

Effects of Different Vegetation Density and Type on Flooding in the Mundy's Landing Area

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Introduction

The Mundy's landing area has a history of flooding that has impacted the individuals who live there. With climate change, it is predicted that flooding will become more severe over time due to more extreme weather conditions.

TUFLOW, a hydraulic modeling software, was used to better understand the effects of vegetation on flooding in the model catchment area. TUFLOW allows individuals to model flooding based on input precipitation and topographic data such as Manning's n values and soil infiltration rates.

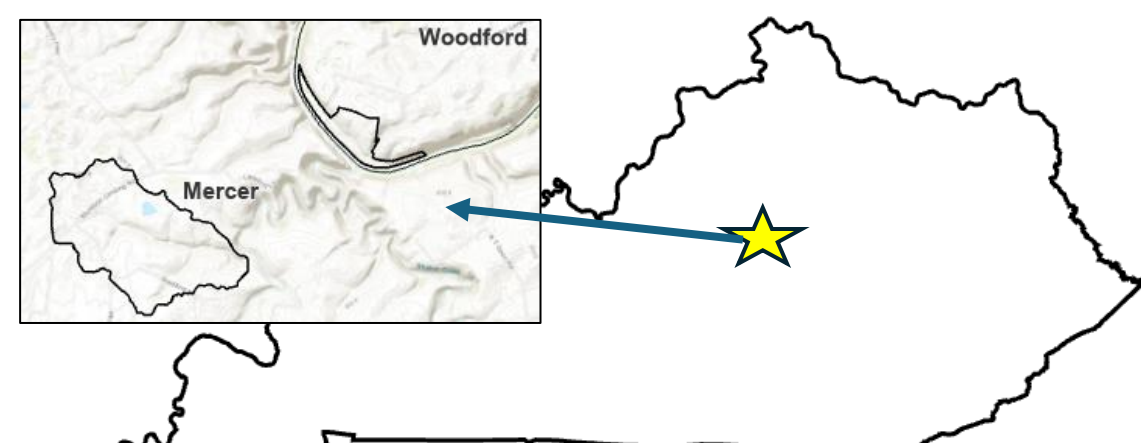


Figure 1: Mundy's Location at the state scale

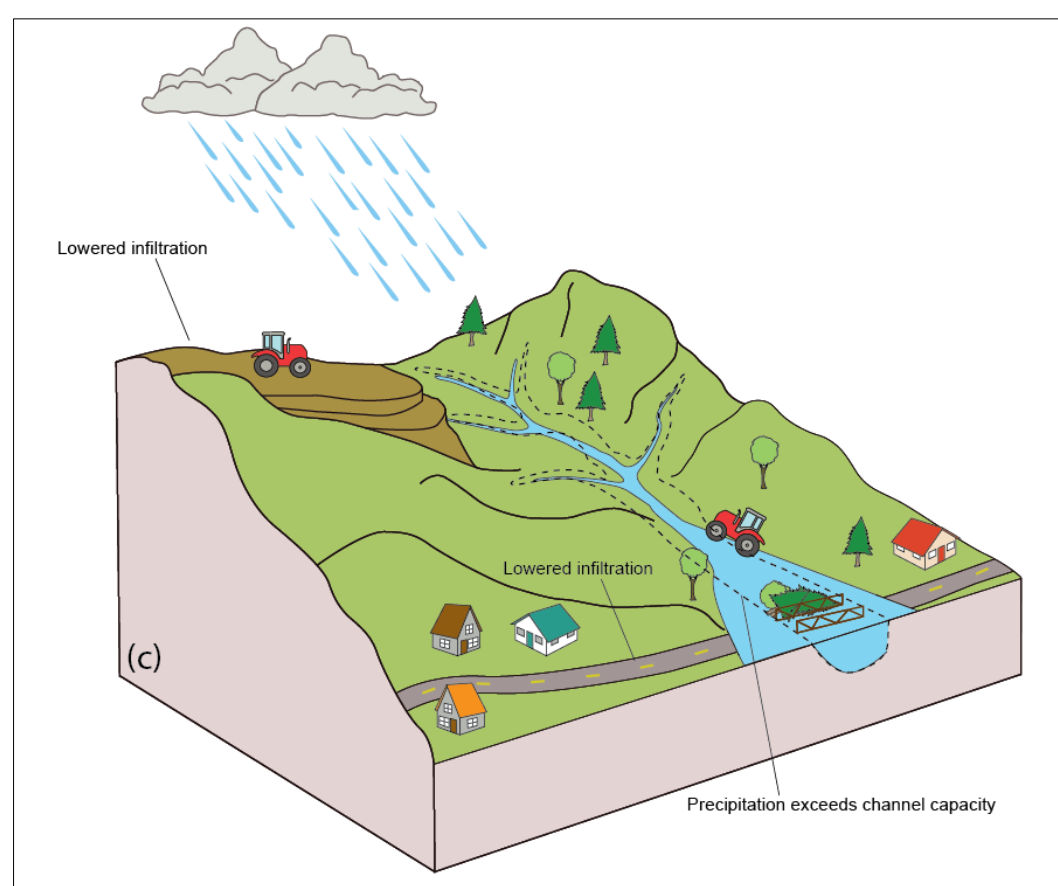


Figure 2: Representation of Model Materials (Swallom et al., 2025)

Methods

To set up the test models, the workflow of Meredith Swallom was followed (Swallom et al., 2025) using Kentucky's phase 1 lidar data from KYFromAbove to create the vegetation layer. Once the base model was created, test models were constructed to represent different vegetation conditions.

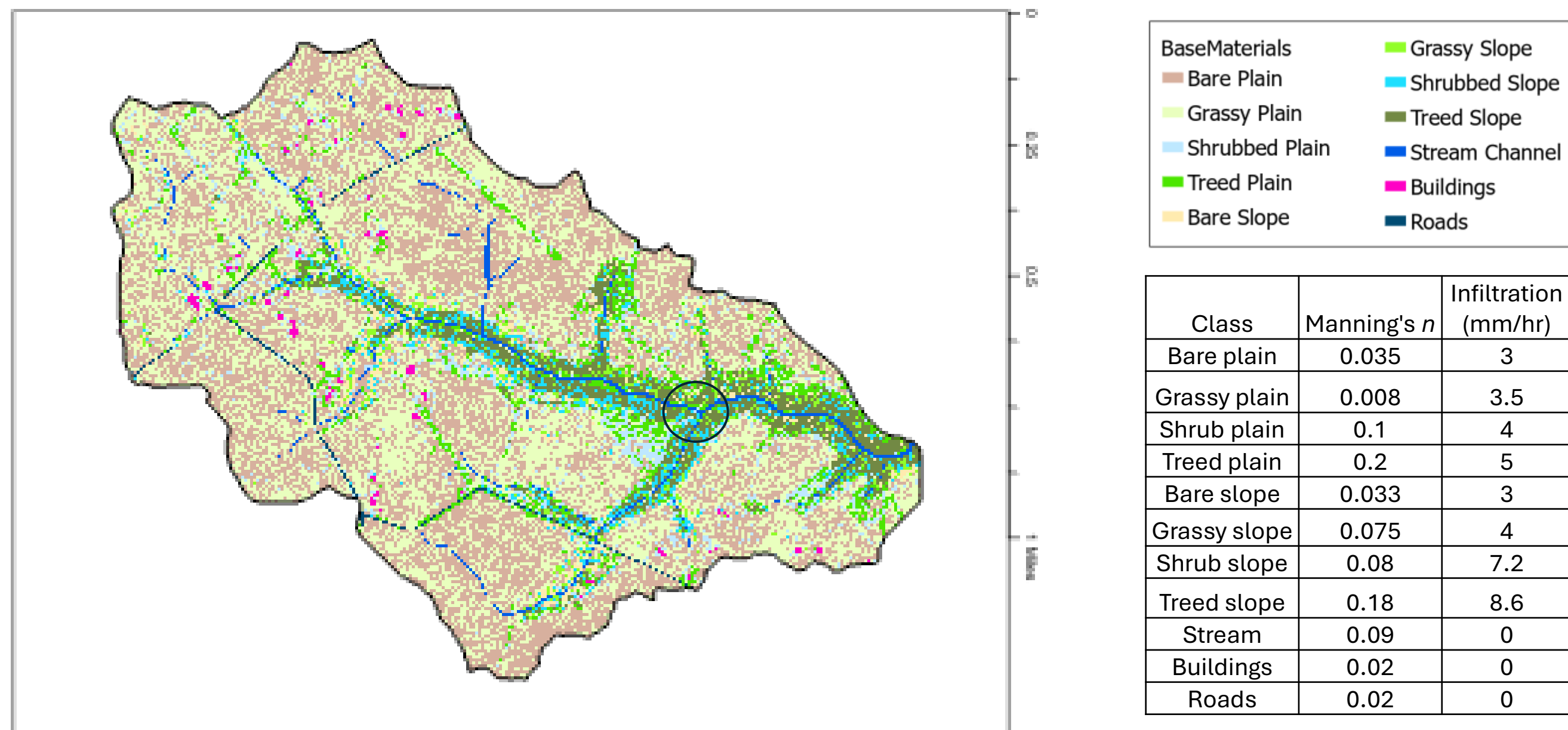


Figure 3: Materials Raster used to create the base model (created from phase 1 LIDAR data)

Values used for the base model

Model:	Materials Raster:	Change:
Base:		The base materials raster was developed using Meredith's workflow and the July 2021 storm precipitation data provided by Vicky's work.
Alder:		Selected for vegetation the Alder height range (8-12 feet) and represented those heights as a new value (red) Assigned Alder infiltration rate (288 mm/hr) to those locations (Jačka et al., 2021).
Reforested:		Removed buildings and roadways, changed all vegetation height and n values to that of trees. Changed infiltration to 90 mm/hr, provided by Finley's infiltration tests in the area.
Understory:		Selected for 4th, 5th, and 6th LIDAR returns to represent vegetation underneath the initial vegetation height returns. Assigned an increased Manning's n value to those locations to represent the increased vegetation roughness. (Locations shown in pink)
2100:		Solved for an annual growth rate for the catchment area by comparing phase 1 and 2 vegetation heights, and applied the growth rate until 2100 to vegetation not currently in agricultural or developed areas. Precipitation data was provided by Vicky's prediction for a 2,100 storm.

Results and Discussion

There was a 4.1% decrease in the total max water height across the catchment area when the agricultural and human development areas were reforested. This shows that flood height could be reduced with the increased infiltration and vegetation roughness that a forested area provides.

Similarly, when infiltration rates were increased to show what a flood could look like with alder species present, the total max height across the boundary decreased by 2.7%. The Alder height range locations were present primarily in the forested areas around the stream, and as a result most of the flood height difference can be seen within those areas (Figure 8)

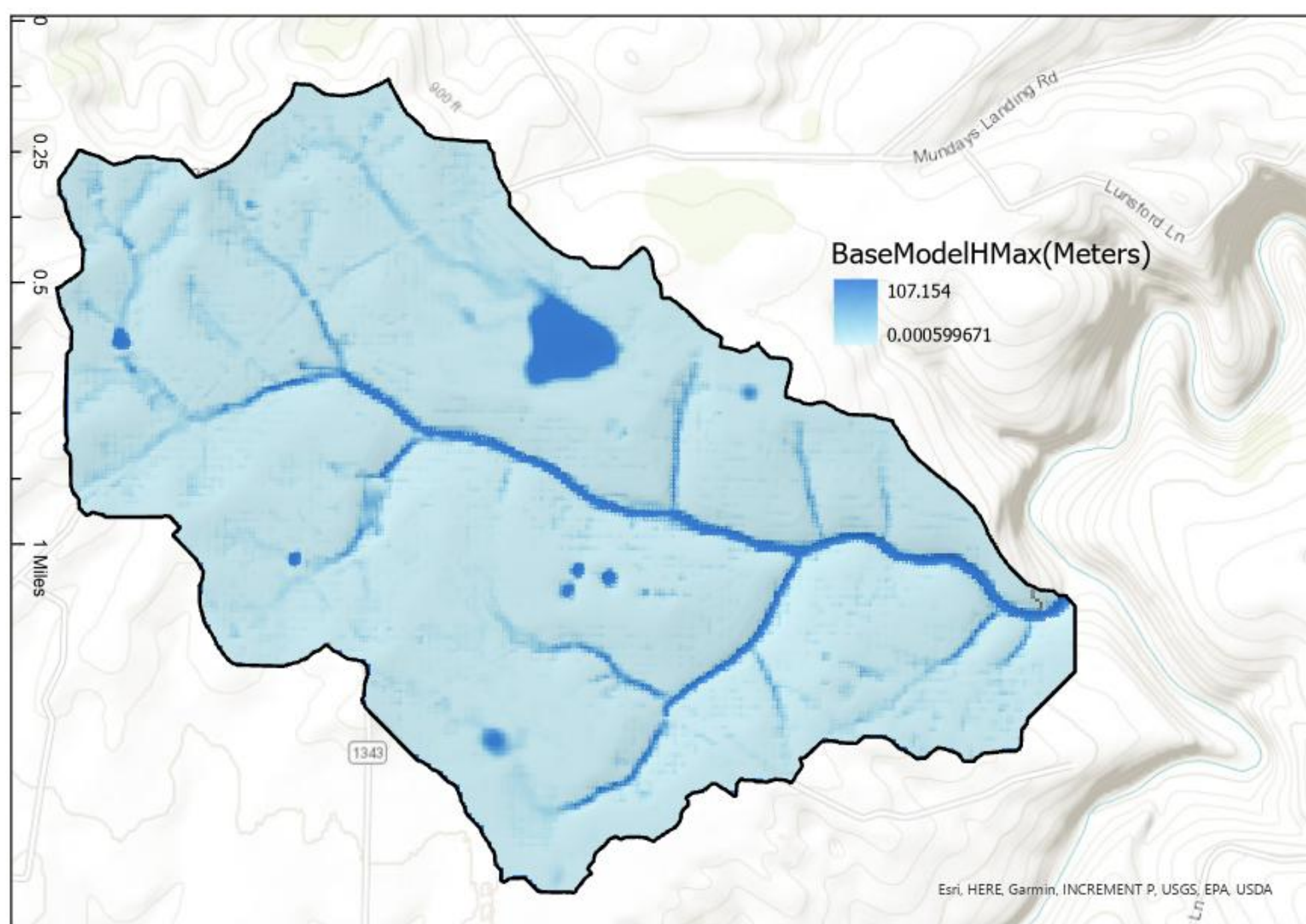


Figure 4: This shows the accumulated flood height results of the base model.

The understory model showed little change from the original base model results, but there was a slight increase in flood height around the stream due to the increased Manning's n in the vegetation around the stream.

The prediction model for the year 2100, run with Vicky's precipitation data, showed a 0.5% increase in the flood height. From these results, we can see that the projected growth rate of about half a foot a year will not be enough to completely mitigate the effects of the predicted increased precipitation.

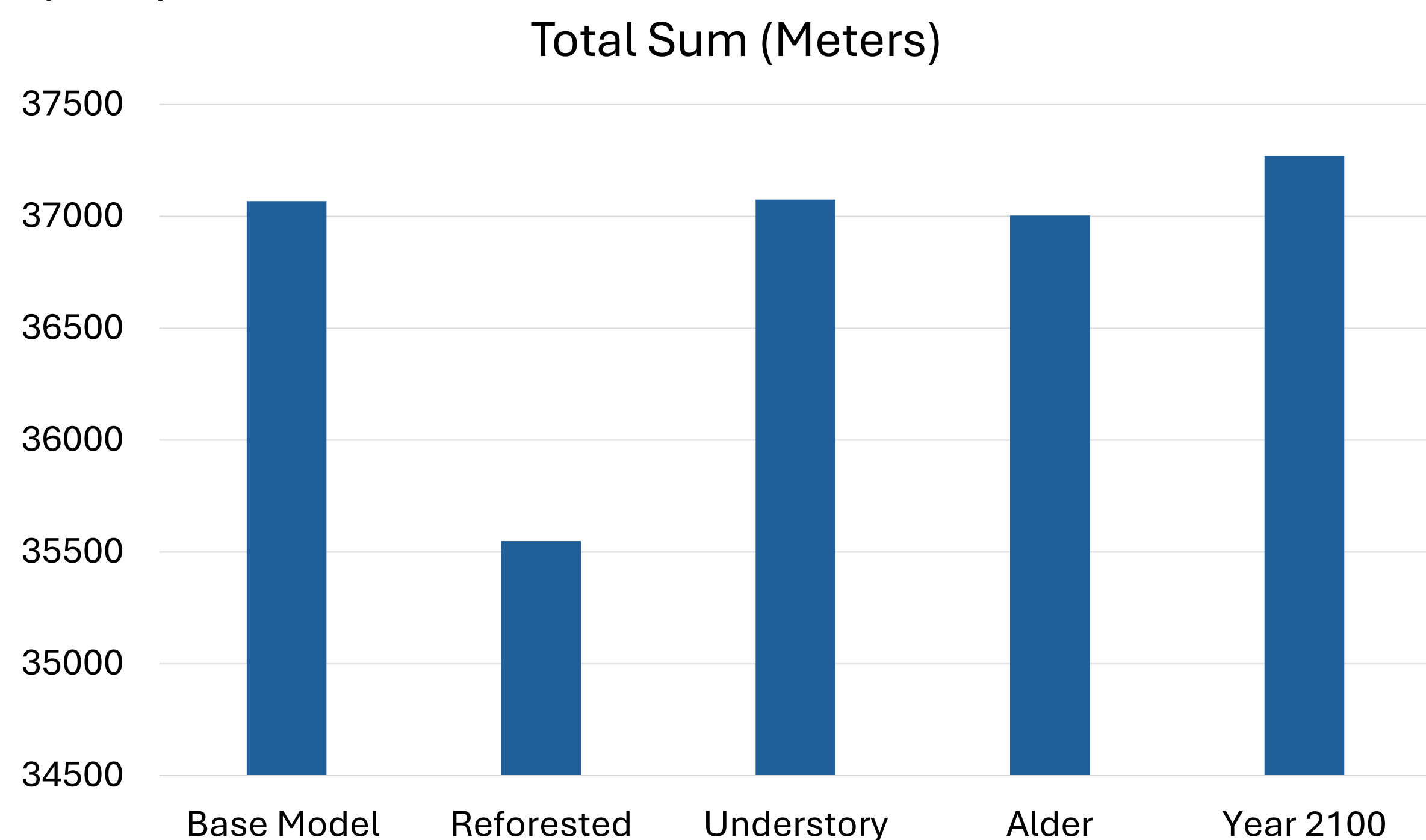


Figure 5: Sum of flood height in meters across the entire catchment

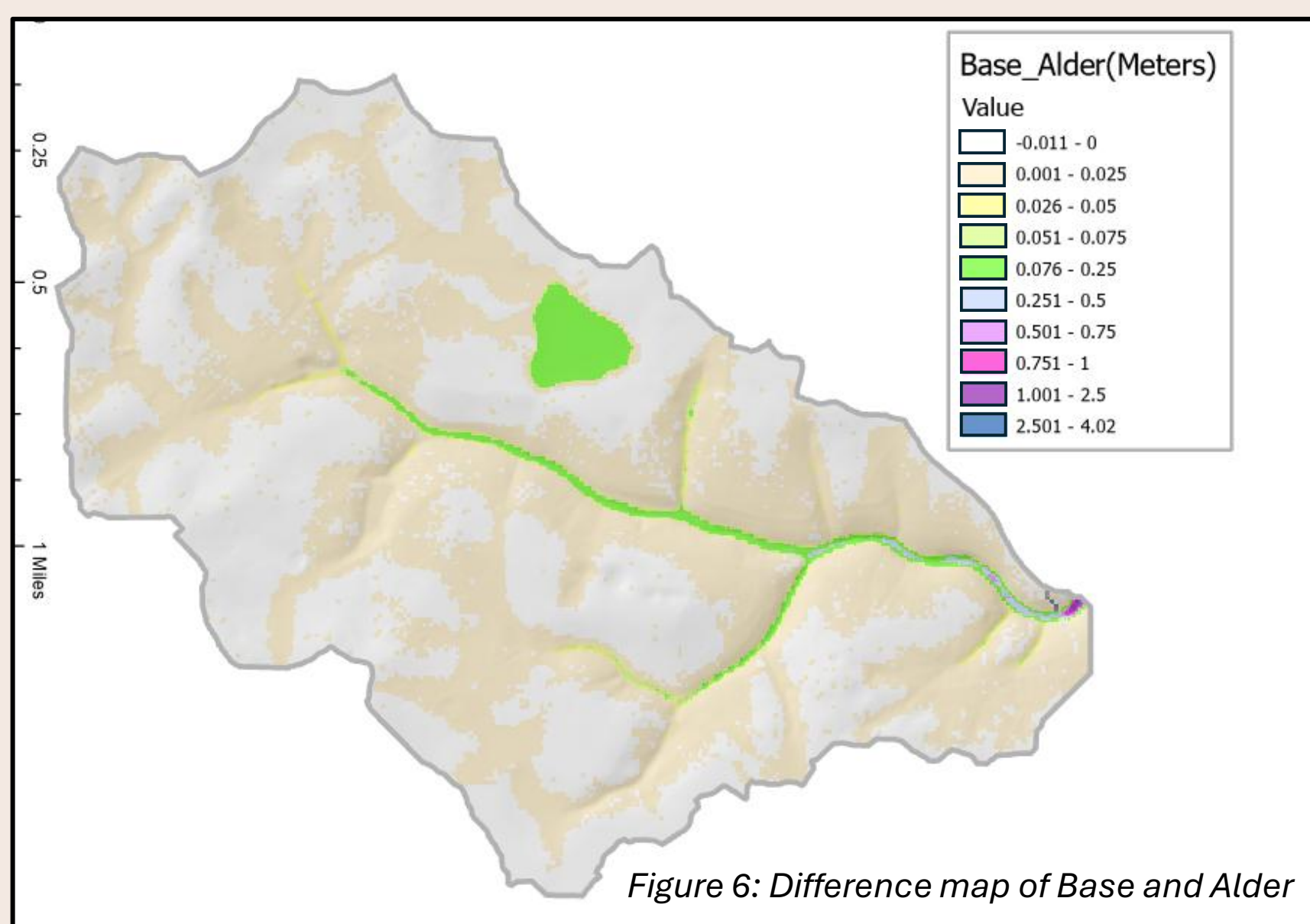


Figure 6: Difference map of Base and Alder

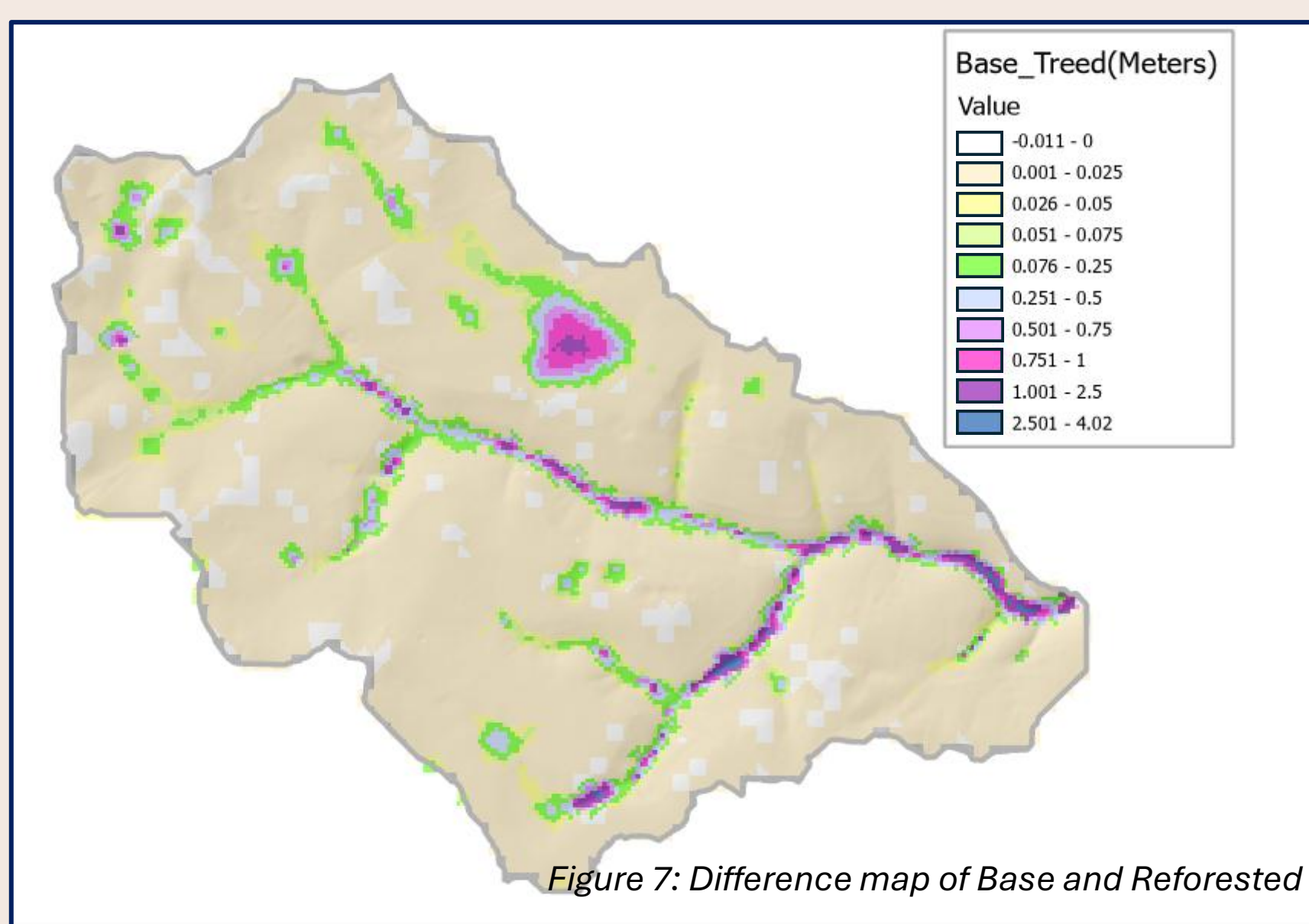


Figure 7: Difference map of Base and Reforested

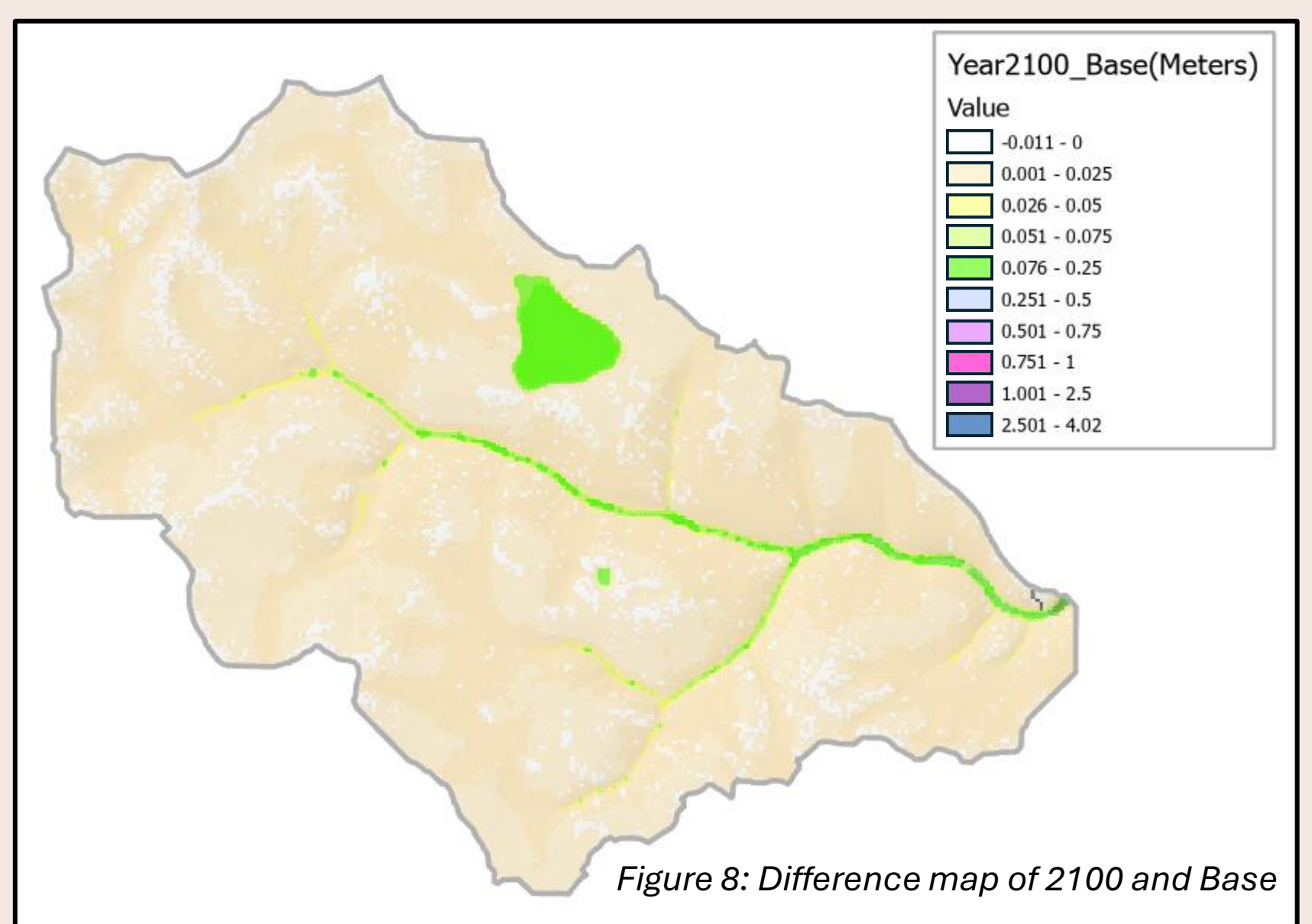


Figure 8: Difference map of 2100 and Base

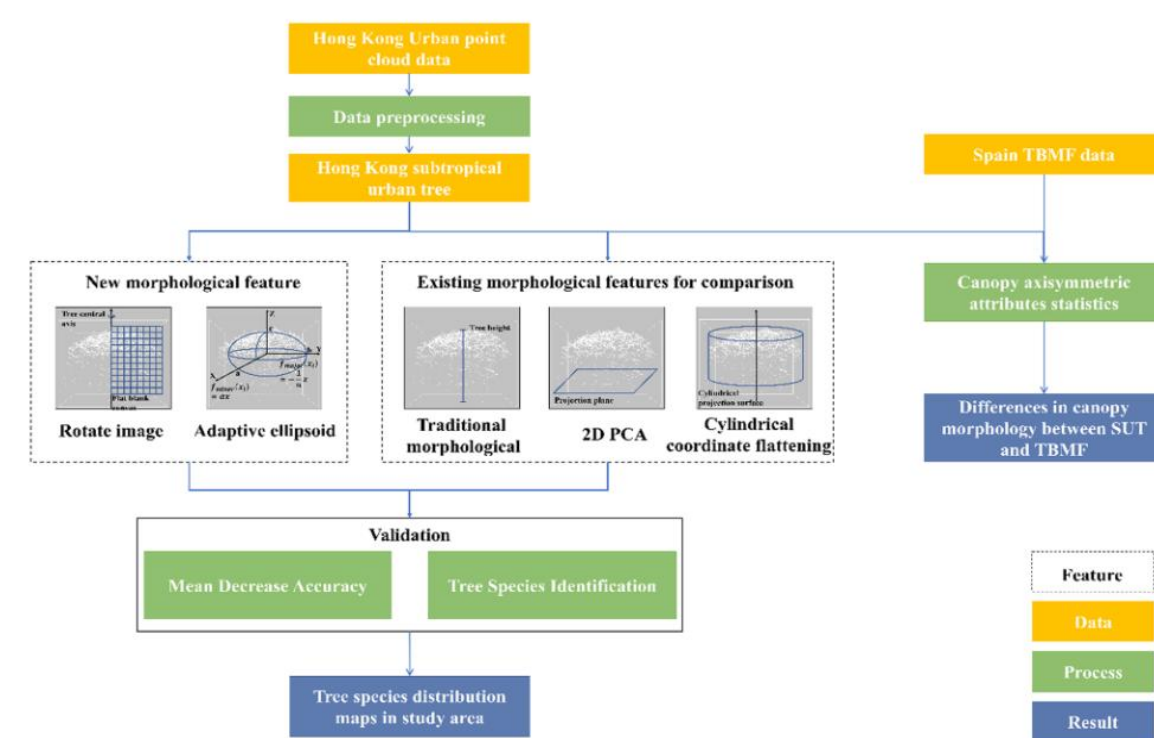
Conclusion

From the results, it is noticeable that the Reforested and 2100 models showed the most significant differences compared to the base model, while the change in the Understory model was more subtle. From this, we can determine that for this study area, the soil infiltration rate was the driving factor of the flood height rather than changes to Manning's n value.

It is also noticeable from the difference maps of the catchment area that the impacts of vegetation on flood height are spatially dependent. For the Alder and 2100 models, most of the height changes occurred around the main waterway. This could be because most changes to the materials raster were in the area close to the stream. The Reforested model instead had widespread changes across the model area and, as a result, had greater and more dispersed value changes around the model area.

Future Work

- Test more native species and their effects to soil infiltration rates
- Identify tree species from Lidar data. This process would most likely entail leaf-on LIDAR data and machine learning.



References

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