Mapping of leptospirosis risk factor based on remote sensing image in Tembalang, Semarang City, Central Java

Sunaryo, Dyah Widiastuti

Research and Development Animal Borne Diseases Control Unit, Banjarnegara, Central Java.

Abstrak

Latar belakang: *Leptospirosis merupakan penyakit zoonosis yang disebabkan oleh bakteri leptospira dan menular kepada manusia melalui kontak dengan urine hewan dan lingkungan yang terkontaminasi bakteri leptospira. Kecamatan Tembalang merupakan daerah endemis leptospirosis selama tiga tahun terakhir. Tujuan penelitian ini mengkaji kegunaan citra penginderaan jauh untuk pemetaan faktor risiko lingkungan leptospirosis.*

Metode: *Penelitian ini menggunakan cara potong lintang, subyek sebanyak 246 dipetakan dengan GPS. Dengan program ArcGis 9.2 kasus leptospirosis ditumpang susun dengan citra Quickbird, kemudian dilakukan interpretasi kenampakan visual, dan dilakukan digitasi layar untuk identifikasi faktor risiko secara visual.*

Hasil: *Berdasarkan visualisasi digital diperoleh data bahwa kasus leptospirosis tahun 2009 terbanyak tersebar membentuk klaster di wilayah Tembalang dengan indeks jarak terdekat 0,009 km, sedangkan indeks jarak terjauh 18 km. Kasus lebih banyak ditemukan pada anak-anak dan remaja laki-laki, secara temporal kasus meningkat pada musim kemarau, antara bulan Juli dan Agustus. Hasil interpretasi visual dan digitasi diperoleh peta penggunaan lahan, badan air, pemukiman, area luasan banjir, kerapatan vegetasi dan ketinggian tempat.*

Kesimpulan: *Citra penginderaan jauh resolusi spasial tinggi sangat baik untuk pemetaan faktor risiko leptospirosis. Sebaran kasus leptospirosis membentuk klaster di wilayah Tembalang, kasus didominasi anak-anak dan remaja laki-laki.* ***(Health Science Indones 2012;1:45-50)***

Kata kunci: *citra penginderaan jauh, leptospirosis, Tembalang*

Abstract

Background: Leptospirosis is a zoonotic disease, caused by leptospira bacteria and transmitted to human by contact though contaminated animal urine and environment. Tembalang Sub District is endemic area of leptospirosis and increased at last three years. The aim of this research was to study the ability and usefulness of image remote sensing for mapping as distribution of leptospirosis, physical environment of risk factor analysis.

Methods: This cross sectional design consisted of 246 leptospirosis subjects mapped with GPS, and processed by using ArcGis 92 program. Leptospirosis case was overlaid with remote sensing (Quickbird image), then is done interpretation of spatial feature, and digitation on screen to visual identify of risk factor.

Results: Based on digital visualization leptospirosis cases in 2009 were clustered in Tembalang with shortest distance index 0,009 km and is furthermost 18 km. More case distribution found at children and men adolescent. Temporally, case increased in the dry season, among of July and August. Result of visual interpretation and digitation can obtain land use map, water body, settlement, floods area, vegetation index and height.

Conclusion: Spatial high resolution remote sensing image is very good for mapping of leptospirosis risk factor. Leptospirosis case distribution forms the cluster in Tembalang; case is predominated by children and men adolescent. ***(Health Science Indones 2012;1:45-50)***

Key word: remote sensing image, leptospirosis, Tembalang

Corresponding author: Sunaryo
E-mail: yok_ban@yahoo.com

Leptospirosis is caused by pathogenic spirochetes (bacteria) of the genus Leptospira, directly or indirectly transmitted from animals to humans.[1] In Indonesia, leptospirosis was widespread in urban regions of flat areas such as Java, Sumatera, Kalimantan and Sulawesi. Semarang is one of leptospirosis endemic area in Central Java Province. The Case Fatality Rate (CFR) of leptospirosis in Semarang between 2006-2008 were recorded to be 25.8%, 12.5% and 5.5%.[2]

Some risk factors that influence the occurrence of leptospirosis include biotic and abiotic environment. A direct effort to determine the environmental risk factors as a cause of leptospirosis transmission will require time and economically high cost. Moreover, the leptospirosis surveillance system is still based on data from the hospital, while the active surveillance in the community have not been optimally implemented.[3] One effort to overcome those problems is the interpretation of remote sensing image as a surveillance method that describes the appearance easy and quick to detect environmental risk factors associated leptospirosis.[4]

Remote sensing is the acquisition of object properties or phenomenon on the earth's surface using data acquired from aircraft and satellites. It is therefore an effort to measure something at a distance, without making physical contact with the object. Quickbird is one of high resolution commercial earth observation satellite. Quickbird's ultra fine resolution makes this valuable imagery for validation and environmental assessment.[5]

This research was aimed to present the characteristics and potentialities of remote sensing as a useful environmental surveillance tool for applied research in the control of endemics in Semarang.

METHODS

Located in northern Java, Semarang city covers around 37.367 hectares, in the central part of Central Java province where land use and elevation are heterogeneous. This site was chosen regarding the high incidences of leptospirosis in urban areas, among the highest in Semarang, suitable to investigate the potential influence of environment on Leptospirosis incidence per village.

One hospital and two local health care centers were inventoried in the study area, and plotted by GPS during field surveys. Each center diagnosing leptospirosis case using lateral flow lepto tek, records information about the patients and details about the consultation, later reported to the local District Health Office at Semarang. Exhaustive records of leptospirosis cases notified between January 2009 and December 2009 were integrated into the GIS database conduct a spatiotemporal epidemiological mapping out of leptospirosis. 226 cases were reported in Semarang city during this period, 129 of which were located in Tembalang.

Quickbird imagery was used to do the registration process and coordinate transformation to map the Earth Indonesia Arts (RBI), incorporation of Quickbird image which consists of two pieces of the map, then cut with a map to get Tembalang administration, then digitized screen to make derivative maps of land use.[6,7] the presentation of maps made of several layers of overlapping stacking map. Interpretation process can be visually from the appearance of spatial abstraction.[14] On-site observations was also done

RESULTS

The pattern of leptospirosis distribution in Semarang during the last two years was concentrated on Tembalang and Gayamsari District. Distance distribution of the index cases of leptospirosis in the nearby city of Semarang is: 0.009 km farthest is 18 km (Figure 1).

Assessment of the population was not directly derived from Quickbird interpretation. This data was obtained from estimating the number of house units in each type of housing in an area and multiplying the number of houses with an average number of family unity for all types of residential homes. Type of housing was identified based on some criteria such as size and shape of the buildings, courtyards, gardens and roads[7]. Average of family members based on census population in 2002 was 4 people in one family. Housing quality can be directly interpreted from Quickbird such as the house size, the plot size, the building densities, buildings where the pullback of the road, the width and condition of roads, sidewalks and suburban conditions, presence of road vehicles , presence of garage, vegetation quality, maintenance yard and open fields, distance to the parking lot, the distance to the industry, while other factors (such as the condition of the building) can not be interpreted directly.[7,8] A visit

to the location of the sample can also determine the quality of residential supports.

Based on those interpretations, the condition of settlement in the region Tembalang divided into two categories i.e. regular and irregular settlements. Leptospirosis cases were distributed predominantly found in irregular settlement (Figure 2).

In this type of irregular settlements visually indicate the level of high density buildings. High building density patterns, and irregular conditions associated with infrastructure and poor sanitation facilities such as drains were not functioning properly. On-site observation showed that in general, houses on the study area using materials from wall and timber, plywood, bamboo and walls. The wall that was made from wood, plywood, bamboo risk for leptospirosis by 1.13 times, while uncovered floor risk for leptospirosis by 1.05 times.[9]

Quickbird digitization results showed that in Tembalang irregular residential area was large enough 10.5 km2 (24.9%) and irregular settlements 149km2 (3.5%). The largest land use was consisted of moor 17.5 km2 (41.7%), and garden 5.6 km2 (13.4%). Density residential buildings affecting the availability of land cover in the region vegetation Tembalang, visual interpretation of the results shows the low level of vegetation density. Vegetation types consisted of grass plants, shrubs and plant ornamental road divider pages. Analysis of Normalized Difference Vegetation Index (NDVI) showed that cases of leptospirosis is more dominant in areas with low vegetation index values, with the range of the index value of -0.38 - 0.095. Most of cases were distributed in areas with vegetation index of - 0.95 to 0.082.[8]

The rat infestation in the leptospirosis area in Tembalang was high, trap success inside the house was 10% - 20%. There were some species of trapped rodents such as house mice (R. tanezumi): 60%, sewer rat (R.norvegicus): 30%, and other mammalian species (M.musculus, S.murinus, Bandicota indica): 10%.[9]

Rivers and water bodies influence the leptospirosis transmission in Tembalang. Distribution of leptospirosis was mostly located around the river at 50 m radius buffer to 300 m. (Figure 3). The results of on-site observation found that many rivers in Tembalang region were not flowing smoothly, it is due to the disposal of household waste by the local community.

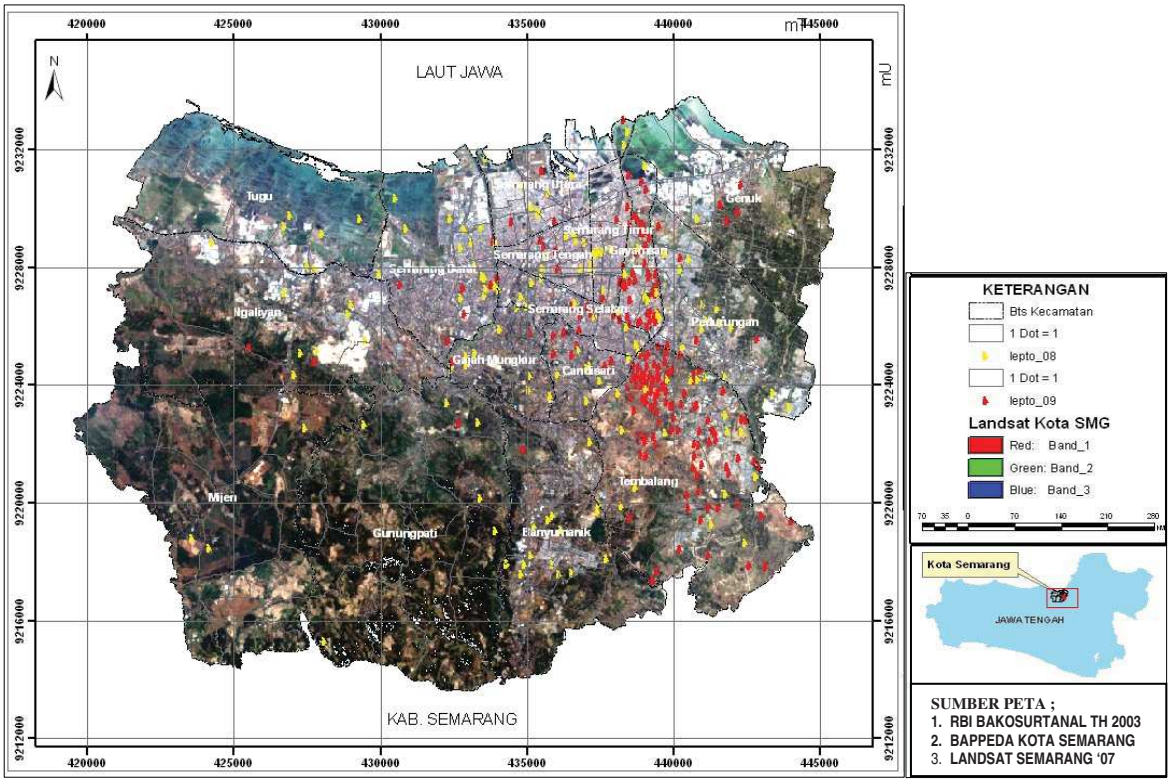

Figure 1. Distribution of Leptospirosis cases in 2008 and 2009 overlaped by original composite color image in Semarang city

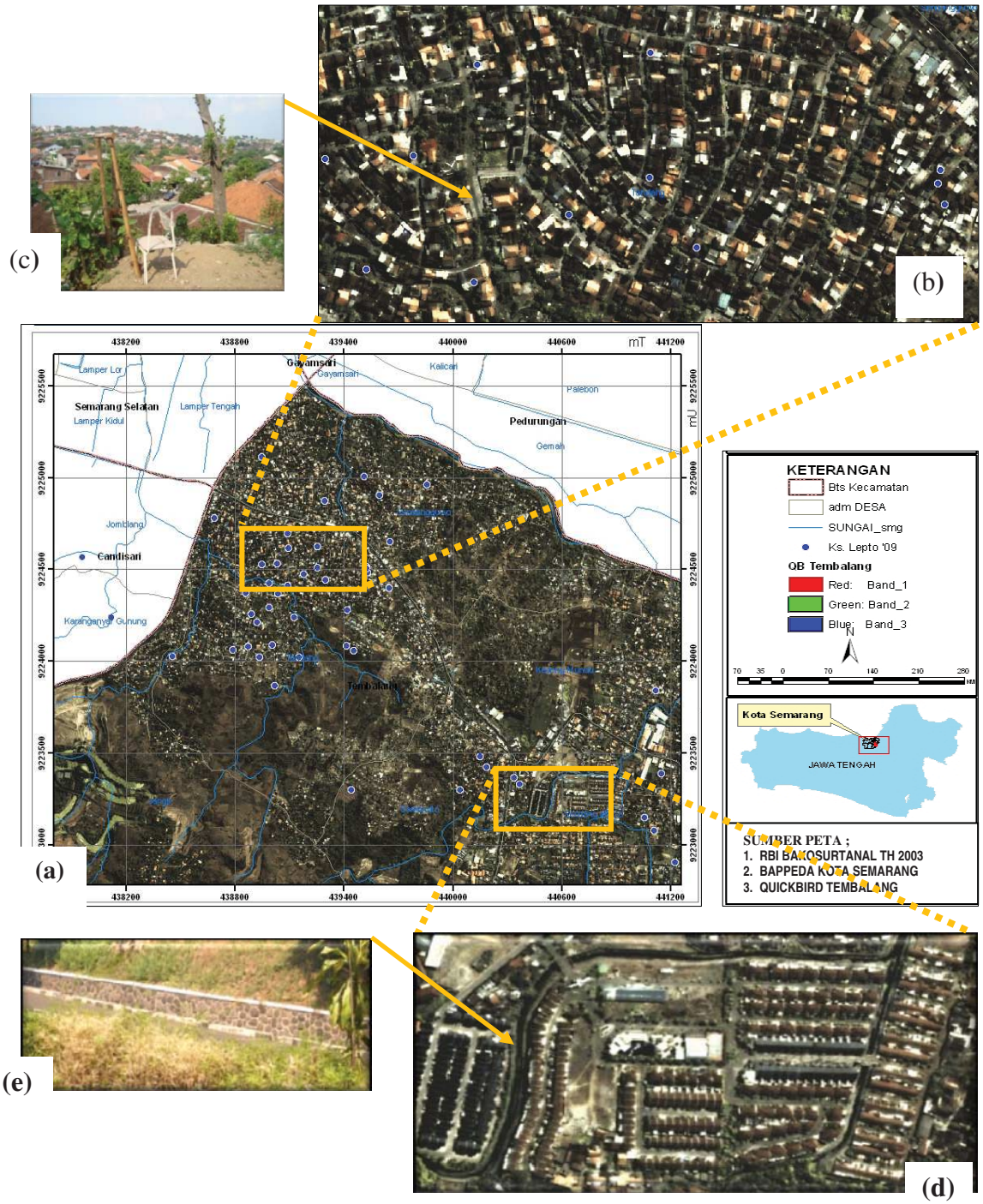

Figure 2. Distribution of Leptospirosis cases in 2009 and Quickbird image (a) in irregular dwelling (b) field visit result for di irregular dwelling (c). Quickbird image on irregular dwelling (d) good water saluran sewage (e)

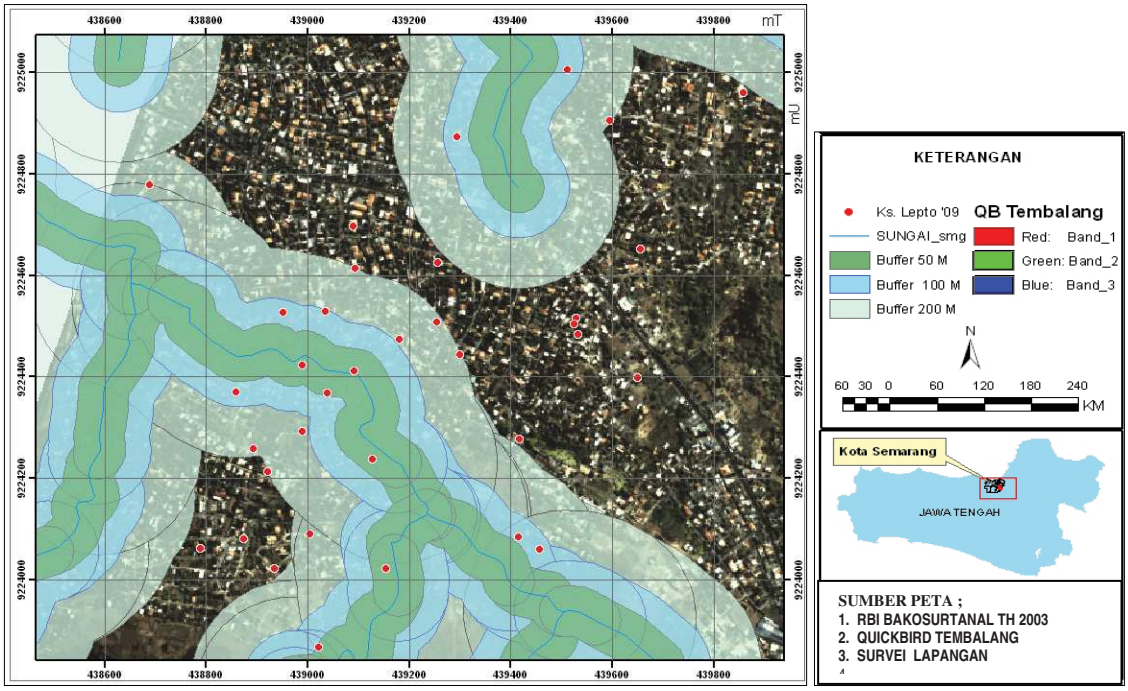

Figure 3. River buffer and distribution of Leptospirosis cases in 2009 at Tembalang, Semarang city

DISCUSSION

Distribution of leptospirosis cases in Semarang tend to cluster in Tembalang region. According to (Cole and King, 1968 in Lo.Yeung, 2002) the distribution of cases in groups called a cluster category. Distribution of leptospirosis cases that make up the cluster is caused by environmental risk factors such as the slum settlements, poor sanitation facilitates (waste disposal) .[10,11] A bad water congestion affects three times (OR = 3) greater than a good ones.[15] Visual interpretation with Quickbird imagery to determine the spread of leptospirosis and environmental risk factors for leptospirosis can be done easier, more cost effective and less time consuming than on-site observation. According to Lintz Jr. and Simonett in Sutanto (1996), there are three series of activities required in the recognition of objects depicted in the image, i.e. : 1) detection, is the observation of an object. 2) Identification, is an effort to characterize the objects that have been detected by using a sufficient explanation based on the shape, size, and location. 3) Analysis, is gathering more information.[7]

Leptospirosis cases in Tembalang were predominantly found in children and male adolescent. These conditions were more likely due to the activities in risky environments such as playing around a muddy environment.[12] while the biggest risk in the environment of high lying area such as Tembalang probably come from around the house. Risk of transmission of leptospirosis around the house such as the presence of reservoir rodents in the house a positive leptospirosis can contaminate the water in the tub, on the barrel or even through the food ready for consumption or prepared food. This is supported by the presence of rats in the house is high above the average normal threshold is 7% trap success[13]

District of Tembalang an altitude of 47 meters above sea level - 200 meters above sea level, and most of its territory is arid regions, it is visible from many locations are still dry. Distribution of leptospirosis cases in 2009 more in the higher elevations and flood-free areas. Environmental factors such as poor drainage facilities, no landfill is a problem encountered in slum area, less community participation also makes the leptospirosis problem more serious.

Climatic factors (rainfall) on the conditions and the specific area has a significant influence on the incidence of leptospirosis, high rainfall one occurrence of flooding and impact on the formation of puddles, especially supported by the type of soil in the area of

clay soils, so the presence of water in inundation may last longer. People who used to play or move at 1.6 times the risk of standing water.[13]

Leptospirosis transmission in Tembalang that was increasing in the dry season between July and August is a new phenomenon that needs to be aware of. So far, the concept and understanding of the disease leptospirosis is still oriented that the disease always related with flood, in fact leptospirosis can also be transmitted in Tembalang which was not a flooded area.

In conclusion, quickbird imagery is very excellent to determine risk factors for leptospirosis. The visual interpretation of high-resolution imagery and digitation on screen can result a map of environmental risk factors for leptospirosis. However, the use of this high resolution imagery in other places or in the wider area to find out the benefits of that image.

Acknowledgments

The authors thank to Prof. Sugeng Juwono Mardihusodo for technical assistance in writing manuscript. Thanks also submitted to: Drs. Projo Danoedoro chairman of the Management GIS and remote sensing PUSPIC laboratory, Universitas Gadjahmada for allowing to process data in the laboratory. In addition to Bambang Yunianto for allowing the use of data leptospirosis.

REFERENCES

1. World Health Organization. International Leptospirosis Society. Human leptospirosis: guidance for diagnosis, surveillance and control**.** Geneva. The organization. 2003.
2. Leptospirosis spot survey in Demak and Semarang city. Semarang .Central Java Prov Health Officer. 2005.
3. Leptospirosis surveyllance in Semarang city. Semarang District Health Officer, Semarang District Health Office. 2008.
4. Gasem MH. Management of human leptospirosis, zoonosis diseases national seminar. Semarang. Dr. Karyadi Hospital & Universitas Diponegoro. 2008
5. Danudoro P. Digital image processing, application and remote sensing theory. Yogyakarta, Faculty of Geography, Universitas Gadjahmada. 1996.
6. Sutanto, Remote sensing part 1. Yogyakarta. Gadjahmada University Press. 1986.
7. Jensen JR. Introductory digital image processing ; a remote sensing perspective. New Jersey: Prentice Hall.1996.
8. Lillesand TM, Kiefer RW. Remote sensing and image interpretation. Yogyakarta. Universitas Gadjah Mada.1999.
9. Prahasta E. Remote sensing, image interpretation, and digital processing by ER Mapper. Bandung. CV Informatika, 2008. Indonesin.
10. Yunianto B, Sunaryo, Widyastuti D, et al. Leptospirosis epidemiology study in Semarang city, research and development animal borne diseases control unit. Banjarnegara. 2008.
11. Lo CP, Yeung. Consepts and techniques of geographic information systems. New Delhi. Prentice-Hall of India. 2002.
12. Barcellos C, Sabroza PC. The place behind the case; leptospirosis risks and associated environmental conditions in a flood-related outbreak in Rio de Janeiro, Cad. Rio de Janeiro. Saúde Pública, 2001.
13. Widarso HS, Wilfried P, Gasem MH, et al. Diagnosis guideline and leptospirosis case management., Jakarta. Ministry of Health. 2003.
14. Ristiyanto, Farida DH, Gambiro PY. Leptospirosis epidemiology study in low land area (Demak, Central Java), 2006.
15. Suharyadi, Danudoro P. Geographic information system, basic concept and note recent condition, in sains geographic information, cartography and remote sensing, Yogyakarta. Universitas Gadjah Mada. 2004.
16. Tangkanakul W, Piyanitt T, Brian D P, et al. Risk factors associated with leptosprosis in Northeastern Thailand, Am J Trop Med Hyg. 2000;63:204–8.