Using air photos to parameterise landscape predictors of channel wetted width at baseflow

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Summary: We used air photos to investigate which landscape and climate-related data (including information on hydrological source of flow) were statistically significant predictors of channel wetted width (WW) at baseflow across a region of the UK where channels are in a near natural state.
As catchment area increases, those catchments with more groundwater dominated flow (less runoff) have narrower WW at baseflow by contrast to those where runoff is greater (less permeable soil and bedrock).

Methods: The study region is an area of 2200 km^2, part of north Wales and western England (Fig 1). It was selected to encompass a broad range of bedrock lithology, topography and land cover types. Elevation is greatest to the west (>1000 m) and declines towards the east to around sea level .Fig 1b shows the spatial distribution of an index relating to hydrological source of flow (BFIHOST) for each $1km^2$.

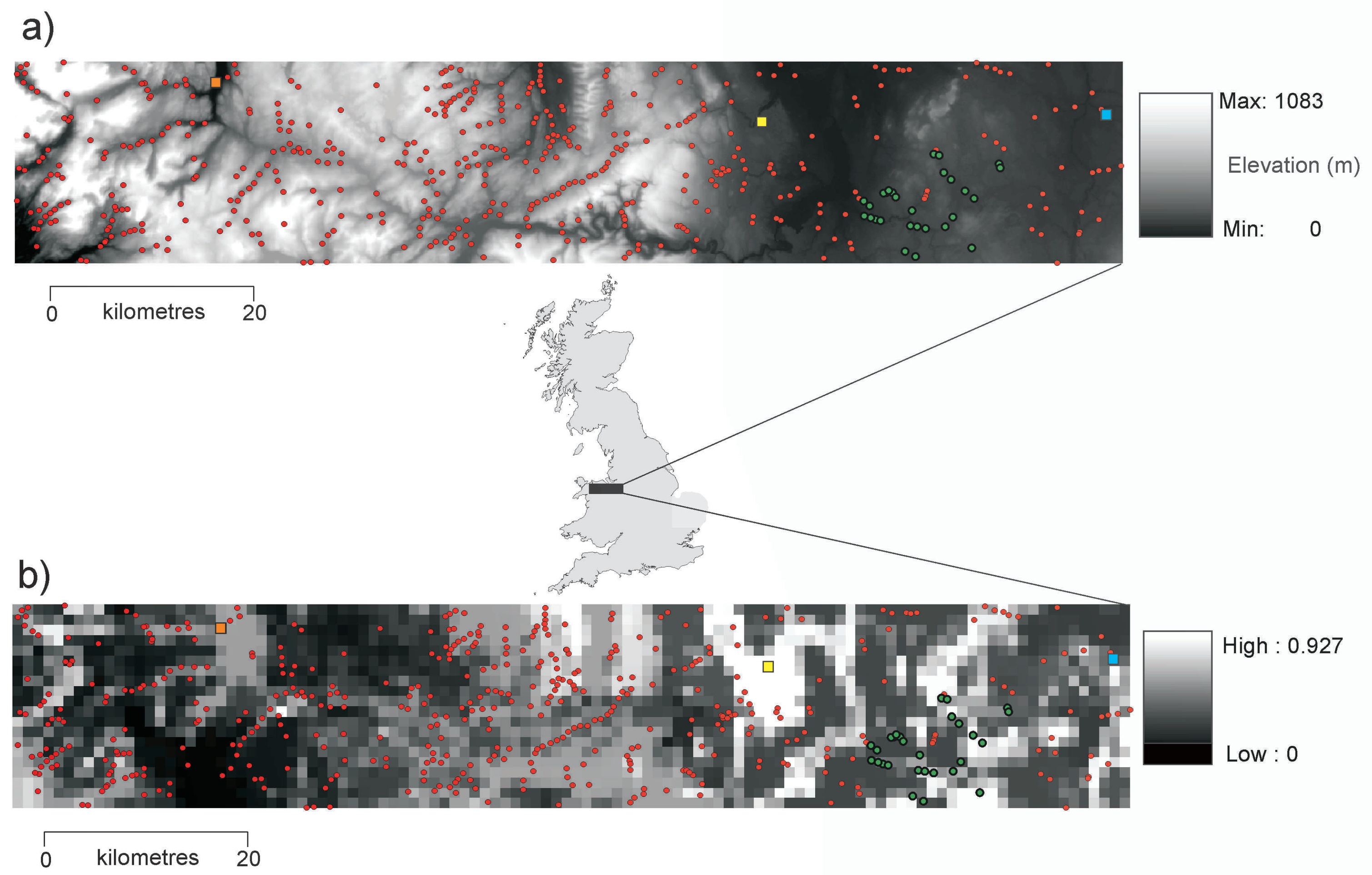


Fig 1: Study region and the distribution of sites (n=472) at which channel wetted widths were measured: a) elevation, b) BFIHOST values.

The red discs are sites where wetted widths were measured from air photos, the green discs (n=28) are sites where field measurements of wetted width were also undertaken.

Analysis: We used 25 cm pixel air photos to measure channel WW under baseflow conditions across the study region. For each catchment which drained to the point of WW measurement we calculated: 1) catchment area $(CA)^{0.5}$, 2) mean BFIHOST, 3) mean annual rainfall, 4) local slope, 5) catchment slope and 6) elevation. We formed models for the prediction of channel WW using OLS regression to estimate coefficients for the landscape predictors. We fit a model using only $CA^{0.5}$ (CA model) as a predictor, and also with all predictors (full model; see Fig 2).

Fig 2: Scatterplot of channel WW measurements (air photos) and predictions. The CA model accounted for 54% of the variance, whilst the full model which includes an interaction between $CA^{0.5}$ and BFIHOST, accounts for 76%.

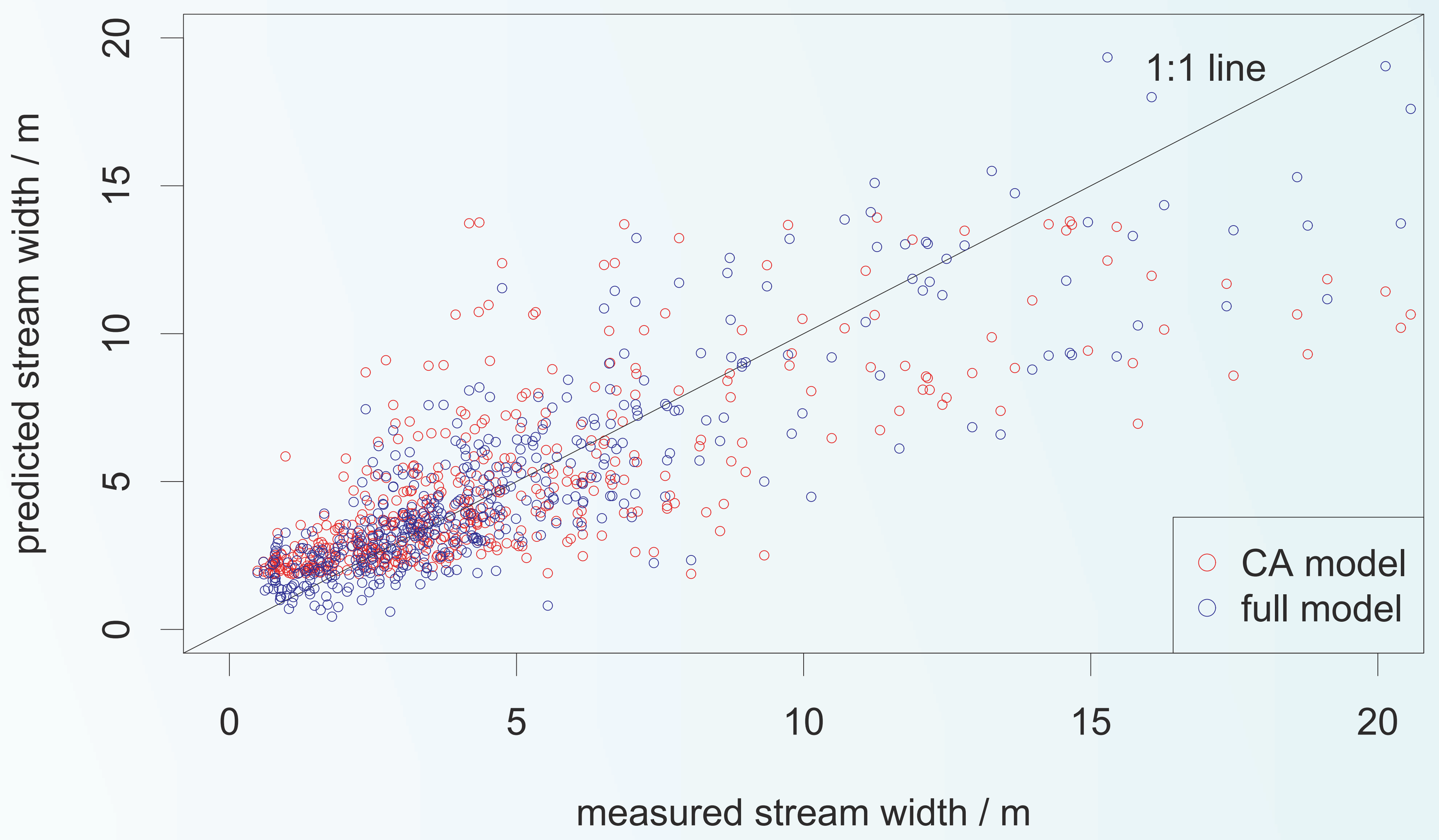
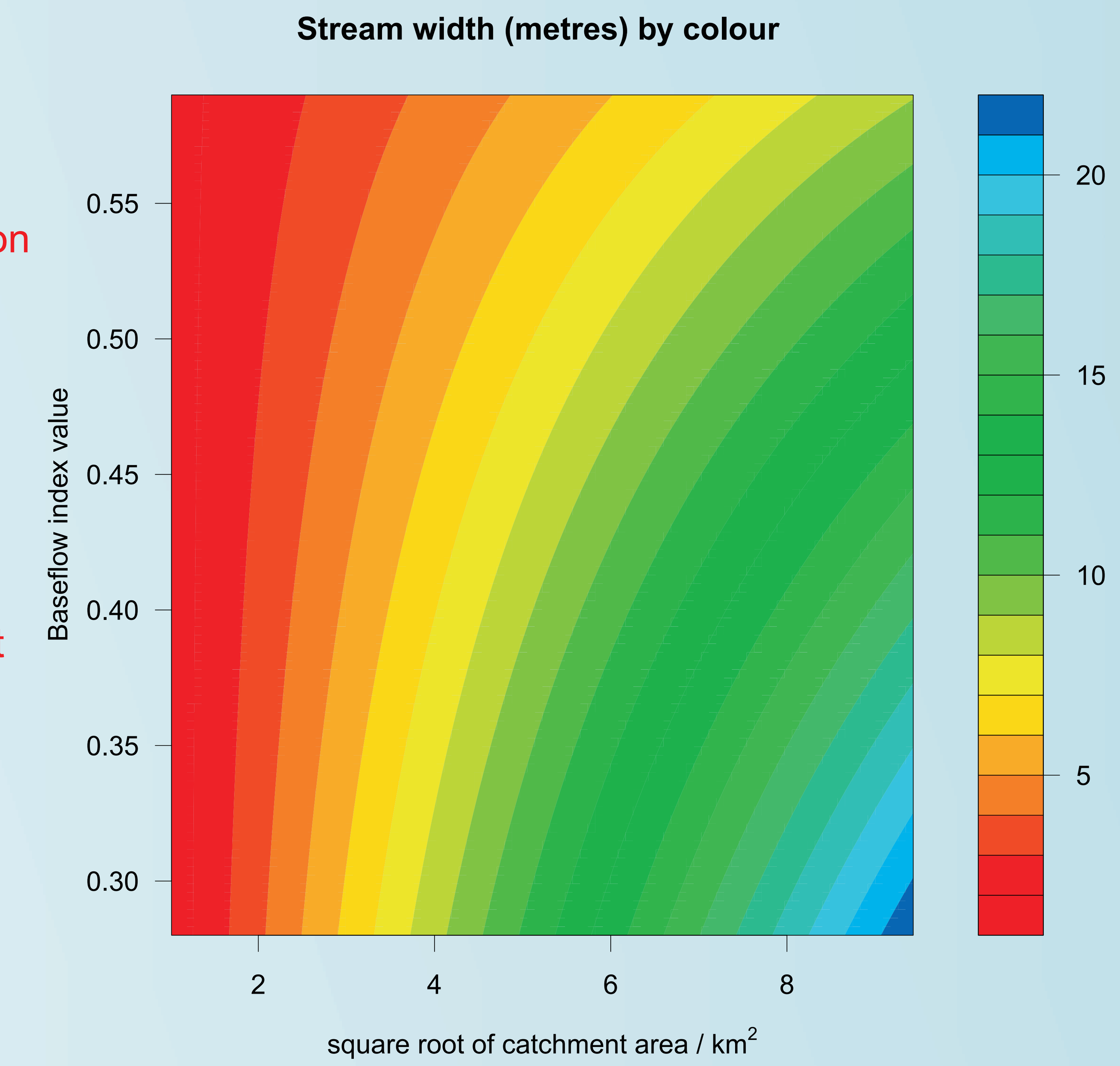


Fig 3: Visualization of the interaction between catchment area ($CA^{0.5}$) and BFIHOST and its effect on channel WW (m) for the study region. Channel morphology responds to the source and type of flow; those channels with more consistent baseflow contributions have narrower, and also likely, deeper channel profiles by contrast to those channels where hydrographs have more flashy responses



Discussion: we cannot be certain that the mechanism through which BFIHOST accounts for channel WW is entirely related to hydrological source because there are other factors that are related to channel WW, such as substrate type, which may also relate closely to BFIHOST values. In regions where there is neither information on hydrological source of flow, nor measurements of flow for gauged catchments, it may be possible to develop a hydro(geo)logical-based classification using maps of soil and geology to estimate a similar index to BFIHOST.

References: Rawlins, B.G., Clark, L. and Boyd, D.S. 2013. Using air photos to parameterise landscape predictors of channel wetted width at baseflow. ESPL (in revision). Email: bgr@bgs.ac.uk