Deep Learning Methods as a Detection Tools for Forest Fire Decision Making Process Fire Prevention in Indonesia

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Abstract. This research examines the collaboration between agencies in policy-making based on hotspot monitoring from satellites. Valid data regarding the number of hotspots from the satellite is needed in decision making because it provides information used to control forest and land fires in Indonesia. For instance, the Ministry of Forestry uses data from the NOAA-18 satellite for analysis, while the BMKG utilizes those from the Agua/Terra. However, the data generated by each satellite has differences in the number of hotspots. Therefore, this research aims to determine the collaboration between the Ministry of Forestry and BMKG in the use of satellite data for decision-makers to determine disaster alert status. This research uses a qualitative approach to analyze secondary data from two popular media sources collected using the Nvivo 12 plus application. The result showed that agencies involved in fire prevention lack collaboration due to institutional designs that lead to a lack of communication and unclear roles for each institution during the decision making process.

1 Introduction

The impact of forest and land fires deteriorates the quality of air in the surrounding area and leads to loss of crops, resources, animal, people, etc. [1]. Due to Indonesia's vast forest area, detecting the fire source or location is quite difficult [2]. Therefore, one of the methods used to detect the source of forest fires is satellite sensing [3]. The data from the satellite provides the ability for forest and land fires to be easily detected. In controlling forest and land fires, collaboration is carried out between BPBD and KLHK as the institution responsible for preventing forest and land fires.

The collaboration of various actors and institutions is essential in making discussions on forest and land fire management. Furthermore, collaboration is also needed to solve arrangements problems to achieve the desired output [4, 5]. Deals regarding the communication interaction between various institutions are significant and need to be carried out for the creation of better results [6]. This discussion is particularly relevant

© Springer Nature Switzerland AG 2021
C. Stephanidis et al. (Eds.): HCII 2021, CCIS 1498, pp. 177–182, 2021.
https://doi.org/10.1007/978-3-030-90176-9_24

because it contributes to understanding institutions' role in forest and land fire management. Besides, the collaborative arrangements created and implemented answer critical questions related to authorities in the forest and land fire governance, such as how the various agencies involved make arrangements designed to work together. Therefore, it is important to determine the capacity needed to reach joint decisions on forest and land fire management [7].

This research aims to analyze the collaboration between the Ministry of Environment and Forestry and BMKG in controlling forest and land fires in Riau Province, especially in determining disaster emergency alert status, based on the number of hotspots from satellite monitoring. This study focuses on making a collaborative decision between initial conditions, institutional design, leadership, and processes.

2 Literature Review

Currently, smokes due to forest fires are being detected by applying deep learning methods to produce satellite-generated images [8]. The use of deep learning methods is due to the numerous disadvantages of traditional methods, such as the time-consuming process and low feature performance analysis in fire detection [9]. It is also used to detect shadows, lighting, and objects that are coloured like fire, thereby leading to false detection [10]. [11] uses deep learning methods for early detection by classifying and extracting fire and non-fire areas simultaneously to resolve the issue. This method also has a high detection rate, which increases the smoke detection speed [12]. Furthermore, the deep learning method used on satellites as a data source in monitoring hotspot produces valid data [12].

Deep learning methods have also been applied to detect fire and smoke from multispectral satellite imagery [12]. The process of detecting hotspots using deep learning methods and MODIS instrument data from the Tera-Aqua satellite easily distinguishes fire and non-fire objects to produce more valid data. [12] also evaluated fire and non-fire imagery to determine the accuracy of the proposed fire detection method. Deep learning methods have better performance and easily used to determine the right fire area, which is extracted based on the thresholding pattern and local binary. [13] generated data for predicting fire smoke in satellite images in fast time using data from the Himawari-8/HI sensor. Every hotspot detected by a satellite is not necessarily valid. Therefore deep learning methods on satellites are needed to prevent errors in decision making.

3 Research Method

Data were first collected from articles related to forest and land fires in three media, namely Kompas, Tribun Pekanbaru, and media indonesia, using the Ncapture feature in the Nvivo 12 plus data processing application. The articles were freely obtained from accessible newspaper archives from january 1, 2014, to December 201, using the keywords "hotspot monitoring," "forest fire," "land fire," "determination of emergency alert status," and "haze." for 564, 435, and 323 articles met the search criteria for kompas.com, pekanbaru.tribunnews.com, and mediaindonesia.com, respectively. Fifty articles were selected per newspaper culminating in 150 articles. The articles were reviewed to ensure they included a substantial section that uses satellites in hotspot detection by removing those not related to news and replacing them with other randomly selected articles. Also, study documents, including policy papers, reports, and updates from provincial governments and interest groups, helped consolidate the study.

4 Result

This study found a lack of collaboration between institutions due to institutional design, which led to inadequate communication in determining the time to choose the alert status for forest and land fires. The emergency alert policy is critical in decision-making because it deals with the increasingly widespread threat of fire hazards. Early warning is part of the collaboration, which focuses on communicating individuals and institutional actors in negotiating interests and concerns on risk assessment and management [6]. This communication encourages exchanging evaluations, estimates and opinions on hazards and risks among the various stakeholders involved. As such, communication governance needs collaboration between multiple agencies involved in forest and land fire prevention.

Collaboration on institutional designs only occurs in 5% of BMKG and 4% of KLHK, as shown in Fig. 1.

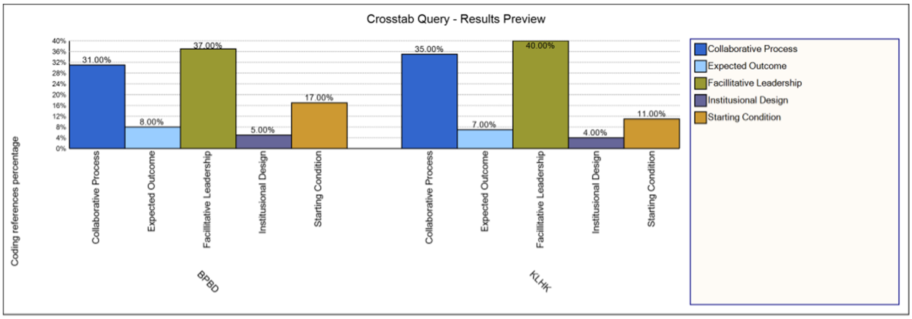

Fig. 1. Collaboration between KLHK and BMKG

Figure 1 shows that KLHK and BMKG collaborate in using satellite data to determine the number of hotspots for policy-making by 5% and 4%, respectively. The institutional design means that the two essential decision-making institutions do not collaborate properly in determining the disaster preparedness status. Lack of communication among stakeholders leads to an inadequate institutional effort to collect and interpret risk signs [6, 14].

BMKG conducts early warning by anticipating forest and land fires when entering the dry season because people in fire-prone areas need to be vigilant. According to information provided by BMKG, the early warning process is carried out in three stages, namely (1) warning to districts/cities whose areas are predicted to experience dry season, (2) 10-day rainfall analysis maps that is analyzed and classified into low, medium and high rainfall, and (3) provides initial information as a basis for determining the status of Emergency Alert in an area [6]. The Ministry of Environment and Forestry, based on satellite data, also provided BPBD with information on the number of hotspots monitored to carry out extinguishing actions at the fire location. However, due to differences in data regarding the number of hotspots, decision making is constrained. Therefore, it is necessary and unnecessary to determine the emergency alert status of BMKG and KLHK, respectively. Early detection activities in preventing forest and land fires are important factors to conduct because it is an effort to obtain very early information on forest fires by applying simple to advanced technology [15]. Furthermore, early detection can determine the decision-making process used to assess forest and land fire preparedness [15]. Accurate detection can assist the fire fighting stage and the sound post-fire handling stage [6]. Also, at the implementation stage, the detection process's accuracy tends to affect the allocation of funds, smooth operation of blackouts, and the need for investigation in cases of violations of environmental law [16]. Early detection is processed by land through patrols, tower observation and guarding in fire-prone areas, while by air, it is carried out by helicopter, aeroplane and satellite [6].

The Ministry of Environment and Forestry and BMKG used information from two different satellites to reference forest and land fires. The data generated by each satellite has a different number of hotspots, which shows that there are obstacles in making emergency alert status decisions, especially in taking essential steps before the fire spreads [6]. The prevention system relies on data used as a reference on the hotspot detection produced by the Terra-Aqua and NOAA satellites. The problem occurred due to the differences in data that became the reference for BMKG and KLHK in making decisions. BMKG and the Ministry of Environment and Forestry are associated with data from the TERRA-AQUA and NOAA satellites. Therefore, based on NOAA satellite monitoring, the real hotspots throughout Indonesia in 2015 and 2016 amounted to 6,595 and 1,950, respectively. Meanwhile, based on the TERRA-AQUA satellite in 2015, and 2016 a total of 8,204 and 2,544 were detected (Table 1).

Table 1. Hotspot monitoring from satellite

Years	Hotspots	
	NOAA	TERRA-AQUA
2015	6.595	8.204
2016	1.950	2.544

In Riau Province, the number of hotspots observed on the NOAA satellite was 1,208 in 2015 and 297 in 2016. On the Terra-Aqua satellite, the number of hotspots was 1,537 and 499 in 2015 and 2016. Data from satellites using the deep learning method is more accurate than those that do not use these methods. This is because the use of deep learning methods is useful for avoiding large-scale fires. Furthermore, effective fire detection from the visual scene is essential [12]. Due to the severe and dangerous consequences that forest fires have on human, animal and plant life worldwide, traditional methods, rapid response, and large detection areas do not apply to detect fires [9]. Therefore, to improve the accuracy of fire detection, the deep learning method is used to classify the data set into the fire and non-fire images, create a matrix to determine the efficiency of the framework, and extract the area where fires occur in satellite imagery which aims to reduce the false detection rate [12].

The NOAA satellites' image resolution is very coarse and allows the location description to be distorted, making it less accurate in identifying forest fires [17]. It provides information from hotspot detection satellites in data on the location and direction of smoke spread [17]. Hotspot information, which is the basis for a fire warning system, sometimes produces an error in decision-making when there is no fire incident in the field [18]. It is common evidence that the absence of acknowledged exchange on information between ministries in forest management is due to a combination of institutions [19]. Organizational weaknesses are caused by various factors, such as the unclear role in organizing [2], the relationship between the organizations involved [1], and their ineffectiveness [20].

5 Conclusion

In conclusion, the use of different satellites results in a varying number of hotspots, thereby leading to various references when making decisions, which can confuse local governments in determining disaster emergency alert status. Furthermore, its use shows a lack of collaboration between institutions due to the institutional design, which causes a lack of communication and unclear roles for each institution in decision making. This collaboration's failure shows that the policy-making process in dealing with forest fires faces significant challenges in strengthening collaboration between government agencies at the national and local levels.

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