How's Peat Doing?

Using Deep Learning and High-Resolution Imagery to Map the Condition of Scotland's Peatland Resource

Fraser Macfarlane [1*], Ciaran Robb [1], Margaret McKeen [2], Rebekka Artz [2], and Matt Aitkenhead [2]
[1] The James Hutton Institute, Invergowrie, Dundee, DD2 5DA, Scotland
[2] The James Hutton Institute, Craigiebuckler, Aberdeen, AB15 8QH, Scotland
[*] Email: fraser.macfarlane@hutton.ac.uk

The James Hutton Institute

Introduction

Aims:

- Improve the spatial resolution of Scotland's peat condition mapping
- Identify specific peat condition features
- Provide GIS layers suitable for other users
- Provide a modular pipeline for use in other remote sensing tasks

Overview:

- Image segmentation datasets of peatland drainage and erosion have been created
- Models for segmenting peatland drainage and erosion features have been developed
- A deep learning pipeline for national scale modelling has been created and deployed on existing HPC infrastructure
- National mapping at 25cm resolution has been carried out

Methods

Model Development

- Semantic segmentation was achieved using manually digitized datasets and a U-Net architecture with a ResNet-101 backbone.
  - 46 tiles of drainage – 7,774 mosaiced image/mask pairs
  - 33 tiles of erosion – 5,577 mosaiced image/mask pairs
  - 90/10% training/validation split

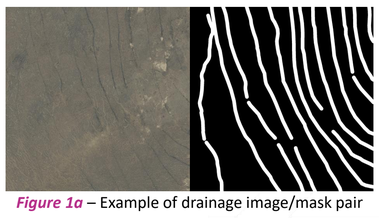

Figure 1a – Example of drainage image/mask pair

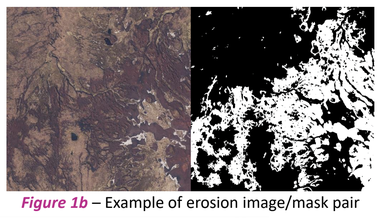

Figure 1b – Example of erosion image/mask pair

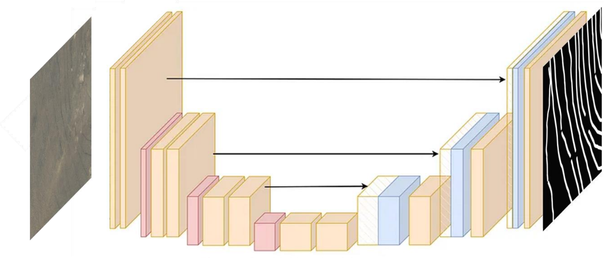

Figure 2 – U-Net Architecture

- Using this architecture and the assembled datasets for both drainage and erosion features two separate models were trained:
  - Drainage: Dice Loss - **0.01095**, F1 Score - **0.99013**, Accuracy - **0.99013**, IoU - **0.98**
  - Erosion: Dice Loss - **0.02587**, F1 Score - **0.97553,** Accuracy - **0.97552**, IoU - **0.95**
    - Indicates good generalisation accross the training datasets

Image Processing/GIS Pipeline

- The trained models were then deployed using the GPU nodes of the Institute's CropDiversity HPC
- The resulting predictions were then cleaned, formatted and validated as GIS layers

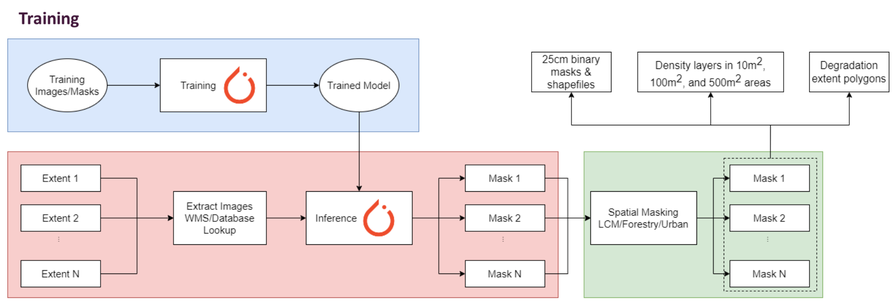

Figure 3 – PeatNet Processing/Mapping Pipeline

Acknowledgements
Special thanks go to Airbus Intelligence for the provision of APGB imagery.

This work is funded by RESAS as part of *JHI-D3-1 CentrePeat, JHI-C3-1 Land Use, and JHI-D5-2 Natural Capital*

Scottish Government
Riaghaltas na h-Alba
gov.scot

Nationwide Density of Peatland Degradation Features in Scotland per 500m² Unit Area

Insets show localised drainage and erosion features at 25cm resolution.

Drainage Density
0.512482
0

Erosion Density
0.741001
0

0 1 2 3 4 km

0 0.5 1 1.5 2 km

0 1 2 3 4 km

0 0.5 1 1.5 km

0 1 2 3 4 km

0 0.5 1 1.5 2 km

0 1 2 3 4 km

N
W
E
S

0 25 50 75 100 km

The James Hutton Institute
All Rights Reserved. APGB Imagery © Bluesky International Ltd and Getmapping Plc 2023
© The James Hutton Institute 2023

Conclusions

- This work presents a pipeline for peatland degradation classification using deep learning
- Estimated 426 km^2 of Eroded peat and 51,700 km of drainage channels in Scotland
- These layers have been validated using existing spatial datasets and will be made available to the wider community
- Future work includes:
  - Incorporating Colour Infrared (CIR) imagery from APGB for improved detection and segmentation of desired features
  - Use instance segmentation over semantic segmentation to detect individual features
  - Automated segmentation and classification of additional features visible in imagery – muirburn, peat extraction, etc.
  - Use of the high-throughput pipeline on other applicable remote sensing tasks