Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

ESTIMATING THE EFFECT OF URBAN GROWTH ON CURVE NUMBER USING GIS IN THE ERBIL SUB-BASIN OF THE KURDISTAN REGION OF IRAQ

Arkan H. Ibrahim[1], Pshtiwan Othman Zaid[*1], Abdulla Abdulwahid Abo[1]
[1]Department of Water Resources Engineering, College of Engineering, Salahaddin University-Erbil, Erbil, Kurdistan Region, Ira

ABSTRACT

The urban development of areas directly affects hydrological processes by changing patterns of surface runoff. Cities growing experience increased flood risks as natural water absorption is reduced by changing permeable ground with structures non-absorbent. The research analyzes how expansion of urban between 2017 and 2023 influenced the Curve Number (CN) in the Erbil Sub-Basin, 1318 km2 using (GIS). This study stands differ from earlier research by focusing solely on how LULC changes affect CN values without considering precipitation data. The study achieves a more precise understanding of urbanization impacts on hydrological responses through its precipitation-independent methodology. This research methodology utilizes high-resolution satellite imagery along with soil classification maps and digital elevation models (DEMs) to determine transformations in land use and land cover (LULC). This study uses the Soil Conservation Service Curve Number (SCS-CN) method to analyze runoff changes caused by urban development. CN values steadily grew from 80.53 in 2017 to 81.50 in 2023 as agricultural and barren lands transformed into urbanized spaces. The growing trend points to an increased risk of urban flooding while decreasing groundwater recharge which makes it essential to develop sustainable water management practices.

Key words: CN, GIS, Hydrology, LULC, Runoff, Urban growth

Received: 13/3/2025, Accepted: 2/7/2025, Published: 31/3/2026

INTRODUCTION

The natural water cycle undergoes major changes as urban development spreads into semi-arid regions where water availability is limited. The urbanization process that replaces permeable land surfaces with impervious structures like roads and buildings leads to decreased natural water infiltration and increased runoff and flood risks (Shariati et al., n.d.). Urbanized basins demonstrate lower groundwater recharge and higher peak discharge in their drainage systems along with more common flooding events according to (Kang et al., 2024). Sustainable water management strategies become essential tools for reducing flood risks while ensuring water supply in expanding urban areas. The Soil Conservation Service Curve Number (SCS-CN) method represents a hydrological model created by the United States Department of Agriculture (USDA) which calculates runoff potential through analysis of land use patterns as well as soil type and previous soil moisture levels (Mishra & Singh, 2013). The CN value functions as a vital measure for runoff generation potential since elevated CN values show increased runoff likelihood whereas reduced CN values demonstrate enhanced infiltration ability (Hawkins et al., 2009). As areas urbanize CN values grow higher because land use alterations decrease soil permeability while creating more impervious surfaces

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

(Cupak & Wałęga, 2017). Figure 1 illustrates how urbanization alters natural water movement patterns by changing pathways from base recharge and infiltration into rapid surface runoff. The change heightens flood dangers and soil erosion while putting more strain on infrastructure which requires better storm water management methods.

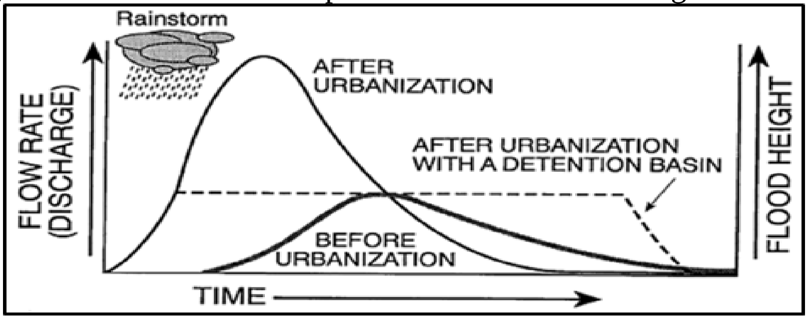

Figure 1. Conceptual representation of Urbanization Effect on Runoff

Recent years have seen quick urban development in the Erbil Sub-Basin which is situated within Iraq's semi-arid zone. Due to the transformation land use and hydrological characteristics experienced in this area now serve as an optimal case study to understand how urban growth affects surface runoff potential. Earlier research examining Erbil's water resources addressed wider hydrological issues including water accessibility and groundwater reduction (Al-Ansari, 2024). Research focusing on CN variations due to urban growth remains scarce in this region. We address the research gap through GIS-based examination of LULC modifications and their subsequent impact on CN values during 2017–2023. Through the use of statistical indicators and GIS methodologies, (Mahdi & Mutlag, 2025) analyzes the influence of climate on bioclimatic comfort in Babylon Governorate throughout the year. Research contributes to improving human well-being by shedding light on important issues for public officials, investors, and planners. Essential to the hydrological cycle, water bodies influence climate change and management of regional water resources. Human activity, climate change, and regional water laws have caused Mosul Dam Lake, one of Iraq's most vital water resources, surface area to vary over past decades (Hansen et al., 2013). (Hansen et al., 2013) discovered that around 2.58 billion m³ of yearly average liquid water content from low clouds in Iraq suggests significant possibility for rainfall augmentation, especially from four main low-level cloud types: Sc5, Cb9, Sc8, and Cu2. (Radwan et al., 2020) found that the Duhok watershed has a high relief ratio, rough topography, dense drainage with a stream frequency of 10.69 streams/km², and a very fine drainage texture of 37.66, suggesting steep slopes, heavy runoff, and a high possible erosion risk. While most physicochemical parameters stayed within WHO and Iraqi guideline values, (Adjovu et al., 2023) revealed that all water resources in the Balak River basin are mostly classified as $Ca\text{-}HCO_3$ type, with spring waters exhibiting higher electrical conductivity and some surface water samples exceeding turbidity limits. With a notable dependence on outside water resources—especially for rice—(Oudin et al., 2018) revealed that the average total water footprint for wheat and rice crops between 2000–2020 was 20.27 and 13.89 billion m³ respectively. Reducing furrow length, changing furrow shape, and using surge flow irrigation—which performed best among the evaluated techniques—(Mishra & Singh, 2013) showed in the findings that irrigation efficiency and water usage efficiency increased. (Miller & Hutchins, 2017) showed that conservation tillage coupled with crop covering greatly lowered water use and evapotranspiration; the T.C treatment used the least water over both seasons in comparison to other treatments. (Shareef et al., 2019) examined geomorphological reactions to urban sprawl in northern Iraq, so altering basin shape and drainage density. (Du et al., 2015) found that variations in impervious surface extent greatly affect surface runoff in the subwatersheds of Baghdad. Based on hydrologic changes in the

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

Upper Zab basin, (Waheed et al., 2022) discovered that land cover changes brought on by urbanization strongly correlate. Moreover, (Adjovu et al., 2023) calculated the combined effects on runoff patterns over several semi-arid Iraqi sub-basins of urban growth and climate variability. With 54% of soils classified as very low quality, 81% of vegetation of low quality, and a moderate climate quality index, indicating major land degradation risks exacerbated by high salinity and low organic matter, (Mahdi & Mutlag, 2025) revealed that the most of the Maymona project area in southern Iraq is critically sensitive to desertification. Using NDVI, (Hansen et al., 2013) found that 60.92% of Al-Zawra Park's total area had medium vegetation density; areas with very high density covered just 1.25%; and 23.30% of the area had low vegetation cover, or barren land. By means of their application in evaluating urban encroachment and agricultural land degradation in Baghdad, (Weng, 2012) revealed that "Remote sensing and GIS techniques are effective tools for monitoring temporal changes in land cover/land use, as demonstrated by their application." "GIS and remote sensing techniques are essential for assessing environmental sensitivity to desertification, as demonstrated by their application in evaluating soil, climate, and vegetation quality index in southern Iraq's Al-Samawa Badia region," (Yang et al., 2003) said. (Fashae et al., 2020) came to see the important influence of human activities on local climate change when "Urbanization growth in Baghdad, analyzed through remote sensing techniques, has significantly increased land surface temperatures and reduced vegetation cover." By means of integrated hydrological and topographical analyses, (Zhang et al., 2014) demonstrated that "Remote sensing and GIS techniques were effectively utilized to determine the optimal dam location in the AL-Abedh basin, addressing water shortage and supporting sustainable development." (Shariati et al., n.d.) revealed severe salinity and sodicity problems threatening agricultural output in central Iraq by showing that "fuzzy logic integrated with GIS effectively mapped chemical soil degradation in the Musyab project." Using remote sensing and GIS approaches, (Wulder et al., 2019) looks at spatial changes in Mosul Dam Lake from 2000 to 2020, so stressing the effects of regional water policies, human activity, and climate change on water surface fluctuations. Using GIS and remote sensing methods, (Radwan et al., 2020) does a morphometric study of the Duhok watershed to assess its hydrological features, drainage patterns, and erosion potential, so offering information for sustainable water resource management. Using GIS tools and satellite images, (Davidson, 2014) tracks the notable decline in Al Razzazah Lake and its environmental effects from 1998 to 2018, so stressing the effects on biodiversity and ecosystem health of lower water levels, higher salinity, and changing land cover. The study investigates Land Use and Land Cover (LULC) changes in the Erbil Sub-Basin from 2017 to 2023 using GIS and remote sensing data, with the aim of analyzing time-series variations in Curve Number (CN) values and their influence on surface runoff and flood risk. It also compares the obtained results with previous studies to identify methodological and outcome differences, and interprets hydrological modeling outputs to propose sustainable urban planning approaches.

MATERIALS AND METHODS

Located in the Kurdistan Region of Iraq the Erbil Sub-Basin functions as an important hydrological unit while undergoing swift urban development. The modification of the area's landscape has transformed natural water movement patterns which now heighten the potential for urban flooding as land cover continues to change. The basin spans latitude 36°0′0″ to 36°20′0″ N and longitude 43°30′0″ to 44°30′0″ E while covering an area of 1318 km² and features varied topography from 300 m to 1,200 m above sea level. The growth of urban areas in the basin interrupts natural flow patterns which lead to diminished soil absorption and greater surface water runoff.

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

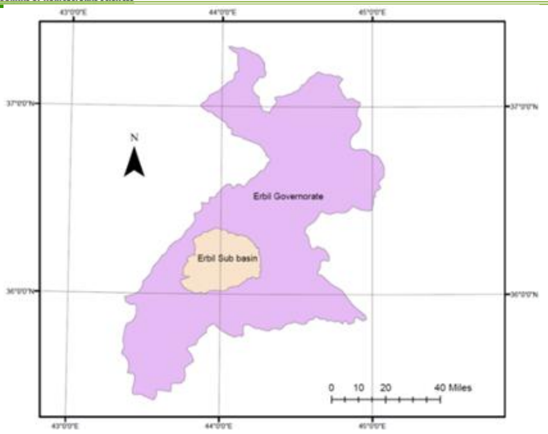

Figure 1. The Study Area of the Erbil Sub-Basin

Erbil Sub-Basin experiences a semi-arid Mediterranean climate that includes hot dry summers followed by mild wet winters. The region receives annual rainfall between 300 mm and 600 mm which mostly falls during November through April and experiences high yearly variability according to Al-Ansari (2024). The high evapotranspiration rates which exceed 1,500 mm annually lead to minimal rainfall contributing to groundwater recharge, which exposes the region to substantial runoff-related hydrological changes. Table 1 shows how the semi-arid climate leads to major water loss which restricts natural infiltration.

Table 1. Climate Characteristics of the Erbil Sub-Basin

Parameter	Value Range	Source
Mean Annual Precipitation	**300–600 mm**	**(1)**
Mean Temperature	**15–23°C**	**(12)**
Dominant Climate Type	**Semi-arid Mediterranean**	**(1)**

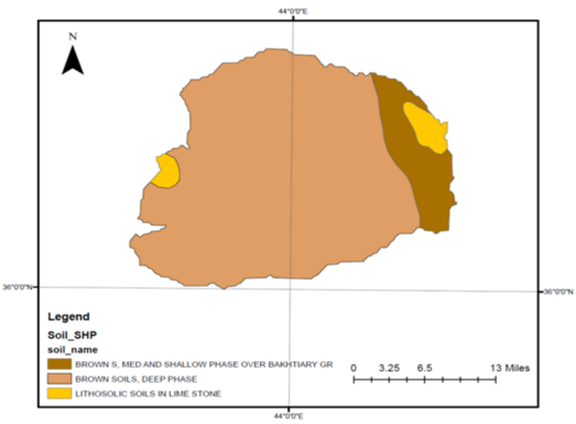

Figure 2. Soil Map of the Watershed

The observed transformations require immediate and extensive hydrological evaluations to guide sustainable development practices in urban areas. Research has demonstrated that urban development without hydrological considerations in semi-arid regions results in more frequent flash floods and greater stormwater runoff while lowering groundwater recharge rates (Jeelani et al., 2021). Erbil's increasing flood threat requires the implementation of urban design approaches that respond to climate changes through stormwater basins and permeable pavements as well as green infrastructure methods to alleviate negative hydrological effects. Future urban expansion will worsen the region's fragile water balance unless appropriate measures are implemented and will increase the difficulty of managing water resources in semi-arid climates. The Erbil Sub-Basin land use experienced major transformations because of swift population growth alongside urban development. Infrastructure development in Erbil which serves as both an administrative and economic hub has resulted in more roads and buildings that create impervious surfaces which change hydrological patterns by diminishing infiltration rates and boosting runoff volumes. Remote sensing data reveals significant expansion of built-up areas while agricultural and barren lands have reduced in extent. Table 2 shows that built-up area grew from 20.54% in 2017 to 25.78% in 2023 as agricultural and open areas decreased to accommodate this expansion. The number of impervious surfaces growing has led to increased Curve Number (CN) values which results in greater surface runoff and diminished groundwater recharge capabilities. The study evaluates variations in CN value throughout the Erbil Sub-Basin across six years to respond to these challenges. The research outcomes will generate empirical evidence for urban policymakers to develop city strategy planning that maintain sustainable hydrology while balancing expansion of urban with effective water management. Moreover: also support flood risk models as well as land use planning and hydrological assessment frameworks critical for preserving Erbil's sustainability.

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

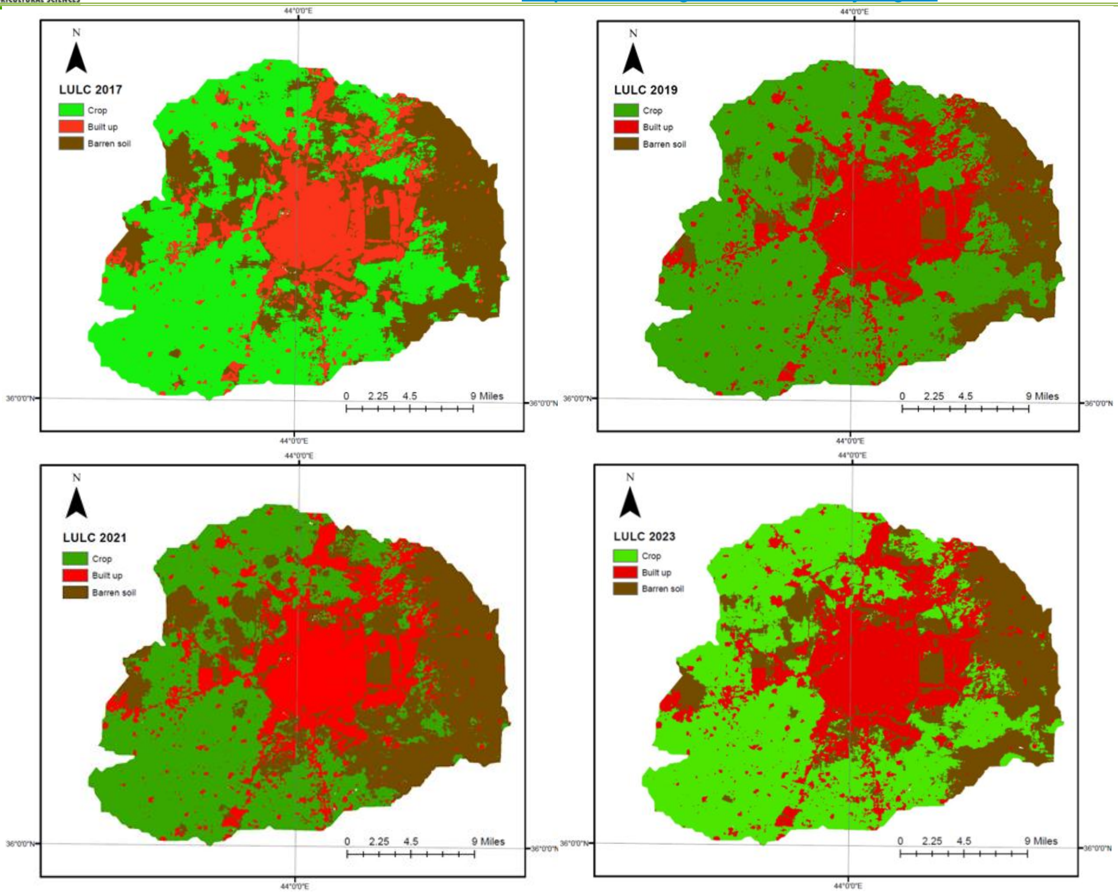

Figure 3. Land Use Land Cover (LULC) of the Sub-Basin (2017-2023)

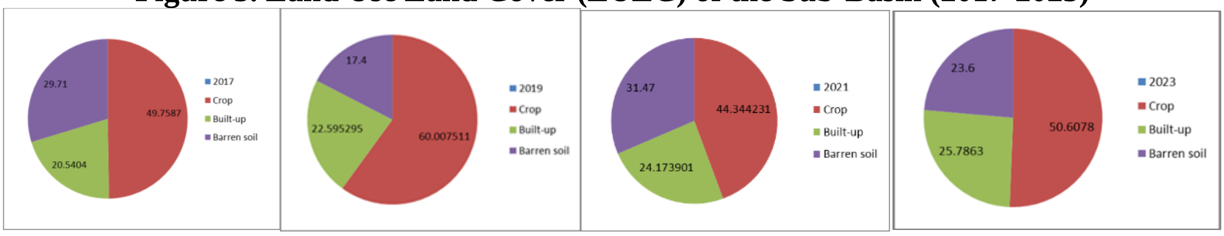

Figure 4. % change of Land Use Land Cover (LULC) of the Sub-Basin (2017-2023)

Table 2. Land Use and Land Cover Alterations in the Erbil Sub-Basin (2017-2023)

Year	Agricultural Land (%)	Built-Up (%)	Barren Land (%)
2017	49.76	20.54	29.71
2019	60.01	22.59	17.40
2021	44.34	24.17	31.47
2023	50.6	25.78	23.6

This study's initial phase required gathering high-resolution satellite imagery from Landsat 8 and Sentinel-2 to determine Land Use and Land Cover (LULC) changes. Previous researches utilized remote sensing methods to differentiate built-up zones from agricultural and barren land through supervised classification techniques in ArcGIS. Executed field surveys were at chosen sites to ensure that the mapped land use types matched actual conditions on the ground. The study (SRTM) elevation data at 30 m resolution for terrain impact analysis on runoff patterns along with soil classification data extracted from the FAO Soil Database to classify hydrologic soil groups. Table 3 summarizes the primary datasets used in this study by describing the sources and resolution details for each dataset.

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

Table 3. Data Source used in the Research

Data Type	Source	Resolution
Satellite Imagery	Landsat 8, Sentinel-2	30m 10m
Elevation Data	Shuttle Radar Topography Mission (SRTM)	30m
Soil Classification	FAO Soil Database	NA
Hydrological Data	Kurdistan Regional Government Water Resources Directorate	NA

After performing land use classification, researchers used the SCS-CN method to calculate runoff potential. The USDA Natural Resources Conservation Service (NRCS) developed this method which remains widely adopted in hydrological research for estimating surface runoff through analysis of land cover type along with soil hydrological properties and antecedent moisture conditions (Mishra & Singh, 2013). Researchers assigned the Curve Number (CN) values to each land cover category by considering the hydrologic soil groups within the study area. The calculation of the total study area weighted CN required this specific equation

$$CN_{avg} = \frac{\sum(A_i \times CN_i)}{\sum A_i}$$

where:

- CN_avg = Average Curve Number
- A_i = Area of land use type i
- CN_i = CN value for land use type i

By combining the classified land use map with the hydrologic soil map researchers were able to spatially allocate CN values throughout the basin. The study utilized GIS-based hydrological modeling methods to analyze and display runoff accumulation patterns in the basin. The analysis pinpointed locations with elevated risks for surface runoff along with areas vulnerable to flooding. The study achieves more accurate assessment effects of urbanization on runoff characteristics through the elimination of precipitation variability which isolates changes in CN due to LULC factors. The method provides valuable data-driven for planners of urban and hydrologists to develop flood risk mitigation and sustainable urban development strategies in other semi-arid regions experiencing rapid urban growth.

RESULTS AND DISCUSSION

Erbil Sub-Basin analysis demonstrates notable time-based changes in Curve Number values which match the growth of swift urban from 2017 to 2023. The observed CN rise values demonstrate decreasing infiltration ability of the soil while simultaneously increasing the likelihood of surface runoff because land use changes have transformed the landscape. Past research analyzed hydrological transformations in semi-arid urban areas support these findings of disrupted natural infiltration patterns due to impervious surfaces expanding (Shariati et al., n.d.). The temporal comparison values of CN demonstrate a steady rise for all land cover types while built-up areas experience the greatest changes. The Erbil Sub-Basin experienced an increase in average CN value from 80.53 in 2017 to 81.50 in 2023 as shown in Table 4 which indicates the shift from natural land cover to urban landscapes.

Table 4. Changes in CN Values over the Study Period

Year	Average CN Value
2017	80.53
2019	80.75
2021	81.40
2023	81.50

Development of urban alongside a decrease in agricultural and barren lands leads to higher values of CN which Figure 6 shows through the spatial distribution across the study area. Because CN values are high in urban areas it leads to low infiltration rates combined with increased runoff potential which underscores the necessity for better stormwater management solutions.

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

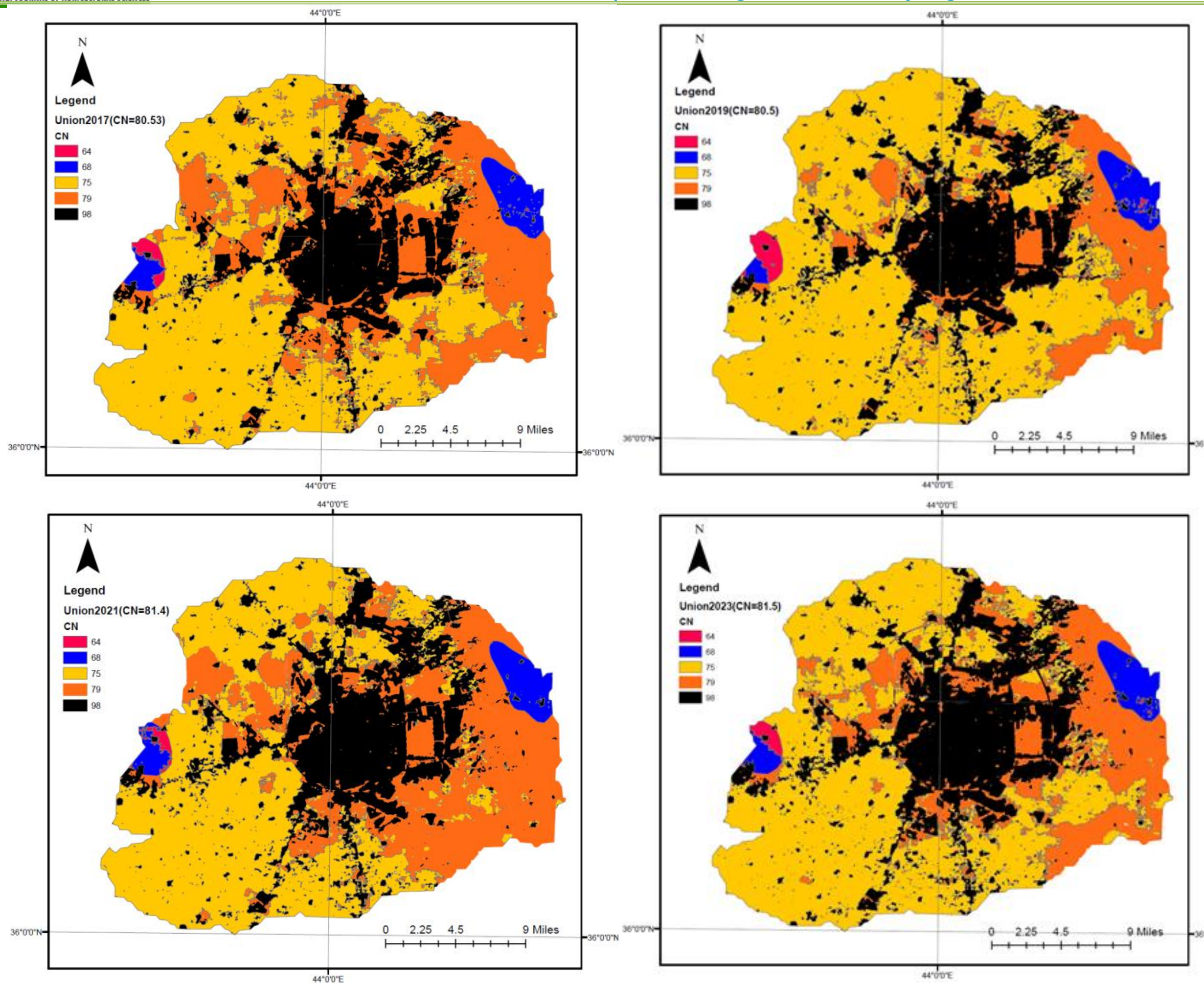

Figure 5. Spatial Distribution of CN Values (2017-2023)

The increase in impervious surfaces has led to higher runoff coefficients, reducing natural infiltration rates and exacerbating urban risks of flood. The land use study shows built-up land coverage expanded from 20.54% to 25.78% within six years which replaced green spaces and heightened flood danger. The study results are consistent with the findings presented by (Wang, n.d.) reported urban-induced hydrological changes within semi-arid settings. The conversion of vegetated land into impervious urban structures changes hydrological responses by raising peak flow levels and lowering groundwater recharge capabilities.

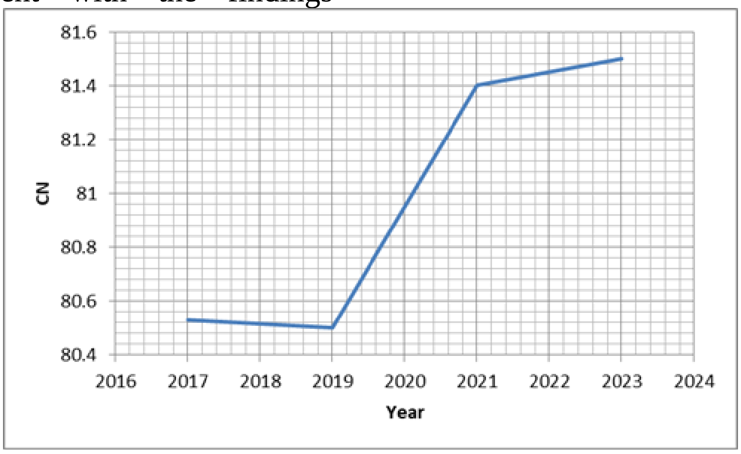

Figure 6. CN Increase (2017-2023)

This study's results call for immediate integration of hydrological considerations into urban planning processes. The ongoing increase in CN values along with runoff

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

potential brings substantial flood hazards to urban areas that are situated at lower elevations. Future city growth will likely worsen flood dangers if no protective measures are taken which will damage infrastructure and disrupt water management systems. Research from several countries shows that green infrastructure approaches such as, stormwater basins, permeable pavements and urban wetlands effectively reduce the effects of urban runoff (Shuster et al., 2005). Urban water retention systems have seen successful implementation in California and Saudi Arabian cities to manage stormwater flow while reducing peak discharge volumes. Enhancing urban resilience in Erbil and other developing cities can be achieved through the adoption of real-time hydrological monitoring alongside climate adaptation strategies. This study delivers important findings about hydrological changes caused by urban development yet it recognizes existing limitations. While GIS-based LULC classification techniques achieve high accuracy they still sometimes produce slight errors because of spectral resemblance between different land cover types. The study operates under the assumption of unchanging soil moisture conditions but fails to account for seasonal fluctuations which impact CN values. Research moving forward must examine how climate-responsive urban design strategies like rainwater harvesting and infiltration basins can reduce risks from urban runoff. Researchers need to study the long-term CN trends within projected urban expansion patterns while using advanced hydrological models to enhance urban flood management approaches. Growing cities will benefit from enhanced predictive capabilities and sustainable water management through the use of remote sensing alongside machine learning and real-time hydrological monitoring.

CONCLUSION

This study shows urban development has significantly altered hydrological processes in the Erbil Sub-Basin since 2017 and 2023 through rising Curve Number (CN) values. The substitution of natural land cover with impervious surfaces has transformed runoff dynamics by decreasing infiltration capacity while elevating risks of flooding in urban areas. The GIS analysis reveals that built-up areas grew from 20.54% to 25.78% and the average CN value rose from 80.53 to 81.50 showing a direct relationship between urban expansion and increased runoff. The results clearly demonstrate that sustainable urban water management solutions must be implemented immediately. Stormwater drainage systems will face increased pressure from ongoing urban expansion which leads to a higher chance of flash flooding and damage to infrastructure if no actions are taken. The processes of city planning by urban planners and policymakers must include hydrological considerations while emphasizing permeable pavements and green infrastructure alongside stormwater retention basins to address the negative effects of increased runoff urban. Evidence from global applications shows proactive stormwater management effectively decreases urban flooding risks which makes it crucial for Erbil's future development planning. The study provides useful insights but contains identified limitations which researchers need to tackle in subsequent investigations. Minor classification uncertainties in land cover emerge from GIS-based systems but these can be reduced by applying higher-resolution satellite images alongside machine learning classification methods. This research focused on how land use increases influence CN values but future research should investigate how urbanization and climate variability affect together hydrological responses. The application of real-time hydrological monitoring systems alongside hydrological modeling techniques can improve predictions of flood risk and strengthen adaptive water management strategies. To assess long-term urbanization effects on runoff generation future efforts must integrate remote sensing data with climate projections and advanced hydrological models. Research should next investigate how green infrastructure solutions prevent urban flooding to generate evidence that informs policy decisions in semi-arid city settings. Erbil needs to implement sustainable urban water planning methods during its expansion phase to support both resilience and environmental soundness in its urban development.

ACKNOWLEDGEMENT

The authors would like to express their gratitude to the Department of Water Resources Engineering, College of Engineering, Salahaddin University-Erbil for providing the necessary facilities and support to conduct this research.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

Originality: The submitted manuscript is entirely original work of the authors.

Figures and Tables: We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.

Participation and Accountability: All authors participated in the work substantively and are willing to share accountability for it

Status of Manuscript: The submitted manuscript has been reviewed and approved by all authors; it is not currently being submitted or considered for publication elsewhere, nor has it been published.

Ethical Standards: The authors adhere to all Ethical Approval Statements, Ethical Clearance, and Animal welfare standards as required by the Editorial Office.

Financial Obligation: The authors are aware they are required to pay for publication if the work is accepted following revision.

Funding: No specific funds were received for this research.

AUTHOR'S CONTRIBUTION STATEMENT

Arkan H. Ibrahim: Designed the study, conducted the main analysis, and prepared the manuscript.

Pshtiwan Othman Zaid: Performed the GIS analysis and Curve Number calculations.

Abdulla Abdulwahid Abo: Supervised the research and reviewed the manuscript. All authors approved the final version.

REFERENCES

Adjovu, G. E., Stephen, H., James, D., & Ahmad, S. (2023). Measurement of total dissolved solids and total suspended solids in water systems: A review of the issues, conventional, and remote sensing techniques. Remote Sensing, 15(14), 3534. https://doi.org/10.3390/rs15143534.

Al-Ansari, N. (2024). Problems of water resources scarcity in Iraq and possible solutions. Madad Al-Adab, 14 (Special Issue of Geography Conference), 1862–1885.

Al-Hussein, A. A., Hamed, Y., & Bouri, S. (2024). Assessment of sediment yield and surface runoff using the SWAT hydrological model: A case study of the Khazir River basin, northern Iraq. Euro-Mediterranean Journal for Environmental Integration, 9(2), 809–825. https://doi.org/10.1007/s41207-024-00373-9.

Berndtsson, R. (2010). Green roof performance towards runoff control. Ecological Engineering, 36(4), 351–360. https://doi.org/10.1016/j.ecoleng.2009.12.014.

Cupak, A., & Wałęga, A. (2017). Basics of hydrology for streams and rivers. In Open channel hydraulics, river hydraulic structures and fluvial geomorphology (pp. 212–240). CRC Press.

Davidson, N. C. (2014). How much wetland has the world lost? Long-term and recent trends. Marine and Freshwater Research, 65(10), 934–941. https://doi.org/10.1071/MF14173.

Du, S., et al. (2015). Impervious surface location and flood peak discharge. Journal of Hydrology, 528, 138–149. https://doi.org/10.1016/j.jhydrol.2015.06.018.

Fashae, O. A., Adagbasa, E. G., Olusola, A. O., & Obateru, R. O. (2020). Land use/land cover change and land surface temperature of Ibadan and environs, Nigeria. Environmental Monitoring and Assessment, 192, 1–18. https://doi.org/10.1007/s10661-020-8054-1.

Hansen, M. C., et al. (2013). High-resolution global maps of land cover change. Science, 342(6160), 850–853. https://doi.org/10.1126/science.1244693.

Hawkins, R. H., Ward, T. J., Woodward, D. E., & Van Mullem, J. A. (2009). Curve number hydrology: State of the practice. American Society of Civil Engineers.

Jeelani, G., Lone, S. A., Lone, A., & Deshpande, R. D. (2021). Groundwater resource protection and spring restoration in

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

Upper Jhelum Basin (UJB), western Himalayas. Groundwater for Sustainable Development, 15, 100685. https://doi.org/10.1016/j.gsd.2021.100685.

Kang, Y., Zhang, K., Zhang, Y., & Zhao, L. (2024). Hydrological response to vegetation restoration and urban sprawl in typical hydrologic years within a semiarid river basin in China. Frontiers in Environmental Science, 12, 1410918. https://doi.org/10.3389/fenvs.2024.1410918.

Khzr, B. O., Ibrahim, G. R., Hamid, A. A., & Ali, S. A. (2022). Runoff estimation using SCS-CN and GIS techniques in the Sulaymaniyah sub-basin of the Kurdistan Region of Iraq. Environment, Development and Sustainability, 24(2), 2640–2655. https://doi.org/10.1007/s10668-021-01553-4.

Mahdi, R. A., & Mutlag, A. H. (2025). Climate and its impact on bioclimatic comfort in Babil Governorate.Zanco Journal of Human Sciences, 29(Conference Issue 1), 73–87.

Miller, J. D., & Hutchins, M. (2017). The impacts of urbanisation and climate change on urban flooding and catchment hydrology. Journal of Hydrology, 552, 269–283. https://doi.org/10.1016/j.jhydrol.2017.06.054

Mishra, S. K., & Singh, V. P. (2013). Soil Conservation Service curve number (SCS-CN) methodology. Springer. https://doi.org/10.1007/978-94-007-5467-0.

Oudin, L., et al. (2018). Impact of urbanization on catchment hydrology. Journal of Hydrology, 559, 706–723. https://doi.org/10.1016/j.jhydrol.2018.02.053

Ponce, V. M., & Hawkins, R. H. (1996). Runoff curve number: Has it reached maturity? Journal of Hydrologic Engineering, 1(1), 11–19. https://doi.org/10.1061/(ASCE)1084-0699(1996)1:1(11)

Radwan, F., Alazba, A. A., & Mossad, A. (2020). Analyzing urban watershed morphometry in arid and semiarid regions using remote sensing and GIS. Arabian Journal of Geosciences, 13, 1–21. https://doi.org/10.1007/s12517-020-06161-5.

Shareef, M. A., Hassan, N. D., Hasan, S. F., & Noori, A. M. (2019). Integrating GIS and fuzzy multi-criteria method to evaluate land degradation and its impact on urban growth of Kirkuk City, Iraq. International Journal of Advanced Science and Technology, 28(15), 800–815.

Shuster, W. D., Bonta, J., Thurston, H., Warnemuende, E., & Smith, D. R. (2005). Impacts of impervious surface on watershed hydrology: A review. Urban Water Journal, 2(4), 263–275. https://doi.org/10.1080/15730620500386529.

Waheed, S. Q., Alobaidy, M. N., & Grigg, N. S. (2022). Forcing data organization for the Lesser Zab River Basin in Iraq to build a coherent hydrological model. Journal of Hydrologic Engineering, 27(12), 05022019. https://doi.org/10.1061/(ASCE)HE.1943-5584.0002175.

Wang, Z. (2015). Mapping the urban landscape: A remote sensing and deep learning approach to identifying forests and land cover features in a desert city (Doctoral dissertation, University of Idaho).

Weng, Q. (2012). Remote sensing of impervious surfaces. Remote Sensing of Environment, 117, 34–49. https://doi.org/10.1016/j.rse.2011.02.030

Wulder, M. A., et al. (2019). Current status of Landsat program, science, and applications. Remote Sensing of Environment, 225, 127–147. https://doi.org/10.1016/j.rse.2019.02.015

Yang, L., et al. (2003). Quantifying impervious surface from Landsat imagery. Remote Sensing of Environment, 86, 389–400. https://doi.org/10.1016/S0034-4257(03)00081-9

Zhang, L., et al. (2014). GIS-based hydrological modelling for runoff estimation. Environmental Modelling & Software, 51, 12–25. https://doi.org/10.1016/j.envsoft.2013.09.019

Iraqi Journal of Agricultural Sciences –2026:57(3):699-709
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/v0jb5g86

تقدير تأثير النمو الحضري على CN باستخدام GIS في حوض أربيل الفرعي في إقليم كردستان العراق

اركان همزه ابراهيم[1]، پشتيوان عثمان زيد[1]، عبدالله عبدالواحد عبو[1]

قسم هندسة الموارد المائية، كلية الهندسة، جامعة صالح الدين – أربيل، إقليم كردستان، العراق [1]

المستخلص

يؤثر التطوير الحضري للمناطق بشكل مباشر على العمليات الهيدرولوجية من خلال تغيير أنماط الجريان السطحي. تواجه المدن النامية مخاطر فيضانات متزايدة حيث يتم تقليل امتصاص المياه الطبيعي عن طريق تغيير الأرض النفاذة مع الهياكل غير الماصة. تهدف الدراسه الى تآثير التوسع الحضري بين عامي 2017 و 2023 على رقم المنحنى (CN) في حوض أربيل الفرعي بمساحة ١٣١٨ كم٢ باستخدام .تركز هذه الدراسهعلى كيفية تأثير تغييرات LULC على قيم CN دون مراعاة بيانات هطول الأمطار. تحقق الدراسة فهمًا أكثر دقة لتأثيرات التحضر على الاستجابات الهيدرولوجية من خلال منهجيتها المستقلة عن هطول الأمطار. تستخدم منهجية البحث هذه صور الأقمار الصناعية عالية الدقة إلى جانب خرائط تصنيف التربة ونماذج الارتفاع الرقمية (DEMs) لتحديد التحولات في استخدام الأراضي والغطاء الأرضي .(LULC) تستخدم هذه الدراسة طريقة رقم منحنى خدمة الحفاظ على التربة (SCS–CN) لتحليل تغييرات الجريان السطحي الناجمة عن التنمية الحضرية.اشارت النتاج الى ارتفاع قيم CN بشكل طردي من 80.53 في عام 2017 إلى 81.50 في عام 2023 مع تحول الأراضي الزراعية والقاحلة إلى مساحات حضرية. يشير هذا الاتجاه المتزايد إلى زيادة خطر الفيضانات الحضرية مع انخفاض تغذية المياه الجوفية مما يجعل من الضروري تطوير ممارسات مستدامة لإدارة المياه. يعزز هذا البحث دراسات علم المياه الحضرية من خلال إظهار كيف تساعد النمذجة القائمة على CN في تقييم التغيرات الهيدرولوجية الناجمة عن التنمية الحضرية.

الكلمات المفتاحية: **CN، GIS، علم المياه، LULC، النمو الحضري، الجريان السطحي.**