Microsoft

AI for Earth Grantee Profile

Tohoku University

Dynamic Disaster Management Cloud Service

Summary

Dr. Yanbing Bai at Tohoku University is developing an intelligent cloud-based disaster management service using Microsoft cloud and AI tools and Esri's geospatial mapping platform to help disaster officials, stakeholders, urban engineers, and planners mitigate the effects of and increase urban resilience to natural disasters.

Using AI to enhance disaster response and urban resilience to natural disasters

The number and costs of natural disasters worldwide are skyrocketing due to a multitude of factors, including climate change, population growth, and rapid urbanization. Climate change is increasing the temperatures of Earth's oceans and atmosphere, contributing to weather severity—including rising rates of storms and droughts, as well as the intensity. According to NOAA's National Centers for Environmental Information, in the US, billion-dollar disaster events caused by weather and climate averaged six per year from 1980 to 2017. However, that average has almost doubled since 2013 to 11.6 per year. 2017 was the most expensive year on record for disasters in the US, causing $306 billion in total damage. Globally, more than 2.5 million people and almost $4 trillion have been lost to natural disasters over the last thirty years.

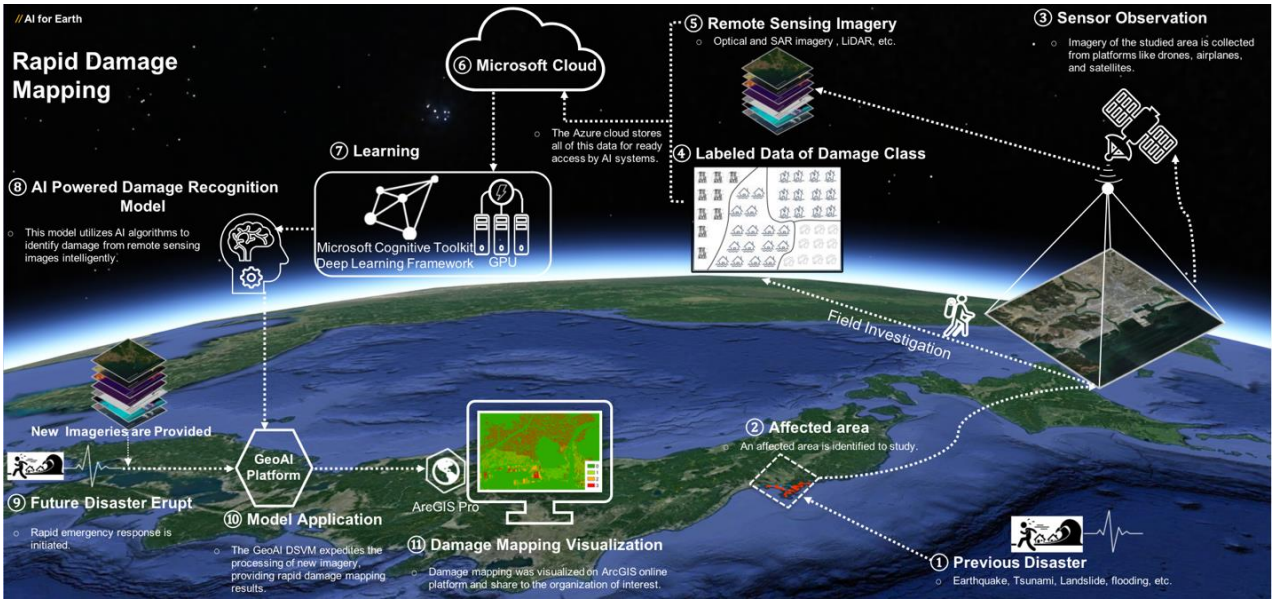
> Globally, more than 2.5 million people and almost $4 trillion have been lost to natural disasters over the last 30 years.

Disaster risk, driven by population growth and rapid urbanization, is also increasing. The United Nations estimates that more than two-thirds of the world's population will live in cities by 2050. Urbanization in regions that are prone to disasters, such as floods, is steadily increasing the likelihood that human injuries and costs will increase. Incredibly, without significant investment into making cities more resilient, natural disasters may cost cities worldwide up to $314 billion each year by 2030.

The frequency and impact of natural disasters is only expected to increase in coming years, so enhancing disaster response and urban resilience by improving our ability to predict disasters and project their impact is critical. However, disaster management practices are historically inefficient and lack rapid and highly efficient post-disaster damage assessment—largely due to the limitations of most organizations' model accuracy and access to high-quality remote sensing data, such as from satellites or ground sensors. Additionally, harnessing the power of remote sensing data requires an intelligent image recognition algorithm that can interpret the information efficiently.

Developing a cloud-based mapping platform

Through a grant provided by the Microsoft AI for Earth program, Dr. Yanbing Bai and colleagues—Professor Shunichi Koshimura from Tohoku University, IRIDeS and Professor Sameer Singh from the computer science department at the University of California, Irvine—are developing an intelligent cloud-based disaster management service. Built on Microsoft cloud and AI tools and Esri's geospatial mapping platform, the service will help disaster officials, stakeholders, urban engineers, and planners mitigate the effects of and increase urban resilience to natural disasters.



Microsoft Azure-based Rapid Damage Mapping

Using big data analysis, deep learning techniques, and geospatial analysis, the Dynamic Disaster Management Cloud Service will reason over satellite remote sensing and geographic information systems (GIS) data to detect patterns that may indicate impending natural disasters. The service will be able to predict potential risks for slow disasters such as deforestation, or rapidly complete post-event damage impact assessments for sudden disasters like earthquakes and floods.

The first phase of the project is focused on developing a streamlined, highly efficient, and accurate deep-learning algorithm-based framework for tsunami damage extraction from remote sensing imagery in Japan. Eventually, Dr. Bai aims to extend the scope to include regions outside of Japan, as well as other natural disasters—such as earthquakes, hurricanes, typhoons, forest fires, and droughts.

Enabling more intelligent and efficient disaster management

Dr. Bai's team is using synthetic aperture radar (SAR) and optical imagery to feed the deep-learning algorithm for tsunami damage extraction. Using these geospatial datasets requires a complex multi-stage processing sequence and massive compute power. To improve the timeliness of responding to natural disasters, the service must be able to efficiently integrate image pre-processing, algorithm model construction, result output, and the visual display of these modules in a pipeline—a task most on-premises environments are not equipped to handle.

> Providing the public with access to the Dynamic Disaster Management Service will help increase efficiency and performance in disaster management.

Microsoft Azure provides a scalable and powerful platform that not only helps the team efficiently build and run the algorithm, but also delivers the results as a service through a near-real-time web-based application. By using powerful graphical processing units (GPUs) in Azure, the team can train the model and crunch new data quickly—which is critical for enabling more rapid disaster response. The GEO AI Data Science Virtual Machine provides an integrated platform combining the Microsoft Cognitive Toolkit deep-learning framework and Esri's ArcGIS Pro package, transforming geospatial information into dynamically visualized damage impact assessments for more efficient and intelligent disaster management.

With Azure, Dr. Bai expects to be able to extend the disaster management tool directly to disaster-related stakeholders, urban engineers, and evacuation planners through a dedicated web-based application that translates model results into meaningful information. Providing the public with access to the Dynamic Disaster Management Service will help increase efficiency and performance in disaster management and provide decision guidance in both pre- and post-disaster events.

About Dr. Yanbing Bai

Dr. Yanbing Bai is a postdoctoral researcher specializing in remote sensing and geoinformatics at the International Research Institute of Disaster Science, Tohoku University. Dr. Bai's research focuses on applying

deep learning technologies to satellite remote sensing data, enabling improved disaster management practices.

Resources

Websites

International Research Institute of Disaster Science (IRIDeS), Tohoku University
Remote Sensing and Geoinformatics for Disaster Management—Dr. Bai's laboratory at IRIDeS
AI for Earth

Press

"How AI can help after disaster." Microsoft corporate video. 2018.

Publications

Bai, Y., Gao, C., Singh, S., Koch, M., Adriano, B., Mas, E., & Koshimura, S. (2018). "A framework of rapid regional tsunami damage recognition from post-event TerraSAR-X imagery using deep neural networks." *IEEE Geoscience and Remote Sensing Letters,* 15(1), 43–47. (Highlighted paper)

Bai, Y., Adriano, B., Mas, E., & Koshimura, S. (2017). "Building Damage Assessment in the 2015 Gorkha, Nepal, Earthquake Using Only Post-Event Dual Polarization Synthetic Aperture Radar Imagery." *Earthquake Spectra,* 33(S1), S185–S195.

Bai, Y., Adriano, B., Mas, E., Hideomi, G., and Koshimura, S. (2017). "Object-Based Building Damage Assessment Methodology Using Only Post Event ALOS-2/PALSAR-2 Dual Polarimetric SAR Intensity Images." *Journal of Disaster Research,* Vol 12, No. 2, pp. I 259–I 271.

Bai, Yanbing; Mas, Erick; Koshimura, Shunichi (2018). "Towards Operational Satellite-Based Damage-Mapping Using U-Net Convolutional Network: A Case Study of 2011 Tohoku Earthquake-Tsunami." *Remote Sens.* 10, No. 10: 1626. https://doi.org/10.3390/rs10101626

Documentation

NOAA National Centers for Environmental Information (NCEI). *U.S. Billion-Dollar Weather and Climate Disasters (2018)*. https://www.ncdc.noaa.gov/billions/

The World Bank. *Disaster Risk Management*. March 28, 2018. (Accessed July 26, 2018). https://www.worldbank.org/en/topic/disasterriskmanagement/overview

United Nations, Department of Economic and Social Affairs, Population Division (2015). *World Urbanization Prospects: The 2014 Revision*. (ST/ESA/SER.A/366). https://esa.un.org/unpd/wup/Publications/Files/WUP2014-Report.pdf