

From Large-Scale Rubber Plantations to Oil Palm Plantations:

Simulating the Impact on Leaf Area Index and Eventual
River Flow
(..a work in progress)

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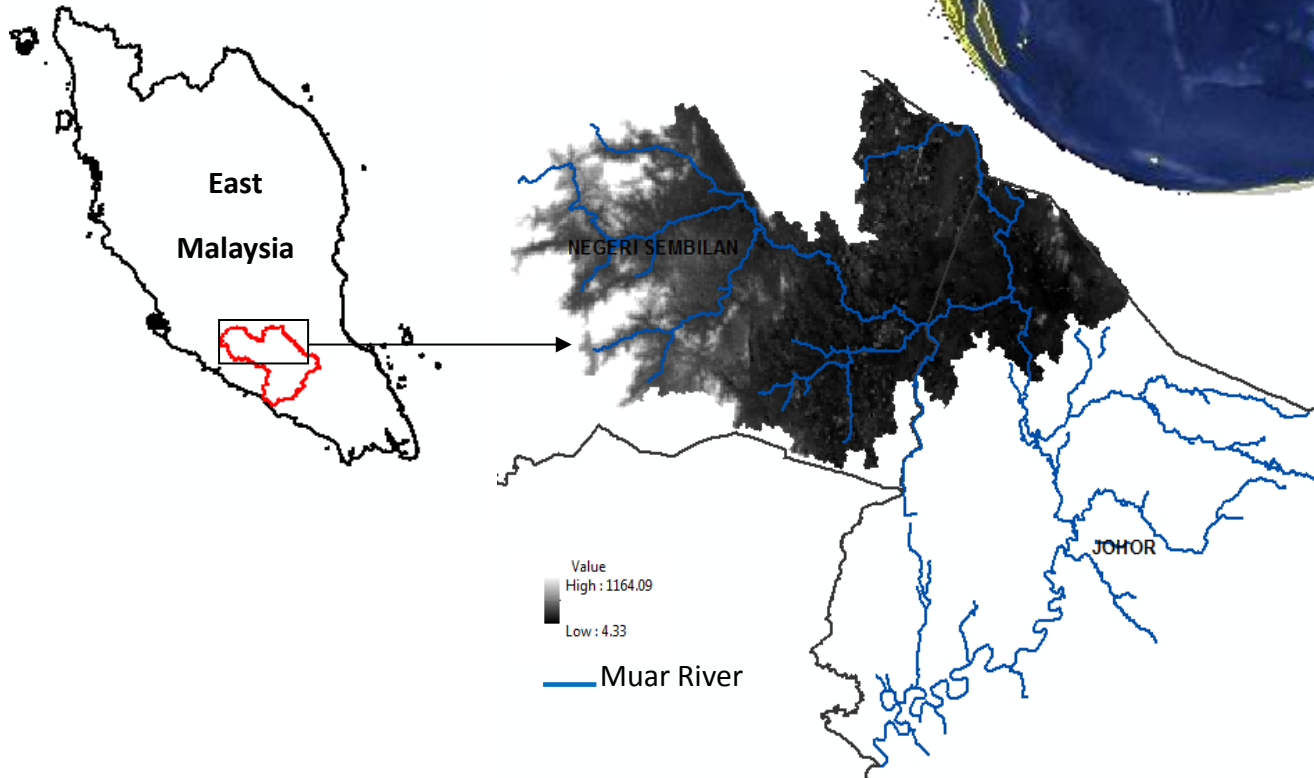
STUDY AREA

Muar River Watershed

Johor, Malaysia

Northern part of Muar River watershed

Total Area: 2982.83 km²



THE ISSUE

Increased Incidences of Flooding ..and magnitudes too.

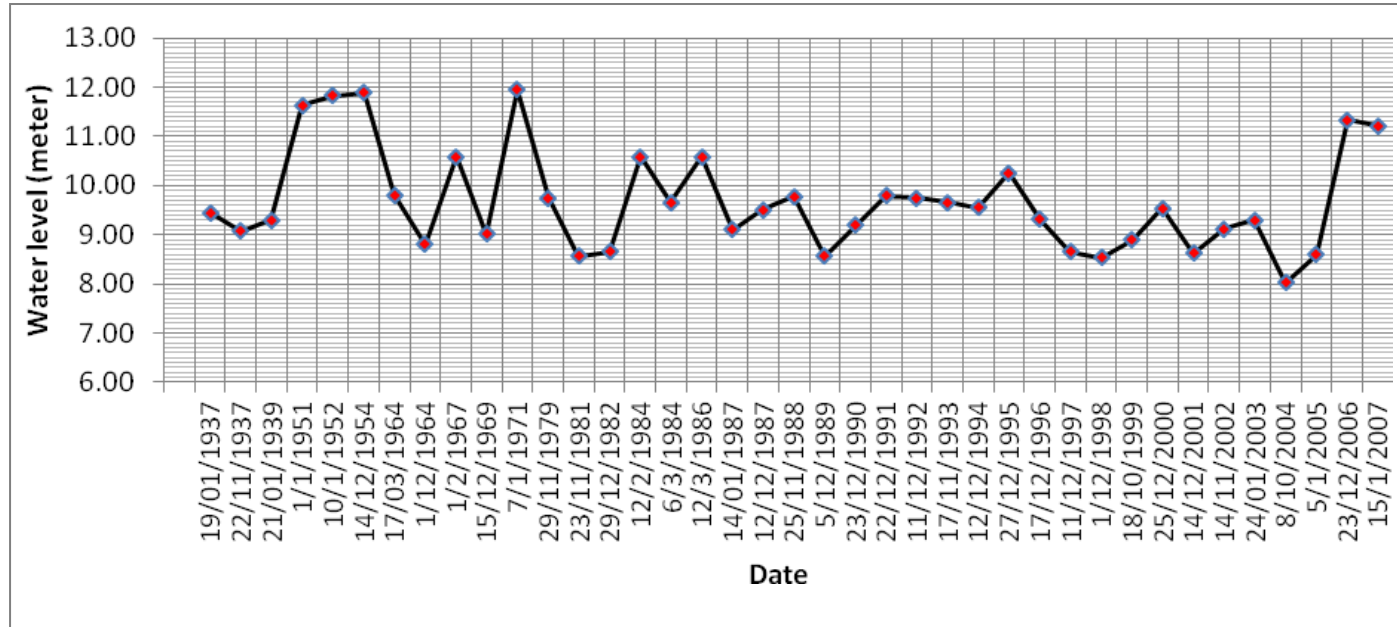


Figure : Flood occurrences in a Muar River

1937 – 1984 (45 years): 0.31 flood/yr

1984 - 2007 (23 years): 1.08 floods/yr

Floods occur during Northeast Monsoon (Nov. – March)

..lately with devastating effects



THE SUSPECT

Succession of vast LU/LC changes

..from original forest (up to 1960s)



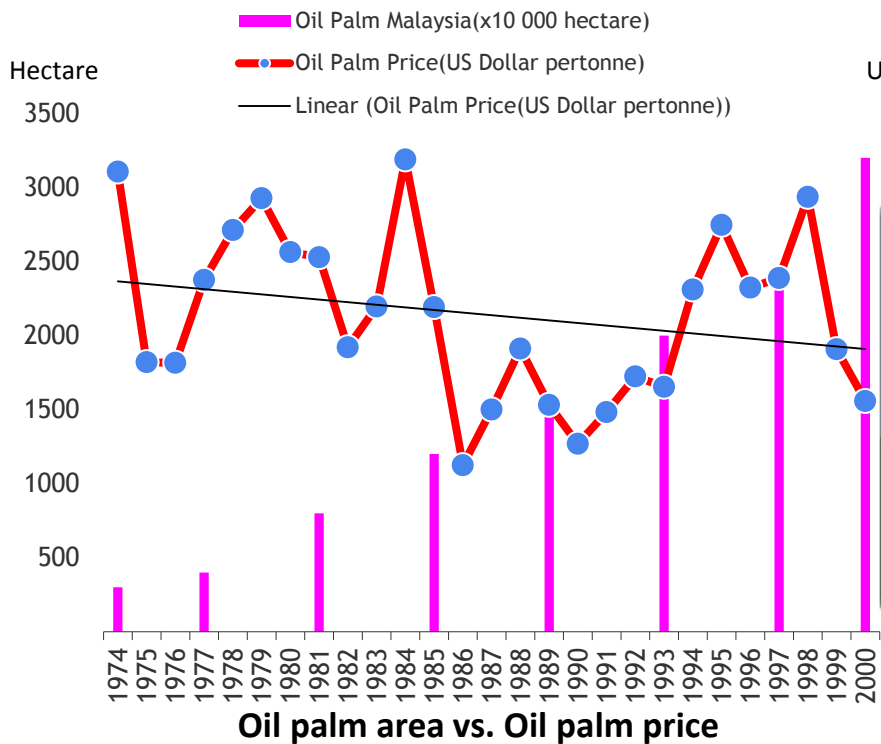
to rubber (up to late 70s)



to oil palm (starting 1980s).

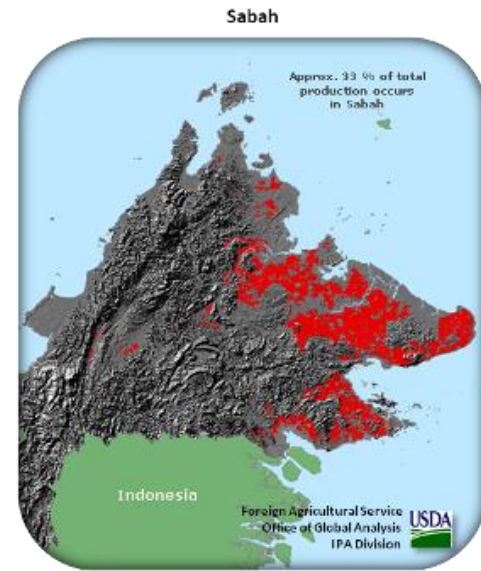
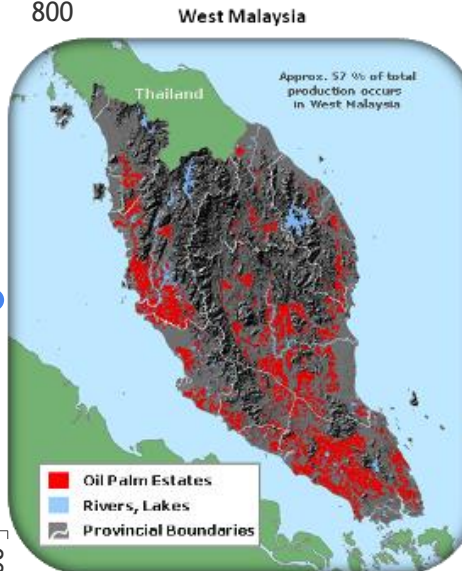
..different land covers hosting different types of plants with different physiologies.



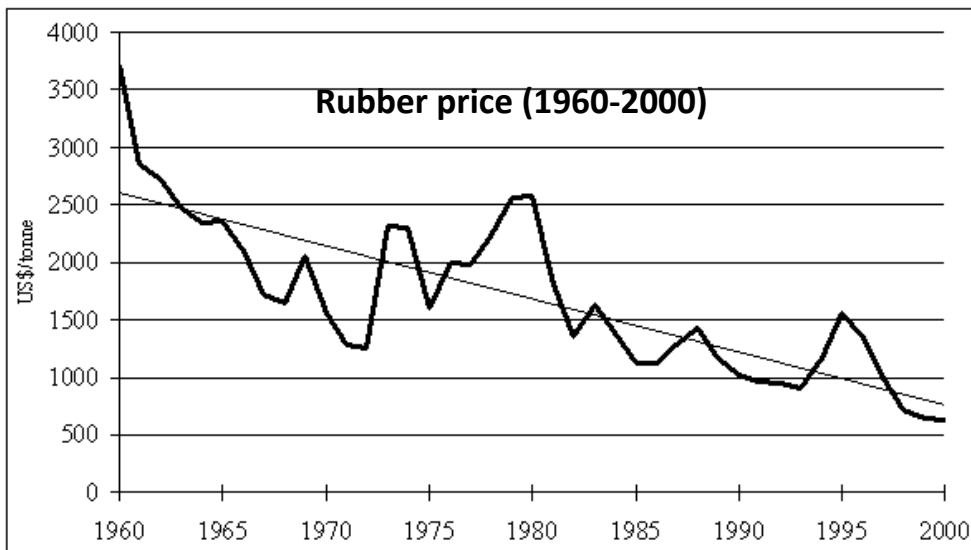


US Dollar
800

MALAYSIA: Palm Oil Plantation Distribution – Main Areas

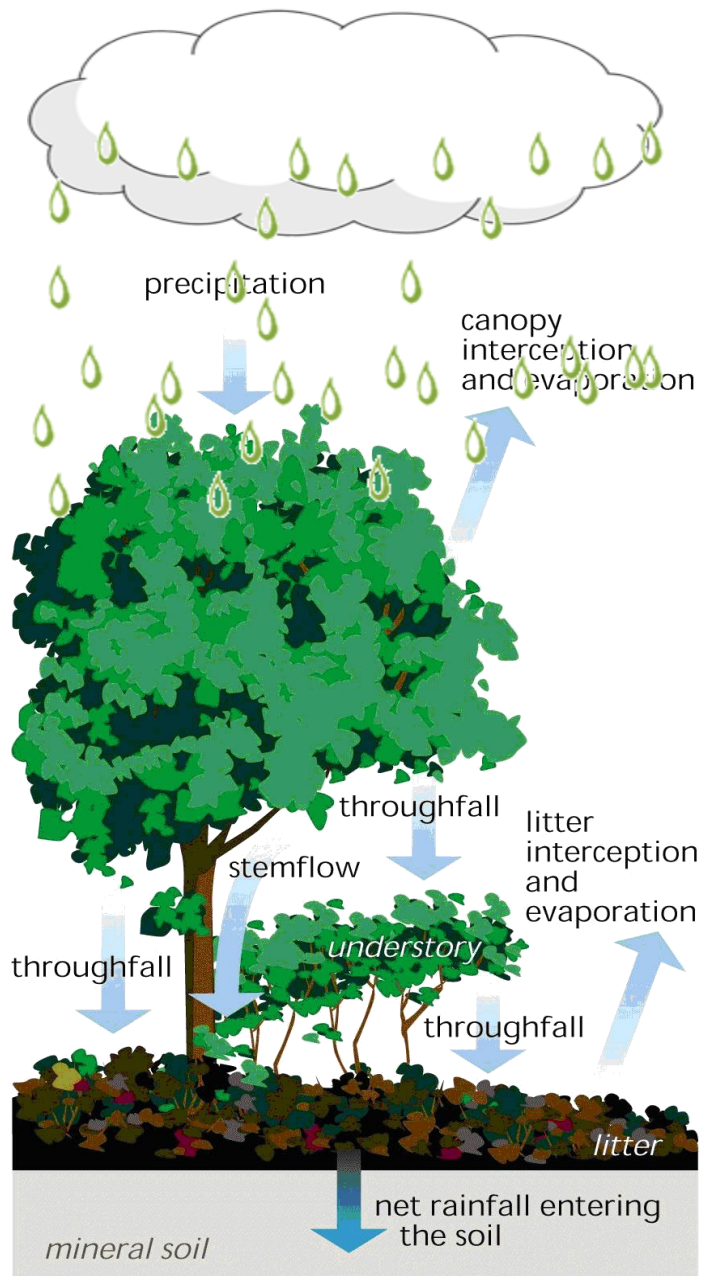
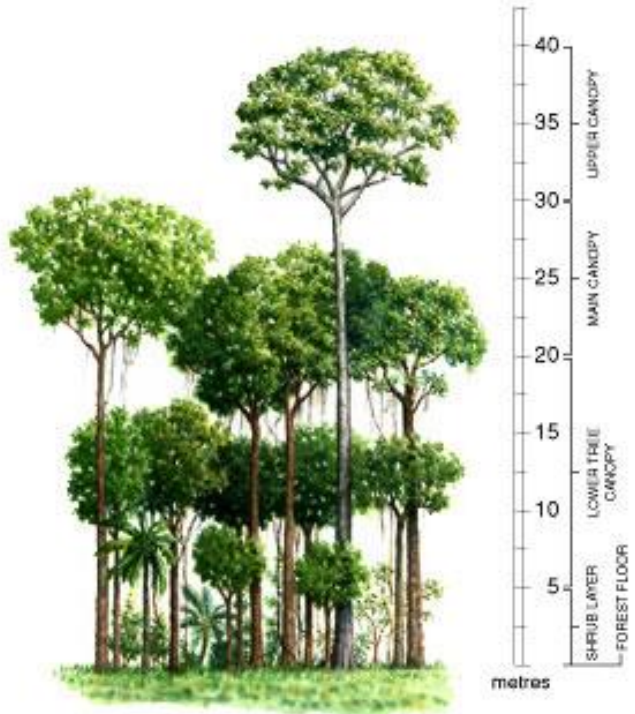


Source: Centre for Remote Imaging, Sensing and Processing (CRISP), Singapore, 2010



	Production of crude palm oil	Total export (Million tonne)	Contribution to Malaysia's economy (RM Billion)
2000	10.84 million tonne	10.84	14.85
2002	11.748 million tonne	10.16	11.33
2003	13.35 million tonne	12.25	22.14
2009	17.56 million tonne	17.56	49.60

FOREST'S INTERCEPTION of RAINFALL..



- Only 10% of the rainfall reaches a stream as runoff.
- Tree leaves, twigs, branches, trunks, and stems, along with the forest floor litter, create an extensive surface area that intercept rainwater and allow much of it to evaporate before reaching the soil
- Interception by forests and individual tree canopies is much greater than that by shrubs and other herbaceous plants (Pitman, 1989)

HEVEA BRASILIENSIS (RUBBER)

Canopy
Leaf
Stem

CHARACTERISTICS



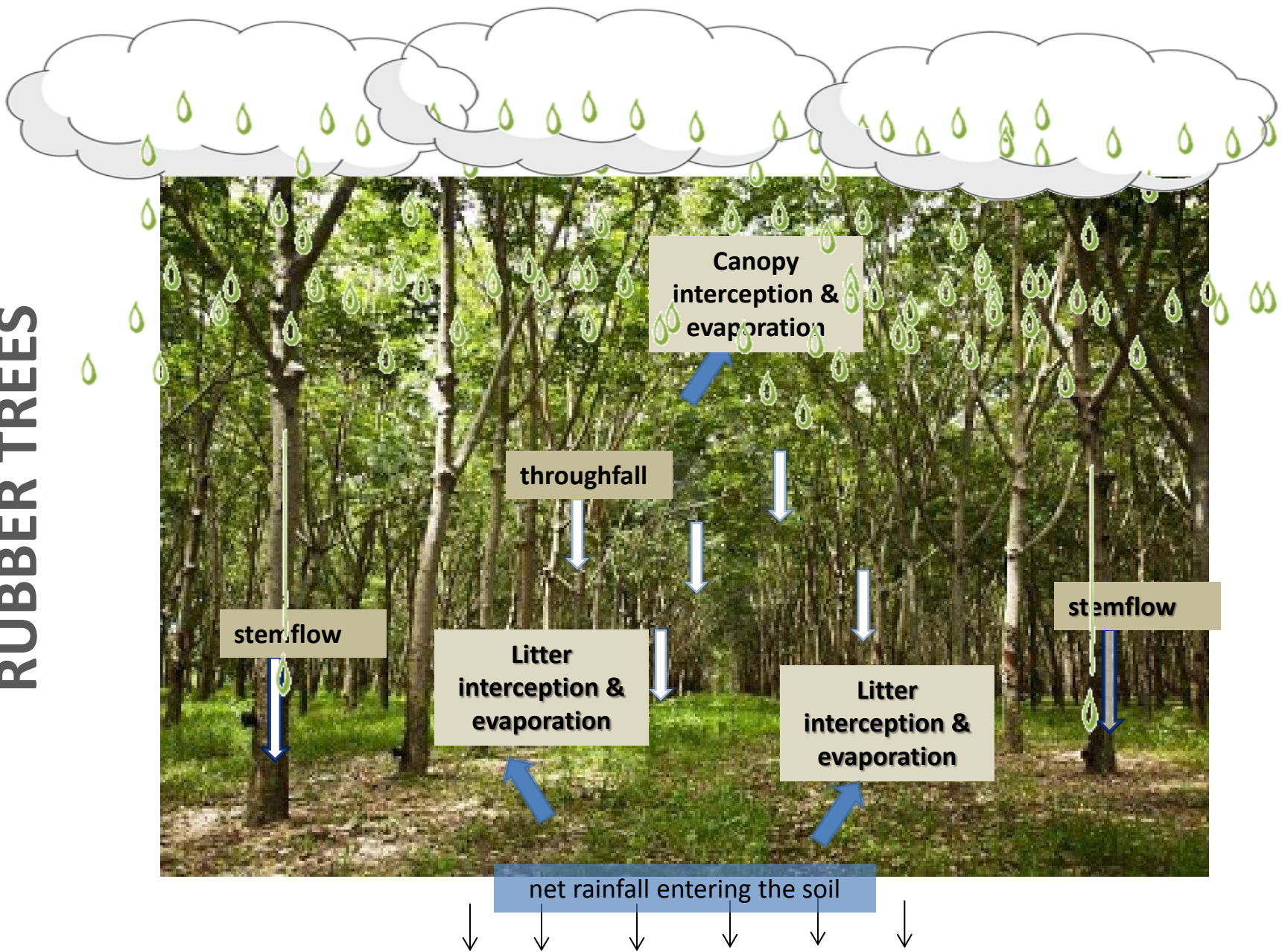
- The plant, growing up to over 40 meters (m) in the wild, characteristically does not exceed 25 m in height when it is under cultivation

- During wintering (lasting for 4-6 weeks), the leaves of the tree die and fall off- create 'sponge' effect.

- LAI : LAI rubber < LAI forest



RAINFALL INTERCEPTION IN RUBBER TREES



ELAEIS GUINEENSIS (PALM OIL) TREE CHARACTERISTIC



- Each tree can grow up to 18 meter and produces compact bunches



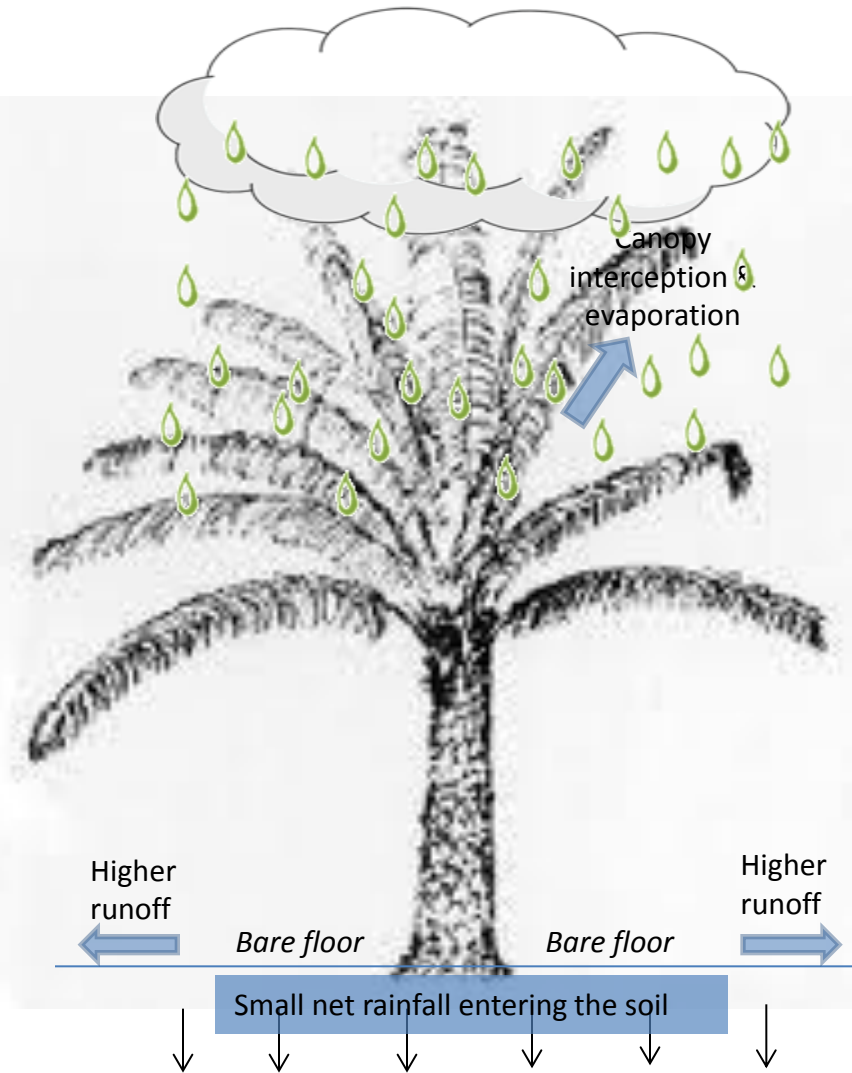
Bare floor

RAINFALL INTERCEPTION IN ELAEIS GUINEENSIS (PALM OIL)

Leaf : More throughfall

Bare Floor : Higher water runoff,
higher velocity– less infiltration

LAI: LAI palm oil < LAI rubber <
LAI forest



DATA INPUT

CLIMATE DATA

- Rainfall
- Temperature
- Relative humidity
- Wind speed
- Solar Radiation

Year 1970 - Year 2011

FLOW DISCHARGE

TOPOGRAPHY

ASTER Digital Elevation Model (DEM)

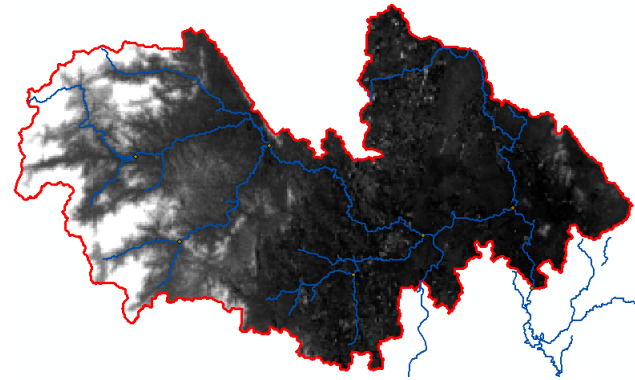
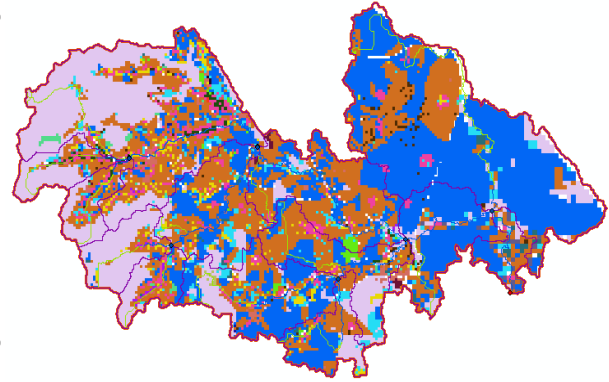
LANDUSE

SOIL

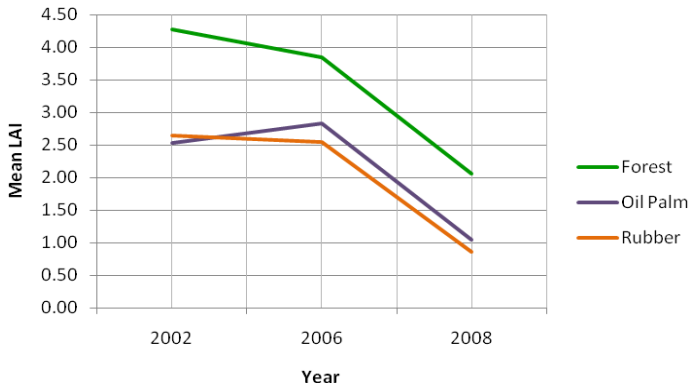
LEAF AREA INDEX (LAI)

MOD15A2: Level-4 MODIS global LAI

LAND USE
(2002, 2006, 2008)



ASTER DEM (30 Meter)



Mean LAI value

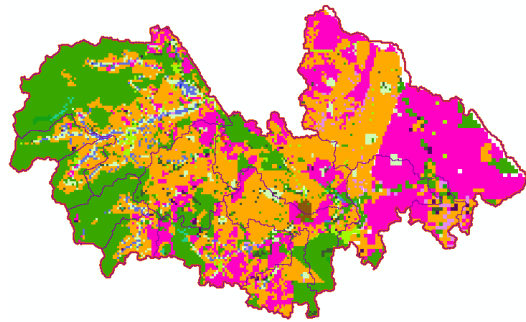


LAI's Value = MODIS LAI x scale factor (0.1)

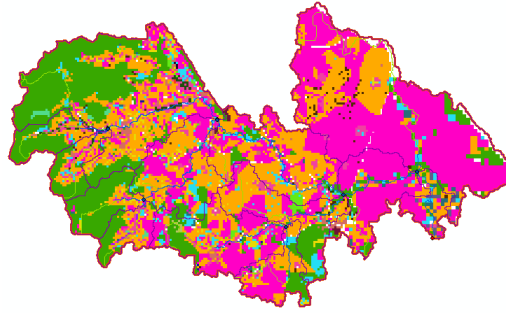
Land cover Type	Mean LAI Value		
	2002	2006	2008
Forest	4.27	3.85	2.06
Oil Palm	2.54	2.83	1.05
Rubber	2.65	2.54	0.85
Overall LAI	3.54	3.30	2.50

RESULTS

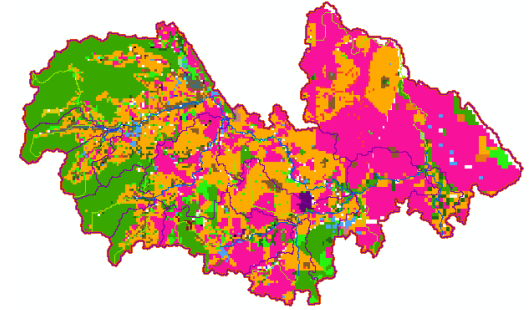
Dominant Land Cover Changes



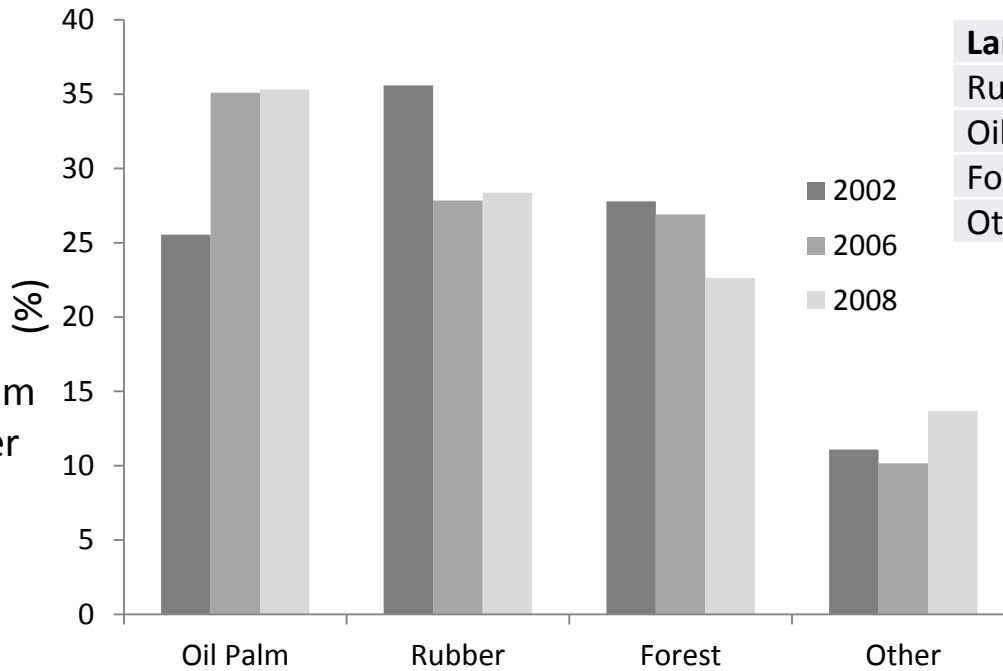
Year 2002



Year 2006



Year 2008



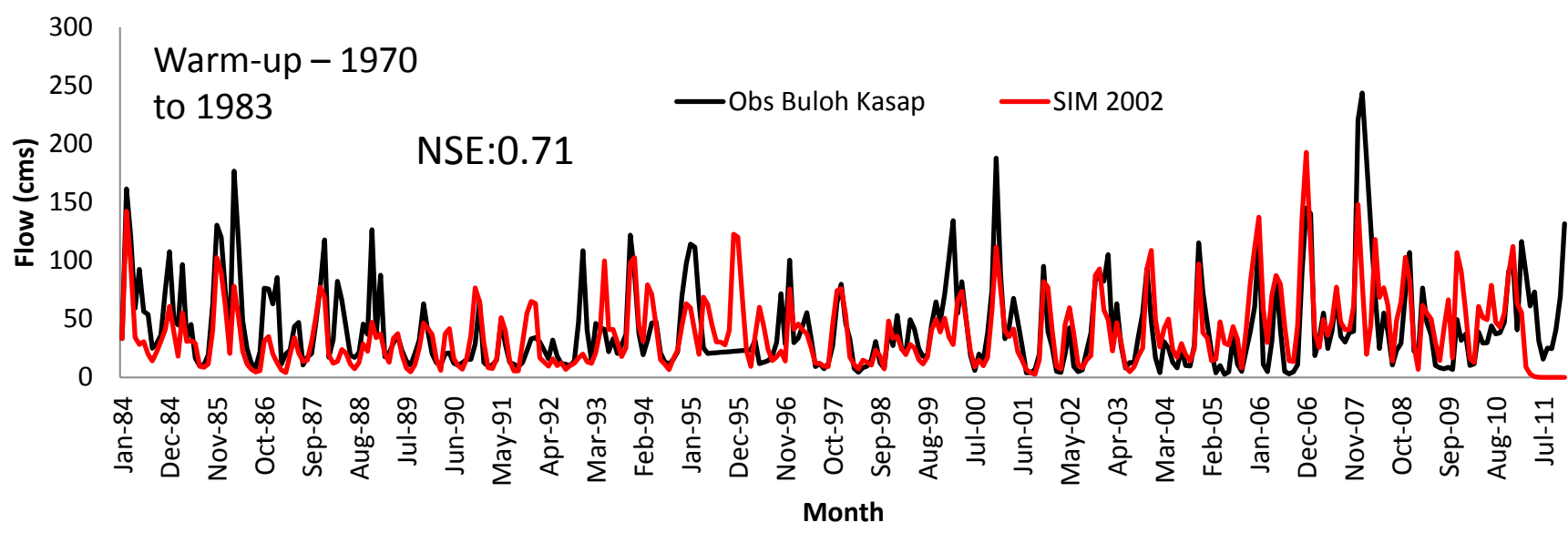
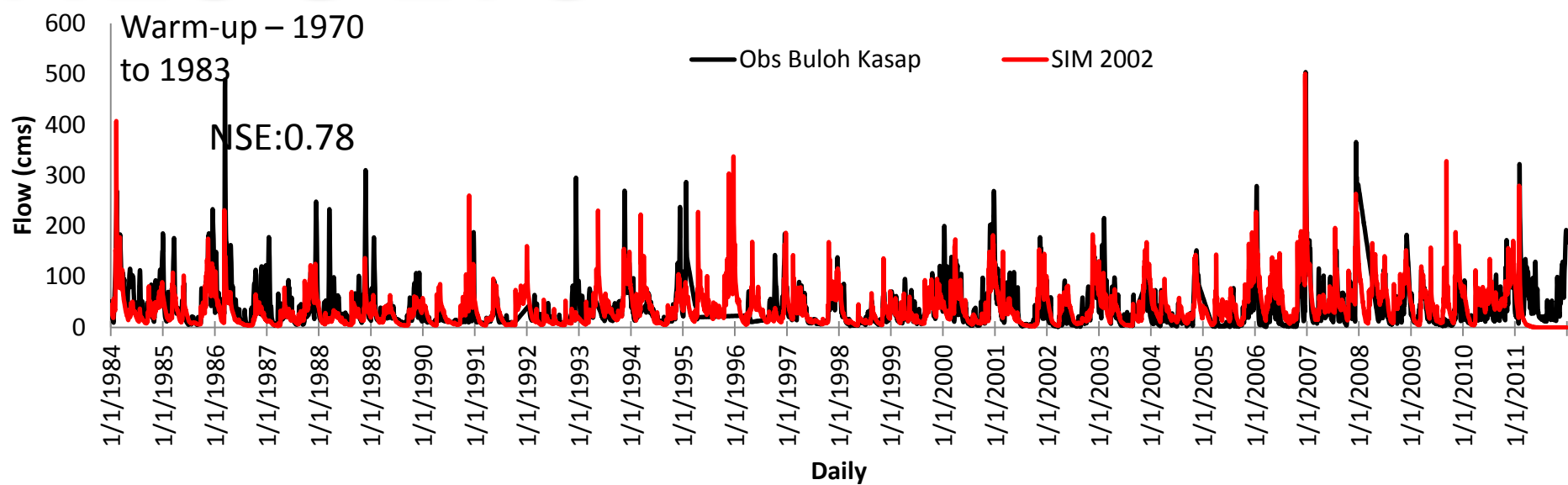
Land cover	2002	2006	2008
Rubber	35.59%	27.84%	28.37%
Oil Palm	25.54%	35.09%	35.31%
Forest	24.48%	23.01%	22.64%
Other	14.39%	14.06%	13.69%

Oil Palm
Rubber
Forest

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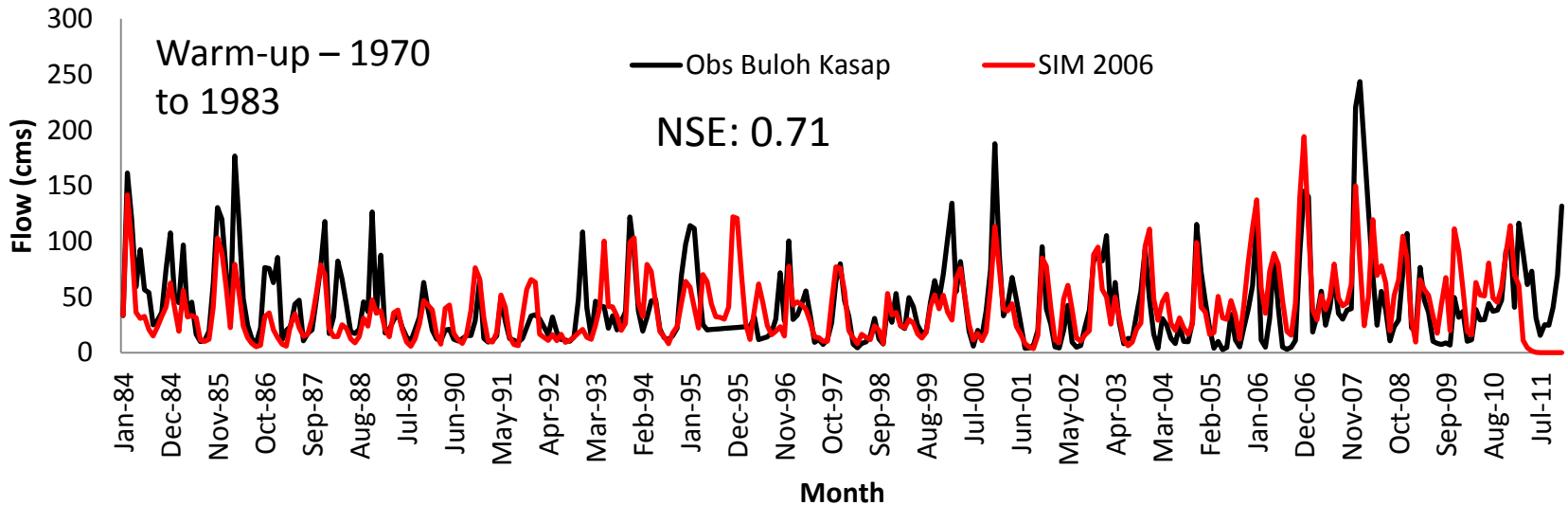
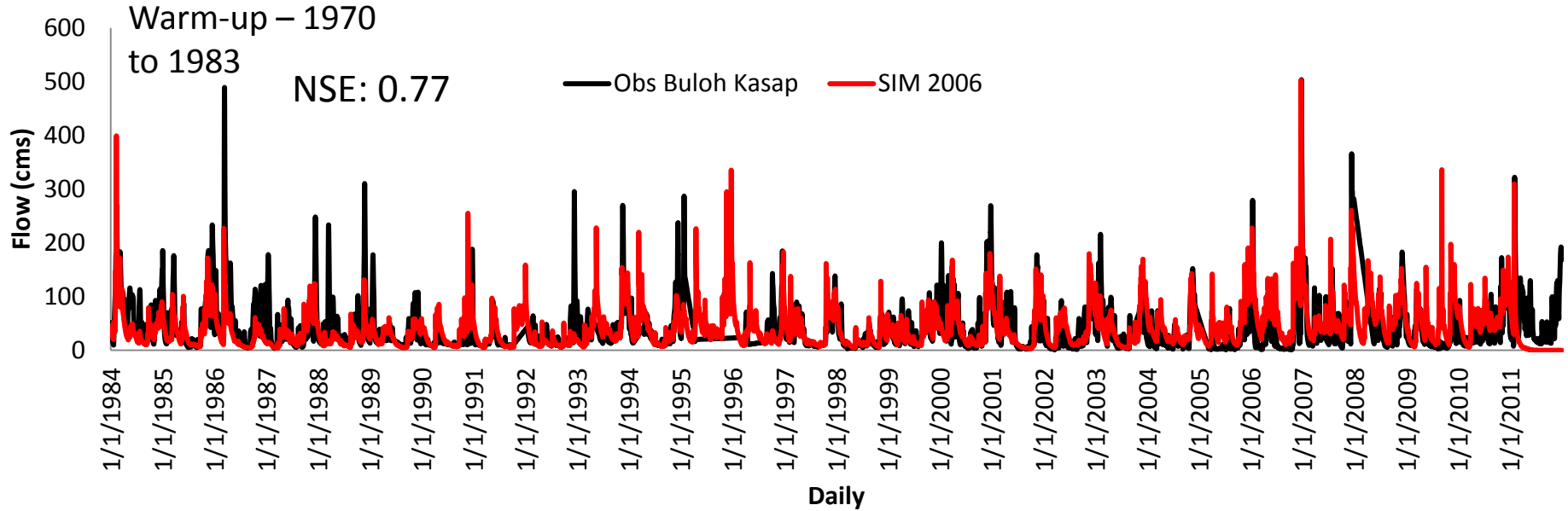
RESULTS

Daily
Simulated Flow using land cover year 2002
Monthly



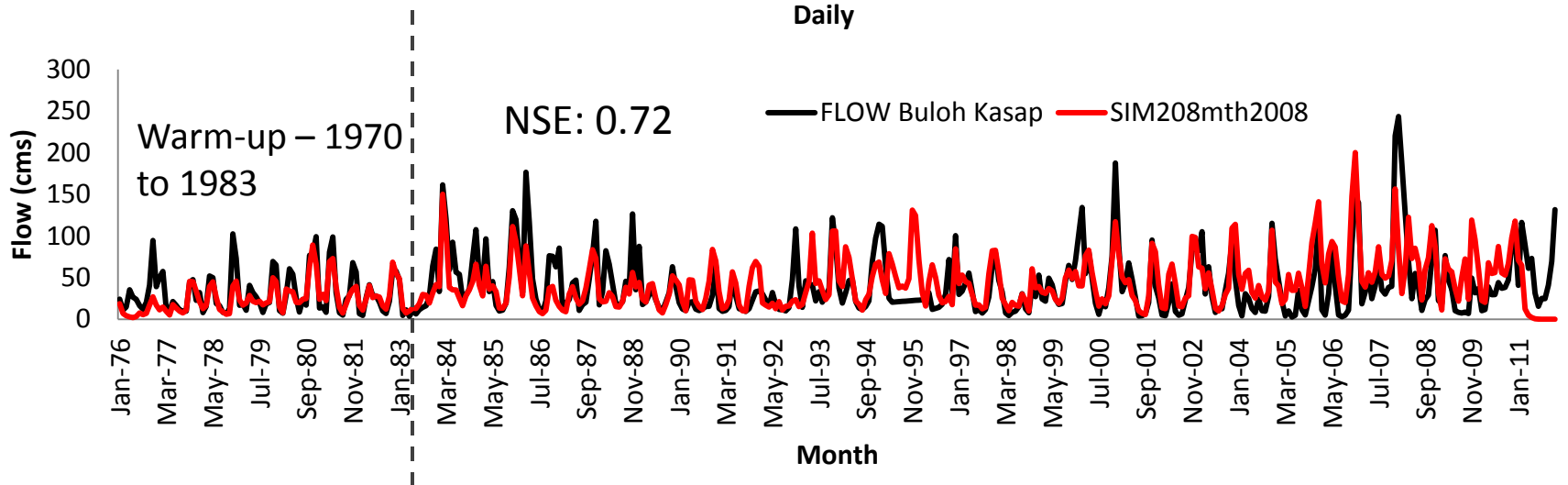
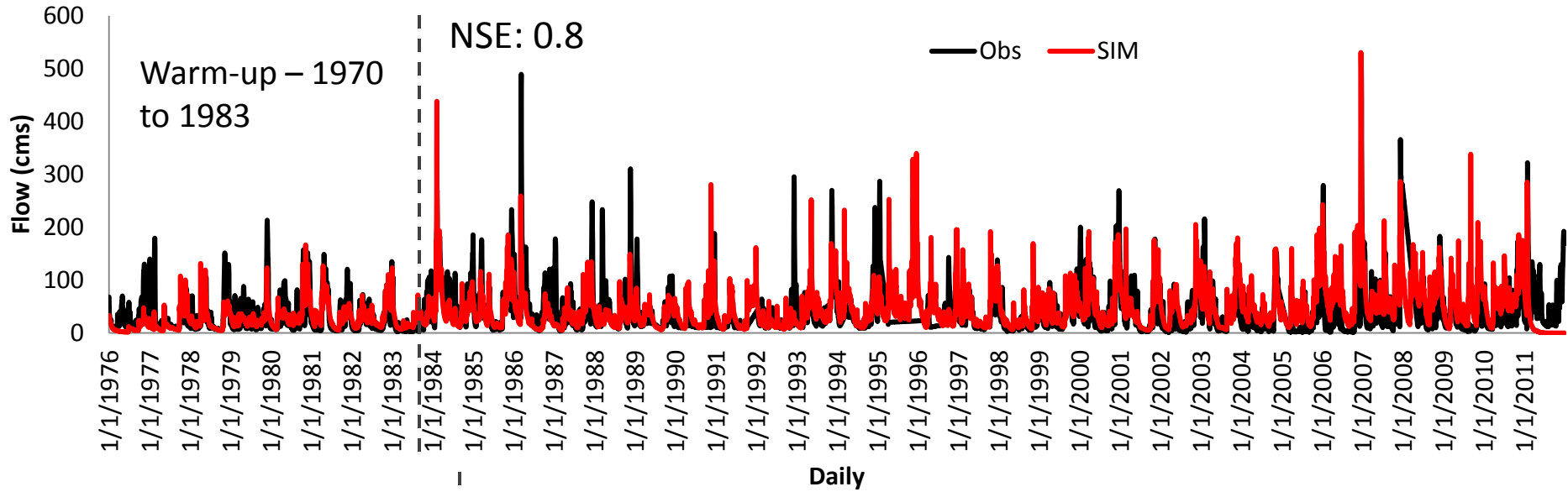
RESULTS

Daily
Simulated Flow using land cover year 2006
Monthly

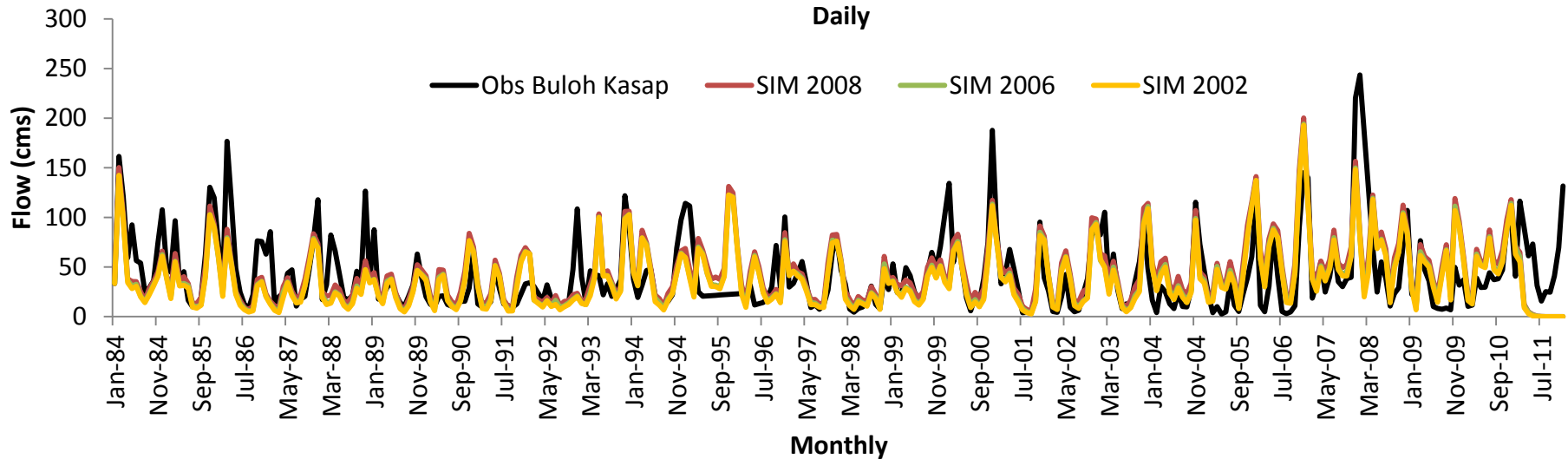
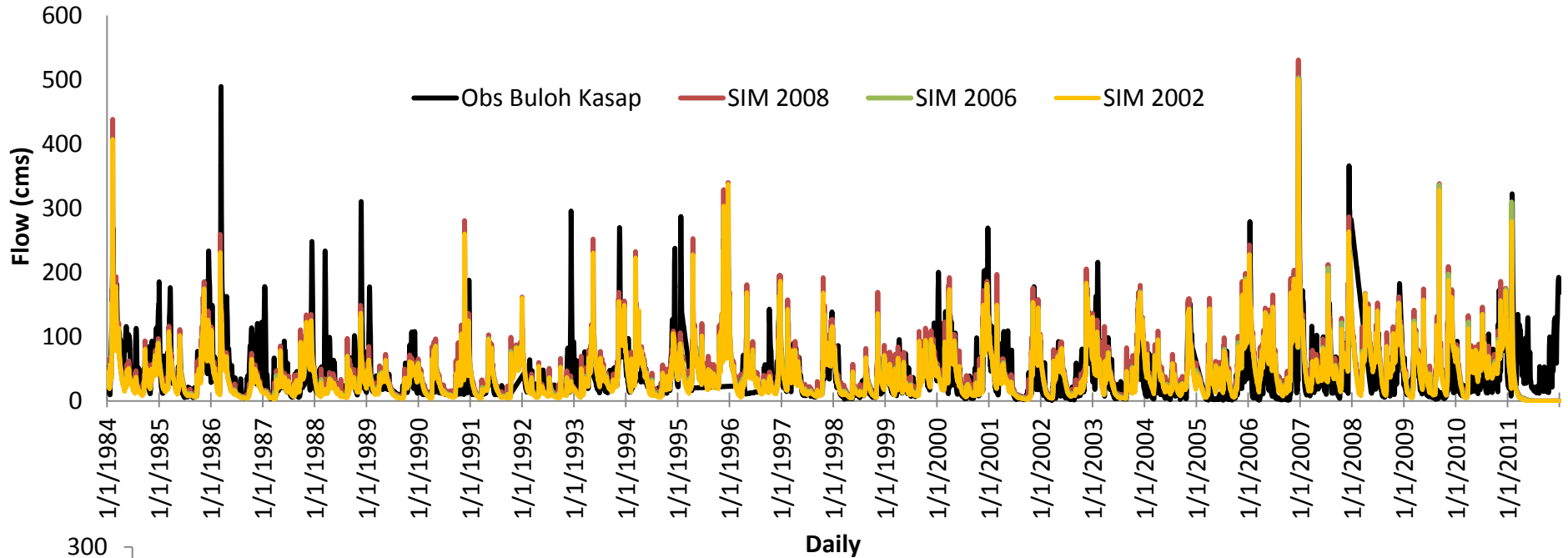


RESULTS

Daily
Simulated Flow using land cover year 2008
Monthly

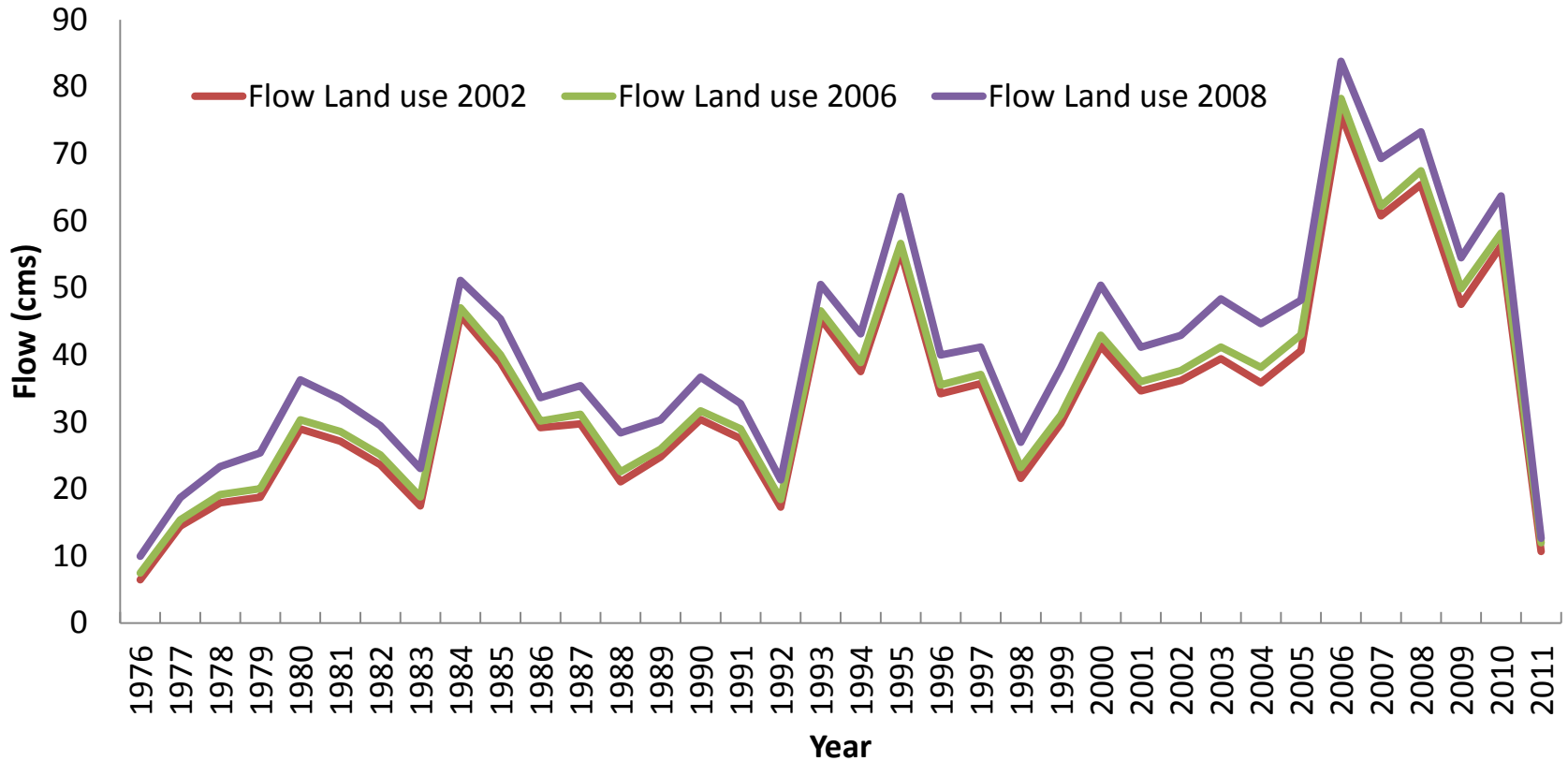


RESULTS Simulated Flow COMPARISONS for 2002, 2006 and 2008



RESULTS

Simulated Annual Flow COMPARISONS for 2002, 2006 and 2008



Conclusion..

- **Vast replacement of rubber to oil palm seem to contribute to increase in frequency and magnitude of flooding.**
- **Still need to check against rainfall events & more detailed subwatershed comparisons needed.**
- **If proven the case, stormwater management plan is necessary for even the rural oil palm plantation to prevent monsoonal flooding.**
- **SWAT is capable of doing hydrology in heavy-rainfall tropical monoculture (rubber, oil palm) environment.**

Merci..

