Impact of Land-use Change on Dengue Hemorrhagic Fever in Kolaka District, Southeast Sulawesi Province, Indonesia

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Abstract: - Land use change is contributing to the emergence of zoonotic diseases in the community. And can cause an increase in the spread of the virus through arthropods. This study aimed to determine the association of land use factors and dengue hemorrhagic fever in Kolaka District, Southeast Sulawesi Province, Indonesia. The secondary data obtained from various governments of Indonesia were used for this study. Data of dengue hemorrhagic fever from Ministry of Health of Republic Indonesia. Land use data is derived from the classification of Citra Landsat 8 on a scale of 1: 250,000 from 2010 to 2020. The Spearman rank correlation test was used to examine the relationship between land-use change and the incidence rate of dengue hemorrhagic fever. The results of this study In Period 2010-2015 is a correlation between Agriculture with *dengue hemorrhagic fever* ($\alpha = 0.812$, $p < 0.05$), and water bodies with $\alpha = 0.812$. The area of agricultural land is increasing every year; in 2010, only 3.32% increase to 51.08% in 2015. Furthermore, in period 2016-2020 is a correlation between Forest with dengue hemorrhagic fever ($\alpha = 0.900$, $p < 0.05$), and Settlement ($\alpha = -0.900$, $p < 0.05$). Our findings could be used to improve the understanding of land-use change and dengue hemorrhagic fever in the Kolaka district and provide information on land use that does not damage the environment.

Key-Words: - Land use; Dengue hemorrhagic fever; Forest; Agriculture; Water bodies; Indonesia

Received: May 26, 2021. Revised: November 14, 2021. Accepted: December 13, 2021. Published: January 9, 2022.

1 Introduction

Dengue hemorrhagic fever (DHF) is an infection caused by the dengue virus [1]. Dengue fever is a highly contagious disease [2]. The dengue virus is transmitted through the *Aedes aegypti* and *Aedes albopictus* mosquitoes [3, 4]. Dengue fever and dengue hemorrhagic fever/dengue shock syndrome are caused by four viral serotypes. In Indonesia, dengue hemorrhagic fever is still an important public health problem [5]. In Indonesia, dengue infection has been endemic for the last two centuries [6]. The World Health Organization estimates that 50-100 million dengue infections occur each year. This situation is increasingly worrying because almost half of the world's population lives in dengue-endemic countries. Globally this virus is spreading very fast, with a 30-fold increase over the last 50 years [7]

In Indonesia, the number of dengue cases reported in 2019 was 138,127 cases. This number increased compared to 2018 of 65,602 cases. Deaths due to DHF in 2019 also increased compared to 2018 from 467 to 919 deaths. Illness and death can be described using the incidence rate (IR) indicator per 100,000 population and the case fatality rate (CFR) as a percentage [8]. In Southeast Sulawesi, there were 3,433 cases reported in 2016, with the Incidence Rate reaching 132.5 per 100,000 population. In 2017 the number of reported cases decreased significantly to 941 cases, with the Pain Rate returning to an average condition ranging from 35.7/100,000 population [9]. In Kolaka, in 2018, there were 213 cases of dengue fever with an Incidence Rate of 82.7 per 100,000 population. Of these cases, 2 cases died [9]. Furthermore, in 2019, the number of dengue cases was 250 cases with an Incidence Rate of 95.5 per 100,000 population. Of these cases, 1 case died [8].

Many studies have been carried out by combining the land change factor with the density of Aedes mosquitoes [10]. Land use such as water bodies in certain agricultural practices was identified as a risk factor for dengue fever [11]. Excessive land use is one of the problems for the emergence of infectious diseases. Natural forest is a complex ecosystem, and as a habit of various flora, if the ecosystem is disturbed, it will impact human health [12]. Land-use change affects mosquito habitat, distribution, vector abundance [13]. The occurrence of land change using the Normalized Difference Vegetation Index (NDVI) indicator is a risk factor for environmental change in urban areas [14]. The objective of our study was to determine the association of land use factors and dengue hemorrhagic fever in Kolaka District, Southeast Sulawesi Province, Indonesia.

2 Material and Methods

2.1 Locations of Study

This research was conducted in Kolaka district, Southeast Sulawesi province, Indonesia. Astronomically, Kolaka district is located along the equator section of the equator, extending from North to South between 3°36'- 4°35' South Latitude (SL) and extending from West to East between 120 ° 45'-121 ° 52 ' East Longitude (EL). Based on its geographical position, the territorial boundaries of Kolaka district in the north is Kolaka Utara district, in the south is Bombana district, in the east is Kolaka Timur district and in the west is Sulawesi Selatan Province in Teluk Bone [15].

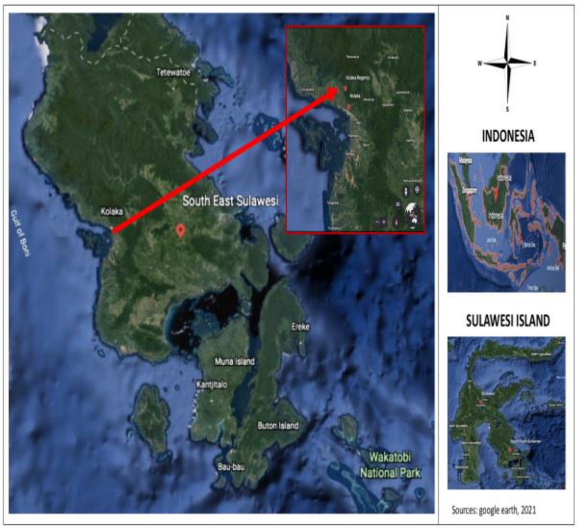

Fig.1: Map of Kolaka district.
Source: www.googleearth.com

2.2 Data Collection

The secondary data obtained from various governments of Indonesia were used for this study. Data of dengue hemorrhagic fever from Ministry of Health of Republic Indonesia. Land use data is derived from the classification of Citra Landsat 8 on a scale of 1: 250,000 from 2010 to 2020. By taking the map using satellite images downloaded https://glovis.usgs.gov. Land use data acquired and interpreted through Landsat imagery using GIS software [16]. Land use is done by the Multispectral interpretation method with a guided classification that is a maximum likelihood algorithm. Interpretation of remote sensing data using spectral channels in the image which is then classified based on the characteristics of the object or land cover. The result is land use data in the form of raster data, with map output. Thematic maps are created and edited, overlay, and visualized in the QGIS [17]. There are four classifications of land use in the district of Kolaka (National Standard of Indonesian). The following table is land-use classification [18]: *Settlement/residential:* Acreage or land used as a residential area or residential environment and the activity place that supports people's lives; *Agriculture:* Agricultural area is flooded by water, either with the technology of irrigation, rained, tides. The agricultural area is characterized by bund pattern and is planted with crops short-lived; *Forest:* Forest that grow on dry land habitats that can be either lowland forests, hills, and mountains, or the tropical highland forests that have undergone human intervention or had appeared logged-over (appearance groove and patches of logged-over); *Water bodies:* The area is natural or unnatural; consist of Swamps, rivers, lakes, and dams.

2.3 Data Analysis

Land use data obtained from the Kolaka district is categorized by sub-district. The proportional land use data type was used to analyze the association with the DHF incidence rate. The climate data was overlaid by years, from 2010 to 2020. The criteria of IR DHF used by an indicator of the Ministry of Health of the Republic of Indonesia [8]. The was visualization by sub-district and by month in 2010 and 2020. The proportion of data in each type was calculated from the area (Ha). As data were not normally distributed, the Spearman rank correlation test was used to examine the relationship between land-use change and the incidence rate of dengue hemorrhagic fever.

3 Results

Table 1. Distribution of Population, DHF cases, and Incidence Rate of DHF in Kolaka district, 2010-2020

Years	Population	DHF Cases	IR DHF
2010	208766	274	131.24
2011	213064	125	58.66
2012	232470	84	36.13
2013	215871	198	91.72
2014	203985	427	209.32
2015	233437	751	321.71
2016	238679	685	286.99
2017	243022	243	99.99
2018	248798	202	81.19
2019	252843	221	87.4
2020	258454	58	22.44

Table 1 shows that the high incidence rate of dengue hemorrhagic fever is in 2015 (321.71 per 10000 population), and the low incidence rate is in 2020 (22.44 per 10000 population).

Table 2. Distribution of Land use change in Kolaka district, 2010-2020

years	Land-use change (Ha)			
	Agriculture	Forest	Settlement	Water bodies
2010	9,561.37	266,680.51	7,658.90	3,741.05
2011	9,526.58	253,282.09	8,765.49	3,717.38
2012	9,561.37	266,680.51	7,658.90	3,741.05
2013	110,809.89	147,598.41	24,054.66	5,153.50
2014	141,610.94	116,408.84	24,367.36	5,229.33
2015	146,906.40	105,711.67	25,915.32	9,083.11
2016	110,975.6	166,226.1	4,568.02	5,931.51
2017	111,734.3	164,005.8	5,469.97	6,491.12
2018	112,396.5	163,429.4	5,472.618	6,402.6
2019	112,528.3	163,292.1	5,632.629	6,248.169
2020	112,471.1	163,223.9	5,952.709	6,053.541

Land use factors in Kolaka District are classified into four variables: agriculture, forest, settlement, and water bodies. The land use information was analyzed using the multispectral interpretation method with supervised classification of maximum likelihood algorithm. The use of this algorithm is for a homogenous object. On the contrary, in the Kolaka district, agriculture areas were extended every year while the settlement areas also increased similar to the agriculture type (**Table 2**)

Table 3. Correlation between land-use change and an incidence rate of DHF

Period (years)	Agriculture	Forest	Settlement	Water bodies
2010-2015	0.812*	-0.754	0.754	0.812*
2016-2020	-0.700	0.900**	-0.900**	-0.100

Correlation is significant at the 0.01 level (2-tailed).**
Correlation is significant at the 0.05 level (2-tailed).*

In period 2010-2015 is a correlation between Agriculture with *dengue hemorrhagic fever* (α = 0.812, p <0.05), and water bodies with α =0.812. The area of agricultural land is increasing every year; in 2010, only 3.32% increase to 51.08% in 2015. Furthermore, in period 2016-2020 is a correlation between Forest with dengue hemorrhagic fever (α = 0.900, p <0.05), and

Settlement (α = -0.900, p <0.05). This is inversely proportional to the forest that has decreased the size of the area. Potential Land change that occurred in the Kolaka district is Cocoa plantation development (**Table 3**)

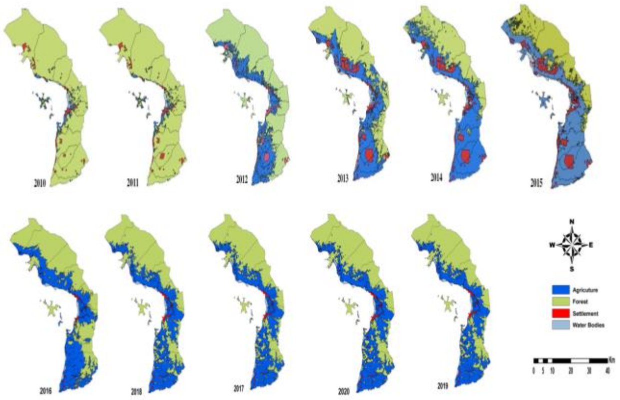

Fig.2: Map of Land use change in Kolaka district, during 2010-2020

Figure 2 shows that land use in Kolaka district has changed every year. Agricultural areas were increased from 9,561.37 Ha in 2010 to 112,471.1 Ha in 2020. In contrast, forest area is narrowed region, in 2010 extensive forest area is decreased from 266,680.51 Ha to 163,223.9 Ha in 2020.

4 Discussion

Land-use changes include deforestation, road construction, agribusiness agro-development, dam construction, irrigation, coastal zone degradation, wetland modification, mining, urban environmental expansion, and other activities [19]. The last few decades in the tropics have experienced dramatic events in the field of land use. Food Agricultural Organization (FAO), in the program of Forest Resources Assessment (FRS), estimates that land-use change causes the loss of tropical natural forests in the world [20]. Land-use change may occur due to demographic, socio-economic, and biophysical factors. Demographic factors include population size and population growth, population structure, and the number of household heads. Socio-economic factors include education levels, family income levels, and types of livelihoods. While the biophysical factors such as soil type and slope [21-23]. This situation causes a change in the function of the land area from a planned function to another function that is not in accordance with its designation. David et al. further mentioned that land-use change is influenced by complex interaction results between human factors and environmental factors [24]. Therefore, the occurrence of changes in the use of agricultural land into non-agricultural cannot be avoided because it is closely related to the dynamics of the population and the dynamics of development [25].

Climate change and land-use change can cause disease in humans, either directly or indirectly [12], and have serious impacts such as direct health problems such as death, injury, casualties, diseases with ecological intermediaries, and plant disease epidemics [26, 27]. The emergence of various diseases is strongly influenced by environmental factors such as climate change or land use. Most diseases are caused by vector arthropods, such as mosquitoes, flies, lice. Because of cold-blooded insects, changes in marginal temperature potentially have biological effects on disease transmission. Thus, climate change can change the incidence, transmission, and geographic range of diseases such as malaria, dengue and yellow fever, *leishmaniasis, lyme* disease, and *onchocerciasis* [26, 28].

Forests are areas that have associated primarily trees and other vegetation types that are capable of producing wood and other forest products [28, 29]. These include forests, private forests, protected forests, which only have forests identified by boundaries. Forests make the most significant contribution to water supply in maintaining high water quality through soil stabilization and erosion prevention. By holding sediments and pollutants from other land uses and slopes, forests can protect water bodies and waterways. Research conducted on Oahu Island found that areas with different vegetation and variety enabled the breeding of *Ae. Albopictus* [30]. Furthermore, wetlands and forest areas opened in lowland areas are good breeding grounds for mosquitoes [31].

Agricultural development can lead to environmental and ecological changes, creating a new vector of diseases and intermediate hosts enabling microclimate conditions that support longer vector life; simple habitat in the area due to the loss of vital predator species that keep the vector population under control; or it may cause an increase in human vector contact frequency [13]

Residential density in settlements favored mosquito breeding. Research conducted in Malaysia found that land use on construction sites and industrial estates played a major role in the incidence of dengue fever [32]. A previous study reported that dengue data had a significant association with slum housing [33]. Research conducted by Scott found that human settlements and non-agricultural areas determined the occurrence of dengue fever cases.

The increased population allows *Aedes* mosquitoes to intimidate an infected person and transfer the dengue virus after infection to others [34]. Water bodies are areas where vectors can breed; in this study, water bodies consist of man-made/lake reservoirs, canals in addition to natural lakes, rivers, and streams

5 Conclusions

Changes in land use have an effect on increasing the incidence rate of dengue hemorrhagic fever. In period 2010-2015 is a correlation between Agriculture with *dengue hemorrhagic fever* (α = 0.812, p <0.05), and water bodies with α =0.812. The area of agricultural land is increasing every year; in 2010, only 3.32% increase to 51.08% in 2015. Furthermore, in period 2016-2020 is a correlation between Forest with dengue hemorrhagic fever (α = 0.900, p <0.05), and Settlement (α = -0.900, p <0.05). Influencing factors include agriculture and water bodies in the 2010-2015 period. Next in the 2016-2020 period is forest and settlement. The land change occurred due to the conversion of land use from forest to agricultural land. This land conversion disrupts the habitat of the *Aedes aegypti* mosquito, so it moves to community settlements. Epidemiological data of dengue hemorrhagic fever through surveillance is essential in efforts to prevent the disease. As well as longitudinal land use data provides a warning for the government to realize environmentally sound development. This is because the conversion over this land does not submit the government, which is influenced by various factors, among others: economic pressure; The increase in population so that they open the land extensively, applicable land regulations have not been able to control the rate of land conversion.

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Conflict of Interest:
The authors declare no conflict of interest.

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)
Concept generation, data collection (FS), writing and editing of the manuscript (RT), critically reviewed (NS), writing, and revision (MS, DY).