WAGENINGEN UNIVERSITY
ENVIRONMENTAL SCIENCES

SarVision

Satellite radar monitoring of tropical peat swamp forests

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Tsukuba, 17 January 2007

www.sarvision.com

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2. Mawas research facility
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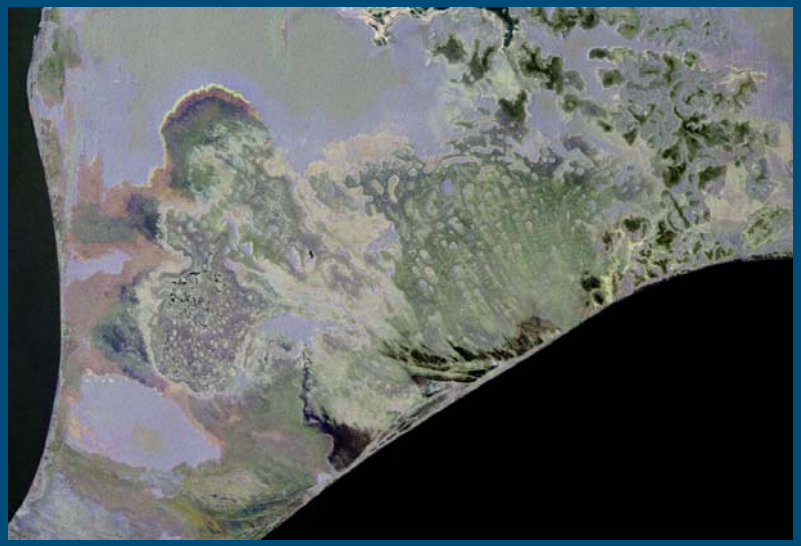
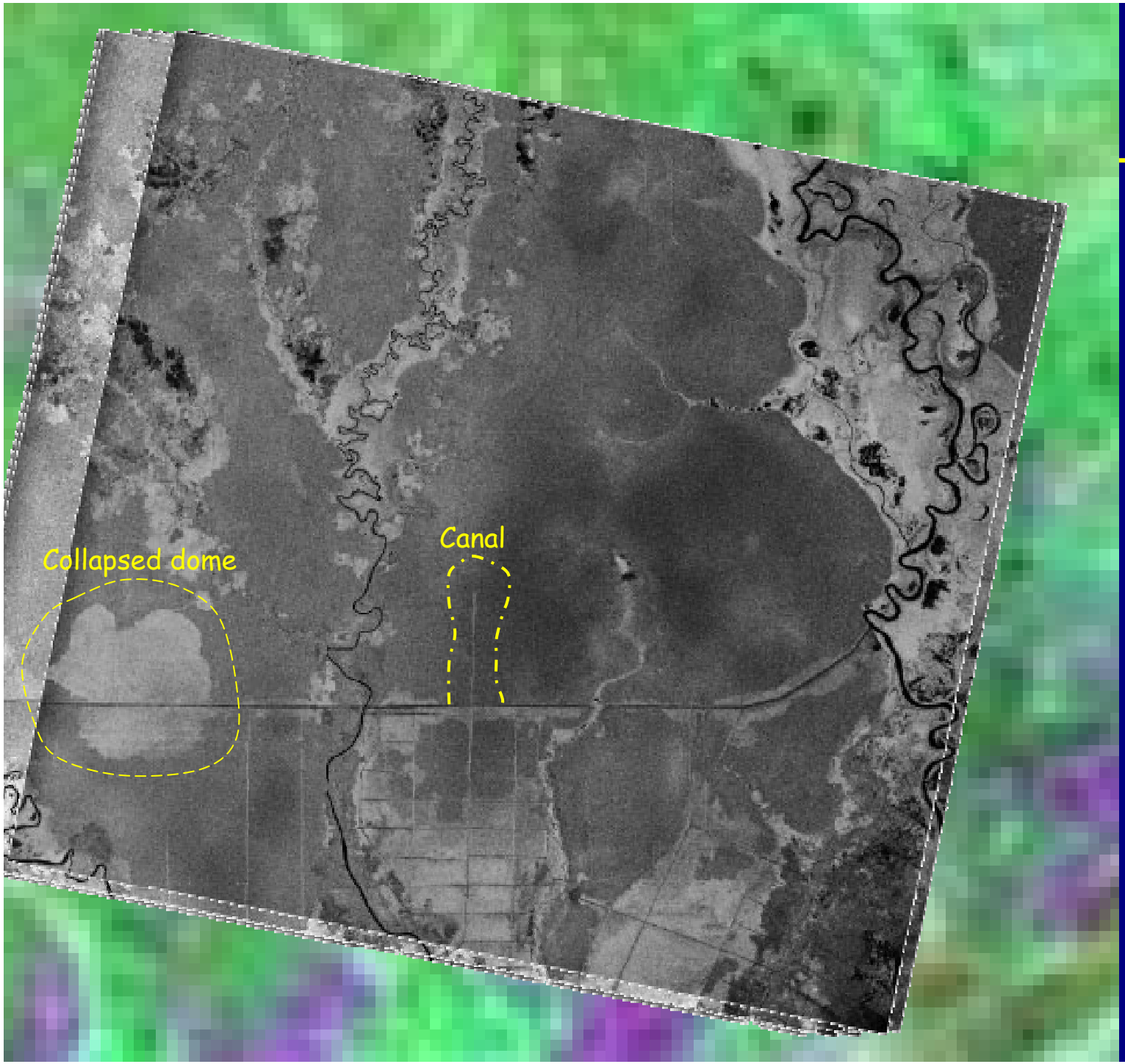


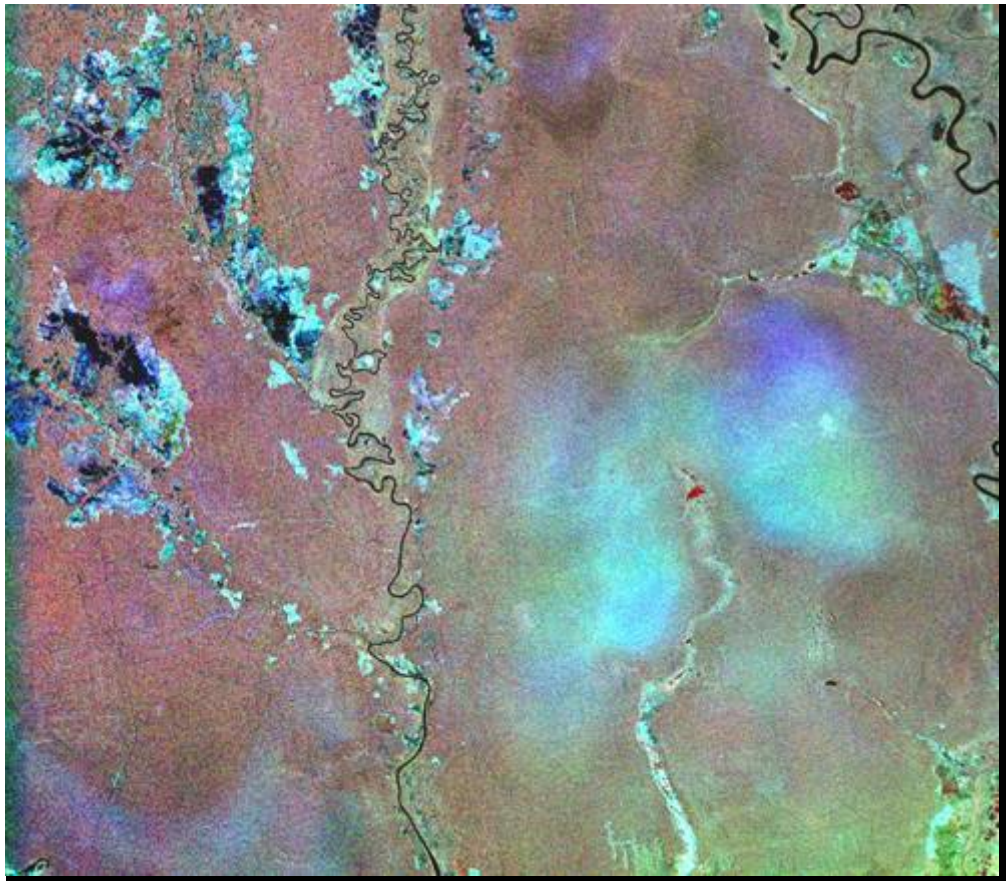
This TERRA-MODIS image acquired 19 August 2002 shows thick haze across Central Kalimantan and spreading across the entire island of Borneo.

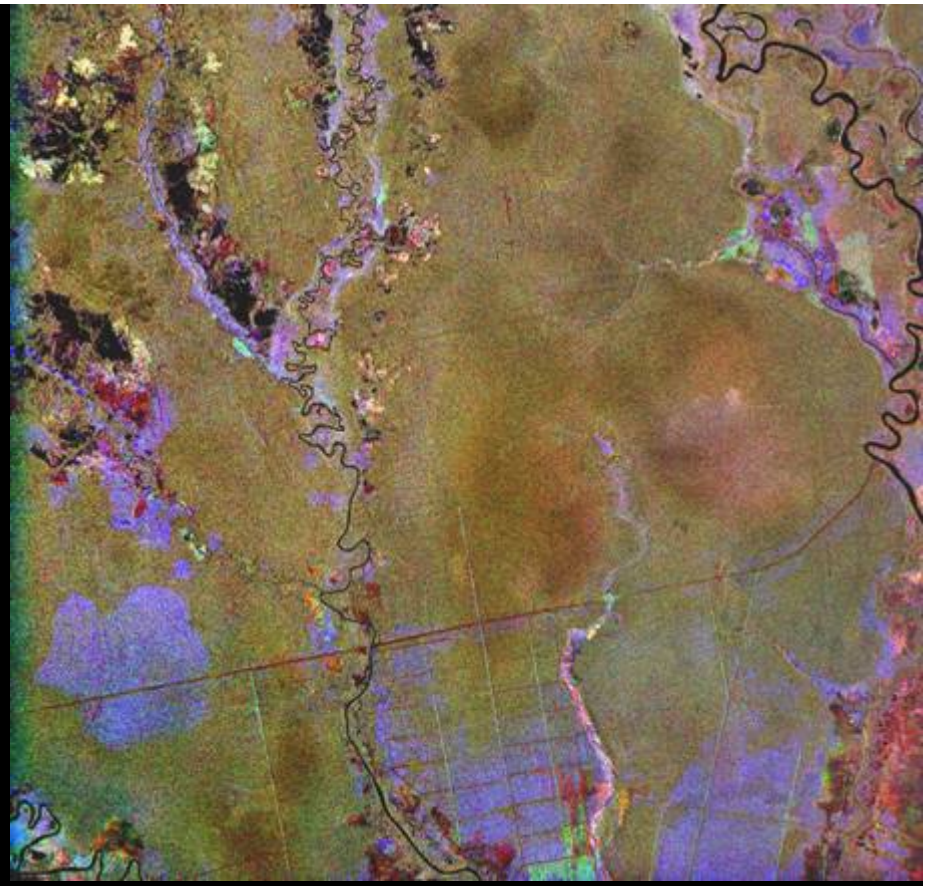
Optical vs. Radar



JERS-1 SAR time series

1998 08 29
1998 01 21
1997 10 25
1997 09 11
1997 07 29
1997 05 02
1997 03 19
1997 02 03
1996 09 24
1995 07 12
1994 07 25





Pre-disturbance
radar image composite

Post-disturbance
radar image composite

Radar can penetrate vegetation, and even soil surface layers, and can reveal important hydrological characteristics

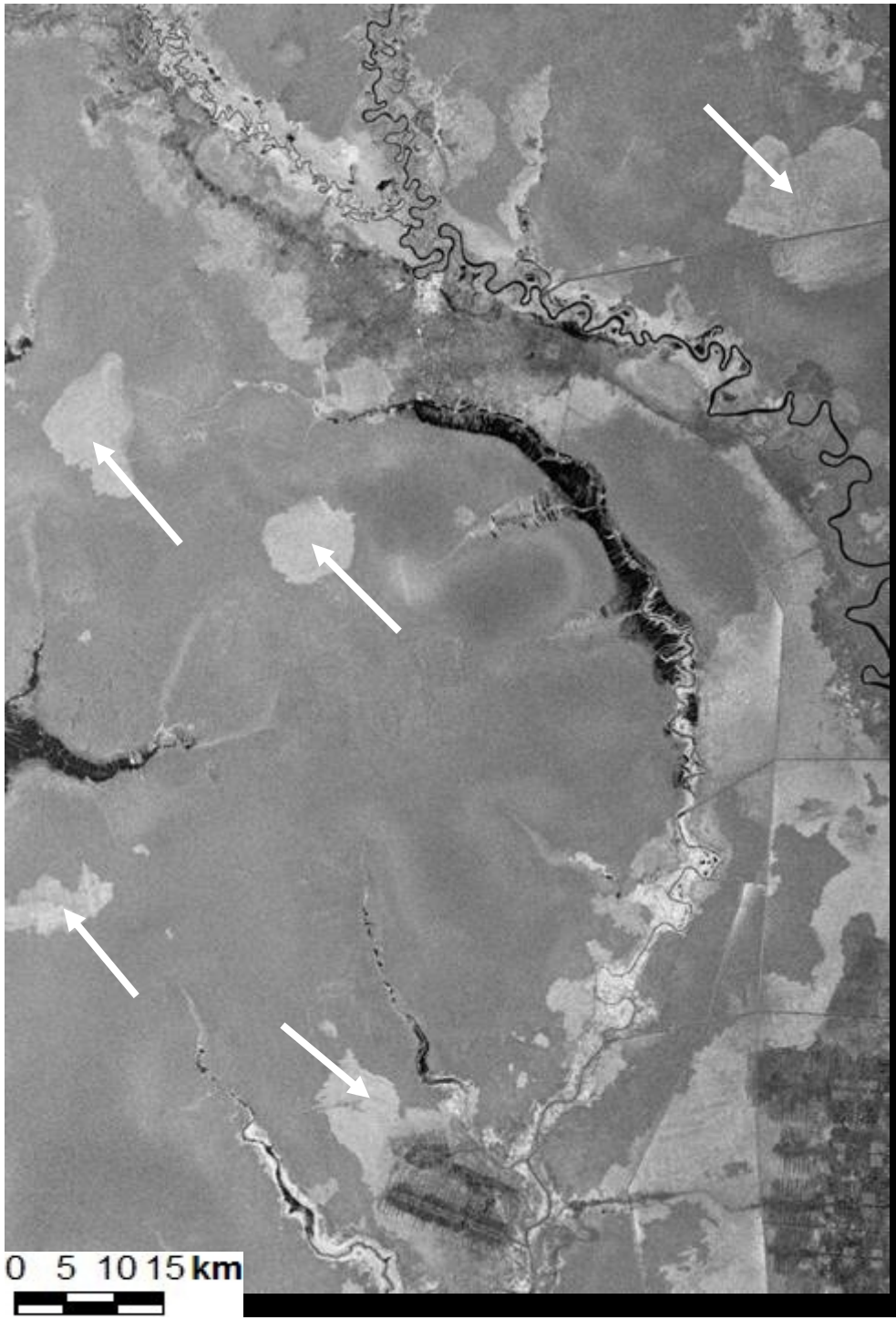


Figure 6. In the **Sebangau National park** several areas of peat dome forest collapse, caused by the 1997 ENSO event, show up as bright areas indicated by the arrows (date: 17 Jul 1998).

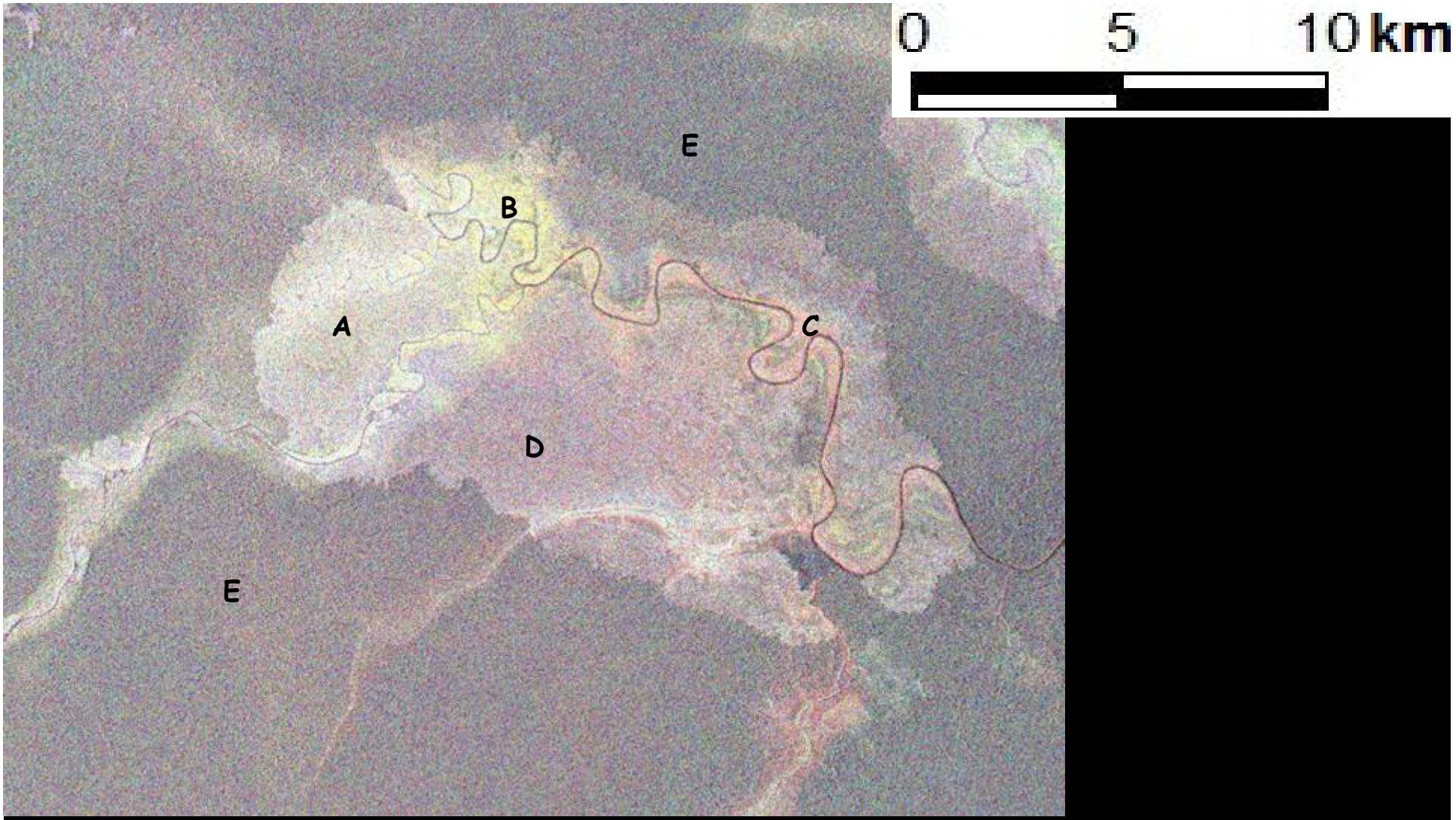
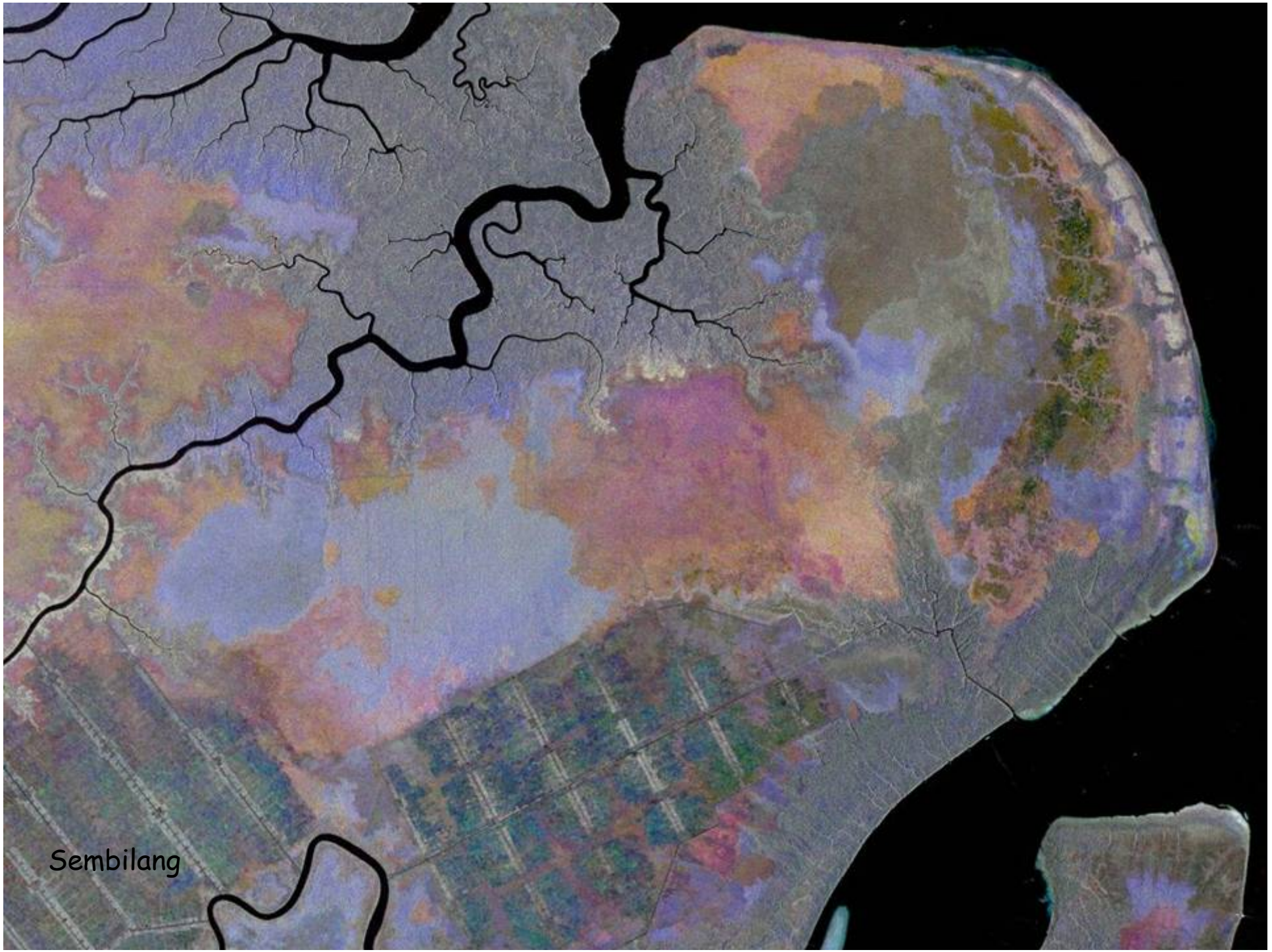
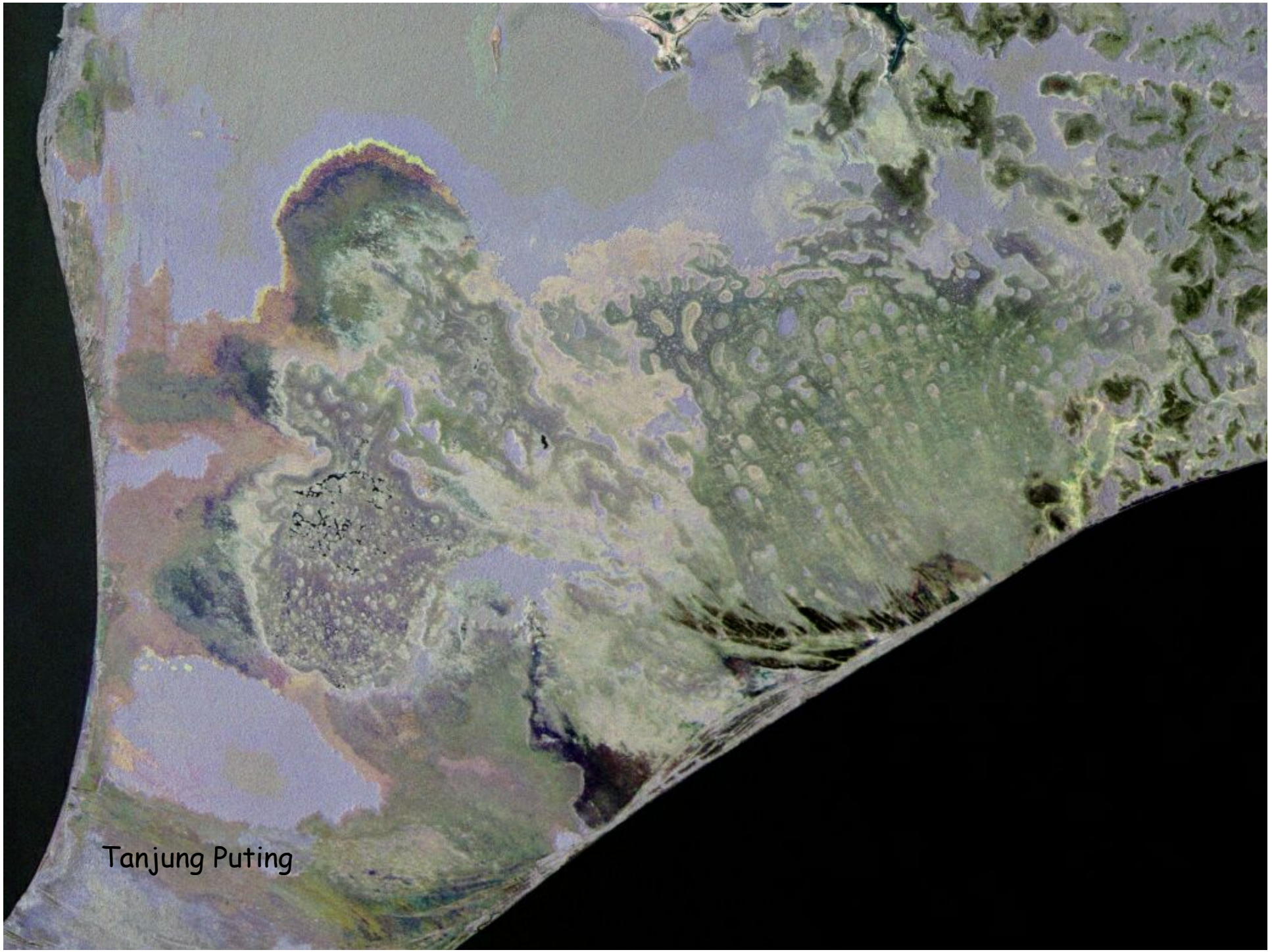


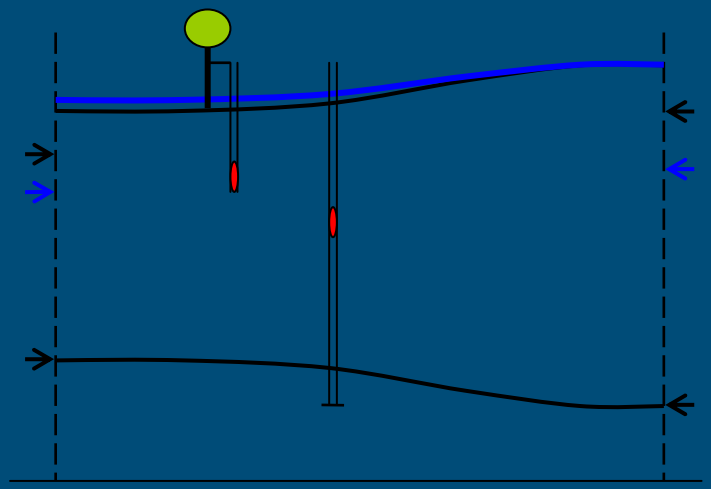
Figure 7. In radar images of the **Berbak National park** the peat swamp forest degradation history can be monitored in terms of fire events and flooding durations. For example, the whitish area A burned at least three times; the yellow and orange areas B and C along the river two times; and the purple area D one time; the dark area E is pristine. This information is an important input for selection of restoration approaches. JERS-1 SAR multi-temporal composite image (Red 25 Jul 1994; Green 24 Jul 1997; Blue 16 Jul 1998).


Sebangau

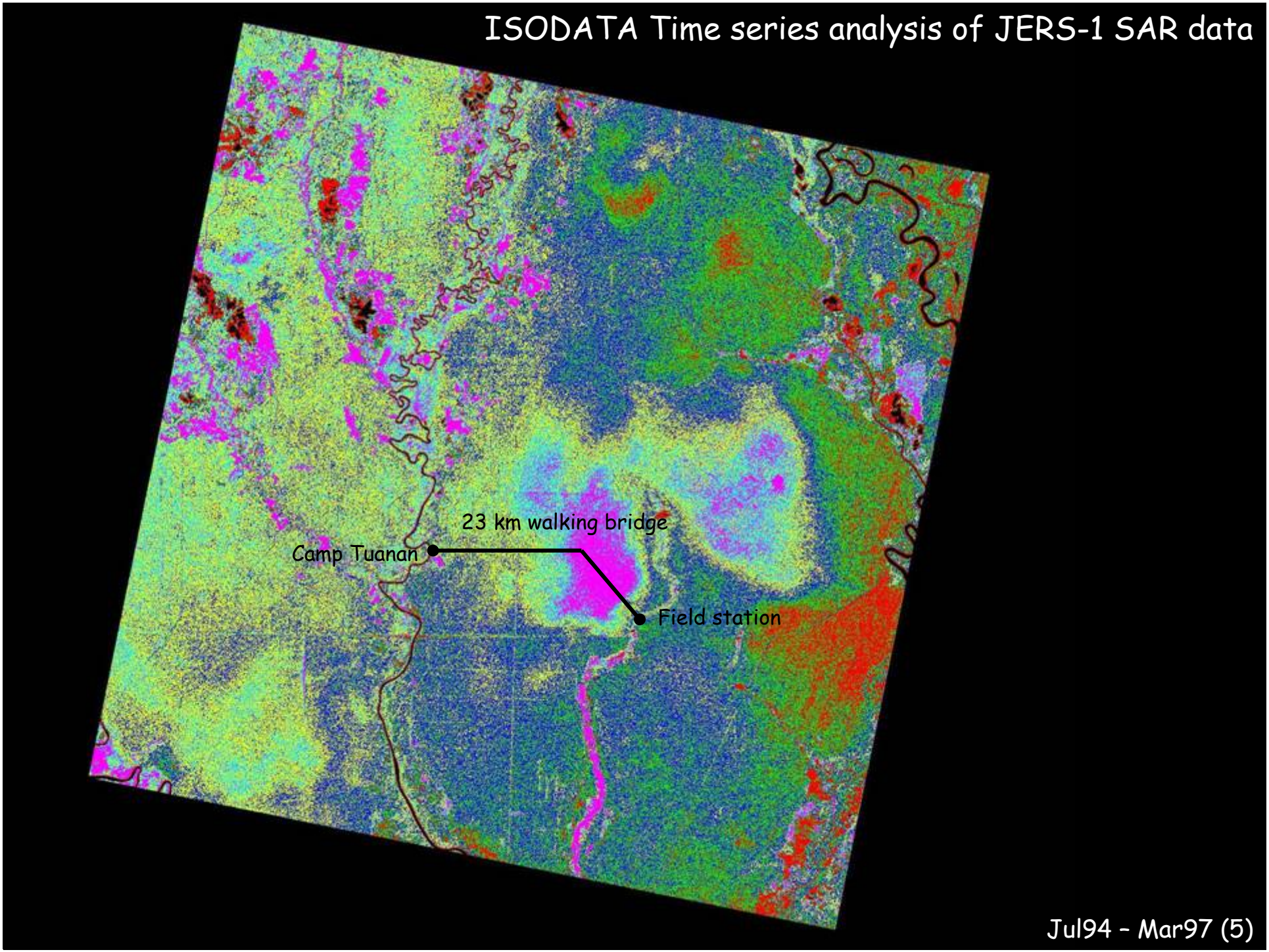

Sembilang

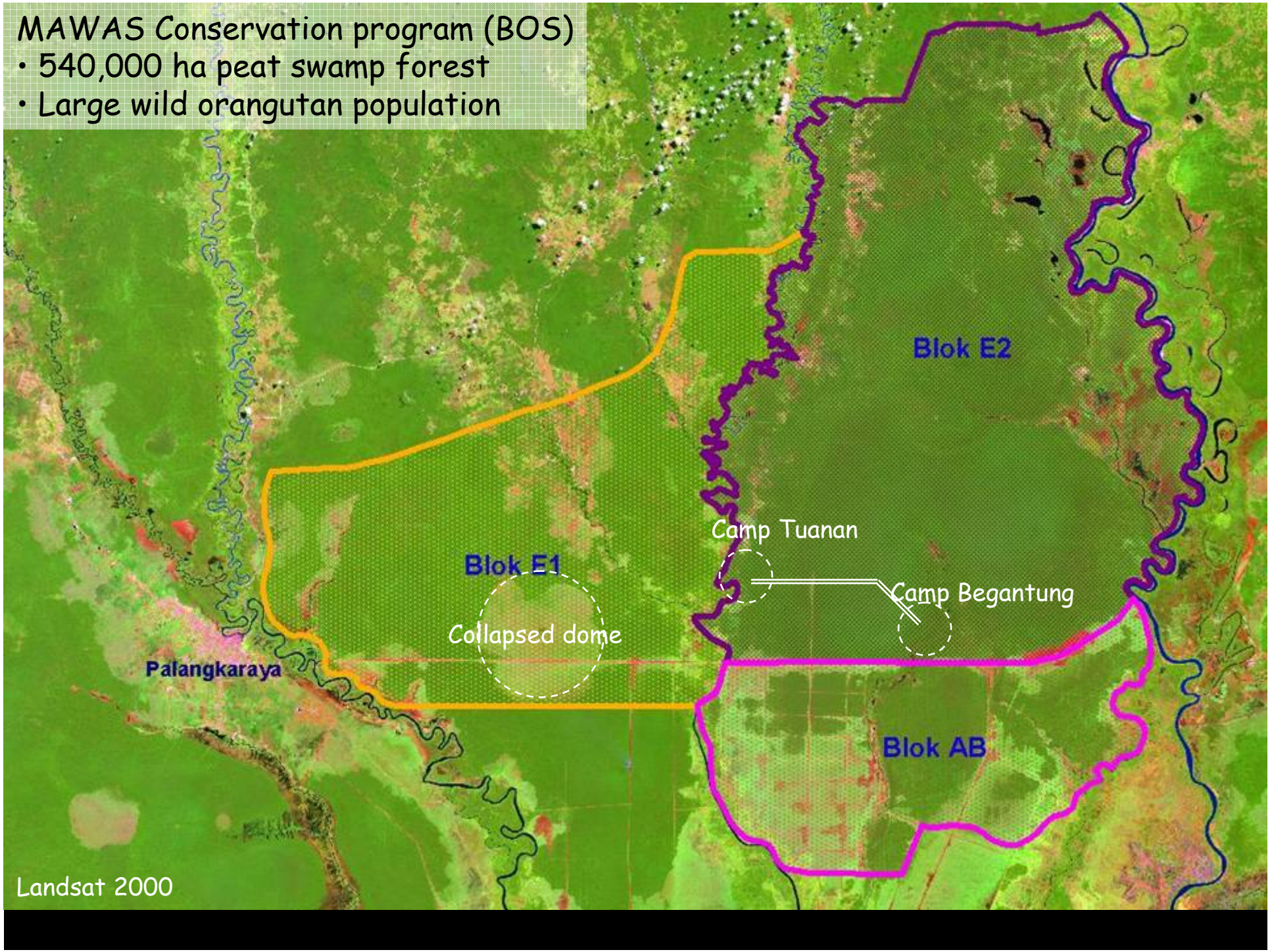

Tanjung Puting

2. Mawas research site

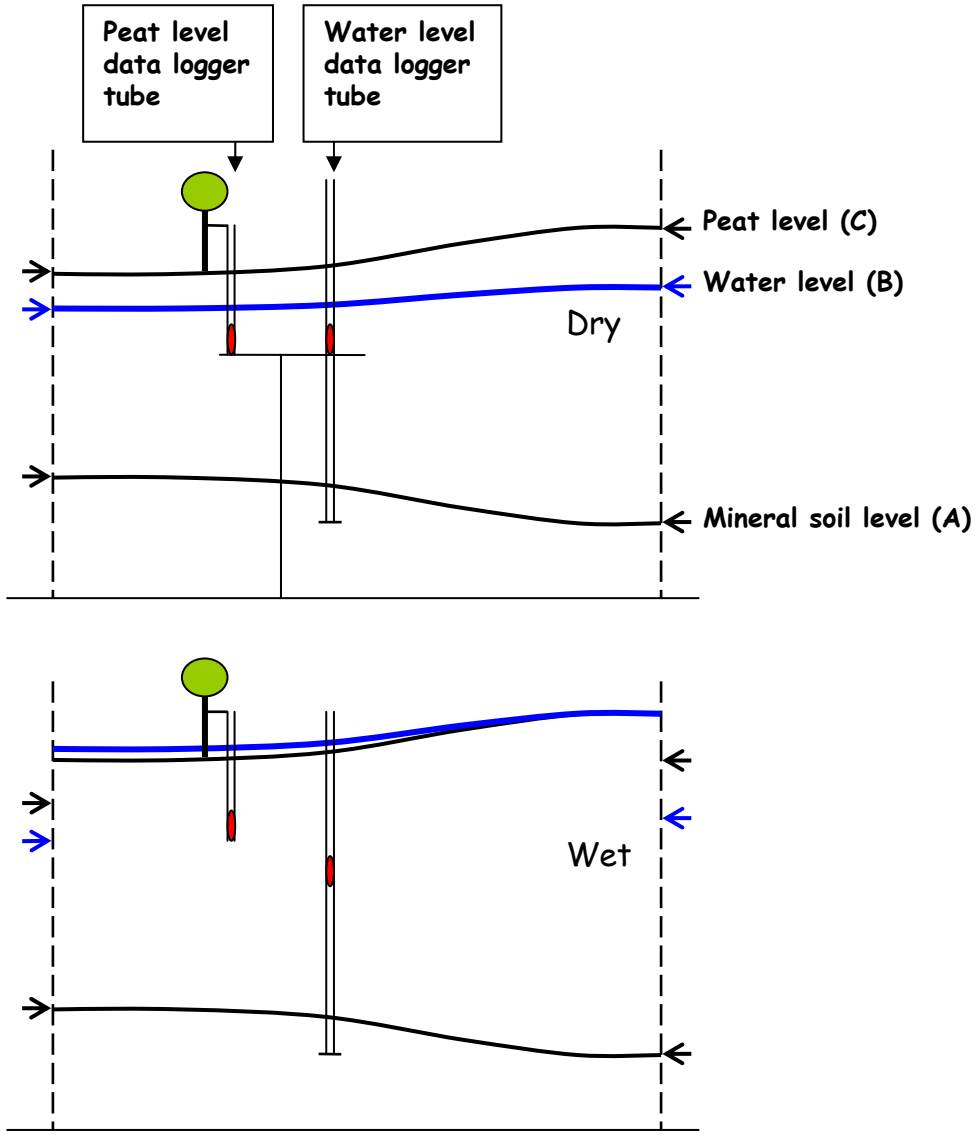


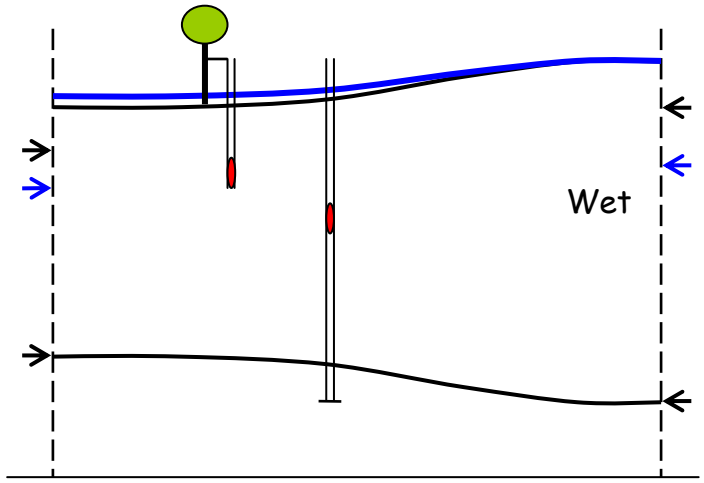

105°
110°
115°
120°
5°
0°
5°
Bandar Seri Begawan
Tarakan
Johor Bahru
Singapore
Batam
Kuching
BORNEO
Pontianak
Samboja
Samarinda
Sungai Wain
Meratus
Balikpapan
Palu
Jambi
Mawas
Palangkaraya
SULAWESI
Palembang
SUMATRA
Tanjung Puting
Banjarmasin
Bandar Lampung
Ujung Pandang
Jakarta
Bogor
Semarang
Surabaya
Bandung
JAVA
Solo
Madiun
Malang
Jogyakarta


ISODATA Time series analysis of JERS-1 SAR data
23 km walking bridge
Camp Tuanan
Field station
Jul94 - Mar97 (5)

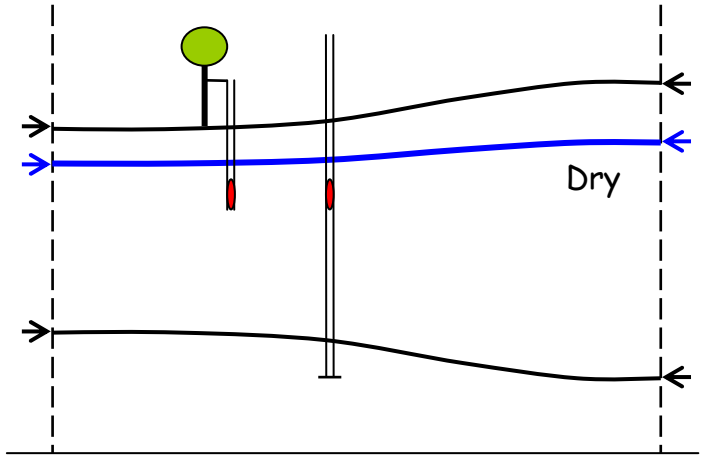

MAWAS Conservation program (BOS)
• 540,000 ha peat swamp forest
• Large wild orangutan population
Blok E2
Camp Tuanan
Blok E1
Camp Begantung
Collapsed dome
Palangkaraya
Blok AB
Landsat 2000


In total ≈ 10,000 trees have been measured !


Peat level data logger tube
Water level data logger tube
Peat level (C)
Water level (B)
Dry
Mineral soil level (A)
Wet



- Peat dome research station
- Floating bridge 9 km length completed
- Twenty data loggers: each 1 measurement per hour for 10 years



- Peat dome research station
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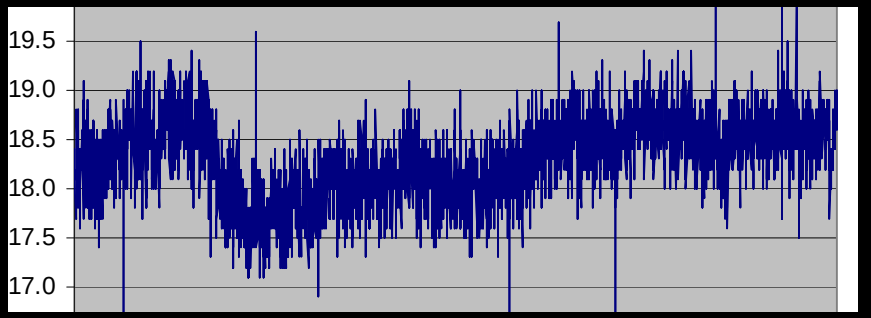
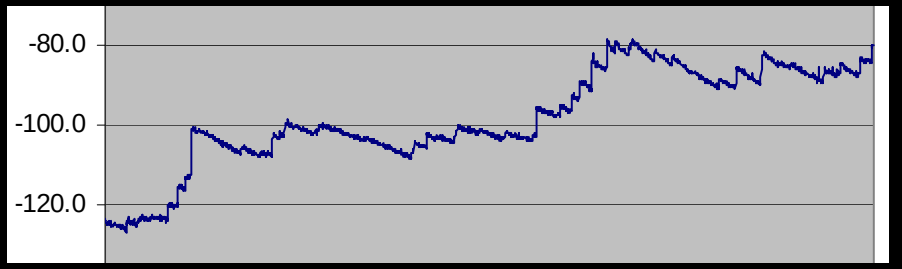
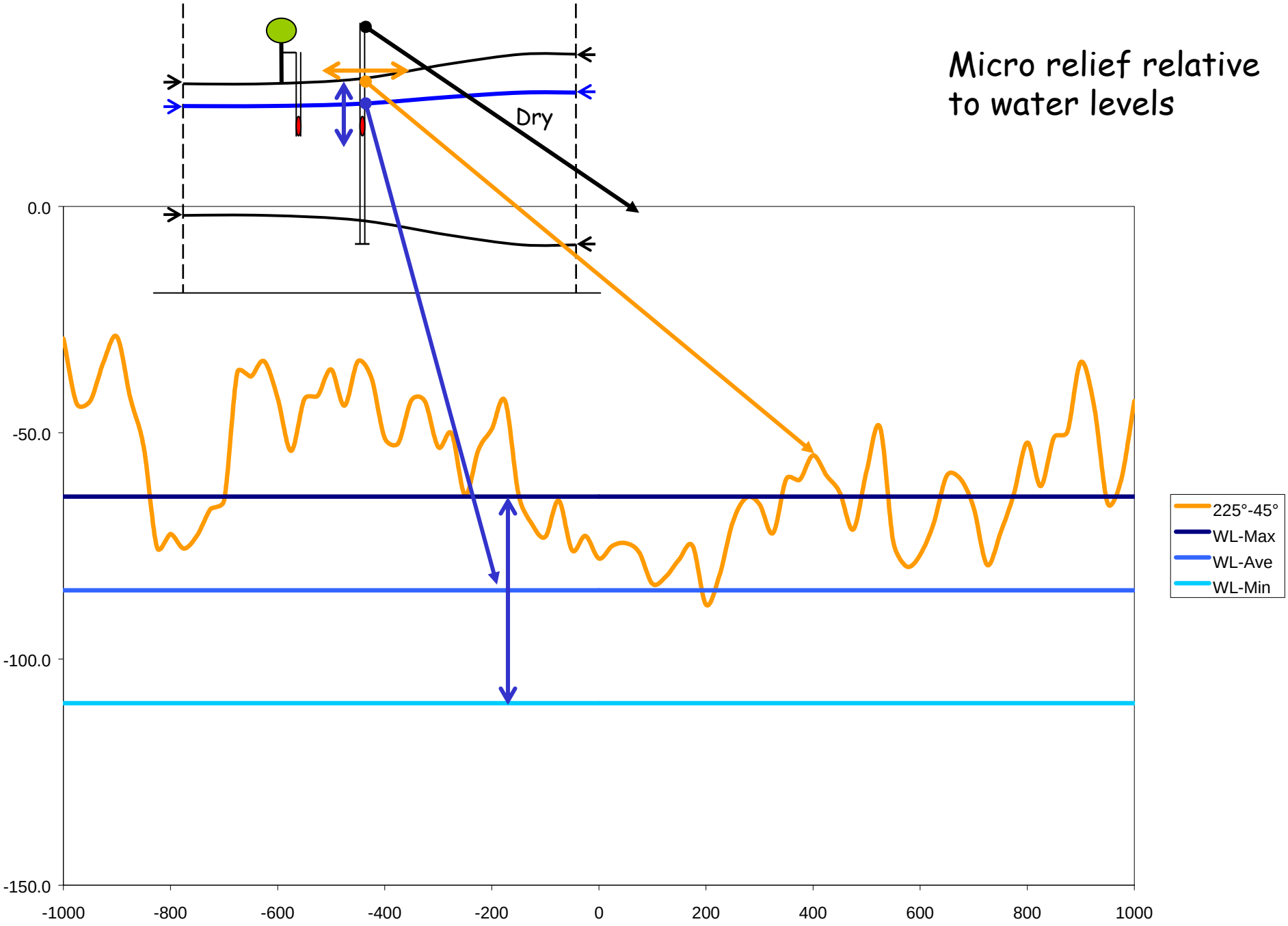


Soil surface fluctuation
(5-6T)



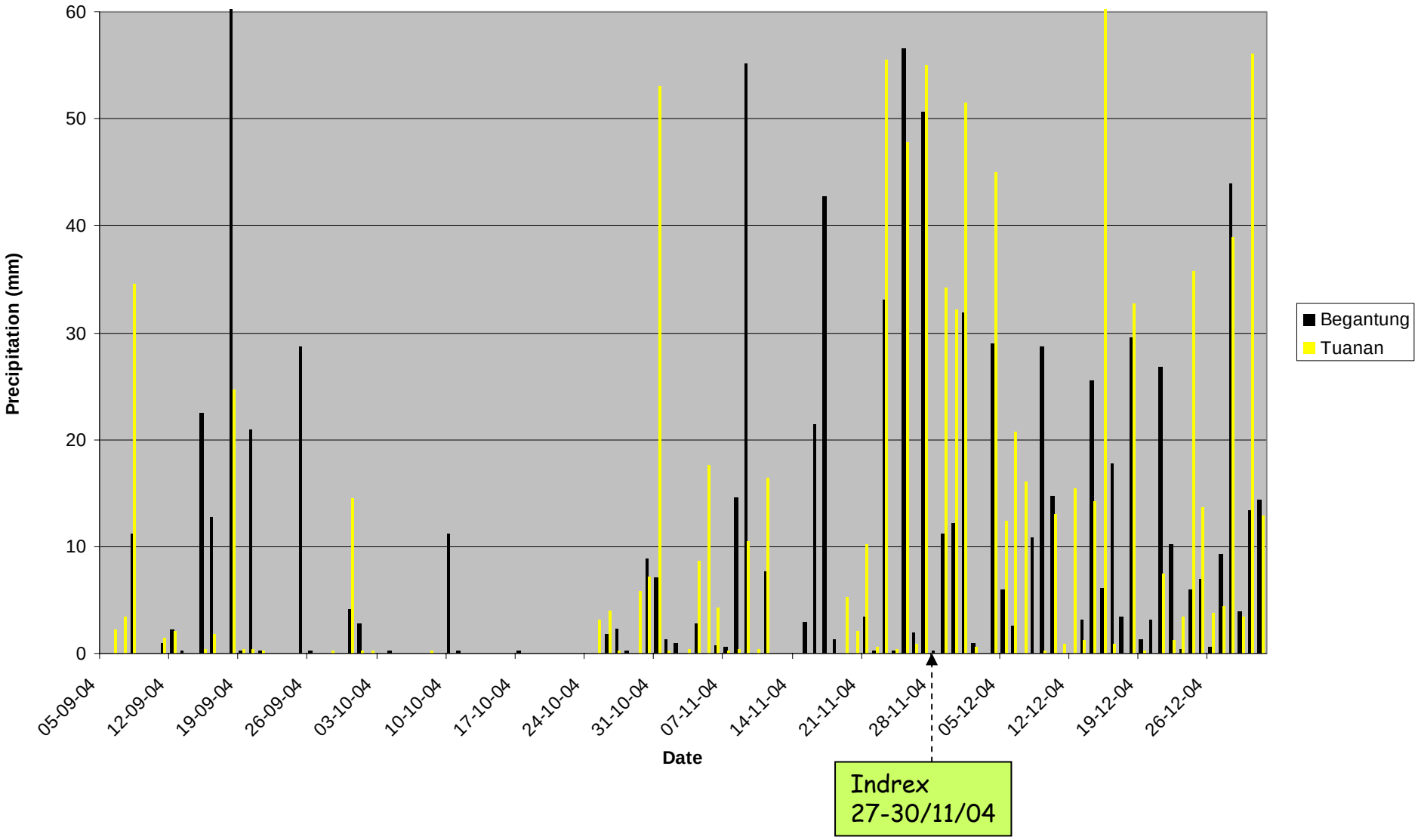
Water level fluctuation
(5)


Micro relief relative to water levels
Dry
0.0
-50.0
-100.0
-150.0
-1000
-800
-600
-400
-200
0
200
400
600
800
1000
225°-45°
WL-Max
WL-Ave
WL-Min

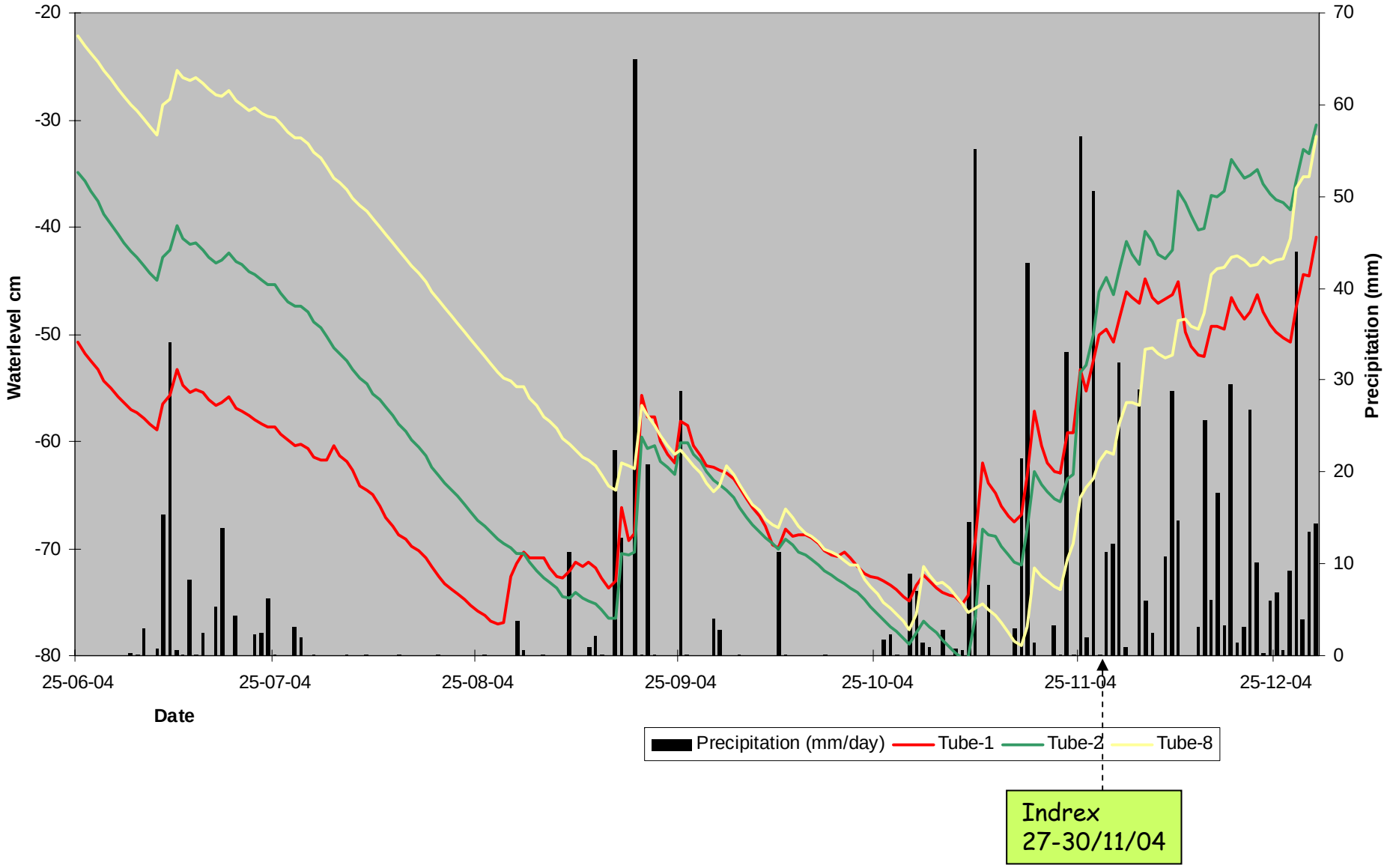

D-CFFU
INDREX 2
INDONESIA RADAR EXPERIMENT
Mawas-Gunung Meratus-Sungai Wain-Balikpapan Bay Mangrove-Samboja Lestari
NOVEMBER, 2004
esa
DLR
BOS
SarVision
AIRBORNE SAR CAMPAIGN OVER TROPICAL FOREST IN P-L-C and X-BAND


Indrex
27-30/11/04
Waterlevel (cm)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
01-01-04
31-01-04
01-03-04
31-03-04
30-04-04
30-05-04
29-06-04
29-07-04
28-08-04
27-09-04
27-10-04
26-11-04
26-12-04
Date
Tube-1
Tube-2
Tube-3
Tube-4
Tube-5
Tube-6
Tube-7
Tube-8
Tube-9
Tube-10
Tube-13
Tube-14
Tube-15

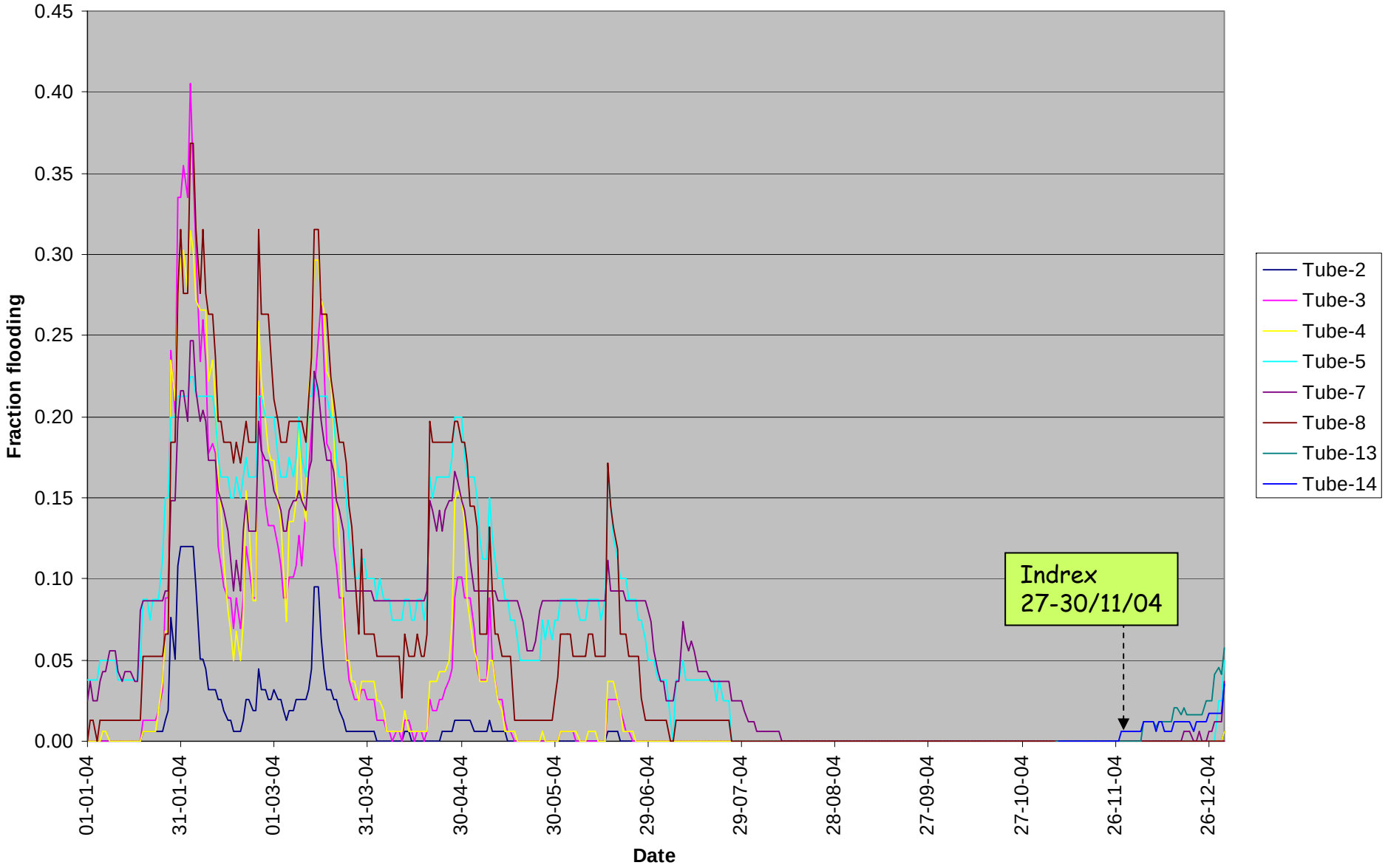
Water level



Precipitation



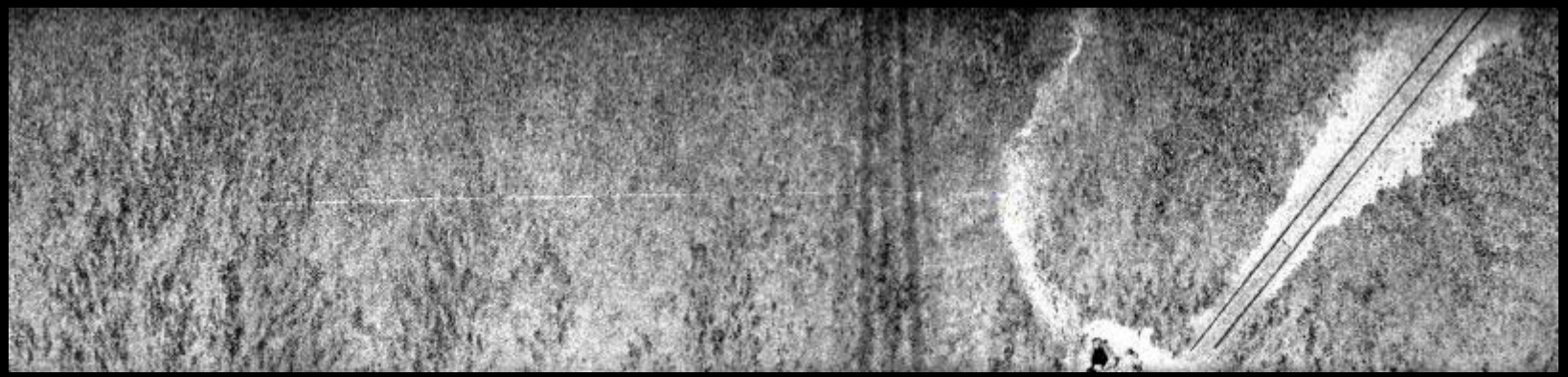
Water level and precipitation



Flooding fraction

P-band PolInSAR

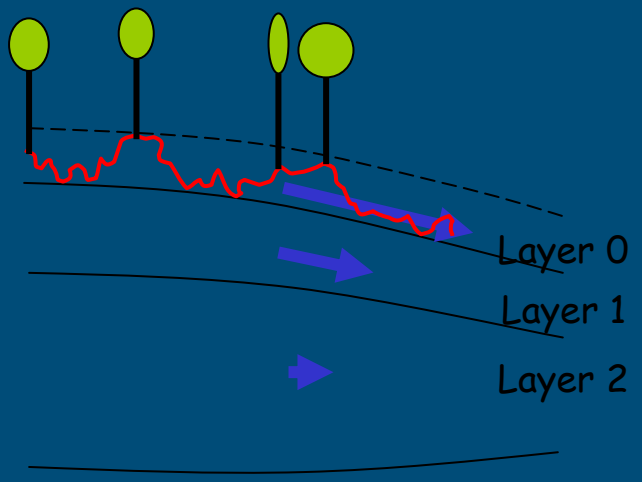
N



L-band PolInSAR

L-band

3. Hydrological model



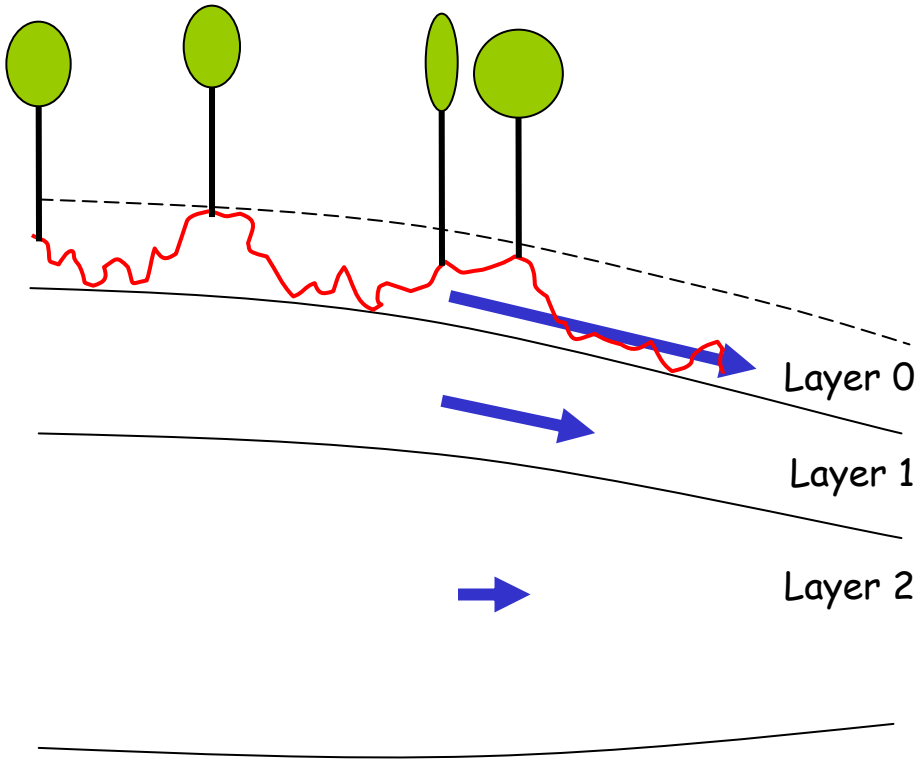
Hydrological model

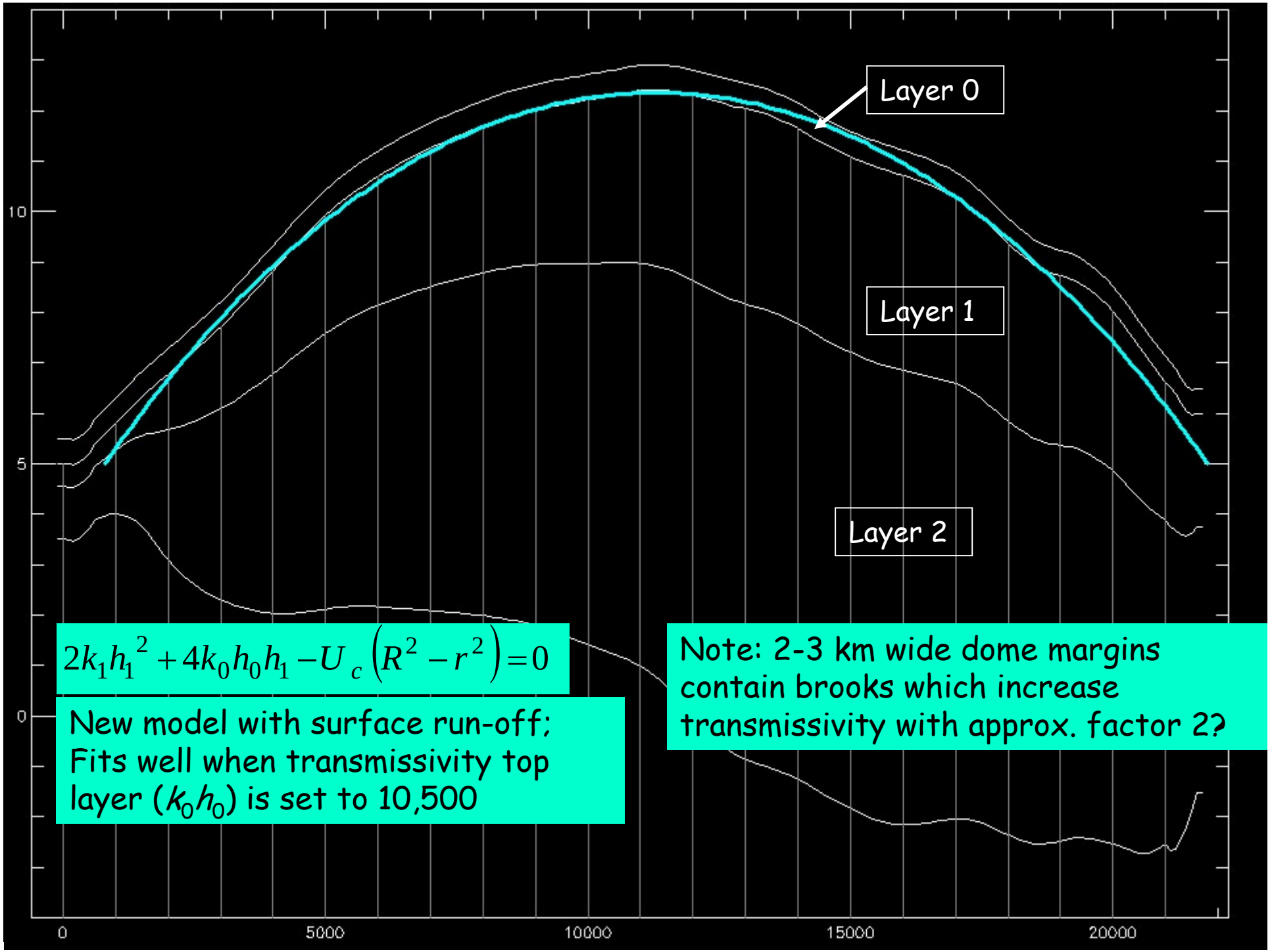
Layer 0:
Upper layer; surface run-off;
Large effective hydraulic conductivity k_0, depending on water table

Layer 1:

Young catotelm: k_1 up to ≈200

Layer 2:
Old catotelm: k_2 up to ≈100

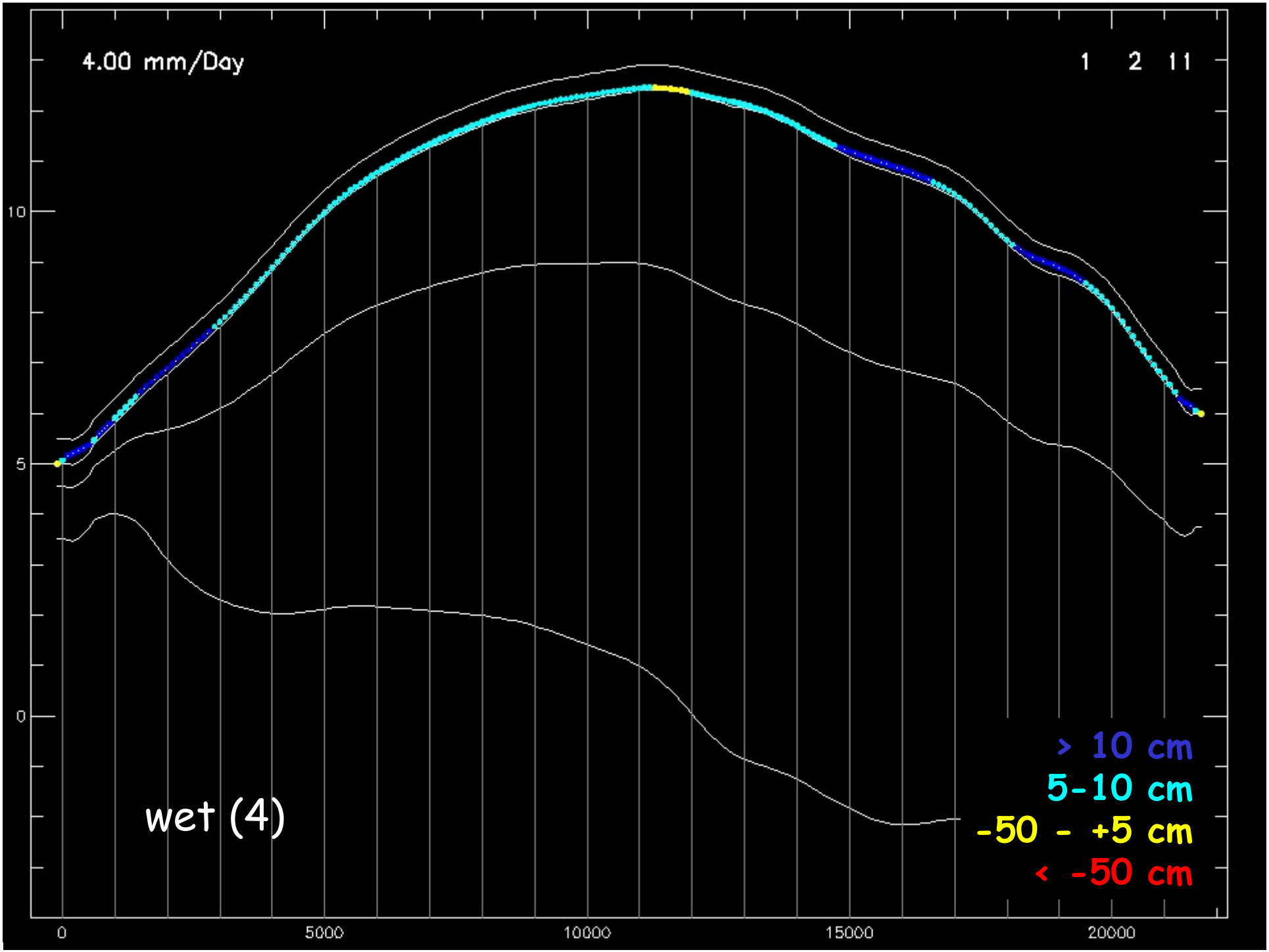


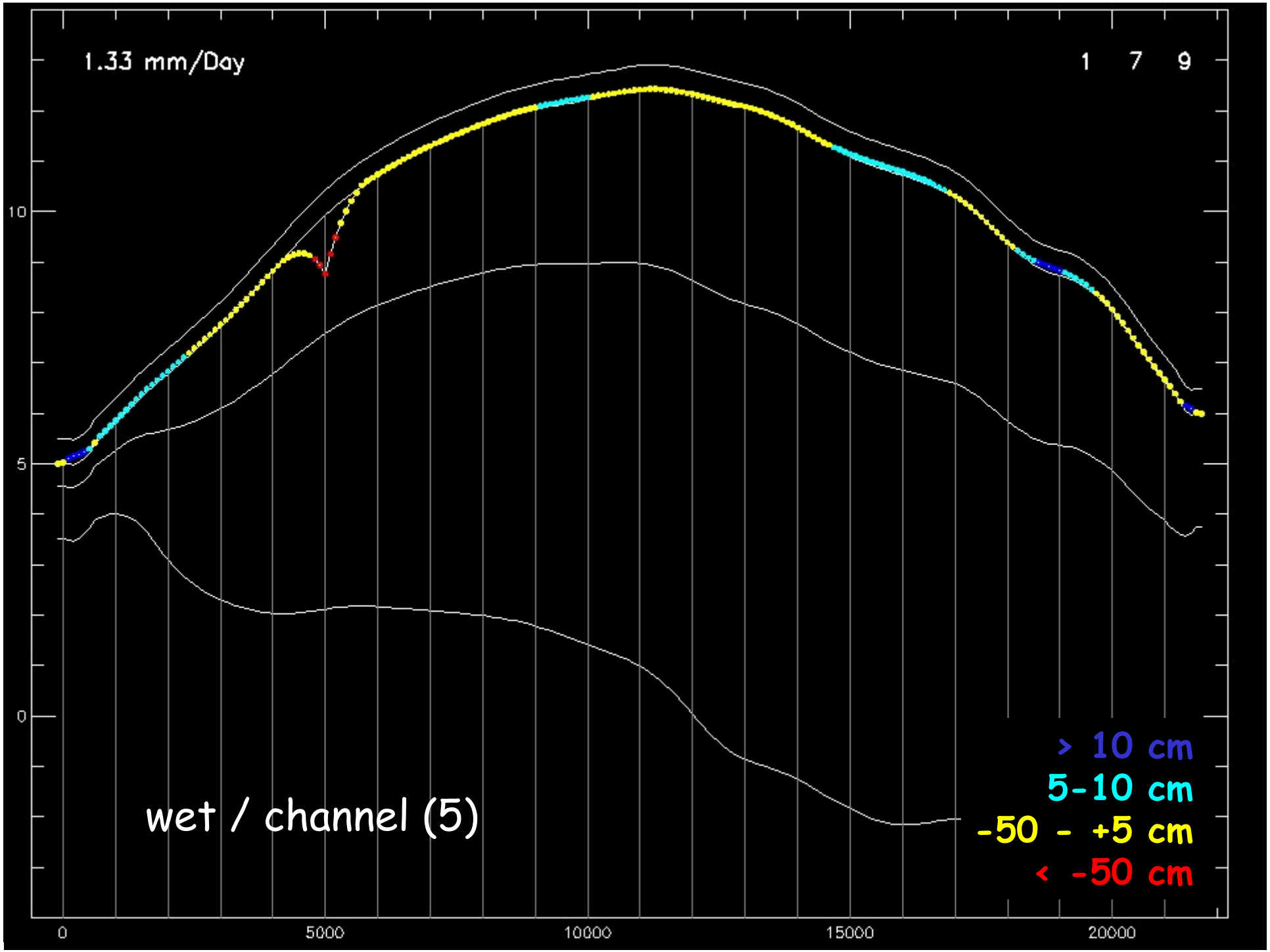


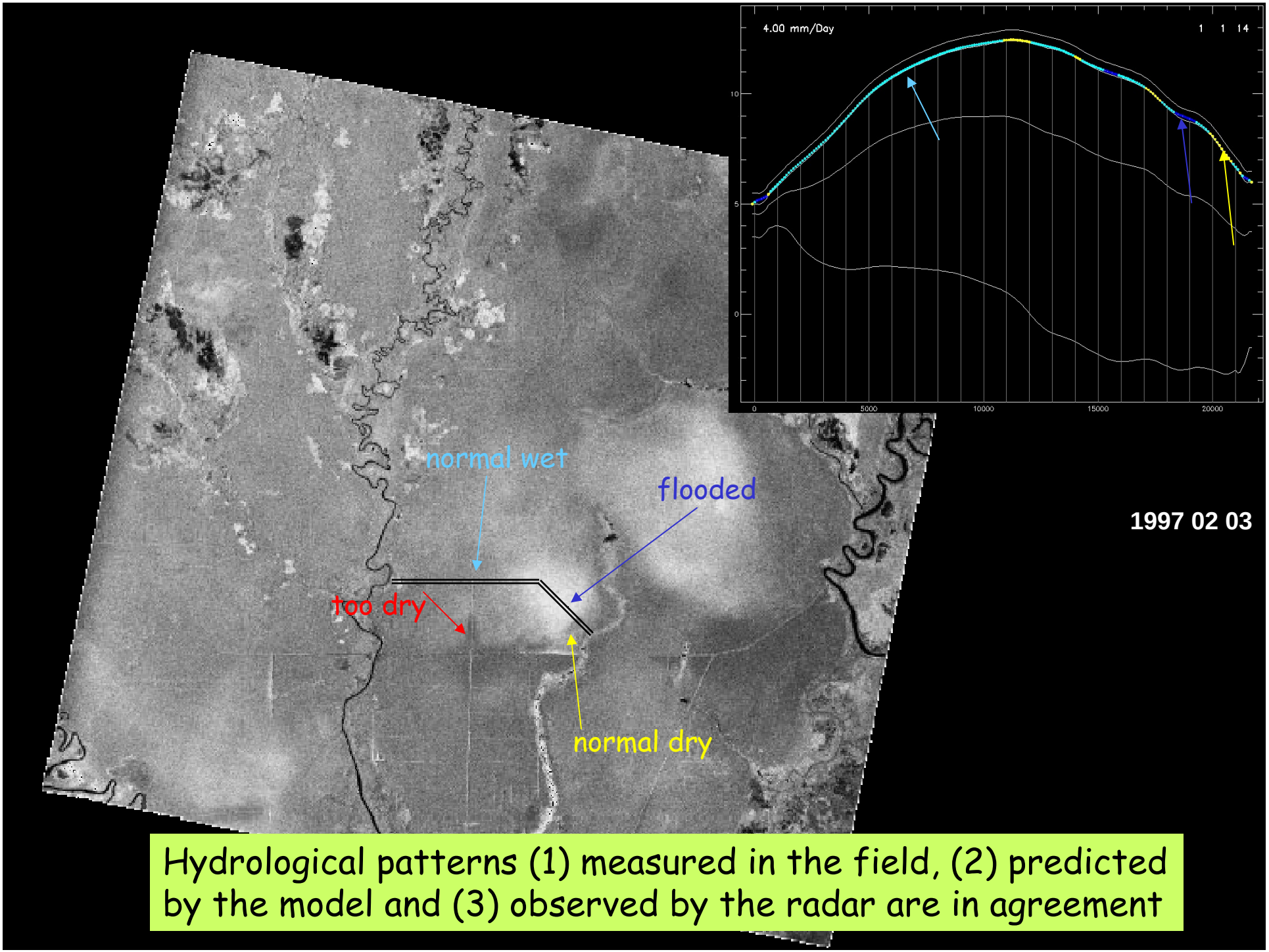
$$2k_1h_1^{\,2} + 4k_0h_0h_1 - U_c\left(R^2 - r^2\right) = 0$$

New model with surface run-off;
Fits well when transmissivity top layer (k_0h_0) is set to 10,500

Note: 2-3 km wide dome margins contain brooks which increase transmissivity with approx. factor 2?


4.00 mm/Day
1 2 11
10
5
0
0
5000
10000
15000
20000
wet (4)
> 10 cm
5-10 cm
-50 - +5 cm
< -50 cm


1.33 mm/Day
1 7 9
10
5
0
0
5000
10000
15000
20000
wet / channel (5)
> 10 cm
5-10 cm
-50 - +5 cm
< -50 cm



Hydrological patterns (1) measured in the field, (2) predicted by the model and (3) observed by the radar are in agreement

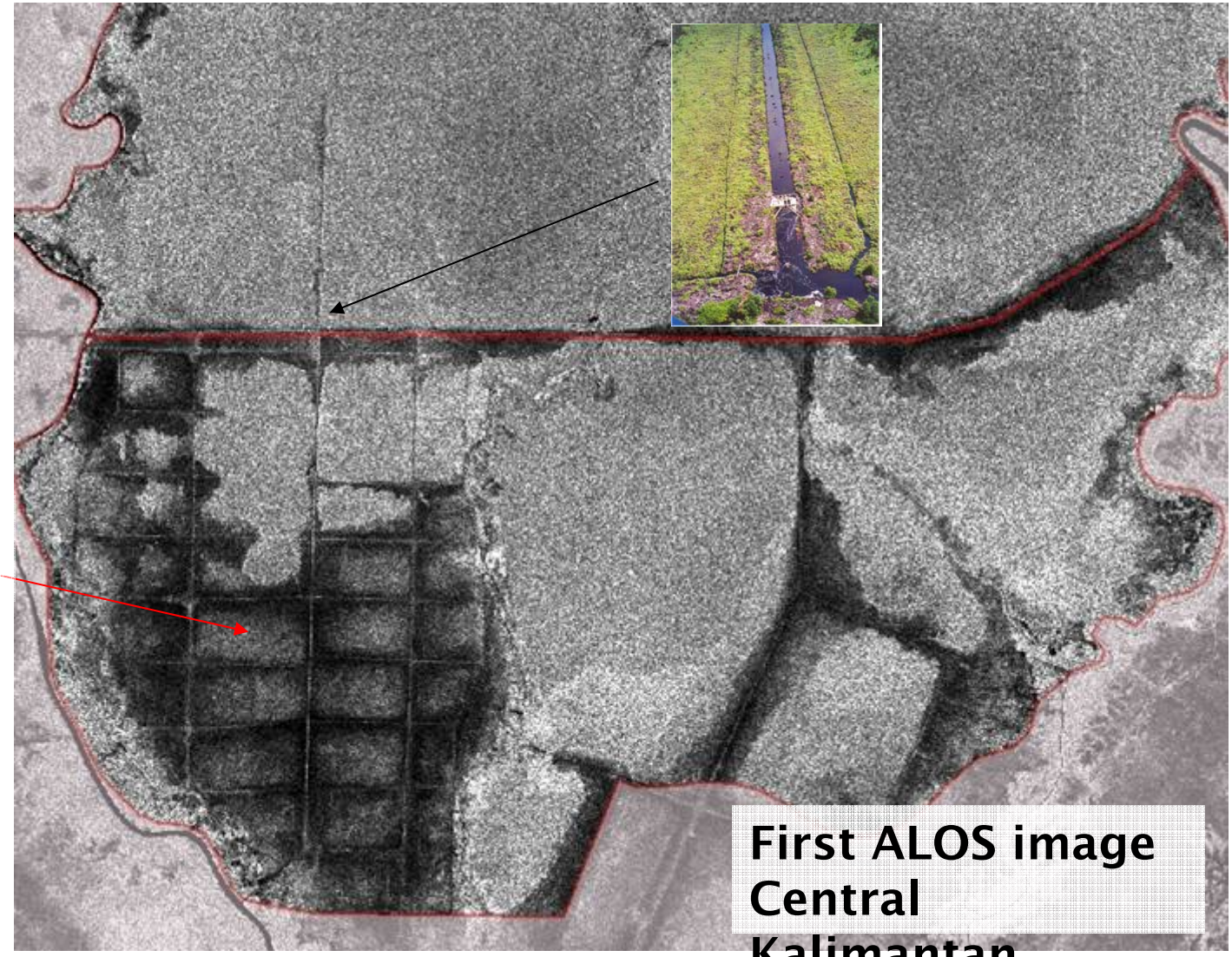
Targeted field response

Black areas:
too dry!

Impact canal
width 7 km

Does blocking canals work?? **1998**

Targeted field response



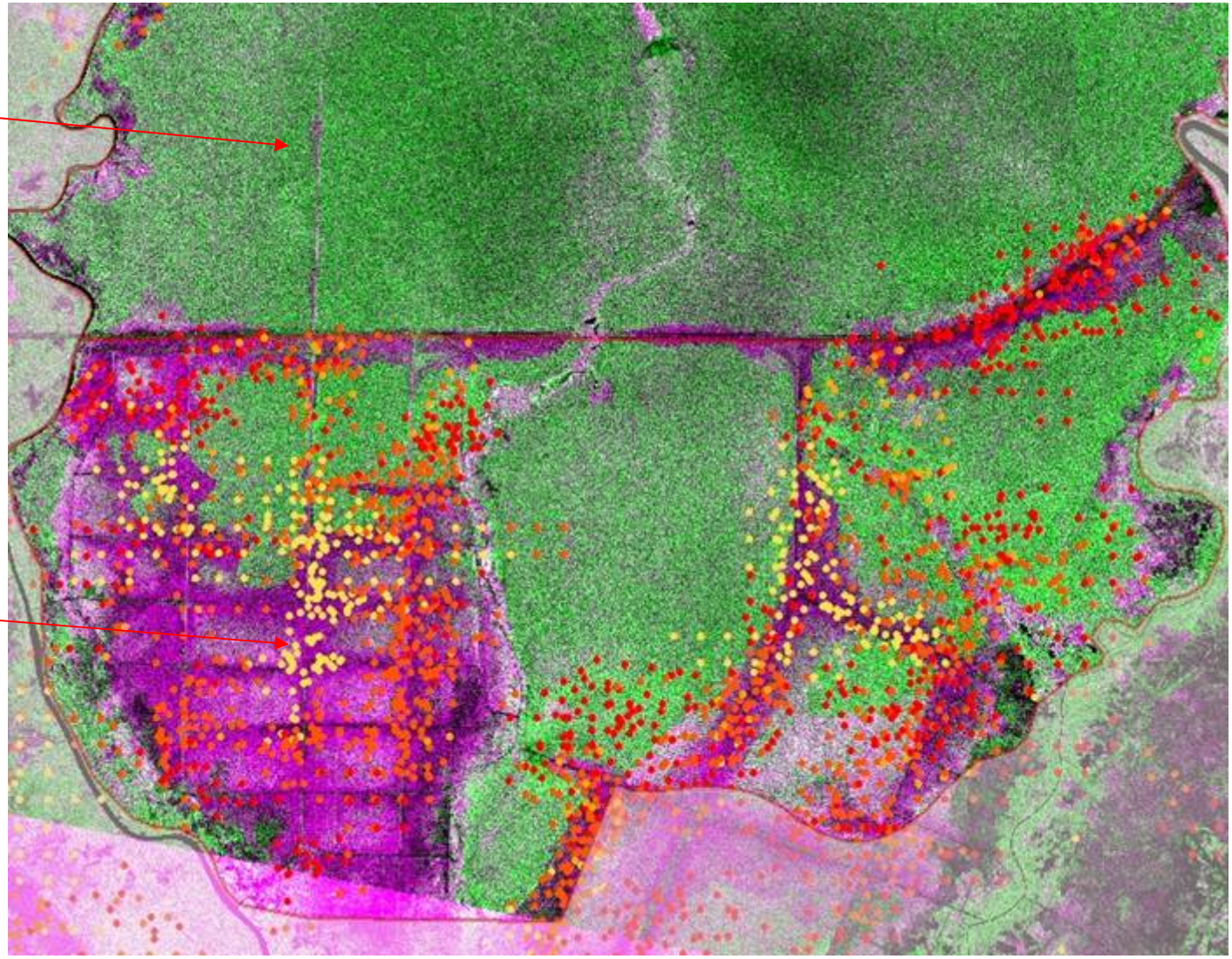
Black areas:
too dry

Does blocking canals work?? **2006: yes?**

Targeted field response

2006:
No
FIRES!!

Too
many
FIRES!!

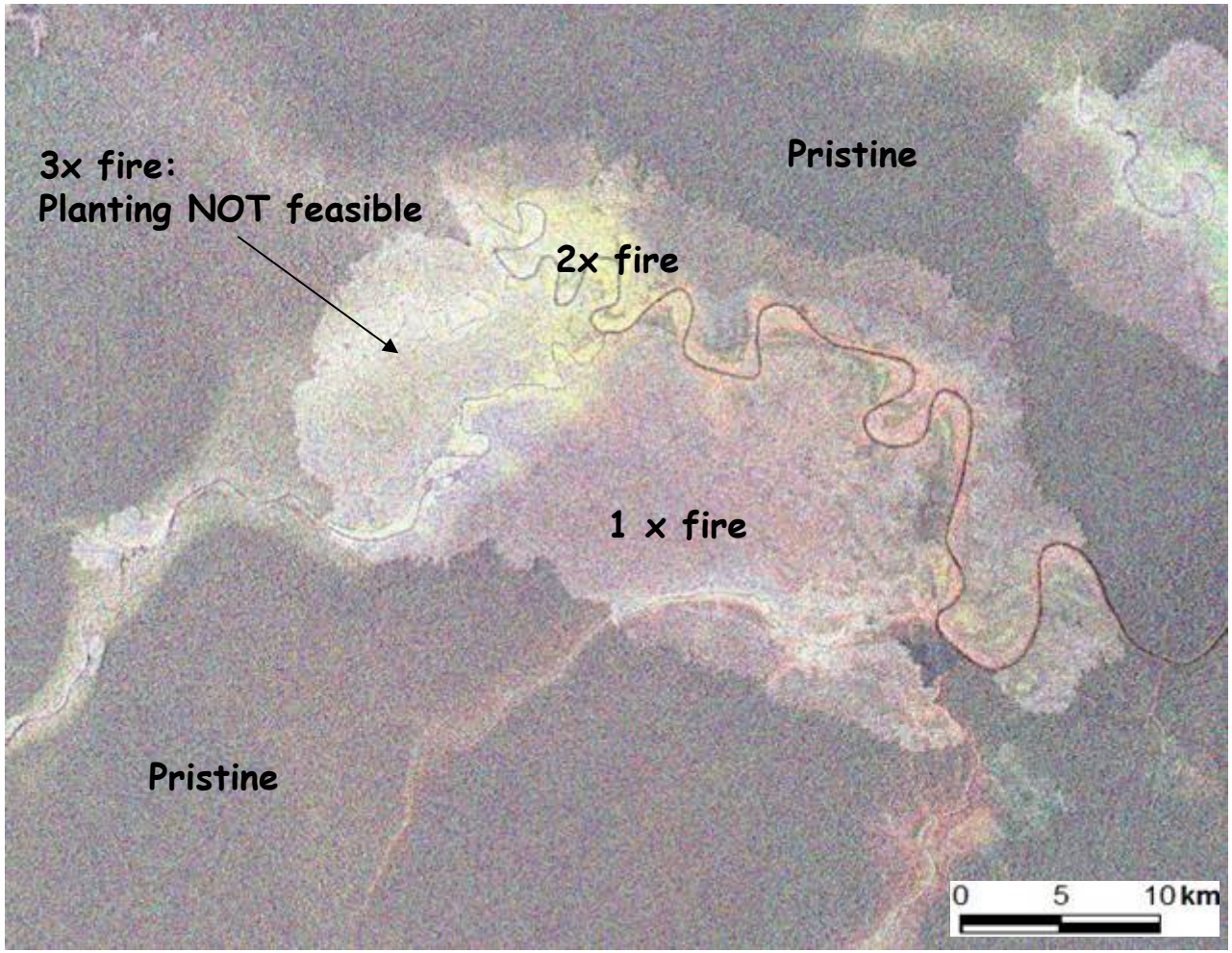


Does blocking canals work?? **2006: yes?**

Targeted field response

Pinpoint optimal locations for dam construction!

Targeted field response



JERS-1 SAR multi-temporal composite image

(Red 25 Jul 1994; Green 24 Jul 1997; Blue 16 Jul 1998).

Berbak National Park Sumatra

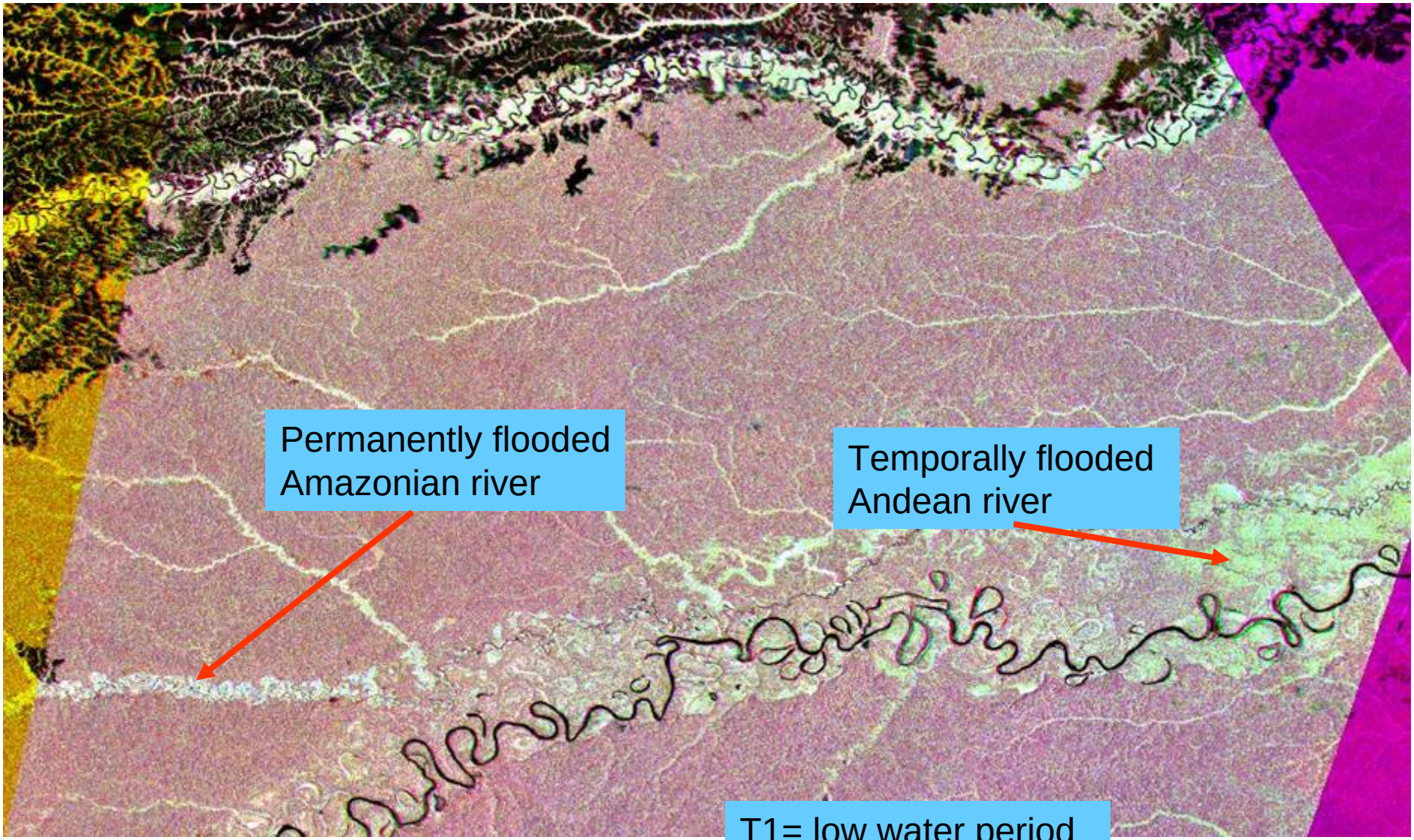
Peat swamp forest degradation history monitoring:

Fire events and flooding durations

Important input for selection of sound <u>restoration approaches</u> ! Where economically feasible??

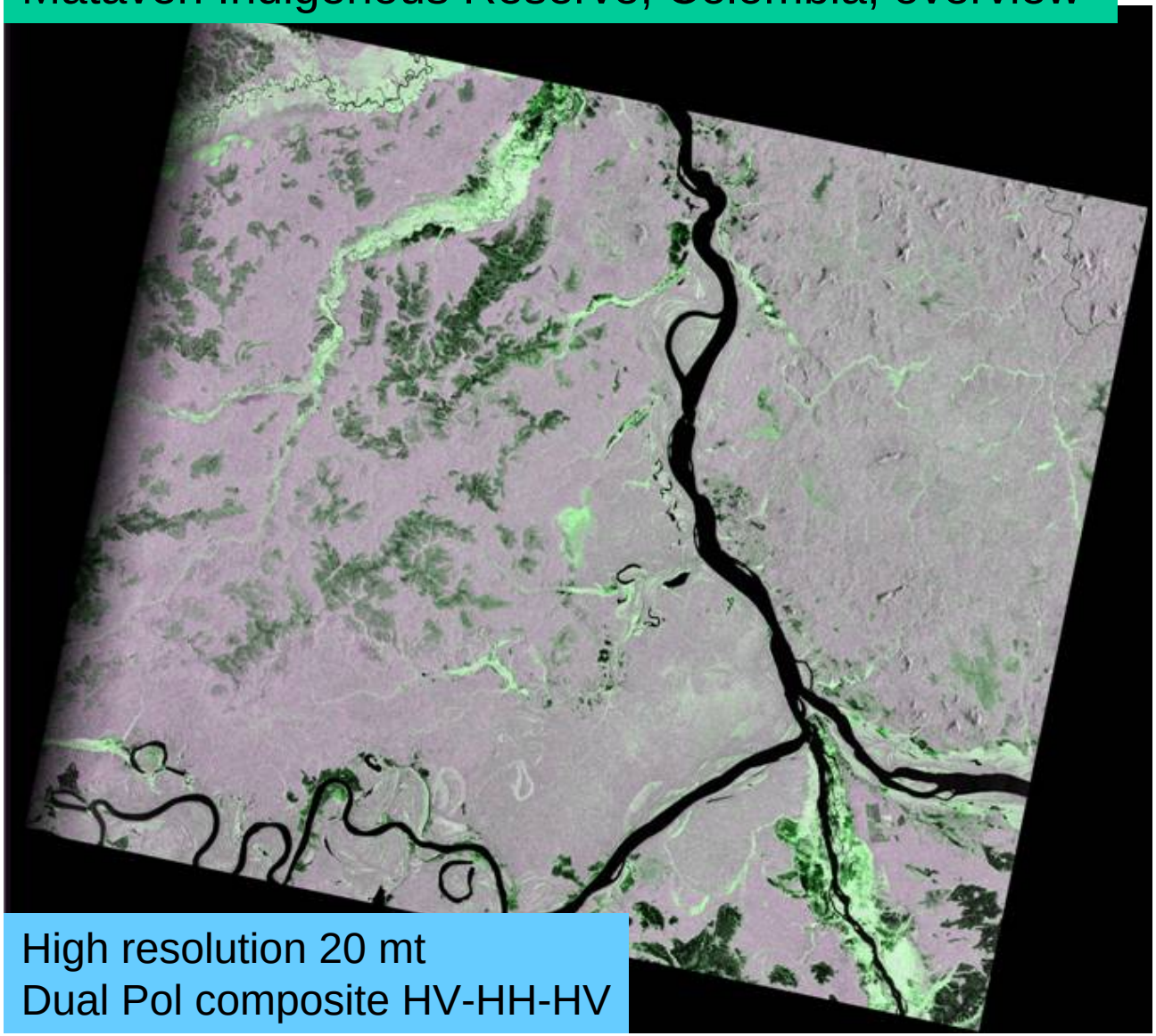
4. Colombia examples

Color composites of multi temporal ALOS PALSAR can provide information about temporal changes and seasonality in inundation regimes (of rivers).



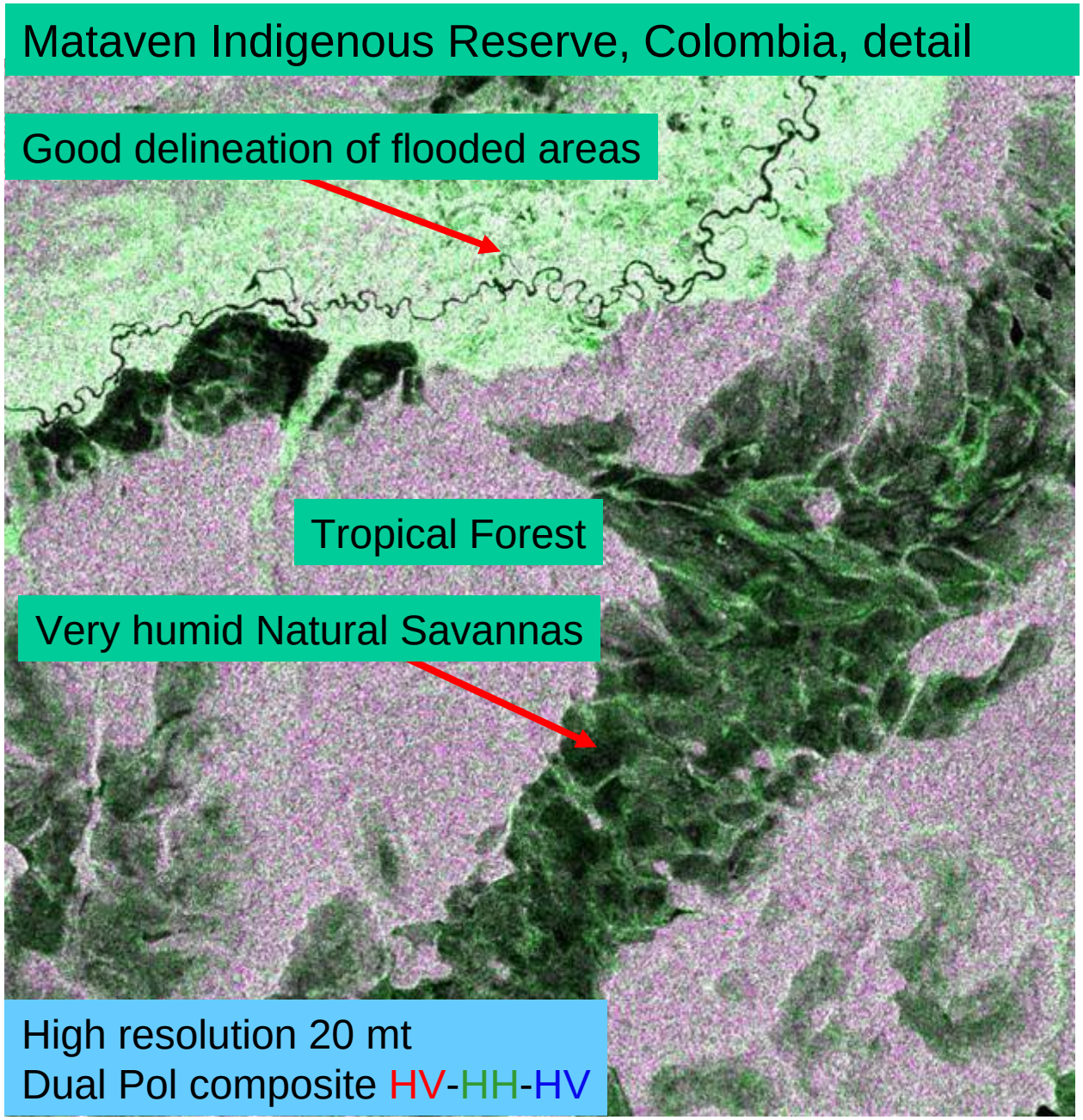
JERSHH-T1,AlosWSHH-T1,AlosWSHH-T2

Mataven Indigenous Reserve, Colombia, overview

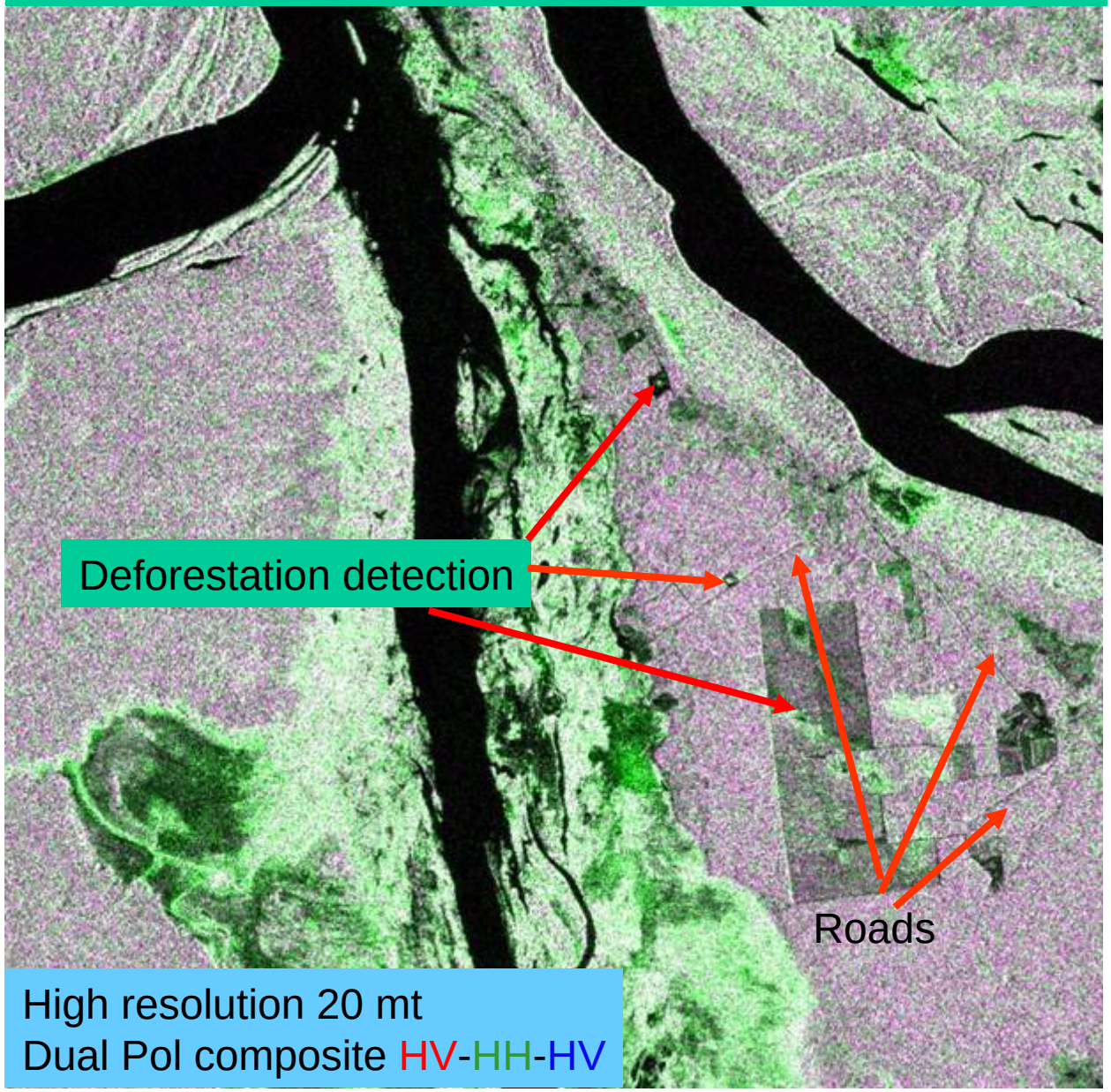


High resolution 20 mt
Dual Pol composite HV-HH-HV

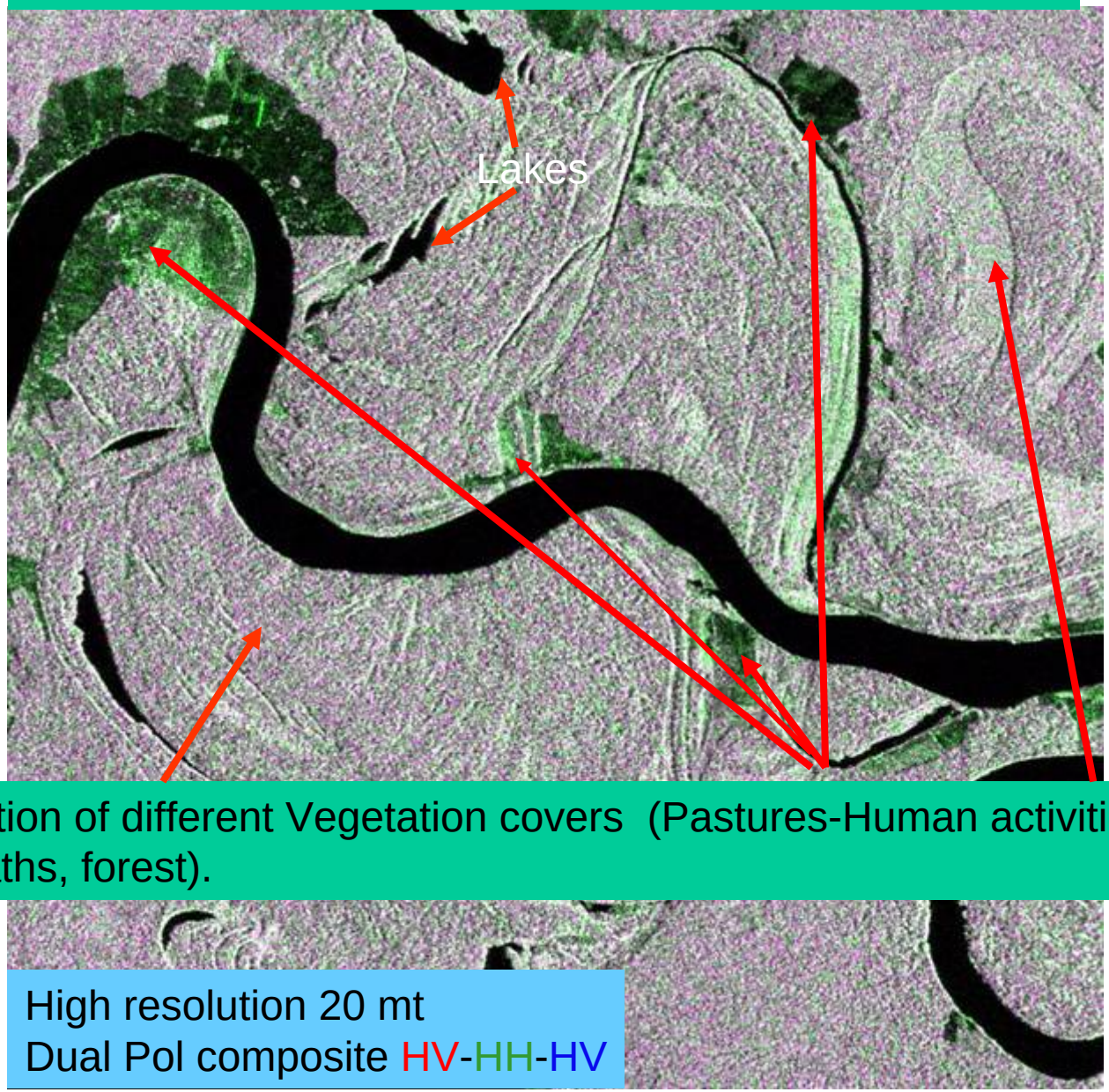
Composites of dual pol or full pol enhance differences between ecosystems


Mataven Indigenous Reserve, Colombia, detail
Good delineation of flooded areas
Tropical Forest
Very humid Natural Savannas
High resolution 20 mt
Dual Pol composite HV-HH-HV

Mataven Indigenous Reserve, Colombia, detail



Mataven Indigenous Reserve, Colombia, detail



Detection of different Vegetation covers (Pastures-Human activities, river old-paths, forest).

High resolution 20 mt
Dual Pol composite HV-HH-HV

5. Summary and conclusions

- Methodology development and calibration of radar systems at Mawas research station
- Historical JERS-1 SAR time series available for many PSF areas
- In principle radar can map PSF characteristics and contribute to improved carbon stock estimation
- Radar monitoring can be utilized to monitor excess drainage dynamics and effects of peat land restoration
- ALOS PALSAR will enable monitoring of all PSF areas during the next 5-6 years