e-ISSN: 2809-7610

Journal of Demography,Etnography,and Social Transformation

The Effect Of Urbanization On Flood Mitigation and Food Security: A Comparative Study Of Rome (Italy) and Semarang (Indonesia)

Ayu Mardalena[1]
[1]Departemen Geografi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Indonesia, 16424 Depok, Jawa Barat, Indonesia
e-mail: ayu.mardalena11@gmail.com

Abstract

The rapid acceleration of urbanization, without proper urban spatial policy planning, can have a significant impact on flood mitigation and regional food security, particularly in the urban areas of Rome and Semarang. This study aims to investigate, review, and compare the influence of land use change on food security and flood mitigation in Rome, Italy, and Semarang, Indonesia. The methods used include a literature review and a comparative analysis of scientific publications, reports, and findings from journals published between 2020 and 2023. The findings revealed that urbanization in Rome had a twofold negative effect compared to forest expansion. Moreover, the decrease in natural land in Rome reduced 249,838 tons in productive agricultural areas. On the other hand, urbanization in Semarang resulted in an increase in built-up land area and a decrease in land elevation, leading to a rise in the number of flood events from 23 in 2020 to 63 in 2022. Additionally, urbanization also led to a decrease in agricultural land, reduced water availability for agriculture, and raised the cost of food transportation due to increased distances between production areas and urban centers. Urbanization in both cities poses a threat to the safety of urban residents, particularly through the heightened risk of urban flooding and decreased food security. It is crucial for the government to take charge and establish sustainable regional development by formulating spatial policies for urban areas.

Keywords: Urbanization; Flood; Food Security; Rome; Semarang.

INTRODUCTION

The urban population has increased from 2.29 billion in 1990 to 4.38 billion in 2020 (S. Li et al., 2023). This increase in urban population is caused by population migration from rural areas to find job opportunities called urbanization (Gutierrez Garzon et al., 2022). Urbanization is a driver of various impacts of socio-environmental changes across scales such as economic growth and land use change in urban areas (S. Li et al., 2023; van Berkum, 2023) which ultimately causes climate problems and land use discrepancies due to population activities (W. Li et al., 2022; Varol et al., 2021). Climate problems driven by land-use change will lead to increased temperatures and high rainfall (Kelly-Fair et al., 2022) causing damage and increased flood frequency (Bibi et al., 2023; Xu et al., 2023). In addition, climate issues and land

use change also hurt agricultural efforts to secure food production (Shi et al., 2023; Tan et al., 2022).

Changes in urban land use dominated by built-up areas into areas of impermeability cause surface runoff which ends in agricultural intensification (Quagliolo et al., 2021). However, some other researchers have different responses, according to van Berkum, (2023) urbanization is related to the opportunity cost of agricultural land which based on Von Thunen's ideas makes agricultural production higher valuable and more intensive. These differences make it important to identify and assess the impact of urbanization on food security for government decision-makers in efforts to plan sustainable land use at the regional and global levels. Food security is the synergistic ability of local resources and human resources to realize the independence of local food consumption and to create good quality and healthy local food products (Handayani & Wicaksono, 2021) According to Beyene, (2023), the stability of food security in a region is very important, this is because food security encourages improved health and human development.

In 2019, 49% of natural disasters that occurred in the world were flood disasters affecting 68% of the world's population (CRED in Marino et al. 2023). According to Marino et al., (2023) in the Italian region, more than 9.8% of the region is vulnerable to flooding, with a total of 82% of cities located in six administrative regions and affecting approximately 3.5 million people. One of the vulnerable areas affected is the City of Rome. The flood phenomenon in Rome is caused by high rainfall and exacerbated by the lack of an efficient sewage system (Lentini et al., 2022) and the construction of high walls along the river banks, radically changing the relationship between stage and river discharge (Mancini et al., 2022).

Indonesia as an archipelagic country causes most urban areas to be located in coastal and lowland areas making them vulnerable to disasters such as floods and tropical cyclones (Ayuni et al., 2022). This condition is exacerbated by the increase in population that has occurred over the past 20 years in urban areas which has caused large-scale land use changes to occur and urban centers to become denser and larger (Kelly-Fair et al., 2022). One of the cities in Indonesia that experiences this is Semarang City. Semarang City is an urban area with high population and population growth and is in low relief (Irawan et al., 2021).

Based on the description above, the two locations have almost the same regional characteristics and city problems so this study aims to study, review, and compare based on relevant literature related to the effect of land use change on food security and flood mitigation in Rome City (Italy) and Semarang City (Indonesia).

METHOD

In this study, we employed a literature-based research method, drawing on relevant scientific publications, reports, and findings published in journals between 2020 and 2023. Our analysis utilized a comparative approach, as defined by Bolbakov

et al., (2020), which allows for comparisons between different objects and their sets and provides insight into existing differences. Specifically, we conducted a comparative analysis of research variables related to urbanization, land use change, flooding, and food security in Rome (Italy) and Semarang (Indonesia). The study results offer a comprehensive overview of the influence of each variable and the resulting impacts on the populations of Rome (Italy) and Semarang (Indonesia).

RESULT AND DISCUSSION

The influence of urbanization in Rome (Italy)

Urbanization in the Rome region saw a significant uptick from 1949 to 1974, resulting in a rise in population and settlement density (Sadat Nickayin et al., 2023). The research by Sadat Nickayin et al., (2023) indicates that settlement expansion was particularly prominent in the early 1950s and mid-1970s, with a more marked population increase in urban centers than in urban suburbs. However, in the subsequent years and up to the present, urban expansion has extended to the outskirts, leading to a decrease in the population density disparity between urban and rural areas (Egidi & Salvati, 2020). This urbanization trend has also brought about changes in land use, potentially impacting the spatial planning of the Rome area.

The dynamics of land use change in Rome, Italy have been the subject of several studies, including those carried out by Bianchini et al., (2021), Marino et al., (2023), and Tomao et al., (2021). In a study spanning from 1949 to 2016, Bianchini et al., (2021) observed significant urban expansion in Rome, resulting in a transformation of the traditional agricultural landscape. The most substantial period of urban change was noted between 1949 and 1974, directly correlating with urbanization in the Rome region. These findings align with the research conducted by Marino et al., (2023) and Tomao et al., (2021). Tomao et al., (2021) analyzed land use change from 2006 to 2018, highlighting a shift from natural land use (agriculture and forests) to artificial land (urban). The study identified the most significant change occurring from 2006 to 2012, particularly affecting agricultural land as opposed to forested areas. Furthermore, Marino et al., (2023) conducted a study spanning from 1990 to 2018, revealing that only 15% of Rome's area experienced land use change (Figure 1). The study indicated a higher prevalence of forest transition change compared to agricultural extensification. However, Marino et al., (2023) elaborated that urban and industrial development resulting from Rome's urbanization placed additional strain on agricultural areas, particularly those adjacent to road infrastructure and the outskirts of the city. The distribution of runoff retention comparison results can be seen in Figure 2.

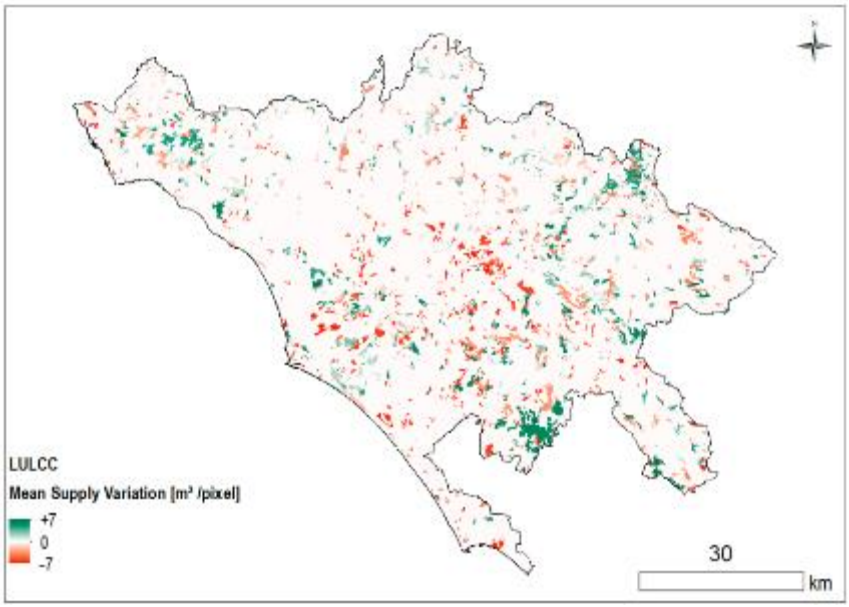

Figure 2. Flood mitigation Supply Variation Map
(Source: Marino et al., (2023)).

The analysis revealed a significant decrease in runoff retention by -513,065 m3, primarily due to urbanization. The results underscore the negative impact of urban development, which reduces runoff retention twice as much as forest expansion increases it. This is largely because natural land is being replaced by artificial surfaces, leading to reduced water infiltration and increased surface runoff (Sugianto et al., 2022) Additionally, the decline in natural land, including arable land, vineyards, orchards, and olive groves in the Roman region, has substantially diminished productive agricultural areas, resulting in an estimated 249,838-ton decline in food production for the population (Marino et al., 2023). Ultimately, the changes in land use in Rome, Italy have had a significant impact, particularly by increasing the risk of river and rainfall-induced floods and compromising agricultural output.

The influence of urbanization in Semarang (Indonesia)

The urban population of Indonesia's Java Island accounts for approximately 56.10% of the total, with a yearly growth rate of 2.5% (BPS, 2023). According to BPS Kota Semarang, (2023), Semarang, Central Java's largest city, had an urban population of 1,659,975 in 2022, with a growth rate of 0.21%. Dewa et al., (2022) projected an 80% urbanization rate for Semarang City in 2010, with a yearly increase of 1.68%. Notably, Semarang City, as a coastal metropolitan area, demonstrates a more dynamic growth pattern compared to inland cities (Yılmaz & Terzi, 2021).

The urbanization in Semarang City goes beyond the movement of people from rural to urban areas and encompasses internal migration and concentration within the city, as discussed by Dewa et al., (2022). According to their research, Semarang City is experiencing rapid urban growth, particularly in the urban fringe areas such as

Banyumanik, Tembalang, Gunung Pati, Mijen, and Ngaliyan Districts. The distribution map that demonstrates these development patterns can be found in Figure 3, and the changes in population per sub-district are detailed in Figure 4.

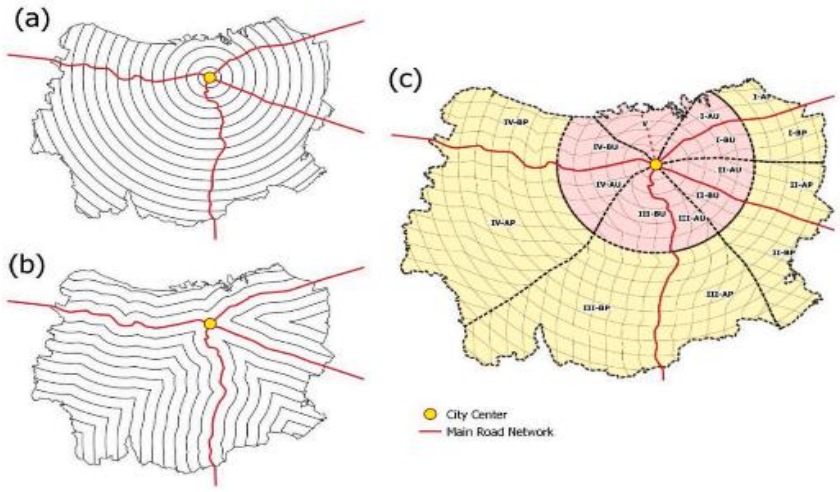

Figure 3. Zoning Schemes a) based on proximity to the city centre, b) based on proximity to the main road network, and c) combined zones.
(Source: Dewa et al., 2022)

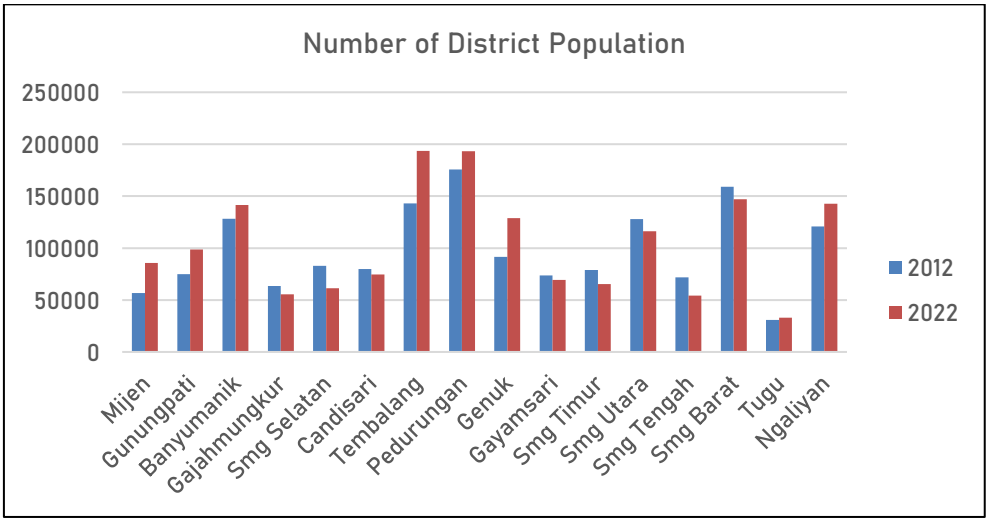

Figure 4. District Population in 2012 – 2022
(source: BPS Semarang City, 2023)

The analysis of Figure 3 and Figure 4 reveals a noticeable shift in population distribution within Semarang City. Over the last decade (2012-2022), the central districts of Semarang, including Central Semarang, North Semarang, West Semarang, South Semarang, East Semarang, Gayamsari, Candisari, and Gajahmungkur, have experienced a decrease in population. In contrast, the suburban and peri-urban areas have seen a

substantial rise in population. This demographic difference is attributed to factors such as the reduced availability of open land in urban and coastal areas, prompting people to seek land in the rural areas to the south of Semarang City (Dewa et al., 2022). The rapid and uncontrolled urban growth in Semarang City has led to changes in land use patterns, resulting in the unchecked expansion of built-up areas at the expense of forests, agricultural land, and plantations. Furthermore, the development of built-up areas has created additional challenges, such as the need for infrastructure and access for residents, necessitating a wider area and incurring higher development costs (Budihardjo et al., 2022). Several studies have examined the land use changes in Semarang City, including research conducted by Dewa et al., (2022), Dwi Raharjo et al., (2020) and Kelly-Fair et al., (2022). Their findings show that Semarang experienced a loss of permeable surfaces covering around 33.05 km2, equivalent to 10% of the total land cover from 2006 to 2015. By 2015, approximately 65.83% of Semarang's area was covered by impermeable surfaces, primarily settlements and commercial/industrial areas (Kelly-Fair et al., 2022).

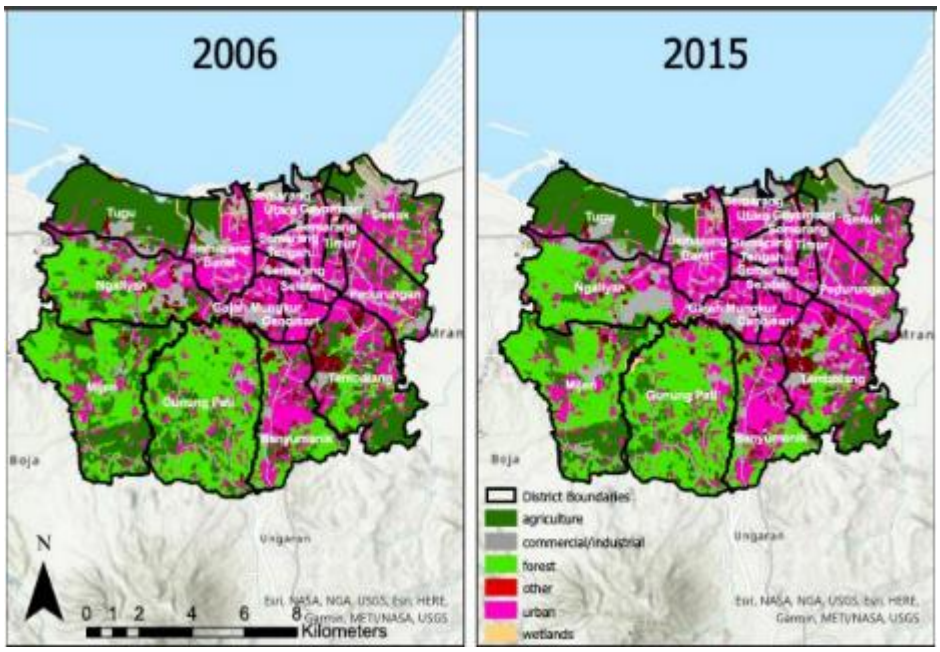

Figure 4. Land Use in 2006 and 2015 Semarang City
(Source: Kelly-Fair et al. 2022)

The findings of a recent study by Kelly-Fair et al., (2022) align with the research conducted by Dewa et al., (2022) and Dwi Raharjo et al., (2020). Dewa et al., (2022) focused on changes in land use from 2010 to 2020, revealing significant shifts in built-up land and forest cover. Specifically, the study noted a 63% decrease in forest cover and a 53% increase in built-up land, particularly in the central area of Semarang City expanding into urban fringe areas. Similarly, Dwi Raharjo et al., (2020) found that built-up areas experienced the most significant changes in land use from 1992 to 2019, with an increase

from 17.42% to 33.19%. This change was attributed to a decrease in open land, forests, and agricultural areas (Dwi Raharjo et al., 2020). The expansion of urban areas in Semarang City has led to deforestation and an increased frequency of flooding over time (Dewa et al., 2022). Data from BPBD Kota Semarang (2023) reveals that the number of flood events in the city rose from 23 in 2020 to 63 in 2022. This surge is attributed to the decrease in forest and catchment areas due to the rise in impermeable surfaces resulting from the development of residential and commercial/industrial areas in Semarang City (W. Handayani et al., 2020). Moreover, the subsidence of land in the city is caused by the growing weight of residential and industrial structures (Esteban et al., 2020). Additionally, the city's location, covered by a layer as described by Irawan et al. (2021), heightens the risk of flooding. Therefore, Rudiarto in W. Handayani et al. (2020) pointed out the significant impact of urbanization in northern Central Java since the 1990s, subsequently leading to an escalation in climate-related disasters, particularly frequent floods. The rapid urbanization in Semarang City has led to increased flood risks and significant changes in agricultural land use. This has resulted in a reduction of available water for farming and higher food transportation costs due to the increased distance between production areas and urban centers (Putra et al., 2020). Research by Kelly-Fair et al. (2022) has highlighted that the conversion of agricultural land in Semarang City hasn't just been limited to urban development but has also seen the transformation of some areas into rubber plantations. Notably, this shift has taken place in Mijen District, which has the largest number of farmers and is the only area with rubber plantations in the city (BPS Kota Semarang, 2023). While the shift to cash crops like rubber can bring economic benefits to farmers, it has also led to a decrease in the availability of food. Continuously subsidizing agriculture and providing tax incentives to encourage farmers to transition from monoculture to agroforestry may be a more suitable approach to addressing food insecurity in Semarang City, as opposed to promoting the export of rubber plantation products (Kelly-Fair et al., 2022).

CONCLUSION

The research suggests that the process of urbanization in Rome, Italy, and Semarang, Indonesia, has a detrimental effect on the safety of urban inhabitants, leading to increased vulnerability to flooding and reduced food security. The swift urban expansion in both city centers and surrounding areas worsens challenges related to land availability and environmental sustainability. As a result, it is imperative for governments to enact comprehensive spatial planning policies to encourage sustainable development at the regional level, particularly in Rome and Semarang.

REFERENCES

Ayuni, S. I., Tsana, S., & Priyandianto, N. R. (2022). Project-induced displacement: Rethinking the impact of spatial planning and disaster mitigation policies in Tambakrejo, Semarang City. IOP Conference Series: Earth and Environmental Science, 986(1). https://doi.org/10.1088/1755-1315/986/1/012063

Beyene, S. D. (2023). The impact of food insecurity on health outcomes: empirical evidence from sub-Saharan African countries. BMC Public Health, 23(1). https://doi.org/10.1186/s12889-023-15244-3

Bianchini, L., Egidi, G., Alhuseen, A., Sateriano, A., Cividino, S., Clemente, M., & Imbrenda, V. (2021). Toward a dualistic growth? Population increase and land-use change in Rome, Italy. Land, 10(7). https://doi.org/10.3390/land10070749

Bibi, T. S., Kara, K. G., Bedada, H. J., & Bededa, R. D. (2023). Application of PCSWMM for assessing the impacts of urbanization and climate changes on the efficiency of stormwater drainage systems in managing urban flooding in Robe town, Ethiopia. Journal of Hydrology: Regional Studies, 45. https://doi.org/10.1016/j.ejrh.2022.101291

Bolbakov, R. G., Sinitsyn, A. V., & Tsvetkov, V. Y. (2020). Methods of comparative analysis. Journal of Physics: Conference Series, 1679(5). https://doi.org/10.1088/1742-6596/1679/5/052047

BPS. (2023). Statistik Indonesia 2023.

BPS Kota Semarang. (2023). Kota Semarang Dalam Angka 2023: Vol. 33740.2304 (BPS Kota Semarang, Ed.). BPS Kota Semarang.

Budihardjo, M. A., Ardiansyah, S. Y., & Ramadan, B. S. (2022). Community-driven material recovery facility (CdMRF) for sustainable economic incentives of waste management: Evidence from Semarang City, Indonesia. Habitat International, 119. https://doi.org/10.1016/j.habitatint.2021.102488

Dewa, D. D., Buchori, I., Sejati, A. W., & Liu, Y. (2022). Shannon Entropy-based urban spatial fragmentation to ensure sustainable development of the urban coastal city: A case study of Semarang, Indonesia. Remote Sensing Applications: Society and Environment, 28. https://doi.org/10.1016/j.rsase.2022.100839

Dwi Raharjo, P., Ansori, C., Puswanto, E., & Hidayat, E. (2020). Spatial Analisis Using Multitemporal Remote Sensing to LULC Identify, Case Study in Semarang City 1992 - 2019. International Conference on Regional Development , 97–103.

Egidi, G., & Salvati, L. (2020). Beyond the Suburban-Urban Divide: Convergence in Age Structures in Metropolitan Rome, Italy. Journal of Population and Social Studies, 28(2), 130–142. https://doi.org/10.25133/JPSSv28n2.009

Gutierrez Garzon, A. R., Lee, T., Merry, K., Bektas, V., Cruise-Palmer, J., & Bettinger, P. (2022). Urban land use cover changes in three developed cities of the United States: San Diego, Denver, and Buffalo. Heliyon, 8(3). https://doi.org/10.1016/j.heliyon.2022.e09093

Handayani, E., & Wicaksono, S. A. (2021). The Increasing of Human Resources quality Through Food Security in Sema-rang City (A Study of Legal Anthropology). International Journal of Multidisciplinary: Applied Business and Education Research, 2(11), 1250–1258. https://doi.org/10.11594/ijmaber.02.11.17

Irawan, A. M., Marfai, M. A., Munawar, Nugraheni, I. R., Gustono, S. T., Rejeki, H. A., Widodo, A., Mahmudiah, R. R., & Faridatunnisa, M. (2021). Comparison between averaged and localised subsidence measurements for coastal floods projection in 2050 Semarang, Indonesia. Urban Climate, 35. https://doi.org/10.1016/j.uclim.2020.100760

Kelly-Fair, M., Gopal, S., Koch, M., Kusumaningrum, H. P., Helmi, M., Khairunnisa, D., & Kaufman, L. (2022). Analysis of Land Use and Land Cover Changes through the Lens of SDGs in Semarang, Indonesia. Sustainability (Switzerland), 14(13). https://doi.org/10.3390/su14137592

Lentini, A., Meddi, E., Galve, J. P., Papiccio, C., & Vigna, F. La. (2022). Preliminary identification of areas suitable for Sustainable Drainage Systems and Managed Aquifer Recharge to mitigate stormwater flooding phenomena in Rome (Italy). Acque Sotterranee - Italian Journal of Groundwater, 11(4), 43–53. https://doi.org/10.7343/as-2022-590

Li, S., Ji, Q., Liang, W., Fu, B., Lü, Y., Yan, J., Jin, Z., Wang, Z., & Li, Y. (2023). Urbanization does not endanger food security: Evidence from China's Loess Plateau. Science of the Total Environment, 871. https://doi.org/10.1016/j.scitotenv.2023.162053

Li, W., Li, P., Feng, Z., & Xiao, C. (2022). GIS-Based Modeling of Human Settlement Suitability for the Belt and Road Regions. International Journal of Environmental Research and Public Health, 19(10). https://doi.org/10.3390/ijerph19106044

Mancini, C. P., Lollai, S., Calenda, G., Volpi, E., & Fiori, A. (2022). Guidance in the calibration of two-dimensional models of historical floods in urban areas: a case study. Hydrological Sciences Journal, 67(3), 358–368. https://doi.org/10.1080/02626667.2021.2022153

Marino, D., Palmieri, M., Marucci, A., Soraci, M., Barone, A., & Pili, S. (2023). Linking Flood Risk Mitigation and Food Security: An Analysis of Land-Use Change in the Metropolitan Area of Rome. Land, 12(2). https://doi.org/10.3390/land12020366

Quagliolo, C., Comino, E., & Pezzoli, A. (2021). Experimental Flash Floods Assessment Through Urban Flood Risk Mitigation (UFRM) Model: The Case Study of Ligurian Coastal Cities. Frontiers in Water, 3. https://doi.org/10.3389/frwa.2021.663378

Sadat Nickayin, S., Egidi, G., Cudlin, P., & Salvati, L. (2023). Investigating metropolitan change through mathematical morphology and a dynamic factor analysis of structural and functional land-use indicators. Scientific Reports, 13(1), 695. https://doi.org/10.1038/s41598-023-27686-1

Shi, J., An, G., Weber, A. P. M., & Zhang, D. (2023). Prospects for rice in 2050. In Plant Cell and Environment (Vol. 46, Issue 4, pp. 1037–1045). John Wiley and Sons Inc. https://doi.org/10.1111/pce.14565

Sugianto, S., Deli, A., Miswar, E., Rusdi, M., & Irham, M. (2022). The Effect of Land Use and Land Cover Changes on Flood Occurrence in Teunom Watershed, Aceh Jaya. Land, 11(8). https://doi.org/10.3390/land11081271

Tan, R., Liu, P., Zhou, K., & He, Q. (2022). Evaluating the effectiveness of development-limiting boundary control policy: Spatial difference-in-difference analysis. Land Use Policy, 120. https://doi.org/10.1016/j.landusepol.2022.106229

Tomao, A., Mattioli, W., Fanfani, D., Ferrara, C., Quaranta, G., Salvia, R., & Salvati, L. (2021). Economic downturns and land-use change: A spatial analysis of urban transformations in Rome (Italy) using a geographically weighted principal component analysis. Sustainability (Switzerland), 13(20). https://doi.org/10.3390/su132011293

van Berkum, S. (2023). How Urban Growth in the Global South Affects Agricultural Dynamics and Food Systems Outcomes in Rural Areas: A Review and Research Agenda. Sustainability (Switzerland), 15(3). https://doi.org/10.3390/su15032591

Varol, T., Canturk, U., Cetin, M., Ozel, H. B., & Sevik, H. (2021). Impacts of climate change scenarios on European ash tree (Fraxinus excelsior L.) in Turkey. Forest Ecology and Management, 491. https://doi.org/10.1016/j.foreco.2021.119199

Xu, K., Zhuang, Y., Yan, X., Bin, L., & Shen, R. (2023). Real options analysis for urban flood mitigation under environmental change. Sustainable Cities and Society, 104546. https://doi.org/10.1016/j.scs.2023.104546

Yılmaz, M., & Terzi, F. (2021). Measuring the patterns of urban spatial growth of coastal cities in developing countries by geospatial metrics. Land Use Policy, 107. https://doi.org/10.1016/j.landusepol.2021.105487