Assessment of fertilisation regimes for specific situations

Refined physiographic map

Jean-Pierre Bouillet – Serge Guillobez – Vincent Freycon
(CIRAD)

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CENTRE DE COOPÉRATION INTERNATIONALE EN RECHERCHE
AGRONOMIQUE POUR LE DÉVELOPPEMENT - FORESTRY DEPARTMENT

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Acknowledgements

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The consultants acknowledge all the people for their warm welcome and their large involvement in the success of their mission in March 2007.

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Assessment of fertilization regimes for specific situations
Deliverable: "Refined Physiographic Map"

1. Introduction

Objectives of the WP
Developing a site specific silviculture for eucalypt stands in order to optimize the fertiliser inputs to 1) achieve a stand production as close as possible to the ecological potential, and 2) reduce the costs of fertilisation practices.

Deliverables
- Preliminary nutrition guidelines and soil indicators of fertilizer requirements from the current fertiliser trials
- Refined nutrition guidelines and soil indicators on the whole set of fertiliser trials.

Working activities
The study was carried out in the Minas Region - Rasau Kuning and Gelombang districts (AA - Riau), and Districts 1 and 4 (WKS - Jambi). These districts have been chosen by AA and WKS as representatives of the dry land plantations.

Three tasks have been identified:

1) Drawing a physiographic map by crossing geological map and landform (slope, topographic position) information
2) Defining the main representative sites by crossing the physical and chemical soil properties with the physiographic map and rainfall information.
3) Establishing, monitoring and analyzing fertiliser trials on the different representative sites.

Milestones

MILESTONES	TIME AFTER PROJECT START (Approx)
Refined physiographic Map	Mid-month 2
Pre-site classification	Mid-month 3
Fertilizer design specified and established	Months 4-5
Assessment of soil variability	Month 4
Refined representative site report	Month 6
Year one measurement and report	Month 21
Year two measurement and report	Month 33
Refined fertilizer and soil indicators	Month 36

Refined physiographic map
The objective of this report is to provide a physiographic map of Riau and of Jambi to AA, and WKS, respectively. This work has been mainly realised at the office in February 2007 and in June 2007, and in the field during a mission in March 2007 (Annex 2).

This report contains also a CD-Rom, where the different layers used to provide the physiographic maps have been included in the Arc-View3.2 format (Annex 3).

2. Physiographic map

2.1. Introduction

The mineral soils of provinces of Riau and Jambi are mainly red-yellow Podzolic soils (Whitten et al. 1997). According to Fanning & Fanning (1989), red-yellow Podzolic soils correspond with ultisols of the Soil Taxonomy, i.e. acrisols of WRB (FAO-ISRIC-ISSS 1998). These soils are low in fertility and characterised by low pH and low base saturation, having an argilic horizon (i.e. clay accumulation).

These characteristics are also encountered in the mineral soils of AA (Soil survey staff) and certainly of WKS, in Riau and Jambi respectively. However, these characteristics have variability because there are other soils than red-yellow Podzolics (e.g. white-yellow Podzolic soils) and/or because there is variability within the same soil type (Bouillet et al. 2006).

Finally, the spatial pattern of soil properties must be better understood in order to optimize and adapted fertilisation inputs in function of the chemical fertility of soi' .

Geomorphology *"deals with the arrangement and differentiation of landforms and the processes that have been or are shaping them"* (Gerrard 1992). Geomorpholy may be a relevant approach to explain spatial pattern of soils properties of Riau and Jambi at different scales. Many studies, summarized for example in Birkeland (1984), Gerrard (1992) and Thomas (1994), actually showed a good relationship between the geomorphology and the pedology. More precisely, these studies showed that soil patterns and landscape elements often coincide and that soil patterns can be predicted by landform units. As consequence a physiographic study, which identifies the main geomorphic units of a study area, should be relevant to explain spatial pattern of soil properties (particle size, chemical fertility) of Riau and Jambi.

Finally, the objectives of this study was (i) to define the main geomorphic units of Riau (AA) and Jambi (WKS) by using geology and topography, (ii) to divide the study area in homogeneous landform units, (iii) and to provide a physiographic map.

2.2. Material and Methods

For each site (Riau, Jambi), we used:

- The Shuttle Radar Topography Mission (SRTM) data, which led to a digital elevation model (DEM) with about 30 m of vertical accuracy on 90 m x 90 m cells
- Numerical topographical maps at 1:50,000 scale.
- A Landsat Thematic Mapper ™, which led to a colored composition.
- Geological map at 1:250,000 scale of the neighbour areas of Riau - Dumai (0817) - and Jambi - Rengat (0915). But we did not use geological maps of the study areas of Riau – Pakanbaru (0816) – and Jambi - Muarabungo (0914) – because it was not possible to get them.
- Explanatory booklet of geological map at 1:250,000 scale of Pakanbaru (0816)

This information allowed carrying out landform segmentation in order to divide the study areas in homogeneous landform units. Physiographic map was the final product of this step.

We checked on the field landform segmentation and physiographic map, covering by car the districts of Rasau Kuning and of Gelombang in Riau and the district 1 in Jambi. We described more precisely some spots (Fig. 2, Fig. 7).

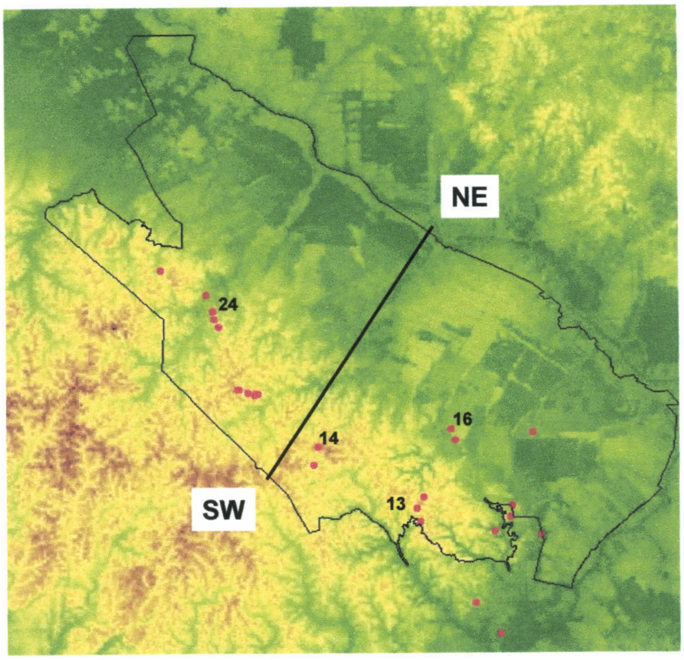

Figure 2. Spots of Riau more precisely described on the field and location of the geological cross section of the Figure 5

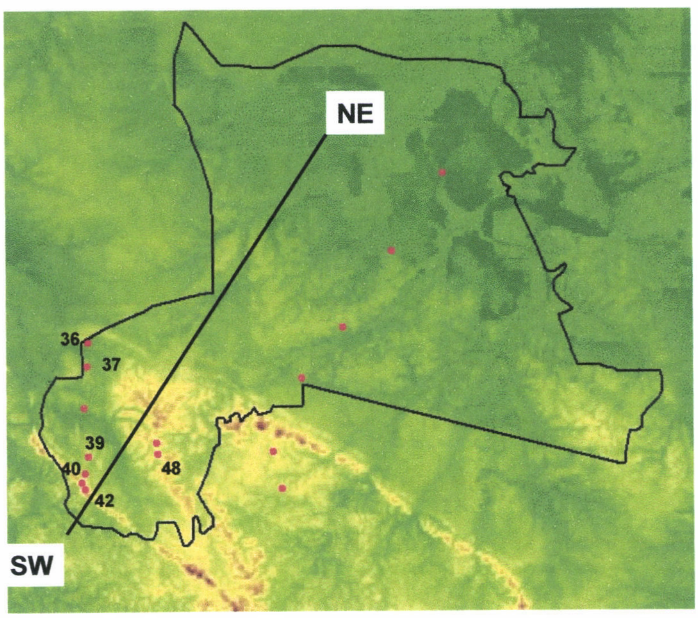

Figure 7. Spots of Jambi more precisely described on the field and location of the geological cross section of the Figure 10

2.3. Results

2.3.1. Physiographic map of Riau

The DEM of Gelombang and Rasau Kuning districts of Riau, which was produced by the SRTM (Fig. 1), allowed clearly dividing study area into plain landform (Synclinal formation) and hilly landform (Anticlinal formation).

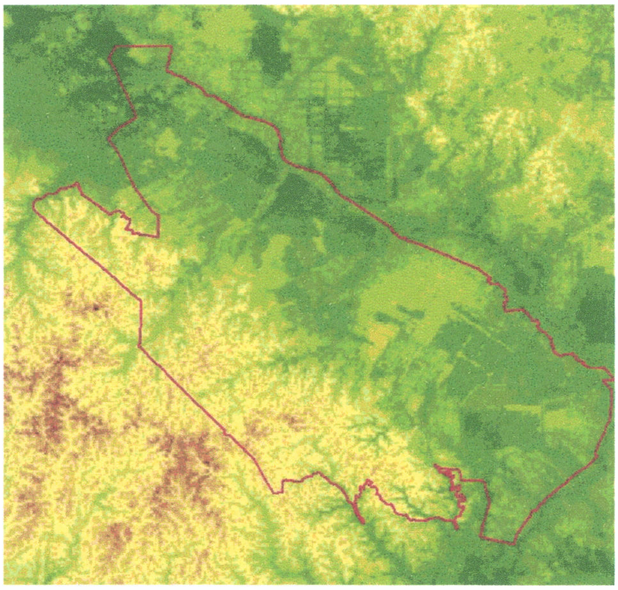

Figure 1: Digital elevation model (DEM) of Riau produced by SRTM

More precise landform segmentation, using Landsat Thematic Mapper ™ (Fig. 3), field observations and topographical maps, allowed us dividing study area into six landform units (Fig. 4). Within the plain landform (Synclinal formation), we distinguished alluvial plain from plain bordering Siak river. Within the hilly landform (Anticline formation) we distinguished hilly landform with gently slopes (Pictures 1, 2) from hilly landform with steep slopes (Picture 3). These hills are dissected by streams and small valleys. A piedmont slope links hilly landform and plain landform (Picture 4).

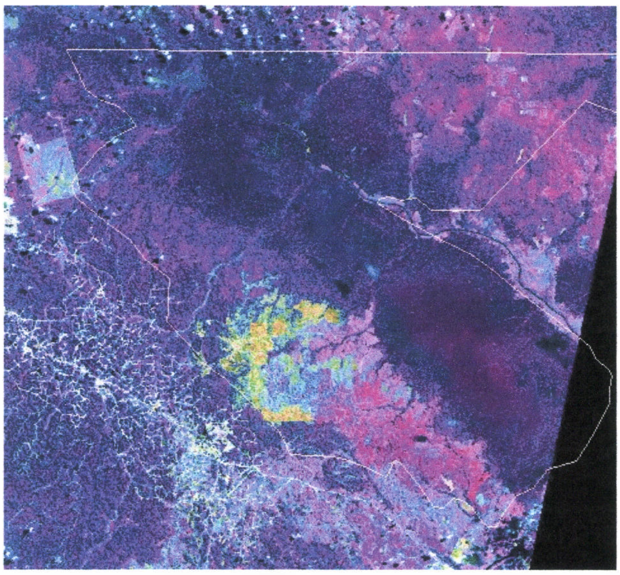

Figure 3. Colored composition of Riau from Landsat Thematic Mapper ™ (1989)

Physiographic Map : Gelombang - Rasau Kuning

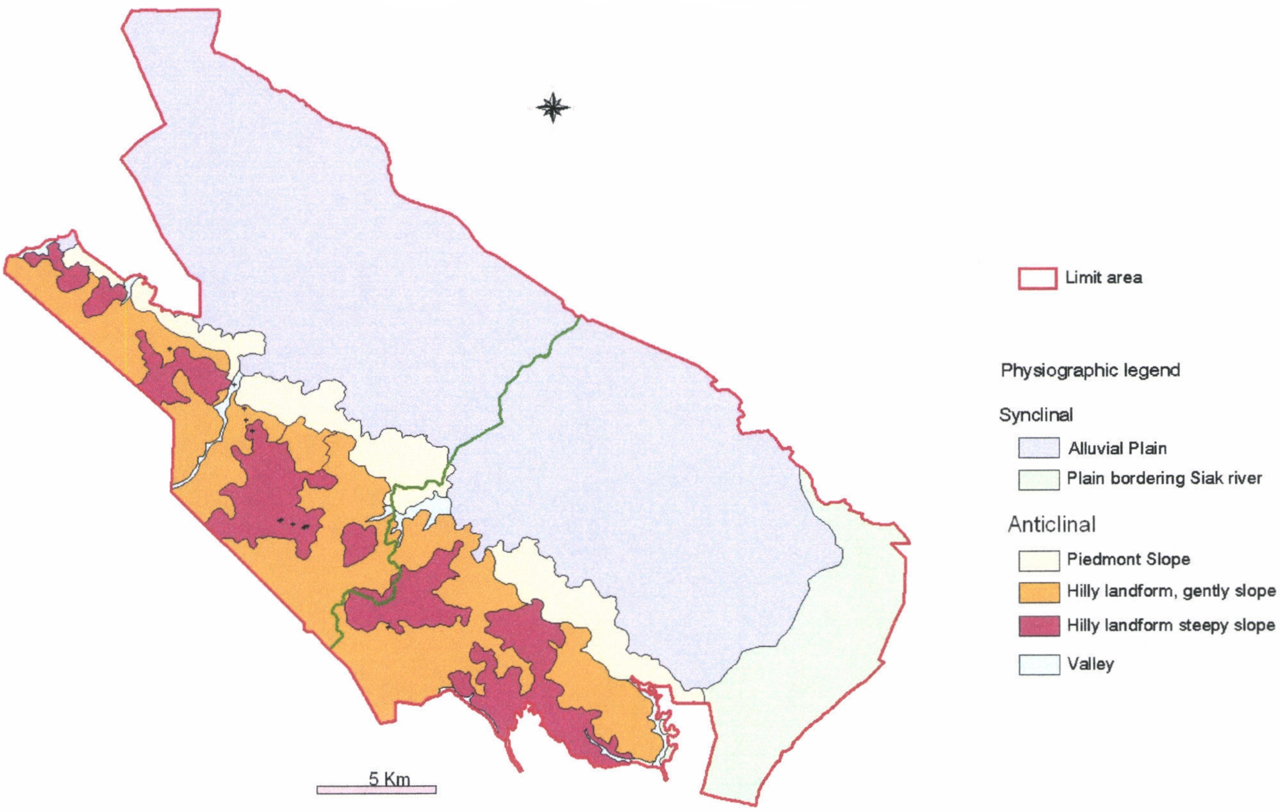

Figure 4. Physiographic map of Riau (Gelombang and Rasau Kuning districts)

Picture 1. Hilly landform, gentle slope (Riau, spot 13)

Picture 2. Hilly landform, gentle slope (Riau, spot 14)

Picture 3. Hilly landform, steep slope (Riau, spot 24)

Picture 4. Alluvial plain (front) and Piedmont slope (back) (Riau, spot 16)

According to the geological map of Pakanbaru, the hilly landform is located on Minas Anticline formation (Pleistocene, quaternary era). The lithology is constituted of *"unconsolidated to semi-consolidated mud, sands and gravels. Extensive pebble beds in mountain front area"* (Clarke et al. 1982). There was no way to link the kind of the rock (mudstone, sandstone) with the hilly landform (gently slopes vs steep slopes). Finally, according to the geological map of Pakanbaru, we proposed a geological interpretation of a cross section (Fig. 5)

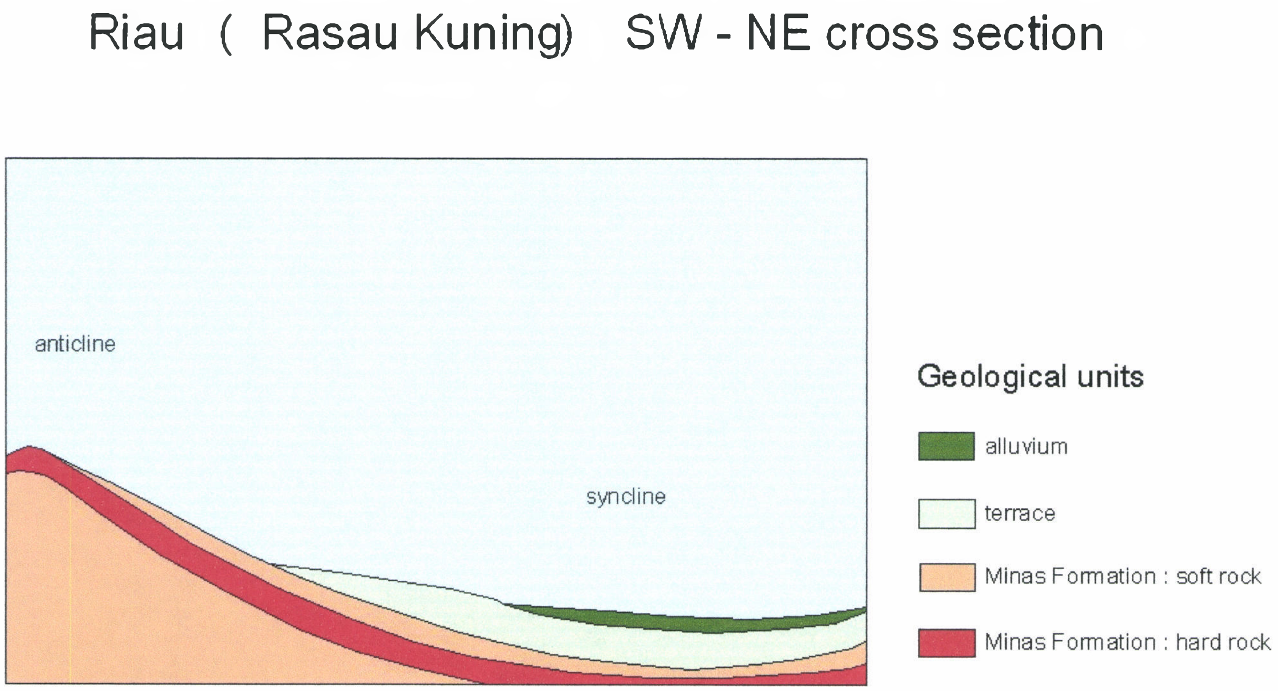

Figure 5. Geological cross section of Riau (Gelombang and Rasau Kuning districts)

2.3.2. Physiographic map of Jambi, District 1

The DEM of district 1 of Jambi, which was produced by the SRTM (Fig. 6), allowed dividing study area into plain landform and hilly landform.

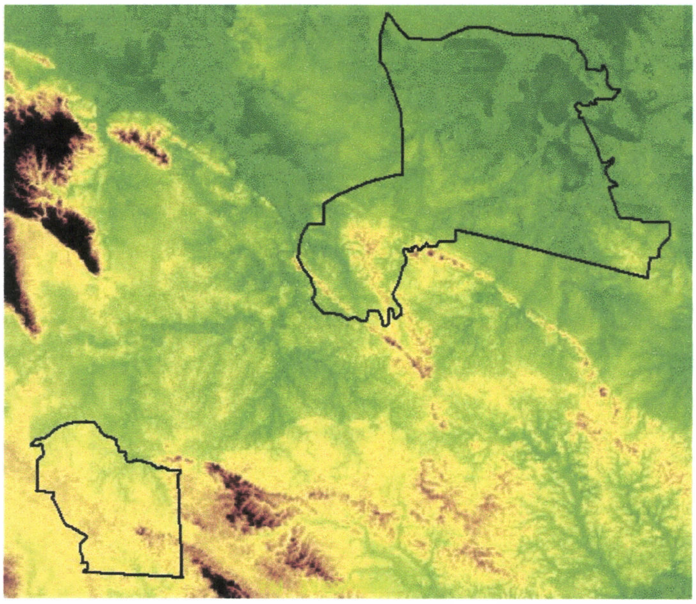

Figure 6. Digital elevation model (DEM) of Jambi produced by SRTM

More precise landform segmentation, using still DEM but also Landsat Thematic Mapper ™ (Fig. 8), field observations and topographical maps, allowed us dividing study area into nine landform units (Fig. 9). Within the plain landform, we distinguished alluvial plain from piedmont slope, a huge area that links alluvial plain and hilly landform. Within the hilly landform, we distinguished firstly the different landform units of an anticline formation, which has a "horseshoe" form (Fig. 7, Fig. 9): (i) anticline flank (e.g. spot 48, Picture 8) (ii) anticline closure (e.g. spots 36 and 37) (iii) and anticline bulge. In its inner part, this horseshoe anticline has been dogged to form an anticline valley. Secondly, we distinguished at the south-west of the horseshoe anticline a synclinal through (e.g. spot 39, Pictures 5, 6) with a limb (e.g. spot 42) characterized by steep slopes (Picture 7).

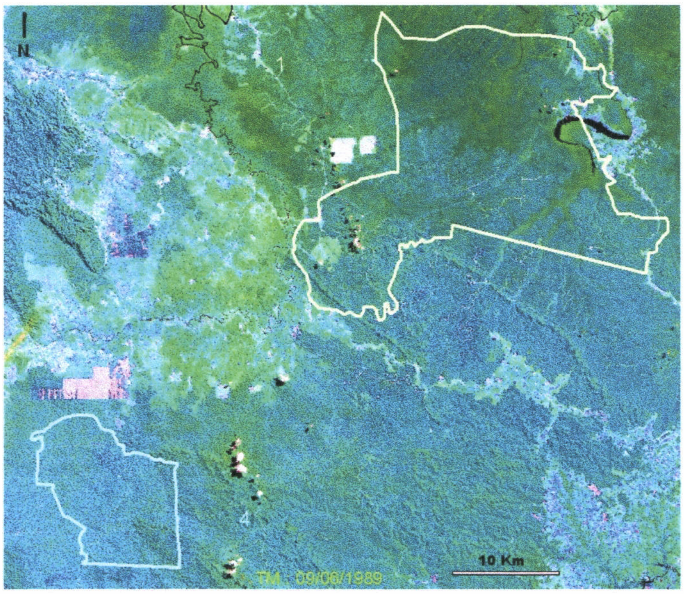

Figure 8. Colored composition of Jambi from Landsat Thematic Mapper ™ (1989)

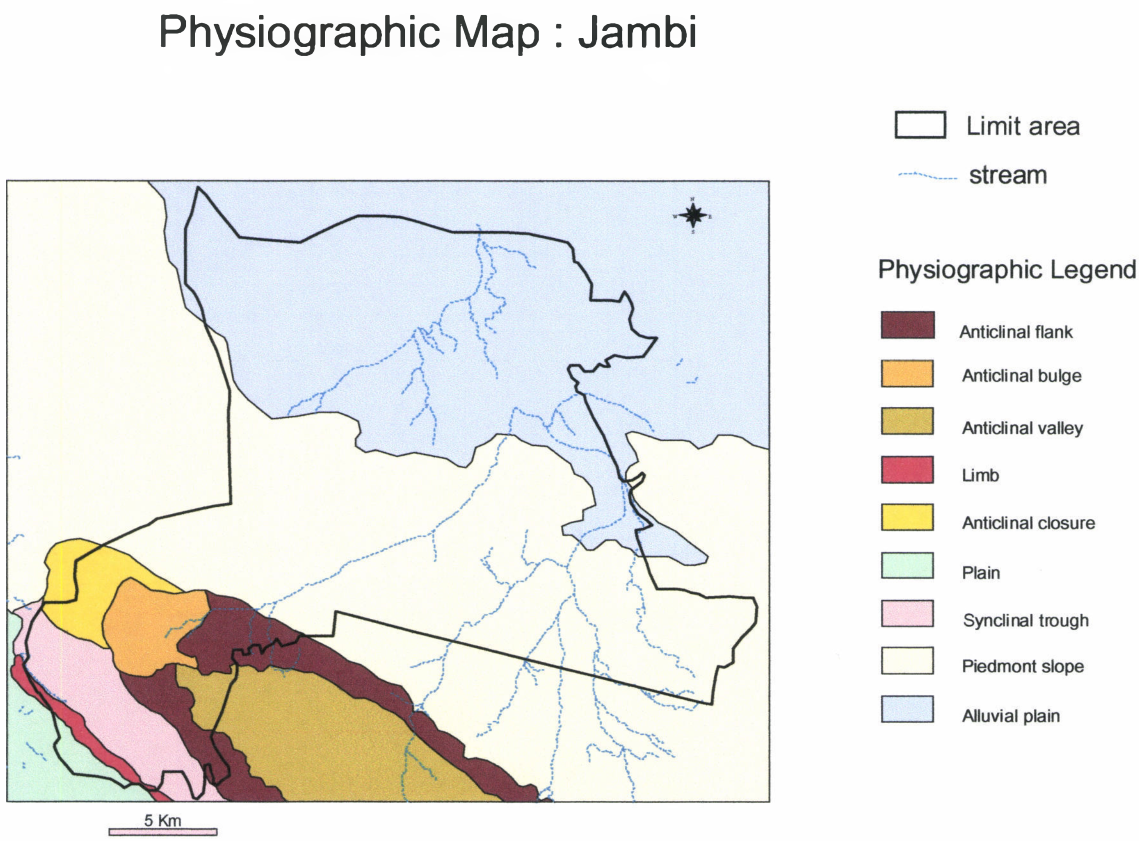

Figure 9. Physiographic map of Jambi (District 1)

Picture 5. Synclinal through (front) and limb (back) (Jambi, spot 39)

Picture 6. Synclinal through (front) and anticlinal bulge (back) (Jambi, spot 40)

Picture 7. Steep slope (Jambi, spot 42)

Picture 8. View of the limb (back) from anticlinal flank (Jambi, 48)

A geological interpretation of a cross section (Fig. 10) summarizes the pattern of these different landform units.

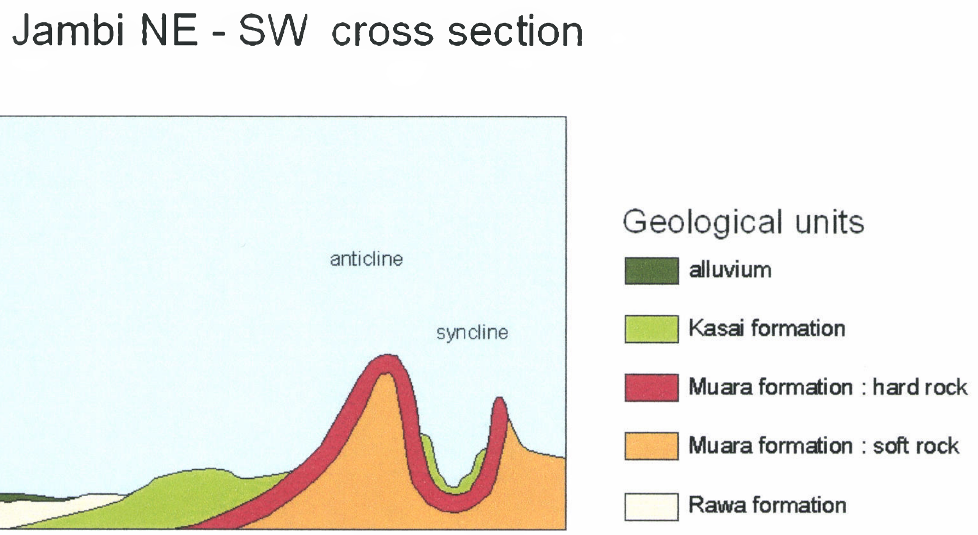

Figure 10. Geological cross section of Jambi (District 4)

BIBLIOGRAPHY

Birkeland, P., 1984. Soils and geomorphology. Oxford University Press, New-York, 372 pp.

Bouillet, J.P., Laclau, J.P. and Deleporte, P., 2006. Eucalyptus nutrition review, CIRAD, 85p.

Clarke, M.C.G., Kartawa, W., Djunuddin, A., Suganda, E. and Bagdja, M., 1982. The geology of the Pakanbaru Quadrangle, Sumatra, Geology Research and Development Centre Bandung.

Fanning, D.F. and Fanning, M.C.B., 1989. Soil morphology, genesis and classification. John Wiley & Sons, New-York, 395 pp.

FAO-ISRIC-ISSS, 1998. World reference base for soil resources, 84. Food and Agriculture Organization of the United Nations, Rome, 109 pp.

Gerrard, J., 1992. Soil-Geomorphology. An interaction of Pedology and Geomorphology. Chapman & Hall, London, 269 pp.

Soil survey staff, 1982. Semi-detailed soil survey for Rasau Kuning resort in Minas district, Silvicultural improvement section. Research and development department. Forestry division. PT. Arara Abadi, 24 pp.

Thomas, M.F., 1994. Geomorphology in the tropics. A study of weathering and denudation in low latitudes. John Wiley & Sons, Chichester, 443 pp.

Whitten, T., Damanik, S.J., Anwar, J. and Hisyam, N., 1997. The Ecology of Sumatra. The Ecology of Indonesia, I. Periplus, Jakarta, 478 pp.

Annex 1. Pictures characteristics

Table 1. Characteristics of pictures of Riau

Picture			Spot		
Id	Aspect (° magnetic)	Commentary	Id	GPS (WGS84, UTM47N)	
				X	Y
1	240		13		
2	0	View from the fire tower	14	780787 E	86128 N
3	Unknown		24	774558 E	94161 N
4	Unknown		16	788727 E	87172 N

Table 2. Characteristics of pictures of Jambi

Picture			Spot		
Id	Aspect (° magnetic)	Commentary	Id	GPS (WGS84, UTM48S)	
				X	Y
5	160		39	293316 E	9865349 N
6	45		40	293186 E	9864467 N
7	45		42	293149 E	9863628 N
8	225		48	297112 E	9865504 N

Annex 2. Participants and schedule of the launch mission of WP1 in March 2007

Participants

Dr JP Bouillet: sylviculturist, WP coordinator
Dr V Freycon: morphopedologist
MSc S Guillobez: geomorphologist, remote sensing data specialist

Mission schedule

- Friday 9 March, 13h50: departure from Montpellier (France)
- Sunday 11 March, 13h15: arrival at Pekanbaru
- Monday 12 March to Wednesday 14 March: discussions with AA R/D team, data collection, field observations and soil sampling.
- Tuesday 15 March: wrap-up meeting with AA R/D; travel by road to WKS R/D (arrival: 17h30).
- Friday 16 March to Saturday 17 March morning: discussions with WKS R/D team, data collection, field observations. Travel by road to Jambi. Flight to Jakarta (arrival: 19h00)
- Sunday, 18 March: discussions and drafting the present report. Departure from France (19h00)
- Monday, 19 March: arrival at Montpellier (8h50).

Annex 3. CD Rom contents

I) JAMBI (UTM 48N)

Satellite imagery landsat TM:

Jambi-landsat-tm-48n.jgw	projection data
Jambi-landsat-tm-48n.jpg	JPEG File

Digital Elevation model imagery :

Jambi-mnt-utm48n.jgw	projection data
Jambi-mnt-utm48n.jpg	JPEG File

Physiographic map :

jambi-physio-utm48n.apr	Project (ArcView 3.2)
jambi-physio-utm48n.dbf	shape file
jambi-physio-utm48n.shp	shape file
jambi-physio-utm48n.shx	shape file
jambi-physio.avl	legend (color)
jambi-physiographic.jpg	JPEG file without reference data

II) RIAU (UTM 47 N)

Satellite imagery landsat TM:

riau-landsat-tm-utm47n.jgw	projection data
riau-landsat-tm-utm47n.jpg	JPEG File

Digital Elevation model imagery :

riau-mnt-utm47n.jgw	projection data
riau-mnt-utm47n.jpg	JPEG File

Physiographic map :

riau-physio-utm47n.apr	Project (ArcView 3.2)
riau-physio-utm47n.dbf	shape file
riau-physio-utm47n.sbn	shape file
riau-physio-utm47n.sbx	shape file
riau-physio-utm47n.shp	shape file
riau-physio-utm47n.shx	shape file
riau-physio.avl	legend (color)
riau-physiographic.jpg	JPEG file without reference data

If path have to be changed before using ***.apr*** *file*