Carnegie Mellon University
Software Engineering Institute

DEFENSE INNOVATION UNIT

Creating xBD: A Dataset for Assessing Building Damage from Satellite Imagery

A collaboration with the Defense Innovation Unit and first responders

KEEPING FIRST RESPONDERS SAFE as they go into post-disaster conditions to recover victims or assess structures is part of the inspiration for the SEI's work with the Defense Innovation Unit (DIU) and first responders such as Cal Fire, the California Air National Guard, and FEMA. Logistics, resource planning, and damage estimation are difficult tasks after a natural disaster, and putting first responders into post-disaster situations is dangerous and costly. Using passive methods, such as analysis on satellite imagery, to perform damage assessment saves manpower, lowers risk, and expedites an otherwise dangerous process.

xBD: The Largest Building Damage Assessment Dataset to Date

Building Annotations	700,000
Countries Represented	15
Area	5,000 km2
Disaster Types Represented	Dam collapse, earthquake/tsunami, flood, landslide, volcanic eruption, wildfire, wind
Environmental Factors Represented	Fire, water, smoke, lava, wind

xBD is a new large-scale dataset for advancing change detection and building damage assessment for humanitarian assistance and disaster recovery (HADR) research. Created with experts from DIU and first responders, xBD provides pre- and post-event multi-band satellite imagery from a variety of disaster events with building polygons, classification labels for damage types, ordinal labels of damage level, and corresponding satellite metadata.

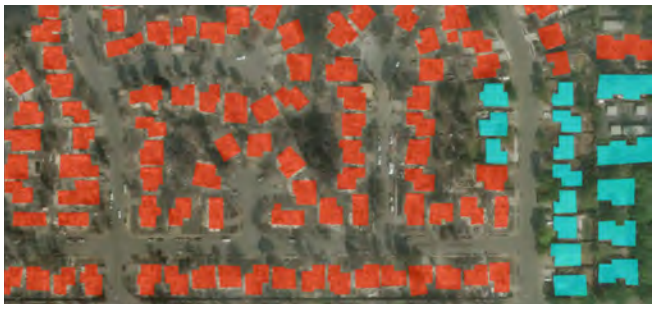
The Joint Damage Scale, A Common Framework for Classifying Damage

Disaster Level	Structure Description
0 (No Damage)	Undisturbed. No sign of water, structural or shingle damage, or burn marks.
1 (Minor Damage)	Building partially burnt, water surrounding structure, volcanic flow nearby, roof elements missing, or visible cracks.
2 (Major Damage)	Partial wall or roof collapse, encroaching volcanic flow, or surrounded by water/mud.
3 (Destroyed)	Scorched, completely collapsed, partially/completely covered with water/mud, or otherwise no longer present.

We also present the Joint Damage Scale, a first attempt to create a unified assessment scale for building damage in satellite imagery across multiple disaster types, structure categories, and geographical locations.

The Joint Damage Scale is based mainly on HAZUS, FEMA's Damage Assessment Operations Manual, the Kelman scale, and the EMS-98. Literature from the GIS community and expert insights from the California and Indiana Air National Guards and the US Air Force help ground the scale in operational relevance.

xBD is the official dataset for the xView 2.0 challenge. For more information, **see xView2.org**



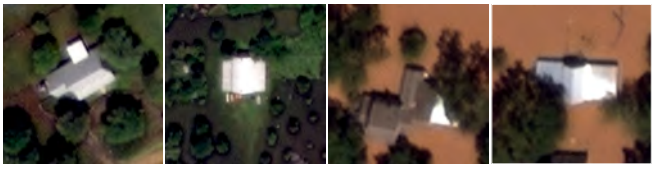
Polygons showing structures in xBD

The xView 2.0 Challenge

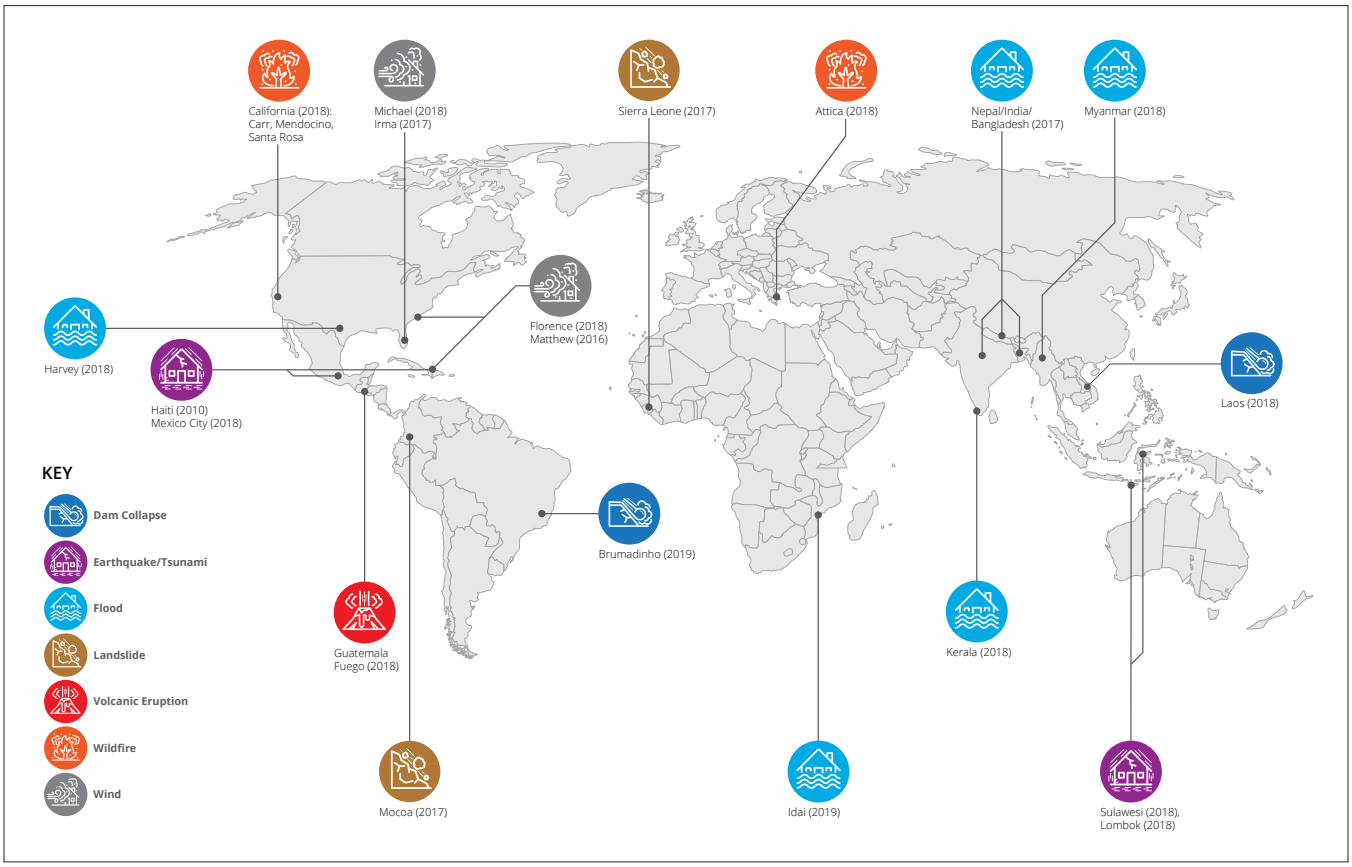
xBD will be the dataset for xView 2.0, DIU's public computer vision competition. Solutions submitted by participants have the potential to improve HADR efforts, and algorithms from the 2018 xView challenge have already been tested for assisting emergency personnel in quickly identifying flooded areas and impassable roads in the aftermath of Hurricane Florence.

Examples of wind damage. None, minor, and major (left to right).

Examples of fire damage. None and destroyed (left to right).



Examples of flooding damage. None to destroyed (left to right).



Geographical distribution and disaster types of all disasters respresented in xBD.

About the SEI

The Software Engineering Institute is a federally funded research and development center (FFRDC) that works with defense and government organizations, industry, and academia to advance the state of the art in software engineering and cybersecurity to benefit the public interest. Part of Carnegie Mellon University, the SEI is a national resource in pioneering emerging technologies, cybersecurity, software acquisition, and software lifecycle assurance.

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