New Mechanism Feasibility Study 2011 – Final Report

New Mechanism Feasibility Study for Avoidance of Peat Aerobic Degradation by Peatland Rewetting and Rice Husk-based Power Generation Associated with Rice Production Increase in Jambi Province, Indonesia

By Shimizu Corporation

1. Organization of survey

- Ministry of Public Works: Counterpart, site survey assistance, data provision
- Jambi Provincial Government: Counterpart, site survey assistance, data provision
- Government of Regency of East Tanjung Jabung: Site survey assistance, data provision
- University of Jambi: General assistance with site survey, peat/water table survey, etc.
- Sriwijaya University: Assessment of rice production potential
- Deltares: Assessment of CO_2 emissions from peatland
- University of Tokyo Institute of Industrial Science: Estimation of water table by remote sensing
- Geosphere Environmental Technology Corporation: Hydrological modeling of channels and groundwater
- Satake Corporation: Assistance with study of rice husk biomass power generation
- Polytech Add, Inc.: Assistance with review of methodology and MRV systems

2. Outline of project/activities:

2.1 Details of project/activities

- Host country: Republic of Indonesia
- Project site: Irrigated land in the regency of East Tanjung Jabung in Jambi, Sumatra, covering an area of approximately 10,000 ha (see Figure 2.1)

Project content:

- Raising of water table in the project area by means of improvement of existing water gates, creation of new water gates, bypass landfill, and improvement of water level management
- Inhibition of aerobic decomposition of peat and limitation of carbon dioxide emissions by means of raising the water table in the peat layer (see Figure 2.2)
- Enabling of dual or double cropping by means of raising water table and increasing yield per crop, thereby contributing to sustainable development of significant benefit to the host region
- Deployment of biomass power generation using rice husks produced by increased rice production to further mitigate greenhouse gas emissions and supply electricity

to non-electrified regions

- Project implementer: It is envisaged that implementation of the project will be funded by a consortium (including Shimizu Corporation) under a bilateral agreement between Japan and Indonesia to reduce greenhouse gas (GHG) emissions.
- Term of project: Envisaged to be approximately 10 years beginning in 2015.
- The project counterparts are envisaged to be the Ministry of Public Works (representing central government) and the Jambi provincial government (as the agency with jurisdiction over the site).
- How the project will reduce GHG emissions: Tidal zone river water will be introduced to the site by means of water level management (including water gate control) to raise and keep water levels at a certain level. Raising water levels will inhibit aerobic decomposition of peat by microorganisms, thereby enabling peat CO_2 emissions to be reduced.

Figure 2.1 Project site (irrigated land in East Tanjung Jabung in Jambi, Sumatra)

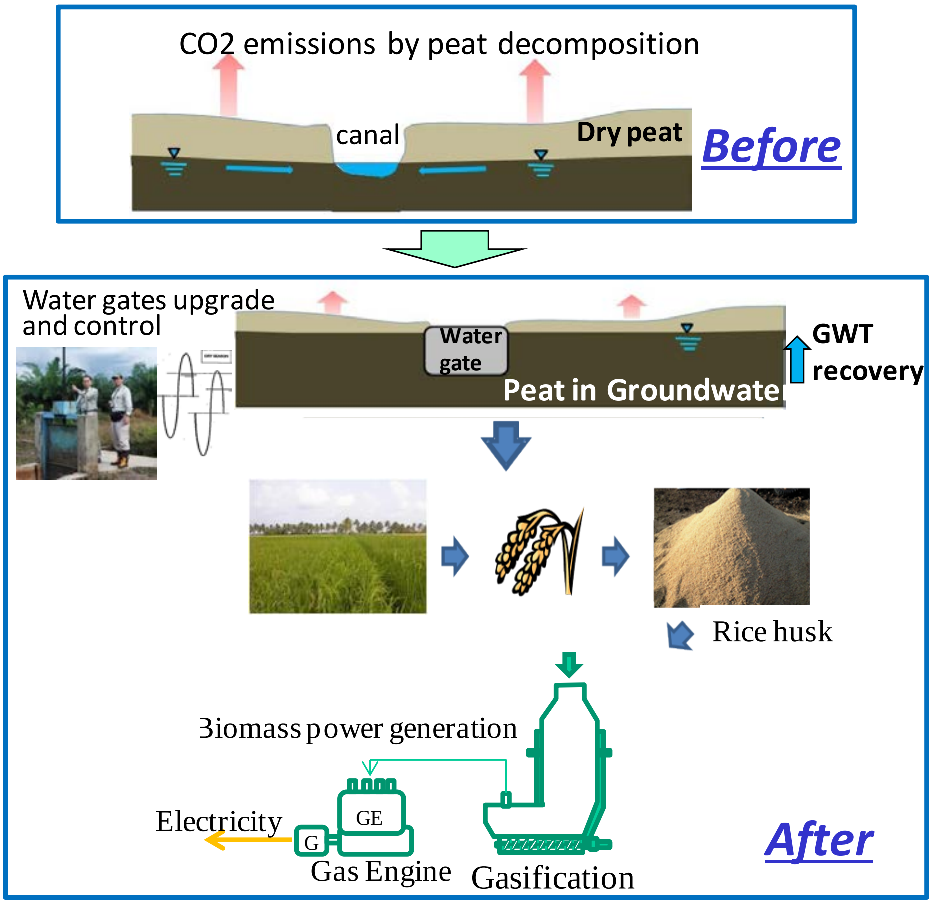


Figure 2.2 Outline of project activities

2.2 Situation in host country

Since last year, the Indonesian government has been developing domestic arrangements in accordance with the NAMA action policy that it presented to the United Nations. While the position of bilateral mechanisms is unclear, below we describe host country policy on NAMAs and REDD (as a component of NAMAs) in view of the likely need for consistency with NAMAs.

Host country policy on new flexible mechanisms (NAMAs, REDD)

- The government ministries and agencies involved in peat conservation are the Ministry of the Environment, the Ministry of Forestry, and the Ministry of Public Works. The Ministry of Public Works is involved in peat management through its responsibility for swamp development.
- The designated national agency (DNA) responsible for NAMAs in Indonesia is the National Council of Climate Change (NCCC).
- In January 2010, the NCCC reported to the UNFCCC on Indonesia’s policy on NAMA initiatives as shown in the table below.
- Indonesia has declared goals of reducing GHG emissions by 26% by domestic NAMAs and by 16% by supported NAMAs by 2020, and peatland heads the list of sectors targeted for action.

Table 2.2.1 NAMAs plan in Indonesia

Total GHG reduction target	Sectoral reduction target/mitigation action sector	Base year or baseline emissions	Climate change plan	Other information
26% reduction through domestic-only action by 2010 41% reduction with international support	1. Sustainable Peatland Management 2. Reduction in Rate of Deforestation and Land Degradation 3. Development of Carbon Sequestration Projects in Forestry and Agriculture 4. Promotion of Energy Efficiency 5. Development of Alternative and Renewable Energy Sources 6. Reduction in Solid and Liquid Waste 7. Shifting to Low-Emission Transportation Mode	BAU	Yes (national action plan)	Sectors covered by national action plan (2010-2010): - Peatland - Forestry - Agriculture - Energy - Industry - Transportation - Waste management Original 1 (English) Original 2 (English)

Source: MOE/OECC New Mechanisms Information Platform.

- CO_2 emissions from peatland came to approximately 800 million tons in 2005, equivalent to 38% of total emissions. If no action is taken, it is estimated that this figure will rise to approximately 1 billion tons in 2020.
- Forest and peatland will remain Indonesia’s largest emission sources, and Indonesia aims to reduce these sectors’ emissions by 670 million tons (domestic NAMAs) and 370 million tons (supported NAMAs).
- Development of NAMA arrangements in Indonesia is presently being led by the National Development Planning Agency (Bappenas).
- President Yudhoyono signed a sectoral reduction plan this September.
- On the question of how credits will be generated by forest management based on REDD, moves are underway to develop an Indonesian I-VER scheme modeled on Japan’s J-VER (according to interviews with NCCC in 2010).
- It was decided at COP16 that the Japanese government would seek to expand the J-VER credit scheme to Indonesia (including, where necessary, making revisions to the scheme) and contribute to capacity building through, among other things, educational programs. This may be regarded as constituting part of Japan’s support for implementation of NAMAs by developing countries.
- Application of an existing scheme in this manner offers the advantage of making it possible to reduce social costs on the Indonesian side. It also appears both consistent with frameworks of bilateral cooperation and leads action by other countries.

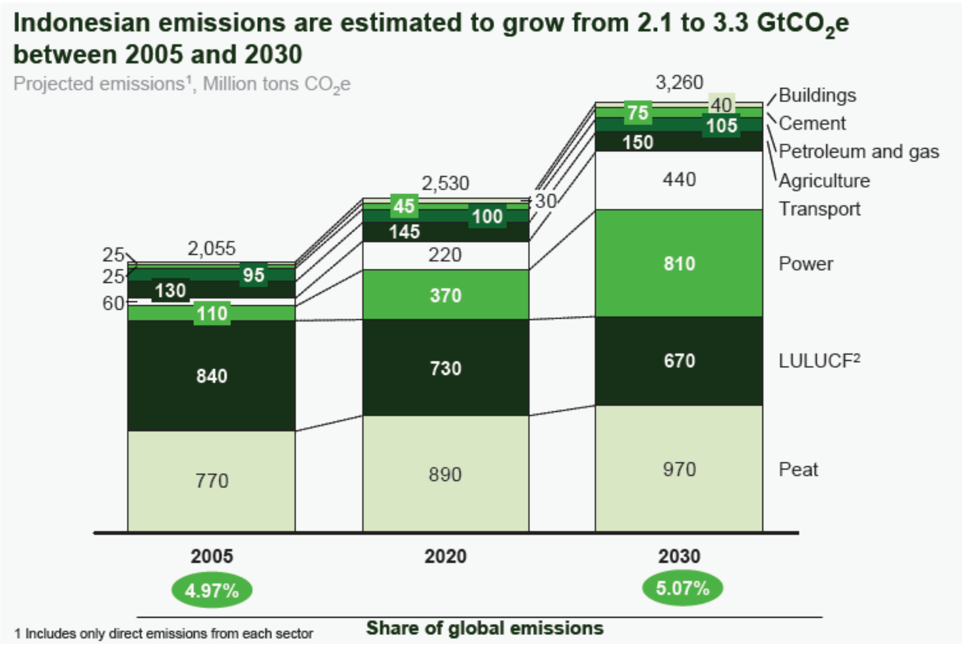


Figure 2.2.1 Indonesian emissions forecast

2.3 Eligibility as new mechanism

The specific principles set forth in the national action plan based on the sectoral roadmap formulated by the Indonesian government to attain its national reduction target by 2020 are as follows.

Main principles:

- Mitigation action should not hinder economic growth and should prioritize people's welfare (particularly in regard to energy resilience and food security)
- Mitigation action should support protection of poor and vulnerable communities, including environmental conservation, in the framework of sustainable development.

In line with these principles, activities under the project can at the same time reduce CO_2 emissions from peatland and contribute to food security through increased rice production. They also meet the requirements for new mechanisms in that they will have the effect of raising the incomes of rural communities at the bottom of society that have been left behind by Indonesia's development.

2.4 Strategy to promote expansion of project/activities:

Activities under the project should serve to both reduce GHG emissions and increase crop yields as a result of improved water level management.

Farmland development in lowland areas and conservation of agricultural land in Indonesia has traditionally been led by the Ministry of Public Works, and the improvement of water level management that is sought through the project coincides with ministry policy. It is essential for Indonesia to continue to develop agricultural land in lowland coastal areas, including areas of peatland, to ensure food security (i.e., a sufficient food supply for its population), and adopting effective water level management will thus be a necessary part of this strategy to secure crop yields. Accordingly, water level management as practiced under the project in the course of collaborative development of farmland by the Ministry of Public Works and Ministry of Agriculture should lead to the wider adoption of practices that reduce GHG emissions from peatland.

3. Details of Survey

3.1 Survey questions

The issues for clarification in the present survey are as listed below.

- Determination of present conditions at site (baseline) and assessment of potential for GHG reduction
  Consistency with government policy, survey of water gates, measurement of peat/water table/flow rates/rainfall, assessment of CO_2 emissions, hydrological modeling, remote sensing, assessment of potential for increased rice production, feasibility study of biomass power generation, assessment of contribution to sustainable development.
- Survey of rice husk power generation and peat-related methodologies
- Survey of reference scenario
- Survey of monitoring methods and plans
- Survey of quantification of GHG emissions and reductions
- Survey of MRV methods

3.2 Survey content

3.2.1 Literature survey: Acquisition and analysis of survey and research reports

3.2.2 Site survey planning and coordination with related organizations

3.2.3 Field survey

Six field surveys were conducted during the survey period to continuously monitor conditions at the site. Tasks including surveying of unevenly distributed peat reserves (depth, properties, bulk density, etc.), measurement of water levels and quality, and soil analyses were performed. Using the findings thus obtained, reference emissions were estimated. A study was also made of how to assess water levels by means of hydrological modeling and remote sensing, and the potential reduction in CO_2 emissions resulting from raising the water table was ascertained and the feasibility of increasing rice crop yields was assessed.

3.2.4 Survey results

Development of reference scenario and estimation of potential for GHG reduction further to determination of current conditions at site

- Measurements were obtained by combining a survey to understand the site in its entirety (site scale survey) and a survey of representative points to understand features of the site in greater detail (plot scale survey) (see Figure 3.2.1).

- Site scale survey items: Peat depth and properties; peat settlement, bulk density, and carbon concentration; groundwater depth and quality; flow regime; permeability, present state of water gates, etc.
- Plot scale survey items (plots A/B/C): In addition to the above, more detailed water table measurement, rainfall measurement, soil surveying, etc.

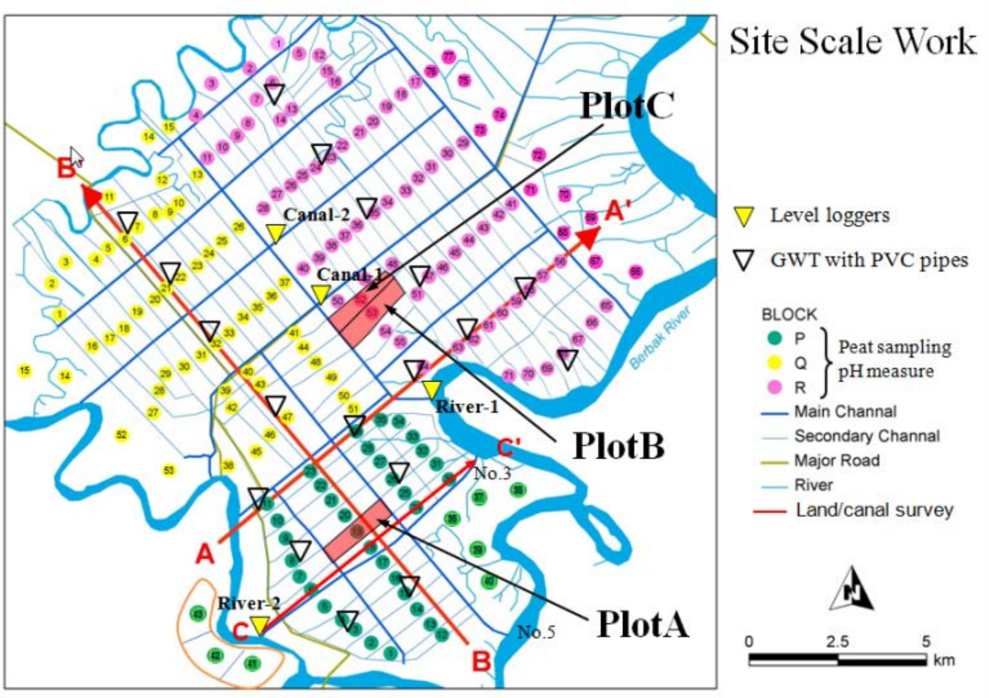


Figure 3.2.1 Plan of site scale survey

- Consistency with government policy (1): Information on the Indonesian government's lowland coastal development and food security plans was obtained from PU and consistency with the present feasibility study was confirmed.
- Consistency with government policy (2): Being an island country, Indonesia's electrification rate outside major urban areas is low and the state-owned electricity utility's electricity sales to the Sumatra grid come to only around 15% of its total. In view of these circumstances, the government has adopted a policy designed to actively expand small-scale power generation using renewable energy resources (including biomass) under Minister for Energy Resources Order No. 1122/K/30/MEM/2002, etc. Accordingly, there is strong demand from the provincial government and residents for supply of electricity to rural communities in the Berbak Delta by means of biomass power generation using rice husks currently discarded as waste.
- Water gate survey: Water gates were surveyed in approximately 200 locations around the site.
- Measurement of peat, water table, flow, and rainfall: Measurements were made at the site of peat depth, bulk density, carbon concentration, water table level, rainfall, etc. between September 2011 and February 2012. Data on water table

levels and weather conditions were used for comparison and inputted into the hydrological model.

- Measurement of peat settlement: PVC pipes have been set up to take ongoing measurements of peat layer settlement at 25 points.
- Assessment of CO_2 emissions: Based on the above data, a study was made of methods of assessing the potential for reduction of CO_2 emissions by means of restoration of groundwater (peatland rewetting) on peat farmland.
- Hydrological model: A model of variations in groundwater level allowing for rainfall and river water was developed to reproduce present conditions and assess the impact of restoration of groundwater levels.
- Remote sensing: Groundwater levels on the site was estimated using satellite data.
- Assessment of potential for increased rice production: In addition to determining the present state of agriculture on the site, an assessment was made of the potential for increasing rice yields by restoring the water table level and obstacles to ongoing sustainable agriculture were identified.
- Survey of potential for biomass power generation: A survey was made of potential power output using rice husks produced by increased rice production, sources of demand, and technological aspects.
- Assessment of contribution to sustainable development: A study was made of elements necessary to raise rural living standards, including increases in rice yields, infrastructure development, and supply of electricity to non-electrified rural communities.

3.2.5 Literature on quantification of GHG reduction through rewetting

Two relevant studies in the literature concerning methodologies for quantification of reduction of GHG emissions by rewetting are VCS's "Baseline and Monitoring Methodology for the Rewetting of Drained Peatlands Used for Peat Extraction, Forestry or Agriculture Based on Gests" and "Rewetting of Drained Tropical Peatlands in Southeast Asia." These two methodologies are both presently undergoing public comment and are subject to partial change. However, the basic principles of quantification are expected to remain unchanged. Given the site's locality, "Rewetting of Drained Topical Peatlands in Southeast Asia" appears applicable to the present project.

3.2.6 Hydrological modeling

Hydrological modeling appears to offer an appropriate method of investigating quantitatively the effects of restoring the water table to conserve peatland and increases in crop yields. Hydrological modeling will also be necessary to supplement measurements of groundwater at the site (monitoring items) and fulfill the necessary conditions at measuring points when the project is actually implemented. The results of analysis using the hydrological model in the present survey are described below.

- A basic overview of the peat wetland subject to analysis by hydrological modeling is depicted in the figure below. The model analyzes interactions between tidal open channel flows, flood flows, and underground fluids (saturated/unsaturated flows) taking into account evapotranspiration and soil evaporation, etc. due to differences in local weather conditions and vegetation.
- Construction of drainage channels, cross-sectional shaping, and channel sloping in the area concerned are important design parameters affecting the scope to which the water table in the peat layer can be stabilized (i.e., the possible range of water conveyance and drainage), and the field survey findings and results of measurements were reflected in the analytical model.
- An analysis of site scale water level variations based on inputs of tidal changes in the depth of the Berbak River and rainfall indicates that there exists a blocking effect on low-lying wetland such that tidal changes propagated to secondary waterways block groundwater drainage in the peat layer. At points of high altitude further from the Berbak River, on the other hand, drainage from peat layer to waterways caused by changes in water depth propagated via waterways is accelerated.
- Based on the results of analysis of this tidal zone, temporary water gates were installed and closed for a certain period during the dry season. As a result, groundwater drainage in the peat layer was subsequently reduced, thus confirming the potential for stabilizing the water table (see below regarding the results of calculation of water level fluctuations in the village of Rantau Rasau).

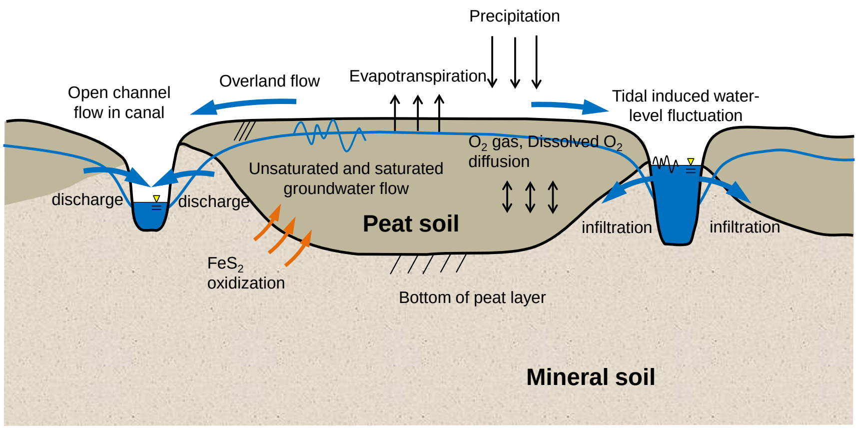


Figure 3.2.2 Main elements of hydrological model of peat wetland for analysis

Figure 3.2.3 Changes in water level when water gates were operated in plots B/C in Rantau Rasau (S2 = gates open, S3 = gates closed)

3.2.7 Assessment of potential for increased rice production

Interviews conducted in the host region and cases of successful past practice in the Palembang/Musi River basin indicate that maintaining the water table is the most important factor in raising rice production in the area, and increases in rice yields at the site appear likely if the water table can be restored by means of water gate management. Below, therefore, it is assumed that increased rice production will be possible.

Based on the above successful past practice in the Palembang, it is estimated that restoration of the water table in paddy fields with a current yield of 2 t/ha per year will result in a doubling of yields in one cropping season and, if dual cropping is continued as at present, an annual yield of 6 t/ha. The yield from a 10,000 ha of paddy fields would in this case amount to a total of 60,000 t/year.

As approximately 15,000 t of rice husks are normally obtainable from 60,000 t of unhulled rice, we consider rice husk power generation assuming the availability of 15,000 t of rice husks.

3.2.8 Assessment of potential for rice husk power generation

(1) Scale of rice husk power generation in Berbak Delta

Considering the scale of rice husk power generation that would be possible based on the above, gasification for power generation of up to 1 MW appears the best option. The reasons for this are as follows.

1) Considering the thermal efficiency of steam turbines, it is estimated that 14 t/h of rice husks would be required. The area of paddy fields needed would be 80,000 ha.
2) Steam turbines require large quantities of rice husks, which would be enormously expensive to collect and transport. In the case of small-scale gasification power generation, collection by human power is also possible.

3) Rice husks for gasification power generation can be used and stored in the form of briquettes. Rice husks will therefore require less storage space and be available for power generation throughout the year.
4) Gasification power generation (using briquettes) is more thermally efficient.

Output per gasification generator is 625 kW, which requires approximately 1 t/h of rice husks. Assuming 24-hour operation for 350 days per year (allowing 15 days/year maintenance), the quantity of rice husks required as fuel per year will be:
1 t/h (quantity of rice husks needed for combustion) x 24 hours x 350 days = 8,400 tons/year
Based on an increase in yield per hectare from 2 t/ha at present to 6 t/ha that the assessment of potential for increased rice production suggests is possible, yield after the increase in production will be as follows:

10,000 ha x 6 tons/ha = 60,000 tons (rice)

Assuming that around 25% of the rice is husk, the amount of rice husk available as fuel for rice husk generation will be as follows:

60,000 tons (rice) x 25% = 15,000 tons (rice husks)

As the project will require 8,400 tons of rice husks per year and availability will be at least 25% above this figure, the requirements for a CDM biomass power generation project are met. As there is extremely little likelihood of sourcing biomass from beyond the project boundaries, there appears to be no need to consider this as a source of leakage in the project.

(2) Indonesian grid emission factor

Drawing on data for the Sumatra grid published by Indonesia's DNPI on its website, the present survey uses a figure of 0.743 tCO_2eq./MWh for the grid emission factor.
(http://pasarkarbon.dnpi.go.id/web/index.php/dnacdm/read/14/emission-factors-for-sumatera-and-jamali-grid-2008.html)
The project region consists of a mix of non-electrified and electrified areas. As non-electrified areas are to be electrified in the near future according to interviewed sources including the host government and the PN, however, it was determined appropriate to use the emission factor for the Sumatra grid in calculating the reduction in GHG emissions on the assumption that decreased use would be made of on-grid power plants due to the replacement of grid power by power generated under the project.

(3) Reduction of GHG emissions by rice husk power generation

The reduction of GHG emissions by rice husk power generation is estimated as follows. Power plant capacity is 625 kW. After deducting 125 kW for quiescent power consumption and 100 kW for motive power to drive briquetting machines, 400 kW will remain available for offsite supply. Output from the project substitutable for grid power is therefore estimated to be as follows:

400 kW x 24 hours x 350 days = 3,500 MWh

Accordingly, the reduction in GHG emissions works out as follows:

3,500 MWh/year x 0.743 tCO_2eq./MWh = 2,600 tCO_2/year

Interviews were conducted to investigate whether fossil fuel use in transportation of biomass would result in project leakage. It was found, however, that rice husks would be transported by rural inhabitants to collection points by bicycle or rowing boat, obviating the need to use fossil fuels for this purpose. Quiescent power for power plant and motive power for briquetting machines would be provided from power generated by biomass power generation, avoiding use of fossil fuels for this purpose too. There will consequently occur no leakage.

4. Findings regarding feasibility of new mechanism project/activities

4.1 Reduction of emissions as a result of project/activities

As maintenance of the status quo—i.e., no restoration of the water table or biomass power generation—is taken as the reference scenario for the project, reductions in CO_2 emissions will be achievable through a combination of restoration of the water table to reduce aerobic decomposition of peat and reduction of grid power use through biomass power generation.

With the assistance of Hooijer et al. of Deltares, the present feasibility study considered reference CO_2 emissions caused by aerobic decomposition on irrigated peatland based on the literature to date and site survey findings. Regarding power generation, an investigation was made of the scale of power generation, grid emission factors, and other relevant data.

Based on the findings of the above, GHG emissions under the reference scenario and GHG emissions in the event of implementation of the project were quantified to estimate the reduction in GHG emissions. These findings also formed the platform for development of the core elements of a methodology for emission reduction projects on peatland in irrigated areas.

4.2 Determination of reference scenario and boundaries

(1) NAMA initiatives and reference scenario

The opinion of the DNPI, as the DNA in Indonesia, on the development of a reference scenario is shown in the figure below.

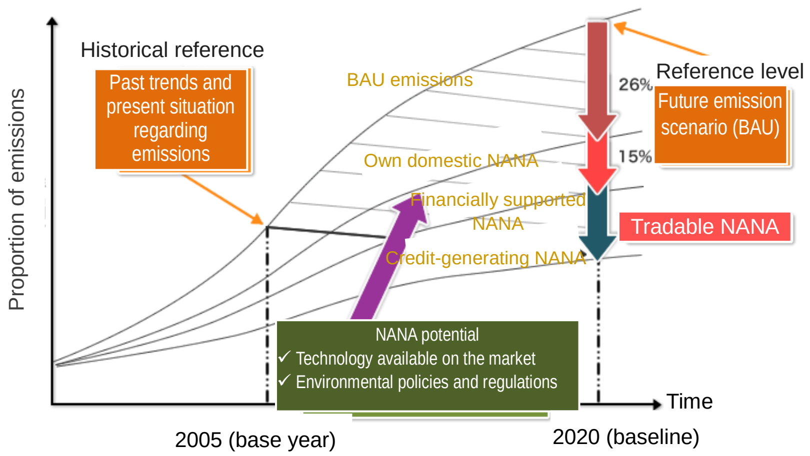


Figure4.2.1 Indonesia's NAMA potential (hypothetical analysis)*

*From the New Mechanisms Information Platform.

Indonesian NAMAs basically cover all sectors targeted for national development (forestry, agriculture, production, mining, energy, public works, etc.) and the methods of attaining emission reduction targets are not clearly identified. Taking BaU as the reference scenario, however, the DNPI envisages a 26% reduction in emissions through use of central government allocated spending (APBN) and implementation of independent domestic NAMAs, and a further 15% reduction in emission achieved through use of official development assistance (ODA) and foreign financed/supported NAMAs. Use of creditable NAMAs as a means of achieving further emission reductions is also indicated as a possibility.*

As regards the present state of peatland, peat destruction due mainly to slash-and-burn agriculture and development is expected to be considerable, thus resulting in increased emissions of GHGs, if the project does not take place. The reference scenario should preferably therefore be based on maintenance of the status quo (BaU); in other words, on water table management not being practiced.

President Yudhoyono recently (September 2011) signed a presidential decree to create a national action plan to cut GHG emissions in individual sectors, and Indonesia's presidential advisor on climate change, Agus Purnomo, told Reuters that emissions in the forestry and peat sectors would be reduced by 672 million tons by 2020 under this plan. This figure could rise to up to 1 billion tons with support from developed countries. Methods of achieving reductions, the specific NAMA frameworks to be used, and other concrete details are expected to be clarified in the future.

(2) Determination of boundaries

The physical boundary of the project covers an area of approximately 10,000 ha of farmland in East Tanjung Jabung, Jambi. More specifically, it consists of an area that was developed as farmland by the Indonesian Ministry of Public Works in the 1970s under the Java Transmigration Plan, and it is presently managed by a local agricultural union. Geographically, it consists of a delta sandwiched between the Batang Hari and the Berbak River, which branches from the Batang Hari near its mouth.

As project activities will consist chiefly of water level control by means of water gates and other devices, the scope of effect of the restoration of the water table through water level control may be regarded as the project boundary, which coincides with the above area.

As there occur practically no peat or forest fires in the project area, the boundary for emissions is limited to CO_2 generated by microbial decomposition of peat.

Even if fires should occur in the project area in the future, it may be assumed that these would have occurred irrespective of project activities, and so they are not included within the project boundary. Should peat reserves decline as a result of such fires, however, this would affect the CO_2 emissions reducible by water table management. Assessment of peat loss should therefore be continued.

Regarding future expansion of the project, the physical project boundary (project area) may be expanded by expanding the monitoring area. However, it is assumed that there will be no change in the gases covered from the CO_2 generated by microbial decomposition of peat.

4.3 Monitoring method and plan

The following approach was employed to assess the reduction in GHG emissions through the project.

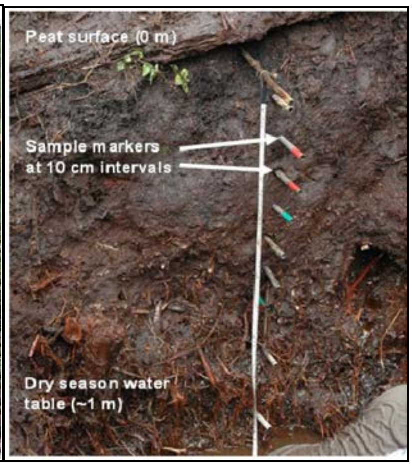
(1) Measurement of reference level (determination of pre-project conditions)

- Reference level of CO_2 emissions due to aerobic decomposition of peat
  1) Measurement of peat depth and properties: The amount of peat present at the site was measured to determine the reference level (baseline). As the quantity of peat varies according to location, peat samples were taken from individual plots to determine the depths and properties (fibric, hemic, sapric) of the peat in these plots. Each plot (one block surrounded by a network of channels on the site) measured around 100 ha in size (see photo).
  2) Measurement of peat settlement: PVC pipes were inserted as far as the ground level below the peat layer in each plot to measure peat settlement based on changes in ground level relative to the pipe (i.e., settlement associated with peat decomposition) (see photo).
  3) Measurement of peat density: Bulk density (BD) was measured in representative plots (see photo).
  4) Determination of quantity of peat present: The amount of peat present before the project was calculated from 1) and 3) above. This offers the greatest potential for reduction of CO_2 emissions at the project site, and needs to be known in order to assess the feasibility of the project.
  5) Calculation of CO_2 emissions: Pre-project carbon loss (= CO_2 generated) is

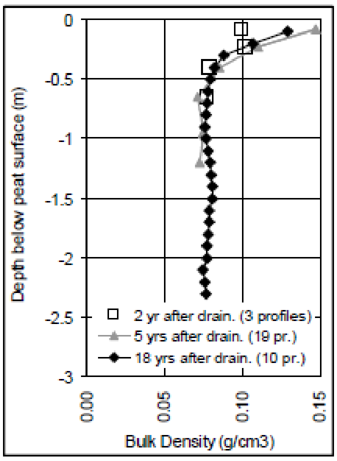
calculated from 2) and 3) above.

6) The reference level was measured by keeping the water table in some plots at the pre-restored level following commencement of the project.

Pipe for measurement of water table/settlement



Sampling for peat bulk density analysis (reference)



Bulk density of Sumatra peatland

- Water table reference level
  1) The water table was measured in each plot to determine the water table reference level. The representativeness of water table measurements was verified by means of hydrological modeling and taking measurements at close intervals.
  2) The reference level was measured by keeping the water table in some plots at the pre-restored level following commencement of the project.

(2) Measurement of emissions after commencement of project

- Measurement of restoration of water table
  1) Measured depth of water table: The water table will be restored after commencement of the project and the water table after restoration measured in each plot.
  2) Rise in water table: The rise in the water table at the project site will be determined from the difference between the water table reference level (I above) and the measured depth of the water table after restoration. This will demonstrate that the water table has actually risen and quantify the rise. This will indicate, in other words, that the following reduction in emissions is due to implementation of the project rather than to other factors.
  3) A hydrological model will be used to provide complementary data on water levels between measuring points and confirm that the values for the rise in the water table are appropriate.
- Quantification of reduction of CO_2 emissions due to aerobic decomposition of peat
  1) Measurement of peat settlement: Peat settlement (due to peat decomposition)

will be measured after project implementation too on the basis of changes in the ground level using PVC pipes inserted in each plot.

2) Calculation of CO_2 emissions: The amount of CO_2 generated when the water table is restored will be determined from data on peat settlement and BD obtained as described in I-3 above.
3) The reduction in emissions after restoration of the water table is determined from the difference between this amount and reference emissions determined as described in I-5.

For the present survey, measurements were taken at the project site following the above approach on reference levels. While it will require several years to obtain reliable data on peat settlement, this data will make possible an assessment of reliable reference levels. As described below, (ex-ante) forecasts of the reduction in emissions can be calculated by hypothesizing water table depth before and after implementation of the project, and this approach was used for the assessment described in this report.

4.4 GHG emissions and reductions

Already in the preceding section, we have described our approach to assessment of reference emissions and the methodology for quantifying the reductions as well as the monitoring items themselves. If the reduction in emissions determined from the above measurements and calculations can be correlated to water level, it becomes possible to calculate the reduction as follows.

Following Hooijer et al. (2011), the relationship between water table decline and carbon loss (= CO_2 generated) on peatland is as shown in the figure below. The relationship for peatland plantations in Jambi is thus expressed by the following equation:

$$CO_2 \text{ loss} = 21 - 69 \text{ x (average water depth)}$$

Expressing this in terms of the relationship between the restoration of the water table (ΔGWT) and the reduction in CO_2 emissions (ΔCO_2) produces the following equation:

$$\Delta CO_2 = 69 \text{ x } \Delta GWT$$

- Reduction potential at the site
  Using the above relational expressions, we find that carbon loss in the event of a 0.5 m rise in the water table is 34.5 $tCO_2$2e/ha/y. The reduction potential for the entire site 10,000 ha site thus works out at 345,000 tCO_2/e/y.
- Reduction potential in Indonesia as a whole
  Irrigated farmland located in tidal areas in the host country (estimated conservatively counting only developed land) comes to 835,000 ha. Much of this is located in the same area as peatland (see figure below). Assuming conservatively that one third is peatland, this yields a figure of 280,000 ha. Accordingly, 280,000 ha x 34.5tCO_2e/y = 9,660,000 tCO_2e/y, which means CO_2 reduction potential is approximately 9,700,000 tons per year.

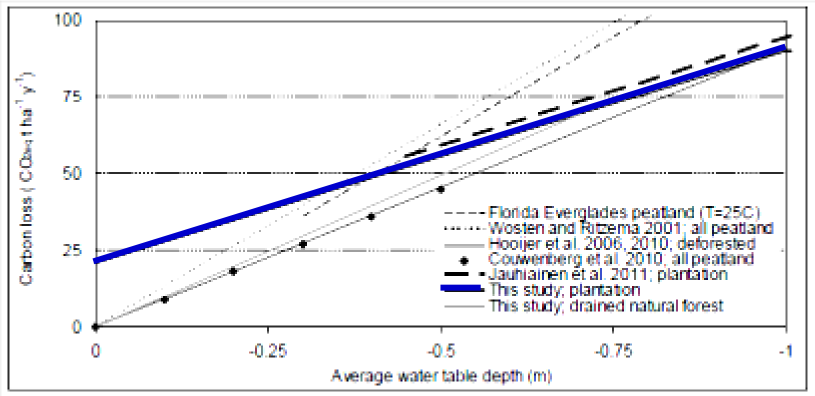


Figure 4.4.1 Relationship between water table depth and carbon loss (at least five years since drainage. applying thick line)

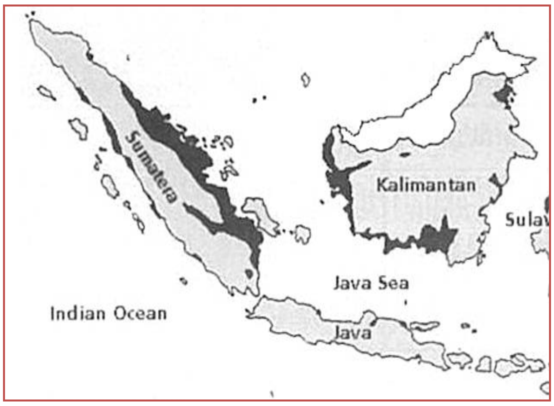


Figure 4.4.2 Lowlands in Indonesia

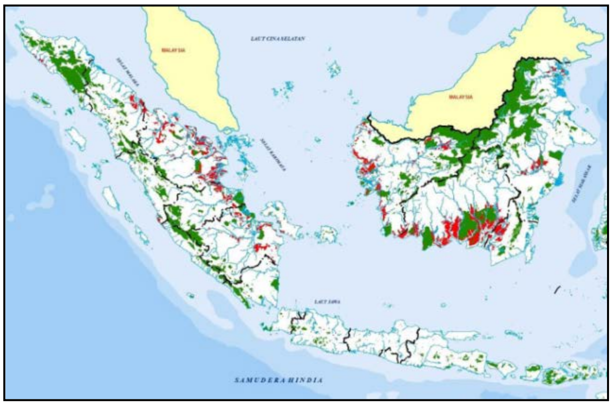


Figure 4.4.3 Distribution of peatlands in Indonesia (shown in red)

Table 4.4.1 Distribution of government-developed lowlands

	Total swampland area						Total area developed by Indonesian Government					
	Tidal		Non-tidal		Total		Tidal		Non-tidal		Total	
Location	Ha ('000)	%	Ha ('000)	%	Ha ('000)	%	Ha ('000)	%	Ha ('000)	%	Ha ('000)	%
Sumatra	6,604	20	2,766	8	9,370	28	615	1.8	279	0.8	895	2.6
Kalimantan	8,127	24	3,580	11	11,707	36	220	0.7	192	0.5	412	1.2
Papua	4,217	13	6,306	19	10,522	31	0	0	6	0	6	0
Sulawesi	1,149	3	645	2	1,793,	5	0	0	2	0	2	0
Total	20,097	60	13,296	40	33,393	100	835	2.5	480	1.3	1,315	3.8

4.5 Methods of measurement, reporting, and verification (MRV) of emission reductions

CO_2 emissions need to be calculated per hydrological unit of terrain regarded as having a uniform average water table depth (plot scale units of the site assumed to measure around 100 ha) and estimates calculated for the site as a whole (approximately 10,000 ha) by the following process (see figure below):

1) Topography, weather conditions, and water level are measured at representative points.
2) Land-observation and weather satellite data on the site are obtained.
3) A GIS database is created containing information on the conditions for each plot scale by means of comparison and correction of the above data.
4) Water level fluctuations across the site as a whole are calculated mathematically using the hydrological model in order to determine the average water level increase (ΔGWT) in each plot.
5) The emission reduction in each plot is calculated from ΔGWT using the above equations and the aggregated total of these reductions treated as the reduction for the site as a whole.
6) Carbon biomass is assessed from the carbon measurements and settlement measurements taken at representative points in order to confirm the calculated emission reduction of each plot.
7) Following the above process, reliable emission reductions can then be reported and verified.

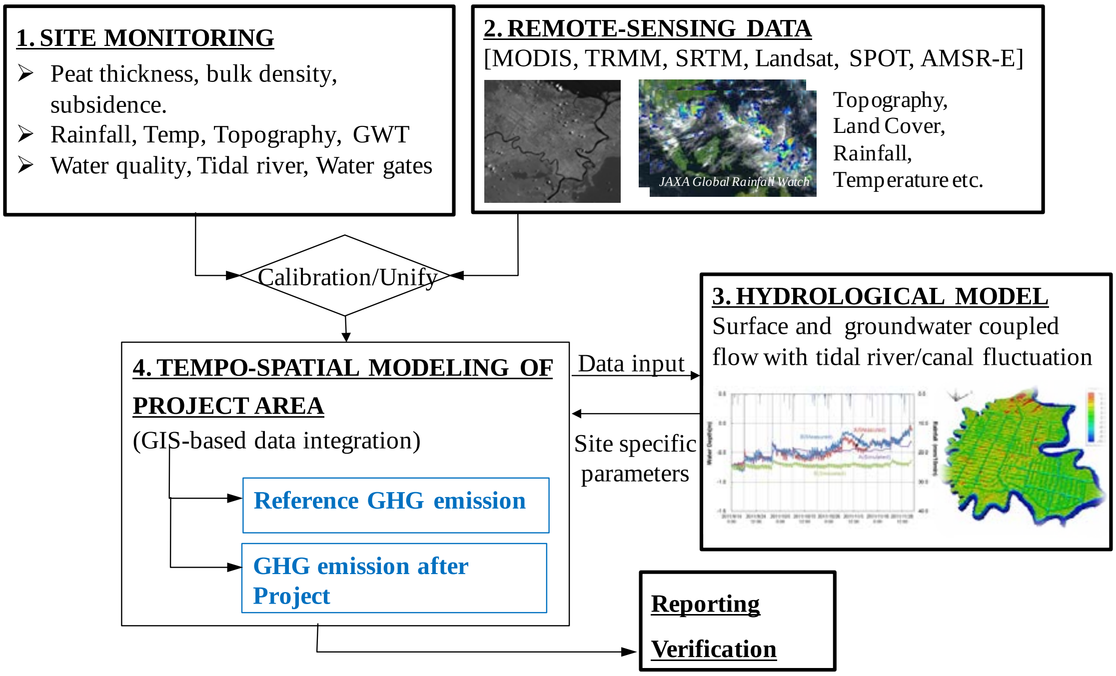


Figure 4.4.4 Structure of MRV for peatland

4.6 Ensuring environmental integrity

The project area was originally wetland where the drying of peat to lower the water table depth through the development of irrigation canals was accompanied by burning and decomposition. The purpose of the project activities is to raise the water table above its current level by introducing water level management so as to restore water levels to something approaching what they were prior to development. As conditions will therefore more closely resemble the original natural conditions, there will be hardly any negative impact on the environment, including ecosystems.

Smoke caused by peat fires in Indonesia poses a health hazard in Singapore and Malaysia as well as Indonesia itself. The application of project activities in areas where such fires occur may therefore be expected to help combat air pollution.

4.7 Other indirect effects

Although comments were received from stakeholders including the provincial government, central government, and rural inhabitants, no particular mention was made in the present survey of indirect negative effects of implementation of the project.

4.8 Comments of stakeholders

Comments were obtained from the following stakeholders.

- Ministry of Public Works (officials including Mr. DjayaMurni, Director-General of the Bureau of Water Resource Use; Mr. Tri Djoko, Vice-Minister for Construction and Internal Affairs; Mr. Prabowo, Director of the Department of Coastal Lowland Development):

  Farmland development in lowland areas and conservation of agricultural land in Indonesia is led by the Ministry of Public Works, and the improvement of water table management sought through the project coincides with ministry policy. Officials therefore indicated that as ensuring food security (i.e., a sufficient food supply for the population) is an important goal of the Indonesian government and lowlands will have to be conserved (including by means of appropriate water level management) in order to increase crop yields, the ministry would cooperate fully in the survey (an MOU was signed).
- Jambi provincial government officials (relevant officials in the bureaus responsible for development policy, public works, agriculture, and the environment):

  Two meetings were held with department heads (including the Administrative Vice-Minister of Jambi Province), and individual meetings were subsequently held with officials of the relevant bureaus and departments. As raising rice production in the Berbak Delta is an important priority for the province, officials indicated that they recognized the importance of outputs of the present feasibility survey and that assistance would be provided with the site survey and collection of data, etc. Data on weather conditions was obtained from the Public Works Bureau, and explanations were received from the Agricultural Bureau regarding the state of implementation of agricultural budgets and the state of agriculture at the site from Agricultural Bureau inspectors.
- Public Works Bureau and Agricultural Bureau officials in Tanjung Jabung:

  Interviews were held on topics including administrative practice in the site area and role sharing with the central and Jambi provincial governments. It was confirmed that assistance could be provided for future surveys using regency budget allocations.

- Rural inhabitants: Village mayors, farmers:
  Rice yields are declining in the villages of Rantau Rasau and Rantau Makmur in the Berbak Delta. Village infrastructure is also insufficient. The respondents therefore welcomed the surveys on increasing rice production and power generation potential, and indicated that they would cooperate in them. Measuring equipment was installed at sites run by three farming households for the feasibility study, and residents are assisting with their maintenance.

4.9 Organization of project and activities

The counterpart if the project is implemented would, under normal circumstances in Indonesia, be the local government concerned. This is because it is the local government that actually monitors activities and administers the region. In the case of the present project, therefore, the Japanese implementers' counterpart would likely be an agency such as the Public Works Bureau or Agricultural Bureau of Jambi Province.

Due to its experience of development of the area and responsibility for future lowland development, the Ministry of Public Works of the Indonesian central government will be the agency overseeing the provincial Public Works Bureau. Also likely to be involved are the Ministry of Home Affairs, which is the central government's point of contact for local administrative affairs, and the National Development Planning Agency (Bappenas), which administers planning and budgets for all ministries and agencies. The Japanese government would be expected to enter consultations with these central government agencies, with instruction and supervision then being provided by the central government on this basis.

The principal stakeholders would be farmers in the area concerned, and we understand that their views may be collectively ascertained through the local agricultural union.

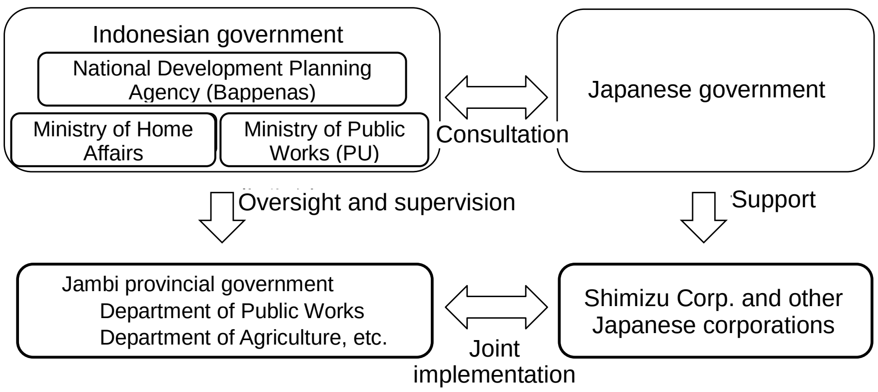


Figure 4.9.1 Framework for project implementation

4.10 Funding plan

It is estimated that the following funding will be required for implementation of the project in the area concerned (covering approximately 10,000 ha).

Initial costs

	Category	Estimated required expenditure (¥100 million)
1	Repair of water gates	1.2 (10 gates x ¥2,000,000, 200 gates x ¥500,000)
2	Improvement of existing main channels	1.0 (50 km x ¥2,000,000/km with excavator)
3	Improvement of existing secondary channels	0.6 (200 km x ¥300,000/km)
4	Construction of new tertiary channels	1.2 (500 km x ¥100,000/km + 1,000 flap-gates)
5	Monitoring equipment (Water gauges, rain gauges, water quality meters, peat, satellite data)	0.5 (100 water gauges x ¥250,000, 10 rain gauges x ¥200,000, 10 water quality meters x ¥50,000, 100 PVC pipes x ¥10,000, etc.)
6	Gasification power plant	3.6
6	Project preparations and certification costs	1.0
	Total	9.1

Running costs (per year)

	Category	Estimated required expenditure (¥10,000)
1	Maintenance of water gates	600 (200 gates x ¥30,000)
2	Maintenance of channels	1,000 (200 km x ¥50,000/km)
3	Control of main water gates	100 (10 gates x ¥100,000/gate)
4	Control of secondary water gates	600 (200 gates x ¥30,000/gate)
5	Monitoring equipment/analysis (water gauges, rain gauges, water quality meters, peat analysis)	300 (10 water gauges x ¥200,000, 3 rain gauges x ¥200,000, 3 water quality meters x ¥50,000, 100 PVC pipes x ¥10,000, 100 peat samples x ¥10,000)
6	Satellite data processing, hydrological modeling	500
7	Operation and maintenance of gasification power plant	3,400
8	Reporting/verification	500
	Total	7,000

Financing is likely to require not only private finance premised on revenue from the sale of credits, but also the direct injection of public funds by the Japanese government, and the injection of funds by the Indonesian government covered by lending received by it. The cost of the latter should be countable as GHG mitigation by NAMA by the Indonesian government.

4.11 Promotion of deployment of Japanese technologies

The Japanese technologies that might be used in the project include measuring/monitoring technologies and biomass (rice husk) power generation technologies.

Regarding, firstly, measuring and monitoring, Japanese remote sensing technologies already offer considerable advantages and do not appear to require any special measures to encourage their use in the project. Development of MRV methods in a manner that makes use of these advantages would, however, serve to encourage their use.

Regarding, on the other hand, biomass (rice husk) power generation, simple systems combining boiler combustion with a steam turbine are extremely orthodox and do not particularly depend upon Japanese technologies. Due to the central importance of rice cultivation in Japanese agriculture, however, Japanese enterprises do have a technological advantage over even their counterparts in other developed countries when it comes to energy technologies that use rice husk resources. Ensuring that such technologies are properly evaluated when the project is implemented might therefore lead to the adoption of Japanese technologies.

Possible measures include the adoption as an adaptation condition during methodology development of GHG mitigation performance per unit of rice husks as a performance requirement of plant systems used for the project, and the attachment of conditions in the form of inclusion of performance requirements for systems on the positive list for bilateral mechanisms.

In the case of projects that need to be accredited by both countries' governments in order to be recognized as bilateral mechanism projects, one option would be to obtain tariff exemptions for Japanese products under a bilateral agreement.

4.12 Future prospects and issues

The roadmap for development of MRV methods and implementation of the project to reduce CO_2 emissions by restoration of peatland water tables is shown below. During the present fiscal year, data needed to develop the reference scenario was collected focusing on ascertaining the features of the site (reference emissions). The next necessary step is to conduct real-world tests to develop MRV methods of assessment of the reduction in CO_2 emissions from peat through water table management. This step is essential also to obtaining the understanding and agreement of stakeholders in the host country (i.e., the Ministry of Public Works, Jambi Province, East Tanjung Jabung Regency, and rural inhabitants). Research for the present feasibility study has shown that the provincial and central governments typically act in accordance with the demands of local inhabitants in Indonesia. As the roadmap indicates, therefore, it is projected that MRV techniques will be established in FY 2012, preparations for implementation made in 2012-14, and implementation commenced in FY 2015 (depending on the state of development of BOCM).

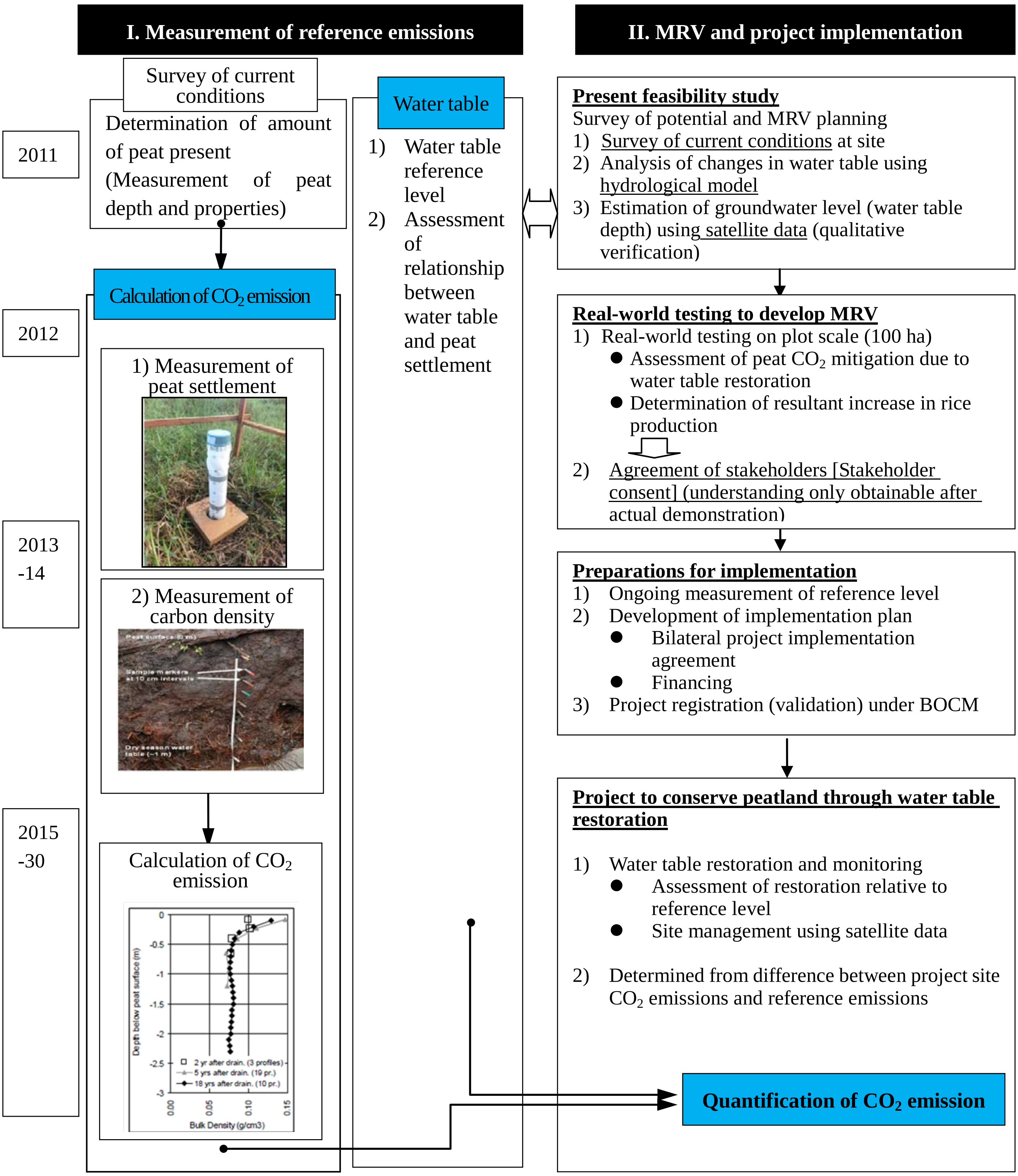


Figure 4.12.1 Roadmap for MRV development and project implementation

5. Survey findings regarding co-benefits

The co-benefits quantitative evaluation manual identifies three benefits for evaluation: prevention of water pollution, improvement of air quality, and waste management.

One of the environmental pollution control effects of implementation of the project activities is improvement of air quality. This is because smoke caused by peat fires in Indonesia causes harm including health hazards and flight delays in Singapore and Malaysia as well as within Indonesia, and so the implementation of project activities in areas where such fires occur may be expected to help combat air pollution.

BaU provides an appropriate baseline for co-benefits before implementation of the project. It may be assumed for the project scenario that no fires would occur with water table management in light of empirical evidence showing that virtually no fires occur when the water level is kept within 50 cm of the surface through water table management.

6. Survey findings regarding contribution to sustainable development

Any consideration of sustainable development in Indonesia must also address the question of food supply stability. This is because Indonesia has a population of 238 million (according to government estimates as of 2010), and there are concerns that growth in food demand as Indonesian living standards rise and the world population grows could lead to food shortages in the future.

To ensure food security, therefore, the Indonesian Ministry of Public Works has made the irrigation of low-lying coastal land and its conversion to farmland over the next several decades an object of state planning. If this results in the construction of large-scale conventional waterways, however, it could lead to extremely heavy GHG emissions from peatland, and may also cause serious air pollution due to peat fires.

To avoid such an outcome and secure the stable food supply that is essential to Indonesia's sustainable development, projects such as the present one have an extremely valuable role to play in limiting GHG emissions through water table management on irrigated farmland.

If water level management can continue to be practiced on existing farmland, where such management has been lacking due primarily to a lack of funds, there is also a strong possibility of being able to increase crop yields per unit of land area, thereby contributing to increased food production and improvements in living standards in rural communities.

Supplying electricity to non-electrified regions by means of rice husk power generation can be expected to raise rural living standards and at the same time increase soil fertility and raise productivity through use of burned rice husk ash as a soil stabilizer.