Update of River Valley Bottom map

Advisory paper from DCA – Danish Centre for Food and Agriculture

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Data sheet

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Background

The Danish Agricultural Agency (LBST) is using the River Valley Bottom map (Greve et al., 2021) together with the Texture-2014 map (Adhikari et al., 2013) as basis for designating areas for the Extensification with Mowing ("Ekstensivering med slæt") scheme. This combination of maps helps delineate peat soils, river valleys, and low-lying areas from other agricultural areas.

The scheme is designed for arable lands on carbon-rich and mineral soils in river valleys – areas that have the potential to be included in a wetland project. The scheme prohibits fertilization on these lands, mandates the establishment of a grass cover, and requires at least one mowing per year.

Accurately identifying these lands is crucial for the scheme's success, and as landscapes evolve and data accuracy improves, updating this map is important to ensure that the most suitable lands are targeted.

Consequently, LBST has requested an updated map with the following objectives:

1. Update the existing River Valley Bottom map by excluding coastal, low-lying areas outside river valleys that do not overlap with the Texture-2014 map.
2. Refine the map layer by discarding areas without immediate proximity to the Texture-2014 map, ensuring the map's relevance to the scheme's purpose of preparing for wetland management of carbon-rich soils.
3. Enhance the accuracy of the map by excluding smaller watercourses that do not overlap or are not in proximity to the Texture-2014 map.

Each objective is requested in a separate map layer.

The updated River Valley Bottom map

The updated map is delivered to the Danish Agricultural Agency in separate GIS-files. This paper describes the methodology used.

Methodology

Data Sources

The following data sources have been used to develop a River Valley Bottom map for the needs of LBST:

- Digital Elevation Model of Denmark
- GeoDanmark stream feature dataset
- Texture-2014 map

GIS workflow

The solution is an ArcGIS Pro Model builder that takes several steps to delineate a River Valley Bottom map that meets all the three needs of LBST.

1.1.1 Environmental Configuration

Before initiating geospatial analyses, the computational environment was configured. This ensured that all outputs were systematically directed to a designated workspace and named correctly. Essential extensions, such as "spatial" was activated to facilitate the deployment of specialized geoprocessing tools.

1.1.2 Stream Processing

For the analysis the stream dataset was processed to provide stream sections with uniform length

- **Paiwise Dissolve**: A dissolve function was executed utilizing the streams dataset. This operation combined all the features, yielding a consolidated representation of stream data.
- **Vertex Transformation**: After the dissolve, the terminal vertices of the resultant line features were transformed into point geometries, capturing each stream segment's commencement and termination.
- **Segmentation of Streamlines**: The consolidated streamlines were then split at the formed vertices resulting in distinct stream line segments.
- **Point Generation Along Streamlines**: Points are generated along the stream segments to further split stream sections with uniform lengths. We used 100m lengths defined by the Stream_Split_Distance parameter.
- **Secondary Streamline Segmentation**: A secondary split was performed on the line segments at the locations of the generated points to generate 100 m stream lengths.

1.1.3 Raster-to-Vector Transformations and Analyses

With the following steps a flow distance raster was created:

- **Polygonal Transformation**: The Texture-2014 raster, delineating organic soils, was transformed to yield polygonal geometries.
- **Spatial Association Analysis**: A spatial join operation was executed between the segmented streams and the organic soil polygons to discern streams traversing organic soil terrains.
- **Vector-to-Raster Transformation**: The spatially-associated stream data was reverted to a raster format.
- **Topographic Refinement**: The Digital Elevation Model (DEM), was subjected to a fill operation, rectifying topographic inconsistencies and ensuring a homogenous surface representation.
- **Hydrological Proximity Analysis**: Employing the refined DEM, a flow distance computation was undertaken for each raster cell, quantifying its vertical proximity to the nearest stream. This gives a representation of "vertical distance to stream network".

1.1.4 Proximity Thresholding

The flow distance raster was subjected to a thresholding operation for each stipulated value within the Thresholds dataset. Cells manifesting flow distances less than or corresponding to the threshold were designated a binary value of 1, while others were assigned a value of 0. The resultant binary rasters delineate regions within the specified hydrological proximity to the nearest stream and the Texture-2014 organic soils.

We used thresholds between 0.5 m and 3 m at increments of 0.5 m. The final maps are labeled as "rvb_[Threshold Value]" The models are shown in figures 1 and 2.

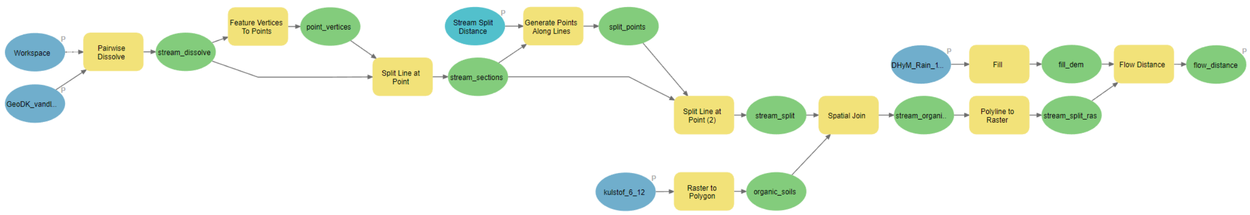

Figure 1: ArcGIS Pro model that calculates the vertical flow distance raster

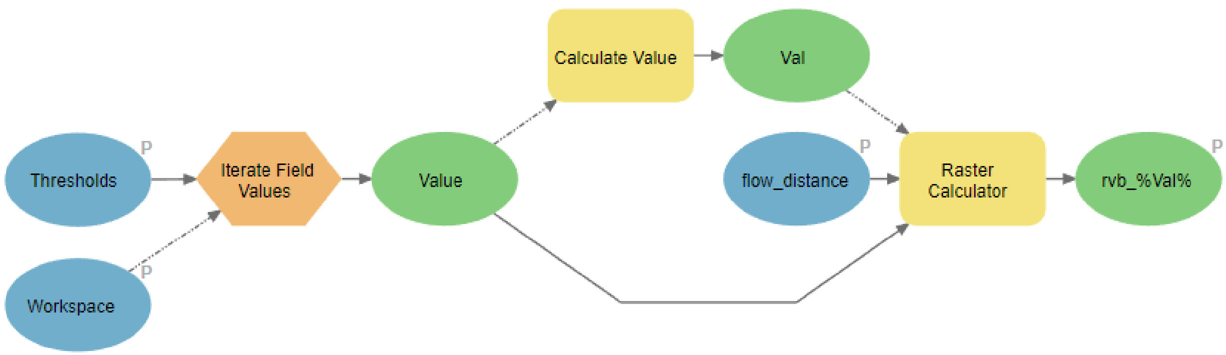

Figure 2: ArcGIS Pro model that thresholds the flow distance into different maps of the final river valley bottom.

Results

The results show that different thresholds of the flow distance work best for different areas. In the coastal areas, low thresholds of 0.5 m and 1 m seem to work better since these areas are low-lying (Figure 3). On the other hand, in an area like the Vejle Ådal, a higher threshold works better as seen in Figure 4, showing the resulting map from thresholds of 2.5 m and 3 m. These thresholds will dictate the overlap and proximity of the river valley bottom map to the Texture-2014 map fulfilling objective 2.

The method delineates river valleys at the areas where there is Texture-2014 map data and has therefore not included the streams that are too small fulfilling objectives 1 and 3.

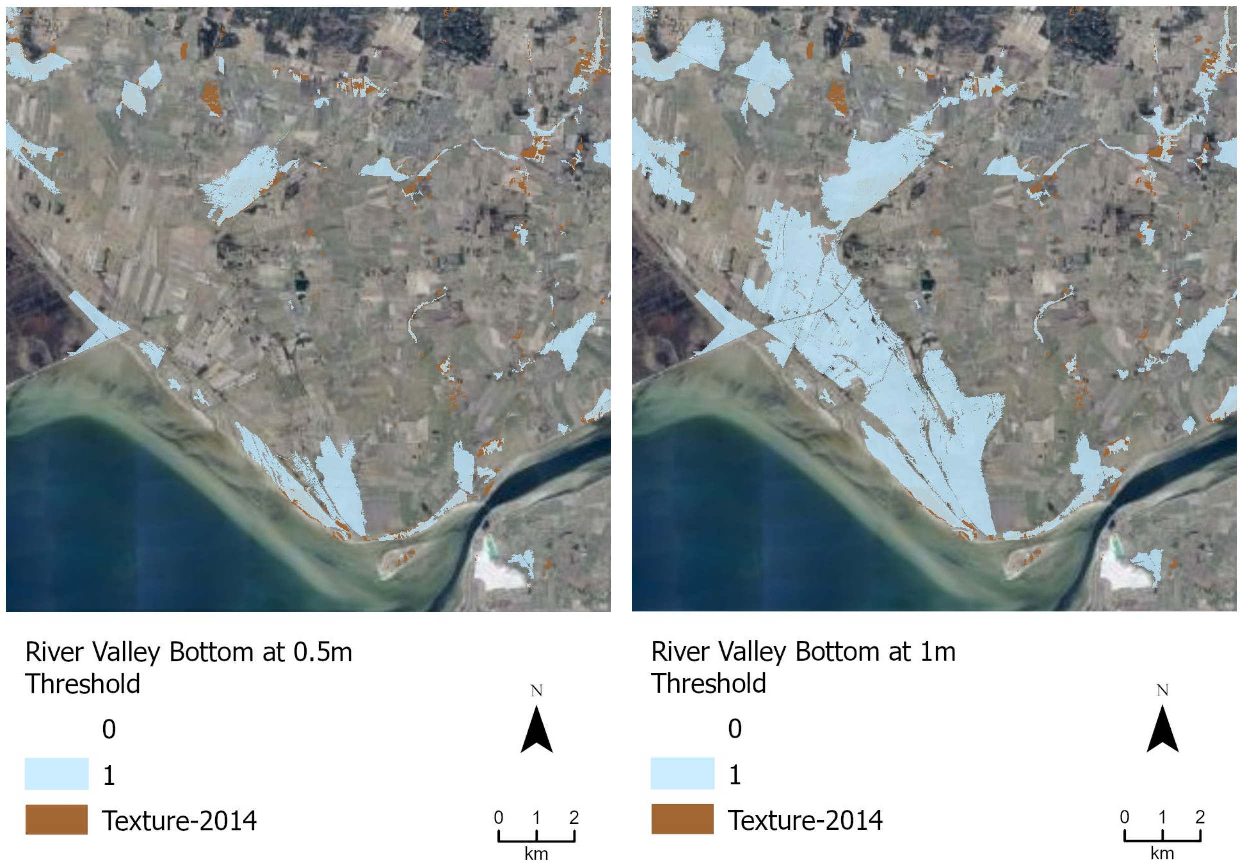

Figure 3: A resulting river valley bottom map from Løgstør widening using two thresholds of 0.5m and 1m

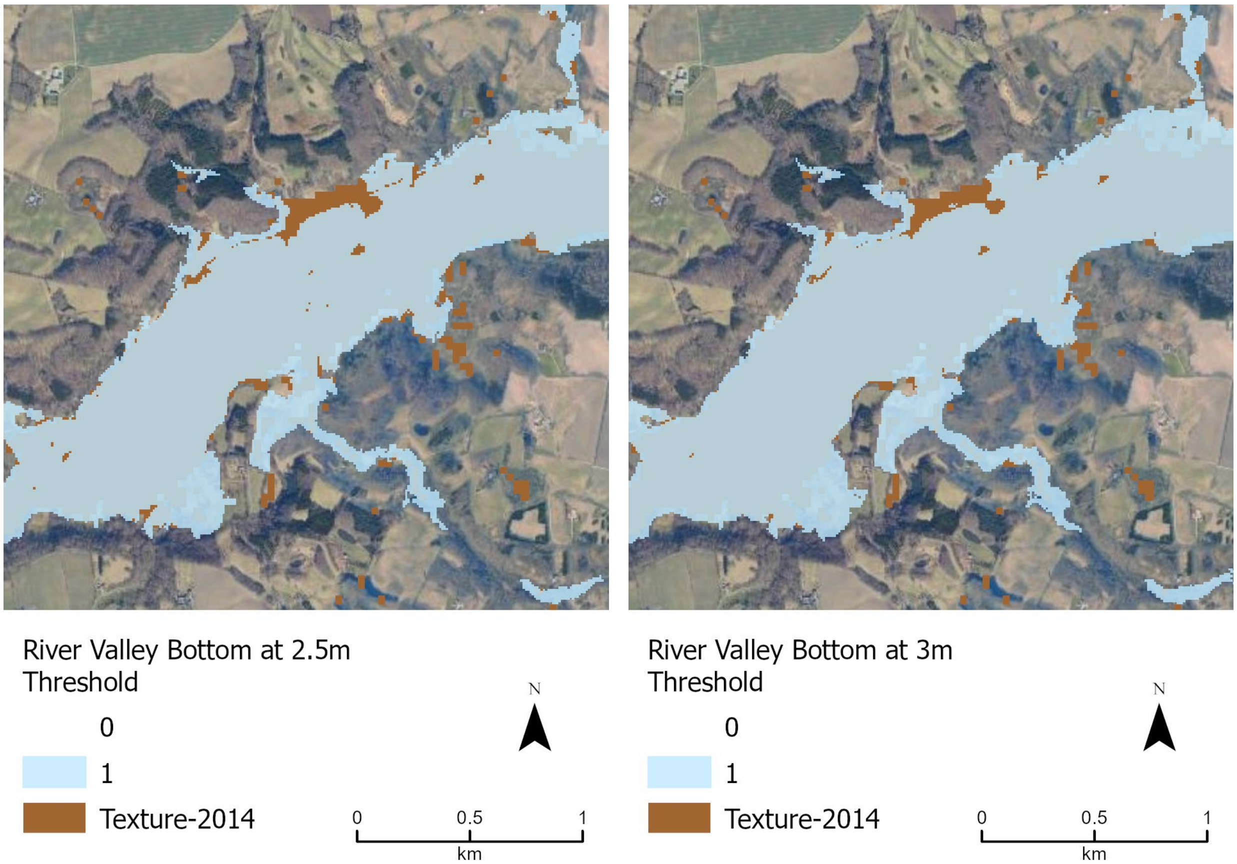

Figure 4: A resulting river valley bottom map from Vejle Ådal using two thresholds of 2.5m and 3m

Conclusion

Based on hydrological proximity analysis, the map can be used throughout Denmark to identify and delineate river valley bottoms. The methodology employed in this assignment, including the vector-to-raster transformation, topographic refinement, and hydrological proximity analysis, has proven effective in producing maps that accurately represent the vertical distance to the nearest stream. The results demonstrate that using threshold values for flow distances, the hydrological proximity analysis successfully identifies and delineates river valley bottoms based on topography and proximity to streams. The results of this study demonstrate that different threshold values of the flow distance raster yield optimal results for different areas. In coastal areas, lower thresholds of 0.5 m and 1 m were found to be more suitable, whereas in areas such as Vejle Ådal, higher thresholds of 2.5 m and 3 m provided better results.

References

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