SPATIAL ANALYSIS OF ENVIRONMENTAL FACTORS FOR LEPTOSPIROSIS OUTBREAK DURING THE FEBRUARY 2007 FLOODS IN JAKARTA, INDONESIA

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EXTENDED ABSTRACT

INTRODUCTION AND AIMS:

Leptospirosis, a zoonotic bacterial disease caused by spirochetes, *Leptospira interrogans*, is endemic in many parts of the world, but can become epidemic in certain conditions such as heavy rainfall or flooding. Leptospirosis can be transmitted by direct contact with urine, blood or tissues of infected animals (mainly feral and peri-domestic rodents, shrews, cattle, pigs and dogs), as well as by indirect contamination occurred when people get in contact with water, damp soil, mud or vegetation which are contaminated with infected animal urine

Within the period of February 1 - 26, 2007, a major flood had occurred in Jakarta Province, inundating 60% of this capital city. In such condition, leptospirosis, as a disaster related disease, may cause outbreak. This study, which was part of MICRODIS project and funded by European Commission under the 6th Framework Programme, was aimed to observe possible relationship of environmental factors with the leptospirosis outbreak occurred immediately after February flood, using mainly spatial analysis.

METHOD:

A combination of case series and ecological study was carried out to analyze 195 leptospirosis case, based on positive finding of *Ig-M rapid immunochromatography dipstick,* which was reported from five major general hospitals in Jakarta. The five general hospitals involved were RSU Persahabatan, RSU Sumber Waras, RSUD Tarakan, RSUD Budi Asih, RSUD Cengkareng,

Geographical and environmental data (flooded areas, slum areas, waste disposal areas, Jakarta's rivers, land altitude and level of flood water) were obtained from government agencies. Software Arcview@, ver. 3.3 was used for spatial analysis to describe the distribution patterns of the leptospirosis cases all over the province.

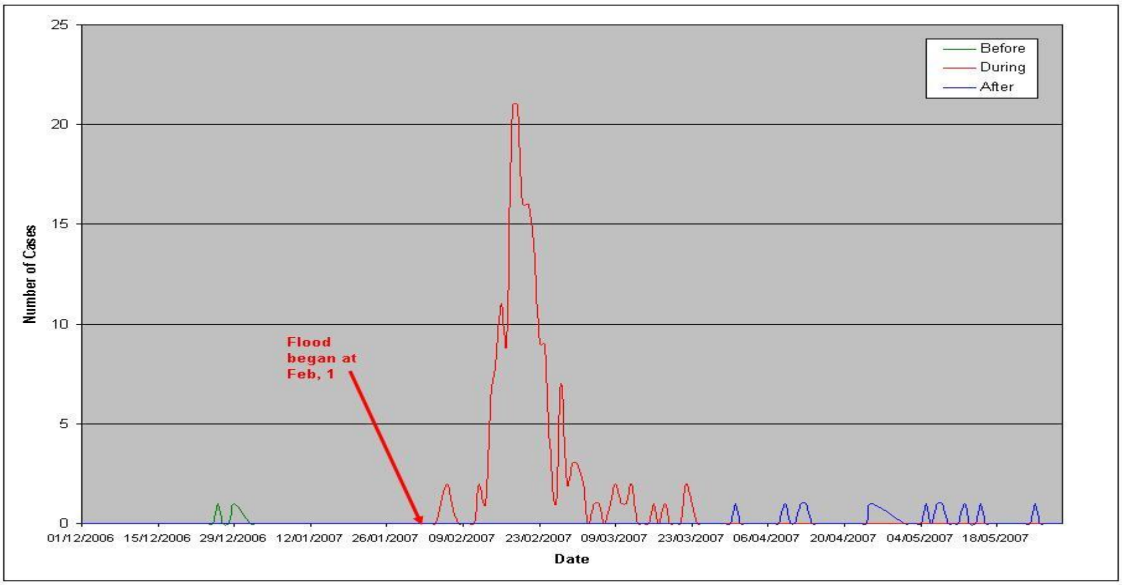
RESULTS AND DISCUSSION:

The leptospirosis cases reported from the 5 general hospitals came from all 5 municipalities in Jakarta Province, i.e. South ("*Selatan*") Jakarta, East ("*Timur*") Jakarta, Central ("*Pusat*") Jakarta, West ("*Barat*") Jakarta, the North ("*Utara*") Jakarta. Most of reported cases (68%) were young adults aged from 18 years to 49 years. Male cases were predominant (77%).

A week after very heavy rains pouring continuously the Jakarta province, the huge floods, which was considered the biggest in Jakarta since the last 3 centuries, started to occur on February 1 and was declared as over on February 26, 2007. Using the range of incubation period, which is between 2 to 30 days we estimated the period during which patients were likely to develop the disease presumably through flood exposure by adding the shortest incubation period to the first day of floods, and adding the longest incubation period to the last day of floods. Thus, the period was determined from February 3 to March 28, 2007. All leptospirosis cases reported before the 3rd of February were labeled as cases infected "before the floods", while those reported after the 28th of March, were labeled as cases infected "after the floods". This very sharp increase of the leptospirosis cases since February 3, as reflected in the epidemic curve (Fig.1), has strongly indicated a leptospirosis outbreak during the flood.

From the epidemic curve, it is seen that the reported leptospirosis cases increased sharply and reaches its highest peak abruptly (23 cases) on 19th of February and falls again in a log-linear fashion, suggesting a point source outbreak, meaning that the population was probably exposed from one common source, i.e., the massive floods, at one point in time. Comparing our epidemic curve with the trend of the whole leptospirosis cases in Jakarta reported by Provincial Health Office in previous years, it is clear that the February outbreak has reached very high level of cases had never been experienced during the previous 2 years.

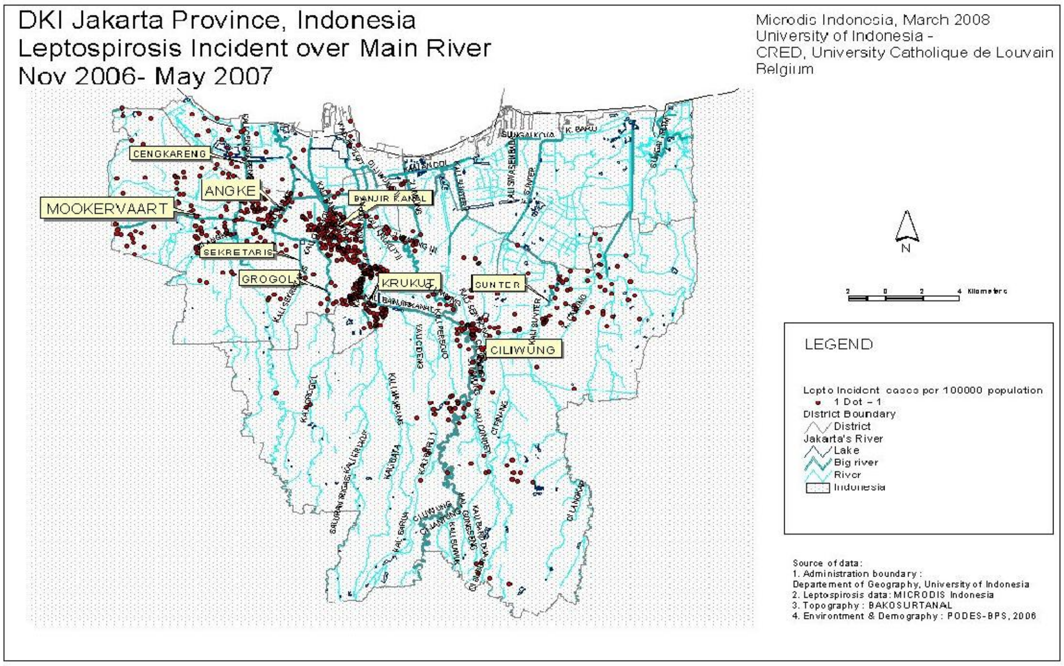
Fig.1.a. Epidemic curve of the leptospirosis cases due to the flood in February 2007



Our data showed that most of leptospirosis cases were more concentrated in flooded areas, especially in northwest part of the province. Concerning the flood itself, most of flooded areas located in northern part of the Jakarta province. This condition was possibly to a certain extent due to the fact that, firstly, the land altitude in northern part is the lowest (≤ 10m) and in southern part is the highest (>40m). About 40% of the areas in Jakarta are under the sea level, especially in northern part, making the areas become more prone to flooding. When, for several reasons (such as torrential rain) the 13 rivers overflow through the province, the flash flood will run from the uphill southern part to the downhill northern part of the province. Secondly, experts estimated that from 1979 to 1991, North Jakarta subsided at a rate of about 25-34 centimeters per year, while other municipals subsided at 2 - 8, centimeters per year, caused by uncontrolled and unlimited deep groundwater extraction.

Interestingly, the clusters of leptospirosis could be observed in certain areas alongside some parts of the main city drains, canals and rivers, like *Saluran Mookevart* drain, *Cengkareng* drain, *Angke* river, *Sekretaris* river, *Krukut* river, *Grogol* river, *Banjir Kanal* canal, *Sunter* river and *Ciliwung* river, the biggest river of the city. In general, most of leptospirosis cases clustered around some parts of *Grogol* river, *Banjir Kanal* canal and *Ciliwung* river (Fig.2.)

Fig.2. Leptospirosis cases distribution based on drain, canal & river location



The leptospirosis case distribution pattern was tried to be linked with the pattern of areas having number of waste disposal sites (defined as sites with container or limited space provided for temporary waste collection from the households, available in each sub-district level). The case distribution pattern did not show clear tendency to cluster in areas with higher number of disposal sites. However, when we drew buffer layer areas in radius distance of "within 500 m (meter)", "500- 1000 m" or "> 1000 m" from the waste disposal sites, seems that most of the cases were distributed in areas within the radius 500 m from the point of disposal.

Many places alongside riverbanks in Jakarta have also frequently become unofficial, waste disposal places, as partly indicated by World Bank in 1994 reporting that about 30% of trash and *solid waste* is believed to get blown or washed away or is dumped into rivers and drains. This waste disposal may become favorable nests and proliferation places of rodents, like rats. When the level of river water was rising and overflowing to the waste disposal sites, the river water was most likely be contaminated with *leptospirae* from the rodent's urine. As reported from many other studies, the three main factors, i.e. waste accumulation, the presence of rodents and floods, have been recognized as common factors contributing to urban leptopsirosis outbreaks. It is also understood that flooding is particularly favorable for the occurrence of leptospirosis, since floods prevent rat's urine from being absorbed into the soil or evaporating, so the leptospirae could pass directly into surface water or persist in mud. It was also reported from other studies that the risk to get infected by *leptospirae*, through skin exposure, increases, especially when the river water level rises during the rainy seasons and flood. We, then, speculated that the flood overflowing the waste accumulation sites, especially in the river/drain banks, may amplify the probability of being infected through increasing people's exposure with flooding river/drain water, contaminated with rodent urine. The flood may even have delivered contaminated water to people living not only in the river banks but also in surrounding farther residential places, leading to the increase probability of leptospirosis outbreaks.

When we tried to see the case distribution based on slum areas, the cluster of leptospirosis cases did not seem to be superimposed with slum areas. This study borrowed a definition of slum area from the Central Statistics Agency, Province of Jakarta, i.e. the neighborhood block where the score for slum indicators of physical and environmental conditions was below acceptable standard, i.e. < 36 (out of 40). The slum indicators comprised 10 conditions, i.e. population density, construction design, housing construction condition, housing ventilation, construction density, road/street condition, water drainage, clean water utility, human excrete disposal and waste management.

Our finding that the case distribution did not show tendency to be more concentrated in slum areas, was not consistent with findings from other studies stating generally that slum areas with poor sanitation may produce high number of cases and may potentially become endemic areas of leptospirosis, especially during periods of flooding and heavy rainfall. This inconsistency needs further elaboration.

CONCLUSION AND RECOMMENDATION:

Our study concludes that; 1). the huge Jakarta flood occurred from 1-26 February and submerging 60% of this capital city was most likely to have induced the point source leptospirosis outbreak in Jakarta province; 2). Certain environmental factors, like flows of rivers, drains/canals and possibly waste disposal sites and slum environment, could be suspected to induce the spread of the leptospirosis, especially in surrounding main city rivers and drains/canals, in Jakarta.

As recommendation, our findings underline the need to increase people awareness concerning the possibility of leptospirosis outbreaks after flood, to improve modifiable environment which may induce the occurrence of the outbreak and to establish biological causal relationship between determinants related to flood and the risk to get leptospirosis infection by conducting further analytical study.

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