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Challenges in satellite-based research on forest and land fires in Indonesia: frequent item set approach

Lailan Syaufina[a,*], Imas Sukaesih Sitanggang[b], Lusi Maulana Erman[b]

[a]*Faculty of Forestry, Bogor Agricultural University, Jl. Lingkar Akademik Kampus IPB Darmaga, Bogor 16680, Indonesia*
[b] *Faculty of Mathematics and Natural Sciences,, Bogor Agricultural University, Jl. Meranti Kampus IPB Darmaga, Bogor 16680, Indonesia*

Abstract

Forest fire research in Indonesia has been in increasing trend since 1982/1983- and 1997/1998-fire episodes. The first episode emphasized on fire impacts and the second episode has more research on emission and pollution. Satellite-based researches on fire are scattered and still limited. This study aimed to analyze fire satellite-based research aspects and challenges for the future. Text mining was applied to analyze selected international as well as national journals containing fire satellite-based research. The study revealed that there are three main research clusters: fire emission and pollution, fire detection, and fire danger and risk.

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Keywords: forest fire; fire episode; satellite-based research; emission; text mining; Indonesia.

1. Introduction

One of the important environmental problems in Indonesia is forest and land fire occurrences, which has been pronounced since 1982/1983 when about 3.6 million ha of tropical rain forest in East Kalimantan burned out. Large fire events recurrent in 1987, 1990/1991, 1994, 1997/1998, 2002, 2006, 2013, 2014, and currently in 2015, which correspond to extreme weather events such as El Nino phenomenon. Two years of satellite-based active fire detections over Peninsular Malaysia, Sumatra, Borneo and Java were examined together with land cover and peat

* Corresponding author. Tel.: +62-813-1102-8233.
E-mail address: syaufina2016@gmail.com.

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land maps [1] showed that fire occurrence nearly tripled (23,000 vs 68,000) from a wet La Niña year (2008) to a drier El Niño year (2009). In both years, fires were concentrated in peat lands (in 2009 41% of fires vs.10% of land area), and the majority of large-scale burning took place in peat lands. Impacts of the fires were experienced by not only local level but also global environment. For science, those fire episodes have been a great challenge to study the impacts and to develop methodology of assessment as well as fire control.

Remote sensing as satellite-based technology plays very important role in forest and land fire assessment, which include: fire detection, fire impact assessment, early warning system, fire management plan, and post fire rehabilitation plan. Furthermore, satellite data have been used to monitor biomass burning at regional and global scale for more than two decades using algorithms that detect the location of active fires at the time of satellite overpass and in the last decade using burned area algorithms that map directly the spatial extent of the area affected by fires [2] such as the MODIS Burned Area Product (MCD45). Forest fire research is one of many appropriate GIS applications. The diversity of factors that affect the beginning and spreading of a forest fire dictates the use of an integrated analysis approach. Considering the intrinsic dynamism of this phenomenon, remote sensing imagery is also very valuable for these kinds of studies. It provides a quick evaluation of the vegetation status, as well as a survey of the effects of fire upon the environment [3]. However, information on the extent and magnitude of the technology application is still limited.

On the other hand, text mining4 commonly defined as a knowledge-intensive process in which a user interacts with a document collection over time by using a suite of analysis tools. It is a new and exciting research area that tries to solve the information overload problem by using techniques from data mining, machine learning, natural language processing (NLP), information retrieval (IR), and knowledge management. The data sources in text mining are document collections, interesting patterns are found not among formalized database records but in the unstructured textual data in the documents in these collections. The technology has been now widely applied including in business, research, and government needs such as biomedical application, software application, online media applications, marketing application, and academic application for examples.

Therefore, this paper aimed to elaborate how far the satellite-based research has been developed and to what extent the research were conducted through text mining analyses using frequent item set approach of journal articles on fire satellite-based researches. The analyses results will be used to identify the challenge of satellite-based research on forest and land fires to be developed in the future, which will provide benefit to minimize forest and land fire occurrences in Indonesia.

2. Data and Methods

2.1. Study area

This study is covering satellite-based researches on forest and land fires conducted in Indonesia as well as those related to fire occurrences and the impacts in Indonesia, particularly in Sumatera and Kalimantan (Fig. 1).

Fig. 1. Map of Indonesia