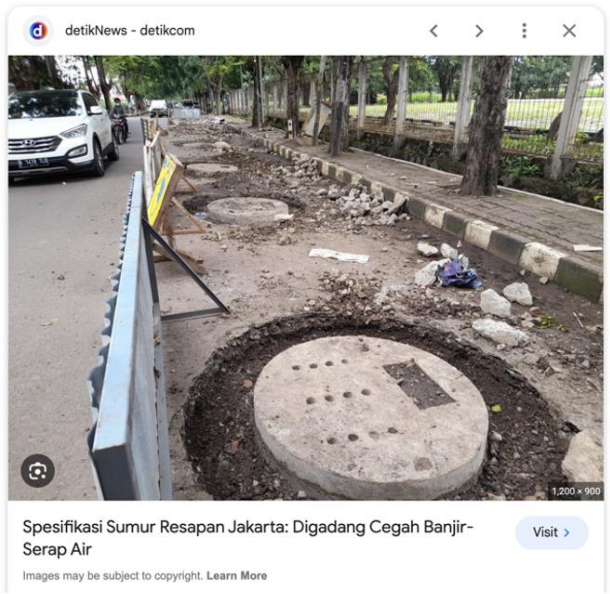
# UrbanRVM

Reducing Local Flood Risk in Jakarta Through Spatial Runoff Management Using Run-Off Volumetric Model

Hack4Resilient Jakarta: Reimagining Urban Futures | 2025

# | Problem Formulation

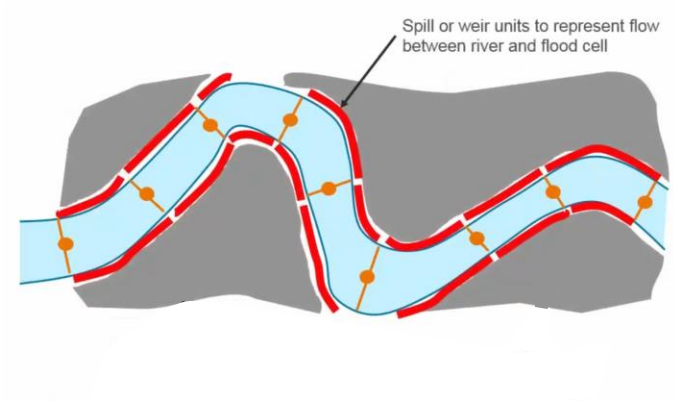
Jakarta frequently faces localized flooding caused by a combination of flat lowland topography, intense rainfall, under-capacity drainage systems, and extensive impervious surfaces. These conditions are exacerbated by rapid urbanization, which accelerates surface runoff and overwhelms existing infrastructure. One critical yet often overlooked issue is the absence of spatially mapped natural depressions or “runoff-stop zones” where water tends to accumulate. This leads to recurring inundation that disrupts urban mobility, damages property, and poses public health risks. Current spatial planning practices do not integrate runoff behavior into zoning or urban design strategies. Thus, the challenge is to model and mitigate urban runoff effectively by identifying, analyzing, and managing these key accumulation points using data-driven spatial approaches.

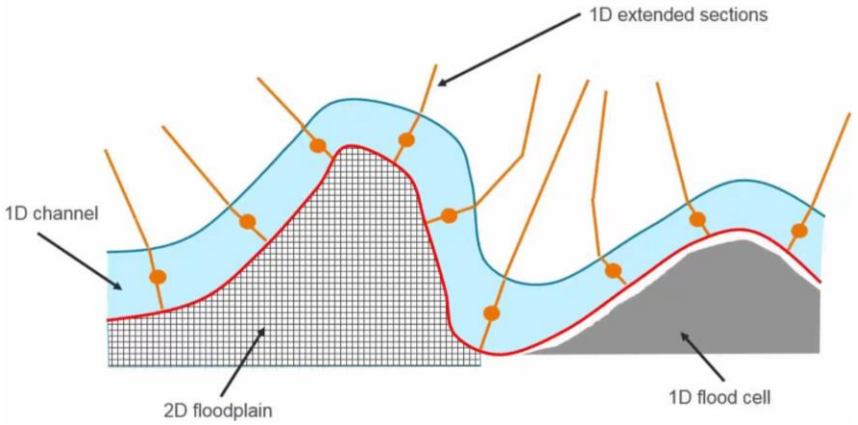
# | UrbanRVM Introduction

**UrbanRVM (Urban Runoff Volumetric Model)** is a tool developed to help **urban planners** define and allocate **infiltration areas** in cities, particularly in Indonesia. UrbanRVM can process **topographic data** such as **DEM (Digital Elevation Model)** along with other data including **land use, rainfall,** and **runoff coefficients** for each land-use type. The model produces several outputs such as **surface runoff direction, runoff stop points, surface water volume, infiltrated water volume,** and **ponded water volume.**

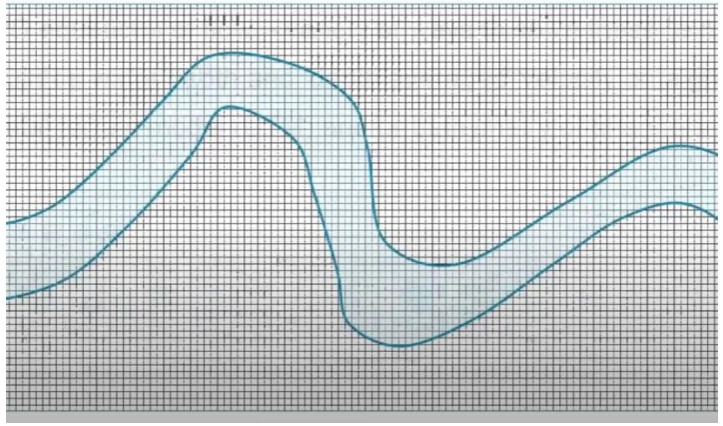
## 1D Model




## Linked 1D/2D Model

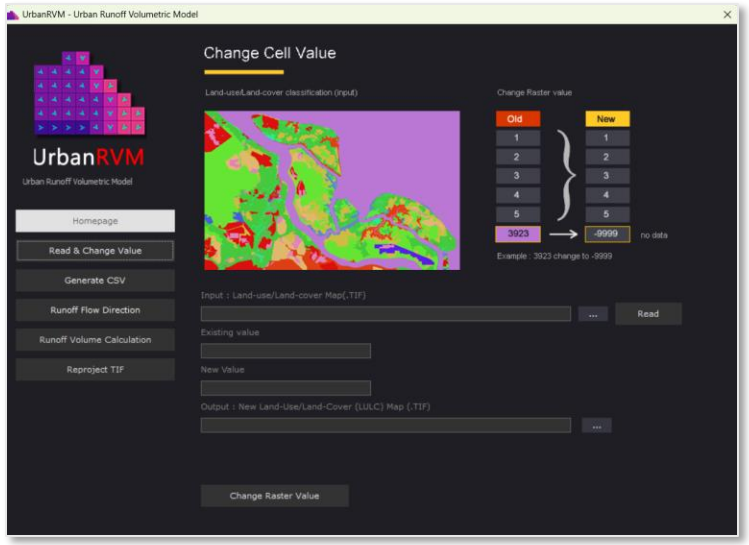


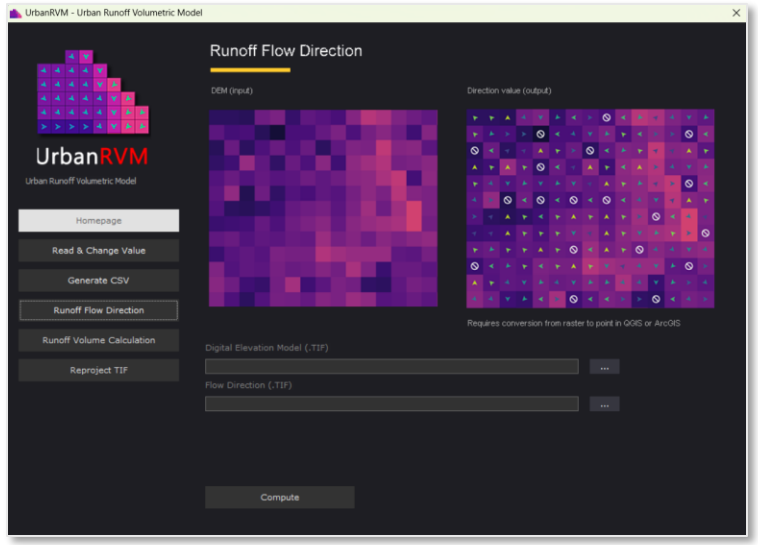

## 2D MODEL

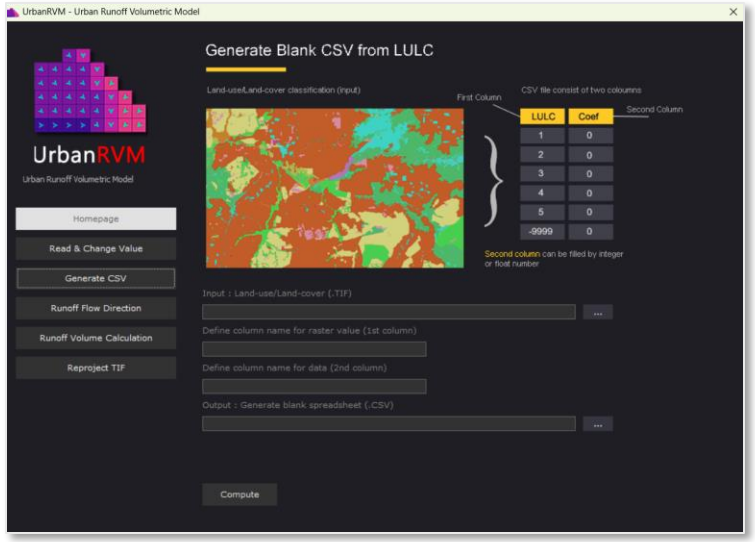


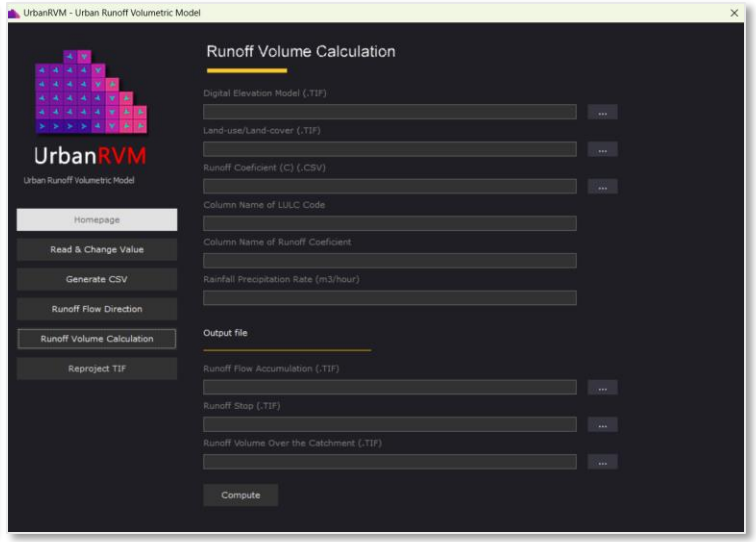
**UrbanRVM** sits in the purely 2D model. By the assumption that not all floods are generated by river overflow; intense rainfall occurs across the entire urban surface. In many cases, insufficient infiltration capacity and reduced soil absorption become the dominant mechanisms that trigger localized flooding or *water ponding* in specific areas, and that 1st contingency of flood mitigation starts from the land management itself

# | UrbanRVM Overview

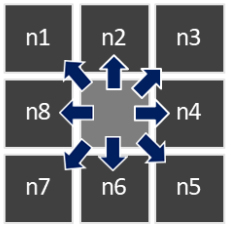


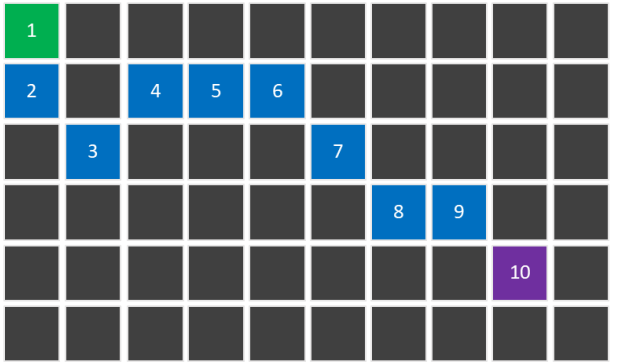

Moore Neighborhood Filter (minimum function)




Digital Elevation Model

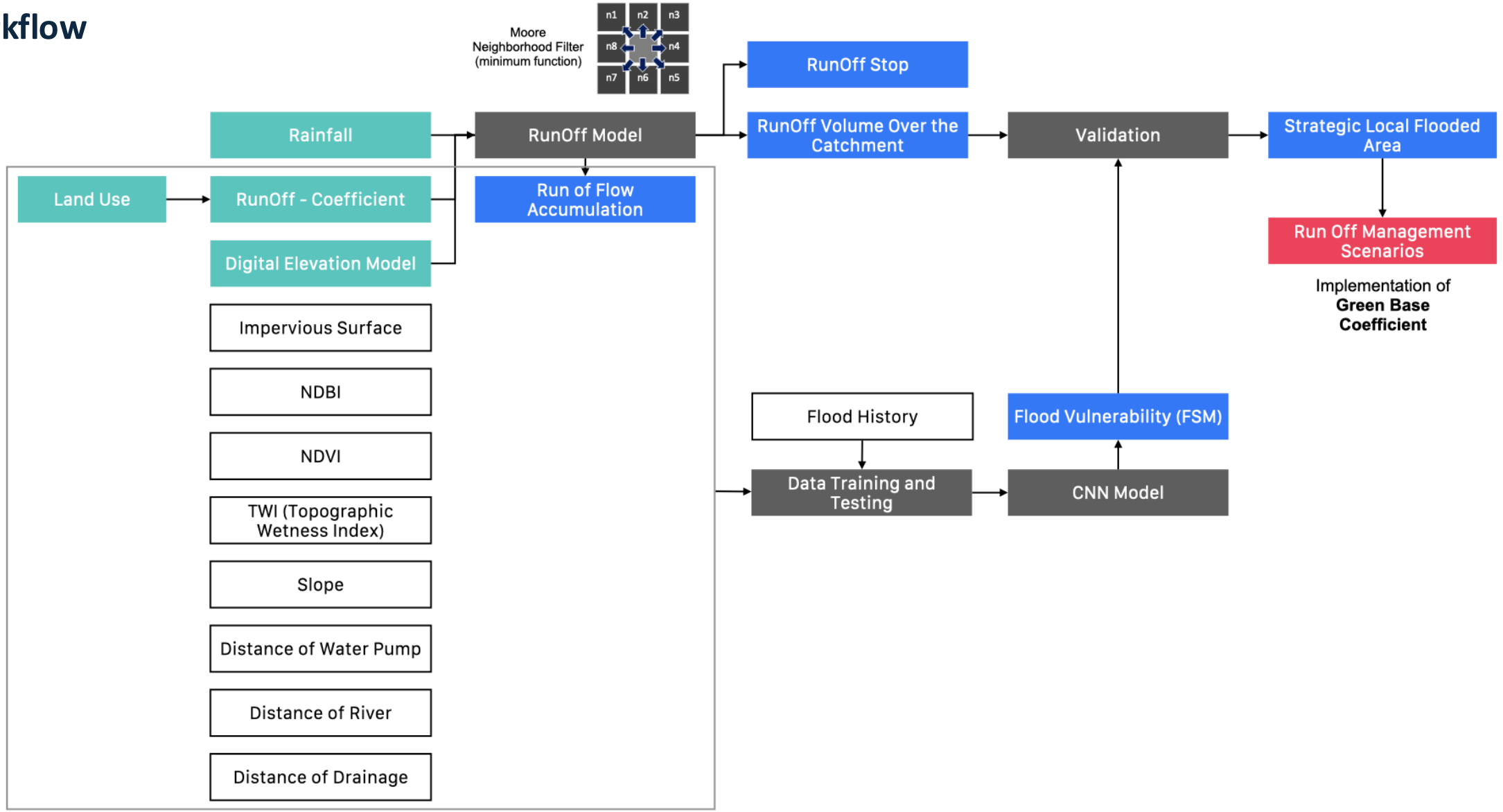
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 92 | 99 | 98 | 98 | 98 | 96 | 95 | 90 | 92 | 90 |
| 90 | 97 | 84 | 80 | 78 | 80 | 94 | 88 | 80 | 81 |
| 89 | 85 | 88 | 82 | 88 | 76 | 88 | 80 | 78 | 85 |
| 92 | 83 | 98 | 80 | 90 | 88 | 75 | 72 | 75 | 98 |
| 89 | 85 | 88 | 87 | 92 | 86 | 73 | 77 | 70 | 74 |
| 92 | 83 | 98 | 86 | 93 | 85 | 70 | 75 | 76 | 73 |

Runoff flows based on neighborhood filter




Runoff Flow start from the cell i  Runoff Flow stop from cell i

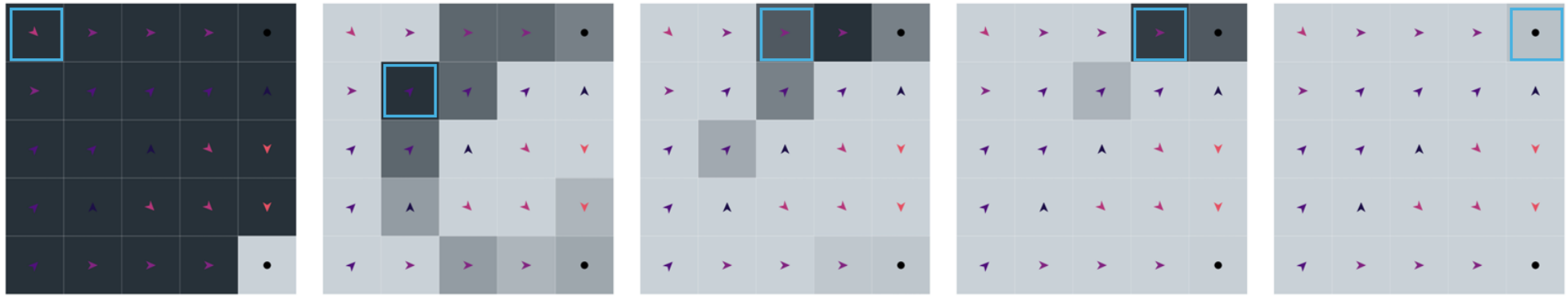
# | Workflow


Moore
Neighborhood Filter
(minimum function)
n1
n2
n3
n8
n4
n7
n6
n5
Rainfall
RunOff Model
RunOff Stop
RunOff Volume Over the Catchment
Validation
Strategic Local Flooded Area
Land Use
RunOff - Coefficient
Run of Flow Accumulation
Digital Elevation Model
Run Off Management Scenarios
Implementation of
Green Base
Coefficient
Impervious Surface
NDBI
NDVI
TWI (Topographic Wetness Index)
Slope
Distance of Water Pump
Distance of River
Distance of Drainage
Flood History
Flood Vulnerability (FSM)
Data Training and Testing
CNN Model

# | Runoff Accumulation Calculation

## Runoff Flow From Each Cell (Using Observed Cell as Sample)

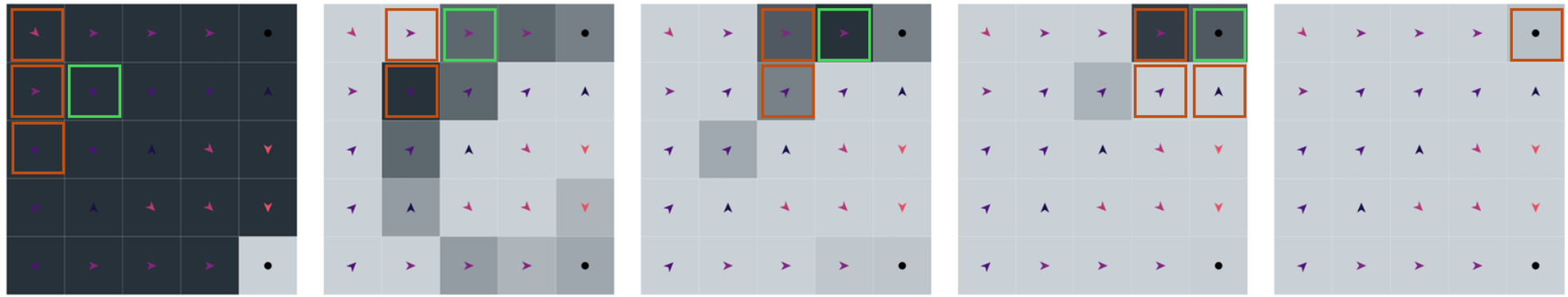
Runoff flow in observed cell



Rainfall Precipitation | 1st iteration | 2nd iteration | 3rd iteration | 4th iteration & so on

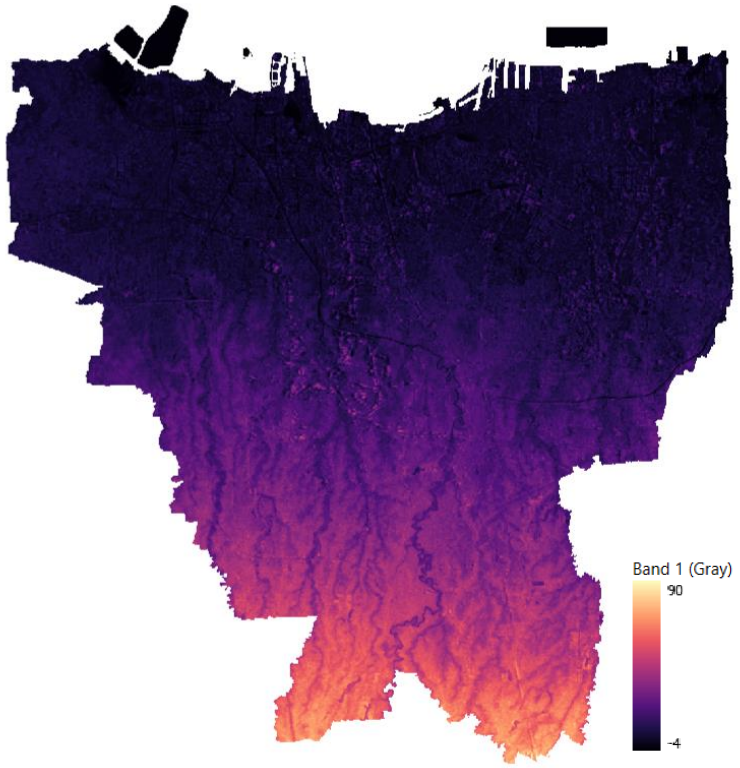
## Runoff Flow Accumulation From Surrounding Cells

From To

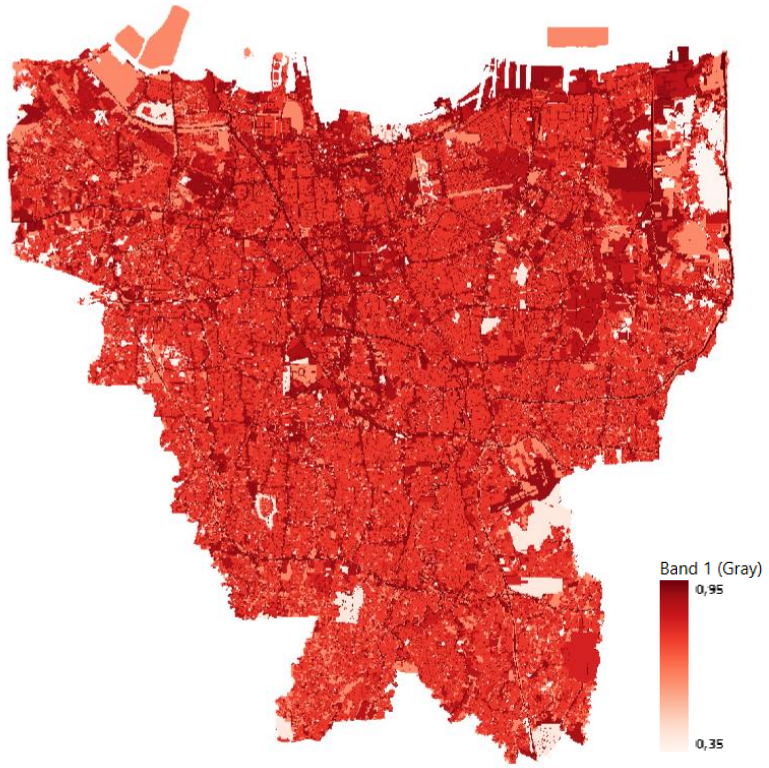


Rainfall Precipitation | 1st iteration | 2nd iteration | 3rd iteration | 4th iteration & so on

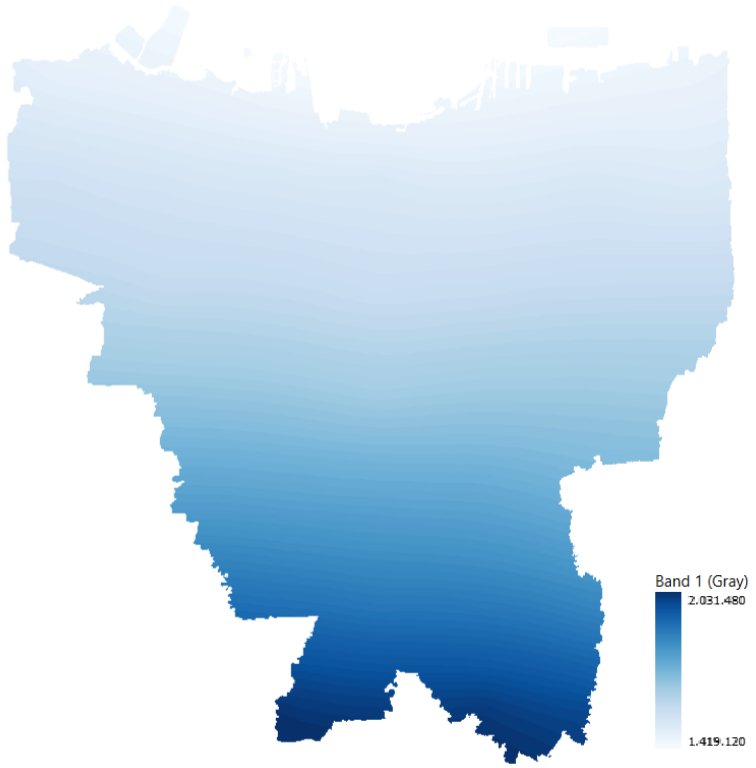
# | Results




Digital Surface Model (30x30)

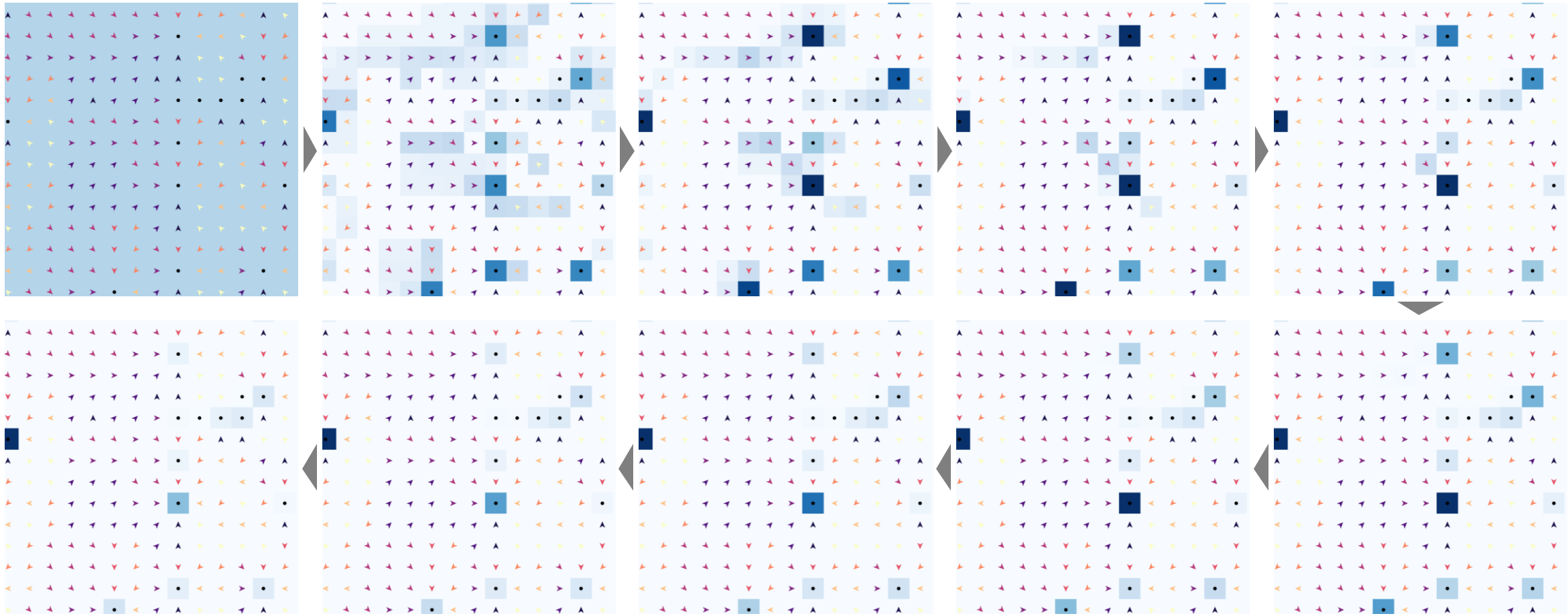



Landuse Runoff Coefficient

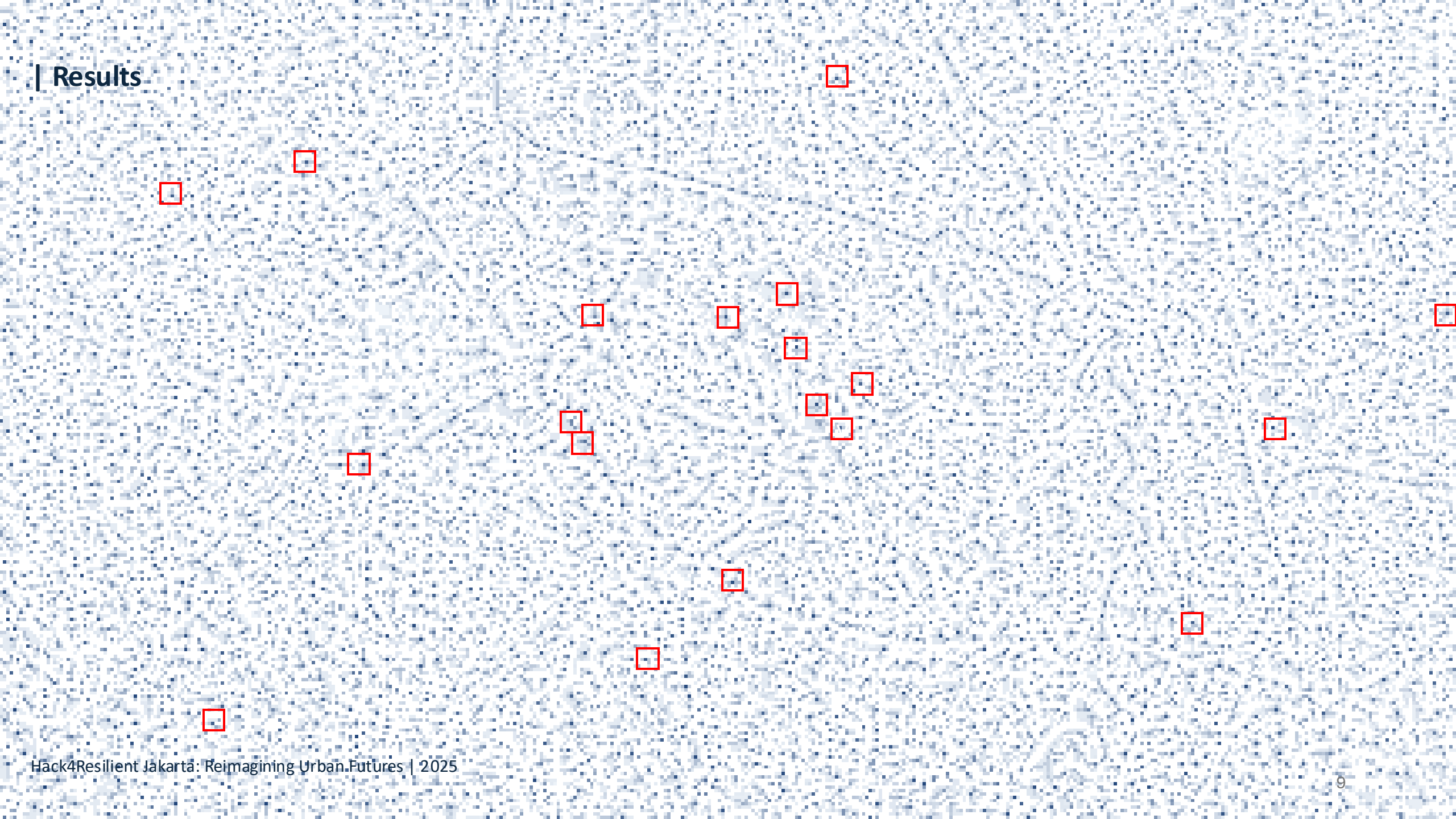



Rainfall (m3/year)

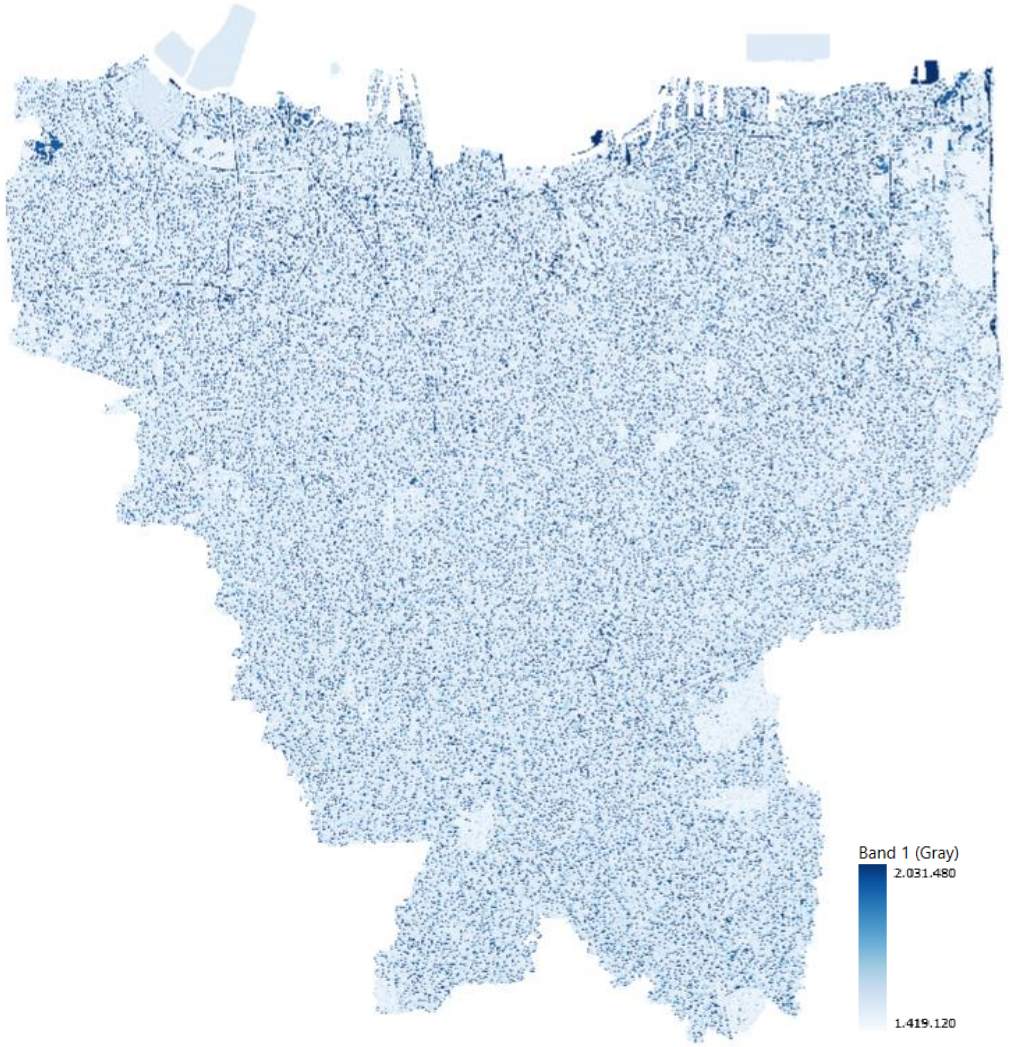
# | Results

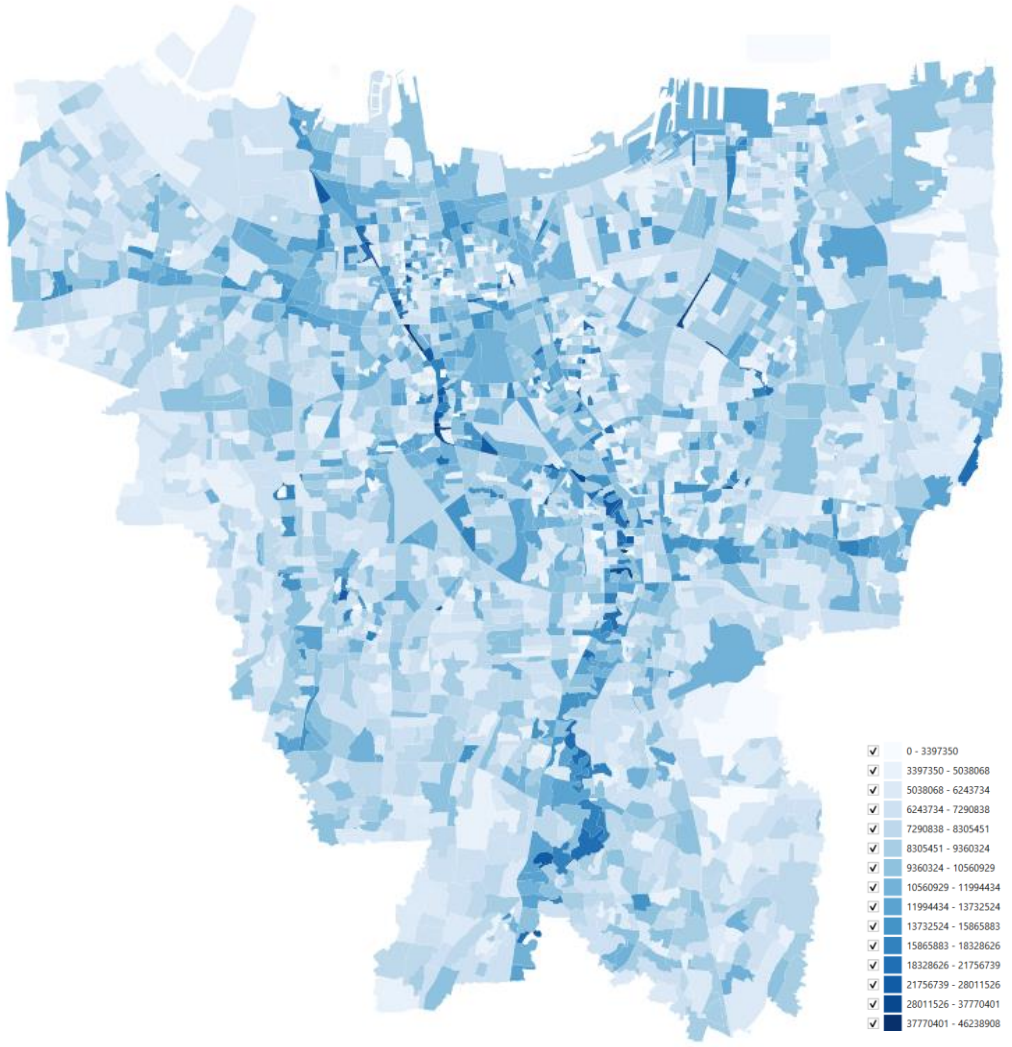


# | Results

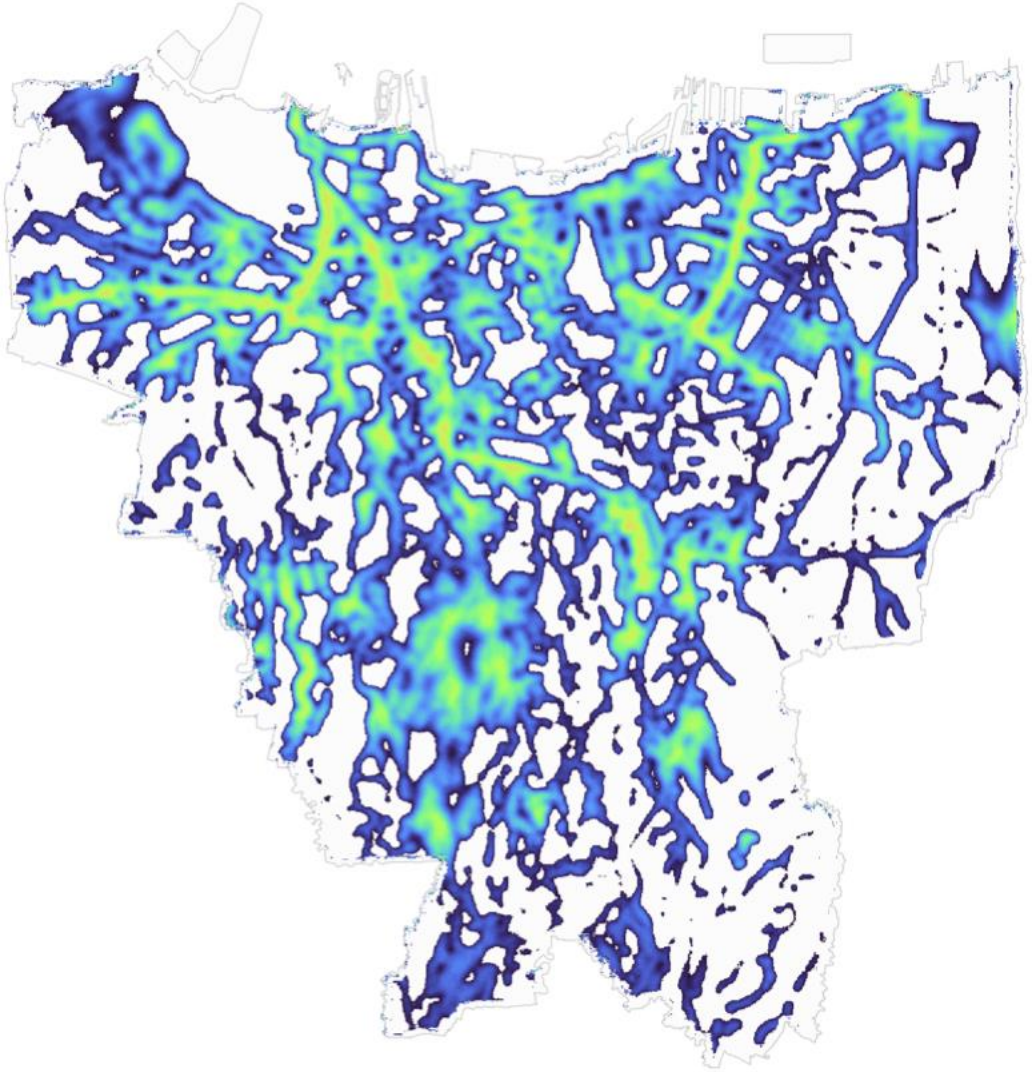


# | Results

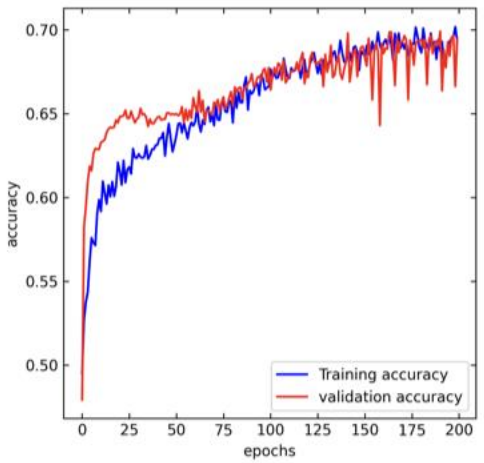

Band 1 (Gray)
2.031.480
1.419.120

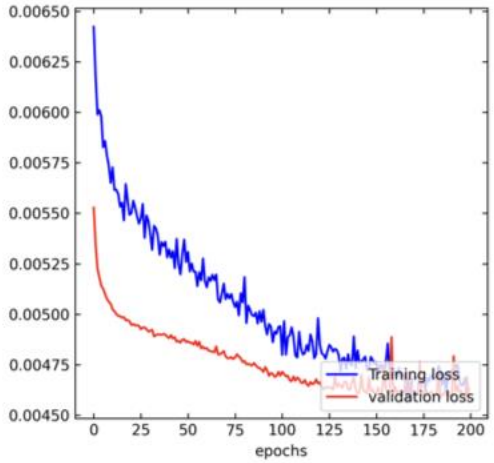

0 - 3397350
3397350 - 5038068
5038068 - 6243734
6243734 - 7290838
7290838 - 8305451
8305451 - 9360324
9360324 - 10560929
10560929 - 11994434
11994434 - 13732524
13732524 - 15865883
15865883 - 18328626
18328626 - 21756739
21756739 - 28011526
28011526 - 37770401
37770401 - 46238908

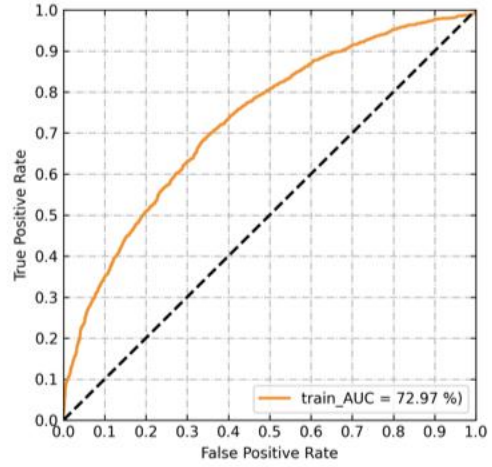
# | CNN (Convolutional neural network) **Flood Model**

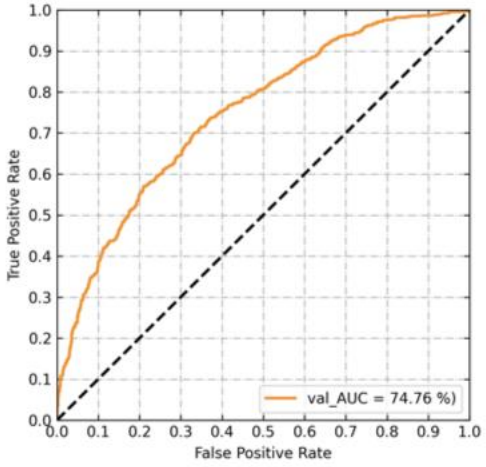


Flood Vulnerability Model



# | Results – Flood Simulation

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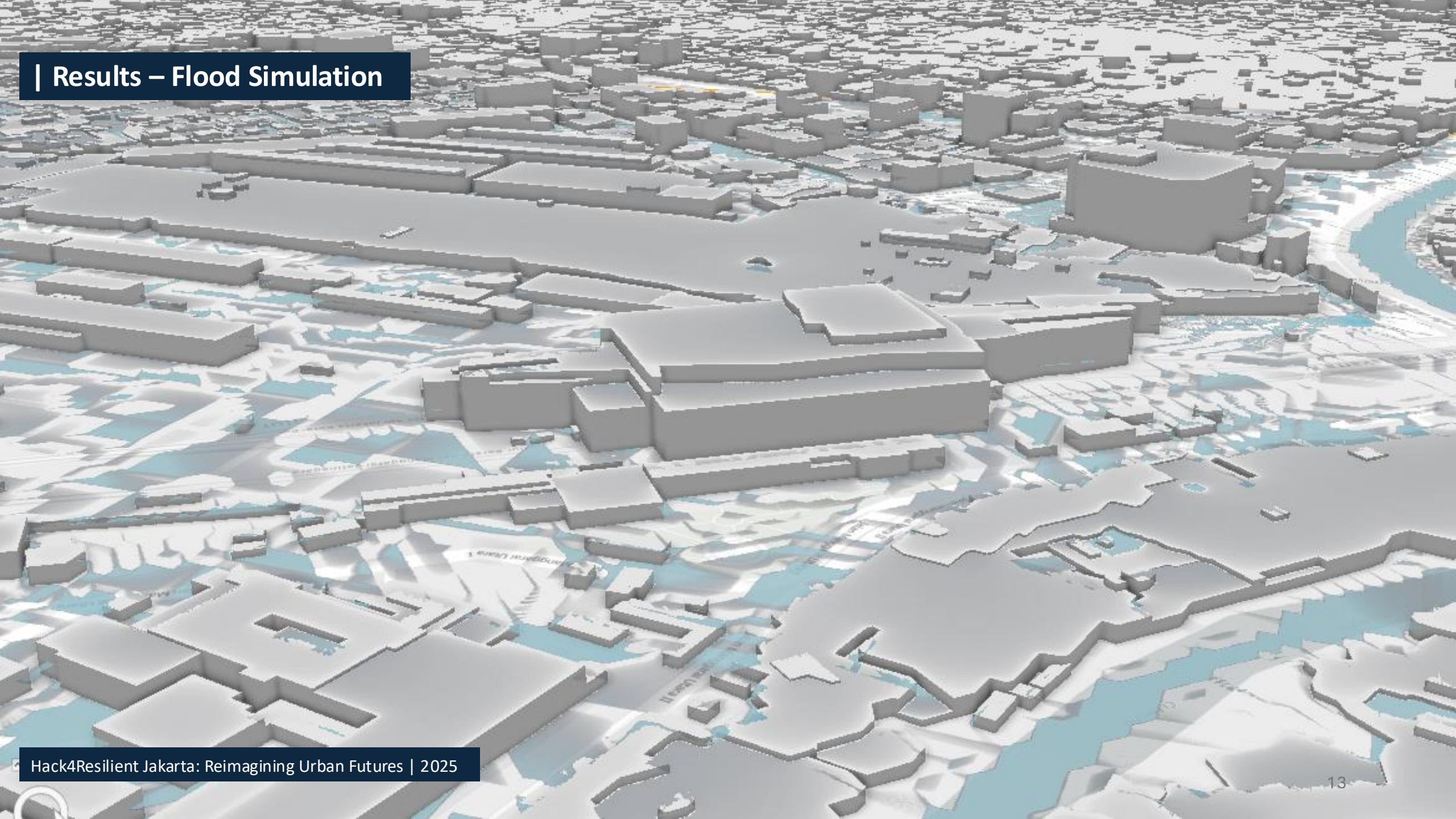

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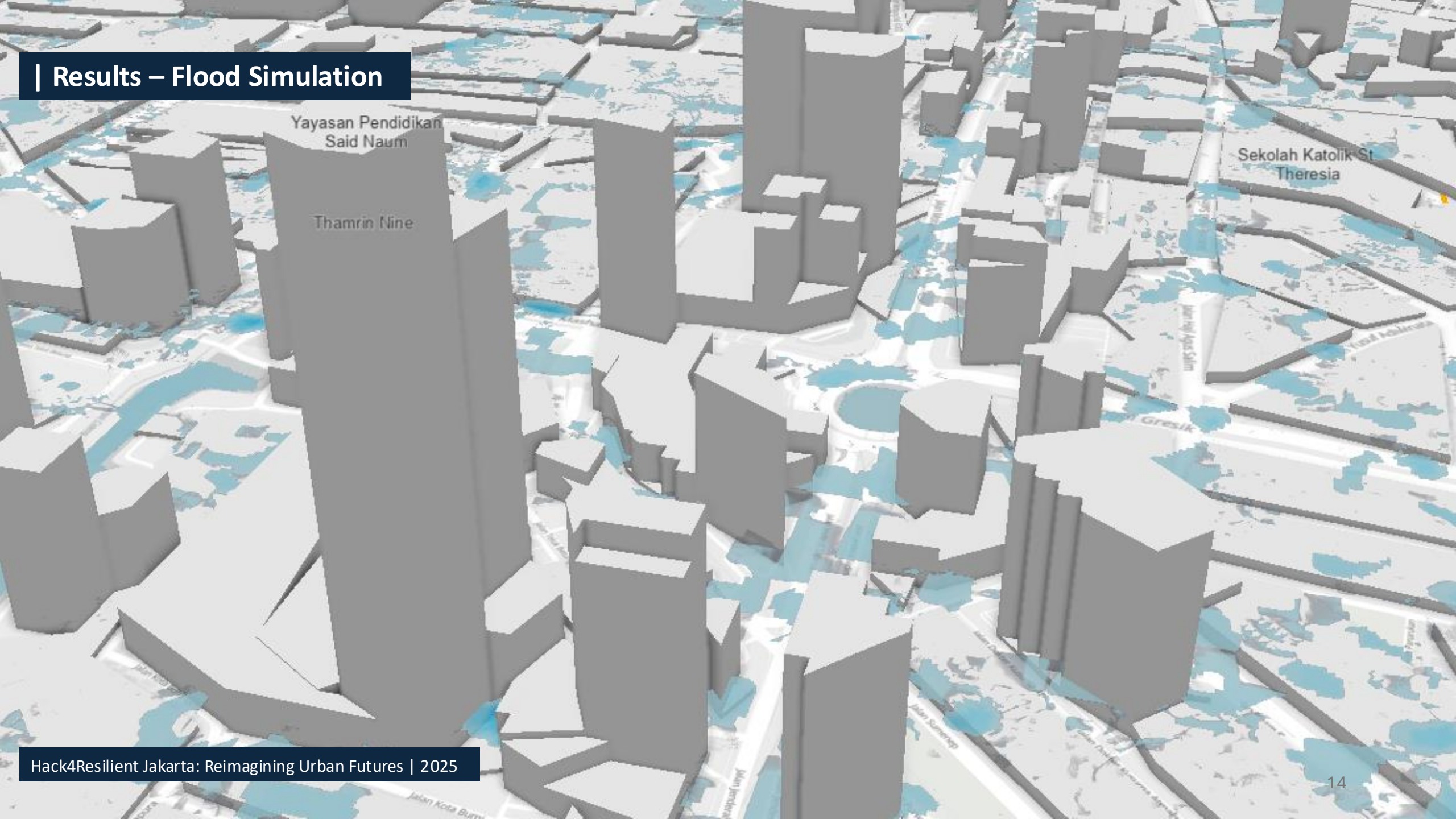
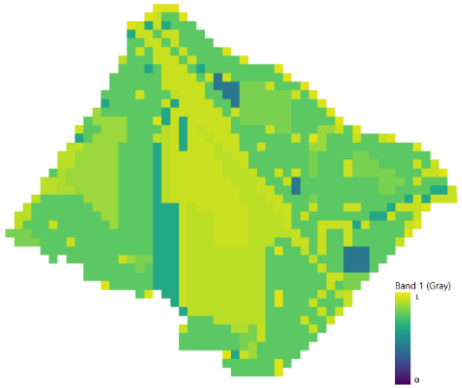


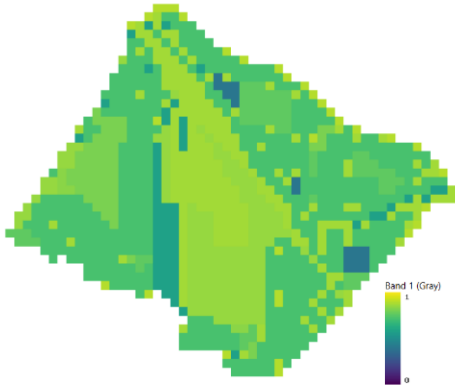
# | Results

## | Scenario Management – Implementation of Green Base Coefficient (GBC/KDH)

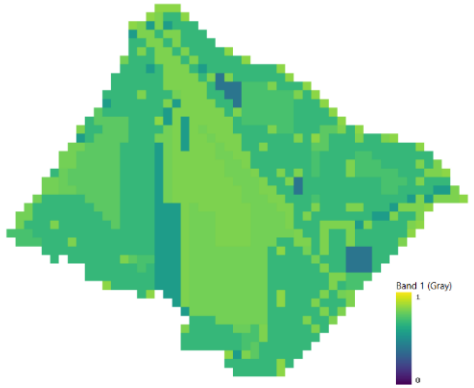
**No intervention**



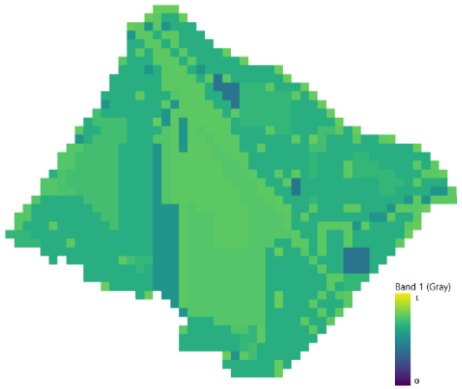

**GBC 10%**



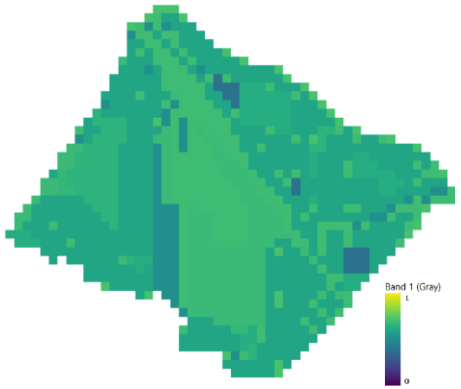

**GBC 20%**



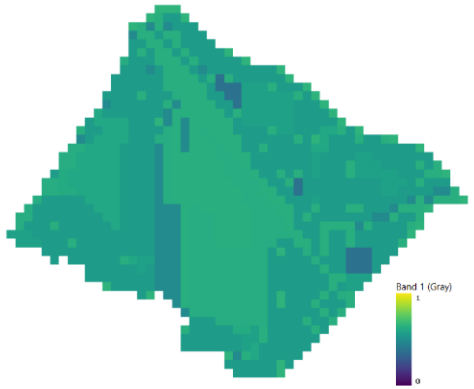

**GBC 30%**

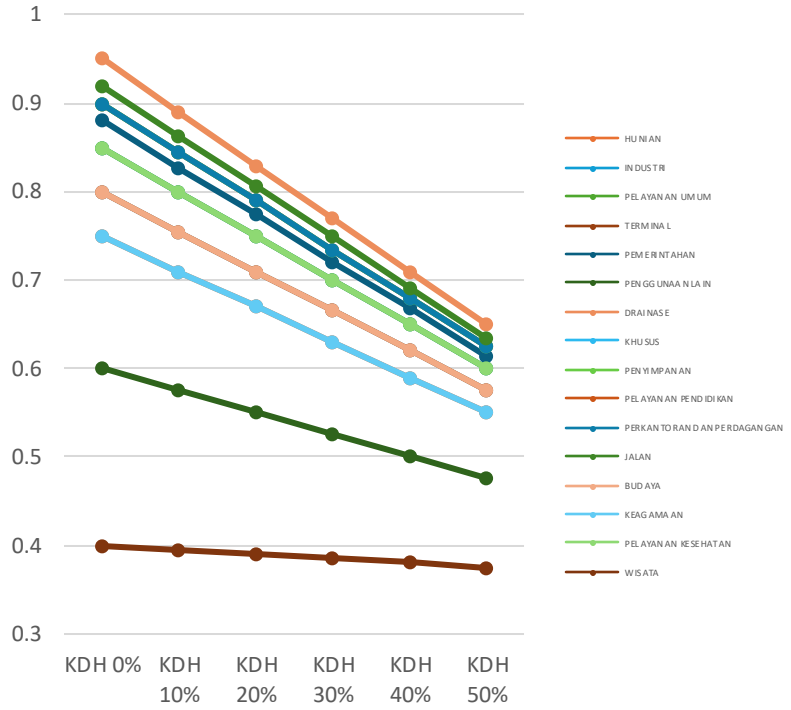



**GBC 40%**




**GBC 50%**

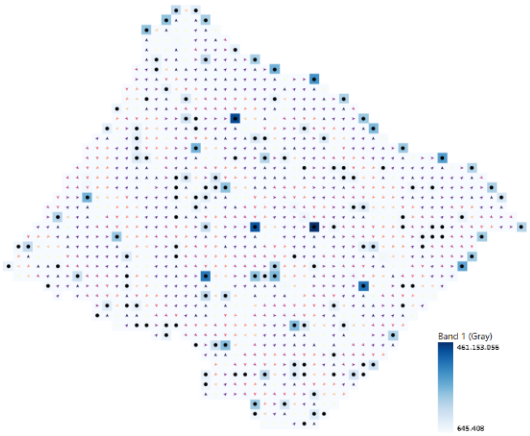


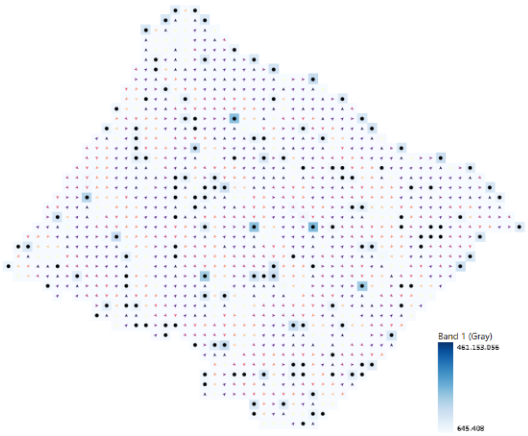
# | Results

## | Scenario Management – Implementation of Green Base Coefficient (GBC/KDH)

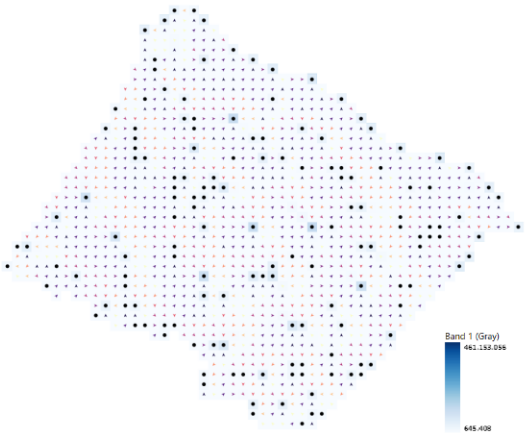
**No intervention**



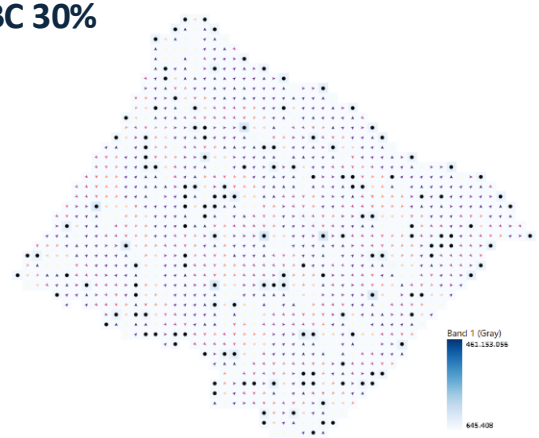

**GBC 10%**



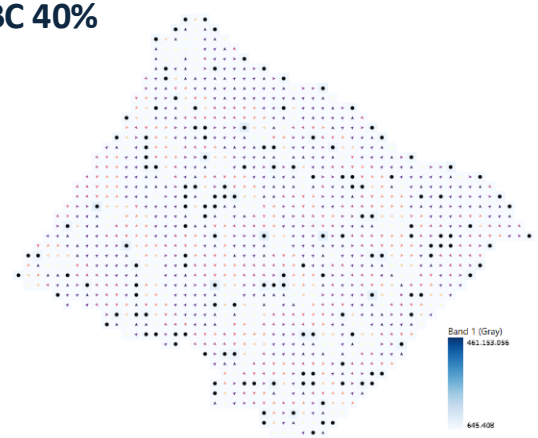

**GBC 20%**



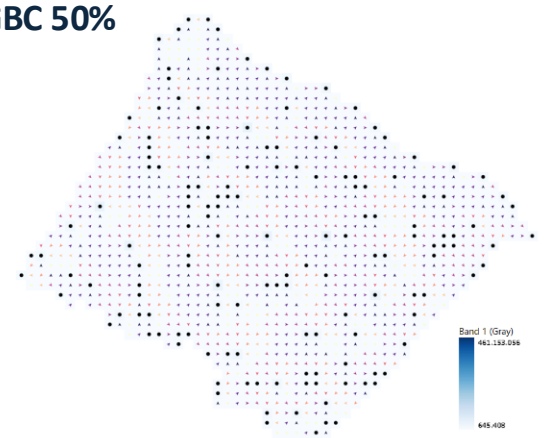

**GBC 30%**




**GBC 40%**




**GBC 50%**



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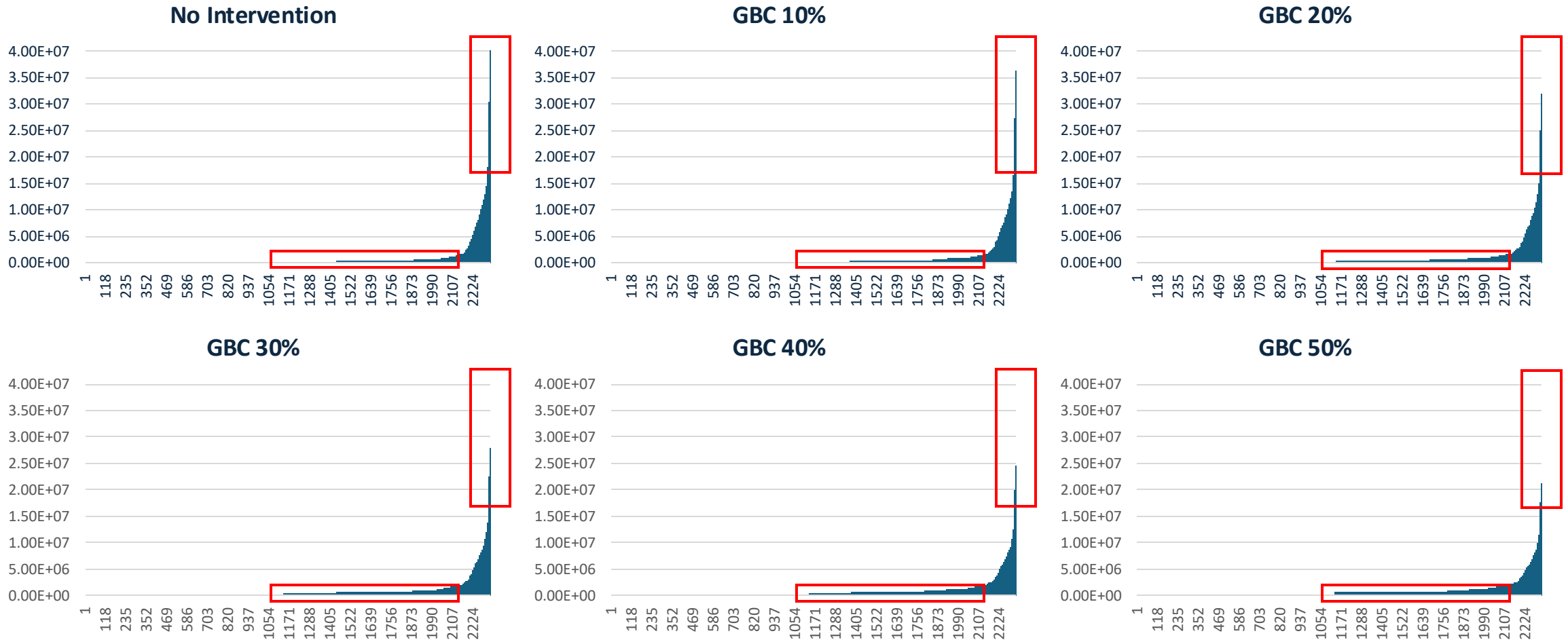

# | Conclusion

- Most hydrological models are based on 1D and 1D-2D approaches that assume flooding occurs due to water overflowing or being unable to be contained by drainage systems or rivers. However, rainfall does not only occur in rivers; it happens across all areas. Each area has varying slopes, surface runoff rates based on land cover, and different rainfall intensities.
- The method used offers a solution that better reflects the actual rainfall phenomenon, enabling a more comprehensive approach to managing surface runoff. This ensures that rainfall across the entire region can be addressed effectively, with each land parcel playing a role in flood mitigation.
- Several scenarios can be implemented, such as land-use and infiltration management through policies like KDH/GBC (Green Base Coefficient), infiltration wells, urban green spaces, and other approaches. For example, applying GBC can reduce the concentration of surface runoff toward low-lying points, allowing rainwater to be absorbed more evenly across different land uses. Ultimately, every type of land use contributes to preventing and managing floods, just as every component of an urban system plays a role in supporting the city's resilience.

# Thank you.

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