Smart Cities

SESSION V: Lecture 2: Urban Simulation and Prediction

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An Outline of My Talk

- What is Urban Science For? What Has It to Do With Smart Cities
- Operational Models: Not Just Better Science *per se* but Better Cities, Better Urban Policy
- Some History: Where From, and Where To ?
- Our Examples: **Tyndall** and **Arcadia** Projects
- Are These Software Projects? Not Quite …
- Small, Fast, Simple Models: **The Dubai Pilot**
- Big, Fast, Spatially Extensive, Many Users: **Quant**: Embedding Models in Practice

What is Urban Science For? What Has It to Do With Smart Cities

There is a sort of disjunction between the material of this last lecture session and the rest – this is more about using computation to understand systems that are composed not of computers like smart cities but of everything we associate with cities, everything else.

We could build urban simulation models of cities composed of computers but cities are still a long way from this so this deals with traditional conceptions of cities and how we use computers to model them

Operational Models: Not Just Better Science per se but Better Cities, Better Urban Policy

These models have been called operational in that they are concerned not only with testing/validating or exploring theory but with making predictions that inform decision-makers, planners, policy makers.

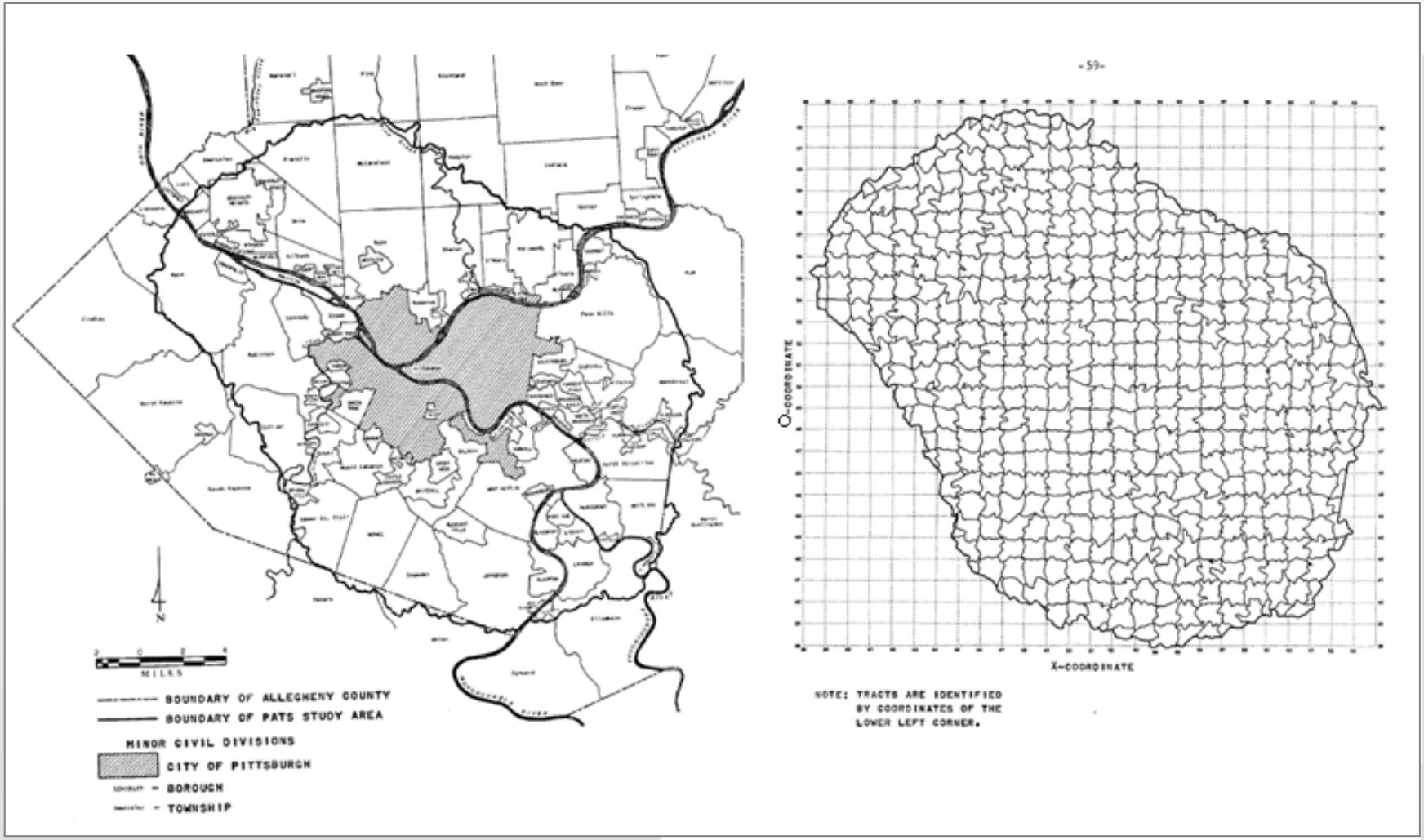
To an extent only now is the real exploration of the underlying theories and models that pertain to such spatial simulations being made clear. Existing models which attempt operationalise these ideas tend to still be a bit of a confusion of motivations – science or prediction or prescription or all of these.

Some History: Where From, Where To?

As soon as mainframes moved out of the labs in the early 1950s, planners began to think about how social physics could be applied in transportation

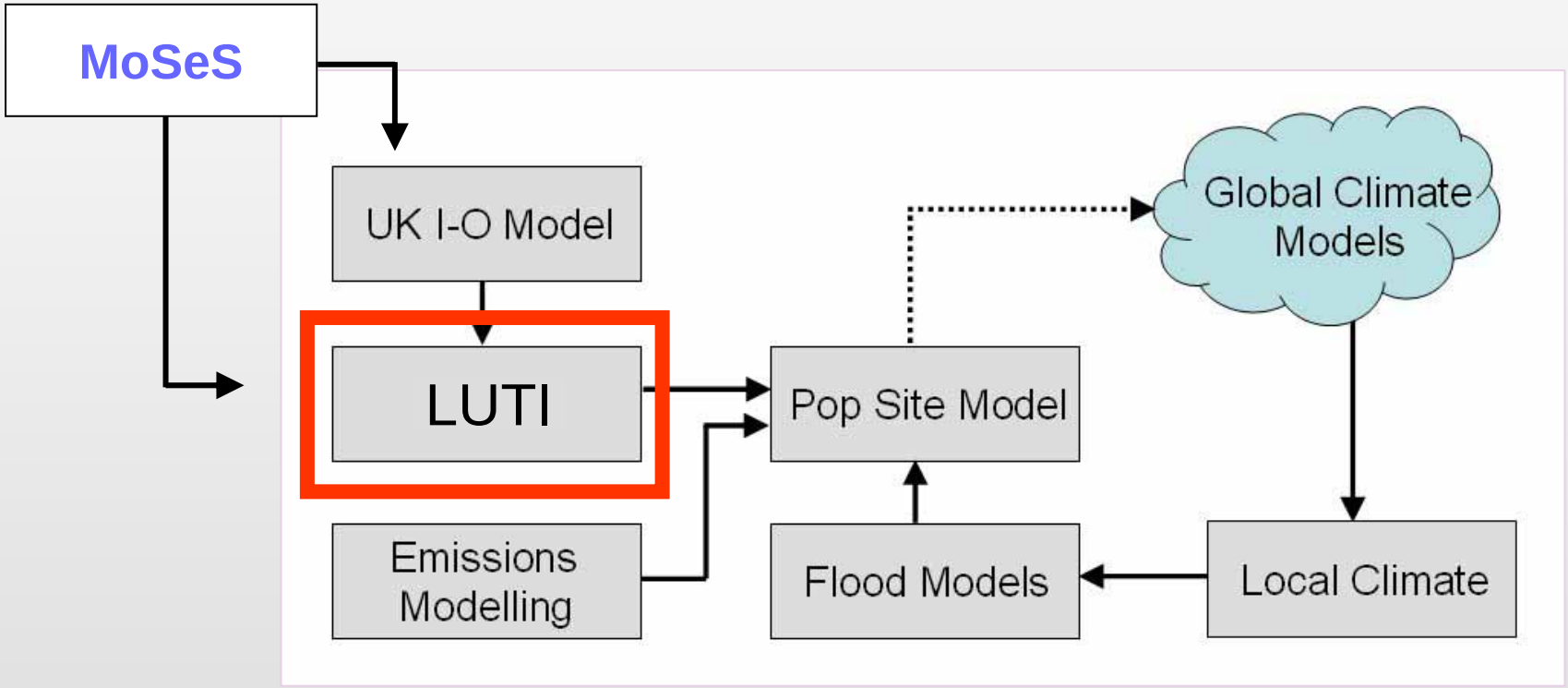
CATS: **Chicago Area Transportation Study 1955**. The 1960s – a great wave of these land use transport models and from then on models have got more detailed, bigger, faster and so on.

Lowry's model for Pittsburgh in fact set the standard for what could be achieved in those days and a lot of work since then is in his spirit



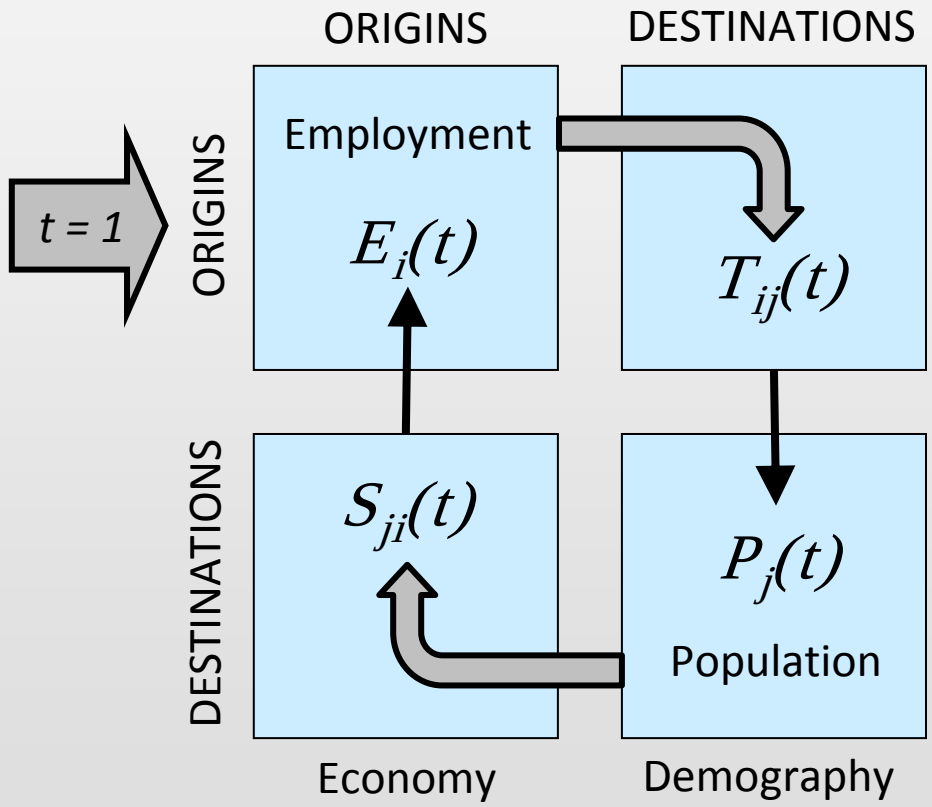
Let me fast forward to the sorts of models we have been building on and off in my group in the last ten years

CASA Models: Tyndall and Arcadia Projects



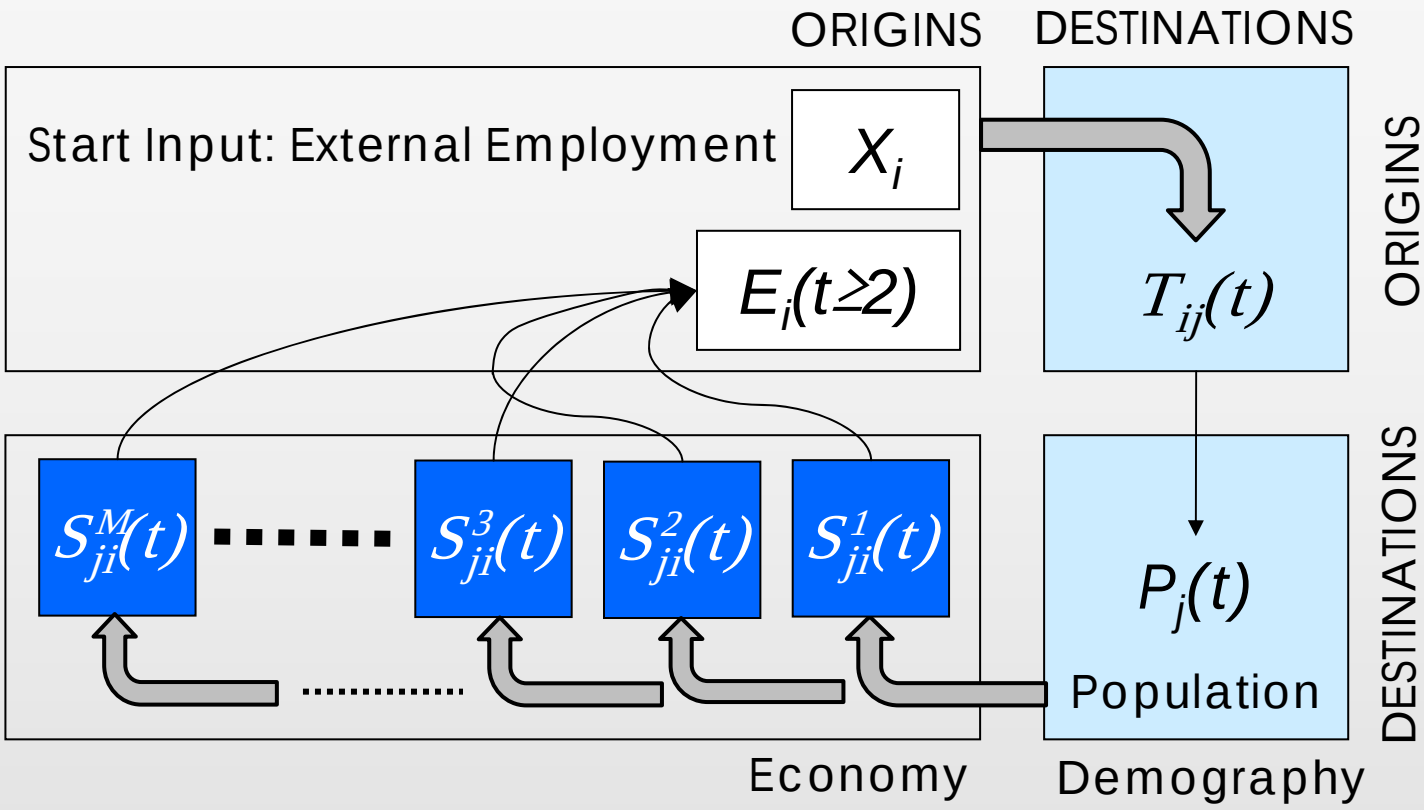
Tyndall Cities – An Integrated Assessment of Sea Level Rise in London: Our work is on the LUTI Model – Land Use Transportation Interaction Model

A quick sketch of the model structure – ie what does it do .....



The grey arrows are spatial interactions, the black are scaling

We can extend this logic very easily into many sectors .....



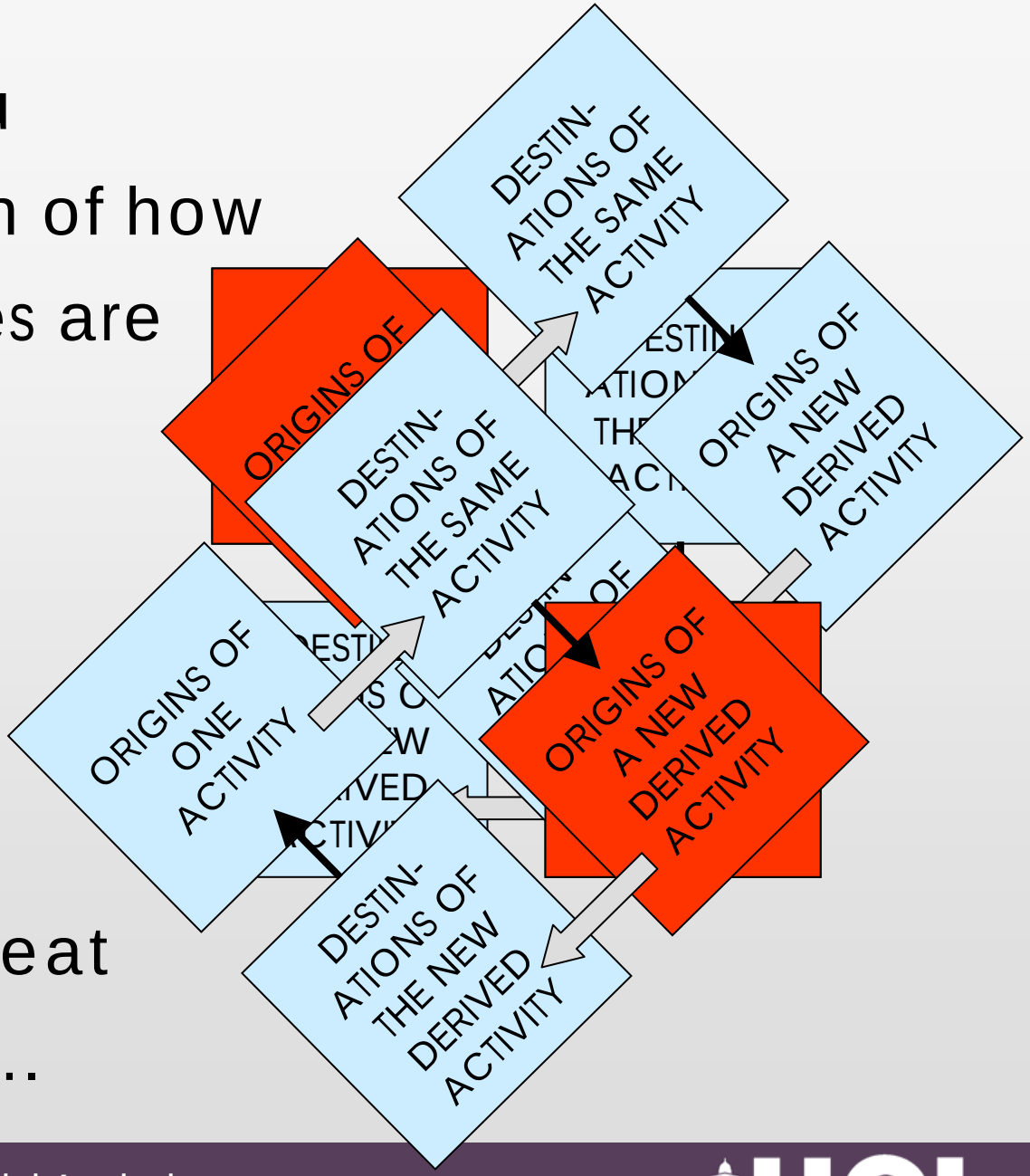
Essentially the model structure is ***input-output*** like and the submodels are ***gravitational***, discrete choice, or radiation etc

Let me show you

another sketch of how

these structures are

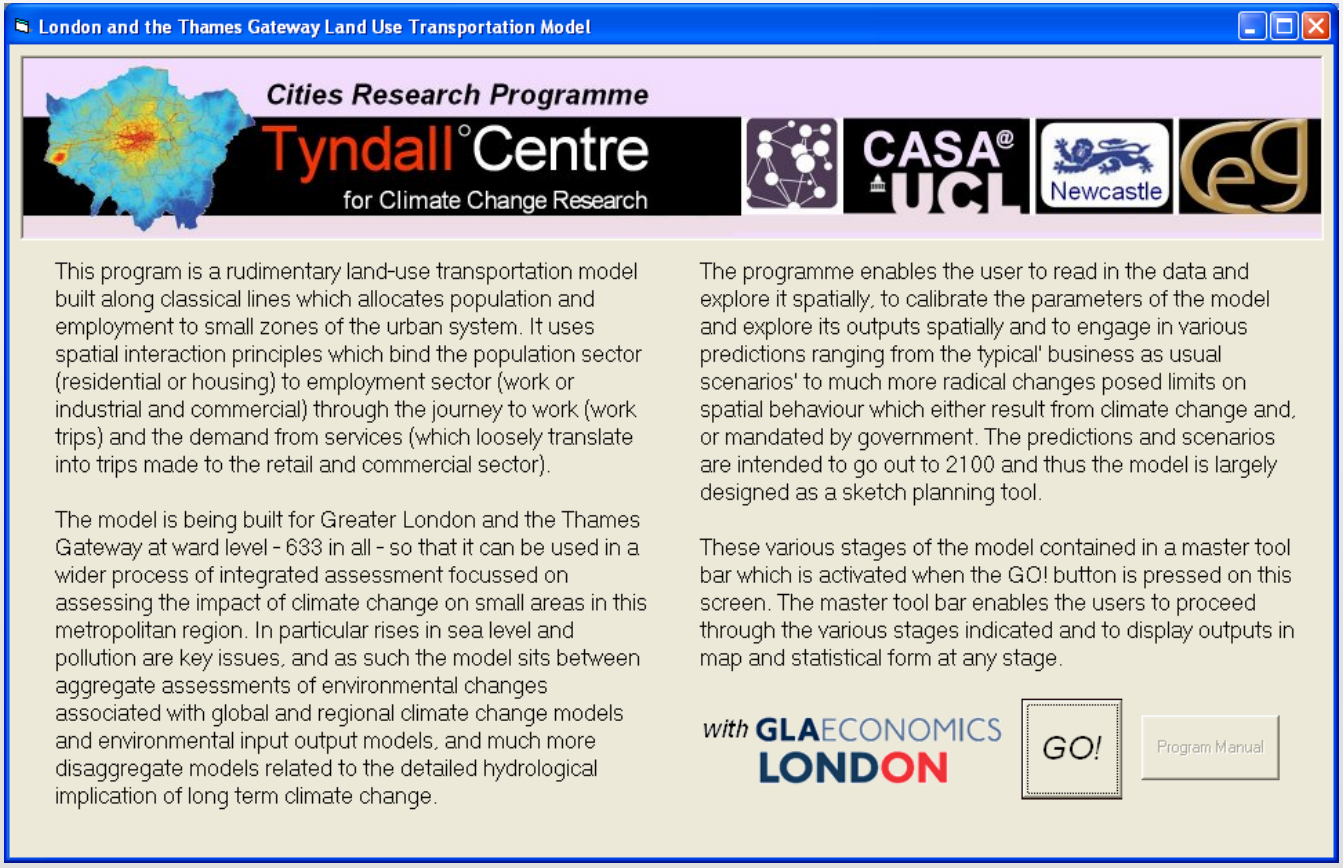
coupled

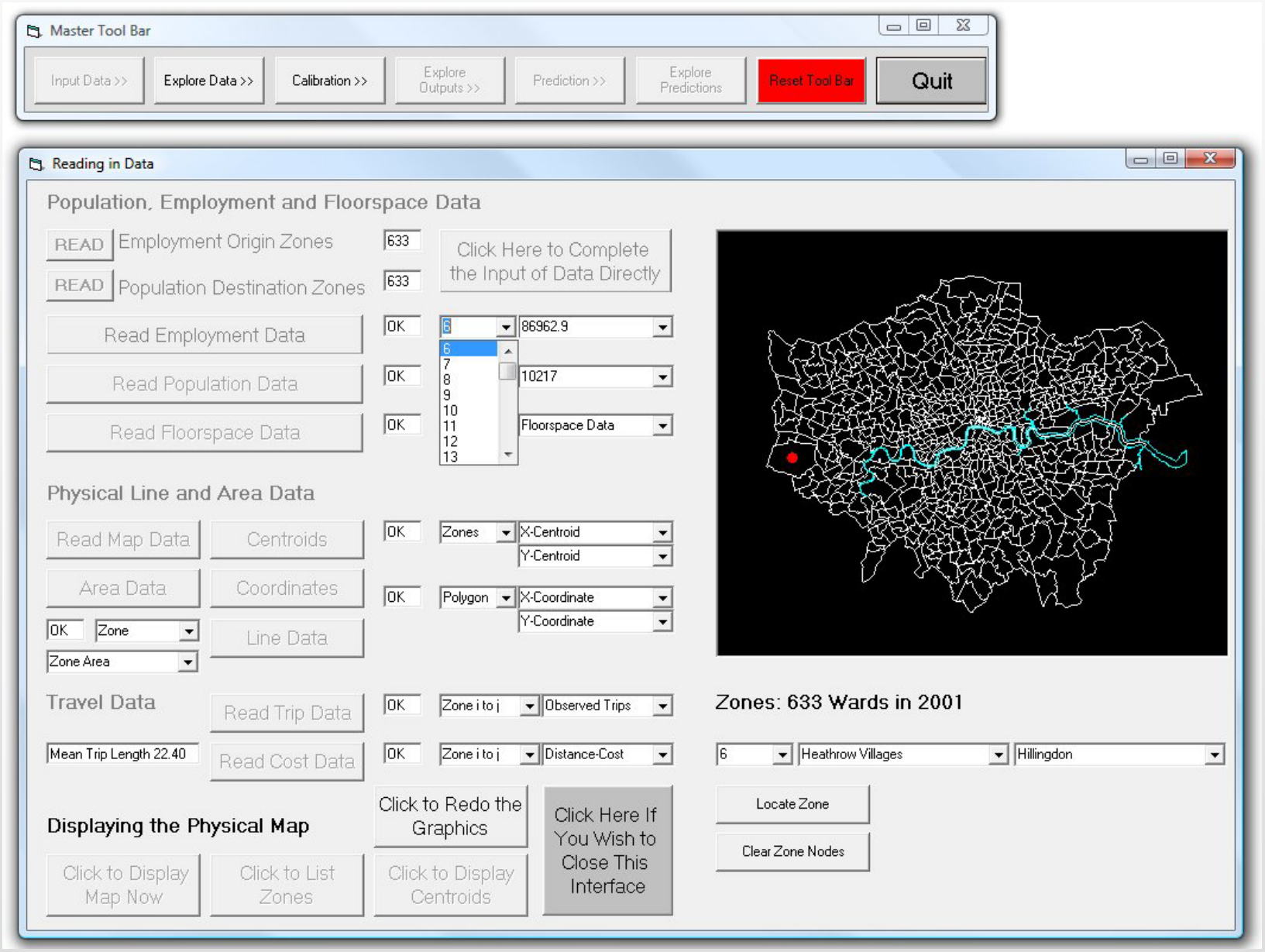


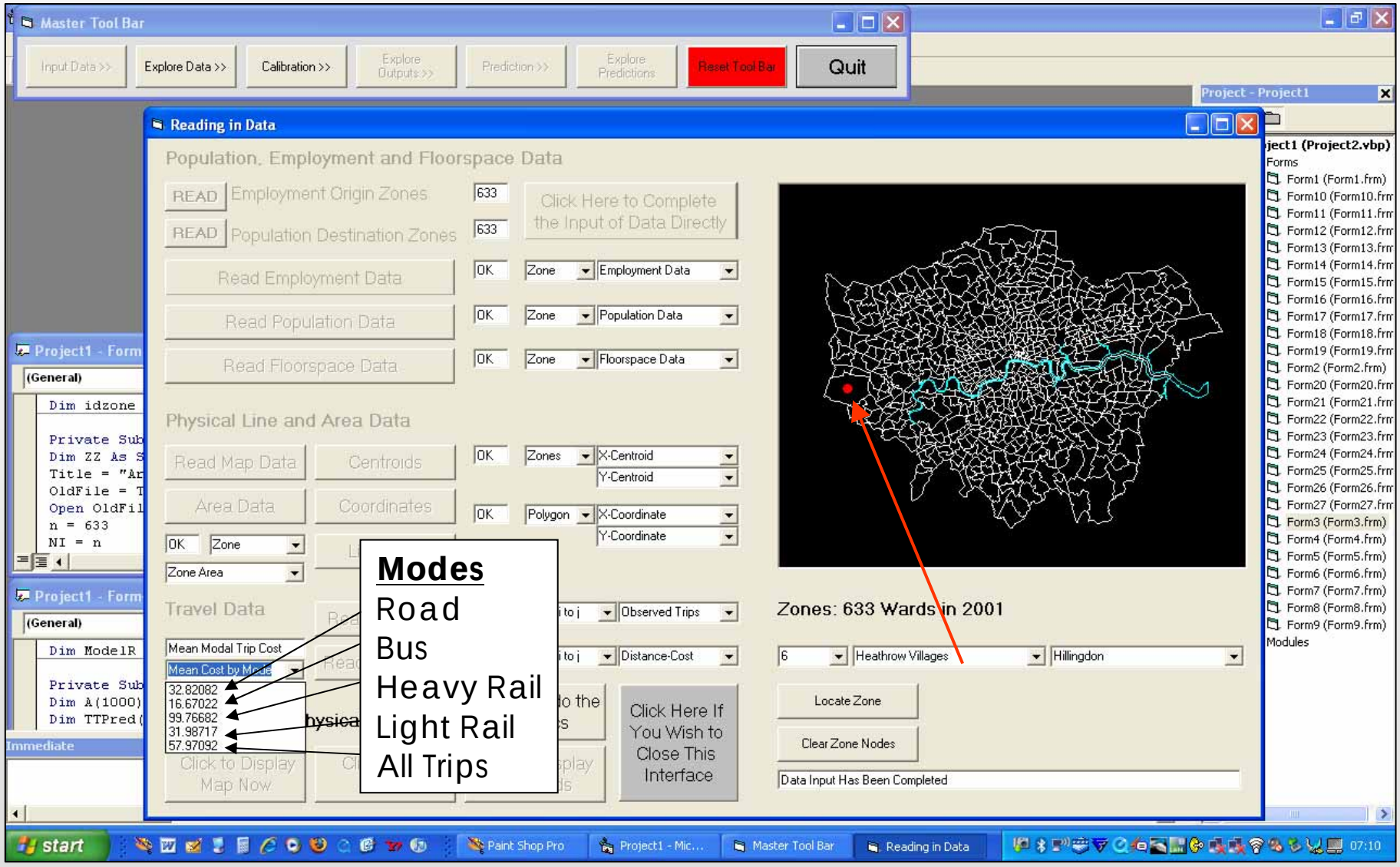
And we can repeat

this indefinitely ....

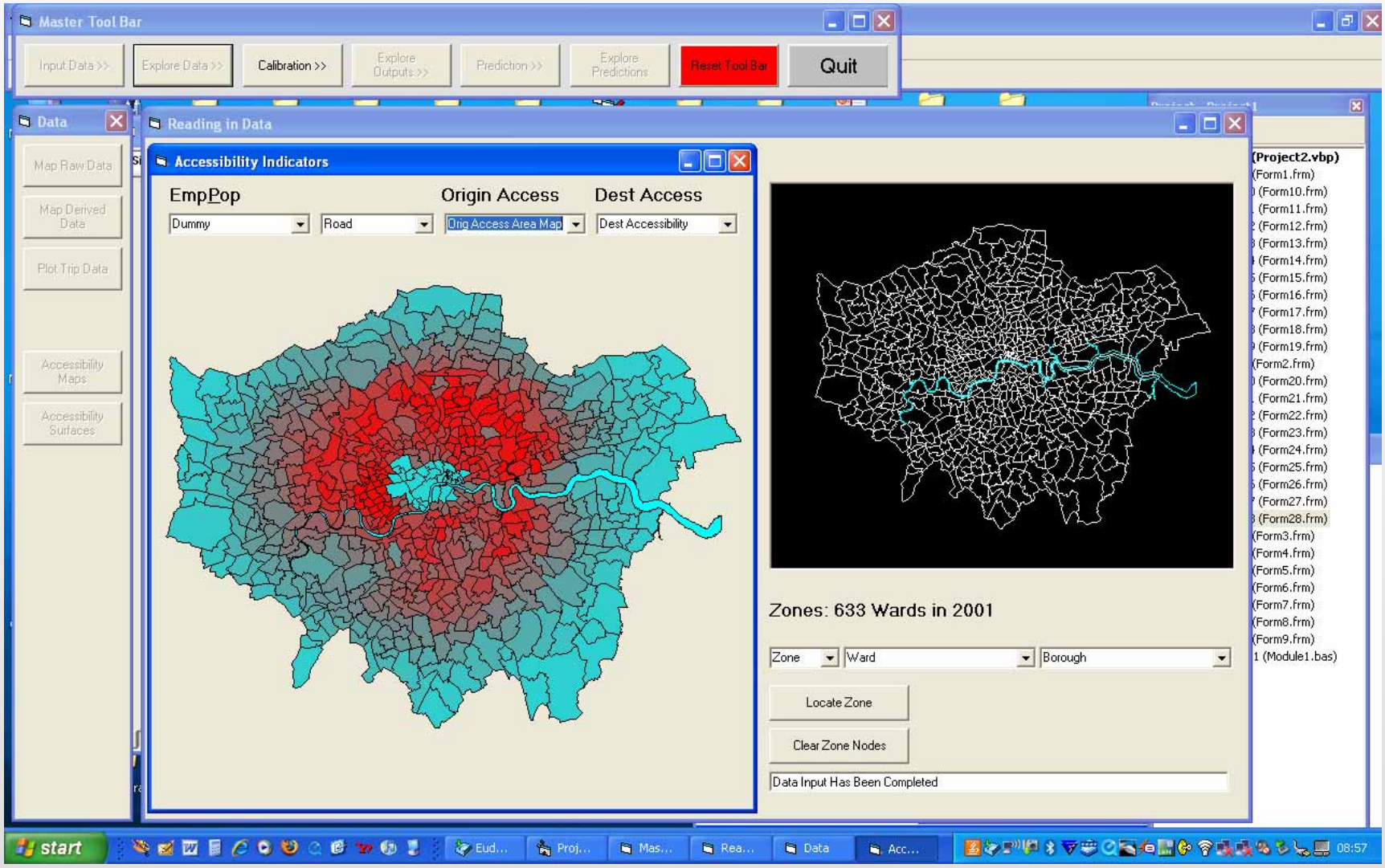
To give a flavour of the model, I will show some screen shots first

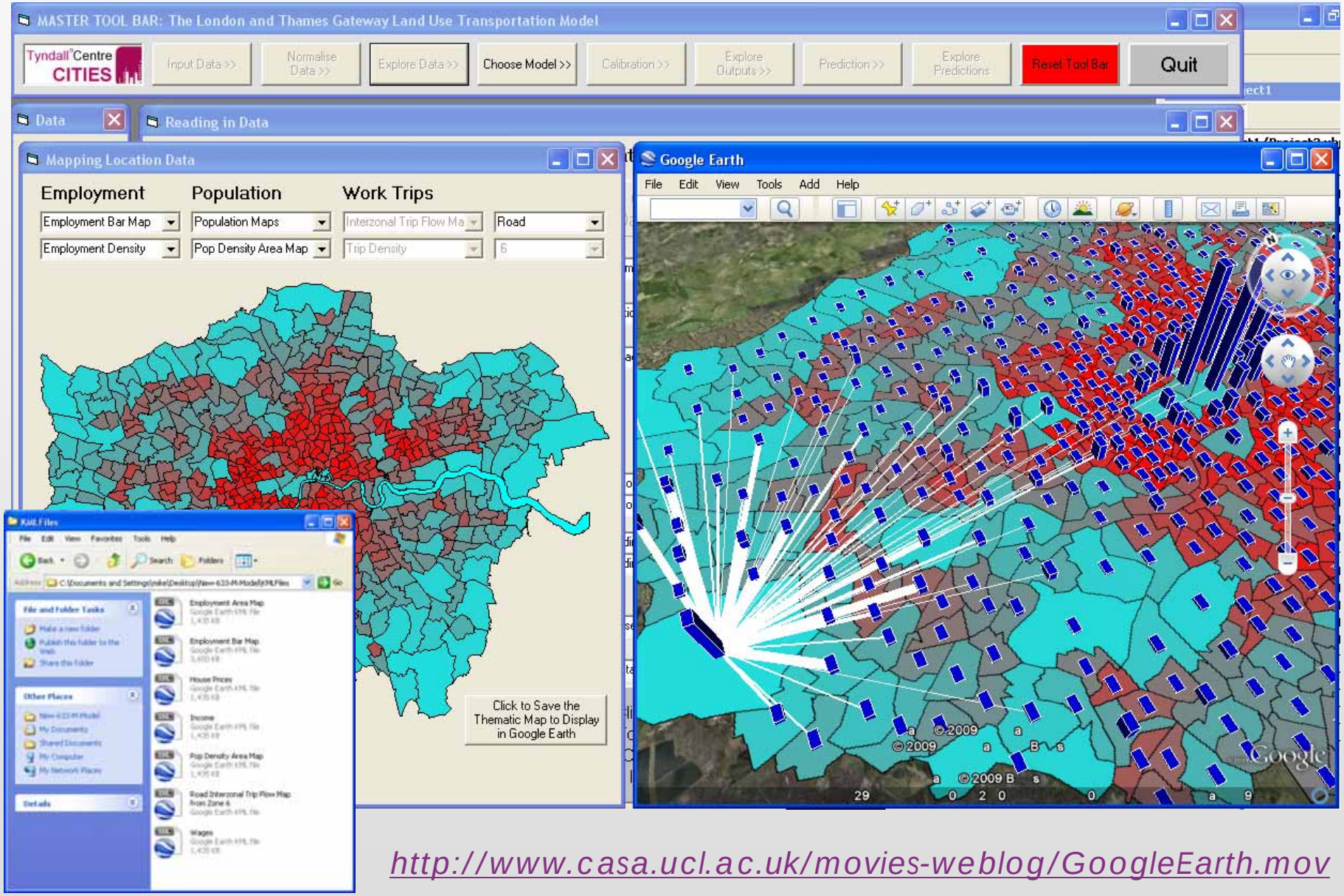



Master Tool Bar
Input Data >>
Explore Data >>
Calibration >>
Explore Outputs >>
Prediction >>
Explore Predictions
Reset Tool Bar
Quit
Reading in Data
Population, Employment and Floorspace Data
READ
Employment Origin Zones
633
READ
Population Destination Zones
633
Click Here to Complete the Input of Data Directly
Read Employment Data
OK
6
86962.9
6
7
8
9
10
11
12
13
Read Population Data
OK
10217
Read Floorspace Data
OK
Floorspace Data
Physical Line and Area Data
Read Map Data
Centroids
OK
Zones
X-Centroid
Y-Centroid
Area Data
Coordinates
OK
Polygon
X-Coordinate
Y-Coordinate
OK
Zone
Line Data
Zone Area
Travel Data
Read Trip Data
OK
Zone i to j
Observed Trips
Mean Trip Length 22.40
Read Cost Data
OK
Zone i to j
Distance-Cost
Zones: 633 Wards in 2001
6
Heathrow Villages
Hillingdon
Displaying the Physical Map
Click to Redo the Graphics
Click Here If You Wish to Close This Interface
Locate Zone
Clear Zone Nodes
Click to Display Map Now
Click to List Zones
Click to Display Centroids

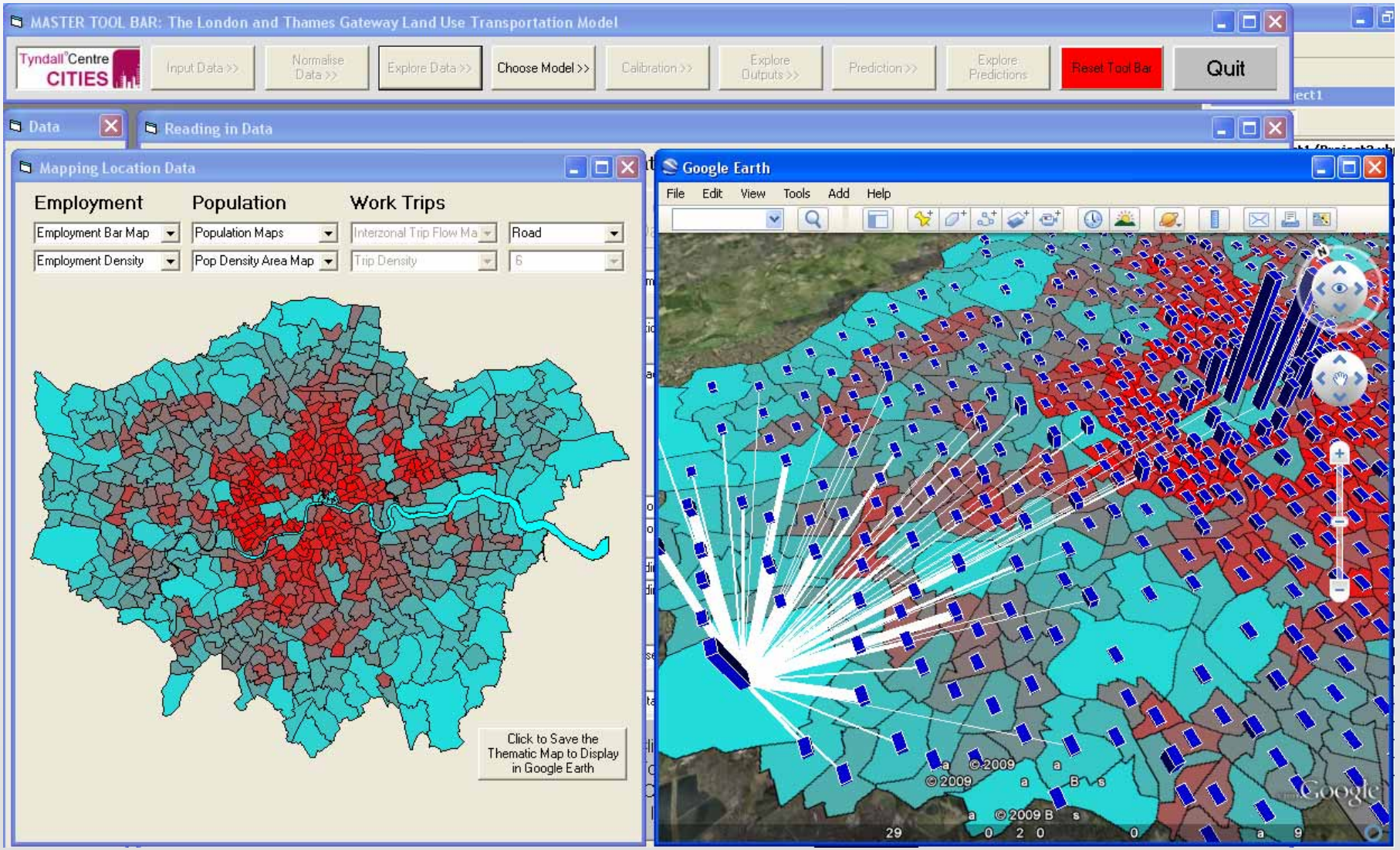


Road: 38%; Bus: 12%: Heavy Rail: 12%: Light Rail 19%; Other (Walk, Bike): 19%

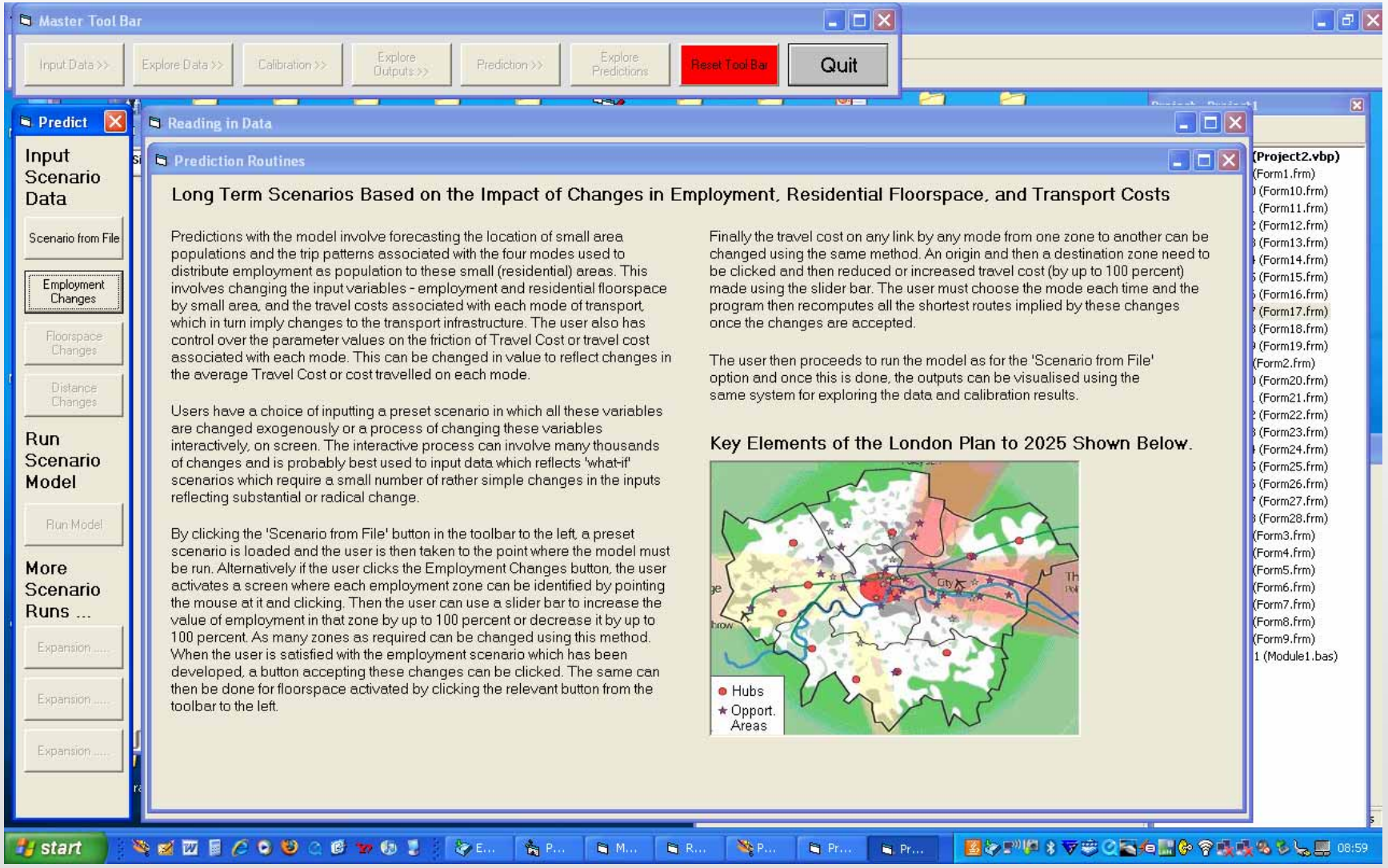

Master Tool Bar
Input Data >>
Explore Data >>
Calibration >>
Explore Outputs >>
Prediction >>
Explore Predictions
Reset Tool Bar
Quit
Data
Map Raw Data
Map Derived Data
Plot Trip Data
Accessibility Maps
Accessibility Surfaces
Reading in Data
Accessibility Indicators
EmpPop
Origin Access
Dest Access
Dummy
Road
Orig Access Area Map
Dest Accessibility
Zones: 633 Wards in 2001
Zone
Ward
Borough
Locate Zone
Clear Zone Nodes
Data Input Has Been Completed
(Project2.vbp)
(Form1.frm)
(Form2.frm)
(Form3.frm)
(Form4.frm)
(Form5.frm)
(Form6.frm)
(Form7.frm)
(Form8.frm)
(Form9.frm)
(Module1.bas)
start
08:57

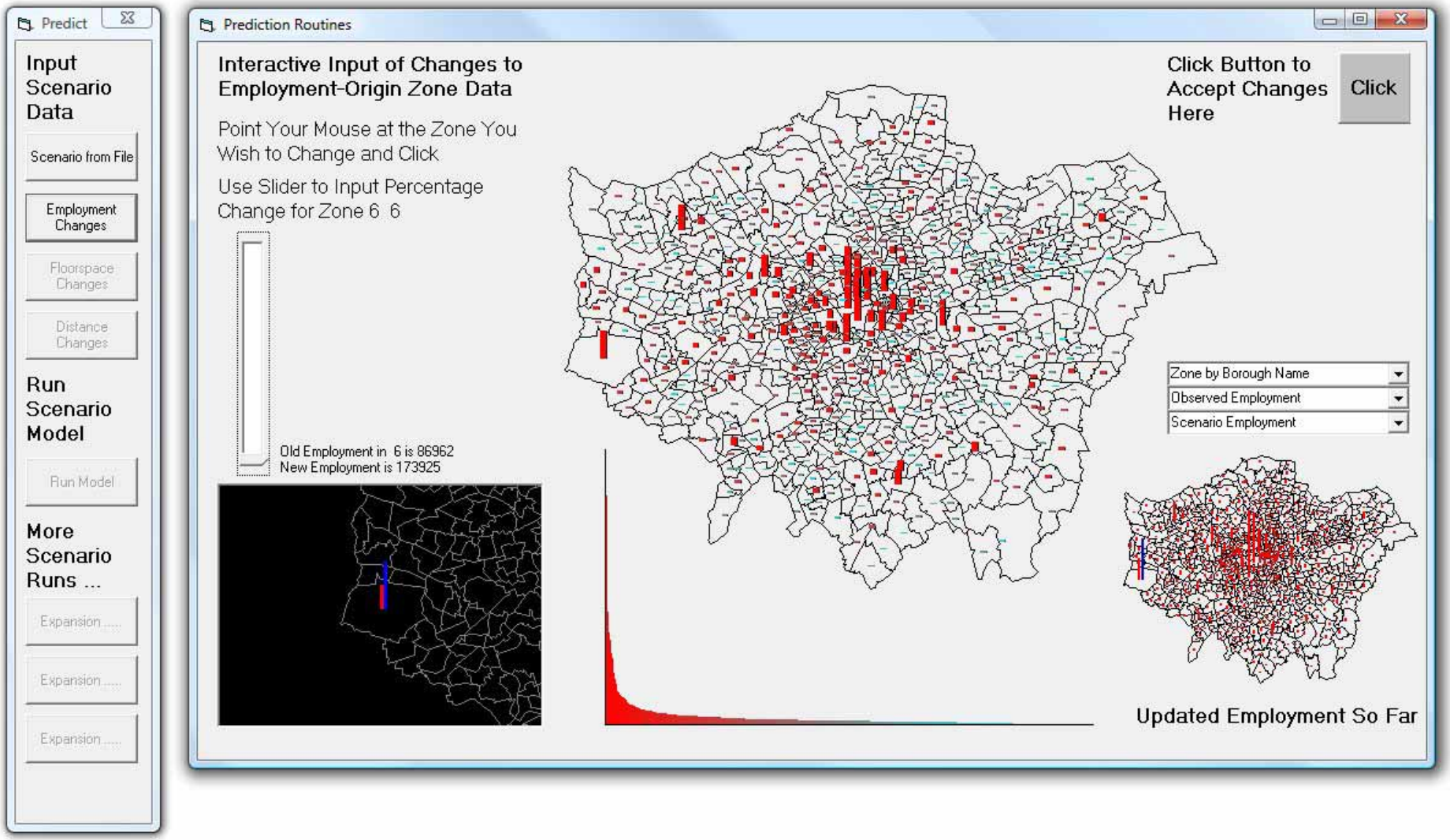


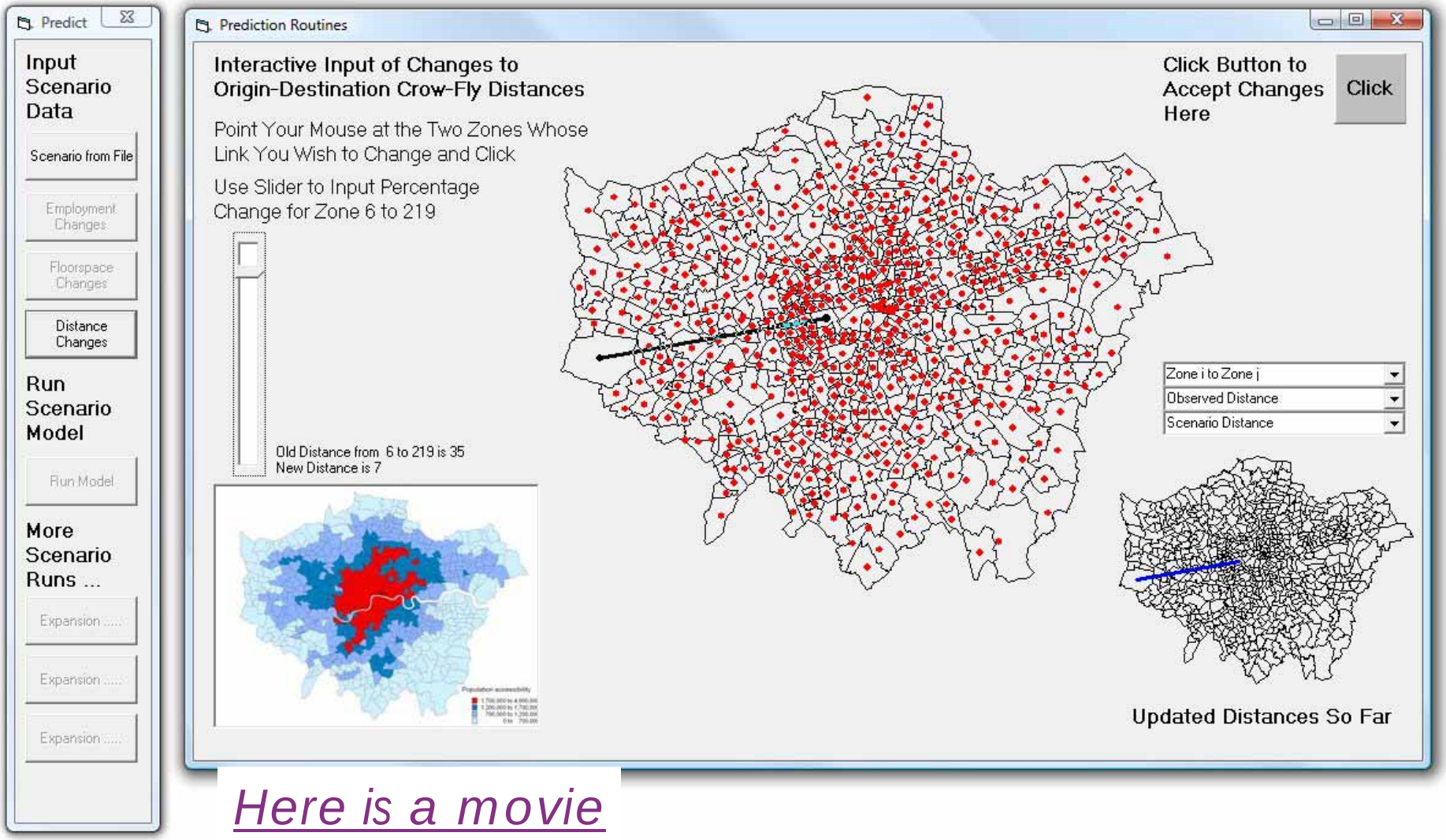
http://www.casa.ucl.ac.uk/movies-weblog/GoogleEarth.mov



Exporting data and predictions to external software on the fly

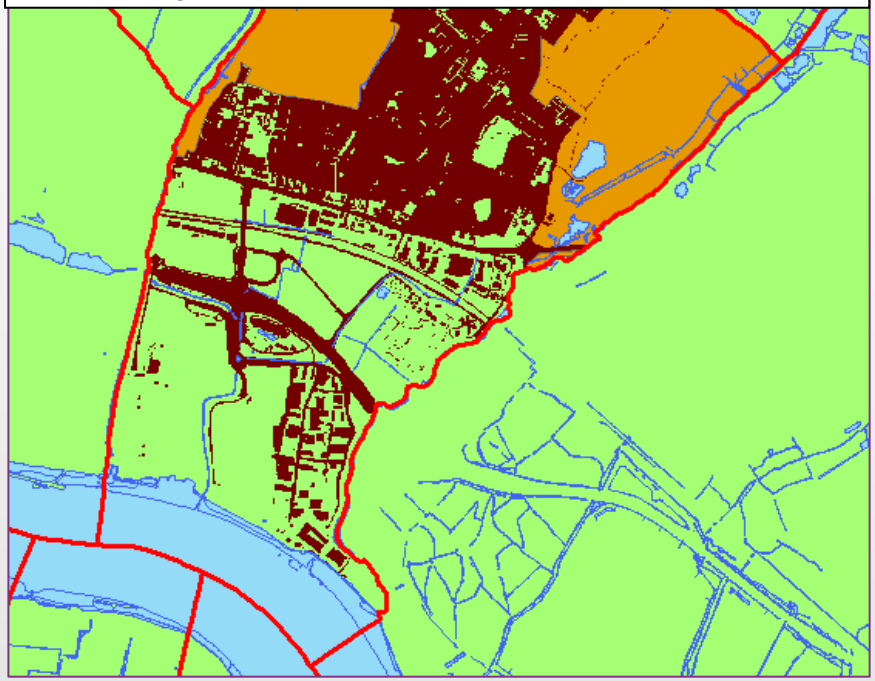

Master Tool Bar
Input Data >>
Explore Data >>
Calibration >>
Explore Outputs >>
Prediction >>
Explore Predictions
Reset Tool Bar
Quit
Predict
Input Scenario Data
Scenario from File
Employment Changes
Floorspace Changes
Distance Changes
Run Scenario Model
Run Model
More Scenario Runs ...
Expansion .....
Expansion .....
Expansion .....
Reading in Data
Prediction Routines
Long Term Scenarios Based on the Impact of Changes in Employment, Residential Floorspace, and Transport Costs
Predictions with the model involve forecasting the location of small area populations and the trip patterns associated with the four modes used to distribute employment as population to these small (residential) areas. This involves changing the input variables - employment and residential floorspace by small area, and the travel costs associated with each mode of transport, which in turn imply changes to the transport infrastructure. The user also has control over the parameter values on the friction of Travel Cost or travel cost associated with each mode. This can be changed in value to reflect changes in the average Travel Cost or cost travelled on each mode.
Users have a choice of inputting a preset scenario in which all these variables are changed exogenously or a process of changing these variables interactively, on screen. The interactive process can involve many thousands of changes and is probably best used to input data which reflects 'what-if' scenarios which require a small number of rather simple changes in the inputs reflecting substantial or radical change.
By clicking the 'Scenario from File' button in the toolbar to the left, a preset scenario is loaded and the user is then taken to the point where the model must be run. Alternatively if the user clicks the Employment Changes button, the user activates a screen where each employment zone can be identified by pointing the mouse at it and clicking. Then the user can use a slider bar to increase the value of employment in that zone by up to 100 percent or decrease it by up to 100 percent. As many zones as required can be changed using this method. When the user is satisfied with the employment scenario which has been developed, a button accepting these changes can be clicked. The same can then be done for floorspace activated by clicking the relevant button from the toolbar to the left.
Finally the travel cost on any link by any mode from one zone to another can be changed using the same method. An origin and then a destination zone need to be clicked and then reduced or increased travel cost (by up to 100 percent) made using the slider bar. The user must choose the mode each time and the program then recomputes all the shortest routes implied by these changes once the changes are accepted.
The user then proceeds to run the model as for the 'Scenario from File' option and once this is done, the outputs can be visualised using the same system for exploring the data and calibration results.
Key Elements of the London Plan to 2025 Shown Below.
Hubs
Opport. Areas
(Project2.vbp)
(Form1.frm)
(Form10.frm)
(Form11.frm)
(Form12.frm)
(Form13.frm)
(Form14.frm)
(Form15.frm)
(Form16.frm)
(Form17.frm)
(Form18.frm)
(Form19.frm)
(Form2.frm)
(Form20.frm)
(Form21.frm)
(Form22.frm)
(Form23.frm)
(Form24.frm)
(Form25.frm)
(Form26.frm)
(Form27.frm)
(Form28.frm)
(Form3.frm)
(Form4.frm)
(Form5.frm)
(Form6.frm)
(Form7.frm)
(Form8.frm)
(Form9.frm)
1 (Module1.bas)
start
08:59

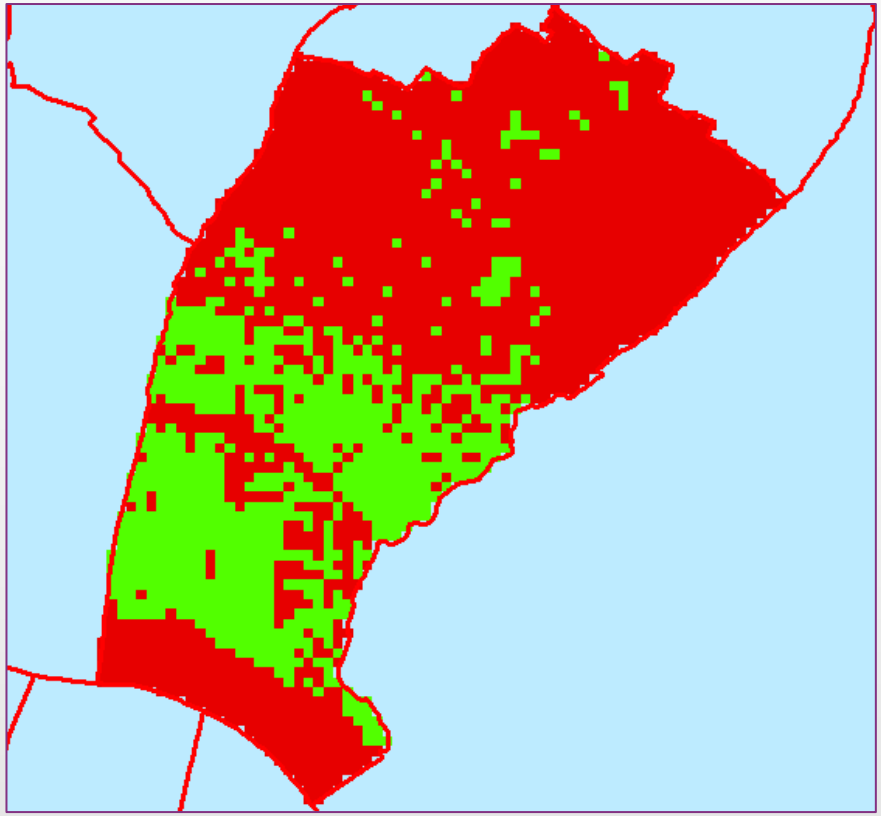

Predict
Input Scenario Data
Scenario from File
Employment Changes
Floorspace Changes
Distance Changes
Run Scenario Model
Run Model
More Scenario Runs ...
Expansion .....
Expansion .....
Expansion .....
Prediction Routines
Interactive Input of Changes to Employment-Origin Zone Data
Point Your Mouse at the Zone You Wish to Change and Click
Use Slider to Input Percentage Change for Zone 6 6
Old Employment in 6 is 86962
New Employment is 173925
Click Button to Accept Changes Here
Click
Zone by Borough Name
Observed Employment
Scenario Employment
Updated Employment So Far



Here is a movie

The local development model
GIS layers at 50 metre resolution

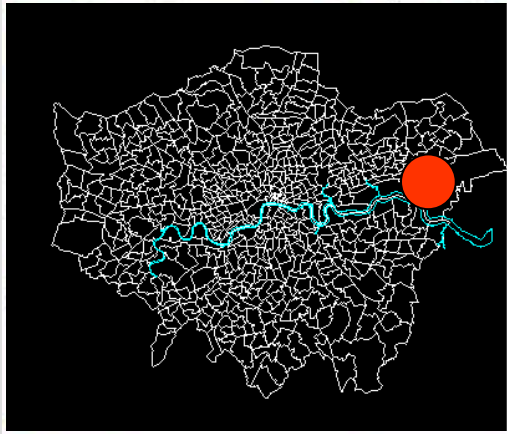


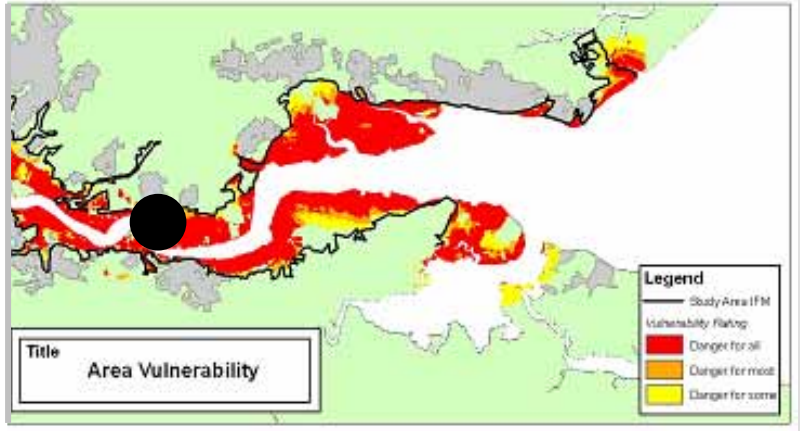


Current Water

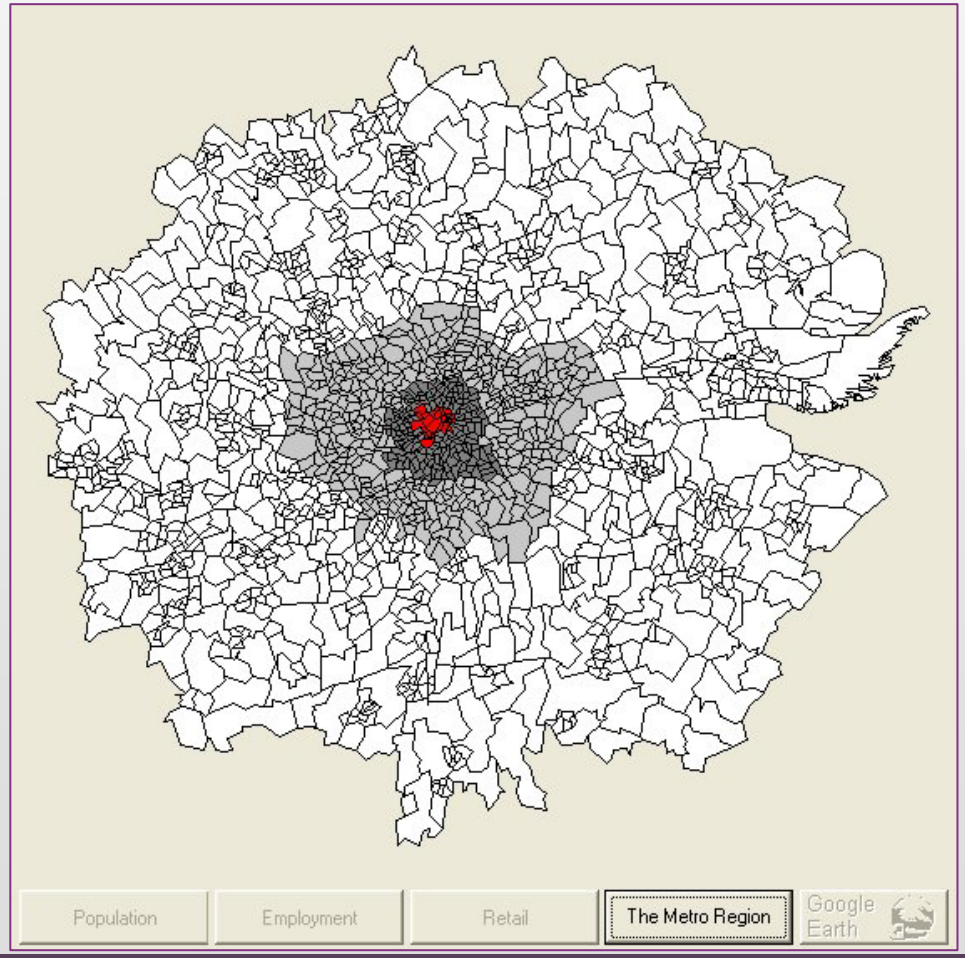
Currently Developed

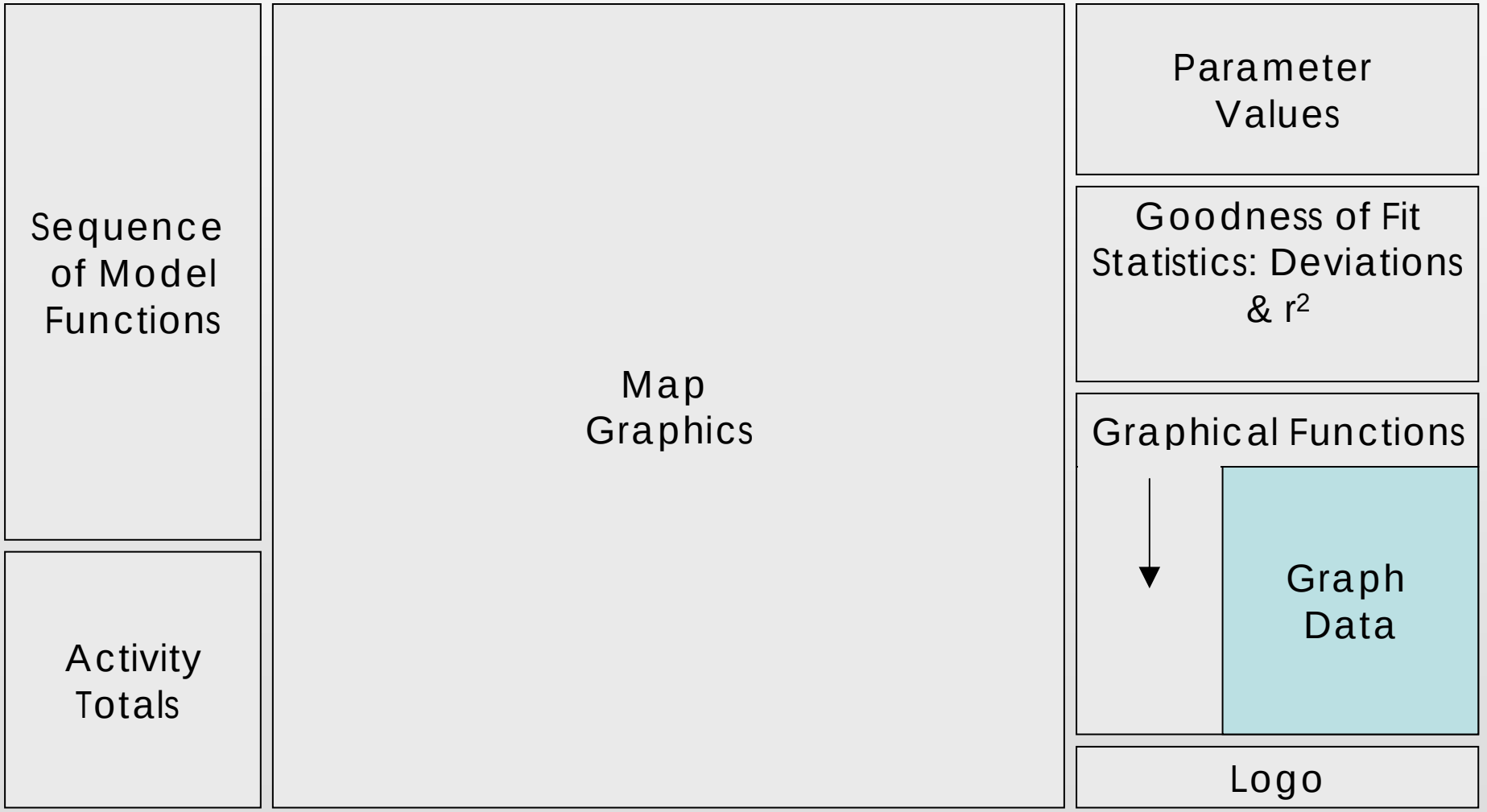
Planning Constrained Land

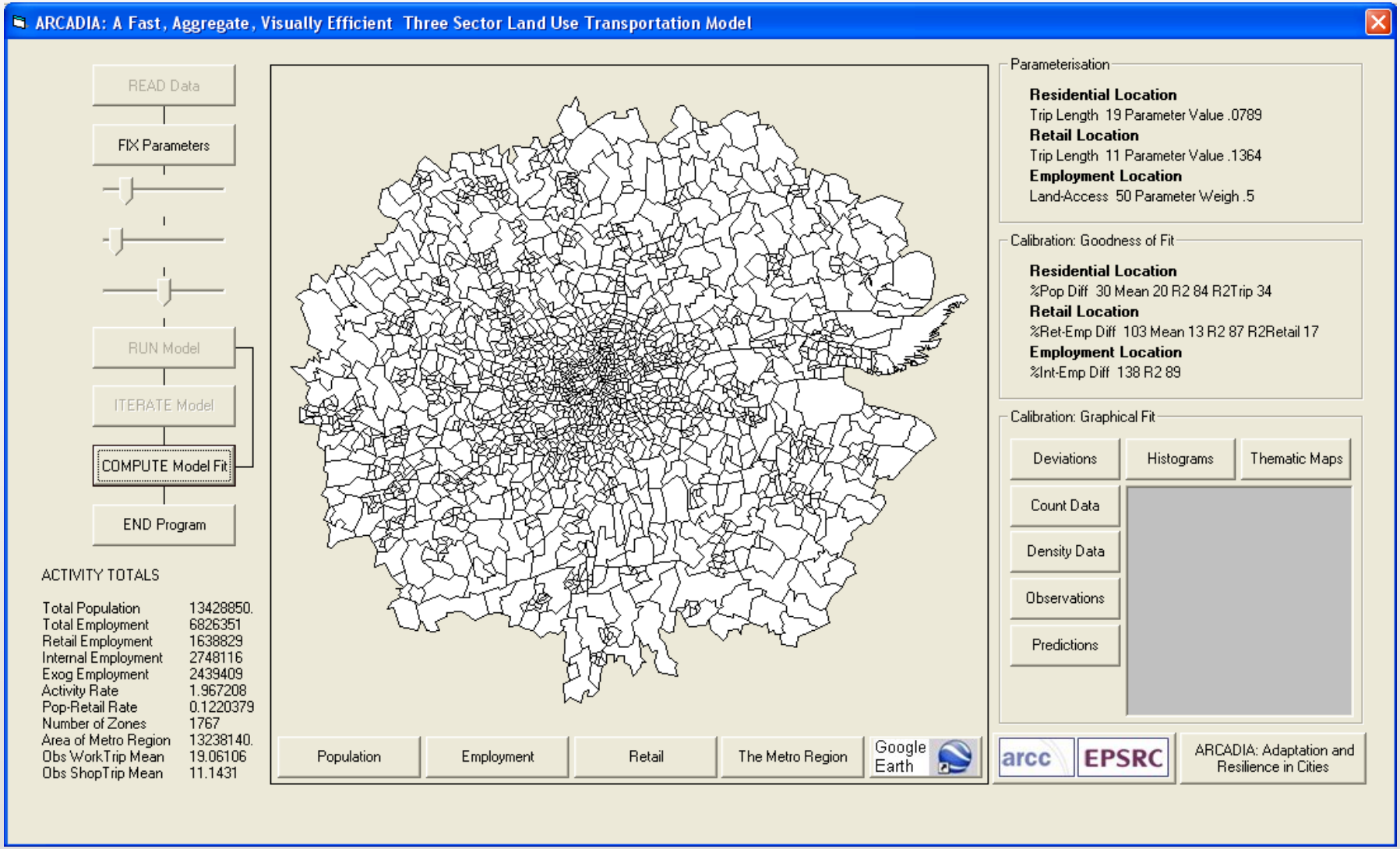


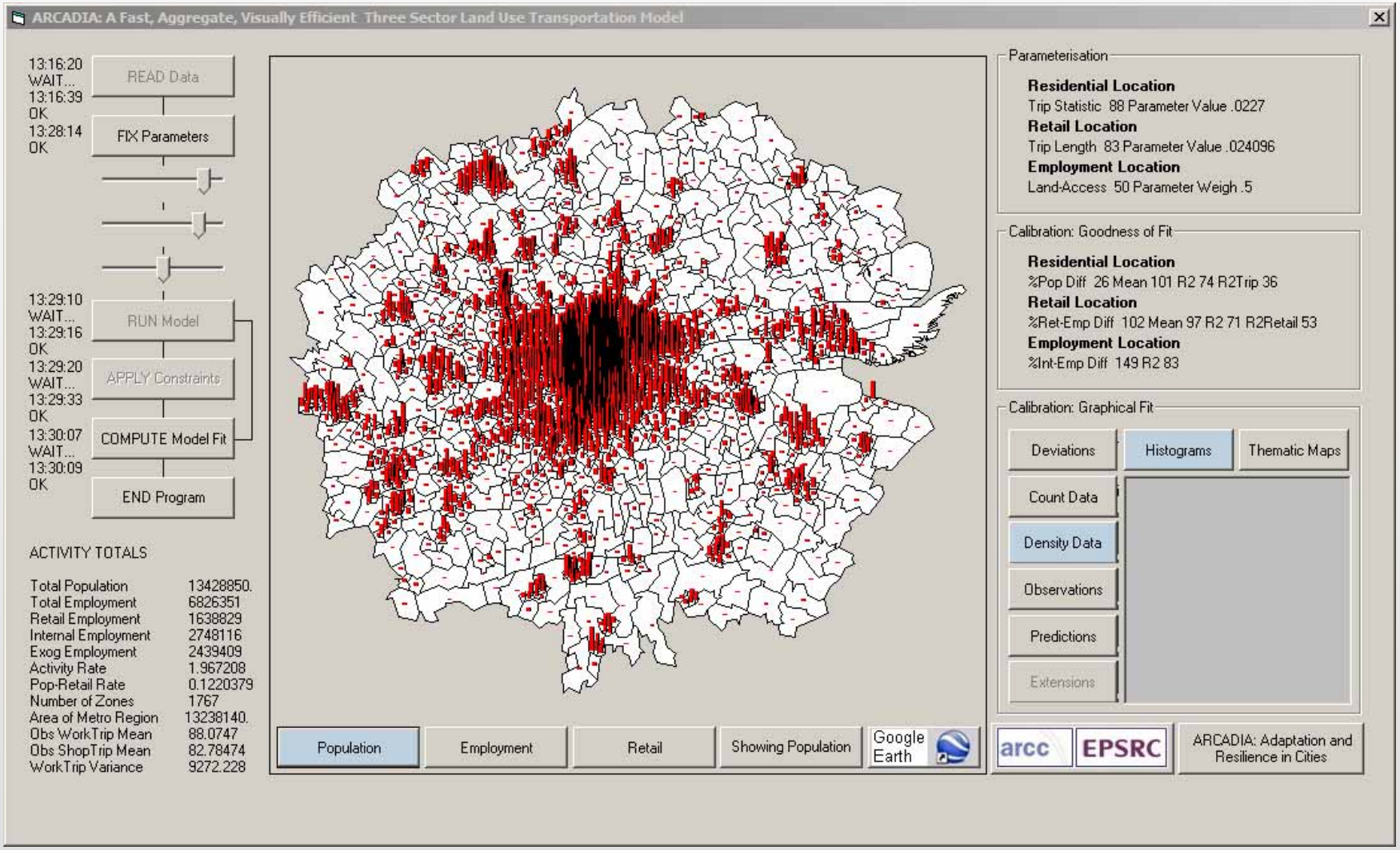


We broadened this model to capture greater spatial extent – simplified the interface – this is the Arcadia pilot build for London and the Outer Metropolitan area



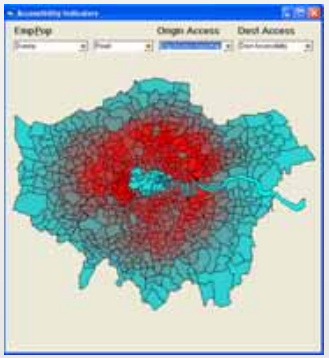

Sequence of Model Functions
Activity Totals
Map Graphics
Parameter Values
Goodness of Fit Statistics: Deviations & r^2
Graphical Functions
Graph Data
Logo

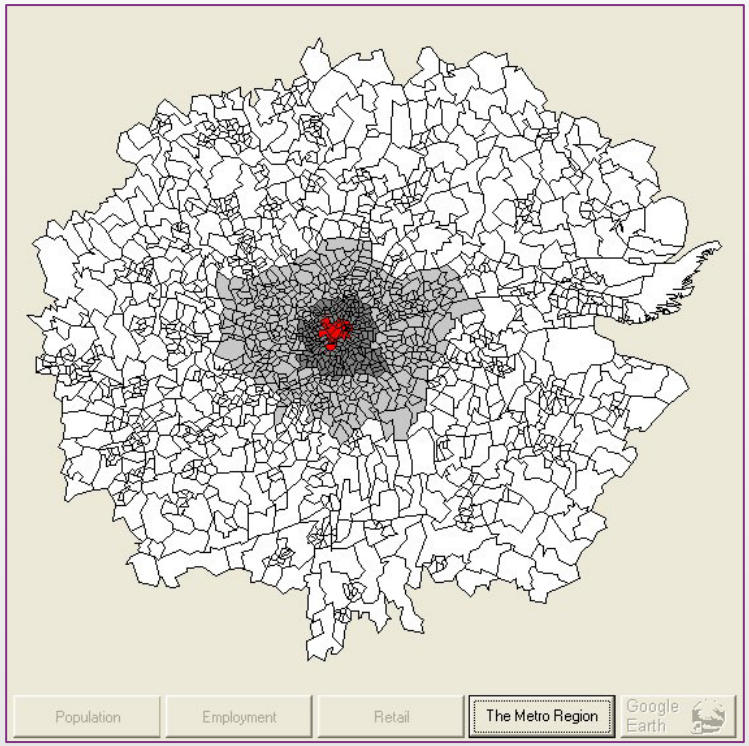

ARCADIA: A Fast, Aggregate, Visually Efficient Three Sector Land Use Transportation Model
READ Data
FIX Parameters
RUN Model
ITERATE Model
COMPUTE Model Fit
END Program
ACTIVITY TOTALS
Total Population 13428850.
Total Employment 6826351
Retail Employment 1638829
Internal Employment 2748116
Exog Employment 2439409
Activity Rate 1.967208
Pop-Retail Rate 0.1220379
Number of Zones 1767
Area of Metro Region 13238140.
Obs WorkTrip Mean 19.06106
Obs ShopTrip Mean 11.1431
Population
Employment
Retail
The Metro Region
Google Earth
Parameterisation
Residential Location
Trip Length 19 Parameter Value .0789
Retail Location
Trip Length 11 Parameter Value .1364
Employment Location
Land-Access 50 Parameter Weigh .5
Calibration: Goodness of Fit
Residential Location
%Pop Diff 30 Mean 20 R2 84 R2Trip 34
Retail Location
%Ret-Emp Diff 103 Mean 13 R2 87 R2Retail 17
Employment Location
%Int-Emp Diff 138 R2 89
Calibration: Graphical Fit
Deviations
Histograms
Thematic Maps
Count Data
Density Data
Observations
Predictions
arcc
EPSRC
ARCADIA: Adaptation and Resilience in Cities

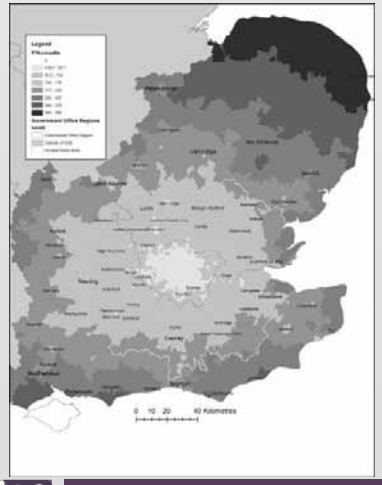

ARCADIA: A Fast, Aggregate, Visually Efficient Three Sector Land Use Transportation Model
13:16:20
WAIT...
13:16:39
OK
READ Data
13:28:14
OK
FIX Parameters
13:29:10
WAIT...
13:29:16
OK
RUN Model
13:29:20
WAIT...
13:29:33
OK
APPLY Constraints
13:30:07
WAIT...
13:30:09
OK
COMPUTE Model Fit
END Program
ACTIVITY TOTALS
Total Population 13428850.
Total Employment 6826351
Retail Employment 1638829
Internal Employment 2748116
Exog Employment 2439409
Activity Rate 1.967208
Pop-Retail Rate 0.1220379
Number of Zones 1767
Area of Metro Region 13238140.
Obs WorkTrip Mean 88.0747
Obs ShopTrip Mean 82.78474
WorkTrip Variance 9272.228
Population
Employment
Retail
Showing Population
Google Earth
Parameterisation
Residential Location
Trip Statistic 88 Parameter Value .0227
Retail Location
Trip Length 83 Parameter Value .024096
Employment Location
Land-Access 50 Parameter Weigh .5
Calibration: Goodness of Fit
Residential Location
%Pop Diff 26 Mean 101 R2 74 R2Trip 36
Retail Location
%Ret-Emp Diff 102 Mean 97 R2 71 R2Retail 53
Employment Location
%Int-Emp Diff 149 R2 83
Calibration: Graphical Fit
Deviations
Histograms
Thematic Maps
Count Data
Density Data
Observations
Predictions
Extensions
arcc
EPSRC
ARCADIA: Adaptation and Resilience in Cities

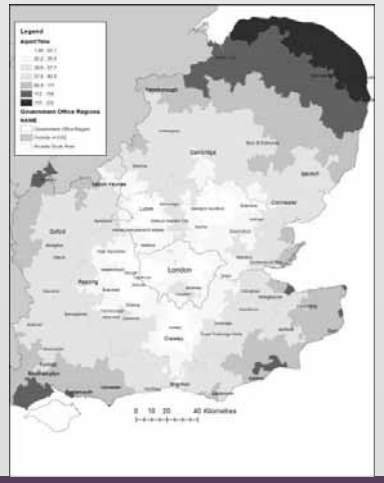

Scotland
North East
North West
Yorkshire & the Humber
East Midlands
East
Wales
West Midlands
South West
South East
London
Regional Boundary
National Boundary
County Boundary
Regional Government Offices


Employment
Population
Work Trips


Origin Access:
Dest Access


Population
Employment
Retail
The Metro Region
Google Earth

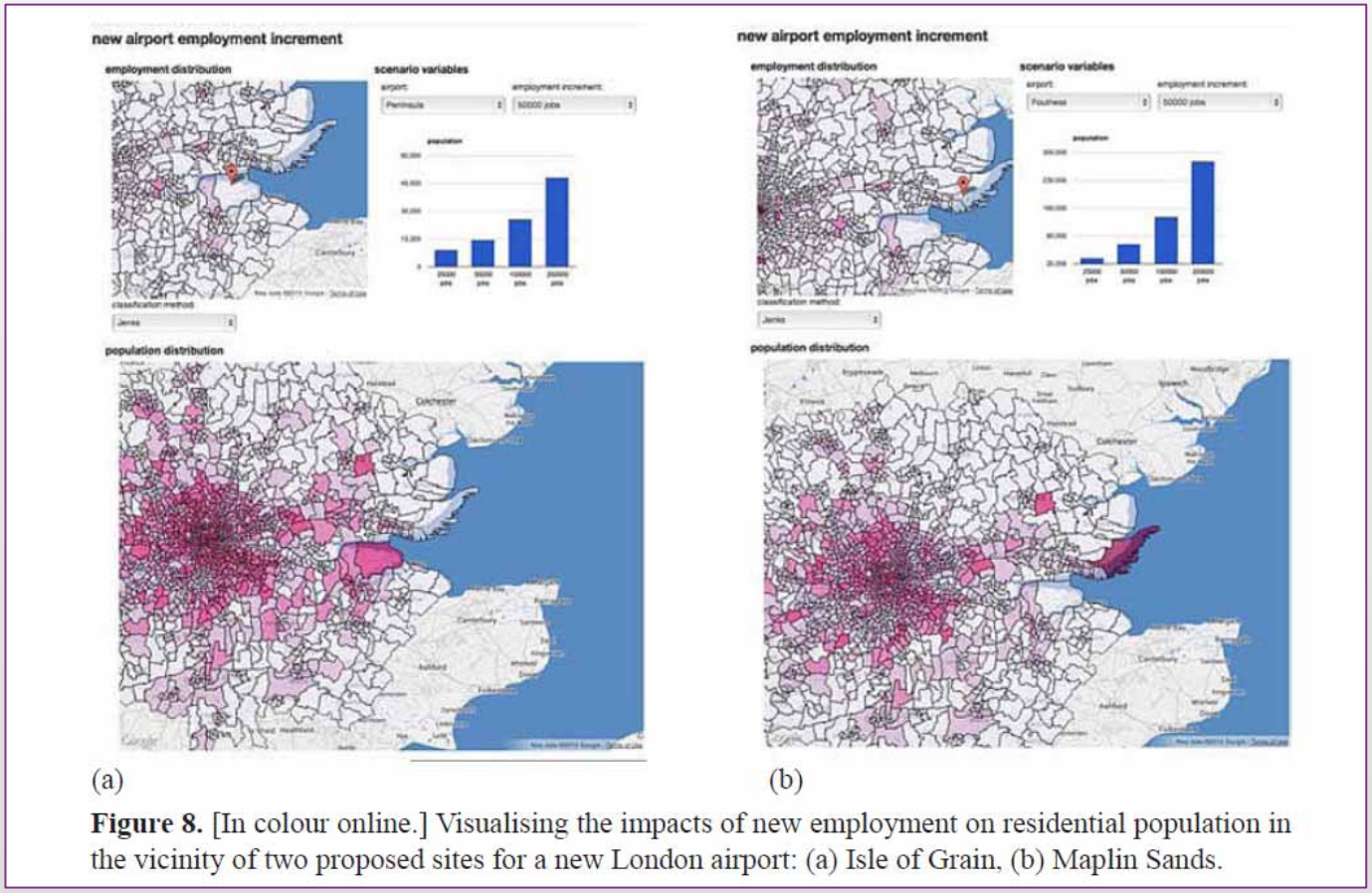





LONDON

Using Such Models to Test Spatial Impacts

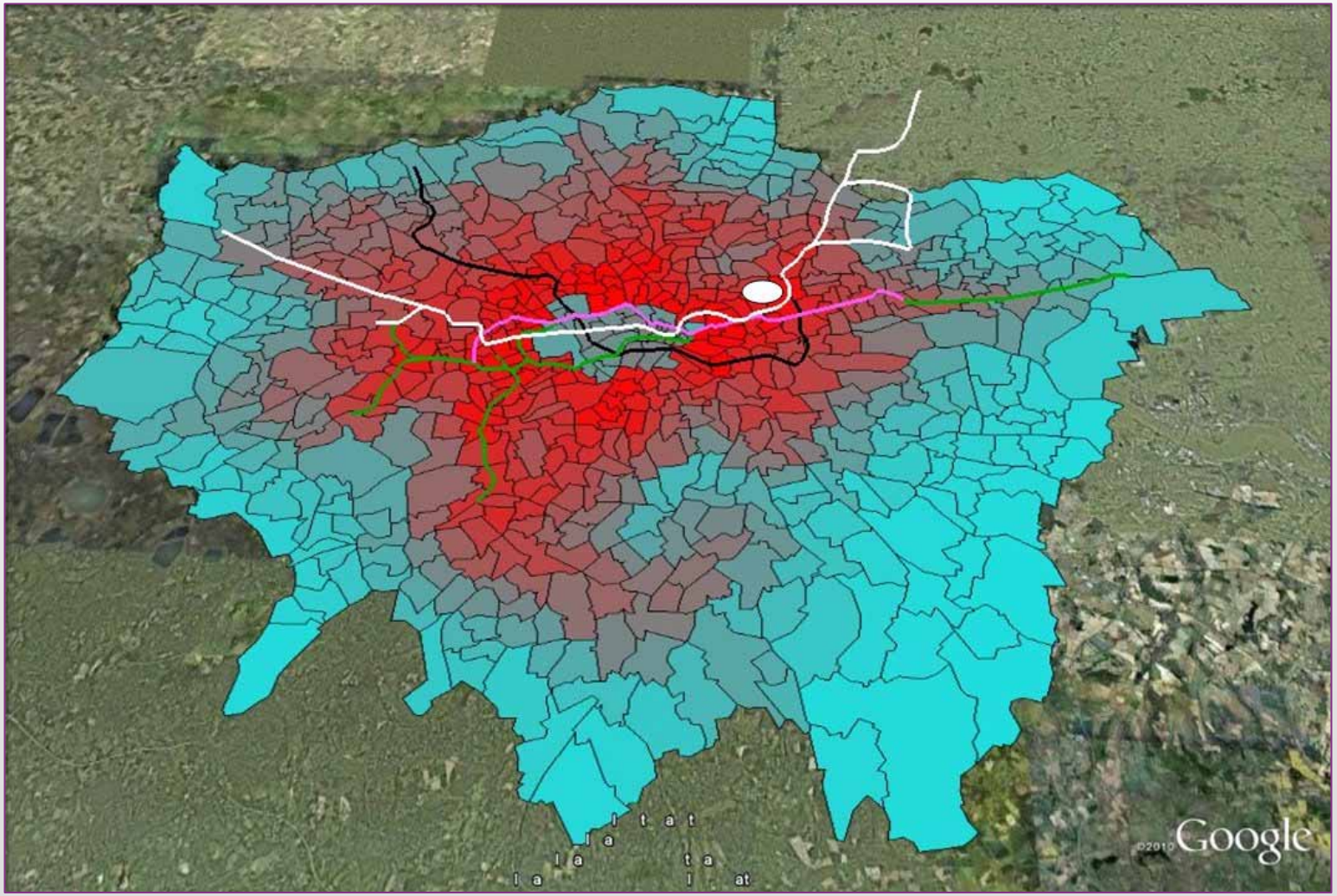
We also have a web based version - SIMULACRA

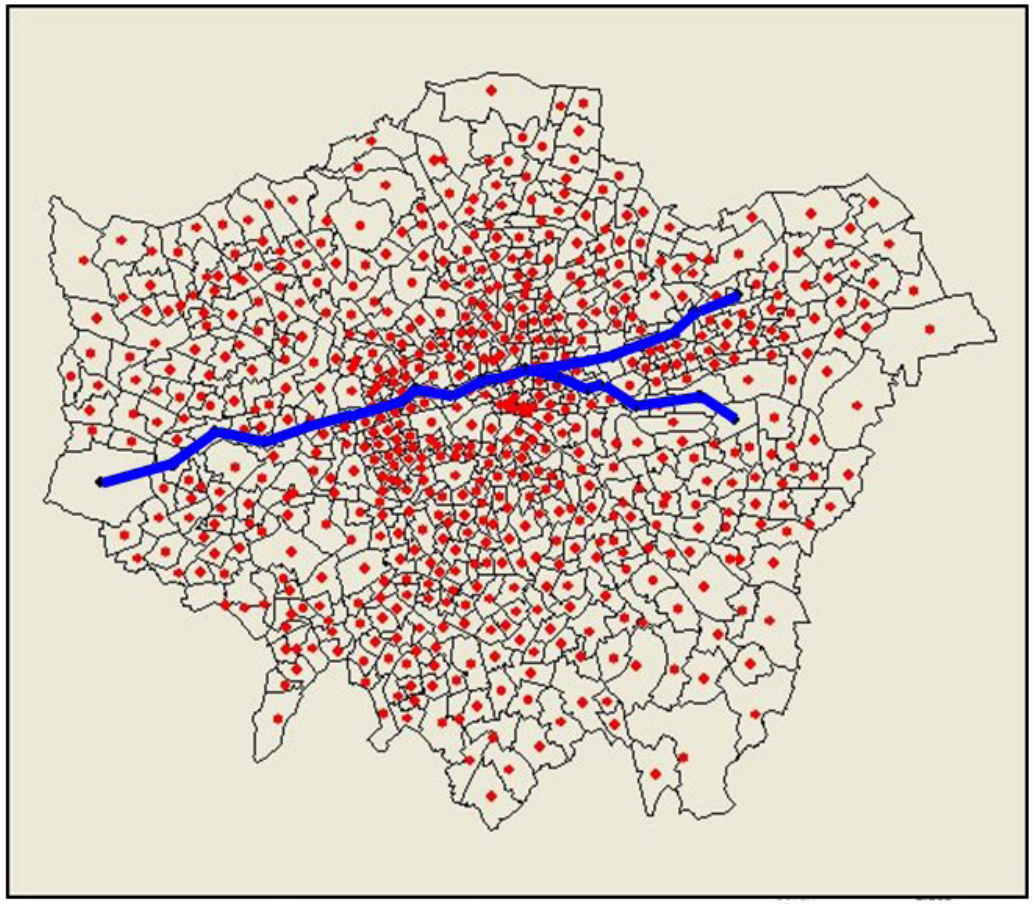


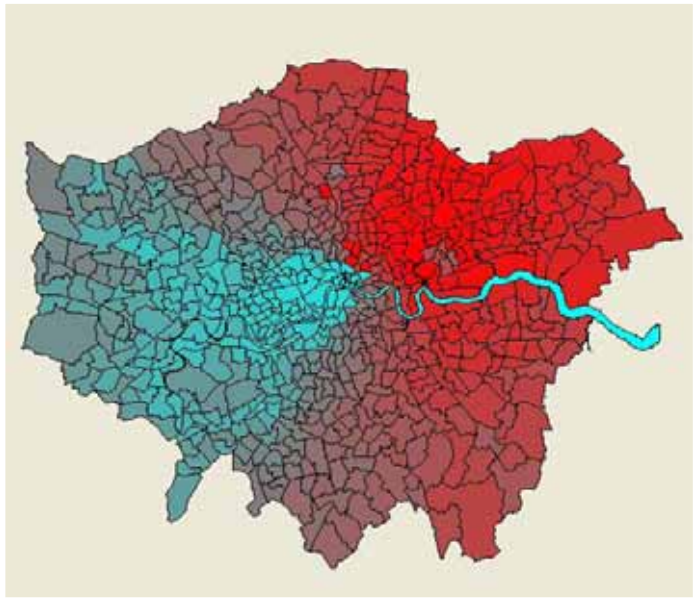
(a) (b)

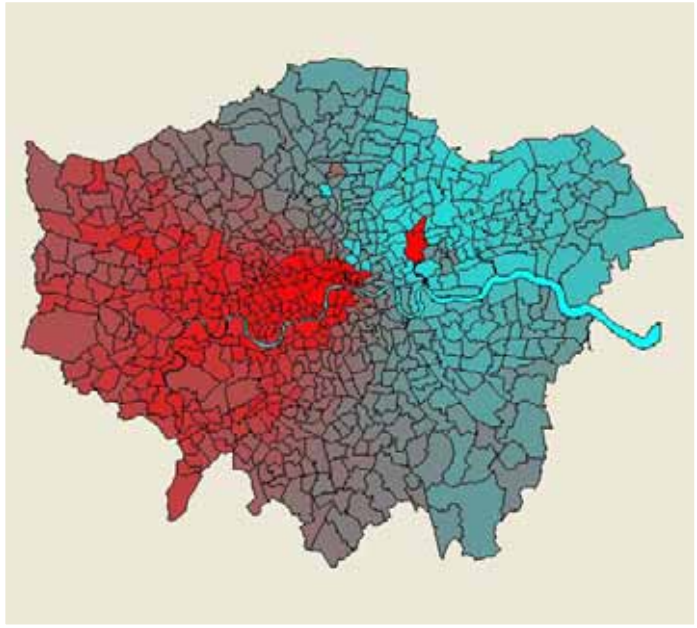
Figure 8. [In colour online.] Visualising the impacts of new employment on residential population in the vicinity of two proposed sites for a new London airport: (a) Isle of Grain, (b) Maplin Sands.

Infrastructure in London: Olympics, 3rd Runway, Cross-rail,










Kings
Park
Romford
Chadwell
Heath
Goodmayes
Illford
Forest
Gate
Maryland
Manor
Park
Stratford
Whitechapel
Farringdon
Bond
Street
Ealing
Broadway
West
Ealing
West
Drayton
Southall
Hanwell
Acton
Main Line
Paddington
Hayes &
Harlington
Heathrow
Liverpool
Street
Tottenham
Court Rd
Isle of
Dogs
Custom
House
Woolwich
Abbey
Wood

Are These Software Projects? Not Quite …

These applications and everything hitherto are not software projects – they are not designed to provide any form of user interaction unless it is to the model-builder, although they are very different from most large scale modelling in that they are visual and ***imply user interaction***

From the beginning, model applications were based on simply calculating model outputs using standard programming – high level programming largely focussed on getting results.

But the users are other scientists – at best policy makers but there has been hardly any focus on user interaction

The field has been dominated by consultants writing programs to make models work to produce results that are presented in traditional terms. Most models are still non visual – our Tyndall and Arcadia models were much more visual but little focus on defining best practice with respect to users.

The key message is that it has taken 40 or more years to get to the point where there is even any thought about users other than model-builders.

The focus has been at best ***on demos*** that others can watch – maybe interact with under supervision – but the notion of truly interactive use at the level of modern software is fairly remote – until this happens the field will remain in the hands of consultants and academics.

It may well be that this will be the case as yet for a long time to come but it has enormous implications for model use and applications in the world of all pervasive IT and smart cities. Much the same, if not more so, it true of economic modelling.

We this will change but first the typical demo ....

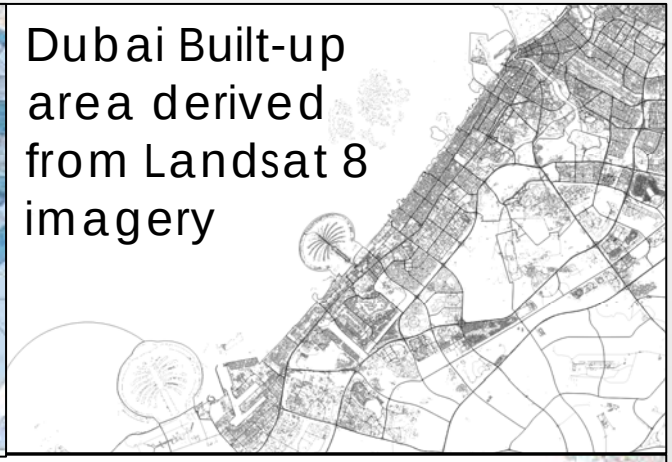
Small, Fast, Simple Models: The Dubai Pilot

A New Retail Centre in Dubai

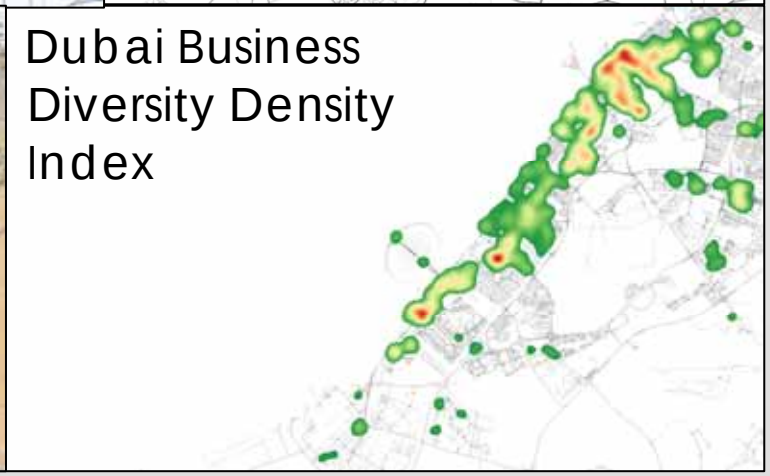
Where did we get the data – in a data poor environment?

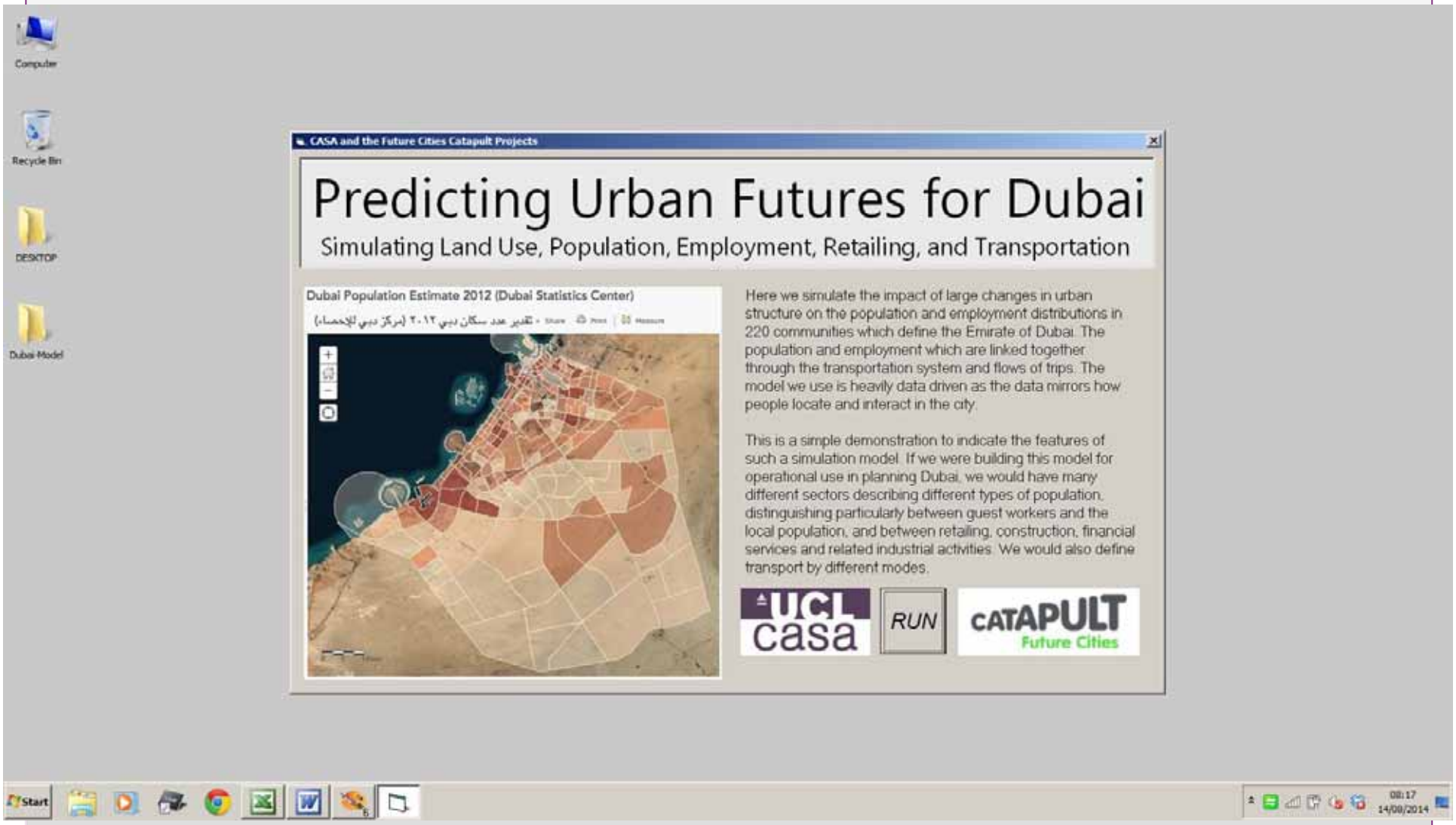
Dubai Business Density derived from Google Places API

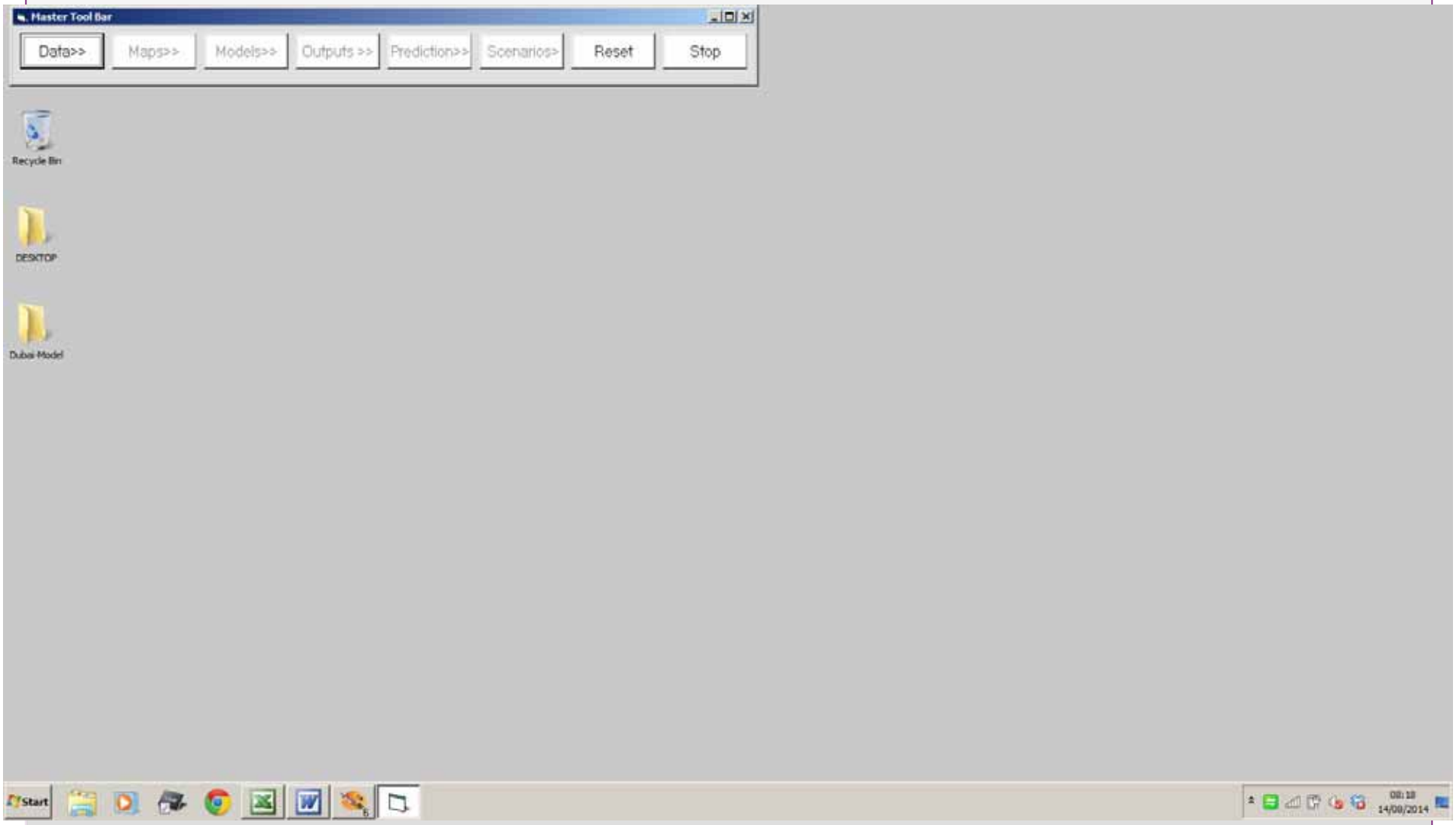
Dubai Built-up area derived from Landsat 8 imagery



Dubai Business Diversity Density Index




CASA and the Future Cities Catapult Projects
Predicting Urban Futures for Dubai
Simulating Land Use, Population, Employment, Retailing, and Transportation
Dubai Population Estimate 2012 (Dubai Statistics Center)
Here we simulate the impact of large changes in urban structure on the population and employment distributions in 220 communities which define the Emirate of Dubai. The population and employment which are linked together through the transportation system and flows of trips. The model we use is heavily data driven as the data mirrors how people locate and interact in the city.
This is a simple demonstration to indicate the features of such a simulation model. If we were building this model for operational use in planning Dubai, we would have many different sectors describing different types of population, distinguishing particularly between guest workers and the local population, and between retailing, construction, financial services and related industrial activities. We would also define transport by different modes.
UCL casa
RUN
CATAPULT Future Cities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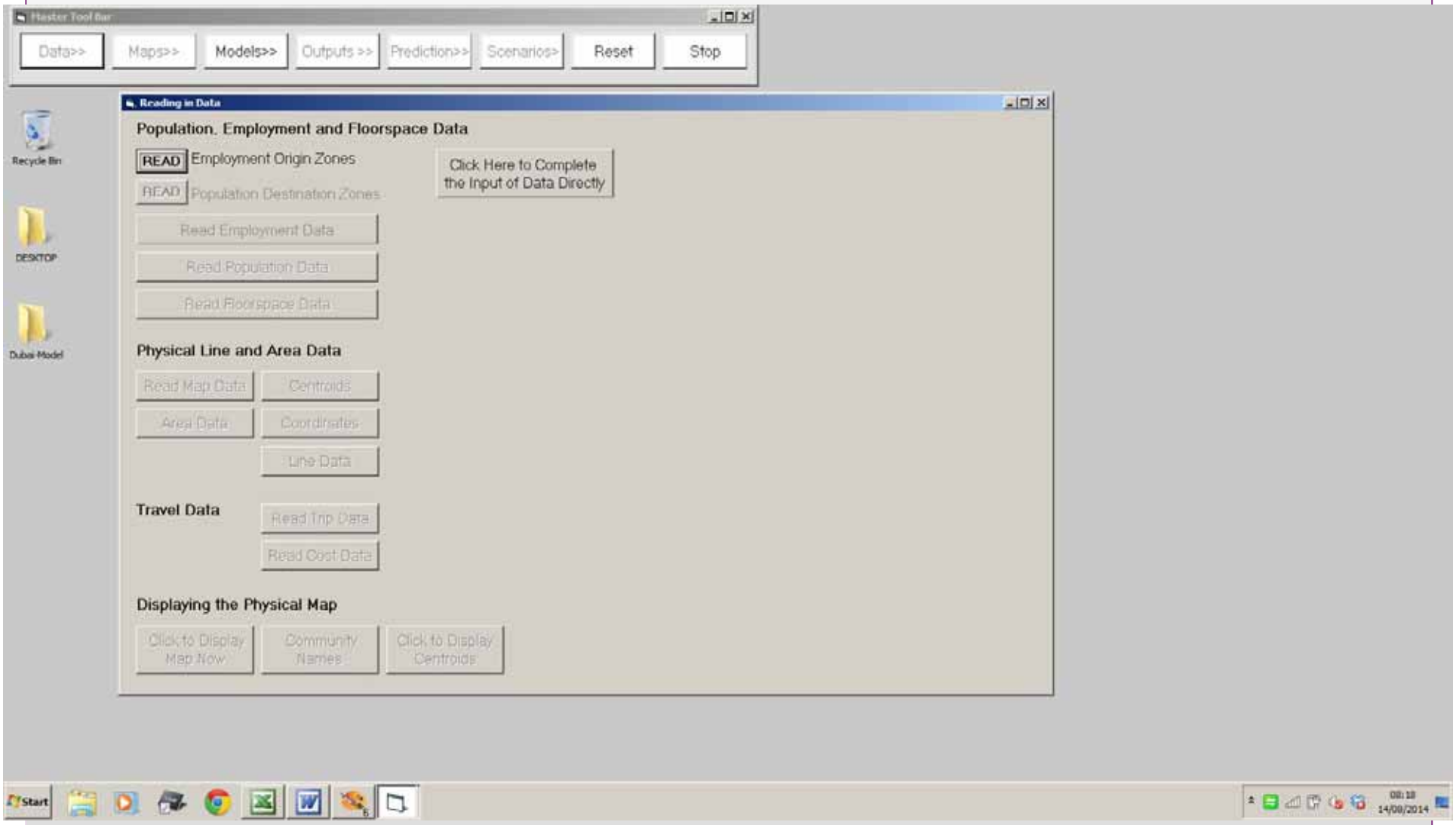
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Read Floorspace Data
Physical Line and Area Data
Read Map Data
Centroids
Area Data
Coordinates
Line Data
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Read Cost Data
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Click to Display Map Now
Community Names
Click to Display Centroids
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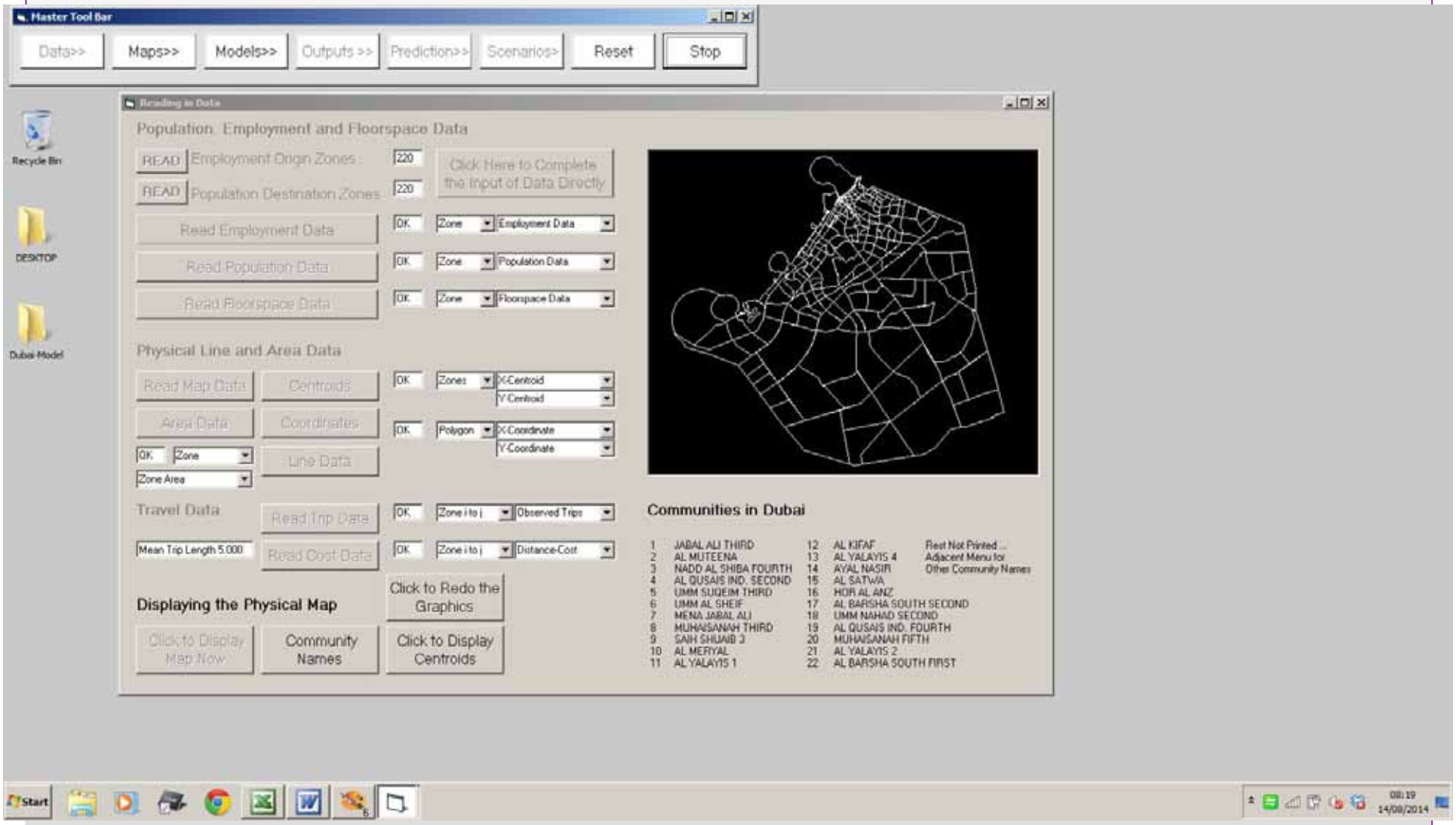
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12 AL KIFAF
13 AL YALAYIS 4
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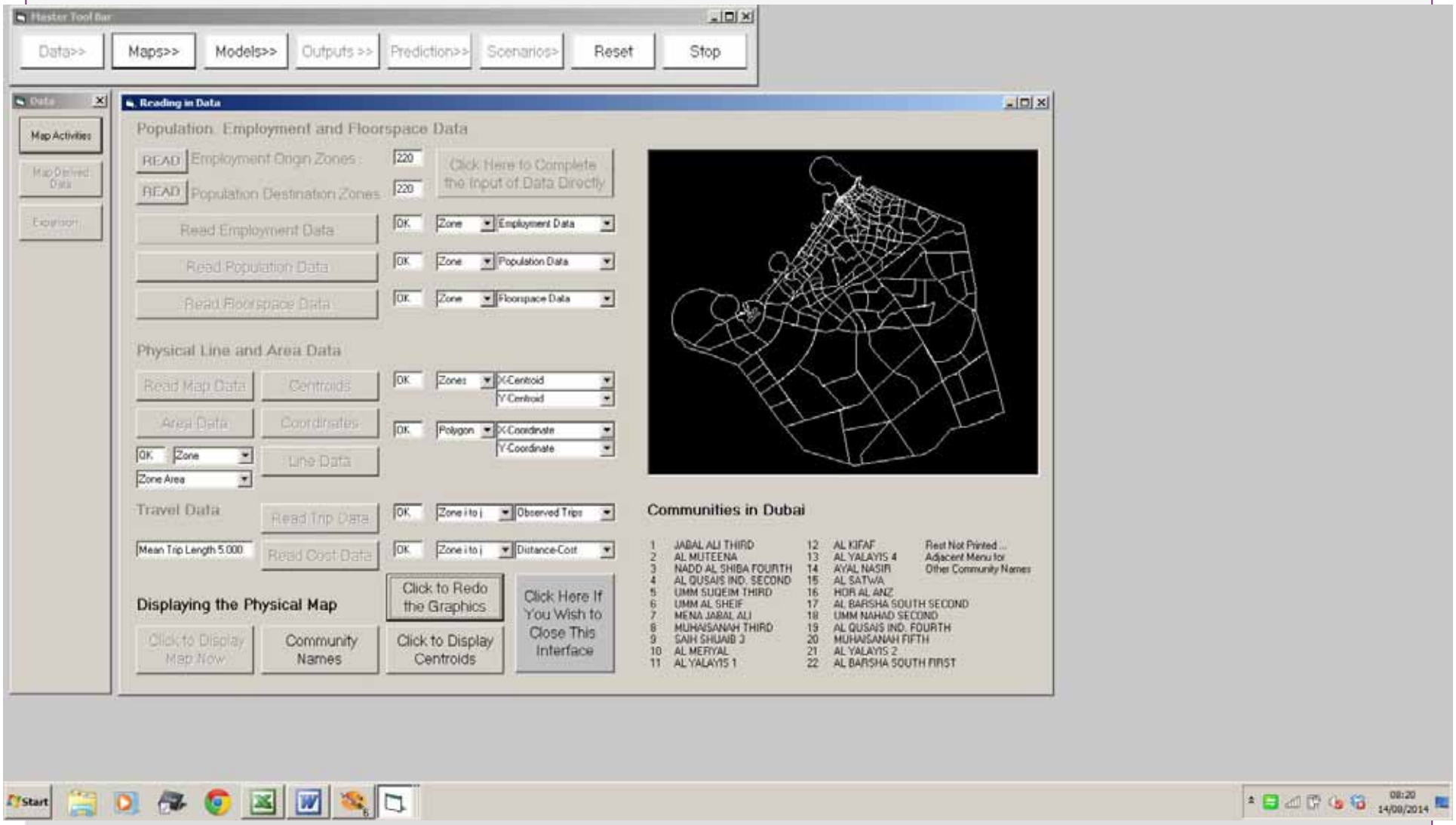
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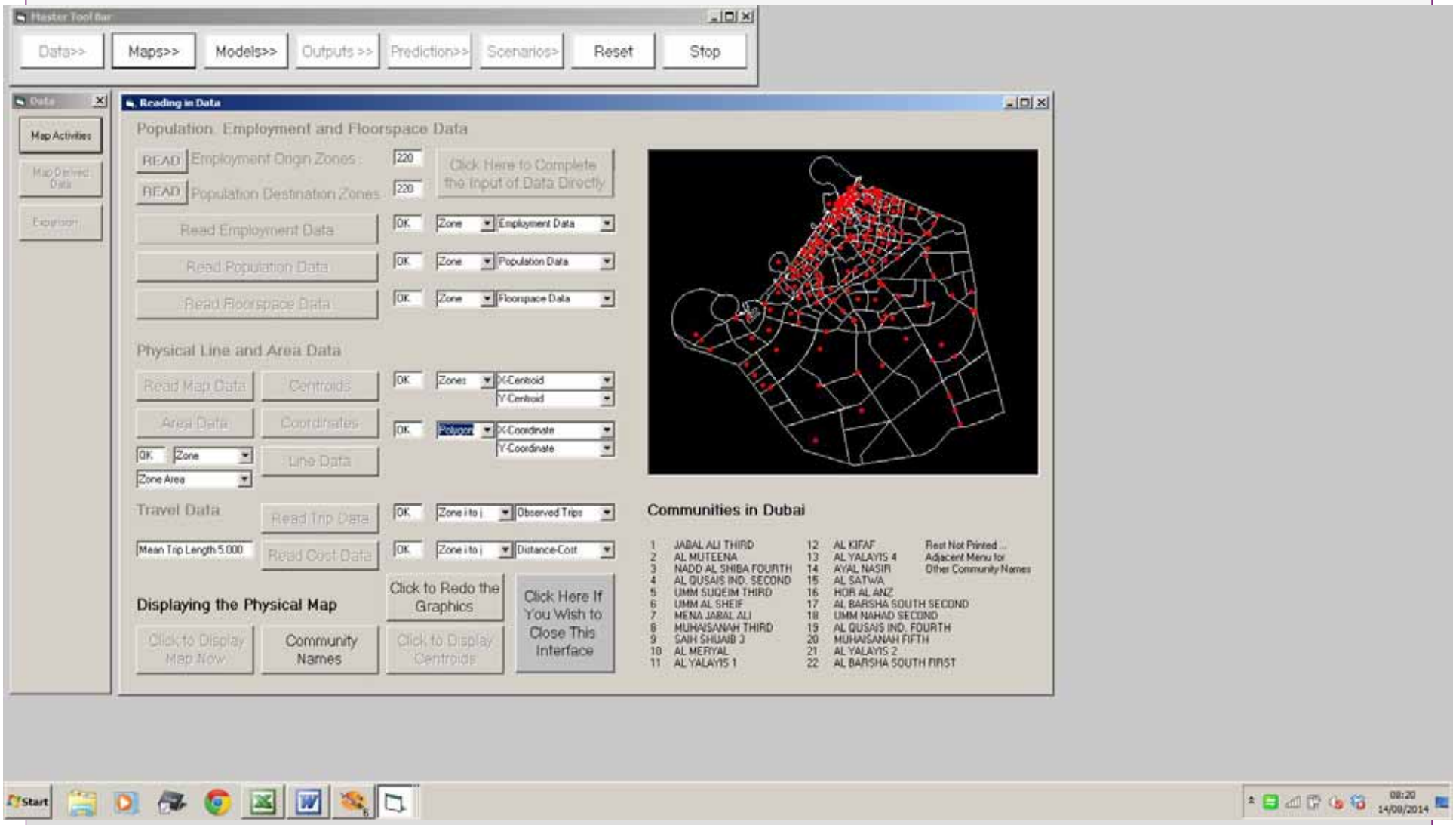
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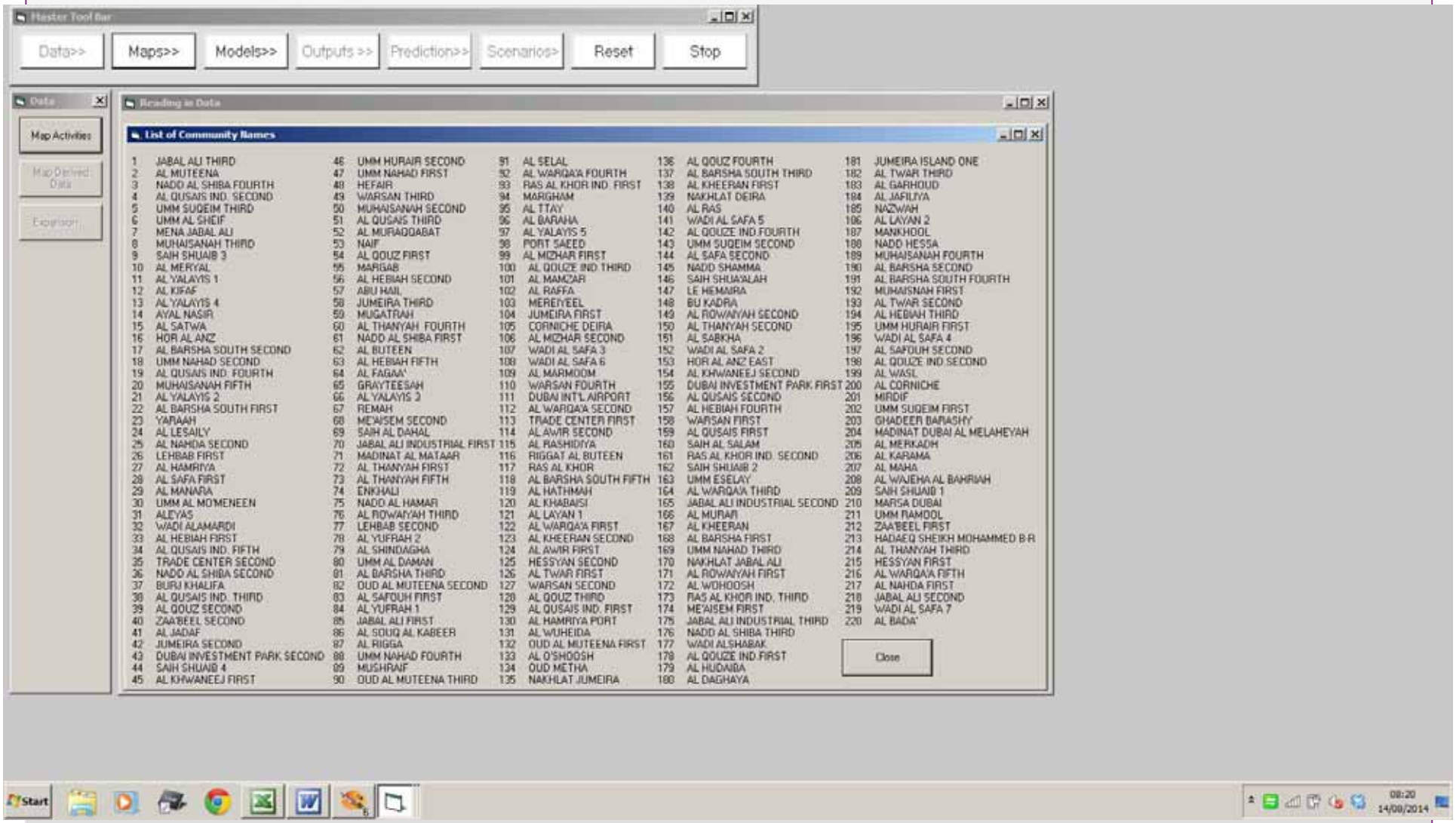
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28 AL SAFA FIRST
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31 ALEYAS
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33 AL HEBIAH FIRST
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36 NADD AL SHIBA SECOND
37 BURJ KHALIFA
38 AL QUSAIS IND. THIRD
39 AL QOUZ SECOND
40 ZAA'BEEL SECOND
41 AL JADAF
42 JUMEIRA SECOND
43 DUBAI INVESTMENT PARK SECOND
44 SAIH SHUAIB 4
45 AL KHWANEEJ FIRST
46 UMM HURAIR SECOND
47 UMM NAHAD FIRST
48 HEFAIR
49 WARSAN THIRD
50 MUHAISANAH SECOND
51 AL QUSAIS THIRD
52 AL MURAQQABAT
53 NAIF
54 AL QOUZ FIRST
55 MARGAB
56 AL HEBIAH SECOND
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58 JUMEIRA THIRD
59 MUGATRAH
60 AL THANYAH FOURTH
61 NADD AL SHIBA FIRST
62 AL BUTEEN
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65 GRAYTEESAH
66 AL YALAYIS 3
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72 AL THANYAH FIRST
73 AL THANYAH FIFTH
74 ENKHALI
75 NADD AL HAMAR
76 AL ROWAIYAH THIRD
77 LEHBAB SECOND
78 AL YUFRAH 2
79 AL SHINDAGHA
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103 MEREYEEL
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110 WARSAN FOURTH
111 DUBAI INT'L AIRPORT
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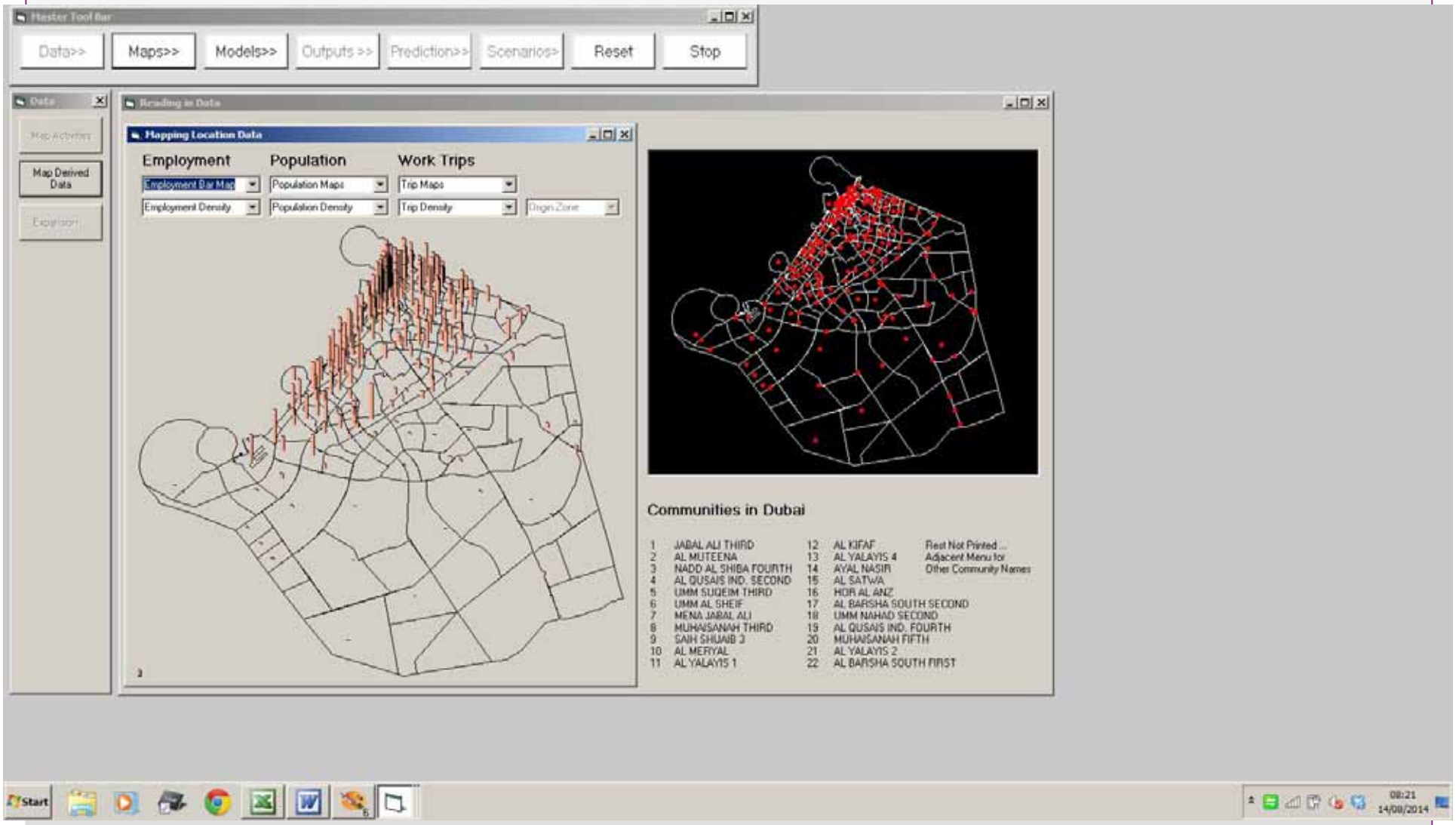
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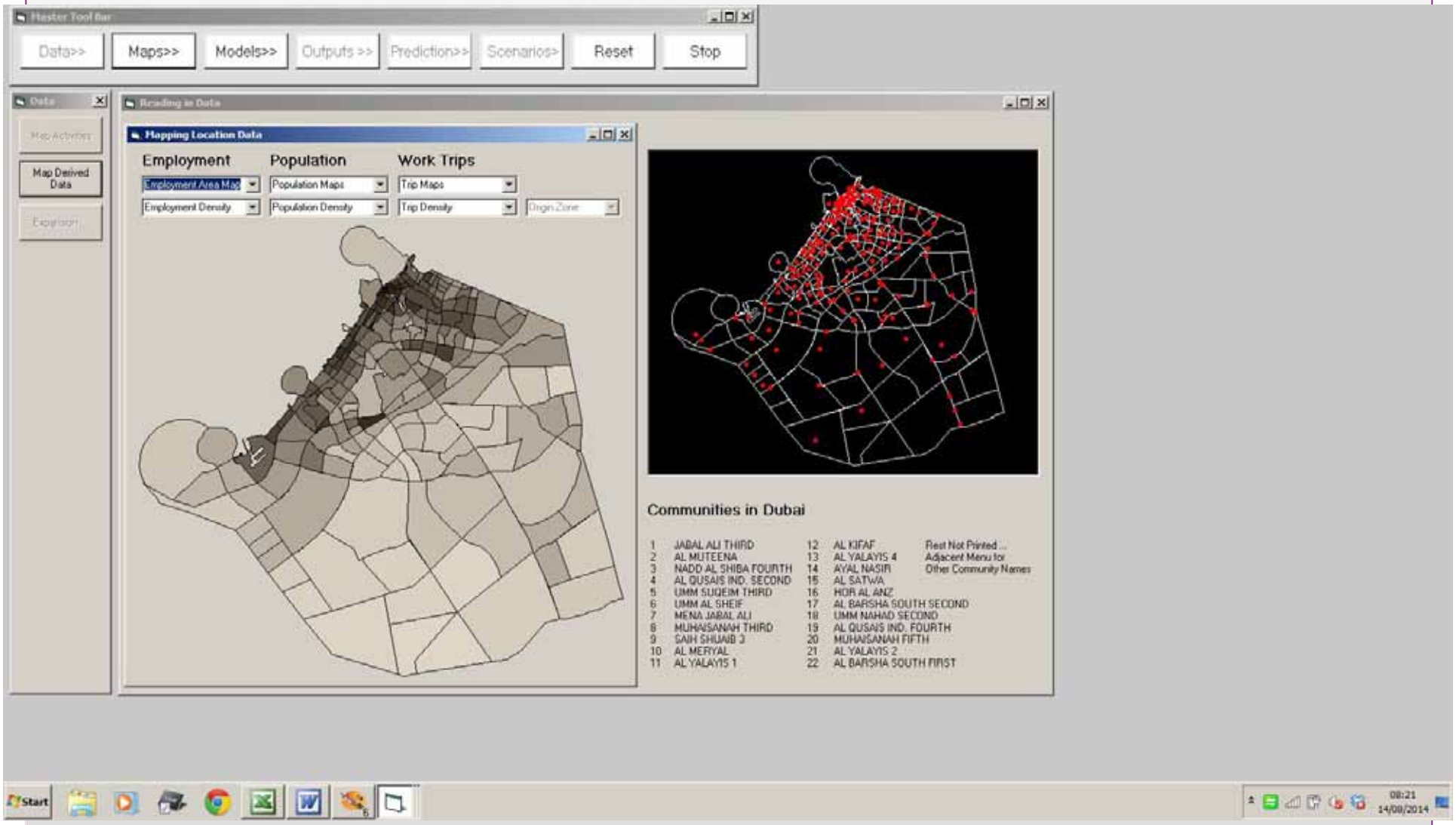
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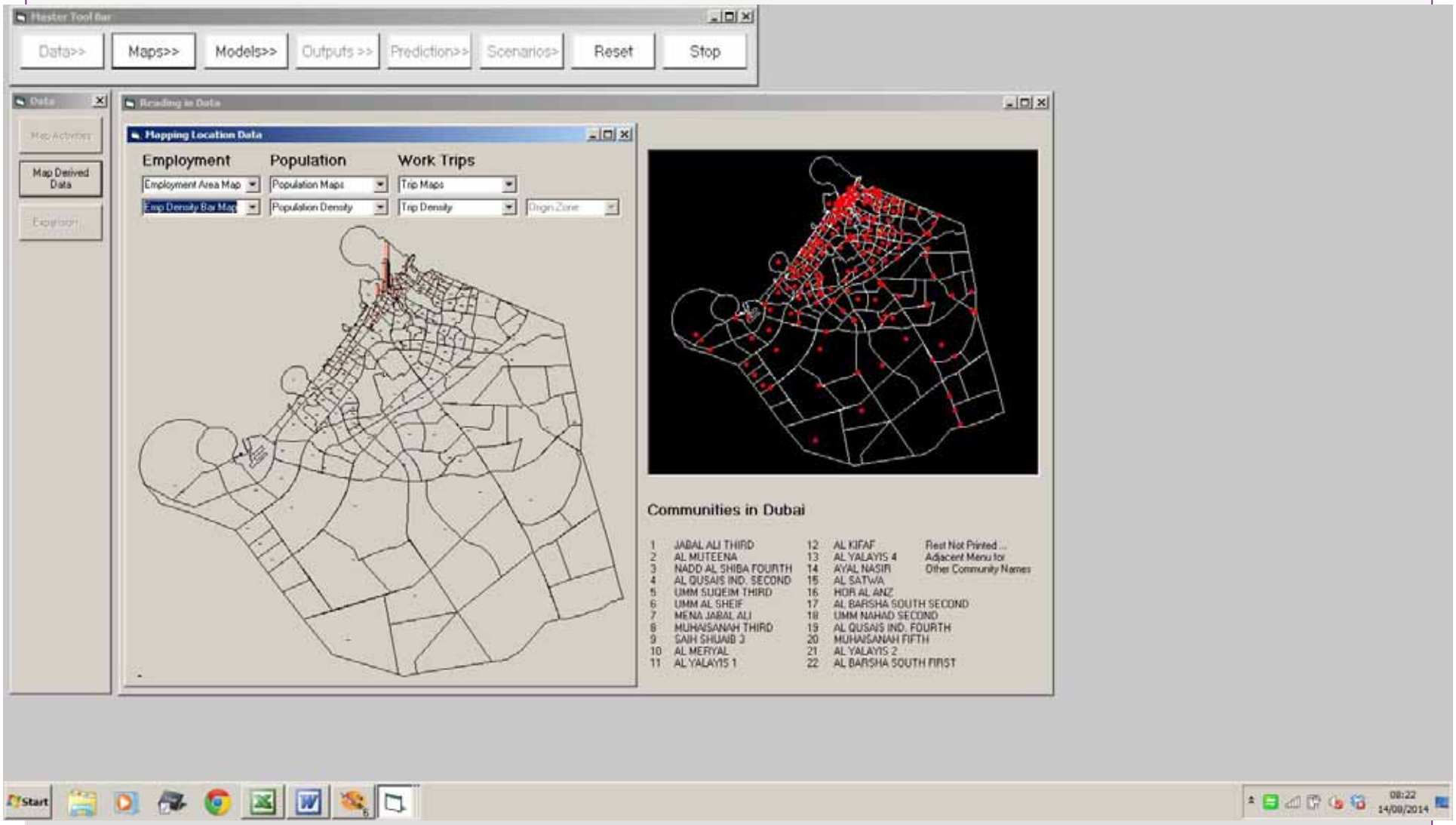
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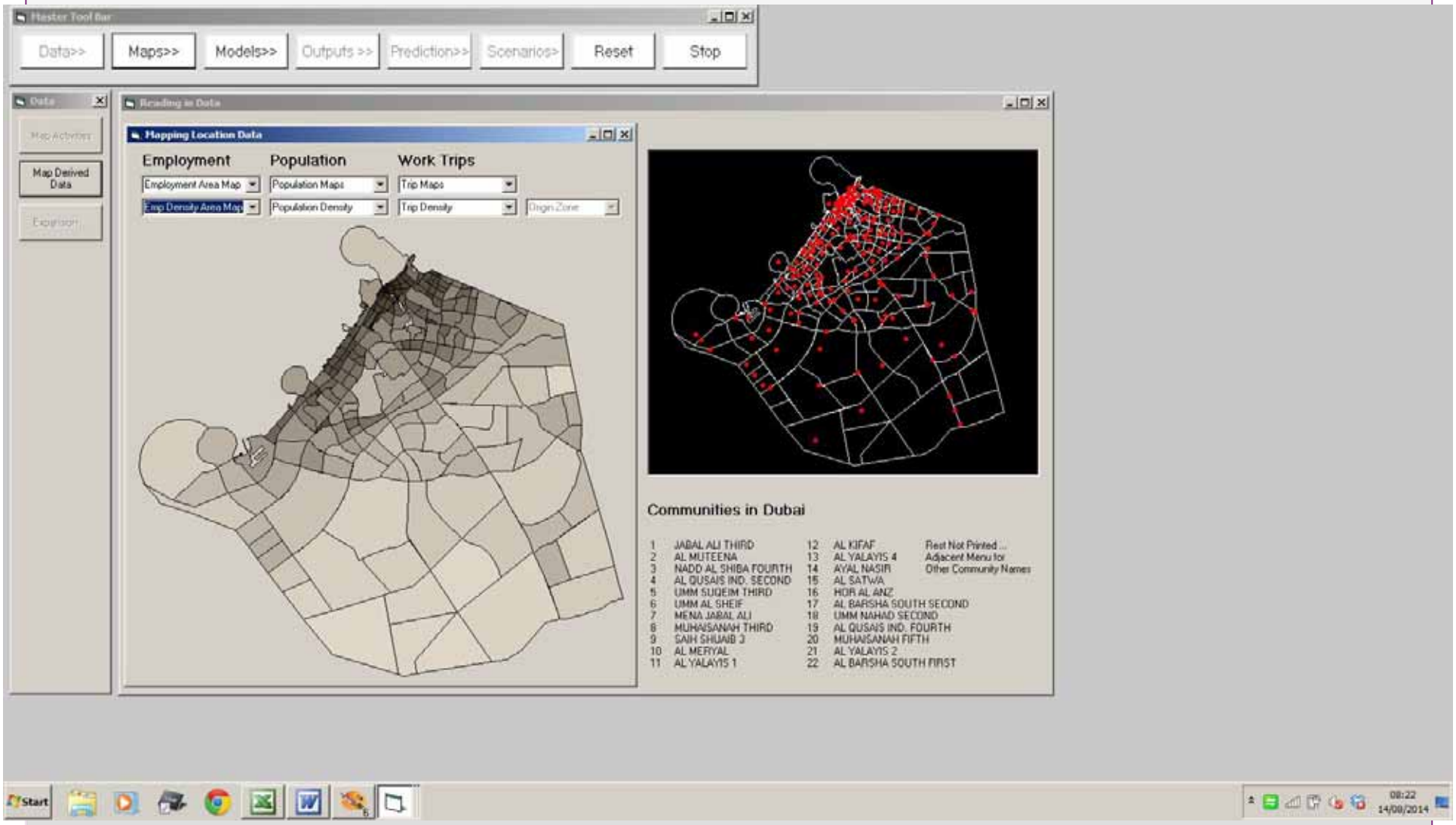
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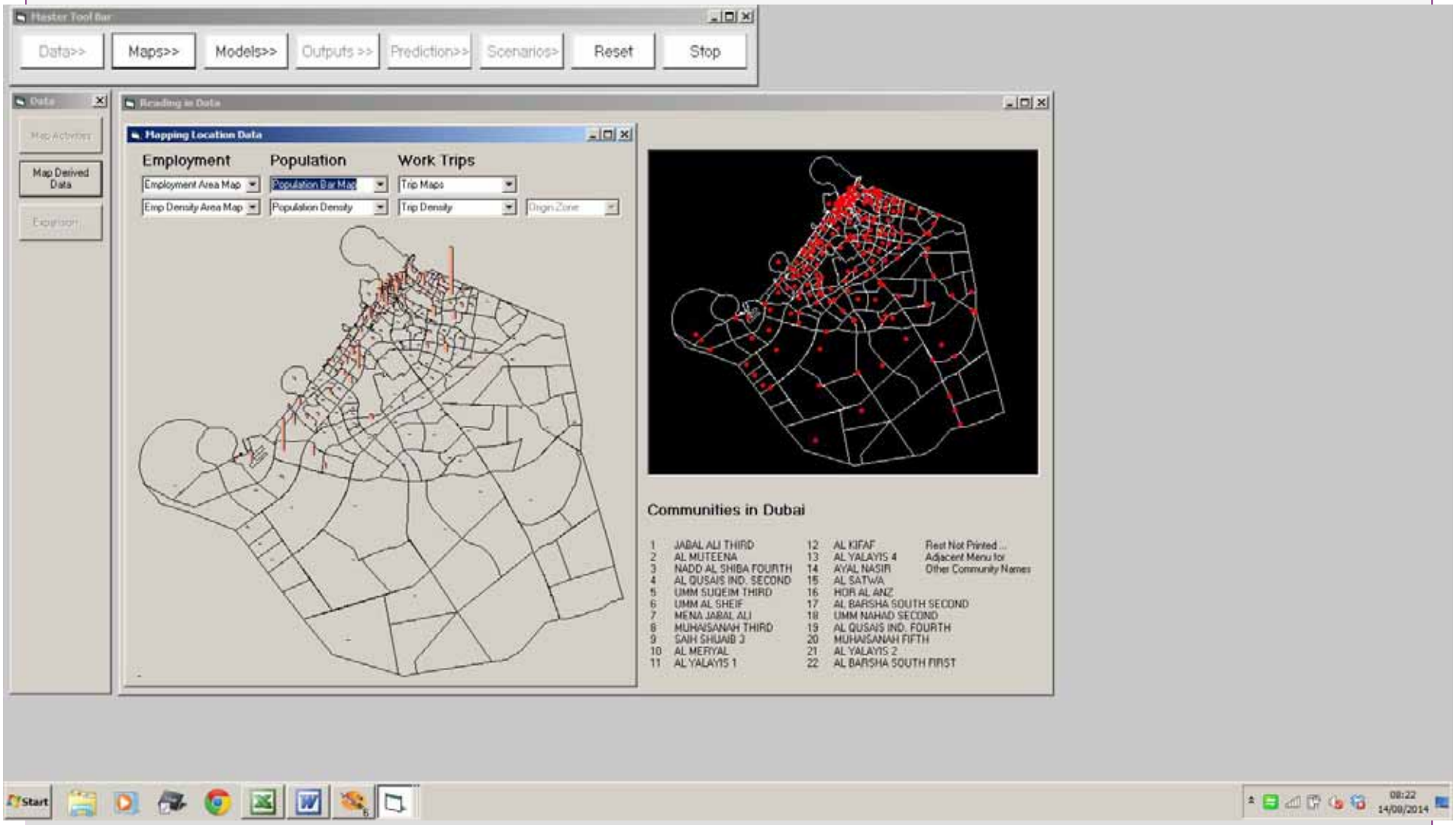
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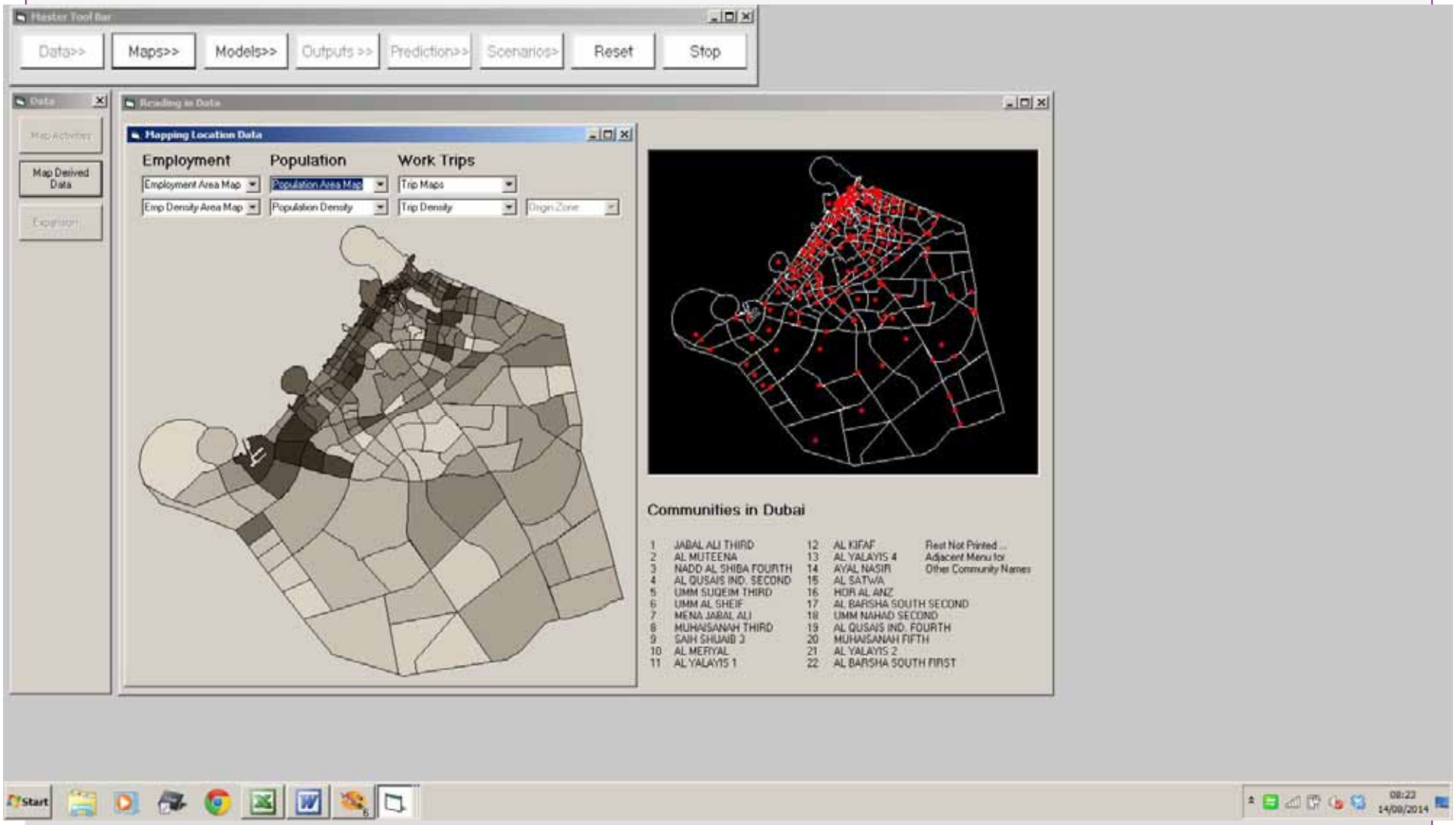
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Mapping Location Data
Employment
Population
Work Trips
Employment Area Map
Population Area Map
Trip Maps
Emp Density Area Map
Population Density
Trip Density
Origin Zone
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
6 UMM AL SHEIF
7 MENA JABAL ALI
8 MUHAISANAH THIRD
9 SAIH SHUAIB 3
10 AL MERYAL
11 AL YALAYIS 1
12 AL KIFAF
13 AL YALAYIS 4
14 AYAL NASIR
15 AL SATWA
16 HOR AL ANZ
17 AL BARSHA SOUTH SECOND
18 UMM NAHAD SECOND
19 AL QUSAIS IND. FOURTH
20 MUHAISANAH FIFTH
21 AL YALAYIS 2
22 AL BARSHA SOUTH FIRST
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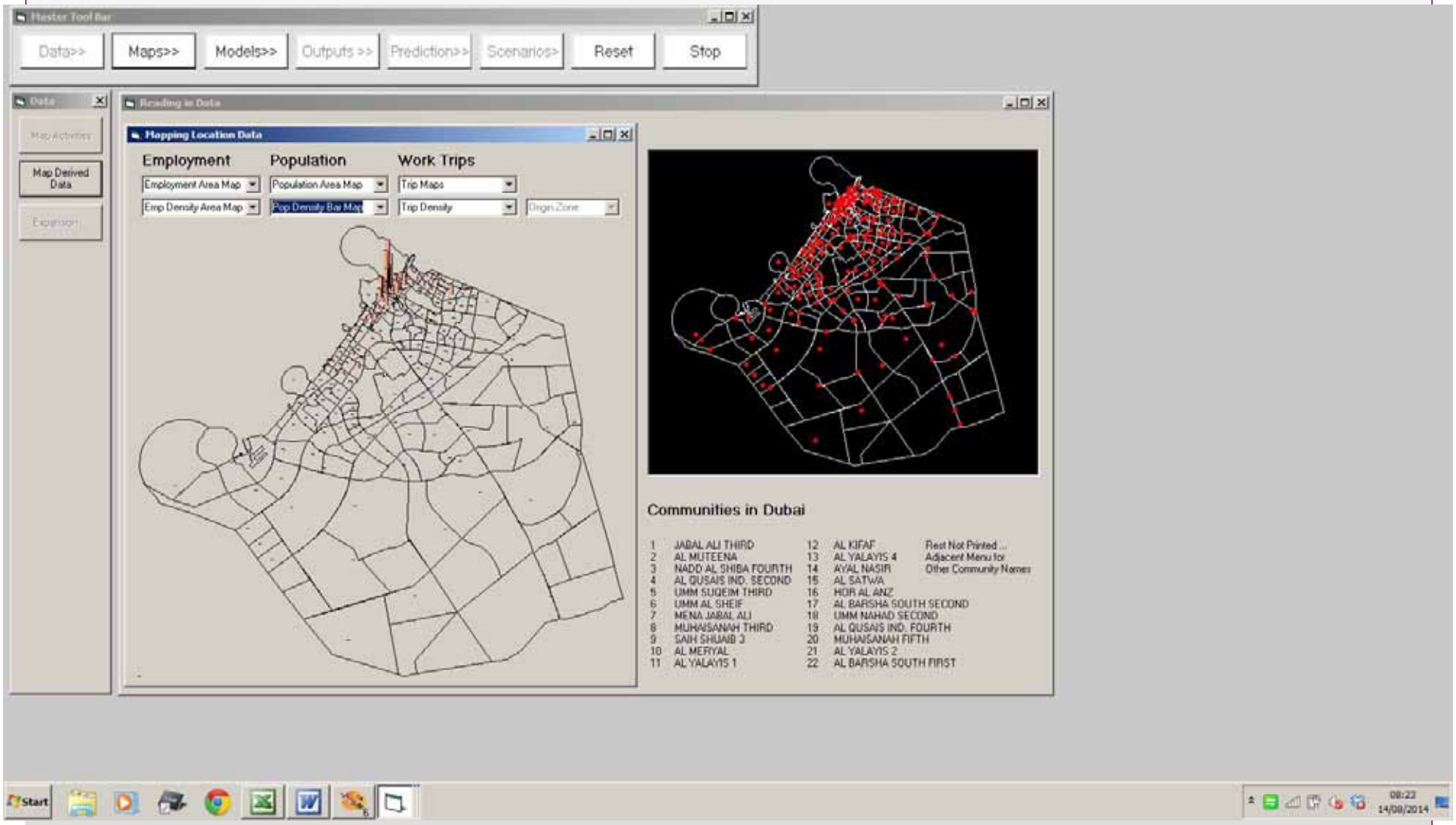
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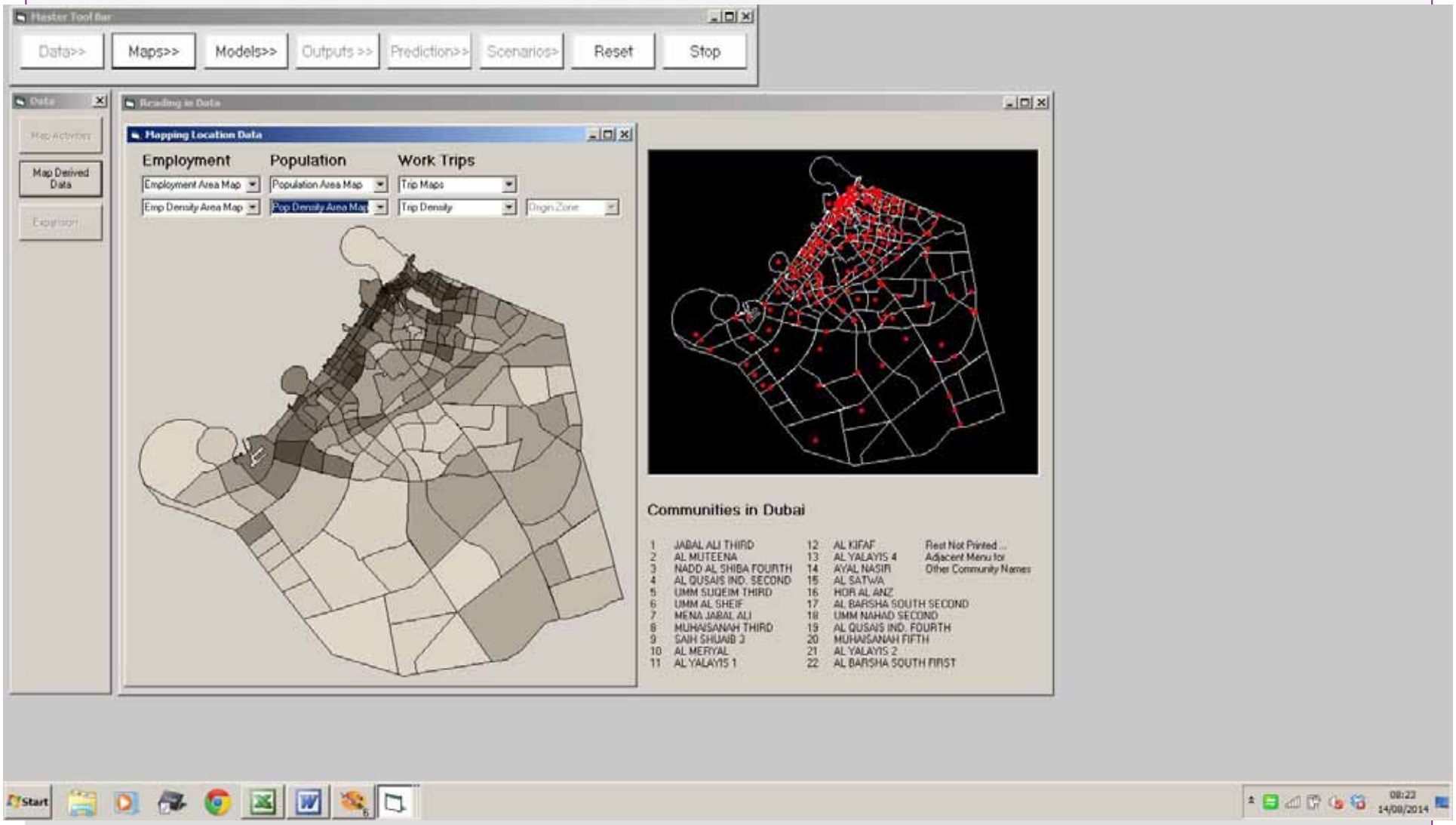
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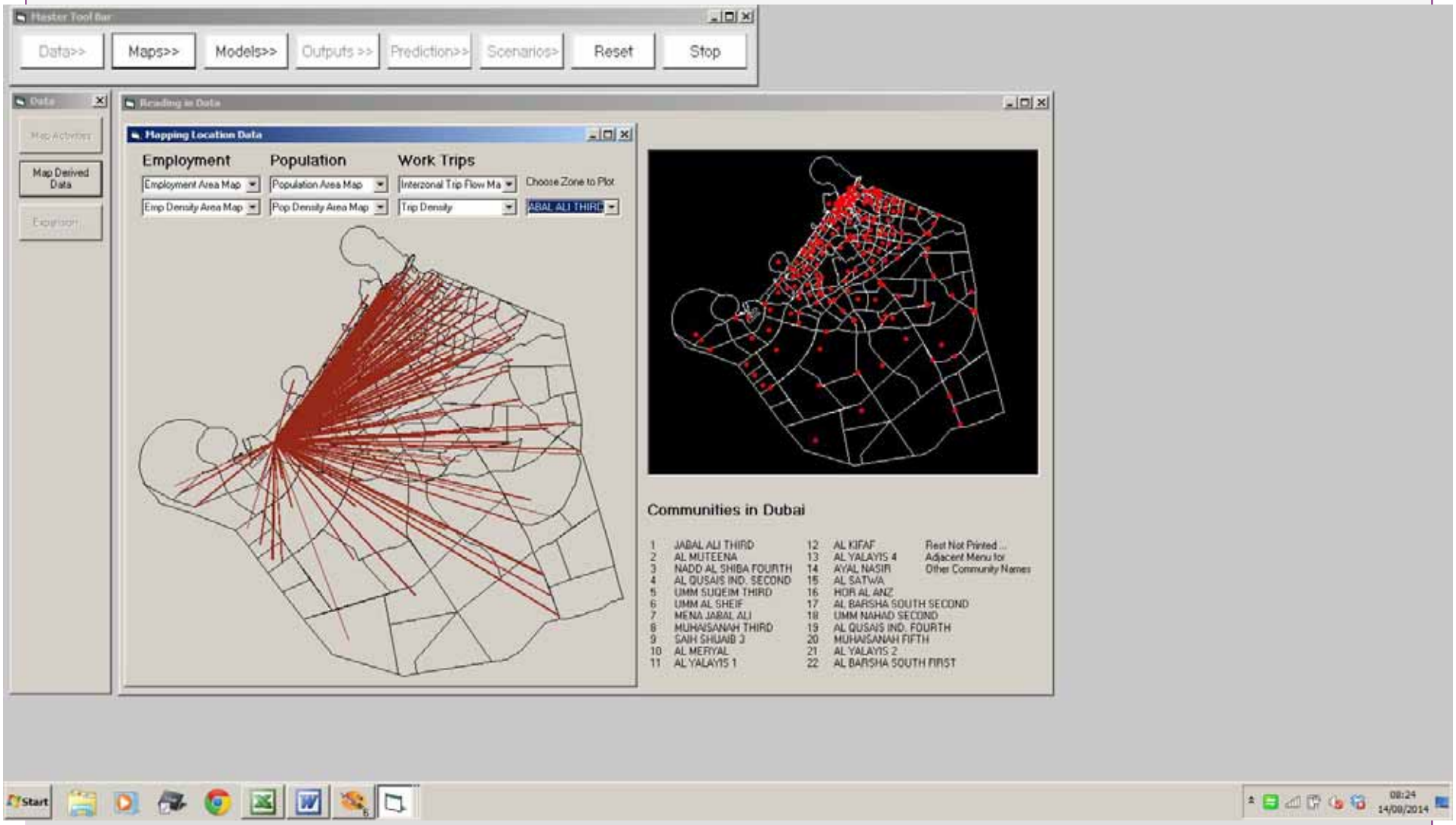
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13 AL YALAYIS 4
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15 AL SATWA
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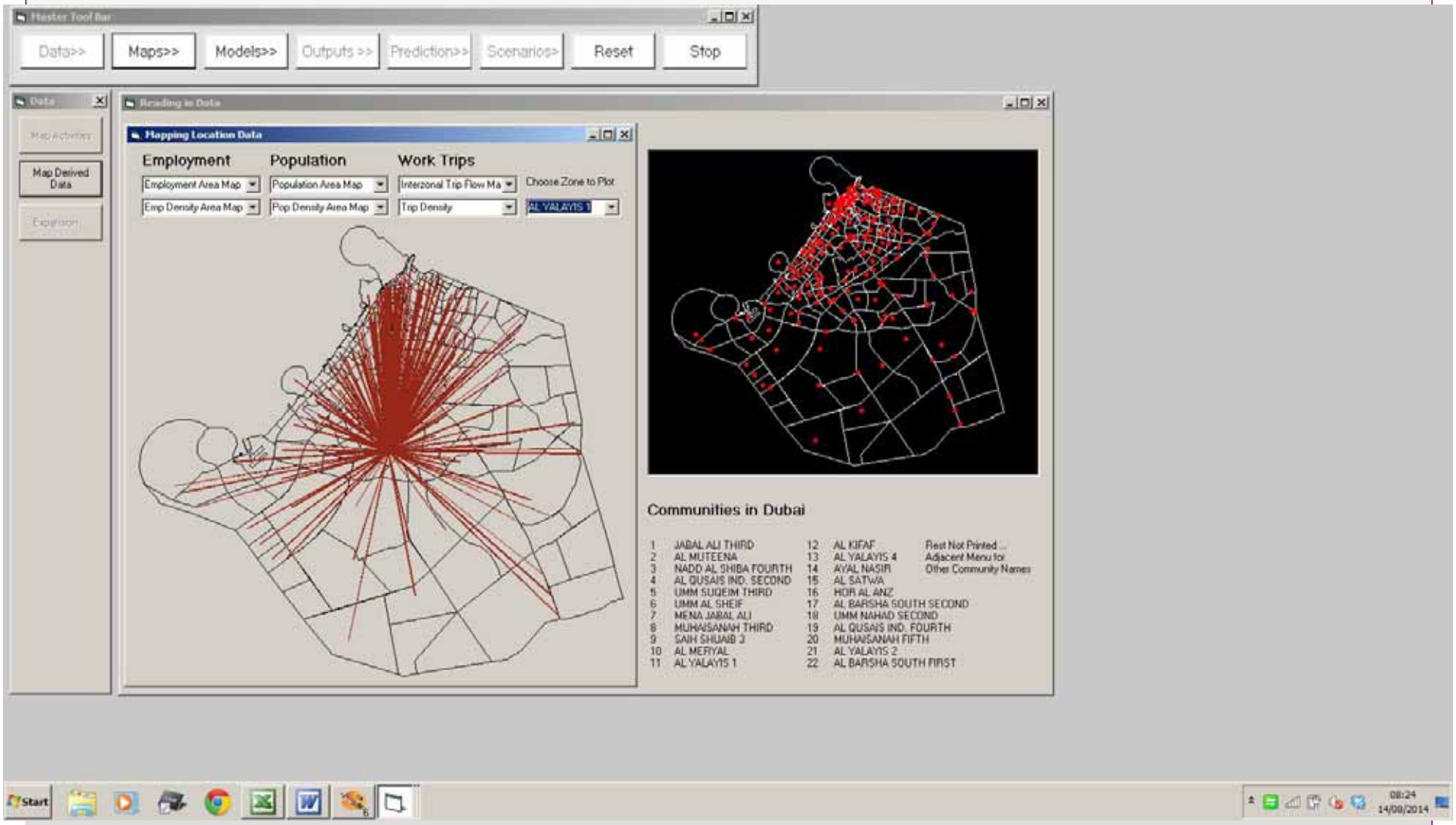
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Exploration
Reading in Data
Mapping Location Data
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Work Trips
Employment Area Map
Population Area Map
Interzonal Trip Flow Ma
Choose Zone to Plot
Emp Density Area Map
Pop Density Area Map
Trip Density
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4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
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Other Community Names
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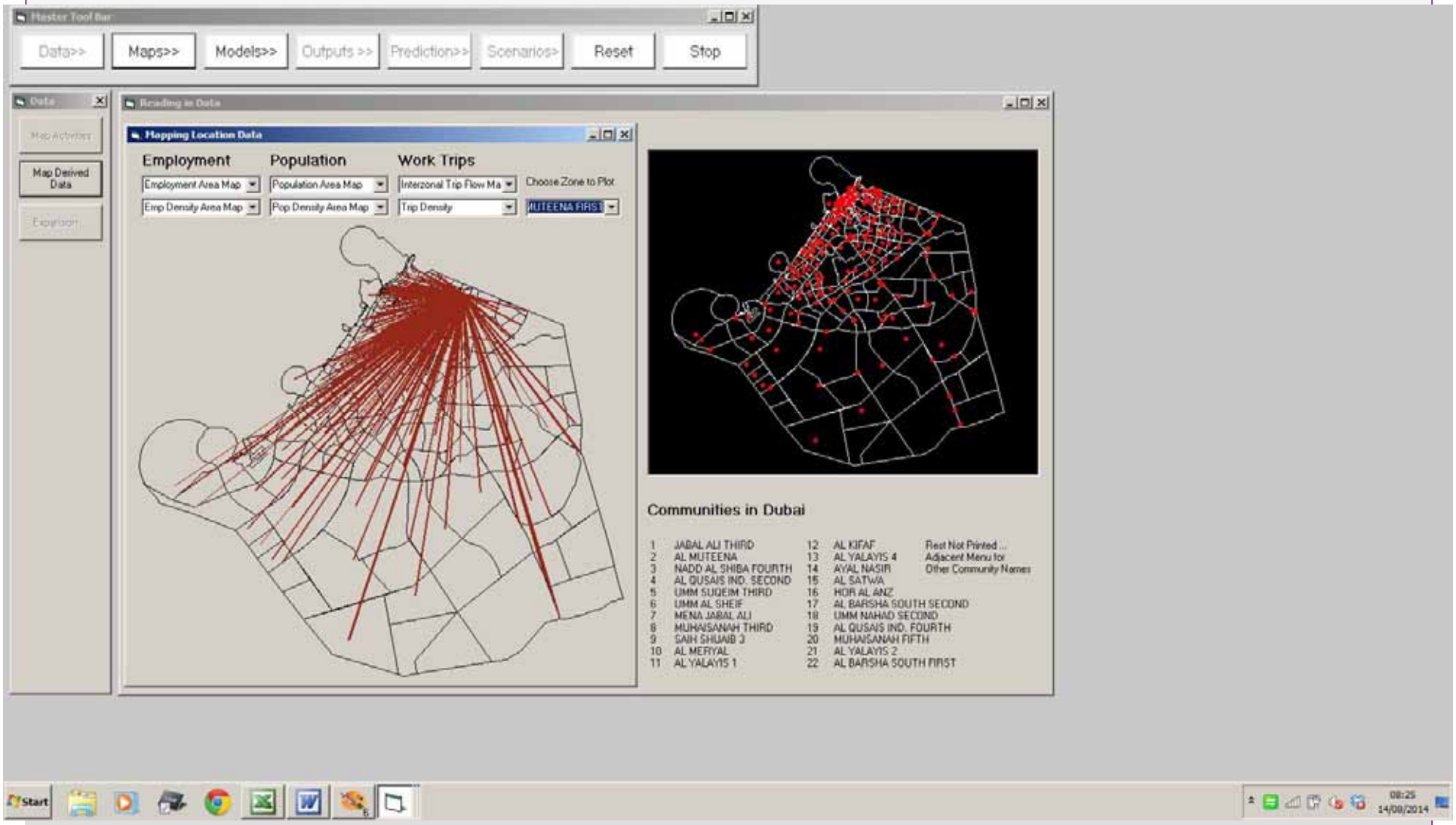
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Exploration
Reading in Data
Mapping Location Data
Employment
Population
Work Trips
Employment Area Map
Population Area Map
Interzonal Trip Flow Ma
Choose Zone to Plot
Emp Density Area Map
Pop Density Area Map
Trip Density
MUTEENA FIRST
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
6 UMM AL SHEIF
7 MENA JABAL ALI
8 MUHAISANAH THIRD
9 SAIH SHUAIB 3
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11 AL YALAYIS 1
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Other Community Names
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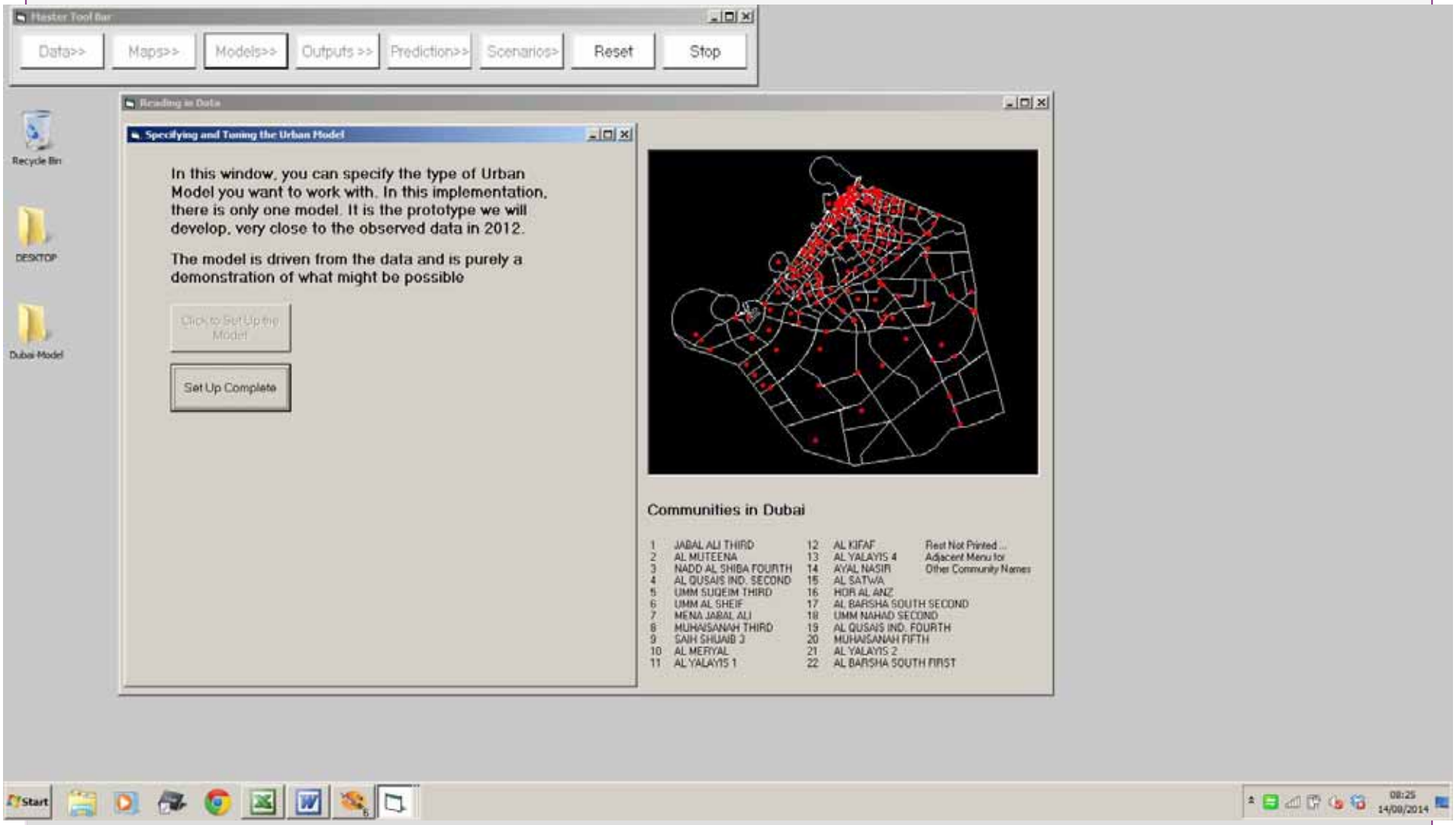
14/08/2014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Data>>
Maps>>
Models>>
Outputs >>
Prediction>>
Scenarios>
Reset
Stop
Reading in Data
Specifying and Tuning the Urban Model
In this window, you can specify the type of Urban Model you want to work with. In this implementation, there is only one model. It is the prototype we will develop, very close to the observed data in 2012.
The model is driven from the data and is purely a demonstration of what might be possible
Click to Set Up the Model
Set Up Complete
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
6 UMM AL SHEIF
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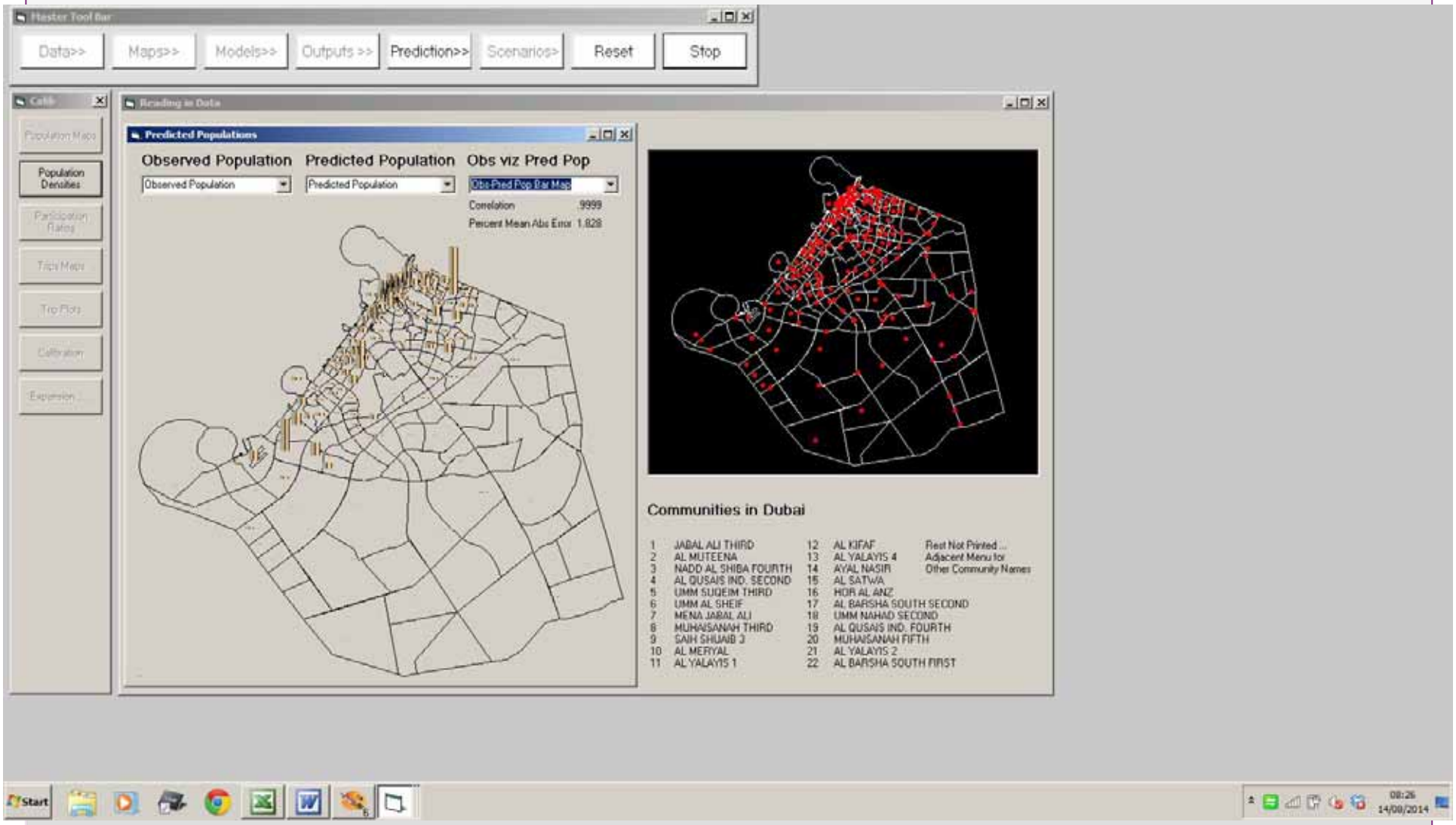
Master Tool Bar
Data>>
Maps>>
Models>>
Outputs >>
Prediction>>
Scenarios>
Reset
Stop
Reading in Data
Predicted Populations
Observed Population
Predicted Population
Obs viz Pred Pop
Observed Population
Predicted Population
Obs-Pred Pop Bar Map
Correlation 9999
Percent Mean Abs Error 1.828
Population Maps
Population Densities
Participation Rates
Trips Maps
Trip Plots
Calibration
Expansion
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
6 UMM AL SHEIF
7 MENA JABAL ALI
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17 AL BARSHA SOUTH SECOND
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19 AL QUSAIS IND. FOURTH
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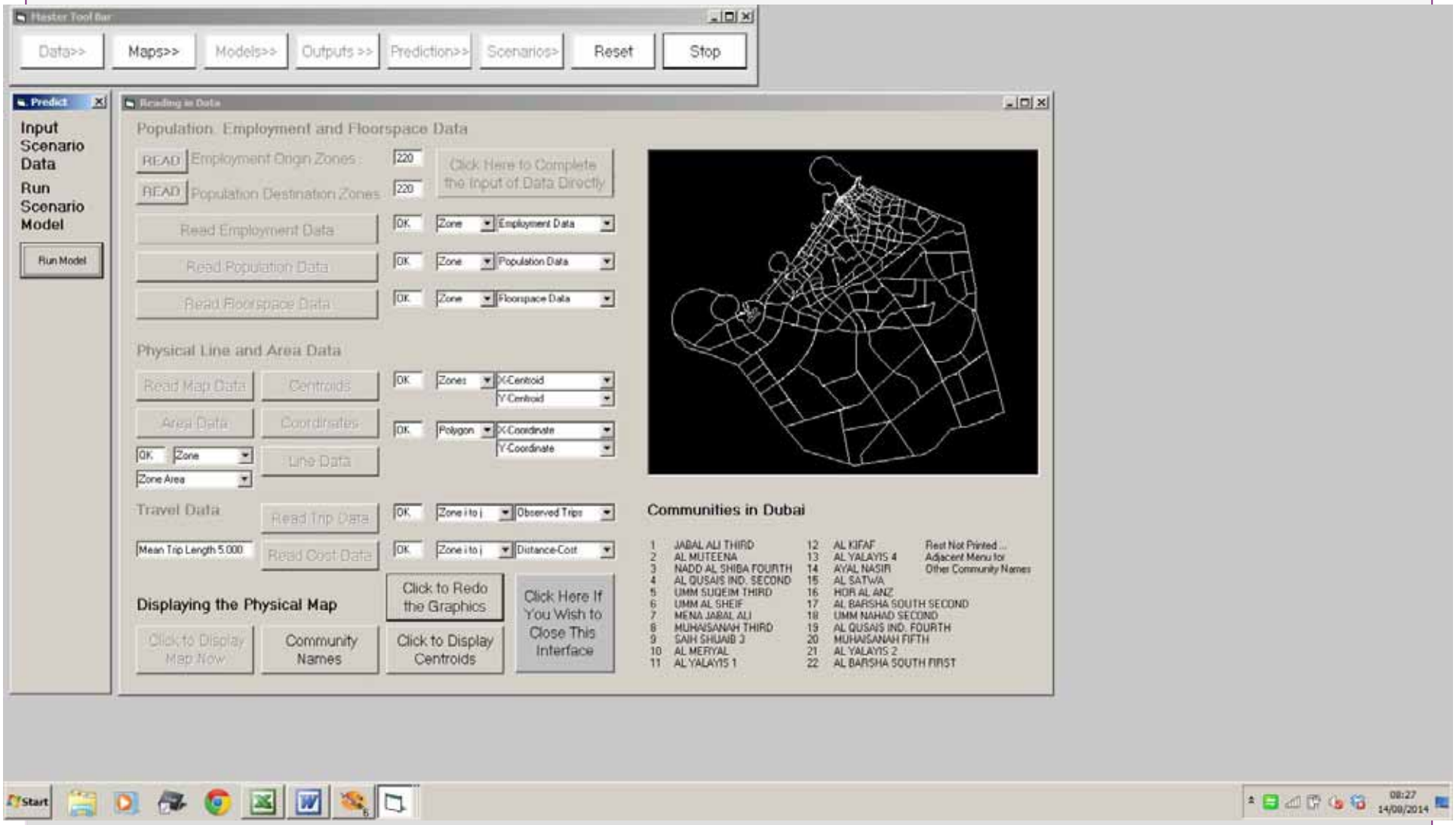
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Data>>
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Models>>
Outputs >>
Prediction>>
Scenarios>
Reset
Stop
Predict
Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
Population, Employment and Floorspace Data
READ
Employment Origin Zones :
220
READ
Population Destination Zones
220
Click Here to Complete the Input of Data Directly
Read Employment Data
Read Population Data
Read Floorspace Data
OK
Zone
Employment Data
Population Data
Floorspace Data
Physical Line and Area Data
Read Map Data
Centroids
Area Data
Coordinates
Line Data
Zones
X-Centroid
Y-Centroid
Polygon
X-Coordinate
Y-Coordinate
Zone Area
Travel Data
Read Trip Data
Read Cost Data
Zone i to j
Observed Trips
Distance-Cost
Mean Trip Length 5.000
Displaying the Physical Map
Click to Redo the Graphics
Click Here If You Wish to Close This Interface
Click to Display Map Now
Community Names
Click to Display Centroids
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
6 UMM AL SHEIF
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16 HOR AL ANZ
17 AL BARSHA SOUTH SECOND
18 UMM NAHAD SECOND
19 AL QUSAIS IND. FOURTH
20 MUHAISANAH FIFTH
21 AL YALAYIS 2
22 AL BARSHA SOUTH FIRST
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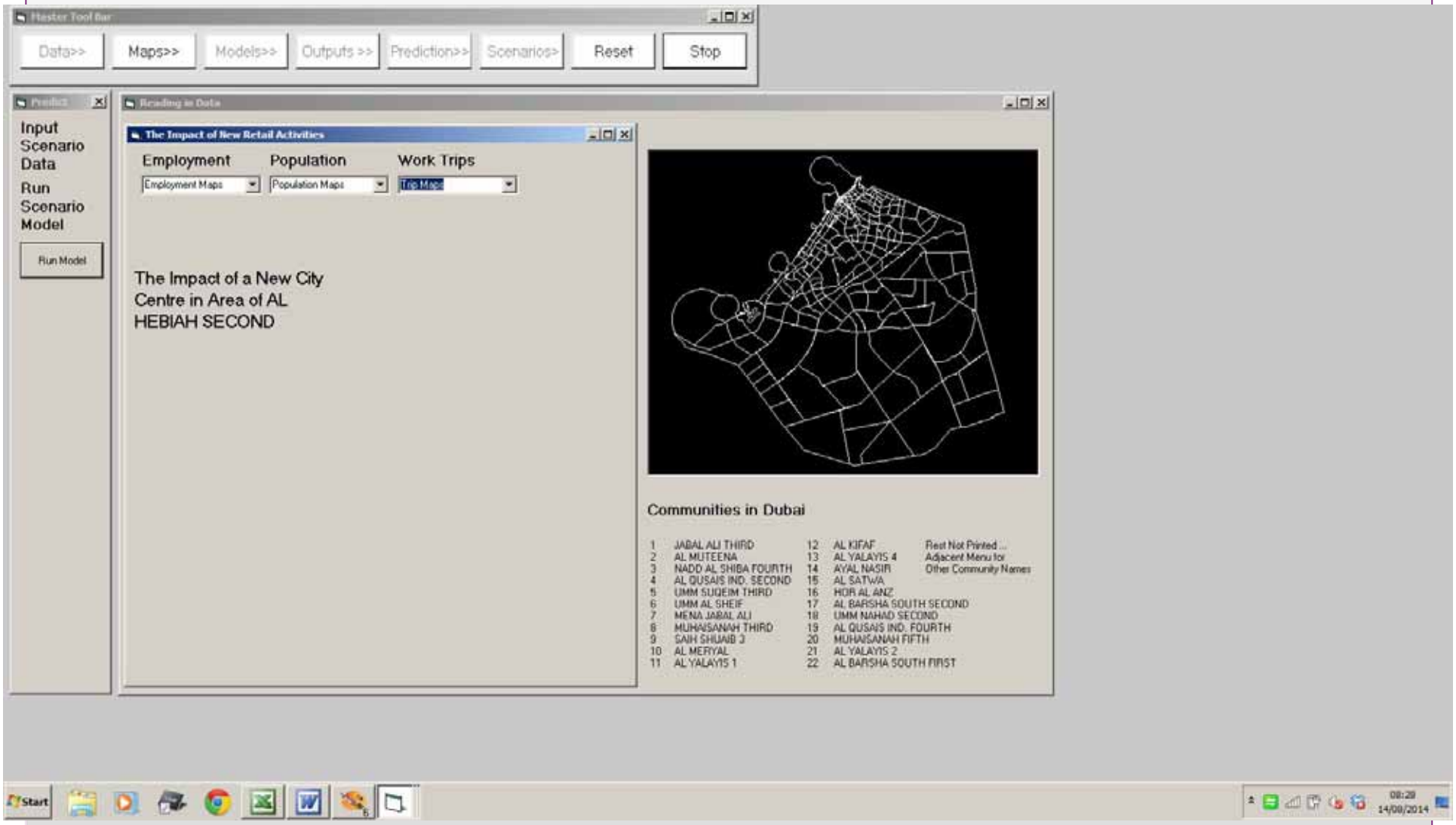
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Reset
Stop
Predict
Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
The Impact of New Retail Activities
Employment
Population
Work Trips
Employment Maps
Population Maps
Trip Maps
The Impact of a New City Centre in Area of AL HEBIAH SECOND
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
5 UMM SUQEIM THIRD
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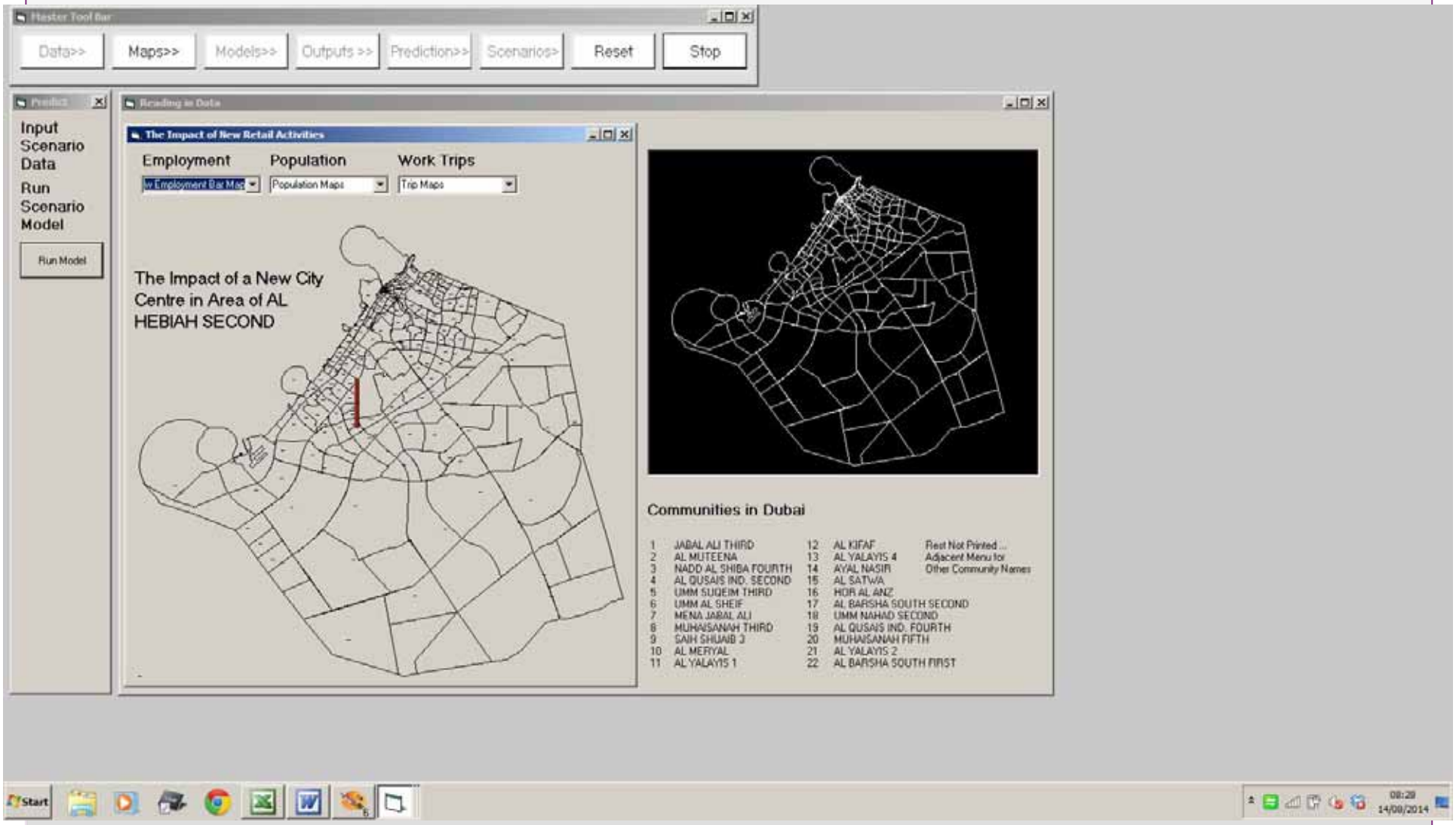
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Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
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Work Trips
Population Maps
Trip Maps
The Impact of a New City Centre in Area of AL HEBIAH SECOND
Communities in Dubai
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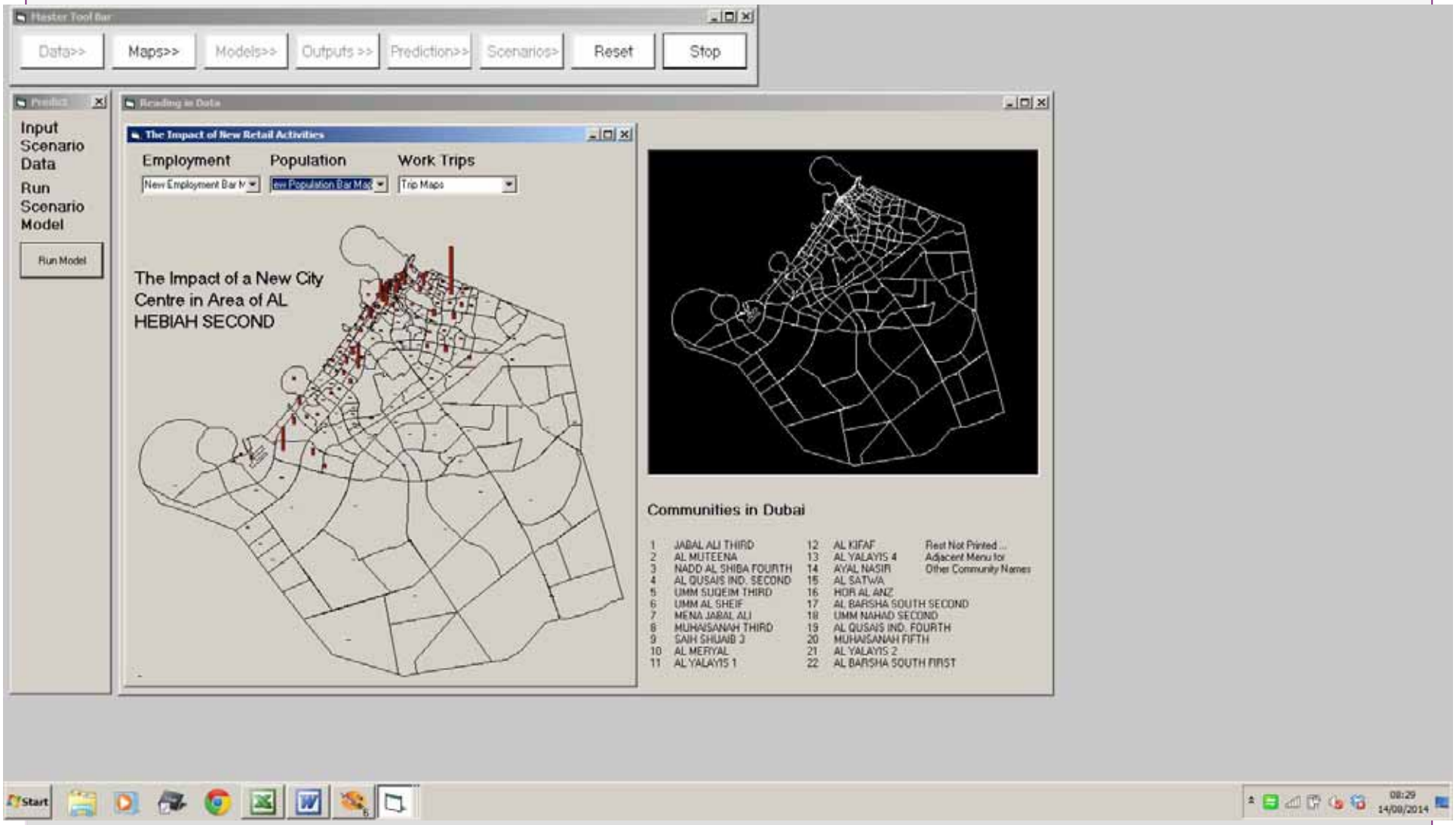
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Communities in Dubai
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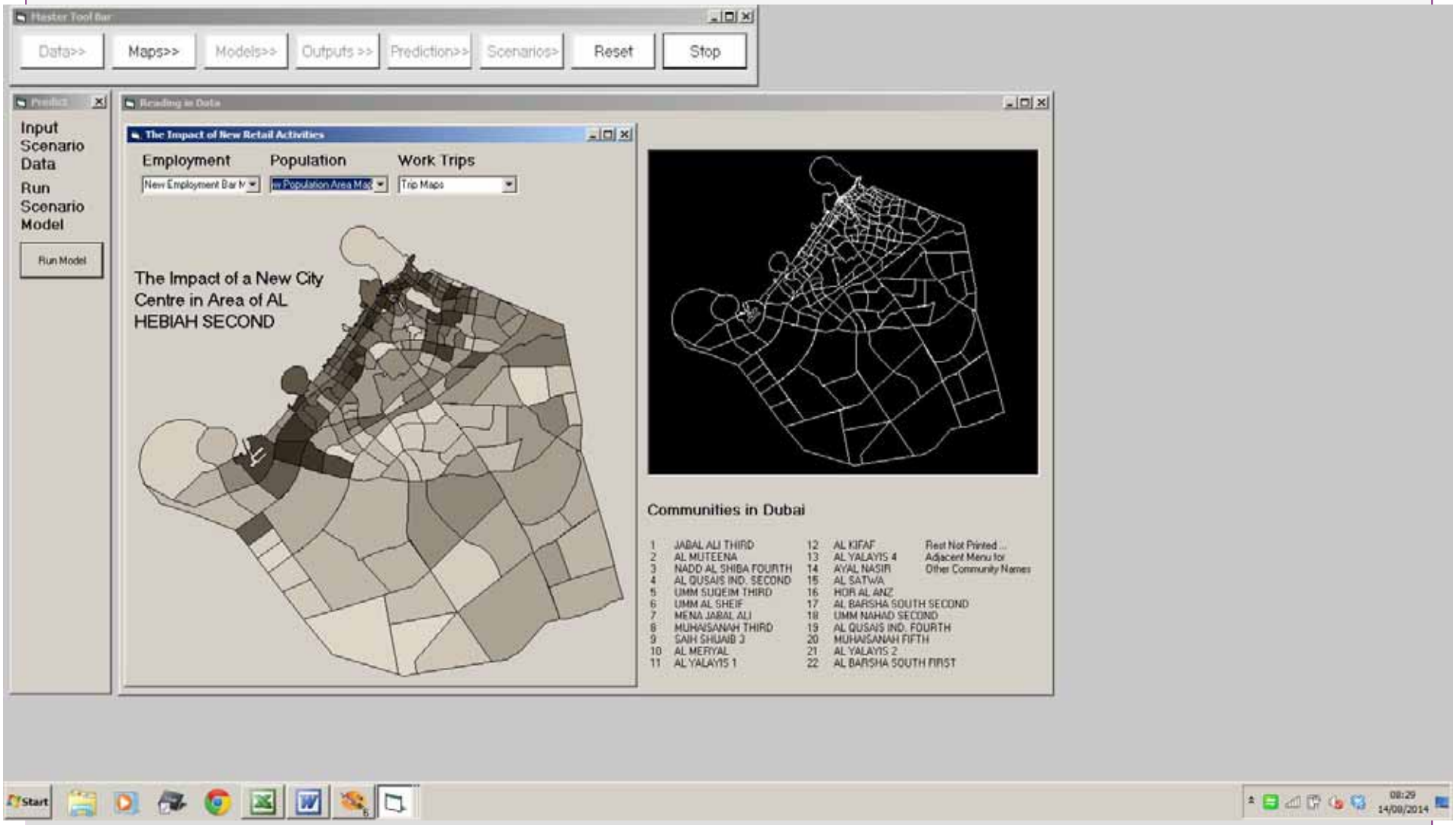
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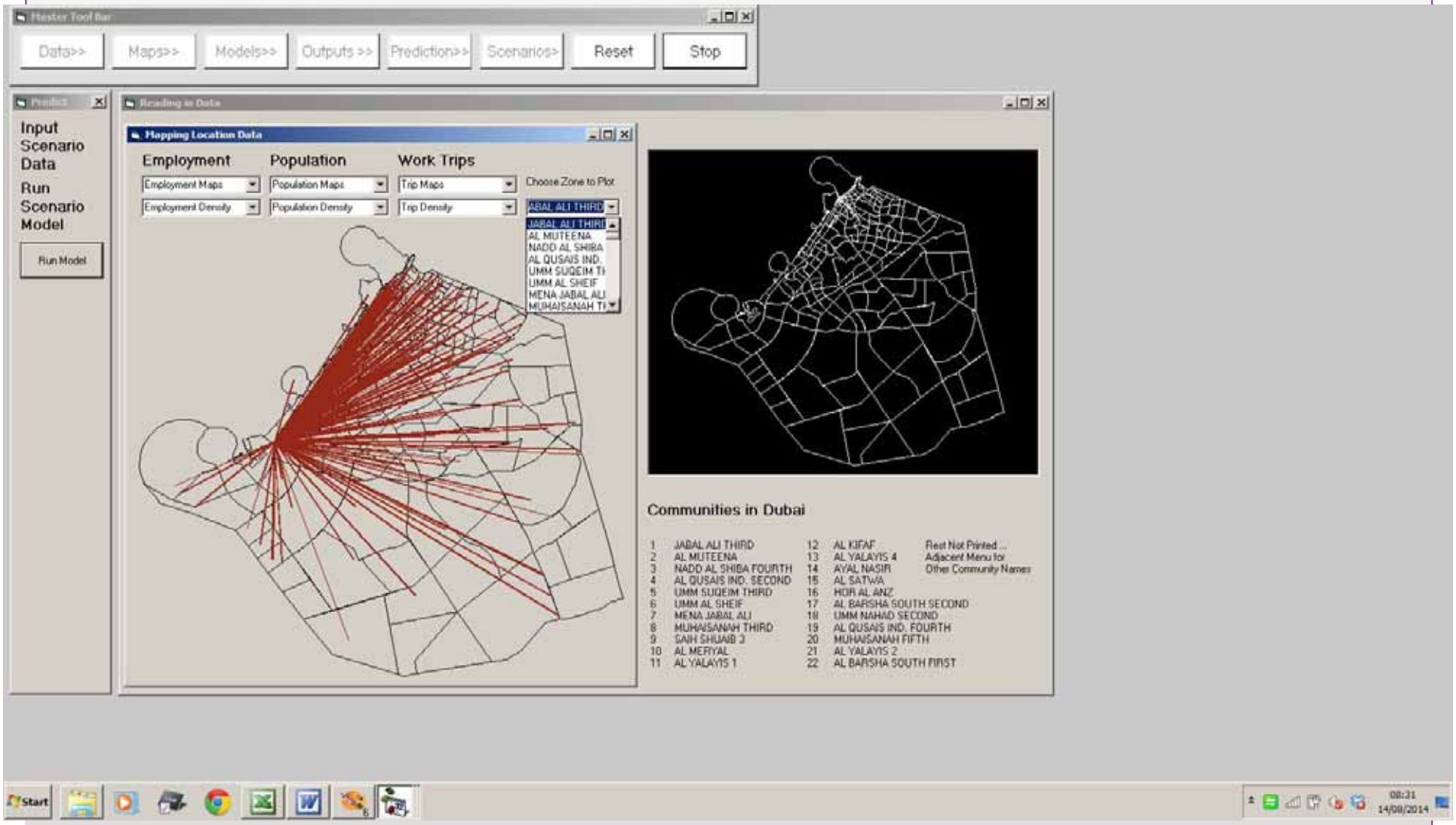
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Scenarios>
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Stop
Predict
Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
Mapping Location Data
Employment
Population
Work Trips
Employment Maps
Employment Density
Population Maps
Population Density
Trip Maps
Trip Density
Choose Zone to Plot
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AL MUTEENA
NADD AL SHIBA
AL QUSAIS IND.
UMM SUQEIM TI
UMM AL SHEIF
MENA JABAL ALI
MUHAISANAH TI
Communities in Dubai
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4 AL QUSAIS IND. SECOND
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6 UMM AL SHEIF
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Other Community Names
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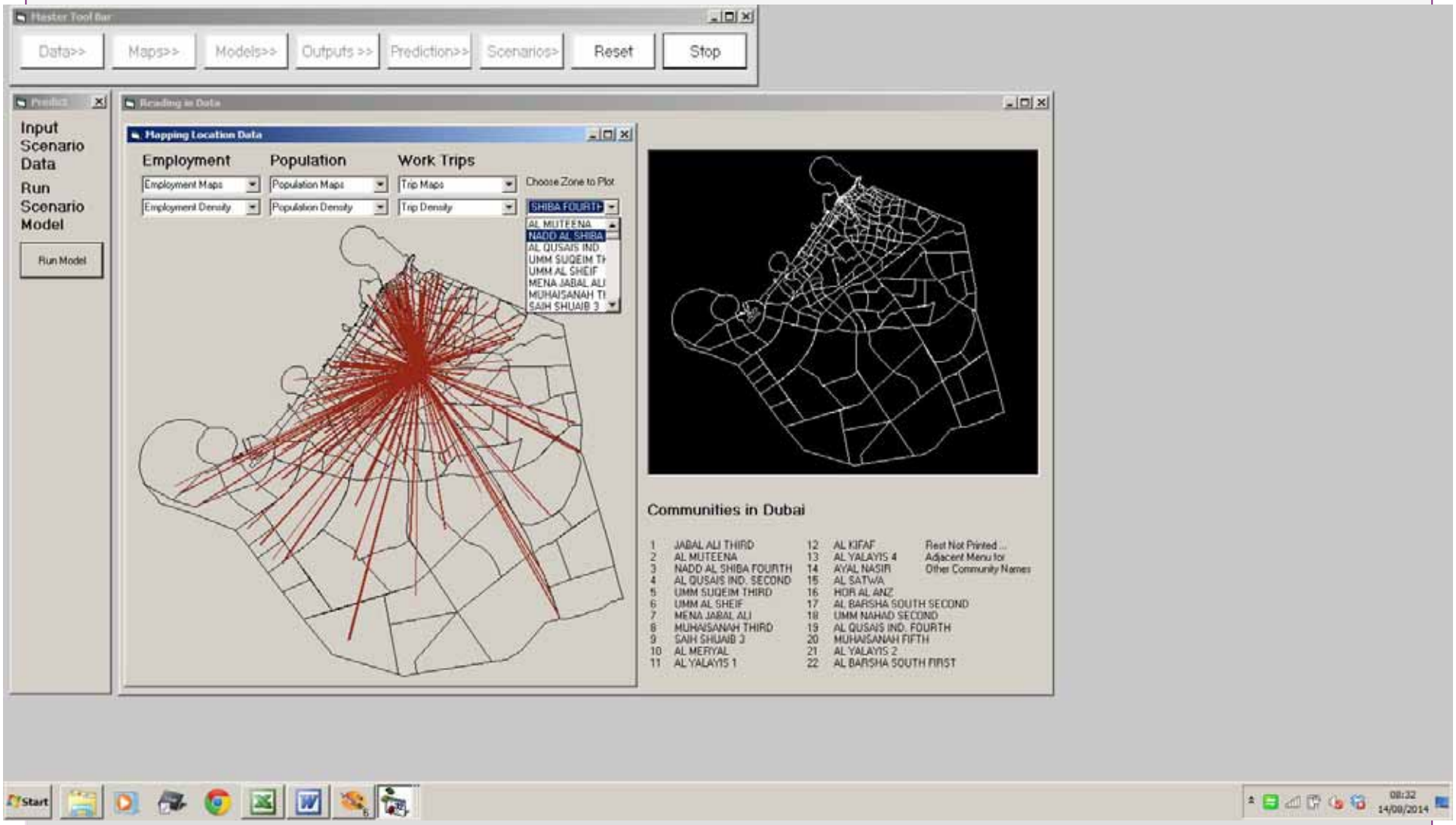
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Scenarios>
Reset
Stop
Predict
Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
Mapping Location Data
Employment
Population
Work Trips
Employment Maps
Employment Density
Population Maps
Population Density
Trip Maps
Trip Density
Choose Zone to Plot
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AL MUTEENA
NADD AL SHIBA
AL QUSAIS IND
UMM SUQEIM TH
UMM AL SHEIF
MENA JABAL ALI
MUHAISANAH TI
SAIH SHUAIB 3
Communities in Dubai
1 JABAL ALI THIRD
2 AL MUTEENA
3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
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17 AL BARSHA SOUTH SECOND
18 UMM NAHAD SECOND
19 AL QUSAIS IND. FOURTH
20 MUHAISANAH FIFTH
21 AL YALAYIS 2
22 AL BARSHA SOUTH FIRST
Rest Not Printed ...
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Other Community Names
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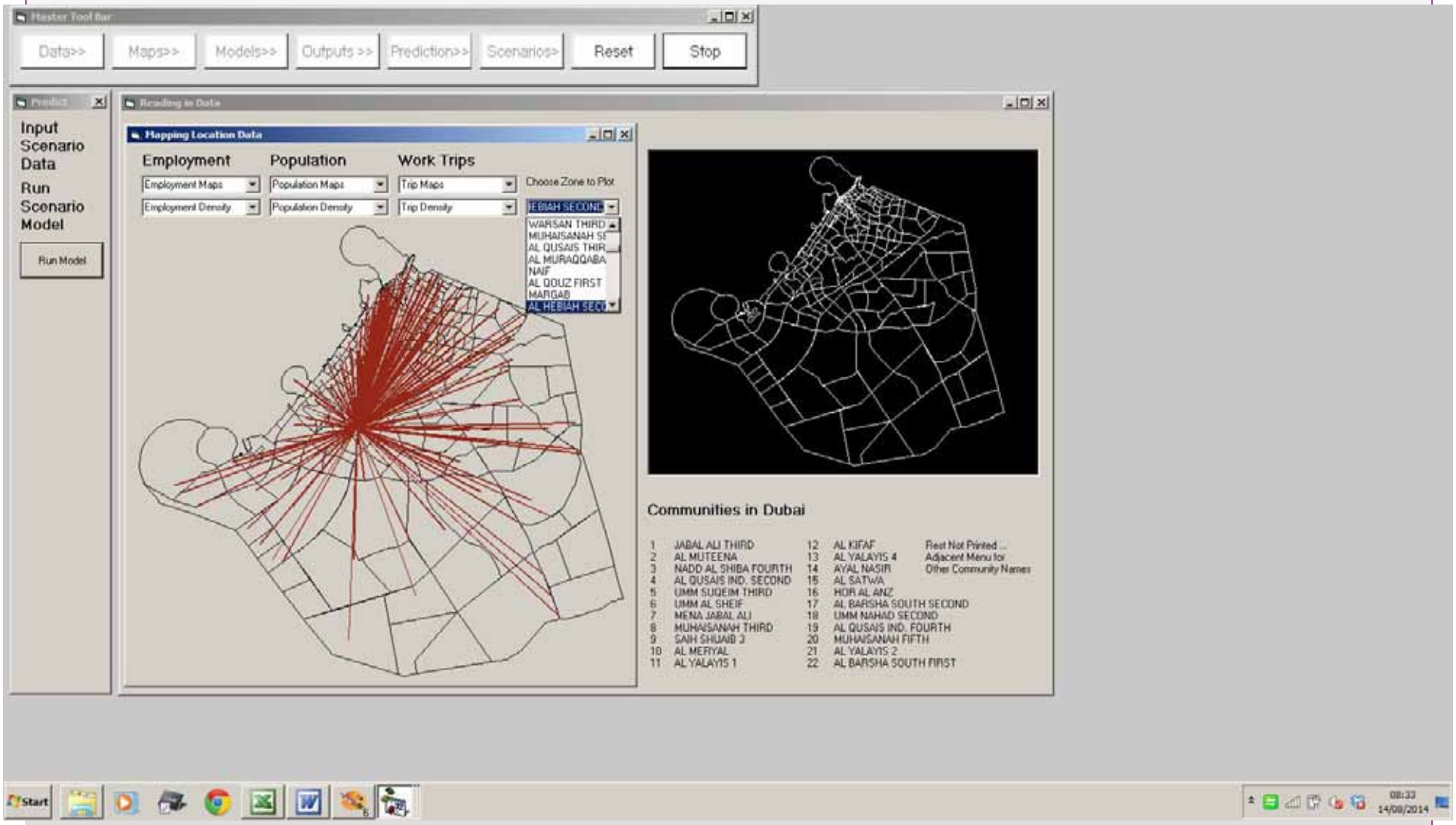
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Predict
Input Scenario Data
Run Scenario Model
Run Model
Reading in Data
Mapping Location Data
Employment
Population
Work Trips
Employment Maps
Employment Density
Population Maps
Population Density
Trip Maps
Trip Density
Choose Zone to Plot
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WARSAN THIRD
MUHAISANAH SE
AL QUSAIS THIR
AL MURAQQABA
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AL QOUZ FIRST
MARGAB
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Communities in Dubai
1 JABAL ALI THIRD
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3 NADD AL SHIBA FOURTH
4 AL QUSAIS IND. SECOND
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10 AL MERYAL
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13 AL YALAYIS 4
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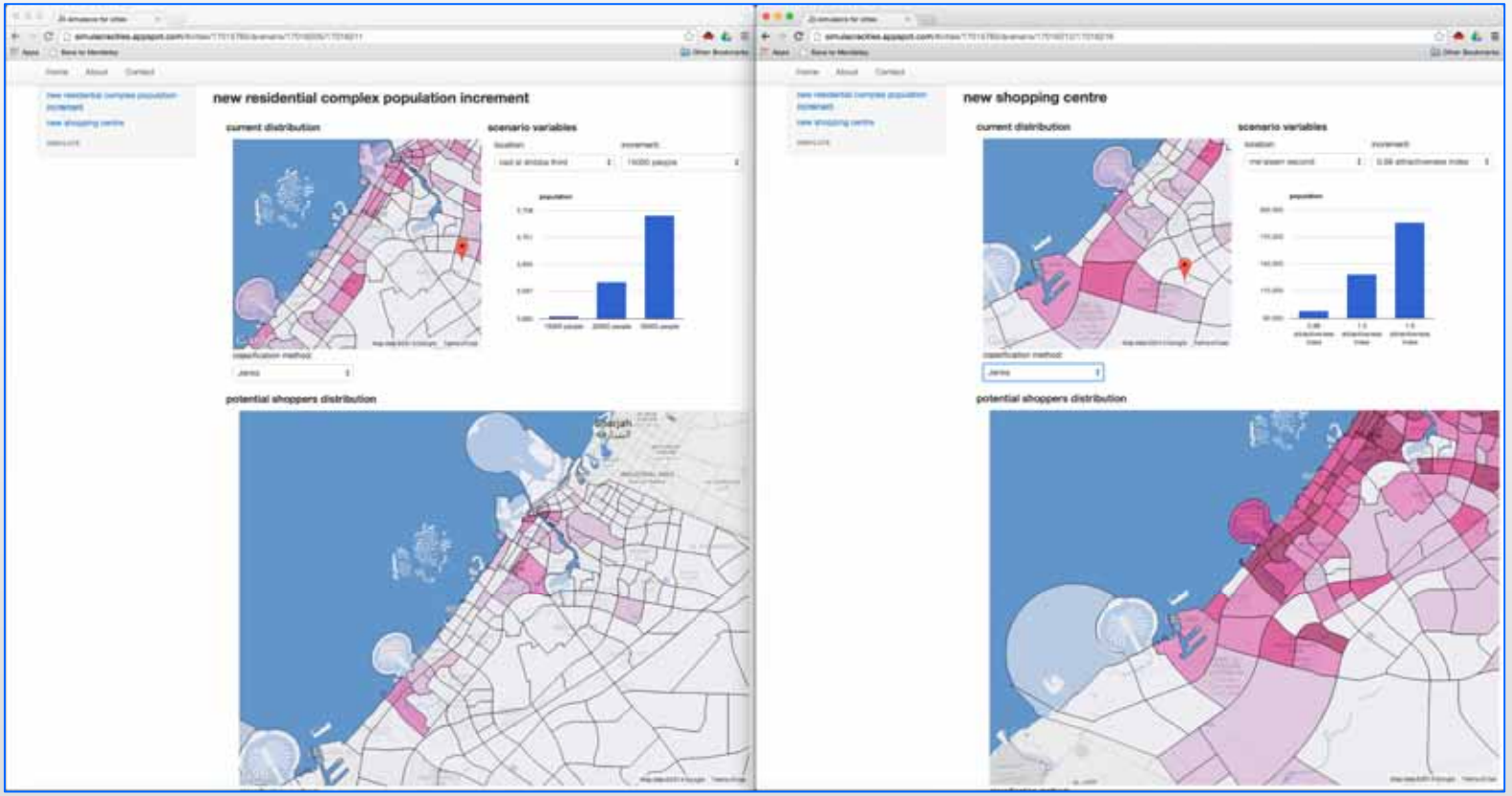
15 AL SATWA
16 HOR AL ANZ
17 AL BARSHA SOUTH SECOND
18 UMM NAHAD SECOND
19 AL QUSAIS IND. FOURTH
20 MUHAISANAH FIFTH
21 AL YALAYIS 2
22 AL BARSHA SOUTH FIRST
Rest Not Printed ...
Adjacent Menu for
Other Community Names
Start
08:33
14/08/2014

Applications

A New Retail Centre in Dubai



Big, Fast, Spatially Extensive, Many Users:

Quant: *this is software*

Our current model is being built for the *Future Cities Catapult* for all of E & W – Scotland will be added but not yet because the 2011 census data wasn't ready in the correct form when we started last year

Then model is dead simple –the journey to work but 7201 zones MSOAs but there are many issues of speed – that Richard our programmer is working on

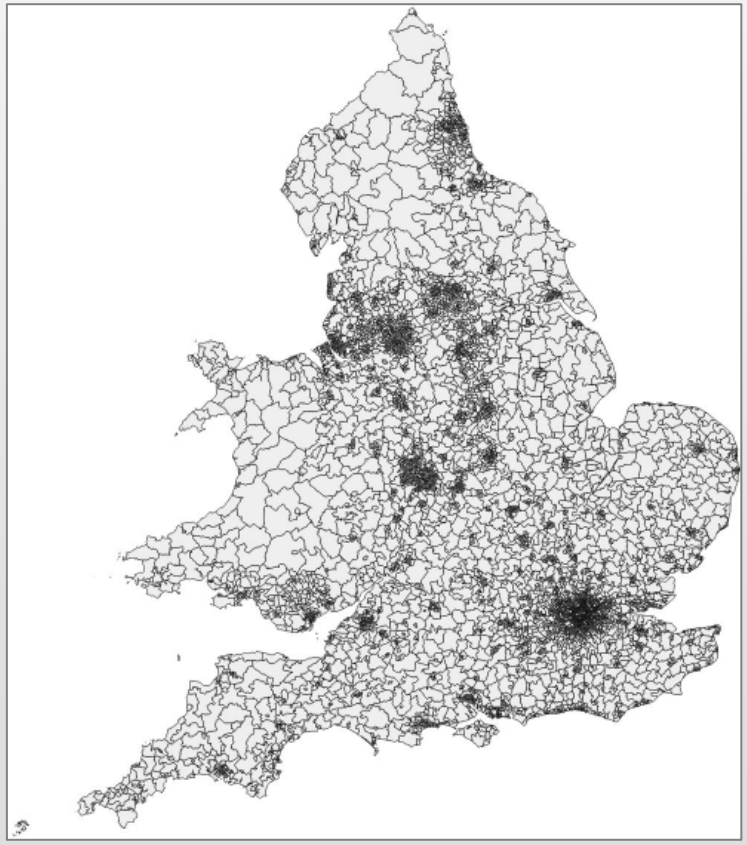
The model will be massively extended once the user interface is sorted and the balance of client-server computation resolved. Of course it is web-based.

The model is now being designed by a small team a programmer, a designer who is a model-builder (me), a user interface specialist and a part time graphics programmer

The model is web-based –very large – an order of magnitude larger spatially than most equivalent models – for all zones in E&W because we need it to be operable by any stakeholder from any area of E&W to test impacts of economic-demographic and transport change.

The size and scale of the models introduces new issues about scalability which we will note as follows

The zoning system is massive – because we need to cover everywhere rather than building specific models for each place.

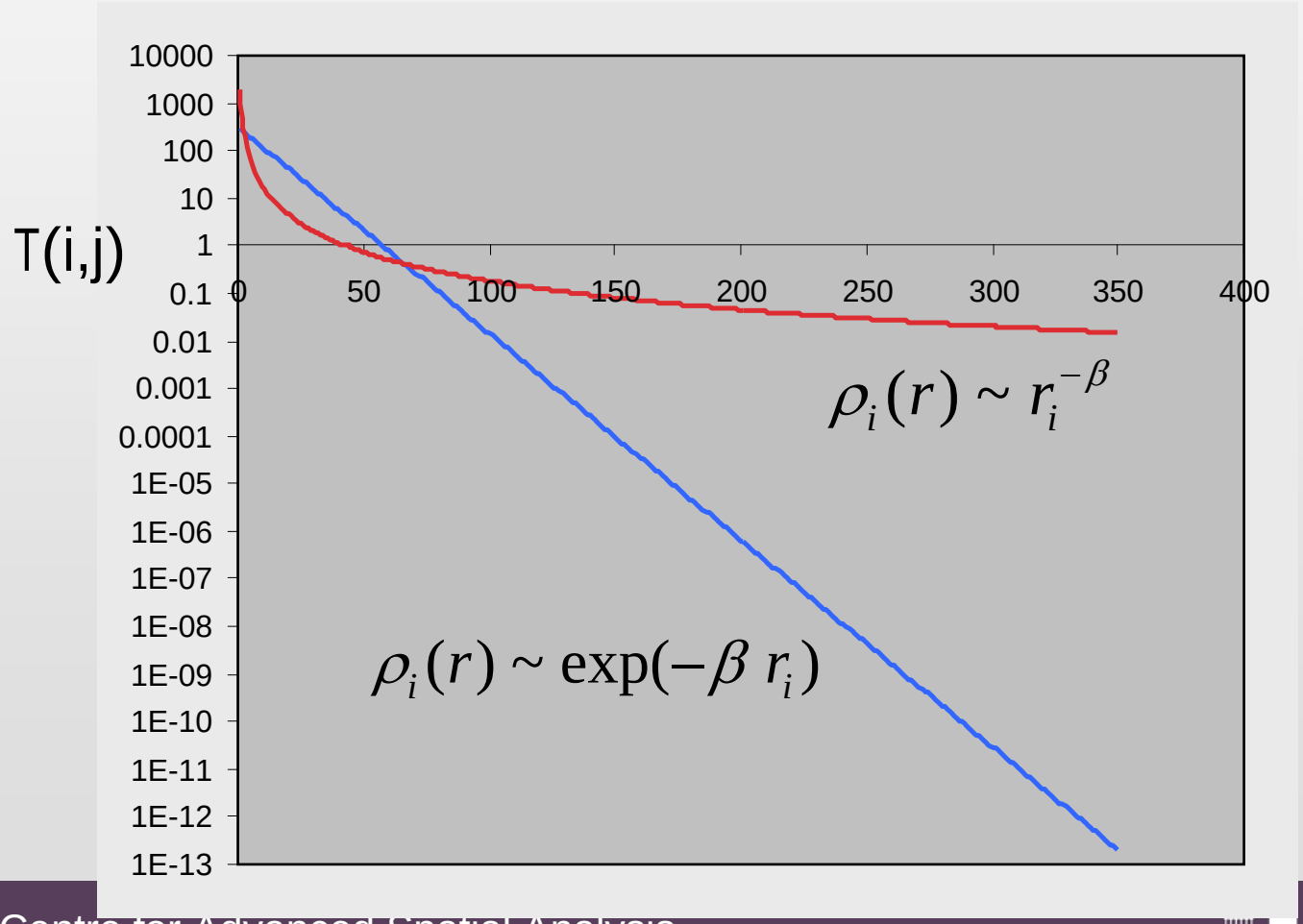


The big issue is – how do we predict long distance travel. We would like to use an inverse distance rather than a negative exponential function of distance i.e.

$$T_{ij} \sim O_i D_j d_{ij}^{-\beta}$$

But we will generate trips at infinite distances and our assumption is that if we extend the zoning system a very very long way from every origin, we will get too many trips – fractions of trips at long distances

In fact, if we use a negative exponential function, on average we reckon that by the time we get 120 kms from a place, we won't get any trips – T(i,j)→0



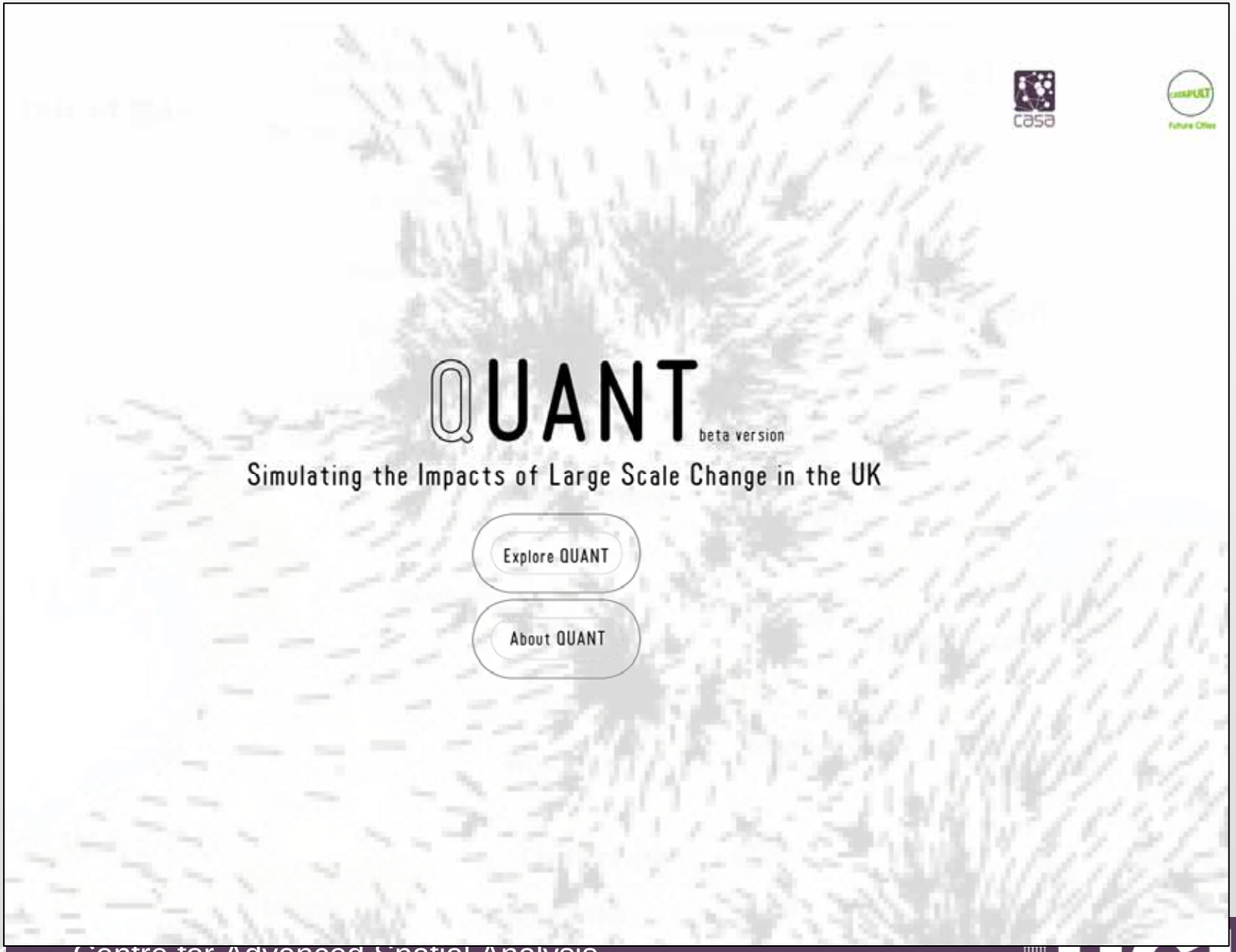
It is 350 kms from Manchester to London and biggest distance is Berwick on Tweed to Lands End 885 kms, so the negative exponential model handles this OK.

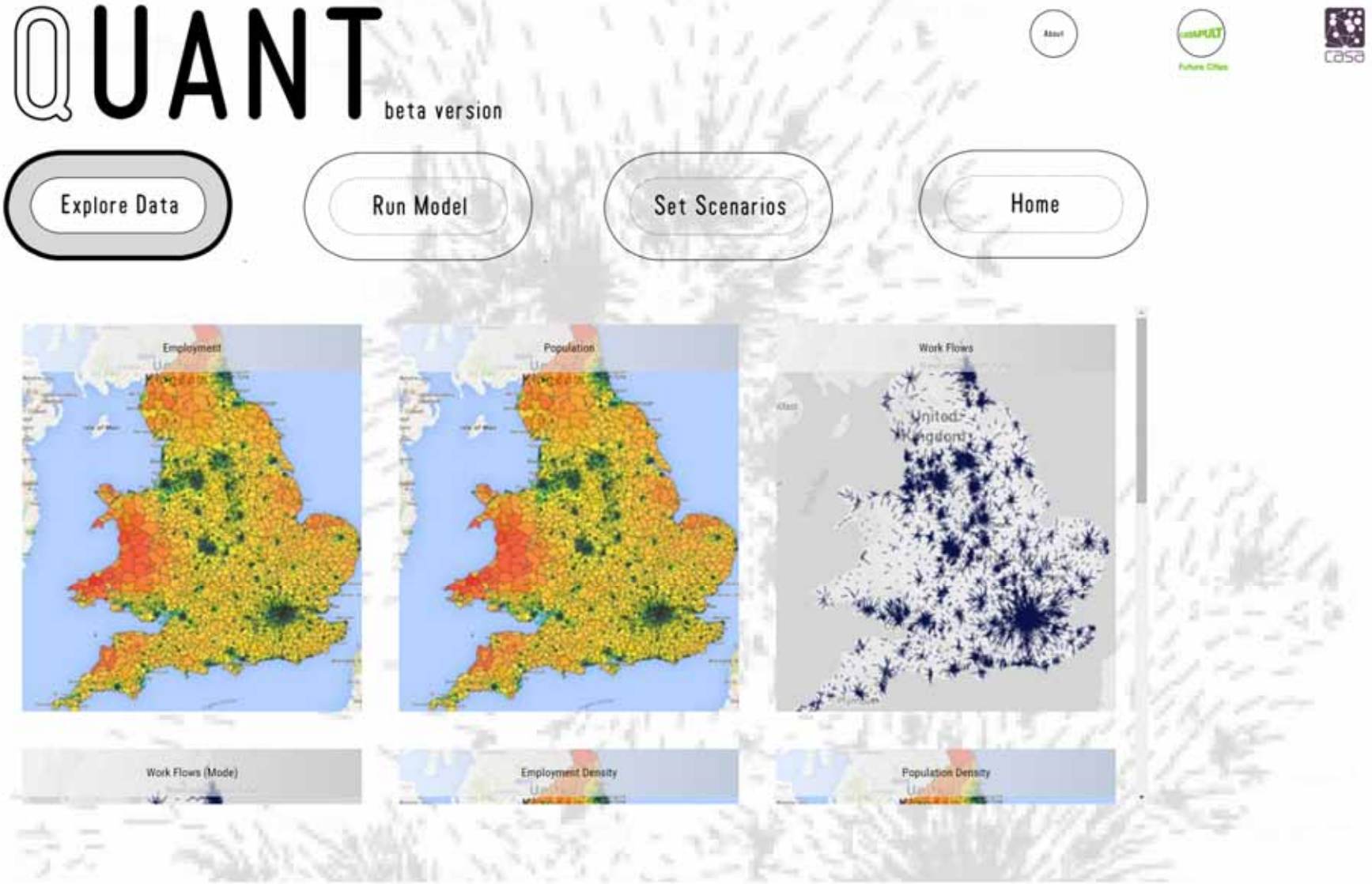
We still have the problem of getting integer trips. Currently we round up or down and this more or less preserves the constraints – we would like to handle this better but if we choose from a probability distribution … well this is not quite the model we are building as it is supposed to distribute aggregates but ideally aggregates that are integral. To do it by assigning each individual in the aggregate seems somewhat odd as it isn't a discrete choice model

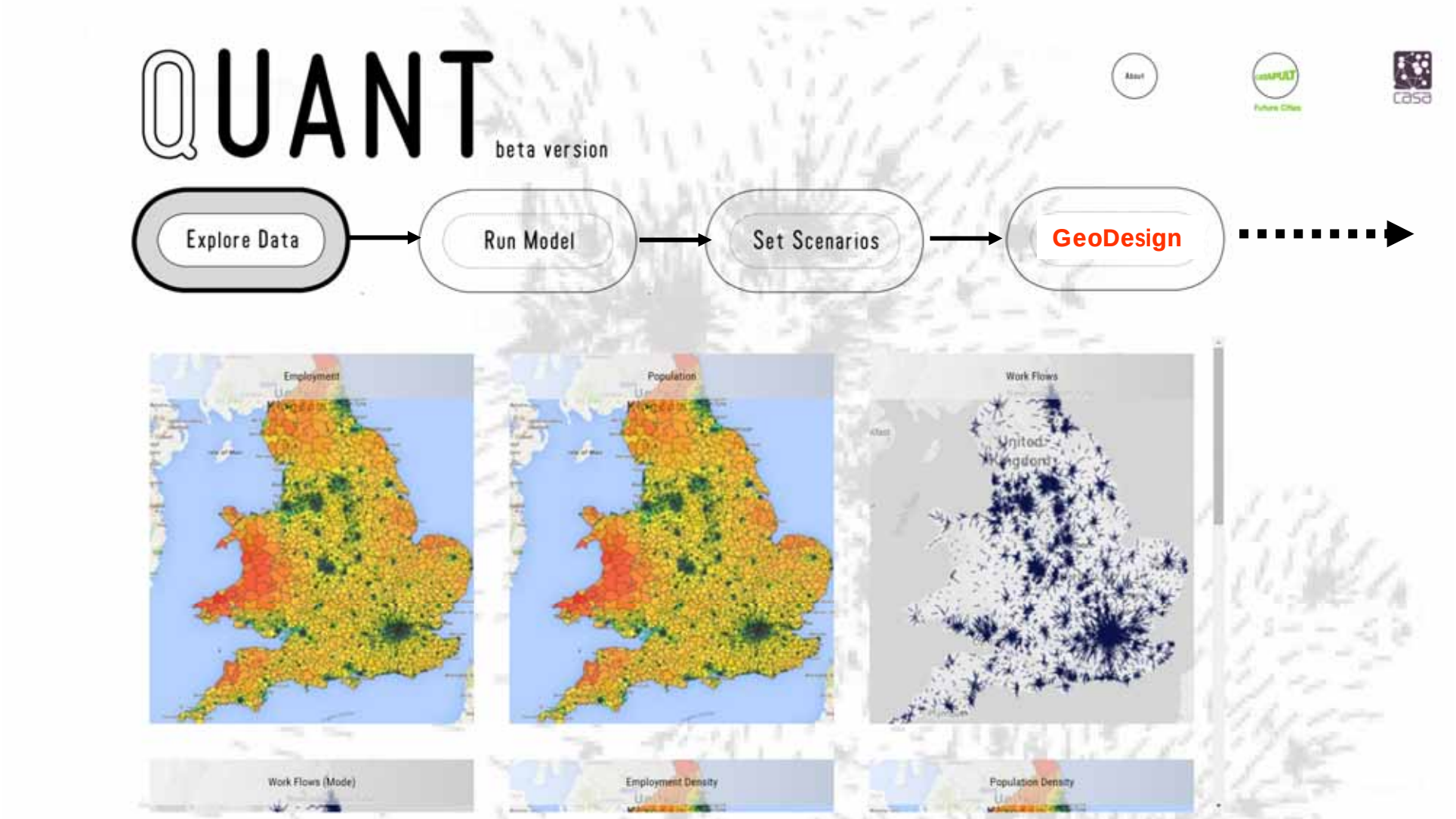
Ok – there are a lot of issues pertaining to software design that we need to handle – and let me list these

- What goes on the client and what on the server – currently data and computation of model on the server, map rendering on the client
- What happens if the model is still computing for one user and another user logs onto the system – has to wait for the first user to complete?
- How fast is the model – ~ 5 seconds – maps take about 5 seconds to render – as we grow the model we need much more speed and we can get it

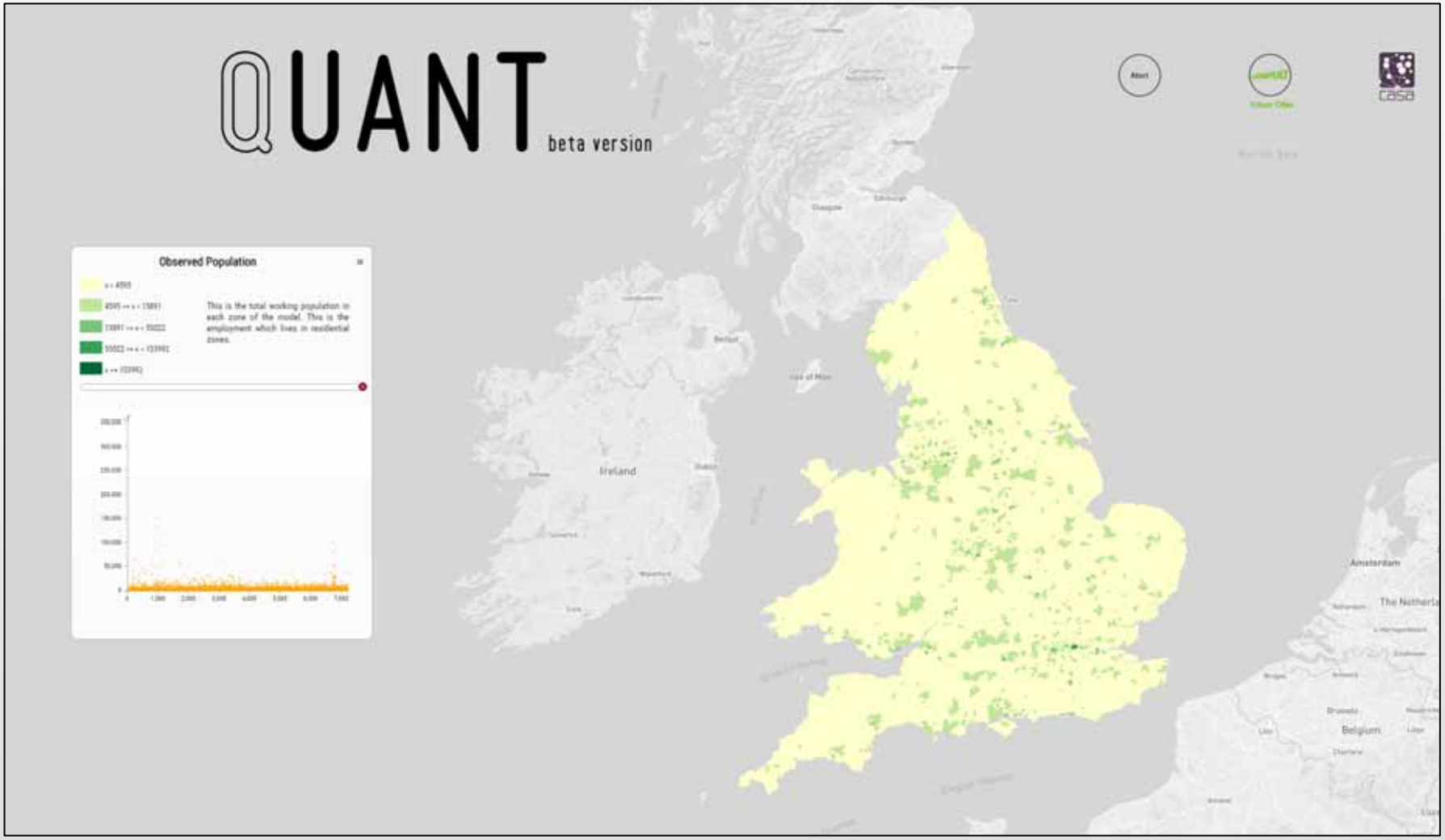
- Our model will be a lot bigger – several sectors, disaggregation of population, employment, capacity constraints, predicting some form of market clearing based on land use area and rent/price
- Assignment of trips to network and capacity constrained assignment
- Multimodal travel – more than one network
- The current model has two variants of the network – crow fly and over the road
- The model is online and you can get this at
- http://quant.casa.ucl.ac.uk/ - don't use Safari

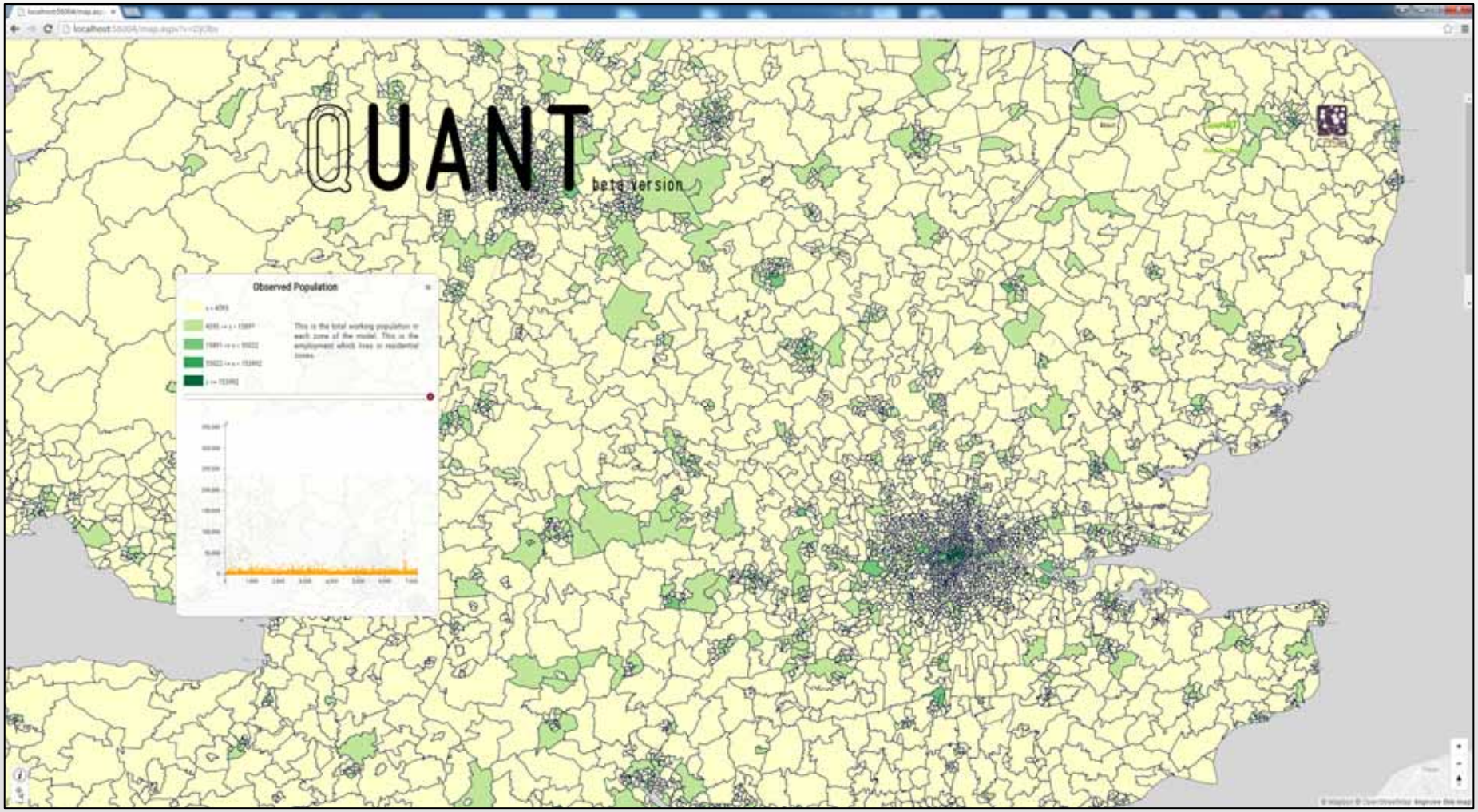

QUANT
beta version
Simulating the Impacts of Large Scale Change in the UK
Explore QUANT
About QUANT


QUANT
beta version
About
Explore Data
Run Model
Set Scenarios
Home
Employment
Population
Work Flows
United Kingdom
Work Flows (Mode)
Employment Density
Population Density

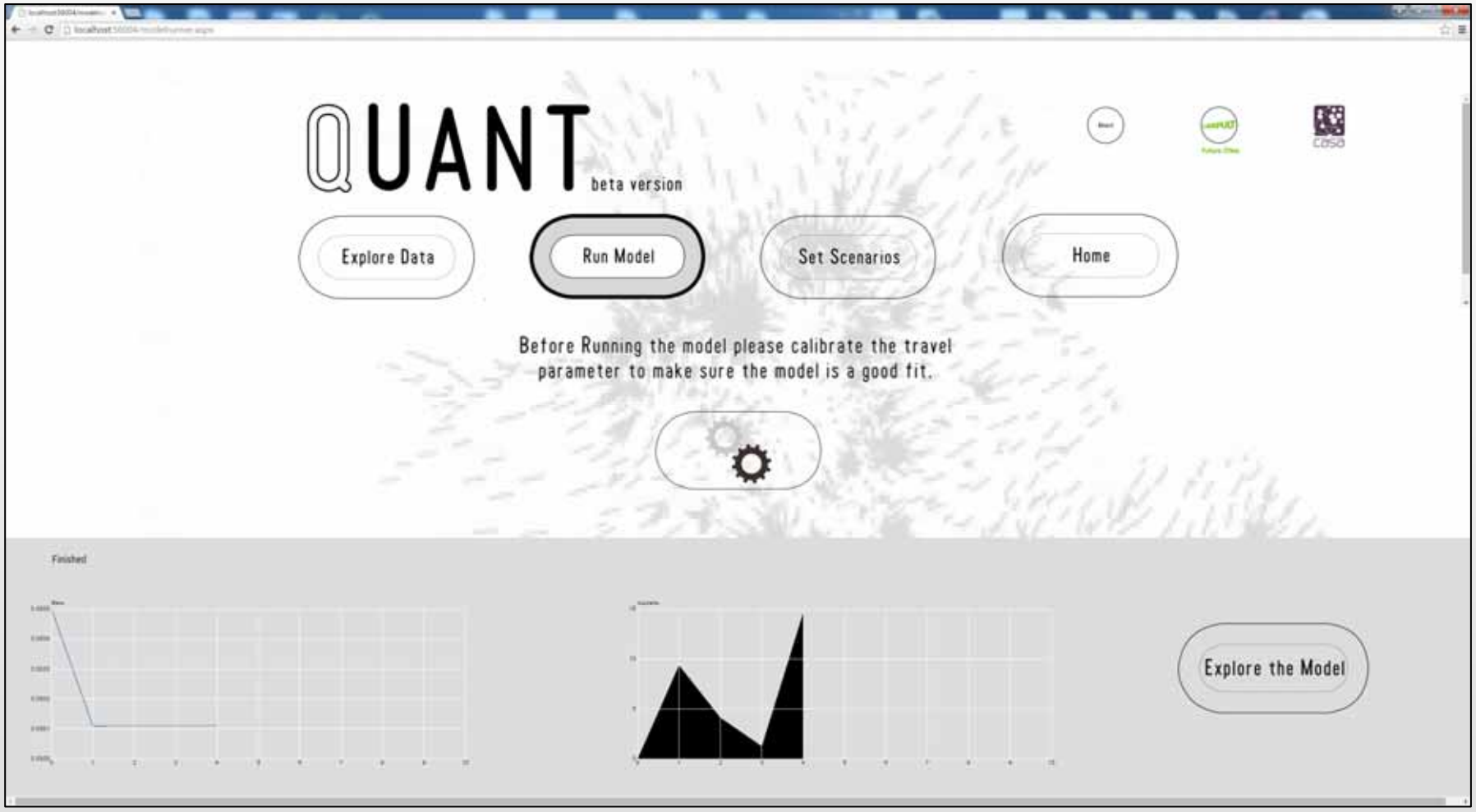


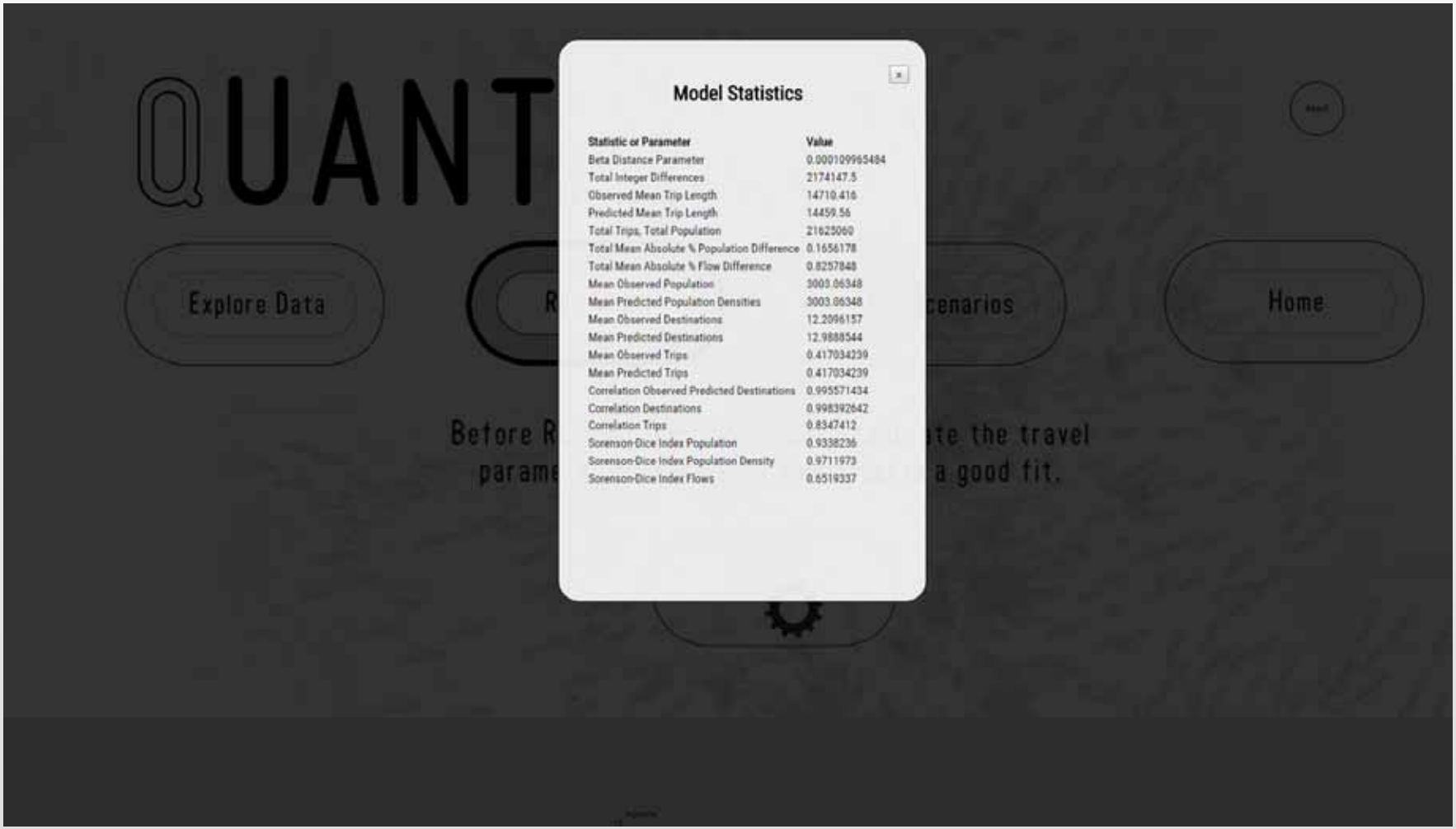
The interface is extensible – and data in terms of maps, flows and so on can be accessed in this way

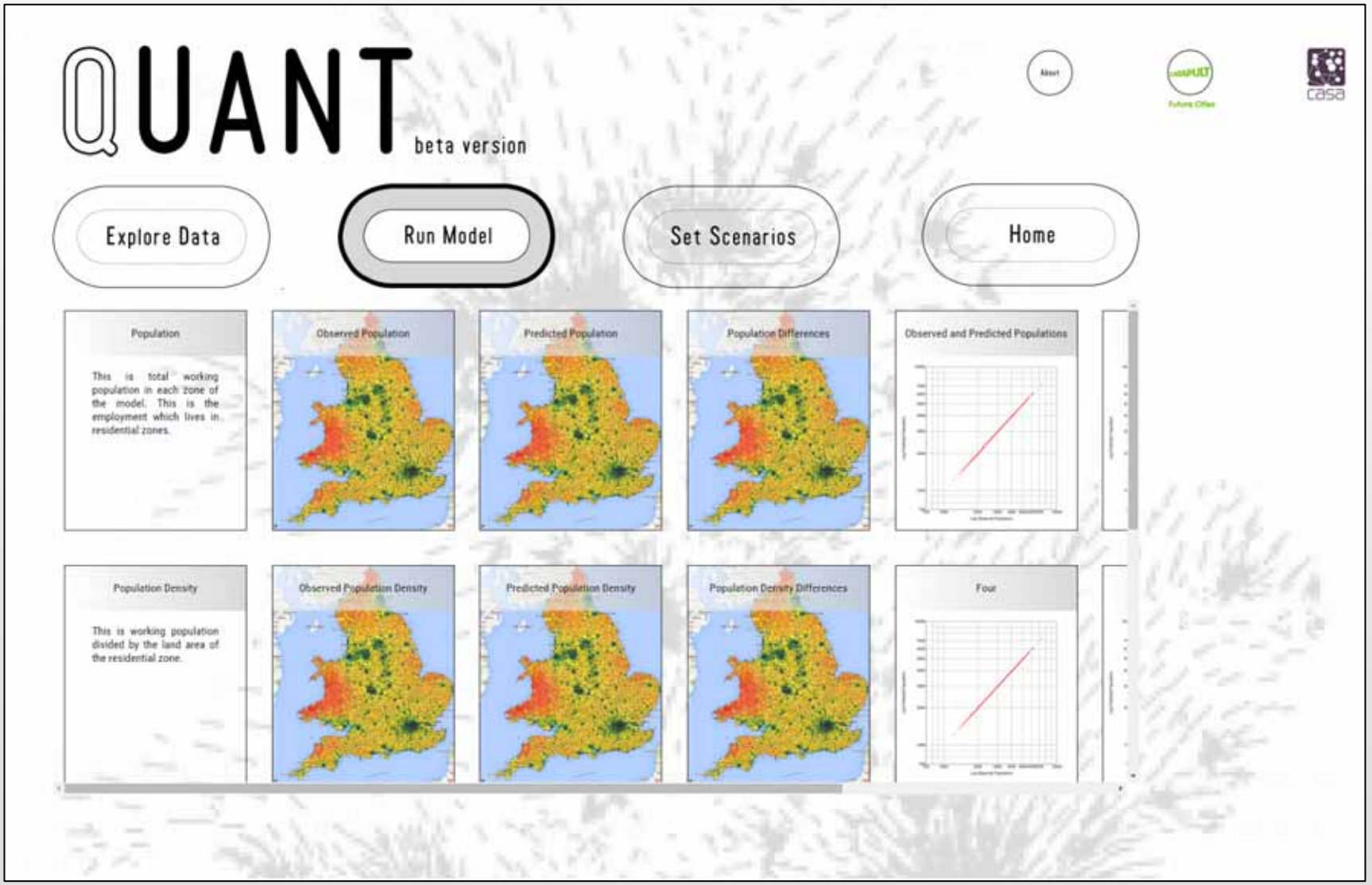

QUANT
beta version
Observed Population
This is the total working population in each zone of the model. This is the employment which lives in residential zones.
Ireland
Belgium
Amsterdam

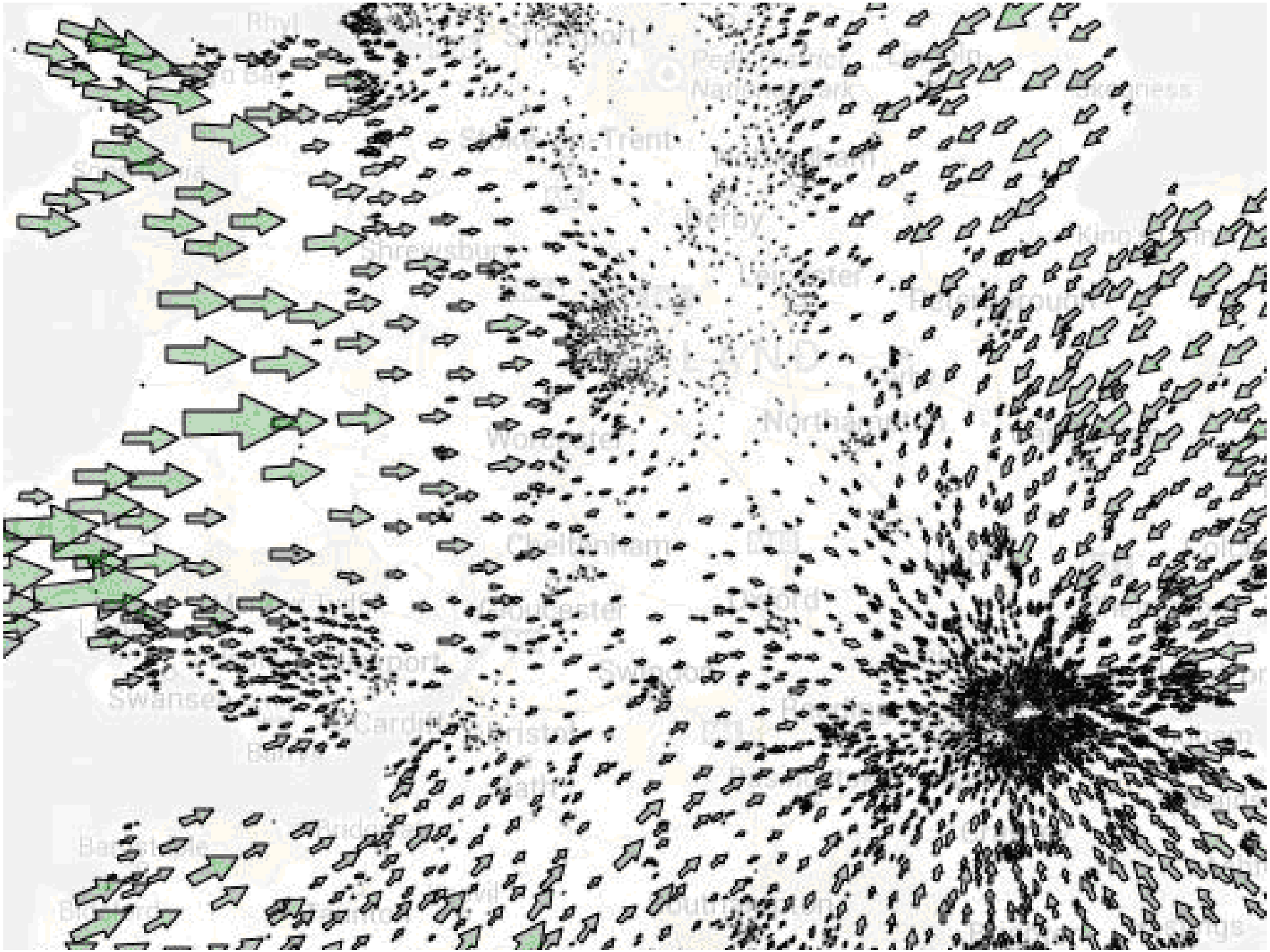


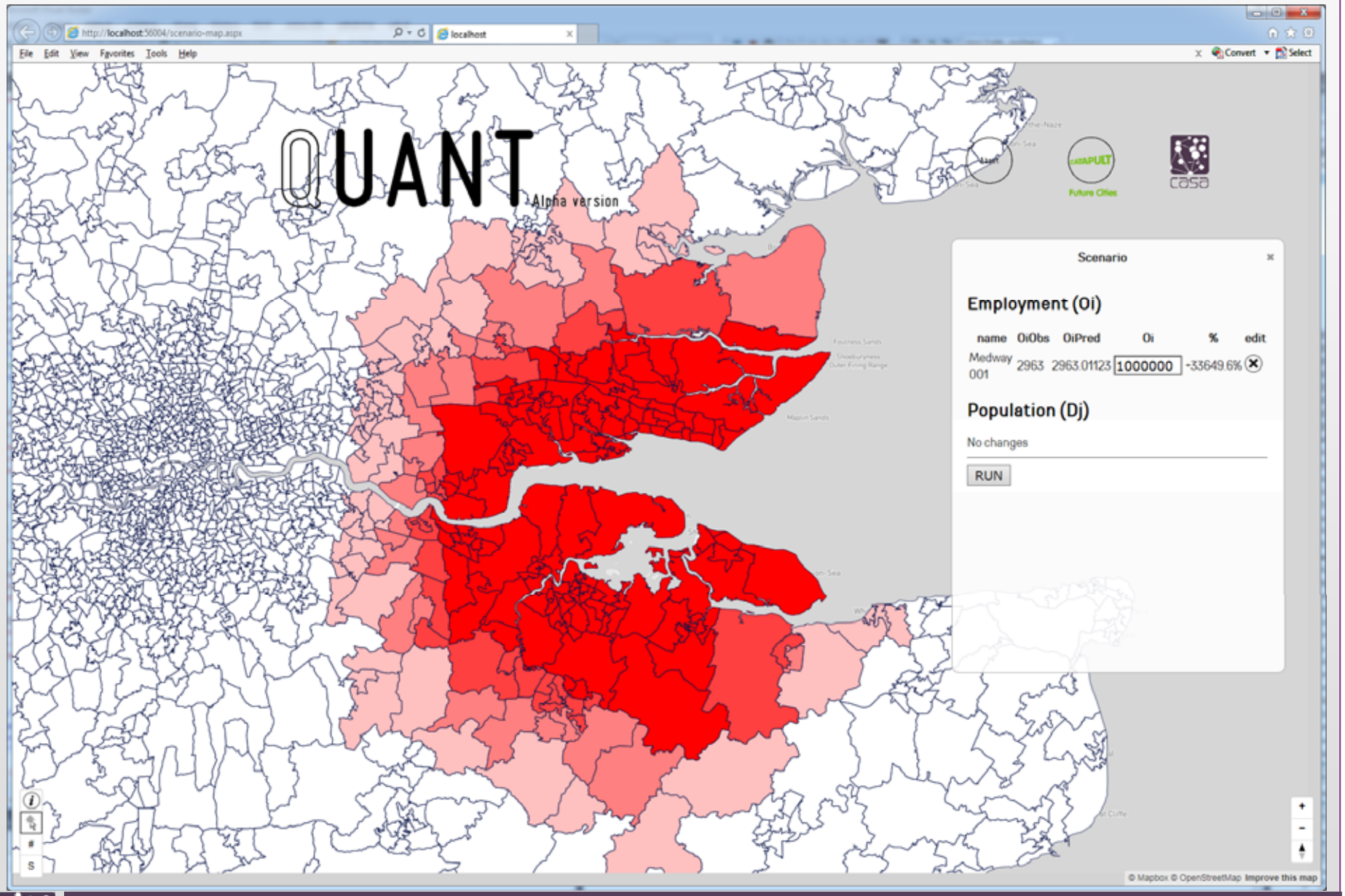
The idea is that we drill down on this map and change its representation to other forms, bar-histogram map, 3D, Google Earth and so on. There are many other graphics that will come through the scrolling graphics interface


QUANT
beta version
Explore Data
Run Model
Set Scenarios
Home
Before Running the model please calibrate the travel parameter to make sure the model is a good fit.
Finished
Explore the Model


QUANT
Explore Data
Home
Model Statistics
Statistic or Parameter
Value
Beta Distance Parameter
0.000109965484
Total Integer Differences
2174147.5
Observed Mean Trip Length
14710.416
Predicted Mean Trip Length
14459.56
Total Trips, Total Population
21625060
Total Mean Absolute % Population Difference
0.1656178
Total Mean Absolute % Flow Difference
0.8257848
Mean Observed Population
3003.06348
Mean Predicted Population Densities
3003.06348
Mean Observed Destinations
12.2096157
Mean Predicted Destinations
12.9888544
Mean Observed Trips
0.417034239
Mean Predicted Trips
0.417034239
Correlation Observed Predicted Destinations
0.995571434
Correlation Destinations
0.998392642
Correlation Trips
0.8347412
Sorenson-Dice Index Population
0.9338236
Sorenson-Dice Index Population Density
0.9711973
Sorenson-Dice Index Flows
0.6519337


QUANT
beta version
About
Explore Data
Run Model
Set Scenarios
Home
Population
This is total working population in each zone of the model. This is the employment which lives in residential zones.
Observed Population
Predicted Population
Population Differences
Observed and Predicted Populations
Population Density
This is working population divided by the land area of the residential zone.
Observed Population Density
Predicted Population Density
Population Density Differences
Four




QUANT
Alpha version
Scenario
Employment (Oi)
name OiObs OiPred Oi % edit
Medway 001 2963 2963.01123 1000000 -33649.6%
Population (Dj)
No changes
RUN
© Mapbox © OpenStreetMap Improve this map

Embedding Models in Practice

There are many things I have not said about how we define scenarios and embed these models in practice – I am thinking here about planning practice and decision-support systems – planning support systems

Lot of work on this area and part of our work with FCC is to provide them with tools like these so that they can introduce them to potential users and stakeholders of various kinds .... I will finish at this point

Thank You

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