remote sensing

MDPI

Correction

Correction: Anderson, H.B. et al. Using Ordinary Digital Cameras in Place of Near-Infrared Sensors to Derive Vegetation Indices for Phenology Studies of High Arctic Vegetation. *Remote Sens.* 2016, *8*, 847

Helen B. Anderson [1], Lennart Nilsen [1,*], Hans Tømmervik [2], Stein Rune Karlsen [3], Shin Nagai [4] and Elisabeth J. Cooper [1]

1 Department of Arctic and Marine Biology, Faculty of Biosciences, Fisheries and Economics, University of Norway, NO-9037 Tromsø, Norway; helen.anderson@uit.no (H.B.A.); elisabeth.cooper@uit.no (E.J.C.)
2 Norwegian Institute for Nature Research, FRAM-High North Centre for Climate and the Environment, P.O. Box 6606 Langnes, NO-9296 Tromsø, Norway; hans.tommervik@nina.no
3 Norut Northern Research Institute, P.O. Box 6434, NO-9294 Tromsø, Norway; stein-rune.karlsen@norut.no
4 Department of Environmental Geochemical Cycle Research, Japan Agency for Marine-Earth Science and Technology, Kanazawa-ku, 236-0001 Yokohama, Japan; nagais@jamstec.go.jp
* Correspondence: lennart.nilsen@uit.no; Tel.: +47-776-46314

Received: 17 August 2017; Accepted: 22 September 2017; Published: 28 September 2017

After the publication of the research paper by Anderson et al. [1], a reanalysis of the data showed that mistakes had been introduced in the calculation of the greenness indices and the filtering for outliers prior to the statistical analysis. The calculation of the 2G_RBi and Channel G% indices were the most affected, while the filtering of the data for outliers had inadvertently removed too many data points which caused poor correlations. Unfortunately, these mistakes affect the conclusions of the paper. The original paper concluded that GRVI had a good correlation with NDVI in all vegetation types, and that 2G_RBi and Channel G% did not. After the reanalysis of the data, however, it became clear that all three vegetation indices show strong correlations with NDVI. In this correction, we present the corrected text and updated versions of Tables 1 and 2 and Figure 2:

- Abstract: "only GRVI showed significant correlations with NDVI in all vegetation types" should be changed to: "GRVI showed the most significant correlations with NDVI among all vegetation types".
- Section 4, near the end of the section: "GRVI values greater than one standard deviation from the mean have been omitted from the analyses to exclude obviously erroneous data" should be changed to: "GRVI values outside the 95% confidence interval of the linear model have been omitted from the analyses to exclude obviously erroneous data".
- Section 5.1, the last sentence of this section: This sentence should be changed to: "The 2G_RBi and Channel G% indices similarly showed high significant correlations in all vegetation types, including *Luzula* spp., but not with the Greenseeker measurements in the mixed plot with *Carex tetragona* and *Dryas octopetala* (Table 1). Overall, GRVI showed the highest correlations of all three greenness indices.
- Section 6, near the end of the first paragraph: "one was highly correlated with NDVI values in all plant groups studied" should be changed to "all were highly correlated with NDVI values in the plant groups studied, while GRVI showed the highest correlations."
- Section 6, the second paragraph: This paragraph should be replaced with the following text (citations are the same as in the original publication): "Similar to our results, other studies that have compared the RGB derived vegetation indices GRVI, 2G_RBi, and Channel G% with NDVI found strong correlations [29,32], or similarity in the seasonal patterns observed [22,47]. Still,

comparable results were not necessarily expected, since these studies were performed in different types of vegetation and described the phenology of broadleaf forest canopies, low-latitude grasslands, and agricultural crops [22,29,32,47]. Indeed, even the heath, fen, and copse vegetation monitored by Westergaard-Nielsen et al. [32] in Greenland with digital cameras, where they found channel G% and 2G_RBi indices to be significantly correlated with NDVI, was situated in the Low Arctic, where the vegetation structure and species composition is quite different to that found at higher latitudes. Although a study from Northern Svalbard (79°40′N) using imagery from the WorldView-2 satellite and an airborne RGB camera found channel G% values to be reasonably well correlated with NDVI, the vegetation surveyed (creeping saltmarsh grass (*Puccinellia phryganodes*) and moss-crust tundra communities) [48] was very different to that presented in this study. Our results therefore are of high relevance to further studies of the high-Arctic vegetation types presented in this paper. Furthermore, we found strong differences in the diurnal variation of the vegetation indices, which for 2G_RBi and Channel G% may be due to the inclusion of the blue channel, which is strongly affected by changes in solar irradiance such as cloudy conditions [49]. Cloud cover is common on Svalbard [50], so noise in the blue channel related to atmospheric conditions during our season-long study may explain the somewhat lower correlations for 2G_RBi and Channel G% compared to GRVI (Table 1). These diurnal variations were not apparent in the derivation of Channel G% values for vegetation in Northern Svalbard as that study used data from only one day [48]. Surprisingly, the spatial scale of operation did not appear to lead to different results, despite the fact that the cameras used in our study monitored vegetation over an area of *c.* 1 m^2, whereas previous studies monitored vegetation over the scale of a few tens to several hundreds of square meters.

- Section 6, the first sentence of the third paragraph: "We did, however, have more success with the RGB derived GRVI (passive)" should be changed to: "We found the best result with the RGB derived GRVI (passive)".
- Section 7, the second conclusion: With the updated correlations, this conclusion should read: "However, the (passive) Decagon sensor had higher correlations with GRVI than the (active) Greenseeker (Decagon 0.88, 0.8, and 0.84, Greenseeker 0.56, 0.69, and 0.52).
- Section 7, the third conclusion: The second sentence of this conclusion should read: "Still, correlations of 2G_RBi and Channel G% with the Decagon were high in all vegetation types (ranging from 0.72 to 0.86), but less so with the Greenseeker where one (2G_RBi) or two (Channel G%) correlations were insignificant.
- Section 7, the fourth conclusion: "Greeenseeker" should be "Greenseeker".
- Tables 1 and 2 and Figure 2: Tables 1 and 2 and Figure 2 have been updated (including their captions) to reflect the updated statistical analysis. Figure 2d had an incorrect y-axis, which is now corrected. In the other panels, minor differences exist as a result of the recalculation of GRVI but these are generally small. The corrected tables and figure are presented below.

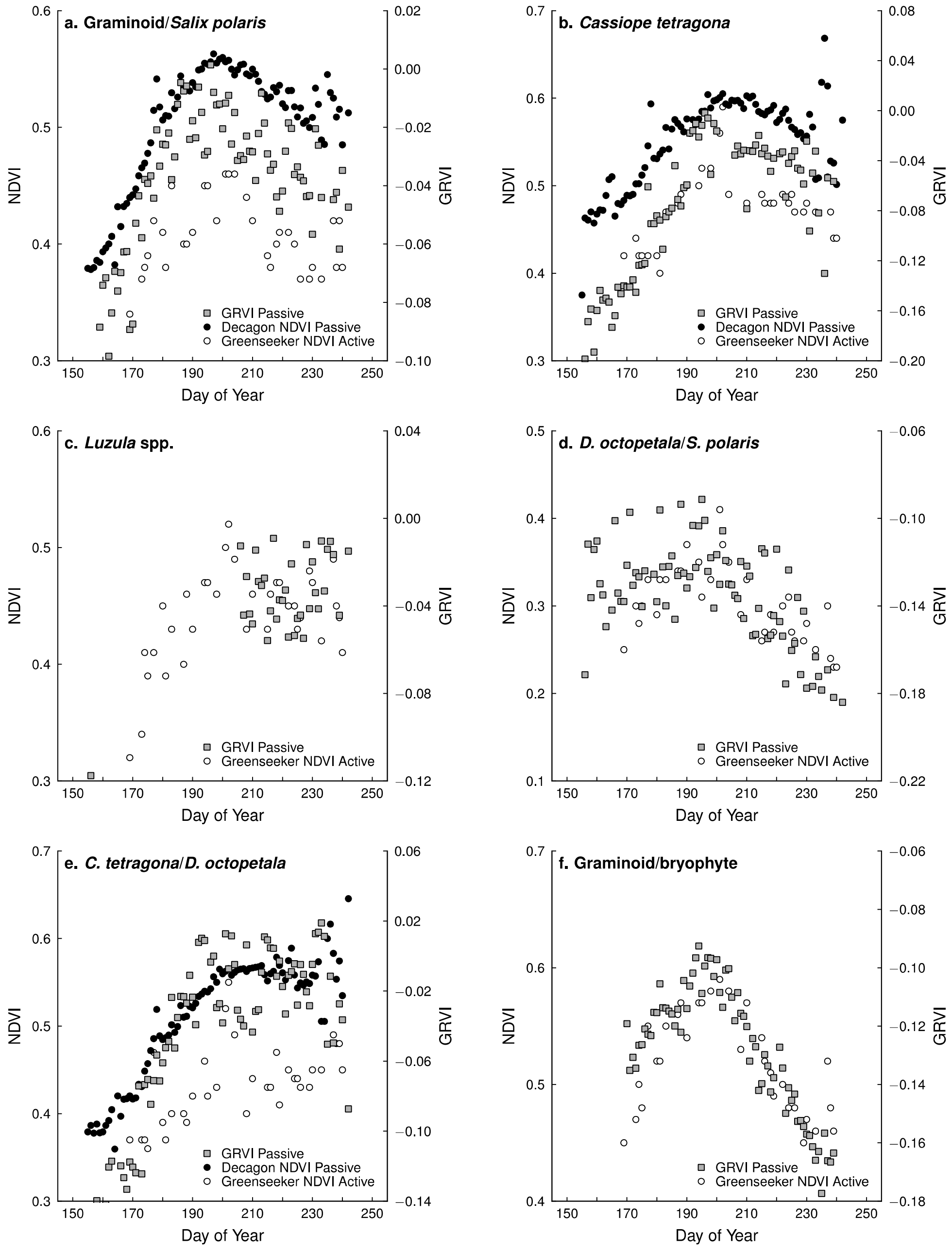

Figure 2. NDVI and greenness index values from six different High Arctic plant communities throughout the growing season. Readings were taken between 5 June (day of year = 156) and 30 August (day of year = 242) 2015 in (**a**) Graminoid/*Salix polaris*; (**b**) *Cassiope tetragona*; (**c**) *Luzula* spp.; (**d**) *Dryas octopetala*/*Salix polaris*; (**e**) *Cassiope tetragona*/*Dryas octopetala*; and (**f**) Graminoid/bryophyte vegetation. NDVI was recorded using Decagon surface reflectance sensors (black circles) and a Trimble Greenseeker handheld sensor (open circles); the Green-Red Vegetation Index (GRVI) values (grey squares) were calculated from red and green channel data from RGB images.

Table 1. Pearson's correlations between NDVI and three different RGB greenness indices in six different High Arctic vegetation types. The NDVI measurement instruments used were Decagon sensors (D) and a Greenseeker device (G). Greenness index values outside the 95% confidence interval of the linear model have been omitted from the analyses to exclude obviously erroneous data. t = t-statistic t_n = the valid sample numbers after filtering the time serial data. Statistically significant relationships are highlighted in bold.

Vegetation	NDVI Sensor	GRVI			2G_RBi			Channel G %		
		t	p	r	t	p	r	t	p	r
Graminoid/*Salix polaris*	D	**t_{82} = 16.55**	**<0.001**	**0.88**	**t_{80} = 9.11**	**<0.001**	**0.72**	**t_{81} = 9.76**	**<0.001**	**0.74**
	G	**t_{33} = 3.73**	**0.001**	**0.56**	**t_{30} = 2.62**	**0.014**	**0.44**	**t_{30} = 2.42**	**0.023**	**0.42**
Cassiope tetragona	D	**t_{76} = 11.45**	**<0.001**	**0.8**	**t_{78} = 14.52**	**<0.001**	**0.86**	**t_{75} = 12.34**	**<0.001**	**0.82**
	G	**t_{28} = 4.87**	**<0.001**	**0.69**	**t_{29} = 3.58**	**0.001**	**0.57**	**t_{27} = 3.01**	**0.006**	**0.52**
Luzula spp.	G	t_{15} = 0.4	0.698	0.11	**t_{15} = 3.01**	**0.01**	**0.64**	**t_{15} = 3.29**	**0.006**	**0.67**
D. octopetala/*S. polaris*	G	**t_{31} = 3.26**	**0.003**	**0.52**	**t_{29} = 3.01**	**0.006**	**0.5**	t_{31} = 1.81	0.08	0.32
C. tetragona/*D. octopetala*	D	**t_{81} = 13.76**	**<0.001**	**0.84**	**t_{79} = 12.05**	**<0.001**	**0.81**	**t_{80} = 10.54**	**<0.001**	**0.77**
	G	**t_{32} = 3.35**	**0.002**	**0.52**	t_{32} = 1.0	0.325	0.18	t_{32} = 0.66	0.513	0.12
Graminoid/bryophyte	G	**t_{30} = 6.87**	**<0.001**	**0.79**	**t_{30} = 9.44**	**<0.001**	**0.87**	**t_{30} = 6.59**	**<0.001**	**0.78**

Table 2. Relationships between day of year and values of different vegetation indices in six different High Arctic vegetation types. GRVI values outside the 95% confidence interval of the linear model have been omitted from the analyses to exclude obviously erroneous data.

Vegetation	Decagon NDVI			Greenseeker NDVI			GRVI		
	F	p	R^2	F	p	R^2	F	p	R^2
Graminoid/*Salix polaris*	$F_{2,89}$ = 46.3	<0.001	0.52	$F_{2,33}$ = 8.34	<0.001	0.36	$F_{2,82}$ = 113.53	<0.001	0.74
Cassiope tetragona	$F_{2,89}$ = 33.57	<0.001	0.44	$F_{2,33}$ = 17.73	<0.001	0.54	$F_{2,76}$ = 198.13	<0.001	0.84
Luzula spp.	-	-	-	$F_{2,34}$ = 21.51	<0.001	0.58	$F_{2,35}$ = 14.55	0.009	0.48
D. octopetala/*S. polaris*	-	-	-	$F_{2,34}$ = 20.4	<0.001	0.57	$F_{2,79}$ = 45.86	<0.001	0.55
C. tetragona/*D. octopetala*	$F_{2,88}$ = 72.7	<0.001	0.63	$F_{2,34}$ = 9.14	0.062	0.37	$F_{2,81}$ = 214.37	<0.001	0.85
Graminoid/bryophyte	-	-	-	$F_{2,31}$ = 22.32	<0.001	0.61	$F_{2,69}$ = 204.36	<0.001	0.86

Acknowledgments: The authors wish to acknowledge F.J.W. Parmentier for his thorough reanalysis of the data, which brought these errors to light.

Reference

1. Anderson, H.; Nilsen, L.; Tømmervik, H.; Karlsen, S.; Nagai, S.; Cooper, E. Using Ordinary Digital Cameras in Place of Near-Infrared Sensors to Derive Vegetation Indices for Phenology Studies of High Arctic Vegetation. *Remote Sens.* **2016**, *8*, 847. [CrossRef]