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From Flash Flood Vulnerability and Risk Assessment to Property Damage Prediction: the Value of Machine Learning

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Flash floods, as a result of frequent torrential rainfalls caused by tropical storms, thunderstorms, and hurricanes, are a prevalent natural disaster in the southeast U.S. (SEUS), which frequently threaten human lives and properties in the region. According to the U.S. National Weather Service (NWS), flash floods generally initiate within less than six hours of an intense rainfall onset. Therefore, there is a limited chance for effective and timely decision-making. Due to the rapid onset of flash floods, they are costly events, such that only during 1996 to 2017 flash floods imposed 7.5 billion dollars property damage to the SEUS. Therefore, estimating the potential economic damages as a result of flash floods are crucial for flood risk management and financial appraisals for decision makers. A multitude of studies have focused on flood damage modeling, few of which investigated the issue on a large domain. Here, we propose a systematic framework that considers a variety of factors that explain different risk components (i.e., hazard, vulnerability, and exposure) and leverages Machine Learning (ML) for flood damage prediction. Over 14,000 flash flood events during 1996 to 2017 were assessed to analyze their characteristics including frequency, duration, and intensity. Also, different data sources were utilized to derive information related to each event. The most influential features are then selected using a multi criteria variable selection approach. Then, the ML model is implemented for not only binary classification of damage (i.e., whether a flash flood event caused any damage or not), but also for developing a model to predict the financial consequences associated with flash flood events. The results indicate a high accuracy for the classifier, significant correlation and relatively low bias between the predicted and observed property damages showing the effectiveness of proposed methodology for flash flood damage modeling applicable to variety of flood prone regions.