PRESS RELEASE

Sophia University
Chubu University

March 23, 2023

Can Artificial Intelligence Predict Spatiotemporal Distribution of Dengue Fever Outbreaks with Remote Sensing Data? New Study Finds Answers

Researchers train machine learning model with climatic and epidemiology remote sensing data to predict the spatiotemporal distribution of disease outbreaks

Cases of dengue fever and other zoonotic diseases will keep increasing owing to climate change, and prevention via early warning is one of our best options against them. Recently, researchers combined a machine learning model with remote sensing climatic data and information on past dengue fever cases in Chinese Taiwan, with the aim of predicting likely outbreak locations. Their findings highlight the hurdles to this approach and could facilitate more accurate predictive models.

Outbreaks of zoonotic diseases, which are those transmitted from animals to humans, are globally on the rise owing to climate change. In particular, the spread of diseases transmitted by mosquitoes is very sensitive to climate change, and Chinese Taiwan has seen a worrisome increase in the number of cases of dengue fever in recent years.

Like for most known diseases, the popular saying “an ounce of prevention is worth a pound of cure” also rings true for dengue fever. Since there is still no safe and effective vaccine for all on a global scale, dengue fever prevention efforts rely on limiting places where mosquitoes can lay their eggs and giving people an early warning when an outbreak is likely to happen. However, thus far, there are no mathematical models that can accurately predict the location of dengue fever outbreaks ahead of time.

To address this issue, a research team including Professor Sumiko Anno from Sophia University, Japan, sought to combine artificial intelligence (AI) with remote sensing data to predict the spatiotemporal distribution of dengue fever outbreaks in Chinese Taiwan. This work, which was published in *Geo-spatial Information Science*, was co-authored by Hirakawa Tsubasa, Satoru Sugita, and Shinya Yasumoto, all from Chubu University, Ming-An Lee from National Taiwan Ocean University, and Yoshinobu Sasaki and Kei Oyoshi from the Japan Aerospace Exploration Agency (JAXA), Japan.

First, the team gathered climatic data of Chinese Taiwan from 2002 to 2020, including data on rainfall, sea-surface temperature, and shortwave radiation. They also gathered information on the place of residence of all reported dengue fever cases registered in the Chinese Taiwan Centre for Disease Control. This enabled the researchers to prepare a labelled training dataset for the AI model, which should ideally be capable of finding hidden patterns between dengue fever cases and climatic parameters.

The AI model in question was a convolutional neural network (CNN) with a U-Net-based encoder–decoder architecture. *"The U-Net model works with remarkably few training images and yields more precise semantic segmentation when provided with the location information,"* explains Prof. Anno about the choice of AI model for their study. This well-established design usually performs well in image segmentation tasks, even when trained with few samples. After training the model, the team attempted to validate it using the remaining gathered data.

Unfortunately, the model did not perform as well as the researchers hoped it would. Most of the pixels on the map of Taiwan marked as predicted dengue fever outbreak locations did not match the original data. However, not all hope is lost for this approach, as Prof. Anno highlights: "*While most of the predicted outbreak pixels did not overlap with the ground truth, some of them were located quite close to actual outbreak locations. This implies that the spatiotemporal prediction of dengue fever outbreaks using remote sensing data is possible*."

Despite the low accuracy of the AI model, this study brought to light some of the current challenges of using remote sensing data for predicting the spatiotemporal distribution of zoonotic disease outbreaks. The research team believes that using a different model architecture, finding a way of balancing the training dataset, and gathering higher-resolution satellite data could all be promising ways to achieve the necessary performance.

More work will be required before we can use machine learning as a tool to pinpoint potential disease outbreak zones based on climatic data, but we must not falter. "*Spatiotemporal visualizations generated by deep learning models could potentially guide the implementation of effective measures against disease outbreaks at the optimal time and location for disease prevention and control,*" concludes Prof. Anno, optimistically.

Let us hope further studies in this field help us keep people safe from zoonotic diseases soon.

Reference

Title of original paper:	Challenges and implications of predicting the spatiotemporal distribution of dengue fever outbreak in Chinese Taiwan using remote sensing data and deep learning
Journal	*Geo-spatial Information Science*
DOI:	10.1080/10095020.2022.2144770
Authors	Sumiko Anno[1], Hirakawa Tsubasa[2], Satoru Sugita[2], Shinya Yasumoto[2], Ming-An Lee[3], Yoshinobu Sasaki[4], and Kei Oyoshi[4]
Affiliations:	[1]Graduate School of Global Environmental Studies, Sophia University [2]Chubu Institute for Advanced Studies, Chubu University [3]Centre of Excellence for Ocean Engineering and Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University [4]Earth Observation Research Center, Japan Aerospace Exploration Agency

Additional information for EurekAlert

Latest Article Publication Date:	17 January 2023
Method of Research:	Data/statistical analysis
Subject of Research:	Not applicable
Conflicts of Interest Statement:	The authors declare no potential conflicts of interest

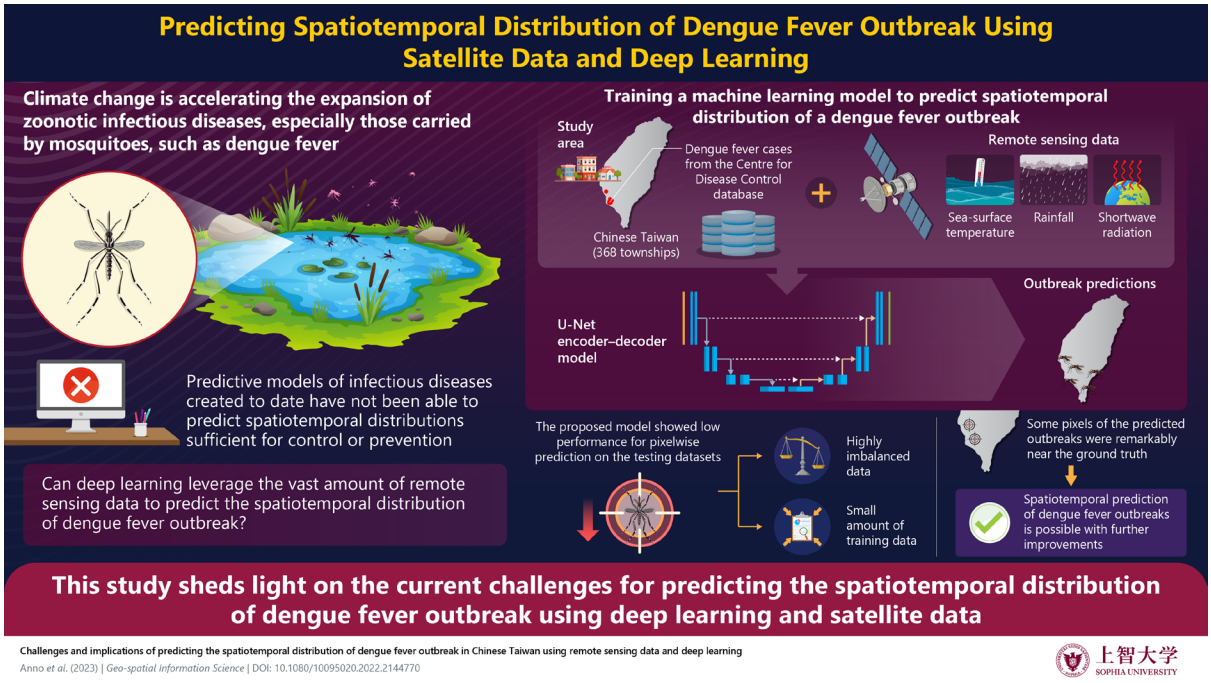

Image title: Predicting the spatiotemporal distribution of dengue fever outbreak using machine learning and remote sensing

Image caption: Climate change is making outbreaks zoonotic diseases, such as dengue fever, more frequent in Chinese Taiwan. Leveraging climatic data and artificial intelligence models could be a convenient strategy to predict the most likely time and place of future outbreaks, helping local governments give out early warnings to potentially affected areas.

Image credit: Sumiko Anno of Sophia University

Source link: NA

License: Original content

About Sophia University

Established as a private Jesuit affiliated university in 1913, Sophia University is one of the most prestigious universities located in the heart of Tokyo, Japan. Imparting education through 29 departments in 9 faculties and 25 majors in 10 graduate schools, Sophia hosts more than 13,000 students from around the world.

Conceived with the spirit of “For Others, With Others,” Sophia University truly values internationality and neighborliness, and believes in education and research that go beyond

national, linguistic, and academic boundaries. Sophia emphasizes on the need for multidisciplinary and fusion research to find solutions for the most pressing global issues like climate change, poverty, conflict, and violence. Over the course of the last century, Sophia has made dedicated efforts to hone future-ready graduates who can contribute their talents and learnings for the benefit of others, and pave the way for a sustainable future while "Bringing the World Together."

Website: https://www.sophia.ac.jp/eng/

About Professor Sumiko Anno from Sophia University

Sumiko Anno obtained a Master of Public Health degree from New York Medical College, USA in 1997 and a PhD degree in Medicine from Kobe University, Japan, in 2001. After over 18 years of work at Shibaura Institute of Technology, she joined Sophia University in 2019. She is currently a Full Professor and leads her own laboratory, which focuses on solving problems in environmental hygiene and public health by applying technologies, remote sensing and deep learning.

Funding information

The study was supported by Japan Aerospace Exploration Agency [Grant No. RA1R803] and the Collaboration Research Program of IDEAS, Chubu University [Grant No. IDEAS202008].

Media contact:

Office of Public Relations, Sophia University
sophiapr-co@sophia.ac.jp

Department of Public Relations, Chubu University
cuinfo@office.chubu.ac.jp

Contact of Authors:

Prof. Sumiko Anno, Sophia University
E-mail: sumiko_anno@sophia.ac.jp

Dr. Tsubasa Hirakawa, Chubu University
E-mail: hirakawa@isc.chubu.ac.jp

Dr. Satoru Sugita, Chubu Univeristy
E-mail: satoru@isc.chubu.ac.jp

Dr. Shinya Yasumoto, Chubu University
E-mail: yasumoto@isc.chubu.ac.jp