THE IMPACT OF CLIMATE CHANGE AND LAND COVER ON AVIAN INFLUENZA (AI) INCIDENCE IN SECTOR 4 LIVESTOCK POULTRY (TRADITIONAL POULTRY) IN LAMPUNG PROVINCE

Rohayati[1*], Muhtarudin[2], Samsul Bakri[3*], Jhons Fatriyadi Suwandi[4]

1) Study Program of Environmental Science,
2) Lecture of Graduate Program of Environmental Science and Poultry Department,
3) Lecture of Graduate Program of Environmental Science and Forestry Department
4) Lecture of Graduate Program of Environmental Science and College of Medicine
The University of Lampung

*Corresponding author: Jl. Soemantri Brojonegoro No.1 Bandar Lampung-Indonesia
Email: samsul.bakri@fp.unila.ac.id. Mobile: 081540877546

ABSTRACT: Indonesia is one of the developing countries that is currently being transformed into an industrial country, and its current transformation is especially characterized by the increasing amount of various human activities in agriculture and agro-industry. The increasing demands of various human needs have resulted in the exploitation of natural resources and forced changes in land use for settlements, agriculture areas and industry which ultimately lead to environmental damage. On the other hand, the world is currently facing climate change, a phenomenon that is characterized by a notable increase in air temperatures and fluctuations in rainfalls. Climate change could interfere with the environmental state so that it affects the resistance of the majority of living things in the world, both humans and animals to climate-based disease infections such as Avian Influenza (AI). The purpose of this study (1) is to build a causal relationship between climate change and land cover on the incidence of AI in livestock poultry sector 4 in Lampung Province and (2) to determine the impact of climate change and land cover on the incidence of AI in poultry in sector 4 livestock in the Lampung province. This research was conducted in August - October 2018 with the scope of the research area of Lampung Province in 2009-2015. The dynamics of land cover change and land use per district/city are identified through geographic information systems and interpretation of landsat images in 2009, 2012 and 2015 and other secondary data, producing a percentage of land cover area and land use. The results showed that there was a significant relationship between changes in water body -3,016 (p = 0,071), Shrub 0,5511 (p = 0.005), settlement 0,03662 (p = 0,472), open land -1,4706 (p = 0.027), swamp body - 0.35421 (p = 0.001), mixed dryland 0.02408 (p = 0.142), rice fields -0.05455 (p = 0.338), sea banks 2.6071 (p = 0.008), mangrove -5,473 (p = 0,436), temperature 2,3496 (p = 0,009), rainfall -0,03007 (p = 0,056) and secondary forest covers -0,2289 (p = 0,056)

Keywords: Avian Influenza (AI), climate change, changes in land cover

1. INTRODUCTION

Bird flu or avian influenza (Bird Flu, Avian influenza/AI) is an infectious disease caused by influenza type A virus and is transmitted by poultry (Indonesian Ministry of Health, 2005 in Susanto et al., 2013). The disease transmitted through birds but is also one of the rare animal disease that can be transmitted to humans (Mulyadi et al., 2005). Avian influenza infiltrated Indonesia by the yearof 2003, and since then has had an effect on various aspects of life in Indonesian population, especially in the economic field. This disease causes almost 90% of

poultry deaths, decreased egg production and a decrease in the percentage of meat and egg sales which results in many poultry farms in Indonesia being out of business (Nofitri, 2014). AI has been declared as one of the strategic infectious diseases in Indonesia.

Lampung Province is categorized as the highest AI endemic province in Indonesia with an average incidence of 0.7 per district (Farnsworth et al. 2011). Most AI incidents in Lampung Province occur in sector 4 farms. According to Ditjennak (2009), sector 4 is a community farm with traditional and non-commercial management, with joined or close-to-the-owner poultry maintenance model. The dynamics of population growth continues to increase which in turn encourages deforestation to meet various human needs. Conversion of forest areas to non-forest areas generally can cause changes in the microclimate, one of them being rainfall (Mustika et al., 2017). Global warming and climate change could directly affect animal species as the main host, including the increasing emergence of stress so that the animals became more sensitive towardspathogenic agentsinfection, resulting in symptoms manifestation of the disease, including AI. In other words, climate change due to changes in land covers may have a significant contribution towards AI incidence in general population.

The incidence of AI is influenced by many factors, one of which is the physical environment, the natural environment of which could be in the form of geographical space, climate, water, sewerage or the poultry market (Muryani, et al., 2013). Water bodies that is contaminated by wild birds, or eating and drinking from sources contaminated with wild bird droppings carrying viruses is one of the major risk factor for transmission from wild birds to livestock poultry and this transmission mainly occurs when these domestic birds are left free to roam around the environment (Capua, et al. 2003).

Argumentations about the relationship of climate change and land covers factors with AI occurrence in poultry produced a simple causality relationship model. The results of this study could be used as a basis for developing policy simulations in controlling AI occurrences in Lampung Province due to climate change and land cover. This study aims to establish a causal relationship between climate change and land cover on the incidence of AI in sector 4 livestock poultry of Lampung Province.

2. RESEARCH METHODS

This study will be conducted in 10 (ten) districts/cities in Lampung Province around the period of August - October 2018. The tools used in this study including computer hardware and software as well as stationery. The hardware used in this research including notebooks, global positioning systems (GPS), and digital cameras. The software materials included GIS software, Minitab17.0 and Microsoft Office 2013. The material used is Landsat recording images in 2009, 2012 and 2015. The type of data used in this study are primary data and secondary data. Primary data was collected in the form of Lampung Province Landsat imagery in 2009, 2012, and 2015. The secondary data in this study includes administrative maps of the districts/cities of Lampung Province, and supporting secondary data (AI incidence, temperature, rainfall) from relevant institutes.

Research Procedure

Processing and Data Analysis

This study used a modeling approach in data processing and analysis. There are two major parts in this study, the data acquisition of the dependent variable and the independent variable which

then builds a linear model that could eventually explain the causality relationship between the two.

1. Dependent variable (Y)
Dependent variable (Y) came in the form of AI incidence cases in all districts/cities in Lampung Province in 2009, 2012 and 2015, a secondary data acquired from the official agency of the Lampung Province Animal Husbandry and Health Service. This data would later became the dependent variable data (Y).

2. Independent variable (X)
Independent variable data (X) consists of: (i) land cover change data, (ii) rainfall data, (iii) temperature data

Image processing procedures
The analysis of changes in forest covers in Lampung Province between 2009, 2012 and 2015 requires a land cover map for each year under study as well as other secondary datas. The land cover classification map is produced through several stages: pre-image processing, digital image processing, and analysis of land cover changes.

Multiple Linear Regression Analysis
Below are the models from multiple linear regression analysis:

$$[Y]1 = \beta0 + \beta1[BAIR]it + \beta2[BLKR]it + \beta3[PMKM]it + \beta4\,[LTBK]it + \beta5[BRAWA]it + \beta6[PLKRCS]it + \beta7[SWH]it + \beta8[TMBK]it + \beta9[MANGROVE]it + \beta10[TEM]it + \beta11[CH]it + \beta12[HUTSEK]it + ei$$

Hipotesis

$$H0 : \beta1 = \beta2 = \beta3 = \beta4 = \beta5 = \beta6 = \beta7 = \beta8 = \beta9 = \beta10 = \beta11 = \beta12 = 0$$

$$H1 : \beta1 \neq \beta2 \neq \beta3 \neq \beta4 \neq \beta5 \neq \beta6 \neq \beta7 \neq \beta8 \neq \beta9 \neq \beta10 \neq \beta11 \neq \beta12 \neq 0$$

Keterangan:
[Y]1 = Incidence Rate AI (case/ year)
$[BAIR]_{it}$ = Water Bodies (%)
$[BLKR`]_{it}$ = Shrub (%)
$[PMKM]_{it}$ = Settlements (%)
$[LTBK]_{it}$ = Barelands (%)
[BRAWA]it = Swanp area (%)
$[PLKRCS]_{it}$ = Mixed dryland farming (%)
[SWH]it =Rice fields (%)
$[TMBK]_{it}$= Sea banks (%)
[MANGROVE]it = Mangrove (%)
$[TEM]_{it}$ = Temperature (mean temperature/year)
[CH]it = Rainfall (mean rainfalls/year)
$[HUTSEK]_{it}$ = Secondary forest (%)
ei= *error* model
β0, β1,...β6 = Parameter Model

3. RESULTS AND DISCUSSION

Descriptive Statistics
The majority of The Lampung Province area has turned into AI endemic areas. Metro City, South Lampung District and East Lampung District shows the highest incidence of AI, while

the lowest being the Pesisir Barat, Mesuji and Tulang Bawang Barat Districts. AI incidences per district/city in Lampung Province in 2009 until 2016 are presented in Figure 1.

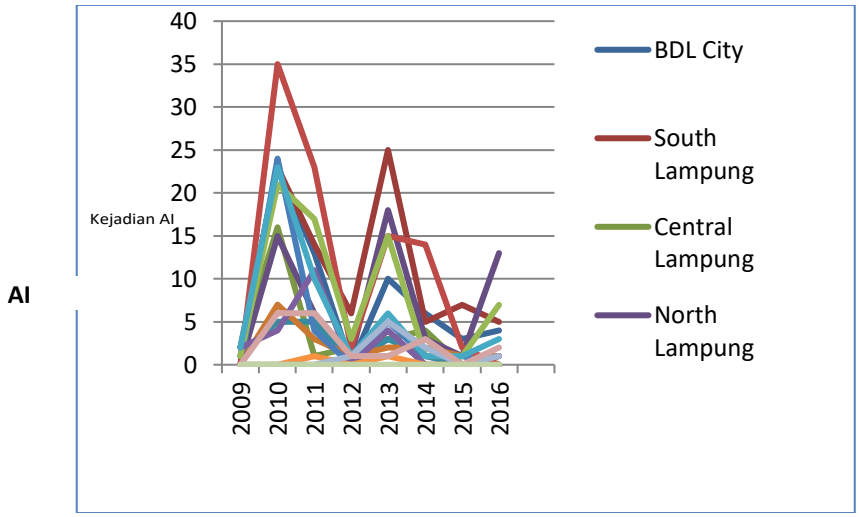


Figure 1. Incidency rate of AI in all municipalities of Lampung Province for 2009 - 2016 (Source: Service Office of Poultry and Veterinary Affairs, 2018 unpublished)

AI incidence in poultry population of the Lampung Province is significantly fluctuated. In 2011 there were 202 cases of avian influenza. In 2015 the rates dropped to 17 cases and in 2016 it rose again to 38 cases. The highest AI incidence found in Metro City with 91 cases and the lowest is in the Mesuji District, a total of 2 cases, while Pesisir Barat District had no reported AI cases. The total AI incidence in 2009-2016 was 556 cases with an average annual incidence of 69.5 cases.

Model parameter optimization

The results of the variation analysis regarding the influence of the independent variables on AI occurrences together resulted in F-count values of 7.27 which were evident at the 99 percent confidence level. Rejecting Ho, meaning that climate change and land cover together affect the incidence of AI. The results of the variation analysis are presented in Table 1.

Table 1. Results of Variation Analysis

Source	DF	SS	MS	F	P
Regression	12	92,98215,983	7,7481,066	7,27	0,000
Residual Erroe	15	108,964			
Total	27				

Source: Analytic results, 2018

The results of t and R square test or coefficient of determination are presented in Table 2.

Table 2. T test results and determination coefficient

Predictor	Symbol	Coef	SE Coef	T	P
Constant	Constant	-56.81	20.63	-2.75	0.015
Water Bodies	[BAIR]	-3.016	1.550	-1.95	0.071

Shrub	[BLKR]	0.5511	0.1673	3.29	0.005
Settlements	[PMKM]	0.03662	0.04961	0.74	0.472
Open Land	[LTBK]	-1.4706	0.6009	-2.45	0.027
Swamp Shrub	[BRAWA]	-0.35421	0.08224	-4.31	0.001
Mixed DrylandFarm	[PLKRCS]	0.02408	0.01552	1.55	0.142
Rice Fields	[SWH]	-0.05455	0.05514	-0.99	0.338
Fish Pond	[TMBK]	2.6071	0.8484	3.07	0.008
Mangrove	[MANGROVE]	-5.473	6.839	-0.80	0.436
Population	[KPTD]	0.000486	0.00051	0.95	0.356
Temperature	[TEM]	2.3496	0.7823	3.00	0.009
Rainfall	[CH]	-0.03007	0.01452	-2.07	0.056
Forests	[HUTSEK]	-0.2289	0.1104	-2.07	0.056
S = 1.03223		R-Sq = 85.3%		R-Sq(adj) = 73.6%	

Source: Research results (2018)

Based on Table 2, the model of the equation formed is:

[Yi]AI = - 56.8 - 3.02 [BAIR] + 0.551 [BLKR] + 0.0366 [PMKM] - 1.47 [LTBK]- 0.354 [BRAWA] + 0.0241 [PLKRCS] - 0.0545 [SWH] + 2.61 [TMBK]- 5.47 [MANGROVE] + 2.35 [TEM] - 0.0301 [CH] –229 [HUTSEK]

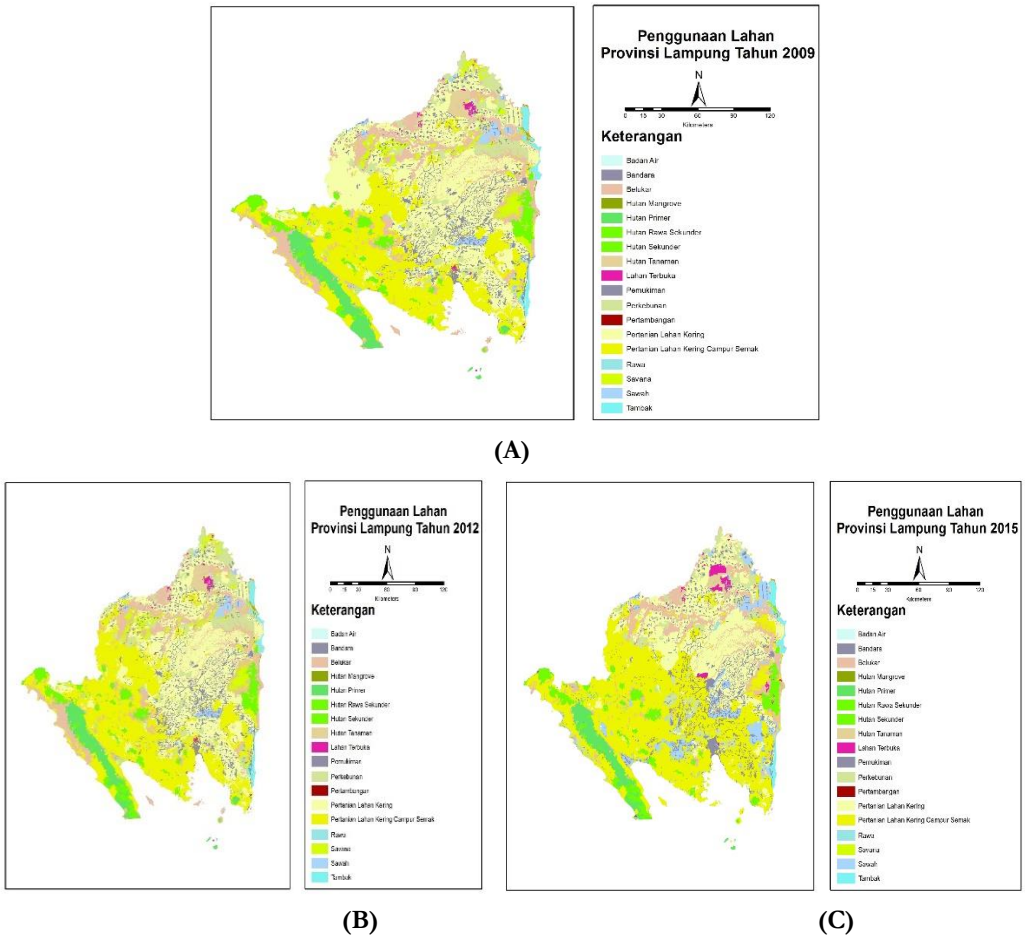
Through the regression calculation that has been done, it could be seen that the adjusted coefficient of determination (Radj) is 73.6%. The value of determination that can be adjusted means that the X variableis able to explain the AI incidence of 73.6% and the remaining 26.4% is explained by other variables not included in the estimation model. Based on the results of the F test, it can be concluded that the overall predictor variable has significant influence on AI occurrence in poultry population in Lampung Province.

Causality Relationship of the Climate Change towards AI Incidence

One of the adverse effects of forest deforestation is the occurrence of changes in micro and global climate. According to Candradewi (2014) in Saharjo et al. (2017), the negative impact caused by considerable forest destruction includes ecological damage, declining biodiversity, declining forest economic value and land productivity, and significant changes in the micro and global climate. AI incidences are also tightly related to climate change. Transmission of several infectious diseases is significantly influenced by several climate factors, especially air temperature, rainfall, humidity, and wind. According to Bahri, et al. (2011), one of the diseases that has the potential to widely spread in relation to climate change, especially with the increasing rainfalls in Indonesia, is AI (H5N1). Temperature variables have a significant effect with a P value of 0.009 and a coefficient value of 2.3496. This means that if the average temperature in Lampung Province rises by 1^{O} C, it will result in AI incidence increase of 2,3496 times per year. The emergence of heat stress in poultry could be a trigger for the emergence of various diseases, the rate of growth and production of eggs decreases and eventually ends with a shortagein profit.The production drop (egg growth and production) is partly due to reduced nitrogen retention and continues to decrease protein and some amino acids digestibility (Tabiri et al. 2000 in Tamzil, 2014). The other climate variables studied are rainfall, which has a real effect with a P value of 0.056 and a coefficient value of -0.03007. This means that every increase of 1 mm of rainfall on average per year will reduce AI incidence by 0.03007 times. Higher rainfall can

increase run off on the surface of the land, indirectly increases the environmental sanitation and land surface so that the spreadings of AI viruses is eventually reduced.

Causality Relationship of the Change in Land Cover towards AI Incidence
The land cover variables examined in this study is forest, water bodies, Shrubs, settlements, open land, swamp Shrubs, mixed dryland, rice fields, ponds and mangrove forests. The results of land cover interpretation are presented in the following figures.



(A) **(B)** **(C)**

Figure 2. Changes in forest and land cover in Lampung Province (A) in 2009, (B) in 2012, and (C) in 2015.

Regression results indicate that the body of water, the Shrub, open land, swamp shrubs, fish pond, secondary forest areas, temperature, and rainfall significantly influence AI incidence in poultry (P <10%), whereas, settlement, mixed dryland, rice field area, and mangrove forest area did not have a significant effect on AI incidence. The following is the relationship of the regression results that have a significant effect on the incidence of AI.

The effect of land use is thoroughly examined through several land cover. From the results of model parameter optimization it is known that several variables have a quite effect such as water bodies with a P value of 0.071 with a coefficient value of -3.016, Shrub with a P value of 0.005 with a coefficient of 0.5511, which means that assuming other variables remain constant, if the area increases by 1 percent, the AI incidence will increase by 0.5511 times per year. The swamp shrub variable also has a significant effect with a P value of 0.001 and a coefficient value of -0.35421, which means that if the swamp cover area increases by 1 percent, it will reduce AI

incidence by 0.35421 times per year. This also applies to open land variable. Open land variable has a P value of 0.027 and coefficient value of -1.4706. Fish pond also has a significant effect towards AI incidence with a value of P value 0.008 and a coefficient value of 2.6071.

The effect of swamp shrub covers is quite different from fish pond, mainly because the ecological equilibrium is significantly better because it is relatively still natural, while fish pond is very low in regards of biodiversity and the intensity of pond management (contamination from poultry excrements). Indonesian population generally do poultry farming traditionally. The poultry gets food and water from the common yard or bushes around the residential area and dispose of its waste in the common yard or bushes. This causes the risk of AI transmission originating from infected poultry excrements becomes even greater. According to FAO, (2005), AI viruses can survive in poultry excrements(faeces) for 3-4 weeks. In addition, the traditional poultry maintenance system is very risky for AI attacks because it does not implement biosecurity systems. Sector 4 (backyard) poultry farms in Indonesia are carried out by an average of 60% of the population with different objectives and almost no application of biosecurity systems so that these conditions are very risky for the incidence of AI (Farnsworth et al., 2011).

Research showed that the percentage of Fish pond area also significantly affected AI events. This is due to the poultry's food-seeking activity around Fish pond/ponds that are still traditionally maintained. Fish pond water/ponds contaminated by AI viruses could be a medium for the AI spread. The data is significantly in line with the results of the study conducted by Elfidasari et al., (2015) that subsequently analyzed the spreading mechanism of AI viruses in wild birds and domesticated poultry in the Pulau Serang Nature Reserve Area. The results showed that direct transmission of VAI subtype H5N1 can occur if the virus infects waterfowl or other animals through direct and without contact with a medium. Indirect transmission occurs through other medias such as water bodiesthat is a source of drinking for wildwater birds and domestic poultry and has been contaminated with AI virus of H5N1 subtype. Indirect mechanisms also occur when there is the use of the same poultry food ingredients in the same location.

4. CONCLUSION

1. AI incidence in poultry (Y) for variable changes in land cover and climate can be constructed in a significant linear relationship.
2. Both climate variables have a significant effect on AI incidence:
   a. Any increase in temperature of 1°C will contribute to an increase in AI performance by 2.34 times.
   b. Each increase in average 1 mm of rainfall will reduce AI incidence by 0.03 times.
3. Every 1% increase in land cover area will increase AI incidence by 0.551 times (for Shrubs) and 2.60 times (for farms), but reduce AI incidence by 3.01 (for Water Bodies), 1.47 times (for open land), 0.35 times (for swamp shrub) and 0.22 times (for secondary forests).

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