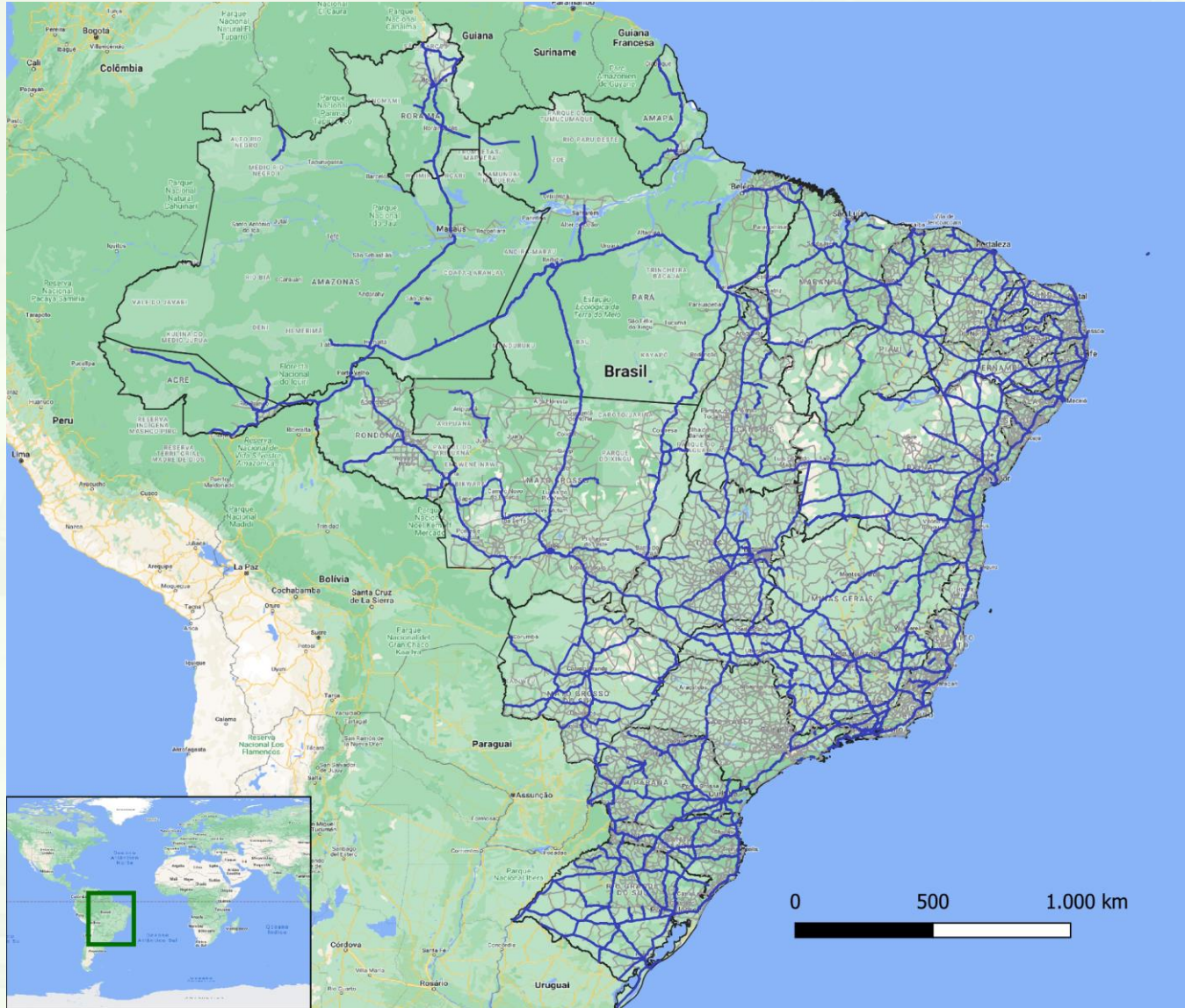


# Where to place WIM stations? The Brazilian Approach Including a Novel Data-Driven Spatial Decision Support System

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# Welcome to: *Brasil*



## Federative Republic of Brazil

- 5<sup>th</sup> largest in area
- 6<sup>th</sup> most populous
- **1.6M km** road network
- 75 000 km under federal jurisdiction (blue)
- 65 000 km under state administration (DNIT)
- 2.9M trucks registered
- 260 000 road freight companies
- 1.5T tkm yearly through road transport (65%)

# Weight enforcement in Brazil

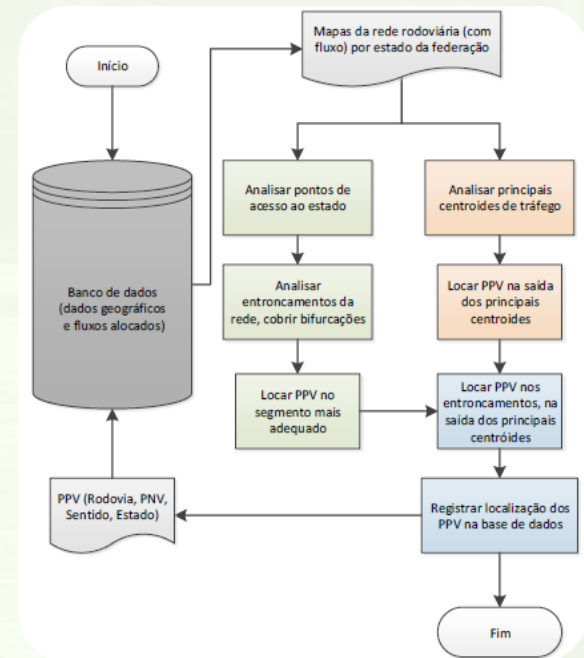
- Since 1975 Brazil uses low-speed WIM as the standard for weight enforcement
- Medium speed WIM was later adopted as preselection to increase effectiveness
- High speed WIM is now starting to be used for on-road preselection
  - *Direct weight enforcement is in the near future!*



# Weigh station placement

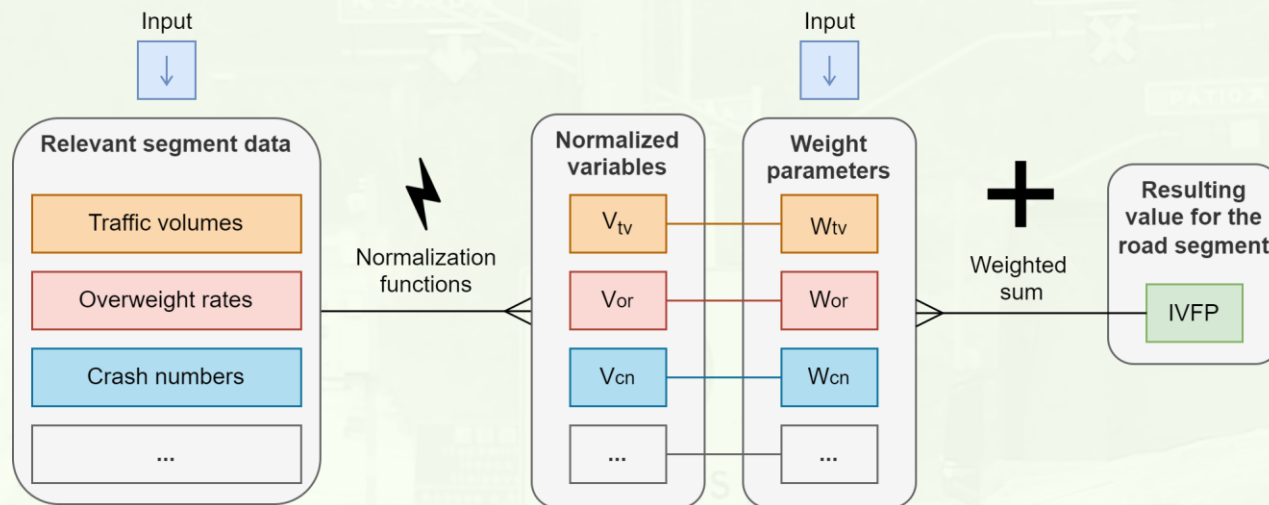
Since weight stations are permanent and expensive and the road network is continental, how to effectively place weight stations?

- Since 2006 DNIT has studied this, seeking for the most effective methodology to place weight stations in the Brazilian road network
- This included creating a methodology to study geographic maps and determine the best locations
- Since 2017 a new methodology has been developed, which includes a multi-criteria decision support method and a spatial system



Flowchart of the method used for weight station location in the National Weighing Strategic Master Plan (PDNEP), developed by DNIT in 2006

# Multi-criteria method

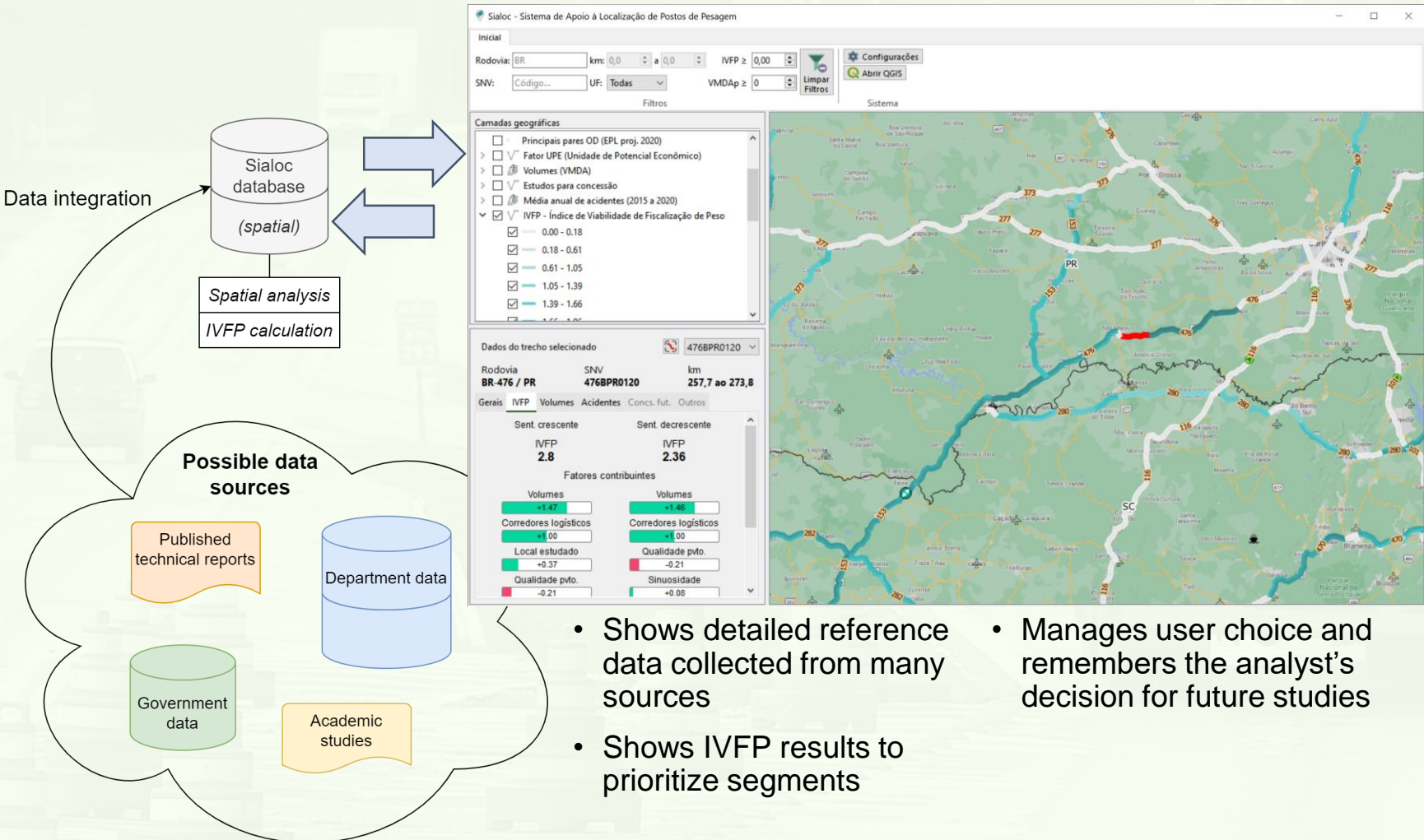


- Traffic volumes
- Private concessions
- Previous placements
- Overweight history
- Logistic corridors
- Road geometry
- Crash history

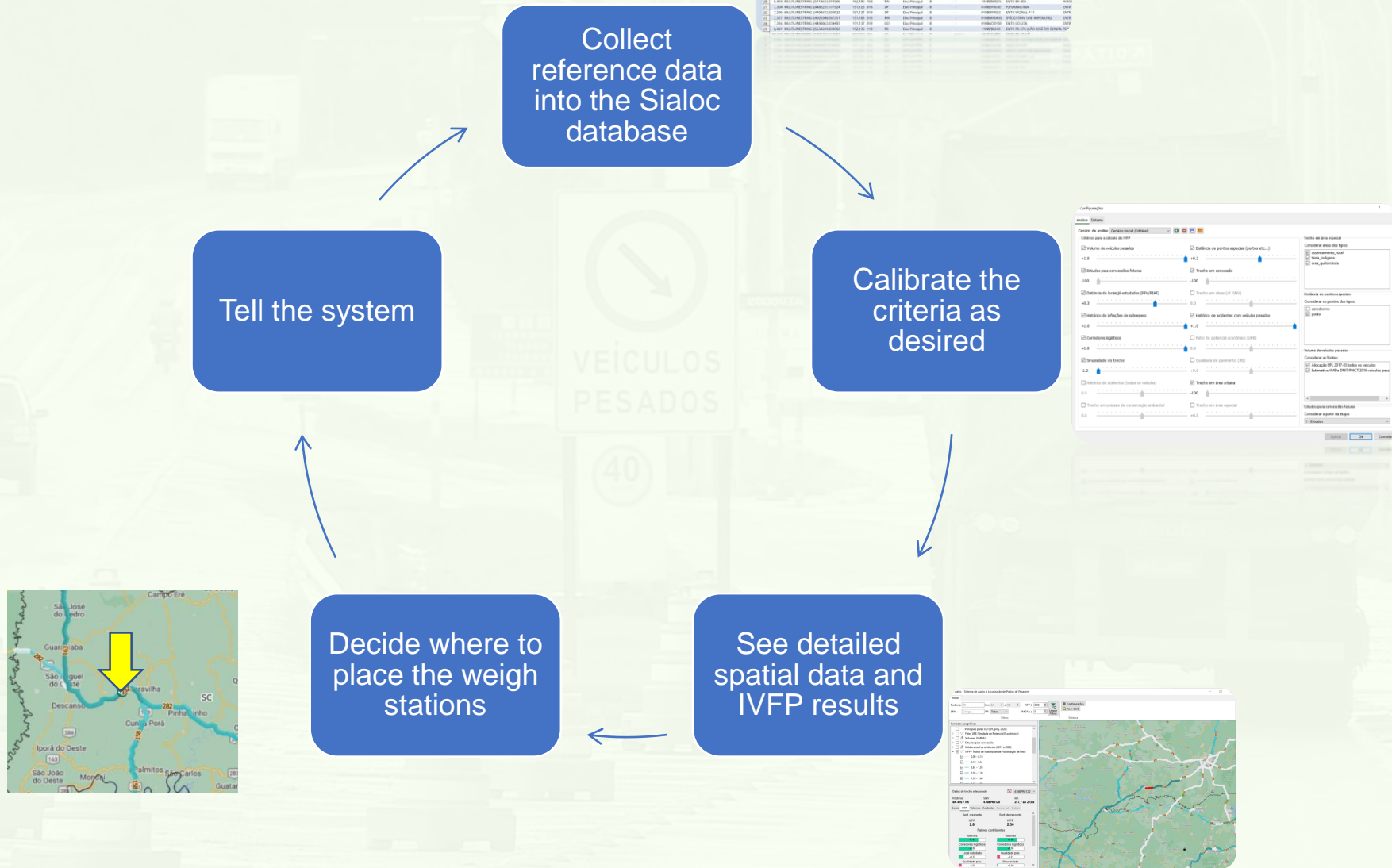
- Placement in protected areas (environmental etc.)
- Nearby interest points (ports, freight terminals etc.)
- Future works predicted
- Economic potential
- Pavement surface quality
- Placement in urban areas

# Spatial decision support system (Sialoc)

Sialoc is a purpose-built GIS for weigh enforcement location



# Practical workflow



# Comments on the method

1. The idea is to provide the analyst with all the information they might need to make a good decision on WIM location.
2. How the decision will be made is up to them, although the system can help prioritize the most critical segments.
  - Most importantly: promptly discard places where WIM is not viable for any (user informed) reason
3. Maps are central to the decision, so using a GIS is a no brainer.
4. GIS software (QGIS, ArcGIS etc.) are hard to operate, but a purpose-built system is accessible to the analyst.

# Future: mathematical optimization

- The problem of enforcement evasion is **very real**
- The WIM paradox:



- Mathematical formulation:  
**Evasive Flow Capture Problem**
- Implemented and tested on for the Brazilian highways



## Effects of drivers' evasive behavior on the placement of automated enforcement equipment in highway systems

*Efeito do comportamento evasivo dos motoristas sobre a localização de equipamentos automáticos de fiscalização em rodovias*

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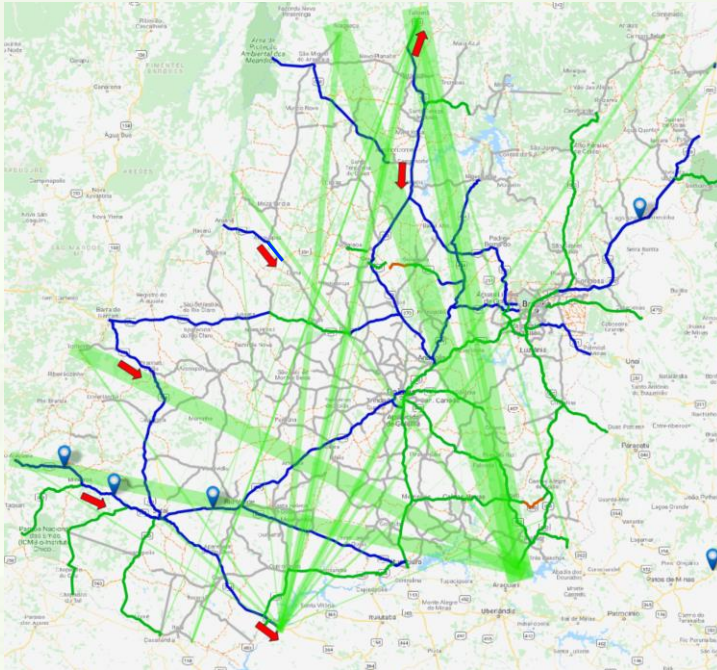
<sup>3</sup>Federal University of Santa Catarina, Santa Catarina – Brazil, luciano.kaesemodel@gmail.com

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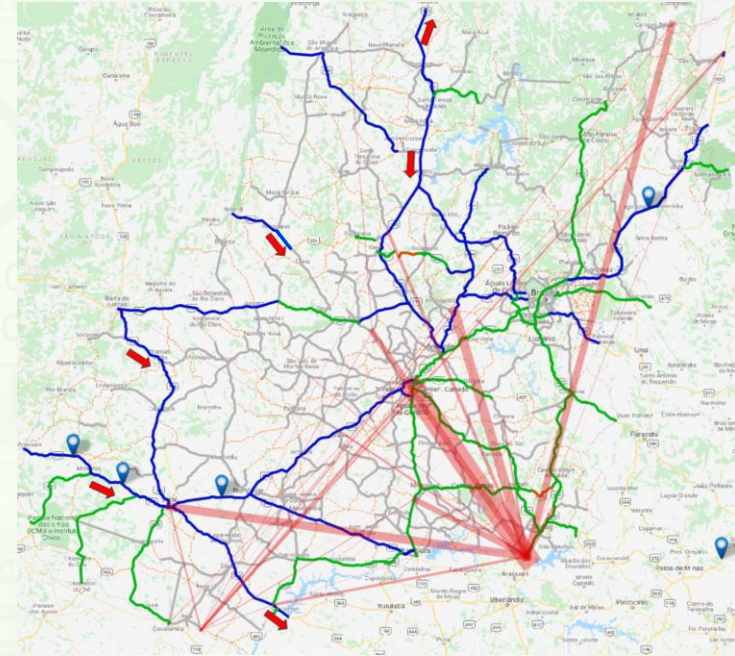
# Future: mathematical optimization

Case study: WIM location via mathematical optimization in the state of Goiás, Brazil

- WIM only on DNIT (blue) roads; using real freight volume data; 20% acceptable detour.



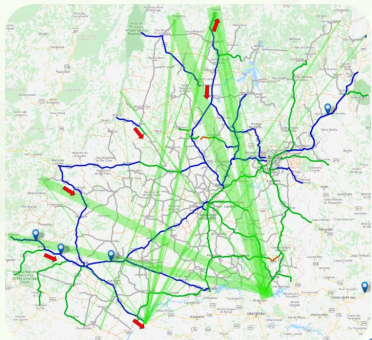
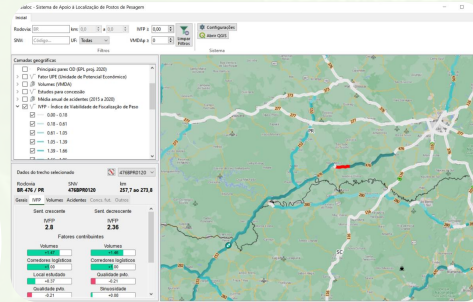
86% of the volume is “captured”, that means, there are **no routes (within 20% distance from the sortest)** from origin to destination that are not monitored by WIM



The remaining 14% are uncaptured, which means that there are possible unmonitored routes

# Future of Sialoc

Reference data visualization

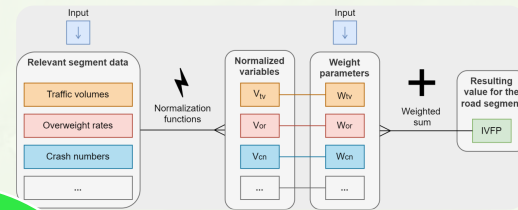


Spatial decision support software (Sialoc)

Mathematical simulation and optimization for evasive flow capture

**WORK IN PROGRESS**

Multi-criteria decision analysis via IVFP



**Thanks!**

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