A High Conservation Value Forest Analysis of the Giam Siak Kecil Landscape – Riau, Sumatra

A report to WWF – International

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Definitions

Term	Definitions
DAS / Das Prioritas / DAS Super-Prioritas	Watersheds / Priority watersheds / Very high priority watersheds.
EIA	Environmental impact assessment. The Indonesian EIA is called AMDAL
FMU	Forest management unit; any block of forest discussed in an analysis and usually applied to timber concessions.
Forest type	A habitat defined by forest such as peat-swamp forest, lowland Dipterocarp forest or montane forest. Forest types can be subdivided into thematic types with different species dominance.
GSK Landscape	The GSK landscape is an approximately 600,000 ha peat swamp area covered by natural forest, plantations and degraded areas.
HCVF	High Conservation Value Forest; a forest that contains one or more High Conservation Values (HCVs).
HCV	High Conservation Value; a conservation attribute that is exceptional. Six HCVs were used in forest certification under the Forestry Stewardship Council definitions. These have been detailed in a **global toolkit** [1], detailed further in a **landscape level toolkit** [2] and further refined for Indonesia in an **Indonesian toolkit** [3].
Landscape	Area in which an investigation/study is conducted.
MoF	Ministry of Forestry
Sub-Landscape	A discrete component of a landscape in which a more intensive investigation is conducted.
Umbrella species	Same as keystone species; a species whose presence is essential to the survival of many others.

Executive summary

High Conservation Value Forest (HCVF) is a concept defined in 1999 by the Forest Stewardship Council (FSC) for use in forest certification. It has been adopted for conservation and natural resource planning, policy, advocacy and improving purchasing policies for wood-based materials by private sector companies and NGOs. HCVF is a forest that contains one or more High Conservation Values (HCVs). An HCVF analysis is a framework that both captures standard conservation and spatial planning information and presents in a format consistent with FSC certification requirements.

In 2003 WWF conducted an HCVF assessment of Riau [4], a province on the island of Sumatra. The Riau study treated the province as one landscape. It was based on satellite data and literature. It defined eight remaining large forest blocks in Riau and treated each as a sub-landscape. A sub-landscape analysis of each is needed to fully assess the conservation values at local levels, and the threats to those values.

This report presents an HCVF analysis of one of these remaining forest blocks, the Giam Siak Kecil (GSK) landscape. It is a peat swamp area of 600,000 ha incorporating two protected areas - the Giam Siak Kecil Game Reserve of 75,000 ha and Bukit Batu Game Reserve of 24,800 ha. The area comprises around 350,000 ha of largely intact peat swamp forest, the remainder *Acacia* plantation and heavily degraded forest with cover lost since 1985. The area was identified in the Riau assessment as one of 8 relatively large blocks of intact contiguous forest left in the province. The analysis:

- Treat the area as one landscape for assessment
- Follows FSC certification guidelines as currently used in Indonesia.
- Treats the GSK landscape in a way that a FSC certification assessment would survey the operations and operational impacts of a forest management unit.
- Follows the methodology described in the HCVF Toolkit for Indonesia [3].
- Was conducted by ecological experts who audit for FSC accredited bodies in Indonesia. They demarcated HCVs and HCVF as they would expect a company to, were it responsible for identifying and managing HCVF in the GSK landscape.

SURVEY CONTEXT

Sumatra, with Borneo and Peninsular Malaysia comprises most of one bioregion, Sundaland, whose lowland forests are dominated by the tree family Dipterocarpaceae. Across this area, which includes territories of Brunei, Indonesia and Malaysia, most lowland forest habitats have been degraded or converted to plantations and small scale agriculture. In 1985 the forest cover of Sumatra was 23,324,000 ha, representing 49% of the island [4]. By 1997 this had dropped to 16,632,000, representing 35%. The decrease in forest from 1985 to 1997, was 6,691,000 ha, 29% forest loss representing 558,000 ha per year.

Riau is about 8 million ha in size. It was largely forested until logging and conversion to industrial plantations for oil palm and pulp fibre expanded over the last twenty years. Remaining forest cover is of varying quality. Some remains in pristine

condition, some has been logged yet still can recover to its original state [5]. Some has been so badly degraded and fragmented that will not recover. Estimates of deforestation rates in Riau vary; the World Bank accepts over 70,000 ha or 2 per cent per year [4], largely due to logging and plantation conversion. The scale of forest destruction may be underestimated; recent reports detailing human rights abuses over natural resources in Riau suggest that deficiencies in law and order continue to provide a backdrop to widespread environmental pillage [6] [7].

The Riau landscape HCVF analysis [8] described the GSK landscape as peat swamp that until recently was relatively undisturbed. It belongs to the *Sumatran peat swamp forest* ecoregion [9] recognised as Critical/Endangered:

> *"More than half of the habitat in this ecoregion has been cleared, especially in the southern portion, where only a few blocks of habitat remain. Large areas of swamp have been drained, mainly for transmigration settlements and large-scale development projects, making this a highly vulnerable ecoregion. There are thirteen protected areas that extend into the ecoregion to cover 4,730 km² (5 percent) of the area…. However, many of the protected areas are proposed, and the official status is still uncertain. Of the gazetted protected areas, only Berbak is greater than 1,000 km²."*
> (http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0160_full.html)

The GSK landscape has become the focus for rapid and widespread clearance and conversion to pulp & paper and oil palm plantations. Most of these operations are going forward either without thorough assessment of the impacts to biodiversity and ecological service provision inside and outside plantation borders, or if such assessments have been done, without adequate mitigation measures. Conversion operations are also providing access to an increasing number of illegal logging operations.

The ecological integrity of the GSK landscape is under enormous threat. LANDSAT satellite image analysis from 1985 until present indicates GSK landscape natural forest cover dropped from about 600,000 ha in 1985 to 350,000 ha in 2002.

IDENTIFICATION OF HIGH CONSERVATION VALUES

The Giam Siak Kecil landscape contains High Conservation Values. The High Conservation Values identified are summarised in the table below.

Table 1: HCV summary

HCV	Component	Present	Potentially Present	Absent
HCV1. Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)	1.1 Protected Areas	🟥		
	1.2 Critically endangered species	🟥		
	1.3 Concentrations of endangered, threatened or endemic species		🟨	
	1.4 Critical temporal concentrations		🟨	

HCV2. Forest areas containing globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns or distribution and abundance.	2.1 FMU is a large level landscape forest	🟥		
	2.2 FMU is an integral part of a large level landscape forest			🟩
	2.3 The FMU maintains viable populations of most naturally occurring species		🟨	
HCV3. Forest areas that are in or contain rare, threatened or endangered ecosystems			🟨	
HCV4. Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control)	4.1 Unique sources of water for daily use		🟨	
	4.2 Forests critical to water catchments and erosion control			🟩
	4.3 Forest providing a barrier to the spread of fire	🟥		
	4.4 Forest with critical impact on agriculture and aquaculture			🟩
HCV5 Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)		🟥		
HCV6. Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance in cooperation with such local communities)				🟩

DELINEATION OF HIGH CONSERVATION VALUE FORESTS

Any forest containing a HCV is deemed to be a High Conservation Value Forest (HCVF). Delimitation of the HCVFs in the GSK Landscape is thus based on the widest ranging and known HCV, which is 2.1 – large landscape level forests.

The approximate boundary of the HCVF within the GSK landscape is shown in figure 7 & 8 – the extent of the large landscape level in-tact forest. A forest manager implementing a policy of no conversion of HCVFs could therefore not clear any forest in the outlined area. From satellite images going back to 1985, aerial and field surveys, the forest within this boundary is either pristine or assumed to be able to recover to pristine or near-pristine state.

Accurate demarcation remains necessary and should be a participatory exercise between local and provincial government, Riau universities, communities, WWF and other NGOs. The multistakeholder participatory workshop conducted between NGOs, government and industry hosted by WWF for this study demonstrates the interest of many institutions in this proposal.

Approximate GSK landscape HCVF boundary
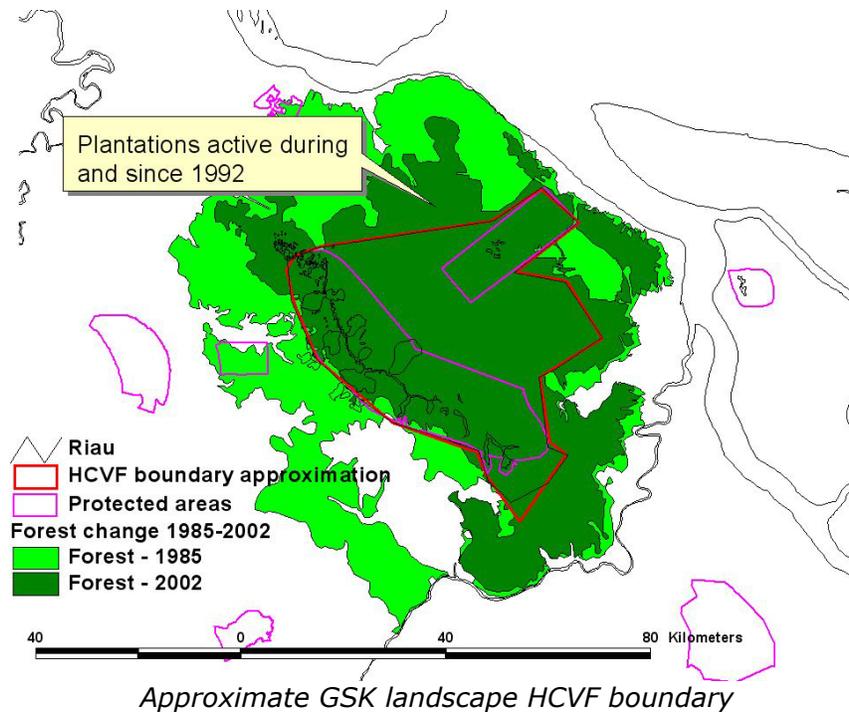
THREATS TO HCVS

There are two, and likely three major types of threat to HCVs in the GSK landscape:

1. **Industrial plantation expansion.** Clearance and conversion of the GSK landscape have been rapid and large over the last few years. The speed and scale of conversion will have caused considerable change to the landscape hydrology; the full extent of this is unclear.
2. **Illegal logging operations.** These appear to be widespread, particularly where there is easy access by road, river and canal. Whereas these may provide short-term economic benefit to local communities, profits are reportedly taken by middlemen. There appear to be no long-term benefits to communities.
3. **Conflicting spatial plans.** A spatial plan submitted to the Riau Parliament in 2002 would have been an additional threat, had it not been withdrawn due to legal problems. It indicated the intention to convert all forest not under current protection. Current management of protected areas in Riau is already failing to protect the conservation values they contain; clearance of adjacent forest is likely to increase the scale of this failure. Furthermore, spatial planning maps used by different land users are causing confusion. Discrepancies among different maps used by government agencies, plantation and forestry managers, over protected reserve boundaries and a lack of definitive ground demarcation has led to intrusion into protected areas. This is an important management issue and easily verifiable. Encroachment into protected areas is clearly evident from ground surveys and satellite images.

MANAGEMENT ACTIONS NEEDED TO MAINTAIN THE HCVS

The GSK landscape contains High Conservation Value Forest, with four identified HCVs and potentially five. Remaining forest and the HCVs it contains are being rapidly eroded. Key management actions to maintain all the HCVs identified are set out below:

- In line with principles and criteria for sound forest management developed by the Forest Stewardship Council, the managers of a HCVF should implement "specific measures that ensure the maintenance and/or enhancement of the applicable conservation attributes consistent with the precautionary approach. These measures shall be specifically included in the publicly available management plan summary". In addition "annual monitoring shall be conducted to assess the effectiveness of the measures employed to maintain or enhance the applicable conservation attributes".
- Until a management plan to maintain or enhance the identified HCVs is in place, the precautionary approach requires a moratorium on further logging and clearing with the GSK HCVF.
- Illegal logging must be controlled. Forest managers must also prevent loggers from accessing forest through lands they are responsible for.
- Forest managers must monitor all canals draining the swamp and monitor their impacts on the hydrology of the area. Internationally accepted flow regulation protocols that minimise drainage impact should be adhered to.
- A mechanism for monitoring and reporting detrimental impacts to the GSK landscape should be developed with the relevant authorities. Impacts should be acted upon and the actions and results disseminated publicly.
- All management operations in and around the GSK landscape should prepare monitored plans that explain how, on a long term basis, impacts of management operations on the hydrology of the swamp will be measured and when found, mitigated. A general policy has to be developed to minimise canal and drain construction and the monitoring of existing canals.
- Rehabilitation of logged areas unsuitable for agriculture and adjacent to the remaining forest boundaries should be encouraged to facilitate natural regeneration.
- Any forestry operations in the GSK landscape should have, as a minimum, thorough, public and transparent EIA documents that monitor company activities and provide a basis for halting environmentally detrimental operations. In these documents, forest management operations should be formulated for both the forests and water system they manage and those they impact downstream. There should be no impact on the hydrological integrity of the swamp and other GSK landscape HCVs.

In addition to the above, the discussion section of this report recommends specific management actions for the individual HCVs identified.

Introduction

HIGH CONSERVATION VALUE FOREST

The High Conservation Value Forest concept became an integral part of the timber certification scheme of the FSC in 1999 and is therefore globally applied and found acceptable within FSC-accepting global trade networks, NGOs and governments. As a standalone concept, it helps:

- Guide purchasing policies of companies wishing to source ethically produced timber products.
- Guide certification compliance practices among forest management companies, even those plantations and estates that cannot be certified under FSC because of recent land conversion.
- Capture and present diverse sources of conservation information in a format compliant with widely accepted and understood FSC guidelines.

The key to the concept of High Conservation Value Forest (HCVF) is identification of High Conservation Values (HCVs). When one or more conservation values are shown to be exceptional or rare they may be HCVs. If an HCV is demonstrated, the forest needed to maintain the HCV is an HCVF. Any type of forest can potentially be an HCVF.

The presence of one single HCV is enough to designate a forest HCVF. Under FSC guidelines, HCVF needs to be appropriately managed in order to maintain or enhance the identified HCVs. AN HCVF may be a particularly valuable part of a larger forest. In that case either this HCVF block has to be exempt from all disturbances, or should its function depend on the integrity of the whole forest block, the whole block has to be exempt from all disturbance that would adversely affect identified HCVs.

For the purposes of certification, identification and demarcation of HCVF has to pass assessment by ecological auditors. The boundary of an HCVF is determined by the widest geographical extent of all HCVs.

Six High Conservation Values are recognised by the FSC (http://www.fscoax.org/principal.htm):

- HCV1   Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, and refugia).
- HCV2   Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.
- HCV3   Forest areas that are in or contain rare, threatened or endangered ecosystems.
- HCV4   Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control).
- HCV5   Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health).

- • HCV6 Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

Toolkits

Toolkits have been prepared to assist interpretation and identification of HCVF. At a global scale, each HCV has been divided into components [1] as follows:

Table 2: HCV components

HCV	Component
HCV1. Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)	1.1 Protected Areas
	1.2 Critically endangered species
	1.3 Concentrations of endangered, threatened or endemic species
	1.4 Critical temporal concentrations
HCV2. Forest areas containing globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns or distribution and abundance.	2.1 FMU is a large level landscape forest
	2.2 FMU is an integral part of a large level landscape forest
	2.3 The FMU maintains viable populations of most naturally occurring species
HCV3. Forest areas that are in or contain rare, threatened or endangered ecosystems	
HCV4. Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control)	4.1 Unique sources of water for daily use
	4.2 Forests critical to water catchments and erosion control
	4.3 Forest providing a barrier to the spread of fire
	4.4 Forest with critical impact on agriculture and aquaculture
HCV5 Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)	
HCV6. Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance in cooperation with such local communities)	

A landscape toolkit [2] explains the use of the components, and is refined in a further toolkit for use in the context of Indonesian forest [3]. The Indonesian toolkit will soon be available on the ProForest website (www.proforest.net).

HCVF AND RIAU

Sumatra, Borneo and Peninsular Malaysia comprise most of one bioregion, Sundaland, whose lowland forests are dominated by Dipterocarpaceae. Across this entire area, which includes territories of three countries, most lowland forest habitats have been badly degraded or converted to agriculture including pulp fibre and oil palm plantations. Whereas the large forest blocks remaining appear of great

conservation value as discussed later, there is increasing pressure to exploit and convert them as industrial interests compete to harvest and convert what remains.

Riau is a province in central Sumatra (figure 1) and its mainland is about 8 million ha in size. It was largely forested until logging and conversion to industrial plantations for oil palm and pulp fibre expanded over the last twenty years. The remaining forest cover for 2002 was estimated to be ca. 3.0 million ha, 37% of the province's mainland [10]. Estimates of rates of deforestation in Riau vary; the World Bank accepts over 70,000 ha per year [4]; WWF calculated from Landsat satellite images that Riau lost an average 196,000 ha every year between 1985 and 2002 [11]. Smallholders have been attributed a large share of the blame, yet the World Bank states this to be less so than in other, comparable, provinces. Conversion to pulp and paper, oil palm and coconut has played a major role in forest loss. It is industrial land managers who have been largely responsible for the loss of forest in Riau. The scale of forest destruction may be underestimated; recent reports detailing human rights abuses over natural resources in Riau suggest that deficiencies in law and order continue to provide a backdrop to widespread environmental pillage [6] [7].

Remaining forest cover is of varying quality. Some remains untouched, some has been logged yet still can recover to its original state [5] and some has been so badly degraded that it stands little or no hope of recovery.
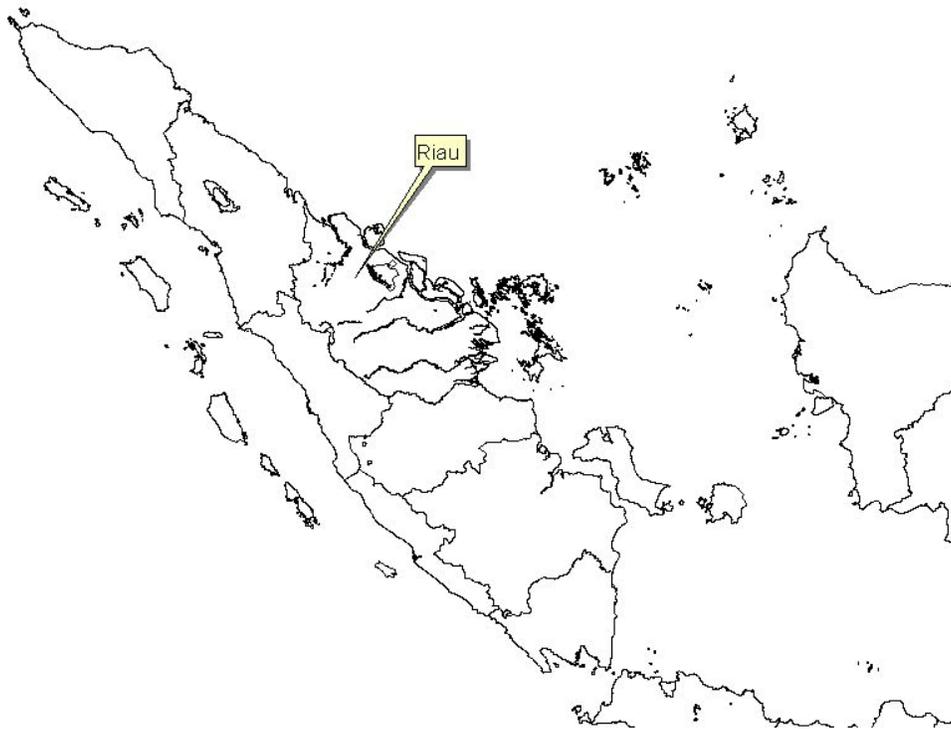

Figure 1- The Sumatran province of Riau

Analysis of LANDSAT satellite images from 2001 indicated 3.8 million ha of natural forest may remain of the approximately 8 million ha area of Riau (including its islands):

Table 3: Remaining forest types by area in all Riau, 2001 [8]

Forest type	Area (ha)
Lowland dry forest	990,384
Mangrove	205,305
Peat forest (< 2 m)	669,450
Peat forest (> 2m)	1,939,019
Submontane forest	13,815
Total	**3,825,945**

Industrial forest conversion in Riau has been the largest cause of forest loss, generally following selective logging. In addition to large scale logging sanctioned by government, logging roads have provided easy access to previously remote natural forest for illegal loggers.

Forest conversion affects land beyond that directly impacted, with significant effect. The most important in Riau is caused when peat-based forest is converted to oil palm plantations or fibre crops like *Acacia*. The land is drained and the pH of the soil changed. Drying affects the drainage of the wider landscape, which in some cases includes protected areas. Fire risk becomes a new hazard, evident in frequent and long lasting forest fires and haze that affects both Indonesia and its neighbours.

In 2003 WWF conducted a High Conservation Value Forest (HCVF) assessment of Riau [8]. The landscape analysis led to the following conclusions about HCVF at the province-wide level:

Table 4: Riau HCVs

HCV	Component
HCV1. Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)	• Protected areas are HCVs and any protected area in thus HCVF. • All protected areas are threatened and are being degraded. • Protected areas protect small fractions of the forest types they cover on paper, and little in reality. Until this situation changes forest managers elsewhere in Riau cannot look to protected areas as maintaining the biodiversity of the province; their responsibility to do so thus increases. • All forests necessary for maintaining the ecological integrity of protected areas are HCVF. • Concentrations of threatened and endangered species (such as tigers and ramin trees) are present, yet cannot be effectively mapped. The precautionary approach is therefore invoked. It is recommended that all forest areas are assumed to contain concentrations of threatened or endangered species, concentrations of endemic species and critical seasonal concentrations of species.
HCV2. Forest areas containing globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns or distribution and abundance.	• There are eight forest blocks in Riau that should be seen as possessing this HCV under the precautionary principle. • It is unclear which of these blocks have a chance for survival • There is an urgent need to conduct ground-based sub-landscape/FMU analyses for each of these blocks. • If funds are limited, WWF should prioritise which blocks to look at first. Strongly recommended are blocks 2 and 4. Each of these was until recently undisturbed yet now faces clearance. Tesso Nilo already has attention. Other lowland areas are more disturbed. The peat swamp should receive priority attention because that is where licensed industrial conversion is already taking place.
HCV3. Forest areas that	• The large forest blocks remaining in Riau of all natural types

are in or contain rare, threatened or endangered ecosystems	are threatened and as such are increasingly valuable HCVs. • As deforestation continues, so the values of any HCVs among forest blocks in Riau rises and the certainty of values indicated by the precautionary principle becomes clearer. • Where an FMU contains significant size of these rare, threatened and endangered forest types then the forest types are considered to be HCV.
HCV4. Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control)	There were insufficient data available to develop effective maps in the analysis for an area the size of Riau, but recommendations have been identified for land managers and WWF: • Land managers need to identify any *contribution* their activities have on critical services in Riau. This may be obvious in some cases like landslides in montane areas to the east. Evidence for effects in the lowlands may be lacking. Using the precautionary principle, assume that any clearing contributes to flooding unless demonstrated otherwise. • Government and NGOs need to develop an overview of which critical services in Riau, whether local or widespread, are being deleteriously affected and by whom. Land managers identified as contributing to critical service degradation should be notified and appropriate action taken. • Marine aquaculture should be assumed to have a critical dependency of mangroves, identified previously as a HCV.
HCV5 Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)	Community level information was lacking and cannot be mapped. It is recommended that Riau-specific components are identified for Riau and information about them built up. As such, the precautionary approach is invoked and large forest areas should be considered HCVs for both HCV5 and HCV 6 unless demonstrated otherwise.
HCV6. Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance in cooperation with such local communities)	

In identifying the HCV relevant to large landscape level forest, the study recognised eight remaining forest blocks in Riau (figure 2).
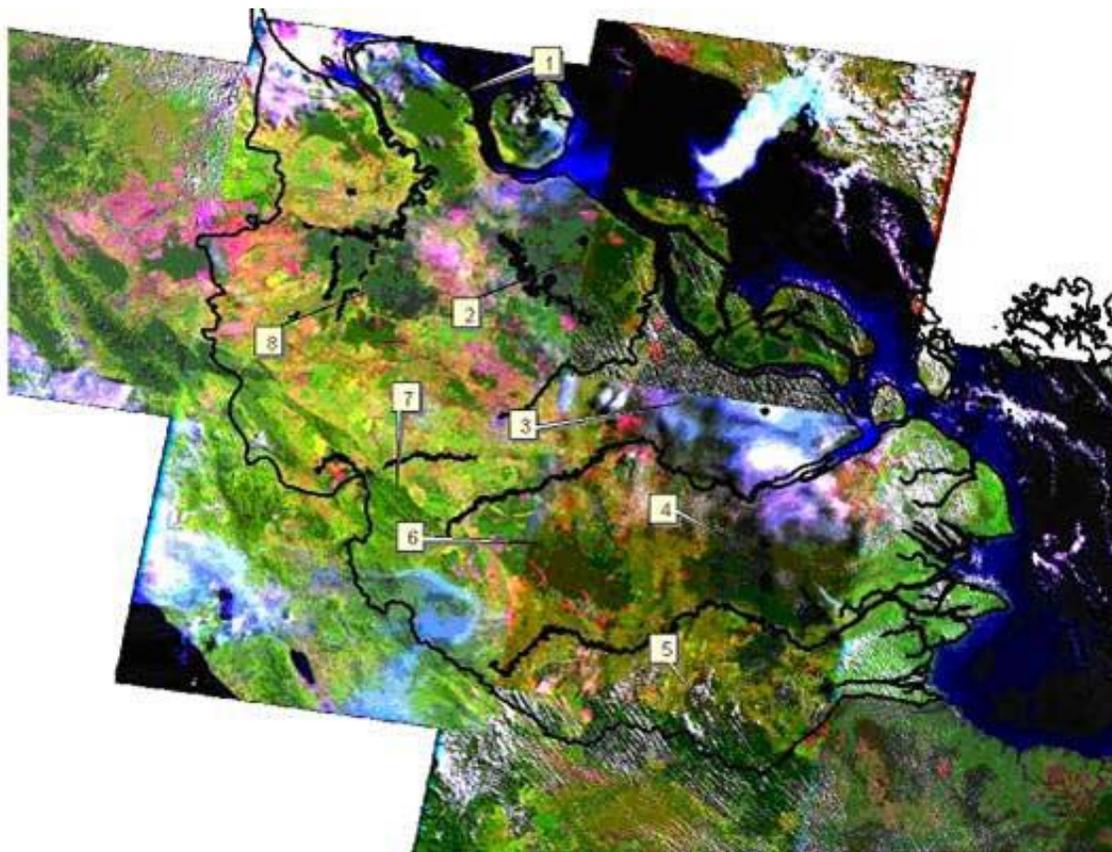
Figure 2 - Remaining forest blocks in Riau [8]

The forest blocks face the following threats:

Table 5: Threats to Riau forest blocks

No.	Forest type	Disturbance
1	Peat swamp	Long established plantations and timber concessions
2	Peat swamp (Giam Siak Kecil area)	Until recently very little disturbance; now being actively cleared for plantations. Remaining protected areas in this forest block likely to suffer from drainage of surrounding landscape
3	Peat swamp	Roads and plantations – some areas appear relatively undisturbed
4	Peat swamp (Kerumutan area)	Until recently relatively undisturbed, now threatened by plantations and timber concessions. There are major drainage threats. The area includes the important Kerumutan reserve, which already has incursions that appear to be both for logging and plantation conversion. Kerumutan will likely suffer from drainage of the surrounding landscape.
5	Sub montane (Bukit Tigapuluh area)	Severe illegal logging widely believed to be a serious issue.
6	Lowland (Tesso Nilo area)	Tesso Nilo landscape; badly fractured by logging roads and poor logging practices in the past, yet with every likelihood of recovery. Illegal logging and conversion threats severe.
7	Peat swamp (Rimbang Baling area)	Fractured landscape yet with relatively large blocks of submontane forest; appears threatened by conversion and illegal logging.

8	Peat swamp/Lowland (Libo area)	Severe logging and conversion pressure.

THE GIAM SIAK KECIL LANDSCAPE

This report presents an HCVF analysis of block 2 in figure 2, the Giam Siak Kecil (GSK) landscape. It is a peat swamp area of 600,000 ha incorporating two protected areas - the Giam Siak Kecil Game Reserve of 75,000 ha and Bukit Batu Game Reserve of 24,800 ha. The area comprises around 350,000 ha of peat swamp, the remainder *Acacia* plantation and heavily degraded forest with cover lost since 1985. The area was identified in the Riau assessment as one of 8 relatively large blocks of intact contiguous forest left in the province.

As noted in the Riau landscape HCVF analysis [8], the GSK landscape is peat swamp and until recently was relatively undisturbed. It belongs to the *Sumatran peat swamp forest* ecoregion [9] recognised as Critical/Endangered:

"More than half of the habitat in this ecoregion has been cleared, especially in the southern portion, where only a few blocks of habitat remain. Large areas of swamp have been drained, mainly for transmigration settlements and large-scale development projects, making this a highly vulnerable ecoregion. There are thirteen protected areas that extend into the ecoregion to cover 4,730 km^2 (5 percent) of the area…. However, many of the protected areas are proposed, and the official status is still uncertain. Of the gazetted protected areas, only Berbak is greater than 1,000 km^2."
(http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0160_full.html)

Peat swamp forests are particularly significant in maintenance and regulation of hydrological cycles. Hydrologically, the GSK landscape swamp acts as a giant sponge providing vital services as an aquifer for groundwater recharge and water supply, in flood and flow regulation and in prevention of saline water intrusion.

The GSK peat swamp has a geomorphology that has led rise to an ombrogenous – rain fed – formation. The GSK peat has a classic dome shape (to the east of the Bukit Batu protected area) and it is the property of this area that it holds water at a higher level at the centre compared to the edges of the swamp. The ability of the swamp to retain water in non-rain periods will depend on the quality and extent of the peat. The volume of peat in GSK at any time depends on the dynamics of peat creation and breakdown, and thus the factors controlling the humus producing process (humification). If the areal extent or the time-period for humification is altered it will have an effect on the volume of peat in GSK and consequently an impact on the amount of water that can be retained within the swamp. Local hydrology is controlled by local ecology. Thus hydrological management of the GSK landscape needs to consider those human activities that have an impact on the ecology of the forest.

The basic hydrological functions of GSK, as with any large peat swamp, are impacted by widespread human activities. For example, ground water entering the ecosystem can be affected by industrial plantation development. Plantation development

replaces natural forests, alters soil profiles and thus has an effect on water infiltration, local water table levels and the quality of ground water.

Many of the benefits provided by the GSK landscape are directly essential to the well being of local and adjacent communities, remaining forest and the biota it harbours. Ironically, it also supports the very plantations and agriculture in the area that threaten its integrity and long-term survival.

The GSK landscape has become the focus for rapid and widespread clearance and conversion to pulp & paper and oil palm plantations. Most of these operations are going forward without obvious assessment of, and plans to mitigate, the impacts to biodiversity and ecological service provision within their borders, or outside. If EIAs have been conducted, they have either not been thorough or are ignored. Furthermore, these operations are providing access to an increasing number of illegal logging operations. The integrity of the landscape is under threat; analysis of LANDSAT satellite imagery indicates that forest cover has reduced from about 600,000 ha in 1985 to 350,000 ha in 2002 (figure 3).

Figure 3: GSK forest; light green 1985, dark green 2002

An analysis of forest loss based on LANDSAT satellite imagery from 1985 – 2002 was conducted using a study area defined as the extent of contiguous forest remaining in 1985 whose boundaries are the Dumai – Pekanbaru road to the west and south of the GSK landscape, the Sg. Mandak/Siak to the east and the coast to the north. In 1985, this forest covered 599,263.7 ha. In the period from 1985 to 2002, 248,024 ha were cleared leaving 351,239 ha with forest cover. This included forest that had been selectively logged but not cleared for permanent agriculture or plantation forestry. Proportionately more of "unclassed" forest, forest unassigned to any land

use, was cleared in the period from 1985 to 2002 than the forest planned for either logging or clearance. This suggests protection and enforcement are not effective on site.

A detailed analysis of forest loss in this landscape is presented in Appendix 1. Summary statistics from this analysis are:

Table 6: GSK summary statistics

Planned land use	Forest extent in 1985	% of total 1985 forest	Forest cleared 1985-2002	% forest cleared 1985-2002	Forest remaining uncleared in 2002	% forest remaining uncleared in 2002
	a	b = a/sum a	c	d = c/b	e	f = e/a
Protected areas	115086	19.2	10822	9.5	104263	90.6
Logging concession	31392	5.2	16725	53.3	14667	46.7
Pulp plantations	240679	40.2	126300	52.5	114378	47.5
Oil palm plantations	60668	10.1	30602	50.4	30065	49.6
Unclassed	151437	25.3	63573	42.0	87863	58.0
Others	599263	100	248024	41.4	351239	58.6

HCVF analysis process

The analysis:
- Follows FSC certification guidelines as currently used in Indonesia.
- Treats the GSK landscape in a way that a FSC certification assessment would survey the operations and operational impacts of a forest management unit under FSC assessment.
- Follows the methodology described in the HCVF Toolkit for Indonesia [3].
- Was conducted by ecological experts who audit for FSC accredited bodies in Indonesia. They demarcated HCVs and HCVF as they would expect a company to, were it responsible for identifying and managing HCVF in the GSK landscape.

The steps were:
- Review of the Riau landscape analysis [8].
- Review of LANDSAT satellite imagery, other relevant data sets and literature (Appendix 2).
- Identification of gaps needed to be filled by local ecological and social survey teams.
- Social and ecological team surveys (Appendix 3 / figure 4) and ecological observation collection
- Data synthesis and final analysis of satellite images with ground-truthed data (Appendix 4)
- Flyover based on findings from field teams and available information sources
- Presentation of findings to stakeholders invited by WWF in Riau and invitation for feedback. Stakeholders included local government departments responsible for forestry and land management, forest managers working in the GSK landscape, and local academics.
- Consultants demarcation of HCVF following HCVF toolkit guidelines
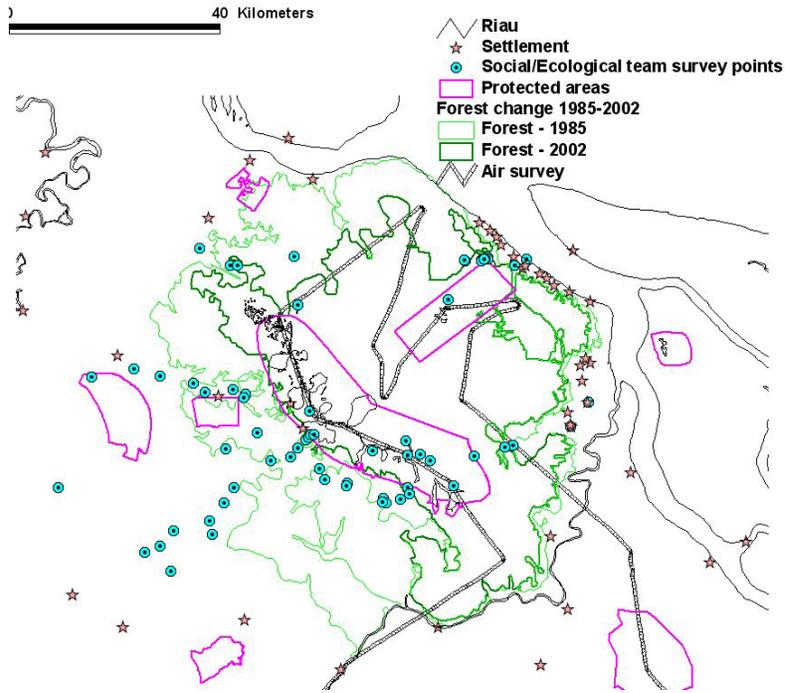
Figure 4: Survey routes and points

The process is summarised as follows:

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┌─────────────────────────────┐
│  Riau HCVF analysis and     │
│  prioritisation of GSK as a │
│  sub-landscape for further  │
│  study                      │
└─────────────────────────────┘
              │
              ▼
┌───────────────────────────────────────────┐
│         Compilation of:                     │
│   •  LANDSAT satellite imagery from 1985 –  │
│      2002 and literature                    │
│   •  Spatial planning coverage              │
│   •  Forest and infrastructure coverages    │
│                                             │
│        Followed by data gap analysis        │
└───────────────────────────────────────────┘
            ↙              ↘
┌──────────────────────┐ ┌──────────────────────┐
│ Selection of ecological│ │ Selection of social team│
│ field team and drafting│ │ and drafting of terms of │
│ of terms of reference  │ │ reference               │
└──────────────────────┘ └──────────────────────┘
            ↘              ↙
        ┌───────────────────────────────┐
        │ Fieldwork and report preparation│
        └───────────────────────────────┘
                    │
                    ▼
            ⬭ Area flyover to ⬭
              confirm data
              compiled to date
                    │
                    ▼
    ┌───────────────────────────────────┐
    │ Compilation of data, presentation to │
    │     multistakeholder workshop        │
    └───────────────────────────────────┘
                    │
                    ▼
    ┌───────────────────────────────────┐
    │ **Incorporation of final inputs and final** │
    │       **report production**          │
    └───────────────────────────────────┘
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HCVF analysis of the GSK landscape

HCV1

Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)

This HCV pertains to management of forest areas and the impacts of operations.

1.1 Protected Areas
1.2 Critically endangered species
1.3 Concentrations of endangered, threatened or endemic species
1.4 Critical temporal concentrations

Identification of HCV 1.1

Task	Findings
Assess the presence of any gazetted or proposed protected areas that may be impacted by FMU operations.	Two protected areas, both Game Reserves, exist within the FMU: • Giam Siak Kecil; 75,000 ha • Bukit Batu; 24,800

OUTCOME

Under the definition of HCV1.1 in the Indonesian Toolkit, all protected areas are HCV, therefore Giam Siak Kecil and Bukit Batu represent HCVs and the landscape supporting them HCVF. Any management of the area is expected to maintain or enhance the values of both these areas.

Threat assessment recommendations for HCV 1.1

Threats from trends and implications	Recommendations
The boundaries of the protected areas are perceived differently by the Ministry of Forestry and conservation NGOs than some forest managers operating in the areas.	There needs to be a commonly accepted boundary definition for each protected area. This must be respected by all stakeholders with interests in the GSK landscape.
The boundaries presented in the maps and figures of this report come from the Riau forestry service (*Dinas Kehutanan*) and are assumed to have a full legal basis.	Management operations should prevent any damage, incursion or other disturbance to protected areas as legally recognised.
This different perceptions concerning boundary recognition has led to parts of protected areas, as recognised by the	Protected area boundaries should be clearly marked and regularly monitored for disturbance.

Ministry, having been cleared by pulp & paper and oil palm companies.	
Where boundaries have not been crossed, clearance and conversion run up to protected area borders. The impacts of clearing and conversion are certain to impact the protected areas because of drainage canals. This will cause: • localised lowering of water table • irreversible oxidation of peat and desiccation; this causes loss of ecological function such as substrate for plant growth • fire hazard will be increased • increased access for small scale illegal operations, hunting and other offences	Management operations close to protected areas should have environmental impact assessments (EIA) that provide detailed information on: • The amount of buffer needed between operations and protected area boundaries to ensure that protected areas are undisturbed. • A monitoring system that regularly checks EIA assumptions of operational impacts and, when the impacts are greater than previously anticipated, closes operations affecting protected areas. Whenever a detailed EIA and monitoring & management plan is not available for operations close to protected area borders then the operation should be assumed to be a threat to the protected area.
Small scale illegal logging is occurring along the river of the Siak Kecil and other accessible areas. Meranti and ramin appear to be targeted. In Bukit Batu field teams observed illegal logging to the north. Satellite imagery indicates more illegal logging to the north and also the centre of this protected area. These practices are definitely occurring elsewhere in the protected areas. The implications are small scale damage and increased accessibility into the protected areas. If illegal logging is profitable it may attract newcomers and increase the potential for conflict over timber resources.	Companies managing land surrounding the GSK forest block should ensure illegal logs are not being transported through areas they are responsible for.

Identification of HCV 1.2: Critically endangered species

Task	Findings
Following assessment of rare, threatened and endangered species,	Taken from http://www.nature-conservation.or.id, showing faunal species from the "Fauna of Giam-Siak Kecil Wildlife Reserve" are species that fall into these

check if any are from the IUCN critically endangered list or CITES Appendix I that are, or potentially are in the FMU.	categories: Mammals • Silvered leaf monkey - *Trachypithecus cristatus* • Sumatran tiger - *Panthera tigris sumatrae* • Malayan sun bear - *Helarctos malayanus* • Sumatran elephant - *Elephas maximus* • Malayan tapir - *Tapirus indicus* Birds • Black Hornbill - *Anthracoceros malayanus* • Wrinkled Hornbill - *Aceros corrugatus* • Long-tailed Parakeet - *Psittacula longicauda* • Masked Finfoot - *Heliopais personata* • Milky Stork - *Mycteria cinerea* • Storm's Stork - *Ciconia stormi* • Lesser Adjutant - *Leptoptilos javanicus* • Fiery Minivet - *Pericrocotus igneus* • Red-throated Sunbird - *Anthreptes rhodolaema* Reptiles • Asian Softshell Turtle - *Amyda cartilaginea* • Bornean Terrapin - *Orlitia borneensis* • False Ghavial - *Tomistoma schlegelii* Fish • Arowana - *Scleropages formosus* There have been few studies conducted in the area thus this list should be treated as incomplete, especially for plants and insects. In an assessment of the *Sumatran peat swamp ecoregion* [9] it is noted that peat swamp forests do not support abundant wildlife and no mammal should be considered endemic to the habitat. There are less bird species than in the surrounding lowland rain forests, and there are no endemic or near-endemic species.
Expert and local stakeholder consultation and analysis to assess presence of locally critically endangered species. Determine if species are protected by special regional or district laws.	• There is no evidence of previous analysis of the presence of locally endangered species. • No special regional or district laws are in effect.

OUTCOME

Little information is available. The intact forest within the GSK landscape is one of the last remaining blocks in Riau where the species concerned may be harboured. The **precautionary principle** is invoked and it is assumed that this component of HCV1 is present.

Threat assessment recommendations for HCV 1.2

Threats from trends and implications	Recommendations
There is little information available on the species of the protected areas. The lack of information invokes the use of the precautionary principle.	Using the precautionary principle, managers should assume that all IUCN critically endangered list or CITES Appendix I species that may occur in the forest are in the forest.
Because there is a mosaic of peat swamp and dry land forest in a landscape where dry land forest has been cleared and converted into plantations much critical habitat has been lost. Larger mammals will be forced to migrate to peat swamp habitat. It becomes a refugium. Zoologically the GSK landscape is a likely last refuge for larger mammals.	The size of the GSK landscape forest indicates it is probably a last refuge for large mammals, which may well include tigers and other large cats, primates and birds, needs immediate review. A company operating in the area needs to assume that the land they are operating on, or otherwise impacting, **is** a refuge. The companies concerned need detailed standard operating procedures (SOP) for determining what critically endangered or otherwise vulnerable species whose conservation values they are responsible for maintaining or enhancing. Monitoring SOPs will also need to be in place. Companies without such procedures should be assumed to be detrimentally affecting large animal refugia.

Identification of HCV 1.3: Concentrations of endangered, threatened or endemic species

Task	Findings
Following assessment of threatened & endangered, or endemic species, check with relevant experts and conservation organisations whether the FMU is: • Part of a landscape with concentrations of threatened & endangered, or endemic species • Contains an area of particular importance to an overall landscape with threatened & endangered, or endemic species	There has been no relevant study to provide information on the distribution and concentrations of such species in the landscape. No Endemic Bird Areas occur within GSK landscape. The importance of the protected areas within the GSK landscape has been noted by various reports, including [10] study on remaining forests in Indonesia. In the absence of detailed surveys, at the present time it would be prudent to assume

• Within an Endemic Bird Area (EBA)	that the fauna and flora that these protected areas were set up to protect may be at least partly dependant upon the wider GSK landscape, and so, following the Precautionary Approach, until further information is available, the area should be assumed to contain this HCV.

OUTCOME

Little information is available. Because the GSK landscape is largely intact forest, and one of the last remaining such blocks in Riau where the species concerned may be harboured, then the **precautionary principle** is invoked and it is assumed that this component of HCV1 is present.

Threat assessment recommendations for HCV 1.3

Threats from trends and implications	Recommendations
The level of hunting in the protected areas, and wider GSK landscape, is unknown yet given the large numbers of illegal logging operations can be assumed to be large.	• Forest managers should not permit poaching and illegal logging in the GSK landscape they manage or provide access to.
Habitat loss caused by plantation operations will lead to the loss of critical habitat for rare, threatened and endangered species (and others) inhabiting the GSK landscape	• Conversion of forest habitat specified HCVF should not be permitted (figure 6) if HCVs are to be maintained or enhanced. Areas adjacent to HCVF, or where management will impact it, should not be cleared unless there are clear grounds for stating why operations will not affect the viability of R/T/E species populations. • Management operations should have EIA documentation that clearly sets out how baseline data for assessment of population viability was collected, how it will be monitored, and how operations will be changed should they be found to be negatively impacting relevant species.
Ramin (*Gonystylus spp.*) is being targeted by illegal loggers and is also becoming locally extinct where land is being converted. This level of pressure may lead to local extinction of the species.	• Industrial operations and customers buying their products should be aware that ramin is a CITES 3 species that also falls under the domestic full logging ban of Ministry of Forestry Decree 127/2000. The Ministry of Forestry Decree means that forest managers cannot legally clear stands of ramin to develop new plantation areas, nor can they legally export wood based products made from this species.

Identification of HCV 1.4: Critical temporal concentrations

Task	Findings
1.4.1 Does the FMU contain extensive mangroves, freshwater swamp forest and peat swamp forest, riparian forest?	The GSK landscape contains peat swamp forest
1.4.2 Does the FMU include any landscape features that tend to lead to a concentration of animals?	There is no evidence that the GSK landscape contains features that tend to lead to concentrations of animals (such as salt licks, high density of strangler figs etc).

OUTCOME

Following the Indonesian HCVF Toolkit, presence of extensive peat swamp forest means that this HCV is potentially present. Whether it is actually preset or not needs to be determined through surveys for migratory species, especially birds, along with consultation with independent experts.

Threat assessment recommendations for HCV 1.4

Threats from trends and implications	Recommendations
The more land that is cleared, the more animal populations will be concentrated in an area too small to sustain viable populations. Whereas this will give a short term impression of a landscape "teeming with wildlife", the long term prospects will be severely reduced numbers and population viability and resources are rapidly depleted.	• Large intact forest lands need to be maintained and rehabilitation of degraded landscapes encouraged to enhance this conservation value. • Existing, large, conversion areas, should have effective conservation refuges. Aerial surveys strongly indicate these are current absent.

HCV2

Forest areas containing globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns or distribution and abundance.

In Indonesia there is a relative paucity of data on population distribution and genetics for almost all species. Therefore this HCV should be considered in two parts. The first pertains to remaining forest in relation to the island it sits on. The second

pertains to viable populations; it is believed that conservation of large blocks of habitat retain species in viable numbers.

RATIONALE

Forests that contain viable populations of most or all native species will be large in size, and relatively unaffected by recent human disturbance and fragmentation.

In the Indonesian context this toolkit has identified the following components:

2.1 FMU is a large level landscape forest
2.2 FMU is an integral part of a large level landscape forest
2.3 The FMU maintains viable populations of most naturally occurring species

Identification of HCV 2.1: FMU is a large level landscape forest

Task	Findings
Determine the extent of remaining forest on the island, and that which the FMU represents.	In 1985 the forest cover of Sumatra was 23,324,000 ha, representing 49% of the island [4]. By 1997 this had dropped to 16,632,000, representing 35%. The decrease in forest 1985 – 1997 = 6,691,000 ha, 29% forest loss representing 558,000 ha per year. In Riau, over the same period, 39% of lowland forest had been cleared; 45% of this total was peat forest.

Remaining forest is threatened. Again. The Siak Kecil protected areas may already have been severely degraded. Another peat swamp protected area in the province, Kerumutan, appeared "mainly intact, although with some encroachment locally". As noted elsewhere in this analysis, Holmes commented that "it is not known what affect the drainage and reclamation of peat swamps downstream will have on the fragile hydraulic regime".

It is widely assumed since Holmes' study that rates of deforestation have increased with Indonesia's chaos surrounding decentralisation. At current rates, the forests of Sumatra are expected to be extirpated with the next few years [12]. The World Bank [4] has predicted that Sumatra's dry lowland plains will lose essentially all of their forest cover soon after 2005. Land clearing pressure will continue in the wetland forests and is likely to increase in the hill and mountain forest as the availability of the other types diminishes. Wetland forests, including peat swamps, are expected to disappear soon after 2010.

Based on a landscape analysis of Riau for WWF [8] the remaining forest areas of Riau (including islands) are: |

Forest type	Protected forest in Riau	Total forest in Riau	Protected forest in Riau (%)
Lowland forest	400,480	990,384	40.44
Mangrove	4,350	205,305	2.12
Peat (< 2 m)	84,000	669,450	12.55
Peat (> 2 m)	238,550	1,939,019	12.30

| | Sub-montane | 2,700 | 13,815 | 19.54 |
| | **Total forest** | **730,080** | **3,817,973** | **19.12** |

Determine whether the FMU now comprises a large landscape level forest.	The GSK landscape is one of eight significant yet isolated forest blocks identified in the Riau landscape HCVF analysis [8]. Of these, 6 are peat swamp forest. Because the GSK landscape was relatively undisturbed until recently it is likely to contain the full species assemblage at relatively natural patterns of abundance and distribution.

OUTCOME

If left alone the GSK landscape should continue to be a self sustaining ecosystem, thus maintaining its current status as a largely intact peat swamp forest that will continue to host its current complement of biodiversity. This HCV component is therefore present.

Threat assessment recommendations for HCV 2.1

Threats from trends and implications	Recommendations
The GSK landscape has: • A diverse set of forest types that together form a natural and integrated landscape • Is largely pristine, and where speculated to have been previously logged to be recovering well • Is otherwise isolated from other forest blocks The GSK landscape is being eroded from all around its borders. From a flyover survey it was apparent that the peat swamp forest of GSK contains several forest types. • The lake vegetation of the Giam Siak Kecil protected area. This is generally scrubby and seasonally flooded. Forest areas around these lakes are being cleared by small scale illegal logging operations. • A forest type in the north of the GSK landscape forest is dominated by a uniform, monopodial, conical crowned species. This area is currently severely impacted by illegal logging.	Maintenance or enhancement of HCVs requires conservation of remaining natural forest. Local pulp and paper companies may wish to focus on increasing site productivity rather than expanding into new if they intend to maintain or enhance HCVs.

• Forest in the extreme north and south of, and adjacent to, the GSK landscape forest. This forest has a complex crown structure with emergents and the highest tree species richness noted. This forest appears to have the best integrity across the entire GSK landscape yet it is also the area slated for conversion to pulp plantation. • Recovering forest and diverse canopy undisturbed forest in the Bukit Batu protected area and adjacent to the west. This forest is being degraded by small scale illegal logging along major water courses, and being converted by pulp and paper companies along its eastern border. • Forest speculated to be growing on dome peat that has a diverse structure with emergents, though fewer emergents than encountered in type 3. This forest appears equally diverse in terms of tree canopy. All forest types appeared to have different tree compositions in different areas.	

Identification of HCV 2.2: FMU is an integral part of a large level landscape forest

Task	Findings
Determine the extent and condition of forest surrounding the FMU.	It is a peat swamp area of 600,000 ha incorporating two protected areas - the Giam Siak Kecil Game Reserve of 75,000 ha and Bukit Batu Game Reserve of 24,800 ha. The area comprises around 350,000 ha of peat swamp forest, the remainder *Acacia* plantation and heavily degraded forest with cover lost since 1985.
Determine whether the loss or severe degradation of the FMU will significantly impact the large landscape level forest.	The FMU is represented by the entire remaining natural forest of the GSK landscape.

OUTCOME

This sub-component is not applicable to the analysis as the entire GSK landscape is the forest block (equivalent to an FMU) in question.

Identification of HCV 2.3: The FMU maintains viable populations of most naturally occurring species

Task	Findings
Select potential umbrella species and assess whether the FMU contains viable populations	Sufficient information not available.
In the absence of information indicating potential umbrella species, or in conjunction with them, look at extent and condition of forest types and ecological gradients in the FMU that may maintain them and seek expert opinion on whether the FMU is large enough to support them.	The landscape is sufficiently large to be a self-sustaining ecosystem and it is therefore assumed that its naturally occurring species, including umbrella or keystone species will continue to be maintained with their habitat.

OUTCOME
This component of the HCV is present.

Threat assessment recommendations for HCV 2.3

Threats from trends and implications	Recommendations
The extreme and rapid annihilation of forest, and indeed any vegetative cover, in the conversion areas around and within the GSK landscape, compounded by a lack of cover elsewhere, will have driven faunal populations into the remaining GSK forests. Further pressure on habitats may unsustainably concentrate animal populations in the short term, while leading to local extinction in the medium to long term.	All forest types should therefore be fully maintained, including connectivity between. These forests are likely to be irreplaceable and are already considered rare; the floral and faunal populations they support have nowhere else to be.

HCV3

Forest areas that are in or contain rare, threatened or endangered ecosystems

RATIONALE
HCV3 focuses on ecosystems, which the forest manager should interpret as broad forest types. Some broad forest types are naturally rare in some regions or particular islands in Indonesia. Heath forests, for example, are limited in extent because they depend in large part on the location of fossil beach sites and favourable climatic or

geological conditions to allow their development and persistence. Recent processes, such as land conversion may have further decreased their extent.

Other broad forest types have become rare through multiple recent threats, such as logging, wildfires and agriculture conversion.

This HCV is designed to ensure that threatened or endangered forest types are conserved. These particularly include forest types which were previously widespread or typical of a much larger region. They also include rare forest types, such as some of the limestone forests and Freshwater Swamp Forests.

Potential forest types to be considered include, but are not limited to:
- Cloud forest
- Upper montane forest
- Lower montane rain forest
- Lowland forest
- Peat swamp forest
- Freshwater swamp forest
- Heath forest
- Savannah
- Limestone forest
- Mangrove

In some parts of Indonesia it maybe appropriate to further subdivide, or add to, the above categories. Additions could include unusual species assemblages.

If more of these habitats are cleared outside the FMU, the importance of these ecosystems inside the FMU increases, which means that they will need more careful management, or perhaps protection. It is therefore in the interest of FMU managers to both monitor what is happening to the ecosystems they manage in the wider landscape, and to help mitigate the threats they are under.

Where an FMU contains significant size of these rare, threatened and endangered forest types and has been identified as a conservation priority area by an independent organization, then the forest types is an HCV. Further, a rare, threatened and endangered ecosystem that is located outside the FMU that is impacted heavily by FMU activities is also an HCV.

Identification of HCV 3: Forest areas that are in or contain rare, threatened or endangered ecosystems

Task	Findings
Identify the extent and quality of habitats found on the island in which the FMU is located.	See discussion for HCV component 2.1.
Identify the forest types present within the FMU and if these are rare, threatened or endangered in the wider landscape.	The Riau landscape HCVF analysis [8] describes the GSK landscape as peat swamp that until recently was relatively undisturbed. It belongs to the *Sumatran peat swamp forest* ecoregion [9] recognised as Critical/Endangered.

	Expert opinion predicts that with current rates of clearance peat swamp will be gone from Sumatra soon after 2010 [4] [12] because of conversion threats.
Overlay the FMU forest type map with maps of areas identified as important for conservation.	GSK has been identified by WWF as an important forest ecosystem [8] that is Critical / Endangered [9].

OUTCOME

Given the extent of threat, HCV 3 is identified as *potentially present* using a precautionary approach. The likelihood of it being certainly present will increase if peat swamp conversion continues.

Threat assessment recommendations for HCV 3

Threats from trends and implications	Recommendations
The GSK landscape has become the focus for rapid and widespread clearance and conversion to pulp & paper and oil palm plantations. Most of these operations are going forward with no apparent concern for either the impacts to biodiversity and ecological service provision within their borders, or outside. If conversion companies have conducted environmental impact assessments (EIAs) they appear either not thorough or ignored. Conversion operations are providing access to an increasing number of illegal logging operations. The integrity of the landscape is under enormous threat. LANDSAT satellite images from 1985 until present demonstrate the GSK landscape forest cover has been reduced from about 600,000 ha in 1985 to 350,000 ha in 2002. An additional threat may arise should a draft spatial plan submitted to the Riau Parliament in 2002, but withdrawn due to legal problems, be enacted. It indicates the intention to convert all forest not under current protection.	Spatial planning is required for the GSK landscape that ensures its integrity if HCVs are to be maintained or enhanced. Forest managers should halt conversion and logging operations impacting the GSK landscape halted until they can demonstrate they are not degrading HCVs and otherwise potentially endangering an important part of the remaining forests making up the *Sumatran peat swamp forest* ecoregion.

HCV4

<u>Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control)</u>

Identified HCV components are:

4.1 Unique sources of water for daily use
4.2 Forests critical to water catchments and erosion control
4.3 Forest providing a barrier to the spread of fire
4.4 Forest with critical impact on agriculture and aquaculture

<u>Identification of HCV 4.1: Unique sources of water for daily use</u>

Task	Findings
Identify specific areas within the FMU that provide drinking water (and other daily water needs) to communities.	• The river and lake system of the Giam Siak Kecil protected area provides water to two villages located within its borders, Tasik Serai and Tasik Betung. The social survey reported a combined population of about 50 families. • The social survey indicates that 37% of the sampled villages are dependent on the forest for water. Rather than direct dependence on the river, they are usually dependent on artesian wells fed by the water table maintained by the GSK peat swamp ecosystem supplemented by localised rainfall. The peat system of the wider GSK landscape is therefore assumed to provide and control water quality and quantity to other, unsampled, villages around it. Without the swamp's water regulatory function water will still be present, yet the quality and regulation of flow will be altered. It is not known how far or intensely it regulates water supply at increasing distance.
Identify whether the communities have access to alternative sources of water that is not dependent on the FMU (for example piped network bringing water sourced from outside the FMU). Check whether	• No other water supplies are available from the GSK landscape. • No other water supplies are available to the sampled villages.

this access is available all year long and at an acceptable cost and conditions.	
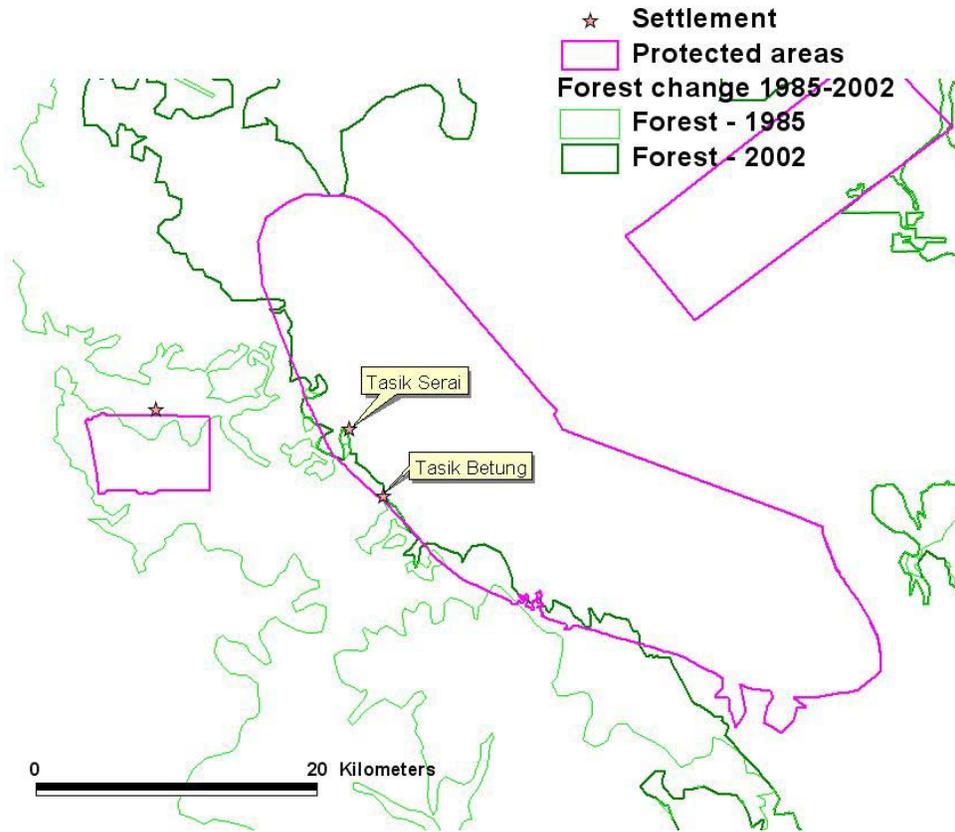
Figure 5: Villages in the Giam Siak Kecil protected area

OUTCOME

This component of the HCV is present.

Threat assessment recommendations for HCV 4.1

Threats from trends and implications	Recommendations
There is illegal logging along the margins of water courses. Given this is a peat swamp ecosystem, short-term impacts on the water supply are going to be limited, if noticed at all, as it appears from aerial survey that there are sufficient water reserves draining from the swamp. Should such logging intensify then pollution of water courses and significant impacts on the water table will likely arise.	This issue should not be dealt with in isolation, but as part of any overall action that protects the GSK landscape and the services it provides.
The GSK landscape is a self-contained peat system, almost 600,000 ha in size. The impacts of drainage and conversion of parts of this system on the area	Forest managers should have EIAs that thoroughly research the impacts of land conversion and clearance outside their work areas. Monitoring systems that

remaining are unknown; hence its impacts are unknown too.
 	
Taking a **precautionary** approach, it should be assumed that conversion of any part of the GSK peat ecosystem, whose boundary still requires detailed demarcation, will have impacts upon other areas. These impacts include lowering of the water table – rate of peat decomposition will increase many-fold due to exposure causing rapid decrease in peat depth manifested by drops in ground levels. This irreversible change will:
   • Decrease the ability of peat to recharge the water table
   • Increase rapid surface run off
	work toward mitigating impacts of operations on the peat ecosystem and hydrology in the wider landscapes need full description.

Identification of HCV 4.2: Forests critical to water catchments and erosion control

Task	Findings
Identify if FMU is within the classified DAS *Super-Prioritas* and DAS *Prioritas*, or other important DAS and Sub-DAS areas.	
Identify if FMU includes designated protection forest *for water catchment*.	*Not relevant for a self-contained peat ecosystem.*
Identify presence of 'cloud forest' catchment function of forests on mountains and ridges, particularly those close to the sea.	
Identify other important DAS and Sub-Das areas in the FMU.	

OUTCOME

The GSK landscape is not a critical water catchment.

Identification of HCV 4.3 Forest providing a barrier to the spread of fire

Task	Findings

Identify fire expertise relevant to your island and obtain information on fire history, causes and forecasts.	For the case of a peat swamp ecosystem like the GSK landscape, the scale and speed of degradation it is currently experiencing will increase likelihood of fire. The peat itself will form the substrate for fire, directly and indirectly. Riau is experiencing major fire and haze problems on an annual basis. It is likely that uncontrolled conversion of the GSK landscape will contribute significantly to this.
Determine whether or not there has been a history of large-scale fires near or bordering the FMU.	From aerial survey it appears that converted blocks are burned before replanting. Thus the area, which before conversion posed no fire risk and acted as a water catchment and regulator, is now an active fire hazard. An analysis of fire induced hot spots has been prepared (figure 6).

OUTCOME

This component of the HCV is present. It is likely to become more critical as more areas are converted.

Giam Siak Kecil Forest Complex 2003 Reported Hotspot
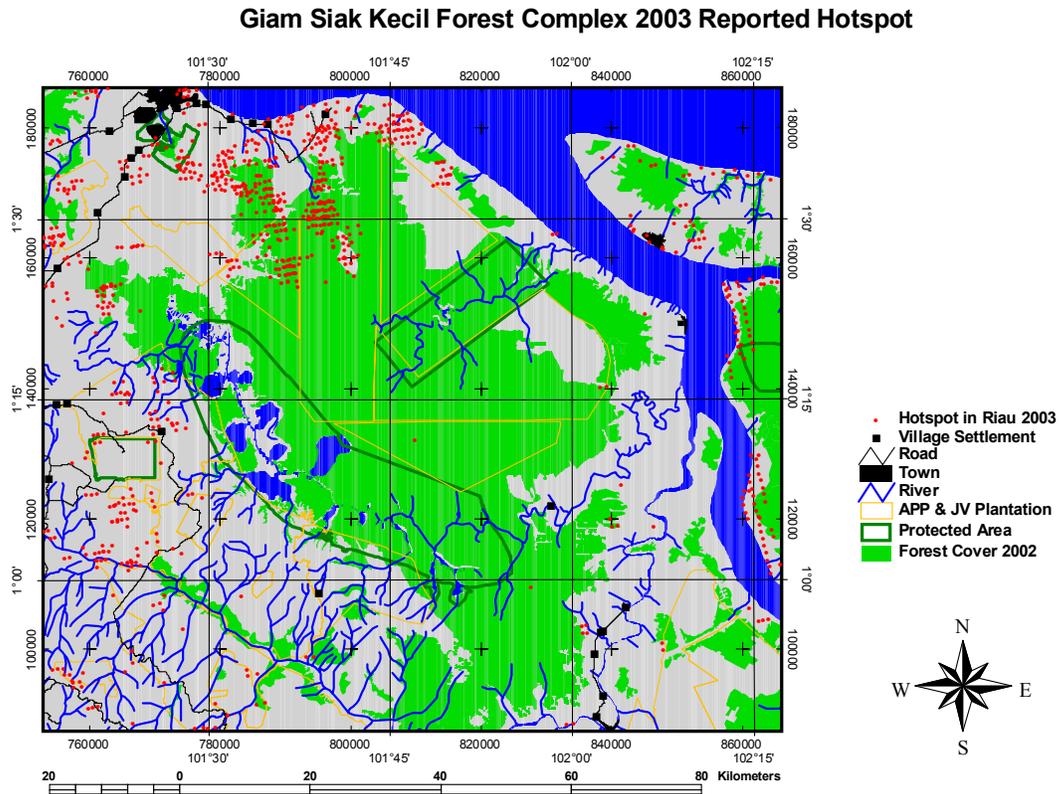
Figure 6: GSK fire map

Threat assessment recommendations for HCV 4.3

Threats from trends and implications	Recommendations
• Conversion to date has led to fire. The full extent of fires and those responsible for causing them need to be identified and reported to the appropriate authorities • Increase land conversion will increase fire hazard.	Further conversion in the GSK landscape should be ceased until such time as current fire hazards are fully assessed and mitigated. Clear operating procedures are in place to minimize the risk of fire in any areas that are able to be converted. Forest managers need to ensure peat substrates they are planting on remain able to resist fire.

Identification of HCV 4.4 Forest with critical impact on agriculture and aquaculture

Task	Findings
Identify the extent of mangrove. Identify communities within or nearby the FMU that are partly or fully dependent on	• There are no mangroves in the FMU and none appear to be impacted • Limited populations are

agriculture, aquaculture, fisheries or tourism that depends upon mangrove.	dependent on fishing for subsistence in the GSK landscape (see HCV5), particularly the +/- 50 families in the GSK protected area.
For each community that is partly or fully dependant on agriculture, aquaculture or fisheries, identify how the forest impacts the level of net productivity (i.e. the level of output and the level of work or investments and inputs needed to reach this output).	Not applicable

OUTCOME

This component of the HCV is not present in Giam Siak Kecil (applies only to mangrove).

HCV5

Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)

RATIONALE

Many conservation designations view humans as purely prejudicial to forests. The definition of HCVFs is different because it recognises that some forests are essential to human well-being. This value is designed to protect the basic subsistence and security of local communities that are derived from forests - not only for "forest-dependent communities", but also for any communities that get substantial and irreplaceable amounts of income, food or other benefits from the forest.

HCV5 applies only to basic needs. For example, for a community that derives a large part of its protein from hunting and fishing in forests where there is no alternative source of meat or fish, the forests would constitute a HCV. If, in another forest, people hunted largely for recreational purposes (even if they did eat their catch) and where they were not dependent upon hunting, then this would not constitute a HCV.

A forest may have HCV status if local communities obtain essential fuel, food, fodder, medicines, or building materials from the forest, without readily available alternatives. In such cases, the High Conservation Value is specifically identified as one or more of these basic needs.

Employment, income and products are values that should be conserved if possible, without prejudice to other values and benefits. However, HCVs do not include excessive extraction, even when communities are currently economically dependent on it. Nor do they include the excessive application of traditional practices, when these are degrading or destroying the forests and the other values present in the forest.

The following would not be considered HCVs:

- Forests providing resources of minor importance to local communities.
- Forests that provide resources that could readily be obtained elsewhere or that could be replaced by affordable substitutes.
- Forests that provide resources that are extracted at unsustainable levels
- Forests that provide resources that are obtained in a way that threatens the maintenance of other HCVs.

Identification of HCV 5

Preliminary Task	Guidance
Identify local communities living in and around forest areas (FMU) or local forest user groups.	Two forest communities with a combined population of about 50 families are located in the Giam Siak Kecil protected area; Tasik Serai and Tasik Betung. The peat swamp habitat appears not widely used by human populations here, as elsewhere in Riau.
Identify migratory or "*peramu*" communities living or using forests within the FMU.	None identified.

OUTCOME

The GSK landscape is a peat swamp over deep peat deposits and appears not to be a preferred habitat for human populations. Only two villages occur in the GSK protected area to the south of the landscape and it is debateable whether or not they have been there over generations. These communities, and other outside the GSK area but dependent on it, rely on the FMU for:

- Water
- Fish (protein)
- Boat material

No alternative sources were apparently available.

The level of absolute human dependency for livelihoods is relatively small, certainly compared to dry land forests. These communities appear dependent on fishing because they have no alternative source of land, food and income as compared to those on permanently dry land. There is a potential that they are marginalised.

HCV 5 is present for water, protein sources and building materials.

Livelihood patterns
See appendix 3.

Sub-groups and basic needs

See appendix 3.

Fundamental forest functions

See appendix 3.

Sustainable uses of the forest compatible with other HCVs

See appendix 3.

Threat assessment recommendations for HCV 5

Threats from trends and implications	Recommendations
Fishing and water are the resources need by those dependent on the FMU, and this largely occurs around the Giam Siak Kecil protected area. Fishing and water supplies do not appear to be currently stressed. This could change if access is improved allowing easier fish extraction by more remote communities, if illegal logging threatens water courses or plantations the local hydrology.	Monitoring of fish and water resources is required.

HCV6

Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance in cooperation with such local communities)

Identification of HCV 6

Task	Findings
Identify local community groups that are: • Isolated (groups living in areas with limited and difficult road and telecommunication access; groups that have almost no contact with outside groups) • Self-governing (with an active system of community laws) • forest-dependant for their livelihoods	Two small communities, Tasik Serai and Tasik Betung occur in the Giam Siak Kecil protected area and have about 50 families between them. Because the GSK landscape is peat swamp it is not a preferred living space for local populations, who prefer dry land with arable soil.
Identify communities that have traditional cultural identities related to forests.	None identified to a degree that would indicate the presence of an HCV.

Determine if communities are culturally linked to forest areas	None identified to a degree that would indicate the presence of an HCV.
When change to a forest can potentially cause an irreversible change to traditional local culture, then the forest should be designated HCVF.	None identified to a degree that would indicate the presence of an HCV. Degradation of services would force the communities to perhaps move, but not necessarily alter culture.
Several forests may be culturally important to local communities, but not all will be critical.	The communities claim to have been in the area for generations, yet satellite imagery shows no presence until about two years ago.

OUTCOME

The HCV was not identified.

Discussion

The Giam Siak Kecil landscape contains High Conservation Values.

The Giam Siak Kecil Landscape contains:
- Two protected areas (HCV1.1)
- Populations of critically endangered species (HCV1.2)
- It is a large landscape level forest (HCV 2.1).
- Provide a critical barrier to the spread of destructive fire (HCV4.3)
- It is fundamental to the livelihood of human populations (HCV5)

In addition, it may also:
- Contain significant concentrations of threatened or endangered species or endemics (HCV1.3) or seasonal concentrations of species (HCV 1.4)
- Maintain viable populations of most naturally occurring species (HCV 2.3)
- Be forest areas that are in or contain rare, threatened or endangered ecosystems (HCV 3)
- Be essential in maintaining water for daily needs to the local communities (HCV 4.1)

The analysis of high conservation values is summarised in the table below:

HCV	Component	Present	Potentially Present	Absent
HCV1. Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia)	1.1 Protected Areas	🟥		
	1.2 Critically endangered species	🟥		
	1.3 Concentrations of endangered, threatened or endemic species		🟧	
	1.4 Critical temporal concentrations		🟧	
HCV2. Forest areas containing globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns or distribution and abundance.	2.1 FMU is a large level landscape forest	🟥		
	2.2 FMU is an integral part of a large level landscape forest			🟩
	2.3 The FMU maintains viable populations of most naturally occurring species		🟧	
HCV3. Forest areas that are in or contain rare, threatened or endangered ecosystems			🟧	
HCV4. Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control)	4.1 Unique sources of water for daily use		🟧	
	4.2 Forests critical to water catchments and erosion control			🟩
	4.3 Forest providing a barrier to the spread of fire	🟥		

	4.4 Forest with critical impact on agriculture and aquaculture			🟩
HCV5 Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health)		🟥		
HCV6. Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance in cooperation with such local communities)				🟩

Values are not constant. As threats to any value increases, so will the value. As threats diminish the value needs less effort to maintain, if any effort at all. Given that the GSK landscape certainly contains most components of four values, potentially five with HCV 3, within a land use pattern that has seen a dramatic rise in forest conversion, close monitoring of identified important features is critically important.

DEMARCATION OF HIGH CONSERVATION VALUE FOREST

The approximate boundary of the HCVF within the GSK landscape is shown in figure 7 & 8 – the extent of the large landscape level intact forest. A forest manager implementing a policy of no conversion of HCVFs could therefore not clear any forest in the outlined area. From satellite images going back to 1985, aerial and field surveys, the forest within this boundary is either pristine or assumed to be able to recover to pristine or near-pristine state.

Plantations active during and since 1992

Riau
HCVF boundary approximation
Protected areas
Forest change 1985-2002
Forest - 1985
Forest - 2002

40   0   40   80 Kilometers
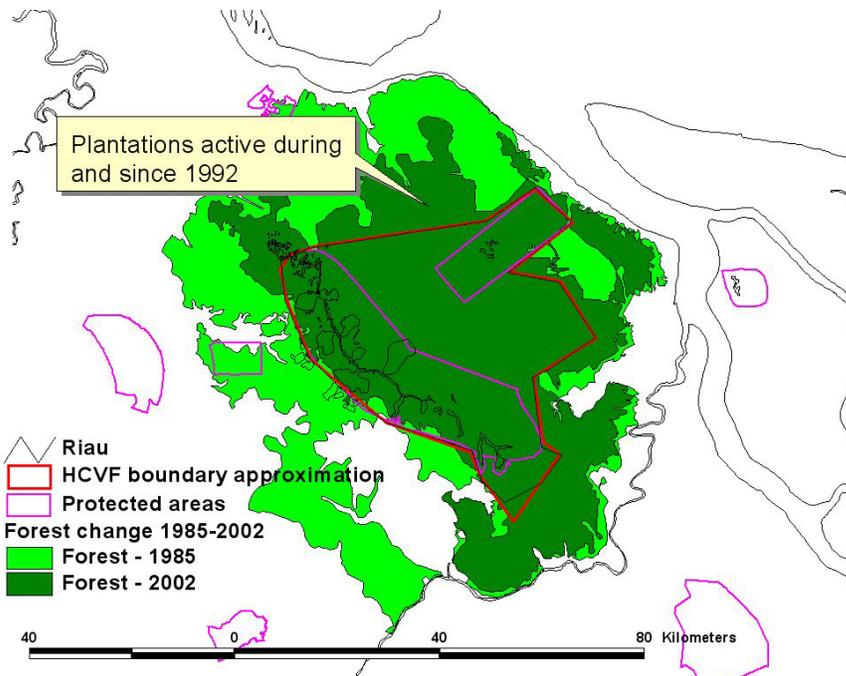
Figure 7: Approximate GSK landscape HCVF boundary
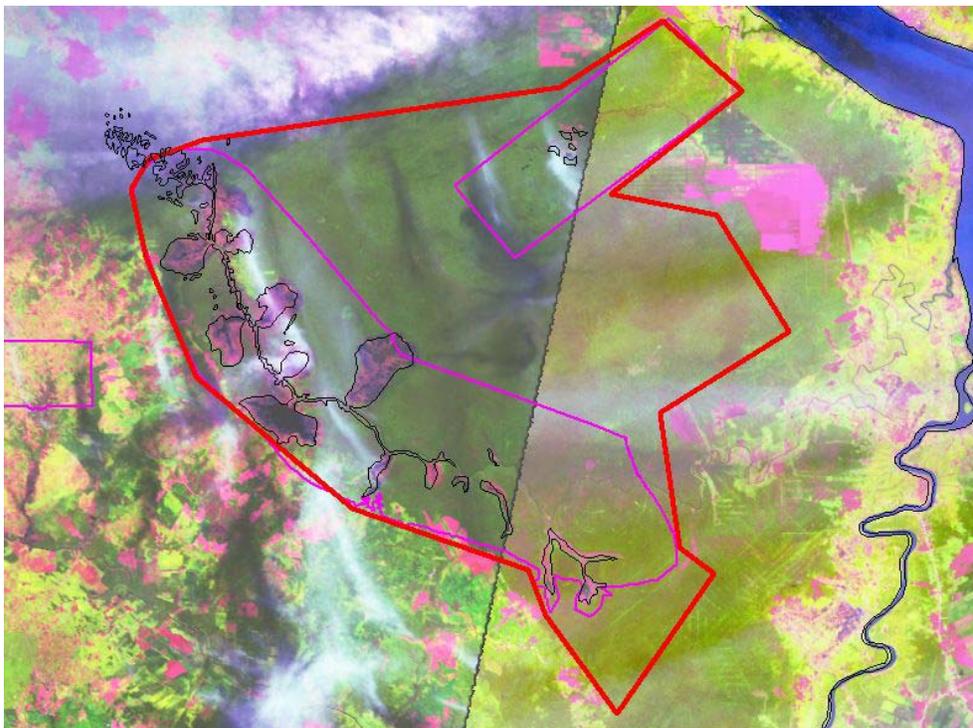
Figure 8: Approximate HCVF boundary superimposed on 2002 satellite images.

Accurate demarcation remains necessary and should be a participatory exercise between local and provincial government, Riau universities, communities, WWF and other NGOs. The multistakeholder participatory workshop conducted between NGOs, government and industry hosted by WWF for this study demonstrates the interest of many institutions in this proposal.

THREATS AND IMPACTS OF THE GSK LANDSCAPE

There mains threats to the GSK landscape are conversion to industrial plantations, illegal logging operations and a lack of a coherent spatial plan.

Industrial plantation expansion

Clearance and conversion of the GSK landscape have been rapid and widespread over the last few years. There is no indication that companies involved in conversion have paid any heed to the full impacts of their operations both within and outside their boundaries. Threats from conversion practices like fire, damaging the water table and water supply, to habitats and the biodiversity they maintain continue to rise as plantations expand.

The full spectrum of impacts caused by clearance and conversion of peat swamp to industrial plantations is yet to be fully felt and accounted for. The speed and scale of conversion will have caused considerable change to the landscape hydrology. The full extent of this is unclear.

Major impacts include production of a large volume of combustible substrate, which until recently would have been waterlogged. The local practice of burning is well established and leads to annual fire and haze events across Riau, and indeed the GSK landscape. Further conversion will lead to accelerated risk.

Effects on the water table may include many types of disruption to water supplies, including moderation of water flow and maintenance of water supplies in dry seasons. Secondary impacts on local fisheries are possible. Any company involved in conversion should have clear evidence that it will not contribute to such impacts.

About a quarter of a million hectares have been lost from the GSK landscape in less than twenty years; this is over 40% of forest extant in 1985 according to satellite imagery. Almost all has been lost through conversion to industrial plantation [4]. All species, not just those that are rare, threatened or endangered, are at peril in the area. Fauna able to flee clearance would have nowhere to move other than the remaining natural forest in the GSK landscape. Top predators like bear and tiger will have narrower ranges available and increased competition for food resources; this threatens both predator and prey alike.

Whereas the loss of peat swamp forest can be calculated, the loss of any particular sub-forest type is unknown. The peat swamp forest is not homogenous. If there are co-dependencies among forest types, or between forest types and particular guilds of species, these are unclear. If they are unclear to ecologists, they will certainly be unclear to those engaged in forest extirpation.

Using a precautionary approach, there is a critical need to understand what is being lost and what the impacts of these losses are before any further conversion should be permitted to continue.

Whereas the net effect of industrial clearance and conversion is so far unclear and probably yet to be fully felt, further expansion is expected to compound changes already put in place.

Illegal logging operations

Illegal logging operations appear to be widespread, particularly where there is easy access by road, river and canal. Whereas these may provide short-term economic benefit to local communities, profits are reported to being made by middlemen. There appear to be no long-term benefits to communities.

Ecologically the impacts are felt along river margins and anywhere close to an access road. A first cut by illegal loggers, especially if they are highly selective, can probably be withstood by the ecosystem over time. However, further cuts and wider spread access to habitat may overcome natural resilience. If this does come to pass, illegal logging operations will be responsible for destruction of habitat.

Conflicting Spatial plans

Figure 8 shows the current land use situation in the GSK landscape and compares it with forest cover in 2002 and the HCVF boundary approximation of this assessment. This shows that almost all the identified HCVF outside protected areas is threatened by conversion by overlapping timber plantation concessions granted by the MoF.
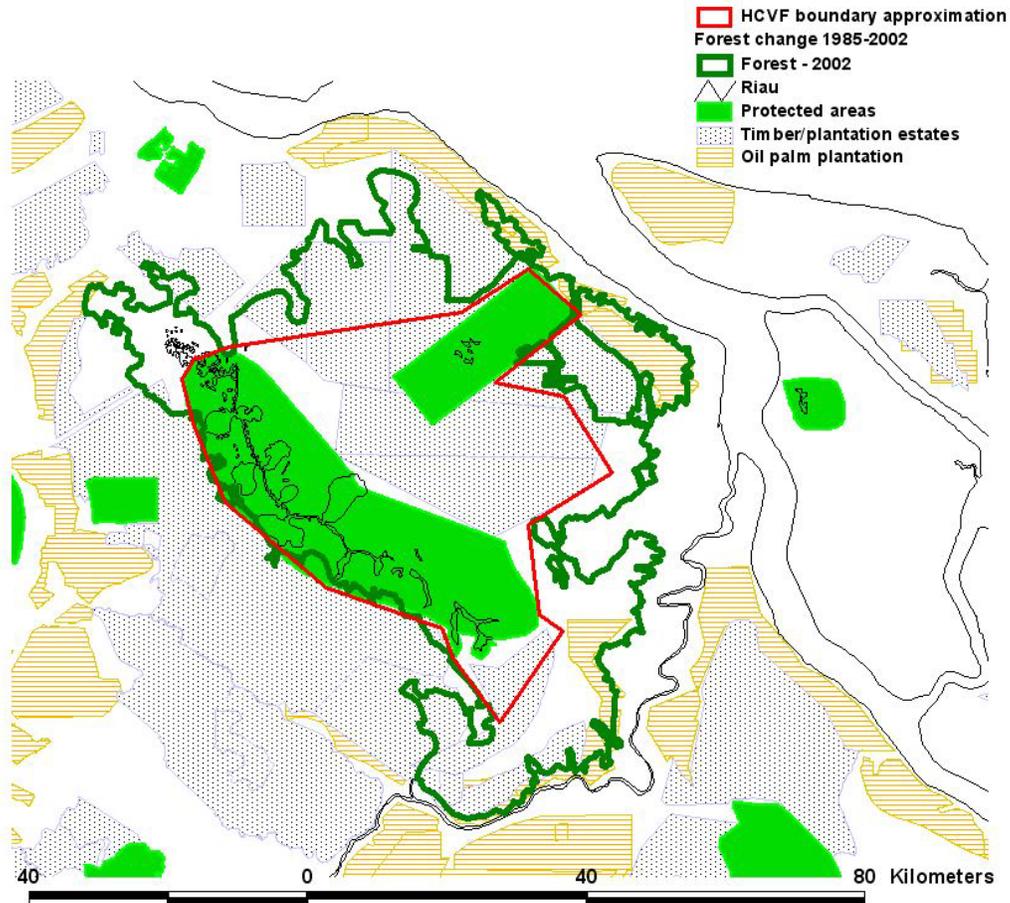
Figure 9: Threats to GSK landscape from Timber/Plantation Estates and Oil Palm Concessions

The Provincial government Land Use Plan issued in 1994 (figure 9) demarcated a protected forest in the GSK landscape somewhat similar to the tentative HCVF demarcation presented by this report. The Land Use Plan may provide a foundation for protection of the GSK landscape HCVF.

Figure 10 shows the Provincial land use draft plan submitted to the Riau Parliament in 2002, which was withdrawn this year due to legal problems. The proposed plan indicated the intention to convert a lot of the remaining natural forest not under current protection, however, still defined some of the HCVF demarcated by this report as a protected area (area in dark green).

Giam Siak Kecil Forest Complex According to Riau Land Use Plan (RTRWP) 1994
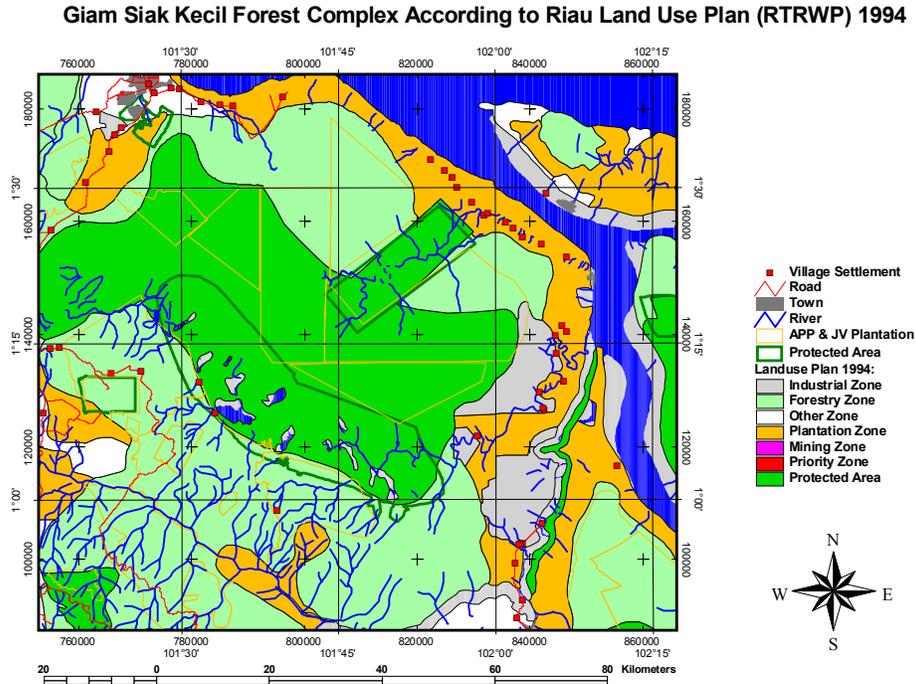
Figure 10:Riau Provincial Land Use Plan 1994

Giam Siak Kecil Forest Complex According to Proposed Riau Land Use Plan 2015
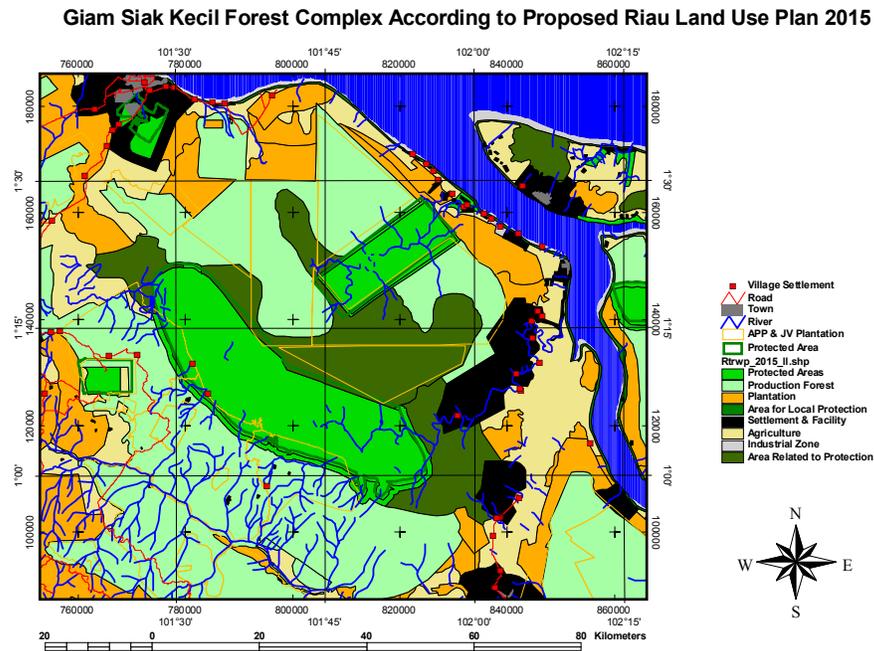
Figure 11: The withdrawn proposed Riau Provincial Land Use Plan 2015

The discrepancies in the forest reserve boundaries and the lack of demarcation on the ground has led intrusion into the protected areas. This is an important management issue. Encroachment was evident from ground surveys and satellite images. All parties involved in the GSK landscape, even with GPS technology, are reported to blame each other for misinterpretation of boundaries.

In order to secure the maintenance or enhancement of identified HCVs on in the long term, the landscape needs to be treated by stakeholders as an integrated whole. Having this reflected in spatial plans would contribute significantly to such an outcome.

MANAGEMENT ACTIONS NEEDED TO MAINTAIN THE HCVS

The GSK landscape contains High Conservation Value Forest, with four identified HCVs and potentially five. Remaining forest and the HCVs it contains are being rapidly eroded. Key management actions to maintain all the HCVs identified are set out below:

- In line with principles and criteria for sound forest management developed by the Forest Stewardship Council, the managers of a HCVF should implement "specific measures that ensure the maintenance and/or enhancement of the applicable conservation attributes consistent with the precautionary approach. These measures shall be specifically included in the publicly available management plan summary". In addition "annual monitoring shall be conducted to assess the effectiveness of the measures employed to maintain or enhance the applicable conservation attributes".
- Until a management plan to maintain or enhance the identified HCVs is in place, the precautionary approach requires a moratorium on further logging and clearing with the GSK HCVF.
- Illegal logging must be controlled. Forest managers must also prevent loggers from accessing forest through lands they are responsible for.
- Forest managers must monitor all canals draining the swamp and monitor their impacts on the hydrology of the area. Internationally accepted flow regulation protocols that minimise drainage impact should be adhered to.
- A mechanism for monitoring and reporting detrimental impacts to the GSK landscape should be developed with the relevant authorities. Impacts should be acted upon and the actions and results disseminated publicly.
- All management operations in and around the GSK landscape should prepare monitored plans that explain how, on a long term basis, impacts of management operations on the hydrology of the swamp will be measured and when found, mitigated. A general policy has to be developed to minimise canal and drain construction and the monitoring of existing canals.
- Rehabilitation of logged areas unsuitable for agriculture and adjacent to the remaining forest boundaries should be encouraged to facilitate natural regeneration.
- Any forestry operations in the GSK landscape should have, as a minimum, thorough, public and transparent EIA documents that monitor company activities and provide a basis for halting environmentally detrimental operations. In these documents, forest management operations should be formulated for both the forests and water system they manage and those they impact downstream.

There should be no impact on the hydrological integrity of the swamp and other GSK landscape HCVs.

Appendix 1 – Access route loss

Contributed by *Tunku Mohammed Nazim Yaacob*

An analysis to determine the scale and speed of forest disturbance in the GSK area was conducted with boundaries defined as:

- The Dumai – Pekanbaru road on the west and south
- The Sg. Mandak/Siak on the south and east – a major navigable river
- The coast along the north.

Using LANDSAT 5 images from 1985 as a data source in a WGS84 projection and UTM grid coordinates, the road, rivers and coast line around the Giam Siak Kecil area were digitized on-screen as a line shape file using ArcMap 8.1. This was them converted to PC ArcInfo coverage. Buffers were drawn around these three lines at 1, 5 10 and 15 km distances and then the polygons created were further divided into the sections with nearest access from the road, river or coast. Using once again a 1985 LANDSAT 5 image of the area, the boundary line between forest with a continuous canopy and forest areas that had either been disturbed or cleared, around the Giam Siak Kecil area were digitized. This shape file was converted into a PC ArcInfo polygon coverage and then overlain with the buffer coverage to determine the extent of forest that had been cleared or converted to agriculture by 1985 at distances of 1,5 10 and 15 km from the road, coast or river. This exercise was repeated with a LANDSAT 7 image from 2002. The results are presented in table form above.

The extent of forest clearance was compared to buffer zones of 5 km widths from the road, river and coast. For the purpose of this model, it was assumed access to the forest is from the closest point from a mapped road, river or the coast.

The total extent of this study area is 778,323 ha.   Before 1985, 193,267 ha of the area had been cleared leaving (233,815 + 351,241 =) 485,046 ha as forest. Between 1985 and 2002 a further 233,815 ha had been cleared leaving 351,241 under undisturbed forest. (This includes areas that hade been selectively harvested but had not been cleared or replanted as agricultural or forest plantations.

In general trends indicate that before 1985, logging declined with distance from means of access. In the period from 1985 to 2002, clearance peaked in the 5 to 10 km buffer from the source of access.

Comparing between means of access – roads, river and coast, most clearance is taking place where there is road access and the least where the river would be the most accessible transport route.

Forest clearance by 5km buffers from access routes are presented in the following table:

Means of access	buffer zones, km.	areas cleared before 1985	forest cleared 1985 - 2002	forest remaining 2002	total access zone area	% forest cleared before 1985	% forest cleared between 1985 and 2002	% forest remaining 2002
		a	b	c	d=a+b+c	e=a/d	f=b/d	g=c/d
Road	1 to 5	56,565	30,128	1,056	87,749	64.5	34.3	1.2
	5 to 10	11,590	53,842	6,402	71,834	16.1	75.0	8.9
	10 to 15	7,386	23,388	25,676	56,450	13.1	41.4	45.5
	>15	14,814	14,453	81,020	110,288	13.4	13.1	73.5
total road		90,355	121,812	114,154	326,321	27.7	37.3	35.0
River	1 to 5	36,954	12,080	8,532	57,566	64.2	21.0	14.8
	5 to 10	13,660	6,264	24,812	44,736	30.5	14.0	55.5
	10 to 15	11,620	4,225	21,838	37,683	30.8	11.2	58.0
	>15	8,480	9,134	63,022	80,636	10.5	11.3	78.2
total river		70,714	31,703	118,203	220,620	32.1	14.4	53.6
Coast	1 to 5	26,427	19,583	5,385	51,395	51.4	38.1	10.5
	5 to 10	4,784	24,692	15,434	44,911	10.7	55.0	34.4
	10 to 15	987	25,199	13,562	39,748	2.5	63.4	34.1
	>15	0	10,825	84,503	95,329	0.0	11.4	88.6
total coast		32,198	80,300	118,884	231,382	13.9	34.7	51.4
	1 to 5	119,946	61,791	14,972	196,709	61.0	31.4	7.6
	5 to 10	30,034	84,798	46,648	161,480	18.6	52.5	28.9
	10 to 15	19,993	52,812	61,076	133,881	14.9	39.4	45.6
	>15	23,293	34,413	228,545	286,252	8.1	12.0	79.8
total all zones		193,267	233,815	351,241	778,323	24.8	30.0	45.1

Appendix 2 – Summary of data sets

Existing land use

Category	Types	Original scale/resolution	Source	Format
Administration	Provincial boundary			Digital (shp)
	District boundary			Digital (shp)
	Coastal line			Digital (shp)
Forest use	Spatial plans for Riau to 2015			Digital (shp jpg), Paper
	Logging concession			Digital (shp)
	Timber plantation (for log)	1:500,000	Province Landuse Plan	Digital (shp,jpg), Paper
	Timber plantation (for pulp)	1:500,000	Province Landuse Plan	Digital (shp,jpg), Paper
	Forest Dept. plan	1:250,000	Dept. of Forestry	Digital (shp,jpg), Paper
Agriculture	Palm oil plantation	1:500,000	Province Landuse Plan	Digital (shp,jpg), Paper
	Rubber plantation	1:500,000	Province Landuse Plan	Digital (jpg), Paper
	Small scale plantation	1:500,000	Province Landuse Plan	Digital (jpg), Paper
	Rice field, garden	1:500,000	Province Landuse Plan	Digital (jpg), Paper
Settlement	Transmigration	1:500,000	Province Landuse Plan	Digital (shp,jpg), Paper
	Urban			Digital (shp)
	Rural			Digital (shp)
Mining	Mining concession	1:500,000	Province Landuse Plan	Digital (jpg), Paper
Infrastructure	Road	1:500,000	Province Landuse Plan	Digital (jpg), Paper
Protected Areas	Initially proposed			Digital (shp)
	Current status	1:500,000	Province Landuse Plan	Digital (shp,jpg), Paper
		1:250,000	Forestry Dept.	Digital (shp)
	New proposed		WWF (Tesso Nilo)	Digital (shp)

Topography and Land System

Category	Types	Original scale/resolution	Source	Format
Topography	Peak	1:250,000	Bakosurtanal	Digital (shp)
	Contour	1:250,000 / 100m interval	Bakosurtanal	Digital (shp)
Hydrology	Main rivers	1:250,000	Bakosurtanal	Digital (shp)
	Small streams	1:250,000	Bakosurtanal	Digital (shp)
Land System	Agricultural suitability (including oil palm and rubber)	1:250,000	Reppprot	Digital (shp)
	Geomorphology	1:250,000	Reppprot	Digital (shp)
	Climate	1:250,000	Reppprot	Digital (shp)

Ecology

Category	Types	Original scale/resolution	Source	Format
Species	Tiger distribution		WWF Indonesia website	Digital (shp, jpg)
	Elephant distribution		WWF Indonesia website	Digital (shp)
	Tiger poaching		WWF Indonesia	Digital (jpg, shp)
	Elephant conflict with human		WWF Indonesia	Digital (shp)
Forest cover	Forest cover 2000		Digitised on screen from Landsat TM images	Digital (shp)
	Forest cover 1998		Forestry Department	Digital (shp)
Vegetation type	Peat more than 200m deep and mangrove	1:500,000	Province land use plan	Digital (shp, jpg)
	Ecoregion		WWF	Digital (shp)
	Forest types (1999)	1:250,000	Department of Forestry	Digital (shp)

Satellite images

Satellite	Path - Row, Year	Original scale/resolution	Source	Format
Landsat MSS	127-59	80m		Digital (img)
	127-60			Digital (img)
	126-59			Digital (img)
	126-60			Digital (img)
Landsat TM	127-59, 26 April 2000 / 5 July 2002	30m		Digital (img)
	127-60, 26 April 2000			Digital (img)
	126-59, 21 May 2000 / 14 July 2002			Digital (img)
	126-60, 5 March 2001			Digital (img)
	126-61, 11 July 2001			Digital (img)

Appendix 3 – HCV 5 tables (from field teams)

Fulfilment of basic needs

Scoring follows the Indonesian HCVF toolkit:

- 4 - Essential = 100% of a given need is fulfilled by one source (for example, if all the water used by the community comes from the forest's rivers, put "4 (all)" in the "forest" column in the "water" row).
- 3 – Critical = more than 50% of a given need is fulfilled by one source
- 2 - Important = between about 15% and 50%
- 1 - not important = less than 15%
- 0 – non existent = 0%

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Food: Carbohydrates (rice, sago…)	1		3	1	1	-	Rice and cassava are planted on their land
animal protein (meat, fish)	3		1	-	-	3	Fishes come from the river, chickens are treated traditionally
fruits, vegetables	1		3	-	-	1	Most of fruits and vegetables are grown on their land and less critically taken from forest
Materials: Housing	2		-	3	-	2	Bricks and corrugated metal roof, cements are purchased while woods are from forest
Boats	3		-	1	-	3	Nails, metallic plates, paints are purchased but woods are taken from forest
furniture, household equipment, tools…	1		-	3	-	1	-
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene and diesel fuel are all purchased.
Medicines	2		-	2	-	2	Some are combined from sources of forest and another some are purchased

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from dug wells around their houses
Cash income	1						
Others: Water for either agriculture or fishery	1						

Sub-Village:Simpang Jambu
Village   :Tasik Serai
Ethnic Group: Bataknese

Needs	FMU	Other	Processed	Purchased	Aid	Other	Explanation, remarks
Food: Carbohydrates (rice, sago…)	1		2	2	-	-	Rice and cassava are planted on their land and also purchased
animal protein (meat, fish)	1		1	3	-	-	Chickens are treated traditionally but meat (chickens and other kind of meat) is purchased
fruits, vegetables	1		2	2	-	-	Some of fruits and vegetables are grown on their land and some other are purchased
Materials: Housing	2		-	2	-	2	Bricks and zinc roof, cement are purchased while woods are from forest
Boats	-		-	-	-	-	
furniture, household equipment, tools…	1		-	3	-	1	Most of them are purchased and only a few of are self-made from forest resources
Fuel	1		-	3	-	1	Fire woods are taken from the forest, kerosene and diesel oil are all purchased.
Medicines	1		-	3	-	1	Most of medicines are purchased and only a few are of combined sources of forest
Animal Feeds	1		3	-			Most of animal feeds are purchased
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses and only a little is from rain
Cash income	1						

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Others: Water for either agriculture or fishery	1						Mostly are provided from rain saved up during rainy season and only a little is from their wells

Village   :**Penaso**
Ethnic Group: Melayu Sakai

Needs	FMU	Other	Processed	Purchased	Aid	Other	Explanation, remarks
Food: Carbohydrates (rice, sago…)	1		3	1	-	-	Rice and cassava are planted on their land and less critically purchased
animal protein (meat, fish)	3		1	-	-	3	Fishes come from the river, chickens are treated traditionally
fruits, vegetables	1		3	-	-	1	Most of fruits and vegetables are grown on their land, and purchased and less critically taken from forest
Materials: Housing	2		-	2	-	2	Woods are mostly taken from forest while other materials are purchased
Boats	3		-	1	-	3	Woods are mostly taken from forest while other materials are purchased
furniture, household equipment, tools…	1		-	3	-	1	Most of them are purchased and only a few of are self-made of forest resources
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene are all purchased.
Medicines	2		-	2	-	2	Fabricated medicines are purchased and traditional ones made of forest sources
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses and another source is river
Cash income	1						
Others: Water for either agriculture or fishery	1						Mostly are provided from rain saved up during the rainy season and others are from wells and river.

Village   :**Langkat**
Ethnic Group: Javanese

Sub-Village:Tasik Serai **Village** :Tasik Serai **Ethnic Group**: Melayu Olak/Pandan							
Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Food: Carbohydrates (rice, sago…)	1		3	-	-	1	Rice and cassava are planted on their land and less critically purchased
animal protein (meat, fish)	2		1	1	-	3	Fishes come from the river, chickens are treated traditionally and the rest is purchased
fruits, vegetables	1		2	1	-	1	Most of fruits and vegetables are grown on their land, and purchased and less critically taken from forest
Materials: Housing	2		-	2	-	2	Wood is mostly taken from forest while other materials are purchased
Boats	3		-	1	-	3	Wood is mostly taken from forest while other materials are purchased
furniture, household equipment, tools…	1		-	3	-	1	Most of them are purchased and only a few of are self-made of forest resources
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene is all purchased.
Medicines	2		-	2	-	2	Artificial medicines are purchased and traditional ones made of forest sources
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses and river
Cash income	1						
Others: Water for either agriculture or fishery	1						Mostly are provided from rain saved up during the rainy season and others are from wells and river.
Village :**Sukajadi** **Ethnic Group**: Melayu							
Food: Carbohydrates (rice, sago…)	1		3	1	1		Rice and cassava are planted on their land
animal protein (meat, fish)	3		1	-	-	3	Fishes come from the river, chickens are treated traditionally

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
fruits, vegetables	1		3	-	-	1	Most of fruits and vegetables are grown on their land, and less critically taken from forest
Materials: Housing	2		-	2	-	2	Bricks, corrugated metal roofs, cements are all purchased while wood is mostly taken from forest
Boats	3		-	1	-	3	Nails, metallic plates, paints are purchased while wood is mostly taken from forest
furniture, household equipment, tools…	1		-	3	-	1	
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene and diesel fuel are all purchased.
Medicines	2		-	2	-	2	Artificial medicines are purchased and traditional ones made of forest sources
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses
Cash income	1						
Others: Water for either agriculture or fishery	1						
Village :**Tanjung Belit** **Ethnic Group**: Melayu **Sub-Group** (based on table 1):							
Food: Carbohydrates (rice, sago…)	1		3	1	1		Rice and cassava are planted on their land
animal protein (meat, fish)	3		1	-	-	3	Fishes come from the river, chickens are treated traditionally
fruits, vegetables	1		3	-	-	1	Most of fruits and vegetables are grown on their land, and less critically taken from forest
Materials: Housing	2		-	2	-	2	Bricks, corrugated metal roofs, cements are all purchased while wood is mostly taken from forest

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Boats	3		-	1	-	3	Nails, metallic plates, paints are purchased while wood is mostly taken from forest
furniture, household equipment, tools…	1		-	3	-	1	
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene and diesel fuel are all purchased.
Medicines	2		-	2	-	2	Artificial medicines are purchased and traditional ones made of forest sources
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses
Cash income	1						
Others: Water for either agriculture or fishery	1						

Village   :**Tasik Betung**
Ethnic Group: Melayu   Olak/Pandan

Needs	FMU	Other	Processed	Purchased	Aid	Other	Explanation, remarks
Food: Carbohydrates (rice, sago…)	1		3	1	1		Rice and cassava are planted on their land
animal protein (meat, fish)	3		1	-	-	3	Fishes come from the river, chickens are treated traditionally
fruits, vegetables	1		3	-	-	1	Most of fruits and vegetables are grown on their land, and less critically taken from forest
Materials: housing	2		-	2	-	2	Bricks, corrugated metal roofs, cements are all purchased while wood is mostly taken from forest
boats	3		-	1	-	3	Nails, metallic plates, paints are purchased while wood is mostly taken from forest
furniture, household equipment, tools…	1		-	3	-	1	

Sub-Village:Tasik Serai
Village   :Tasik Serai
Ethnic Group: Melayu Olak/Pandan

Needs	Sources						
	FOREST		Processed	Purchased	Aid	Other	Explanation, remarks
	FMU	Other					
Fuel	3		-	1	-	3	Fire woods are taken from the forest, kerosene and diesel fuel are all purchased.
Medicines	2		-	2	-	2	Artificial medicines are purchased and traditional ones made of forest sources
Animal Feeds	1		-				
Water for drinking and daily needs	1		3	-	-	1	Fresh and clean water is coming from wells they have around their houses
Cash income	1						
Others: Water for either agriculture or fishery	1						

Identification of fundamental forest resources

Sub-Village : Tasik Serai Village : Tasik Serai **Ethnic Group : Melayu Olak/ Pandan**		
Resources from the forest	Ranking of importance of the forest in meeting this need	Explanation, remarks
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Tasik Serai sub-village, it will be impossible to import its substitution such as kinds of saltwater fishes.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. If mentioned materials can not be found in the forest any longer so the community will hardly find for its complement. To come it from other places will highly cost them. Thus, most of them can not afford to buy it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found within it so community will hardly find its complement.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not buu it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Sub-Village : Simpang Jambu **Village :** Tasik Serai **Ethnic Group : Batak**		
Housing materials	2	The housing materials meant here are kinds of woods. If the materials can not be found in the forest any longer, the community will relatively easy to find its complement. The complements such as bricks, corrugated metal, roofs and cement are provided nearby with a high price and only some of them can afford but them.
Village : Penaso **Ethnic Group : Melayu Sakai**		
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Penaso village, it will be impossible to import its substitution such as kinds of saltwater fishes. The only substitution will be relatively few free-range chickens.
Housing materials	2	The housing materials meant here are kinds of woods. If the materials can not be found in the forest any longer, the community will relatively easy to find its complement. The complements such as bricks. Corrugated metal. roofs and cements are provided nearby with a high price and only some of them can afford but them.
Boats,	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found

small dinghy		within it so community will hardly find its complement.
Fuel	2	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not but it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village : Langkat **Ethnic Group : Javanese**		
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Langkat village, it will be impossible to import its substitution such as kinds of saltwater fishes.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. If mentioned materials can not be found in the forest any longer so the community will hardly find for its complement. To come it from other places will highly cost them. Thus, most of them can not afford to buy it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found within it so community will hardly find its complement.
Fuel	2	Fuel that community needs is fire woods. Almost every households requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not buy it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village : Sukajadi **Ethnic Group : Melayu**		
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Sukajadi village, it will be impossible to import its substitution such as kinds of saltwater fishes.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. If mentioned materials can not be found in the forest any longer so the community will hardly find for its complement. To come it from other places will highly cost them. Thus, most of them can not afford to buy it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found within it so community will hardly find its complement.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not but it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.

Village	: Tanjung Belit	
Ethnic Group : Melayu		
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Tanjung Belit village, it will be impossible to import its substitution such as kinds of saltwater fishes.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. If mentioned materials can not be found in the forest any longer so the community will hardly find for its complement. To come it from other places will highly cost them. Thus, most of them can not afford to buy it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found within it so community will hardly find its complement.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not but it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village	: Tasik Betung	
Ethnic Group : Melayu Olak/Pandan		
Animal protein	3	The animal protein sources meant are freshwater fishes. It will be much difficult for the community to seek for other sources if these fishes will be no longer found there. For community lives within Tanjung Belit village, it will be impossible to import its substitution such as kinds of saltwater fishes.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. If mentioned materials can not be found in the forest any longer so the community will hardly find for its complement. To come it from other places will highly cost them. Thus, most of them can not afford to buy it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. If these woods can not be longer found within it so community will hardly find its complement.
Fuel	3	Fuel that community needs is fire woods. Almost every households requires fire woods as their primary fuel and for cooking. Another fuel such as kerosene is very difficult to be found, if only it is available the price will surely too high and they can not but it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Sub-Village : Tasik Serai		
Village	: Tasik Serai	
Ethnic Group : Melayu Olak/ Pandan		
Animal protein	3	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it.

Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Boats, small dinghy	3	These transportation means are made of woods, such as meranti and kulim which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Sub-Village : Simpang Jambu **Village :** Tasik Serai **Ethnic Group : Batak**		
Housing materials	2	The housing materials meant here are kinds of woods and kinds of leaves for roofs. The community lives in Simpang Jambu sub-village used to be Batak strangers. They have been setting up their own settlement since 1980s. Recently, it is realized that the quantity of these materials is decreasing due to the intervention of outside parties. Any way, the community will relatively easy to find its complement. However, still they believe to depend on the forest.
Village : Penaso **Ethnic Group : Melayu Sakai**		
Animal protein	3	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it .
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.

Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Fuel	2	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village **: Langkat** **Ethnic Group : Javanese**		
Animal protein	2	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Boats, small dinghy	3	These transportation means are made of woods which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Fuel	2	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.

Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village : Sukajadi **Ethnic Group : Melayu**		
Animal protein	3	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it.
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Boats, small dinghy	3	These transportation means are made of woods, such as meranti and kulim which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it .
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it . The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village : Tanjung Belit **Ethnic Group : Melayu**		
Animal protein	3	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it.

Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Boats, small dinghy	3	These transportation means are made of woods, such as meranti and kulim which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it. The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.
Village	: Tasik Betung Ethnic Group : Melayu Olak/Pandan	
Animal protein	3	The animal protein sources meant are freshwater fishes. This kind of food has been consumed since generations. They are certain to continuous consumption of the sources for much longer. Recently, it is realized that the quantity of the fishes is decreasing due to the intervention of outside parties. However the quantity and the quality of the sources are changing; still they believe to depend on it .
Housing materials	2	The housing materials meant here are kinds of woods and leaves for roofs. Mentioned materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Boats, small dinghy	3	These transportation means are made of woods, such as meranti and kulim which are mostly found in the forest. These materials have been used since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it .
Fuel	3	Fuel that community needs is fire woods. Almost every household requires fire woods as their primary fuel and for cooking. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it.
Medicines	2	The traditional medicines are made of leaves of trees, tree barks and kinds of roots. They have been keeping this way since generations. Recently, it is realized that the quantity of these is decreasing due to the intervention of outside parties. However they are not powerful to halt the destructions, still they believe to depend on it . The community with a traditional healer are dependant on these materials. Artificial medicines with a medical aide can be an alternative choice but the cost will be more expensive rather than traditional ones.

Appendix 4 – GIS methodology

To support HCVF analysis of the GSK area, current information on land use change (ground features) is required. These land use changes include the following:

- Forest conversion to agricultural and wood based plantations
- Logging and associated activities (legal and illegal)
- Infrastructure development
- Clearing for small scale agricultural activities
- Land utilization by local communities
- Expansion of settlements; and others

A landscape visualization of the in the GSK area is a key prerequisite directing and utilising ground information collection and site activity design. From a conservation point of view, fragmentation and isolation of forested areas and the intactness of protected areas need to be determined at the very least through qualitative visual assessment.

The process of investigating the status of current land use was undertaken by the combination of satellite image processing and GIS overlay methods. This produced maps combining enhanced satellite imagery displaying thematic polygons (integrated thematic maps). This spatial arrangement of images and polygons enabled a qualitative landscape analysis of land use in the GSK area and also confirmed whether planned activities by the government and commercial entities conforms to legal land use plans, agricultural conversions and harvesting concession agreements. HCVF analysis in the GSK case required rapid assessment methodology, provided by satellite image interpretation particularly focusing on subjective rather than quantitative analysis. This being the case, image enhancement techniques were utilized instead of classification techniques for ground feature extraction.

The production of enhanced integrated thematic maps for HCVF analysis is divided into two components:

1) Enhancement of Landsat 7 ETM+ satellite images, 126/59 and 127/59 (July 2002).
2) GIS map production, overlaying thematic layers on the enhanced Landsat 7 ETM+ satellite images.

The satellite image processing and GIS methodology is presented as a flow chart (Figure 1)

SATELLITE IMAGE ENHANCEMENT

The 30 metre resolution Landsat 7 ETM + images were enhanced using ERDAS Imagine 8.5 image processing software. A summary of the steps are:

I. The two images were mosaicked with histogram matching, this was necessary as the GSK area is contained in both images.

II. The visual appraisal of different band combinations was undertaken to determine which combination produced the most effective visually discriminating image display, especially for the Peat Swamp areas and associated wetlands. In this exercise, the following band combination was viewed as most effective:

Band	Wavelength (micrometers)	Nominal spectral location	Principal application
5 (Red)	1.55-1.75	Mid Infrared	Indicative of vegetation moisture content and soil moisture.
4(Blue)	0.76-0.90	Near Infrared	Useful for determining vegetation types, vigor and biomass content, for delineating water bodies, and for soil moisture discrimination.
7(green)	2.08-2.35	Mid Infrared	Useful for discrimination of mineral and rock types. Also sensitive to vegetation moisture content.

III. The mosaicked image with the 5,4,7 infrared band combination was subjected to enhancement which in general is the process of making the image more interpretable for HCVF analysis. Enhancement was required to make features of raw remotely sensed data more interpretable to the human eye allowing the study and locating of features/objects on the ground and deriving information useful for landscape analysis and interpretation. Basic spatial and radiometric enhancements were undertaken. **Spatial enhancing** is based on using the values of individual and neighbouring pixels. Radiometric enhancement is based on using value of individual pixels within each band.

IV. Spatial enhancement – Convolution filtering , the process of averaging small sets of pixels, in this case a 3 X3 pixel across the image was undertaken (3 x 3 pixel moving window) primarily to:
- Reduce haze in the image;
- Provide a 3 x 3 pixel summarized image for better visual feature discrimination.

V. Radiometric enhancement- The spatially enhanced image was then subjected to histogram equalization. This is a process where pixel values are redistributed with a non linear contrast stretch so that there is approximately the same number of pixels with each value within a range. This has the visual effect of crude image classification. For HCVF analysis this was deemed sufficient. The equalized imaged was then subjected to on screen manipulation of contrast and brightness producing an image clearly discriminating most ground features necessary for HCVF analysis. This image formed the background for GIS overlaying and map production.

GIS METHODS

Using ArcView 8, the enhanced background created from the two recent satellite images projected on the WGS84 datum using UTM 48N metric coordinates were overlaid with the following thematic layers (re-projected and transformed as necessary to conform to the background image):
- Protected areas,
- The APP and other concession areas,
- Current and proposed areas for palm oil plantations, as well as
- Proposed moratorium areas,

This allowed the creation of a series of thematic integrated maps with clearly discriminated ground features providing information for ground verification and HCVF component assessment.

Figure 1: Image Processing and GIS Methodology Flowchart for GSK HCVF Analysis
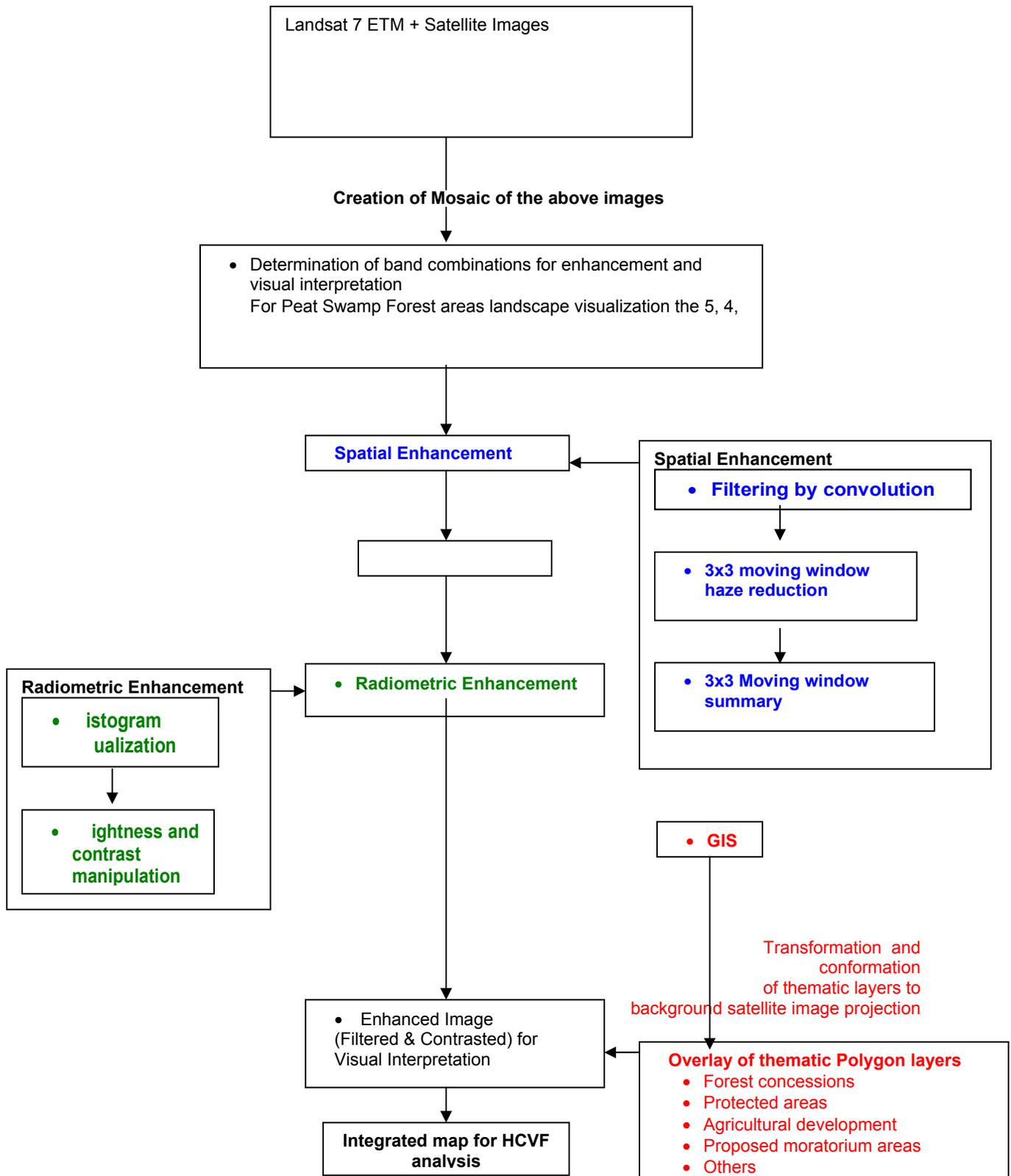
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