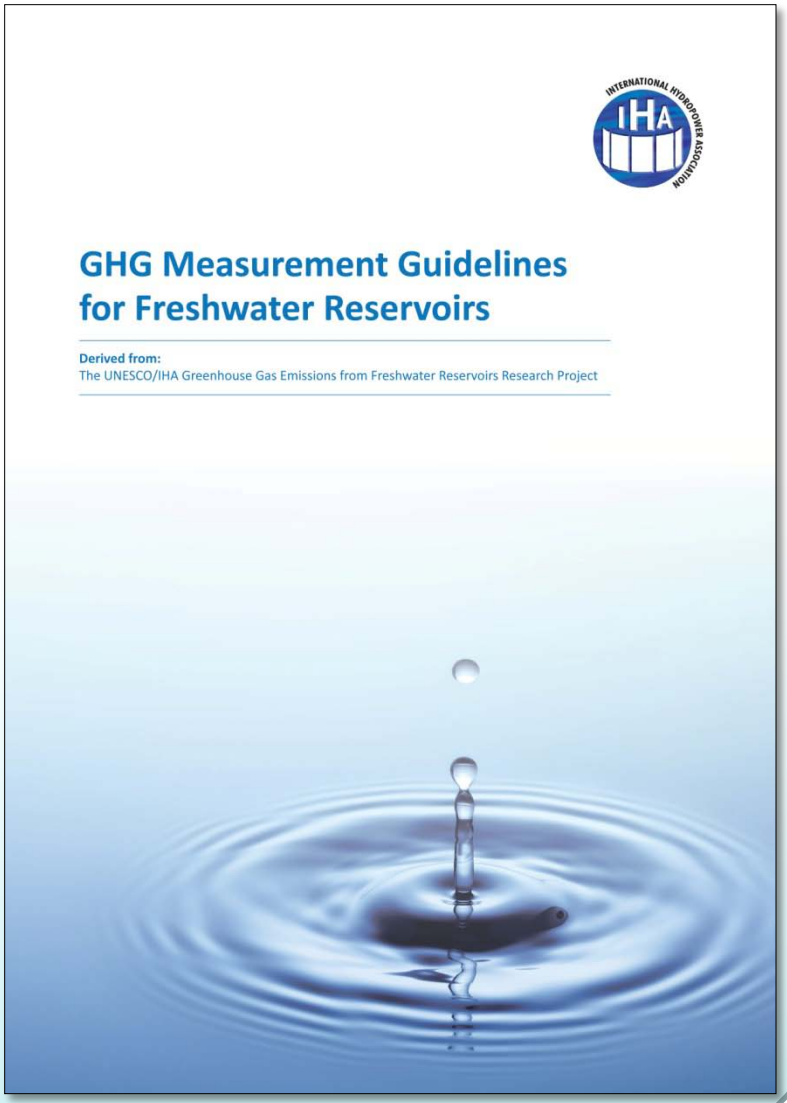
3. develop predictive modelling tools to assess the GHG status of unmonitored reservoirs and potential new reservoir sites

4. develop guidance and assessment tools for mitigation of GHG emissions for vulnerable sites

Developing standard measurement guidelines

1. Executive Summary
2. Concepts and Processes
3. Field Manual
4. Calculation Manual
5. Glossary

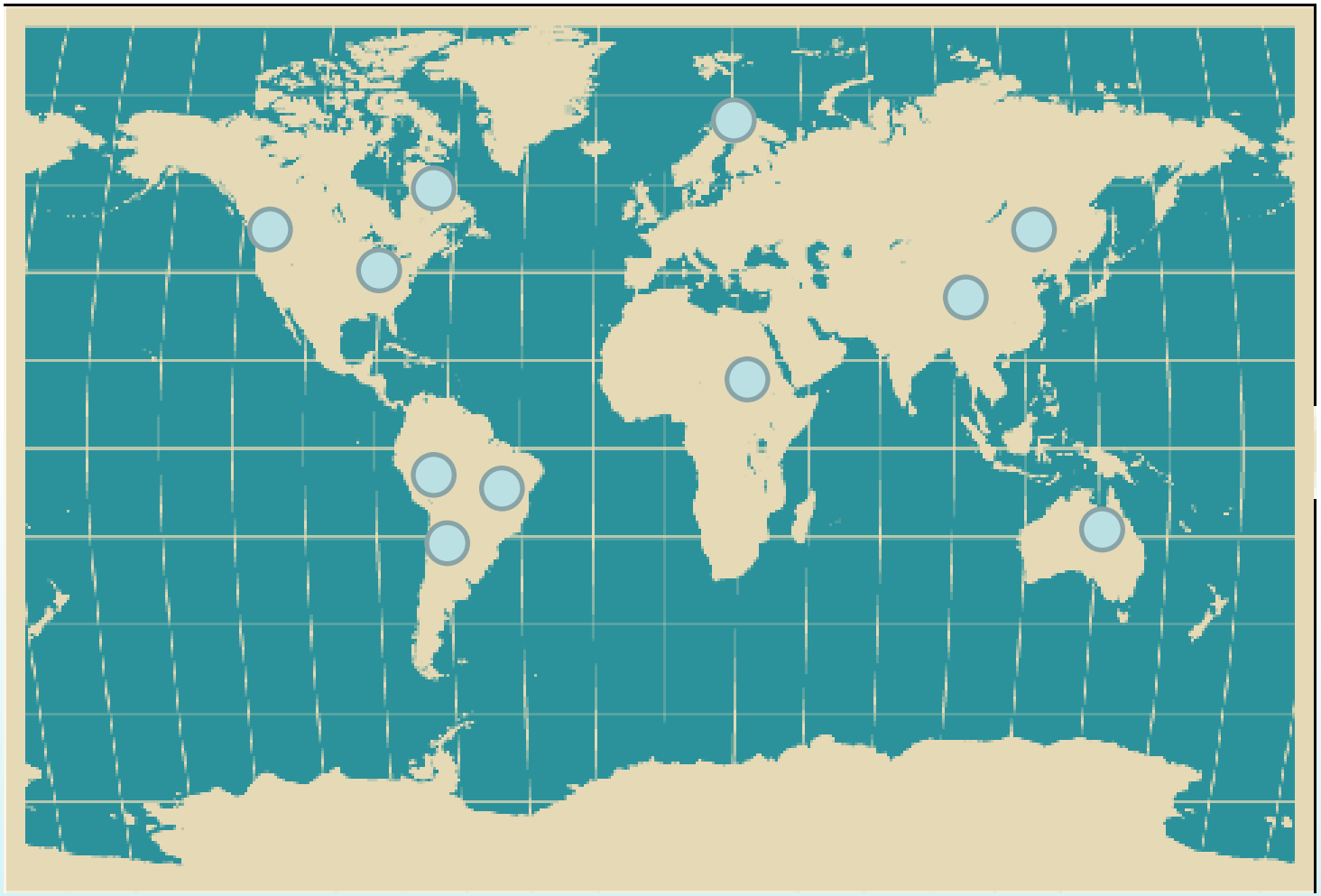
Launched in July 2010.



Next Steps

- **Propagate the GHG Measurement Guidelines**
- **Ensure application on a representative set of reservoirs**
- **Build a database of results, with emphasis on filling knowledge gaps**
- **Develop an empirical predictive model**
  to assess the vulnerability to gross/net GHG emissions,
- **Define the main concepts for a process-based model**
  to allow comparison of the impacts of different alternatives
  to evaluate potential mitigation measures for vulnerable sites
- **Quality Assurance, Quality Control, and Capacity Building issues**

Application at representative reservoirs through partnerships - worldwide



The Database

- **database for available data obtained through the standard methodology (GHG Guidelines), and supporting basic parameters**
  - standardized format of data and supporting information
  - to encourage meta-analyses on GHG effects of reservoirs
  - to promote sharing of information between scientists and stakeholders
  - the data accepted to this database must pass a quality assurance
  - management of commercial sensitivities and copyright

Predictive Models

- **Development of predictive modelling tools to assess the GHG status of unmonitored reservoirs and potential new reservoir sites**
  - **An empirical predictive modelling tool,** to assess the vulnerability of an existing reservoir or a new site to gross/net GHG emissions, using information from key parameters
  - **A process-based predictive model,** to allow comparison of the impacts of different alternatives for reservoir design, and to evaluate potential mitigation measures of GHG emissions for vulnerable sites

Main take-home points

- **Complexity of the processes involved**
- **Available data not obtained under standard conditions:**

  comparisons of the available results are not easy to obtain, requiring intense data interpretation
- **Misunderstanding and bad perception of the real role of freshwater reservoirs over climate change:**

  NEED FOR ROBUST, STANDARD PROCEDURES
- **UNESCO/IHA GHG Research Project:**
  - **Measurement Guidelines**
  - **Results database**
  - **Predictive Models**
  - **Mitigation Measures**
  - **Scientific, consensus based approach**

Back to the initial question

Where is the truth ?

Field Data from a RANGE of representative reservoirs

Scientific Research

The UNESCO/IHA GHG Research

GHG Status of Freshwater Reservoirs

aims to improve understanding on the impact of reservoirs on natural GHG emissions in a river basin

promote scientifically rigorous measurements and calculate net emissions from a representative set of freshwater reservoirs

Thank you for your attention!

Any further information, please contact:

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