Research Questions and Flowmap Solutions: Overview

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To familiarize yourself with the possibilities of Flowmap for Analysis based on Spatial Interaction and/or Transport Network Distance a number of Research Questions and their Flowmap Solution have been prepared. For each set of research questions and solutions full training guides and test datasets will become available in the download section of the Flowmap Website. So check in this document whether or not any research question and solution catches your specific attention. If so download the Training Guide and read the step by step Analysis section. In case you want to try Flowmap hands on yourself also download the Free Flowmap App and the matching data set. The full training includes data import and data preparation but the training material is setup in such a way that import and preparation can be skipped and a direct start can be made with the actual analysis. At this moment full training sets are available for the Canada and Texel Solutions. In case you have some Flowmap experience and also have all relevant data available for your own study area, you can off course directly swap the exercise data for your own data.

Topics covered so far in this document:

BladMos: Evaluating the need for and effect of extra (possibly stacked) parking spaces

Canada: Location of Radiotherapy Centers and its implications for different population groups

Mamelodi: Evaluating/Improving the spatial performance of ‘last mile’ parcel delivery

Texel: Evaluating the spatial coverage by ambulance and pharmacy services

Vaanplein: Improving coordinate locations by mobile lab’s GPS-tracks measuring air pollution

Topics forthcoming (tested but not yet documented):

Amsterdam: Improving the siting of drop-points for garbage collection by self-navigating canal vessels

Cape Flats: Application of Pressure Map principles while investigating low income job accessibility

Randstad: Examining the possible overlap of trade areas by professional soccer-clubs

Western Cape: Evaluating the effect of admission policies for children’s hospitals

Research Questions regarding the Evaluation and Improvement of Parking Availability for Bladmos street in Houten-Zuid

Question Bladmos 1: Can the odds of finding parking space within 150-meter walking distance from home be determined by combining two straightforward accessibility measures into a so-called 'Pressure Map'

Question Bladmos 2: Can eventual parking issues be remediated by the use of 'stacked parking'

Research Questions regarding the Location of Radiotherapy Centers and its implications for different population groups on Central Prince Edward Island, Canada:

Question Canada 1: Is there a difference in the study area between population groups in physical accessibility to radiotherapy centers, when accessibility is measured as the average distance from each dissemination zone to its nearest center?

Question Canada 2: What would be the effect on accessibility for the indigenous population group in the study area of relocating existing radiotherapy centers to optimal locations specific for this group?

Research Questions regarding the spatial performance of parcel delivery in Mamelodi, South Africa

Question Mamelodi 1: The South African township Mamelodi near the city of Pretoria is currently home to almost twenty parcel delivery / pickup points from the same company. The slogan of the company is that they provide 'last mile delivery' and a master student wants to examine if all households in the township can indeed reach a pickup point within a walking distance of one mile.

Question Mamelodi 2: Internet Cafés are among the preferred (spaza) shops to host a pickup point. In case the one mile walking distance coverage is not complete, what would be the best positioned internet café(s) to extend the distribution network and what would be its impact on overall spatial performance?

Research Questions regarding ambulance and pharmacy service coverage on the Island of Texel, the Netherlands:

Question Texel 1: From which locations can an entire study area be covered by a single facility, like an ambulance post, given a maximum acceptable travel/waiting time of 12 minutes?

Question Texel 2: How can the best candidate location be identified to cover an entire study area by a single facility like an ambulance post given a maximum acceptable travel/waiting time of 12 minutes?

Question Texel 3: What is the optimal site for an additional pharmacy from both a cooperation and a competition perspective and can cannibalization of already existing facilities (of the same chain/company) be avoided?

Research Questions regarding the Improvement of GPS-Tracks around the Vaanplein in Rotterdam, the Netherlands

Question Vaanplein 1: How can the actual route travelled be identified before the "Near Operation" is applied in GIS to make sure the projection takes place on the correct road segments?

Question Vaanplein 2: Can the GPS-timestamp somehow be used to spatially discriminate between measurement locations in case the recorded longitude and latitude fail to do so?

Flowmap Solutions regarding the Evaluation and Improvement of Parking Availability for Bladmos street in Houten-Zuid

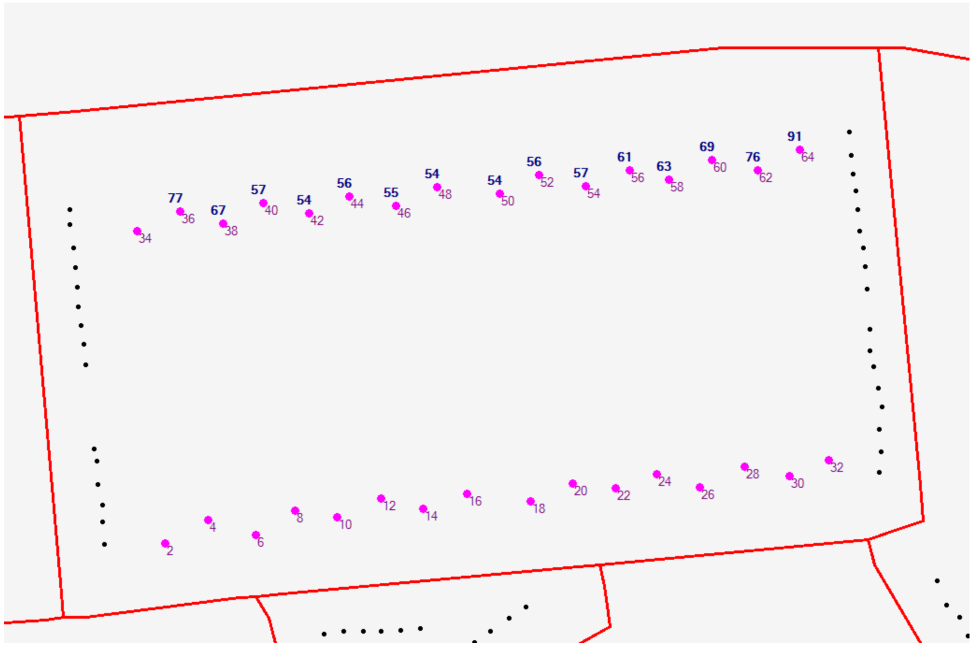
Preface: Some 30 years after inception the Houten-Zuid development has matured. Around Bladmos the last gap is filled in to the North West, but with high income dwellings with limited access and not participating in the communal parking scheme. The Bladmos building block consists of two parallel solid rows of houses with parking facilities only at the far ends and in front of the houses on the east side putting them at a serious parking advantage. The pictures show 3 houses (10, 12 & 14) in the middle east side with parking options directly in front.

Solution Bladmos 1: On the assumption of a basic requirement of a need of one car parking space per household and one household per dwelling a simple procedure can be set up to calculate the odds for individual houses of finding a parking space within 150 meter walking distance using the three step approach following the Pressure Map Principles[1]:

- Use a **Regular Proximity Count** accessibility measure to sum the number of houses within a 150-meter walking distance along the street for each parking space
- Weigh each parking space with the number of houses in reach simulating the pressure/competition effect by dividing one (or more in case of stacking) by the outcome of the previous step
- Again use the **Regular Proximity Count** accessibility measure to sum the weighed parking spaces from the previous step within 150 m walking distance along the street for each house

[1] Accessibility analysis and spatial competition effects in the context of GIS-supported service location planning, J.R. Ritsema van Eck & T. de Jong. Computers, Environment and Urbans Systems, 1999, Pages 75-89

To show the results at individual house level the map has been rotated 90 degrees so West has become North:



House numbers are shown in purple and odds lower than 100% are shown in blue. So 15 off the 32 Bladmos houses can't reach a 'guaranteed' parking space with a 150-meter walking distance.

Solution Bladmos 2: At either end of the Bladmos street there are dead end (for cars) alleys that provide an excellent opportunity for stacked parking. What would be the effect in case the last 9 parking spots at either were stacked in two or three layers like the before and after pictures show?

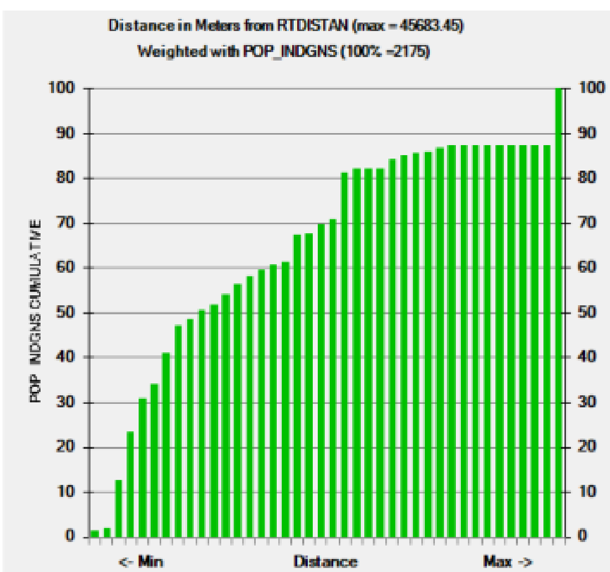
No need to redo the full analysis. Take for example house Bladmos 54 that currently has parking odds of 57.4% which is the summation of the weighed parking capacity of the 60 parking space that are within a 150-meter walking distance of that house. The exact parking spaces considered for house 54 can be identified with **Catchment Area Analysis.** Part of these 60 parking spots are the 18 spots considered for stacked parked, these 18 spots currently contribute for 19.9% of the total 57.4% score; the remaining 37.5% is contributed by the 42 spots also in reach but not considered for stacking. So in order to get to 100% for all the Bladmos houses, the stack would have to raise to a height of (100 - 37.5) / 19.9 = 3.14; which effectively would come down to (or go up) 3 additional layers.

Conclusion Bladmos: Adding 3 layers of stacked parking places on top of 18 existing places would solve the problems for all houses in Bladmos street but, for starters, also require a lot of subsidy. Having a second look at reserved parking spaces or increasing the acceptable walking distance from 150 to 250 meter might provide more viable alternatives. The latter option is added as an exercise in the training material.

Flowmap Solutions regarding the location of Radiotherapy Centers on Central Prince Edward Island, Canada:

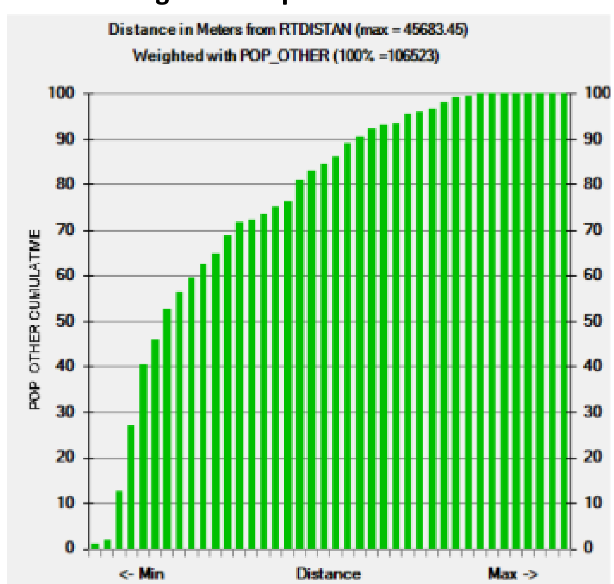
Solution Canada 1: The difference in physical accessibility measured in average distance between population groups to radiotherapy can be measured with a 'Regular Catchment Area Analysis' that assigns each dissemination zone via the road network to its closest radiotherapy center and records the length of the shortest path involved in each allocation. These allocation distances are in turn input to create 'Catchment Profiles' that show the accumulation of allocated population group totals as allocation distance increases. The matching accessibility statistic is the 'Proximity Coefficient', popularly defined as the percentage of the graph covered by the green bars. The higher the number (maximum is 100%, indifferent is 33.3%, minimum is 0%) the better the accessibility. The 'Catchment Profiles' also produce other relevant accessibility statistics, like in this case the average weighed allocation distance.

Indigenous Population



Accessibility Measures
Effective Worst Case Distance: 45.684450 Kilometers
Average Distance: 16.539110 Kilometers
Overall Proximity Coefficient: 64.868080 %

Non-Indigenous Population

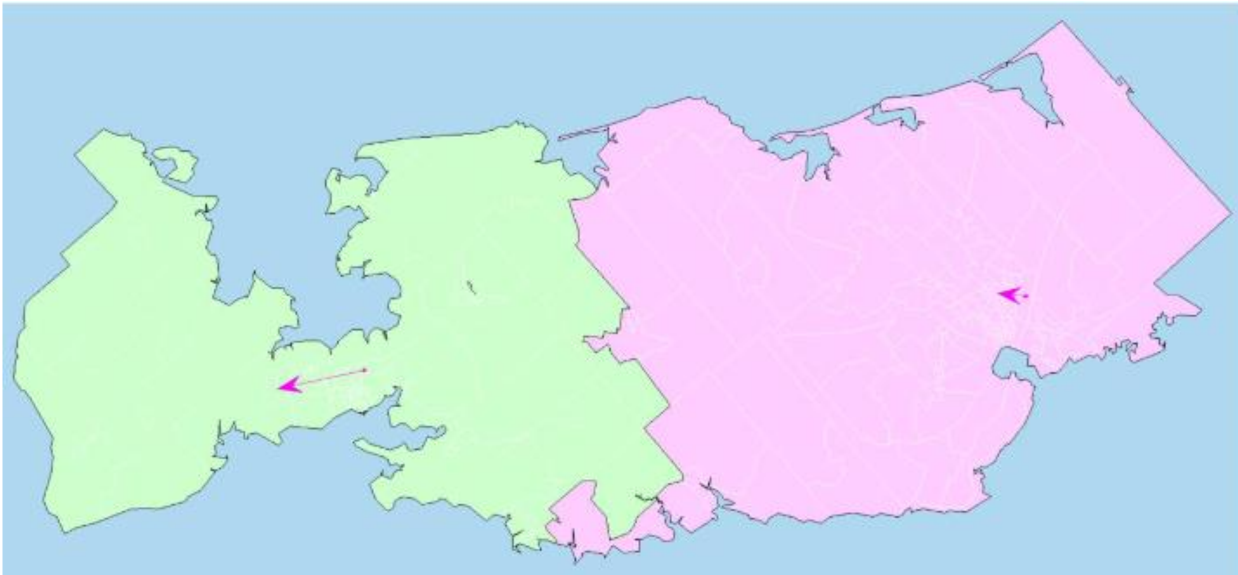


Accessibility Measures
Effective Worst Case Distance: 45.684450 Kilometers
Average Distance: 11.57020 Kilometers
Overall Proximity Coefficient: 75.927660 %

Catchment Area Analysis followed by the creation of a Catchment Profile for the two different population groups reveals significant differences for the Central Prince Edward Island Study Area. The average distance via the road to the closest treatment centre is about 42% longer for the indigenous population and the proximity coefficient is over 16% lower.

Solution Canada 2: The effect of relocating existing radiotherapy facilities to optimal locations regarding accessibility (average distance) for the indigenous population can be measured by running a Service

Relocation Model in Flowmap:



The resulting relocation arrows, pointing from the current to the optimal locations, show that the current sites are not far off from the optimal sites, where the average distance would be minimized.

	Current Sites	Optimal Sites
Average Distance	16.6 km	15.2 km

The statistical table matching the map show only a meagre improvement in terms of average distance reduction. Disregarding economic viability for the moment, it is clear that at least one extra treatment center would be necessary to seriously improve accessibility.

Flowmap Solutions regarding the spatial performance of parcel delivery in Mamelodi

Solution Mamelodi 1: As the data about the location of individual houses and shacks is incomplete for Mamelodi the dwelling count for the 460 residential areas from the census 2011 will be used as a proxy for the target market. The one-mile coverage by the currently existing pick up points can be measured with a '**Regular Catchment Area Analysis'** that can be set to assign each residential area to its nearest pickup point as long as the walking distance along the road does not exceed one mile. Afterwards the township can be split in (shown in green below) covered parts, that are within one mile walking from their nearest pickup point, and (shown in red below) uncovered parts that are more than one-mile walking removed from their nearest pickup point. The circle shaped symbols are proportional to the number of dwellings in each residential area.

Top locations are the 'Hair Café Salon', 'Ciiro Café' and 'Charlie Pay and save' serving within one mile 12346, 10544 and 9250 nearest dwellings respectively. Next there is a group of 8 sites that serve between 3800 and 6300 nearest dwellings. Worth mentioning off course is the '**Gift** Tuck Shop' serving 4848 dwellings. All remaining locations serve less than 2200 dwellings each. Of the two sites in the one-mile border just outside Mamelodi only 'Carols Business Centre' in Nelmapius serves a serious amount of new dwellings in Mamelodi Extension 14. The blue bars signify the current pickup points and are in height proportional to the numbers of dwellings assigned to each point. The white lines show the full street-network considered for walking and the grey lines show the walkable shortest paths along the roads from each residential area to its nearest pickup point. **Transport Network Analysis** was applied identify these shortest paths

Catchment Profile Statistics

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Accessibility Measures
Worst Case Distance:                        4.01220 Miles
Average Distance:                         0.9818097 Miles
Overall Proximity Coefficient:             76.16650 %
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A **Catchment Profile** can be generated to view the overall statistics; the worst case distance is just over 4 miles and the average distance for all Mamelodi dwellings to their closest pickup is almost 1 mile. Within one mile walking distance the current 1pickup points together cover 270 out of 460 residential areas thereby leaving 67,359 (45.51%) out of 148,006 houses 'uncovered'.

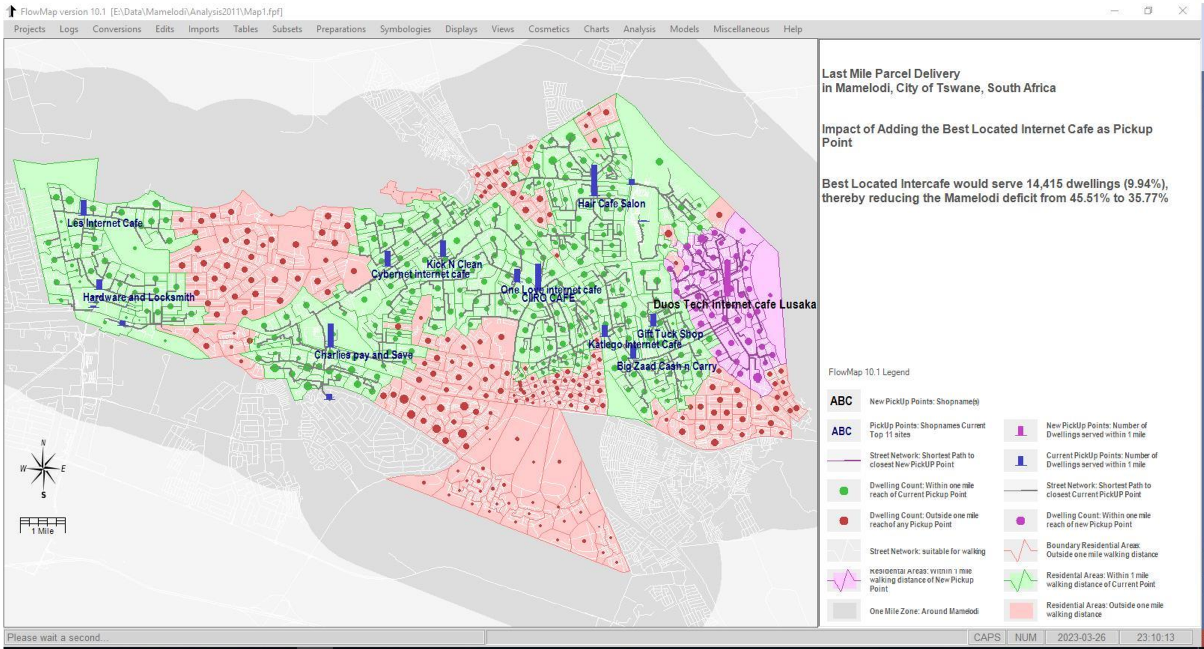
Catchment Profile Table

Distance Unit Miles	Allocated DWLCNT2020	Cumulative Amount	Cumulative Percentage
1.0	80647.0	80647.0	54.489010
2.0	63354.0	144001.0	97.294030
3.0	3267.0	147268.0	99.501370
4.0	670.0	147938.0	99.954060
5.0	68.0	148006.0	100.0

The table matching the above catchment profile further reveals that over 99% of dwellings is within 3 miles walking distance leaving only some 738 dwellings in the 3-5 mile distance range. The map also shows that the yet uncovered part of Mamelodi is concentrated in several different pockets which is bound to results in a need for more than one additional pickup point to do better regarding the 'last mile delivery claim'.

Solution Mamelodi 2: An investigation of the current pickup points reveals that a popular original core business is "Internet café". No less than 5 of the 19 current pickup points fall in that category. There are about 40 internet café well spread over Mamelodi that do not yet double as a pickup point.

For the purpose of this exercise these 40 internet cafés are the prime candidates to extend the pickup point network and improve the one-mile coverage. The best candidate can be identified by applying **the 'Proximity Count' accessibility measure** to sum up for each candidate exclusively the number of dwellings in to the hitherto uncovered residential areas with a one-mile radius. Out of the 40 candidates the highest scoring location can be selected and provisionally added to the existing pickup points raising their number from 19 to 20. Then the catchment area analysis from before can be repeated with in new number of pickup points and also the resulting map can be redrawn this time giving special attention to the effect of the new addition.

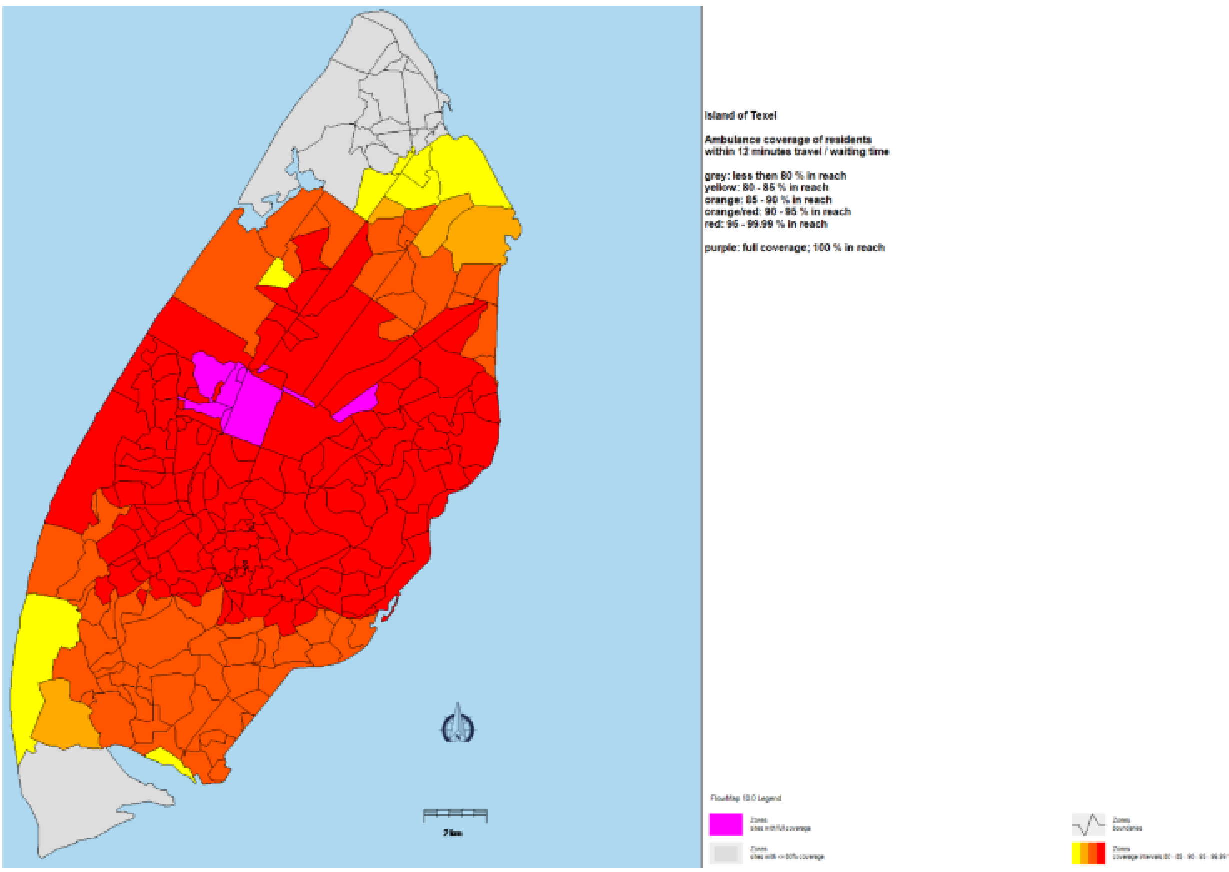


The purple area focuses on the prime candidate; an internet cafe named ‘Duos Tech internet café Lusaka’. Its promotion to pick up point would potentially bring another 41 residential areas, containing 14415 dwellings, within the one-mile target. However, this amount of dwellings implies that at least another four more internet cafes must be promoted to get anywhere near the target of the slogan.

Conclusion Mamelodi: This extension procedure can be repeated until no viable locations remain or a Flowmap service location model can be applied to the same effect, but the main purpose of this exercise was to investigate the validity of the ‘Last Mile Delivery’ Slogan in current conditions. And for this parcel delivery company in Mamelodi an update of the slogan to ‘Last Two Mile Delivery’ seems to be called for.

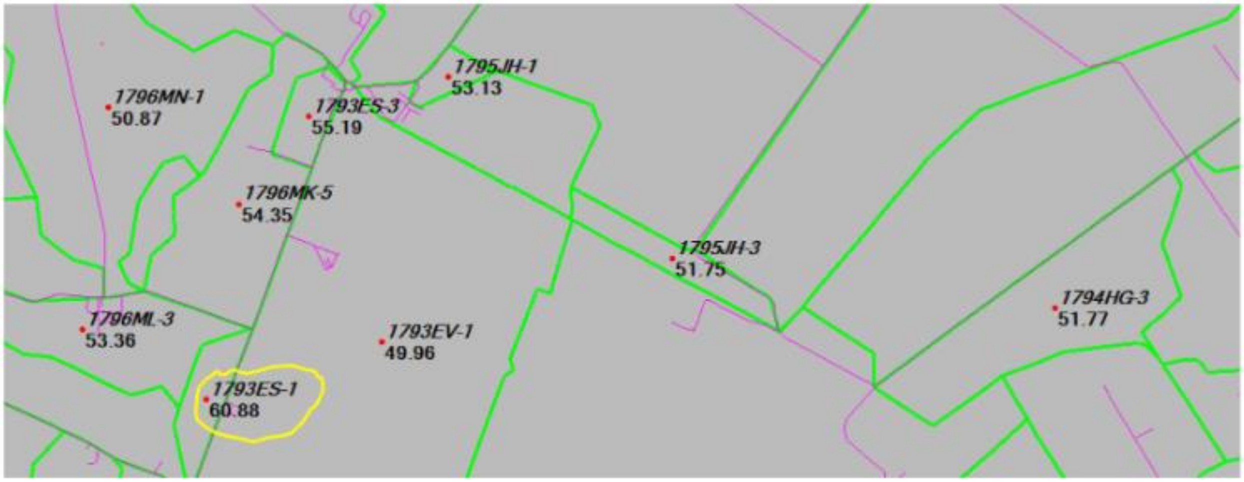
Flowmap Solutions regarding the ambulance and pharmacy service coverage on the Island of Texel, the Netherlands:

Solution Texel 1: A **Proximity Count accessibility measure** (a.k.a. cumulative opportunity index) can be calculated to show the percentage of the target market in reach. A 100% score indicates a suitable location from where the whole area can be covered by a single facility.



For all 249 locations in the study area the above suitability map shows the percentage of target market that is in reach. Reach is in this case defined as ‘within a maximum net car travel time of 12 minutes’. 9 locations (highlighted in purple) score the full 100%.

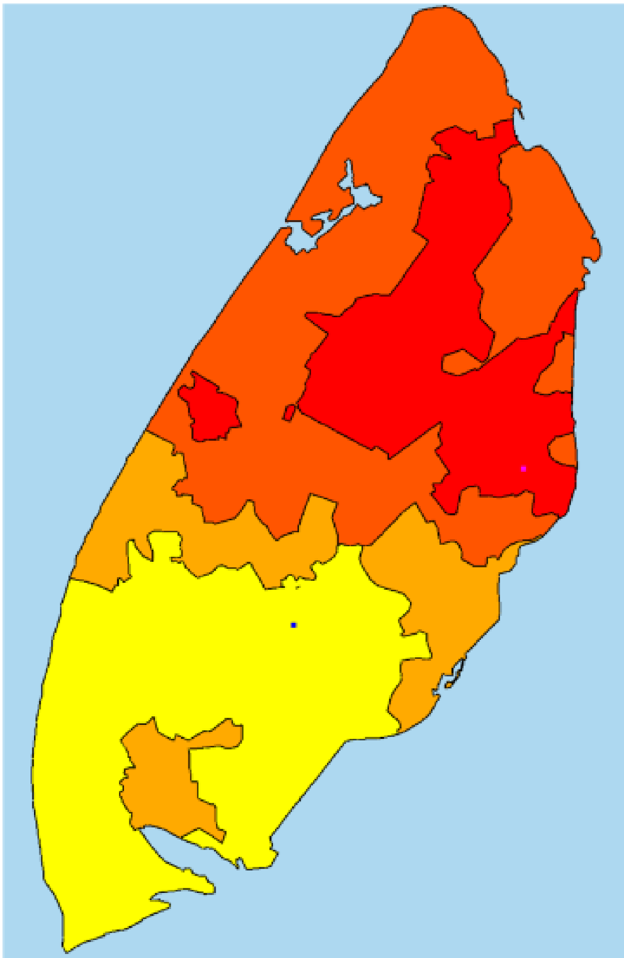
Solution Texel 2: Locations with very different location profiles may end up with the same 100% score. But the score does not reflect whether the bulk of the target market is at a one-minute travel time or at eleven minutes travel time or somewhere in between. Based on the Location Profile of each of the 15 sites the **Proximity Coefficient Accessibility Measure** can be used to distinguish between sites with a similar proximity count score and make a clear distinction between in a close to 100% score when the bulk of the target market is at less than one-minute travel time and a close to 0 score when the bulk of the target market is at over 11 minutes travel time.



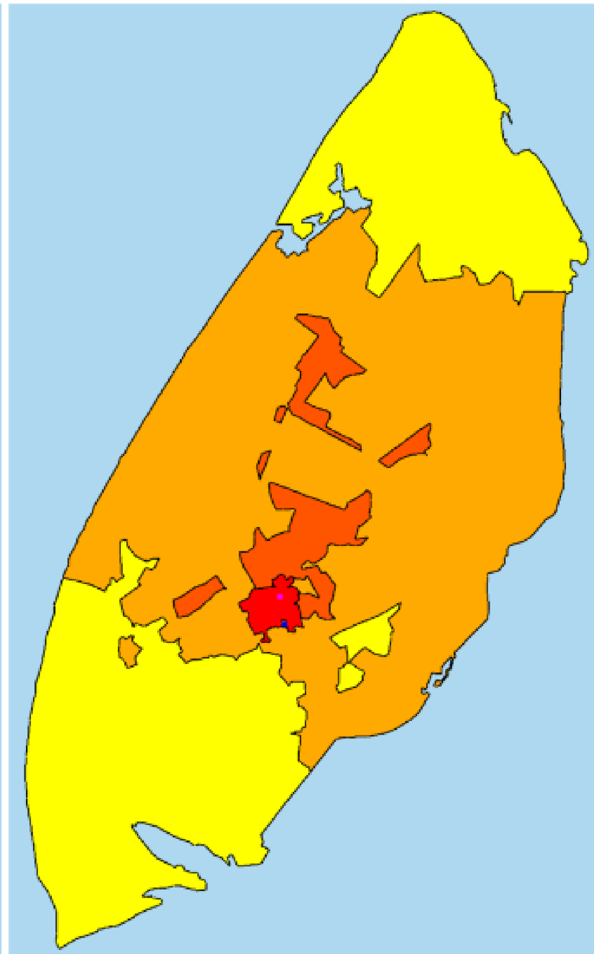
The nine Zones witch a positive proximity coefficient are of course the same as the top locations from the previous solution, but instead of all having the same perfect 100% score, the zones can now be differentiated with proximity coefficient scores ranging from under 50% to over 60%. The top location with label 1793ES-1 is in the yellow circle.

Solution Texel 3: At the moment there is only one pharmacy located on the island of Texel. The basic research question is to identify the optimal site for a second pharmacy on the island either in cooperation or in competition with the existing pharmacy and how to avoid cannibalization in the latter case. Optimal in this case will be defined as the highest expected turnover. Travel time will be based on cycle traffic as the bicycle is the preferred mode of travel on Texel. A **Regular Catchment Area Analysis** is applied to calculate the travel time from all zones to the existing pharmacy. Next the **Average Distance in Competition** method can be applied to determine for all zones the overall average distance in case that zone was elected to host the second pharmacy. The zone with the lowest score would be the optimal site for the second pharmacy. A pharmacy is not only a public health care facility but also a commercial enterprise. The above solution favors the public health care perspective where the new pharmacy is located in such a way that overall client travel time is minimized in cooperation with the already established site. From a pure commercial competition perspective, the new site should be located where the highest turnover can be expected. In that case another Accessibility Measure in Competition should be applied; the '**Proximity Count in Competition'**.

Cooperation Solution



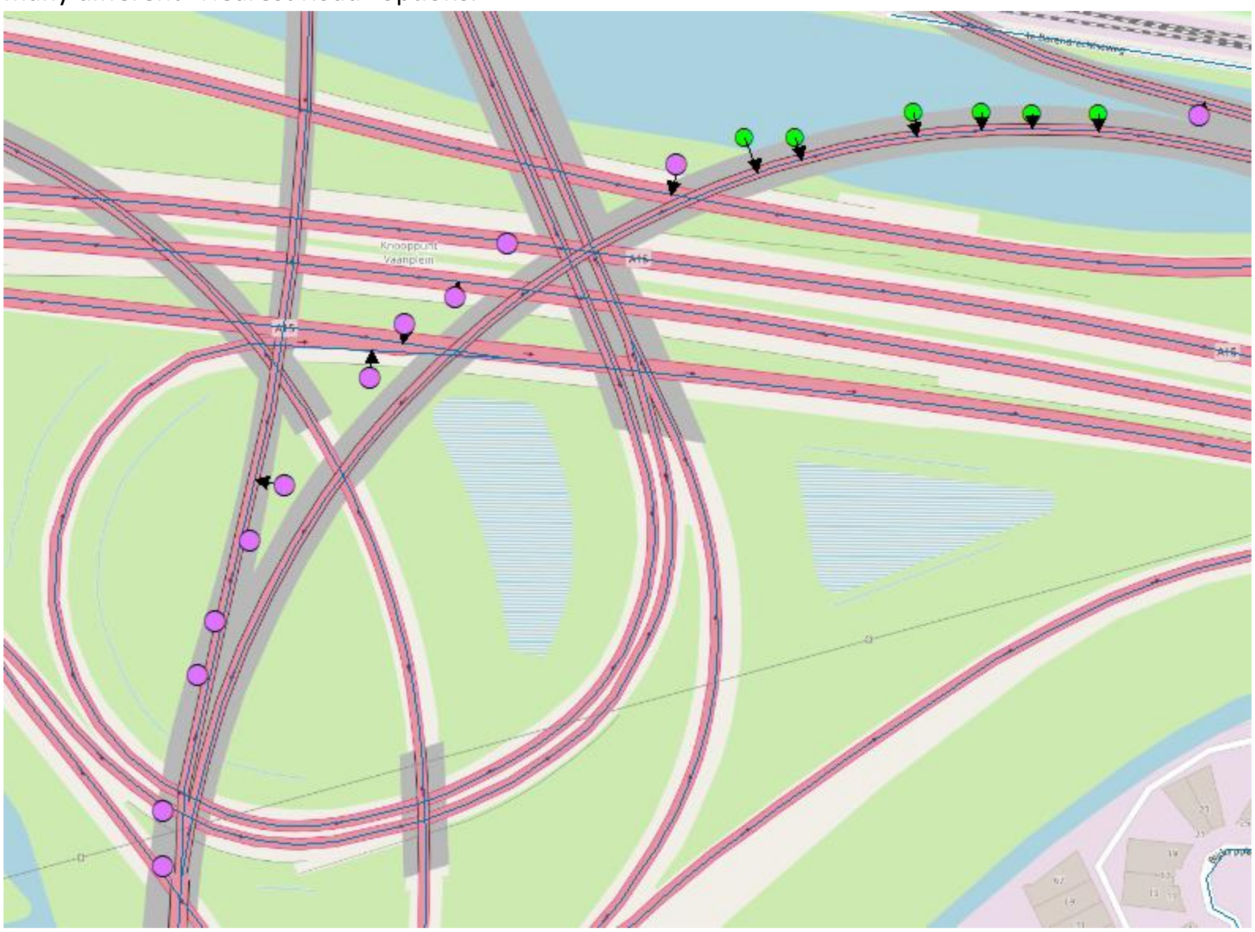
Competition Solution



In both maps the red zones are the ‘hotspots’, the blue squares indicate the existing site and the purple squares the top solution. The map on the left shows the result of cooperation scenario where the average customer distance is minimized. Adding a second pharmacy on top of the existing one would have no effect on the score so the highest (worst) score occurs at the current site (blue square). Other scores vary in one minute classes down from yellow (new average distance of fourteen or more minutes) to red (new average distance 11-12 minutes). At the best scoring site (purple square) a new average distance of just under 11.5 minutes could be realized. The map on the right shows the result of competition scenario where the expected turnover of the new site if maximized. In line with the principles of “spatial competition” the best scoring sites are now located close to the existing pharmacy to ‘steal’ as many customers as possible. Of course, this means that public accessibility statistics hardly improves. Again adding a second pharmacy on top of the existing one would have no effect on the score so the lowest (worst) score occurs at the current site. Other scores vary in 1600 customer classes up from yellow (0-1600) to red (4800+) potential customers. The best scoring site (purple square) could realize 6259 potential customers out of 14148. This means that some 56% of all customers would remain visiting at the existing pharmacy. In case the new site attracts too many customers away from the existing site some form of cooperation can be added by subtracting some time from the initial catchment distance; for instance, a subtraction 120 seconds would mean that the new site would only attract those customers that would benefit by 2 minutes or more by changing to the new site. In case the existing facilities are composed of outlets from 'own' and 'competing' chains the reduction could be applied only to zones that belong to the catchment area of the 'own' chain.

Flowmap Solutions regarding the Improvement of GPS-Tracks around the Vaanplein in Rotterdam, the Netherlands

In the city of Rotterdam air pollution is monitored with mobile labs that drive around and regularly visit fixed measurement stations and also measure of amongst others carbon dioxide and nitrogen levels at 20 meter[2] intervals on the way. To increase spatial accuracy a master student wants to project the GPS locations of the measurements on the centerline of the actual road/lane travelled. A standard "Near Operation" in GIS will provide for each GPS-location the projection point on the nearest road segment. But while travelling, these mobile labs sometimes pass complicated multilevel intersections providing many different "Nearest Road" options.



As the above picture of the Vaanplein intersection between A15 and S103 highways shows, the

[2] 1 second intervals actually but the data has been sampled and slightly randomized for training purposes

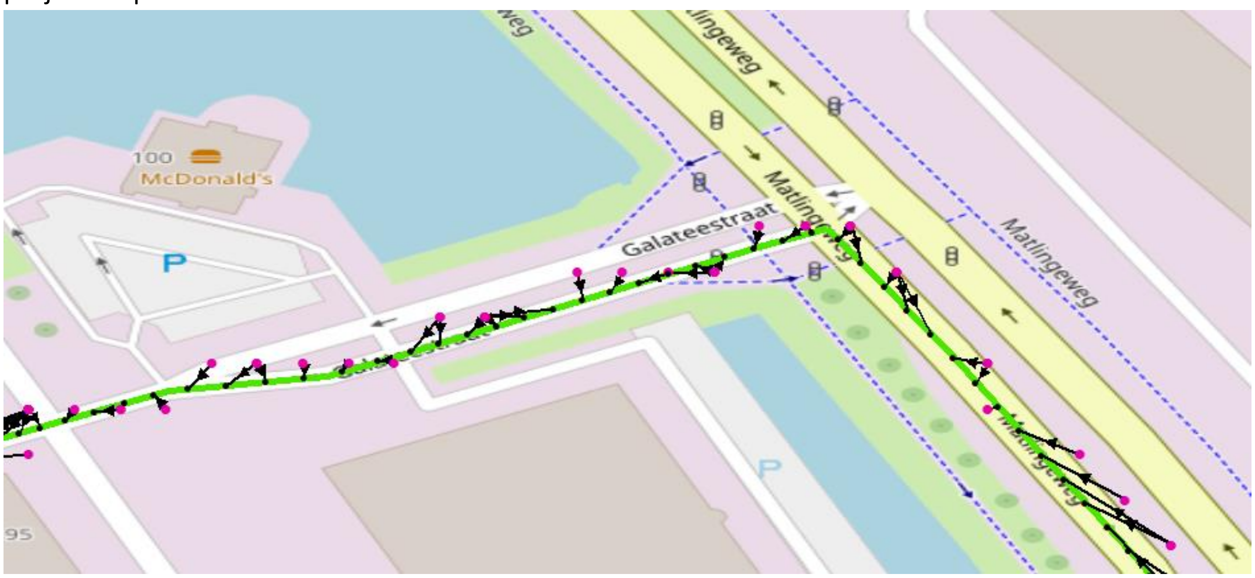
projection points found often ‘hit’ the wrong road segment (like the purple GPS-Points in the picture below).

Moreover, the actual measurement data turns out to contain a high amount of exactly duplicated GPS-locations. As is happened the recorded Latitude and Longitude variables were not accurate enough to discriminate between all locations at 1 second intervals.

Flowmap Solution Vaanplein 1: Depending on the nature of the track different solutions must be applied. It makes a difference if the traveler just wants to get from A to B, is spatially rational and follows some kind of shortest path. Or, as is this case, the traveler is more touring around, not necessarily spatially rational and might backtrack parts of the route or even end up in the start location again. The solution to identifying the actual route travelled in this latter situation involves some preparatory work in standard GIS (See Appendix) to restrict the active network to the close proximity of the GPSpoints. The resulting travel time fields, excluding a large part of the network, can be copied to the Flowmap Transport Network File and the **Flow Assign to Network method** can be applied to identify the most likely actual path followed when touring through the restricted network from station to station.

The green line represents the identified actual road travelled and hence all GPS-points can now be correctly projected. Please note that in case of a round trip at least two way points have to be added to the start / end location to make sure the identified path travels the full circle and in case of backtracking or almost coinciding roads more extra waypoints are needed to prevent the solution from shortcutting.

Flowmap Solution Vaanplein 2: Although the map below could be produced during testing, regrettably, the **Dedicated Accessibility Point** functionality in **Transport Network Analysis** to split road segments at regular intervals is in currently still in the development stage and will only become available in Flowmap 10.2. In principle, waypoints can be calculated at regular time intervals along the identified actual route travelled. Speeds will vary per road segment accommodating the correct number of measurement points, but along the same road segment effectively a uniform speed is assumed. Using their time-stamp GPS recordings can be matched to these waypoints and the matched waypoints can become the projection points on the actual route travelled for the measurement data.



Note that several of the purple original GPS locations translate into multiple black projection points indicating that multiple GPS-points are sharing the same location. Matching the waypoints to the original GPS-points is remarkably easy provided the travel time on the road segments has been set equal to the time interval the mobile lab took to traverse the segment. Basically the resulting waypoints can be directly sorted in the same order as the original GPS-points.