the River Restoration Centre
Working to restore and enhance our rivers

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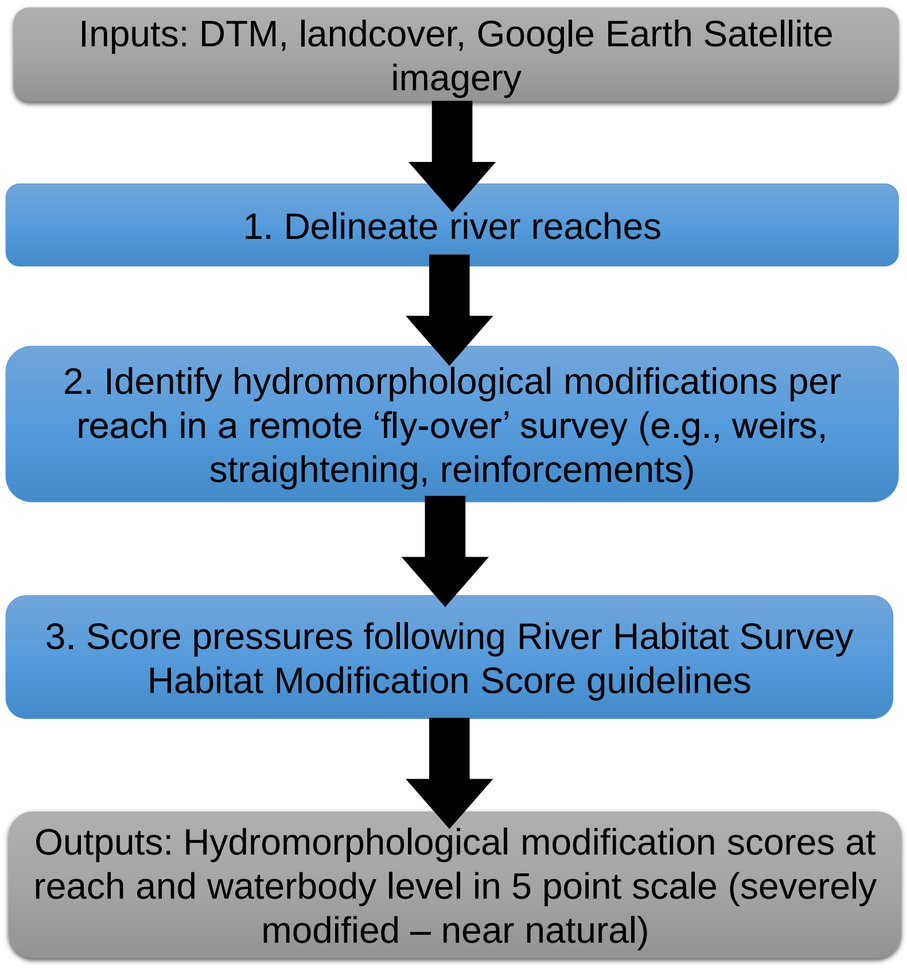
A framework for assessing hydromorphological modifications using remote technologies

Introduction

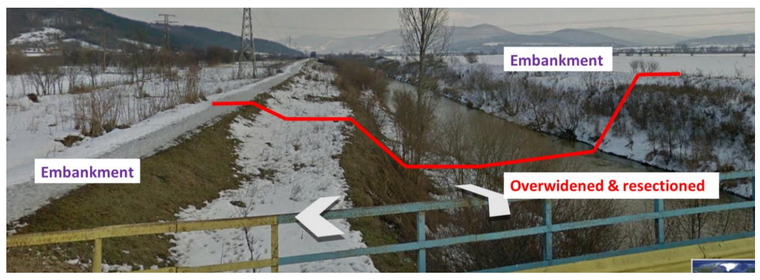
The Water Framework Directive (WFD) requires an assessment of river hydromorphology to support the high ecological status classification of rivers. Hydromorphology is defined as 'the physical habitat constituted by the flow regime (hydrology and hydraulics) and the physical template (fluvial geomorphology)' (Orr et al., 2008).

Hydromorphological assessments are usually carried out on the ground. Few studies have explored the identification of hydromorphological modifications using remotely sensed datasets beyond the reach scale.

The RRC developed a framework to identify river hydromorphological modifications using freely available satellite imagery from Google Earth and Google StreetView 360 degree photos. The approach was applied at a national scale across 14,357 reaches spanning 51,300km of rivers in Bulgaria to produce a hydromorphological condition assessment.



CEN element	Features/pressures recorded in the 'fly over' survey
Morphology	Planform Modification
	Over widening and/or over deepening
	Bank and/or bed modification
	Type of bank/bed modification
Continuity/ Hydrology	Embankments
	Land cover
	Weirs
	Crossings
	Culverts
	Dams
	Hydrological regime



Right – 360 degree street view image used for identifying channel modifications.

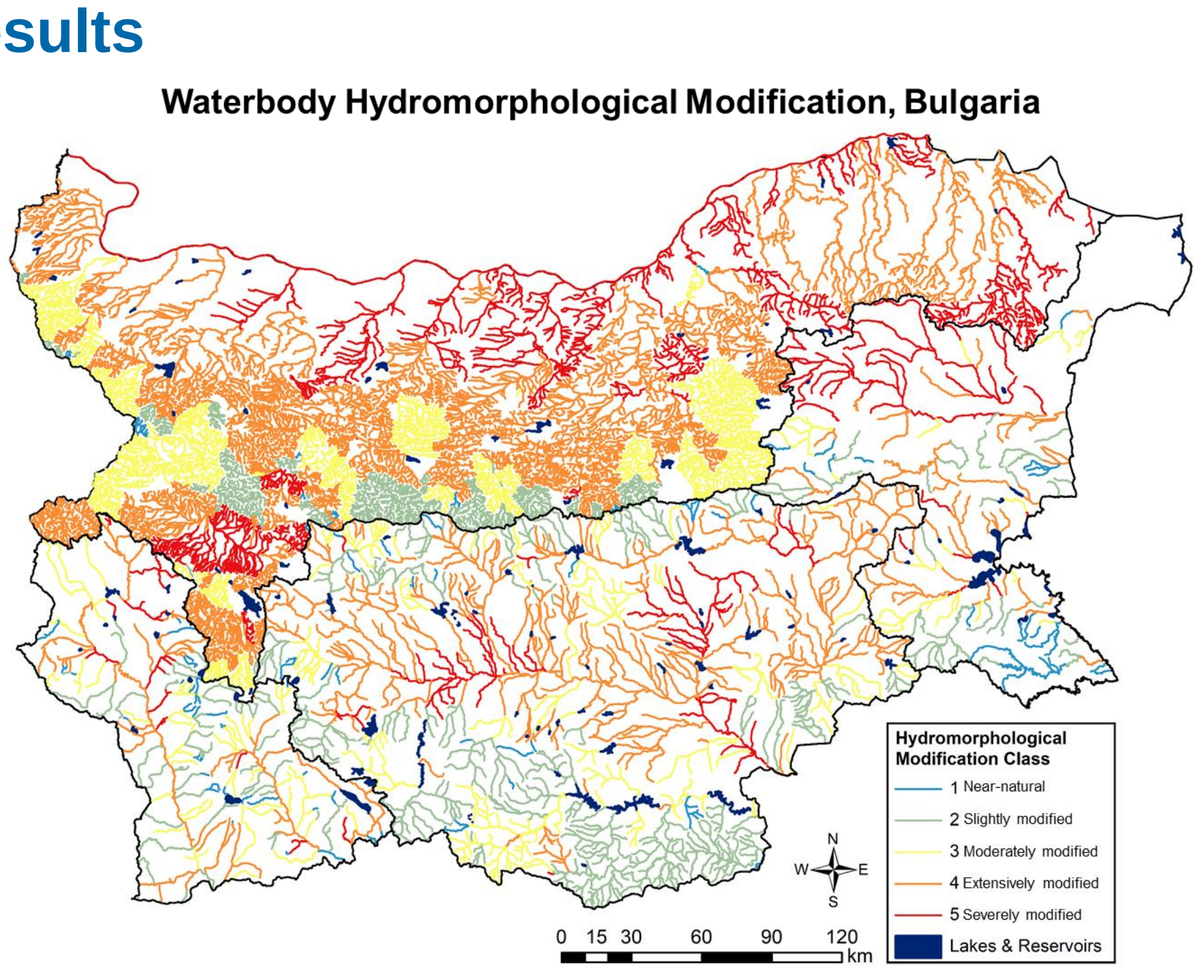
Method

A river network was created from a high resolution DTM covering Bulgaria. The river network was split into reaches based on river network characteristics (tributaries – Source ID, Strahler stream order), land cover and hydromorphological characteristics. At each reach a 'fly over' assessment was undertaken, which involved recording the absence or presence of hydromorphological modifications/pressures. Pressures recorded in the fly over surveys were based on those in the CEN guidance (e.g., planform modification, bank /bed modification, weirs, crossings). River pressures were scored using the River Habitat Survey's Habitat Modification Scores, which are weighted scores based on pressure extent across the channel cross section area and resilience (e.g., the duration the modification is expected to affect the channel). Reach scores were combined and weighted to produce overall waterbody scores.

Results

In total, across Bulgaria, 11% of rivers were in a near-natural condition, 23% were slightly modified, while 19%, 33% and 14% of rivers were moderately, extensively and severely modified (respectively). Morphological alterations were most prominent, with planform straightening and bank/bed modifications affecting >33% of river reaches surveyed. Continuity pressures, defined by the extent of different infrastructure, were also widely prevalent, with 54% of reaches impacted by channel crossings.

A subset of the remote surveys were compared to field based surveys, there was a high agreement between remote versus field-based methods (linear regression: $R^2 = 0.53$), differences were due to fieldwork sampling locations (e.g., at bridges) and, localised pressures that were not visible using aerial imagery.



The remote approach is effective for providing an initial assessment of hydromorphological conditions rapidly across large spatial scales.