衛星・気象観測データを用いたカリマンタン島FPIの予測
Fire potential prediction using satellite data and surface observations in Kalimantan Island

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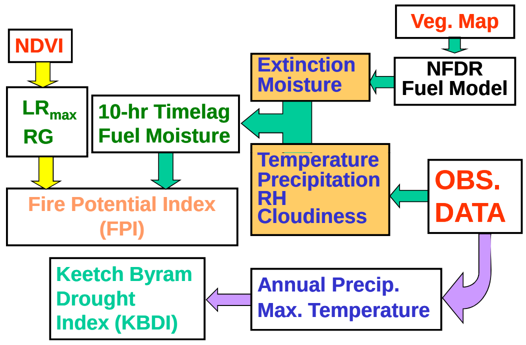
Introduction

- Developing methodologies and system for monitoring and predicting fire occurrence in a certain area is very important
- In the fire management system, one important aspect is monitoring and prediction of danger integrated in an early warning system
- Indonesia still has many difficulties in realizing the system, since it should be based primarily on a number of meteorological and satellite data

Objectives

- Develop the fire danger estimation described as FPI (Fire Potential Index) using global NDVI and climate data from meteorological observations in Kalimantan
- The fuel model map was modified from the US NFDRS map to match the vegetation types in tropics
- Compare the results with KBDI (Keetch Byram Drought Index)

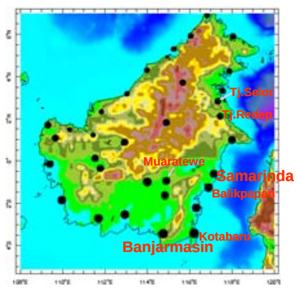
Estimation Process



Global NDVI Datasets

- Source: global 10-day composite 8 km AVHRR NDVI data
- Resolution: 4 min. lat. x 4 min. lon.
- Temporal cov.: Jul. 11, 1981~Dec. 31, 2000
- NDVI = (DN-128) x 0.008
- AOI: Kalimantan (9.33N,106.67E~ 4.76S, 120.67E)

Kalimantan Observation Sta.

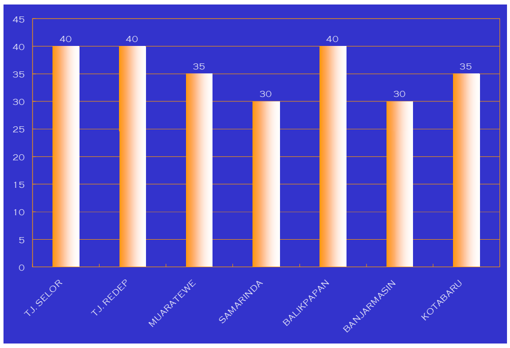


- 24 active stations of 34 NOAA Daily NCDC WMO Stations available
- AOI: South, East Kalimantan
- Period: Jan. 1, 1994~Dec. 31, 1998
- Climate datasets: Daily Temperature, Precipitations, Dew point temp.

NFDR Fuel Model

- Fuel models are a set of numbers that describe vegetation
- The land cover for tropics: forested area, mangroves, swamp forest, man-made forest, dryland, wetland, agriculture, estate and settlement
- Models adopted from US NFDR: water, hardwoods, agricultural land, heavy, intermediate and light logging slash
- Extinction moisture: hardwoods (40%), estate (30%), agricultural (30%), dryland (20%), swamp forest (30%) and wetland (35%)

Extinction Moisture [%]



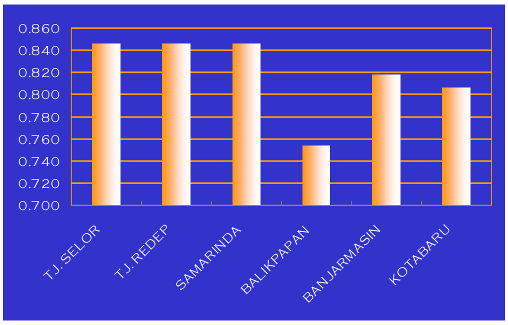
Maximum Live Ratio

- Maximum live ratio (LR_{max}): a function of the live and dead loads assigned to each fuel model.
- LR_{max} is used to avoid similar LRs for fuel models that represent different vegetation types

$$LR_{max} = 35+40 \times (ND_{max} - 100)/80$$

where: $ND_{max} = NDVI_{max} \times 100+100$

Time Series-LR_{max}



Relative Greenness

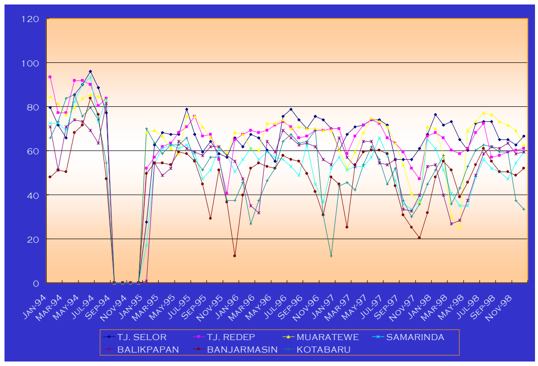
- Relative Greenness indicates how green each location currently is in relation to the range of historical NDVI
- Derived from the NDVI which is calculated from NOAA/AVHRR global data.

$$RG=(NDVI_o-NDVI_{min})/(NDVI_{max}-NDVI_{min})\times 100$$

where:

$NDVI_o$: highest observed NDVI value for a 10-days composite period
$NDVI_{max}$: historical maximum NDVI
$NDVI_{min}$: historical minimum NDVI

RG AOI 1994-1998



Ten hour timelag fuel moisture

- Given an ignition source, the probability that a wildland fire will ignite and spread is strongly dependent on the moisture content of small dead vegetation
- 10-hour timelag period is proved to be the most appropriate by US NFDRS
- Calculated from temperature, relative humidity, and state of weather (cloudiness and occurrence of precipitation) observed from the observation stations

FPI Computation

- Set FPI to “no data” ($FPI = 105$)
- Convert RG to fractional values: $RG_f = RG/100$
- Calculate current live fuel ratio:
  $LR = RG_f \times LR_{max}/100$
- Find normalized 10-h fuel moisture (min. 2%) from 10-h moisture and extinction moisture:
  $TN_f = (FM_{10} - 2)/(MX_d - 2)$
  TN_f : fractional 10-h fuel moisture
  FM_{10} : 10-h moisture [%]
  MX_d : dead fuel extinction moisture [%]
- Calculate $FPI = (1 - TN_f) \times (1 - LR) \times 100$

KBDI (Keetch Byram Drought Index)

- KBDI: an index of drought based on the moisture content of the soil (scaled 0~2000)
- Calculated using mean annual rainfall of a station, today’s maximum temperature, and today’s rainfall

$$DF = \frac{(2000 - KBDI) \times (0.9676^{(.0875 T_{max} + 1.552)} - 8.299) \times 0.001}{1 + 10.88^{(-.00175 Rain_{ann})}}$$

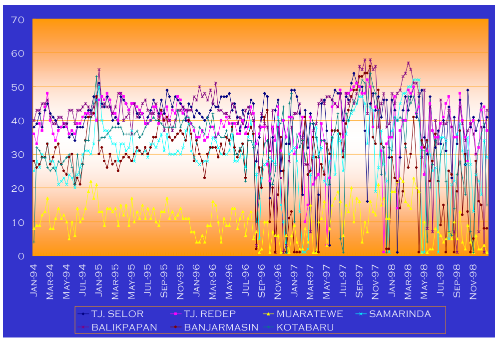
T_{max} : daily maximum temperature;
$Rain_{ann}$: mean annual rainfall for the area

- $KBDI = \Sigma KBDI_{yesterday} + (10 \times Rain_{today} - DF_{today})$

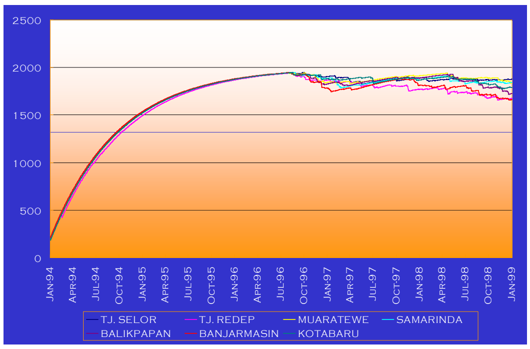
KBDI (Keetch Byram Drought Index)

- KBDI is set to “0” at the starting point, meaning the soil is saturated by water
- Keetch and Byram (1986) found such a point as the day after a rainy period with 150 to 200 mm rainfall within a week

FPI South-East Kal.



KBDI South-East Kalimantan



Conclusions

- Based on modified US-NFDRS, the algorithm to predict fire danger in Kalimantan showed a strong relationship to the KBDI, especially in South and Central provinces during the forest fire event in 1997
- In the next research, we extend the FPI algorithm to treat 2-D profiles