Predicting and Alleviating Road Flooding for Climate Mitigation

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Georgia Tech

Flooding severely impacts human mobility and critical infrastructure

Flooding caused by Hurricane Harvey in Houston, Texas

Flood hazards will increase over more than half of the globe, including Africa (IPCC 5th Assessment Report WG2 Ch3)

globally, there were
524 floods from 1980-1989,
865 from 1990-1999, and
1729 from 2000-2009 *(UNISDR)*

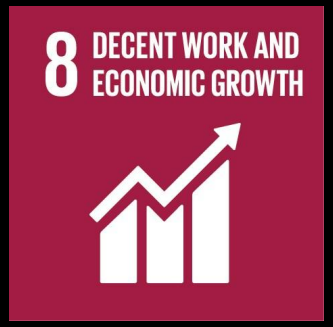
floods are responsible for
52% of deaths and
44% of economic damages
from natural disasters in 2017 *(CRED)*

Flooding and mudslides in Africa caused over **1,240 deaths this August**

https://qz.com/1068790/floods-in-africa-in-august-killed-25-times-more-people-than-hurricane-harvey-did/

How can we help?

Determine the most critical roads to upgrade to improve flood resilience



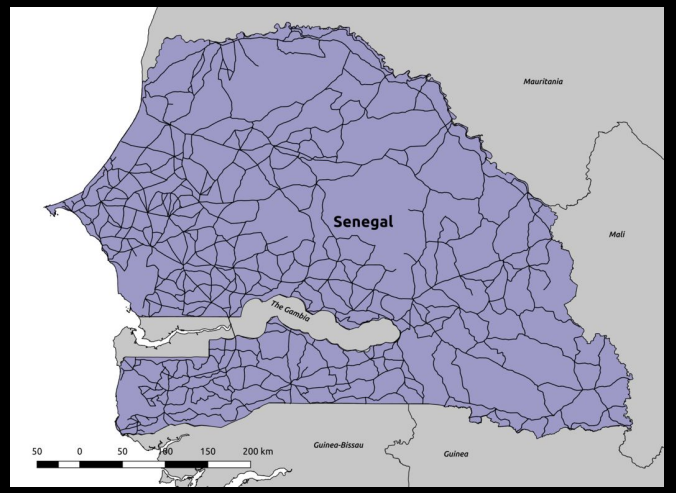
1. Estimate flooding effects on road network
2. Compute resulting impact on mobility
3. Recommend road fortifications that most effectively prevent loss of mobility

South Africa: Rehabilitation of Mpumalanga road

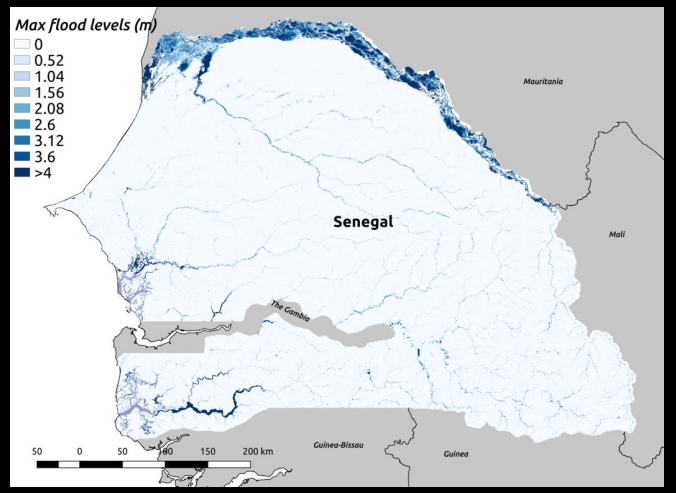
https://constructionreviewonline.com/2015/02/south-africa-rehabilitation-mpumalanga-road-end-next-year/

How is the Road Network Affected by Floods?

*GIS data on Senegal highway network (**OSM**)*



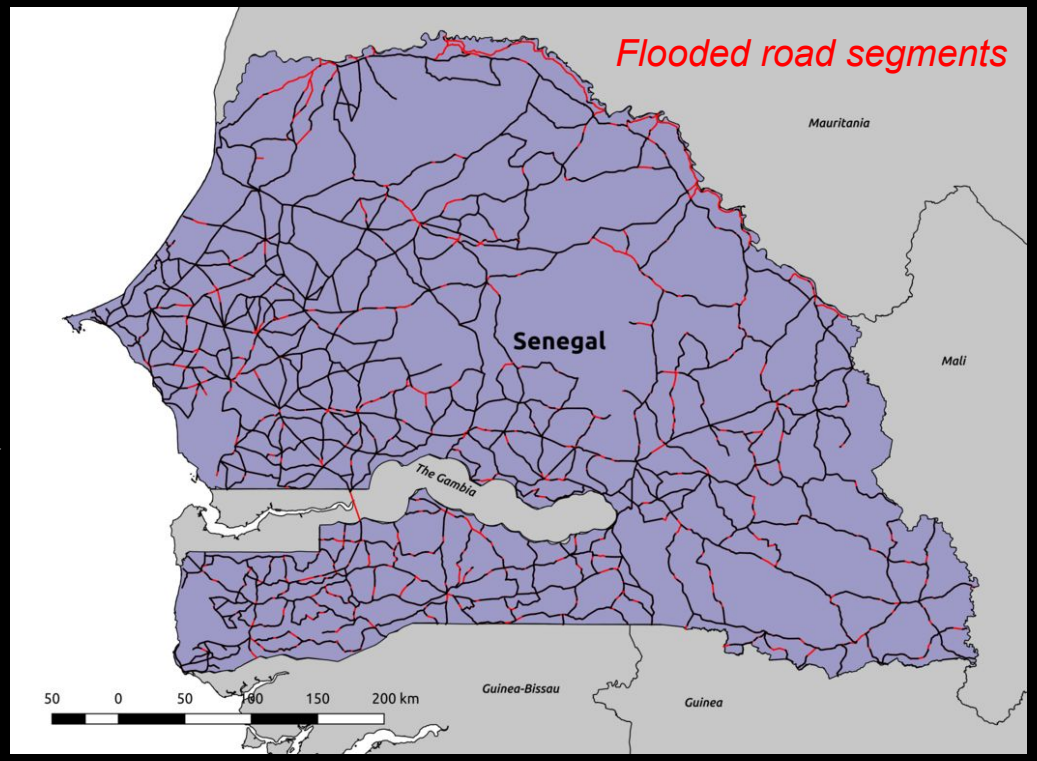
*Estimated flood maps for different flood return periods (**Fathom**)*



apply flood depth threshold

compute intersections

designate segment as flooded



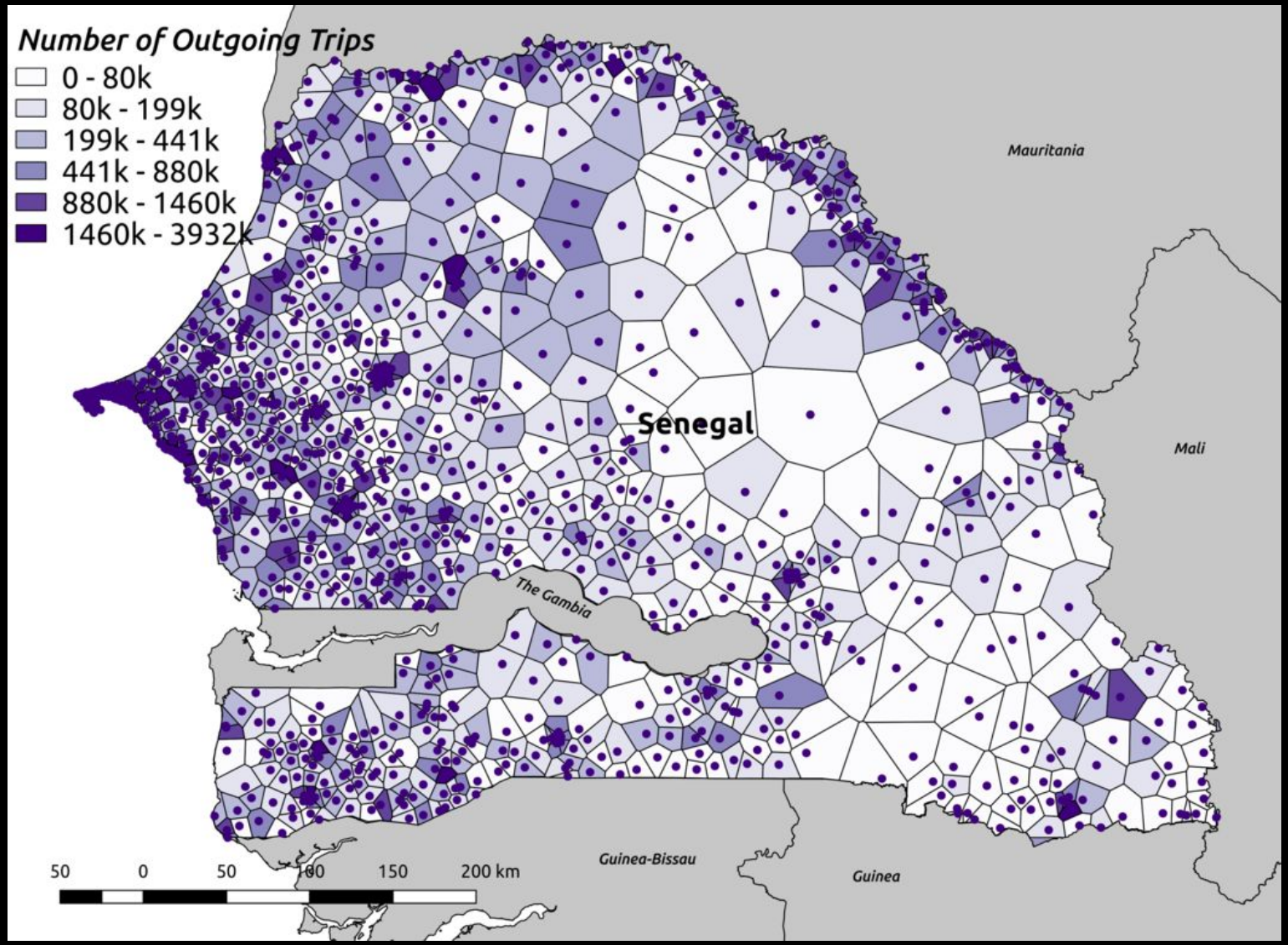
Road segments estimated to be impassable during a flooding event of the given return period

How is Mobility Affected by Flooded Roads?

Using data from **Orange** we estimate the trips people are taking over the road network

Using trips people are taking we estimate how they are disrupted by flooding

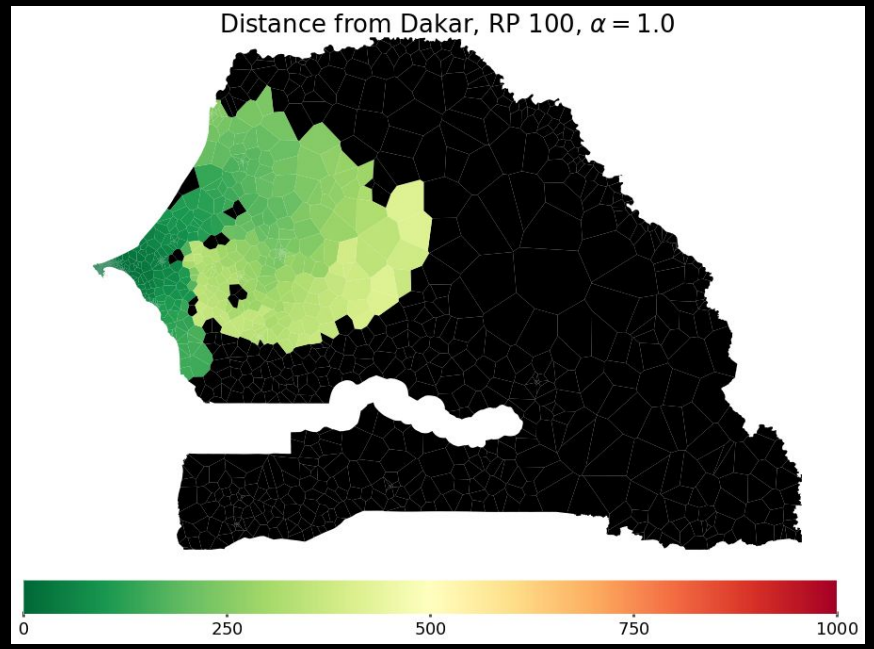
- **Shortest path distance** from origin to destination along the road network
- Number of **infeasible trips**



Estimated number of outgoing trips for zones defined by Orange cell tower locations

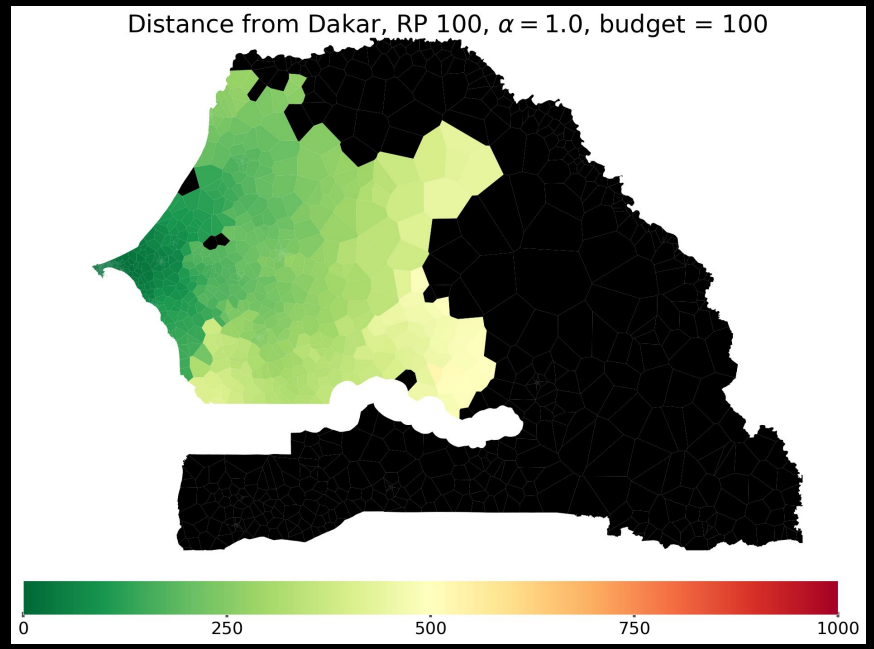
Which Road Upgrades Would Have the Largest Impact on Mobility?

Given a limited budget, which set of roads should we fortify to maximize accessibility under a certain flooding scenario? **A hard combinatorial optimization problem!**



budget for 100km upgrade

Approximation Algorithm for Optimization



Distance from Dakar before Improvements
(black areas are unreachable)

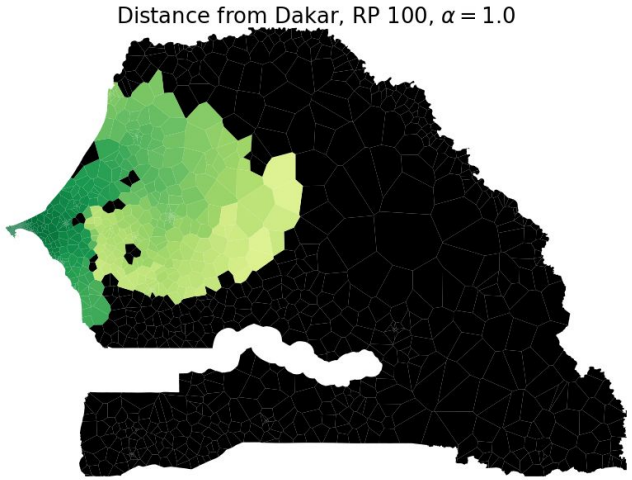
Distance from Dakar after Recommended Improvements

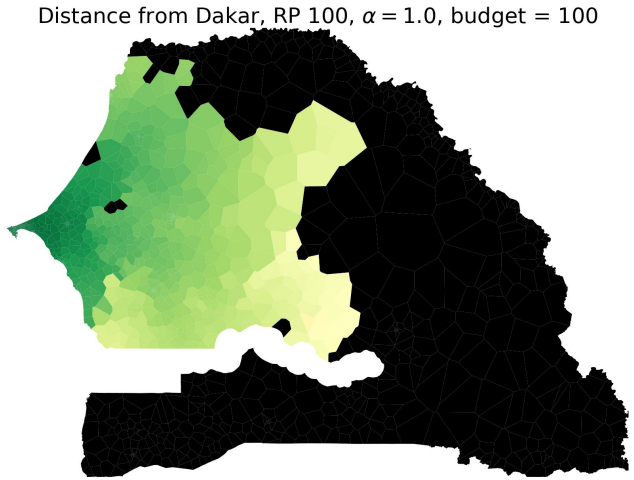
No Upgrades

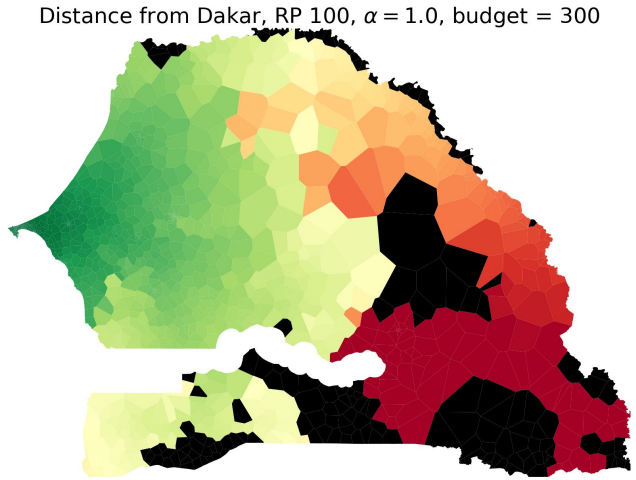
Fortify 100km

Fortify 300km

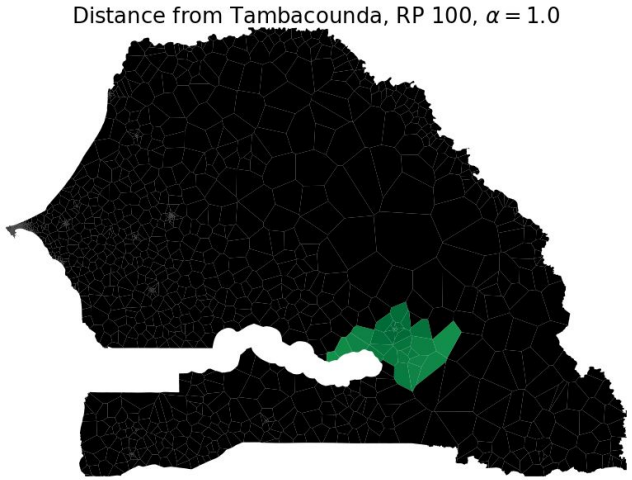
Dakar
(high population)

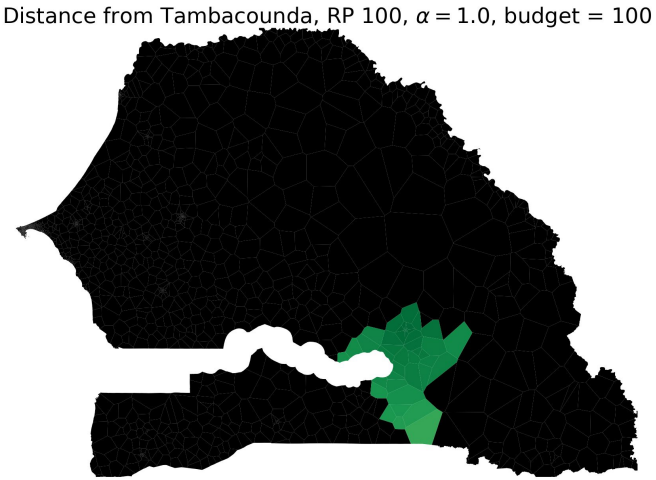


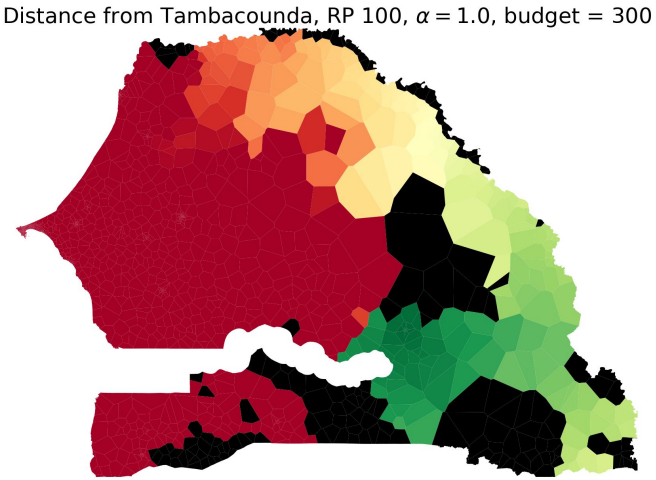


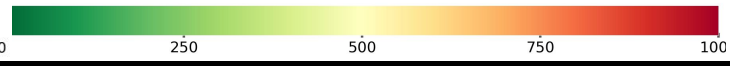


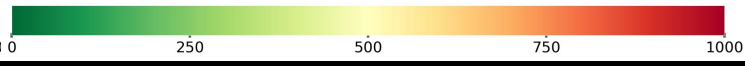
Tambacounda
(low population)











As more budget is used to minimize infeasible trips, more areas become reachable along the road network

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Thank you **Data for Climate Action Challenge**

Thank you **Fathom.global** for access to flooding data

Thank you **Data Science for Social Good Summer students** for the hard work and brainstorming

Thanks!

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