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SPATIAL ANALYSIS OF HUMAN TOXOPLASMOSIS IN GIANYAR REGENCY BALI

Ni Putu Eka Febianingsih [1*], Wayan Tunas Artama [2], Citra Indriani [3]

Abstract: *Toxoplasmosis is a zoonosis of human and warm-blooded animals. This infection is caused by the parasitic protozoan Toxoplasma gondii. This parasite distributed worldwide. Human Toxoplasmosis causes severe congenital abnormalities including hydrocephalus and mental retardation in infants. T. gondii has infected 15-80% of the world population. The seroprevalence of toxoplasmosis in women in Bali was 63.9% with the highest percentage in Gianyar. The present study was designed to know the spatial distribution of human toxoplasmosis. The study was carried out in Gianyar Regency, Bali Province, in 2015. Seroprevalence of human toxoplasmosis was examined by an indirect ELISA method for IgG Anti-T.gondii with a total of 240 sera. Geographical and environmental characteristics are measured with the Global Positioning System (GPS) and hygrometer. The spatial distribution of toxoplasmosis was mapped by using Geographic Information System (GIS). Seroprevalence of human toxoplasmosis in Gianyar District was 56.7%. Data analysis showed that the elevation and distance of the river from the house are related to the incidence of human toxoplasmosis in Gianyar. The spatial distribution of toxoplasmosis was mapped per cluster by using GIS. Different spatial patterns of toxoplasmosis were identified in elevation and watershed. Cluster with a positive percentage is most prevalent in lowland areas (<200mdpl). High seropositive toxoplasmosis in Gianyar Regency. Toxoplasmosis seropositive should receive treatment and health information. Keep in efforts to increase health knowledge about toxoplasmosis and transmission.*

Keywords: *toxoplasmosis, seroprevalence, spatial analysis*

I. INTRODUCTION

Toxoplasmosis is a zoonotic disease caused by the protozoan parasite Toxoplasma gondii (T. gondii). All warm-blooded animals, including humans, can potentially serve as intermediate hosts, harboring T. gondii in the form of tissue cysts. For the most part, infection only causes mild clinical disease in humans. This disease does not have typical clinical symptoms, so it is difficult to detect early through clinical symptoms. The clinical form of T. gondii infection in humans besides miscarriages and fetal abnormalities that are born can be in the form of toxoplasma retinochoroiditis, tissue cysts in the lungs, heart and skeletal muscle tissue (Gilbert, Harden, & Stanford, 2011). These infections have two mechanism for transmission. Vertical transmission occurs from a pregnant mother to the fetus. Horizontal infection related to the lifestyle and environment. Lifestyle risk is the habit of eating meat or vegetable raw /undercooked and or eating or drinking milk contaminated with infective T. gondii oocysts (Kijlstra & Jongert, 2008) (Andrade, Carneiro, Medeiros, Neto, & Vitor, 2013). Environmental factors such as landscape

[1] Ni Putu Eka Febianingsih* is a doctoral student at Stikes KesdamIX/Udayana, Denpasar, Indonesia.
[2] Wayan Tunas Artama is a doctoral student at Eco Health Resource Center, Gadjah Mada University, Yogyakarta, Indonesia.
[3] Citra Indriani is a doctoral student of Field Epidemiology and Training Program, Gadjah Mada University, Yogyakarta, Indonesia.
*Correspondence Email: putekafebi@gmail.com

composition and climatic variations influence the transmission of *T. Gondii*. Contaminated water sources by oocysts from the ground when it rains or floods washed ashore lower (Ishaku, Ajogi, Umoh, Lawal, & Randawa, 2009). Toxoplasmosis based on environment and geographical areas can be distributed by spatial analysis. Spatial analysis of disease data outlining geographically covering the distribution and risk factors for toxoplasmosis. Geographic imagery and environmental detection associated with toxoplasmosis can be done using remote sensing technology (remote sensing) and Geographic Information System (GIS). This system can determine the area of distribution of toxoplasmosis, which can act as early prevention of disease spread.

Toxoplasmosis in blood donor in some countries it ranged from the low of 0,96% in Namibia, 4,1% in Thailand, 22% in Lahore Pakistan, 20,3% di Karnataka, 53,6% in Saudi Arabia, and 75% in Brasilia (Shahzad et al., 2006) (Sundar, Mahadevan, Jayshree, Subbakrishna, & Shankar, 2007) (Foroutan-rad et al., 2016). Seroprevalence in Surabaya was 58% and 70% in Jakarta (Terazawa, Muljono, Susanto, Margono, & Konishi, 2003). Toxoplasmosis in Yogyakarta Special Region of 61.5% (Sujono, 2010). Health Office Bali Province in 2013 has reported 57% of toxoplasmosis patients are male. Toxoplasmosis in women in Bali was 63.9% with the highest prevalence in Gianyar regency 82.5% (Laksemi, Artama, & Wijayanti, 2013). The present study was designed to determine the prevalence, risk factors and the spatial distribution of toxoplasmosis in Gianyar regency.

II. METHODS

This study was a cross-sectional analytical conducted from July to November 2015. The sample was randomly grouped (random cluster sampling) with a total sample of 240 people aged ≥15 years. Data collected through three stages: interviews, blood sampling, and laboratory testing. Interview and blood sampling in Gianyar regency. Examination of IgG Anti-T. gondii by ELISA was conducted by researchers and Laboratory assistant at the Laboratory of Biochemistry, Biotechnology Study Center, Gadjah Mada University. The variables studied were demographic characteristics, lifestyle and environmental characteristics as independent variables and toxoplasmosis as the dependent variable. Data were analyzed by using the Poisson regression with robust variance estimators (Barros & Hirakata, 2003) (Zou, 2004) (Coutinho, Scazufca, & Menezes, 2008) (Deddens & Petersen, 2008). The spatial distribution of toxoplasmosis was mapped by using GIS.

III. RESULTS AND DISCUSSION

Human toxoplasmosis in Gianyar regency is 56.7% with an average age of 40 years old. Male proportion is higher than women 66.67%. In the higher education group, the proportion of respondents with positive IgG is even higher at 75.86% than the proportion of negative IgG is in the same group. Higher IgG positive in Sukawati Sub - District was 90%.

Multivariate analysis showed that risk factors for toxoplasmosis in Gianyar Regency were the consume raw food/meat/Lawar (aPR: 1.40; 95%CI: 1.05- 1.86), male (aPR: 1.42; 95%CI: 1.12 to 1.81), presence of animals/cats (aPR 1.48; 95%CI 1.04-2.09), Rarely wash hands (aPR: 1.25; 95%CI: 1.01 to 1, 56), elevation/altitude (aPR 0.99; 95%CI: 0.99-0.99), Distance to the river from the house (aPR 0.99; 95%CI: 0.99-0.99).

People who live at altitudes <200 meters above sea level have a 1.36 times higher risk than those who live in the altitudes > 250 meters above sea level (PR;1.36 95%CI:1.03-1.79). The risk of toxoplasmosis is also increasing when the distances of the river are <200 meters. Risk of toxoplasmosis is 1.32 times higher (PR: 1.32; 95%CI: 1.02-1.70) (Table 1).

Table 1. Risk Factors of Human Toxoplasmosis in Gianyar Bali

No	**Variable**	**Coef**	**aPR *(95%CI)***	***p value***
1	Consume raw food/meat/*Lawar*	0.334	1,40 (1,05-1,86)	0.024
2	Male	0.354	1,42 (1,12-1,81)	0.004
3	Presence of animals/cats	0.392	1,48 (1,04-2,09)	0.026
4	Rarely wash hands	0.225	1,25 (1,01-1,56)	0.044
5	Elevation/altitude	-0.002	0,99 (0,99-0,99)	0.000
6	Distance to the river from the house	-0.001	0,99 (0,99-0,99)	0.002
	Constant	-0.804		

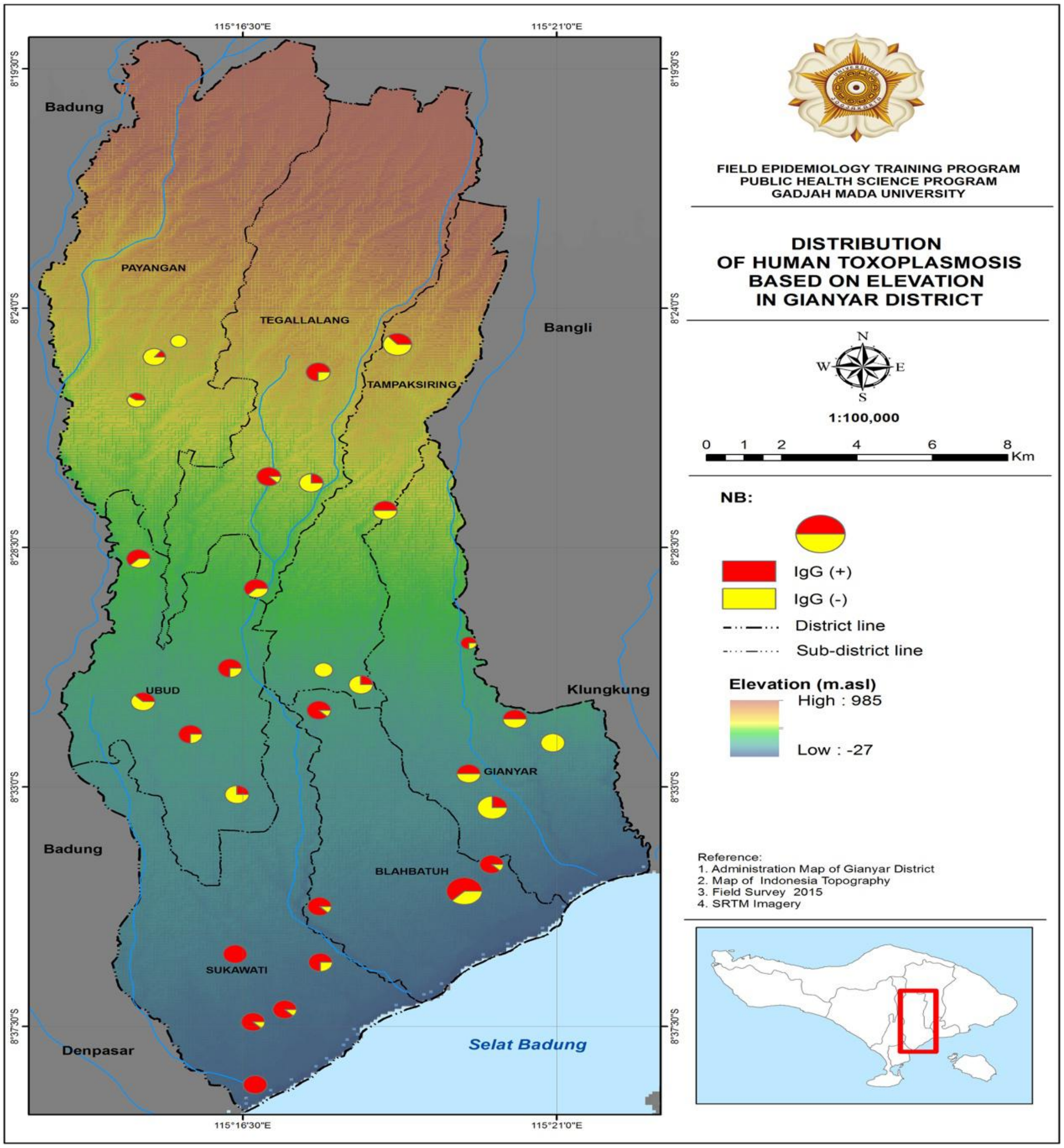

Figure 1. Distribution of Human Toxoplasmosis in Gianyar Regency based on altitudes

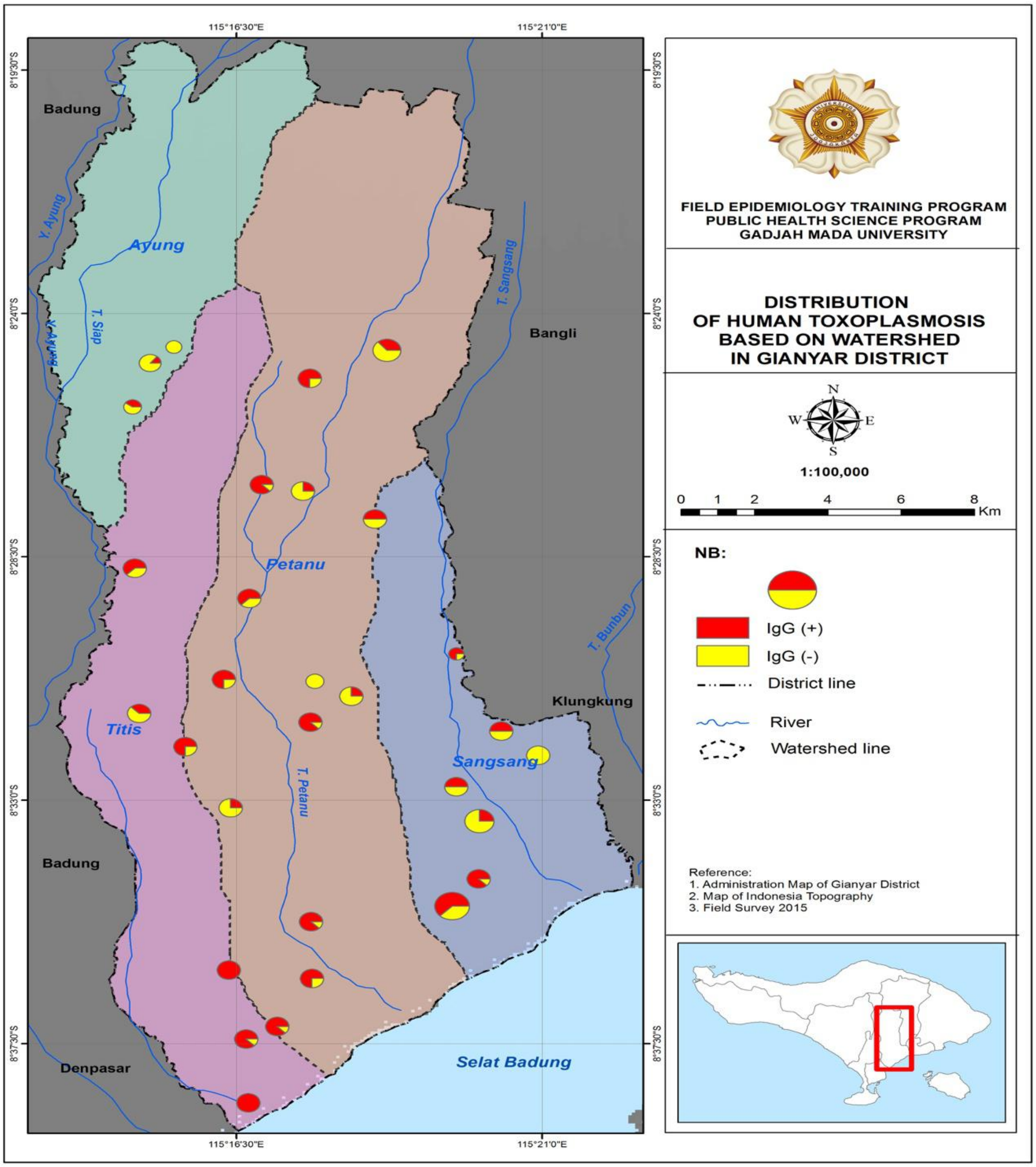

Figure 2. Distribution of Human Toxoplasmosis based on watershed in Gianyar

Thirty clusters were mapped by using GIS. Red color indicates a positive IgG *anti-T.Gondii* and yellow one indicates respondents with negative IgG. Cluster with the number of red circles is the majority in the low landscape area (<200masl). Clusters with a full positive IgG are in Ketewel and Celuk villages which are areas with relatively low altitudes (Figure 1). Toxoplasmosis in the Ayung watershed and Titis watershed have a similar distribution pattern. There is a cluster that consists of a full red circle indicating clusters of all respondents were positive toxoplasmosis (Figure 2).

The seroprevalence of toxoplasmosis in the Gianyar Regency is 56.7%. This infection spread almost all over the world with different prevalence in each region. Data from the Center for Disease Control and Prevention (CDC) showed that 22.5% of the population aged ≥12 years had been infected. Seroprevalence toxoplasmosis in Amazonia is 65.8% (Ferreira et al., 2009), IgG *anti-T. gondii* in blood donors in Recife Brazil was 75% (Coêlho, Kobayashi, & Carvalho-Jr, 2003); 35.56% of patients in cancer patients and 17.44% in a population of healthy/noncancerous seropositive in China (Cong et al., 2015). Seroprevalence of toxoplasmosis at Khartoum, Sudan was 24.6% in women and 30.5% in men (Ali, 2012); Seroprevalence of toxoplasmosis in Indonesia was 70% in the population of Jakarta (Terazawa et al., 2003); 61.5% in Jogjakarta (Sujono, 2010); and 62.54% in the southern part of Central Java (Retmanasari, 2015).

Transmission can occur through food, by eating the meat contaminated by *T. gondii* cysts and uncooked can cause toxoplasmosis infections. The habit of eating meat that is not thoroughly cooked increases the risk of toxoplasmosis infection. One of the regional specialties of Bali is *Lawar*. *Lawar* consists of vegetables, raw or undercooked meat (pork/beef/duck meat) and some spices.

Multivariate analysis shows that consuming raw/undercooked meat/*Lawar* 1.4 times is higher to get toxoplasmosis. Similar results were found in studies conducted in China, showed that respondents who had consumed raw or undercooked meat at risk for toxoplasmosis were 1.4 times higher than control (95% CI: 1.077 to 1.773) (Cong et al., 2015).

Livestock, which contained bradyzoite and uncooked, would be a source of transmission of toxoplasmosis by food (foodborne disease). Tissue cysts or bradyzoite existing muscle or livestock meat eaten by humans will be broken down in the digestive tract. Bradyzoite ruptured will repeat the tachyzoite phase and penetrate the intestinal epithelial cells then multiply in human cells (Black & Boothroyd, 2000). Antibody tests by using latex agglutination test cattle in Khartoum Arab showed positive as much as 11% in sheep and 18% in cattle (Ali, 2012). The prevalence of toxoplasmosis in sheep was 26.3% in Brazil Leste Potiguar and 17.8% in Central Potiguar (Andrade et al., 2013). Research on the meat of livestock (cattle and sheep) in Chaharmal va Bakhtiari Province, southeast Iran in 2012, found that 12% of the meat products infected by *T. gondii*, which 8.57% of cattle and 38% of sheep infected (Azizi, Shiran, Boroujeni, & Jafari, 2014).

T. gondii infection in goats and sheep in Java was 42.9% (Iskandar, 2008). The prevalence of toxoplasmosis in sheep slaughtered in Yogyakarta was 72% (Siregar & Yuswandi, 2014). Livestock and pets in Banda Aceh show that *T. gondii* infection occurs in 40% goats, 25% chickens, 23% cattle, 20% ducks, 16% cats, 15% buffalo, and 10% sheep (Hanafiah, Kamarudin, Nurcahyo, & Winaruddin, 1978). Seroprevalence of toxoplasmosis in chickens in Bali was

41.8% in 2010 (Mastra, 2011), 91.64% in 2011 (Apsari et al., 2011) and 24.8% in 2012 (Dwinata, Oka, Suratma, & Damriyasa, 2012).

Infected meat can be a source of transmission of *T. gondii* in humans if it is not cooked correctly/optimal heating. The form of *T. gondii* that contaminates meat is bradyzoite. The freezing process can cause all cystic tissue to become non-infectious (at -12 ° C or lower). It can reduce the risk of infection but it will be safer if the meat or innards are thoroughly cooked or heated at ≥67^{0}C for >10 minutes (Tenter, 2009). Not tasting meat or food when spiced or cooked can reduce the risk of infection (Cook et al., 2000).

Males have a higher risk than women with substantial aPR of 1.42. Study in the United States showed that the results of the high prevalence of toxoplasmosis was higher in men than women. The seroprevalence of toxoplasmosis in men is more elevated with p-value 0.002. Risk in men in the United States was 1.14 times higher than for women (Jones et al., 2009); by 79% in men in Recife Brazil (Coêlho et al., 2003); and 30.5% in men in Khartoum Sudan (Ali, 2012). There is no difference in risk between men and women. Men and women have the same risk. *T. gondii* infection can occur because of both behavioral and environmental factors. *T. gondii* infection in infertile couples in Suzhou Cina was (34.83%) higher than fertile couples (12.11%). This study showed that Anti-sperm antibody levels were higher in couples with toxoplasmosis infected (Zhou et al., 2011). Another study in Shenyang China showed that among 100 cases of sterile males, 7% were TOX-IgG positive, 16% TOX-IgM positive and 13% TOX-CAg positive. Among 100 normal males, 7% were TOX-IgG positive, 3% TOX-IgM positive and 1% TOX-CAg positive (Qi, Su, Gao, & Liang, 2005).

People who often neglect washing hands have 1.25 times higher risk of being infected with T. gondii with a p-value of <0.05. Research in Poland, 91% of women reported always washes their hands before food preparation, but a statistically significant relationship between hand washing with toxoplasmosis was not present (Salamon & Bulanda, 2014). A Study in Indonesia showed that workers in slaughterhouses and butchers in Kulon Progo, Yogyakarta who rarely wash hands, are seven times higher to have toxoplasmosis than those who always wash their hands (Hariyah, 2012).

The presence of wild animals (cats/fowl) increased the risk 1.48 times. Seropositive for toxoplasmosis in cats reached 65.2% in France (Afonso et al., 2013); and 42-48% in Izmir Turkey (Can et al., 2014). Cats with toxoplasmosis infection can spread oocysts in the feces into the environment. Low humidity, high temperatures favor the development of oocysts become infective. Cats that are not appropriately maintained and roam around the house increase the risk of toxoplasmosis infection.

An additional 1 meter of the distance of the river from the house can decrease 1% of toxoplasmosis risk. Transmission of *T. gondii* through the water found in studies conducted in the State of Rio de Janeiro Brazil. These study results indicate that drinking water without the filtration process can increase the risk of toxoplasmosis 3 times higher in the low socioeconomic population and the middle-income population (Bahia-oliveira et al., 2003). A study in the municipality of Greater Victoria indicates that there is a significant correlation between acute *T. gondii* infections with residence in a water distribution system (Bowie et al., 1997). Reports of toxoplasmosis outbreaks have been reported in a village along the Maroni River Suriname (Demar et al., 2007). People who live in higher areas have lower risks than those who live in a low area. This study showed that an additional one meter of altitude/elevation, there will be a reduced risk of toxoplasmosis by 1%. Research in Wuhan, Hubei China, showed that contamination occurred in all public parklands by *T. gondii* oocysts. Prevalence was decreased from spring to winter (Du et al., 2012). Oocysts that contaminate the soil can be carried by rainwater or flood into lower areas.

The elevation area and watershed spatially described the distribution of toxoplasmosis in the Gianyar Regency. People who live in the area <200masl have higher risks 1.31 times. The distribution of cases seen that a cluster with the highest seropositive was found in the Sukawati sub-District and Blahbatuh sub-District. Toxoplasmosis seropositivity was more on cluster living in lowland areas (Figure 1). Distribution of cases in Gianyar Regency based on the watershed, it is known that clusters with a high percentage of positive IgG occur in the Petanu watershed and Titis watershed (Figure 2).

The study of toxoplasmosis in the southern part of Central Java showed that seropositive were most numerous in the lower reaches of the river (Retmanasari, 2015). Oocyst contamination was also reported briefly unsettled the market in a watershed Victoria, British Columbia, Canada had caused an outbreak of toxoplasmosis (Aramini et al., 1999). Downstream to the estuary shore contamination occurred in Canada. Oocyst contamination in the marine environment occurs through runoff from the entire watershed Boreal, during periods of snowmelt (Simon, Poulin, Rousseau, & Ogden, 2013)

IV. CONCLUSION

Toxoplasmosis seroprevalence in Gianyar Regency was 56.7%. The risk factors of this infection are raw meat/*lawar* consumption; male, presence animal/cat; rarely wash their hands; elevation, and the river distance from the house. The spatial distributions seropositive of toxoplasmosis in every region have a relatively similar pattern in each cluster. Distribution of clusters was mostly found in the sub-district of Sukawati and Blahbatuh. Toxoplasmosis distribution based on the watershed showed that clusters with the highest seropositive were at Titis and Patanu watershed in the downstream part.

Seropositive cases of toxoplasmosis should receive treatment and health information regarding that toxoplasmosis infection is not reactive. It needs an effort for a feasibility study on livestock quality and processing meal/*Lawar* at the village.

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