Comparing Buffer Methods in Modeling Lake Depth

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Introduction

In `04_nla_morpho_revisted`, we modifed the direct linear modeling approach used in Hollister et al.[1] with a profile curvature term calculated on the surrounding elevation data. Although the depth models were equivalent to the original paper, the buffer region was calculated somewhat differently. While Hollister et al. used a dynamic buffer region dependent on maximum distance from shoreline, we simply buffered 200m. Now, we will compare this model when we exactly recreate the buffering process used in the paper. In particular, we have two questions:

1. Does the buffering method used, either dynamic or constant-distance, affect how the surrounding terrain is characterized?
2. Does the buffering method used affect lake depth modeling performance?

Methods

Buffer Calculation

The buffering procedure used in Hollister et al. is as follows:

1. For a lake polygon, calculate the further distance from shoreline in the lake.
2. Identify all catchments intersected by the lake polygon.
3. Clip the catchments in (2) to only the geometry within the distance calculated in (1).

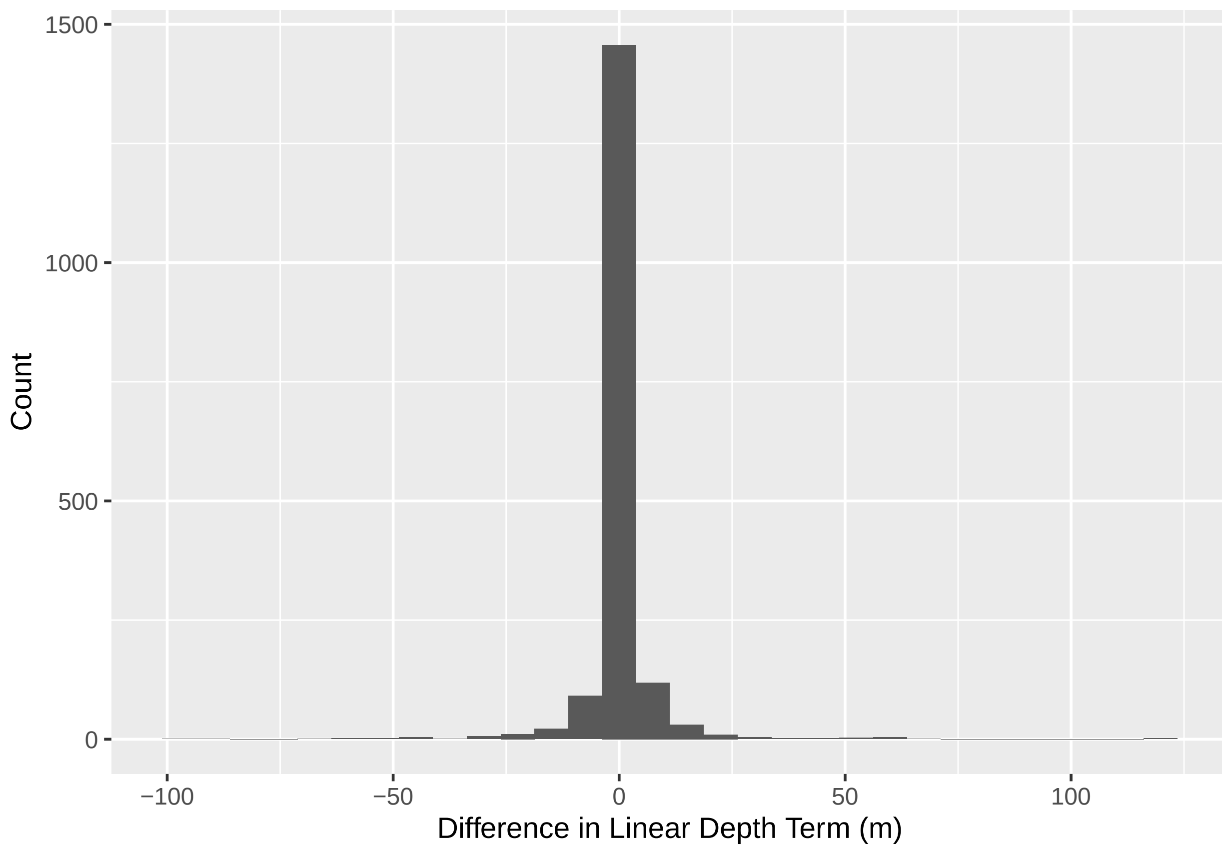
This procedure was performed by calculating the maximum distance to shoreline using the *Pole of inaccessibility* tool in QGIS[2]. A buffer region was created for each lake using this distance. Simplified catchments from The National Hydrography Dataset were clipped to these buffer regions (https://www.epa.gov/water-data-and-tools/nhdplus-simplified-catchment-extension-files). Finally, a unique lake identifier was joined to each catchment and the catchments were dissolved by lake identifier to form the final dynamic buffers.

Results

Paired Sample Comparison

The most important variable for depth modeling is median slope within the buffer region. We first consider whether this value appreciably changes when a different buffering procedure is used. For our purposes, slope is used to construct the linear term $D_{max} \times S_1$ in the maximum depth model. So, we will consider whether the value of this term appreciably changes when the buffer method is changed.

```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  slope_compare$linear_depth_static and slope_compare$slope_hollister
## W = 3134706, p-value < 2.2e-16
## alternative hypothesis: true location shift is greater than 0
```



The Wilcoxon test indicates that the dynamic buffer results in a slightly greater slope estimate. We know that simple linear modeling of lake depth with slope results in overestimation, so we would expect this result to make this issue worse.

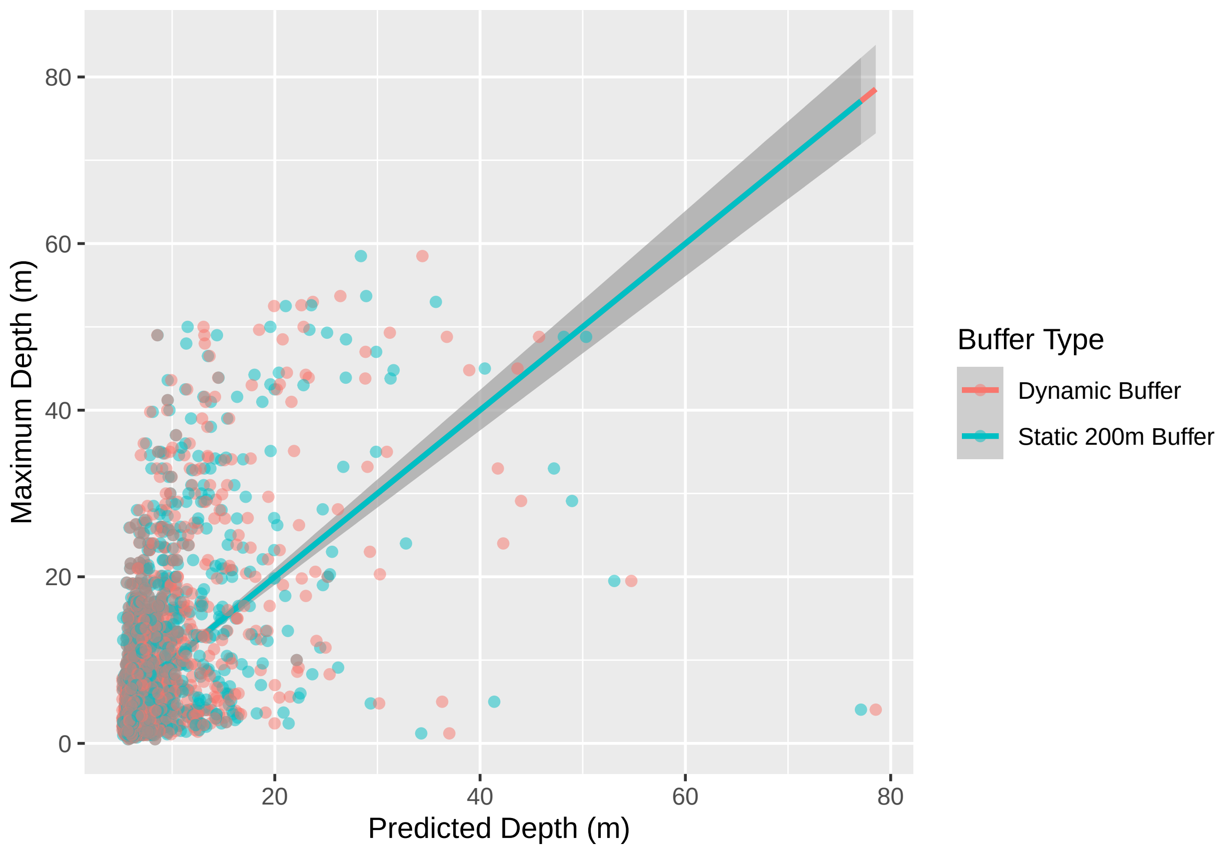
Model Performance Comparison

We will compare bias-corrected maximum lake depth models constructed from slope in a static buffer and slope in the buffering procedure described above.

```
## Analysis of Variance Table
##
## Response: maxdepth
##                       Df Sum Sq Mean Sq   F value Pr(>F)
## linear_depth           1  77013   77013 1365.9435 <2e-16 ***
## buffer                 1      0       0    0.0006 0.9811
## linear_depth:buffer    1      9       9    0.1581 0.6910
## Residuals           3550 200153      56
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The ANOVA comparing both of these linear models is not significant, so we can conclude that the buffer procedure used does not affect the relationship between the linear depth term and maximum depth.

Finally, we plot the regression lines.



As is evident, the change in slope does not have a significant effect on the line of best fit.

References

[1] J.W. Hollister, W.B. Milstead, and M.A. Urrutia, PLoS ONE **6**, e25764 (2011).
[2] Q.D. Team, (2020).