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Review

Understanding the impact of land use change on urban flood susceptibility mapping assessment: A review

Eggy Arya Giofandi[1*], Boedi Tjahjono[2], Latief Mahir Rachman[2]

[1] Graduate Program of Regional Planning Science, Faculty of Agriculture, IPB University, West Java, Indonesia
[2] Department of Soil Science and Land Resources, Faculty of Agriculture, IPB University, West Java, Indonesia

[*]corresponding author: eggyarya@apps.ipb.ac.id

Abstract

Over the past few years, numerous urban areas have been identified in floodplains and coastal regions. These areas should be repurposed as water storage zones to enhance surface water infiltration. The escalating demand for land in flat areas adds complexity to the susceptibility of urban areas to flood hazards. The observation focuses on understanding how land use change influences urban flood susceptibility assessment. Several aspects assumed to have a significant relationship with the flood phenomenon include the impact of land use change, environmental health impact, modification of land typology, explanation of urban flooding, appropriate model for flood-prone assessment, current state of research, appropriate steps in decision-making in susceptibility areas, and challenges of the scenario-based flood-prone mapping model in the future. Additionally, the assessment aspect should consider the impact of land degradation resulting from land use change. Integrated measures are necessary to guide future studies aimed at improving ecological quality and restoring environmental health. The availability of free and open-source datasets facilitates conducting studies to support decision-making both locally and regionally.

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Introduction

Urban areas exhibit rapid population mobility compared to non-urban areas. The impact of climate change and all anthropogenic activities on the surface can be influenced by the pressure on urban resources and unequal distribution (Wu et al., 2019). Many floodplains are chosen for urban development due to their fertile and flat land. The complexity of flood risks in urban areas is contributed to by different land use categories, construction density, and the diversity of urban projects, in contrast to rural areas (Khodadad et al., 2023). Flood disasters are a significant concern in the world's hydrometeorological disasters (Costache et al., 2022). Urbanization growth and socio-economic activities occur massively in urban areas, and land conversion can become uncontrollable by local governments due to an uncontrolled increase in community occupancy (Rezvani et al., 2023). Therefore, flood disaster susceptibility requires the division and mapping of areas discussing spatial zoning to minimize the occurrence of flood disasters (Guzha et al., 2018). The information obtained from this assessment will be used to develop strategies for implementing effective disaster risk mitigation measures.

Alterations in land use have notably contributed to the escalation of urban flooding (Gayen et al., 2022). Approximately 60% of floods are influenced by damage sustained within the watershed area (Duan et al., 2022). Intermediate areas are indirectly affected by activities such as illegal logging, urban expansion, and open agricultural practices on steep slopes in the upstream region of the catchment area (Gutierrez-Lopez, 2022). Recent findings indicate that climate change phenomena are not only responsible for a rise in global surface temperature but also significantly contribute to flooding through occurrences of extreme rainfall and diminished soil infiltration capacity (Yamashita et al., 2016). The resultant land degradation, encompassing soil structure impairment, reduction in ecosystem services, and augmented sedimentation of riverbeds, constitutes fundamental elements of the assessment of flood risks stemming from surface runoff (Eggert et al., 2023).

The development of flood susceptibility mapping is an important step in mitigation planning, necessitating the implementation of protective measures (Koko et al., 2021). Researchers have proposed various techniques for global disaster mapping, taking into account both the push and pull factors of flood events (Bouamrane et al., 2020). Guidelines for assessing flood hazard susceptibility have been proposed by several scientific communities and global institutions to assist practitioners in conducting thorough analyses (Ghaffarian et al., 2018). Flood hazards in urban areas comprise four key components: morphological, spatial, temporal, and probability of occurrence (Şen, 2016). Therefore, there is a need for a review to foster a comprehensive understanding through the application of a spatial approach to assess the impact of land use change on urban flood-prone mapping.

Based on existing knowledge, a comprehensive outline of the understanding of the influence of land degradation resulting from land use change on urban flood susceptibility assessment was provided in this study. Related research will be systematically reviewed with objectives including the impacts of land use change, effects on environmental health, modification of land typology, explanations of urban flooding, suitable models for flood susceptibility assessment, current research status, appropriate steps in decision-making in susceptibility areas, and challenges of future scenario-based models in addressing urban flood disasters.

Impact of Land Use Change

The dynamic aspects of interrelated processes are involved in the effect of land use change on flood hazards (Hyde-Smith et al., 2022). In urban areas, the configuration of the land structure, originally useful for suppressing interception, has been altered due to the need for built-up land, resulting in a decrease in storage capacity and even indirectly contributing to the degradation of soil characteristics (Wang et al., 2022). This condition significantly affects flooding patterns, with runoff water increasing, wetlands and floodplains being lost, or natural water parking areas being diminished, along with interactions with climate change, deforestation, alterations in drainage flow patterns, and modifications to surface channel processes (Yin et al., 2021).

The potential for hydrometeorological disasters is significantly influenced by the impact of land use change. In the occurrence of a flash flood in an area, there is also an indirect implication of drought (Okeola et al., 2023). The ability of vegetation to thrive and the capacity of soil to retain water are no longer fulfilled, leading to the critical condition of the land and the cessation of its natural regulatory function (Lu et al., 2017). Overall, the effects are intricate and dependent on various contexts, such as local topography, climatology, soil and land characteristics, and the absence of regulation in land use control. In the context of urban areas, flooding generally originates from damage to the upstream watershed (Dasallas et al., 2022), necessitating an integrated policy in watershed control encompassing actions to address deforestation, illegal logging, land degradation, regulation of community activities in the upstream area, and other control activity policies.

Impact on Health Environment

Environmental health has been indirectly impacted by the phenomenon of flood hazards. This is evidenced by factors related to community and environmental conditions that are influenced by flood events. The risk of infectious diseases is increased by the contamination of water sources with bacterial or viral findings in locations lacking adequate sanitation infrastructure (De Cicco et al., 2018). Furthermore, indoor air quality is affected, and exposure to mold spores and other indoor pollutants is accelerated by flooding-induced mold growth and humidity (García et al., 2020). Further attention needs to be given to the level of contamination in well water to enhance preparedness for contamination risks associated with the effects of flooding. Although this concern is often overlooked, it is typically the potential consequences that are observed in the aftermath of an event and that influence behavior within the local community (Busayo et al., 2022).

The Modification of Land Typology

The natural phenomena related to climatology, the hydrological cycle, and land morphology occur closely and are mutually influenced by each other (Farid et al., 2022). Anomalies in the timing, frequency, intensity, and duration of rainfall are produced by shifts in atmospheric cyclical patterns (van der Plank et al., 2022). Runoff is increased, and water infiltration is decreased by impermeable conditions at the surface. Conversely, infiltration is increased, and surface flow levels are reduced by land planted with vegetation with strong root systems (Slavíková and Milman, 2023). Additionally, water runoff can be accommodated through the development of wetland drainage channels and the creation of ponds as water parking areas in floodplain morphology. The presence of humans as objects directly impacted by urban flooding necessitates intervention in detailed hydroclimatic processes through changes in land configuration in urban areas (Taubenböck et al., 2011). Modification of land cover typology from biophysical characteristics was carried out to reduce evaporation and increase retention capacity to slow down outflow. Soil modification or improvement to enhance the infiltration process has also been undertaken. Furthermore, engineering of the topography of the landscape, such as changes in elevation and slope, is used to influence the intensity of water flow. However, the retention of water for extended periods and the provision of an ecological space for surrounding biodiversity are made possible by the development of water catchments and storage areas. Furthermore, modifications to agricultural land, ranging from crop patterns to surface water consumption systems, are aimed at increasing infiltration into the aquifer section (Gabriels et al., 2022). Finally, adjustments to land-use configuration were undertaken as a process of transitioning from one land use to another to mitigate flooding. This includes the relocation of community activities from floodplains, the limitation of agricultural land expansion to improve the quality of agricultural products, the integration of two activities on a single land (such as agroforestry, intercropping, land sharing, and silvo-fishery), or other modifications oriented toward sustainability.

Urban Flooding

In recent years, urban areas have experienced increased flooding, making it one of the most frequent hydrometeorological disasters (Rogger et al., 2017). The intensity, frequency, and severity of flooding are heightened by various natural factors and human activities. The risk of inundation, as well as its impact on livelihoods and infrastructure development, is exacerbated by climate change and rapid urbanization activities. Urban flooding is classified into three types based on its morphology and climatological impact: tidal flooding, fluvial flooding, and pluvial flooding. Therefore, understanding the complexity of urban flooding is crucial to selecting mitigation strategies and adaptation measures that can effectively safeguard people's mobility and enhance the resilience of urban areas.

Tidal flooding

The occurrence of tidal flooding in urban areas situated in coastal regions, characterized by a generally flat morphology, is significantly influenced (Utami et al., 2021). Typically, this issue is associated with phenomena such as land subsidence and sea-level rise. The susceptibility of these coastal areas to tidal activity can result in land erosion or abrasion, especially when mangrove ecosystems are absent. Coastal areas experience significant impacts during the rainy season and high tides, which indirectly contribute to land degradation. This degradation is initiated by uncontrolled urban development and excessive groundwater extraction, leading to land subsidence that forms depressions and creates conditions for new inundations (Rahman et al., 2021).

Fluvial flooding

The risks posed by fluvial flooding are intertwined with the direct or indirect risks associated with shallow water flow activities, such as flooding phenomena, changes in the flow direction in floodplains, land degradation, lateral and vertical erosion, sedimentation along riverbanks, pollution, and degradation of water quality. These events are encountered within fluvial morphologies, and contributions to fluvial flood risk are directly influenced by land use change, hydrological management in floodplains, and degradation of hilly areas at the watershed scale, as well as influences from hydro-climatological hazards (Stover et al., 2018). The phenomenon of fluvial flooding is connected to the occurrence of flash floods, which predominantly impact urban areas along rivers and pose risks to communities in the floodplain. Generally, areas with sloping to flat morphological conditions are designated residential areas. The conversion of vegetated land cover into built-up areas with little consideration for green spaces has indirectly led to increased losses in the community. Therefore, it is necessary to restore the natural function of floodplain geomorphology as a means of urban fluvial flood control.

Pluvial flooding

In general, pluvial flooding occurs when the intensity of high rainfall exceeds the capacity of the soil to infiltrate, resulting in surface waterlogging (Agonafir et al., 2023). Pluvial flooding in urban areas is often associated with impervious surfaces and alterations in natural drainage systems. However, on the outskirts of urban areas, the symptoms of land degradation have a significant impact on pluvial flooding. This process begins with the discovery of pollutants, sediments, and garbage deposited on the soil surface, which alter the composition and fertility of the soil. During pluvial flooding events, runoff water erodes the particles of the fertile soil surface layer, leading to reduced nutrient availability for vegetation and agricultural productivity. The adverse effects of pluvial flooding include compaction of soil particles, reduction of pore space, and alterations in soil structure, resulting in diminished nutrient content and water absorption capacity. Additionally, land degradation resulting from pluvial flooding has long-term adverse impacts on the environment. Efforts to mitigate the impact of flooding through sustainable land management practices are increasingly necessary, as this action reflects a significant concern for the environment.

The Flood-Prone Assessment Model

Data and indicators

Urban flood-prone assessment indicators are influenced by climate, topography, hydrology, land use, soil type, and other factors. In general, climate data is obtained from regional climatology station records or satellites (e.g., CHIPRS, NOAA, etc.) (El-Rawy et al., 2022). When utilizing rainfall data from remote sensing, a process combined with a machine learning approach is required, involving simulation analysis as well as manual interpretation. This ensures that the resulting bias or difference from the field data is not substantial and is deemed acceptable for use in observations. Climatology, as represented by rainfall variables, provides an overview of the case study area, offering insights into the potential for surface runoff, susceptibility, and intensity of flood events. Following this, information on river flow and drainage in the study area was provided using hydrological data. These data are often represented by river networks, flow direction, flow accumulation, and drainage density. Certain indicators are derived from satellite technology, specifically in the form of remote sensing data. The existence of these data facilitates the extraction of information tailored to researchers' needs in building the desired research indicators (Tjahjono et al., 2011). Moreover, topographic data (elevation, slope, topographic wetness index, curvature, stream power index, topographic position index, topographic roughness index, aspect, and slope length factor) are required for susceptibility assessment, control, disaster risk and capitalization when using remote sensing data with the digital elevation model data type.

Spatial unit assessment

The most frequently used spatial unit size for assessing urban flood-prone areas is the grid unit. In general, spatial grid units are determined by the selection of resolution confidence using geographic information system tools. The accuracy of the assessment unit is significantly impacted by the selection process of an appropriate map resolution (Kwon and Kim, 2021). Better accuracy is not guaranteed if the pixel resolution is too coarse or fine. The determination of the unit size needs to consider the resolution of the data used. If the data has variations in resolution, the resolution equalization process is carried out (Ali, 2018). This consideration must align with cartographic principles, preventing the conversion of medium data into more detailed data without adding information from the field (Giofandi et al., 2023). Therefore, the results of the analysis process will be affected by the choice of spatial unit size. Representative studies illustrating the spatial unit size in the assessment of urban flood-prone areas are presented in Table 1. Differences in the use of spatial unit sizes resulted in varying levels of information for interpretation. This is significantly influenced by the size of the remote-sensing image data. Generally, the difference in scale for each parameter is the primary factor in determining research results that are representative of flood susceptibility. The section (Table 1) demonstrates the different pixel sizes used to construct the model.

Beginning with the application of high resolution at 5 x 5 m (Youssef et al., 2016), followed by 10 x 10 m (Tehrany et al., 2019), 12.5 x 12.5 m (Narimani et al., 2021), 30 x 30 m (Zeng et al., 2021), up to 90 x 90 m (Yariyan et al., 2020). The resolution of raster data is influenced by topographic parameters through the selection of digital elevation model data such as the Shuttle Radar Topography Mission (SRTM), Advanced Spaceborne Thermal Emission and Reflection Radiometer Global Digital Elevation Model (ASTER GDEM), and national elevation data. The precision of the optimal resolution selection depends on the size of the observation area. Therefore, the raster size units may vary from one observation area to another. Determining the best resolution can be achieved through assessment and comparison of accuracy at each resolution and by dividing the size of the grid unit using each resolution size that closely matches field conditions. Furthermore, the assessment of flood susceptibility accuracy can adapt the calculation to produce an optimal resolution pixel size. The inability of the model to be applied resulted from limited event data and information regarding the environmental characteristics of the observation area. Consequently, the selection of the raster size without adequate model validation leads to an inability to accurately represent the extent of flooding.

Table 1. Spatial unit assessment.

Researchers	Research Area	Objective	Unit Size
Youssef et al. (2016)	Jeddah City, Saudi Arabia	To assess flood-prone areas using a statistical approach.	5 x 5 m
Tehrany et al. (2019)	Busan City, South Korea	To address the limitation of logistic regression in handling bivariate probabilities.	10 x 10 m
Narimani et al. (2021)	Seoul City, South Korea	To identify potential flood zones and validate flood-prone areas in Seoul City, South Korea.	12.5 x 12.5 m
Zeng et al. (2021)	Jian City, China	To assess the flood-prone model in Jian City, China.	30 x 30 m
Yariyan et al. (2020)	Saqqez City, Iran	For mapping flood-prone areas and potential floods using a statistical model in north-west Iran.	90 x 90 m

These limitations in addressing ignorance may introduce biases and fail to adequately represent population groups, thereby causing inappropriate information. An indirect effect of inappropriate raster size on the generalization of information was observed. This issue arises from limitations in data collection, including inaccurate or incomplete data, which influence the determination of the raster data size. Consequently, undetected errors may fail to capture all the complex interactions and dynamics involved. Thus, setting the appropriate model pixel size is crucial, as it significantly affects the model's performance.

Assessment of the Model

A crucial aspect with significant implications for assessing flood-prone mapping models is the methodology employed. Prediction of the likelihood of flooding, including various approaches such as machine learning, statistics, and deep learning, is undertaken by these models. Estimates of inundated areas were provided by models developed for flood susceptibility assessments. However, certain weaknesses, such as uncertainty in the return periods and the need for additional calibration of field discharge data to validate the accuracy of the model, have been identified (Neves et al., 2022). The calculation of surface runoff and determination of flood sensitivity levels were conducted using sensing approaches and geographic information system technology for further susceptibility analysis (Demissie et al., 2023). Recently, a hybrid model was created by integrating geographic information system-based machine learning, hydrology, hydrodynamics, and statistical models. Studies comparing the performance of different models have aimed to establish the best model that is adaptable to areas with similar surface characteristics (Wakabayashi et al., 2019). A combined model of multiple criteria with machine learning has been adopted in most studies (Komolafe et al., 2019; Vitale et al., 2023).

Current State of the Research

The findings from our review indicate that there is a growing body of research on urban flood-prone areas, disaster management, risk assessment, susceptibility, population density, monitoring studies, influences, and flood mitigation. However, the research does not specify whether the region is categorized as a developed or developing country (Nkwunonwo et al., 2020). The impacts and effects of flash floods on both urban and non-urban areas were also found in a previous review (Arosio et al., 2021). It is observed that some studies assessing urban resilience with a disaster risk management approach have examined the effects of both natural and non-natural disasters (Wang et al., 2019). Meanwhile, research addressing the physical aspects of the region remains an inseparable aspect of disaster assessment. Various physical parameters across landscapes were used as the dominant influencing factors at the urban landscape scale in more than half of the studies examining flood susceptibility. Various components of river flows have also been assessed. However, there is room for a more influential humanities approach in altering flows, as water utilization is required in the interaction between humans and nature for daily needs and settlement growth (Tadesse et al., 2022). There is a lack of studies focusing on not involving multi-temporal urbanized surface flow changes.

The most common observation was the demand for cross-sectoral synergies built among various stakeholders. A strong applied focus in flood-prone area management can be demonstrated through a social research perspective developed in planning (Amante, 2019). While the nature of this urban flood-prone area research allows for similarities with global research partners, the understanding and assessment aspect of mapping methods is emphasized by addressing physical, social, economic, environmental, ecological, and integrated considerations, as well as opportunities in urban areas.

The Decision-Making Process in Flood-Prone Areas

The importance of safety procedures in disaster events cannot be overstated. The susceptibility condition of the area, along with the presence of individuals with limited theoretical knowledge of flood management, has resulted in inadequate policy implementation (Ke et al., 2023). The complex nature of flood disasters, influenced by hydrometeorological factors and human activities, complicates the assignment of responsibility for the resulting losses (Islam and Meng, 2022). Consequently, community adaptation measures and locally-based treatments are not always successful in preventing potential flood disasters (Thieken et al., 2016). Adapting assets linked to international institutions and risk management strategies for flood disaster management proves challenging using a top-down approach in real-time, which may not efficiently address the needs of all flood-prone locations. The alignment with disaster-affected component systems must be tailored to the specific local requirements and ongoing indigenous trust processes in each region (Nhangumbe et al., 2023). The decision-making process in urban flood-prone areas is formulated based on responding to the environmental needs of urban communities, incorporating various dimensions and indicators of the likelihood of occurrence (Khadka et al., 2021). This process involves weighing different criteria in decision-making, either interconnectedly or independently (Fu et al., 2021). Two approaches exist, namely subjective (expert-driven) and objective (stochastic). The selection of the appropriate technique depends on the context and challenges faced by the researcher. Further investigation is warranted in future research endeavors to determine the most suitable approach, both theoretically and practically, in flood disaster-prone areas.

Challenges of Scenario-Based Flood-Prone Mapping Model in the Future

The geospatial modeling of flood-prone areas is considered a crucial tool for the development of hydrometeorological disaster risk control policies (Ford et al., 2019). In this discussion, based on a literature review, various physical environmental parameters are identified as not being applied in specific regional conditions, with the assumption that these parameters have a low influence on the flood model building process. Weaknesses in the study, including the lack of detailed information and its relationship with floodplain areas and flood event frequency, have been pointed out in several studies (Skrydstrup et al., 2022; Azad and Pritchard, 2023). The discussion includes an examination of the frequency of occurrence to estimate the probability of inundation distribution during extreme rainfall periods (Tiepolo et al., 2023). The current methodological approach has resulted in scenarios representing the past, present, and various future years. Mathematical models built using machine learning and deep learning have become recurring topics of discussion in recent years.

Floods are the result of interconnected causes, some of which contribute to land degradation. Factors such as land use change, deforestation, unsustainable agriculture, increasing urbanization, and climate change are significant elements that must be considered in flood hazard mitigation efforts (Bosseler et al., 2021). Adopting a holistic approach involves considering these complex interactions as driving factors in an integrated manner, alongside implementing comprehensive measures in the management of flood-prone areas. This includes maintaining the physical structure of the soil, reducing chemical inputs, and enhancing land quality to mitigate adverse impacts during flood events (Salata and Arslan, 2022). Moreover, the limited availability of historical data poses a challenge in temporally assessing the severity of land degradation impacts during flood events and real-time monitoring, particularly in developing areas lacking monitoring experts. A viable step toward improving data collection methods is the utilization of remote sensing technology (Kaaviya and Devadas, 2021). However, it is imperative to ensure the quality of the data obtained and tailor it to observational requirements. Addressing the challenge of flood-prone models at a detailed scale necessitates high-resolution data as the primary benchmark for observation accuracy. While the utilization of unmanned aerial vehicles (UAVs) presents a potential solution, challenges associated with global demand and substantial operational costs are entailed. The presence of artificial intelligence offers advantages to researchers in facilitating information searches, providing a solid conceptual basis expected to address flood problems from different perspectives often overlooked by researchers. However, the process of assessing the accuracy of prediction results has not been fully validated in the field, requiring considerable time to reach the assumed year from the prediction results. Additionally, the results so far are probabilistic, introducing a level of uncertainty in their application (He and Weng, 2018). Therefore, in adopting an urban flood-prone area assessment model, a model comparison is suggested to reduce assessment bias in different landscape conditions compared to previous research.

Based on the information presented in Table 2, several studies that serve as assessments of model representation are summarized, all of which are utilized for flood susceptibility assessments. The data in the table are intended to present models that are pertinent for conducting further analysis. However, the significance of models in various operational measures for hydrometeorological disasters has been delineated in the literature. Examples include the application of 2D models (Abdrabo et al., 2020), hydrodynamic models (Chen et al., 2021), statistical models (Lee et al., 2020), decision-making models (Cabrera and Lee, 2019; Li et al., 2021; Taromideh et al., 2022), and machine-learning models (Pourghasemi et al., 2021; Al-Areeq et al., 2022; Li et al., 2022). Despite their ability to simulate flood susceptibility, these models exhibit several limitations, resulting in errors in their application and necessitating calibration stages in different regions.

Limitations in the availability of high-resolution satellite image data affect the processing techniques employed. Community mobility is proposed as a representation of human activity required at a detailed scale to yield a comprehensive understanding of the influence of land-use changes on flood susceptibility levels. The instability of model measurements and their failure to reflect the area's condition, the necessity for accurate data, the incorporation of physical variables to enhance further analysis, and the comparison of specific spatial models are the principal issues addressed throughout the article employed in systematic preparation. However, the optimization of flood susceptibility models by representing hydraulic processes is deemed very important in determining the influence of land use change on flood assessment. Unfortunately, the significant question of how to solve the process representation optimally and dynamically, considering the accuracy of the model and completeness of the main data, remains a debate that has not been fully realized. In addition to the accuracy issues in the model, decisions regarding the main processes that can be represented in the flood model are also deemed important, along with the uniqueness of the flood-affected location.

Table 2. Summary of several research representation assessment models.

Researchers	**Model**	**Method**	**Conclusion**	**Limitation**
Abdrabo et al. (2020)	2D Hydrology	A hydrological model, specifically the 2D RRI Model, is employed to simulate urban floods by integrating remote sensing data to construct flood depths.	The model can establish current and future flood situations by considering the depth of flooding.	Occurrence and rainfall data are limited, necessitating the validation and calibration of various regions.
Lee et al. (2018)	Statistical Model	The (FR) and (LR) models are used to determine the flood area and the factors that affect flood-prone areas, which are then combined with topography, soil, geology, and land-use factors.	The (FR) model is more suitable for mapping urban flood-prone areas, where settlements and transportation networks are more vulnerable to flooding than other land-use types.	The study is limited in validating the timing of field data collection, making it not correlate with flood events.
Al-Areeq et al. (2022)	Machine Learning Model	In the study, four models BE, LT, k-SVM, and KNN were used for flood zoning mapping in the study area.	The (BE) model demonstrates more precise performance in mapping flood-prone areas in the study area.	Limitations in data availability and high-resolution satellites.
Cabrera and Lee (2019)	Multiple Indicators Integration Model	The (AHP), weights by rank (WR), and (RW) models used for flood-prone areas in the study area incorporate topography, climatology, soil type, and social aspects.	The AHP model is deemed more suitable for assessing flood-prone areas in the study area.	Querying high-resolution data, calculating flood depth, assessing the impact of flood events, and employing data mining techniques and machine learning.
Taromideh et al. (2022)	Integration of decision making and machine learning	Exploration of four models, including (CARTs), (RFs), (BRTs), (MARSs), (MDAs), and (SVMs), followed by the validation of these models for flood disaster assessment in the study area.	The CARTs model demonstrates better performance in flood disaster assessment, identifying significant indicators that affect the occurrence of floods.	Further validation is required, along with the incorporation of detailed human activities in flood disaster modeling.
Pourghasemi et al. (2021)	Machine Learning Model	The (BRT) and (GLM) models were utilized to generate flood susceptibility maps, incorporating 12 physical variables. Google Earth Engine was employed to identify flood inundation areas in the study area.	The assessment of the flood susceptibility model using the BRT model is more suitable in the study area, producing significant values for flood prevention and management services.	The data lacks accuracy; hence, field data validation is necessary.
W. Li et al. (2022)	Machine Learning Model	The PBLC and ANN modeling approaches were employed to create flood-prone maps, integrating physical, climatic, and environmental factors of the study area.	PBLC produces more accurate predictive values and is effective in addressing the issue of event sample setting.	Limited sample size and absence of other environmental factors.
Chen et al. (2021)	Hydrodynamic Model	An ArcSWAT-based hydrodynamic model was developed for flood-prone areas, incorporating	The prediction model can be applied in the study area and linked to social susceptibility	The model is unstable and fails to explain simulated flood conditions.

Researchers	Model	Method	Conclusion	Limitation
		morphology, rainfall, soil type, and land use to simulate flooding in the study area.	results for risk zoning in the Yangtze River economic center.	Additionally, users require a detailed understanding of the simulation flow.
Z. Li et al. (2021)	Decision-Making Model	The AHP model was employed to assess flood proneness by incorporating environmental and social aspects.	The AHP model proves effective in conducting flood risk assessments.	Further validation is necessary, along with the inclusion of physical variables in urban flood-prone assessments.
Priscillia et al. (2021)	Statistical Model	Three models such as (ANN), (k-NN), and (SVM) are utilized to delineate flood-prone areas in the study area, followed by the integration of regional characteristics and climatology.	The ANN model achieves higher accuracy and is suitable for mapping flood-prone areas at the village level in this region.	The model is stable, and a spatially specific comparison of the ANN model's performance is necessary.

Conclusion

This research conducted a systematic review of articles addressing the impact of land use change on urban flood susceptibility assessment. This paper examines the impacts on environmental health, land degradation resulting from land use change, modifications of land typology, explanations of urban flooding, appropriate models for flood-prone assessment, the current state of research, suitable steps in decision-making in susceptibility areas, and challenges of scenario-based flood-prone mapping models in the future. This paper discusses applications and data requirements. Additionally, we anticipate that research on flood-prone areas will integrate various aspect assessments comprehensively, not solely focusing on the physical characteristics of the area. It is expected to include studies on building damage, integrated early warning systems, shelter construction, presence of emergency posts, and other rescue responses. The interconnection between local, regional, and global aspects in standardizing data resolution utilization with a value of understanding can serve as a bridge between neighbors to assess the findings of flood-prone area assessments.

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