

**Optimal Investment Strategies to Minimise Flood
Impact on Road Infrastructure Systems
(OSIRIS)
in Vietnam**

**Graphical User Interface 1.0
Manual**



June 2019

Acknowledgements

The Graphical User Interface (GUI) and the mathematical models which it uses, have been developed under the GCRF-OSIRIS Project in Vietnam. GCRF-OSIRIS stands for the **Global Challenges Research Fund: Optimal Investment Strategies to Minimise Flood Impact on Road Infrastructure Systems in Vietnam**. The project is implemented by the University of Kent, UK, in partnership with the University of Nottingham, and with Vietnamese partner institutions: the Asian Management and Development Institute (AMDI), the Transport and Development Strategy Institute (TDSI), the Vietnam Institute of Meteorology, Hydrology and Climate Change (IMHEN) and the Vietnam Academy of Science and Technology (VAST).

The University of Kent and all its partners thank the British Academy, UK, for their generous support to the project.

Purpose of the Manual

This manual provides instruction on the use of the Graphical User Interface (GUI), which enables planners and policy makers in Vietnam to utilise the mathematical models and optimisation tools developed under the GCRF-OSIRIS project. The GUI enables users to identify and visualise optimal investment strategies, to minimise flood impacts, in terms of damage and congestion, on Vietnam's road infrastructure systems, under two different climate change scenarios. The GUI can be used without prior knowledge of mathematical programming and optimisation methods.

1. Structure

The GUI has five key forms, illustrated below.

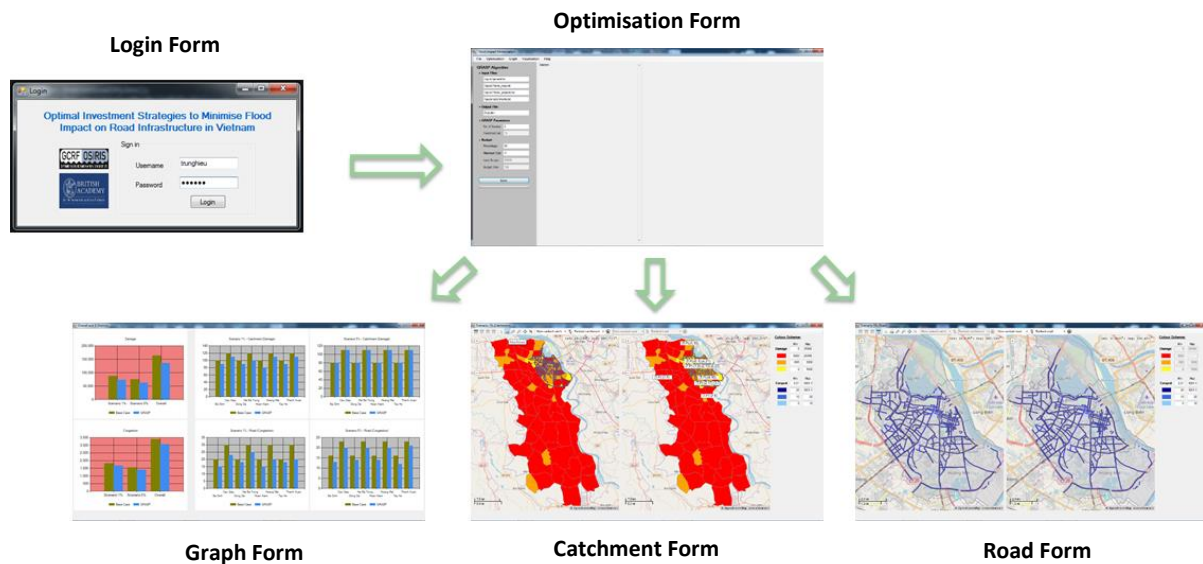


Figure 1. Five Forms

- **The Login Form** enables authorised users to enter the system.
- **The Optimisation Form** is used to connect the solution methods (CPLEX or GRASP) to solve the problem.
- **The Graph Form** compares the impacts of flooding between the base case, and the solutions obtained by CPLEX/GRASP, in terms of two objective functions – minimisation of damage, and minimisation of congestion. This is presented under two different climate change scenarios.
- **The Catchment Form** illustrates the damage values in the catchment area.
- **The Road Form** illustrates the congestion values on roads, before and after intervention measures/projects are implemented.

2. Login Form



Figure 2. Login Form

When clicking on the application, the Login Form appears (Figure 2). The user can enter the system with a username and password provided by the system administrator.

3. Optimisation Form

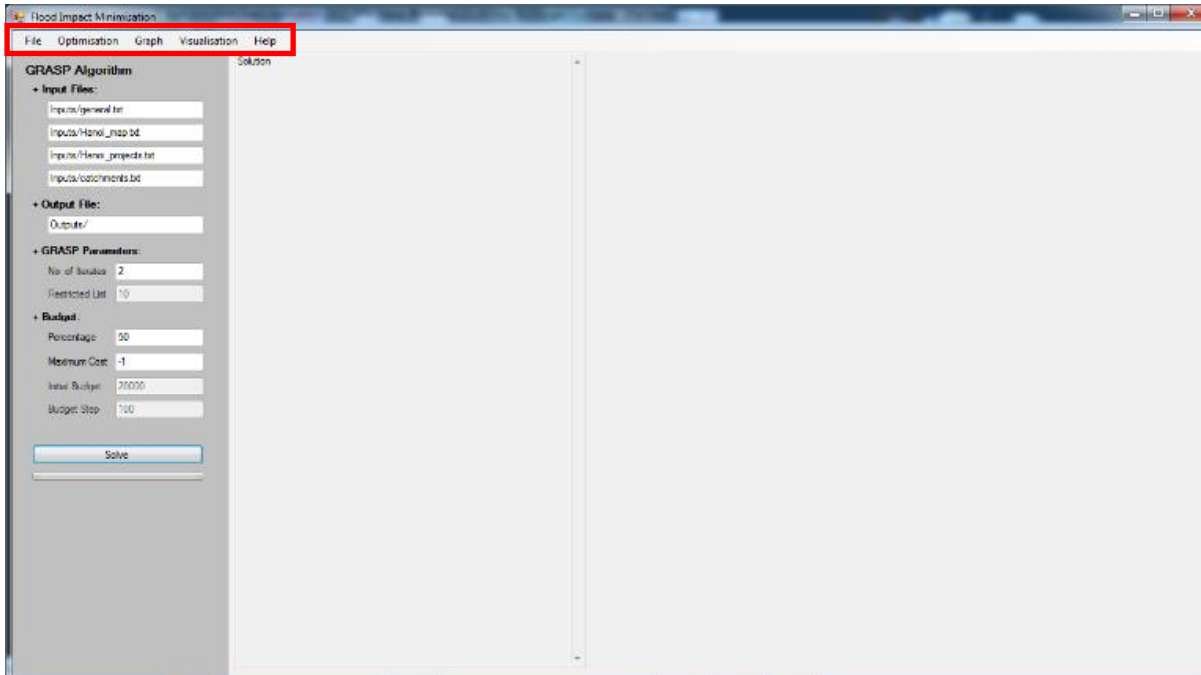


Figure 3.1. Optimisation Form

The Optimisation Form has five tabs, highlighted in red, above: File (New, Open, Print, Exit), Optimisation (CPLEX, GRASP), Graph (Overall, 8 Districts), Visualisation (Scenario 1% or Scenario 5%, Catchment or Road), and Help (About, User Manual).

File Enables a new problem to be created by clicking on *New*, or an existing problem to be opened by clicking on *Open*. Users can also print documents, or quit the application by clicking on the *Print* or *Exit* tabs, respectively.

Optimisation Enables the user to select either CPLEX (the IBM mathematical programming solver) or GRASP (Greedy Randomised Adaptive Search Procedure) to solve the problem, by clicking on the respective tabs.

Graph Takes the user to the Graph Form, to compare the base case (that is, the current situation, without intervention measures/projects) against the solution obtained by CPLEX or GRASP with intervention measures, using different 'objective functions' (damage, or congestion). The form provides a comparison of eight districts in Hanoi on the two objective functions, using two different scenarios of climate change.

Visualisation This tab enables users to view the corresponding damage or congestion map, in catchment areas and on roads, under each climate change scenario, (1% or 5%).

Help This tab provides information of this project (*About*) and how to use the application (*User's Manual*).

The optimisation process requires a selection of either CPLEX (the IBM mathematical programming solver) or GRASP (Greedy Randomised Adaptive Search Procedure).

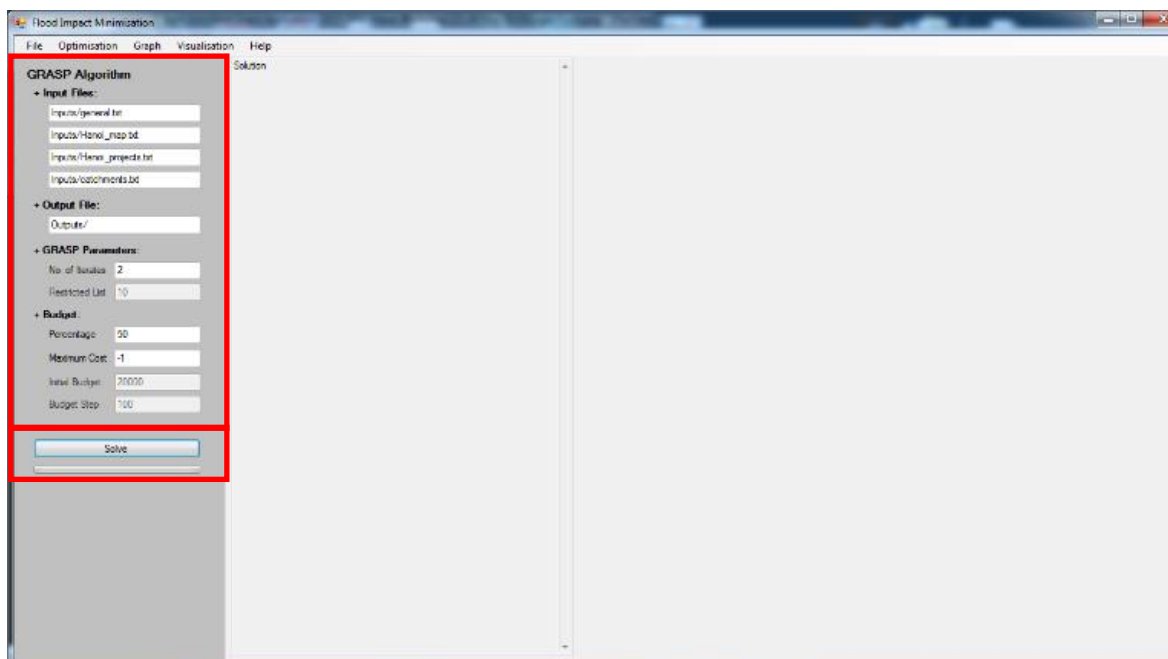


Figure 3.2. Optimisation Form: Inputs and Solving with GRASP

Figure 3.2 shows the user interface for inputs into GRASP. (CPLEX can be used in a similar way, if the user has a CPLEX licence.) The inputs need to be prepared in advance, as follows.

- Four input files:
 - General.txt (general information about the problem such as the number of time periods, number of climate change scenarios, their weights and values, weights of the objective functions)
 - Hanoi_map.txt (ID, weights and areas, flooded area of catchments, volumes, capacity, speed and flooded length of links/roads, relationship of catchments and links/roads, etc.)

- Hanoi_projects.txt (ID of projects, their costs and benefits, etc.)
- Catchments.txt (the list of catchments).
- Output file: to store a set of outputs after solving the problem.
- GRASP parameters: number of iterates (iterations used in GRASP); Restricted List (default value)
- Budget scenarios: Percentage (i.e., total budget = percentage of total project costs); Maximum cost (i.e., removing any project where the cost is higher than or equal to the maximum cost. If the user wishes to consider all the projects, then a value of **-1** must be used as input); Initial budget and budget steps (used to define uniform distribution, equally increasing/decreasing distribution of budget portions over time). If random budget portions are required over the time period, these need to be input in general.txt.

After the input of data as above, the user clicks the *Solve* button.

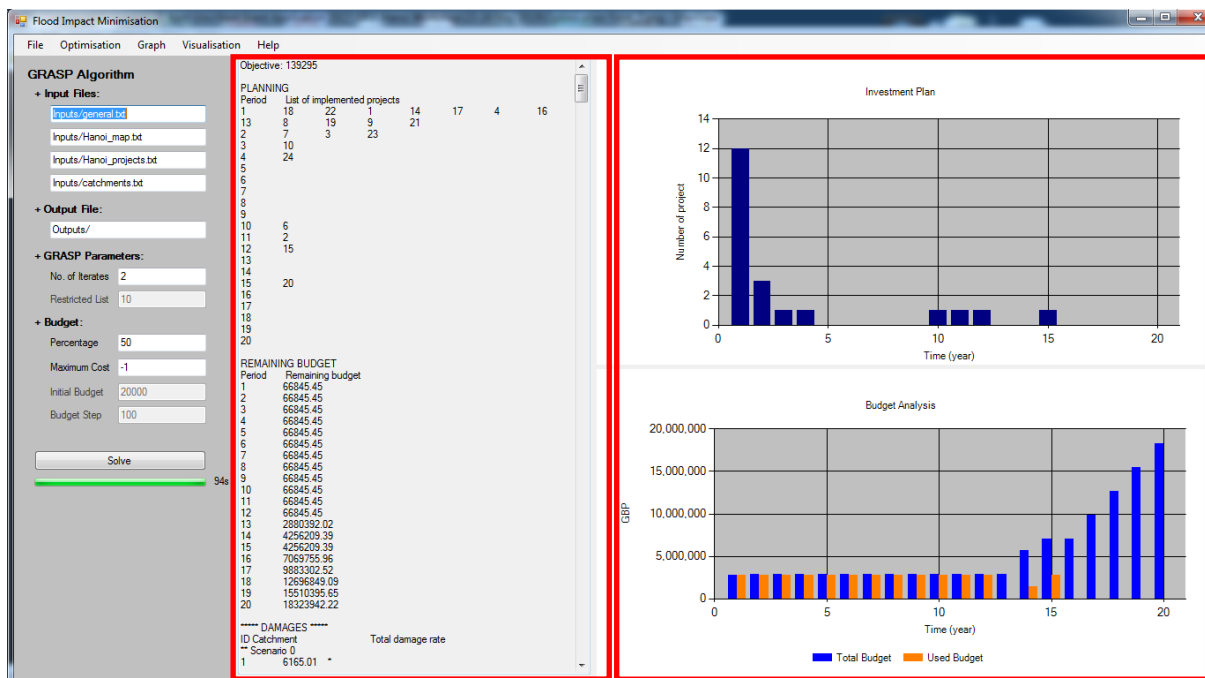


Figure 3.3. Optimisation Form: GRASP's Solution and Graphs

While GRASP is running, the progress bar indicates time remaining (in seconds) to complete the solution procedure. Eventually, the solution will be shown in a text box, and two illustrative graphs, as highlighted in the red boxes in Figure 3.3 above.

The text box shows the value of the weighted objective function, the project investment plan over the required time period, the remaining budget over the same time period, damage

values for catchment areas, and congestion values for roads, under the two climate change scenarios.

On the right-hand side, two graphs describe the number of projects implemented in each time period, total budget and the used budget in each time period when the project investment plan is implemented.

4. Graph Form



Figure 4.1. Graph Form (Overall Comparison).



Figure 4.2. Graph Form (Eight Districts Comparison)

The Graph tab shows an overall comparison between the base case (that is, the current situation before any intervention measures/projects) and the solution obtained by CPLEX/GRASP under the two climate change scenarios, with two objective functions (damage and congestion, see Figure 4.1), and a comparison of the eight selected districts of Hanoi. The GUI shows the calculated reduction in damage and congestion in each district, following the implementation of the proposed measures/investments.

5. Catchment Form

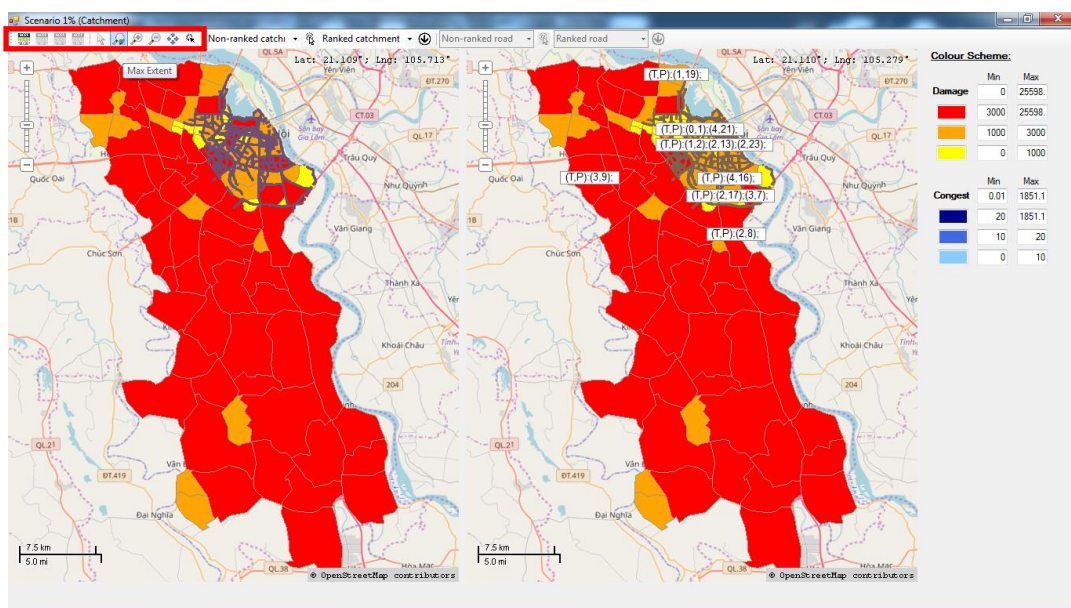









Figure 5.1. Catchment Form

In the Catchment Form, the user selects a scenario of climate change, and a catchment map. The Form has the following tabs:

- Project logo : click on this logo to link the solution with the catchment map.
- Cursor : select the label and click on the catchment area to see its information.
- Max extent : click on the label to see the maximum extent of the map.
- Zoom in : select the label and click on the area, to zoom in.
- Zoom out : select the label and click on the area, to zoom out.
- Pan map : select the label, click, then hold and move the mouse on the map to see different areas.

- Zoom To HanoiUrban  : click on this label to zoom into the eight focus districts of Hanoi (see Figure 5.2).

On the catchment map, the left-hand map is the base case, before/without any implemented intervention measures/projects. The right-hand map is the solution obtained where (T, P) represents the Time period and Project implemented in the specified catchment.

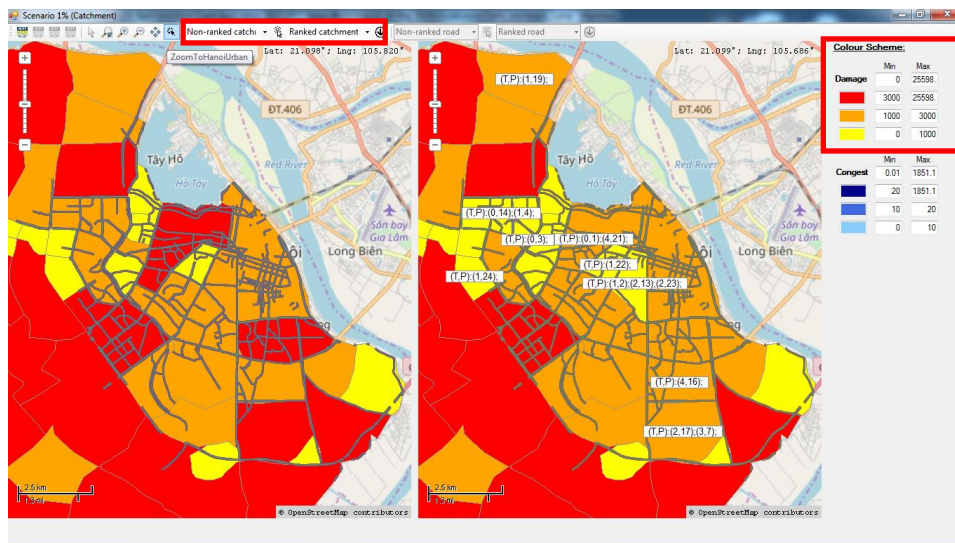


Figure 5.2. Catchment Form (clicking on the Zoom Into HanoiUrban)

Users can also redefine the high/medium/low damage levels, by editing the corresponding minimum and maximum values in the colour scheme (on the right-hand side of Figure 5.2), and clicking again on the project logo to update the catchment map's colour scheme.

There are two combo-boxes, as highlighted at the top of Figure 5.2. One is for viewing information on non-ranked catchment areas, the other is for viewing information on the ranked catchment areas, based on the amount of damage reduction after implementation of investment measures/projects. By clicking on a combo-box and selecting a catchment, the map zooms into the corresponding catchment to show its information.

The information on any catchment area consists of: ID and name, shape length, shape area, rainfall, urban (i.e., 1 = catchment in urban Hanoi, 0 = catchment outside urban Hanoi), damage (i.e., damage value on the catchment), project (i.e., the list of potential projects in the catchment), improve (i.e., the amount of damage reduction after implementing projects), as illustrated in Figure 5.3, below.

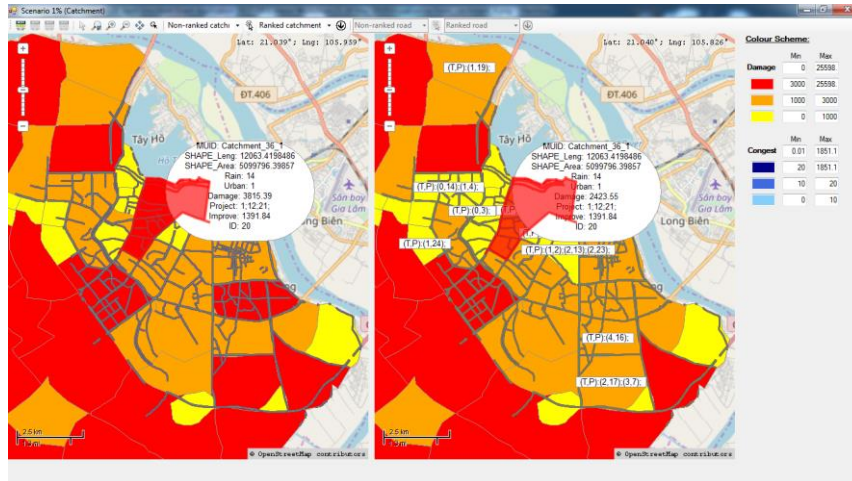


Figure 5.3. Catchment Form (showing catchment information)

6. Road Form

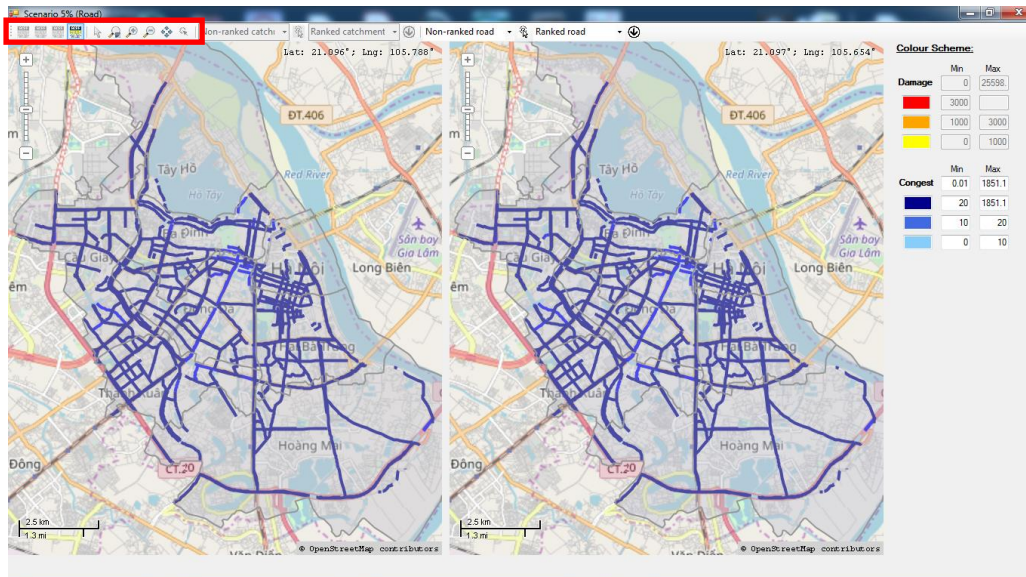









Figure 6.1. Road Form (tabs)

When using the Optimisation Form and selecting a scenario of climate change together with a road map, the programme will take the user to the Road Form shown in Figure 6.1. The form consists of the following tabs:

- Project logo  : click on this logo to link the congestion values to the road map.
- Cursor  : select this label and click on the road to see its information.
- Max extent  : click on this label to see the maximum extent of the map.
- Zoom in  : select this label and click on a selected area to zoom in.

- Zoom out : select this label and click on a selected area to zoom out.
- Pan map : select the label, click, then hold and move the mouse on the map to see different areas.
- Zoom To HanoiUrban : will not function when map is already zoomed into Hanoi urban.

The left-hand side of the road map shows the base case (without intervention measures/projects), and the right-hand side map shows the solution obtained.

Users can also redefine the high (dark blue), medium (blue), and low (light blue) congestion levels, by editing the corresponding minimum and maximum values in the colour scheme (on the right-hand side in Figure 6.2), and then clicking on the project logo to update the road map's colour scheme.

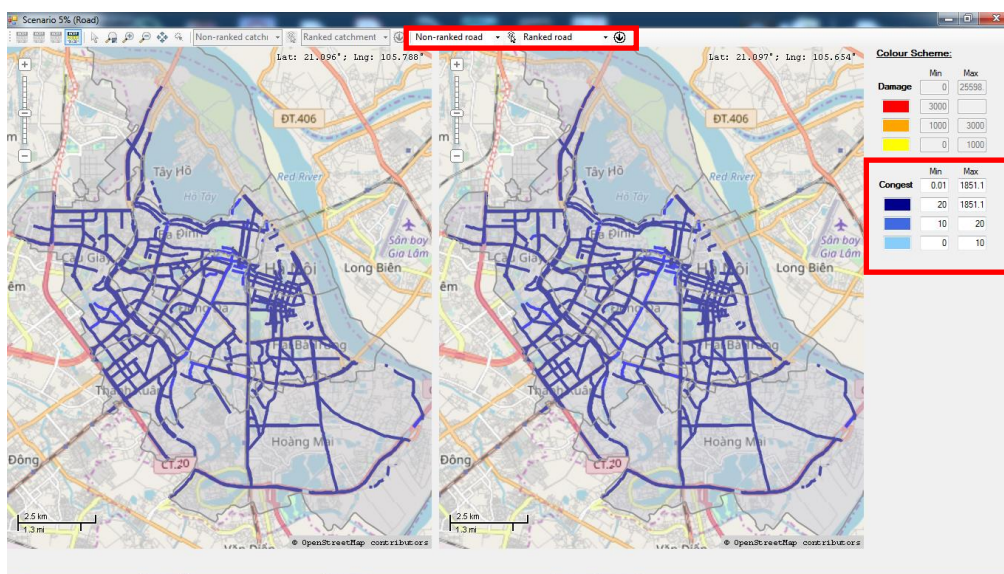


Figure 6.2. Road Form (Colour Scheme)

There are two combo-boxes as highlighted at the top of Figure 6.2. One is for viewing information on non-ranked roads, the other is for viewing information about ranked roads, based on the reduction in congestion levels on each road, after implementation of the planned intervention measures/projects. When clicking on a combo-box and selecting a road, the map zooms into the selected road to show its information, as shown in Figure 6.3, below.

The road information consists of: name (the road's name), length (the road's length), Object ID (the road's ID in the flood model), MUID (the ID of the catchment to which the road

belongs), rain (rain type for this road in the flood model), congestion (the congestion value of the road), improve (the amount of congestion reduction after implementing projects), ID (the road's ID as assigned in this GUI), as shown in Figure 6.3. below.

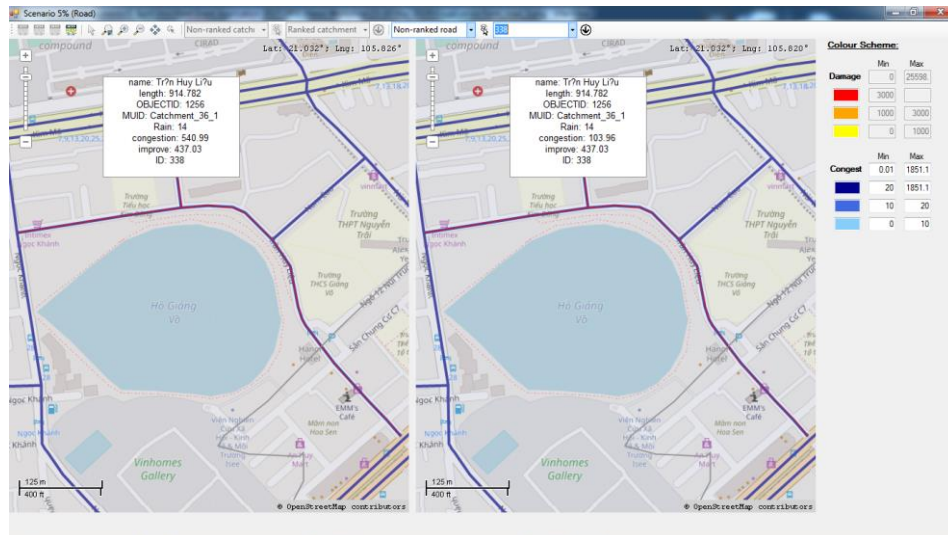


Figure 6.3. Road Form (Road Information)