Catchment characteristics and water quality of Scottish drinking water catchments

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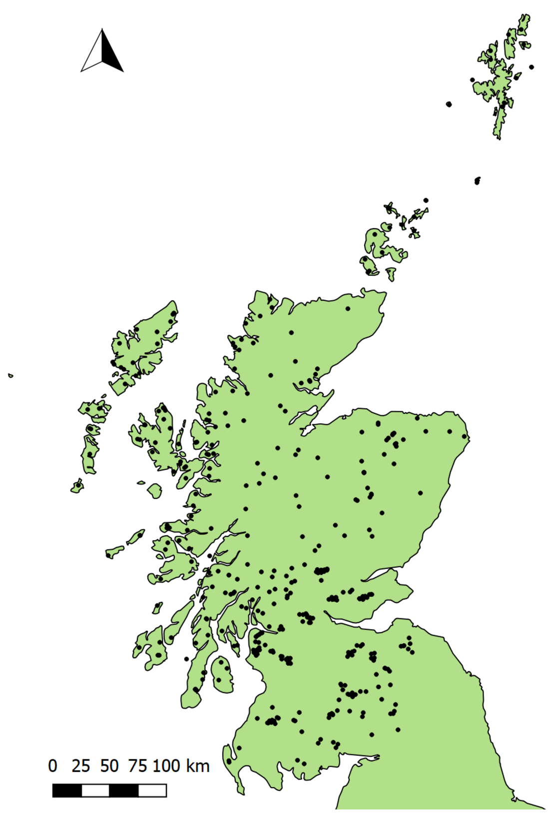
Drinking Water

An essential commodity



The provision of drinking water is an essential service, and drinking water is usually sourced close to its consumption. This means that water resources all over Scotland are used to supply drinking water (Fig. 1). Most of these are surface waters, which are, compared to groundwater, sensitive to changes in rainfall and runoff patterns. To minimise the costs of treatment, pollution of the drinking water sources should be minimised.

In Scotland, the majority of households (2.5 million [1]) receive their drinking water through the public provider, Scottish Water.

Figure 1: Location of drinking water catchments in Scotland.

Catchment characteristics

Scottish Water operates 245 water treatment works that are supplied by 398 active catchments. These comprise 141 rivers, 49 lochs, 146 impounding reservoirs, 21 springs, and 41 boreholes.

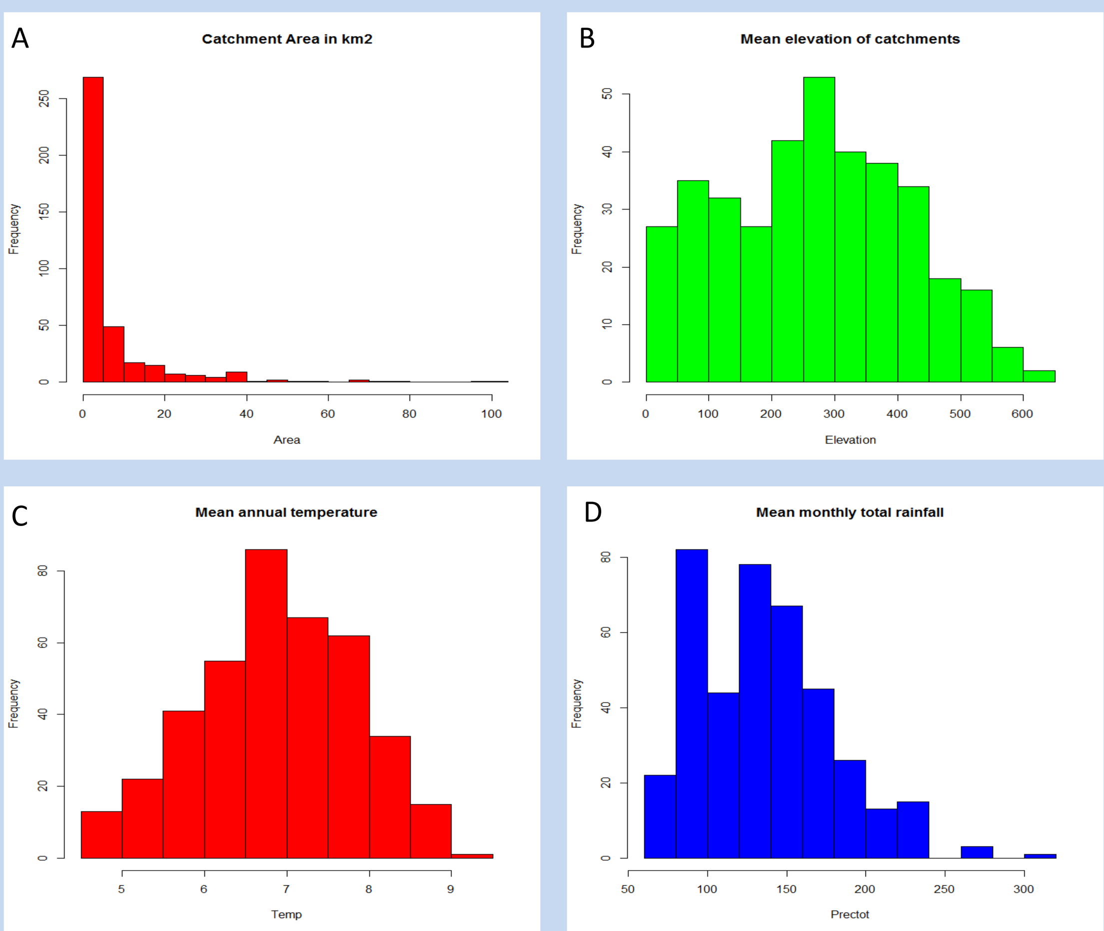


Figure 2: Histograms of A. Catchment size in km^2. Catchments above 100 km^2 in size have been omitted (16), B. Mean elevation of catchments, C. Mean annual temperature in °C per catchment, and D. Mean monthly rainfall in mm per catchment.

The great majority of drinking water sources are small catchments, with a few exceptions (Fig. 2 A). The median catchment size is 3.14 km^2. Only three catchments are larger than 1000 km^2, and another 13 are larger than 100 km^2. Most are smaller than 5 km^2. Most catchments have a mean elevation of between 250 and 300m (Fig. 2 B). The mean annual temperature in the catchments ranges between 4.5 and 9.1 degrees Celsius, with most catchments having a mean temperature between 6.5 and 7 degrees (Fig 2 C). The mean monthly total rainfall is 135mm, although a few catchments have significantly higher mean monthly total rainfalls (Fig. 2 D).

Most catchments are highly dominated by igneous and metamorphic types of bedrock. Some are also situated on sandstone, but only few show a higher percentage (above 20%) of limestone (4) or other types of sedimentary rocks (12) (Fig. 3 A). Many catchments have a lot of peaty soils, while 10 are covered by 25% or more of eroded peat (Fig. 3 B). Catchments are highly dominated by semi-natural or natural habitat, followed by coniferous forest (Fig. 3 C). Most catchments have few urban areas (below 10%). An average of 67% semi-natural habitat is slightly above Scotland as a whole (55%), while arable areas are underrepresented (mean of 2.7%, compared with 8.9% for Scotland as a whole).

Drinking water catchments reflect natural conditions of Scotland (e.g. topography, bedrock, soil, climate) very well. Differences found in land cover classes are probably due to attempts to choose more pristine waters that are subject to fewer anthropogenic influences, if and where possible.

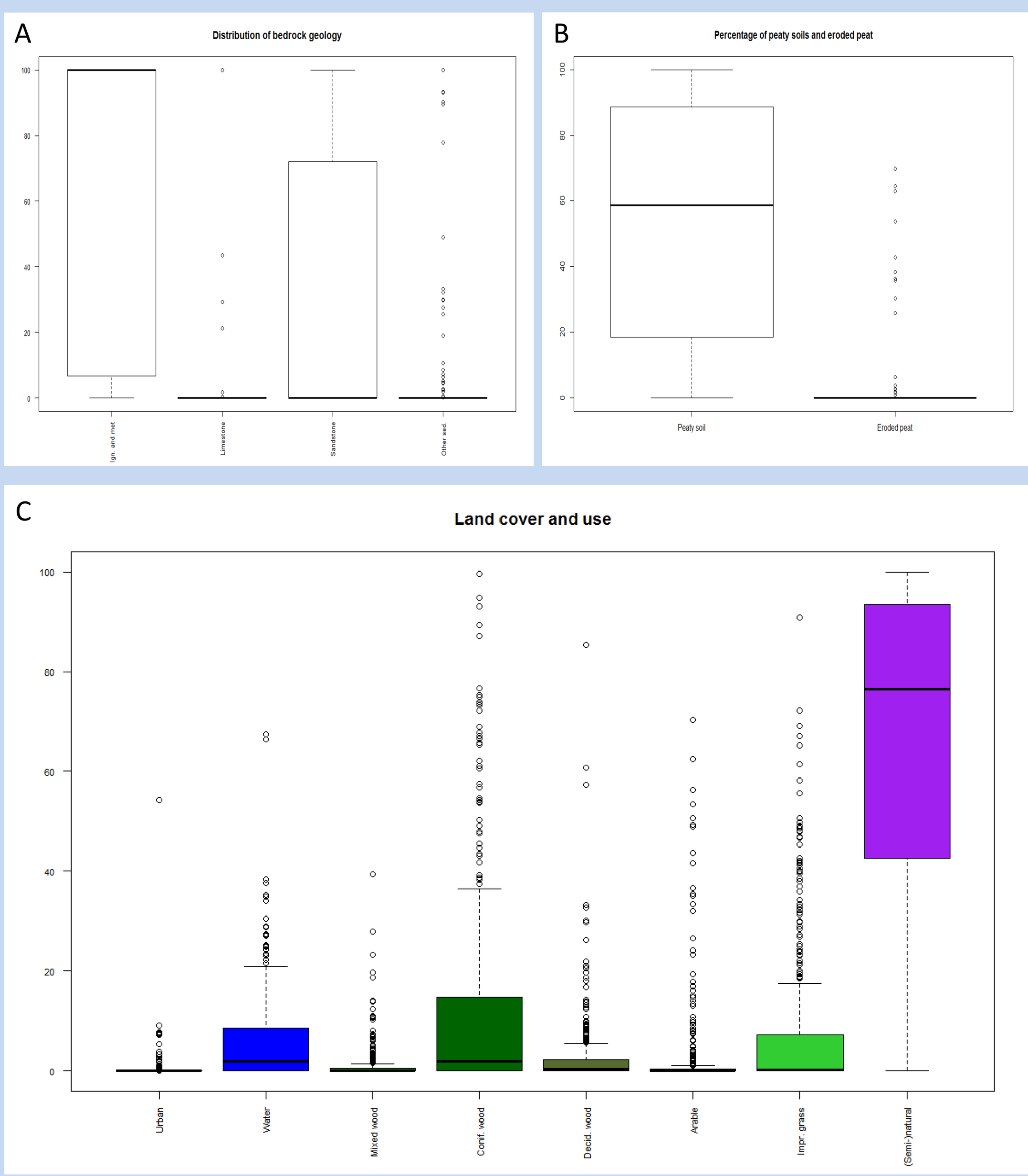


Figure 3: Distribution (percent cover in a catchment) of A. Type of bedrock geology , B. Distribution of peaty soil cover, and C. Land cover and use.

Water quality

Before water is distributed to the consumer, it is made “wholesome and clean“ (Art. 4.1 of the EU Drinking Water Quality Directive [2]). The water is collected, sampled and treated at water treatment plants. For some catchments, Scottish Water also samples the water separately (source water samples). These samples are tested for a number of parameters. Analysing the source water samples can help to understand how catchment characteristics influence water quality and how catchments react to anthropogenic influences.

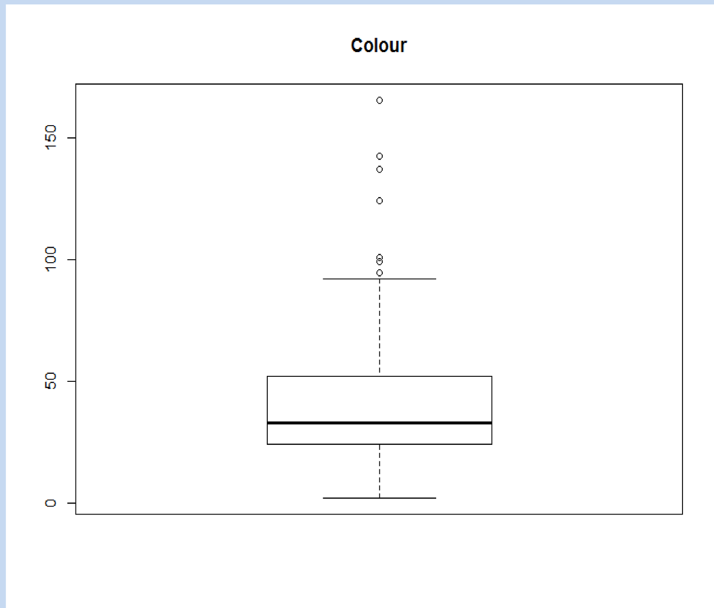


Figure 4: Distribution of median catchment values for colour (in mg/l Pt/Co).

Most catchments, for most parameters, show a fluctuation around a median value with occasional extreme peaks. Similarly, most catchments show comparatively low median values with some catchments having considerably higher medians (Fig. 4 for colour as an example).

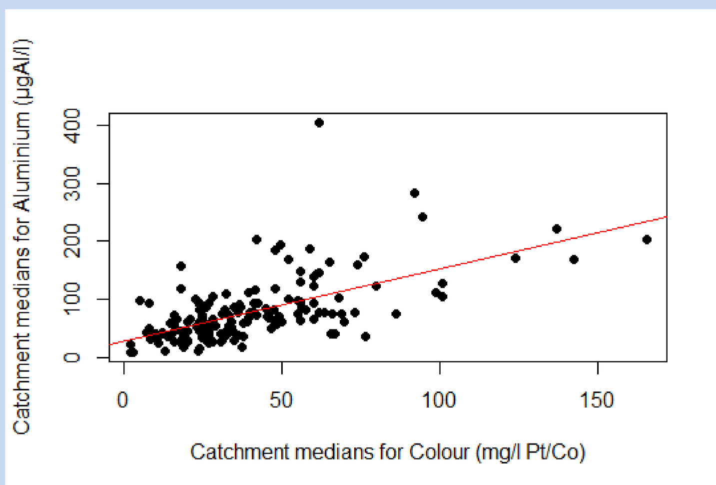


Figure 5: Catchment median aluminium concentration plotted against catchment median colour concentration, with a fitted regression line.

Several water quality parameters will exhibit similar behaviour in a catchment. For example, catchments showing higher median values for colour often also show higher median values for aluminium (Fig. 10). This is probably due to similar catchment related processes influencing the concentration of these parameters.

The bigger picture

Scottish drinking water catchments are described and source water samples are analysed as part of the PhD project „Safeguarding and Improving Raw Water Quality by Increasing Catchment Resilience”. The project aims to find statistical models that describe relationships between catchments and water quality depending on natural and anthropogenic characteristics. These will then be used to assess the risk to drinking water quality from future climate and land use changes (Fig. 6). The results will help to inform management and investment strategies and shed light on the usefulness of a catchment approach and ecosystem based adaptation to protect drinking water sources in Scotland.

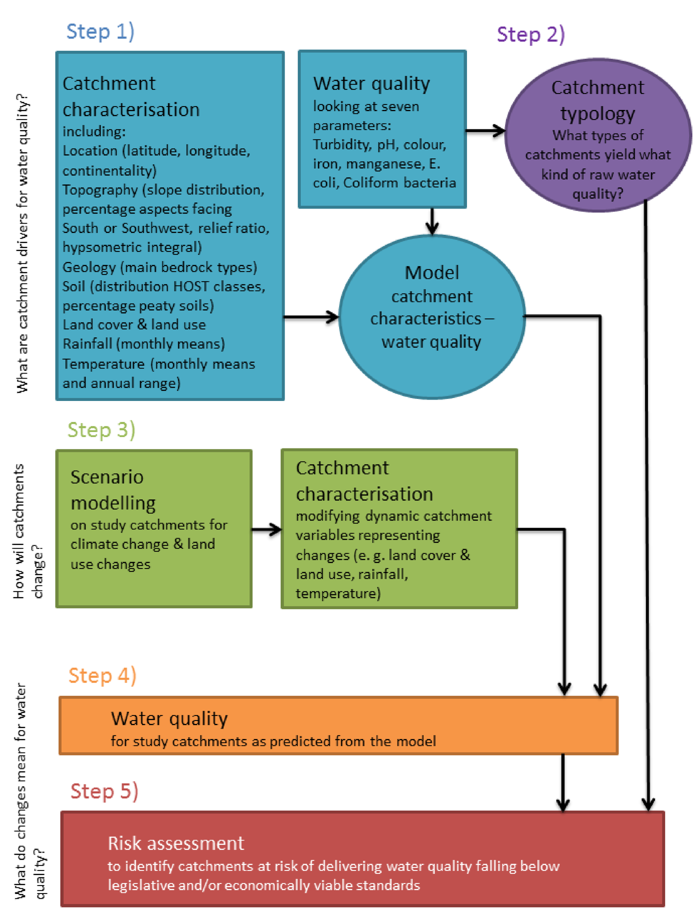


Figure 6: Steps in the proposed methodology of the project.

References:

1. Scottish Water, 2017. Annual Report & Accounts 2016/2017 [pdf].
2. COUNCIL DIRECTIVE 98/83/EC of 3 November 1998

Acknowledgements:
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