TROPICAL PEATLANDS CANAL SEGMENTATION FROM HIGH RESOLUTION OPTICAL IMAGE USING U-NET ARCHITECTURE

M. HAIDAR[1,2], **and W. TAKEUCHI**[3]

[1] PhD student, Department of Civil Engineering, The University of Tokyo, Tokyo, Japan,
[2] Mapping Surveyor, Geospatial Information Agency, Bogor, Indonesia,
[3] Professor, Institute of Industrial Science, The University of Tokyo, Tokyo, Japan,
Correspond to M. HAIDAR (muhammad.haidar@big.go.id)

***Keywords**: SPOT-6, SPOT-7, Deep learning, Resnet-34, Artificial drainage detection*

1. BACKGROUND

A complete and accurate distribution of artificial canal is fundamental for advancing studies of human-induced carbon emission in tropical peatlands. The most recent publicly available drainage canals map in Southeast Asian Peatlands is a collection from Stanford Digital Repository that generated from 5-meter Planet Basemaps satellite imagery using a convolutional neural network [1]. This dataset displayed intersection over union (IoU) score of 0.85, however, the determination of a true positive was loosened within 25-meter distance. Given extremely low load bearing capacity in peat soil, roads are also labeled as canals. This assumption and relaxing the true positive criteria could lead to the uncertainty in canal detection. We proposed to address that uncertainty by incorporating higher resolution of satellite images where canal and non-canal can be visually better distinguished. Thus, this study aims to deliver classification models for automatically extracting artificial canal map from high-resolution (HR) satellite images.

2. METHOD

Here we exploit a deep learning method to automatically segment surface water features from 1.5-meter resolution pan-sharpened SPOT-6/SPOT-7 orthomosaic. Two models are developed to distinguished between (1) water and non-water; and (2) canal and non-canal. True color SPOT images are provided by Indonesia Space Agency (LAPAN) that acquired between 2014 and 2017 as part of national distribution of nearly cloud-free HR satellite images.

Data labelling for supervised learning is created by visually interpreting the input images from SPOT-6/SPOT-7. Label images covers 660 km^2 in Indragiri Hilir Regency, Riau Province, Indonesia and split to 70%, 20%, and 10% for training, validation and testing respectively. Given the high resolution of input images, we were able to precisely identify surface water features. Canal networks is not necessarily connected due to sedimentation, poor maintenance, or canal blocking activity.

The neural network designs we use in this study follow the *U-Net* architecture [2] combined with *Resnet-34* backbone, a fully convolutional encoder-decoder network with skip-connections. The input to the network is a patch $x \in \mathbb{R}^{512x512x3}$, and the output is a segmentation map $\Phi(x) \in [0.2]^{512x512x1}$. The model was compiled by using *Adam* optimizer, loss function using *Jaccard binary cross entropy*, and evaluate the performance by using *IoU* score.

3. RESULT

Both models are applied to test dataset to assess the reliability for unseen data.

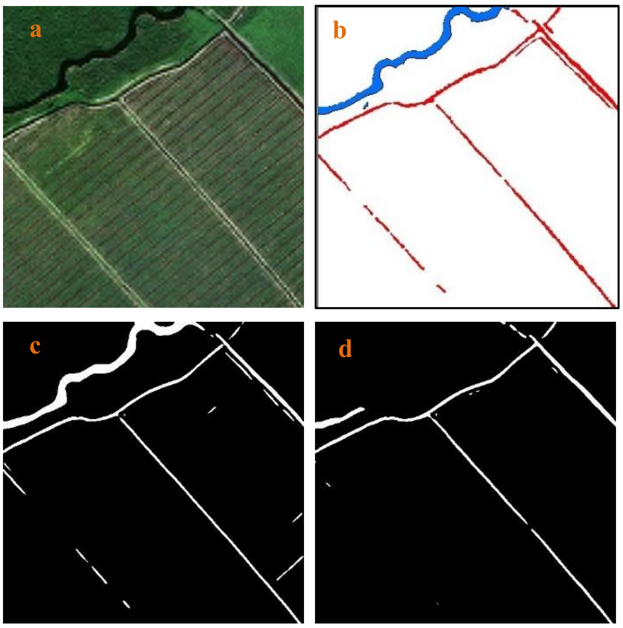

Figure 1. A patch of test image, (a) input image; (b) corresponding label, blue is river, red is canal; (c) Model 1 prediction; (d) Model 2 prediction

4. CONCLUSIONS

Validation dataset yields IoU score of 0.75 and 0.68 for Model 1 and Model 2 respectively. However, when evaluated on the test dataset the IoU score decrease to 0.67 for Model 1 and 0.59 for Model 2. Employing higher resolution of satellite images without any conflicting assumption could lead to more objective and realistic results.

REFERENCES

[1] N.C. Dadap, A.M. Hoyt, A.R. Cobb, D. Oner, M. Kozinski, P.V. Pua, K. Rao, C.F. Harvey, A.G. Konings, Drainage Canals in Southeast Asian Peatlands Increase Carbon Emissions, *AGU Advances*. 2 (2021) e2020AV000321.

[2] O. Ronneberger, P. Fischer, and T. Brox, U-Net: Convolutional networks for biomedical image segmentation, *Proc. Int. Conf. Med. Image Comput.*, (2015), pp. 234–241.