Technology Fact Sheet

Peat water management technology Peat re-mapping[i]

1) Introduction

The ICCSR (Indonesia Climate Change Sectoral Roadmap) of forestry sector (BAPPENAS 2009), suggested the most feasible scenario to reach the target of reducing GHG emissions by 26% in the year of 2020 called SC3: increasing sink and creating conditions for preventing further deforestation. Most of the mitigation efforts in this scenario come from the improvement of management practices implemented on 244 newly developed FMU (forest management units) – KPH (Kesatuan Pemangkuan Hutan), in an area extent of 24 million hectares. This scenario has the lowest abatement cost per unit of emission reduction and to reduce annual GHG net emission of 800 abate to 496 MtCo2e within a time period of 2011 – 2020.

In addition, the ICCSR suggested policy oriented mitigation options for the improvement of peat management practices aimed at "low carbon" peatland management by enforcing existing legal requirement and establishing new standards of best practices. Two main mitigation options are suggested: zero burning and water management best practices to reduce annual emission of 470 MtCO2e, from 1700 MtCO2 e of BAU down to 1230 MtCO2e within a time period of 2011 – 2020.

Considering the large size of spatial forest extent and the large number of KPH involved for implementing the mitigation scenario, scientifically credible data and information for carbon accounting of the results of implementing the above mentioned mitigation scenario must be available. This implies that a technological system – a proper combination of expertise (knowledge and skills), tools (equipments and models), and institutional framework (working group, task force, teamwork, etc.) – to facilitate integrated forest-peat measurement and monitoring of carbon stock on targeted forest and peatland areas of mitigation measures needs to be newly invented. Furthermore, its technical reliability and economic feasibility need to be demonstrated for the purpose of technology transfer and diffusion.

2) Technology characteristics

By nature, peat ecosystem is typically characterized by landscape of peat swamp environment. Whenever this natural landscape is utilized into human-made landscapes such as agriculture land, plantation estate, or industrial forest, the most common way is by draining out the peat swamp water to get the largest possible dryer land surfaces. By doing so, the anaerobic environment condition of the peat swamp is converted into aerobic environment of newly built peatland surfaces suitable for cultivation.

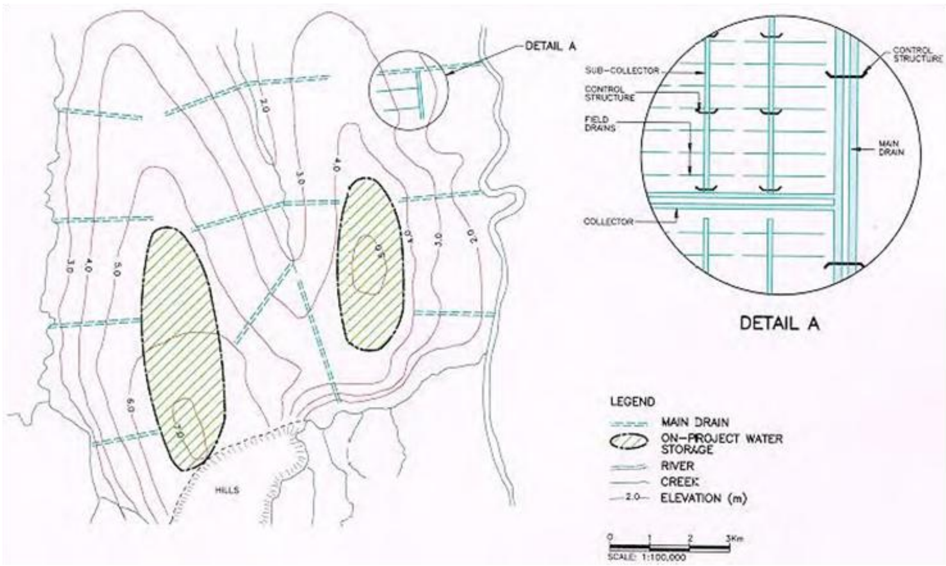
Peatlad Water Management technology is characterized by integrated knowledge and water management infrastructures in forms of irrigation channel networks, regulated drainage channel networks, and or vegetation barriers aimed to reduce emission from cultivated and planted peatlands. Figure 1 shows blocking drainage channel technologies of HTI in Riau and agriculture land in Central Kalimantan.

Figure 1 Water management technology: comb structures applied to HTI drainage channel at Kampar Peninsula, Riau (left) and Tabat (right) applied to agriculture land rehabilitation in central Kalimantan

(Source: Hooijer at al, 2007)

Knowledge of proper spatial configuration of water management structures over a peat domes area is suggested by Ritzema (2007) as depicted in Figure 1.

Figure 2 Spatial configuration of water management structures over a peat domes area



Knowledge of vegetation barriers for protecting hydrological function of peat-domes was only recently recognized by Gunawan et al (2007). The initial purpose of the green belts was to protect the Acacia plantation blocks from wind disturbance, but they also affect hydrological and ecological functions. Such green belts were recognized to maintain water table of no more than 50 cm from the forest surface.

Knowledge on such longitudinal vegetation barriers were also recognized by Hooijer et al (2007). They recognized that most effective buffer will be vegetation belts of non-drained area. Where drained areas are allocated as buffer zones, these should be intensively managed to keep water levels as high as possible given the production requirements; alternative water-tolerant crops should be considered.

3) Country-Specific Applicability

Most of peatswamps in Indonesia have been drained and converted into agricultural lands, plantation estates, and production forest. The most common impact of draining peatswamps for such newly developed landscapes is the significant increase of CO_2 emission because of peat decomposition and subsidence. In addition, over-drained peatlands also promote the occurrence of peatfire during dry season and thus increasing CO_2 emission.

Water management strategies by the use of regulated dams and or stripped vegetation buffer applied to timber and estate crops plantations as well as agriculture lands are proven effective to reduced carbon emissions from drained peatlands. Pilot projects of such water management strategies carried out on timber and estate crops plantations areas of Kampar peninsula's peat domes (Fig 23 left) and on ex mega rice project of Central Kalimantan (Figure 1) have demonstrated the effectiveness of elevating water tables as much as possible, which is achieved by controlling surface water (in drains and channels).

Based on tentative findings in ongoing peatland water management pilot projects, which are funded by APRIL (Asia Pacific Resources International Holdings, Ltd), Hooijer et al (2007) suggested implementing water management improvements at a large scale as soon as possible. The longer it takes to start this, the further peatlands will degrade and the higher the cost of stopping or reversing this process. Ongoing pilot projects provide knowledge on water management measures and strategies suitable for different land use targets, which can be applied to other areas in the future. DNPI (2010) estimated that Restoration of the hydrological functions of the peat by blocking drainage channels facilitates abatement of more than 100 MtCO2e by 2030. Annual emission of 1700 MtCO2e will be reduced to 1230 MtCO2e by implementing "low carbon" peatland management (zero burning policy and water management best practice).

4) Status of Technology in Country

Peatland water management technology is still in the stage of R&D to demonstrate and test its benefits for reducing carbon emission of peatlands because of peat decomposition, peat subsidence, and peat fires. The locations of pilot projects of water management demonstration and test pilot project are Kampar Peninsula (KP) in Riau and the Ex Mega Rice Project (EMRP) area in Kalimantan consist predominantly of peatland, covering many hundreds of thousands of hectares.

The projects in which water management methods and strategies are being tested are (Hooijer et al, 2007):

- The Kampar Science Based Management Support Project, which promotes water management improvements in and around APRIL's pulp wood plantations on the Kampar Peninsula peatlands in Riau (Sumatra), with the aim of optimizing peatland forest and carbon conservation;
- Central Kalimantan Peatlands Project (CKPP), which pilots rehabilitation methods including dams in part of the Ex Mega Rice Project peatlands in Central Kalimantan.

- RESTORPEAT project, also active in the Ex Mega Rice Project in Central Kalimantan, is testing different approaches to channel blocking and retarding water runoff linked to vegetation rehabilitation.

CIMTROP (Center for International Cooperation in Sustainable Management of Tropical Peatland) of the University of Palangkaraya also carried out blocking canal experiments by constructed 8 tabats (blocking dams) along the Kalampangan and Taruna canals in Block C of the former Mega Rice Project (Sulimin et al, 2007). The dams were constructed in July and August 2005 and, resulting elevated water tables in a proximity of 400 m on each side of the channel. The maximum water table increase after dam construction in October 2005 by 151 cm compared with that of prior August 2005.

A major policy which facilitates the implementation of technology for water management of peatland was initiated in the form of Presidential Instruction No. 2 2007. The instruction which is directed specifically to peat water management was directed to Ministers of Forestry, Public Works, and Environmental Affair. These ministers were instructed to block the cutting peat dome canal.

The president instruction No2 2007 has limited geographical area of implementation. It is enough to support national target of annual emission CO_2 emission abatement from implementing “low carbon” peatland management facilitated by new approach to peatland water management. Upscaling of water management methods to national geographical area urge more than ‘business as usual’ measures. Current ongoing knowledge and techniques of water management acquired from the aforementioned pilot project and experiments have to be improved and utilized. International supports would also need to be justified especially for the benefit of reducing global CO_2 missions. This implies that TTD of water management technology will facilitate the abatement potential turn into reality. The prerequisite for TTD should be conducted, aiming to formulate key prototypes of water management technology trough the following measures:

- Compile all of technology components resulted from previous and current R&D on water management, including expertise, tools and equipments, and key players.
- Formulate “ready to test” prototypes of water management technology to facilitate three mitigation options: conservation, rehabilitation, and rehabilitation of peatlands.

Once such prototypes have been formulized, the second chain of “innovation system” for TTD will be ready to start. Again, by the use of the same approach employed by dissemination of technology A1 and A2, the following innovation process should be conducted by employing “interactive learning” of key players of technology diffusion for demonstrating reliability, practicality and financial feasibility of the newly invented prototypes of water management technology:

- Use of all available knowhow and expertise of the first chain of innovation
- Utilize the most practical, reliable, credible, and inexpensive tools (hardware) for the operation of water management prototypes applied for peatland conservation, rehabilitation, and or restoration
- Define the most effective coordination mechanism among the key players of water management (i.e., BPPT, Min of Forestry, Min of Environment, Min of Agriculture, Min of Public Works, Universities, plantation industries, and small holder agriculture).

5) Barriers

Barriers of Technology Transfer and Diffusion (TTD) for this technology is illustrated as a problem tree presented in Figure A (which can be seen in the Appendix below) of this report. It is important to note that the problem tree was defined by selecting a starter problem*: Lack reference project of viable, credible and reliable peatland water management reference project*. This starter problem roots from a total number of four barriers within the root zone and further propagates to four 'canopy' barriers through two stem barriers weak collaborative learning and insufficient knowledge of and or access to proven peat water management technology.

Within the context of innovation system TTD process, root barriers correlate with maturing R&D chain and those of canopy barriers correlate with technology diffusion chain. In other words, the maturing R&D process deals with barriers to provide a *reference project of viable, credible and reliable peatland water management project*, whereas the chain of technology diffusion deals with barriers of adopting this technology in facilitating mitigation measures to establish *a n effective peatland water management* for "low Carbon" peatland management.

To assess possible solutions for overcoming barriers, a hierarchical logical framework analysis was applied to objective trees, followed by a rapid benefit cost/consequence analysis, with special consideration of critical and difficult nature of "take off" – the initial phases when the reliability, practicality and financial feasibility of the technology is demonstrated. Furthermore, the results of such assessment were used to recommend the following overcoming barrier solutions:

Table 1 Recommend overcoming barrier solutions

Recommended Solutions	
Maturing R&D Phase	**Technology Diffusion Phase**
Policy Action: *Establish a "National Demonstrator" project to demonstrate the reliability, practicality and financial feasibility of newly invented peatland water management technology.* *Mode of Action:* *International Capacity Building for a national expert consultation working group through the development of an operational, reliable, credible, and feasible prototype of peatland water management carried out on national demonstrator R&D field stations.*	*Policy Action:* *Establish a "Collaborative Learning" program for technology diffusion to transfer and operationally implement the newly invented prototyped of peatland water management technology.* *Mode of Action:* *On the Job Training for personnel of KPH, HTI, HPH, and other local stakeholders carried out on national demonstrator R&D filed stations followed by a certain time period of trial and adjustment in their areas. The program is designed and implement by national expert consultation working group*

6) Benefits

The ultimate benefit GHG mitigation measures are

- annual GHG net emission of will be 800 reduced to 496 $MtCO_2e$ by implementing KPH-HTI mitigation scenario within a time period of 2011 – 2020
- annual emission of 1700 $MtCO_2e$ will be reduced to 1230 $MtCO_2e$ by implementing "low carbon" peatland management (zero burning policy and water management best practice).

From the perspective of CO_2 emission, the use of proper water management on such newly-built landscapes is critical. Lack of proper water management would lead to over-drained condition of peatland, promoting rapid decomposition and peat fires. Peat decomposition and peat fire contribute annual emission of 300 $MtCO_2e$ and 472 $MtCO_2e$ in 2005 respectively. Under BAU conditions, they will increase up to 370 $MtCO_2e$ and 532 $MtCO_2e$ in 2020. Direct benefit of constructing regulated dams for water management startegies in timber and estate crops plantations located on peatlands will significantly reduce emissions. DNPI (2010) estimated technical abatement of more than 100 $MtCO_2e$ per year in 2030 from restoration of the hydrological functions of the peat by means of blocking drainage channels.

A qualitative assessment of specific benefits of TTD of peat water management technology by this report suggested the followings:

Table 2 Goal: to achieve zero risk of peatland degradation, peatland fire, and peat forest fire

Goal: *To Achieve Zero Risk of Peatland Degradation, peatland fire, and Peat Forest Fire*							
Maturing R&D				**Technology Diffusion**			
Objective *Establishment of reference project of viable, credible, and reliable peatland water management*				Objective *Provide effective water management for "Low Carbon" peat management on HTI, plantation estate, and irrigated farmland*			
Measure (M)	P	C	B	Measure (M)	P	C	B
M1. Establishment of peatland water management task Force	M	L	H	M5. Establish coordination forum of relevant ministries , KPHs, and other stakeholders	M	L	H
M2. Establishment of expert working group for peatland water management	H	L	M	M6. Carry out on-site job training for development and implementation of peatland water management practices	H	H	H
M3. Establish international capacity building for peatland water management prototype development	H	H	H	M7. Develop and implement organization mechanism to establish peatland water management	L	M	M
M4. Provide adequate R&D field stations and facilities for peatland water management prototyping (hardware and software)	H	M	H				
Notes: : P= Priority, C= Cost, B =Benefit , H= High, M= Moderate, L=Low							

7) Operations

Technology for water management strategy is the essential part of 'low carbon' peatland management. Two types of operations are recognized for the implementation of this technology. Firstly, the regulated blocking canal structures applied to HTIs, HPHs, and plantation estates is a capital good technology type of operation and secondly, blocking canal structures applied to forest conservation areas and agriculture lands is a public good technology type of operation.

The first type is operated by HTIs, HPHs, and plantation estates as a part of timber production or plant commodity production processes. Suggested operation and maintenance works are as follows (Hooijer et al, 2007):

- Oil palm plantations require frequent access over water, for maintenance and harvesting. This is done with relatively small boats, so weir/sluice structures can be small in size. Frequent access means that regular maintenance and operational water level control are possible, so constructions can be quite light.
- In pulp wood plantations the canal system is partly dictated by transport, not only water management requirements. Canals must be about 8 to 10 metres wide to allow

log transport with barges every crop rotation, approximately every 5 years. Dams must be removed to allow barges to pass. Such temporary dams are easily constructed from peat; in these plantations excavators are available to construct and remove dams. As peat dams erode quickly if water flows over them, bypass channels and spillways need to be constructed that allow water level control. As water level control is very difficult in channels across contour lines (i.e. following the peat gradient), it is best to only have transport in canals along contour lines, and to use roads for further transport down the slope

The second type is operated by regional office of Ministry of Public Works and Ministry of Forestry. Suggested operation and maintenance are as follows (Hooijer et al, 2007):

Operational water level control with adjustable crests is neither required nor feasible: the aim is to keep water levels as high as possible at all times. Also, boat access is usually not a priority; in fact an aim of structures should be to reduce accessibility. Consequently, permanent dams without bypass channels and requiring little maintenance are to be preferred; if possible these should be backfilled with any remaining material that was excavated in the first place.

Further research and scientific assessment to improve current available knowledge on peatland water management strategy related to carbon emissions of peatlands need to be carried out continuously. National expert consultation working group need to do on site assessment of the results of on going peatland water management measures and best practices. In addition, various types of meetings in the forms of Focused group discussion, workshop, seminar, conference and the like at both regional and national levels of experts and practitioners for communicating and sharing their ideas and experiences need to be established regularly.

8) Costs

In a typical drained peatland area with an average surface gradient of 0.1m/km and a channel spacing of 1km, creating water level steps of 0.2m means that roughly 1 structure is required for every 200 hectares. Each structure costs hundreds to thousands of dollars, depending on type, location and implementing organization (Hooijer et al, 2007). Assuming that each plantation area or peatlands rehabilitation area having 10,000 hectares, a total number of 50 water management structures are required for each of them. With additional assumption hundred dollars equal to USD 500 and thousands dollars equal USD 5,000 the construction of water management structures will need capital cost of USD 25,000 to 250,000. This implies that estimation of other costs (operation and maintenance, administration cost, and enabling environmental cost) of TTD process for this technology will be figuring a wide range of costs. Such an estimation costs, presented in low, medium, high estimate are as follows:

Table 3 Estimation of other costs peat water management technology

Item	Estimated Cost (USD)		
	Low	Medium	High
A. Capital costs one unit of management area of 100,000 ha 1. Construction of 50 water management structures 2. Installation of automatic water level recorder	**125,000**	**250,000**	**350,000**
B. Annual operations and maintenance for each management unit 1. Operation cost 2. Maintenance of water management structure	**15,000**	**75,000**	**125,000**
C. Annual administration costs 1. field assessment by expert consultation working group	**22,500**	**25,000**	**27,500**
D. Annual costs for developing and enabling environment 1. National Workshops 2 times per year @15,000 2. National Seminar and Conference once per year@25,000		**30,000** **25,000**	

9) References and Additional Information

Hooijer Aljosja, Marcel Silvius, and Henk Wösten. (2007). Tropical peat carbon pools and water management: discussion of current investigations and important considerations to achieve reduction of co2 emissions through mitigative water management. In: J.O. Rieley, C.J. Banks and Bostang Ragjagukguk (eds). *Proceeding of the International Symposium and Workshop on Tropical Peatland , Yogyakarta, 27-29 August 2007. Carbon-climate-human interactions on tropical peatland: carbon pools, fire, mitigation, restoration and wise use.* CARBOPEAT Department of Geography University of Leicester University Road Leicester United Kingdom.

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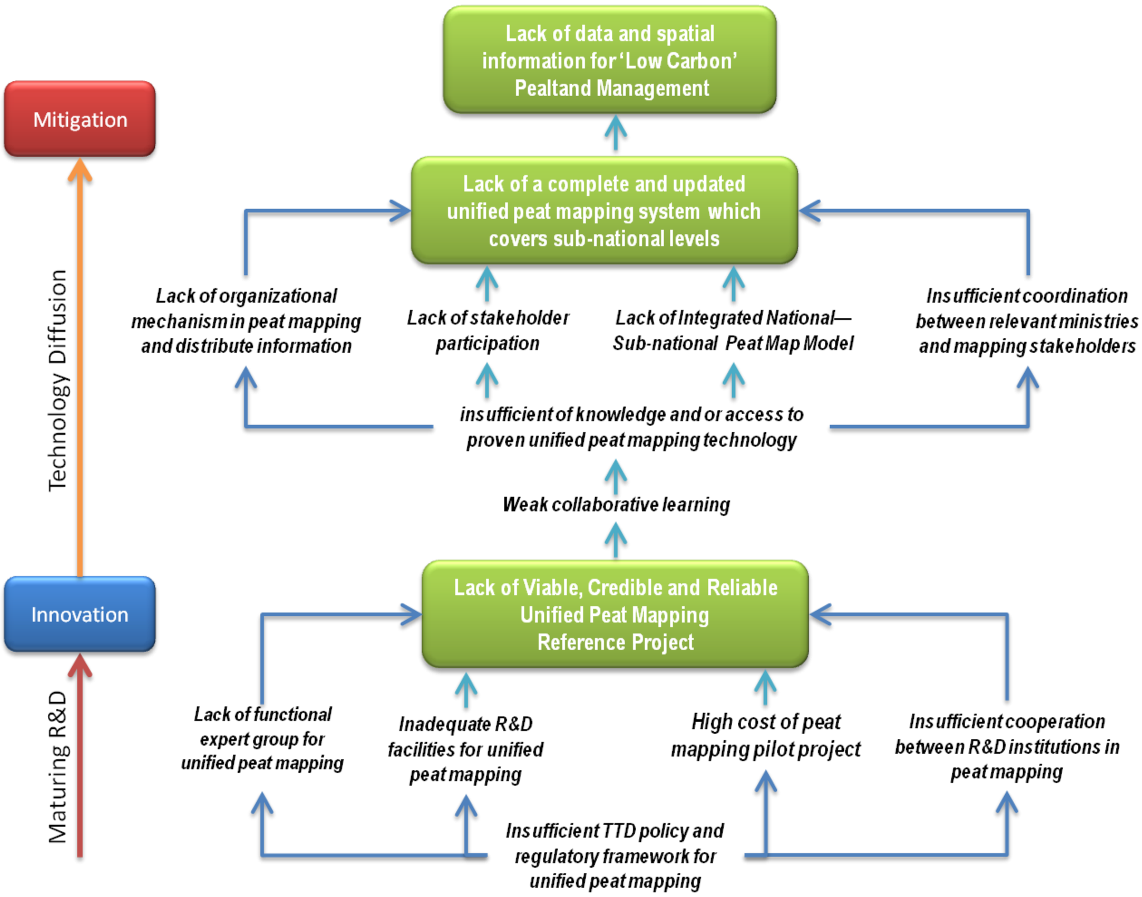
http://www.deltares.nl/en/project/192983/kampar-science-based-management-support-project
http://www.geog.le.ac.uk/carbopeat/yogyaproc.html
http://www.peat-portal.net/view_file.cfm?fileid=247

Appendix

Figure A Problem tree of prioritized technology PRM



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[i] **This fact sheet has been extracted from TNA Report - Mitigation for Indonesia. You can access the complete report from the TNA project website http://tech-action.org/**