Mapping Science: Flood mapping using LiDAR data

Methodology

This report aims to display methods in which spatial data such as satellite imagery and LIDAR data can be used to display and perform analysis within GIS software using the ArcMap and ArcScene platforms. The report will do this by determining the areas within the allocated study area which are most vulnerable to varying levels of potential flood scenarios caused by the River Arun. The study area for this report is a square kilometre area encompassing a section of the River Arun and surrounding the town of Arundel, West Sussex, UK.

A polygon of the bridge along the river Arun was created and used to remove the bridge height's from interpolation, giving a more accurate estimation of the river height distribution. The height of the river was calculated using the LIDAR data to be 0.154m. The lowest bank height of 2.78m was then calculated to give an estimation of how much water input in regards to elevation is necessary to cause a flood. Using these statistics, the three Flood Scenarios were assigned extent values of 3m, 6m, and 10m for Flood Scenarios 1, 2, and 3, respectively. These flood extent values were chosen to give a well distributed analysis of potential flood scenarios.

Each flood scene were produced by inputting the LIDAR data provided, in to 'Raster Calculator', reclassifying this dataset, and then changing the raster dataset to a polygon shapefile through the 'Raster to Polygon' tool. Using the 'Select by Location' feature, a polygon shapefile was produced to display the total flood extent for that test scenario correlated with the base height inputted.

To then calculate the total amount, and total area of buildings affected by each flood scenario, I used the 'Select by Location' tool to select the features from the clipped buildings polygon layer that intersect the each flood extent polygon feature class. This allowed to create a new feature layer displaying the amount of buildings affected within each flood scenario, and calculated the amount and area within this layer using the statistics tool (Figure 2 and Table 2).

Point Of Interest data supplied by Ordnance Survey within Edina Digimaps from the PointX© Database (Digimaps Edina), was clipped to each flood extent to give more detail as to what infrastructure would be affected from each flood scenario (Figure 2 and Table 2).

Land Classification data in the form of a 'ShapeFile Feature Class' was supplied by Natural England (Data.gov), once reclassified the shapefile displayed graded land classes throughout the study area. Using the 'Clip Analysis' tool within ArcMap, the graded land class ShapeFile was clipped to the extent of each flood scenario to display, along with the buildings and POI's, potential damage on the study area (Figure 3 and Table 3).

3D flood scenarios were also produced to more accurately simulate a potential flood scenario, as seen in Figure 4. This was done by 'floating' the base-height of the Raster DEM, and then 'extruding' both the buildings layer and flood extent layer for their respective flood scenarios.

Results

Figure 1: *Displays the varying flood extent's of the different scenarios over the study area overlaying the OS Mastermap Imagery Layer supplied. It is clear that the higher levels of flooding results in a greater area of flood extent. This can be seen with Flood Scenario 3 which attributes a 10metre flood scenario, covers a much great area than Flood Scenario 1 which only attributes a 3metre flood input. These inferences are backed up by Table 1, which provides statistical evidence of this correlation, where flood scenario 1 has a 707028m²area affected, compared to*

Figure 1a: Flood Scenario 1.

Figure 1b: Flood Scenario 2.

Figure 1c: Flood Scenario 3.

Flood Scenario	Number of buildings affected by flood	Area affected by flood (m²)	POI's affected
1	208	707028	17
2	793	872303.1162	58
3	953	939010.7172	73

Table 1: *Statistical representation of the varying extents of the different flood scenarios.*

Figure 2: Displays the varying levels of Buildings and POI's (Edina Digimap) affected by the different flood scenarios overlaying the OS Mastermap supplied. It can also be seen from Figure 2, in accordance with Figure 1, that the increased heights of flood results in a greater number of buildings and POI's affected within the scenario. However, it can be noted that Figure 2 and Table 1 suggest that there is a significance difference from 3m to 6m (Scenario 1 to Scenario 2) in respect to buildings and POI's affected. Yet, a far less significance from 6m to 10m in Scenario 3. This is most likely as a result of the land class which is that is affected by the greater flood

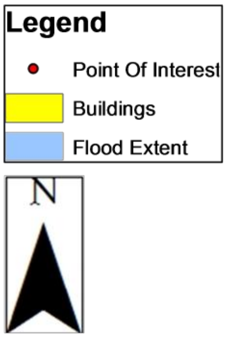


Figure 2a: Flood scenario 1.

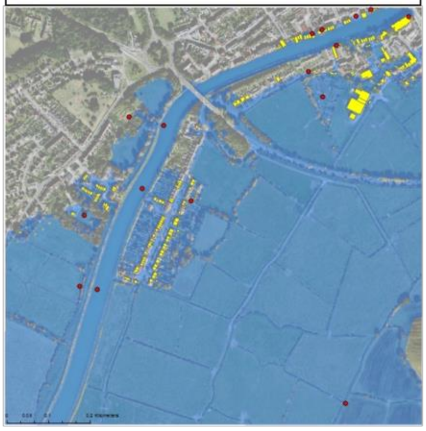


Figure 2b: Flood scenario 2.

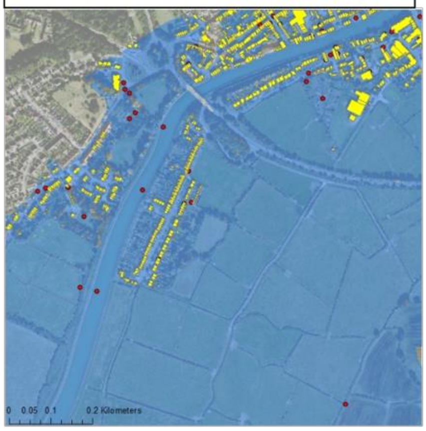
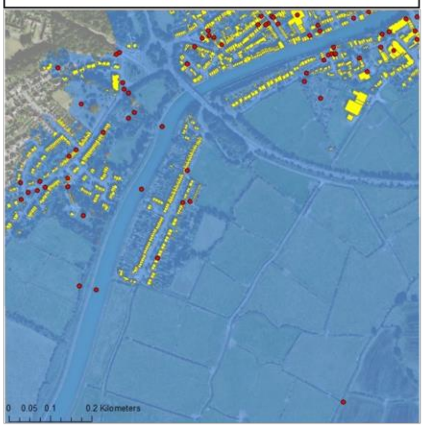


Figure 2c: Flood scenario 3.



POI Category	All POI's	Scenario 1	Scenario 2	Scenario 3
Commercial services	33	5	26	31
Attractions	6	1	2	4
Public infrastructure	27	7	20	27
Manufacturing and production	4	3	9	4
Transport	9	-	-	6

Table 2: Table showing which POI categories were affected the most from each flood scenario.

Figure 3: *Displays what Land Grade Classification (Data.gov) each flood scenario affects overlaying the OS Mastermap supplied. It can be seen in Figure 3 that the predominant land class that Flood Scenario's 2 and 3 cover more of than Scenario 1 is Non-Agricultural land. This correlates with Figure 2 and Table 2 which displayed far more buildings and POI's affected as they lay on the Non-Agricultural land not affected by Flood Scenario 1. The Land Classification data, coupled with the buildings and POI's data would allow a more comprehensive analysis in to the*

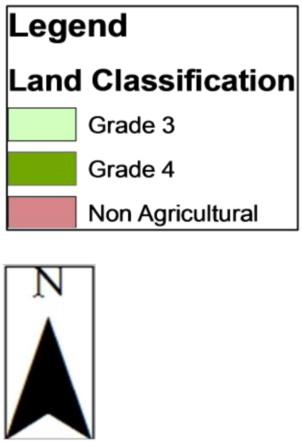


Figure 3a: *Scenario 1.*

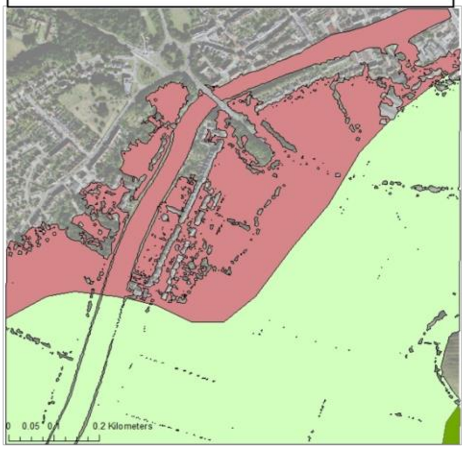


Figure 3b: *Scenario 2.*

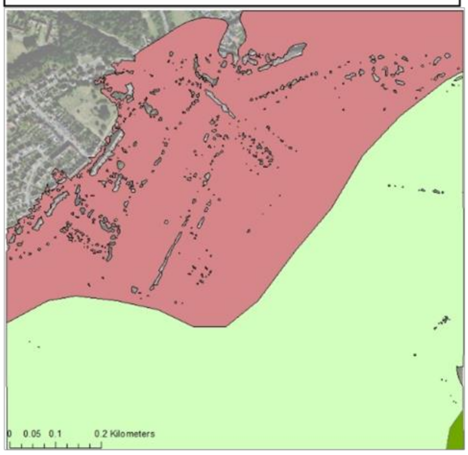


Figure 3c: *Scenario 3.*

Flood Scenario	Grade 3 (m^2)	Grade 4 (m^2)	Non Agricultural (m^2)
1	448011.06	2405.6012	256611.7327
2	458867.66	2411.2727	411041.1512
3	459581.75	2419.7047	477009.2705

Table 2: *Statistical representation of how the levels of Land Classification changes throughout the different flood scenarios.*

Figure 4: *The extruded 10m flood extent and buildings layers, overlaying the floating DEM on ArcScene.*

Figure 4a: *A profile of the full study area with 10m 3D flood scenario implemented.*

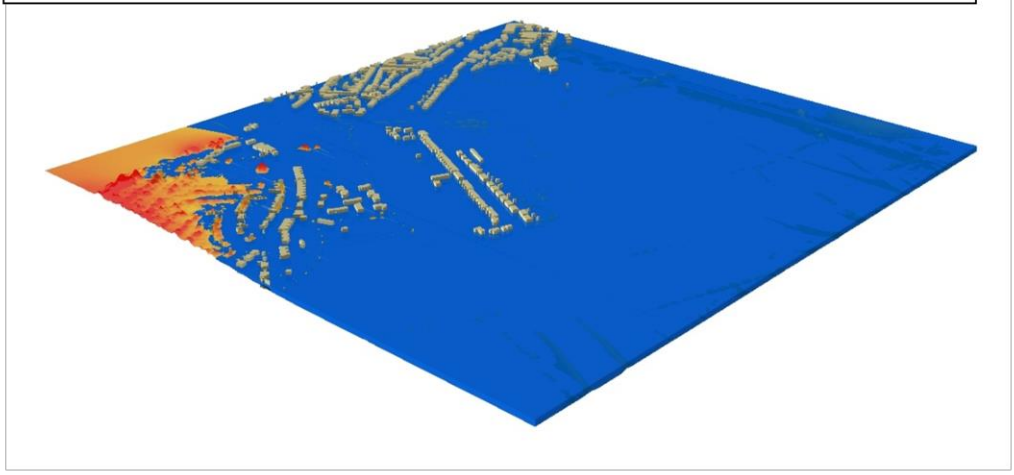
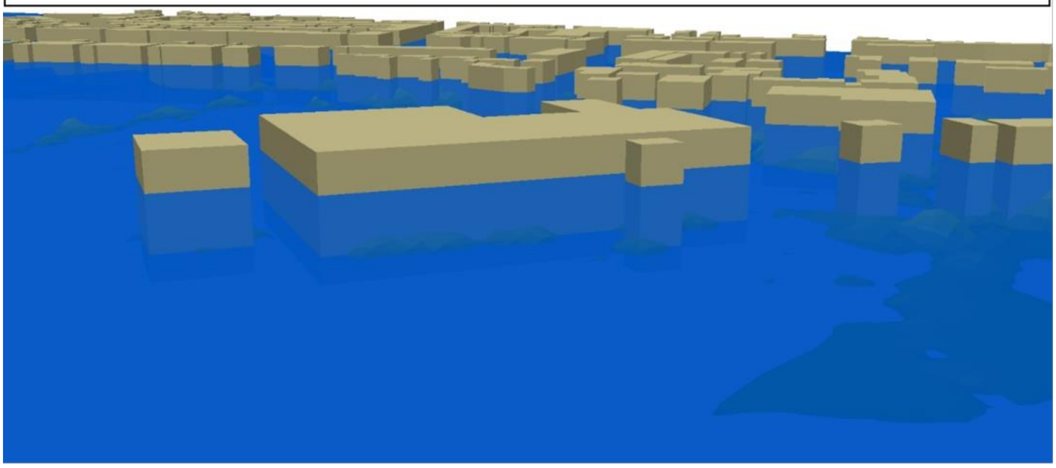


Figure 4b: *A close-up representation of the flood scenario on the buildings layer.*



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