World Health Organization

QUALITY CRITERIA FOR THE EVALUATION OF CLIMATE-INFORMED EARLY WARNING SYSTEMS FOR INFECTIOUS DISEASES

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IISBN 978-92-4-003614-7 (electronic version)

ISBN 978-92-4-003615-4 (print version)

Suggested citation. Quality criteria for the evaluation of climate-informed early warning systems for infectious diseases. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO.

Cataloguing-in-Publication (CIP) data. CIP data are available at http://apps.who.int/iris.

Editing, design and layout by Inis Communication

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ACKNOWLEDGEMENTS

Quality criteria for the evaluation of climate-informed early warning systems for infectious diseases was written by Laith Hussain-Alkhateeb (School of Public Health and Community Medicine, University of Gothenburg, Sweden). It was coordinated and edited by Diarmid Campbell-Lendrum and Elena Villalobos Prats of the Health and Climate Change Unit, Department of Public Health, Climate Change and Health, World Health Organization (WHO).

WHO extends its gratitude to the Foreign, Commonwealth and Development Office (FCDO) for its financial support to develop this guidance document.

WHO appreciates the contributions from the following reviewers and contributors: Annika Green (WHO consultant), Simon Hales (University of Otago, New Zealand), Hyun Kim (WHO consultant), Axel Kroeger (University of Freiburg), Rachel Lowe (London School of Hygiene and Tropical Medicine, United Kingdom of Great Britain and Northern Ireland), Nicholas Ogden (Public Health Agency of Canada), David Olson (WHO), Max Petzold (University of Gothenburg, Sweden), Jan Semenza (European Centre for Disease Prevention and Control (ECDC), Yesim Tozan (New York University, United States of America), and Laith Yakob (London School of Hygiene and Tropical Medicine, United Kingdom).

WHO is also grateful for the review and inputs to the tool provided by Waltaji Terfa Kutane (WHO Mozambique), Shamsul Gafur Mahmud (WHO Bangladesh), Raja Ram Pote Shrestha (WHO Nepal), and Badri Thapa (WHO Myanmar), as well as the national teams in Bangladesh, Myanmar and Mozambique for piloting the tool. WHO also acknowledges the review work and inputs by David Benitez (Mexico), Rose Nani Binti Mudin and her team (Malaysia), and Gustavo Sanchez Tejeda (Mexico).

Lastly, WHO appreciates the contributions made by all participants to the expert meetings on "Using climate and weather information for predicting and preparing for cholera and vector-borne diseases" held in 2019 and 2020.

ACRONYMS

AN	actual no-outbreak
AO	actual outbreak
CAR	conditional auto-regressive models
EWS	early warning system(s)
FN	false negative
FP	false positive
GI	Getis-Ord Gi statistic
GIS	geographical information system
GLMM	generalized linear mixed models
GWR	geographically weighted regression
IHR	International Health Regulations
IT	information technology
LISA	local indicators of spatial association
M&E	monitoring and evaluation
MoH	Ministry of Health
NPV	negative predictive value
PD	probability of detection
PF	probability of false alert
PPV	positive predictive value
RCT	randomized controlled trial
ROC	receiver operating characteristic
SAR	spatial auto-regression
SMS	short message service
TN	true negative
TP	true positive
WHO	World Health Organization
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

The frequency of infectious disease epidemics is increasing, and the role of the health sector in the management of epidemics is crucial in terms of response *(1)*. In the context of infectious disease epidemics, the use of climate-informed early warning systems – EWS (the organized mechanism to detect as early as possible any out-of-control state of disease phenomena *(2)*) – has the potential to increase the effectiveness of disease control by intervening before or at the beginning of the epidemic curve, instead of during the downward slope. Currently, the initiation of interventions is heavily reliant on routine disease surveillance systems – data that often arrive too late for preventative response. However, forecasting of disease outbreaks using surveillance and weather information shows promising potential *(3,4)* – there also remains further scope to examine seasonal climate forecasts *(5–7)*. By combining these elements in new EWS based on computational models, it will be possible to improve both the timeliness and impact of disease control.

Until recently, EWS have rarely applied statistical methods to detect changes in trends or sentinel events that would require intervention, and generally lacked essential assessment for effective, implementable and scalable tools. In most cases, EWS rely on an in-depth review of incoming data by local epidemiologists, which rarely follow a systematic process. The World Health Organization (WHO) is strengthening existing surveillance systems for infectious diseases to enable the development of more robust and timely EWS, which has resulted in the rapid development and innovation of EWS for disease outbreaks.

The core elements of climate-informed EWS are to: (i) monitor environmental conditions; (ii) forecast high-risk conditions, initiate active surveillance; (iii) send alerts and communication; and (iv) establish a mechanism for early response. However, in view of the advances in mathematical modelling, the availability of big data and their complex analytical designs – as well as issues related to the quality of national surveillance programmes and local response protocols – other technical and operational aspects are essential for monitoring the effectiveness and cost-effectiveness of existing decision-support tools.

In June 2019, an expert meeting on using climate and weather information for predicting and preparing for cholera and vector-borne diseases was convened in Geneva, Switzerland, and supported by the Climate Change and Health Unit (WHO), the World Meteorological Organization (WMO), the Met Office (United Kingdom), UK AID and the Department for International Development. One key outcome from this meeting