# Recent history of a modified peat dome - Coastal Riau, Sumatra

*ASEAN Workshop - Bogor*

*Enhancing sustainability of forestry practices on peatlands*
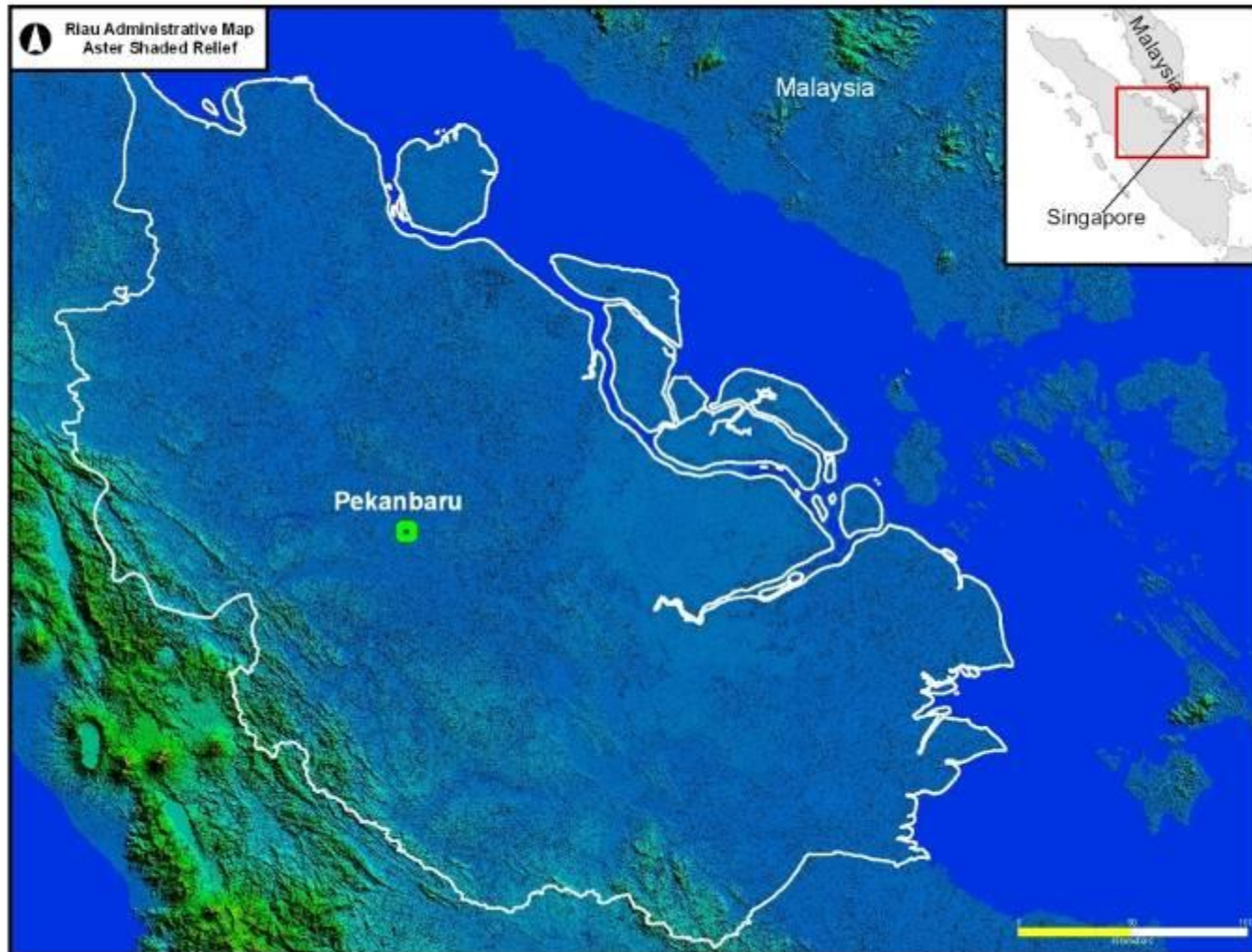
*Wed 27 June*

*John Bathgate*                    *Reddy Rachmady*

*Forestry Scientist*              *GIS Analysis*

*Riau Fiber Technical - APRIL Group*

# Riau Province – 40% of area is peatland

# Coastal landscape of raised peat domes

# Study Area: sub dome to alluvial river bank

# 1995 - Landscape Vegetation Cover
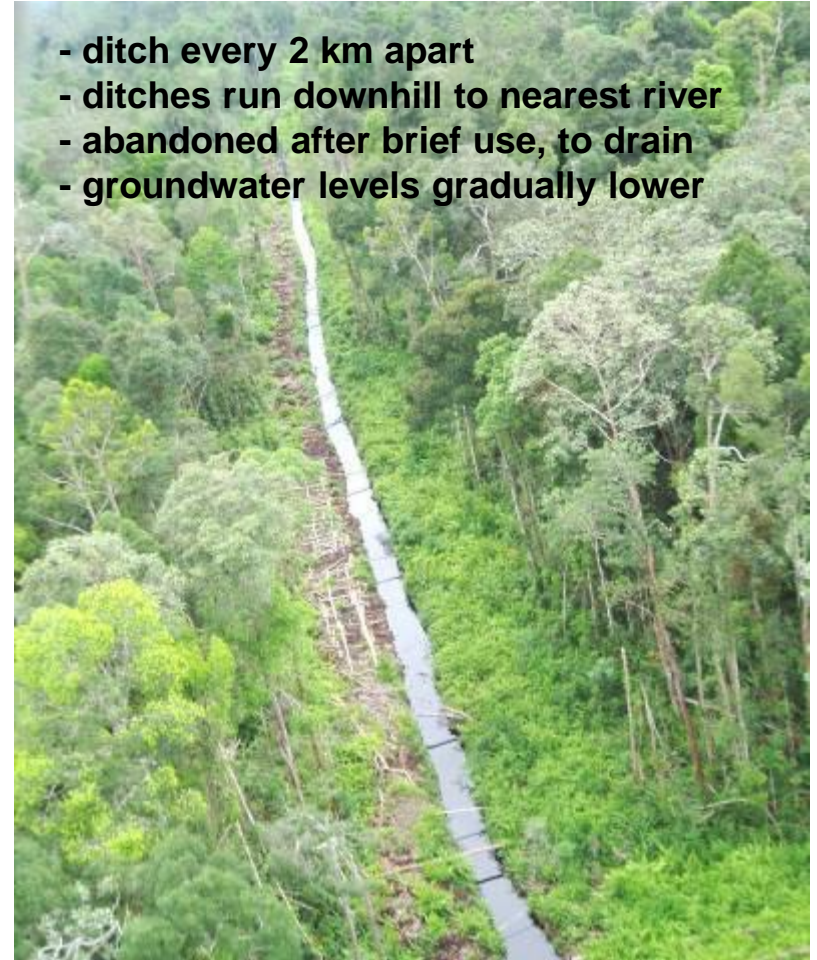### (selection logging was mostly completed)

# 2000  - Illegal Logging Era

**Log extraction trails lead to Ditches**
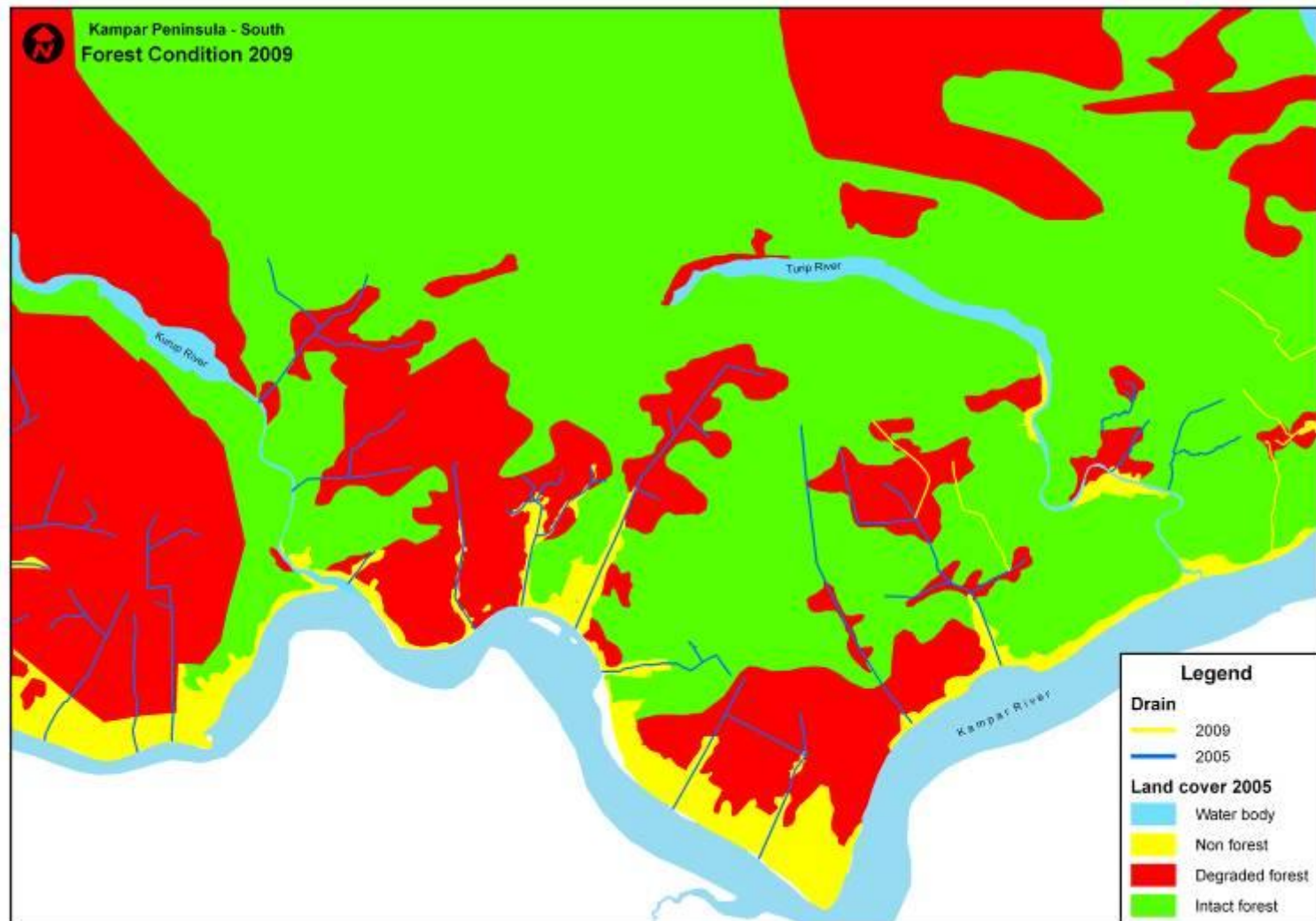


**Ditches dug by hydraulic excavator**

- ditch every 2 km apart
- ditches run downhill to nearest river
- abandoned after brief use, to drain
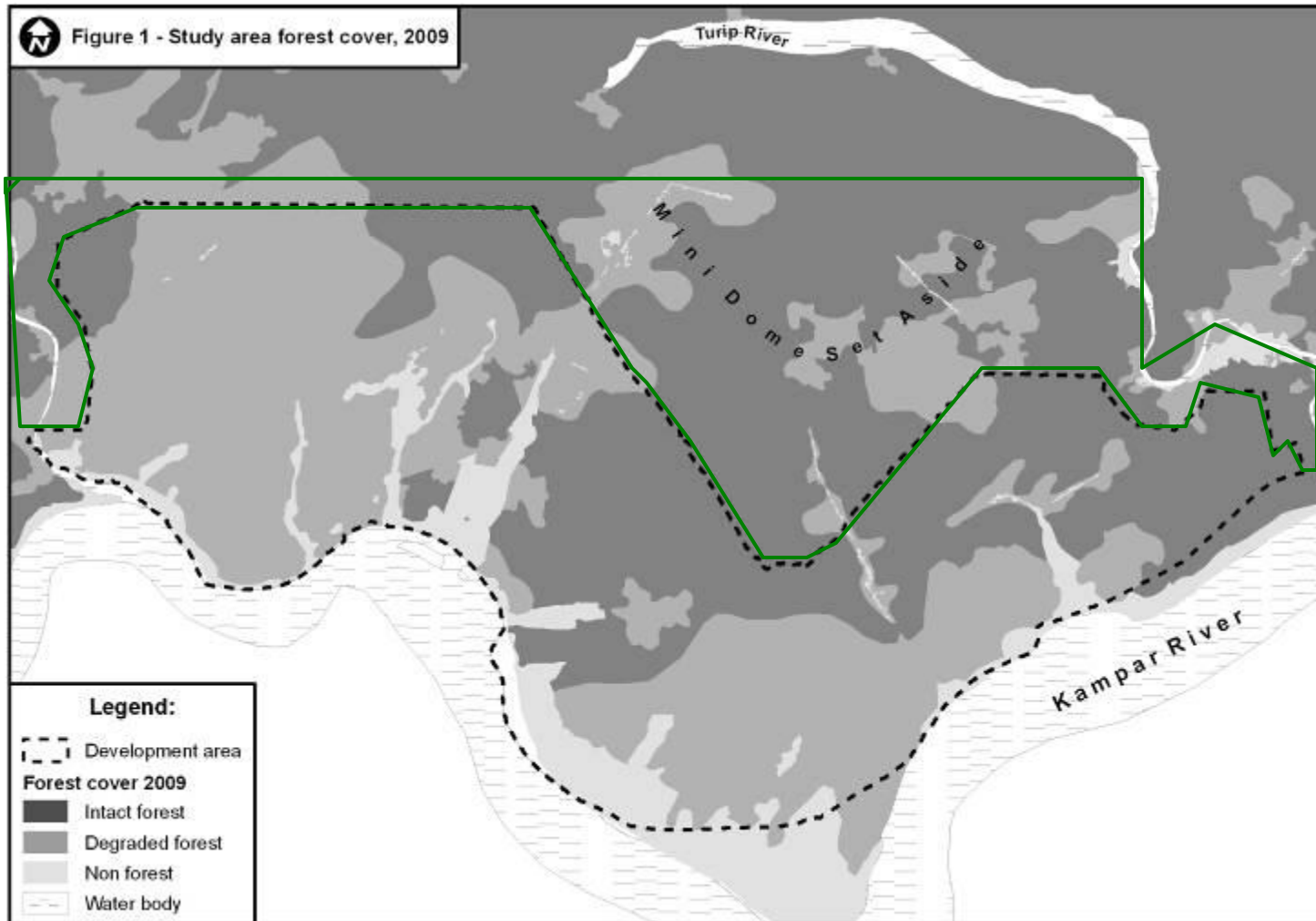- groundwater levels gradually lower

# Vegetation Cover types defined



Kampar Peninsula - South
Aerial Photo 2009

**Forest Cover Definition**
Intact          most original canopy trees (>8 m crown diameter) remain
Damaged    >50% original canopy trees have gone
Non-forest  majority cover is non woody vegetation

Log extraction ditches are digitized

# 2009 - Landscape before development

# 2010 - Study Area Developed



Figure 1 - Study area forest cover, 2009

Turip River

Mini Dome Set Aside

Kampar River

Legend:

Development area

Forest cover 2009
Intact forest
Degraded forest
Non forest
Water body

# 2010 - Terrain Damage Revealed

**Degraded & Non Forest**

- covered 51% of the study area

- dense network of abandoned ditches

- soil subsidence centered on ditches



*Canal for development dug Dec 2009*
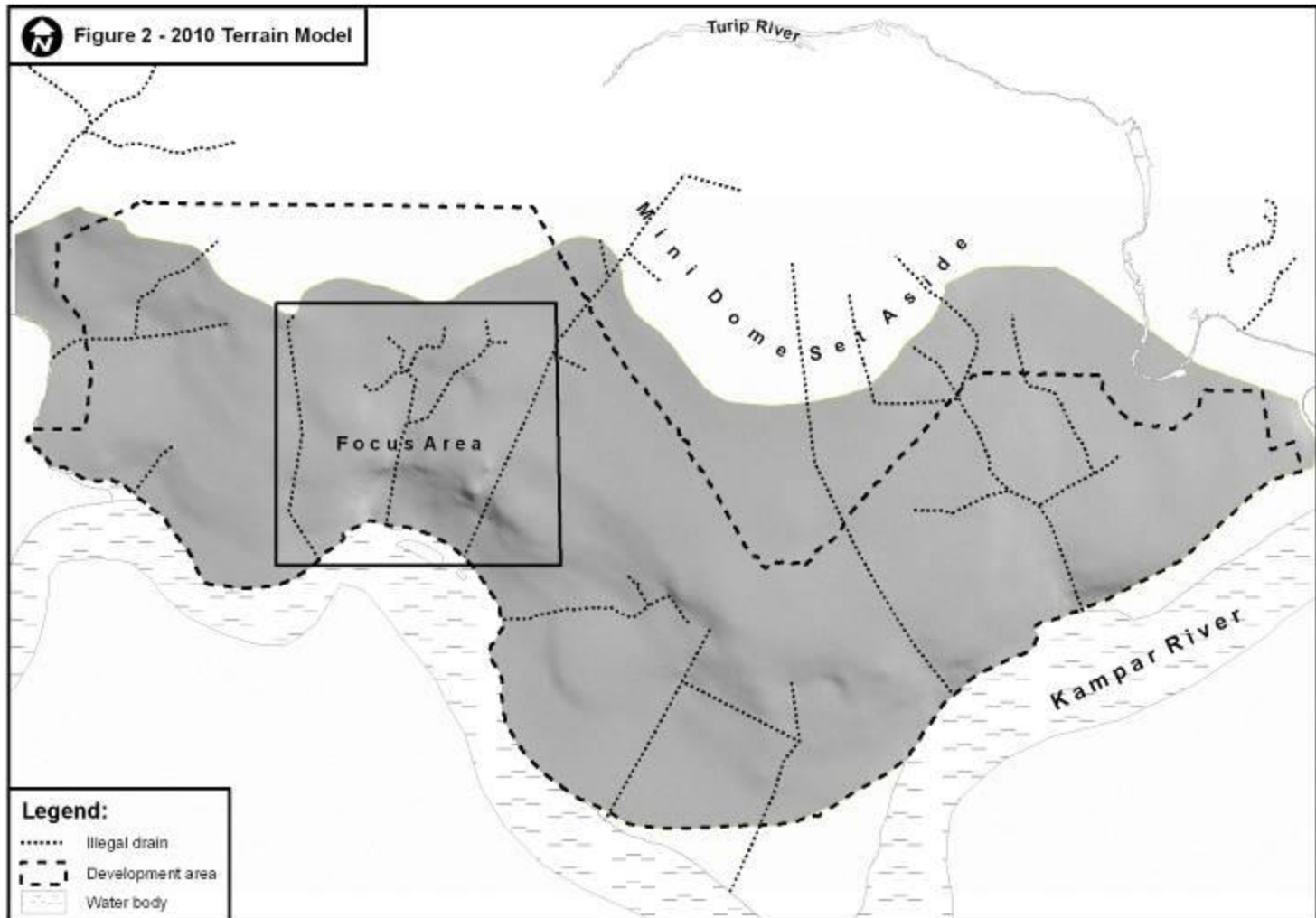
*Abandoned 'wild' ditch, from 2002*

# Topographic Leveling Survey 2003 & 2010
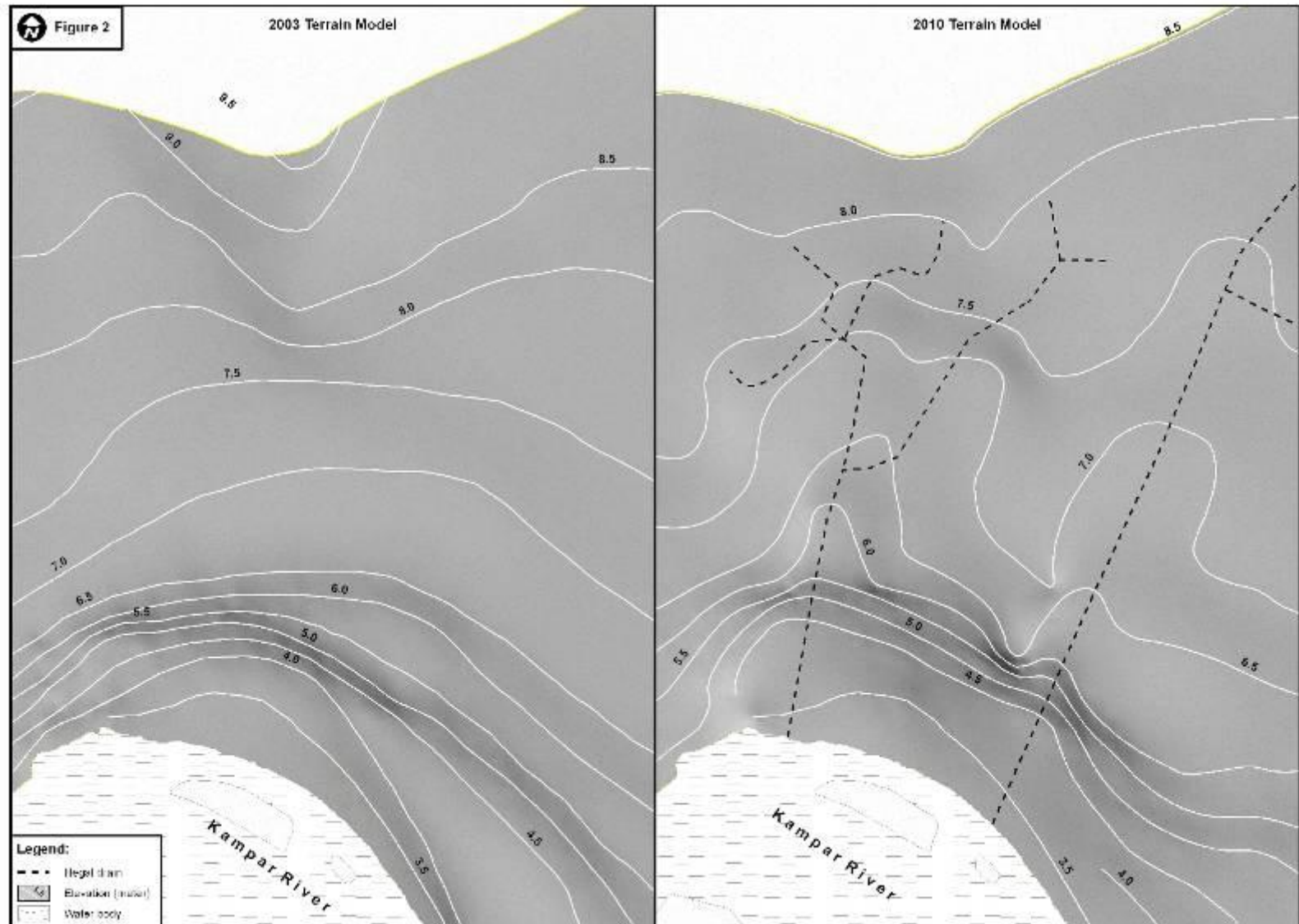
**Double-stand leveling**

- stands agree within 0.002 m elevation

- survey polygon sides of 3-4 km

- 2003 elevation closure ~ 0.10 m / 3-4 km

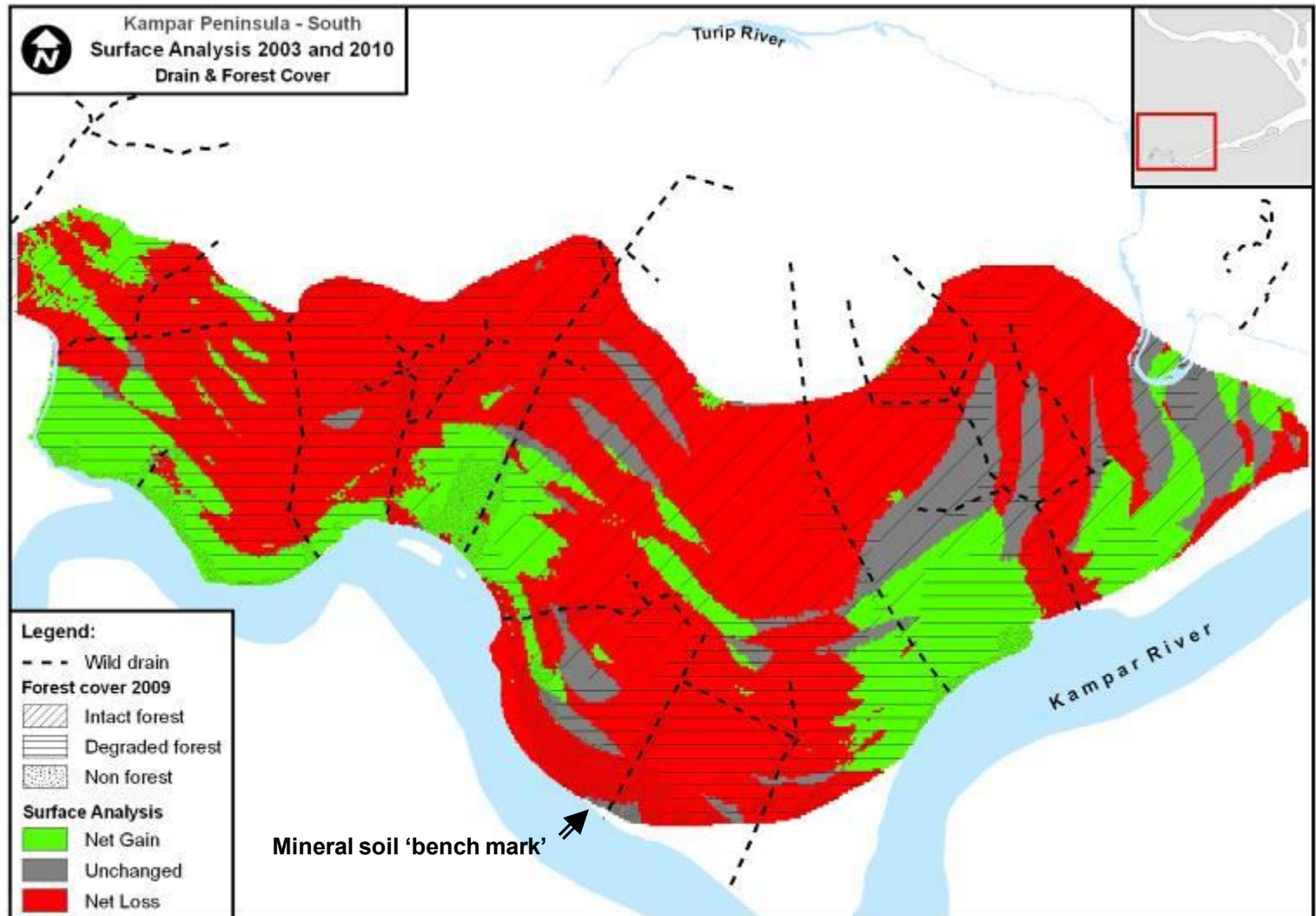- 2010 elevation closure ~ 0.08 m / 3-4 km

# Terrain Model – 2010



Figure 2 - 2010 Terrain Model

Legend:
- ........ Illegal drain
- ⌐ ¬ Development area
- Water body

# Terrain Models – 2003 & 2010

# Indicative Terrain Change  2003-10



Kampar Peninsula - South
Surface Analysis 2003 and 2010
Drain & Forest Cover

Turip River

Kampar River

Legend:
- - - Wild drain
Forest cover 2009
- Intact forest
- Degraded forest
- Non forest
Surface Analysis
- Net Gain
- Unchanged
- Net Loss

**Mineral soil 'bench mark'**

# Indicative soil carbon loss  2003-10

Net Loss     -44 M m$^3$ / 118 M m$^2$  = -0.37 m subsided

Net Gain    +13 M m$^3$ /   42 M m$^2$  = +0.31 m raised

Unchanged                   19 M m$^2$
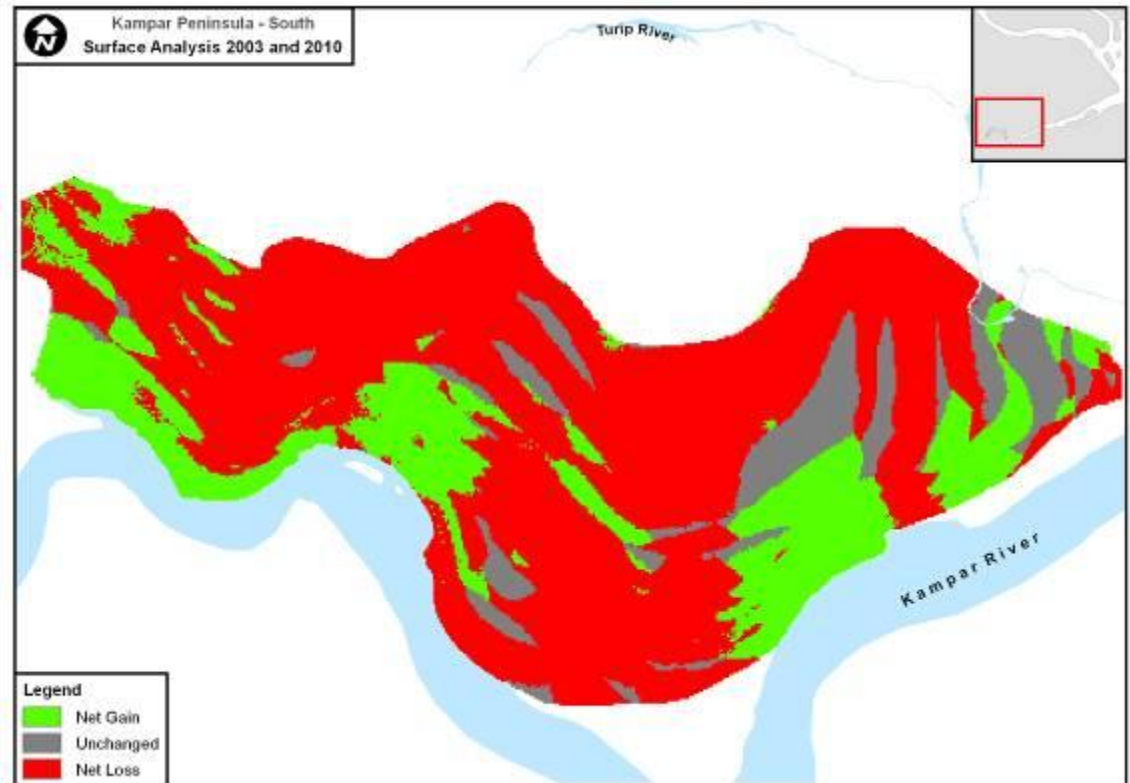
Mean     -31 M m$^3$ / 179 M m$^2$

            = -0.17 m subsidence
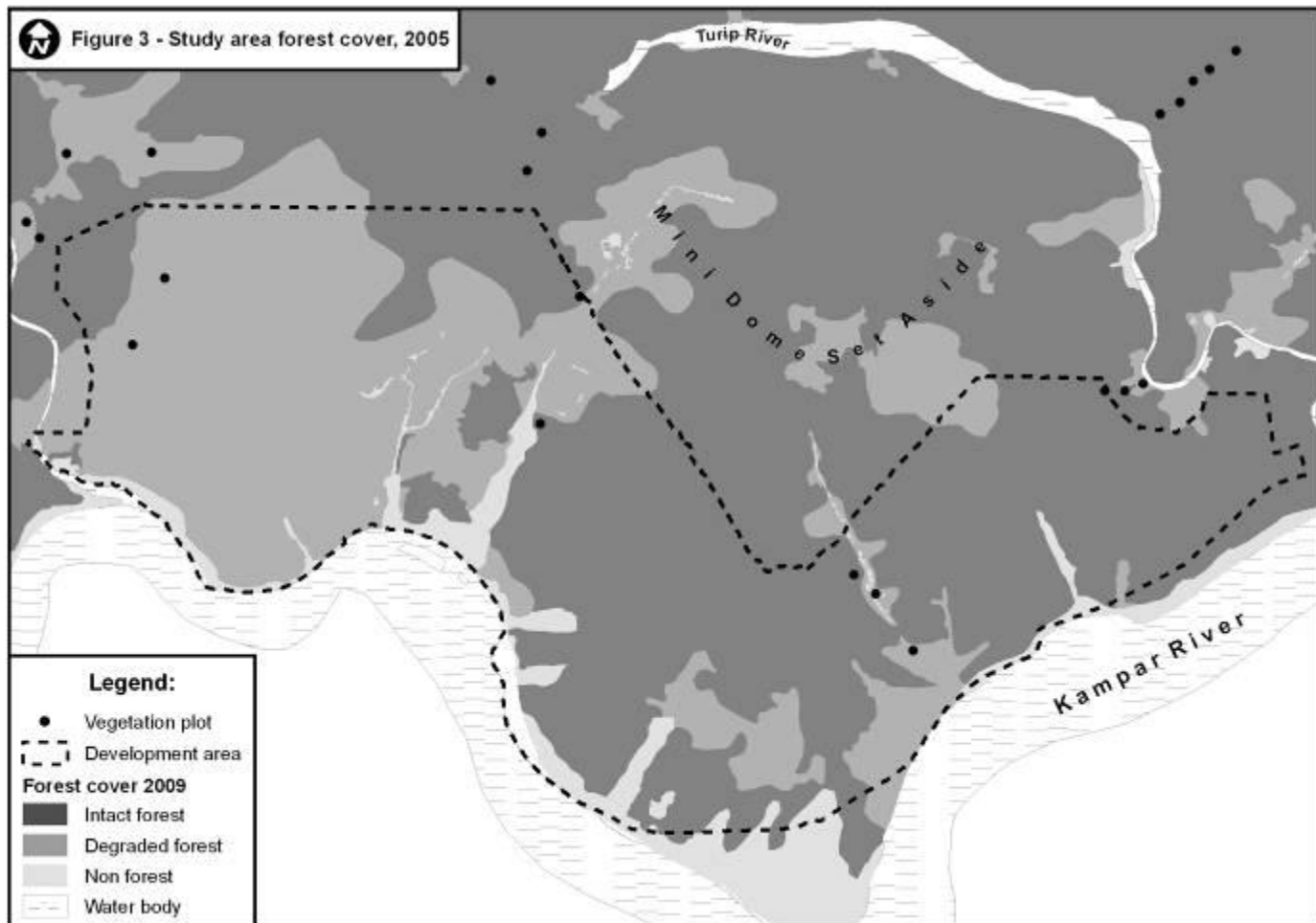
Peat bulk density 0.07 (data)

Peat Carbon 54% (data)

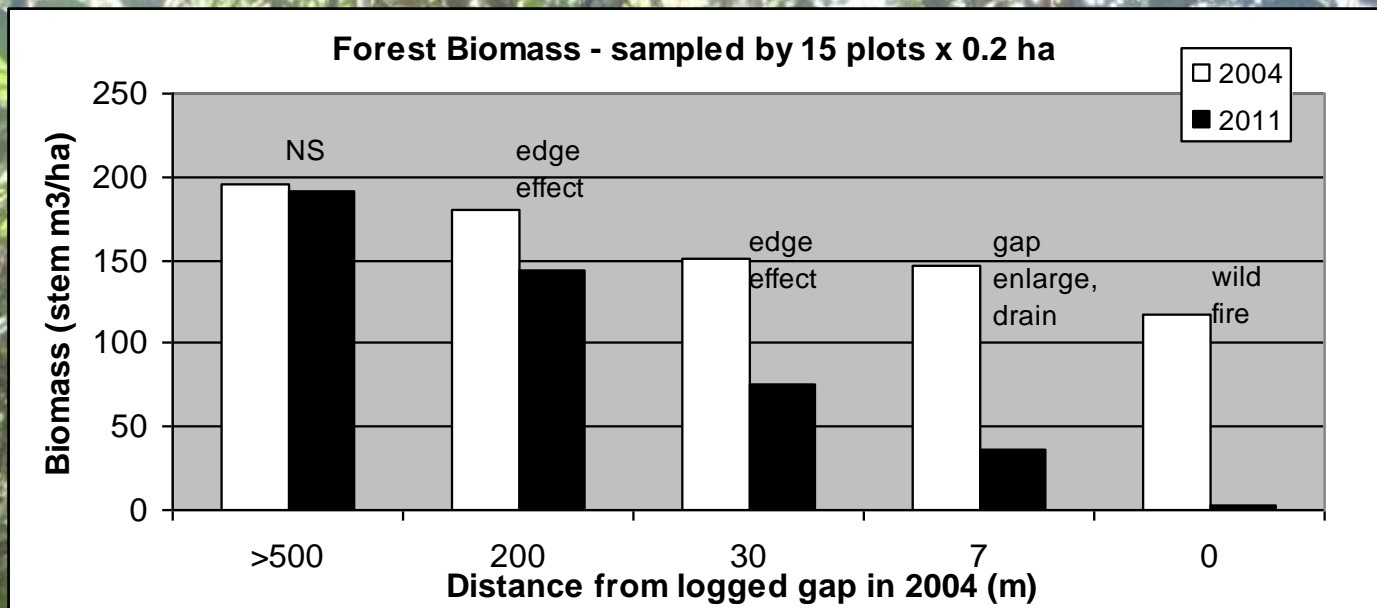Oxidation 60% (assumed)

**~20 t ha$^{-1}$ yr$^{-1}$ CO$_2$**



Kampar Peninsula - South
Surface Analysis 2003 and 2010

Turip River

Kampar River

Legend
Net Gain
Unchanged
Net Loss

# Natural forest condition monitored 2004-11

## Forest description sample plots (22) 100 x 20 m



Figure 3 - Study area forest cover, 2005

# Decline in Biomass

## Monitored over 8 years that followed logging



**Forest Biomass - sampled by 15 plots x 0.2 ha**

Legend: □ 2004, ■ 2011

Y-axis: **Biomass (stem m3/ha)** (0, 50, 100, 150, 200, 250)

X-axis: **Distance from logged gap in 2004 (m)** (>500, 200, 30, 7, 0)

Labels: NS, edge effect, edge effect, gap enlarge, drain, wild fire

# Landscape change in vegetation cover



**Landscape Vegetation Cover - from digitized images**
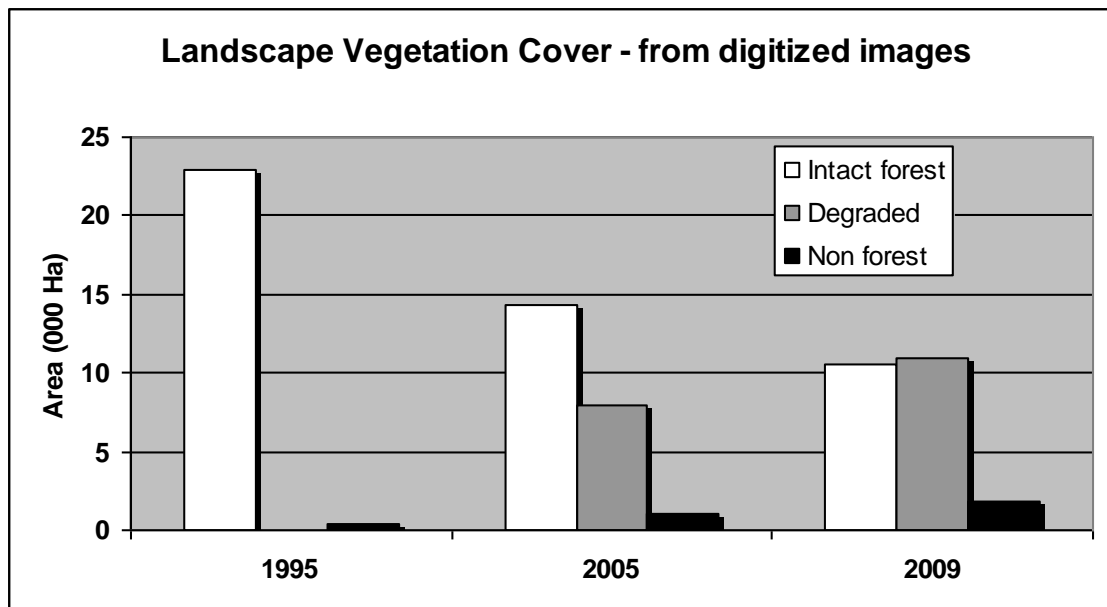
**Estimated decline in study-area forest biomass, 2005-09:**

1) Area changed from intact to degraded and from degraded to non-forest x mean biomass ha$^{-1}$ each type from plot-scale samples in 2004

2) Area that remained unchanged category, intact and degraded forest,    x mean biomass decline each type 2009 on 04 from plot-scale sampling

**Indicative Result:  7- 8 ton $CO_2$ ha$^{-1}$ yr$^{-1}$ biomass decline**

# Concluding Discussion

## A non-intact landscape a legacy from illegal logging

- Illegal logging drainage started c. 2000 has caused lasting distortion of terrain
- incised valleys will likely continue subsiding until permanently flooded, in very long term

## Significant loss of forest biomass

- still occurring years after illegal logging has moved on
- 'edge effects' to large trees from exposure – decades before recovery commences?
- exposure rather than soil drainage effects on forest appear the widest impact

## Land-use planning needs accurate DEM

- e.g. to locate set-asides on the least distorted landforms
- new technology needed to remote sense & model landscape terrain regardless of forest canopy and soil water levels

## Carbon footprint

- monitoring must encompass landscape scale over very long time horizons

# Rehabilitation of set-aside Natural Forest

**Abandoned illegal ditches closed – inside natural forest set-asides**

- 1st leveling survey of ditch course

- 12 permanent weirs built of geo-textile sand bags

- at each 0.2 m elevation gradient on ditch course

- materials long-lined in by helicopter

- weir monitoring & maintenance is ongoing

- significant cost per hectare protected

- before ditch closing, mean water tables 47 – 60 cm deep

- subsidence valleys now flooded, ridges not so in dry spells

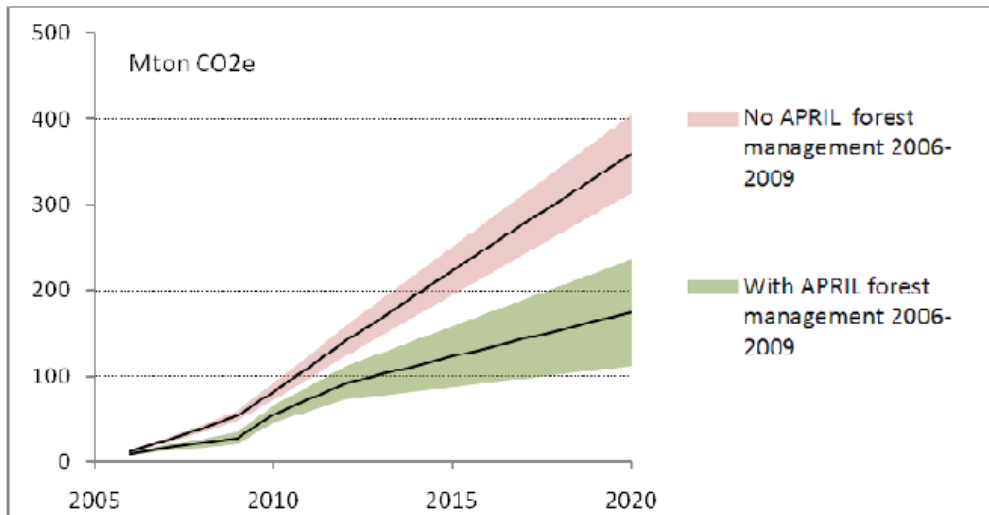- forest collapse & peat subsidence are occurring – slowing?

# APRIL pulp & paper Carbon Footprint 2009

### done independently by Swedish Environment Research Institution
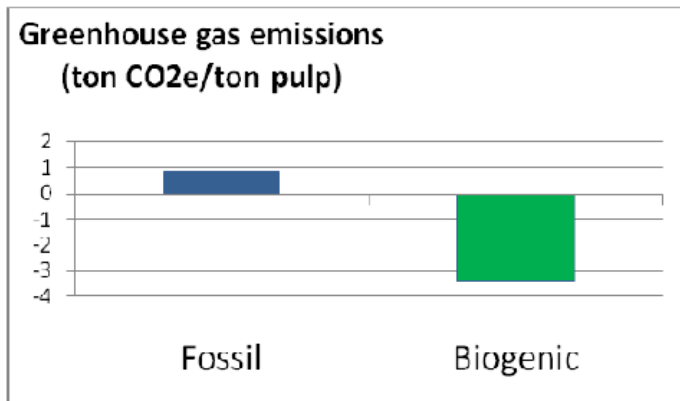


**GHG balance from APRIL pulp & paper production**

**negative values = removals relative to the baseline**



**Extrapolated GHG emissions**

- **includes all APRIL lands**

- **same area with/out APRIL**

- **uncertainty range with/out APRIL**