Complex networks approaches to the Urban Transport Master Plan in Kinshasa. Advantages, constraints and perspectives

Dr. Arch. Emanuele Strano

THE WORLD BANK

Some theory...

Our daily life is embedded in a network-like environment, roads.

Strano et al. (2013) *Urban street networks, a comparative analysis of ten European cities.* Environment and Planning B 40-6.

Some theory...

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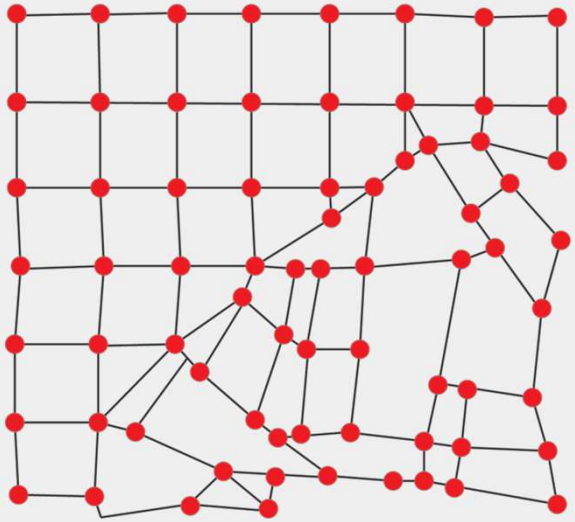
Roads network of Barcelona



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Centrality in urban road networks

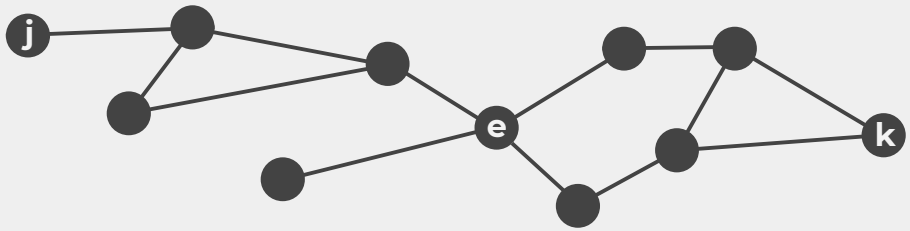
Measuring places *in between*

Roads network of Barcelona

Betweenness centrality (b)

Measures how many times a node is transversed by shortest paths connecting all pair of nodes.

$$b(e) = \frac{1}{(N-1)(N-2)} \sum_{\substack{j,k \in \mathcal{N} \\ i \neq k, j \neq k}} \frac{n_{jk}(e)}{n_{jk}}$$



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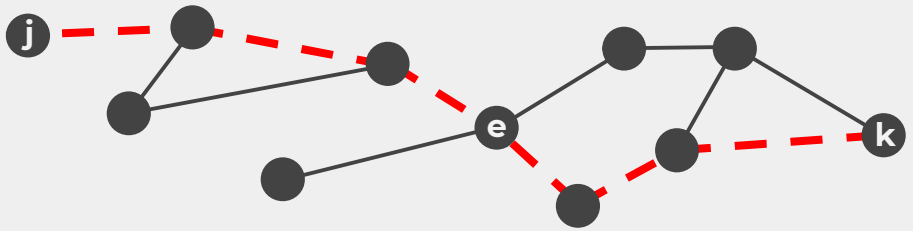

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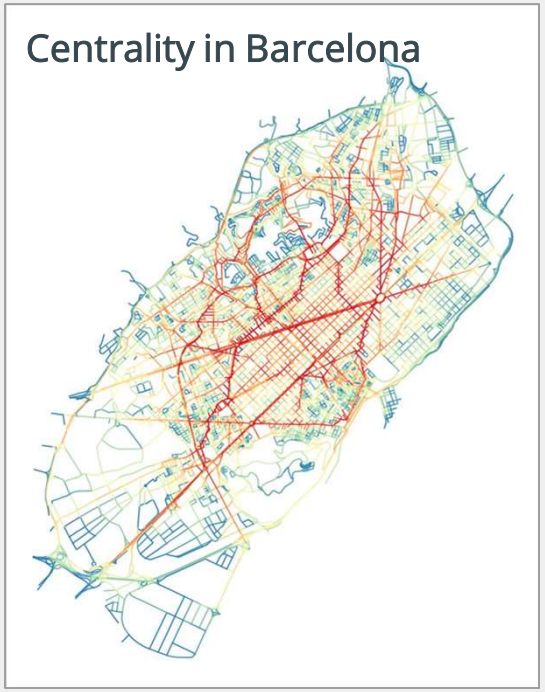

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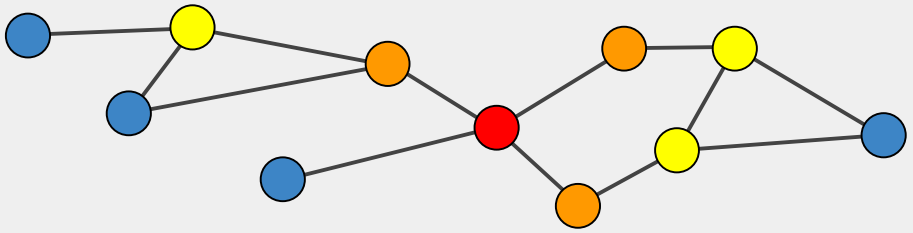

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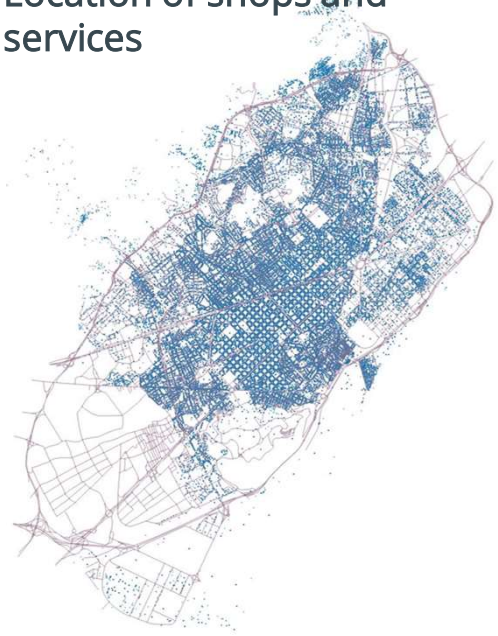
Road structure vs. micro economic activities

Does roads' structure imply the location of economic activities ?

Centrality in Barcelona

Location of shops and services



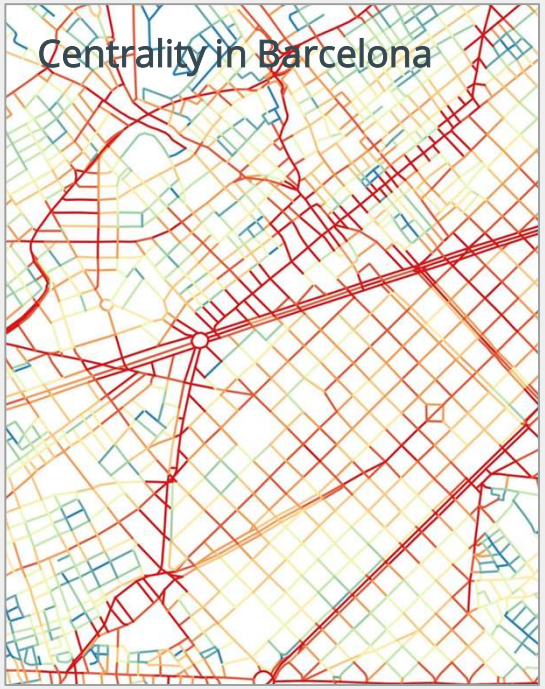
The Mario's dilemma

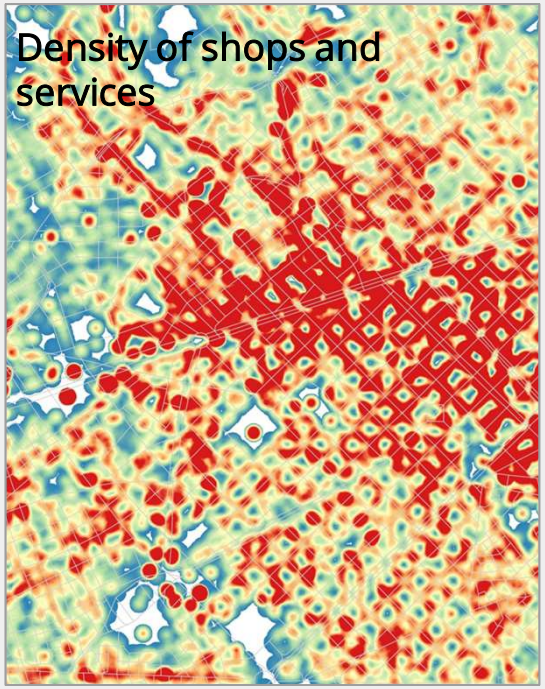
Where I open my new pizzeria?

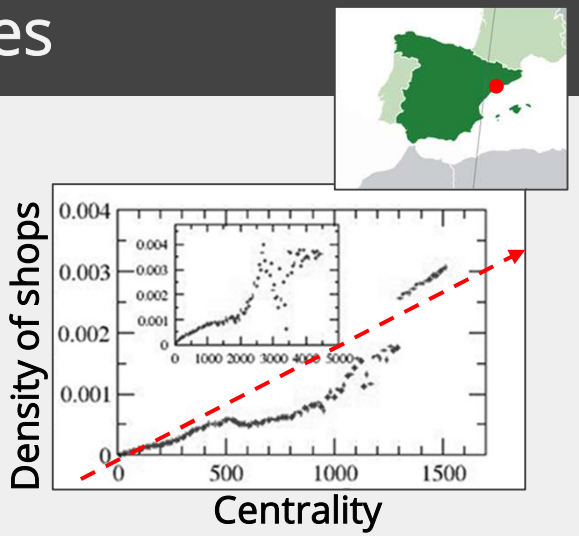
Porta,S. Latora,V. Wang,F. Rueda,S. **Strano,E.** et al. *Street centrality and the location of economic activities in Barcelona street networks.* Urban Studies 49-7.

Road structure vs. micro economic activities

Road centrality is correlated with shops' locations





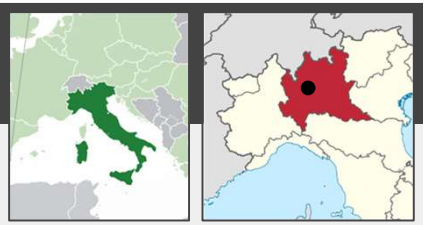


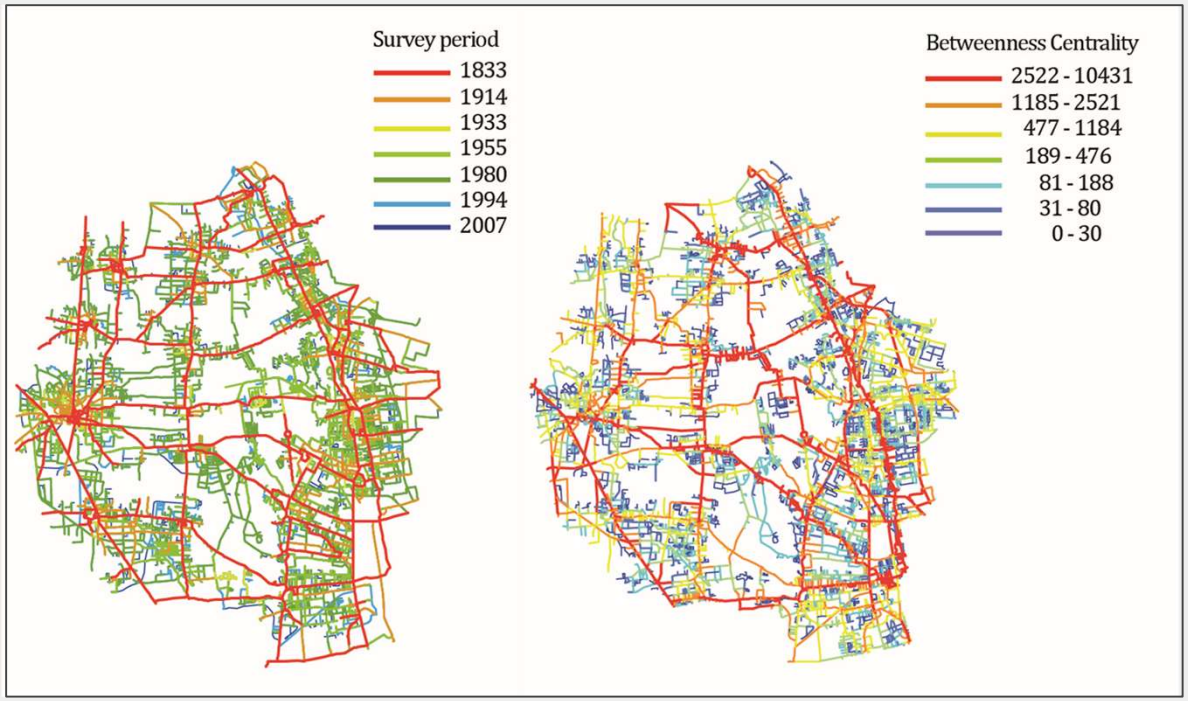
Finding: a place itself may not attract people or cargo as a major trip destination, but it may take advantage of its unique location as merely a pass-through nexus to generate great business opportunities. Hence a **high value of betweenness centrality often implies a high concentration of commercial or service activities.**

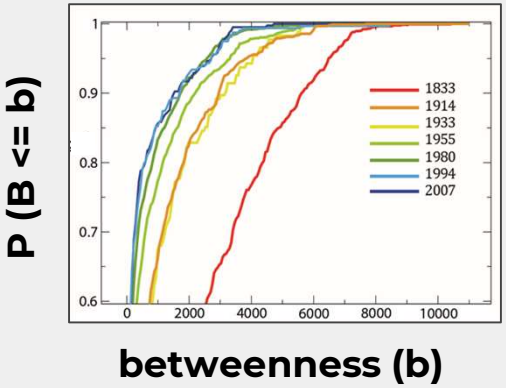
Porta,S. Latora,V. Wang,F. Rueda,S. **Strano,E.** et al. *Street centrality and the location of economic activities in Barcelona street networks.* Urban Studies 49-7.

Processes of evolution in road systems

Centrality remains stable over time



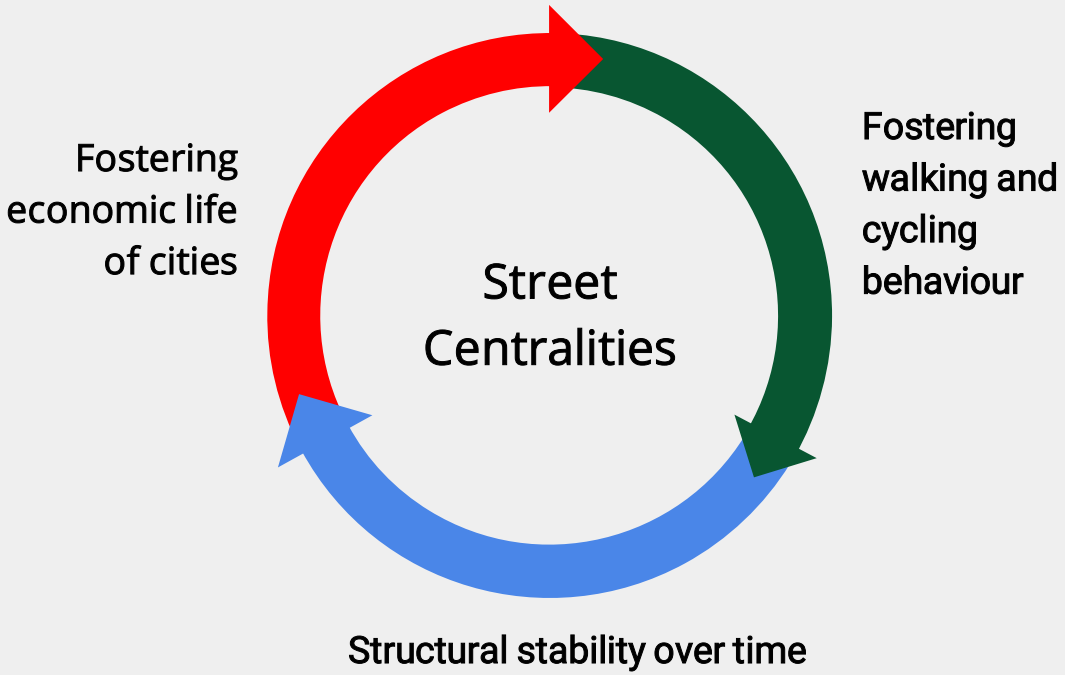




Finding: The backbone structure in road system remains stable over decades, suggesting that:
1: Once a central place emerges is likely to stay there for long time.
2: Creating a new central place must imply a great eff

Strano et al. *Elementary processes governing the evolution of road networks.* Nature Scientific Report 2-296.

Few lessons learnt…



… but how we can use it in real planning practices?

Kinshasa (RDC)

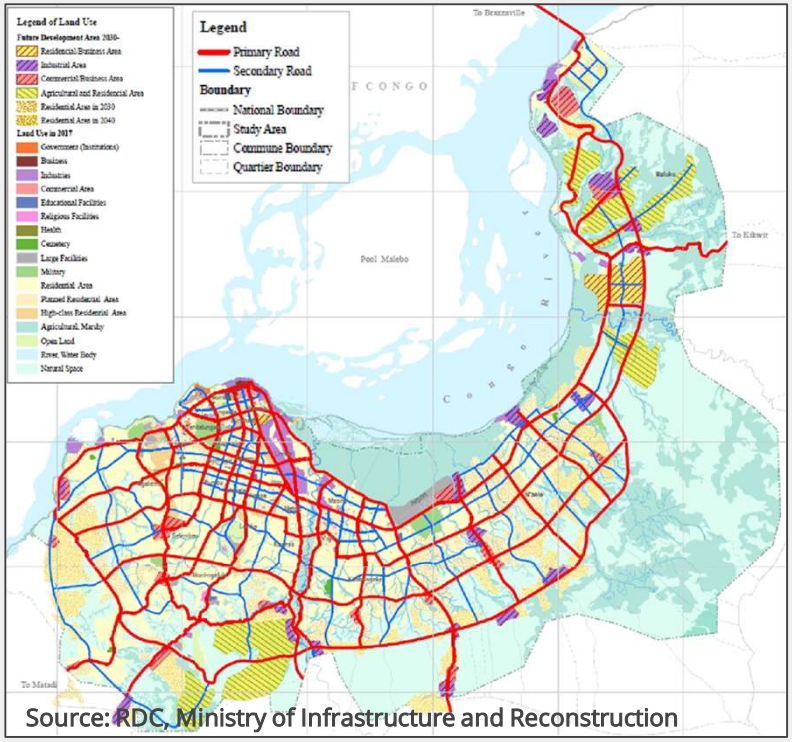
Estimated pop 2017: 12M
Estimated pop 2040: 26M

Fertility rate 6.1 (RDC)
Fertility rate 5.1 (Kinshasa)

Severe risk exposure (erosion)

Lack of infrastructures

Urban transport master plan to 2040

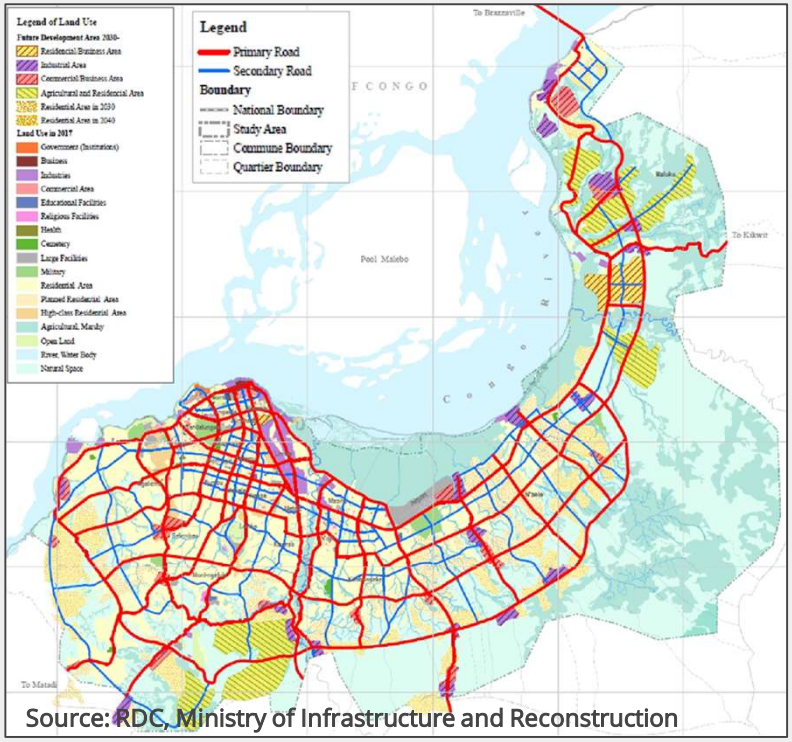


Source: RDC, Ministry of Infrastructure and Reconstruction

- **Spatial planning goals:** toward a highly connected African metropoly. Decreasing risk exposure (erosion).
- **Estimated total cost**: 33B
- **Funding schema**: Internal government schema (incremental taxation + land value capture (LVC)).
  External founds: loans and donations.

Urban transport master plan to 2040

Managing the transition from current state to 2040



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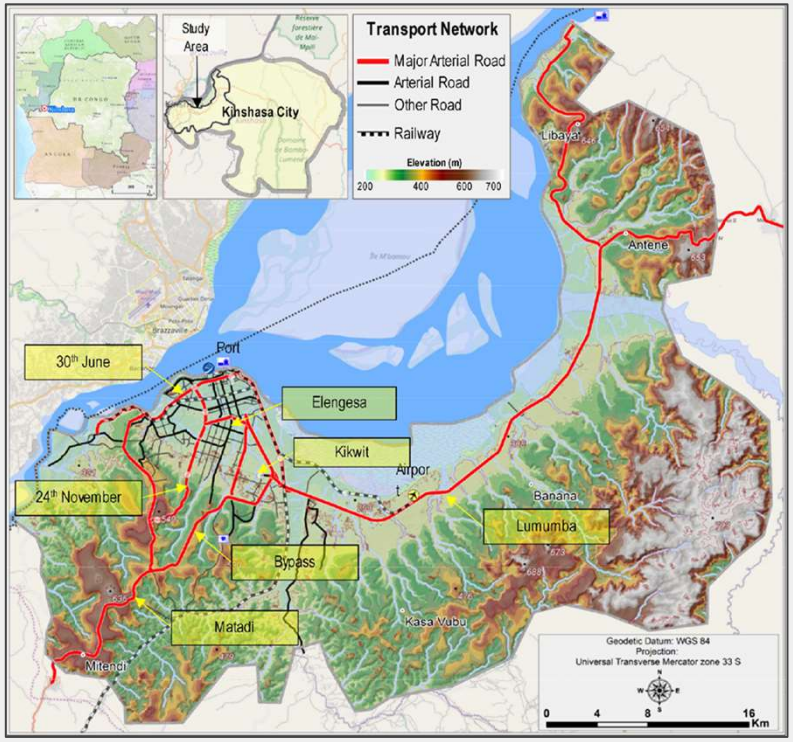
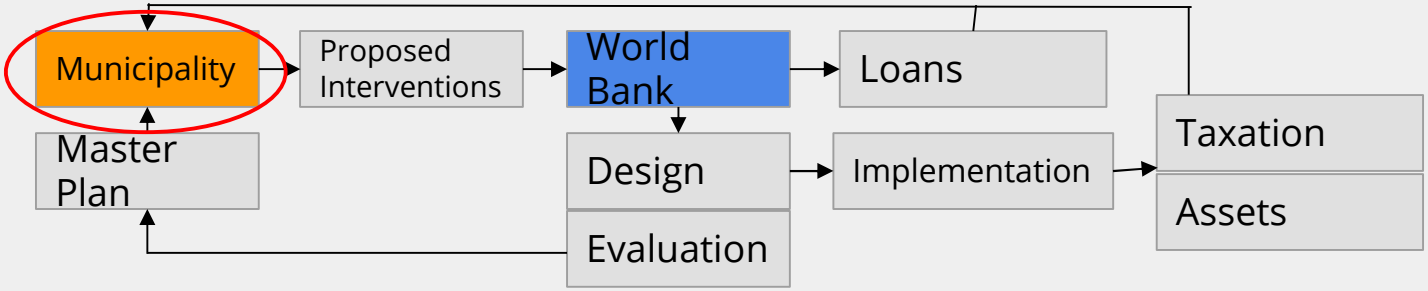
2040 goal

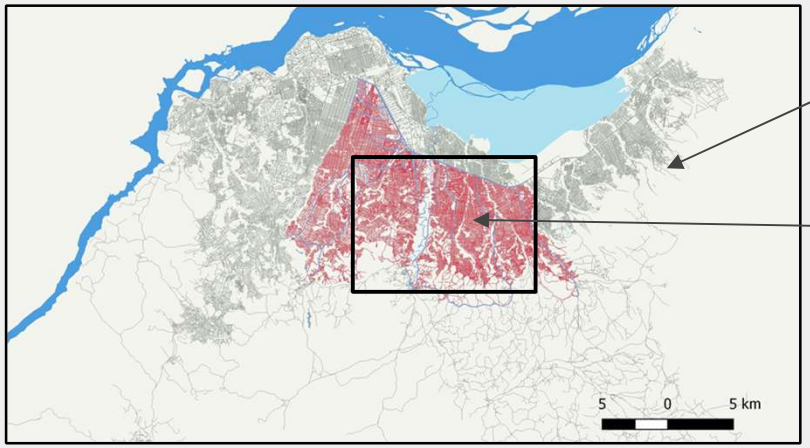


Current situation

Transport master plan in Kinshasa (RDC)

Implementation schema



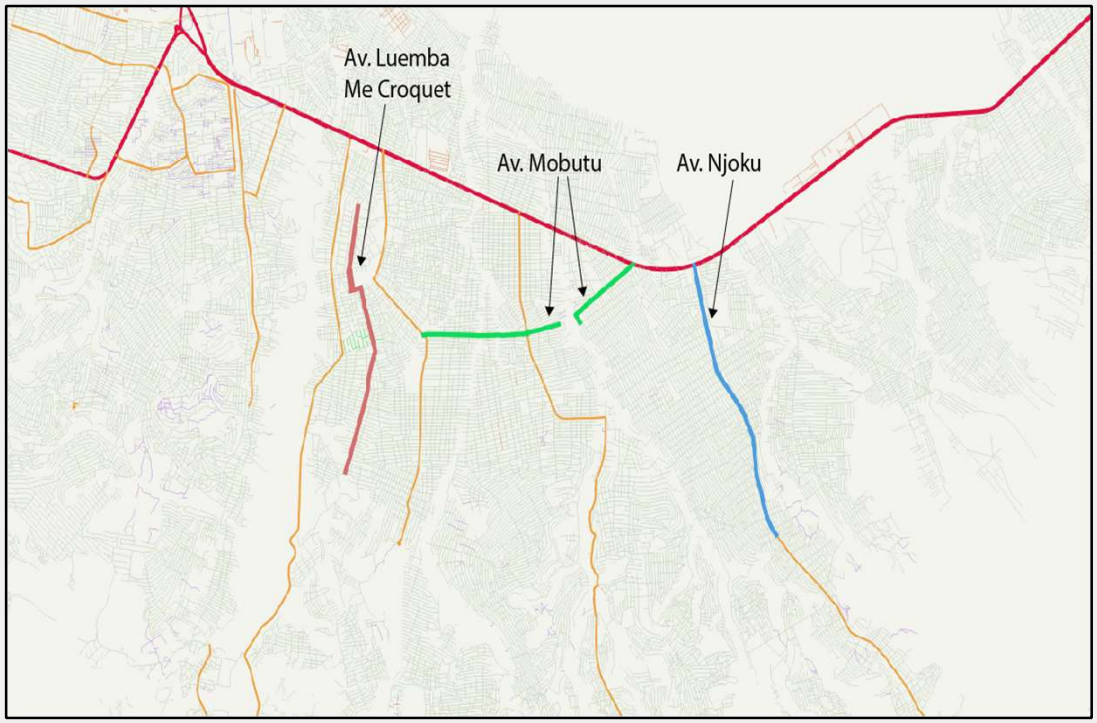


Road network of Kinshasa

Area of interventions

Transport master plan in Kinshasa (RDC)

Example roads upgrading interventions



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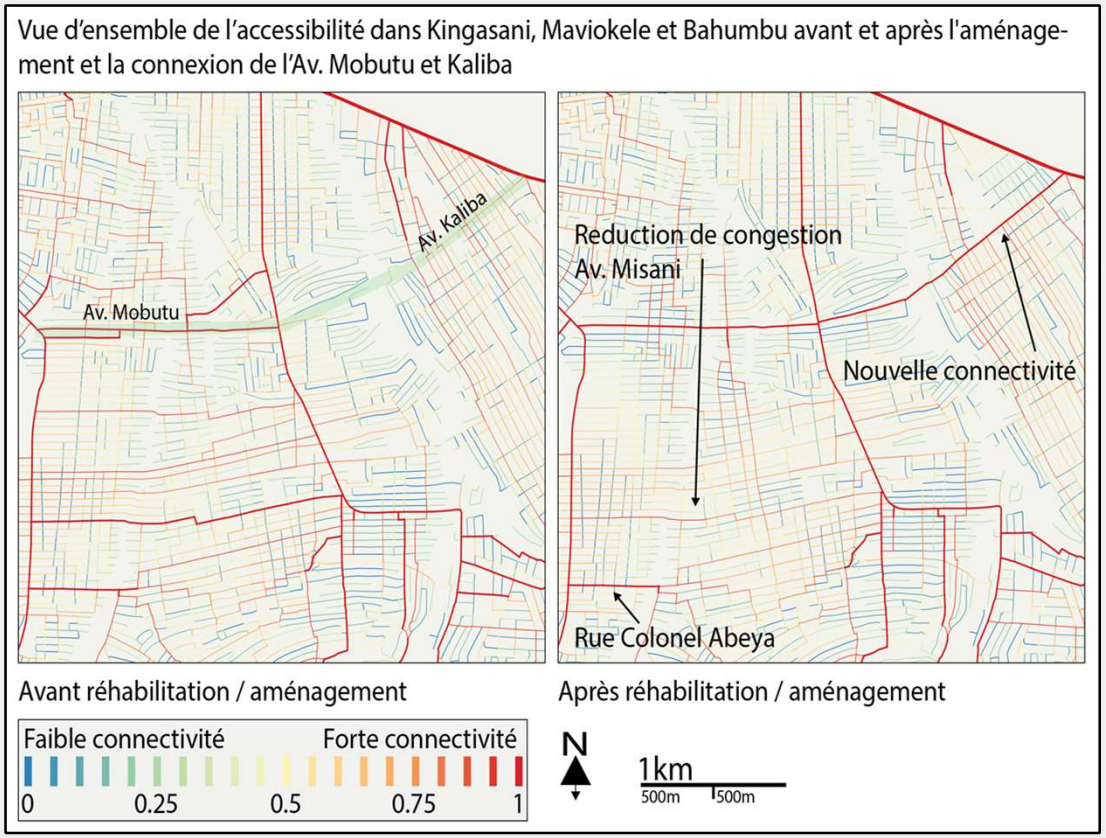
- Fast tool to measure the impact of road network accessibility given some interventions

Transport master plan in Kinshasa (RDC)

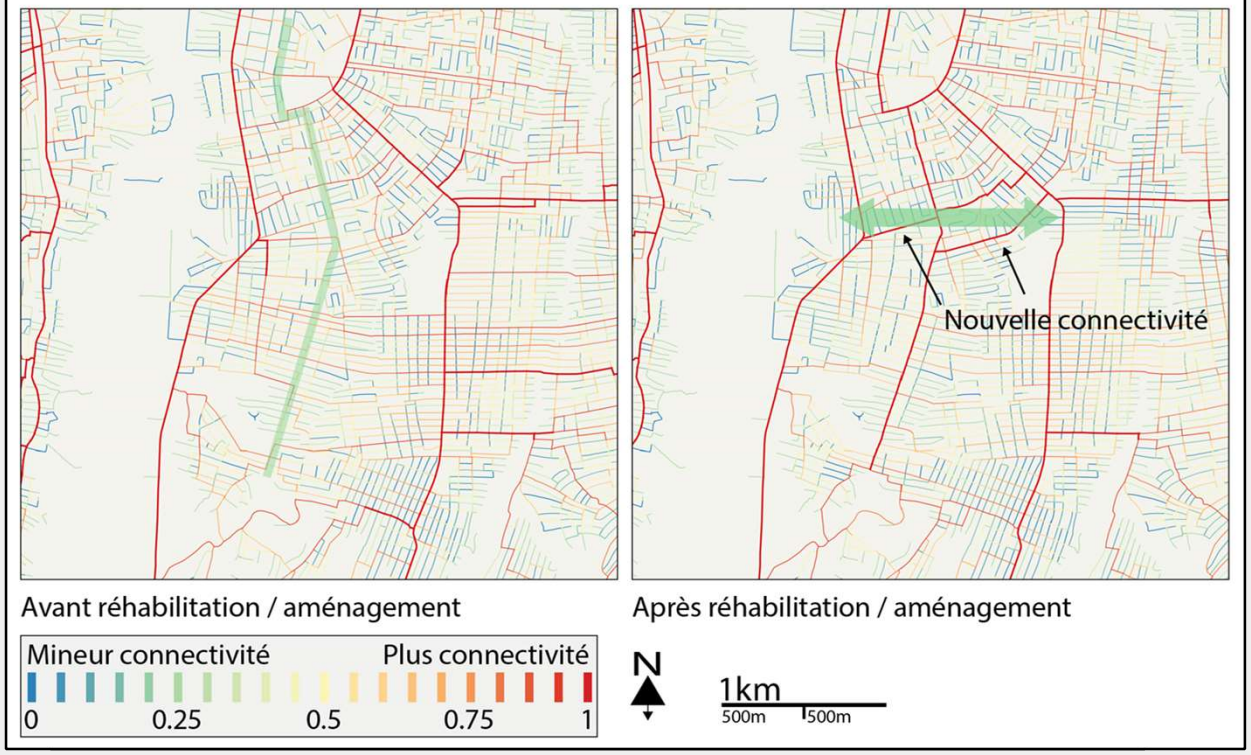


Evaluation(improved version of Betweenness Centrality)

- Analysing the effect of upgrading intervention on overall connectivity.
- Propose further interventions according to the MP and the new connectivity patterns.

Transport master plan in Kinshasa (RDC)

Vue d'ensemble de l'accessibilité dans le Quartier 5-6-13 avant et après l'aménagement de l'Av. Luemba et Me Croquet.



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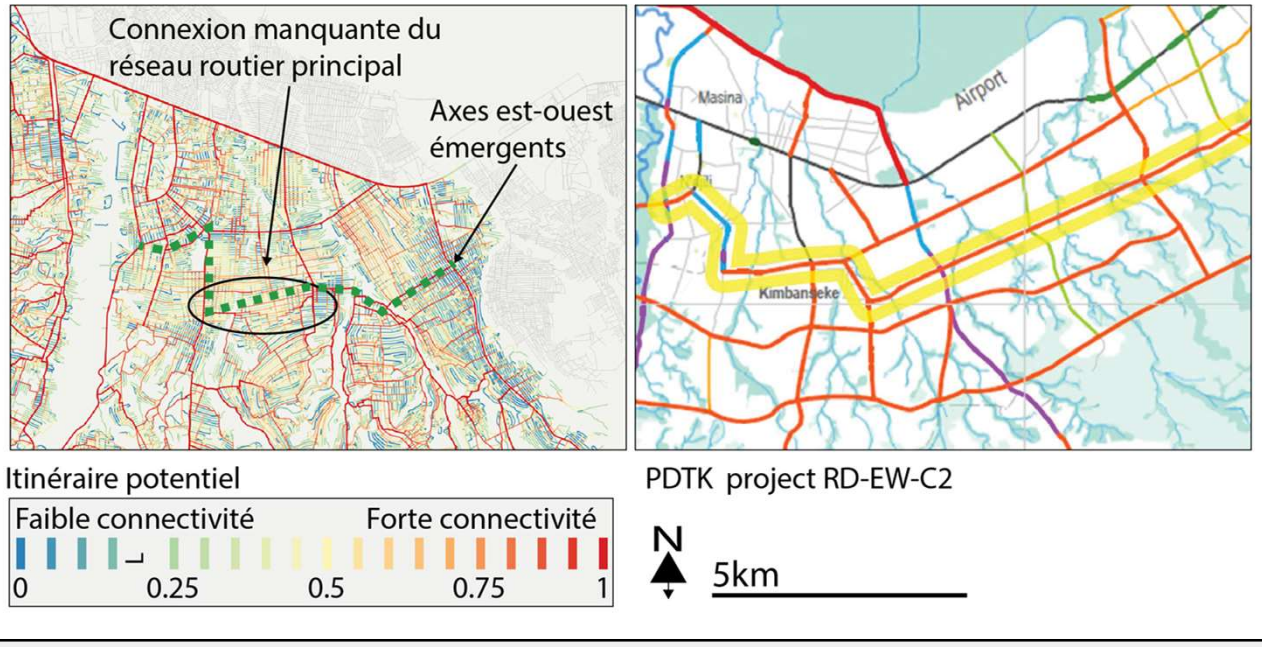
Transport master plan in Kinshasa (RDC)

Evaluation du stade ultérieur de développement en fonction de la nouvelle centralité et du PDTK projet RD-EW-C2 pour le deuxième axe est-ouest dans la division centrale



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Conclusions

Advantages of network approach

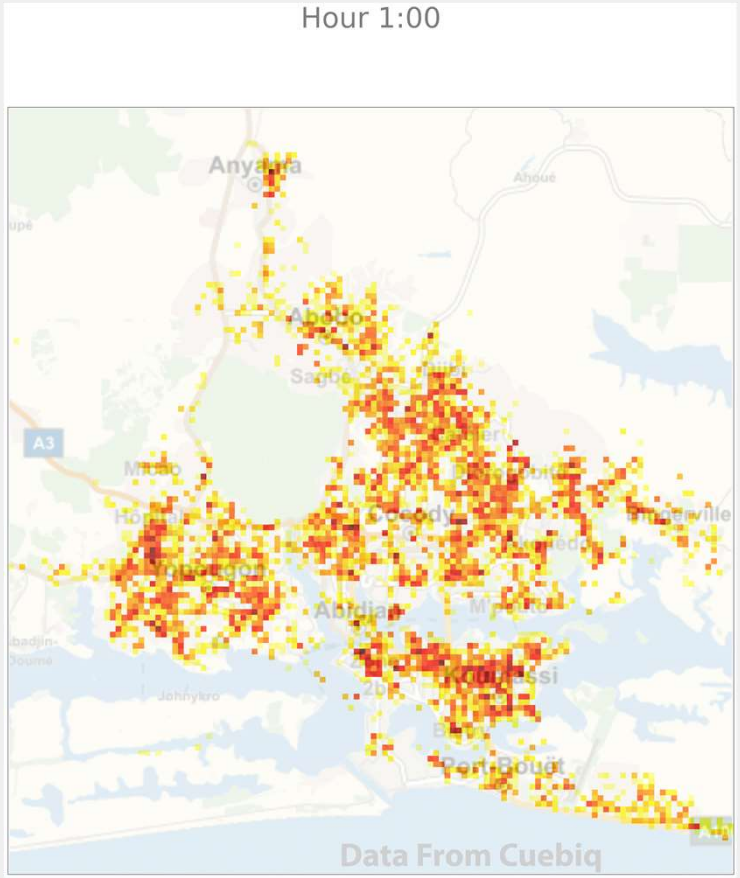
- Speed of the analysis. In absence of mobility data a traditional transportation model is impossible to calibrate.
- Connection with other urban assets beyond transportation (economic activities, urban form, street layout, urban design)

Constraints

- OSM data can be improved for transportation analyses.
- Absence of data to make validation tets.

Perspectives and future approach

Abidjan mobility maps, frequency of people in 250x250m cell



High frequency mobility data

- Anonimous mobility data coming from multiple mobile application.
- Possibility to calibrate mobility model at street level.
- Monitoring mobility change due to some specific intervention.

THANKS

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