APPENDICES
Appendix 1. Interview guide of local knowledge on forest management

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<th>Respondent group</th>
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A. Identification of respondent group member

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B. Identification of respondent group's perception

**Procedure**

1. Everyone in the group is asked to think of factors that are important to be considered in order to achieve good forest management. They must put those factors on a piece of paper using marker.

2. Those factors are then sticked on the wall and discussed with the group member. Finally those factors are grouped (i.e. social, ecological, etc.).

3. In the discussion facilitator should ask why those factors are important for them, what are their reason for mentioning those factors.

**Other notes:**
Appendix 2. List of criteria and indicators from internationally recognized sources

1.1. List of ITTO C&I

POLICY

P.1 SUSTAINABLE FOREST MANAGEMENT RELATED TO POLICY ASPECT

C.1.1 Enabling Conditions for Sustainable Forest Management

I.1.1.1 Existence of a framework of laws, policies, and regulations to govern:
(a) national objectives for forest including production, conservation and
protection, (b) the establishment and security of the permanent forest estate, (c)
land tenure and property rights relating to forests, (d) the control of forest
management, (e) the control of forest harvesting, (f) the control of encroachment,
(g) the health and safety of forest workers, and (h) the participation of local
communities

I.1.1.2 Amount of investment and reinvestment in forest management, administration,
research, and human resource development from: (a) national and sub-national
government sources, (b) the Bali Partnership Fund (not applicable at the Forest
Management Unit level), (c) other international governmental contribution, and (d) private
sources, domestic and foreign

I.1.1.3 Existence of economic instruments and other incentives to encourage
sustainable forest management

I.1.1.4 Number and adequacy of institutions to support sustainable forest
management

I.1.1.5 Number and adequacy of trained professional and technical personnel
at all levels to perform and support management, implementation, research and
extension

I.1.1.6 Existence and application of appropriate technology to practice
sustainable forest management and the efficient processing and utilization of
forest produce

I.1.1.7 Capacity and mechanisms for planning sustainable forest management
and for periodical monitoring, evaluation and feedback on progress

I.1.1.8 Degree of public participation in forest management, such as in
planning, decision-making, data collection, monitoring and assessment

I.1.1.9 Adequacy and timeliness of information to increase public awareness
about forest policies, legislation and sustainable forest management practices

ECOLOGY
P.2 SUSTAINABLE FOREST MANAGEMENT RELATED TO ECOLOGY ASPECT

C.2.1 Forest Resource Security

I.2.1.1 Extent (area) and percentage of total land area under: (a) natural forest, (b) plantation forest, (c) permanent forest estate, and (d) comprehensive integrated land-user plans

I.2.1.2 Extent (area) and percentage of total land area under each forest type

I.2.1.3 Length and percentage of external boundaries of the permanent forest estate demarcated or clearly defined

I.2.1.4 Area of the permanent forest estate converted to permanent non-forest use

I.2.1.5 Existence of procedures to control encroachment, fire, grazing and illegal exploitation of forests

C.2.2 Forest Ecosystem Health and Condition

I.2.2.1 Within the permanent forest estate, the extend and nature of: (a) encroachment, (b) agriculture, (c) roads, (d) mining, (e) dams, (f) unplanned fire, (g) shifting agriculture, (h) nomadic grazing, (i) illegal exploitation, (j) inappropriate harvesting practices, (k) harvesting more than once during the cutting cycle (re-entry), (l) hunting, and (m) other forms of forest damage such as change in hydrological regime, pollution, introduction of harmful exotic plant and animal species, browsing and grazing. (These should be specified)

I.2.2.2 Within the permanent forest estate, the extent and nature of forest damage, caused by: (a) wild fire, (b) drought, (c) storms or natural catastrophes, (d) pests and diseases, and (e) other natural causes

I.2.2.3 Existence and implementation of quarantine and phytosanitary procedures to prevent the introduction of pests and diseases

I.2.2.4 Existence and implementation of procedures to prevent the introduction of potentially harmful exotic plant and animal species

I.2.2.5 Availability and implementation of procedures covering: (a) use of chemicals in the forest, and (b) fire management

C.2.3 Biological Diversity

I.2.3.1 Statistics of protected areas in each forest type: (a) number, (b) extent, (c) percentage of forest type covered, (d) range of sizes and average size of protected area, and (e) percentage of boundaries demarcated or clearly defined

I.2.3.2 Percentage of total number of protected areas connected by biological corridors or stepping-stones between them
I.2.3.3 Existence and implementation of procedures to identify endangered, rare and threatened species of forest flora and fauna

I.2.3.4 Number of endangered, rare and threatened forest-dependent species

I.2.3.5 Percentage of original range occupied by selected endangered, rare and threatened species

I.2.3.6 Existence and implementation of a strategy for in situ and/or ex situ conservation of the genetic variation within commercial, endangered, rare and threatened species of forest flora and fauna

I.2.3.7 Existence and implementation of management guidelines to: (a) keep undisturbed a part of each production forest, (b) protect endangered, rare and threatened species of forest flora and fauna, and (c) protect features of special biological interests such as seed trees, nesting sites, niches and keystone species

I.2.3.8 Existence and implementation of procedures for assessing changes of biological diversity of the production forests, compared with areas in the same forest type kept free from human intervention

C.2.4 Soil and Water

I.2.4.1 Extent and percentage of total forest area managed primarily for the protection of soil and water

I.2.4.2 Extent and percentage of area to be harvested for which off-site catchments values have been defined, documented and protected before harvesting

I.2.4.3 Extent and percentage of area to be harvested which has been defined as environmentally sensitive (e.g. very steep or erodible) and protected before harvesting

I.2.4.4 Extent and percentage of area to be harvested for which drainage systems have been demarcated or clearly defined and protected before harvesting

I.2.4.5 Percentage of length of edges of watercourses, water bodies, mangroves and other wetlands protected by adequate buffer strips

I.2.4.6 Existence and implementation of procedures to identify and demarcate sensitive areas for the protection of soil and water

I.2.4.7 Availability and implementation of guidelines for forest road layout, including drainage requirements and conservation of buffer strips along streams and rivers

I.2.4.8 Availability and implementation of harvesting procedures: (a) to protect the soil from compaction by harvesting machinery, and (b) to protect the soil from erosion during harvesting operations
I.2.4.9 Existence and implementation of procedures for assessing changes in the water quality of streams emerging from production forests as compared with streams emerging from the same forest type kept free from human intervention

SOCIAL

P.3 SUSTAINABLE FOREST MANAGEMENT RELATED TO SOCIAL ASPECT

C.3.1 Economic, Social and Cultural Aspects

I.3.1.1 Value and percentage contribution of the forestry sector to the Gross Domestic Product

I.3.1.2 Quantity (volume) and value of wood and non-wood forest products traded in: (a) the domestic market, and (b) the international market

I.3.1.3 Quantity (volume) and value of wood and non-wood forest products for subsistence use, including fuel wood

I.3.1.4 Ratio of domestic log production to the processing capacity of wood-based industries

I.3.1.5 Efficiency of utilization in terms of the percentage of felled volume processed

I.3.1.6 Existence and implementation of mechanisms for the effective distribution of incentives and the fair and equitable sharing of costs and benefits among the parties involved

I.3.1.7 Existence and implementation of procedures to ensure the health and safety of forest workers

I.3.1.8 Employment in the forestry sector: (a) number employed, (b) percentage of total work force (not applicable at the Forest Management Unit level), (c) average wage rate (not applicable at the Forest Management Unit level), and (d) injury rate

I.3.1.9 Number and extent of forest sites available primarily for: (a) research (not applicable at the Forest Management Unit level), (b) education (not applicable at the Forest Management Unit level), (c) the direct use and benefit of local communities, and (d) recreation

I.3.1.10 Number of people dependent on the forest for subsistence uses and traditional and customary lifestyles

I.3.1.11 Area of forest upon which people are dependent for subsistence uses and traditional and customary lifestyles

I.3.1.12 Number of visitors to forest for recreational purposes

I.3.1.13 Total amount of carbon stored in forest stands
I.3.1.14 Number of important archaeological and cultural sites identified, mapped and protected

I.3.1.15 Extent to which tenure and user rights over the forest are documented and recognized

I.3.1.16 Extent to which forest planning and management practices and processes consider and recognize legal or customary rights with respect to indigenous people and local communities, forest dwellers and other forest-dependent communities

I.3.1.17 Extent or participation by indigenous people and local communities, forest dwellers and other forest-dependent communities in forest-based economic activities

I.3.1.18 Number of agreements involving local communities in co-management responsibilities

PRODUCTION OF GOODS AND SERVICES

P.4 SUSTAINABLE FOREST MANAGEMENT RELATED TO PRODUCTION OF GOODS AND SERVICES ASPECT

C.4.1 Flow of Forest Produce

I.4.1.1 Extent and percentage of forest for which inventory and survey procedure have been used to define: (a) the quantity of the main forest products, and (b) resource rights and ownership

I.4.1.2 Estimate of level of sustainable harvest for each main wood and non-wood forest product for each forest type

I.4.1.3 Quantity (volume) of wood and important non-wood forest products harvested for each forest type

I.4.1.4 Existence and implementation of: (a) forest management plans, and (b) forest harvesting (operational) plans

I.4.1.5 Existence and percentage of: (a) production forest covered by management plans, and (b) compartment/coupes harvested according to harvesting (operational) plans

I.4.1.6 Existence of long-term projections, strategies and plans for production, including the use of tree plantations

I.4.1.7 Availability of historical records on the extent, nature and management of forest

I.4.1.8 Availability and implementation of management guidelines for each of the main wood and non-wood forest products to be harvested, to cover: (a) the
assessment of natural regeneration, and (b) measures to supplement natural regeneration where necessary

I.4.1.9 Availability and implementation of procedures to monitor and review the management guidelines

I.4.1.10 Availability and implementation of guidelines for reduced/low impact logging to minimize damage to residual stand

I.4.1.11 Availability and implementation of: (a) procedures for comprehensive evaluation of the implementation of management guidelines, (b) procedures to assess damage to the residual stand, and (c) post-harvest surveys to assess the effectiveness of regeneration

I.4.1.12 Percentage of area harvested for which: (a) management guidelines have been completely implemented, and (b) post-harvested surveys have been conducted to assess the effectiveness of regeneration

1.2. List of Forest Stewardship Council P&C

POLICY

P.1 COMPLIANCE WITH LAWS AND FSC PRINCIPLES

C.1.1 Forest management shall respect all national and local laws and administrative requirements.

C.1.2 All applicable and legally prescribed fees, royalties, taxes and other charges shall be paid.

C.1.3 In signatory countries, the provisions of all binding international agreements such as CITES, ILO Conventions, ITTA, and Convention on Biological Diversity, shall be respected.

C.1.4 Conflicts between laws, regulations and the FSC Principles and Criteria shall be evaluated for the purposes of certification, on a case-by-case basis, by the certifiers and the involved or affected parties.

C.1.5 Forest management areas should be protected from illegal harvesting, settlement and other unauthorized activities.

C.1.6 Forest managers shall demonstrate a long-term commitment to adhere to the FSC Principles and Criteria.

P.2 TENURE AND USE RIGHTS AND RESPONSIBILITIES

C.2.1 Clear evidence of long-term forest use rights to the land (e.g. land title, customary rights, or lease agreements) shall be demonstrated.
C.2.2 Local communities with legal or customary tenure or use rights shall maintain control, to the extent necessary to protect their rights or resources, over forest operations unless they delegate control with free and informed consent to other agencies.

C.2.3 Appropriate mechanisms shall be employed to resolve disputes over tenure claims and use rights. The circumstances and status of any outstanding disputes will be explicitly considered in the certification evaluation.

ECOLOGY

P.3 ENVIRONMENTAL IMPACT

C.3.1 Assessment of Environmental impacts shall be completed - appropriate to the scale, intensity of forest management and the uniqueness of the affected resources - and adequately integrated into management systems. Assessments shall include landscape level considerations as well as the impacts of on-site processing facilities. Environmental impacts shall be assessed prior to commencement of site-disturbing operations.

C.3.2 Safeguards shall exist which protect rare, threatened and endangered species and their habitats (e.g., nesting and feeding areas). Conservation zones and protection areas shall be established, appropriate to the scale and intensity of forest management and the uniqueness of the affected resources. Inappropriate hunting, fishing, trapping and collecting shall be controlled.

C.3.3 Ecological functions and values shall be maintained intact, enhanced or restored, including: 1) Forest regeneration and succession, 2) Genetic, species, and ecosystem diversity, 3) Natural cycles that affect the productivity of the forest ecosystem.

C.3.4 Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources.

C.3.5 Written guidelines shall be prepared and implemented to: control erosion; minimize forest damage during harvesting, road construction, and all other mechanical disturbances; and protect water resources.

C.3.6 Management systems shall promote the development and adoption of environmentally friendly non-chemical methods of pest management and strive to avoid the use of chemical pesticides. World Health Organization Type 1A and 1B and chlorinated hydrocarbon pesticides; pesticides that are persistent, toxic or whose derivatives remain biologically active and accumulate in the food chain beyond their intended use; as well as any pesticides banned by international agreement, shall be prohibited. If chemicals are used, proper equipment and training shall be provided to minimize health and environmental risks.

C.3.7 Chemicals, containers, liquid and solid non-organic wastes including fuel and oil shall be disposed of in an environmentally appropriate manner at off-site locations.
C.3.8 Use of biological control agents shall be documented, minimized, monitored and strictly controlled in accordance with national laws and internationally accepted scientific protocols. Use of genetically modified organisms shall be prohibited.

C.3.9 The use of exotic species shall be carefully controlled and actively monitored to avoid adverse ecological impacts.

P.4 MAINTENANCE OF NATURAL FORESTS

C.4.1 Trees planted in natural forests may supplement natural regeneration, fill gaps or contribute to the conservation of genetic resources. Such plantings shall not replace or significantly alter the natural ecosystem.

C.4.2 The use of replanting as a technique for regenerating stands of certain natural forest types may be appropriate under certain circumstances. Guidelines on the acceptable intensity and spatial extent of tree planting will be addressed in national and regional forest management standards to be approved by the FSC. In the absence of such national or regional standards, guidelines developed by the certifier and approved by the FSC will prevail.

SOCIAL

P.5 INDIGENOUS PEOPLE’S RIGHTS

C.5.1 Indigenous peoples shall control forest management on their lands and territories unless they delegate control with free and informed consent to other agencies.

C.5.2 Forest management shall not threaten or diminish, either directly or indirectly, the resources or tenure rights of indigenous peoples.

C.5.3 Sites of special cultural, ecological, economic or religious significance to indigenous peoples shall be clearly identified in cooperation with such peoples, and recognized and protected by forest managers.

C.5.4 Indigenous peoples shall be compensated for the application of their traditional knowledge regarding the use of forest species or management systems in forest operations. This compensation shall be formally agreed upon with their free and informed consent before forest operations commence.

P.6 COMMUNITY RELATIONS AND WORKERS’ RIGHTS

C.6.1 The communities within, or adjacent to, the forest management area should be given opportunities for employment, training and other services.

C.6.2 Forest management should meet or exceed all applicable laws and/or regulations covering health and safety of employees and their families.
C.6.3 The rights of workers to organize and voluntarily negotiate with their employers shall be guaranteed as outlined in Conventions 87 and 98 of the International Labor Organization (ILO).

C.6.4 Management planning and operations shall incorporate the results of evaluations of social impact. Consultations shall be maintained with people and groups directly affected by management operations.

C.6.5 Appropriate mechanisms shall be employed for resolving grievances and for providing fair compensation in the case of loss or damage affecting the legal or customary rights, property, resources, or livelihoods of local peoples. Measures shall be taken to avoid such loss or damage.

PRODUCTION OF GOODS AND SERVICES

P.7 BENEFITS FROM THE FOREST

C.7.1 Forest management should strive toward economic viability, while taking into account the full environmental, social and operational costs of production, and ensuring the investments necessary to maintain the ecological productivity of the forest.

C.7.2 Forest management and marketing operations should encourage the optimal use and local processing of the forest's diversity of products.

C.7.3 Forest management should minimize waste associated with harvesting and on-site processing operations and avoid damage to other forest resources.

C.7.4 Forest management should strive to strengthen and diversify the local economy, avoiding dependence on a single forest product.

C.7.5 Forest management operations shall recognize, maintain and, where appropriate, enhance the value of forest services and resources such as watersheds and fisheries.

C.7.6 The rate of harvest of forest products shall not exceed levels, which can be permanently sustained.

P.8 MANAGEMENT PLAN

C.8.1 The management plan and supporting documents shall provide: 1. Management objectives; 2. Description of the forest resources to be managed, environmental limitations, land use and ownership status, socioeconomic conditions, and a profile of adjacent lands; 3. Description of silvicultural and/or other management system, based on the ecology of the forest in question and information gathered through resource inventories; 4. Rationale for rate of annual harvest and species selection; 5. Provisions for monitoring of forest growth and
1. Dynamics; 6. Environmental safeguards based on environmental assessments; 7. Plans for the identification and protection of rare, threatened and endangered species; 8. Maps describing the forest resource base including protected areas, planned management activities and land ownership; 9. Description and justification of harvesting techniques and equipment to be used

C.8.2 The management plan shall be periodically revised to incorporate the results of monitoring or new scientific and technical information, as well as to respond to changing environmental, social and economic circumstances.

C.8.3 Forest workers shall receive adequate training and supervision to ensure proper implementation of the management plan.

C.8.4 While respecting the confidentiality of information, forest managers shall make publicly available a summary of the primary elements of the management plan, including those listed in Criterion 7.1.

P.9 MONITORING AND ASSESSMENT

C.9.1 The frequency and intensity of monitoring should be determined by the scale and intensity of forest management operations as well as the relative complexity and fragility of the affected environment. Monitoring procedures should be consistent and replicable over time to allow comparison of results and assessment of change.

C.9.2 Forest management should include the research and data collection needed to monitor, at a minimum, the following indicators: 1. Yield of all forest products harvested; 2. Growth rates, regeneration and condition of the forest; 3. Composition and observed changes in the flora and fauna; 4. Environmental and social impacts of harvesting and other operations; 5. Costs, productivity and efficiency of forest management

C.9.3 Documentation shall be provided by the forest manager to enable monitoring and certifying organizations to trace each forest product from its origin, a process known as the 'chain of custody'.

C.9.4 The results of monitoring shall be incorporated into the implementation and revision of the management plan.

C.9.5 While respecting the confidentiality of information, forest managers shall make publicly available a summary of the results of monitoring indicators, including those listed in Criterion 8.2.
C.10.1 The management objectives of the plantation, including natural forest conservation and restoration objectives, shall be explicitly stated in the management plan, and clearly demonstrated in the implementation of the plan.

C.10.2 The design and layout of plantations should promote the protection, restoration and conservation of natural forests, and not increase pressures on natural forests. Wildlife corridors, streamside zones and a mosaic of stands of different ages and rotation periods, shall be used in the layout of the plantation, consistent with the scale of the operation. The scale and layout of plantation blocks shall be consistent with the patterns of forest stands found within the natural landscape.

C.10.3 Diversity in the composition of plantations is preferred, so as to enhance economic, ecological and social stability. Such diversity may include the size and spatial distribution of management units within the landscape, number and genetic composition of species, age classes and structures.

C.10.4 The selection of species for planting shall be based on their overall suitability for the site and their appropriateness to the management objectives. In order to enhance the conservation of biological diversity, native species are preferred over exotic species in the establishment of plantations and the restoration of degraded ecosystems. Exotic species, which shall be used only when their performance is greater than that of native species, shall be carefully monitored to detect unusual mortality, disease, or insect outbreaks and adverse ecological impacts.

C.10.5 A proportion of the overall forest management area, appropriate to the scale of the plantation and to be determined in regional standards, shall be managed so as to restore the site to a natural forest cover.

C.10.6 Measures shall be taken to maintain or improve soil structure, fertility, and biological activity. The techniques and rate of harvesting, road and trail construction and maintenance, and the choice of species shall not result in long term soil degradation or adverse impacts on water quality, quantity or substantial deviation from stream course drainage patterns.

C.10.7 Measures shall be taken to prevent and minimize outbreaks of pests, diseases, fire and invasive plant introductions. Integrated pest management shall form an essential part of the management plan, with primary reliance on prevention and biological control methods rather than chemical pesticides and fertilizers. Plantation management should make every effort to move away from chemical pesticides and fertilizers, including their use in nurseries. The use of chemicals is also covered in Criteria 6.6 and 6.7.

C.10.8 Appropriate to the scale and diversity of the operation, monitoring of plantations shall include regular assessment of potential on-site and off-site ecological and social impacts, (e.g. natural regeneration, effects on water resources and soil fertility, and impacts on local welfare and social well-being), in addition to those elements addressed in principles 8, 6 and 4. No species should be planted on a large scale until local trials and/or experience have shown that they are ecologically well-adapted to the site, are not invasive, and do not have significant negative ecological impacts on other ecosystems. Special attention will
be paid to social issues of land acquisition for plantations, especially the protection of local rights of ownership, use or access.

1.3. List of Montréal Process C&I
CRITERIA AND INDICATORS FOR THE CONSERVATION AND SUSTAINABLE MANAGEMENT OF TEMPERATE AND BOREAL FORESTS
http://www.mpci.org/whatis/criteria_e.html

The Montréal Process Working Group agreed on a framework of criteria and indicators that provide member countries with a common definition of what characterizes sustainable management of temperate and boreal forests. The framework identifies seven criteria that are further defined by 67 associated indicators which are aspects of the criteria that can be identified or described.

The following six criteria and associated indicators characterize the conservation and sustainable management of temperate and boreal forests. They relate specifically to forest conditions, attributes or functions, and to the values or benefits associated with the environmental and socio-economic goods and services that forests provide. The intent or meaning of each criterion is made clear by its respective indicators. No priority or order is implied in the alphanumeric listing of the criteria and indicators.

Indicators followed by an "a" are those for which most data are available. Indicators followed by a "b" are those which may require the gathering of new or additional data and/or a new program of systematic sampling or basic research.

IUCN categories include: I. Strict protection, II. Ecosystem conservation and tourism, III. Conservation of natural features, IV. Conservation through active management, V. Landscape/Seascape conservation and recreation, VI. Sustainable use of natural ecosystems.

Criterion 1: Conservation of biological diversity

Biological diversity includes the elements of the diversity of ecosystems, the diversity between species, and genetic diversity in species.

Indicators:
Ecosystem diversity
a. Extent of area by forest type relative to total forest area-(a);1
b. Extent of area by forest type and by age class or successional stage-(b);
c. Extent of area by forest type in protected area categories as defined by IUCN2 or other classification systems-(a);
d. Extent of areas by forest type in protected areas defined by age class or successional stage-(b);
e. Fragmentation of forest types-(b).

Species diversity
a. The number of forest dependent species-(b);
b. The status (threatened, rare, vulnerable, endangered, or extinct) of forest dependent species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment-(a).
Genetic diversity
a. Number of forest dependent species that occupy a small portion of their former range-(b);
b. Population levels of representative species from diverse habitats monitored across their range-(b).

Criterion 2: Maintenance of productive capacity of forest ecosystems
Indicators:
a. Area of forest land and net area of forest land available for timber production-(a);
b. Total growing stock of both merchantable and non-merchantable tree species on forest land available for timber production-(a);
c. The area and growing stock of plantations of native and exotic species-(a);
d. Annual removal of wood products compared to the volume determined to be sustainable-(a);
e. Annual removal of non-timber forest products (e.g. fur bearers, berries, mushrooms, game), compared to the level determined to be sustainable-(b).

Criterion 3: Maintenance of forest ecosystem health and vitality
Indicators:
a. Area and percent of forest affected by processes or agents beyond the range of historic variation, e.g. by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinisation, and domestic animals-(b);
b. Area and percent of forest land subjected to levels of specific air pollutants (e.g. sulfates, nitrate, ozone) or ultraviolet B that may cause negative impacts on the forest ecosystem-(b);
c. Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes (e.g. soil nutrient cycling, seed dispersion, pollination) and/or ecological continuity (monitoring of functionally important species such as fungi, arboreal epiphytes, nematodes, beetles, wasps, etc.)-(b).

Criterion 4: Conservation and maintenance of soil and water resources
This criterion encompasses the conservation of soil and water resources and the protective and productive functions of forests.
Indicators:
a. Area and percent of forest land with significant soil erosion-(b);
b. Area and percent of forest land managed primarily for protective functions, e.g. watersheds, flood protection, avalanche protection, riparian zones-(a);
c. Percent of stream kilometres in forested catchments in which stream flow and timing has significantly deviated from the historic range of variation-(b);
d. Area and percent of forest land with significantly diminished soil organic matter and/or changes in other soil chemical properties-(b);
e. Area and percent of forest land with significant compaction or change in soil physical properties resulting from human activities-(b);
f. Percent of water bodies in forest areas (e.g. stream kilometres, lake hectares) with significant variance of biological diversity from the historic range of variability-(b);
g. Percent of water bodies in forest areas (e.g. stream kilometres, lake hectares) with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals (electrical conductivity), sedimentation or temperature change-(b);
h. Area and percent of forest land experiencing an accumulation of persistent toxic substances-(b).

Criterion 5: Maintenance of forest contribution to global carbon cycles

Indicators:
a. Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages-(b);
b. Contribution of forest ecosystems to the total global carbon budget, including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon)-(a or b);
c. Contribution of forest products to the global carbon budget-(b).

Criterion 6: Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies

Indicators: Production and consumption
a. Value and volume of wood and wood products production, including value added through downstream processing-(a);
b. Value and quantities of production of non-wood forest products-(b);
c. Supply and consumption of wood and wood products, including consumption per capita-(a);
d. Value of wood and non-wood products production as percentage of GDP-(a or b);
e. Degree of recycling of forest products-(a or b);
f. Supply and consumption/use of non-wood products-(a or b).

Recreation and tourism
a. Area and percent of forest land managed for general recreation and tourism, in relation to the total area of forest land-(a or b);
b. Number and type of facilities available for general recreation and tourism, in relation to population and forest area-(a or b);
c. Number of visitor days attributed to recreation and tourism, in relation to population and forest area-(b).

Investment in the forest sector
a. Value of investment, including investment in forest growing, forest health and management, planted forests, wood processing, recreation and tourism-(a);
b. Level of expenditure on research and development, and education-(b);
c. Extension and use of new and improved technologies-(b);
d. Rates of return on investment-(b).
Cultural, social and spiritual needs and values
a. Area and percent of forest land managed in relation to the total area of forest land to protect the range of cultural, social and spiritual needs and values-(a or b);
b. Non-consumptive use forest values-(b).

Employment and community needs
a. Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment-(a or b);
b. Average wage rates and injury rates in major employment categories within the forest sector-(a);
c. Viability and adaptability to changing economic conditions, of forest dependent communities, including indigenous communities-(b);
d. Area and percent of forest land used for subsistence purposes-(b).

Criterion 7: Legal, institutional and economic framework for forest conservation and sustainable management

Indicators:
Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it:

a. Clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides means of resolving property disputes by due process;
b. Provides for periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors;
c. Provides opportunities for public participation in public policy and decision-making related to forests and public access to information;
d. Encourages best practice codes for forest management;
e. Provides for the management of forests to conserve special environmental, cultural, social and/or scientific values.

Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to:

a. Provide for public involvement activities and public education, awareness and extension programs, and make available forest-related information;
b. Undertake and implement periodic forest-related planning, assessment, and policy review including cross-sectoral planning and coordination;
c. Develop and maintain human resource skills across relevant disciplines;
d. Develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services and support forest management;
e. Enforce laws, regulations and guidelines.

Extent to which the economic framework (economic policies and measures) supports the conservation and sustainable management of forests through:
a. Investment and taxation policies and a regulatory environment which recognize the long-term nature of investments and permit the flow of capital in and out of the forest sector in response to market signals, non-market economic valuations,
and public policy decisions in order to meet long-term demands for forest products and services;
b. Non-discriminatory trade policies for forest products.

Capacity to measure and monitor changes in the conservation and sustainable management of forests, including:
a. Availability and extent of up-to-date data, statistics and other information important to measuring or describing indicators associated with criteria 1-7;
b. Scope, frequency and statistical reliability of forest inventories, assessments, monitoring and other relevant information;
c. Compatibility with other countries in measuring, monitoring and reporting on indicators.

Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services, including:
a. Development of scientific understanding of forest ecosystem characteristics and functions;
b. Development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies, and to reflect forest-related resource depletion or replenishment in national accounting systems;
c. New technologies and the capacity to assess the socio-economic consequences associated with the introduction of new technologies;
d. Enhancement of ability to predict impacts of human intervention on forests;
e. Ability to predict impacts on forests of possible climate change.

1.4. List of Finnish C&I

ECOLOGY

C.1. Maintenance and appropriate enhancement of forest resources and their contribution to global carbon cycles Instruments to regulate the maintenance of forest resources
Forest rights
Regulation of the forest resource through land use
Forest and other wooded land and their proportion of total land area
Total volume of growing stock
Age structure of forest
Managing the carbon balance
Carbon balance
Use of wood-based energy

C.2. Maintenance of forest ecosystem health and vitality Instruments to regulate the maintenance of forest ecosystems health and vitality
Deposition of air pollutants
Changes in the defoliation of forests using the UN?ECE and EU defoliation classification
Damages causes by biotic or abiotic agents

C.3. Maintenance, conservation and appropriate enhancement of biological diversity in forest ecosystems Instruments to regulate the maintenance, conservation and appropriate enhacement of biodiversity in forest ecosystems
Threatened and vulnerable species of flora and fauna
Protected forests with felling restriction
Valuable forest habitats and their protection
Tree species composition
Pure and mixed forest stands
Reserved and decayed trees in commercial forests and conservation areas
Gene reserved forest

C.4. Maintenance and appropriate enhancement of protective functions in forest management (notably soil and water) Instruments for the maintenance and appropriate enhancement of protective functions in forest management
Water protection in harvesting and site preparation
Phosphorus and nitrogen load on water systems caused by logging
Water protection plans in drainage projects
Area of forestry land in protected forests

SOCIAL
C.4. Maintenance of other socio-economic and cultural functions and conditions (economy and employment, public participation in decision making, cultural and multiple-use of forests) Instruments for securing the operating conditions of the forest sector in the national and regional economy
The proportion of the forest sector of gross national product
Domestic and foreign trade of the forest sector
Labour and employment support in the forest sector
Small and medium-sized enterprises in the forest sector by branch
Social factors of the forest workforce
Instruments for securing and maintaining equitable opportunities for the public to participate in the decision making
Instruments to maintain the multiple use and cultural values of forests
Cultural values - archaeological monuments and landscape values
Recreational use of forest

PRODUCTION OF GOODS AND SERVICES
C.5. Maintenance and encouragement of productive of forests (wood and non-wood) Instruments for safeguarding wood production
Increment of growing stock
Total drain
Coverage of forest advisory services
Coverage of forest management planning
Silviculture and forest improvement
Profitability of private forestry
Structure of roundwood production
Instruments to safeguard the management of forests related to non-wood products
Quantity and economic significance of non-wood forest products
Ecotourism

1.5. List of African Timber Organization C&I

POLICY

P.1 (GENERAL POLICY). SUSTAINABILITY OF THE FOREST AND ITS MULTIPLE FUNCTIONS IS A HIGH POLITICAL PRIORITY.
C.1.1 The Government has clear forest development objectives and a realistic action plan to meet them.

I.1.1.1 There is a permanent forest estate governed by laws and regulations which are the basis for its sustainable management. This permanent forest estate is the result of negotiation between all stakeholders within the framework of a procedure of coordinated planning of the allocation of lands, based on appropriate and updated information.

I.1.1.2 The Government has a system of reliable, adequate and updated information on the forestry sector (especially a national forest inventory), which enables it to update its action, plans and adjust the means of implementation.

C.1.2 The Government allocates adequate means for sustainable management of forests.

I.1.2.1 There is a mechanism for sustained and adequate funding for the management of Government forests.

I.1.2.2 There is a forestry service in charge of the management of all the forests, with adequate staffing to fulfill its mandate.

I.1.2.3 Forest research is allocated sufficient means (human and material) and its results are applied.

C.1.3 Action is taken by the Government to reduce all types of pressure on the forest.

I.1.3.1 Existing, on-going and future plantations in the national forest plantation plan can contribute to supply the timber sector.

I.1.3.2 The Government implements appropriate programmes to stabilize agriculture.

C.1.4 At international level, the Government has ratified or approved treaties, conventions or recommendations on sustainable development of forests issued especially by such organizations as ILO, CITES, ITTO, FAO, UNCED.
ECOLOGY

P.2 THE MAIN ECOLOGICAL FUNCTIONS OF THE FOREST ARE MAINTAINED

C.2.1 The capacity of the forest for natural regeneration is ensured.

I.2.1.1 Logging is not authorized if the vertical stratification of forest is disturbed.

I.2.1.2 Light demanding (pioneer) species do not form dense stands within the forest.

I.2.1.3 Actions are taken to assure natural regeneration when necessary.

C.2.2 Negative impacts of various interventions on biodiversity are minimized.

I.2.2.1 Zones of biological protection where no interference is authorized are created in the permanent forest estate.

I.2.2.2 The size of biological reserves is adapted to suit the object of preservation.

I.2.2.3 Selection of biological preservation areas should take into account their potential for effective protection.

I.2.2.4 Special provisions for the protection of sensitive areas, plains, stream banks, steep slopes should be defined in the management plan.

I.2.2.5 The management plans of forest only provide for single - specie or exotic specie plantations when other types of silviculture action have been considered by forest management experts and abandoned for justified reasons.

I.2.2.6 If enrichment plantings are carried out in logged over forests, preferences will be given to species that were actually harvested in the forest.

I.2.2.7 Rare or endangered species are protected.

I.2.2.8 Non-timber forest products in high demand are the object of conservations and domestication trials.

C.2.3 The function of water filtration (protection of water and soils) of the forest is maintained.

I.2.3.1 Water system (regime) and quality do not decrease.
PRODUCTION OF GOODS AND SERVICES

P.3 AREAS DEVOTED TO FORESTRY ACTIVITIES OR THE PERMANENT FOREST ESTATE ARE NOT DECLINING.

C.3.1 Areas devoted to forestry activities or permanent forest estate are clearly delimited and their boundaries have been well established.

I.3.1.1 There exists a map showing the boundaries of the permanent forest estate.

I.3.1.2 The boundaries of the permanent forest estate are well marked in the field.

C.3.2 Efficient measures have been taken by the authorities to monitor the forest and to protect it against clearing, fire, settlements and illegal gathering of forest products.

I.3.2.1 There is a control mechanism (direct or delegated control, type and frequency of control) complied with by the forest service.

I.3.2.2 The procedure of control is followed by results. (Mission reports, case files, transactions, condemnations, etc...).

I.3.2.3 There is collaboration between the forestry service, agricultural service, public order authorities and other public services concerned in forest management.

C.3.3 The Government implements measures in order to promote the participation of various stakeholders (mainly neighboring villagers) in protecting the forest.

I.3.3.1 There is a direct, sustainable, efficient system to interest various stakeholders in protecting the forest against clearing, fires and poaching.

I.3.3.2 Programmes for the enlightenment and education of the rural population are implemented.

P.4 FORESTS ARE ADEQUATELY MANAGED AND DEVELOPED IRRESPECTIVE OF THEIR ROLE.

C.4.1 A management plan has been established for the sustainable management of the forest taking into account all its components and functions such as timber production, other forest products, contribution to the well-being of the local people, ecology.

I.4.1.1 There is a management plan comprising: (1) Definition of the forest area subjected to sustainable management (2) Key findings of studies and analyses on all the functions and uses of the forest (timber production, other forest products, farmer-forest relationship, forest ecosystem) (3) Definition of objectives in these various uses, their spatial organization and their hierarchy (4) Relevant action plans to meet these objectives (5) Reference to laws and regulations governing such actions (particularly the national directives on...
management) (5) Economic and financial evaluation (6) A set of maps allowing a clear summarized overview of the results of studied (vegetation map, forest settlement map, etc.), the objectives (map of working circles) and the action plans (map of blocks for harvesting, coupes, replanting, etc.).

I.4.1.2 Management is approved by the Minister in charge of forests.

I.4.1.3 Management is effectively implemented.

I.4.1.4 The follow-up and the control of the implementation of the management plan are done based on the information included in the appropriate documents.

C.4.2 Forestry service and other stakeholders of the sector have enough capacity to properly developed and manage the forest for all its roles (timber production, other forest products, ecology, farmer-forest relationship).

C.4.3 Standards for silviculture and other activities adapted to the specific ecology of the forest and ensuring sustainable management have been developed and are operational.

I.4.3.1 Adequate effort of investigation is undertaken to define, validate or adjust silviculture and work standards.

I.4.3.2 Silviculture and work standards are explicit and easy to implement, easy to control.

I.4.3.3 In the area of harvesting, the standards are explicit on: (1) Minimum number of large trees to be retained as seed producers (mother trees) per ha and species (2) Maximum number of trees to be harvested per ha (3) Harvesting techniques for large trees to be removed should be such as to avoid too large gaps (4) The minimum exploitable diameter for each species.

C.4.4 Planning and implementation of logging are carried out in conformity with guidelines of the management plan and the contract agreement based on technical and social standards as well as financial specifications.

I.4.4.1 Operational law-impact felling and skidding techniques are available.

I.4.4.2 Fully consistent with silviculture standards, and based on previous inventory, the area to be harvested over the management plan period is assessed and mapped.

I.4.4.3 Calculations of allowable cut and rotation period are clearly detailed in the management plan and are consistent with silviculture standards, increment data, prior inventory and harvestable areas, and are established at levels considered compatible with sustainable production of the forest.

I.4.4.4 The felling and work programme is operational, clear and realistic. Each harvest is subject to prior validation and design.

I.4.4.5 Felling programmes are adjusted rapidly if the change in data collected on the field is significantly different from that on which the manager’s initial estimate is based. The management plan is amended to be consistent with the true data.
I.4.4.6 Trees to be felled are previously plotted on a map and marked. Their selection is in compliance with silviculture standards and protection measures specific to the particular coupe.

I.4.4.7 Trees to be felled are previously plotted on a map and conspicuously marked, prior to harvest.

I.4.4.8 Financial clauses, technical standards for logging and specific arrangements to protect the forest are clearly specified in the management plan compartment register.

I.4.4.9 The application of provisions of the contract agreement is to be assessed periodically. Non-compliance is penalized.

C.4.5 Deforested areas are regenerated by natural or artificial means.

I.4.5.1 Reforestation is implemented with chosen species in conformity with the specifications of the management plan.

C.4.6 Infrastructure (roads, bridges, firebreaks, etc…) is designed, established and maintained in such a way that negative impacts on the environment (forest, soil, water course network) are reduced to a strict minimum.

I.4.6.1 The planning and establishment of infrastructure (primary and secondary roads, timber yards, skidding tracks) takes into consideration the topography of the forest area and the needs of exploitation.

I.4.6.2 Sizes of infrastructure (primary and secondary roads, timber yards, skidding tracks) are reduced to the barest minimum possible.

I.4.6.3 Minimum infrastructure required for logging is made permanent.

C.4.7 Non timber forest products and their uses are identified.

C.4.8 Guidelines for rational harvesting of non-timber forest products are defined and put into practice.

C.4.9 Research is undertaken in order to define the conditions for a sustainable use of non-timber forest products.

C.4.10 Guidelines for harvesting of non-timber forest products are monitored, evaluated and can be corrected if necessary.
Appendix 3. The screen shows of the implementation of the built KBS

The Knowledge Base System was designed to be easily understood and used. Good interfaces allow users to maximize its capability in supporting the development and assessment criteria and indicators for sustainable forest management. Below are the main interfaces for the KBS.

a. Main Menu
b. Registration
c. Dialog for Adding Criterion or Indicator
d. Dialog for Deleting Criterion or Indicator

e. Dialog for Editing Criterion or Indicator
e. Detail Explanation of Criteria and Indicators

f. The Hierarchy of Decision Making Process
g. Direct Assessment
Appendix 4. The selected stakeholders’ characteristics

Table 1. Stakeholders’ secondary activities

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Secondary Activity</th>
<th>Annually target</th>
<th>Area</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhutani II</td>
<td>Community development</td>
<td></td>
<td>Villages</td>
<td>PMDH</td>
</tr>
<tr>
<td>Long Seturan</td>
<td>Collecting NTFP</td>
<td></td>
<td>FMU</td>
<td>Using traditional knowledge and tools</td>
</tr>
<tr>
<td>Long Loreh</td>
<td>Collecting NTFP</td>
<td></td>
<td>FMU</td>
<td>Using traditional knowledge and tools</td>
</tr>
<tr>
<td>Langap</td>
<td>Collecting NTFP</td>
<td></td>
<td>FMU</td>
<td>Using traditional knowledge and tools</td>
</tr>
<tr>
<td>Central Government</td>
<td>Provide information</td>
<td></td>
<td>FMU</td>
<td>Direct communication</td>
</tr>
<tr>
<td>Local Governments</td>
<td>Monitoring</td>
<td></td>
<td>FMU</td>
<td>Field observation</td>
</tr>
</tbody>
</table>

Table 2. Primary communication of the stakeholders

<table>
<thead>
<tr>
<th>Row to column communication</th>
<th>Inhutani II</th>
<th>Long Seturan</th>
<th>Long Loreh</th>
<th>Langap</th>
<th>Local Governments</th>
<th>Central Government</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inhutani II</td>
<td>x</td>
<td>PMDH</td>
<td>PMDH</td>
<td>PMDH</td>
<td>reporting</td>
<td>reporting</td>
</tr>
<tr>
<td>Long Seturan</td>
<td>Propose activities</td>
<td>x</td>
<td>Village boundaries</td>
<td>Village boundaries</td>
<td>Budgeting for village development</td>
<td>x</td>
</tr>
<tr>
<td>Long Loreh</td>
<td>Propose activities</td>
<td>Village boundaries</td>
<td>x</td>
<td>Village boundaries</td>
<td>Budgeting for village development</td>
<td>x</td>
</tr>
<tr>
<td>Tanjung Lapang</td>
<td>Propose activities</td>
<td>Village boundaries</td>
<td>Village boundaries</td>
<td>Village boundaries</td>
<td>Budgeting for village development</td>
<td>x</td>
</tr>
<tr>
<td>Langap</td>
<td>Propose activities</td>
<td>Village boundaries</td>
<td>Village boundaries</td>
<td>x</td>
<td>Budgeting for village development</td>
<td>x</td>
</tr>
<tr>
<td>Local Governments</td>
<td>monitor</td>
<td>coordination</td>
<td>coordination</td>
<td>coordination</td>
<td>x</td>
<td>coordinat</td>
</tr>
<tr>
<td>Central Government</td>
<td>regulate</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>coordinatio</td>
<td>x</td>
</tr>
</tbody>
</table>

Note: ‘x’ is no communication between related stakeholders
<table>
<thead>
<tr>
<th>No</th>
<th>Stakeholder</th>
<th>Why is this group important?</th>
<th>What does this major user group do?</th>
<th>Role in Forest Management</th>
<th>Positive activities</th>
<th>Negative activities</th>
<th>Impacts of inclusion</th>
<th>Impacts of exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inhutani II</td>
<td>Has legal rights</td>
<td>Timber cutting and planting</td>
<td>Infrastructure development</td>
<td>Over cutting</td>
<td>Damage forest, erosion, infrastructure available</td>
<td>Better forest condition, less erosion, slow infrastructure development</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Long Seturan</td>
<td>Live subsistent</td>
<td>Practice shifting cultivation and collecting NTFP</td>
<td>Collect NTFP wisely</td>
<td>Open too much virgin forest shifting cultivation</td>
<td>More opened forest</td>
<td>Less opened forest</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Long Loreh</td>
<td>Live subsistent</td>
<td>Practice shifting cultivation and collecting NTFP</td>
<td>Collect NTFP wisely</td>
<td>Open too much virgin forest shifting cultivation</td>
<td>More opened forest</td>
<td>Less opened forest</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Long Loreh</td>
<td>Live subsistent</td>
<td>Practice shifting cultivation and collecting NTFP</td>
<td>Collect NTFP wisely</td>
<td>Open too much virgin forest shifting cultivation</td>
<td>More opened forest</td>
<td>Less opened forest</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Langap</td>
<td>Live subsistent</td>
<td>Practice shifting cultivation and collecting NTFP</td>
<td>Collect NTFP wisely</td>
<td>Open too much virgin forest shifting cultivation</td>
<td>More opened forest</td>
<td>Less opened forest</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Local Governments</td>
<td>Has legal rights</td>
<td>Execute and monitor regulations</td>
<td>Develop good regulation</td>
<td>KKN</td>
<td>KKN will go on</td>
<td>No formal regulation in forest management</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Central Government</td>
<td>Has legal rights</td>
<td>Provide regulations</td>
<td>Develop good regulation</td>
<td>KKN</td>
<td>KKN will go on</td>
<td>No formal regulation in forest management</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5. Digital maps used in the simulation

Figure 1. The study area in the East Kalimantan map
Figure 2. Forestland use agreement map

Figure 3. Vegetation map
Figure 4. Main road map

Figure 5. Main road map
Figure 6. Five-year plan map

Figure 7. Annual plan map
## Appendix 6. Costs and revenues of Inhutani II

### Table 1. Fixed investment

<table>
<thead>
<tr>
<th>Element</th>
<th>Cost (xRp. 1000/Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Master plan</td>
<td>8,835</td>
</tr>
<tr>
<td>2. Boundary mark</td>
<td>1,389</td>
</tr>
<tr>
<td>3. Five-year plan documents (I - IV)</td>
<td>4,000</td>
</tr>
<tr>
<td>4. Main road construction</td>
<td>96,000</td>
</tr>
<tr>
<td>5. Building</td>
<td>11,365</td>
</tr>
<tr>
<td>6. Fire protection</td>
<td>3,617</td>
</tr>
<tr>
<td>7. Vehicles purchasing</td>
<td>12,297</td>
</tr>
<tr>
<td>8. Exploitation tools</td>
<td>742,676</td>
</tr>
<tr>
<td>9. Communication tools</td>
<td>9,042</td>
</tr>
<tr>
<td>10. Electricity and water</td>
<td>18,083</td>
</tr>
<tr>
<td>11. Stationary</td>
<td>4,589</td>
</tr>
<tr>
<td>12. Tools for survey</td>
<td>900</td>
</tr>
</tbody>
</table>


### Table 2. Direct investment

<table>
<thead>
<tr>
<th>Element</th>
<th>Cost (xRp. 1000/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Working area establishment</td>
<td>25,000</td>
</tr>
<tr>
<td>2. Pre-logging inventory</td>
<td>20,000</td>
</tr>
<tr>
<td>3. Pre-logging field preparation (<em>pembukaan hutan</em>)</td>
<td>147,165</td>
</tr>
<tr>
<td>4. Exploitation</td>
<td>2,730,114</td>
</tr>
<tr>
<td>5. Post-logging liberation (<em>perapihan</em>)</td>
<td>30,000</td>
</tr>
<tr>
<td>6. Post-logging inventory</td>
<td>22,000</td>
</tr>
<tr>
<td>7. Liberation cutting I</td>
<td>30,000</td>
</tr>
<tr>
<td>8. Seedling procurement</td>
<td>36,000</td>
</tr>
<tr>
<td>9. Enrichment planting/rehabilitation</td>
<td>20,000</td>
</tr>
<tr>
<td>10. Planting road sides</td>
<td>20,000</td>
</tr>
<tr>
<td>11. Plant maintenance</td>
<td>48,000</td>
</tr>
<tr>
<td>12. Liberation cutting II</td>
<td>18,000</td>
</tr>
<tr>
<td>13. Liberation cutting III</td>
<td>18,000</td>
</tr>
<tr>
<td>14. Thinning I</td>
<td>50,000</td>
</tr>
<tr>
<td>15. Thinning II</td>
<td>50,000</td>
</tr>
<tr>
<td>16. Thinning III</td>
<td>50,000</td>
</tr>
<tr>
<td>17. Protection and Research &amp; Development</td>
<td>45,000</td>
</tr>
<tr>
<td>18. Costs for Environmental plans</td>
<td>17,000</td>
</tr>
<tr>
<td>19. Community development</td>
<td>18,160</td>
</tr>
</tbody>
</table>

Table 3. Operational cost

<table>
<thead>
<tr>
<th>Element</th>
<th>Cost (xRp. 1000/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Annual year plan document</td>
<td>10,000</td>
</tr>
<tr>
<td>2. Building maintenance</td>
<td>1,130</td>
</tr>
<tr>
<td>3. Road maintenance</td>
<td>14,720</td>
</tr>
<tr>
<td>4. Vehicle maintenance</td>
<td>18,445</td>
</tr>
<tr>
<td>5. Tools replacement</td>
<td>74,270</td>
</tr>
<tr>
<td>6. Salary</td>
<td>273,420</td>
</tr>
<tr>
<td>7. General costs (office tools, traveling etc.)</td>
<td>45,210</td>
</tr>
<tr>
<td>8. Electricity and water cost and maintenance</td>
<td>5,425</td>
</tr>
</tbody>
</table>


Table 4. Timber cutting projection of Inhutani II (in thousand rupiah).

<table>
<thead>
<tr>
<th>Budget year</th>
<th>Concession year</th>
<th>Area (ha)</th>
<th>Volume (m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990/1991</td>
<td>1</td>
<td>878</td>
<td>45,101</td>
</tr>
<tr>
<td>1991/1992</td>
<td>2</td>
<td>887</td>
<td>45,592</td>
</tr>
<tr>
<td>1992/1993</td>
<td>3</td>
<td>874</td>
<td>44,937</td>
</tr>
<tr>
<td>1993/1994</td>
<td>4</td>
<td>802</td>
<td>41,232</td>
</tr>
<tr>
<td>1994/1995</td>
<td>5</td>
<td>789</td>
<td>40,518</td>
</tr>
<tr>
<td>1995/1996</td>
<td>6</td>
<td>1,937</td>
<td>99,519</td>
</tr>
<tr>
<td>1996/1997</td>
<td>7</td>
<td>1,182</td>
<td>60,731</td>
</tr>
<tr>
<td>1997/1998</td>
<td>8</td>
<td>717</td>
<td>36,835</td>
</tr>
<tr>
<td>1998/1999</td>
<td>9</td>
<td>687</td>
<td>35,321</td>
</tr>
<tr>
<td>1999/2000</td>
<td>10</td>
<td>826</td>
<td>42,438</td>
</tr>
<tr>
<td>2000/2001</td>
<td>11</td>
<td>1,940</td>
<td>99,671</td>
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**Total** 36,771,206 71,284,354 10,180,625 118,236,185
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Appendix 7. The Smalltalk codes of the communities’ reasoning and activities

Function: Initiation of the communities
Smalltalk representation:

```smalltalk
self mailBox: OrderedCollection new.
transaction:= OrderedCollection new.
belief := Dictionary new.
transaction:= OrderedCollection new.
ciSupernatural := OrderedCollection new.
ciSosec := OrderedCollection new.
ciBiophysic := OrderedCollection new.
ciSupernatural add:'respect supernatural spirits'; add: 'recognize natural signs'.
ciSosec add:'recognizing other stakeholders'; add: 'collaboration'.
ciBiophysic add:'there is fallow period'; add: 'normality of NTFP'.

belief at: #CIsupernatural put: ciSupernatural.
belong at: #CIsosec put: ciSosec.
belong at: #CIbiophysic put: ciBiophysic.
belong at: #Transaction put: transaction.
self beliefs: belief.

initDesires:= OrderedCollection new.
initDesires add:'to have better income'.
self desires: initDesires.

initIntentions:= OrderedCollection new.
initIntentions add: 'rice field practice'; add: 'NTFP collection'.
self intentions: initIntentions.

experience := Dictionary new.
event := OrderedCollection new. event add: 'noEvent'.
action := OrderedCollection new. action add: 'noAction'.
feedback := OrderedCollection new. feedback add: 'noFeedback'.
experience at:#Event put: event.
experience at:#Action put: action.
experience at:#Feedback put: feedback.
```

Figure 1. Initiation of community agents
### Function: to revise communities' beliefs

**Smalltalk representation:**

```smalltalk
beliefRevision:eventQ

"B := brf(B,p)"

<table>
<thead>
<tr>
<th>revisedBeliefs revisedTransaction</th>
</tr>
</thead>
</table>
revisedBeliefs := self beliefs.
revisedTransaction := (self beliefExplore:eventQ).
revisedBeliefs at: #Transaction put: revisedTransaction.

self beliefs: revisedBeliefs.

beliefExplore:eventQ

<table>
<thead>
<tr>
<th>eventCat sosecBeliefs currBeliefs bioBeliefs supraBeliefs consistency</th>
</tr>
</thead>
</table>
newTransaction eventCatColl newTransactionColl |
currBeliefs := self beliefs.

|---|
eventCatColl := OrderedCollection new.

|---|
eventQ do: [:event |
|---|
eventCat := self eventCategory:event.

|---|
eventCatColl add:eventCat].

|---|
sosecBeliefs := currBeliefs at:#CIsosec.

|---|
bioBeliefs := currBeliefs at:#Cibiophysic.

|---|
supraBeliefs := currBeliefs at:#CIsupernatural.

|---|
newTransactionColl := OrderedCollection new.

|---|
eventCatColl do: [:ec |
|---|
   (((sosecBeliefs includes:ec) | (bioBeliefs includes:ec) | (supraBeliefs includes:ec))
   ifTrue:[consistency := #yes] ifFalse:[consistency := #no].

   |---|
   (consistency == #yes) ifTrue:[newTransaction := #consistent]

   |---|
   ifFalse:[newTransaction := #notConsistent].

   |---|
newTransactionColl add:newTransaction.
```

Figure 2. Beliefs revision function smalltalk codes
Function: to generate possible options
Smalltalk representation:

```smalltalk
optionGeneration

"D := options(B,I)"

"Desires could be consistent (=goals) and inconsistent, but without commitments"
"intentions are conditions that inevitably hold on each selected paths"

options := OrderedCollection new.
currentBeliefs := self beliefs.
currentIntentions := self intentions.
transactionBelief := currentBeliefs at:#Transaction.

(transactionBelief first = #consistent)
ifTrue:
    [(currentIntentions includes:'rice field practice')
     ifTrue:
     [options add:'rice field practice']
    ].

(temp:=transactionBelief.
"temp removeFirst."
(temp first = #consistent)
ifTrue:
    [(currentIntentions includes:'NTFP collection')
     ifTrue:
     [options add:'NTFP collection']
    ].

(transactionBelief last = #consistent)
ifTrue:
    [(currentIntentions includes:'co-logging')
     ifTrue:
     [options add:'co-laboration']
    ].

self desires: options.
```

Figure 3. Options generation Smalltalk codes
Function: to choose intentions among available options

Smalltalk representation:

```smalltalk
filter
"I := filter(B,D,I)"
"Intentions are chosen options and the agent is committed "
\( \text{currentBeliefs currentDesires currentIntentions revisedIntentions transactionBelief temp} \)\)
\( \text{currentBeliefs := self beliefs.} \)
\( \text{currentDesires := self desires.} \)
\( \text{currentIntentions := self intentions.} \)
\( \text{revisedIntentions := OrderedCollection new.} \)
\( \text{transactionBelief := currentBeliefs at:#Transaction.} \)

\( \text{(transactionBelief first = #consistent)} \)\n\( \text{ifTrue:} \)
\( \text{[(currentDesires includes:'rice field practice') \( \text{ifTrue:} \)} \)
\( \text{[(currentIntentions includes:'rice field practice') \( \text{ifTrue:} \)} \)
\( \text{[ revisedIntentions add:'rice field practice'. ]} \)

\( \text{temp := transactionBelief.} \)
\( \text{"temp removeFirst."} \)
\( \text{(temp first = #consistent)} \)\n\( \text{ifTrue:} \)
\( \text{[(currentDesires includes:'NTFP collection') \( \text{ifTrue:} \)} \)
\( \text{[(currentIntentions includes:'NTFP collection') \( \text{ifTrue:} \)} \)
\( \text{[ revisedIntentions add:'NTFP collection'.] \)

\( \text{(transactionBelief last = #consistent)} \)\n\( \text{ifTrue:} \)
\( \text{[(currentDesires includes:'colaboration') \( \text{ifTrue:} \)} \)
\( \text{[(currentIntentions includes:'co-logging') \( \text{ifTrue:} \)} \)
\( \text{[ revisedIntentions add:'co-logging'.] \)

\( \text{self intentions: revisedIntentions.} \)
```

Figure 4. Options filtering smalltalk codes
Function: to select action(s) among available intentions
Smalltalk representation:

```smalltalk
actionSelection:m on:fm at:t
"execute intention(s)"
| currentIntentions actionColl |
currentIntentions := self intentions.
actionColl := self action.

actionColl add:t.
(currentIntentions includes:'co-logging')
ifTrue:[self cologging:m on:fm at:t.  actionColl add:'co-logging' ].
(currentIntentions includes:'rice field practice')
ifTrue:[self ricefieldPractice:t.  actionColl add:'rice field practice' ].
(currentIntentions includes:'NTFP collection')
ifTrue:[self collectNTFP.  actionColl add:'NTFP collection' ].
self action: actionColl.
```

Figure 5. Action selection smalltalk codes

Function: to update intentions
Smalltalk representation:

```smalltalk
updateIntention:event

| currentIntentions currBeliefs sosecBeliefs bioBeliefs supraBeliefs eventCat |
currentIntentions := self intentions.
currBeliefs := self beliefs.

eventCat := self eventCategory:event.
sosecBeliefs := currBeliefs at:#CIsosec.
bioBeliefs := currBeliefs at:#Cibio. 
supraBeliefs := currBeliefs at:#CIsupernatural.

((sosecBeliefs includes:eventCat) | (bioBeliefs includes:eventCat) | (supraBeliefs
includes:eventCat))
ifTrue:[currentIntentions add:'co-logging' ].

self intentions: currentIntentions.
```

Figure 6. Intention updating smalltalk codes
Function: Rice field practice
Smalltalk representation:

```smalltalk
ricefieldPractice:t
| currentRiceFieldSites rotation currentRiceFieldSites1 currentRiceFieldSites2 size1 size2 |
"there are two possibilities in doing ricefieldPractice, whether they back to the previous field (assumed 5-year rotation) or open new forest"

rotation := 5.

t\rotation=1 ifTrue: [
">1 ifTrue:[currentRiceFieldSites do: [:c|c ladangGrow]]."
currentRiceFieldSites1 := (self riceFieldArea select:[x|x riceFieldRotationTh =1]) asOrderedCollection.
size1 := currentRiceFieldSites1 size.
size1 > 0 ifTrue:
[ currentRiceFieldSites1 do:
  [:s| self leave. self moveTo: s. self openOrNot]

  ifFalse: [self openNewLadang].
].


t\rotation= 2 ifTrue: [
">1 ifTrue:[currentRiceFieldSites do: [:c|c ladangGrow]]."
currentRiceFieldSites2 := (self riceFieldArea select:[x|x riceFieldRotationTh =2]) asOrderedCollection.
size2 := (currentRiceFieldSites2 size).
size2 > 0 ifTrue:
[ currentRiceFieldSites2 do:
  [:p| self leave. self moveTo: p. self openOrNot]

  ifFalse: [self openNewLadang].
].


t\rotation= 3 ifTrue: [
currentRiceFieldSites := (self riceFieldArea select:[x|x riceFieldRotationTh =3]) asOrderedCollection.
currentRiceFieldSites size > 0
  ifTrue:
    1 to: currentRiceFieldSites size do:
      [:s| self leave. self moveTo: (currentRiceFieldSites at:s). self openOrNot].

  ifFalse: [self openNewLadang].
].
```

Figure 7. Rice field practice smalltalk codes
t\r\n\t\rotate = 4 ifTrue: [ 
    currentRiceFieldSites := (self riceFieldArea select:[:x|x riceFieldRotationTh = 4])
    asOrderedCollection.
    currentRiceFieldSites size > 0
    ifTrue:[
        1 to: currentRiceFieldSites size do:
        [:s| self leave.  self moveTo: (currentRiceFieldSites at:s). self openOrNot.]
    ]
    ifFalse: [self openNewLadang].
].

(|
\t\rotate = 0) & (t>1) ifTrue: [ 
    currentRiceFieldSites := (self riceFieldArea select:[:x|x riceFieldRotationTh = 5])
    asOrderedCollection.
    currentRiceFieldSites size > 0 ifTrue:
    1 to: currentRiceFieldSites size do:
    [:s| self leave.  self moveTo: (currentRiceFieldSites at:s). self openOrNot.]
    ifFalse: [self openNewLadang].
] .
    self riceFieldIncome.

Figure 8. Rice field practice smalltalk codes (continued)

Function: Rice field practice
Smalltalk representation:

collectNTFP
| collect ntfpIncome |
"hunting, rattan collecting, fishing, eagle wood collecting"
collect := (self perception:5) asOrderedCollection.
collect removeAllSuchThat:[:n|n landDynamic ~= 1 ].

(collect isEmpty)
    ifTrue: ["self halt"]
    ifFalse:
        "destination := Cormas selectRandomlyFrom: collect.
        self leave. self moveTo: destination."

    "income from hunting, fishing, eagle wood collecting (langap HH survey)"
    ntfpIncome:= 112667.
    self income: self income + ntfpIncome].

Figure 9. NTFP collection smalltalk codes
Function: collaborative logging between communities and Inhutani II
Smalltalk representation:

cologging:m on:fmu at:t

// theSender mShare areaComanage |
areaComanage := m object.
areaComanage do:[a | a vegetation: 7].

self calculateCuttingVolume:areaComanage at:fmu.
self income: areaComanage size.

(t \35 = 5) & (t \35 = 1) 

ifTrue: ["True:
theSender := m sender.
mShare := ActorsMessage new.

mShare symbol: #moneyCollaboration; object: m object;
amount: 0; sender: self; receiver: theSender.

self sendMessageAsynchronously: mShare.
]

Figure 10. Collaborative logging Smalltalk codes