

Convolutional neural network shows greater spatial and temporal stability in multi-annual land cover mapping than pixel-based methods

Supplementary Material

Table S1. 2015-2016 transition statistics: No change (**bold**), possible change (plain text), and unlikely (*italics*) and implausible (underlined) changes showing class transitions.

2015-2016 transition	Count	Percent
No change	15,369,786	96.06%
Possible change	454,390	2.84%
<i>Forest=>Water</i>	26,149	0.16%
<i>Horticulture=>Grassland</i>	6,502	0.04%
<i>Horticulture=>Builtup</i>	47	0.00%
<i>Plantation=>Water</i>	87	0.00%
<u>Forest=>Plantation</u>	<u>33,163</u>	<u>0.21%</u>
<u>Grassland=>Forest</u>	<u>25,180</u>	<u>0.16%</u>
<u>Grassland=>Plantation</u>	<u>4,329</u>	<u>0.03%</u>
<u>Horticulture=>Plantation</u>	<u>26</u>	<u>0.00%</u>
<u>Plantation=>Forest</u>	<u>27,509</u>	<u>0.17%</u>
<u>Plantation=>Horticulture</u>	<u>1</u>	<u>0.00%</u>
<u>Bare=>Forest</u>	<u>170</u>	<u>0.00%</u>
<u>Water=>Forest</u>	<u>6,926</u>	<u>0.04%</u>
<u>Water=>Plantation</u>	<u>43</u>	<u>0.00%</u>
<u>Water=>Built-up</u>	<u>2,057</u>	<u>0.01%</u>
<u>Built-up=>Forest</u>	<u>2,106</u>	<u>0.01%</u>
<u>Built-up=>Grassland</u>	<u>40,241</u>	<u>0.25%</u>
<u>Built-up=>Horticulture</u>	<u>2</u>	<u>0.00%</u>
<u>Built-up=>Plantation</u>	<u>12</u>	<u>0.00%</u>
<u>Built-up=>Water</u>	<u>1,274</u>	<u>0.01%</u>
Total	16,000,000	100.00%

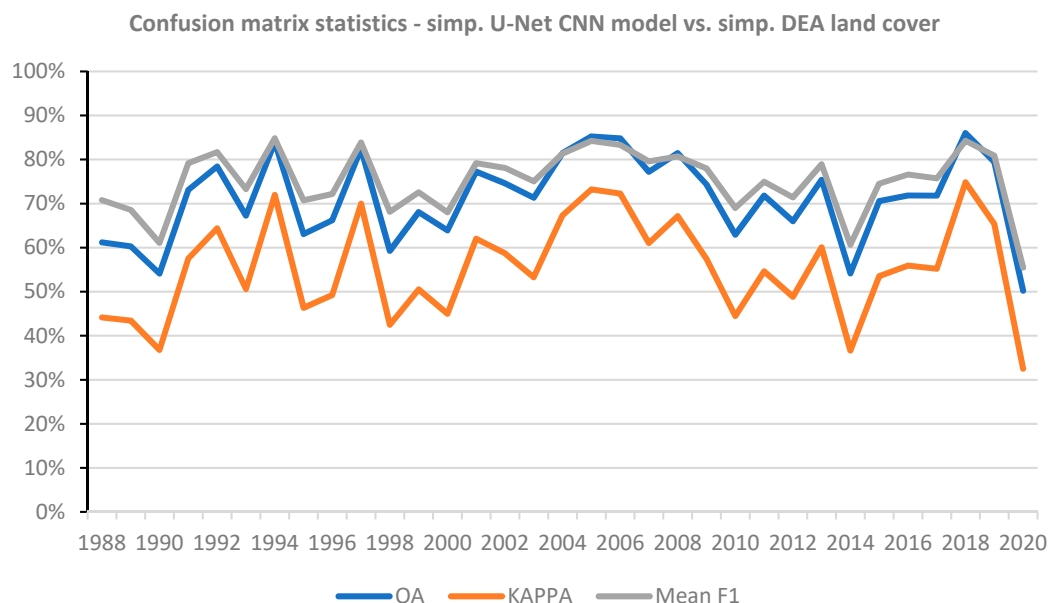


Figure S1. 1998-2020 simplified CNN vs. DEA mapping confusion matrix statistics

Table S2. Simplified U-Net CNN model vs. simplified DEA Land Cover for 2018. OA=86%, Kappa=75% and weighted-mean F1=84%. Excludes No data pixels.

Pixel Count Simp. CNN Model	Simp. DEA Land Cover							User's accuracy	Commission errors	Total
	Forest	Grassland	Crop	Bare	Water	Built-up	Total			
Forest	6,266,397	181,394	2,416	1,290	361	15	6,451,873	97.1%	2.9%	100.0%
Grassland	633,863	7,314,061	386,685	32,130	977	79	8,367,795	87.4%	12.6%	100.0%
Crop	254	1,076	384	51	0	0	1,765	21.8%	78.2%	100.0%
Bare	1,557	14,113	443	8,639	2,777	863	28,392	30.4%	69.6%	100.0%
Water	77,725	190,520	13,831	62,279	83,433	129	427,917	19.5%	80.5%	100.0%
Built-up	161,054	322,386	18,493	130,340	850	72,365	705,488	10.3%	89.7%	100.0%
Total	7,140,850	8,023,550	422,252	234,729	88,398	73,451	15,983,230	86.0%	Overall accuracy	
Producer's acc.	87.8%	91.2%	0.1%	3.7%	94.4%	98.5%				
Omission errors	12.2%	8.8%	99.9%	96.3%	5.6%	1.5%				
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	74.8%	Kappa		
F1	92.2%	89.2%	0.2%	6.6%	32.3%	18.6%	84.3%	Weighted-mean F1		

Table S3. Simplified U-Net CNN model vs. simplified DEA Land Cover for 2020. OA=50%, Kappa=33% and weighted-mean F1=56%. Excludes No data pixels.

Pixel Count Simp. CNN Model	Simp. DEA Land Cover							User's accuracy	Commission errors	Total
	Forest	Grassland	Crop	Bare	Water	Built-up	Total			
Forest	6,208,504	349,255	24,929	38,938	4,213	21	6,625,860	93.7%	6.3%	100.0%
Grassland	979,452	1,441,618	5,610,664	10,909	7,517	49	8,050,209	17.9%	82.1%	100.0%
Crop	6,893	1,325	29,363	81	2	0	37,664	78.0%	22.0%	100.0%
Bare	2,480	13,294	2,286	8,240	3,643	495	30,438	27.1%	72.9%	100.0%
Water	119,695	70,168	58,537	5,668	254,032	170	508,270	50.0%	50.0%	100.0%
Built-up	198,520	208,820	118,320	115,449	1,938	82,625	725,672	11.4%	88.6%	100.0%
Total	7,515,544	2,084,480	5,844,099	179,285	271,345	83,360	15,978,113	50.2%	Overall accuracy	
Producer's acc.	82.6%	69.2%	0.5%	4.6%	93.6%	99.1%				
Omission errors	17.4%	30.8%	99.5%	95.4%	6.4%	0.9%				
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	32.5%	Kappa		
F1	87.8%	28.4%	1.0%	7.9%	65.2%	20.4%	55.5%	Weighted-mean F1		

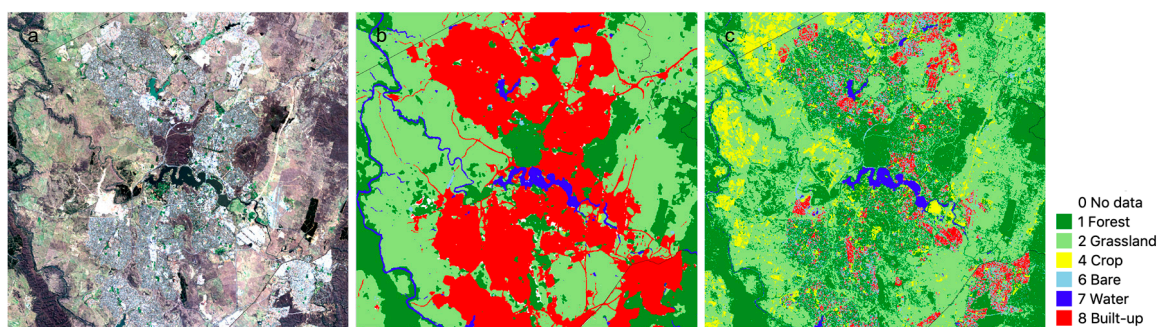


Figure S2. Simplified U-Net CNN model (b) and simplified DEA Land Cover (c) and input Landsat data as True colour RGB (a) for Canberra urban area in 2013.

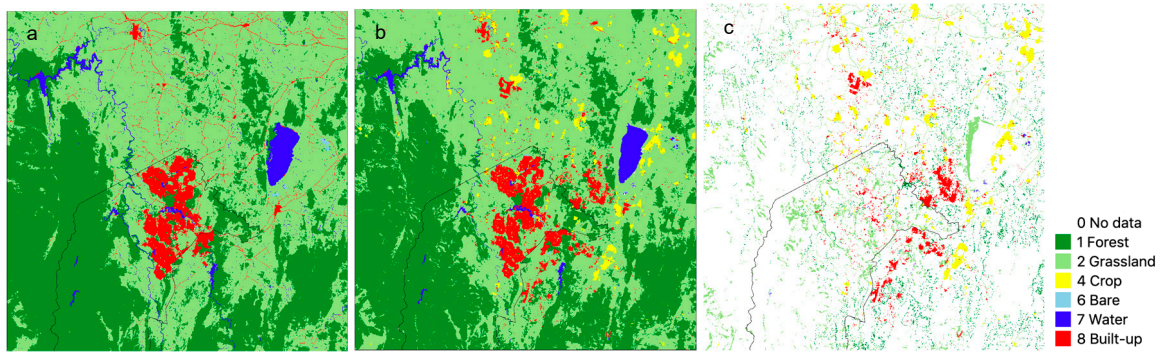


Figure S3. 2017 simplified U-Net CNN Model (a), simplified ESRI Land Cover (b) and differences (c). Difference map shows ESRI Land Cover classes where they are different to the U-Net CNN model.

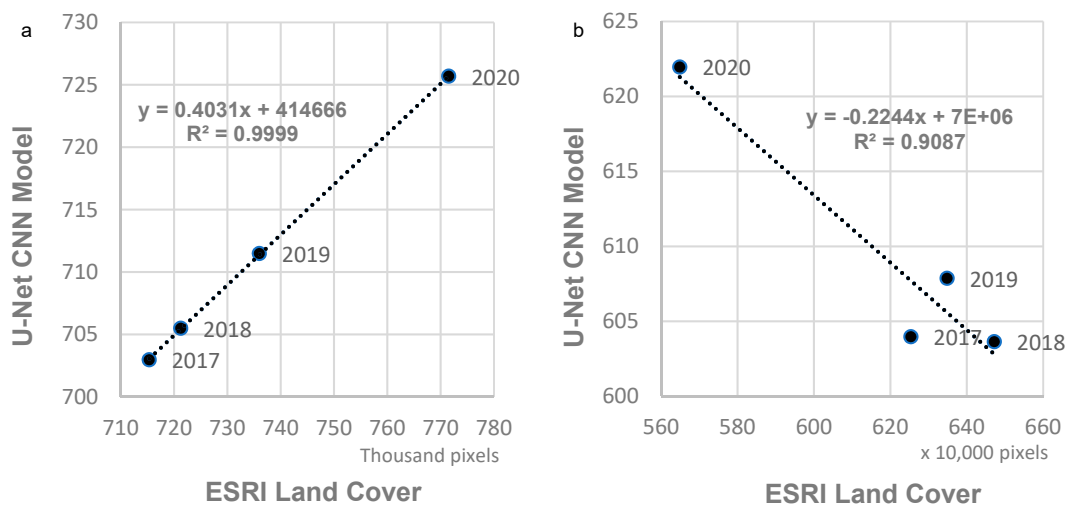


Figure S4. Relationship between ESRI Land Cover and U-Net CNN model for Built area vs. Built-up (a) and Trees vs. Forest+Plantation (b). Other classes are less well correlated.