Arndt-Corden Department of Economics
Crawford School of Public Policy
ANU College of Asia and the Pacific

Mortality from the influenza pandemic of 1918-19 in Indonesia

Pierre van der Eng

Research School of Management

ANU College of Business and Economics

The Australian National University

pierre.vandereng@anu.edu.au

June 2023

Working Papers in Trade and Development

No. 2023/06

This Working Paper series provides a vehicle for preliminary circulation of research results in the fields of economic development and international trade. The series is intended to stimulate discussion and critical comment. Staff and visitors in any part of the Australian National University are encouraged to contribute. To facilitate prompt distribution, papers are screened, but not formally refereed.

Copies are available at https://acde.crawford.anu.edu.au/acde-research/working-papers-trade-and-development

Mortality from the influenza pandemic of 1918-19 in Indonesia

Pierre van der Eng

Research School of Management

ANU College of Business and Economics

The Australian National University

pierre.vandereng@anu.edu.au

Abstract

This paper discusses existing estimates of the number of deaths due to the 1918 Spanish influenza pandemic in Indonesia, particularly in the core island of Java. Chandra (2013) estimated these deaths to be 4.26 to 4.37 million. The paper substantiates that these estimates are the result of a methodology that relies on an overestimated annual average population growth rate of 1.75% during 1880-1930. Using a more realistic growth rate of 1.1% per year reduces the estimate to a still considerable 1.47 million deaths in 1918. A rough estimate of excess mortality among the non-Indonesian population in Java and the whole population in the outer islands of Indonesia suggest a total of 2 million excess deaths related to the Spanish flu in 1918-19. The paper also briefly scrutinises the available vital statistics obtained from the village registers in Java. Correcting these as much as possible for under-recording confirms the impression that the estimates in Chandra (2013) are too high. The paper identifies opportunities for further historical demography research related to the 1918 flu pandemic in Indonesia.

Keywords: Spanish flu, epidemic, influenza pandemic, mortality, Java, Indonesia

JEL codes: I19, J11, N35

Mortality from the influenza pandemic of 1918-19 in Indonesia

1. Introduction

The 2020-21 COVID-19 pandemic raised questions around the world about the likely human toll and the most effective containment measures. Answers to these questions were difficult to predict in light of a multitude of uncertainties. Some answers were sought on the basis of past experiences with pandemics, particularly the 1918-19 Spanish influenza pandemic and its impact on populations and economies (*e.g.* Barro *et al.* 2020).

In the case of Indonesia there was also a flurry of media interest in the 1918-19 pandemic when the COVID pandemic started. However, except Gallardo-Albarrán and De Zwart (2020), no new scholarly work was published that analysed the impact of the Spanish influenza. Publications on this topic generally refer to Brown (1987: 235) which argued that at least 1.5 million people died in Indonesia's densely populated core island of Java due to the 1918-19 flu pandemic, and to Wibowo *et al.* (2009) which offered a historical narrative of the pandemic. Some noted that Brown's estimate had been challenged by Chandra (2013). References to this publication were possibly muted, because Chandra estimated a formidable 'population loss' of 4.26 to 4.37 million in Java in 1918. This seems exorbitant, because the estimates suggest mortality rates of 12 to 13 percent during 1918, if we use total population according to the 1920 population census as the denominator. That would suggest that the mortality rate was much higher in Java than the global average of 2.5 to 5 percent (Johnson and Mueller 2002: 114).

This paper serves two purposes. Firstly, it scrutinises the estimates of mortality in Java related to the 1918-19 Spanish flu pandemic in Chandra (2013), by discussing the data and methodology it used. Its second purpose is to discuss the key source available for a more detailed analysis of the impact of the Spanish flu epidemic in Indonesia. The discussion will consider whether closer scrutiny of the available evidence about the spread of the Spanish flu has relevance to the further analysis of the COVID-19 pandemic.

2. Data and methodology in Chandra (2013), new estimates

The estimate of 1.5 million deaths in Brown (1987) is an informed guess, rather than the result of an analysis of available data. Inter alia, it seems based on the argument that the existing mortality data for Java during the 1918-19 pandemic were under-recorded in the village registers from which they came. This issue was explored in

detail in another chapter in the book that published Brown's chapter (Gardiner and Oey 1987). In fact, it was already known at the time of the pandemic that these registers under-recorded population and vital statistics (Winckel 1919: IX; Breman 1963: 261). However, the extent of underestimation was long not known. Indonesia's first population census of 1920 counted 34.4 million Indonesian people in Java (excluding Europeans and Chinese).[1] This was almost the same as the total population from the 1920 village registers, which suggested that the village registers were relatively accurate. It took until after the results of the 1930 census became available that it appeared that the village registers had under-recorded population in Java by about 8%.[2]

In 1918, the data from the village registers indicated that the total mortality rate (including old age, and other illnesses) was 35‰, while the average for 1912-17 was 20‰, suggesting that excess mortality in 1918 due to the Spanish flu was 15‰. Assuming that the village registers may also have under-recorded the number of deaths by 8%, and correcting the 1918 village register population of 33.6 million for 8% underreporting and multiplying the result by 15‰ yields a toll of 0.5 million. As the flu pandemic continued until September 1919, excess mortality of 8.5‰ during 1919 of about 0.2 million needs to be added. However, this total of 0.7 million flu-related deaths during 1918-19 does not come close to Brown or Chandra's estimates.

The estimates in Chandra (2013) are based on the five-yearly residency-level population registration data, collected from the village registers for 1880-1905, and the 1920 and 1930 population censuses. The methodology is intricate. In basic terms, it allows Chandra to estimate average population growth rates for each residency, as well as a weighted average for Java as a whole of 1.75% per year (restricted model) before and after the 1918 pandemic. Chandra then extrapolates 1880-1905 growth to 1918 and retropolates 1920-1930 growth back to 1918.

Figure 1 shows a simplified replication of the methodology, based on the data used in Chandra (2013). Rather than use the quinquennial population counts of 1880-1905 at residency level, as Chandra did to estimate population growth, Figure 1 uses the aggregated data for Java as a whole from the same sources. The difference between the extrapolated and retropolated lines is the 'population loss', *i.e.* the net result of a combination of excess mortality and depressed fertility, or the upper limit of excess mortality related to the flu pandemic (Chandra 2013: 190). The simplified replication yields an estimate of 'population loss' that is very similar to Chandra's: 4.2 million in 1918.

[1] The population numbers discussed in this paper only refer to ethnic Indonesians and exclude people of other ethnicities living in Indonesia at the time.

[2] The last published total population according to the village registers was 37.1 million in 1929. Assuming the same growth as in 1929, the 1930 village register population may have been 37.8 million, or about 8 percent lower than the 40.9 million according to the 1930 census.

[Figure 1 about here]

The problem with the methodologies used in Chandra (2013) and Figure 1 is that they take no account of the fact that population numbers were under-recorded in the village registers and also in the quinquennial population counts of 1880-1905 that were based on these registers and even in the 1920 census. It also takes no account of the fact that demographers Boomgaard and Gooszen (1991: 61) scrutinised these data before offering their most plausible estimates of the Indonesian population in Java for the benchmark years 1850, 1900 and 1920. Combined with the results of the 1930 census, the annual average population growth rates based on these estimates 1.1% 1900-1920, and 1.0% 1920-1930; much lower than 1.75% per year.

The consequences of the use of this high annual average 1.75% population growth rate, rather than a lower annual average rate of 1.0 to 1.1%, to estimate 1918 population are significant. Figure 2 uses the Java-total data from Boomgaard and Gooszen (1991) to replicate the method shown in the simplified way indicated in Figure 1. The result is an estimated death rate of 1.47 million, which is close to the estimate in Brown (1987). It represents a still horrific toll of 3.9% of the population in Java in 1918, but is much lower than the 4.3 million estimated in Chandra (2013).

[Figure 2 about here]

These estimates do not take account of the excess mortality among 'other Asian' and 'European' populations, nor of excess mortality in Indonesia's outer islands. A civil registration system for 'European' population recorded deaths and births that existed in all major cities. This group consisted of the non-Asian population of colonial Indonesia, but included Japanese citizens and anyone, regardless of their ethnicity, who had applied for and secured 'equalisation' ('*gelijkstelling*') of their legal status to that of Dutch nationals.[3] In addition, in accordance with the 1911 diplomatic convention between The Netherlands and China, ethnic Chinese persons born in Indonesia after 1910 were automatically granted Dutch citizenship. Unless their parents were nationals of the Republic of China and registered their newborn at one of the Republic's consulates in Indonesia. So, from 1911, an accumulating number of ethnic Chinese also secured 'equalisation'. For ethnic Chinese people who did not, a civil separate registration system for 'other Asians' than Indonesians and European

[3] After 1920, until 1949, the term 'declaration of applicability' ('*toepasselijk verklaring*') rather than '*gelijkstelling*' was used, in order to indicate that the process did not necessarily involve an extension of Dutch citizenship. To acquire Dutch citizenship, applicants had to follow a separate naturalisation ('*naturalisatie*') process. A database with the outcomes of both processes is available online: http://naturalisaties.decalonne.nl

was created, but by 1918-1919 it had only just been introduced in Jakarta and was still only under consideration for other cities.

The first mortality data from this registration system in Jakarta indicated for 1918 that 'other Asians', most of them ethnic Chinese and ethnic Middle Eastern residents, had suffered just as badly from the Spanish flu as the Indonesian population, particularly during the months of September, October and November 1918 (*Bataviaasch Nieuwsblad*, 8 and 9 August 1919). No records have been published for the 'European' population, but the 1908-1923 death rates in the army of colonial Indonesia indicate that they were 85.1‰ for 'Europeans' and 82.6‰ for military personnel of other ethnicities during 1918; almost the same (Bobbert and Van Dam 1925: Graph III). The non-ethnic Indonesian population of Java was 505,153 in 1917, possibly 520,000 in 1918. Assuming excess mortality was 3.9%, like among ethic Indonesians in Java, adds 20,280 flu victims.

Indonesia's Outer Islands did not have a consistent village-based population registration system. Data in Boomgaard and Gooszen (1991) indicate that the 1920 population census showed the total population there to have been 14.8 million, and that assuming 8% underestimation like in Java, yields possibly 16 million in 1920, therefore possibly 15 million in 1918. Assuming excess mortality in the outer islands to have been 3.9%, like in Java, adds 585,000. Consequently, in all, the Spanish flu epidemic may have taken the lives of around 2 million inhabitants of Indonesia.

3. Vital statistics from the village registers

Another way to estimate mortality in Indonesia related to the Spanish flu during 1918-1919 is to consider the ways in which the village registers recorded vital data, before these were aggregated and reported by the government in colonial Indonesia. Apart from Boomgaard and Gooszen (1991), these vital data have been scrutinised by several demographers, including Breman (1963), Nitisastro (1970), Gardiner (1981), Gardiner and Oey (1987) and Gooszen (1999).

During much of the 19th century, village heads were required to maintain village registers containing numerical information on prescribed topics. The regional officials of the colonial public service in Indonesia harvested and accumulated these data every year, including data on population, births and deaths. These accumulated data were published in the annual Colonial Report (*Koloniaal Verslag*) which the Dutch government submitted to parliament.

It was known at the time that the village registers suffered from inaccuracies, and that these could possibly be remedied through closer scrutiny of the work of regional Indonesian public services. This was not only the case with population data in villages, also with data on agricultural land and land use (Van der Eng 2016: 230-

232). In light of budget limitations, the colonial government in 1880 decided to scrutinise the collection of population data from the village registers on a five-yearly basis. However, deficiencies remained, publication of the vital statistics was halted in 1894 and of population data in 1905, because of the poor quality of the data (Gardiner 1981: 44). The government's intention was to organise a proper population census, which eventually took place in 1920.

In the meantime, village authorities continued to record population in village registers. In 1911 the Public Health Service (*Burgerlijke Geneeskundige Dienst*, BGD) was formally tasked with improving the vital statistics in the registers for the purpose of improving disease surveillance in Java (Gardiner 1981: 33, 45-46). In 1912 it started with a new system involving the weekly reporting of the number of deaths at village level under the supervision of the regional health inspectors of the BGD. The intention was to improve its ability to analyse the temporal and spatial patterns of mortality and the impact of diseases and epidemics in Java.

The BGD harvested and accumulated these improved data and since 1916 it reported them at subdistrict (*onderdistrict* or *kecamatan*) level in Java. These data informed the work of a committee commissioned by BGD in November 1918 to study the flu pandemic. The committee surveyed 83 medical practitioners across Indonesia. Most of the committee's report published in 1920 reports the survey results, but it also analysed the registered mortality data (Report 1920). The report informed the development of epidemiology and public policy in Indonesia after 1920.

Figure 3 reveals the annual variations in the temporal and spatial degrees to which the flu pandemic spread in Java during 1918-19. The numbers of reported deaths on which the maps were based were too low, due to continued underreporting. At the same time, total population was underestimated as well, possibly by 8%, as mentioned. Assuming that underreporting was similar across subdistricts, the report and Figure 3 thus reveal three issues that could be relevant to a comparative analysis of the impact of COVID-19 on mortality in Indonesia. Closer scrutiny of these data, together with other available regional data, may reveal further patterns.

[Figure 3 about here]

Firstly, the report shows that the first cases of infection were reported in Indonesia in July 1918, mostly among people who had travelled from or via Singapore. However, the onset of the pandemic was in September 1918. The peak of its impact was in late-November 1918, 8 weeks later. The impact was most intense during 8 weeks, from late-October until early-December 1918. Except voluntary self-isolation, hospital treatment and the use of experimental medicines, the report does not discuss the use of any large-scale measures to contain the spread of the virus. That suggests that the virus raged largely unabated.

Secondly, the impact of the pandemic was very unevenly spread across subdistricts in Java. Central and East Java and cities in West Java were most badly affected in 1918. The report offers no clear indication whether geographical features such as topography or population density of a subdistrict mattered. To explain geographical variation, the report pointed to variations in the virulence of the flu virus and in immunity of the local population.

Thirdly, the pandemic had a long 'tail'. Figure 4 extends a graph from the report with data for 1919. It shows the annualised weekly mortality rate, and the rate of increase in the degree to which the Spanish flu ravaged Java's population. The mortality rate decreased quickly after November 1918, but flared up regionally, especially during June 1919. It took until September 1919 before the mortality rate returned to the level of the 1912-1917 average.

[Figure 4 about here]

Clearly, there was no 'flattening of the curve' during 1918-1919 in Java. The 1920 report contains tales of an insufficiently prepared and overstretched system for public health and medical care, which has been confirmed with other sources by Wibowo *et al.* (2009). Consequently, Figure 4 indicates that Java – and by implication Indonesia – achieved 'herd immunity' at a horrendous cost. But was that cost 1.5 million or 4.3 million lives in Java?

An alternative way to estimate flu-related deaths is to use the degree to which the weekly annualised average mortality rate exceeded the 20.5‰ average of 1912-1917. Then correct the weekly excess mortality rate for the degree to which total recorded deaths were underestimated, which Gardiner (1981: 42) put at 20%. The last step is then to project these rates onto the interpolated population numbers from Boomgaard and Gooszen (1991: 61) for 1918 and 1919 shown in Figure 2, in order to capture the underestimation in the village registers. This yields an excess mortality of in Java of 1.13 million during 1918-1919.

Thus, this paper presented two alternative approaches to estimating excess mortality in Java related to the 1918-19 flu pandemic that yielded estimates of respectively 1.47 and 1.13 million deaths. Qualitative information in the 1920 report suggests that the impact of the pandemic may have been roughly the same in the Outer Islands, as assumed above. Applying the same excess mortality rate to estimates of the population in the Outer Islands (Touwen 2001: Appendix A) and adding these to the numbers for Java, indicates that the total number of deaths in Indonesia due to the flu pandemic during 1918-1919 were respectively 2.12 and 1.63 million. Again, a horrendous toll, but these totals are still far removed from the 4.26 to 4.37 million population loss in Java estimated in Chandra (2013).

Is it possible that all the village-based enumerators and the supervising health inspectors in Java, who were responsible for the compilation of the weekly mortality data were unable to account for between 2.79 (= 4.26 – 1.47) and 3.24 (= 4.37 – 1.13) million deaths in Java during 1918? In case of the second estimate, this would be in addition to the 20% of deaths already accounted for.

Gardiner (1981: 229-248) analysed the degree of underreporting of vital statistics in the 1970s on the basis of surveys. He noted that the 1970s rate of underreporting was similar to the 1920s. In both decades, there was no legal obligation to report deaths, nor were there specific penalties for the non-registration of deaths. Two of Gardiner's findings stand out. Firstly, that deaths in early childhood tended to be more under-registered than deaths at later ages. This was not because infant deaths were purposely hidden, but because both cultural and practical factors lowered registration rates. The infant mortality rate may have been high at 250‰ around 1920 (Van der Eng and Sohn 2019: 219). If so, this is likely to be a major explanation for the under-recording of deaths in 1918-19.

Secondly, Gardiner found that local publicity and communication about the purposes and procedures of vital registration improved registration rates, large irrespective of socio-economic conditions and illiteracy. However, this was contingent on the esteem and authority of the village head. This could be a further explanation for under-recording in 1918-19, because the BGD health inspectors focused on supporting the work of the village authorities. The BGD only stepped up using publicity campaigns about hygiene and diseases in the course of the 1920s (Boomgaard 1993).

In 1930, Java had 1,515 subdistricts and about 22,000 villages (Schoel 1931: v). In other words, according to Chandra's estimates, the village enumerators must on average each have missed between 125 and 145 deaths, and the inspectors on average each missed 1,800 to 2,100 deaths in each subdistrict. Vital statistics were reported weekly since 1912. In addition, death and burials were guided by rituals involving religious village authorities and by public service prescriptions such as the 1911 government ordinance on epidemics (Departemen Dalam Negeri 1922). Leaving aside the under-recording of infant deaths for cultural and practical reasons, it seems unlikely that village enumerators missed very many deaths of adults. They may have overlooked adults who died in remote rural areas well-away from villages, where they were buried by their relatives without the involvement of village authorities. However, distance and relative isolation make it unlikely that such deaths were related to the 1918-19 pandemic.

4. Conclusion

This paper has pointed out that the high estimates of excess mortality related to the Spanish flu pandemic in Java in 1918 in Chandra (2013) are a consequence of the use of under-estimated populations from the sources available for 1880-1930, particularly the quinquennial population data for 1880-1905. Using the same methodology and more realistic estimates of population growth during 1880-1930 yields an estimate of 1.47 million death in 1918. Scrutiny of the available vital statistics that are based on the village registers in Java, and correcting these as much as possible for under-recording confirms the impression that the estimates in Chandra (2013) are too high.

Both Chandra (2013) and this paper echo a question that Brown (1987: 235) posed: why is there such limited scholarship on the history of the 1918-19 Spanish influenza pandemic in Indonesia? After all, the likely magnitude of this episode in Indonesia's demographic history is only comparable to the 1944-45 famine that caused excess mortality of about 2.4 million people in Java and the 1965-66 massacres in Indonesia (Van der Eng 2002: 503; Chandra 2017). In addition, there is an abundance of quantitative and qualitative sources to draw on for closer studies of the impact of the 1918-19 pandemic.

Wibowo *et al.* (2009) indicate the opportunities for qualitative research. In terms of historical demography, there are still options to research to analyse the ways in which the 1918-19 pandemic impacted on the development of epidemiology and the development of public policy in the areas of epidemic containment or health and hygiene public information campaigns.

After taking due account of limitations on their accuracy, the availability of regional quantitative data on regional mortality could yield new research. In historical demography, there are opportunities to analyse regional variations in the impact of the flu pandemic on the basis of the 1918-19 mortality data and district-level data. For example, data that capture the regional socio-economic fabric of Java (MCKS 33, 1926) and the regional existence of roads and railways as a proxy for the mobility of people, in order to identify factors that mitigated or accelerated the spread of the flu virus. A question that could be analysed is what consequences increased excess mortality had for birth rates during 1918-19 for population growth during the 1920s and 1930s, given that it affected younger people more than older people. Or, using the 1930 population census data, research could analyse whether the regional impact of the 1918-19 flu had consequences for domestic migration in Java. In terms of economic history, it would for example be relevant to test the resilience of rural economies to a pandemic, by analysing the regional impact of weekly excess mortality on agricultural production using the monthly regional data on the areas of harvested farm crops during 1916-1922 (MCKS 15, 1924). The outcomes of such research may inform

answers to the many questions that surrounded the COVID-19 pandemic that unfolded in Indonesia and the rest of the world during 2020-2021.

References

Barro, Robert J., Ursúa, José F. and Weng, Joanna (2020) 'The coronavirus and the great influenza pandemic: Lessons from the "Spanish flu" for the coronavirus's potential effects on mortality and economic activity.' *NBER Working Paper No.26866.* Cambridge MA: National Bureau of Economic Research. http://www.nber.org/papers/w26866

Bobbert, A.C. and Van Dam, S. (1925) 'Graphische voorstellingen van de voornaamste ziekten betreffende het Nederlandsch-lndische leger gedurende de jaren 1908 tot en met 1923, bewerkt naar gegevens van het Hoofdkantoor van den Militair Geneeskundigen Dienst' [Graphs of the main diseases in the army of colonial Indonesia during 1908-192. Processed on the basis of data from the hearquaters of the Military Health Service], *Geneeskundig Tijdschrift voor Nederlandsch-Indië*, 64: 728-729.

Boomgaard, Peter and Gooszen, Abrahamine J. (1991) *Changing Economy in Indonesia Vol.11: Population Trends 1795-1942.* Amsterdam: Royal Tropical Institute.

Boomgaard, Peter (1993) 'The development of colonial health care in Java; An exploratory introduction', *Bijdragen tot de Taal-, Land- en Volkenkunde*, 149(1) 77-93.

Breman, Jan (1963) 'Java: Bevolkingsgroei en demografische structuur' [Java: Population growth and demographic structure], *Tijdschrift van het Koninklijk Nederlands Aardrijkskundig Genootschap*, 80(3) 252-308.

Brown, Colin (1987) 'The influenza pandemic of 1918 in Indonesia', in Owen, Norman G. (ed.) *Death and Disease in Southeast Asia: Explorations in Social, Medical, and Demographic History.* (Oxford: Oxford University Press) 235-256.

Chandra, Siddharth (2013) 'Mortality from the influenza pandemic of 1918-19 in Indonesia', *Population Studies*, 67(2) 185-193.

Chandra, Siddharth (2017) 'New findings on the Indonesian killings of 1965-66', *Journal of Asian Studies*, 76(4) 1059-1086.

Departemen Dalam Negeri (1919) 'Ketentoean tentang mengoeboerkan majat di Hindia Belanda dan peratoeran lain-lain jang berhoeboengan dengan itoe' [Provisions regarding the burial of dead bodies in the Netherlands Indies and other regulations related to that]. *Pemimpin oentoek Prijaji-Prijaji Boemipoetera ditanah Djawa dan Madoera, No. 45/B.B.* Batavia: Departemen Pemerintahan Dalam Negeri.

Gallardo-Albarrán, Daniel and De Zwart, Pim (2020) 'A bitter epidemic: The impact of the 1918 influenza on sugar production in Java', *Economics and Human Biology*, 42: 101011.

Gardiner, Peter (1981) *Vital Registration in Indonesia: A Study of the Completeness and Behavioral Determinants of Reporting of Births and Deaths.* PhD thesis, Department of Demography, The Australian National University, Canberra.

Gardiner, Peter and Oey, Mayling (1987) 'Morbidity and mortality in Java, 1880-1940: The evidence of Colonial Reports' in Owen, Norman G. (ed.) *Death and Disease in Southeast Asia: Explorations in Social, Medical and Demographic History.* (Oxford: Oxford University Press) 70-90.

Gooszen, Hans (1999) *A Demographic History of the Indonesian Archipelago, 1880-1942.* Leiden: KITLV Press.

Johnson, Niall P.A.S. and Mueller, Juergen (2002) 'Updating the accounts: Global mortality of the 1918-1920 "Spanish" influenza pandemic', *Bulletin of the History of Medicine*, 76(1) 105-115.

Liem, Giok Kiauw Nio (2009) *De Rechtspositie der Chinezen in Nederlands-Indië 1848-1942: Wetgevingsbeleid tussen Beginsel en Belang* [The legal position of the Chinese in colonial Indonesia 1848-1942: Legal policy between principle and interests]. Leiden: Leiden University Press.

MCKS 15 (1924) 'Statistics of the harvested and planted areas of the principal native crops for the years 1916 up to and including 1922.' *Mededeelingen van het Statistisch Kantoor No.15.* Weltevreden: Departement van Landbouw, Nijverheid en Handel. https://digitalcollections.universiteitleiden.nl/view/item/2363985

MCKS 33 (1926) 'Agricultural atlas of Java and Madura, Part II: Report and tables.' *Mededeelingen van het Centraal Kantoor voor de Statistiek No.33.* Weltevreden: Departement van Landbouw, Nijverheid en Handel. https://digitalcollections.universiteitleiden.nl/view/item/1454492

Nitisastro, Widjojo (1970) *Population Trends in Indonesia.* Ithaca: Cornell University Press.

Report (1920) 'Report on the influenza-epidemic in Netherlands-India 1918', *Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië,* no.1920-10: 76-157. https://resolver.kb.nl/resolve?urn=MMKITLV3:002275004:pdf

Schoel, W.F. (1931) *Alphabetisch Register van de Administratieve- (Bestuurs-) en Adatrechtelijke Indeling van Nederlandsch-Indië. Deel I: Java en Madoera* [Alphabetical register of the administrative and adat-law divisions of the Netherlands Indies. Part I: Java and Madura]. Batavia: Landsdrukkerij.

Touwen, Jeroen (2001) *Extremes in the Archipelago: Trade and Economic Development in the Outer Islands of Indonesia, 1900-1942.* Leiden: KITLV Press.

Uittreksel (1922) 'Uittreksel uit het jaarverslag van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië over 1919' [Abstract from the annual report of the Public Health Service in the Netherlands Indies 1919], *Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië*, no.1922-1: 83-133. https://resolver.kb.nl/resolve?urn=MMKITLV3:002488001:pdf

Van der Eng, Pierre (2002) 'Bridging a gap: A reconstruction of population patterns in Indonesia, 1930-1961', *Asian Studies Review*, 26(3) 487-509.

Van der Eng, Pierre (2016) 'After 200 years, why is Indonesia's land cadastre still incomplete?' in McCarthy, John F. and Robinson, Kathryn (eds.) *Land and Development in Indonesia: Searching for the People's Sovereignty.* (Singapore: ISEAS) 227-244.

Van der Eng, Pierre and Sohn, Kitae (2019) 'The biological standard of living in Indonesia during the 20th century: Evidence from the age at menarche', *Economics & Human Biology*, 34(3) 216-224.

Wibowo, Priyanto *et al.* (2009) *Yang Terlupakan: Sejarah Pandemi Influenza 1918 di Hindia Belanda* [The forgotten: History of the 1918 influenza pandemic in the Netherlands Indies]. Depok: Unicef Jakarta/Komnas FBPI.

Winckel, Ch.W.F. (1919) 'Explanatory remarks at the demonstration of some maps and diagrams of mortality figures, medical institutions and medical staff in Netherlands India', *Mededeelingen van den Burgerlijken Geneeskundigen Dienst in Nederlandsch-Indië*, no.1919-1: Appendix E. https://resolver.kb.nl/resolve?urn=MMKITLV3:002275006:pdf

Figure 1: Population in Java, Simplified Replication of Chandra (2003), 1880-1930 (millions)

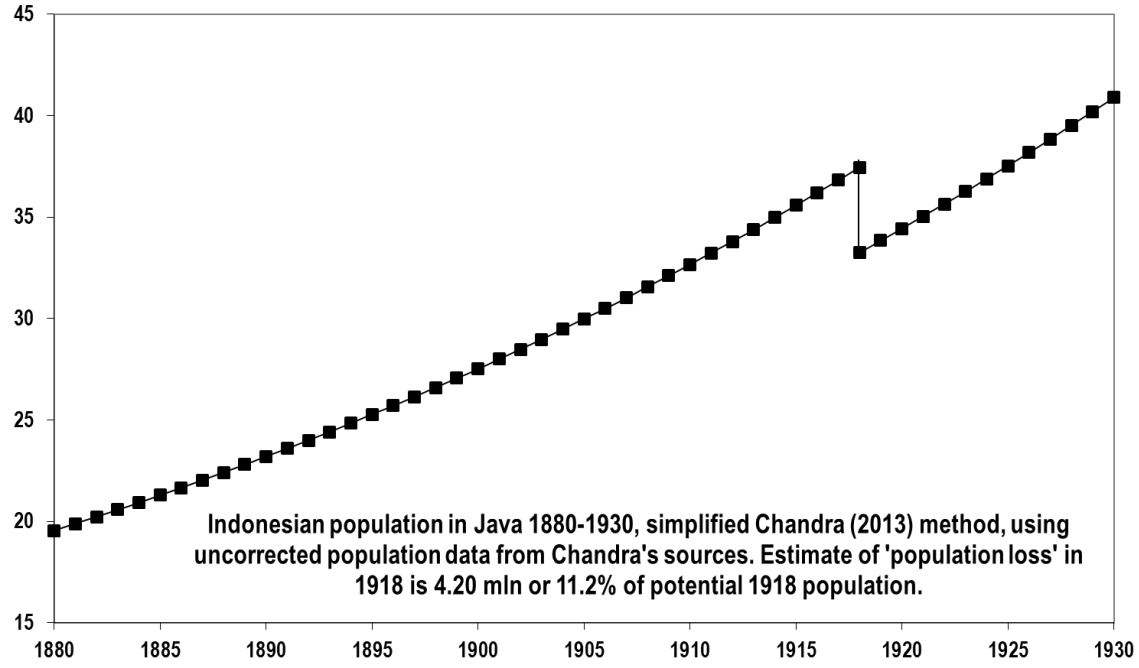


Figure 2: Population in Java, Based on Boomgaard and Gooszen (1991), 1880-1930 (millions)

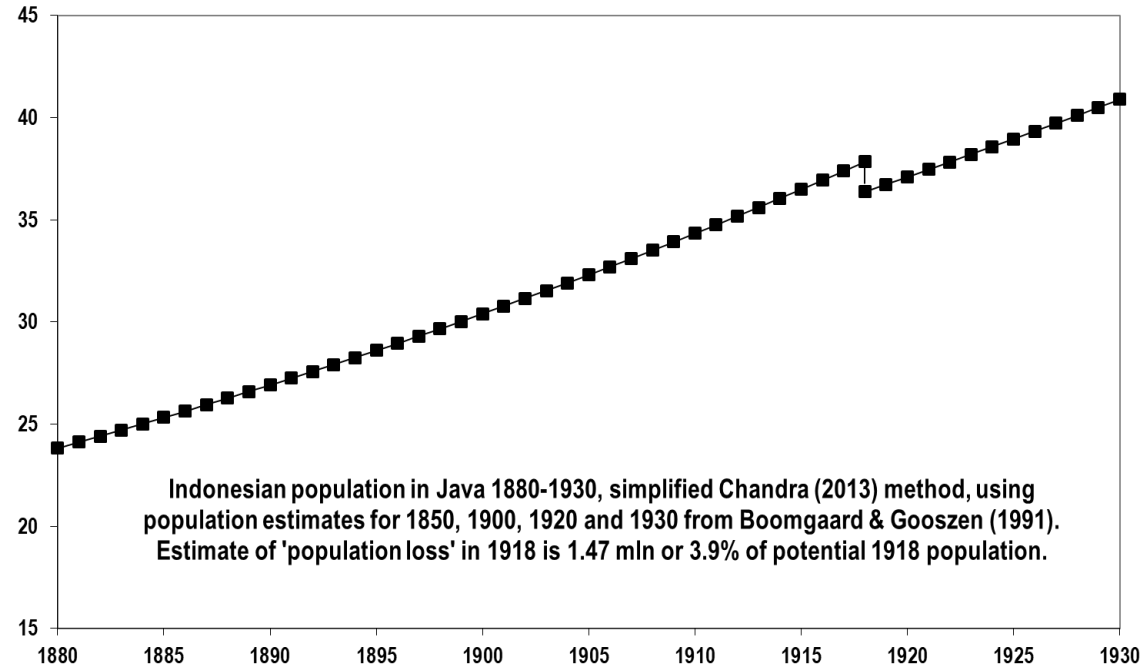
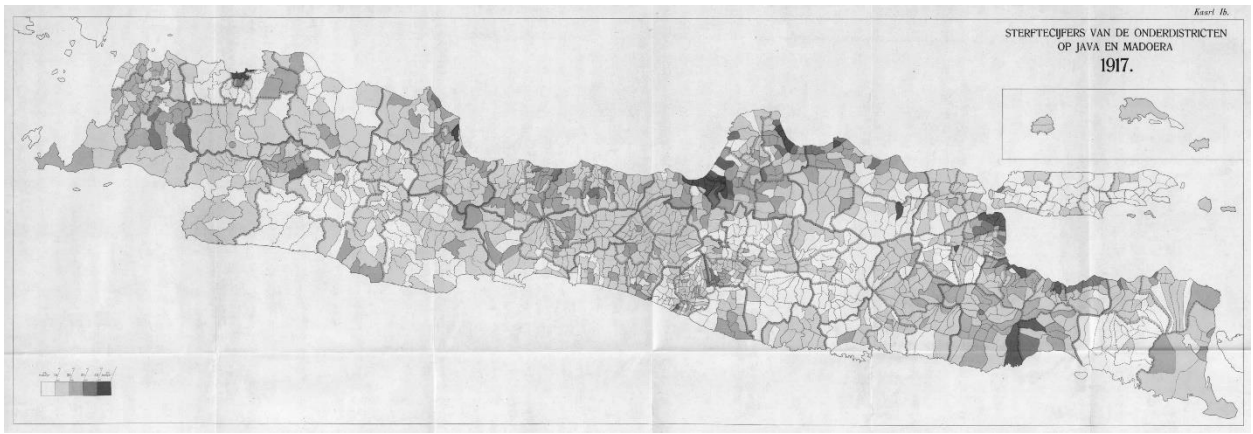
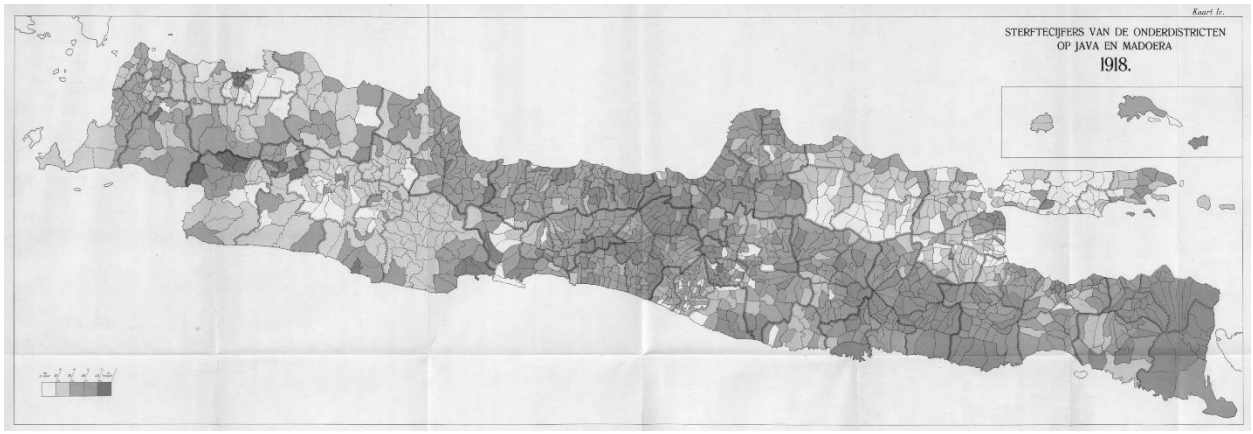
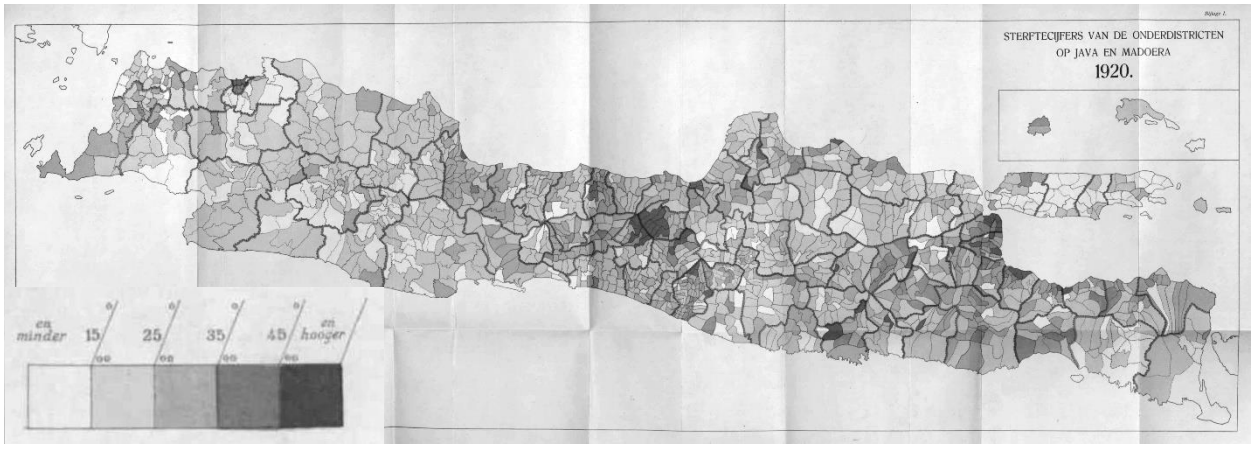


Figure 3: Mortality Rates by Sub-District in Java, 1917, 1918 and 1919 (‰)

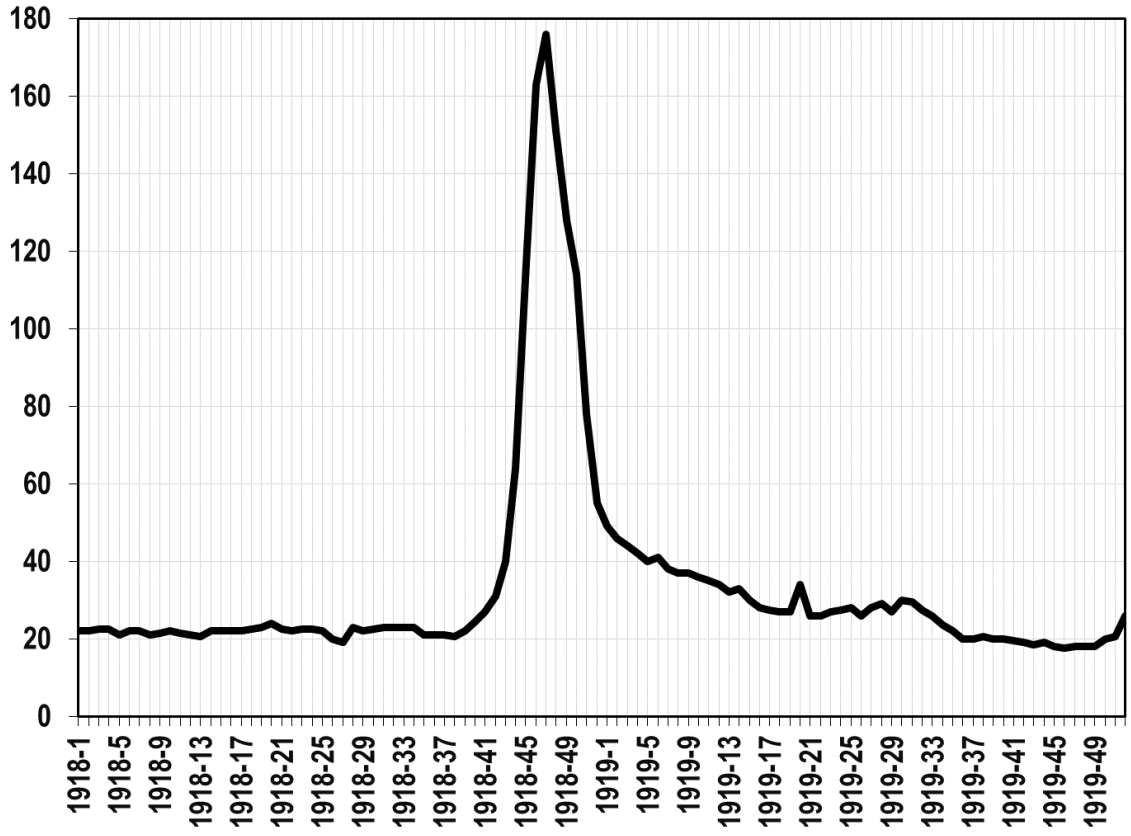






Sources: Winckel (1919); Uittreksel (1922).

Figure 4: Average Annualised Weekly Mortality Rates in Java, 1918-1919 (‰)



Sources: Report (1920); Uittreksel (1922).