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A Review of Remote Sensing-Based Proxies and Data Processing Methods for Urban Disaster Risk Management

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Disaster risk management (DRM) and reduction has been gaining in importance as a result of increasing impacts of natural disasters. Reliable and informative data are the foundation of any comprehensive and effective DRM. Synoptic and multi-type remote sensing has become an essential tool for rapid acquiring of geospatial data, particularly for complex and dynamic urban areas. Accordingly, it has been used for the assessment of all components of the disaster risk cycle, ranging from disaster preparedness to rapid damage assessment. However, due to the complex and multifaceted characteristics of many urban elements, in particular social and economic activities and functions, accurate risk assessment that takes account of the varied and complex set of vulnerabilities and their associated dynamics continues to be very difficult, and direct remote sensing observations are frequently insufficient. Therefore, methods have been developed to indirectly estimate the risk, utilizing image-based proxies. In recent years, using proxies has become a predominant way for such measurements in the DRM field for both pre- and post-disaster phases, at times with similar proxies being used for both situations. For example, the presence of vegetation in urban areas is used as a proxy for both pre-event social vulnerability and for post-disaster recovery assessments. In addition, existing proxies do not sufficiently address all assessment requirements, e.g. there is no proxy for building-based functional damage assessment. Another persistent challenge is the extraction those proxies as a basis for automating the urban DRM process. Although several remote sensing data processing methods have been developed to derive information for DRM in recent years, extracting proxies from remote sensing data requires more accurate results in detecting objects and features.

In this study we carried out a comprehensive review of remote sensing-based proxies for different urban DRM phases, identified duplications on efforts, inconsistencies in terminology, but also remaining gaps. With a specific focus on post-disaster recovery assessment, which particularly relies on measures to assess the progress in functions and processes, the review was then used as a basis for the development of new proxies and indicators. The focus is on developing robust proxies to go beyond the physical evaluation perspective, and to extract socio-economic information and functional assessment of urban areas using new strategies, such as multiple-proxies approach, and fusing object- and pattern-based proxies from various remote sensing data, including very-high resolution satellite and aerial images, drone data, LiDAR data. In addition, the reliability of current remote sensing data processing methods in extracting proxies will be discussed, and accordingly how remote sensing data processing methods can contribute to developing reliable proxies will be demonstrated (e.g. using new pattern recognition, texture, and object detection methods).