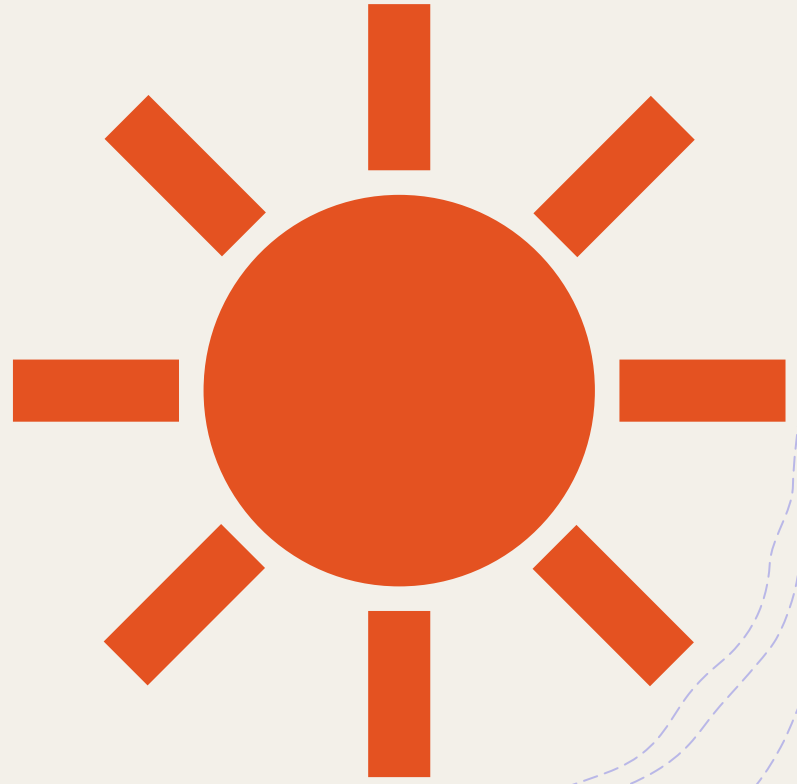
PLANNING FOR CLIMATE CHANGE IN A FLOOD PRONE COMMUNITY

A SPATIAL ANALYSIS OF THE CITY OF DES MOINES, IOWA

YUSUF TAYO
CRP 552

INTRODUCTION

CLIMATE CHANNGE: A long time change in the statistical distribution of weather pattern over periods ranging from decades to million



FLOODING: Is not always directly attributed to a river, stream, or lake overflowing from its banks, it is the combination of excessive rainfall or snowmelt, saturated ground, and inadequate urban drainage.

PETROPOLIS, BRASIL

DES MOINES, IOWA, 1993


Sky8
KCCI 8
NEWS

DES MOINES, IOWA, 2018

Literature review - Methodology

Author	Units of Analysis	Variable Used	Methods	Source
Fahy et al., 2019	Census block	Sociodemographic variables and environmental hazard potential	Topographic Wetness Index (WTI) and Urban Heat Index (UHI) using GIS	ACS
di Baldassarre et al., 2014	Neighborhood	Socioeconomic variables	Inundation modelling and cluster analysis	Questionnaire and physical observation
Hossain & Meng, 2020	Census block	Demographic data	Spatial clusters analysis	Census data
Niall et al., 2019	Counties	Storm and flood	Multivariate statistical model	Census Data

Project design

Research Question

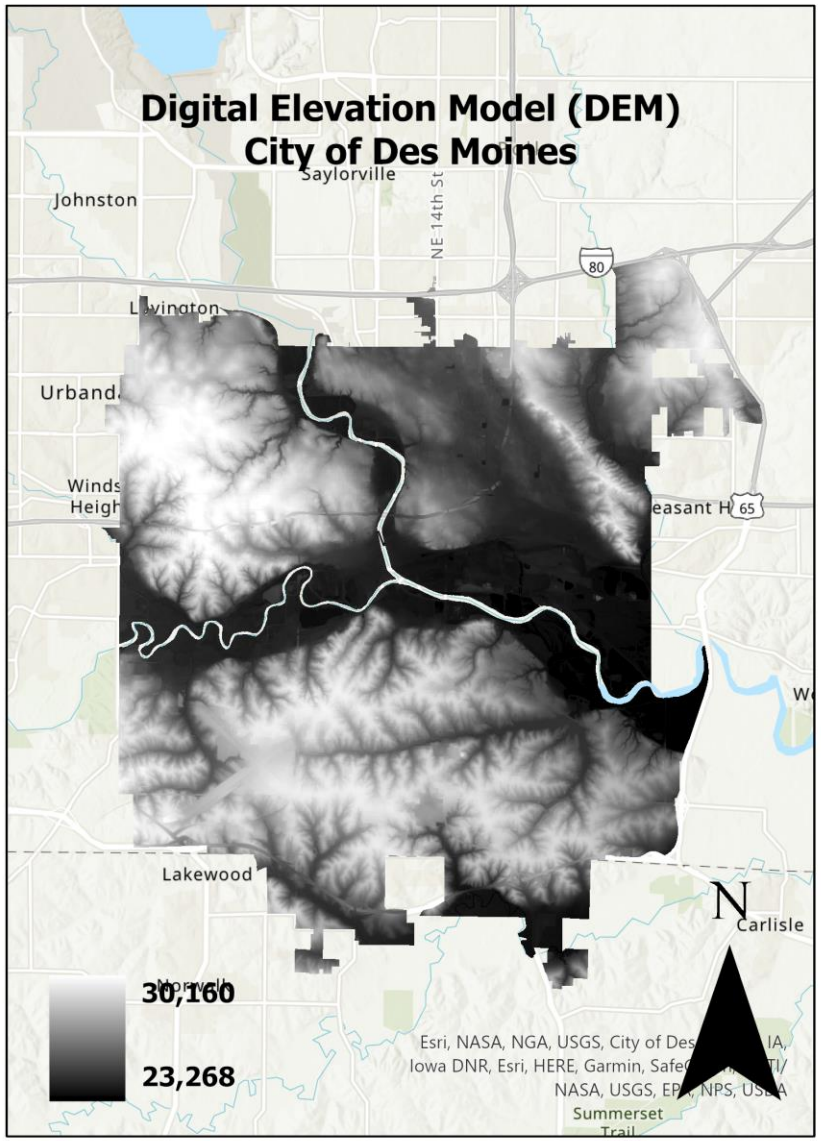
What areas are more vulnerable to flooding in the city of Des Moines?

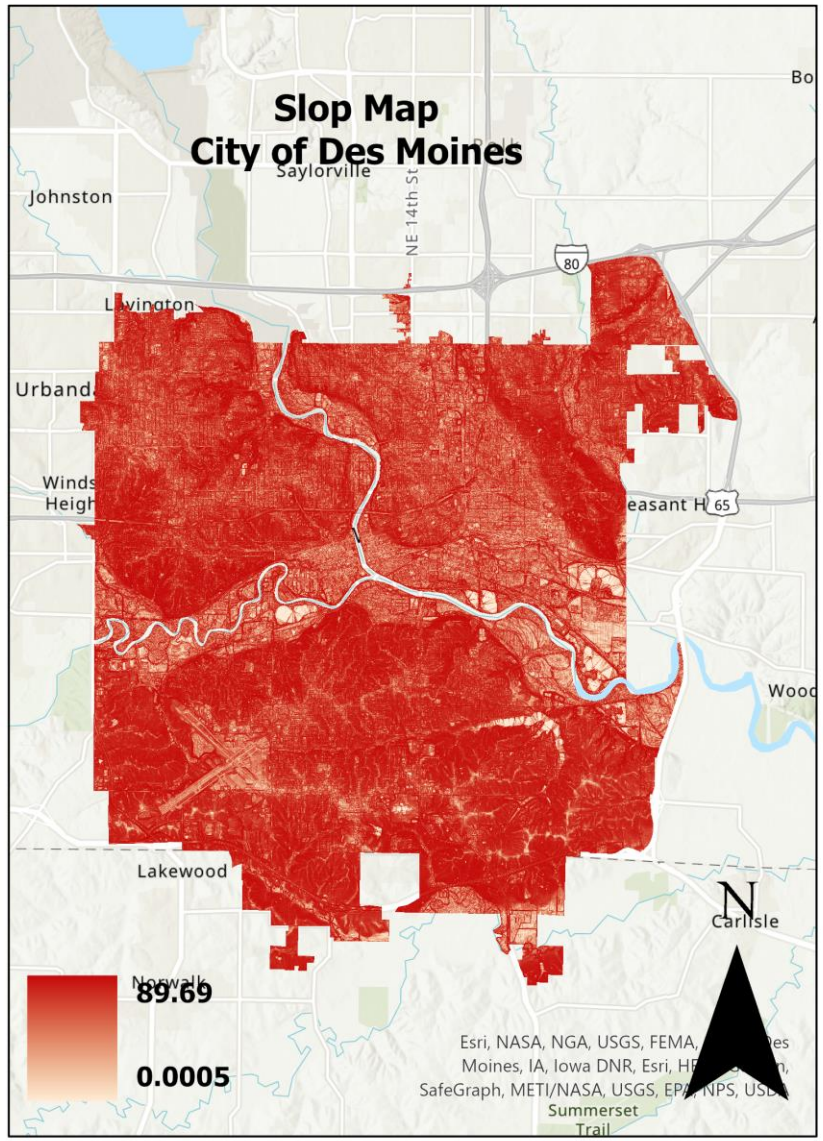
Objectives

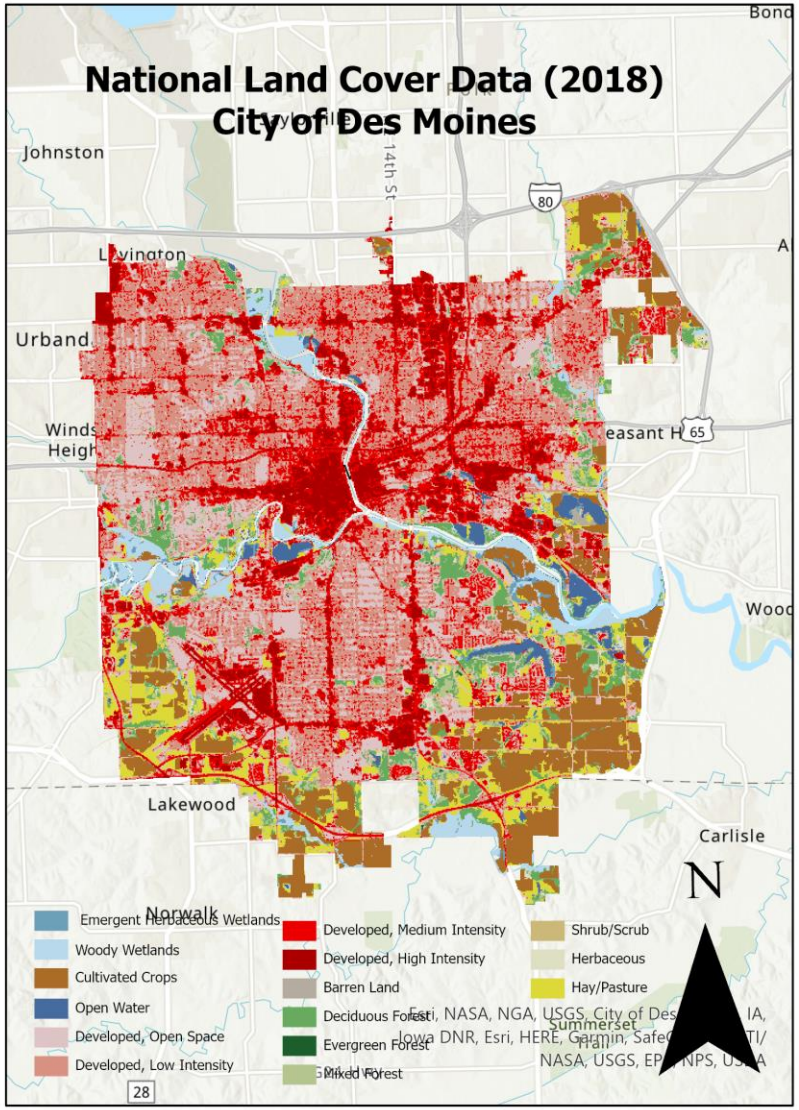
i. Identify areas that are susceptible to river overflow and accumulation points
ii. Identify areas with low terrain
iii. Identify areas with a high sum of annual precipitation
iv. Identify the residential landuse

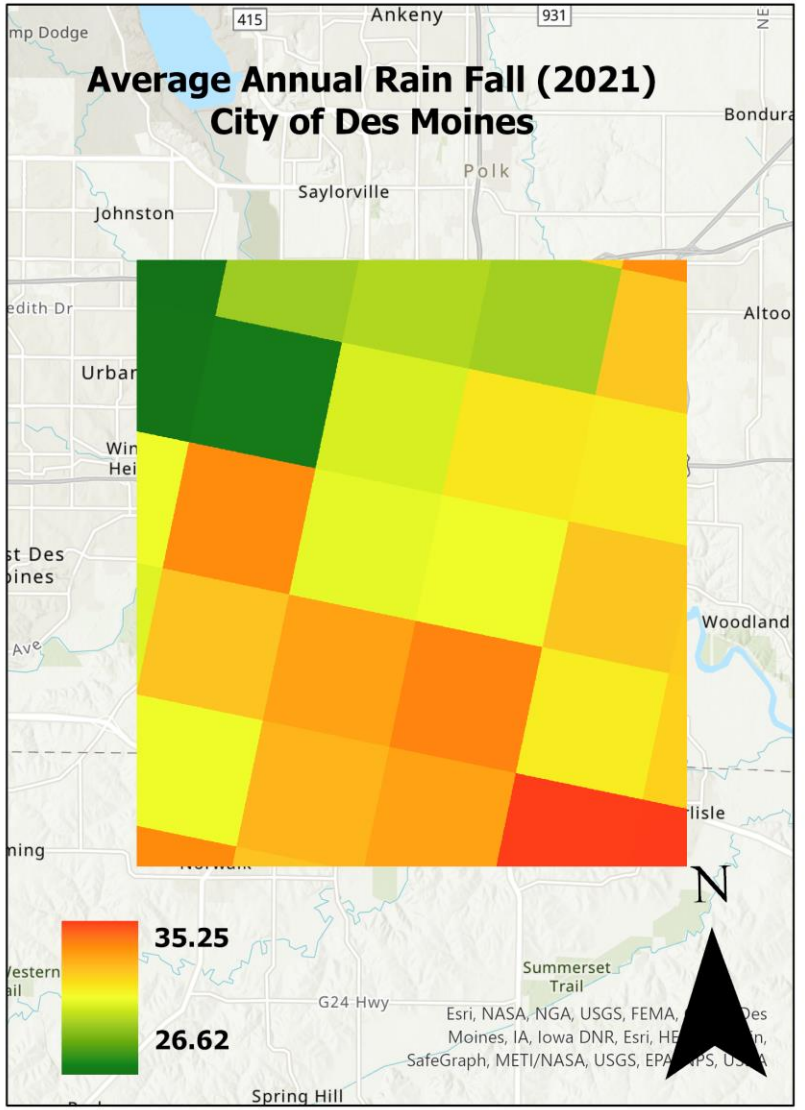
DATA DISCRIPTION

FILE NAME	TYPE	DESCRIPTION	SOURCE
NLCD2018	Raster	USGS National land cover date (2018)	USGS
DEM	Raster	Digital elevation model (2008)	ISU GIS Facility
LNDCover	Raster	City of Des Moines land cover (2018)	City of Des Moines GIS data
Rain	Vector	Average annual rainfall (2021)	USGS
Roads	Vector	Road in bounding area	City of Des Moines GIS data


Digital Elevation Model (DEM)
City of Des Moines
Saylorville
Johnston
NE 14th St
80
Urbandale
Windsor Heights
Beaver
65
Lakewood
Carlisle
Norwalk
30,160
23,268
Summerset Trail


Slop Map
City of Des Moines
Saylorville
Johnston
NE 14th St
80
Urbandale
Windsor Heights
65
Lakewood
Carlisle
Norwalk
89.69
0.0005
Summerset Trail

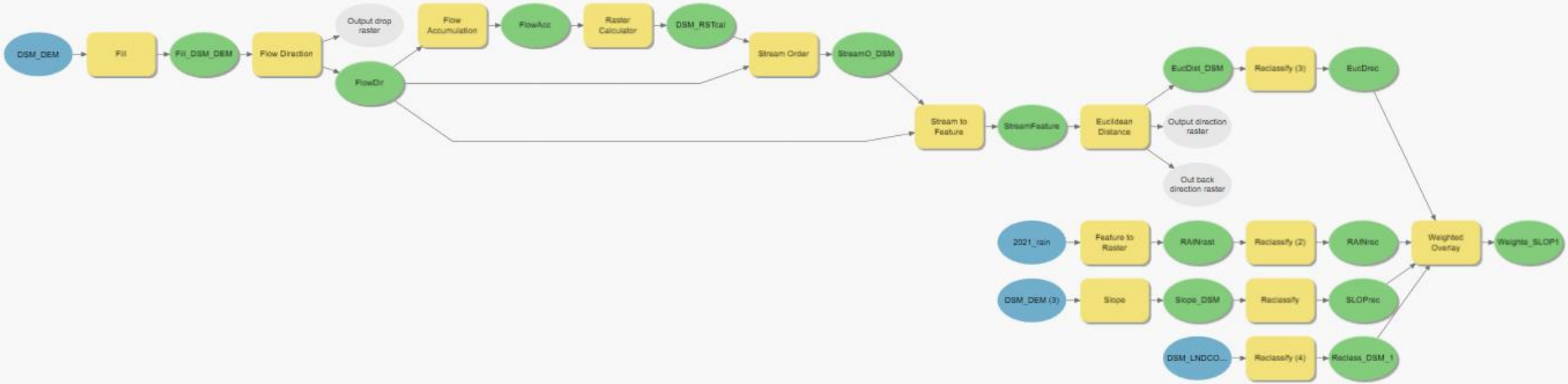

National Land Cover Data (2018)
City of Des Moines
Johnston
Urbandale
Lakewood
Carlisle
Norwalk
N
Emergent Herbaceous Wetlands
Woody Wetlands
Cultivated Crops
Open Water
Developed, Open Space
Developed, Low Intensity
Developed, Medium Intensity
Developed, High Intensity
Barren Land
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Herbaceous
Hay/Pasture
Esri, NASA, NGA, USGS, City of Des
IA,
Iowa DNR, Esri, HERE, Garmin, Safe
TI/
NASA, USGS, EP
NPS,


Average Annual Rain Fall (2021)
City of Des Moines
Ankeny
Saylorville
Johnston
Polk
Woodland
Summerset Trail
G24 Hwy
Spring Hill
N
35.25
26.62
Esri, NASA, NGA, USGS, FEMA,
Moines, IA, Iowa DNR, Esri,
SafeGraph, METI/NASA, USGS, EPA

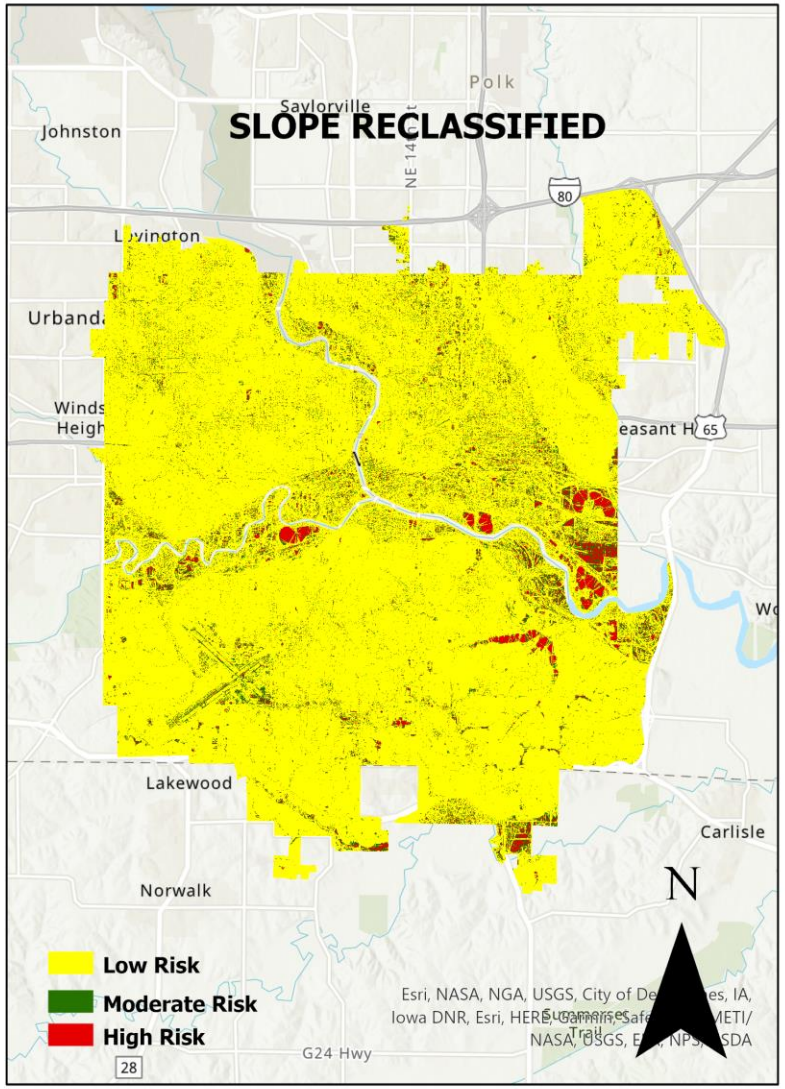
Suitability Scale for weighted overlay

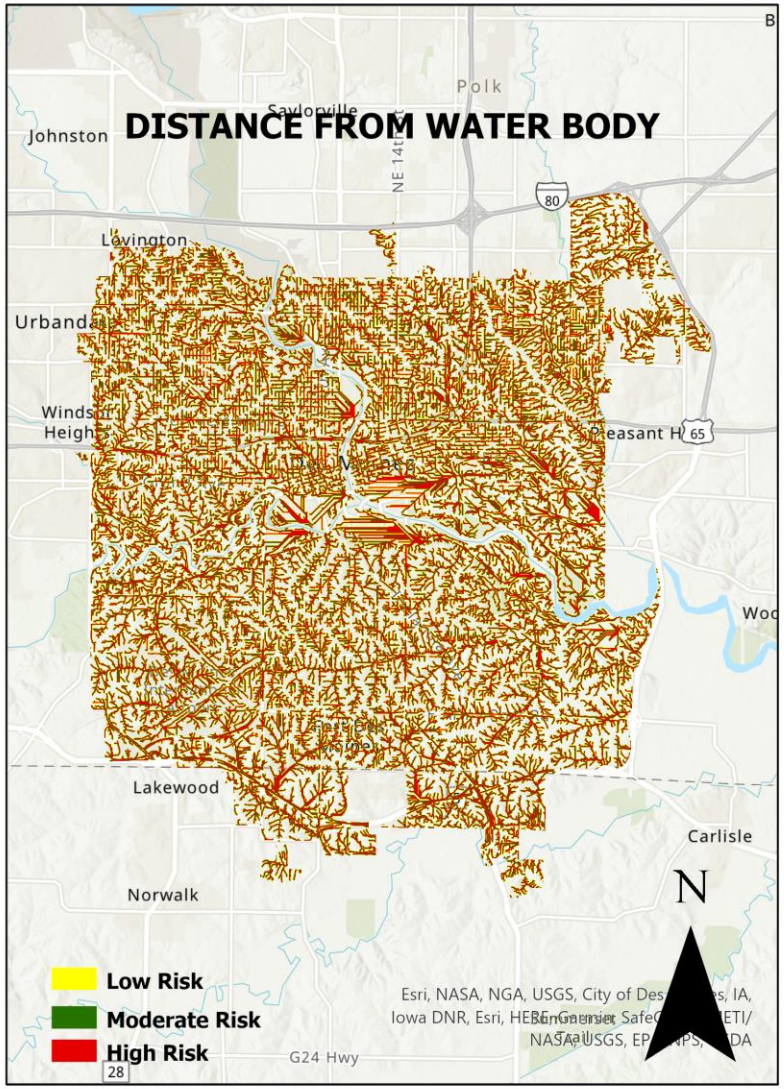
Spatial Layer	Attribute	Name	Low Risk	Moderate Risk	High Risk
Rain	Value	Rain	26.62 - 27.86	27.86 – 31.00	31.00 – 33.40
Slope	Value	Slope	0 - 25	25 - 45	45 - 90
Euclidean distance	Value	Euclidean distance	0 - 10	10 - 20	20 - 30
NLCD2018	Value	NLCD2018	Open water, Deciduous Forest, Evergreen Forest, Mixed forest, Woody wet land, and Herbaceous wetland.	Barren land, Shrub, Herbaceous, Pasture, and Cultivated crops.	Developed low intensity, Developed medium intensity and Developed high intensity.

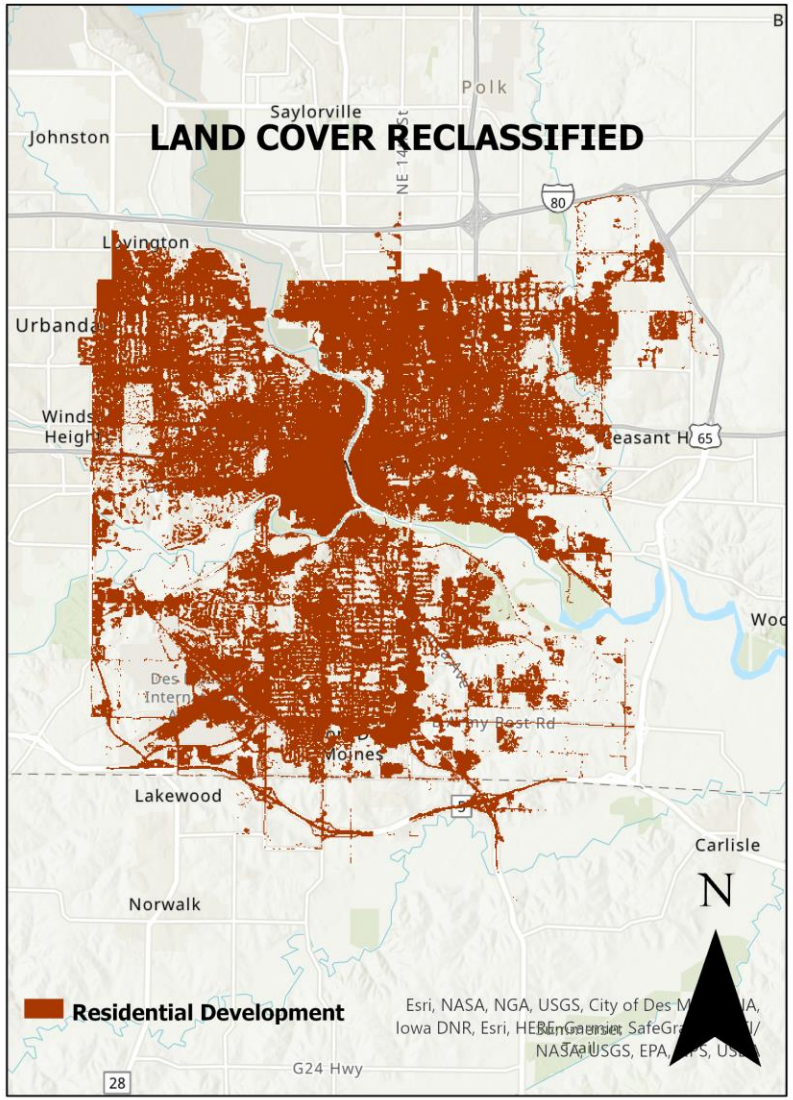
METHODOLOGY

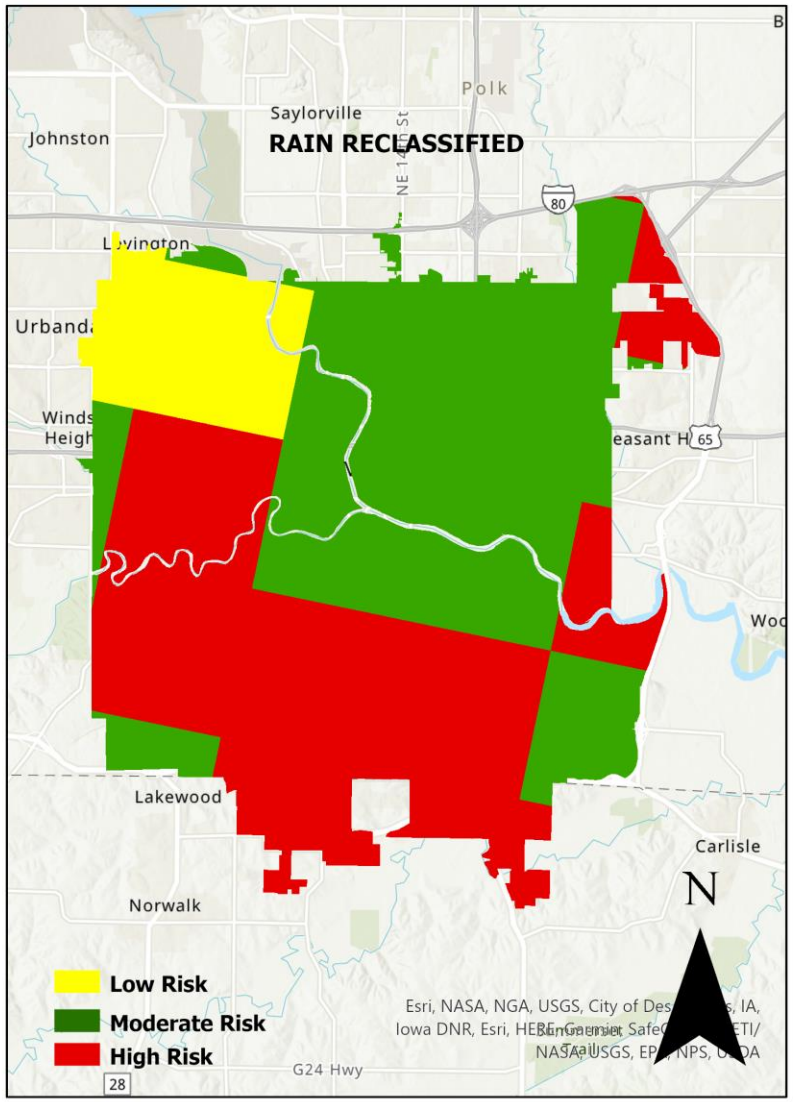


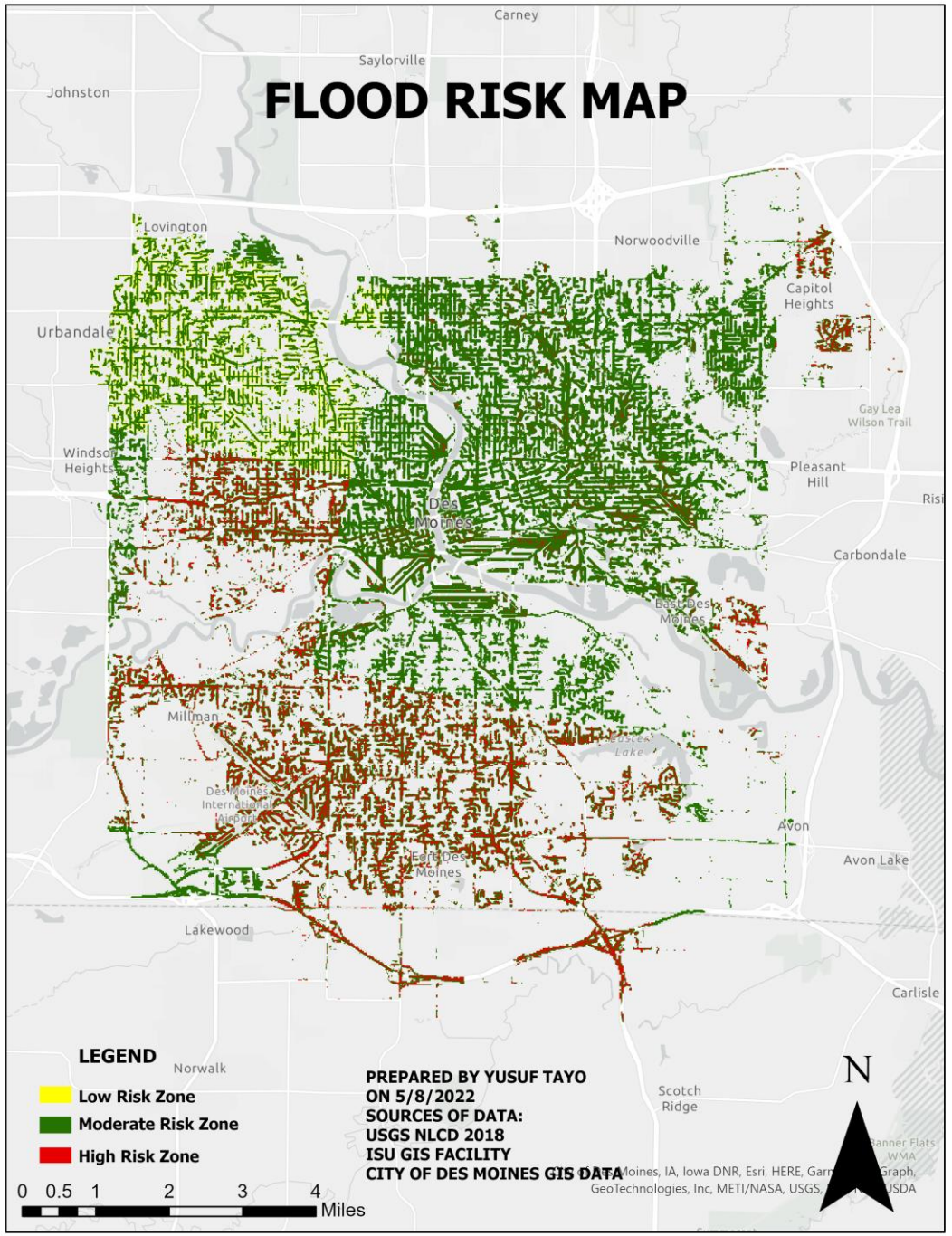
MODEL BUILDER

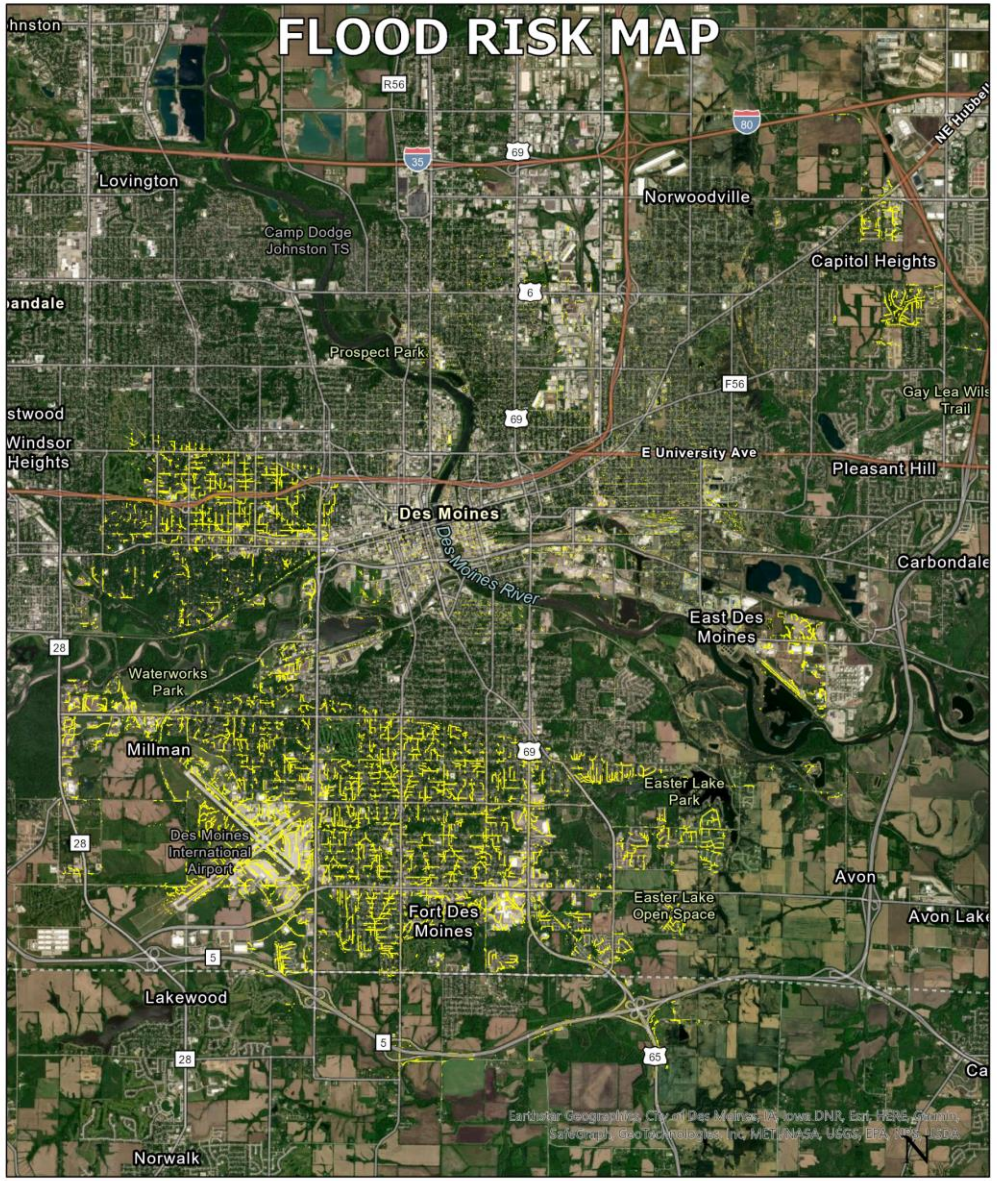

SLOPE RECLASSIFIED
Polk
Saylorville
Johnston
80
Urbandale
Lakewood
Carlisle
Norwalk
G24 Hwy
28
65
N
Low Risk
Moderate Risk
High Risk
Esri, NASA, NGA, USGS, City of Des
Iowa DNR, Esri, HERE, Garmin, Safe
NASA, USGS, E

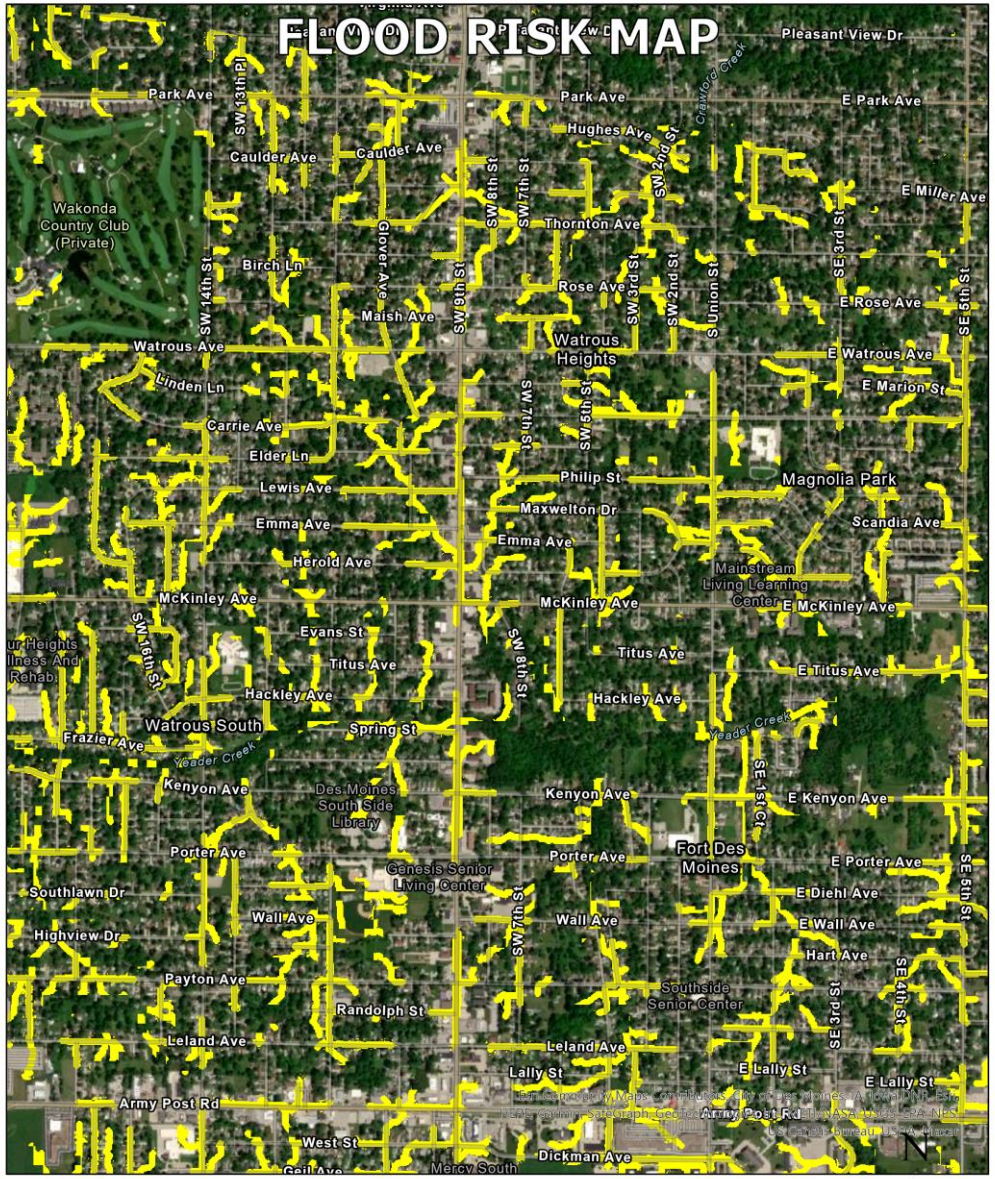

DISTANCE FROM WATER BODY
Polk
Saylorville
Johnston
80
Urbandale
Lakewood
Carlisle
Norwalk
G24 Hwy
28
65
N
Low Risk
Moderate Risk
High Risk
Esri, NASA, NGA, USGS, City of Des
Iowa DNR, Esri, HERE, Garmin, Safe
NASA, USGS, E


LAND COVER RECLASSIFIED
Polk
Saylorville
Johnston
Lovington
Urbandale
Windsor Heights
Pleasant Hill
Des Moines
Lakewood
Carlisle
Norwalk
G24 Hwy
28
80
65
N
Residential Development
Esri, NASA, NGA, USGS, City of Des Moines, IA, Iowa DNR, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USDA


RAIN RECLASSIFIED
Polk
Saylorville
Johnston
Lovington
Urbandale
Windsor Heights
Pleasant Hill
Lakewood
Carlisle
Norwalk
G24 Hwy
28
80
65
N
Low Risk
Moderate Risk
High Risk
Esri, NASA, NGA, USGS, City of Des Moines, IA, Iowa DNR, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, USDA


FLOOD RISK MAP
Carney
Saylorville
Johnston
Lovington
Norwoodville
Capitol Heights
Urbandale
Gay Lea Wilson Trail
Windsor Heights
Pleasant Hill
Des Moines
Carbondale
East Des Moines
Millman
Webster Lake
Des Moines International Airport
Avon
Avon Lake
Fort Des Moines
Lakewood
Carlisle
Norwalk
Scotch Ridge
Banner Flats WMA
LEGEND
Low Risk Zone
Moderate Risk Zone
High Risk Zone
0 0.5 1 2 3 4
Miles
PREPARED BY YUSUF TAYO
ON 5/8/2022
SOURCES OF DATA:
USGS NLCD 2018
ISU GIS FACILITY
CITY OF DES MOINES GIS DATA
N


FLOOD RISK MAP
Lovington
Norwoodville
Camp Dodge Johnston TS
Capitol Heights
Prospect Park
Windsor Heights
E University Ave
Pleasant Hill
Des Moines
Des Moines River
Carbondale
East Des Moines
Waterworks Park
Millman
Easter Lake Park
Des Moines International Airport
Avon
Easter Lake Open Space
Fort Des Moines
Lakewood
Norwalk
High Risk Zone
0 0.5 1 2 3 4 Miles
Sources: USGS, ISU GIS Facility, City of Des Moines GIS data
N


FLOOD RISK MAP
Pleasant View Dr
Park Ave
E Park Ave
Hughes Ave
Caulder Ave
Crawford Creek
SW 13th Pl
SW 8th St
SW 7th St
SW 2nd St
E Miller Ave
Wakonda Country Club (Private)
Thornton Ave
SE 3rd St
Birch Ln
SW 14th St
Glover Ave
SW 9th St
SW 3rd St
SW 2nd St
S Union St
Rose Ave
E Rose Ave
SE 6th St
Maish Ave
Watrous Ave
Watrous Heights
E Watrous Ave
E Marion St
Linden Ln
SW 5th St
SW 7th St
Carrie Ave
Elder Ln
Philip St
Magnolia Park
Lewis Ave
Maxwelton Dr
Scandia Ave
Emma Ave
Emma Ave
Herold Ave
Mainstream Living Learning Center
McKinley Ave
McKinley Ave
E McKinley Ave
SW 16th St
Evans St
SW 9th St
Titus Ave
Titus Ave
E Titus Ave
Hackley Ave
Hackley Ave
Watrous South
Spring St
Frazier Ave
Yeader Creek
Yeader Creek
SE 1st Ct
Kenyon Ave
Des Moines South Side Library
Kenyon Ave
E Kenyon Ave
Porter Ave
Porter Ave
Fort Des Moines
E Porter Ave
Genesis Senior Living Center
SE 5th St
Southlawn Dr
E Diehl Ave
Wall Ave
Wall Ave
E Wall Ave
Highview Dr
SW 7th St
Hart Ave
Payton Ave
Southside Senior Center
SE 4th St
SE 3rd St
Randolph St
Leland Ave
Leland Ave
Lally St
E Lally St
E Lally St
Army Post Rd
Army Post Rd
West St
Dickman Ave
Mercy South
N
High Risk Zone
0 0.070.15 0.3 0.45 0.6
Miles
Sources: USGS, ISU GIS Facility,
City of Des Moines GIS data

Limitation

- Analysis was not detail enough
- Methodology not applicable in the global south as the focus of environmental disaster is different
- No suitable zoning plan to further classify the land uses affected

Conclusion

- Most residential neighborhoods south of the city are largely prone to flooding.
- It will be encouraged that further intense research should be carried out to identify the extent of damages, the population affected, and the demography as part of the effort to mitigate the effect of climate change
- The methodology can be adapted to another region with similar characteristics and challenges.

Recommendation

- ✓ The city of Des Moines should work on policies that will restrict and redirect development in flood-prone areas.
- ✓ The climate action and adaptation plan should prioritize the flood-prone areas, mostly in the south of the city.
- ✓ The analysis revealed that development cut across some flood paths. As such, building on flood paths should be demolished to allow proper drainage.
- ✓ The proposed plan should accommodate policy for insurgency pending the full implementation of the plan.

Reference

Fahy, B., Brenneman, E., Chang, H., & Shandas, V. (2019, March 21). Spatial analysis of urban flooding and extreme heat hazard potential in Portland, OR. International Journal of Disaster Risk Reduction. Retrieved May 9, 2022, from https://www.sciencedirect.com/science/article/pii/S2212420918310446

di Baldassarre, G., Yan, K., Ferdous, M. D. R., & Brandimarte, L. (2014, September 16). The interplay between human population dynamics and flooding in Bangladesh: A spatial analysis. Proceedings of IAHS. Retrieved May 9, 2022, from https://piahs.copernicus.org/articles/364/188/2014/

Hossain, M. K., & Meng, Q. (2020, November 3). A multi-decadal spatial analysis of demographic vulnerability to urban flood: A case study of Birmingham City, USA. MDPI. Retrieved May 9, 2022, from https://www.mdpi.com/2071-1050/12/21/9139

Niall, Q., Paul, D. B., Jeff, N., & Andy, S. (2019, February 13). The spatial dependence of flood hazard and risk. wiley online library. (n.d.). Retrieved May 9, 2022, from https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018WR024205