

Ecohealth Approach in Anticipating Japanese Encephalitis in Tulungagung District, East Java Province

Bina Ikawati^{1*}, Tri Wijayanti¹, Dyah Widiastuti¹, Nova Pramestuti¹, Tri Isnani¹, and Tri Ramadhani¹

¹ Banjarnegara Health Research and Development Unit, National Institute of Health Research and Development, Ministry of Health Republic of Indonesia Selamanik St Num 16 A Banjarnegara, Central Java

Abstract. Japanese-B-encephalitis (JE) is a disease caused by the Japanese encephalitis virus from the Flavivirus group, the Flaviviridae family. In Indonesia, JE cases have not been widely reported in both animals and humans, although encephalitis in humans is common. Yamanaka reported positive for anti-JE antibodies in 96 (6%) pigs in Tulungagung District. Environmental elements need to be identified to support the establishment of a healthy ecosystem to minimize the potential of JE transmission. This study aims to identify the environment that can support JE transmission and conceptualize possible approaches. The method is carried out by conducting environmental observations of risky environmental conditions in April-November 2016 and searching for supporting literature. The results showed that there were many puddles in the environment of chicken and pig farms. Besides that, there were many open puddles of household waste in the residential areas. This place is the habitat for *Culex* Sp. mosquitoes. Another research reported 19.05% of pigs who were positive for Ab JE in Tulungagung District. Environmental improvement can be done by cultivating fish that is resistant to dirty water, for example, catfish in ponds in chicken and pig farms and the construction of closed disposal facilities.

Keywords: ecohealth, Japanese encephalitis, Tulungagung, environment, pigIntroduction

1 Introduction

Japanese-B-encephalitis (JE) is a disease caused by *Japanese encephalitis* virus, Flavivirus group, the Flaviviridae family.[1] In humans, JE infection can cause inflammation of the brain that can be fatal. Generally, JE sufferers are commonly found in children under ten years of age.[2] The clinical symptoms include high fever, vomiting, headaches, seizures and stiffness, paralysis, even at an advanced stage that can lead to impaired consciousness (coma) that can be fatal.[3] Pigs are known to be the best reservoir for the JE virus to

* Corresponding author: bina.ikawati@gmail.com

reproduce. Humans and horses are the final target of the transmission cycle (dead-end) because viremia is so short that it is difficult to transmit to other people.[4]

In Indonesia, JE cases have not been widely reported in both animals and humans, although there are many encephalitis cases in humans.[5] From January 2005 to December 2006 the Indonesian Health Research and Development Agency has conducted surveillance for JE in children under 15 years of age. The survey involved 15 hospitals in 6 provinces include East Java, East Nusa Tenggara, West Nusa Tenggara, West Sumatra, West Kalimantan, and Papua. The survey locations were selected based on geographical differences and representative of areas with low and high risk in terms of environmental conditions. The survey results showed that JE cases were confirmed in the six provinces using the JE IgM-capture ELISA examination.[6]

As a zoonotic disease, JE can cause encephalitis outbreaks in humans, considering that JE vectors are widely available around us and the virus has been isolated from livestock.[7] According to Huang in Sendow [8] the clinical manifestations of JE in livestock depend on the species and age of the infected animal. Clinical symptoms in livestock are generally invisible.[8]

The spread of JE cannot be transmitted through direct contact but must be through vectors, namely through the bites of mosquitoes containing the JE virus. The incubation period for infectious mosquitoes is between 9-12 days, mosquitoes infected with the JE virus during their lifetime will become infective and could transmit to animals and humans.[9] The incubation period in humans lasts about 5-15 days.⁹ The existence of rice fields and pigs are the main risk factors for the JE disease transmission cycle in a place if supported by the presence of the mosquito vector, *Culex* sp. Besides *Culex*, *Anopheles* Sp and *Mansonia* Sp, it can also be a vector of JE. [10]

Tulungagung District is one of the districts in East Java Province with the highest number of pig farms. Pig livestock in Tulungagung has increased from 2010 amount to 2,972 (19.03% of the pig population in East Java Province) to 10,058 heads in 2013 (21.82%) and increasing to 10,567 (25.23%) in 2014.[11]·[12] The total population in 2010 was 990,158 people and 1,053,276 in 2013.[13] This shows that the ratio between humans and pigs in Tulungagung is getting smaller from year to year, from 333: 1 in 2010 to 105: 1 in 2013. Pigs are known to be a potential reservoir and an effective host of JE virus amplifiers. This can be seen from the Wei[14] report, which states that JE cases in humans will increase if the ratio between the human and pig population gets smaller. Survey results reported by Yamanaka et al[15] in Bali (Mengwi) and East Java (Tulungagung District) in 2008 showed that 123 (49%) pigs in Bali and 96 (6%) pigs in East Java were positive for anti-JE antibodies. with the Hemagglutination-Inhibition (HI) test.

Ecosystem health (ecohealth) is a system based on an approach to promoting health and well-being that focus on social and ecological/environmental interactions.[16] This study aims to identify environmental conditions that support JE transmission and conceptualize an ecohealth approach that can be used to eliminate or minimize potential transmission of JE.

2 Materials and Methods

The research method using the ecohealth approach was carried out by observing local environmental conditions carried out in April-November 2016 and searching for supporting literature that refers to human health supporting ecosystem services which consist of three major components, namely buffering hazard, sustaining capacity, and promoting health. These three components are reciprocal with natural infrastructure.[17] The analysis was carried out descriptively.

3 Results

Tulungagung District has an area of 1,055.65 Km² located at 111°43'-112°07' East Longitude and 7°51'-8°18' South Latitude. The district has an elevation of 94.83% of its area below 500 m above sea level, including the Ngunut Sub-district where there are many pig farms. This District is bordered in the North by Kediri, South with the Indonesian Ocean, West with Trenggalek District, East with Blitar District. There are 32 rivers in Tulungagung District and for the Ngunut area, there is the Brantas River. The total population in Tulungagung District is 1,035,290 people in 2018, with 49% of the population being male.[18]

Data from the Animal Husbandry Service of Tulungagung District in 2015 stated that there were 32 pig farms, in Kedungwaru Sub-district 3, Ngantru Sub-district 12, Pagerwojo Sub-district 2, Ngunut Sub-district 12, and Sumbergempol Sub-district 3. Data confirmation with the Tulungagung District Animal Husbandry Office and Animal Husbandry officers in the field shows that there are far fewer pig breeders, what remains are farms that have quite a lot of pigs (not traditional breeders) that are still surviving around the Brantas river. One of the causes of the decline in the number of pig breeders is due to protests from residents around the farm. The remaining pig farms are concentrated in Ngunut Sub-district. The map of Ngunut Sub-district which is located in Tulungagung District, East Java Province, Indonesia can be seen in Figure 1.

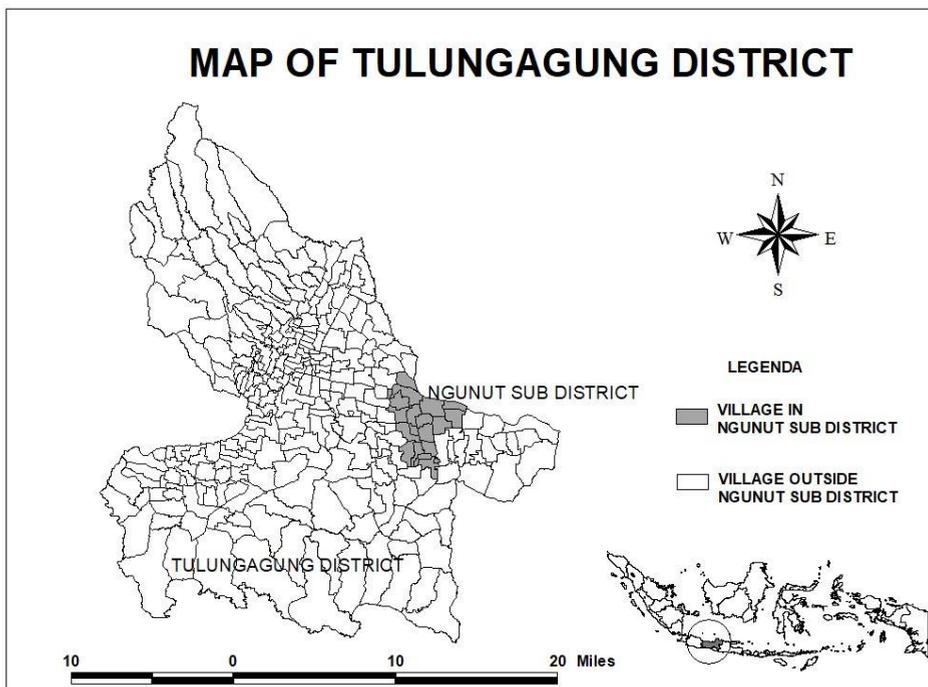


Fig. 1. The map of Ngunut Sub-district which is located in Tulungagung District, East Java Province, Indonesia

Agricultural land is located in the middle area of Tulungagung District with low soil contour conditions. The Ngunut Sub-district is not agricultural but rather a center for livestock raising mainly for pigs. In addition to pig farming, there are also poultry farms, quail, cows, goats and sheep. The map of Tulungagung District based on land contours, agricultural land and rivers is shown in Figure 2.

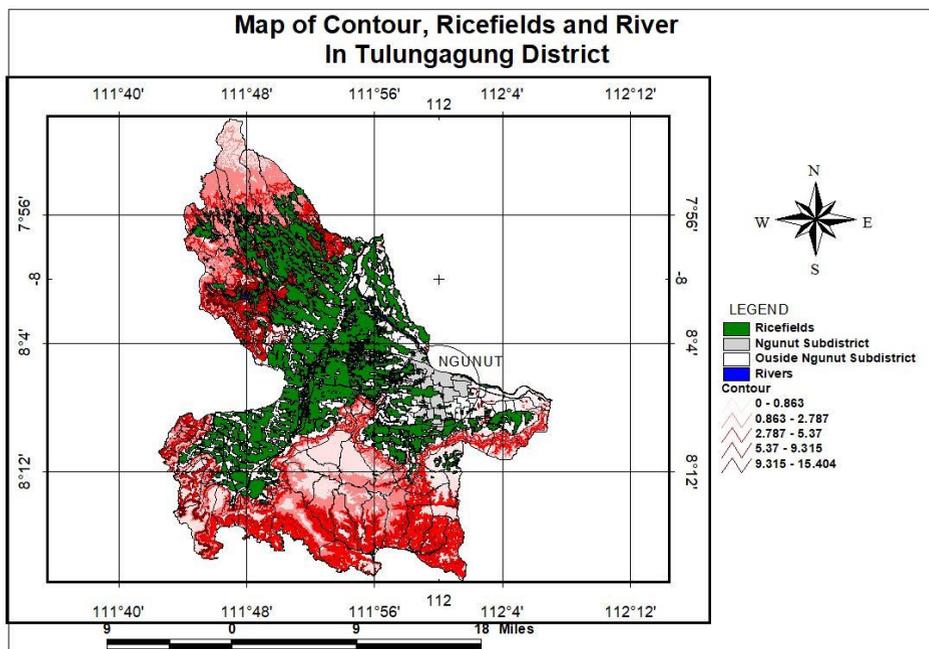


Fig 2. Contour maps, agricultural land, and rivers in the District Tulungagung

Environmental observations in Ngunut Sub-district show the pig farming areas that are concentrated in Kaliwungu and Pulosari Villages. In the two villages, there are many stagnant household wastewater, household water reservoirs and in pig and chicken farms, many water reservoirs, especially during the rainy season. In pig farms, there are many empty ponds. In both villages, during the dry season, puddles in the livestock environment are shrinking and dry except the pond in the pig farm. The literature search showed that 19.05% of the 63 samples examined JE reactive antibody in pigs in Ngunut and Kalidawir Sub-district. Infection in pigs was higher (23.1%) on farms found *Culex* larvae.[19]

The catch of mosquitoes in the pig farm in the Ngunut area was dominated by *Anopheles vagus* (53.4%), *Culex vishnui* (14.2%), and *Cx. quenequefasciatus* (12.7%), although no JE positive test results were found in mosquito samples. The value of the Human Blood Index, which shows that mosquitoes suck human blood, is in the range of 0.3.[20][21] Table 1 shows the supporting components in implementing ecohealth in Tulungagung District to anticipate JE transmission.

Table 1. Ecohealth supporting components in anticipation of JE in Tulungagung District

No.	Component	Identification	Output
1.	buffering hazard	-existence of standing water, empty ponds on the farm (vector habitat) - existence of the JE vector -existence of pig as JE reservoir - rice fields	The focus of the risk area, Ngunut Sub-district
2.	sustaining capacity	-Healthy and productive livestock / agricultural policies	-Create a plan for prevention efforts - closed sewage disposal facilities, -pol in the cattle pen given catfish - Stagnant water in the rainy season is poured or filled
3.	promoting health.	Promote through approaches to agricultural / livestock extension, environmental health extension, government and community leaders: - closed sewage disposal -pol in the cattle pen given catfish - Stagnant water in the rainy season is poured/filled	Promotional efforts to implementation

4 Discussion

The conditions on the farms and settlements in the Ngunut area are puddles, ponds on the farms, the presence of mosquitoes that are potential vectors of JE, namely *Culex vishnui* and *Cx. quenequefasciatus*. The existence of the JE virus in mosquitoes has been proven in a study by Ratna[22] which has successfully isolated the virus from four (4) species of vector mosquitoes, namely *Culex bitaeniorhyncus*, *Cx. quinquefasciatus*, *Anopheles kochi* and *Armigeres subalbatus* in Semarang District, Central Java. In addition to this, the presence of pigs and proximity to rice fields increases the potential risk of JE transmission in the Ngunut area.

Tulungagung District, East Java Province, based on Ngunut Sub-district and its surroundings. The existence of pigs based on a survey in Indonesia in 2012 showed a JE infection rate of 14.2%.[23] Apart from the economic aspect, breeders should pay attention to the effects of livestock on the surrounding environment and human health. Law no. 18 of 2009 regarding animal husbandry and animal health in which it is necessary to organize animal health that protects human and animal health and their ecosystems as a prerequisite for the implementation of advanced, competitive, and sustainable livestock as well as the provision of safe, healthy, intact and halal food so that it needs to be utilized for prosperity and community welfare.[24] Good animal husbandry practices are influenced by four things, namely: animal welfare, safe animal feed, animal health, and healthy living conditions. Good animal health practices will affect building herd immunity, preventing the

entry of germs into the farm, management of animal health programs, the use of chemicals and animal medication as recommended.[25]

Improve the environment can be carried out by constructing a closed disposal facility in residential and livestock areas. In the pond in the pigpen, fish that can survive in that place can be maintained, such as catfish.[26] In addition to avoiding the pond as a mosquito habitat, it is also expected to provide economic value. In the rainy season, the removal of potential mosquito breeding habitats such as puddles and other objects that can hold water should be a concern. This concept must be continuously disseminated to breeders and communities in settlements in Ngunut Sub-district so that JE can be prevented. Pig breeders need to pay attention to the diseases that exist in pigs, including the possibility of transmitting these diseases to humans. Concerning JE, breeders must understand the transmission cycle and provide support to break any potential JE transmission. The concept of biosecurity in animal husbandry is currently receiving attention besides improving animal health as well as providing health to humans.[27]

5 Conclusion

Many found standing water that can be a breeding habitat for mosquitoes. Also, there is a lot of standing water in the home environment from open sewerage channels. This place can be a habitat for *Culex* sp. The existence of pigs is also a risk in Tulungagung.

Recommendations. Environmental improvement can be done by raising fish that are suitable for empty ponds in areas for pigs and chickens and by constructing closed sewage disposal in residential and livestock areas.

Author's contribution. BI and TW as main contributors play a role in conceptualization ideas; formulation of overarching research goals and aims, visualization preparation, creation of the published work, writing-original draft preparation. DW, NP, TI, TR as a supporting writers play a role in validation verification of the overall reproducibility of results and other research outputs, writing-review & editing. All author play a role in investigation process, specifically performing the data/evidence collection, validation verification of the overall reproducibility of results and other research outputs.

Acknowledgements. The authors would like thank to the Head of Banjarnegara Health Research and Development Unit that motivates us to write this article. We would like also to extend our sincere thank to the researchers and technicians at the Banjarnegara Research and Development Unit who supported the implementation of the survey and to all parties in Tulungagung who helped carry out activities.

Competing interests. The authors report no conflict of interest in this work.

References

1. Rosen L, *The natural history of Japanese encephalitis virus*. Annu Rev Microbiol, (1986).
2. N. H. Rampengan, "Japanese Ensefalitis," *J. Biomedik*, vol. 8, no. 2, pp. 10–22, (2016).
3. V. Bui, C. Hang, V. Tran, and R. Lindquist, "Early mental mid neurological sequelae after Japanese B. encephalitis," *Southeast Asian. J. Trop. Med. Public. Hlth*, vol. 25, no. 3, pp. 549–553, (1994).
4. I. Lubis, "Masalah Penyakit Japanese Encephalitis di Indonesia," *Cermin Dunia Kedokt.*, vol. 61, pp. 24–27, (1990).

5. S. Wuryadi And T. Suroso, "Japanese encephalitis in Indonesia," *Trap. Med. Pub. Hlth*, **vol. 20**, no. 4, pp. 575–580, (1989).
6. R. I. Depkes, "Japanese Encephalitis (JE) Surveillance in Indonesia: Project Activities and Results." Jakarta, (2005).
7. L. Olson, T. Ksiazek, V. Leece, R. Ten, and R. Shope, "Isolation of Japanese encephalitis virus from *Anopheles annularis* mid *Anopheles vagus* in Lombok, Indonesia," *Trans. Roy. Soc. Trop. Med. Hyg.*, **vol. 79**, no. 6, pp. 845–847, (1985).
8. I. Sendow, S. Bahri, and A. Sarosa, "Prevalensi Japanese-B-Encephalitis pada Berbagai Spesies di Indonesia," *JITV*, **vol. 5**, no. 1, pp. 276–279, (2000).
9. Winarno, "Vektor Japanese Encephalitis di Indonesia," in *Workshop and training Surveilans JE di Rumah Sakit*, (2005).
10. P. P. Bhupen Barman, KG Lynrah, "Japanese encephalitis," in *OIE Revue Scientifique et Technique*, **vol. 34**, no. 2, , pp. 441–452 (2015).
11. Kementerian Dalam Negeri Republik Indonesia, "Pemetaan Potensi Ekonomi Daerah Koridor Wilayah Jawa: Tabel Potensi Peternakan."(2014).
12. Dinas Peternakan Provinsi Jawa Timur, "Data Statistik Populasi Ternak Kab/Kota di Jawa Timur," <http://disnak.jatimprov.go.id/web/layananpublik/datastatistik/statistikpopulasiternak>. .
13. B. K. Tulungagung, "Penduduk menurut Kelompok Umur dan Jenis Kelamin, (2013)," <http://tulungagungkab.bps.go.id>. .
14. L. Wei, "Disease Burden of Japanese Encephalitis: epidemiolog perspectiv.," in *Workshop and training Surveilans JE di Rumah Sakit*, (2005).
15. A. Yamanaka *et al.*, "Prevalence of Antibodies to Japanese Encephalitis Virus among Pigs in Bali and East Java , Indonesia , 2008," *Jpn. J. Infect. Dis.*, **vol. 63**, pp. 58–60, (2010).
16. G. A. Hill-Cawthorne, "One Health/EcoHealth/Planetary Health and their evolution," *One Planet, One Heal.*, no. May, pp. 1–20, 2019, doi: 10.2307/j.ctvggx2kn.6.
17. F. Cochran, L. Jackson, A. Neale, J. Lovette, and L. Tran, "A community ecohealth index from enviroatlas ecosystem services metrics," *Int. J. Environ. Res. Public Health*, **vol. 16**, no. 15,doi: 10.3390/ijerph16152760 (2019).
18. BPS Tulungagung., *Kabupaten Tulungagung Dalam Angka 2019*. (2019).
19. D. Widiastuti, T. Wijayanti, T. Isnani, N. Pramestuti, and S. M. P. Wijayanti, "Seroprevalence of Japanese encephalitis Infection in Pigs in Tulungagung, East Java," *Balaba J. Litbang Pengendali. Penyakit Bersumber Binatang Banjarnegara*, **vol. 15**, no. 2, pp. 125–132, 2019, doi: 10.22435/blb.v15i2.(1888).
20. N. Pramestuti, T. Wijayanti, D. Widiastuti, and T. Isnani, "Deteksi Virus Japanese Encephalitis Pada Manusia Dan Vektor Di Kabupaten Tulungagung, Jawa Timur," *Vektora J. Vektor dan Reserv. Penyakit*, **vol. 12**, no. 1, pp. 33–40, doi: 10.22435/vk.v12i1.2649 (2020).
21. D. Tri Wijayanti, "Infeksi Japanese encephalitis (JE) pada manusia, host amplifier dan vektor serta faktor-faktor yang mempengaruhi penularan JE di Kabupaten Tukungagung, Provinsi Jawa Timur," (2016).
22. R. Tan, S. Nalim, H. Suwasono, and G. Jennings, "Japanese Encephalitis Virus Isolated from Seven Species of Mosquitoes Collected at Semarang Regency, Central Java," *Bul. Penelit. Kesehat.*, **vol. 21**, no. 1, pp. 1–5, (1993).
23. S. Ompusunggu, M. Sembiring, R. Marleta Dewi, and S. Subangkit, "Infeksi Japanese Encephalitis Pada Babi di Beberapa Provinsi Indonesia Tahun 2012," *Media Penelit. dan Pengemb. Kesehat.*, **vol. 25**, no. 2, pp. 1–8, doi: 10.22435/mpk.v25i2.4230.71-78 (2015).
24. Presiden Republik Indonesia, "Undang-Undang Nomor 18 Tahun 2009 tentang Peternakan dan Kesehatan Hewan," (2009).

25. R. Premier, “Good Animal Husbandry Practices,” no. December, pp. 1–9, (2015).
26. J. M. J. Hermilinda Parera, “Peningkatan Manajemen Kesehatan Babi dan Pertanian Terpadu di Kelompok Mawar dan Kelompok Lorosae,” *J. Pengabd. Masy. Peternak.*, **vol. 1**, no. 1, pp. 40–47, (2016).
27. L. V. Alarcón, A. A. Alberto, and E. Mateu, “Biosecurity in pig farms: a review,” *Porc. Heal. Manag.*, **vol. 7**, no. 1, doi: 10.1186/s40813-020-00181-z (2021).