Neural Networks, Remote Sensing, and Discharge:

An Accessible Non-Linear Environmental Discharge Model

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Aims:

1. Record the water velocity, channel dimensions, and bed material for three sections of three rivers over 36 months.
2. Train a NN to predict the discharge of these catchments at any location given recorded parameters.
3. Minimise the disagreement between existing models via a NN to create a new universal open source database.

$$Q = Au$$

- Easy to assume linear discharge
- Overlooks intricate details we could observe
- Oversimplifies the nonlinearity of rivers

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} \rightarrow Q = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

$$\frac{\partial A}{\partial t} = R_{net} - \frac{\partial Q}{\partial x}$$

- Non-linear models
- Much more accurately models changing discharge *including* considering net runoff (surface and sub-surface) and bed material
- *BUT* much more difficult to resolve by hand or using linear databases

V = water velocity (ms^{-1})

n = Manning's drag coefficient

R = wetted perimeter (m)

S = gradient (m/m)

$\frac{\partial A}{\partial t}$ = change in cross-sectional area

R_{net} = net runoff

$\frac{\partial Q}{\partial x}$ = change in discharge over longitudinal space

So why a neural network?

The equations themselves are ***hard*** to resolve by hand. Since they are also non-linear, and model a very dynamic system, the resolution and measurement accuracy would be low if we did not automate the calculations. They easily assimilate new, very complex data, and can uncover surprising hidden patterns.

BUT not just a neural network… Remote sensing is crucial too!

DJI-LiDAR Range Finder (RS)

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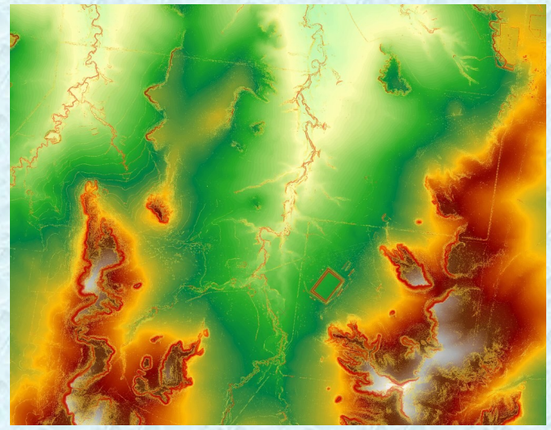
ArcGIS



Example of a LiDAR-derived digital elevation model. The raster dataset can be integrated into a python file (via ArcGIS Pro), then into the neural network.