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# Urban Flooding and Climate Change Vulnerability-A Case Study of North Karachi

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Urban flooding in Karachi has been exacerbated by insufficient climate resilience measures, inadequate urban planning, and underdeveloped drainage systems. These deficiencies have led to widespread flooding in residential and commercial areas, causing significant damage to infrastructure and amenities. North Karachi, a densely populated suburb, is particularly vulnerable due to its proximity to major water bodies such as the Lyari River (LR) and Gujjar Nala (GN). The area's elevation ranges from 5 to 96 meters, creating a natural slope towards the southeast, making areas in this direction, including UCs 3, 5, 6, and 8, highly prone to flooding. This vulnerability is further influenced by the geographical layout, with the Lyari River and the surrounding Pub Ranges affecting rainfall runoff patterns. To evaluate flood vulnerability in North Karachi Town, various analyses were performed. Elevation data, sourced from Google Earth Pro, was converted from vector to raster format using ArcMap's interpolation tool. This analysis revealed a slope from the northwest to the southeast, influenced by the Pub Ranges to the west and the Lyari River to the east. UCs 4, 7, and 9 are especially at risk due to their lower elevations and proximity to the Lyari River. The Normalized Difference Vegetation Index (NDWI) was employed to assess vegetation stress. Pre-monsoon NDWI values ranged from -0.26898 to -0.04352, indicating severe water stress. Post-monsoon values ranged from -0.2021 to 0.04597, with the maximum value of 0.04597 corresponding to humid and flooded conditions. The study highlights the crucial need to maintain clear waterways to manage flood risks effectively. Authorities should focus on ensuring that drains and river channels are free of debris and encroachments to mitigate future flooding.

**Keywords:** Urban Flooding, Climate Change, Watershed, Remote Sensing, GIS.

## Introduction:

Urban flooding in Karachi has been significantly worsened by inadequate climate resilience measures, poor urban planning, and insufficient drainage systems. These issues have resulted in severe flooding in residential and commercial areas and have caused major disruptions to critical infrastructure [1]. The impacts of climate change, including storm surges, rising sea levels, and extreme weather events such as heat waves and heavy rainfall, have intensified Karachi's vulnerabilities. Notable examples include the 2010 floods and the 2015 Karachi heatwave, which caused substantial loss of life and damage [2]. By 2023, property damage from coastal flooding is expected to increase tenfold, exacerbating flooding and damaging urban services such as drainage and water supply [3].

Rapid population growth and urban expansion in Karachi have outpaced the development of its drainage infrastructure, which includes 58 major stormwater drains (nullahs) and over 600 smaller drains [4]. Informal settlements and encroachments along these nullahs obstruct the natural flow of water, leading to siltation and blockages [5]. Heavy rainfall, such as the record-breaking downpour on August 27, further strains this inadequate drainage system, resulting in severe urban flooding [6].

Flooding has caused major disruptions to roads and streets, leaving travelers stranded in their vehicles for hours and leading to severe traffic congestion [7][8]. Additionally, floodwaters mixed with sewage pose a significant risk of waterborne diseases, including diarrhea, cholera, and other gastrointestinal infections, exacerbating health risks for residents [9]. To address these issues, it is crucial to:

- Assess the impact of climate change on the frequency and intensity of extreme rainfall events in North Karachi and their effect on urban flooding [10].
- Evaluate the condition and effectiveness of the drainage infrastructure in North Karachi, including stormwater drains and smaller tributary sanitation systems, and identify areas requiring improvement or expansion [11].
- Examine encroachments and structural changes to natural drainage channels (nalas) in North Karachi and assess their impact on flood risk [12].

Encroachments and degradation of drainage channels in North Karachi have diminished their capacity to handle heavy rainfall [13]. The lack of investment in drainage infrastructure has not kept pace with rapid population growth, and urban expansion has further compromised natural drainage channels and water collection areas, worsening flooding. Power outages during heavy rains affected over 700 power lines, leaving many areas in North Karachi without electricity [14].

Standing water from flooding creates breeding grounds for disease-carrying mosquitoes, increasing the risk of vector-borne diseases such as malaria and dengue. Direct contact with polluted floodwaters heightens the risk of skin and eye infections, particularly for those wading through the water. Flood damage to infrastructure also deteriorates air quality, potentially leading to respiratory issues, especially for vulnerable populations such as children and the elderly [15].

## Research Objectives:

1. **Identification of Vulnerable Union Councils (UCs):** To identify the UCs within North Karachi Town that are most susceptible to urban flooding. This will guide targeted interventions and strategies to mitigate potential flood damage in these areas.
2. **Mapping Rainwater Flow Paths:** To delineate the likely paths of rainwater flow across the study area. Understanding these dynamics will help in implementing measures to clear and maintain drainage systems, thereby reducing the risk of urban flooding during heavy rainfall events.

## Study Area:

North Karachi, a densely populated suburb of Karachi, Pakistan, serves as both a residential and commercial hub. This area was selected for detailed analysis due to its elevation and proximity to significant water bodies like the Lyari River (LR) and Gujjar Nala (GN) (see Figure 1). The area faces significant urban challenges, including infrastructure deficiencies, inadequate sanitation, and frequent power outages, particularly during heavy rains, which often lead to severe urban flooding [14]. North Karachi also hosts numerous educational institutions and markets serving the local community. Current urban development efforts are focused on addressing these issues by improving existing conditions and upgrading infrastructure.

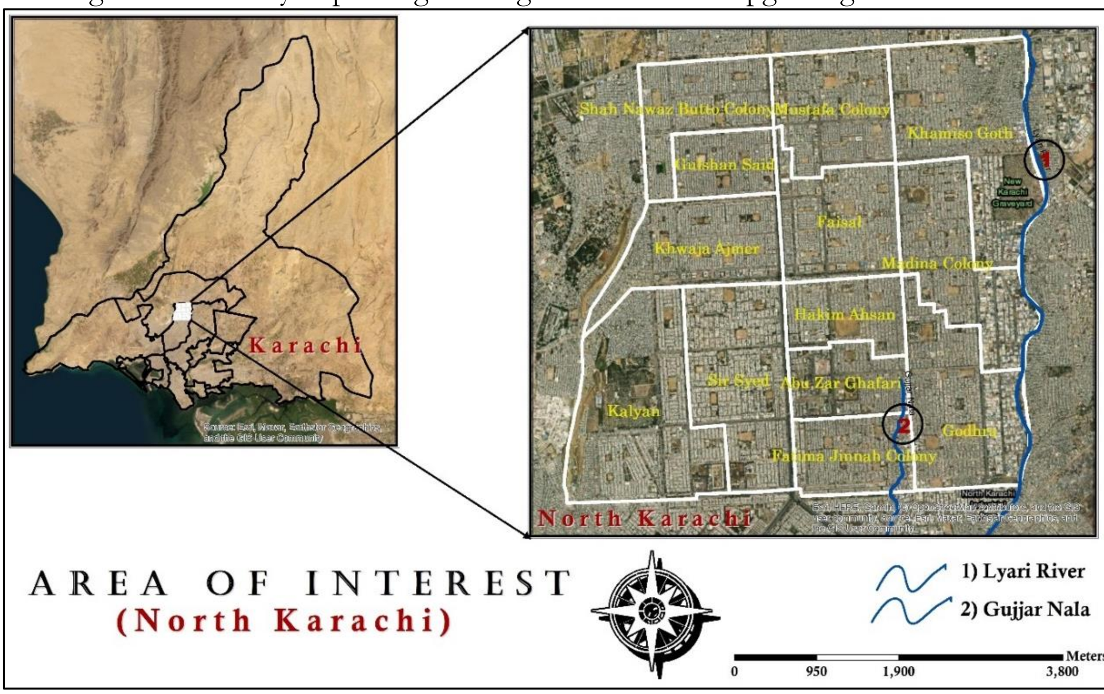



**Figure 1:** Study Area (North Karachi) along with river

**Methodology:**

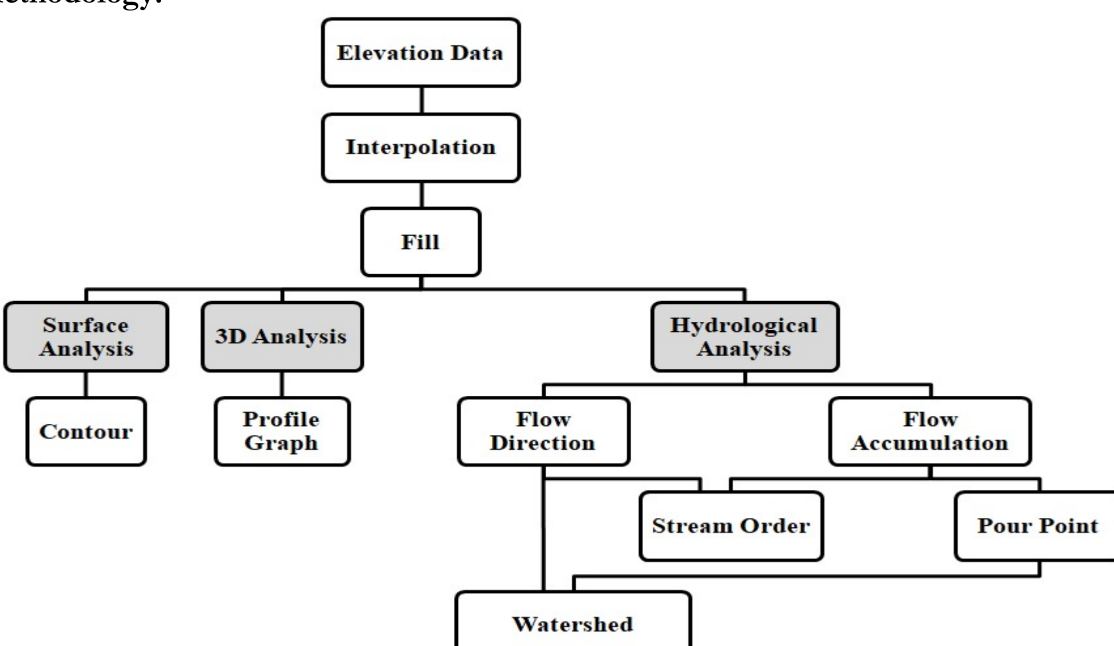



**Figure 2:** Methodological Framework

Multiple analyses were performed to identify the most flood-prone areas in North Karachi Town. Elevation data was obtained from Google Earth Pro in vector format and subsequently converted to raster format using the interpolation tool in ArcMap. The analyses conducted include:

**Surface Analysis:** This analysis involved generating contour maps to better understand and visualize the terrain of the area.

**3D Analysis:** Using updated USGS digital elevation data from November 2014, we ensured the accuracy and reliability of the data for urban planning, environmental monitoring, and hydrological analysis. As of November 2014, no significant seismic events have been recorded (United States Geological Survey, 2024). Multiple profile graphs of the Digital Elevation Model (DEM) were created to offer detailed graphical representations of the region's terrain and highlight areas of interest.

**Hydrological Analysis:** This analysis focused on determining flow accumulation, watershed boundaries, and stream order. These elements are crucial for understanding the hydrology of the study area, as shown in Figure 2.

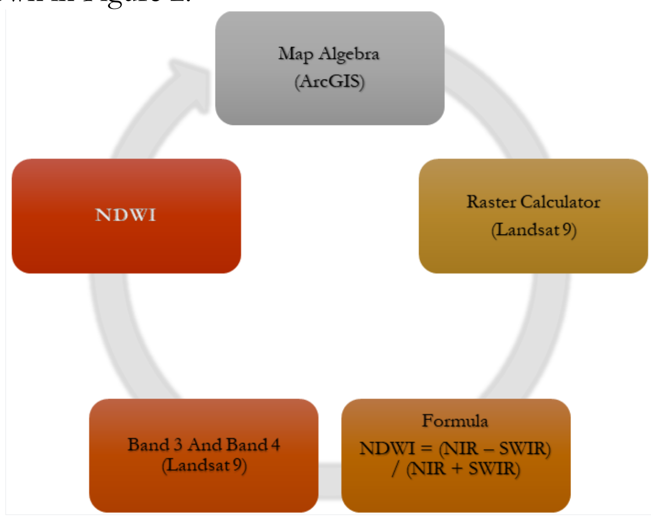



**Figure 3:** Methodological Framework for NDWI

Satellite imagery was acquired from USGS sources, including multispectral bands such as green and near-infrared (NIR). Atmospheric correction was performed using the formula detailed in Figure 3, followed by processing the imagery through map algebra to ensure accurate readings.

**Results:**

**Surface Analysis:**

**Profile Graphs and Elevation:**

Profile graphs demonstrate a consistent decline in elevation from west to east. The elevation ranges from 35.5 m to 96 m, with a general decrease from the northwest to the southeast, as illustrated in Figure 4.

Five profile graphs were generated to visually represent the terrain of the study area. These graphs depict cross-sections of the Digital Elevation Model (DEM), showing a gradual decline in elevation from west to east, consistent with the contour map and DEM in Figure 5. The elevation in the study area ranges from approximately 35.5 m to 96 m, with a total elevation difference of about 60.5 m (Figure 4). The second and third profile graphs reveal the highest elevations, exceeding 85 m, while the fourth and fifth graphs indicate lower elevations around 45 m. This pattern suggests a natural slope from the northwest to the southeast, influenced by the Pub Ranges to the west and the Lyari River to the east. The profile graphs highlight a topographical gradient that directs rainfall flow from northwest to southeast.

The analysis indicates that Union Councils (UCs) 13 and 12 are likely to experience flash flooding during rainfall events. However, these areas are expected to have less persistent standing water compared to other UCs (Figure 5). In contrast, UCs 4 and 3 are highly vulnerable to flooding, particularly prone to prolonged inundation if drainage systems are obstructed by debris. Poor maintenance of waterways could exacerbate flooding not only within these UCs but also in surrounding areas, suggesting a broader risk of urban flooding.

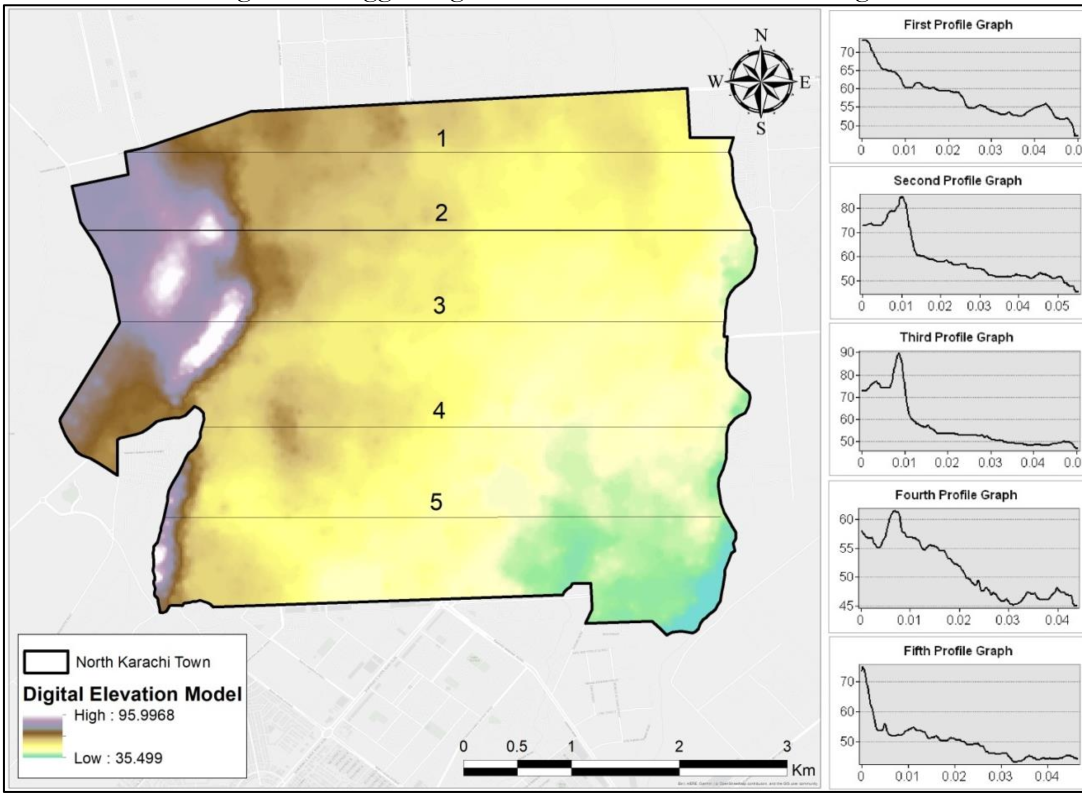



**Figure 4:** Surface analysis with profile graph

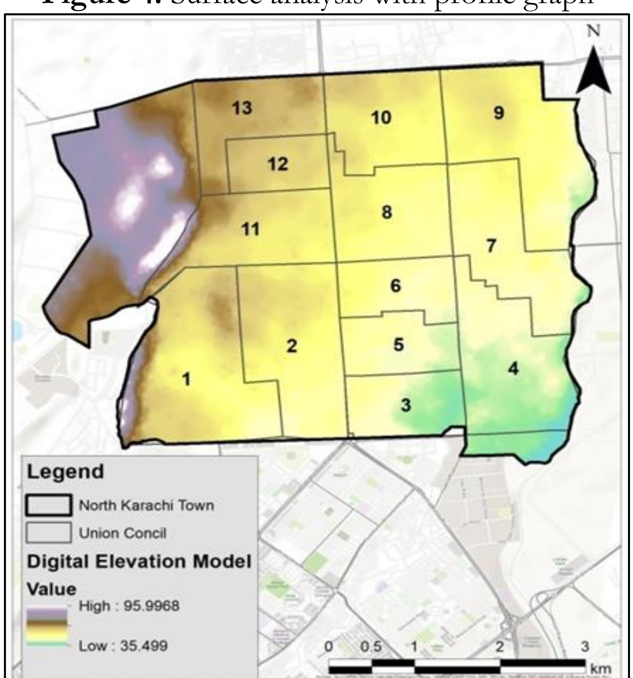
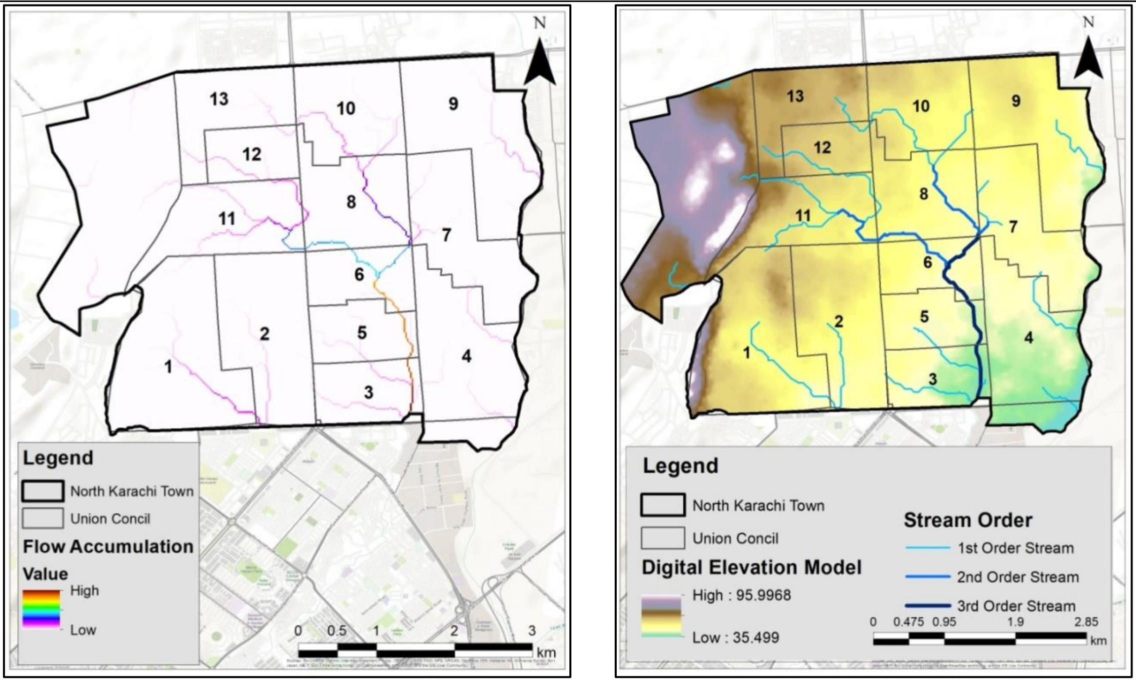



**Figure 5:** DEM with Union Council

**Hydrological Analysis:**




(a) (b)

**Figure 6 (a) (b):** Flow Accumulation

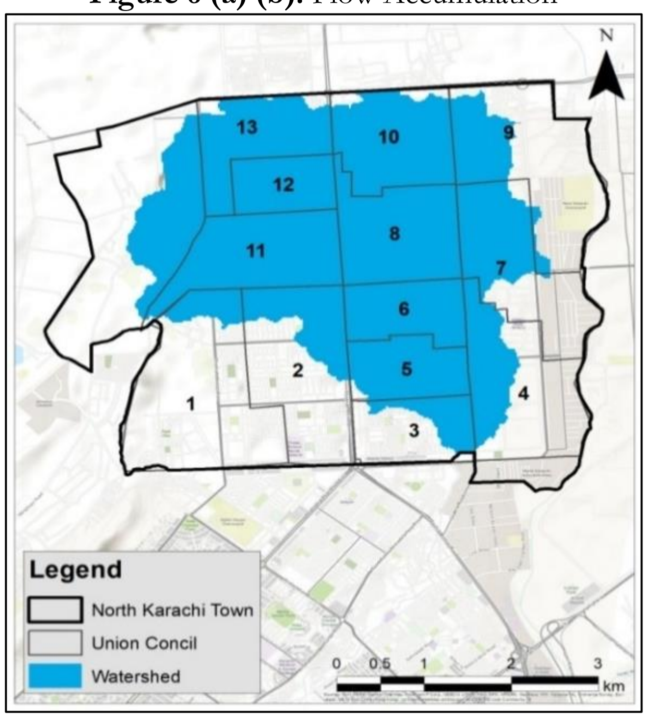



**Figure 7:** Watershed of North Karachi

The results of the hydrological analyses, as shown in Figures 6(a) and 6(b), corroborate the findings from the surface analyses. The data reveals a natural flow of water from the northwest to the southeast, highlighting the vulnerability of Union Councils (UCs) in the southeastern part of North Karachi—specifically UC 3, UC 5, UC 6, and UC 8—to flooding. To mitigate urban flooding, it is essential to maintain key drainage channels, such as Gujjar Nala in UC 3, by keeping them free of debris and preventing encroachment. Other waterways, as depicted in Figure 8, must also be regularly cleared, especially before the rainy season, to ensure effective rainwater drainage.

The analysis further indicates that UC 1 and UC 2 are less likely to be significantly impacted by the hydrological conditions affecting other UCs due to their location outside the primary flow paths. However, these UCs could still be influenced by the drainage system of the adjacent North Nazimabad Town to the south of North Karachi Town. UC 4, positioned between Gujjar Nala to the west and the Lyari River to the east, requires focused interventions to remove garbage and prevent accumulation in these watercourses (Figure 7). Failing to address these issues could exacerbate flooding during rainfall events and obstruct water flow from surrounding UCs, thereby increasing the overall flood risk.

Additionally, UCs 4, 7, and 9 are particularly susceptible to flooding due to their low elevations and proximity to the Lyari River. The Lyari River, a major watercourse in Karachi flowing into the Arabian Sea, has its upper course running through North Karachi. Inadequate maintenance and debris accumulation in downstream sections of the river can significantly impact the upper course areas, including UCs 4, 7, and 9. These findings underscore the need for comprehensive flood management strategies, including regular maintenance of drainage systems and proactive measures to keep waterways clear of obstructions. Effective flood management is crucial to mitigating the risk of urban flooding in North Karachi Town.

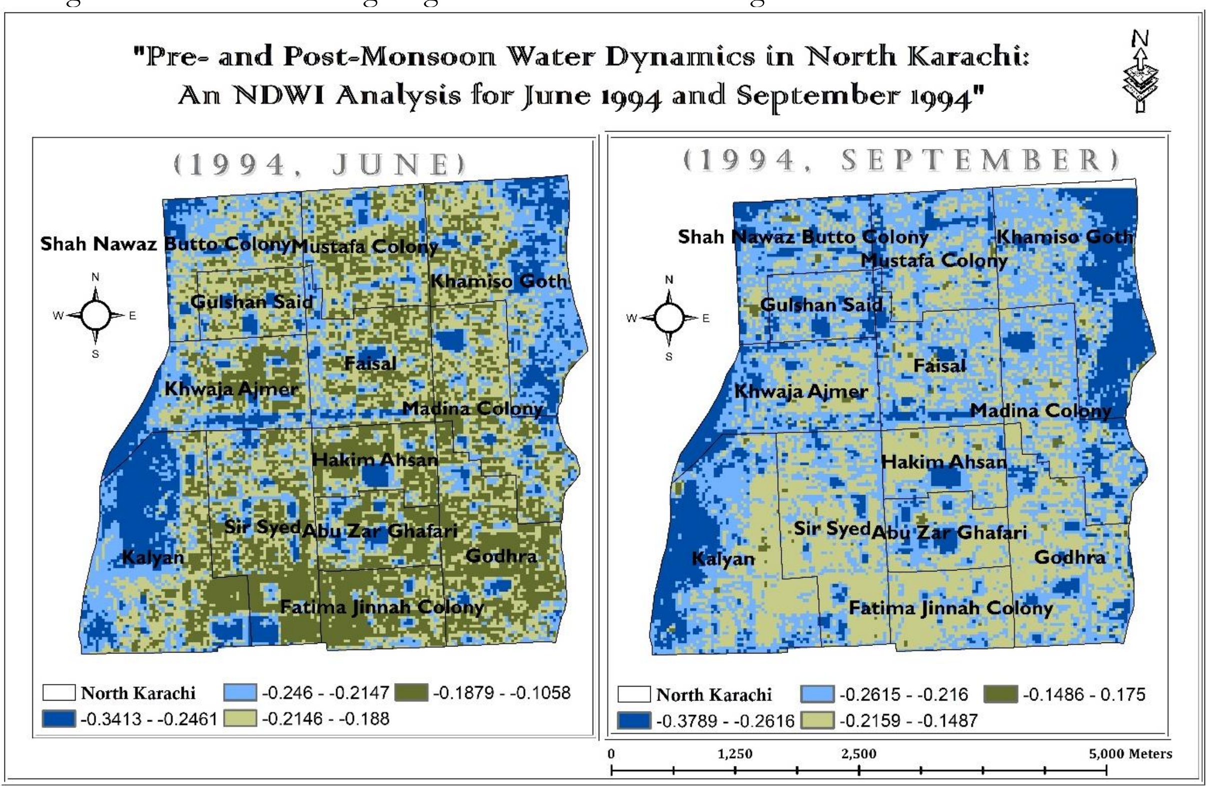



**Figure 8:** Pre- and post-monsoon 1994

**Table 1:** Pre-monsoon water dynamics 1994-6

| S | UC_NAMES | AREA | MIN | MAX | RANGE | MEAN | STD |
|---|---|---|---|---|---|---|---|
| 1 | Gulshan Said | 729000 | -0.31274 | -0.162602 | 0.150140 | -0.205889 | 0.0252206 |
| 2 | Shah Nawaz Bhutto Colony | 1242000 | -0.30645 | -0.163934 | 0.142517 | -0.217801 | 0.0246101 |
| 3 | Khwaja Ajmer | 1562400 | -0.30216 | -0.105769 | 0.196389 | -0.214254 | 0.0316278 |
| 4 | Kalyan | 2756700 | -0.31839 | -0.139013 | 0.179372 | -0.224849 | 0.0348509 |
| 5 | Sir Syed | 2048400 | -0.31488 | -0.129707 | 0.185172 | -0.197258 | 0.0301347 |
| 6 | Fatima Jinnah Colony | 1000800 | -0.27018 | -0.135338 | 0.134837 | -0.184550 | 0.0225258 |
| 7 | Abu Zar Ghafari | 893700 | -0.32331 | -0.123711 | 0.199597 | -0.199983 | 0.0306877 |
| 8 | Hakim Ahsan | 903600 | -0.30403 | -0.128440 | 0.175589 | -0.195293 | 0.0295125 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | Mustafa Colony | 1480500 | -0.28873 | -0.136564 | 0.152168 | -0.202552 | 0.0229099 |
| 10 | Faisal | 1485000 | -0.28873 | -0.149171 | 0.139561 | -0.205196 | 0.0254812 |
| 11 | Khamiso Goth | 2505600 | -0.34127 | -0.108696 | 0.232574 | -0.221545 | 0.0285541 |
| 12 | Godhra | 1979100 | -0.28571 | -0.117647 | 0.168067 | -0.191847 | 0.0240175 |
| 13 | Madina Colony | 1747800 | -0.30798 | -0.108434 | 0.199551 | -0.203558 | 0.0266369 |

**Table 2:** Post-Monsoon Water Dynamics 1994_9

| OBJECT ID | UC_NAMES | AREA | MIN | MAX | RANGE | MEAN | STD |
|---|---|---|---|---|---|---|---|
| 1 | Gulshan Said | 729000 | -0.3555556 | -0.15923567 | 0.1963199 | -0.23363510 | 0.02906004 |
| 2 | Shah Nawaz Bhutto Colony | 1242000 | -0.3529412 | 0.17500000 | 0.5279412 | -0.23604339 | 0.04146851 |
| 3 | Khwaja Ajmer | 1562400 | -0.3593073 | 0.09803922 | 0.4573466 | -0.23275360 | 0.04036401 |
| 4 | Kalyan | 2756700 | -0.3370787 | -0.03278688 | 0.3042918 | -0.23449078 | 0.04166806 |
| 5 | Sir Syed | 2048400 | -0.3270142 | -0.09219858 | 0.2348156 | -0.20912209 | 0.02924185 |
| 6 | Fatima Jinnah Colony | 1000800 | -0.3043478 | -0.10958904 | 0.1947588 | -0.20331802 | 0.02460081 |
| 7 | Abu Zar Ghafari | 893700 | -0.3789474 | -0.11688311 | 0.2620643 | -0.22149210 | 0.03424845 |
| 8 | Hakim Ahsan | 903600 | -0.3248945 | 0.01052632 | 0.3354208 | -0.21497716 | 0.03727231 |
| 9 | Mustafa Colony | 1480500 | -0.3369565 | 0.01204819 | 0.3490047 | -0.22730869 | 0.03017060 |
| 10 | Faisal | 1485000 | -0.3191489 | 0.01851852 | 0.3376674 | -0.22571286 | 0.03281613 |
| 11 | Khamiso Goth | 2423700 | -0.3789474 | -0.02400000 | 0.3549474 | -0.25562609 | 0.04414857 |
| 12 | Godhra | 1979100 | -0.3381295 | 0.02521008 | 0.3633396 | -0.21766288 | 0.03158590 |
| 13 | Madina Colony | 1747800 | -0.3559322 | 0.09734514 | 0.4532773 | -0.22671422 | 0.03623772 |

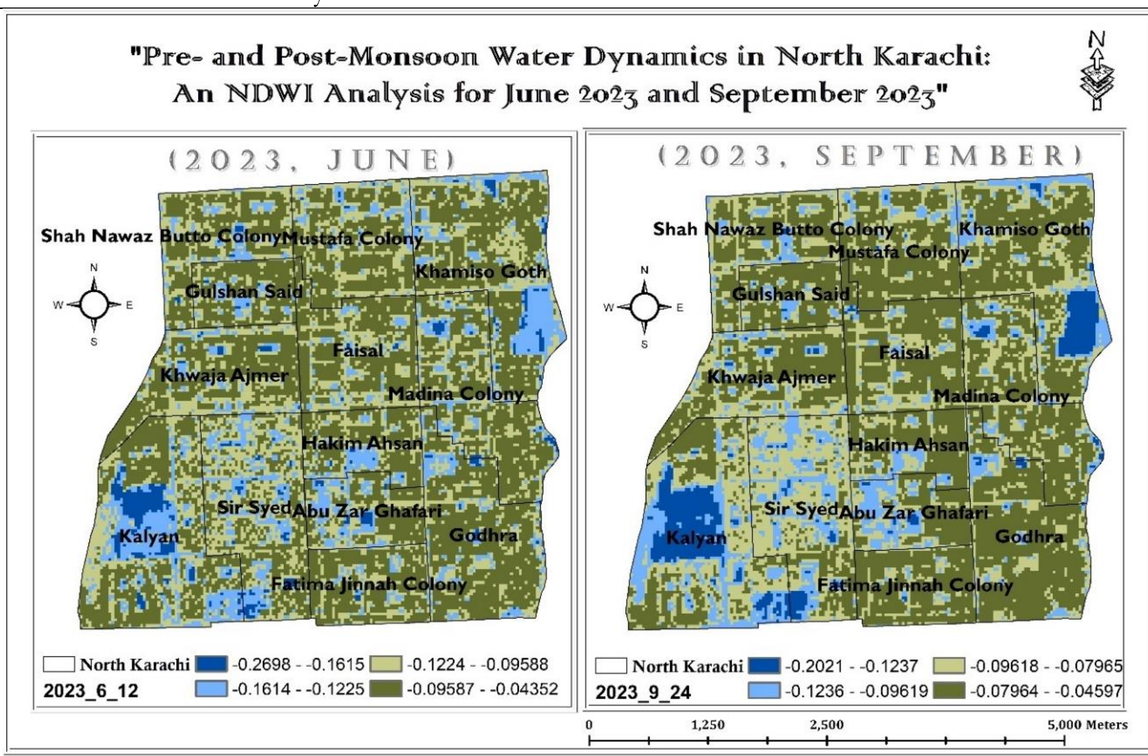



**Figure 9:** Pre- and post-monsoon 2023

The water dynamics of the study area were evaluated for both pre-monsoon and post-monsoon periods (Figure 9). The Normalized Difference Water Index (NDWI) was utilized to assess vegetation stress across the region. During the pre-monsoon period, NDWI values ranged from -0.26898 to -0.04352, indicating extreme water stress in the area. In contrast, post-monsoon NDWI values ranged from -0.2021 to 0.04597, with the highest value of 0.04597 reflecting a more humid surface and regions affected by flooding [16].

The analysis reveals an improvement in water conditions, with the NDWI value increasing by approximately 0.1 from the pre-monsoon to the post-monsoon period. This increase, resulting in a final NDWI of 0.05648, suggests enhanced water availability and reduced vegetation stress following the rains.

**Table 3:** Pre-Monsoon Water Dynamics 2023_6

| OBJECT ID | UC_NAMES | AREA | MIN | MAX | RANGE | MEAN | STD |
|---|---|---|---|---|---|---|---|
| 1 | Gulshan Said | 729000 | -0.203294 | -0.0654753 | 0.1378182 | -0.0974122 | 0.01833540 |
| 2 | Shah Nawaz Bhutto Colony | 1242000 | -0.220241 | -0.0702587 | 0.1499822 | -0.1004462 | 0.01938385 |
| 3 | Khwaja Ajmer | 1562400 | -0.232999 | -0.0649645 | 0.1680345 | -0.0985902 | 0.02009971 |
| 4 | Kalyan | 2756700 | -0.253751 | -0.0438844 | 0.2098662 | -0.1139303 | 0.03346551 |
| 5 | Sir Syed | 2048400 | -0.269791 | -0.0500170 | 0.2197741 | -0.1081184 | 0.02472517 |
| 6 | Fatima Jinnah Colony | 1000800 | -0.196308 | -0.0504688 | 0.1458390 | -0.0931427 | 0.01788917 |
| 7 | Abu Zar Ghafari | 893700 | -0.263718 | -0.0639323 | 0.1997858 | -0.1058697 | 0.02741509 |
| 8 | Hakim Ahsan | 903600 | -0.184270 | -0.0522269 | 0.1320428 | -0.0990967 | 0.02037612 |
| 9 | Mustafa Colony | 1480500 | -0.193652 | -0.0549664 | 0.1386860 | -0.0979024 | 0.01854198 |
| 10 | Faisal | 1485000 | -0.201785 | -0.0543013 | 0.1474835 | -0.0955962 | 0.01746115 |
| 11 | Khamiso Goth | 2505600 | -0.265741 | -0.0483060 | 0.2174346 | -0.1046596 | 0.02582126 |
| 12 | Godhra | 1979100 | -0.218316 | -0.0492196 | 0.1690966 | -0.0949144 | 0.02157339 |
| 13 | Madina Colony | 1747800 | -0.214981 | -0.0435249 | 0.1714558 | -0.0980111 | 0.02184412 |

**Table 4:** Post-monsoon water dynamics 2023_9

| OBJECT ID | UC_NAMES | AREA | MIN | MAX | RANGE | MEAN | STD |
|---|---|---|---|---|---|---|---|
| 1 | Gulshan Said | 729000 | -0.132685 | -0.06386 | 0.068822 | -0.07963 | 0.010750 |
| 2 | Shah Nawaz Bhutto Colony | 1242000 | -0.138166 | -0.06169 | 0.076478 | -0.08287 | 0.010842 |
| 3 | Khwaja Ajmer | 1562400 | -0.155190 | -0.06451 | 0.090677 | -0.08229 | 0.011566 |
| 4 | Kalyan | 2756700 | -0.202146 | -0.06574 | 0.136410 | -0.09996 | 0.025530 |
| 5 | Sir Syed | 2048400 | -0.160850 | -0.06423 | 0.096624 | -0.09135 | 0.014347 |
| 6 | Fatima Jinnah Colony | 1000800 | -0.137193 | -0.05441 | 0.082787 | -0.07497 | 0.009687 |
| 7 | Abu Zar Ghafari | 893700 | -0.152507 | -0.05899 | 0.093519 | -0.08653 | 0.017486 |
| 8 | Hakim Ahsan | 903600 | -0.133415 | -0.06198 | 0.071434 | -0.07955 | 0.012243 |
| 9 | Mustafa Colony | 1480500 | -0.139068 | -0.05424 | 0.084824 | -0.07929 | 0.011169 |
| 10 | Faisal | 1485000 | -0.167095 | -0.05207 | 0.115023 | -0.07819 | 0.011282 |
| 11 | Khamiso Goth | 2505600 | -0.172194 | -0.05797 | 0.114225 | -0.08823 | 0.021647 |
| 12 | Godhra | 1979100 | -0.151621 | -0.04802 | 0.103605 | -0.07523 | 0.013577 |
| 13 | Madina Colony | 1747800 | -0.169318 | -0.04597 | 0.123352 | -0.08000 | 0.013832 |

The NDWI analysis reveals that pre-monsoon conditions exhibit high water stress, while post-monsoon values indicate a modest improvement in water availability. This suggests that water stress might intensify over time before the monsoon, but conditions are expected to slightly improve following the rains (Tables 1-3).

**Future Recommendations:**

This research highlights the vulnerability of certain Union Councils (UCs) to urban flooding and underscores the necessity for precautionary measures and strategic interventions. Key recommendations include:

- **Develop Comprehensive Flood Management Plans:** Authorities should implement new strategies to address flooding, including proactive measures to manage water flow and maintain drainage systems.

- **Ensure Clear Waterways:** Regular maintenance and clearing of catchment areas, free from encroachments and debris, are crucial to preventing flood anomalies.
- **Enhance Drainage System Reliability:** Effective maintenance of drainage systems is fundamental to controlling flood risks.

The findings indicate a pressing need for targeted flood management measures. Special attention should be given to UCs 3, 4, 5, 6, and 8, which are particularly prone to flooding. Early interventions, such as clearing water channels before the monsoon and constructing flood control structures, can mitigate flood impacts. Improving community protection, managing settlements properly, and enhancing resilience in North Karachi Town are essential for reducing urban flood risks. Implementing these recommendations will help manage flood risks more effectively and safeguard vulnerable communities.

**Limitations:**

This study acknowledges several limitations that may impact the comprehensiveness of the findings regarding urban flooding:

- **Exclusion of Sewage Systems:** The research focuses solely on natural drainage systems and does not account for sewage systems, which significantly influence flood dynamics. Future studies should include sewage system analysis for a more complete understanding of flood risks.
- **Scope of Drainage Analysis:** The study was limited to natural drainage systems within the specified area. However, drainage conditions in adjacent or upstream areas can affect flooding dynamics. Future research should broaden the scope to include interconnected drainage systems across neighboring regions.
- **Integrated Approach to Flood Risk:** The study primarily examines natural drainage without integrating factors such as land use, infrastructure, and climate variability. A more integrated approach combining these elements with drainage assessments would provide a comprehensive evaluation of flood risks and improve management strategies.

Addressing these limitations in future research will enhance the accuracy and applicability of flood risk assessments, leading to more effective flood management and mitigation strategies.

**Reference:**


[1] Tayyab, M., Zhang, J., Hussain, M., Ullah, S., Liu, X., Khan, S. N., Baig, M. A., & Hassan, W. (2020). GIS-Based Urban Flood Resilience Assessment Using Urban Flood Resilience Model: A Case Study of Peshawar City, Khyber Pakhtunkhwa, Pakistan. Remote Sensing, 13(10), 1864. https://doi.org/10.3390/rs13101864 https://www.mdpi.com/2072-4292/13/10/1864

[2] Asian Development Bank (ADB). (2017). Climate Change Profile of Pakistan. https://www.adb.org/publications/climate-change-profile-pakistan

[3] Bari, M. (2022, February 21). Displacement and generational loss in flooded Karachi. afpak.boell.org

[4] Urban Resource Centre. (2022, August 17). Why Karachi floods? urckarachi.org

[5] Hasan, A. (2020, October 27). Urban flooding: The case of Karachi. *International Institute for Environment and Development*. https://www.iied.org/urban-flooding-case-karachi

[6] Express News (2023, February 4). 700 power feeders' trip as heavy rains cause urban flooding in Karachi. The Express Tribune. tribune.com.pk https://tribune.com.pk/story/2455371/700-power-feeders-trip-as-heavy-rains-cause-urban-flooding-in-karachi

[7] The News. (2023, May 4). Heavy rain causes urban flooding and disrupts life in Karachi. https://www.thenews.com.pk/latest/1154308-heavy-showers-bring-down-temperature-in-karachi

[8] Shams, S. (2020, August 28). Who is responsible for Karachi's flood woes? Society Asia. Retrieved from https://societyasia.net/

[9] Taseen, S., Jawed, S., & Ameen, A. M. (2022). Cholera outbreak amidst urban flooding in Karachi: An emergency condition. Annals of Medicine and Surgery, 81. https://doi.org/10.1016/j.amsu.2022.104365

[10] Hasan, A. (2020, October 27). Urban Flooding in Karachi, Pakistan. International Institute for Environment and Development [IIED]. Retrieved from https://www.iied.org/urban-flooding-case-karachi

[11] Scribd. (2023). Factors responsible for urban flooding in Karachi: A case study of DHA. *Scribd*. https://www.scribd.com/document/657670919/Factors-Responsible-for-Urban-Flooding-in-Karachi-A-Case-Study-Of-Dha

[12] IMARAT Institute of Policy Studies. (2023, July 14). Urban flooding: The case of Karachi. *IMARAT Institute of Policy Studies*. https://iips.com.pk/urban-flooding-the-case-of-karachi/

[13] Raza, S. (2020, September 7). Why Karachi floods. *Dawn*. https://www.dawn.com/news/1578061

[14] The Express Tribune. (2023, July 12). 700 power feeders trip as heavy rains cause urban flooding in Karachi. *The Express Tribune*. https://tribune.com.pk/story/2455371/700-power-feeders-trip-as-heavy-rains-cause-urban-flooding-in-karachi

[15] Hafeez, S. (2022, August 8). Pakistan's deadly floods are an annual occurrence. The Diplomat. thediplomat.com

[16] Sheereen. (2023). Drought Risk Assessment in Districts Khairpur Mir's: Temporal Analysis 2001-2021. Pp 84