Generalisation of heterogeneous topographic linear features to derive a German Alpine club map

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This project presents two models for the generalisation of heterogeneous linear data. They address demands for network generalisation, coalescence conflicts between linear features and alignment of contour lines to a reference hydrological network. The models were built in support of an ongoing mapping project that brings together various public heterogeneous datasets for use in an Alpine map at a target scale of 1:33,000. Among these were, crowdsourced OpenStreetMap data, various satellite image services, and global digital elevation models.

M1: NETWORK GENERALISATION AND COALESCENCE CONFLICT RESOLUTION

This model (M1) functions to:

- Generalise the road network to refine (select and omit) features, balance remaining features and maintaining connectivity through the map.
- Generalise linear features to solve coalescence conflicts.

The Model Solution (M1) (fig 1 (A)) co-opts pre-existing tools available in ArcGIS Pro and takes a semi-automated approach generalisation [1]. The **Thin Road Network Tool** performs the task of selection and omission of features. Based on a thinning hierarchy and minimum length distance. It considers the role features play in connectivity and highlighting features for removal particularly those less than the prescribed minimum length distance.

Together, the **Graphical Conflict Detection** tool and **Resolve Road conflicts tool** are used to detect coalescence conflicts between different linear features and calculate the displacement (feature) needed to resolve the conflict (fig 1 (B)). The displacement feature stores the magnitude and direction information that an inferior feature is required to move to eliminate the coalescence conflict at the output scale. The model only detects features that over-

lap with each other features. Self-coalescence conflicts on the other hand need to be manually identified and resolved by the user assisted the model. This is done by introducing a barrier feature dataset into modelling process. The barriers create a new coalescence conflict to force apart self-overlapping features (fig 1(C, D)).

The actual displacement of features is applied by the **Propagate Displacement Tool**. It implements a smooth displacement of continuous features based on the direction and distance information stored in the displacement feature data. It also maintains the connectivity and spatial relationships amongst features.

M2: CONTOUR LINE ADJUSTMENT TO HYDROLOGICAL NETWORK.

This model (M2) functions to:

- Align contour lines to the river network so that rivers flow correctly in the talweg (line of lowest elevation in a valley). Incorrect alignment results from using heterogeneous data to derive the contours and river network separately.

The Model (M2) co-opts an **open-source toolbox for Digital Elevation Model Conflation** [2] that merges elevation data to a hydrological network. The output is a conflated DEM from which new contour lines are created that have improved alignment

to the hydrological network.

For the target scale of 33,000 a hybrid M2 solution is implemented to resample the global DEM data from 30m to 10m grid size cells. This results in a conflated surface whose drainage more closely with the reference rivers from OSM. Also observable in the sample profile cuts where the actual river position is aligned to the talweg best in the hybrid results that blends 10m resolution stream extractions with 30m DEM conflation as shown in the figure 2 (A) model, (B) contour results and (C) Profile cut comparison.

CONCLUSION

The models presented provide solutions for the generalisation of heterogeneous linear features. Model M1 provides a semi-automated generalisation approach for linear features. It works best with high quality data pre-checked for topological errors and supports user interventions to increase or decrease the degree of network generalisation and varieties of coalescence conflicts with linear features. Model M2 successfully aligned contour lines to match the hydrological network. Limitations of the approach are linked to iteratively optimising the counterpart extraction parameters and identifying the ideal DEM resolution required. The approach is therefore more suitable for smaller scale applications.
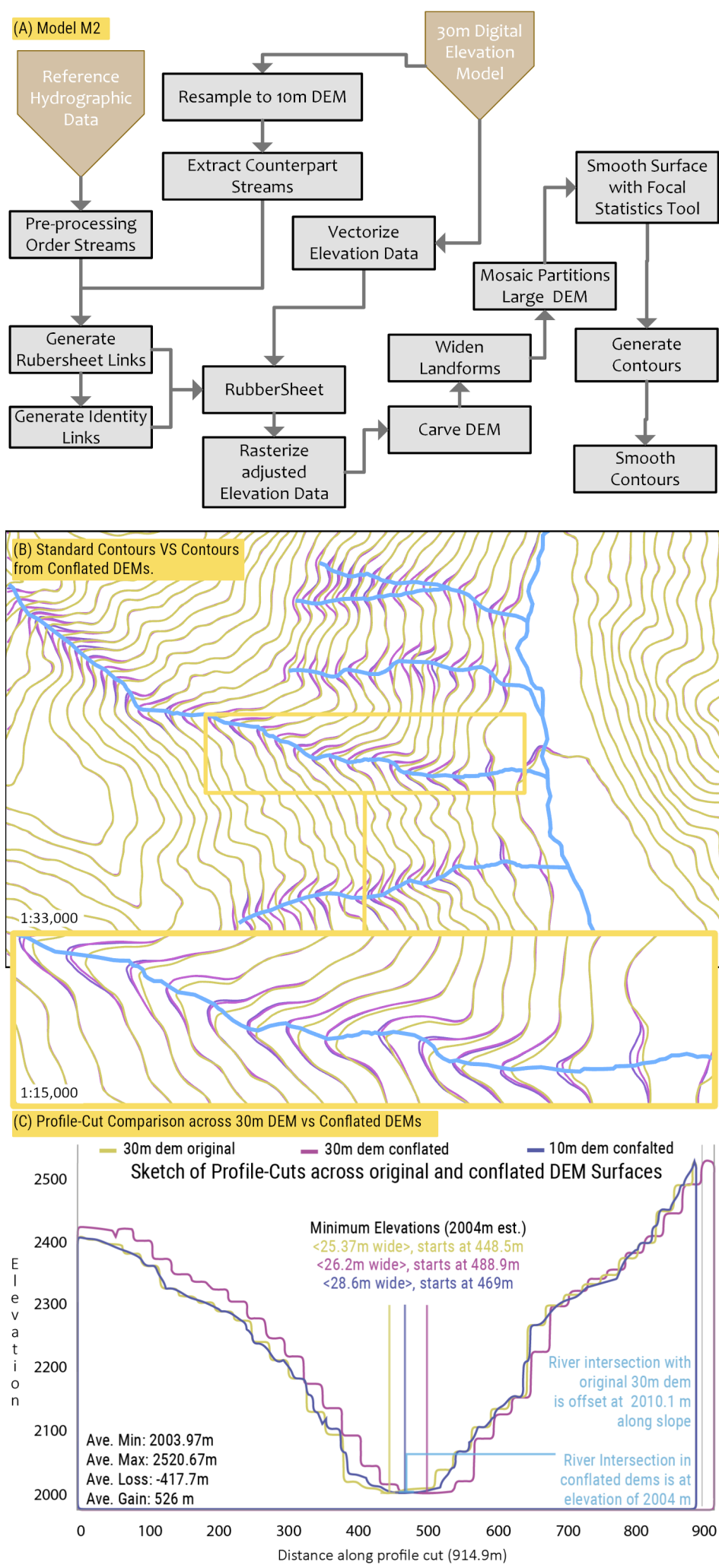
Figure 2: (A) Model (M2). (B) Sample results comparing improved 30m standard and hybrid contours from conflated DEMs to contours from global 30m DEM (C) Profile cut across all DEMs
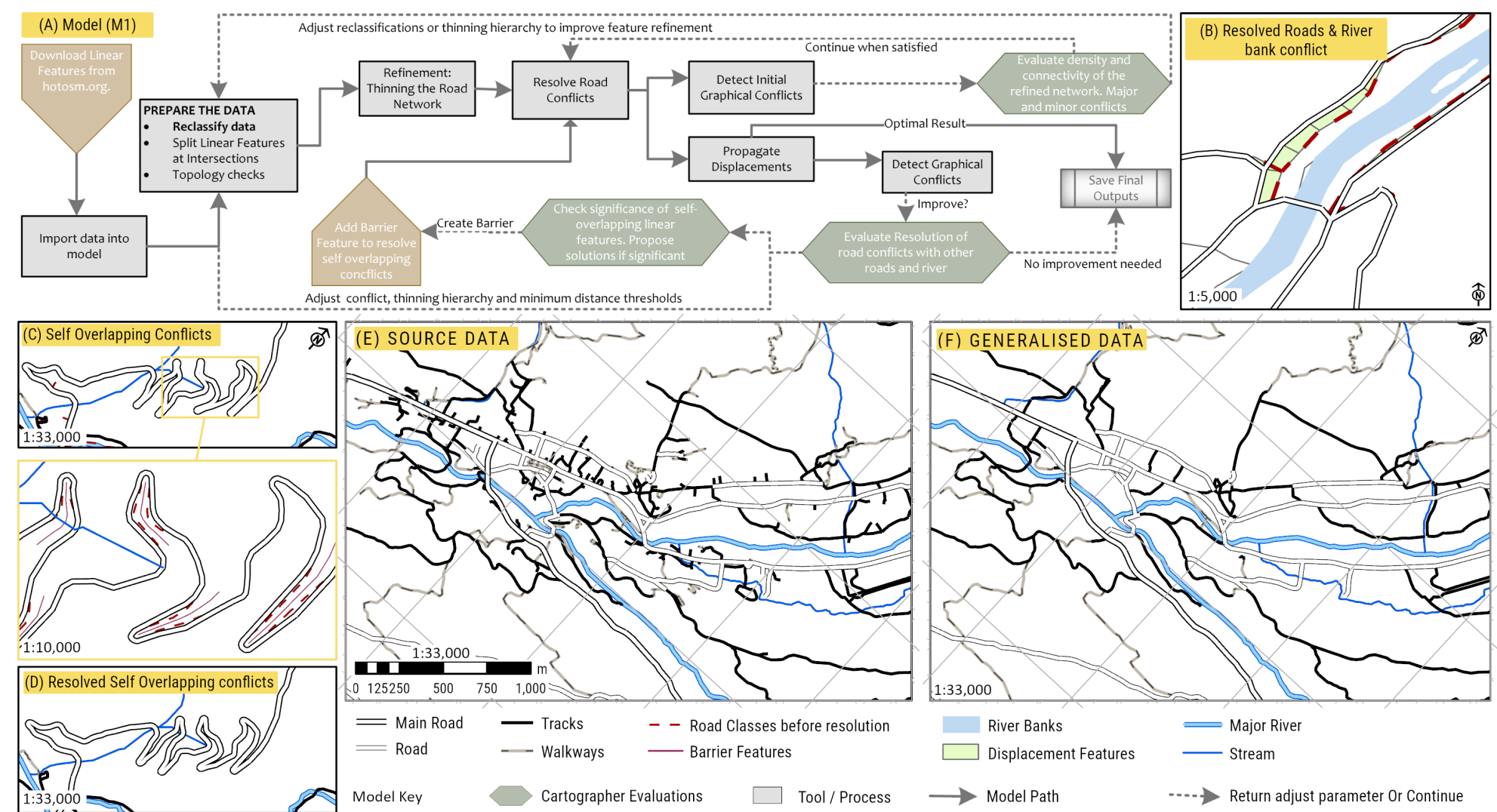
Figure1: (A) presents a standard generalisation model (m1) for linear features. (B) Shows resolved coalescence conflict with displacement feature in green and the old position of road in red. (C, D) show before and after results of a Self-Overlapping Conflict using a barrier feature to resolve. (E,F) show before and after results or linear feature generalisation at 1:33000 scale.

REFERENCES

[1] Punt, E., & Watkins, D. (2010). User-directed generalization of roads and buildings for multi-scale cartography. Zurich – Punt & Watkins, 1.

[2] Samsonov, T. E. (2020). Automated Conflation of Digital Elevation Model with Reference Hydrographic Lines. In ISPRS International Journal of Geo-Information (Vol. 9, Issue 5). https://doi.org/10.3390/ijgi9050334