Hillslope Hydrology and Landuse Effect on Streamflow and Water Quality in the Batanghari River Basin, Indonesia

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RESEARCH PAPER

Influences of forested watershed conditions on fluctuations in stream water temperature with special reference to watershed area and forest type

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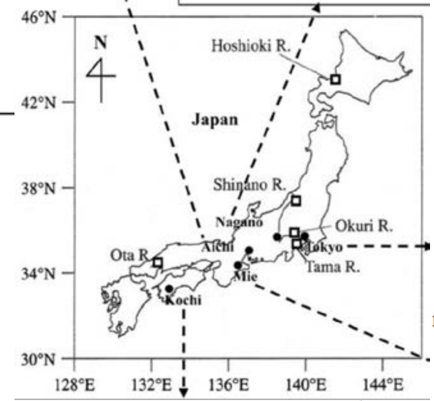
Abstract In order to gain insight into the effect of watershed conditions on fluctuations in stream water temperature, we statistically analyzed water temperature data for 1 year, using root mean square (Rms) and harmonic (*A* Amplitude, *φ* delay time) methods. The average values of delay time (days) between air and water temperatures (T_a and T_w) of small (< 0.5 ha), medium (0.5–100 ha) and large (> 100 ha) watersheds were 4.53 ± 0.82 days, 11.83 ± 3.88 days and 4.45 ± 1.52 days, respectively. Fluctuations in stream water temperature expressed by Rms (Rms T_w/Rms T_a) and harmonic methods ($A - T_w/A - T_a$) in the medium-sized watersheds with moderate slope gradients were 0.37 ± 0.09 and 0.56 ± 0.14, respectively. These values increased in the larger watersheds with low slope gradients, including five large rivers covered by various landscapes, with their averages of 0.53 ± 0.09 and 0.78 ± 0.09, respectively, indicating the influences of solar radiation and heat transfer processes. In the smaller watersheds with high slope gradients, these values were 0.73 ± 0.02 and 0.87 ± 0.03, respectively, suggesting that



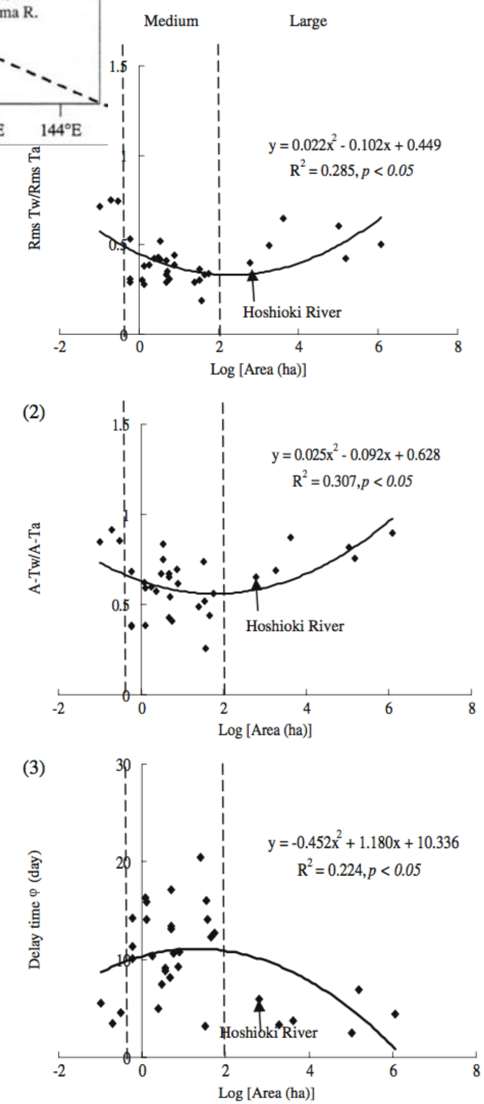
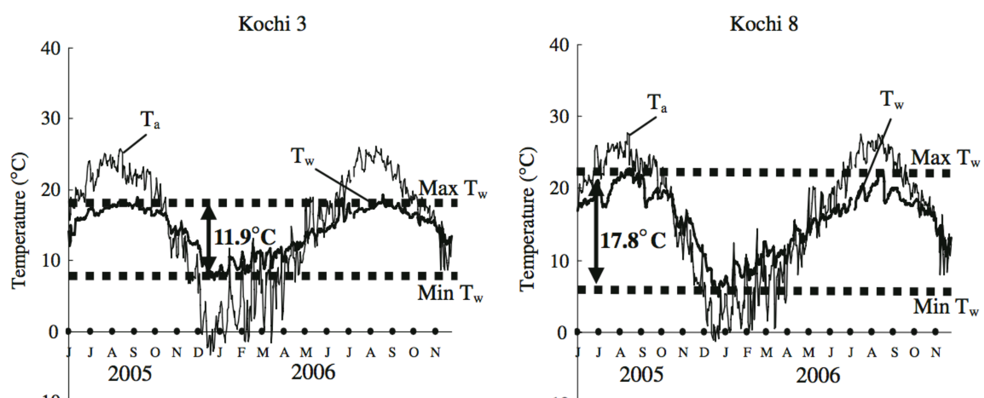


Fig. 7 Logarithm of the watershed area vs Rms T_w/Rms T_a (*1*), $A - T_w/A - T_a$ (*2*) and delay time (*3*)

Fig. 4 Daily air and water temperatures (T_a and T_w) at Kochi 3 and Kochi 8



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RESEARCH PAPER

Analysis of stream water temperature changes during rainfall events in forested watersheds

Luki Subehi · Takehiko Fukushima · Yuichi Onda · Shigeru Mizugaki · Takashi Gomi · Ken'ichirou Kosugi · Shinya Hiramatsu · Hikaru Kitahara · Koichiro Kuraji · Tomomi Terajima

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Abstract Despite continued interest in stream water temperature (Tw) analysis, there are few studies of Tw response to rainfall events at forested watersheds. We examined 61 sets of data on Tw for 21 rainfall events at 16 watersheds with various slope gradients (from 0.08 to 0.56) in four regions of Japan from June 2004 to December 2005. The investigation focused on the changes of specific discharge (ΔQs) and ΔTw at medium-sized watersheds (0.5–100 ha). The results clearly demonstrated different flow patterns expressed by Qs vs. Tw hysteretic loops. Those

were clockwise in Peric
terclockwise in Period
lower slope gradient a
loops were observed in
hysteretic loops could t
Tw and in response tim
surface and groundwate
probably determined by
level of groundwater. W
temperature (ΔTa) influ
Qs. The average rainfall
(9.3 ± 1.7 and 5.4 ± 0.

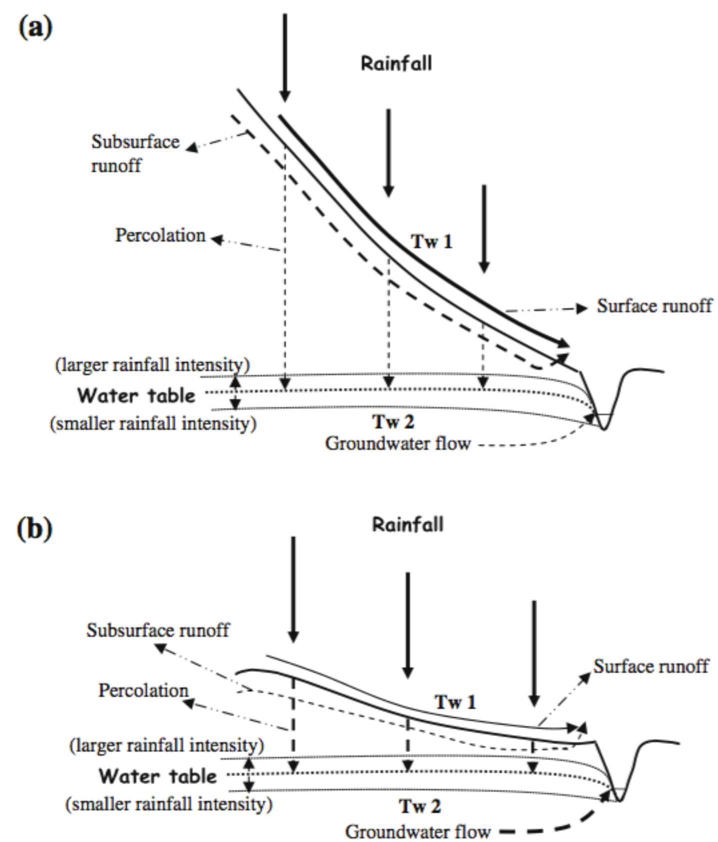

Fig. 4 Rainfall, surface/subsurface runoff, percolation, and groundwater flow in watersheds with different slope gradients. **a** Higher slope gradient, **b** lower slope gradient

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THE CHANGES IN STREAM WATER TEMPERATURE AND WATER QUALITY PARAMETERS DURING RAINFALL EVENTS IN FORESTED WATERSHEDS: SCALING OF OBSERVATIONS

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ABSTRACT

We studied the changes in stream water temperature (Tw) and water quality (Wq) during rainfall events in forested watersheds. The parameters of Wq (SS, DOC, NO_3^--N, DTN, Na^+, Si and K^+) were observed in four regions of Japan

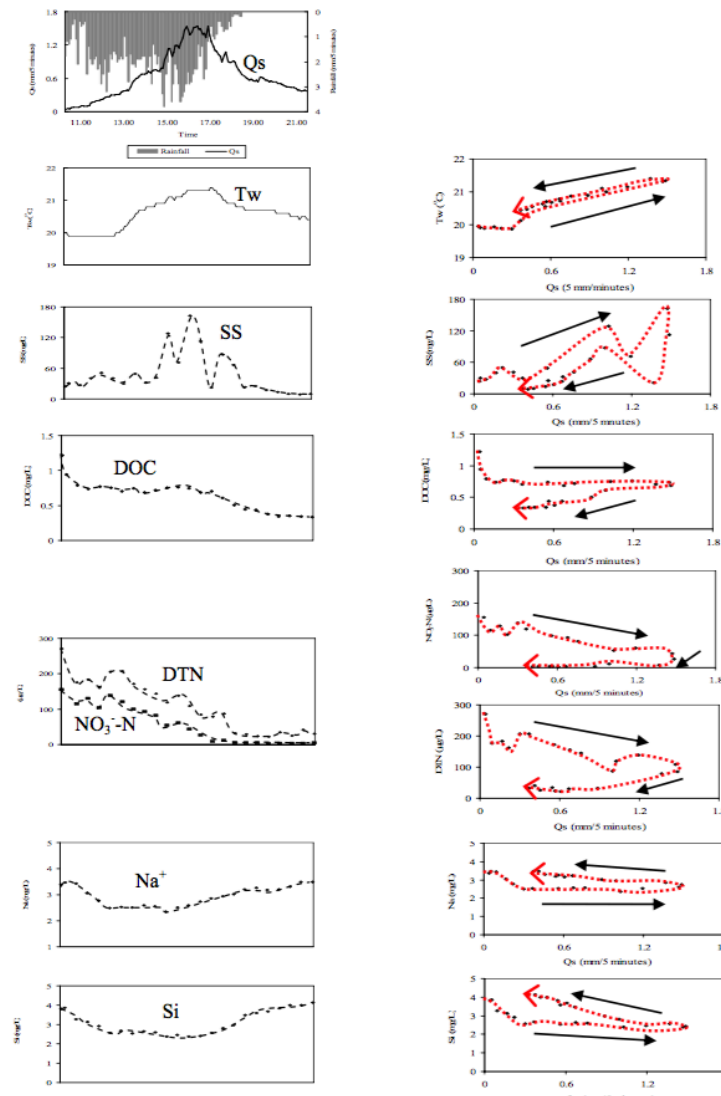


Figure 3. Stream hydrograph and time series of Tw, SS, DOC, NO_3^--N, DTN, Na^+, Si and hysteretic loops at Mie 2 (October 20, 2004)

Some references

- Generally, stream water temperature often has been related to air temperature that also related to global warming and meteorological conditions as annual or longer time-scale fluctuations (Mohseni *et al.*, 1999; Fukushima *et al.*, 2000; Tung 2006).

- Characteristics of stream water temperature fluctuations at forested watershed should be elucidated in order to manage downstream water quality control for protection of aquatic habitat and environment (Danehy *et al.*, 2005). It could be also explained that stream water temperature fluctuations influence the change in species composition.

- Precipitation may cause changes in stream water temperature due to direct inputs (i.e. channel interception) and by inducing runoff from various hydrological stores and pathways (Kobayashi *et al.*, 1999; Brown and Hannah 2007).

- Changes in stream water temperature during rainfall events help to identify the mechanism that generates the initial response as direct inputs of rainwater, surface and subsurface flows or discharge of groundwater.

- Stream water temperature as a supplementary tracer is used to identify the water sources contributing to runoff processes at forested watersheds (Shanley and Peters 1988; Kobayashi *et al.*, 1999).

Important information

The forested watershed conditions affect the fluctuations in stream water temperature

The changes in Tw and water quality parameters during rainfall events and analysis of the hydrological dynamics

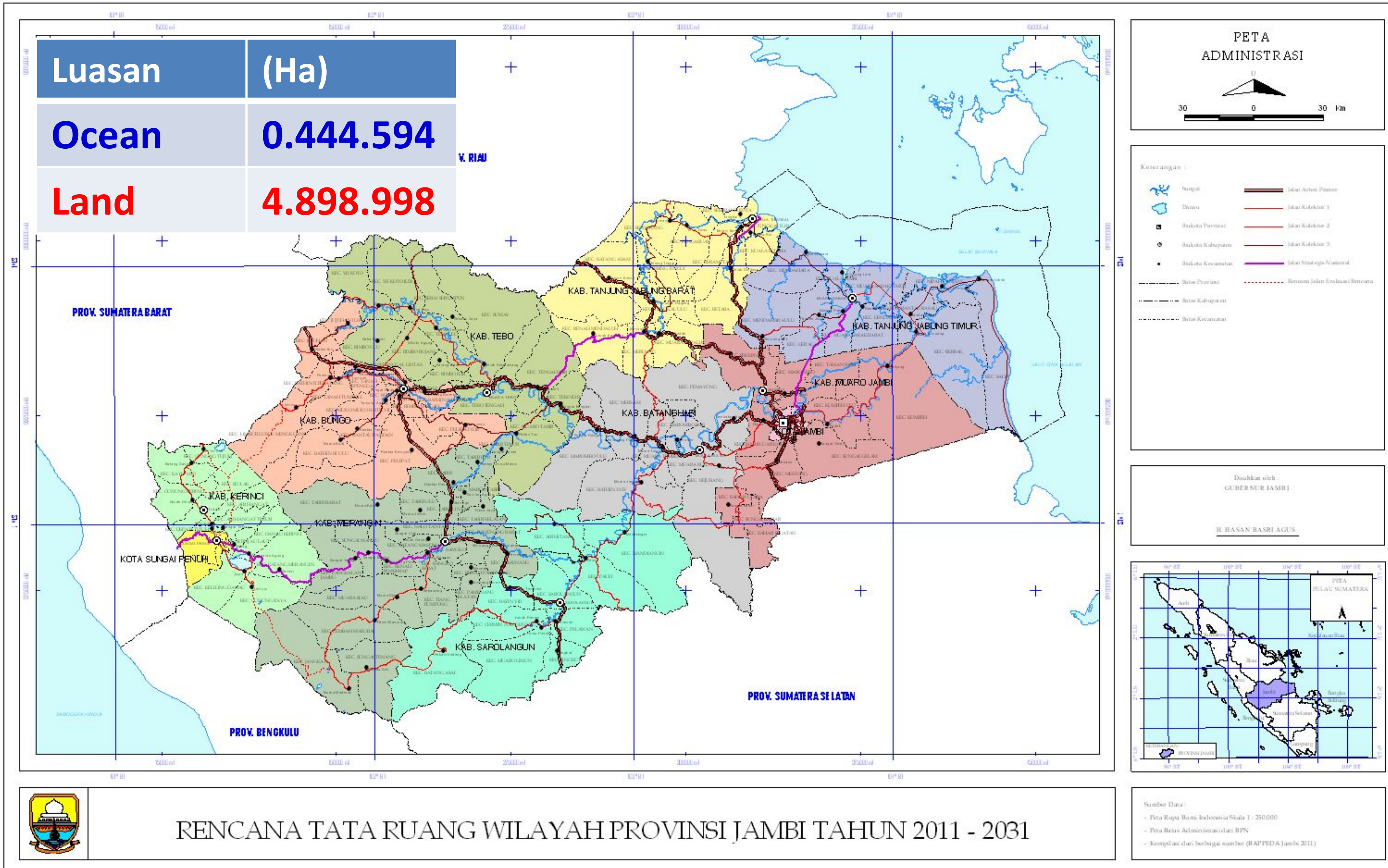
The changes in Tw and water quality parameters could indicate the flow paths and trace the contribution of surface, subsurface and groundwater flows into the stream in different ways due to slope gradients during rainfall events.

How about the characteristics in Tropical Forest ???

GENERAL DESCRIPTION OF LOCATION

ADMINISTRATION MAP

Luasan	(Ha)
Ocean	0.444.594
Land	4.898.998



Source : Bappeda Prov. Jambi

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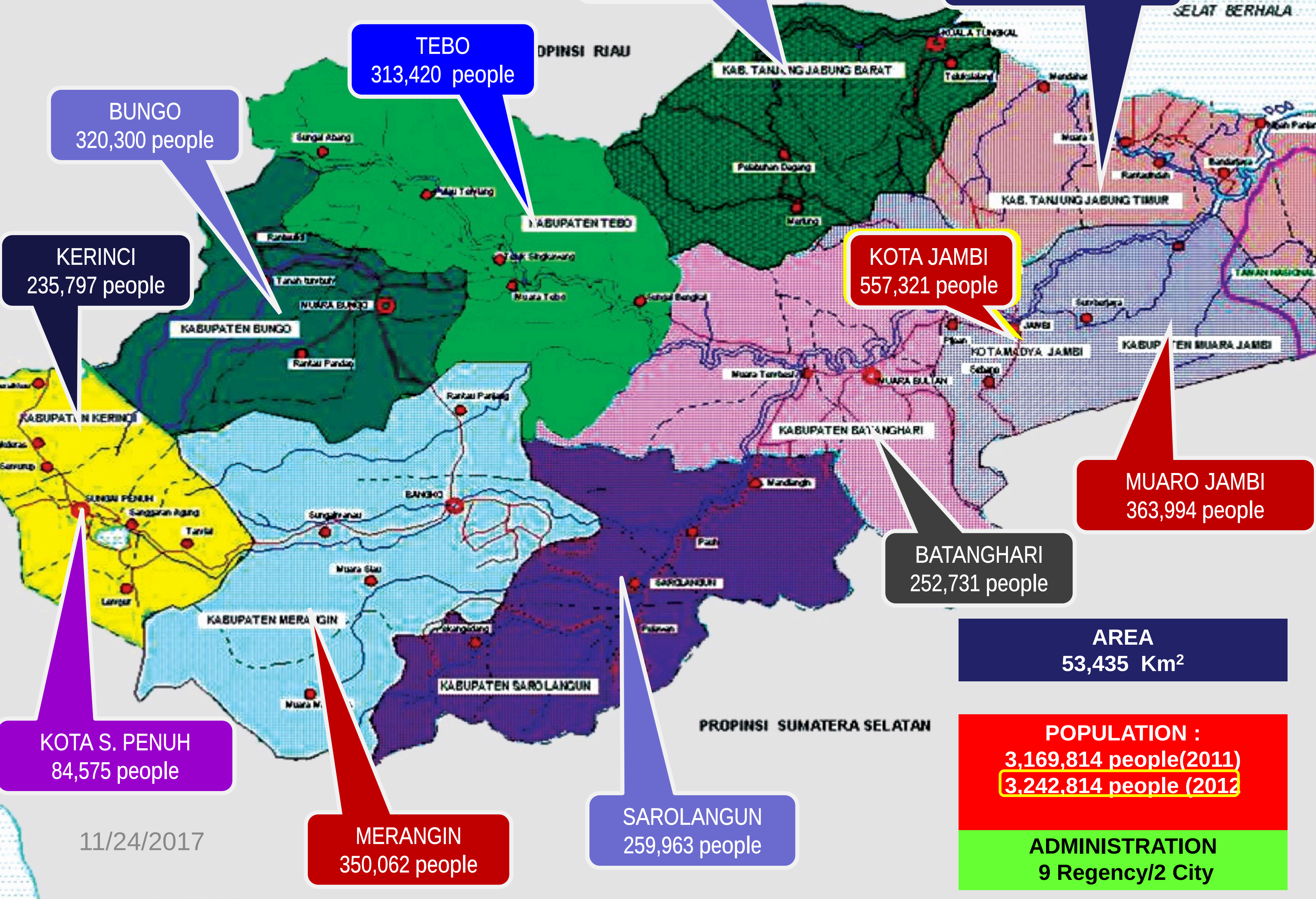
PROVINCE JAMBI



AREA
53,435 Km²

POPULATION :
3,169,814 people(2011)
3,242,814 people (2012

ADMINISTRATION
9 Regency/2 City

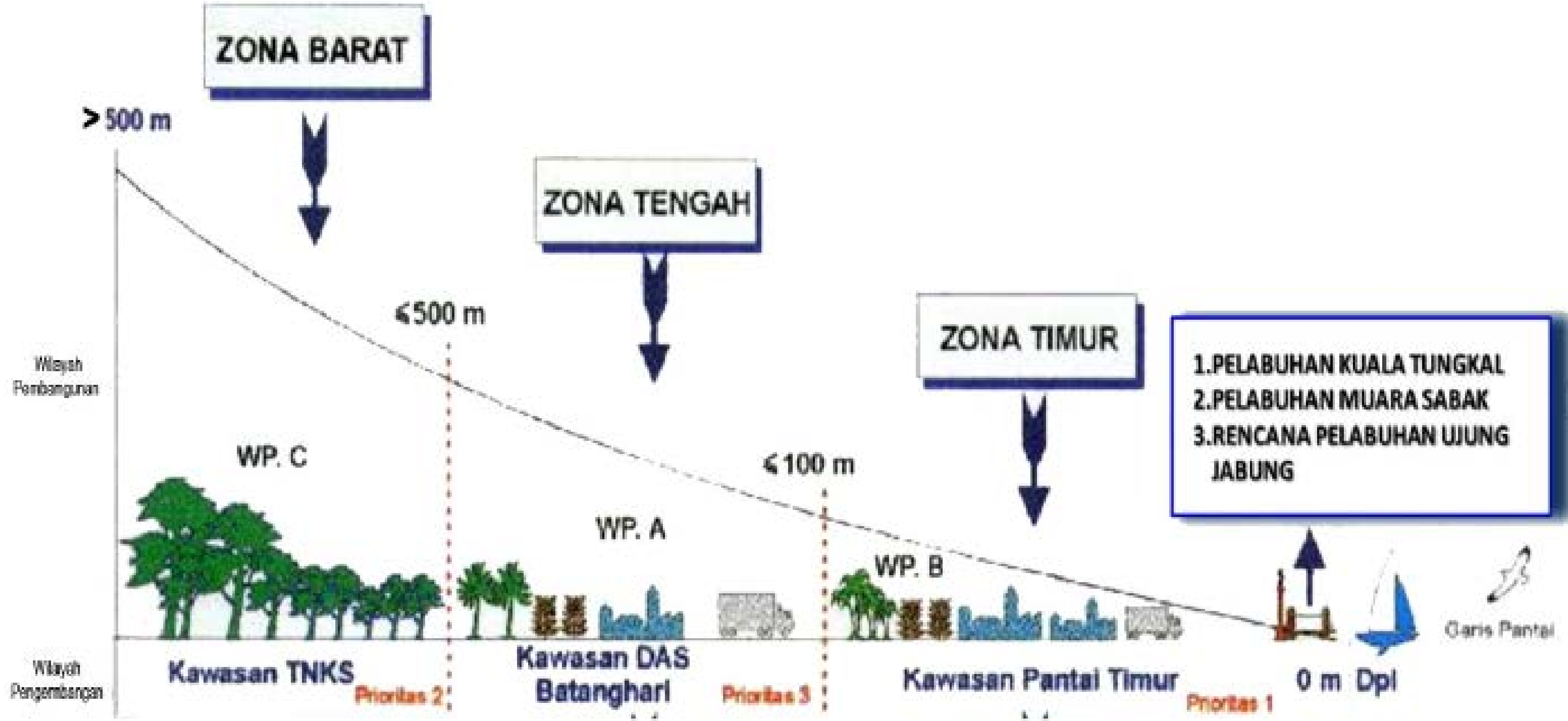
Source : Bappeda Prov. Jambi

TOPOGRAPHY

TOPOGRAPHY/ HEIGHT (M/ASL)	AREA		REGIONAL
	HA	%	
Low Land (0 – 100)	3.431.165	67	KOTA JAMBI, TANJUNG JABUNG BARAT, TANJUNG JABUNG TIMUR, MUARO JAMBI, MERANGIN, BATANG HARI
Middle Land (100 – 500)	903.180	17	SEBAGIAN SAROLANGUN, TEBO, SEBAGIAN BATANG HARI, KOTA SUNGAI PENUH, MERANGIN, SEBAGIAN TANJUNG JABUNG BARAT,
High Land (> 500)	765.655	16	KERINCI, KOTA SUNGAI PENUH, SEBAGIAN MERANGIN, SEBAGIAN SAROLANGUN DAN SEBAGIAN BUNGO
TOTAL	5.100.000	100	

Source : Bappeda Prov. Jambi

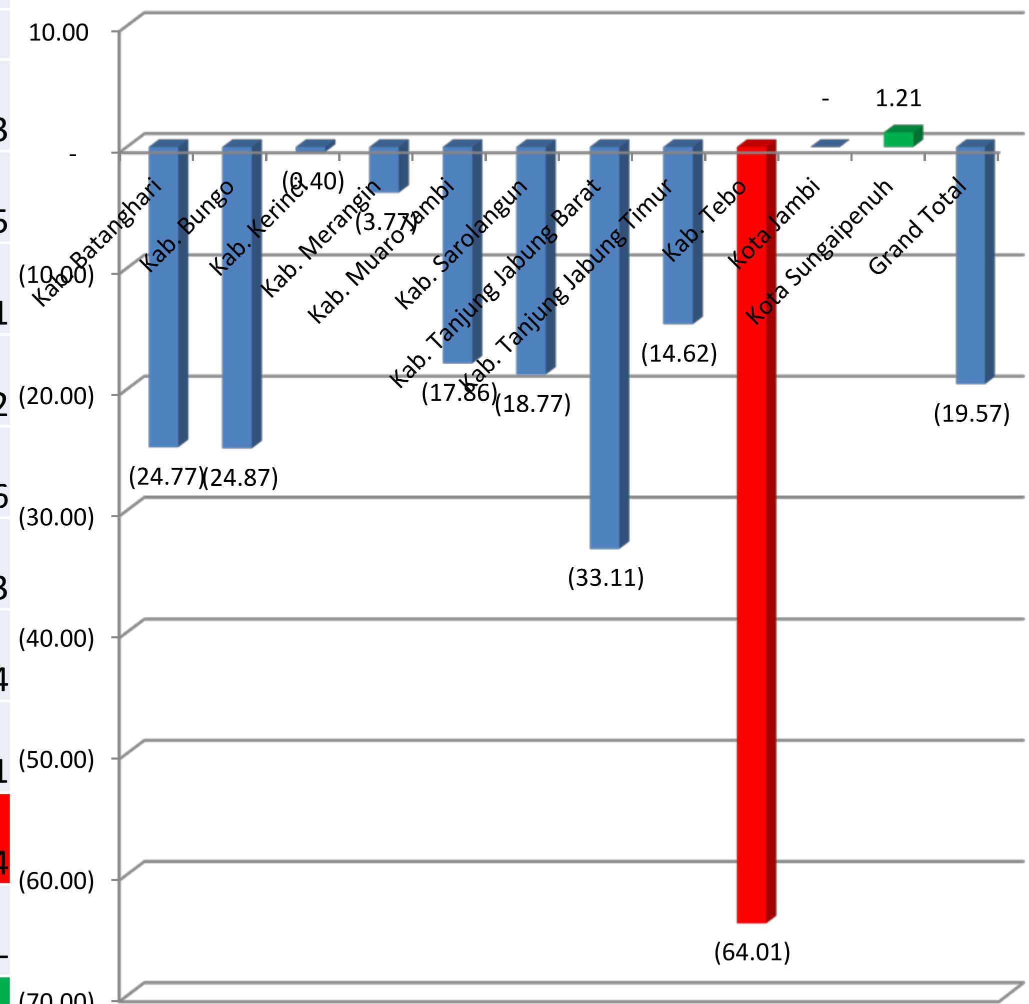
GENERAL CONDITIONS



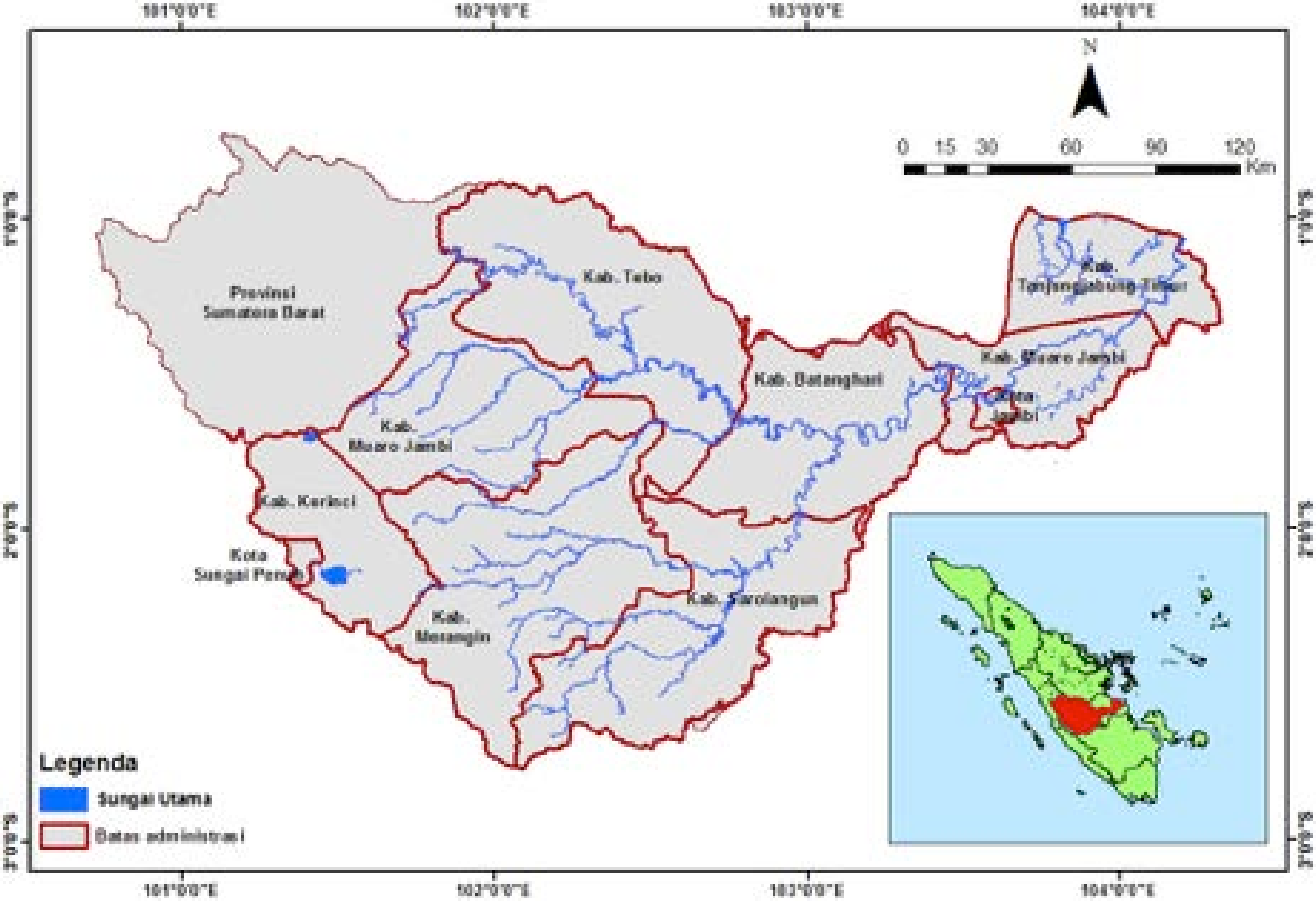
Source : Bappeda Prov. Jambi

Percentage of Natural Forest Area Decline

Regency	Area (Ha)	
	2000	2009
Kab. Batanghari	129,188	103,543
Kab. Bungo	141,983	113,705
Kab. Kerinci	182,614	181,881
Kab. Merangin	319,808	308,192
Kab. Muaro Jambi	107,529	91,236
Kab. Sarolangun	181,619	152,913
Kab. Tanjung Jabung Barat	117,611	88,354
Kab. Tanjung Jabung Timur	130,852	114,161
Kab. Tebo	270,805	165,114
Kota Jambi	-	-
Kota Sungaipenuh	22,410	22,683
Total	1,604,419	1,341,781



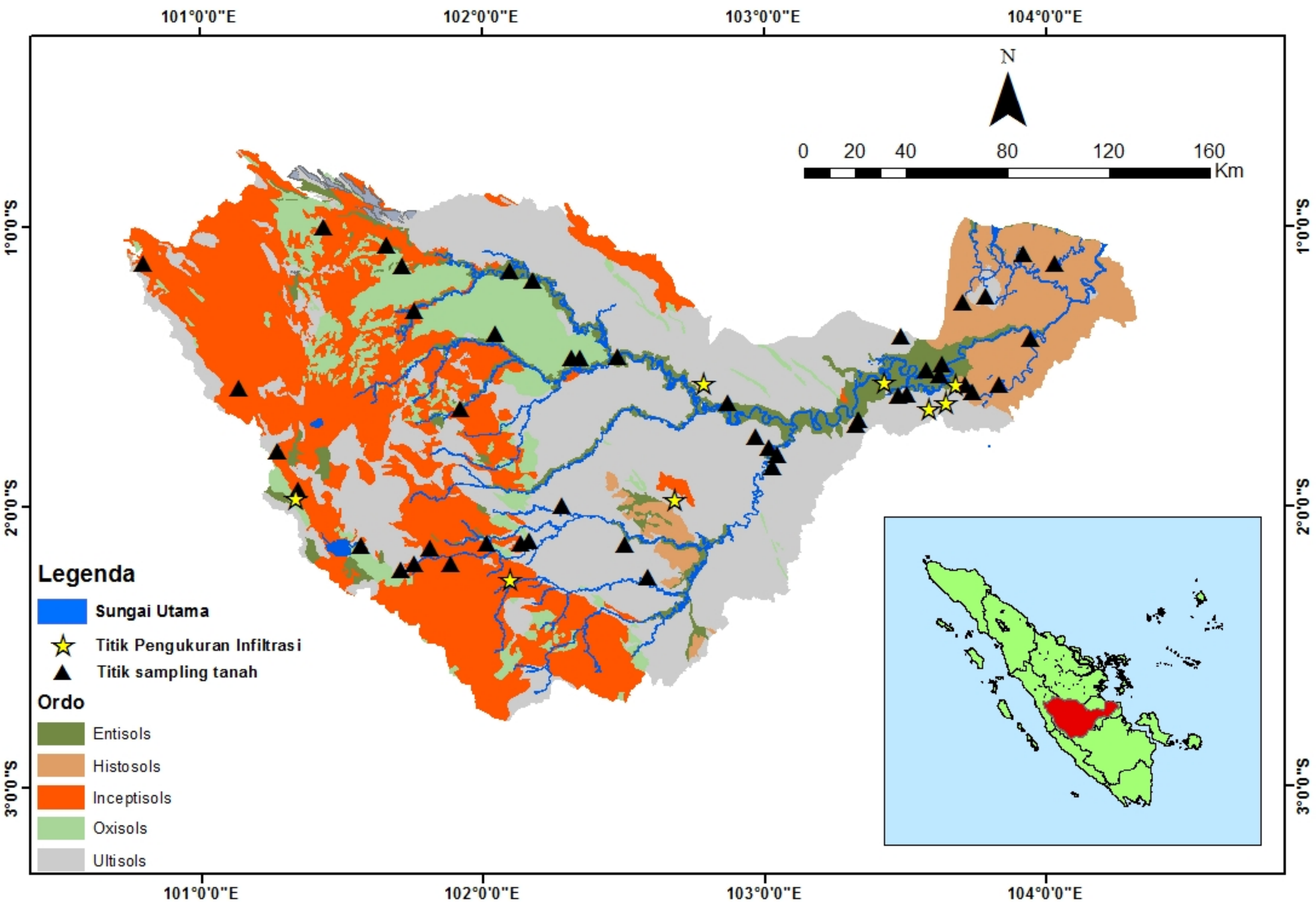
Jambi EMAS



Site Location – Batanghari Watershed

Location for water quality sampling

Location of soil sampling and infiltration measurement



Materials and Equipment

Primary Data

✓Soil Properties from laboratory analysis; permeability, texture, organic matter, bulk density, porosity

✓Infiltration of the results of measurements in the field

Secondary Data

✓ Land System Map (Indonesian Soil Research Institute)

✓ Land use map (Landsat imagery in 2013)

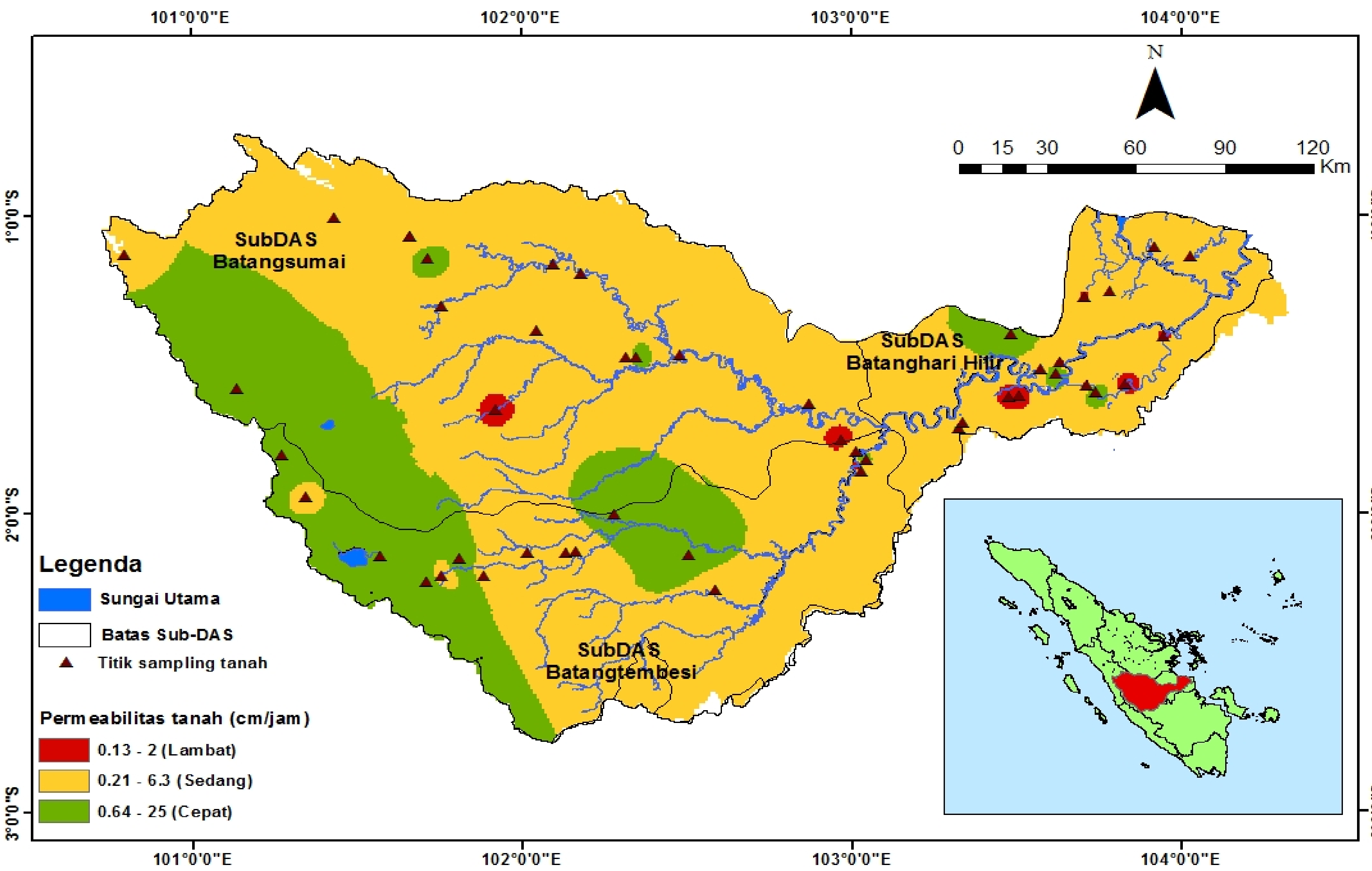
✓ Rainfall data (Indonesian Agency for Meteorology)

✓ Hydrological data (Water Resources Research Centre – PU)

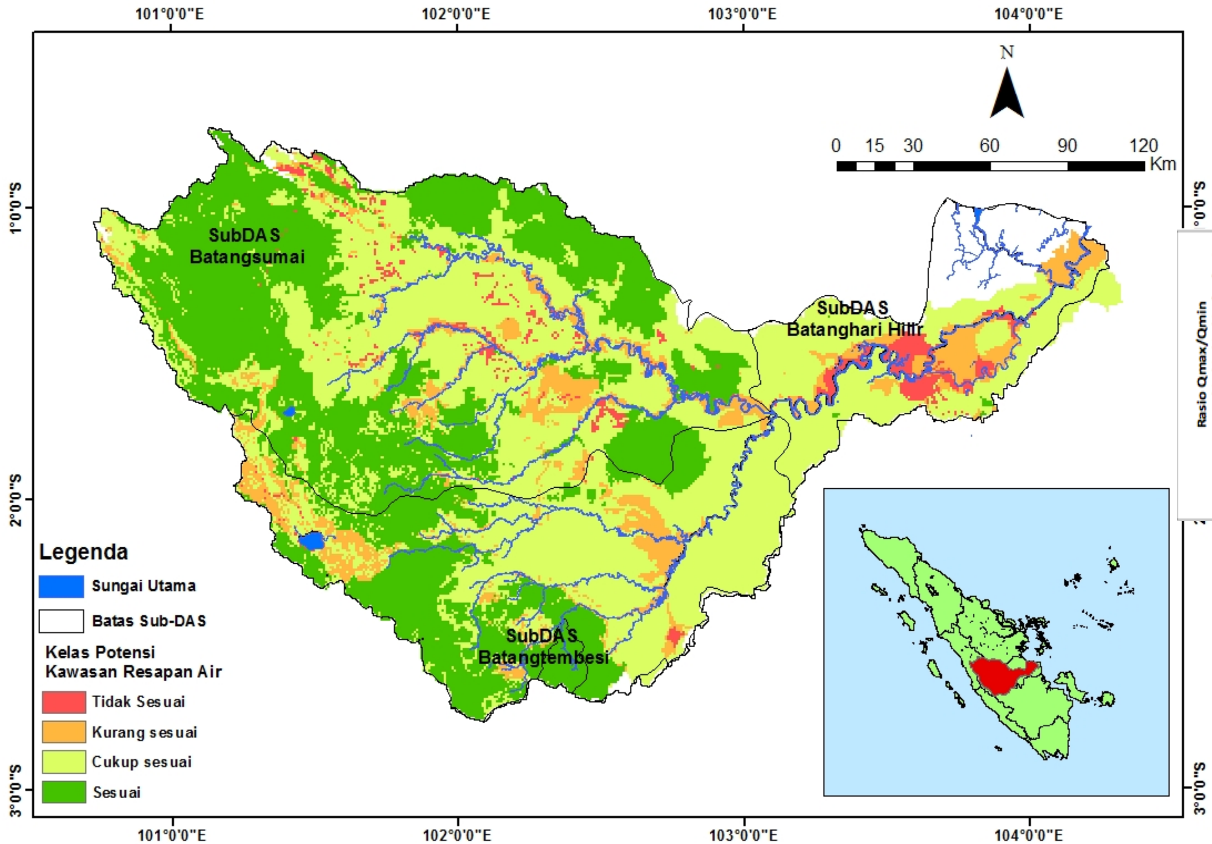
✓Administration Map (Central River Region VI)

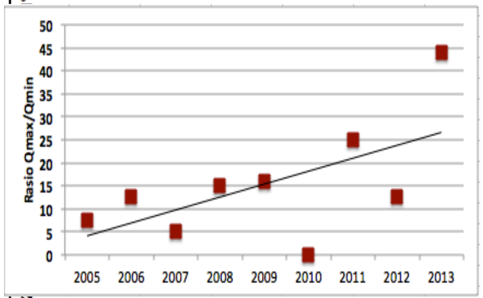
Turf – tec infiltrometer

Spatial distribution of soil permeability



Potential water catchment areas





Ratio of Qmax/Qmin tends to increase

Source BLHD Prov. Jambi

PARAMETER

- Parameter Physics: Water temperature, Conductivity, TDS, TSS (total suspended solid), Turbidity, Colour.

- Parameter Chemical : pH, BOD, COD, DO (Oksigen Terlarut), Phospat (PO_4), Amoniak (NH_3-N), Nitrat (NO_3), Nitrit (NO_2), Cl. Fe, Mn, Pb.

CONDITIONS AROUND BATANGHARI WATERSHED

- Human domestic activity:

  Bath, wash, etc

- Illegal mining :

  Gold mining, sand and stone

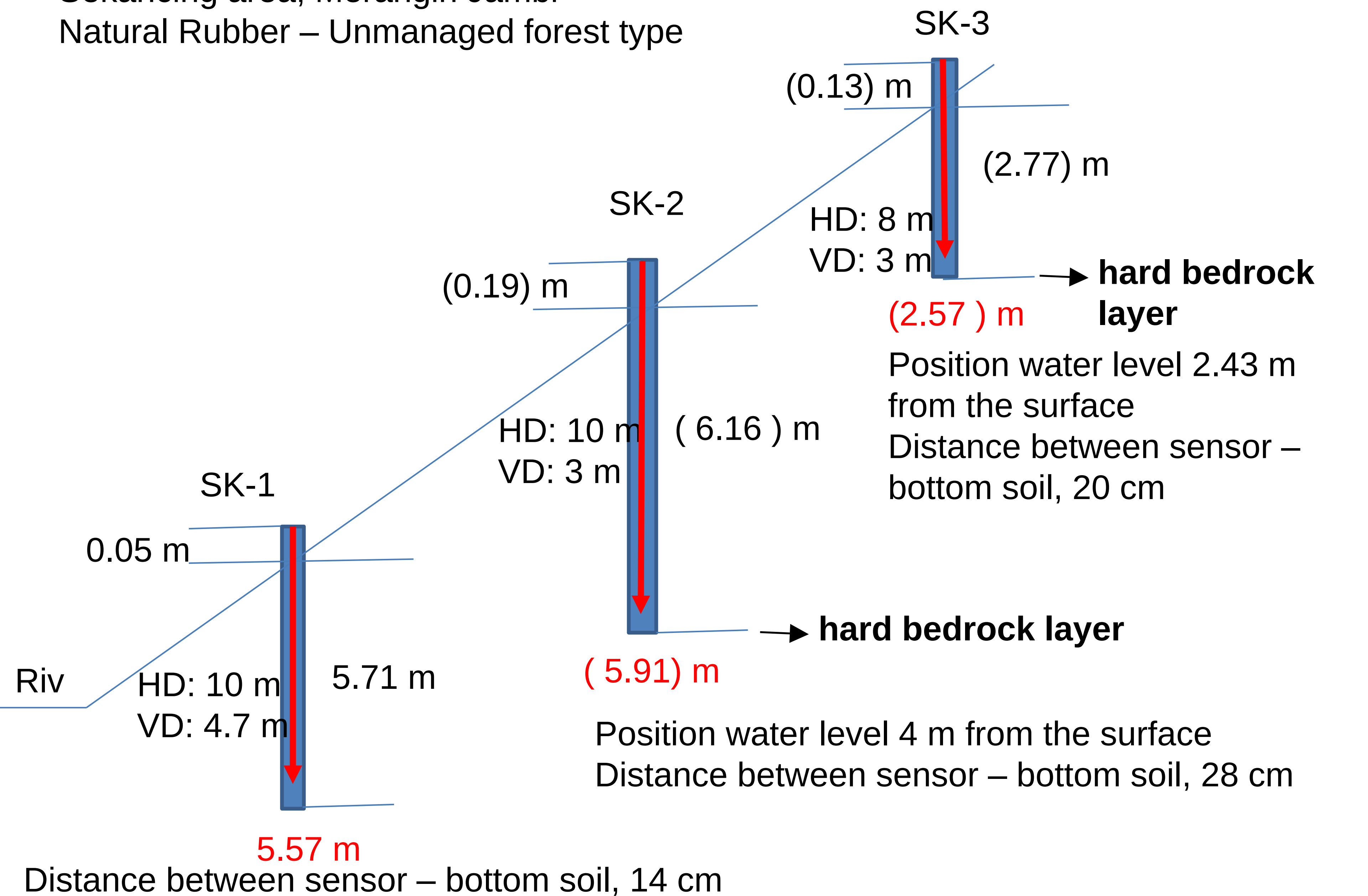
- Plantation : Crude palm oil (CPO) and other industries

Some analysis of Turbidity

Parameter	Turbidity (NTU)	
	2015	2016
Downstream		
Danau Sipin	3.48	11.9
Danau Teluk	4.43	12.9
Middle		
Kab. Tebo	12.54	16.12
Kab. Merangin	10.12	17.32
Upstream		
Kab. Kerinci	3.84	19.12
Outlet D. Kerinci	3.75	10.45

Location of Study Area Plan

Sekancing area, Merangin Jambi
Natural Rubber – Unmanaged forest type



Rainfall simulator

- Based on Meyer and Harmon (1979)
- Nozzle: Veejet 80150 (Spraying System Co. Ltd., U.S.A.)
- Water Input Current meter: LF10-PTN, HORIBA, JAPAN)
- Nozzle height: 2m above surface
- Rainfall intensity: 190.6~195.4 mm/h (about 15 J/m2/mm)
- Every 30 sec, recording runoff discharge and sampling

Prof. Kim JinKwan – CNU (2017)

Surface conditions

Floor covered

Bare undisturbed

Bare plowed

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Water sampler (27)
0.5m

THANK YOU