

UNESCO-IHA Project on the Greenhouse Gas (GHG) Status of Freshwater Reservoirs

PROJECT OUTLINE – August 2008

OBJECTIVE

The four main objectives of this Project are to:

- develop measurement guidance for net GHG measurements in freshwater reservoirs
- to promote scientifically rigorous measurements and calculate net emissions from a representative set of freshwater reservoirs
- develop predictive modelling tools to assess the GHG status of unmonitored reservoirs and potential new reservoir sites
- develop guidance and assessment tools for mitigation of GHG emissions when necessary

The output from this Project would include:

- A standardized, credible set of data from representative reservoirs
- A methodology and set of tools for predicting reservoir-induced emissions
- Guidance on mitigation options for vulnerable sites

BENEFIT

The Project will benefit decision-makers by improving the understanding of the climate impact of the land-use change relating to the creation of freshwater reservoirs.

The Project will standardize measurement methodology and make it feasible to set up objective measurement programmes in order to quantify net GHG emissions. Part of this process is intended to build consensus on the discounting of emissions that would have occurred naturally in the river basin, and also to discount emissions caused by human activities unrelated to the reservoir.

GHG emission data and net GHG emission calculations from representative reservoirs will be used to populate a database. It is recognized that the most conspicuous paucity of data relates to the tropical and sub-tropical regions.

The Project will develop predictive tools, which will benefit all assessments of GHG emissions from planned and existing reservoirs.

The Project will develop guidelines for mitigation of potential GHG emissions from reservoirs, enabling design, construction and operation of vulnerable reservoirs with sensitivity to this aspect.

BACKGROUND

Freshwater reservoirs are used to regulate flow for water supply, irrigation, navigation and hydropower, as well as security against flood and drought. The measurements of carbon dioxide (CO₂) and methane (CH₄) from the surface and downstream reaches of some reservoirs indicate that the emissions warrant further investigation. The investigation needs to check to what extent emissions may have been elevated or reduced by the creation and operation of the reservoir. Currently, there are not enough information and tools to support sound decisions about existing and new reservoirs and the possible mitigation measures, particularly any relevance to global inventories of greenhouse gas fluxes.

In order to quantify the net greenhouse gas (GHG) emissions from a reservoir, it is necessary to study emissions before and after the construction of the reservoir. The difference between pre- and post-reservoir emissions from the whole river basin will be the true net GHG emission. The study period of emissions should be calculated for 100 years (IPCC 2006).

Data from tropical reservoirs indicates that methane emission varies not only among reservoirs, but also within each reservoir, as a function of type and density of the drowned vegetation, aquatic macrophyte growth, wind speed, temperature, oxygen saturation, water level and other factors. However, only a limited number of sites in the tropical and sub-tropical regions have been investigated. Indeed, few reservoirs have been studied in detail anywhere in the world. The methodology being used for measurements are not standardized; most of the investigations to date have been using surface flux measurements only, and therefore lack the rigour and scope to estimate the emission increase or reduction induced by the reservoir.

IPCC National GHG Inventory Guidelines and criteria for CDM and JI proposals also indicate a strong need for more data. Both IPCC and UNFCCC officials have been briefed on this Project, and are following its progress.

Two scientific workshops on the Greenhouse Gas Status of Freshwater Reservoirs have been hosted by UNESCO in 2006 and 2007. One of the conclusions from the workshop in Paris, France 5-6 December 2006, was to focus more research and better understanding of processes and key parameters leading to the emission of methane from tropical reservoirs. The workshop held in Foz do Iguaçu, Brazil 4-5 October 2007, recommended the following:

"An analytical process will be developed to determine whether GHG emissions from future reservoir sites are likely to be a significant issue. This process will use a small number of key indicators, for example hydrology, reservoir type, climate and organic load. Where this process indicates the potential for significant GHG emissions, more detailed analysis will be applied. To support this process, ~20 representative tropical/sub-tropical reservoir schemes will be selected. At each of these sites, data will be collected within the context of developing a process based model, including a number of sites where more intensive process measurements will be made."

A Working Group of scientists was established after the Brazil workshop in order to develop a Scoping Paper (Annex 1) describing how these recommendations should be carried out. This research programme has been developed by the Working Group.

ACTIVITIES

The Project is divided into several sub-activities, grouped in two steps:

Step one

- Develop a measurement specification
- 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 (including publication in peer-reviewed journals)

Step two

- Develop a process-based predictive model
- Propose mitigation measures for vulnerable sites
- Validate the models and mitigation measures, and report (including publication in peer-reviewed journals)

Guidance for measurement methodology and site selection

Critical to this initiative is to develop guidance for measurement methodology, and to choose a robust set of criteria for the selection of reservoirs for measurements.

In order to have reliable measurements of variables and parameters, a guide is required to create a standard code to be followed in new measurements. It is also necessary to develop guidance in how to use existing measurements and assessments.

Several indicators such as geographical areas and gradients in characteristics should guide the selection of sites for measurements and model development and testing. Sites should include all continents, but have emphasis on tropical regions in Latin America, Africa and Asia. An expert panel will define the site selection criteria in detail. Possible important criteria include:

- Carbon loading, including natural and anthropogenic inputs
- Reservoir area
- Reservoir depth
- Reservoir residence time
- Reservoir age
- Engineering issues such as intake level and location of gates
- Flooded soil and vegetation
- Climate
- Hypolimnion condition

Since all combinations of gradients cannot be represented, it is recommended to select one or two parameters as the primary criteria and to determine how representative the chosen reservoirs are according to the other criteria. Practical issues like accessibility to the reservoir, political situation in the country, local facilities, manpower available, and the support/resources of the host, will also influence the selection process.

Conduct measurements in reservoirs

With full measurement specifications in place, several measurement teams can be engaged through a competitive tender to conduct the monitoring programmes, or the host/owner may wish to build internal capacity to monitor according to the agreed framework. With robust site selection criteria, a clear measurement specification and expert external observation, it may be possible to reduce the minimum number of monitored reservoirs. The measurement teams will be co-ordinated and supervised to ensure standardized results. Each monitoring programme will be funded by the reservoir owner or responsible authority.

Assessment of GHG emissions from reservoirs

A major effort is required within this initiative to account for the natural (pre-reservoir) emissions, and the emissions caused by external human activities in the catchment, that should be subtracted from the 'gross' measurements. The methodology will be focussed on the impact on the GHG emissions within the river basin throughout the (100 year) life of the reservoir. Particular attention will be required in the assessment of the carbon inflow, carbon retained in the reservoir (sedimentation, NPP, preserved flooded stock), influence of a reservoir on the balance in emissions between carbon dioxide and methane and carbon transported to the downstream river, lake or ocean.

Develop predictive modelling tools

The Project will commission the development of an initial empirical model (step one) based on the data collected, with a view to the development of a process-based model approach (step two).

The empirical model will use measured data derived from field studies (on-going programmes and the new studies) prepared in a standardized way following the guidance described above.

Parallel to the development of an empirical model, the process-based model approach will build on one or several existing models. The panel of experts will initiate and keep scientific quality control of the model development.

Describe potential mitigation options

Potential mitigation may be suggested in sites where net GHG emissions are considered unsatisfactory. These sites may act as case studies for mitigation. More detailed general advice may also be developed in a special report. Conversely, in some reservoirs, it may also be possible to design and operate the reservoir to act as a GHG/carbon sink.

REPORTING

As this field of science lacks information and knowledge, it is extremely important to communicate results and findings in a broad range of media, from peer-reviewed scientific papers to more general articles in magazines and on the internet. The following reporting activities will be carried out:

Subject (M = management team, and E = expert panel)	Internet	General article	Technical report	Conference presentation	Peer-reviewed paper
Measurement guidance	M		E		E
Mitigation options	M	M	E	E/M	E
Predictive modelling	M			E/M	E
Each measurement site	M		E	E	E
Assessment of GHG from reservoirs	M	M		E/M	E

WORK SCHEDULE AND OUTPUTS

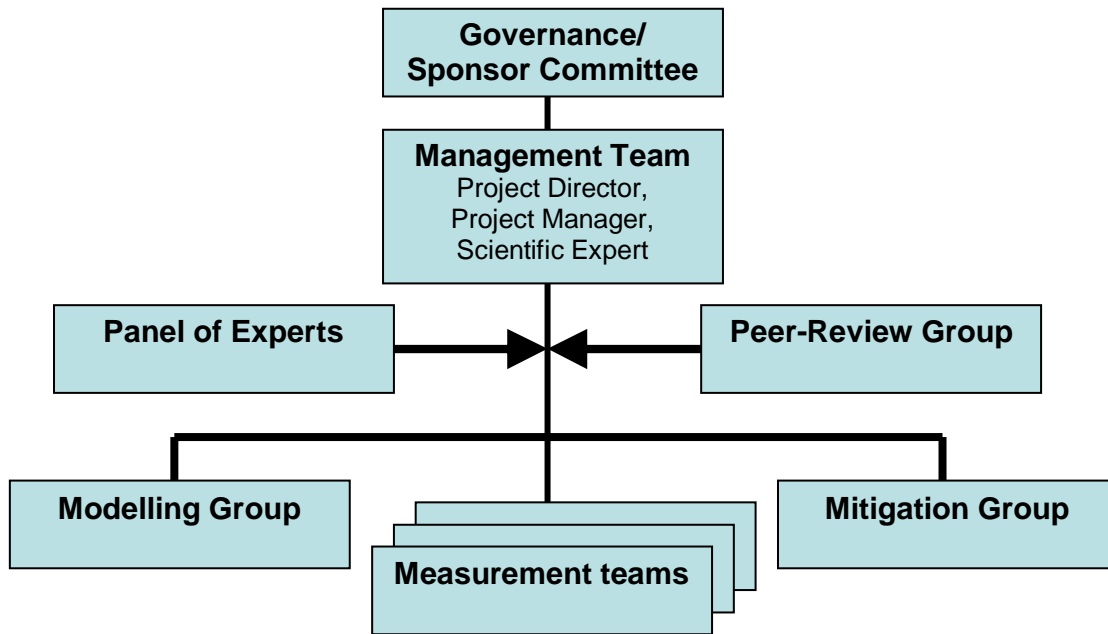
Step one of the Project could be completed in a two-year timeframe. The outputs would be:

- A credible set of data from representative reservoirs, including the tropical- and sub-tropical belt.
- A methodology for estimating net emissions from existing reservoirs and future sites (including a definition of the main concepts for a process-based model.
- Guidance on mitigation options for vulnerable reservoirs.

Work schedule (quarters of each fiscal year to 31 March)	Year to 31.03.2009				Year to 31.03.2010			
	06/08	09/08	12/08	03/09	06/09	09/09	12/09	03/10
Project management	X	X	X	X	X	X	X	X
Assessment methodology		X	X					
Measurement specification		X	X					
Site selection & supervision		X	X	X	X	X	X	X
Model development					X	X	X	
Model assessment						X	X	X
Mitigation guidance						X	X	X
Reporting							X	X
Governance	X	X	X	X	X	X	X	X

ORGANIZATION

A governance body will be established to ensure transparency and the resolution of any issues encountered during the Project, in addition to the scientific guidance by a panel of experts and a peer-review group. The operational management will include a member of the panel of experts, a coordination manager and a director. The Figure below illustrates the organization chart.



BUDGET

The Project may receive financing from a number of sources which have been divided into three components, principally: management, development and monitoring. Sources of funding may include government research funds, global research funds, reservoir owners/developers, and in-kind contributions. The budget summarized below covers the management and development components (EUR k).

Pending refinement of the measurement specification, it is estimated that the cost of monitoring each reservoir will be some EUR 100k/year.

GHG Expenditure (EUR k, fiscal years ending 31 March 2009 and 31 March 2010)	04/2008-03/2009	04/2009-03/2010	SUM
Project management (Personnel and travel costs)	126	165	291
Assessment methodology	53	0	53
Measurement specification	53	0	53
Site selection & supervision	14	10	24
Model development	0	338	338
Model assessment	0	87	87
Mitigation guidance	0	109	109
Reporting	0	42	42
Governance	0	17	17
Sum	232	768	1000
Value pledged (as of June 2008)	190	100	290
Proportion of pledged to total	82%	13%	29%
Costs of monitoring reservoirs: ca. 20 * 100k			2000
To be funded by reservoir developers / operators			

Sponsors committed as of June 2008

The following organizations have agreed to support the Project to date:

- World Bank
- EdF
- International Aluminium Institute
- SN Power
- Statkraft

Negotiations continue with potential direct Project sponsorship, together with reservoirs owners and authorities willing to participate in monitoring programmes.

Discussion continues with various governmental, public and private-sector organizations in relation to harmonizing efforts on current and new initiatives that have been planned independently. For example, dialogue has begun on collaboration with the Brazilian Ministry of Science and Technology, in relation to a possible campaign to measure emissions at representative sites in Brazil. Discussions are also advancing on the planning to start measurements in several existing Asian reservoirs, as well as the possibilities of working with initiatives in Scandinavia and North America.

CURRENT STATUS

- The Scoping Paper has been completed after a thorough consultation process engaging the Peer-Review Group, and is being published as a bulletin of UNESCO's International Hydrological Programme (Annex 1)
- UNESCO has issued a letter of support for the Project, confirming its involvement and supporting IHA's role as coordinator of the Project (Annex 2).
- The Expert Panel is being assembled, under the chair of Prof. Dr. Carlos Tucci and in consultation with UNESCO.
- Drafting of the Measurement Specification has begun, with Atle Harby (SINTEF) taking the lead on scoping the document.
- A Project Manager has been recruited (subject to contract): Prof. Dr. Joel Goldenfum.
- Dialogue is established with key governments, including Brazil and Canada, together with organizations that are interested to contribute to the budget.
- Dialogue is established with IPCC (IHA is represented in the relevant Expert Groups: 'GHG Inventories' and 'Renewables and Climate Change')
- Dialogue is established with UNFCCC/CDM (IHA is represented as an Observer Organization and is in direct contact with the CDM Methodologies Panel).

Update: Richard Taylor, August 2008