Global Geospatial Conference 2013

GIS-based accessibility analysis:

An approach to determine public primary health care demand in South Africa

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‘One of the main problems with health care is not simply that it lacks quality and comprehensiveness but also that, because of maldistribution of facilities and their resources, it is often not easily accessible to those in need’ WHO (1993)

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Outline

- Concerns in health provision in developing countries
- Addressing provision through Service Access Planning
- GIS-Based accessibility analysis model as an option
- Key challenges to application
- Application
- Preliminary results
- Concluding remarks

Planning for health care

- Provision of adequate health care is becoming difficult:
  - Rapid growth of informal settlements and population
  - Urbanization of poverty
  - Slow econ
- **CHALLENGE**: health benefits to the greatest number of people through efficie
- Health care pl ange of to ce delivery system
- GIS-based ac be useful t of some aspects of performance tegic healt
- Overall level availability sess performance

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Service access planning

WHO gets WHAT, WHERE and HOW?

Objective 1:

Improvement of service accessibility and availability from the perspective of existing and potential customers

Approach

- Process:
  - Analyse existing service accessibility and availability
- Explore & adjust facility locations & sizes in relation to:
  - spatial distribution of demand
  - threshold targets
  - other facilities / clusters / nodes

Objective 2:

Attraction of the threshold volume of customers that is needed to cover the overheads and make the service viable

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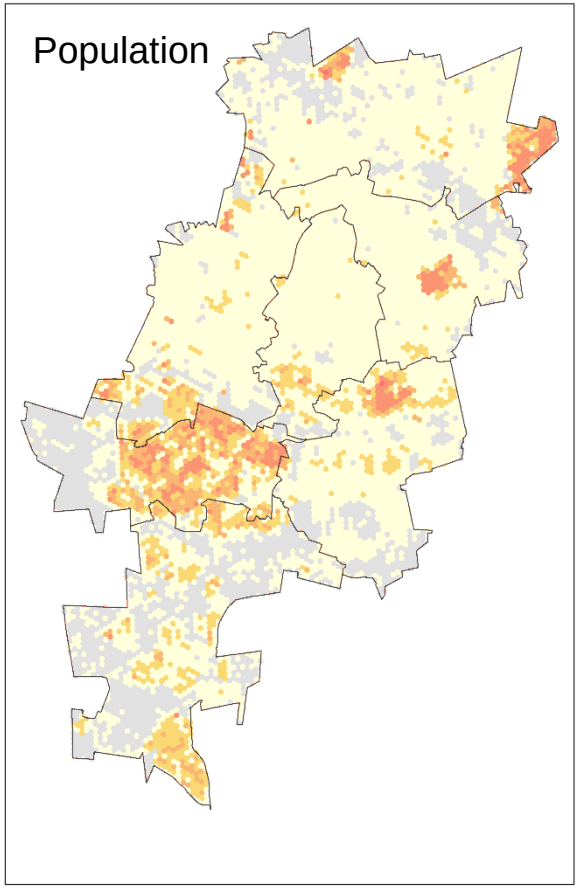
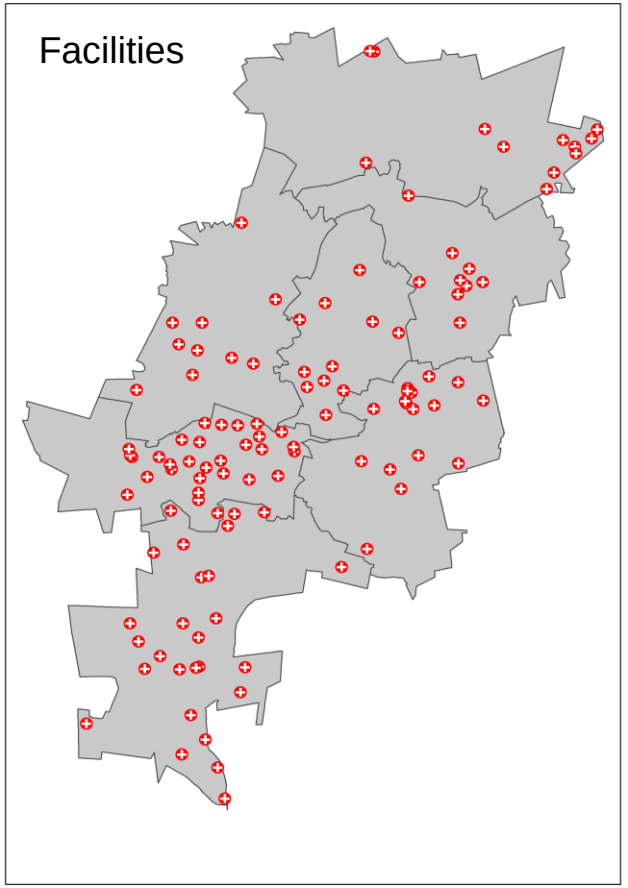
What is accessibility analysis?

- Models the accessibility and availability of facilities, evaluating the spatial relationship between demand and supply for services
- It's based on assumption of rational choice to use the closest facility
- At a strategic level analysis which takes the entire city / sub-region into consideration it shows whether provision is
  - sufficient and
  - equitably available

How does it work: inputs





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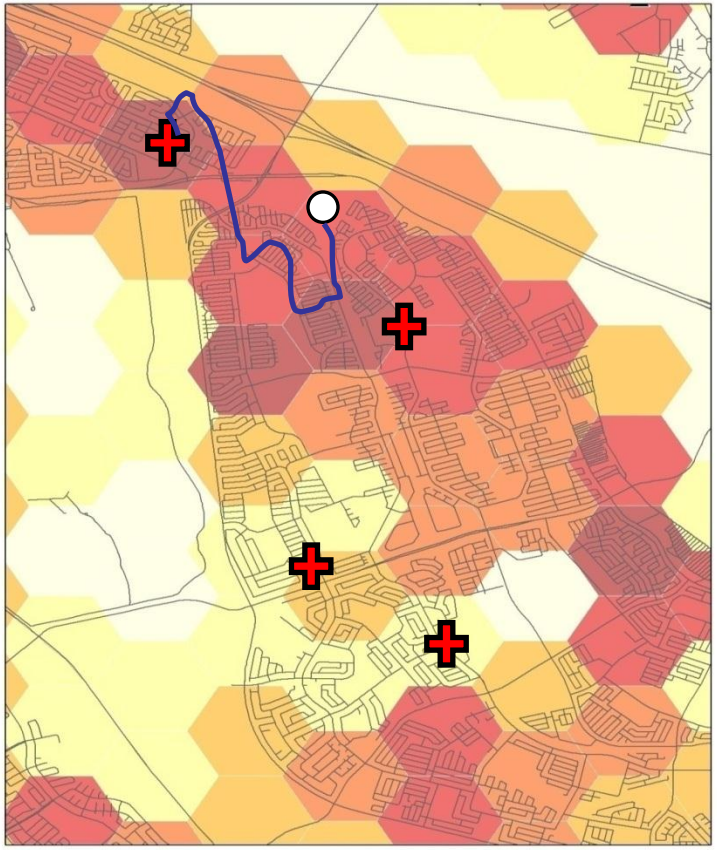
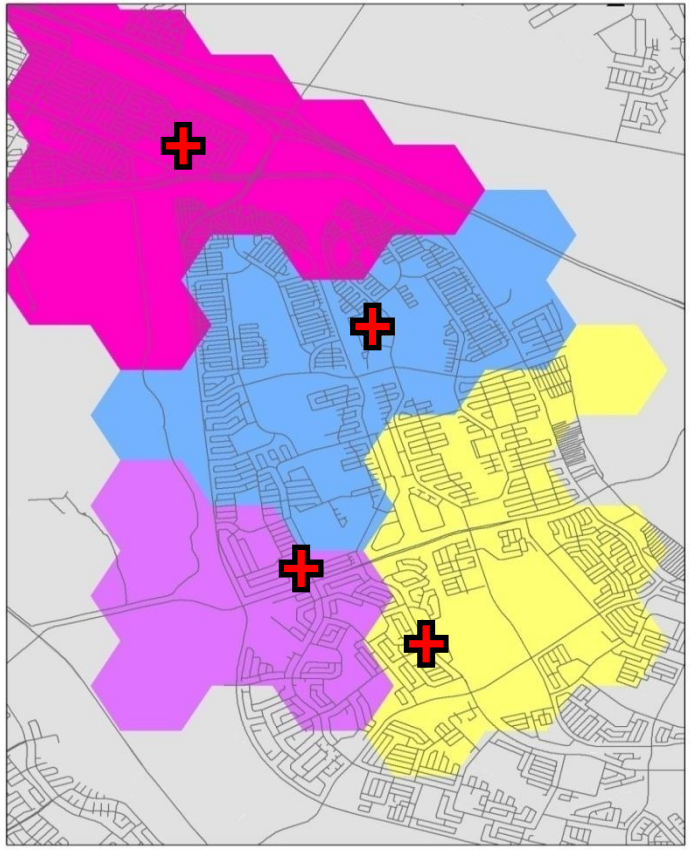
How does it work: process & outputs





Contribution of accessibility analysis to planning

- Accessibility modelling - improved means of measuring facility access and of identifying poorly served areas and backlogs (spatially)
- Inform long term plans
- Measure progress w.r.t. service delivery of services
- Assist in setting service standards and benchmarks

Key challenges to application

- GIS is proving to be a useful tool for service access planning,

BUT

  - Based on untested assumptions in measurement
  - Lack of data inputs in many developing countries
- This raises the question in how far contemporary GIS accessibility analysis is applicable in South African health planning practice of today

- **Two main challenges:**

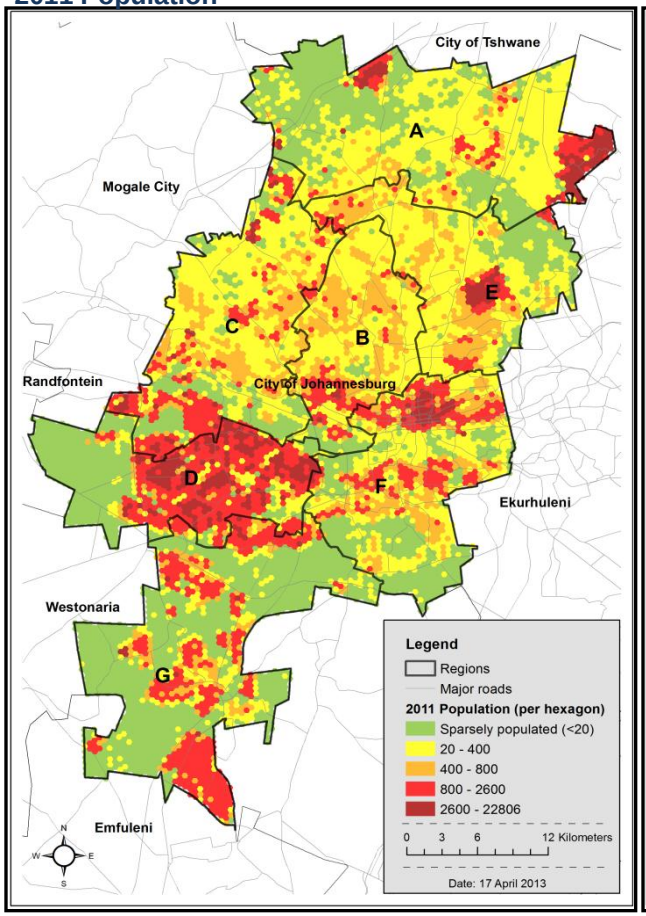
(a) What method is the best in determining demand in the absence of accurate databases indicating public versus private health care usage?

(b) How accurate is a rational choice based model regarding people's actual decisions?

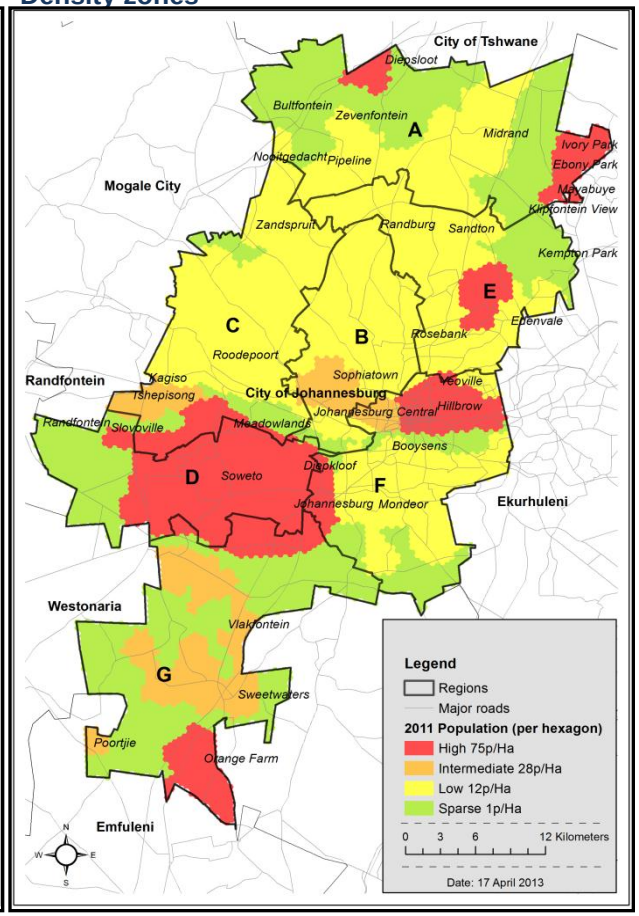
Application in an urban context

Context: City of Johannesburg

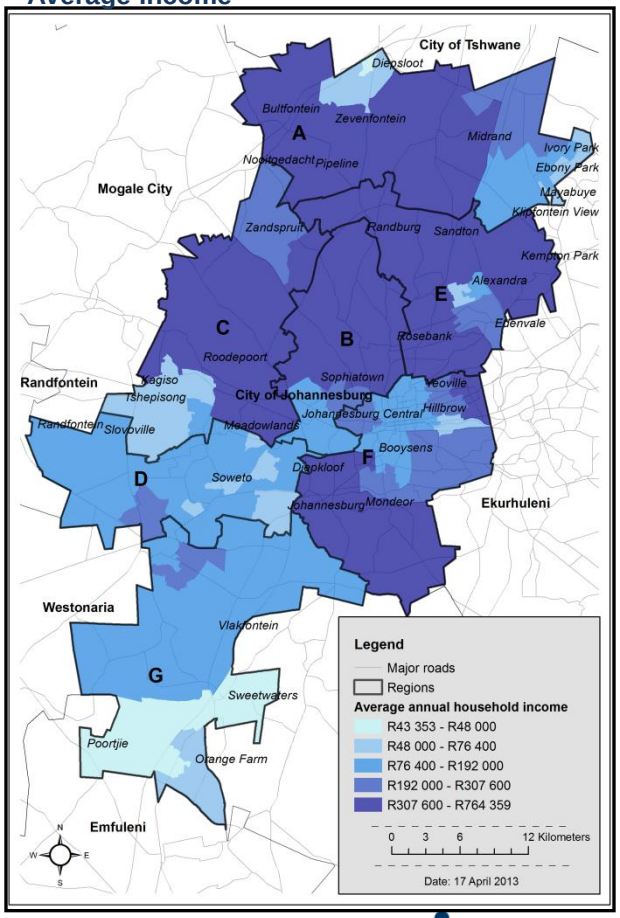
2011 Population



Density zones



Average income



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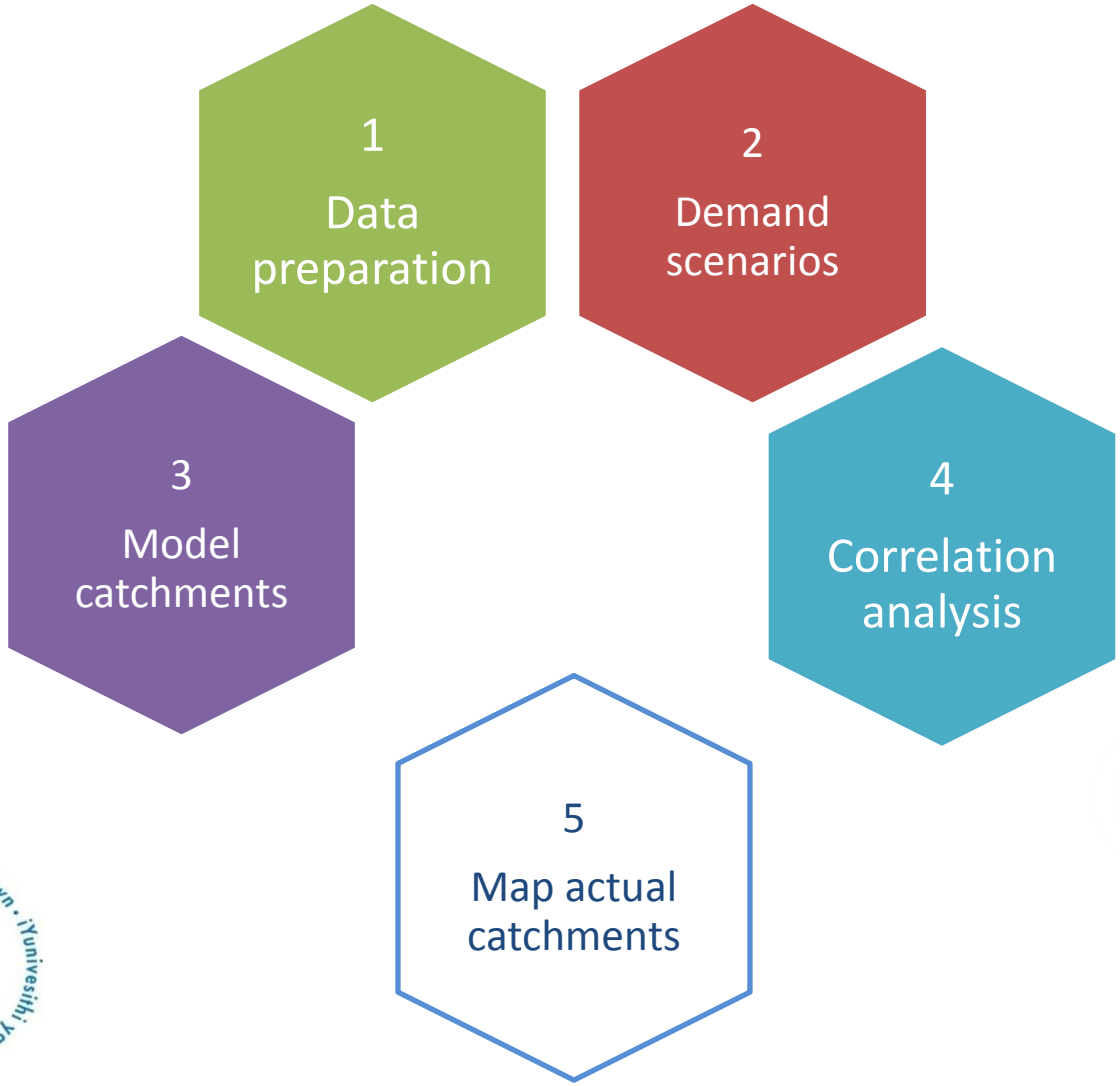
Methodology: Analysis steps



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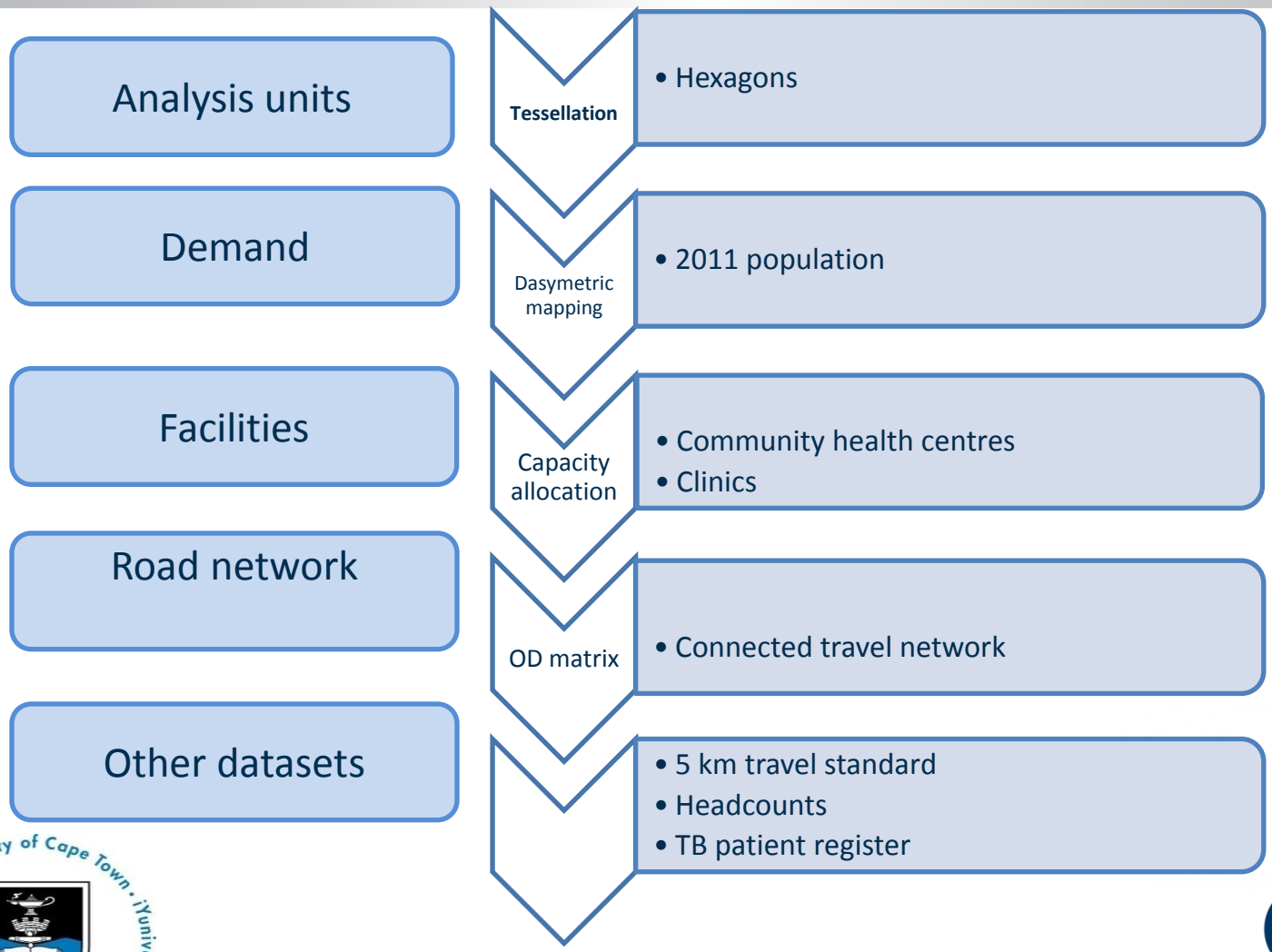
Methodology: Datasets / preparation (1)

1
Data preparation



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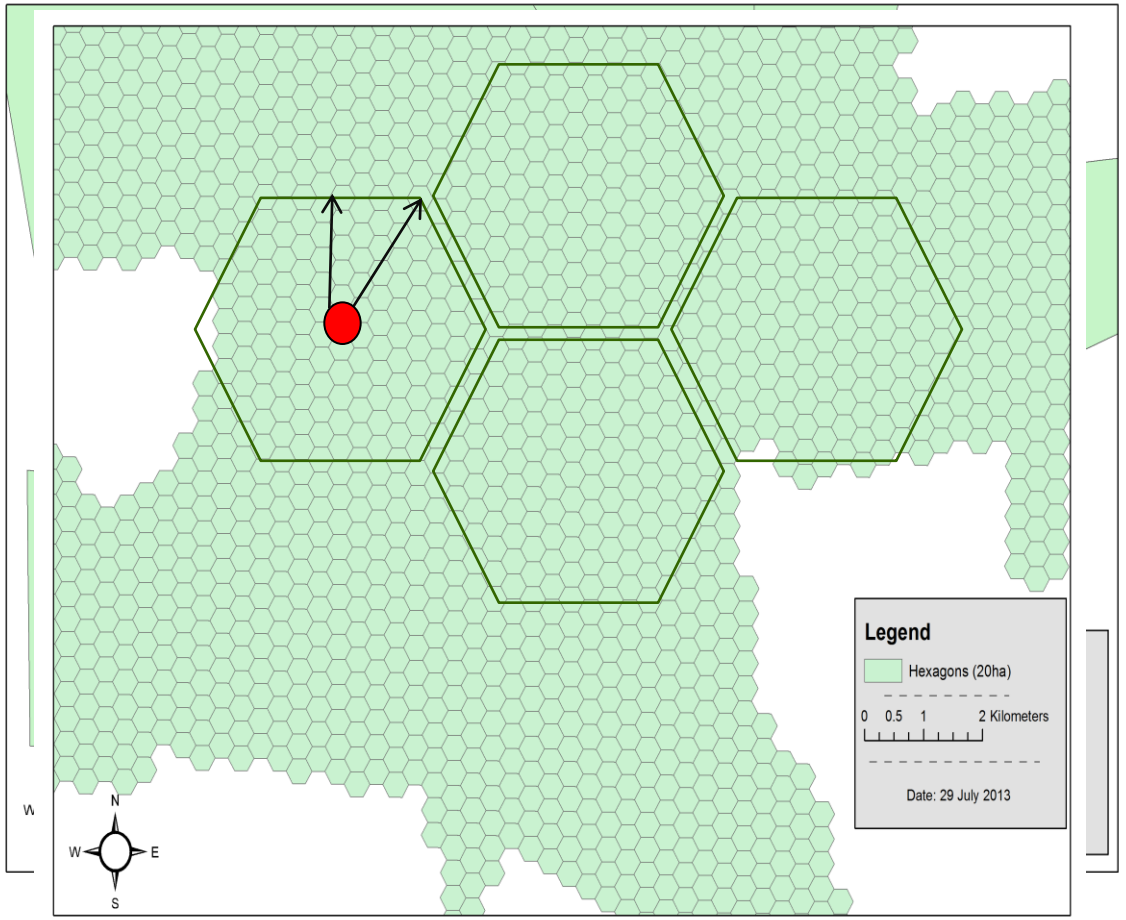
Methodology: Data sets / preparation (2)

1
Data
preparation

Analysis units

- Tessellate study area into a detailed grid
- Consisting of hexagonal polygons of 20 ha each
  - Outputs produced at a detailed level
  - Hexagons nest
  - Better distance measure



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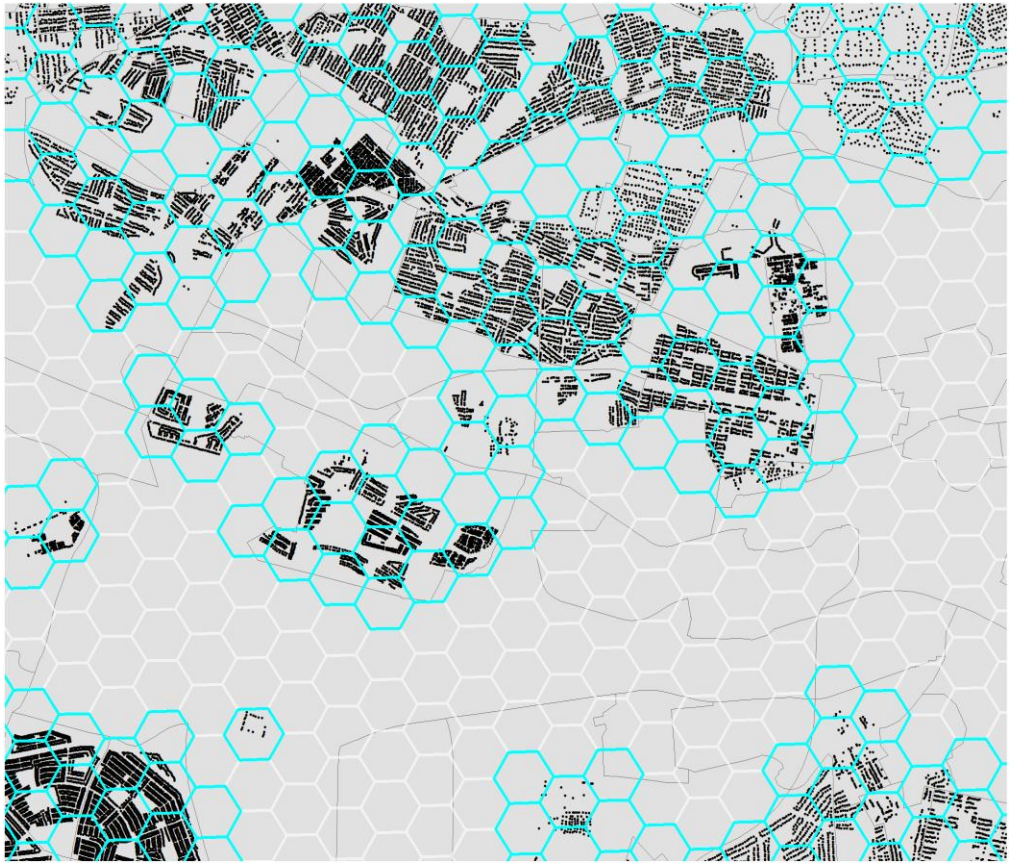
Methodology: Data sets / preparation (3)

1
Data
preparation

Demand

- 2011 StatsSA Census population data
- Data extraction
  - Age breakdown (>5 years and <5 years)
  - Five income segments (StatsSA)
- Disaggregate demand to analysis units using dasymetric mapping



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Methodology: Data sets / preparation (4)

1 Data preparation

Facilities

- 116 public primary health care facilities
- First point of contact
- Facility selection:
  - administered by the public sector,
  - fixed geographical location, and
  - accessible attribute data
- Total facility capacity = can accommodate **64 311 030** visits per annum

CAPACITY ALLOCATION FORMULA

pw / d = n (1)

and

n x s x ps x d = capacity (2)

where,

pw	= professional nurse working days
n	= number of nurses at a facility per shift
s	= hours of operation of a facility
ps	= number of patients a nurse can attend to in one shift
d	= number of days per annum that the facility operates

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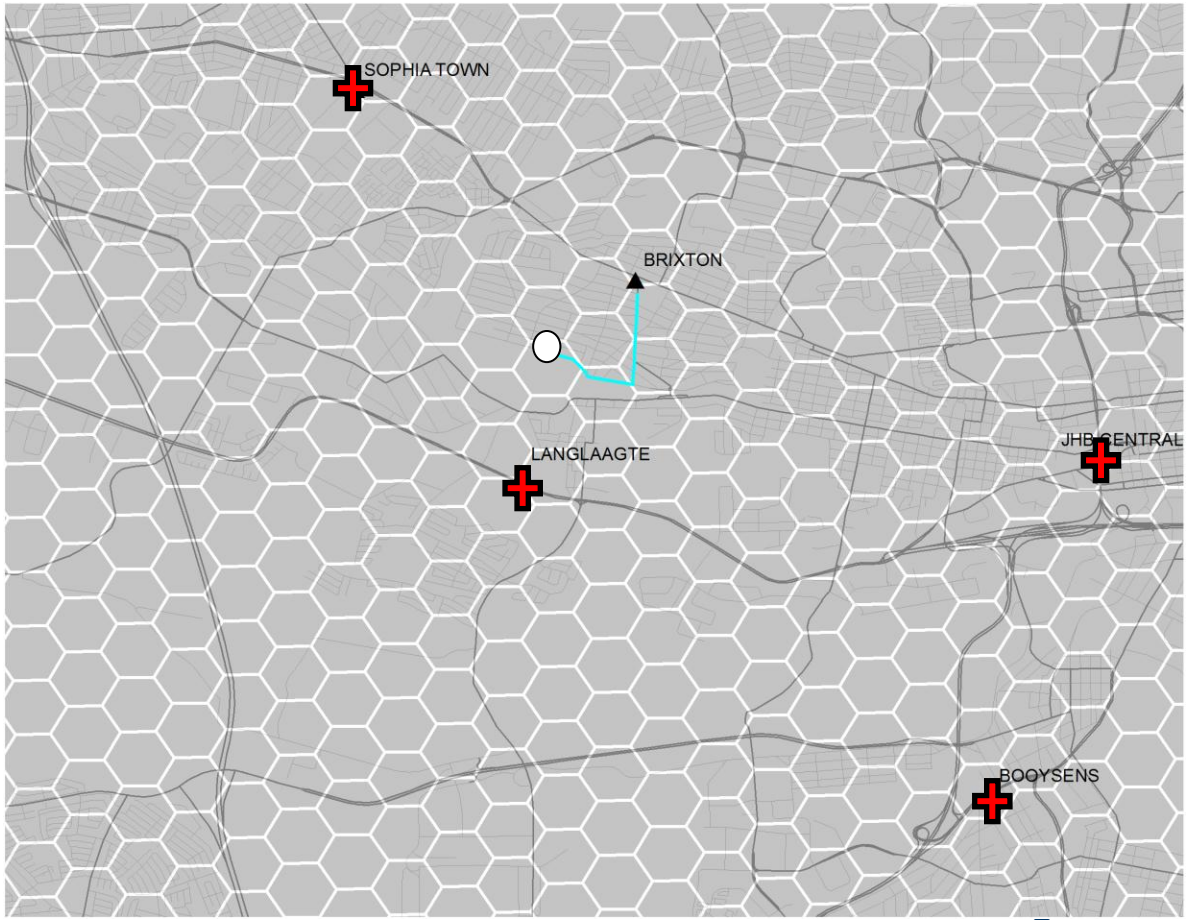
Methodology: Data sets / preparation (5)

1
Data
preparation

Road network

- Complete road and street network
- Create an origin-destination (OD) table based on the network



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Methodology: Data sets / preparation (6)

1
Data prep

Distance parameter

- National standard
- 5 km travel distance

Headcounts

- 2011 PHC actual visits
- Total for entire city: 7 684 912

TB patient register

- TB records with:
  - residential address
  - Actual facility visited

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What method is the best in determining demand in the absence of accurate databases indicating public versus private health care usage?

Methodology: Demand scenarios

2
Demand scenarios

SCENARIO 1

7 124 518 visits

The StatsSA general household survey data on the percentage of medically insured and uninsured population is used to proportionally allocate uninsured population per ward as the demand for this scenario.

SCENARIO 2

7 149 055 visits

Using the income classes, all persons in the low income group and 50% of persons in the middle income group are allocated to each ward as the demand for this scenario.

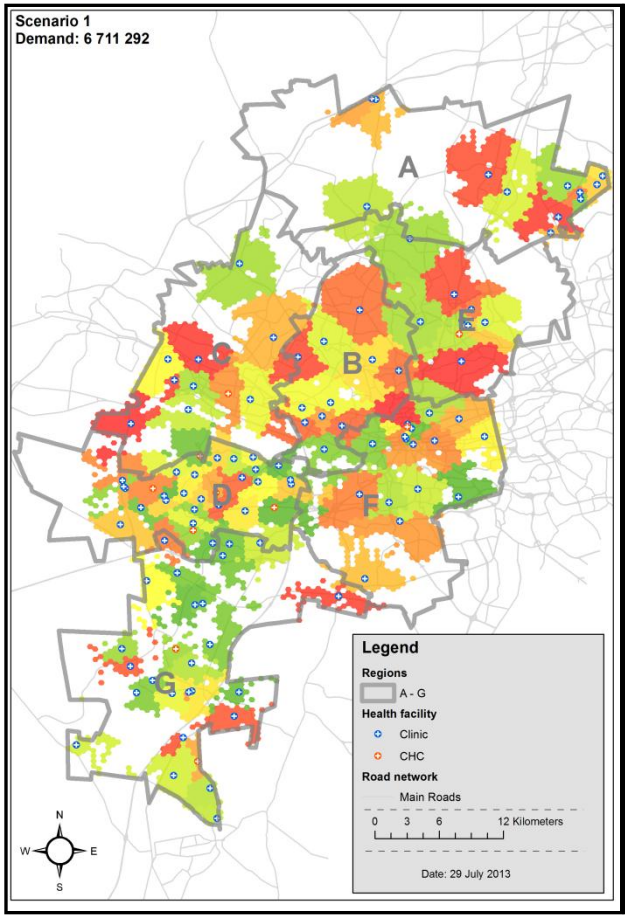
SCENARIO 3

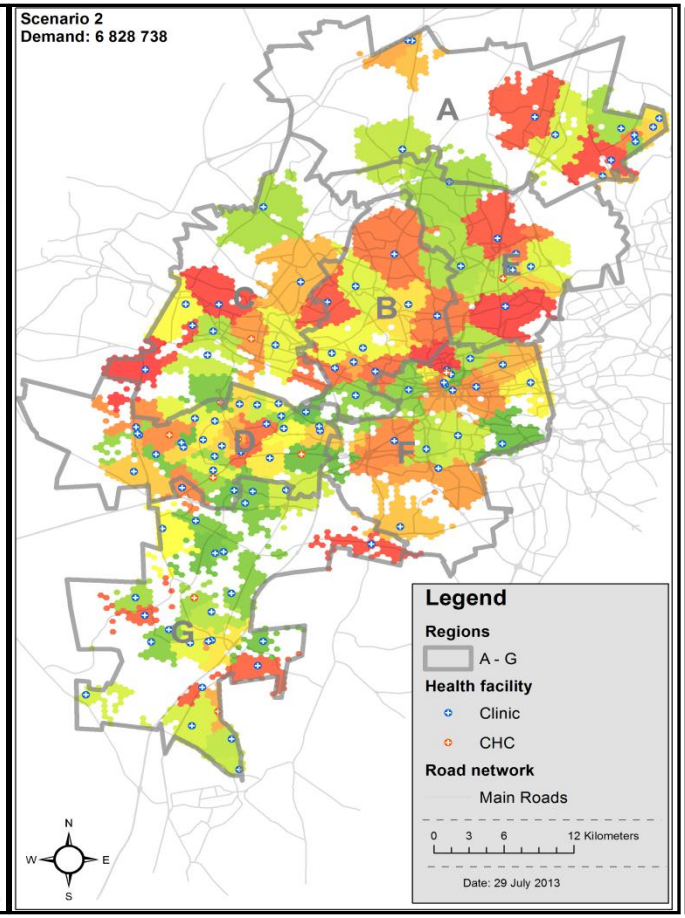
7 416 886 visits

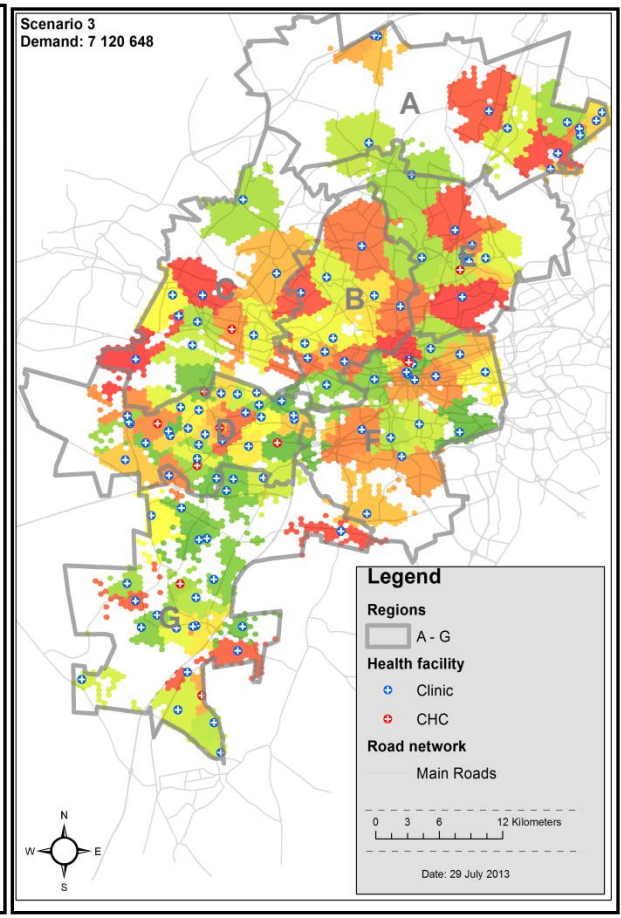
Using the income classes, persons from the highest income category are first assigned the status of “insured”, and then people from the next highest income category and so on until the total insured population has been assigned. Once the total number of insured population is reached, the remainder of the population is assigned the status as uninsured and therefore demand for this scenario.

Results: Modelled catchments

3
Model catchments







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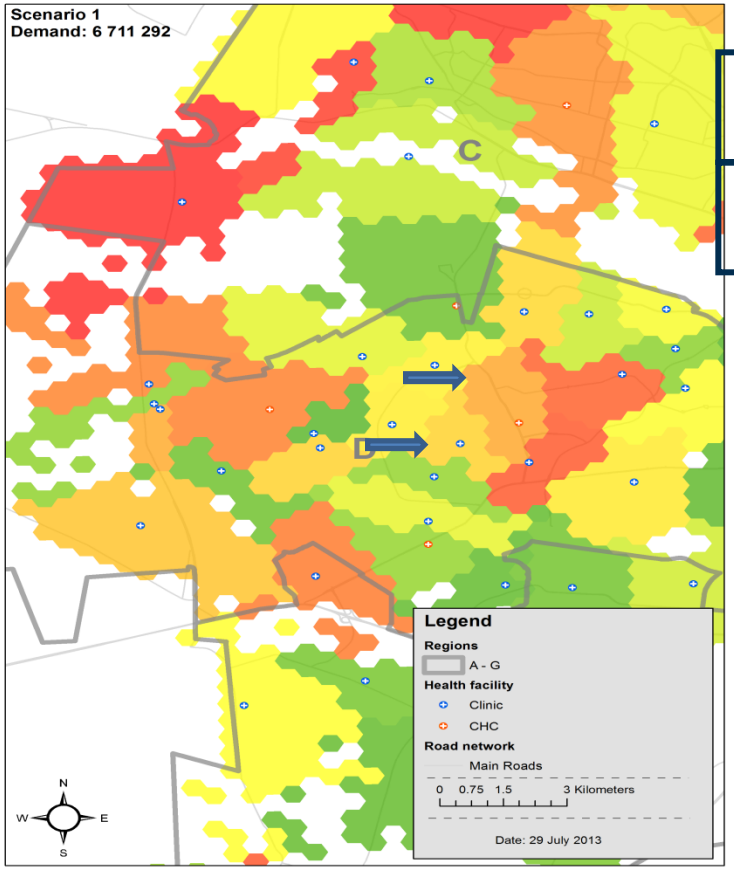
Results: Modelled catchments

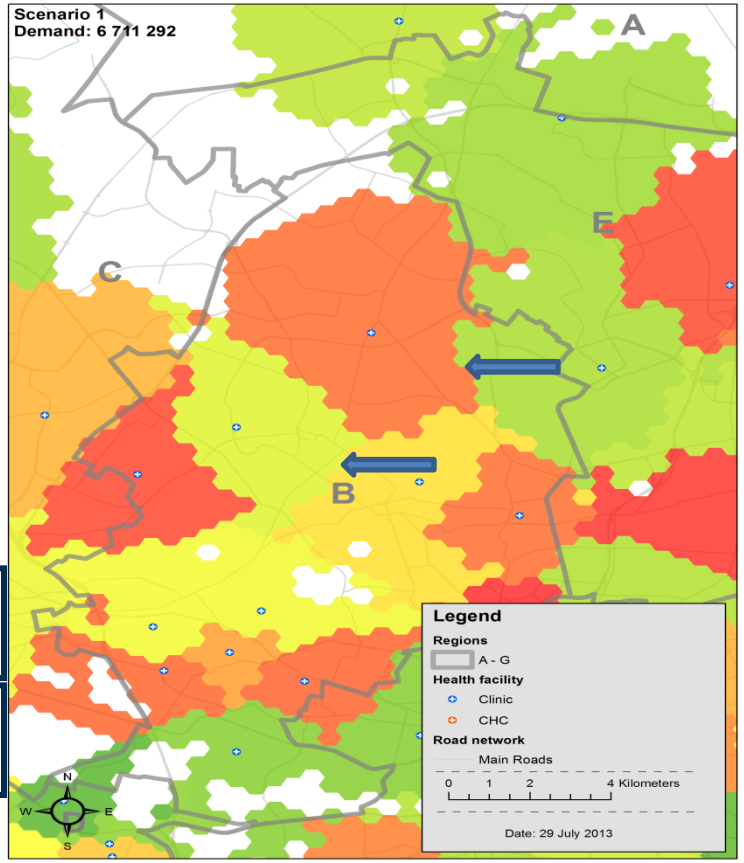


77 831 allocated demand

70 792 allocated demand

36 135 allocated demand

23 473 allocated demand



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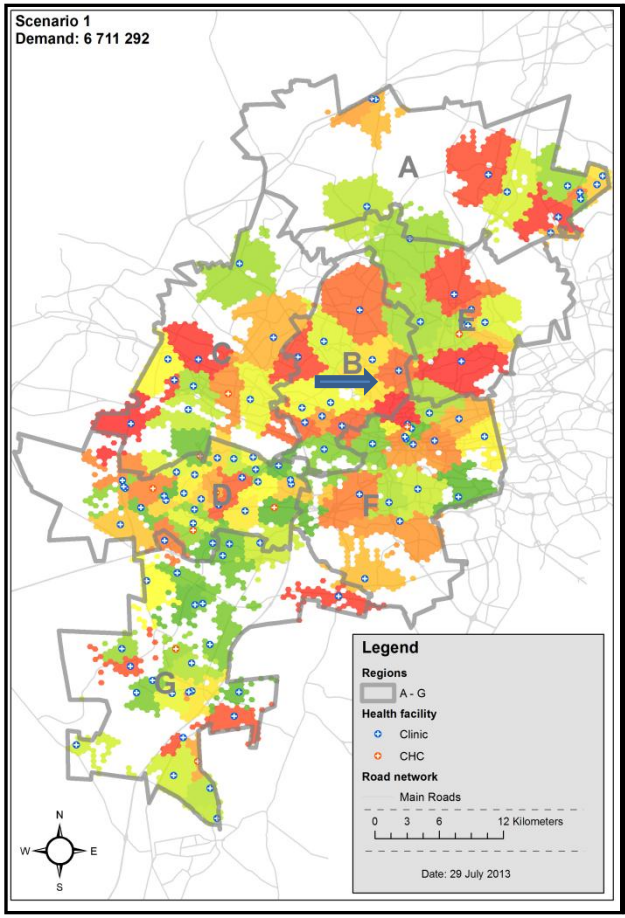
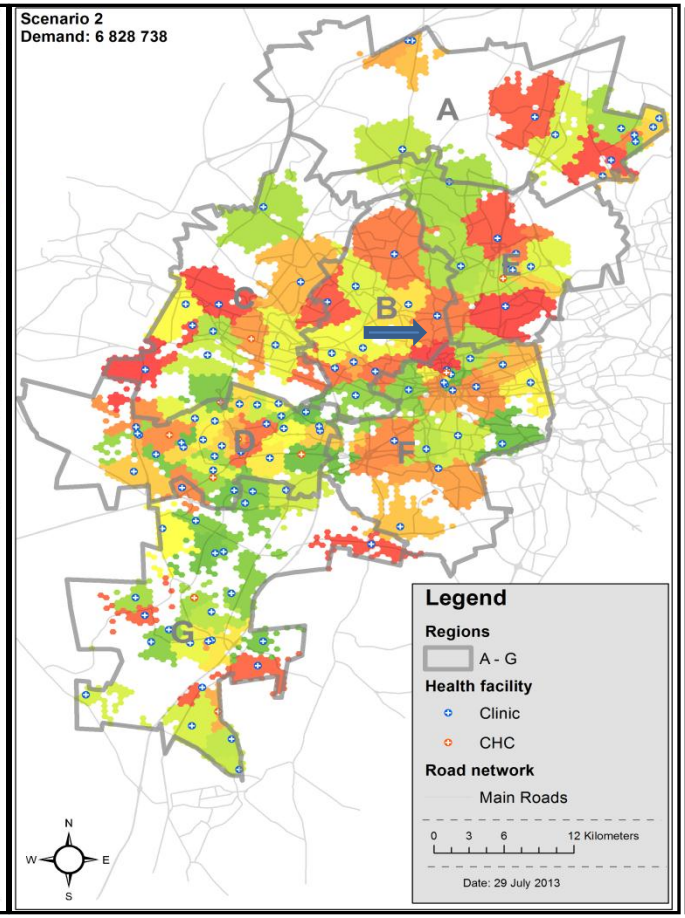
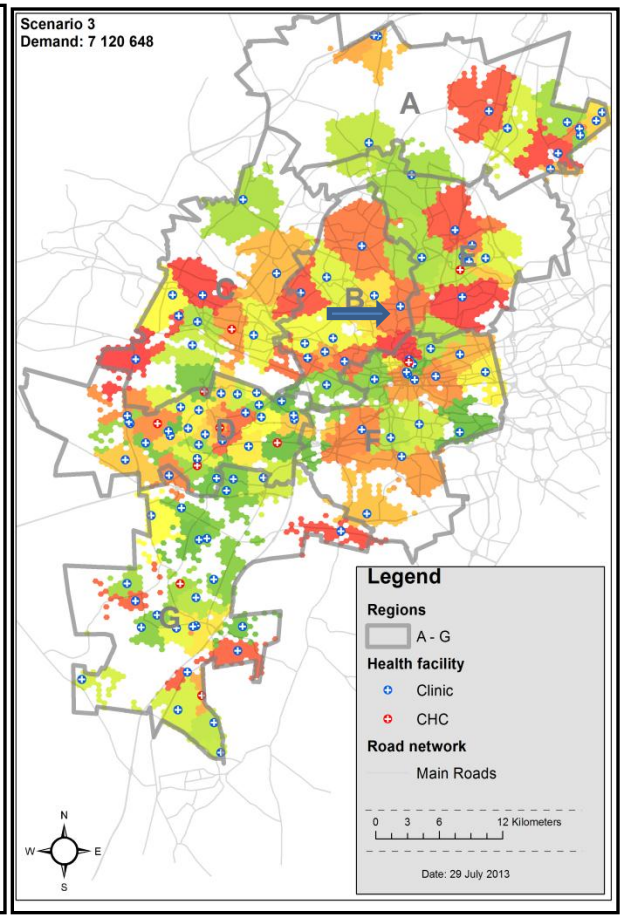
Results: Modelled catchments







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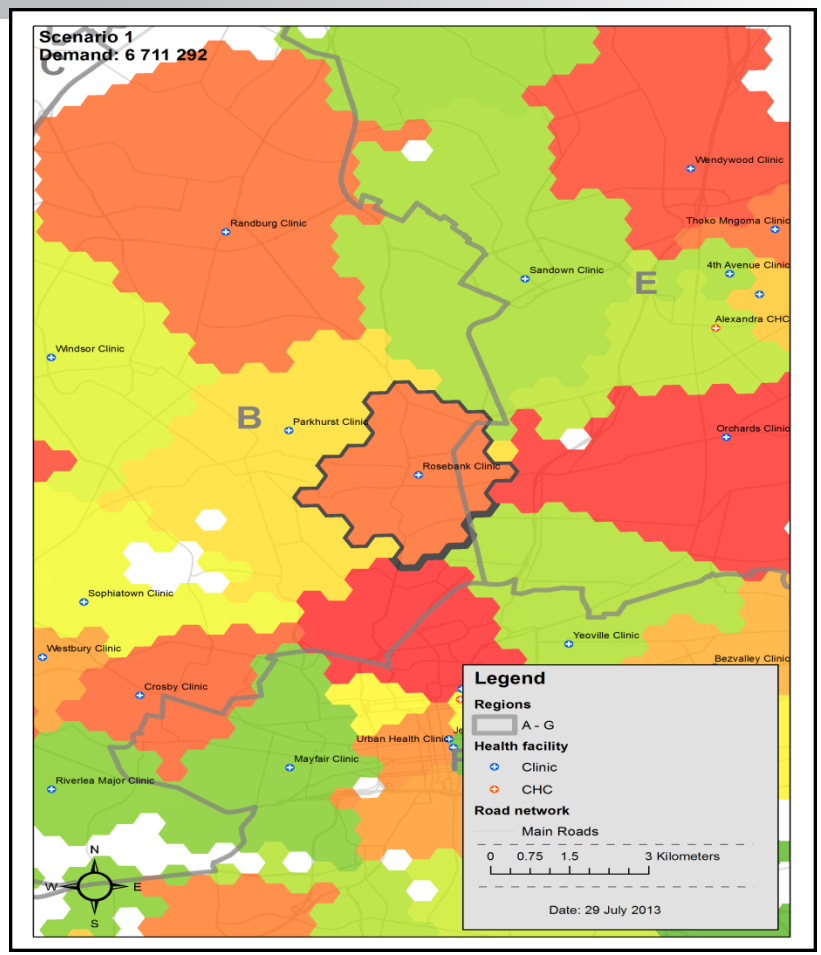
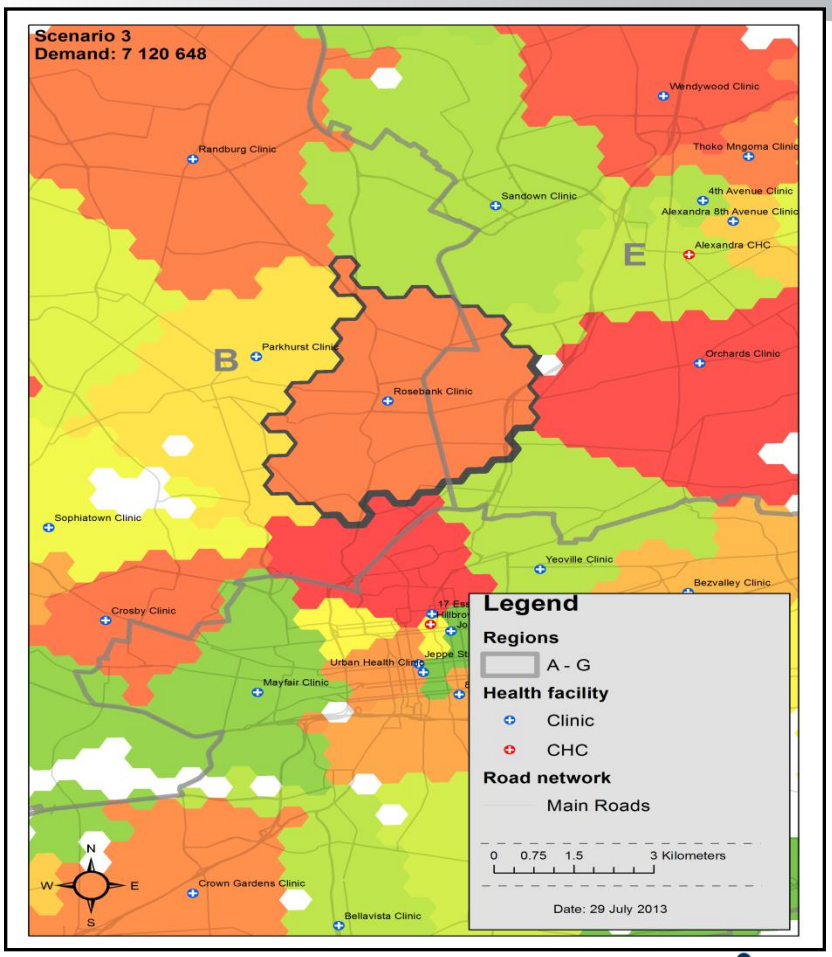
Results: Modelled catchments

3
Model catchments





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Results: Preliminary findings

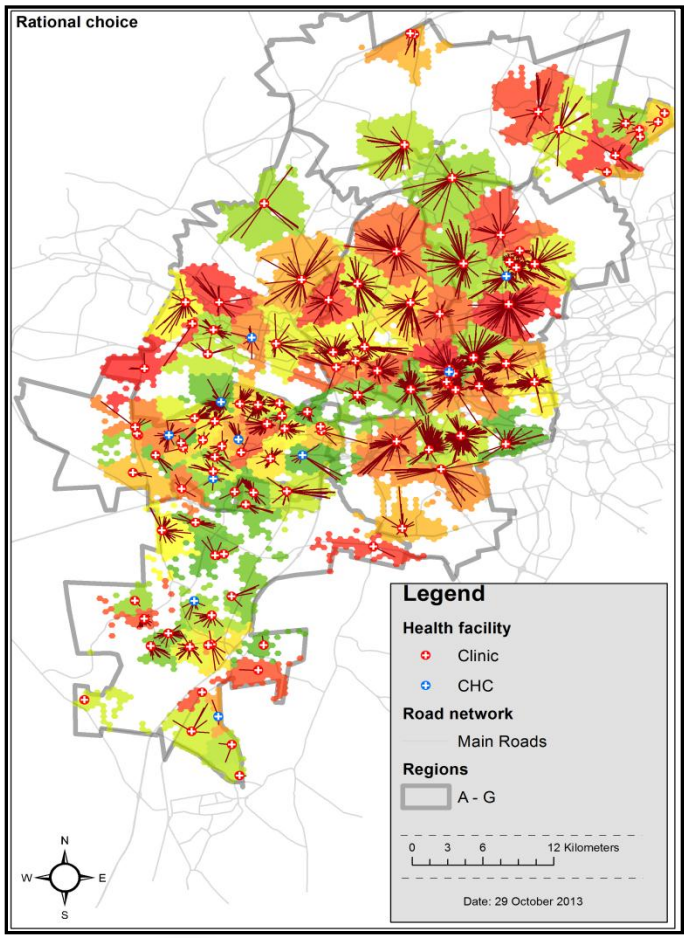
4
Correlation analysis

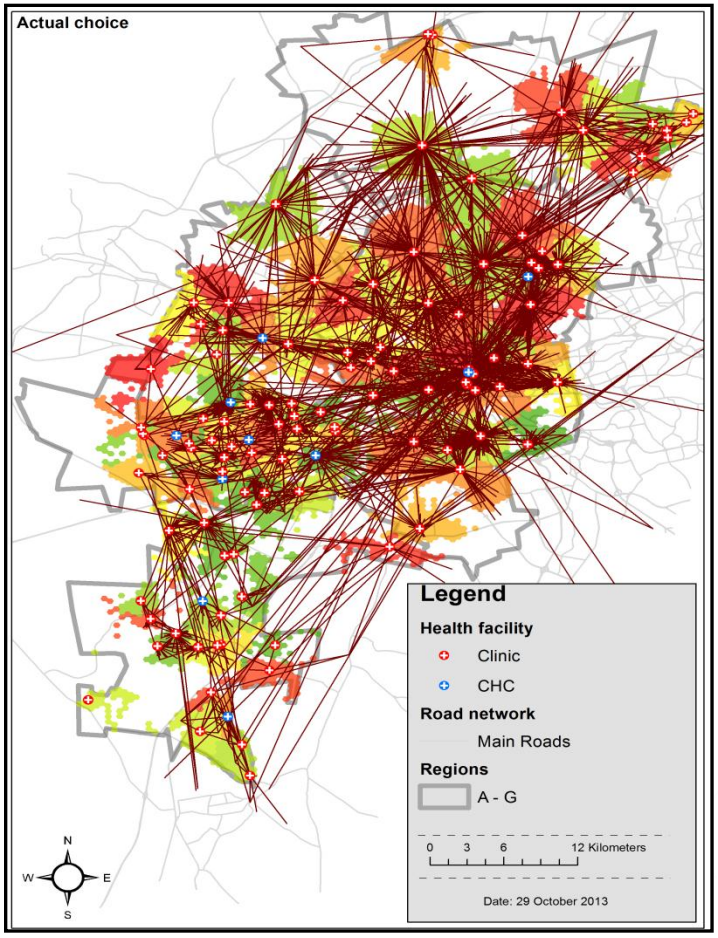
- Three demand scenarios analysed:
  - No significant difference in spatial extent of catchment areas of facilities
  - Significant demand increase per scenario: scenario 1<scenario 2<scenario 3
- The total modelled demand in scenario 3 strongly correlated with the total number of PHC visits (headcounts) recorded in the city: moderate positive correlation of 0.35

How accurate is a rational choice based model regarding people's actual decisions?

Comparing modelled demand to revealed demand -using TB patient data as a proxy

Results: Revealed demand (using TB patient data as a proxy)





- 1% residing outside the city boundary
- 44% not residing in catchment areas of the facility they visited
- Significant flows in the direction of Johannesburg CBD

Concluding remarks

- Establishing the demand profile for public health facilities is crucial:
  - Population growth and migration trends
  - Continued change in demand
- **Implications for this project:**
  - Results emanating from the TB register suggest another round of analysis
  - The modelled demand catchments need to be compared to the catchments based on the actual visits to establish weighted zones / areas of influence, and
  - Develop or calculate the probability variance of rational choice vs. actual choice based on a distance measure to further enhance the model's capabilities
- **Steps to improved demand estimate for future health planning projects:**
  - Improved algorithm to estimate demand
  - Availability of spatially linked population employment data
  - Detailed patient registers

Thank you

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