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## Untangling the causes of the 2016–18 Cholera epidemic in Yemen



As war continues to rage in Yemen into its third year, the disruption to civil society has been immense. An estimated 22.2 million Yemenis are in need of humanitarian assistance and 2 million people have been displaced by the conflict and live in desperate conditions in Yemen itself or have sought refuge elsewhere in the region.

Amid this deepening crisis sits the largest documented cholera epidemic of modern times. In *The Lancet Global Health*, Anton Camacho and colleagues<sup>1</sup> address this epidemic from an epidemiological perspective and have sought to explain the key triggers for the massive surge in cases in May 2017. The publication of these results is very timely since one of the key triggers identified in the study links the surge in cases to the advent of the rainy season in May, with the concern that a resurgence in transmission of the disease could occur in 2018 when the rains start. The research addresses the causal factors of the epidemic and investigates the size, spatial extent, and key populations affected by both waves of the epidemic. A key driver for the research was to identify public health interventions to try to mitigate the effects of a possible third wave in 2018. The mapping of the epidemic has shown the full extent of the problem and is key to implementing the intervention. The research maps the transmission and incidence of cholera in over 1 million suspected cases in Yemen, and the methods used are applicable to conflict zones and humanitarian situations globally.

The paper highlights the difficulties associated with carrying out research in war zones. When civil society is stretched to its limits, data gathering can be near impossible. The close working between the research team, the Health Authorities in Yemen, and WHO facilitated the production of a well kept line list database of cases, which formed the basis for the outbreak data.

Gathering environmental data poses similar difficulty in a conflict zone. The hypothesis that water sources were contaminated by rainfall in the second wave of the outbreak in May 2017 requires more than anecdotal evidence to be proven. The use of the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) system was a novel approach

to estimating precipitation levels during the period in question. It is recognised that the use of more localised data would have produced a more robust correlation; however, given the conflict in Yemen, the installation and maintenance of local weather stations would have been impractical. The research team have recognised the level of detail available and some inherent biases of the CHIRPS product used. Because of the aerial averages from satellite data used in the production of localised data by CHIRPS, it is likely that precipitation was underestimated. While accuracy is important, it is useful to note that an underestimation of precipitation levels does not invalidate the hypothesis in this research that the second wave was caused by the start of the rainy season.

The methods used for the assessment of precipitation levels follows recent trends in the use of earth observation data from recognised sources. The level of detail possible is increasing and it may be worth exploring the possibilities of using real time (RT) or Near Real Time (NRT) data from these satellite data sources to assess the extent and quality of local water resources.<sup>2</sup> The challenges of implementing these earth observation data into a study such as the cholera outbreak in Yemen are not to be underestimated; however, given the difficulty in obtaining real time local data, the effort may be worthwhile, particularly if algorithms can be developed to manipulate the Big Data available in a meaningful way. An increase in local accuracy might also contribute to a greater understanding of the different impacts of spring rainfall to summer rainfall and their relative impact on water quality.

The paper also highlights the possible effect that local cultural practices had on the transmission of the disease, particularly during Ramadan. The research concluded that the risk of being reported as a suspected cholera case during Ramadan was 1.19 times (1.14–1.25) higher than that of the preceding month and that this risk varied substantially across districts. This hypothesis is supported by the data, but more research would be required to show why Ramadan had an effect on transmission. The variability across districts would also merit further investigation. A social survey of the areas involved might

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For more on the Yemen

emergency see <http://www.unhcr.org/yemen-emergency.html>

For more on CHIRPS see <http://chg.geog.ucsb.edu/data/chirps/>

illuminate the reason for these correlations, but the transient nature of populations in these times of conflict could make this an overly onerous task.

In conclusion, the paper represents a timely investigation of the plausible causes for the two waves of cholera outbreak in Yemen between 2016 and 2018. More social research on the influence of Ramadan on transmission of the disease would further add to the quantitative analysis presented in the paper. There is a real opportunity to develop remote methods of assessing water quality using earth observation satellite data in RT or NRT, which would create a generalised methodology for assessing the likelihood of disease spread in conflict zones. The methods would also be applicable to other areas of humanitarian need such as post-disaster refugee camps.

With this work, and future planned work, Camacho and colleagues<sup>1</sup> are helping to implement a public health

strategy to mitigate against a possible third wave of the outbreak following the rains due in May 2018. It is hoped that further data will be collected in 2018 to further the models developed in this research.

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I declare no competing interests.

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- 1 Camacho A, Bouhenia M, Alyusfi R, et al. Cholera epidemic in Yemen, 2016–18: an analysis of surveillance data. *Lancet Glob Health* 2018; published online May 3. [http://dx.doi.org/10.1016/S2214-109X\(18\)30230-4](http://dx.doi.org/10.1016/S2214-109X(18)30230-4).
- 2 Tyler AN, Hunter PD, Spyarakos E, Groom S, Constantinescu AM, Kitchen J. Developments in earth observation for the assessment and monitoring of inland, transitional, coastal and shelf-sea waters. *Sci Total Environ* 2016; **572**: 1207–321.