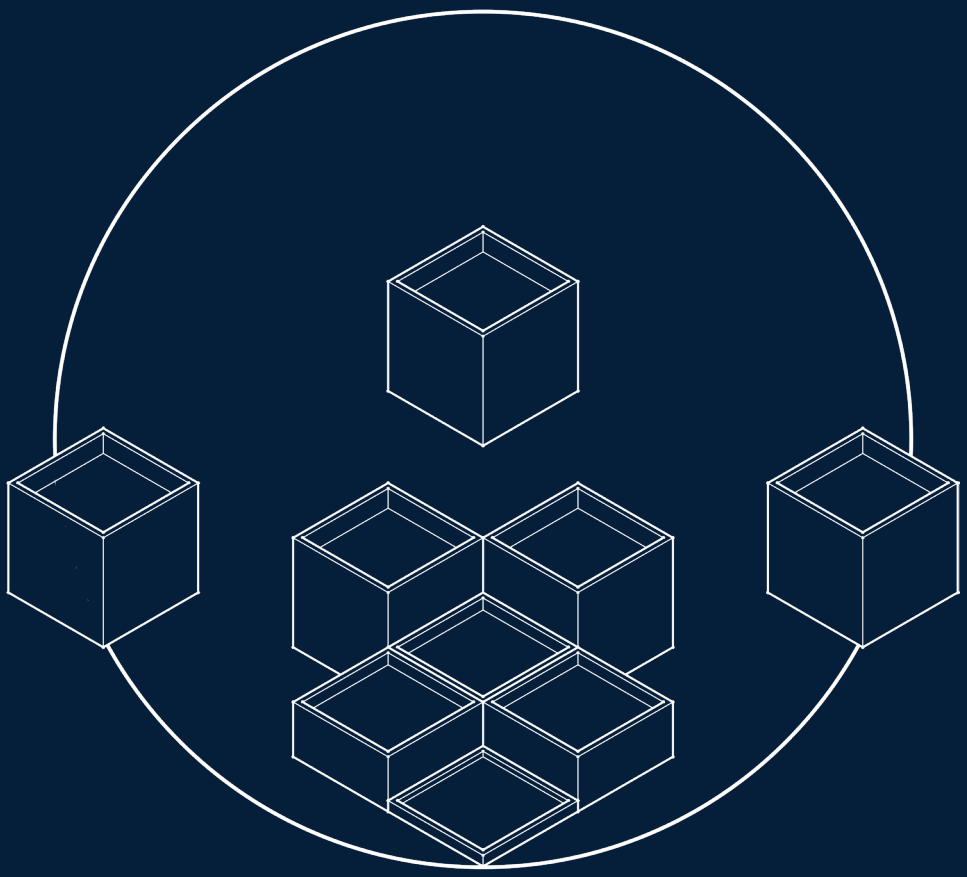
CHAPTER 5
User Interface



USER INTERFACE

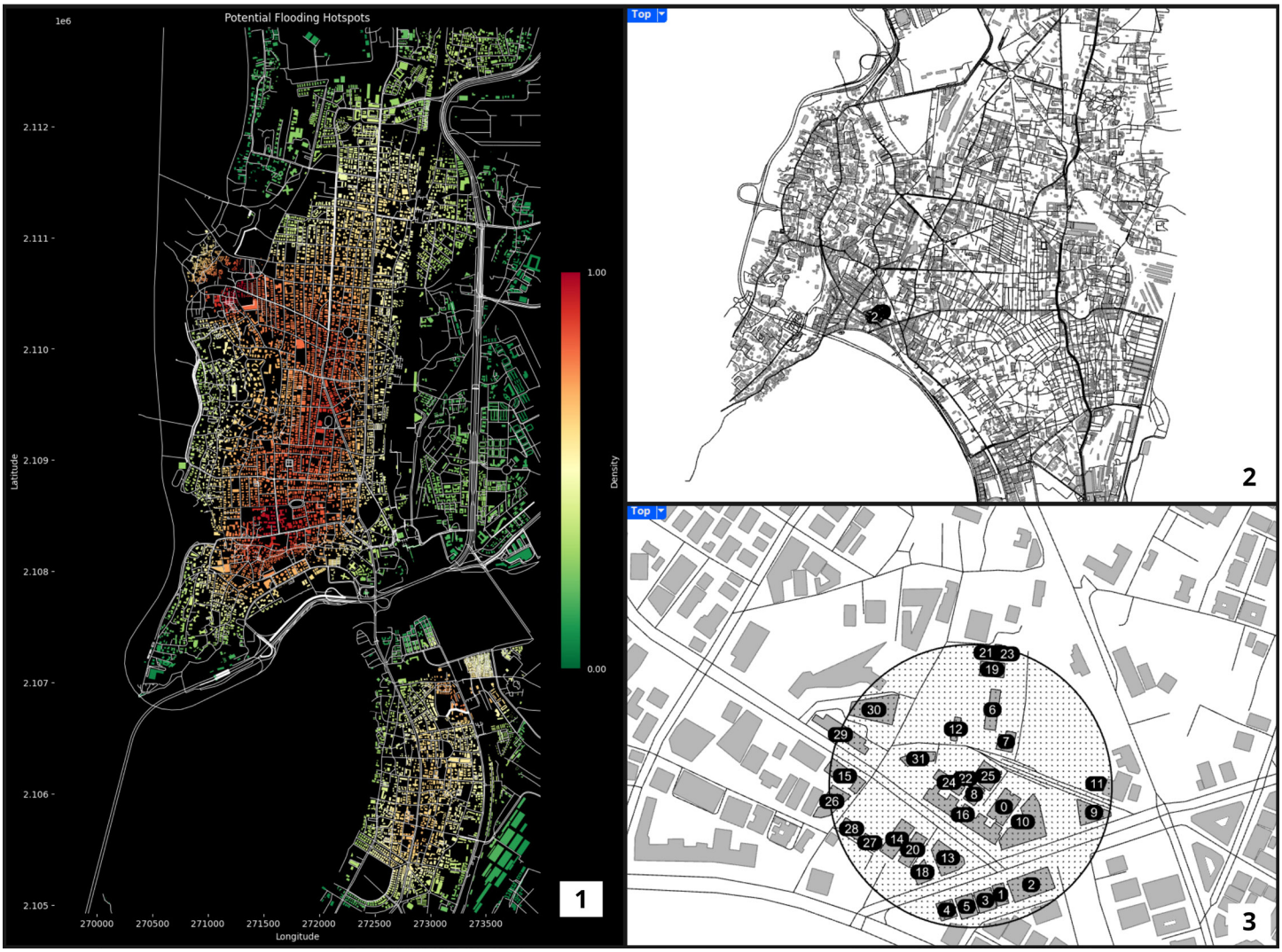


Figure 43: Left: Macro level Colab file output, Top right: Target Region selected, Bottom right: Target Region zoomed in with building tags visible. Made by authors

Welcome to our app generated via **Rhino (8), Grasshopper and Human Ui**, also with the help of a few more plugins.

To access our app you will download our package through **github** in the link below or through google drive also on the link below, and when starting grasshopper please insure that you download all the plugins listed here.

Now diving into the app, when opening our grasshopper script this window will automatically popup and you can read this explanation of our aim, through the first section you can choose to **"Go Macro First"** button that will take you to our **Colab Notebook** were you can adjust a zone of study and visualize a plot that will investigate the critical hotspots in the chosen zone and also download Geojson files, getting back to grasshopper the user can import the downloaded Geojson files or use their own, after that selecting **"find my layout"** will relocate the view port to the layout, at this point the user can freely choose a point with the MD slider on his map and also adjust the radius of the selected Region.

URBAN FLOOD MITIGATION

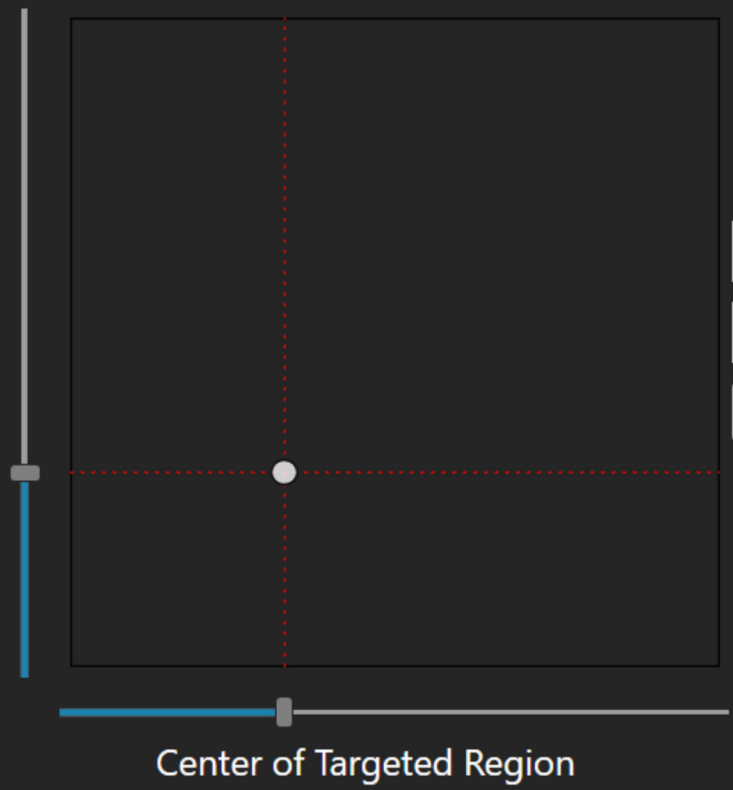
Intro | Zone Analysis | Preliminary investigation | GreenRoof

Urban areas frequently face challenges with rainwater management, including excessive runoff, flooding, and inefficient water collection. This research seeks to develop a parametric model that optimizes roof design for effective rainwater management. By collecting and analyzing data on urban locations with rainwater issues, we aim to inform the design process and achieve a balance between maximizing water collection and minimizing runoff.

Go Macro First

This analysis offers a holistic overview for identifying potential flooding hotspots caused by high urban density.

Site Selection



Center of Targeted Region

Import Geojsons for the study zone

Buildings Geojson

Highway Geojson

Find my layout

Region radius (m) 60

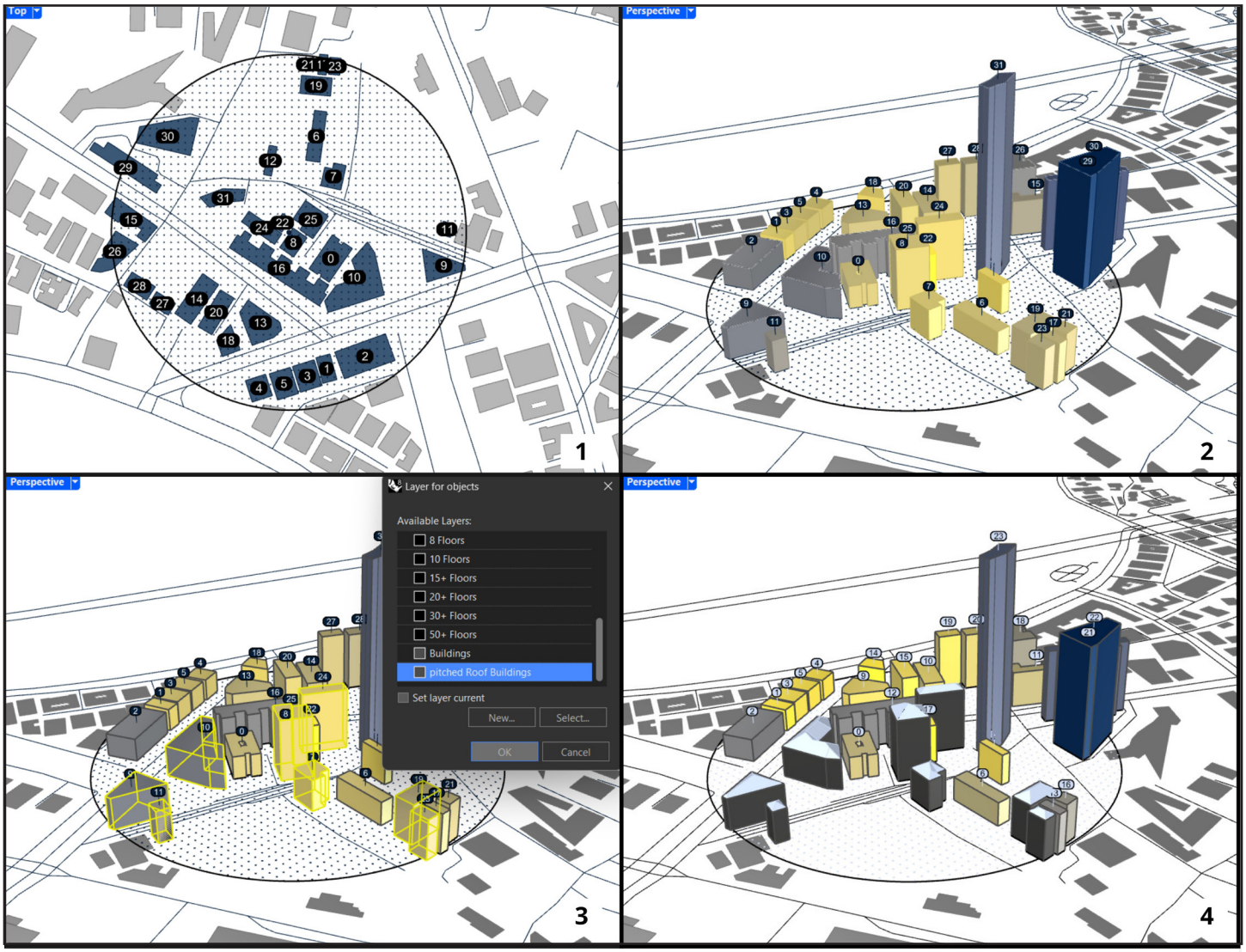


Figure 44: Rhino viewport - Heights assigned as per building tags. Made by authors.

A way to refine the context and to have a more realistic results, the user is provided with this checklist to mark the building according to their tags seen on the view port. After the user finishes this, by pressing "Bake!" Twice the buildings will appear with the heights assigned.

By simply selecting the buildings on rhino view port and hitting the "change to pitched roof layer" button you can separate the pitched roofed buildings from the flat roofed ones. Users can also select to zoom in again if lost in the view port or select then delete if they want to adjust the heights again.

Note: pitched roofed buildings are not taken in consideration in our current solutions seen in the next steps, stay tuned for new updates regarding that.

URBAN FLOOD MITIGATION

Refine Your Context

Assign heights as per Building Tag

2 Floors	4 Floors	6 Floors	8 Floors	10 Floors	15+ Floors	20+ Floors	30+ Floors	50+ Floors
☐ 0	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0	☐ 0
☐ 1	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1	☐ 1
☐ 2	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2	☐ 2
☐ 3	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3	☐ 3
☐ 4	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4	☐ 4
☐ 5	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5	☐ 5
☐ 6	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6	☐ 6
☐ 7	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7	☐ 7
☐ 8	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8	☐ 8
☐ 9	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9	☐ 9
☐ 10	☐ 10	☐ 10	☐ 10	☐ 10	☐ 10	☐ 10	☐ 10	☐ 10
☐ 11	☐ 11	☐ 11	☐ 11	☐ 11	☐ 11	☐ 11	☐ 11	☐ 11
☐ 12	☐ 12	☐ 12	☐ 12	☐ 12	☐ 12	☐ 12	☐ 12	☐ 12
☐ 13	☐ 13	☐ 13	☐ 13	☐ 13	☐ 13	☐ 13	☐ 13	☐ 13
☐ 14	☐ 14	☐ 14	☐ 14	☐ 14	☐ 14	☐ 14	☐ 14	☐ 14
☐ 15	☐ 15	☐ 15	☐ 15	☐ 15	☐ 15	☐ 15	☐ 15	☐ 15
☐ 16	☐ 16	☐ 16	☐ 16	☐ 16	☐ 16	☐ 16	☐ 16	☐ 16

Bake ! **Select/Zoom** **Delete**

Select the pitched Roof Buildings in the study zone.

Then press this button to change their layer to Pitched Roof layer

Change To Pitched Roof Layer

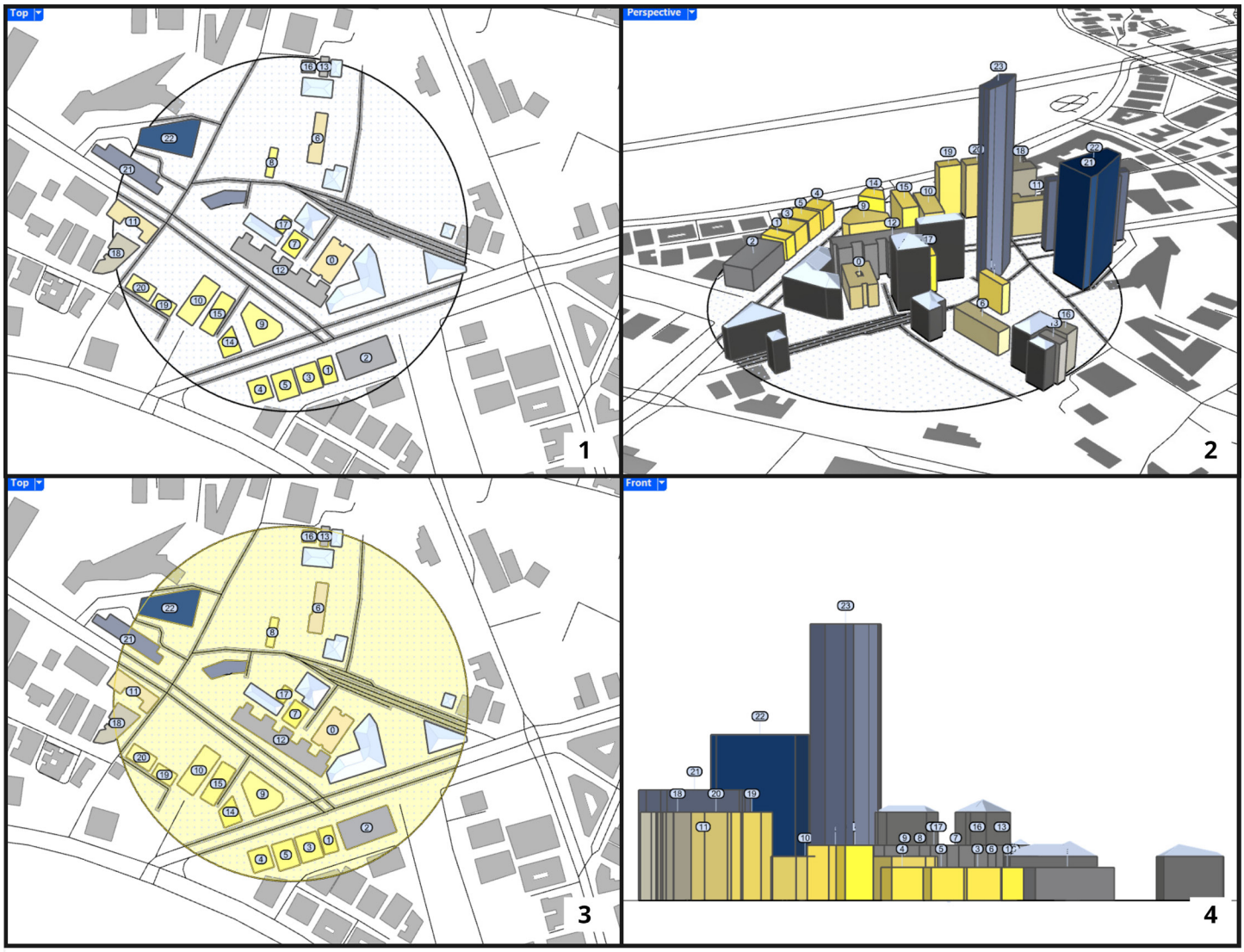


Figure 45: Rhino viewport - Zone Analysis. Made by authors.

Moving on from the "Intro" tab to the "Zone Analysis" tab and by pressing the Start button, you will get these analytical values of **Region Area, Building Count, Area of Non-built surfaces and the built up area**.

Separating these surfaces and calculating this area helps estimating as accurate as possible the **Run-off volume** for the selected region according to the **"Maximum Rain fall m/h"** set by the user.

Note: For the Maximum Rain fall m/h don't forget to press the button

URBAN FLOOD MITIGATION

Intro | Zone Analysis | Preliminary investigation GreenRoof |

start

On

You have selected an area of 70686 m2

With a building count of 24 Buildings

The non-built up area of this region is 67544 m2

The built up area of this region is 12339 m2

Estimated Total Runoff Volume (Existing)

Maximum Rain fall m/hr 0.0653

1972.87 m3 in one hr

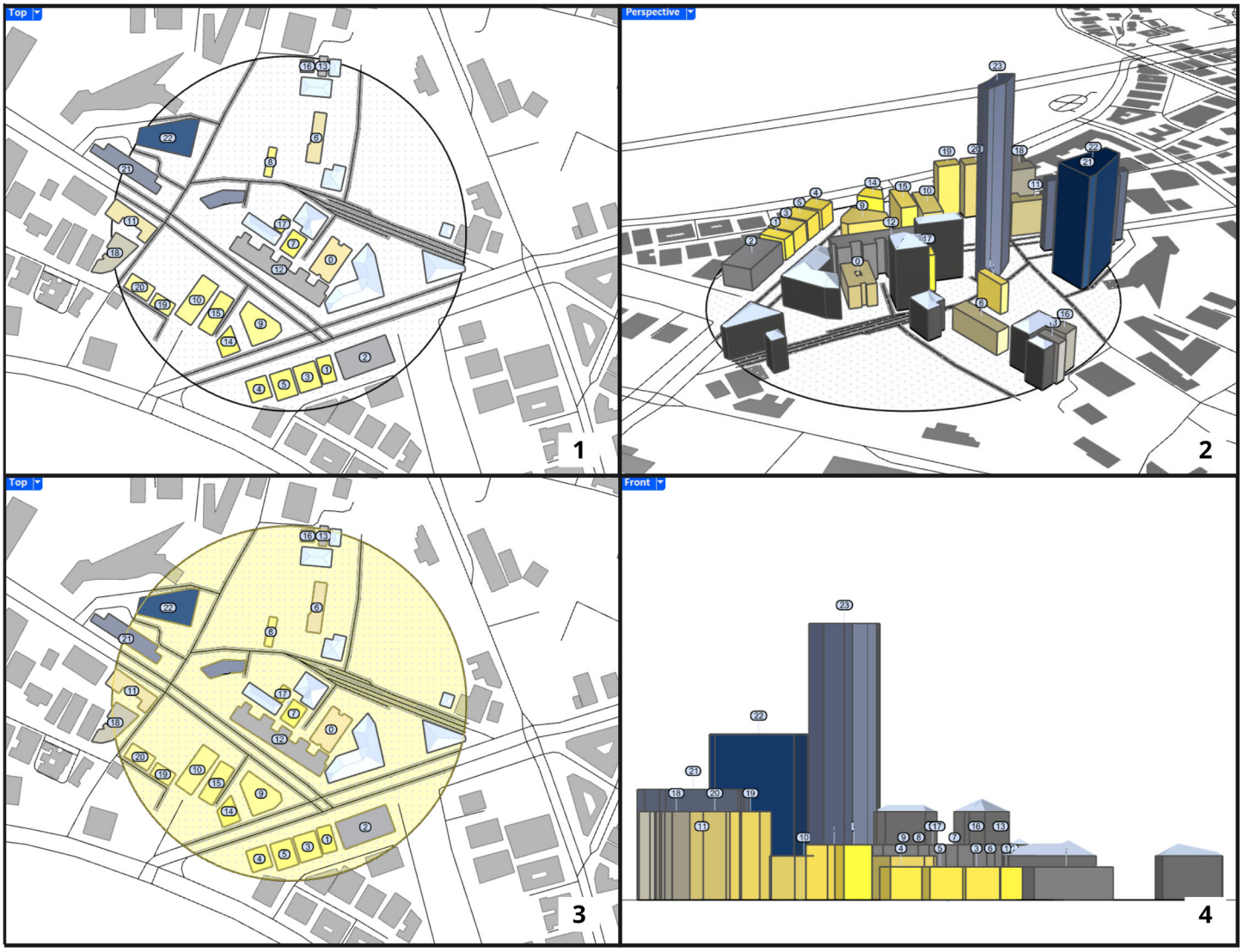


Figure 46: Rhino viewport - Zone Analysis. Made by authors.

To further more analysis for the combination of areas you can check out the pie charts, visualizing the distribution of Runoff Volume according to area of each surface, dividing them into 4 surfaces **[Roads (asphalt), Flat Roofs (Concrete), Pitched roofs (Tiled or brick), Other lands (unimproved)]** , assisting you to tackle more the critical sections.

Run off Coefficients used for our calculations are:

- Concrete =0.70
- Tiled roof (sloped) =0.90
- Asphalt = 0.95
- Unimproved lands = 0.20

More details about run off coefficient can be found in the link below.

URBAN FLOOD MITIGATION

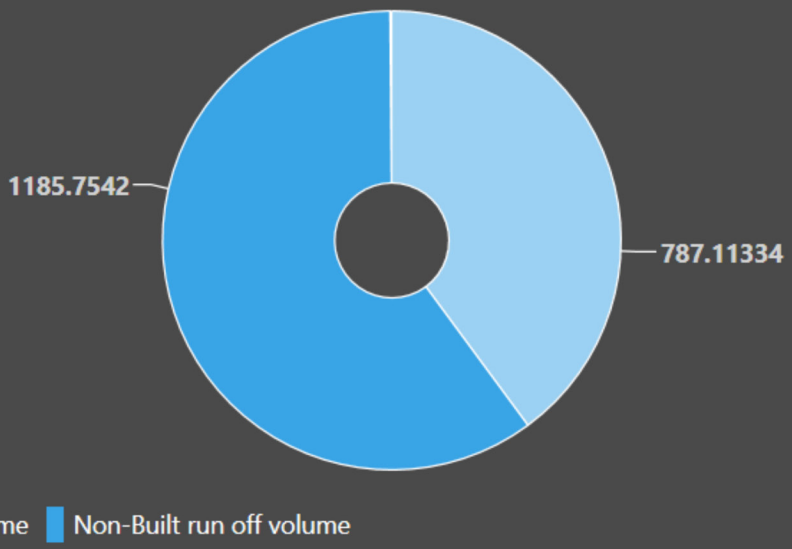
Estimated Total Runoff Volume (Existing)

Maximum Rain fall m/hr 0.0653

1972.87 m3 in one hr

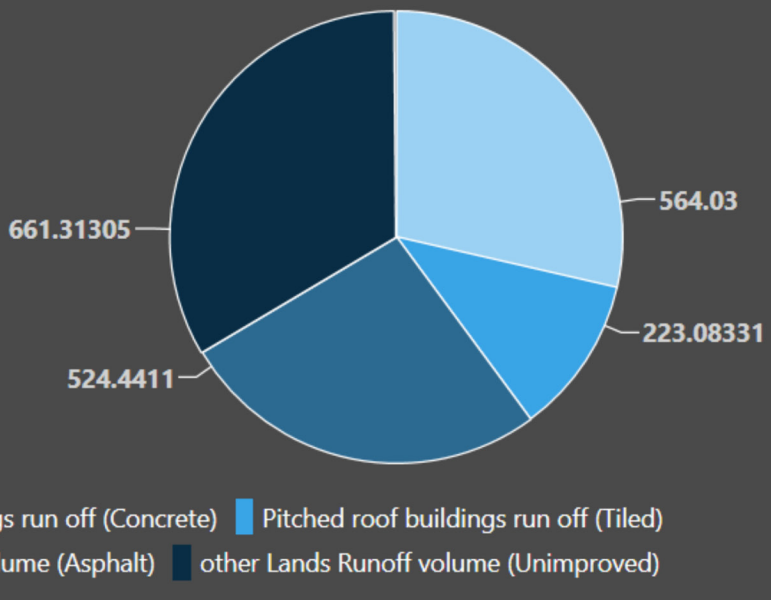
Estimated run off volume for built and non built

for region 150m radius



Estimated run off volume detailed

for region 150m radius



The Next tab is "Preliminary investigation", This macro-scale model tab provides a streamlined approach to estimate the green roof area required to achieve surface runoff reduction targets, without the need for a detailed 3D model. It serves two main purposes:

1. Estimate Green Roof Area: Quickly estimate the necessary green roof area to meet specified runoff reduction goals.
2. Initial Benchmark: Establish a preliminary benchmark for further design optimization in later stages of your project.

Model Specifications
As detailed in **Chapter 4** the XGBoost model was trained on 1400 samples of neighborhoods with varying urban densities ,and as seen in **Figure 2**,showed a strong diagonal trend,with a R^2 score of 0.981.

Inputs
To use the model, you will need to provide the following inputs:

- Total Building Roof Area: The aggregate area of all building roofs under consideration.
- Green Roof Percentage: The proportion of each roof area that will be converted into a green roof.
- Rainfall Data: Maximum rainfall intensity or total rainfall over a given period.
- Soil Properties: Saturated soil density and other relevant soil characteristics.
- Estimated Green Roof Area: The total area of green roofs required to achieve the runoff reduction targets.

Output

- Runoff Reduction percentage estimate: The estimated reduction in surface runoff based on the implemented green roof areas.

Using the Model

1. Enter Inputs: Fill in the required data fields with accurate information.
2. View Results: Review the estimated green roof area and runoff reduction estimates displayed on the results page.

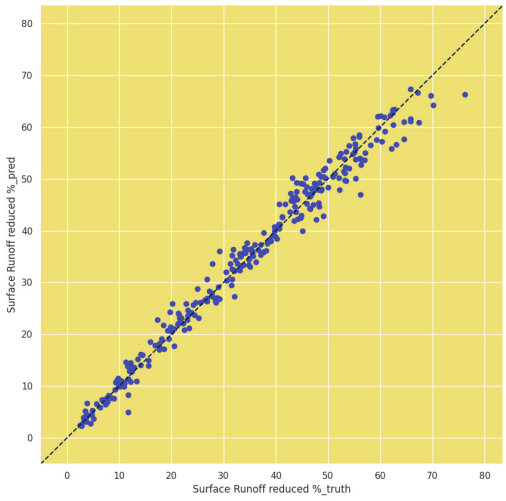


Figure 47: XGBoost Regression Model; chosen for deployment
Hyperparameters: learning rate:0.2, maximum depth: 3, number of estimators: 300 and subsample of 0.8

URBAN FLOOD MITIGATION

Intro | Zone Analysis | Preliminary investigation | GreenRoof

Tool to estimate the average green roof area needed for the targeted surface runoff reduction.
(The percentage of green roof calculated here serves as a starting point for green roof design)

Total region area: 1100

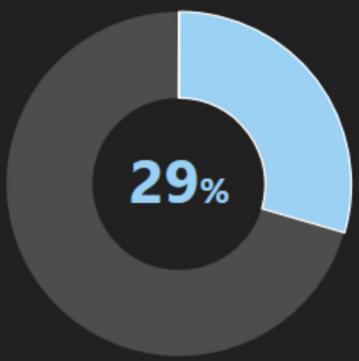
Total buildings roof area: 500

Green roof percentage %: 50

Green roof Vegetation type: EXTENSIVE MINERAL SUBSTRATE

Max rain fall in one hour: 0.065

Predicted Reduction Run Off %



Reduced run off percentage

Green Roof Area (m2) = 250

The results are from shallow machine learning XG Boost regression model, trained on datasets of 1400 neighborhoods with varying urban densities, achieved an R^2 score of 0.981. The predicted vs. actual values plot reveals a strong diagonal trend, indicating good model performance.

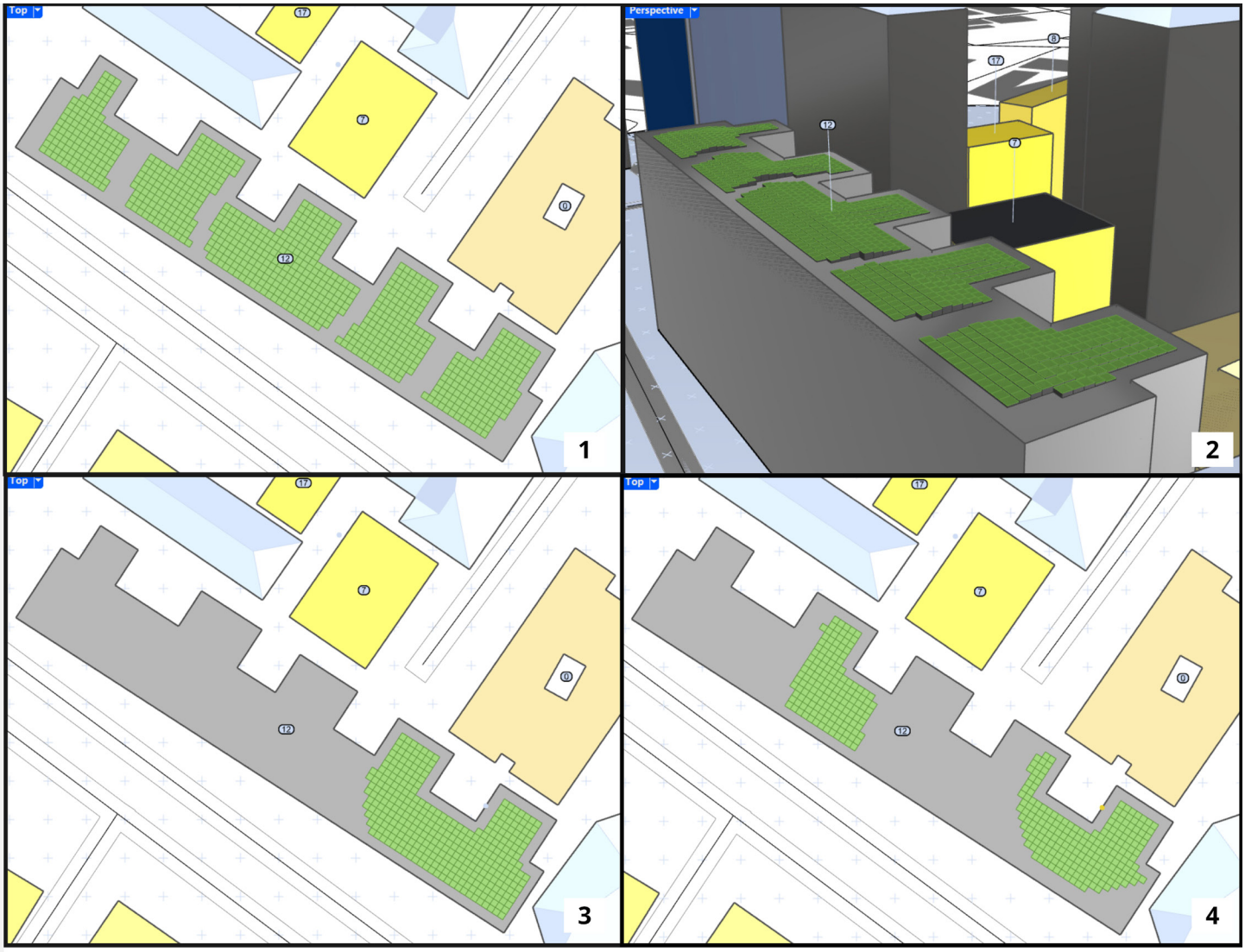


Figure 48: Rhino viewport - Generic green roof division options, top images:divide proposed area equaly and radaily, bottom locate the proposed area manually. Made by authors.

Last but not least the Green Roof tab, there are 2 methods to apply the green roof.

First is a Generic one where you can do the following:

- Set the Green roof percentage.
- Set the Grid size.
- Have your Green roof as one block or divide it into [1, 2, 3, 4] blocks.
- And then you can also locate to a certain point on the edge of the building.

The load part is made to adjust the height to a reasonable load on the building, as the stepped green roof has a range of heights, its made to control the upper bounds of that range if its set less that “600” that we see on the screen the highest box will automatically be lower and lower as the number goes down.

Note: Make sure when you are adjusting your parameters that the preview button is off to be able to have less computational time, and switch it on after you are set with your parameters.

URBAN FLOOD MITIGATION

Intro | Zone Analysis | Preliminary investigation | GreenRoof

Select method ------->

Generic Green Roof

Design my Own Roof

Choose between 2 methods :

-The Generic roof where you have control over the percentage and the grid size.

-Design Your Roof gives the flexiability to manipulate the roof spaces more, place items that might be on the roof... etc.

start

On

Select a Building 12

Generic Roof

Green roof percentage 80.000

Grid size (m) 1.0

Divide into groups 3

Locate 0.24

Preview

Off

LOADS

Roof Dead Load (Kg/m2) 600

A reference Dead load for the green roof blocks, to be adaptable to the allowable extra loads on the roof.

Note: the Green roof blocks height will adapt automatically to this input.

image (3)

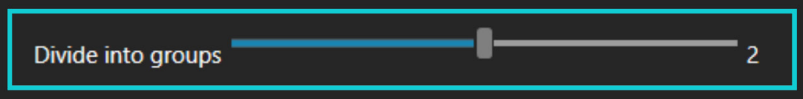


image (4)

Figure 49: Rhino viewport -Design you roof option flow representation. Made by authors.

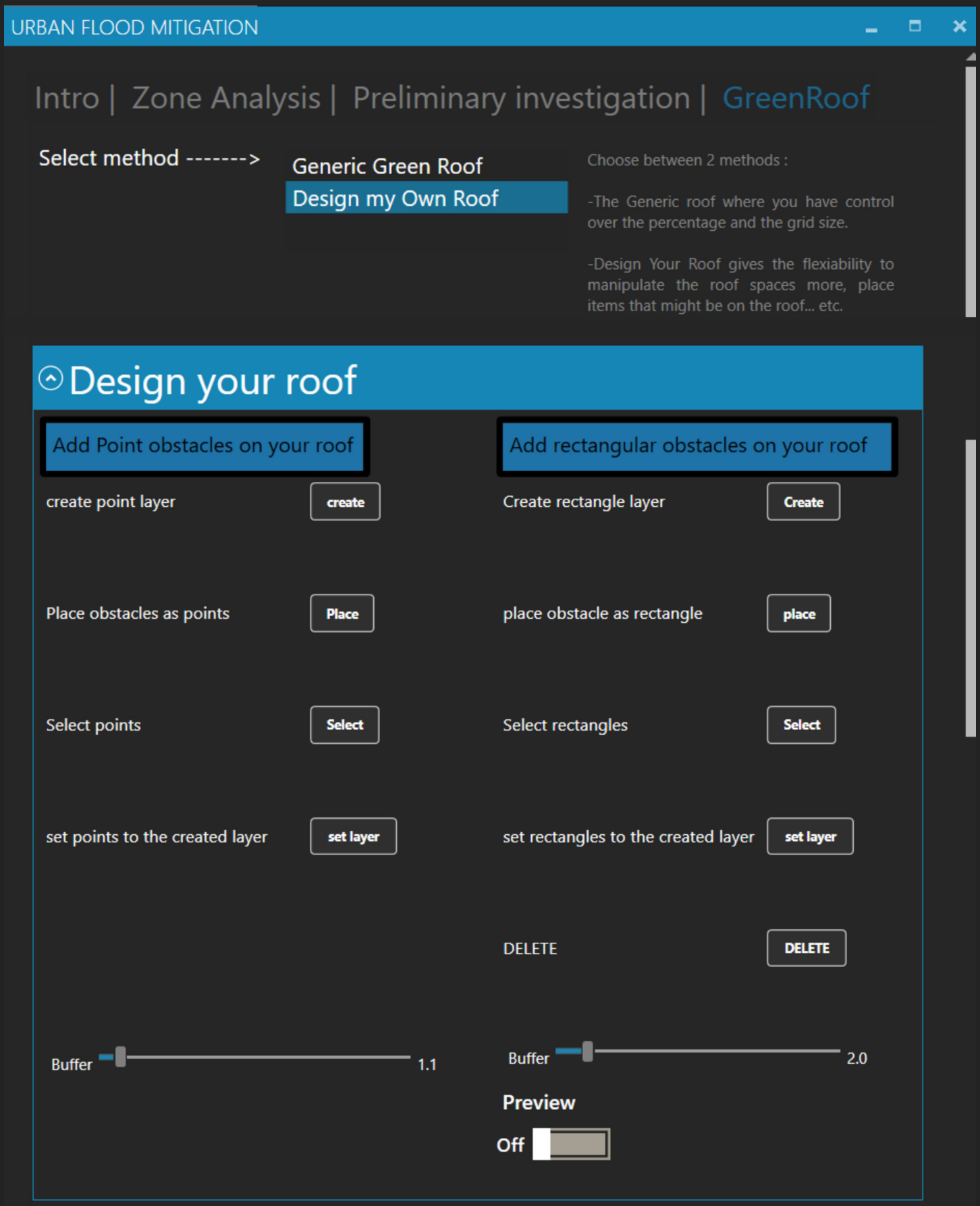
Secondly is the **"Design your roof"**, because in most cases we don't have these **ideal roof spaces** as we saw before and usually we have a **Stair case room, AC units or Chillers**. So the user can actually set these as they wish by adding points or rectangles (preferable on the top view port).

By create then place the point buttons, you can place points on the roof layout and then select them by the select button and change their layer to the **"Point obstacle layer"**, and same thing for the Rectangle but setting them to the **"Rectangle Obstacle layer"**.

A delete button can be used for the selected geometries to draw them again.

The user can adjust the buffer around the drawn geometries above the roof.

Note: Make sure when you are adjusting your parameters that the preview button is off to be able to have less computational time, and switch it on after you are set with your parameters.


URBAN FLOOD MITIGATION
Intro | Zone Analysis | Preliminary investigation | GreenRoof
Select method ------->
Generic Green Roof
Design my Own Roof
Choose between 2 methods :
-The Generic roof where you have control over the percentage and the grid size.
-Design Your Roof gives the flexiability to manipulate the roof spaces more, place items that might be on the roof... etc.
Design your roof
Add Point obstacles on your roof
create point layer
create
Place obstacles as points
Place
Select points
Select
set points to the created layer
set layer
Buffer
1.1
Add rectangular obstacles on your roof
Create rectangle layer
Create
place obstacle as rectangle
place
Select rectangles
Select
set rectangles to the created layer
set layer
DELETE
DELETE
Buffer
2.0
Preview
Off

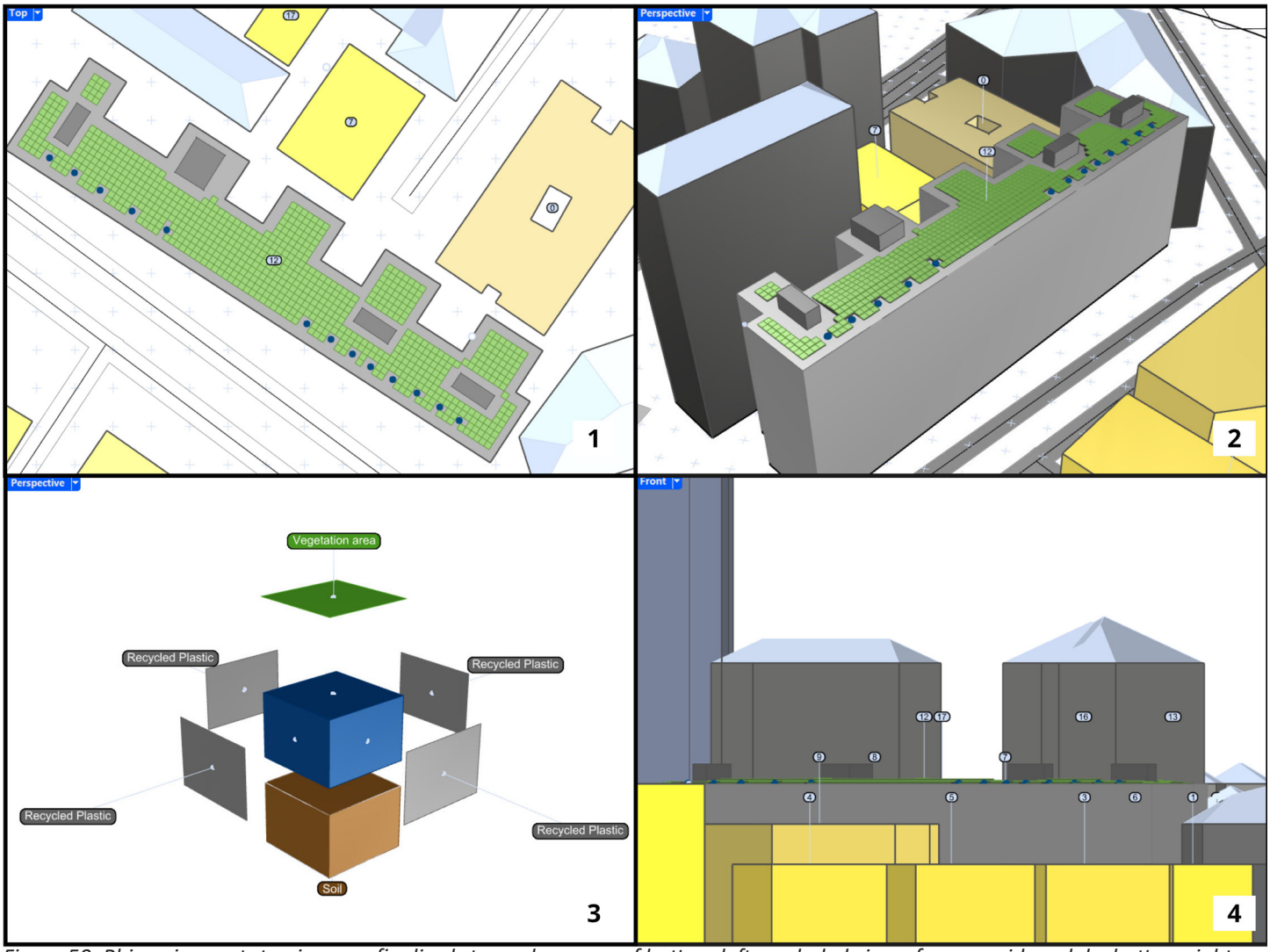


Figure 50: Rhino viewport -top images: finalized stepped green roof bottom left: exploded view of green grid module, bottom right: side view of stepped green roof. Made by authors.

After setting up the Green roof a Run off Analysis is made for the exact percentage of Green roof implemented, and this calculation is taking also into consideration the average height of the modular Green roof boxes.

An Estimated material Cost is generated from breaking down elements of each module (box) to have them as follows:

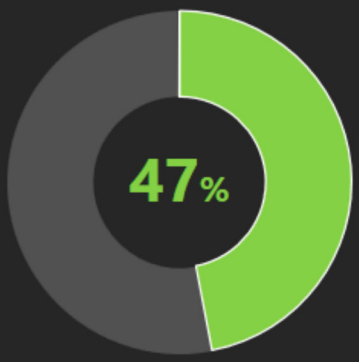
- Plastic sides of the box in m2.
- Soil the volume of the box in m3.
- The vegetation as the top side in m2.

At the end also the user can set the currency they prefer.

URBAN FLOOD MITIGATION

RUN OFF

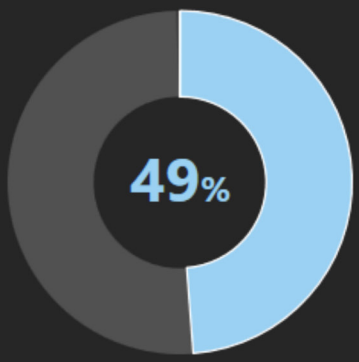
Green Roof Percentage



Building 12

Run Off Reduction

percentage %

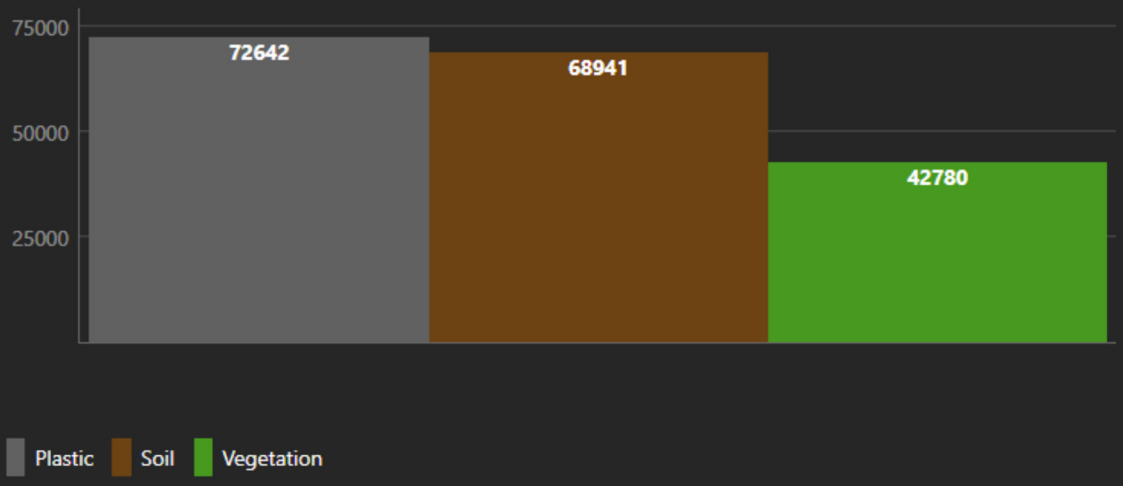


Building 12

COST ESTIMATE

Plastic

Estimate cost



Plastic price	40	Vegetation price	60
Soil price	250	Currency	

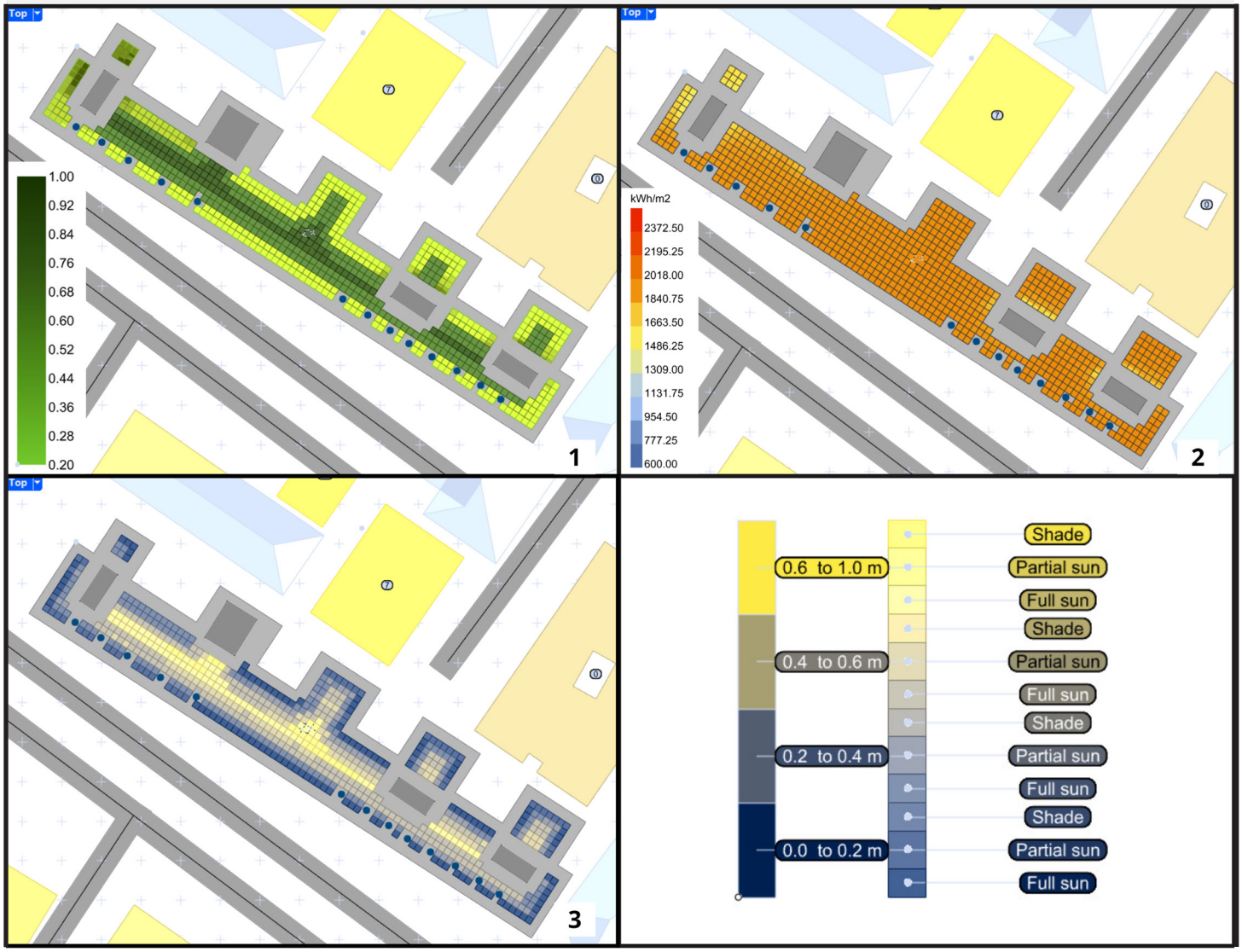


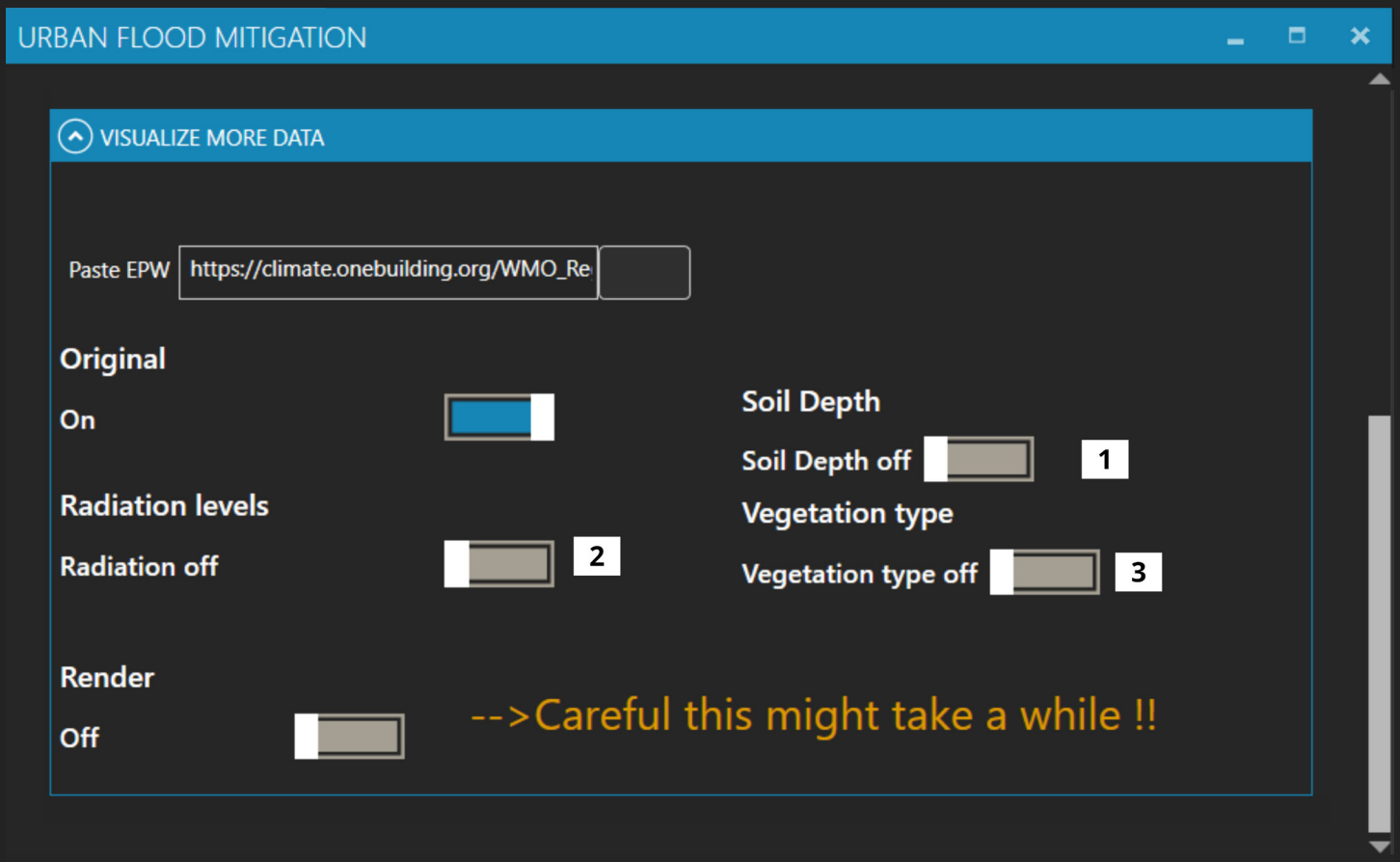
Figure 51: top left- soil depth variation of green roof, top right: incident solar radiation mapped on the green roof, bottom left: green roof mapped as per depth and radiation with legend in bottom right. Made by authors.

Finally the Visualizing section, where the user can analyses 3 main parts which are:

- Soil Depth
- Radiation levels
- Vegetation Types

The user is required to get an EPW (weather file) to get the results of the radiation and have more accurate suggestion for the vegetation types.

About the vegetation types suggestion they are made following the criteria shown above, combining 2 factors the soil depth and the radiation all together, to suggest **Grass, Plants, Shrubs or Trees**.


URBAN FLOOD MITIGATION
VISUALIZE MORE DATA
Paste EPW
https://climate.onebuilding.org/WMO_Re
Original
On
Radiation levels
Radiation off
2
Render
Off
Soil Depth
Soil Depth off
1
Vegetation type
Vegetation type off
3
-->Careful this might take a while !!

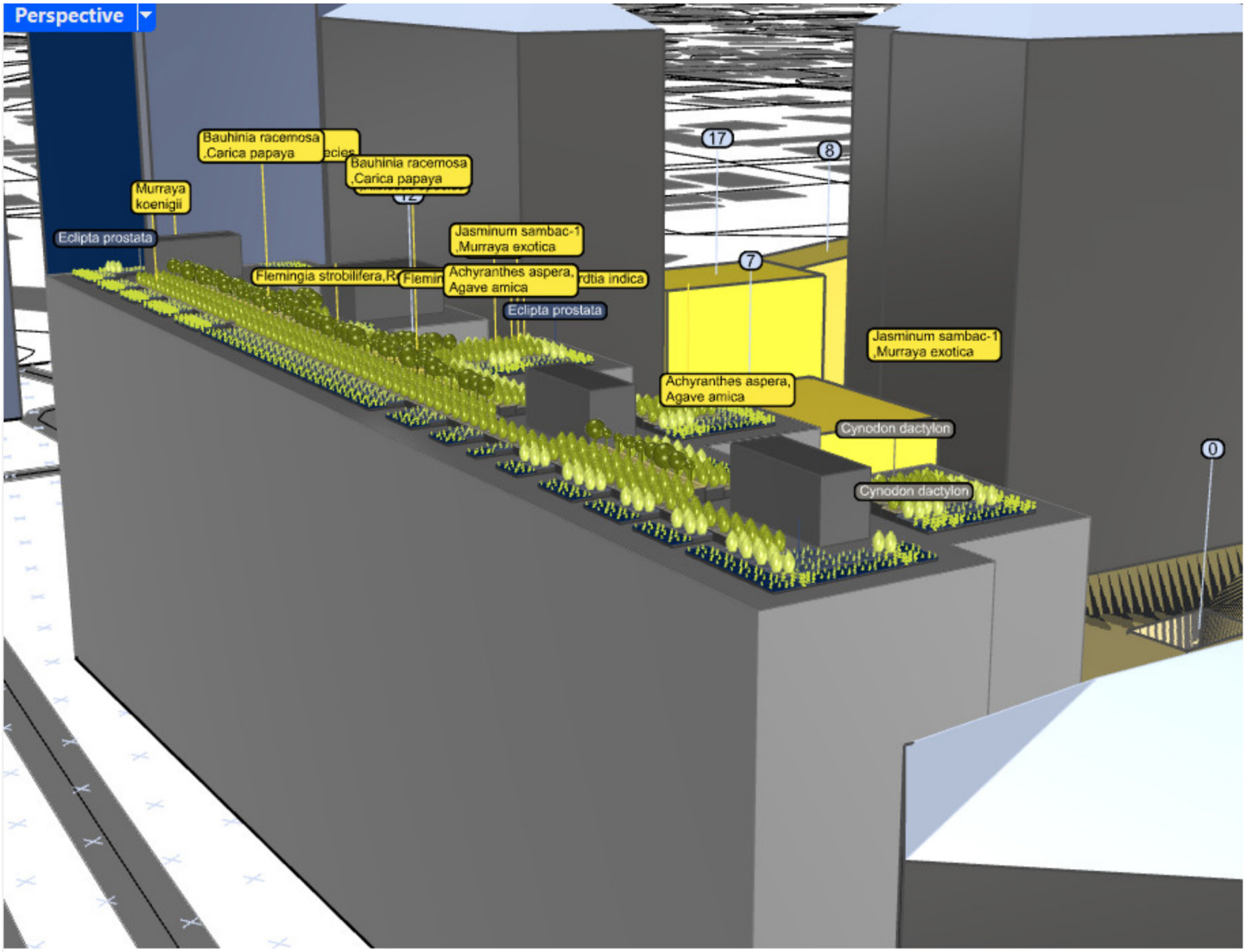
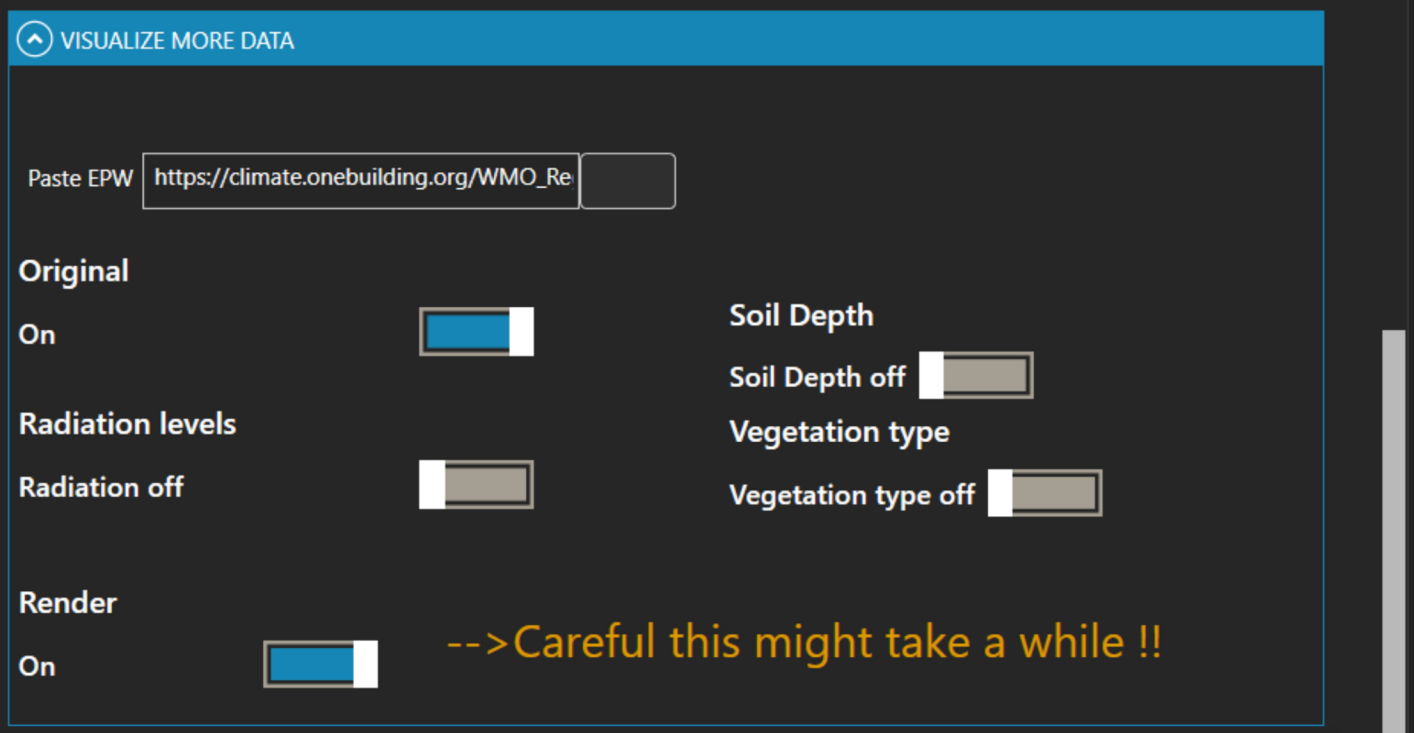


Figure 52: perspective view of target green roof with vegetation render and name tags. Made by authors

An a the "Render" button should be only pressed when ready because it takes some computational power so (not recommended if you have a huge green roof area) .

That is it for our application explanation, also the video tutorial in the link below.

Tutorial link : https://drive.google.com/drive/folders/1y1NHBHXCN6ycNErkSaZ6L0JfJIkq8ZAn?usp=drive_link


VISUALIZE MORE DATA
Paste EPW
https://climate.onebuilding.org/WMO_Re
Original
On
Radiation levels
Radiation off
Soil Depth
Soil Depth off
Vegetation type
Vegetation type off
Render
On
-->Careful this might take a while !!