Interferometric Coherence Based Damage Proxy Mapping for Post-Disaster Damage Analysis

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Abstract: Damage Proxy Maps (DPMs), derived from satellite data analysis, are vital tools for aiding local governments and emergency responders in identifying areas most in need after a disaster. These maps, which predict the path and impact of disasters, are especially useful in rapidly detecting structural damage in the aftermath of events like earthquakes or explosions. Radar remote sensing, particularly Synthetic Aperture Radar (SAR), plays a key role due to its ability to operate regardless of lighting or weather conditions. InSAR coherence differencing is a prominent method for generating damage maps by comparing radar signals before and after a disaster. Incoherent change detection identifies damage based on backscatter amplitude differences, while Coherent Change Detection (CCD) relies on phase decorrelation to detect surface changes. Researchers have successfully used these techniques to assess damages from various disasters including earthquakes, floods, and explosions.

This study developed and evaluated four different interferometric coherence-based methods—Coherence Change Detection (CCD), Temporal CCD (TCCD), Histogram-Matched CCD (HCCD), and Histogram-Matched TCCD (HTCCD)—to generate DPMs for three events: the 2020 Maradu building demolition, the 2020 Beirut explosion, and the 2019 Mirpur earthquake. Using Sentinel-1 SAR data, the HTCCD method consistently provided the most accurate results with fewer false alarms. For the Maradu event, large buildings and debris areas were effectively detected using HTCCD. During the Beirut explosion, although all methods identified major damage, HTCCD and HCCD showed better performance. Similarly, the HTCCD method best captured co-seismic liquefaction and structural damage in the Mirpur earthquake. Overall, the study concludes that HTCCD is the most reliable technique for generating accurate DPMs across both natural and human-made disasters.