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Flood Risks Analysis in Upton Upon Severn: Assessing the Baseline Conditions and Future Scenarios for 100 and 1000-year Flood Events with a 2050 Climate Change Perspective.

Tasneem Haider Khan

Student, University of Manchester

Abstract
This paper investigates the flood risks in Upton upon Severn, a town in Worcestershire, England, which is prone to fluvial flooding from the River Severn. Historical events, such as the significant floods of 1947 and 2007, highlight the town's vulnerability and underscore the importance of analysing current and future flood risks. This research uses a one-dimensional hydraulic model, using Flood Modeller and QGIS software, to assess baseline flood conditions and predict the potential impacts of severe and extreme flood events, including 1 in 100-year and 1 in 1000-year flood scenarios. Additionally, it examines the projected effects of climate change by incorporating a 20% increase in flood risk estimates for the year 2050. The model results reveal that the baseline scenario poses limited flood risks, with only 17 properties affected, and key infrastructure like the A4104 road remains passable. However, under the 1 in 100-year event, approximately 336 properties are at risk, with significant road blockages and a flooded area of 5.09 Km^2. The 1 in 1000-year flood scenario predicts a peak flow of 1807 m^3/s, threatening more properties and covering a larger area of land. When climate change is factored into the 1 in 100-year scenario, the risks become similar to those of the 1 in 1000-year event, with 500 properties and key infrastructure, including the fire station and primary school, at risk and the A4104 road becoming impassable. These findings provide vital insights for flood risk management, especially given the possible effects of climate change, and stress the need for long-term solutions to flooding.

Keywords: flood risks, Upton upon Severn, climate change, hydraulic modelling, 1D modelling, flood risk mitigation, River Severn.

1.1 Introduction
Upton, a town located in Worcestershire, England, is historically and geographically susceptible to fluvial flooding, particularly from the River Severn ('Upton-upon-Severn',2023). In 2007, southern Britain, including Upton, faced an extraordinary pattern of late spring and early summer rainfall. This weather pattern caused flooding that was worse than anything seen in recent years, with many sudden floods and long-lasting flooding in low-lying areas from mid-June to the end of July. In some places, the flooding was even worse than the major flood in March 1947 (Marsh and Hannaford, 2007). Past events, such as the floods of March 1947 and July 2007 (Figure 1), underscore the need for a comprehensive understanding of flood risks, especially in the context of Climate Change. This report focuses on

developing and applying 1D hydraulic modelling to assess flood risks in Upton for different scenarios, utilizing Flood Modeller and QGIS software. These scenarios include the baseline conditions for a foundational understanding of the area's natural flood dynamics. The model also simulates severe and extreme flood events that might happen once every 100 or 1000 years. The model is further modified to reflect the anticipated effects of climate change for the year 2050.

Figure 1: The Great Floods of 2007 at Upton Marina (Webb, 2020)

1.2 Aim

The primary aim of this study is to examine the susceptibility of buildings and evacuation routes under various flood scenarios, particularly taking into consideration the effects of climate change. To achieve this aim, it is necessary to make use of a one-dimensional hydraulic model in order to display the catchment area of the River Severn on a Flood Modeller software. Perform simulations of flows for a variety of return periods and create flood maps. Utilizing QGIS software, conduct an assessment of the number of properties that are in danger as well as the effects on evacuation roads. The main goal is to prepare for climate change, create resilient evacuation routes and emergency responses, and propose practical flood risk reduction techniques (Lowe, 2023).

1.3 Study Area

The research area encompasses both the River Severn catchment and the town of Upton, Including its infrastructure such ad buildings and road networks. This visual representation is derived from Google Earth Pro (Figure 2).

Figure 2: Upton on Severn Study Site

1.4 Method

The methodology of this study is described in figure 3 (Lowe, 2023).

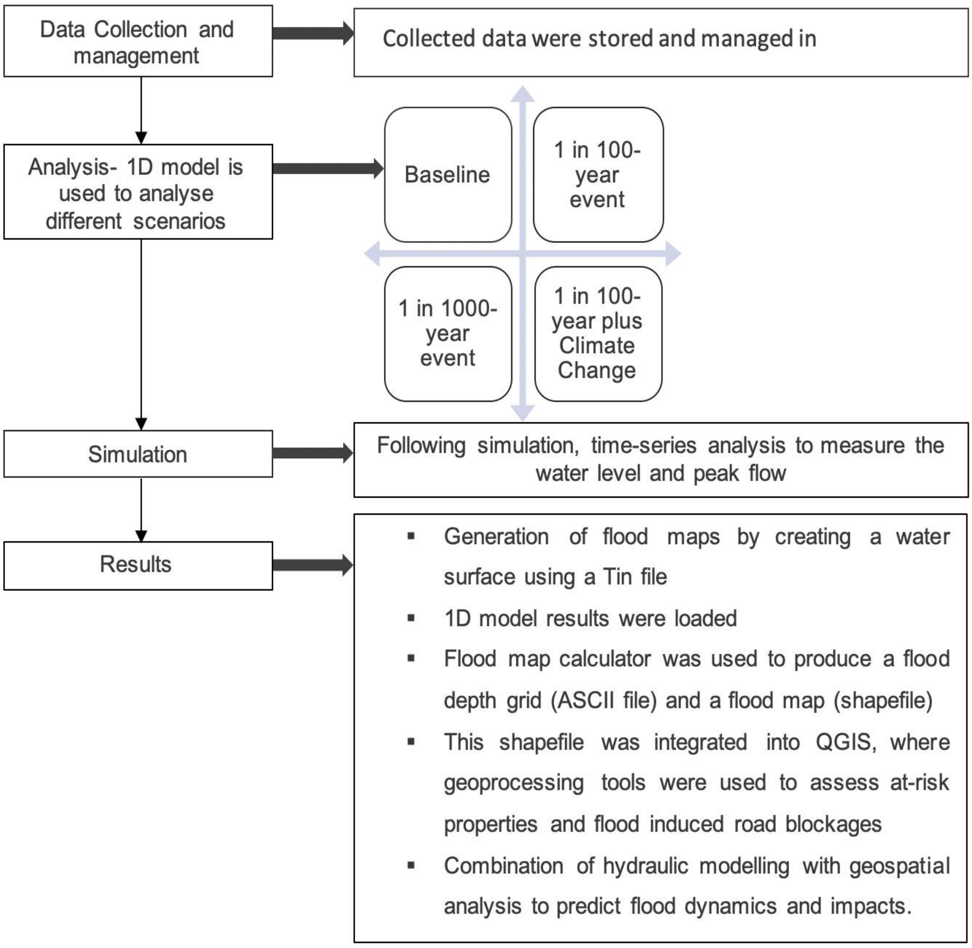

Figure 3: Overview of Study Methodology

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1.5 Results

1.5.1 Baseline Scenario

The baseline, reflecting current flood risks, indicates a peak flow of 818 m^3/s and a maximum peak stage of 12.2 mAD. This represents a relatively limited impact, with only 17 properties identified as being at risk. Importantly, the A4104, a critical transportation route, remains unobstructed, and area of 4.03 km^2 is potentially affected (Figure 4).

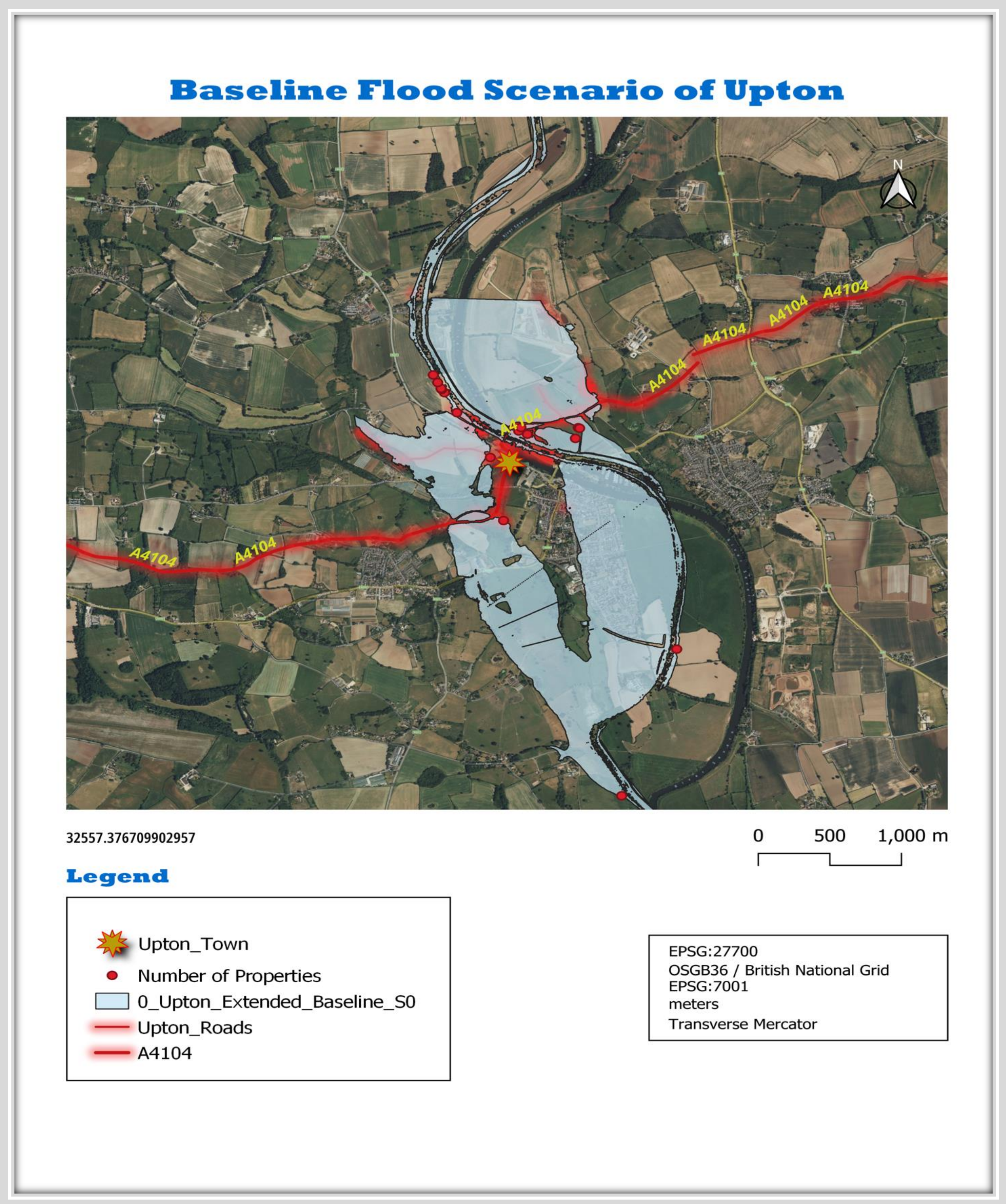

Figure 4: Baseline Flood Scenario of Upton

1.5.2 1 in 100-year event – Increased Flood Risks

In this scenario, the peak flow escalates significantly to 1172 m^3/s, and the maximum peak stage rises to 14.7 mAD. This forecasts a substantial increase in risk, with approximately 336 properties at risk, primarily in the main town of Upton, notably around the opposite of marina. The scenario also predicts the blocking of evacuation roads and an increase in the flooded area to 5.09 km^2 (Figure 5).

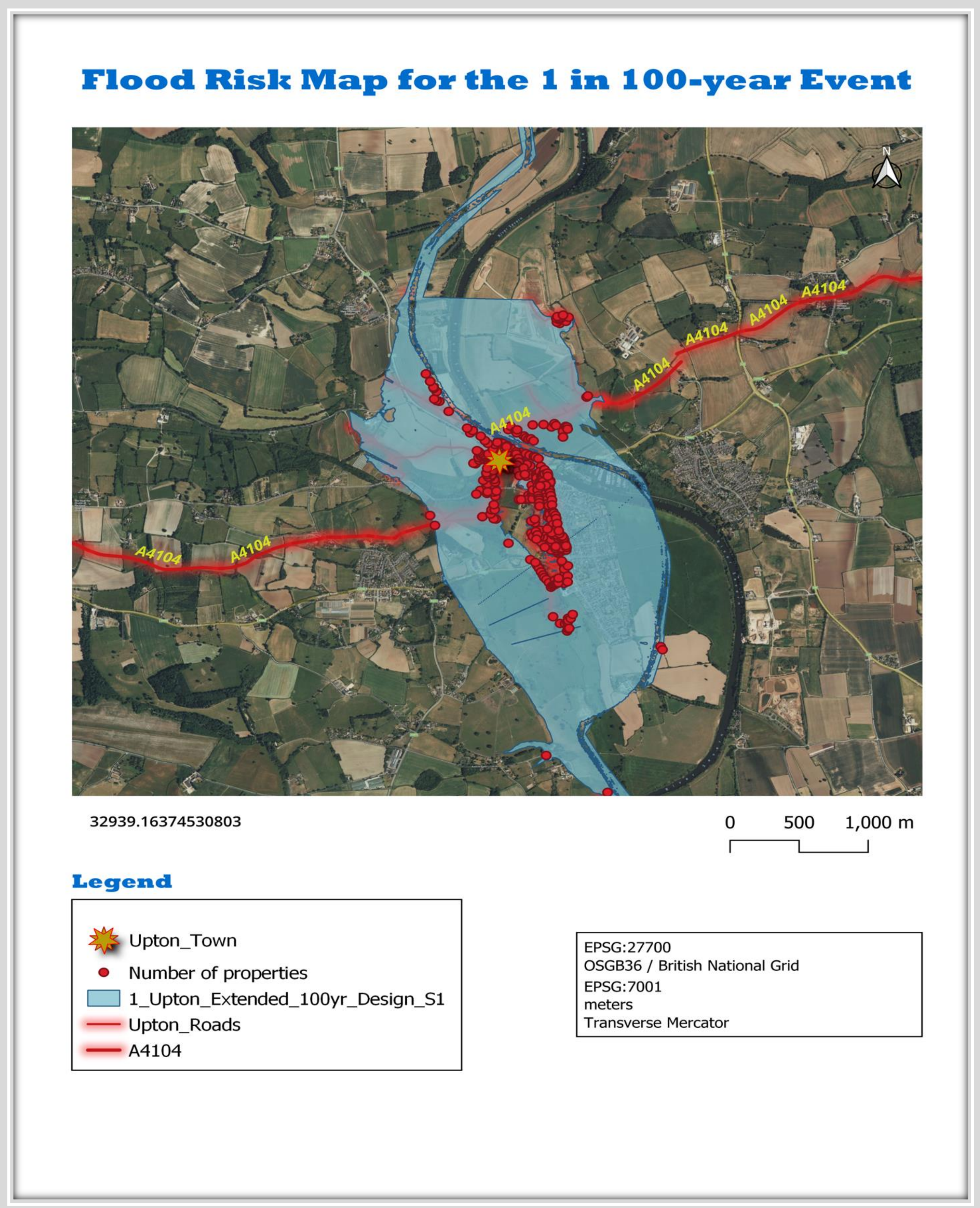

Figure 5: Flood Risk Map for the 1 in 100-year Event

1.5.3 1 in 1000-year event – Extreme Flood Risks

This event represents an extreme risk scenario with a peak flow of 1807 m^3/s and a maximum peak stage of 16.8 mAD. In this case, a significant portion of the town, including its centre, is at risk, impacting 526 properties. The scenario also shows the obstruction of evacuation roads and an affected area expanding to 5.55 km^2 (Figure 6).

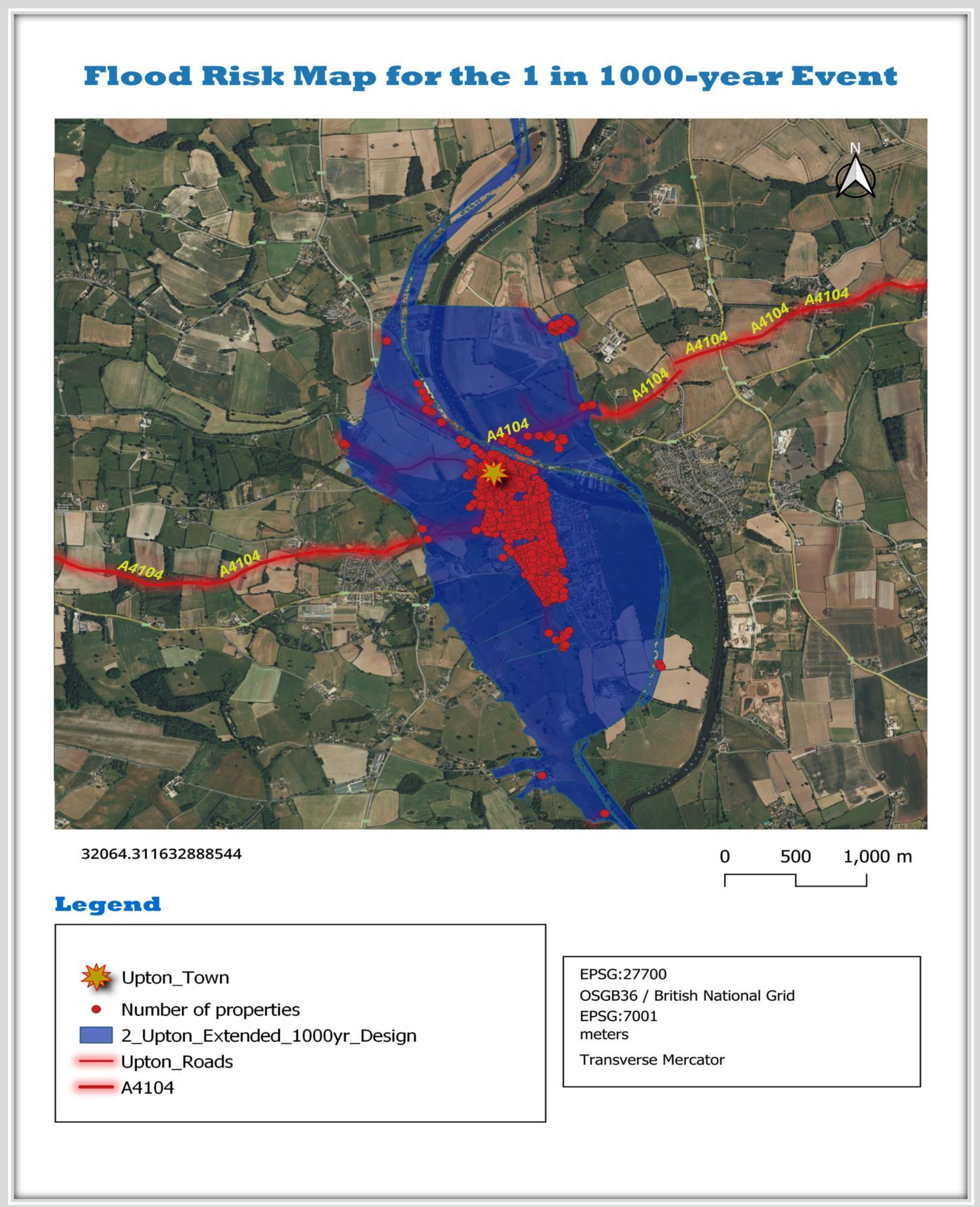

Figure 6: Flood Risk Map for the 1 in 1000-year Event

1.5.4 1 in 100-year event plus Climate Change

The peak flow is projected to increase to 1406 m^3/s, which represents a 20% uplift attributed to climate change effects. The maximum peak stage is expected to reach 15.6 mAD. In this scenario, around 500 properties are at risk, including important infrastructure such as the fire station and primary school. The A4101 road is blocked, complicating evacuation of residents to the west. About 5.37 km^2 of area will become flooded. This scenario indicates that rare events are likely to occur more frequently. Notably, it is striking that the flood risks are closer in magnitude to the extreme 1 in 1000-year events (Figure 7).

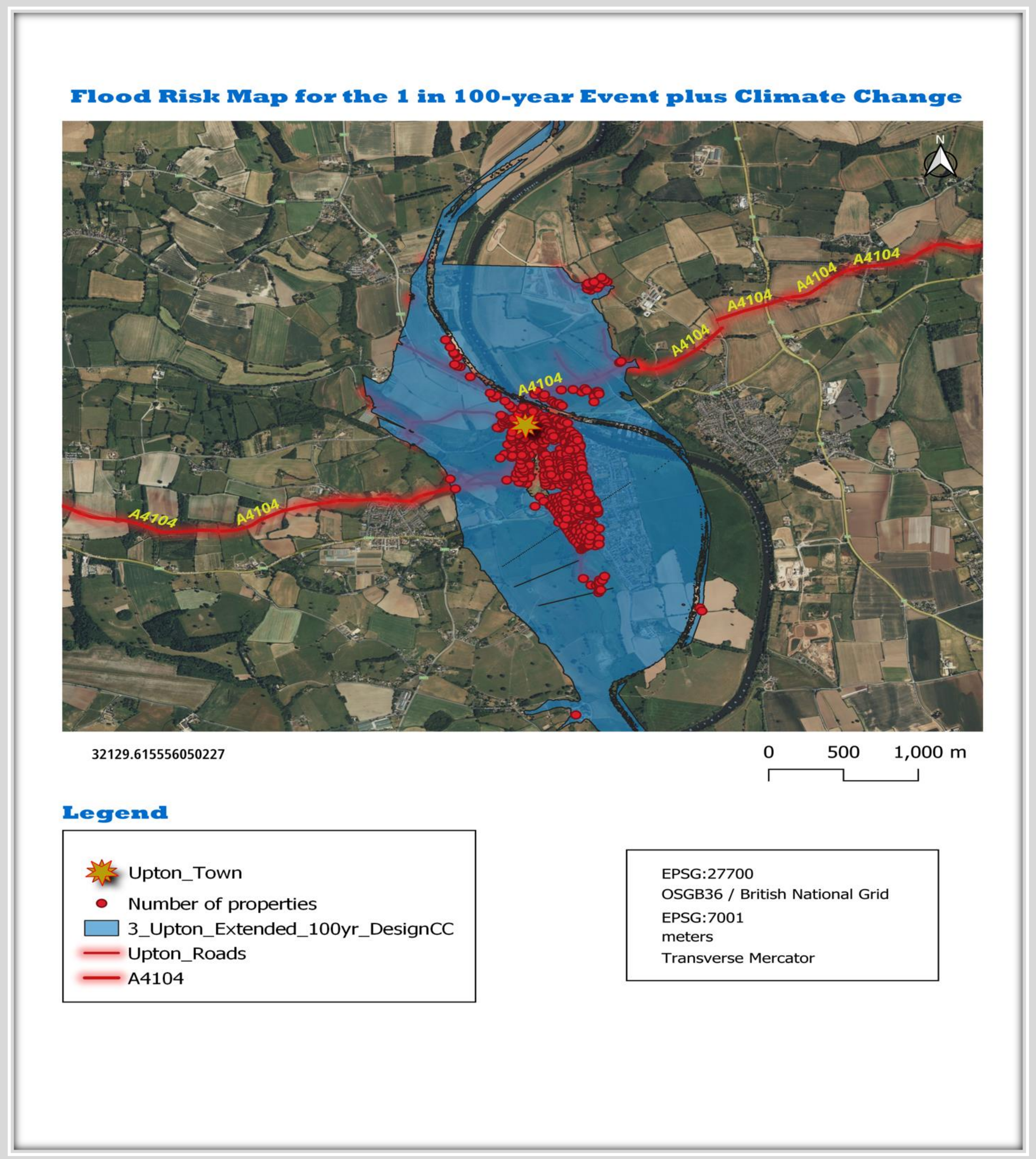

Figure 7: Flood Risk Map for the 1 in 100-year Event plus Climate Change

1.6 Limitations and Constraints

1.6.1 Data Availability and Reliability: This affects model accuracy. Issues can arise due to errors in survey data or incorrect dimensions of the bridge in the model.

1.6.2 Unpredictability of Climate Change: The prediction of a 20% uplift due to climate change might be incorrect. This affects flood risk estimations.

1.6.3 Simplifications in the model: The model is 1D and might not fully represent complex natural processes. This could lead to overestimation of flood risks, especially since it does not consider flood defenses or urban drainage facilities.

1.6.4 Flow and Velocity Assumptions: The model uses average flow and velocity, not accounting for variations at the surface or bottom.

1.6.5 Difficulty in Interpretation: Applying these models to real-world scenarios can be challenging due to their inherent limitations and the complexities of real-world environments.

1.7 Conclusion

This study highlights increasing flood risks in Upton, particularly due to climate change. The risk has grown significantly, with properties at risk from 17 to 336 in a 100-year event, and 500 with climate change effects. This scenario is almost as severe as a 1 in 1000-year event. Furthermore, the blockage risks of vital roads like the A4104, underscores the urgency for adaptive strategies and resilient infrastructure to protect against this growing threat.

1.8 Recommendations

For future flood risk studies, enhancements in data collection, such as satellite imagery, are crucial. Regular revision of models to reflect climate change patterns and using advanced 2D or 3D models and machine learning will more accurately reflect natural processes. Updating software to include flood defense mechanisms is also important.

Integrating strategies from the Netherlands' Giant Delta Work is key ('Delta Works', 2023). This includes the use of strong flood barriers, levees. Reforestation helps by increasing water absorption into the ground, reducing runoff into floods. For road resilience, elevating roads above flood levels, using permeable materials for better water drainage, and reinforcing road infrastructure to withstand flood conditions are effective strategies. Regulating construction in vulnerable areas and designing buildings to withstand exposure to floodwater by using brickwork, concrete floors, water- resistant fittings, and raised electrical sockets, minimizes damage. All these initiatives require long-term investment, emphasizing the need for a sustainable approach to flood risk mitigation.

References

1. 'Delta Works' (2023). *Wikipedia*. Available at: https://en.wikipedia.org/wiki/Delta_Works (Accessed: 8 December 2023)
2. Lowe, A. (2023) 'Introduction to Modelling-Applying Model Strategy', *EART66001: Pollution Management in Practice 1*. University of Manchester. 10 November.
3. Marsh, T., and Hannaford, J. (2007). *The summer 2007 floods in England & Wales: a hydrological appraisal*. Centre for Ecology & Hydrology.
4. 'Upton-Upon-Severn' (2023). *Wikipedia*. Available at: https://en.wikipedia.org/wiki/Upton-upon-Severn (Accessed: 8 December 2023)

5. Webb, J.C.K. (2020) *Upton Marina during the great floods of 2007 from the air.* Available at: https://www.webbaviation.co.uk/aerial/picture.php?/23544/category/1120 (Accessed: 9 December 2023)