Supplementary Materials: Estimation of Forest Topsoil Properties Using Airborne LiDAR-Derived Intensity and Topographic Factors. *Remote Sensing* 2016, *8*, 561

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Table S1. LiDAR system parameters.

Sensor	LiteMapper 5600
Platform	Cessna Caravan 208
Acquisition date	8 September 2009
Mean flight altitude	About 800 m above ground
Mean acquisition speed	180 km/h
Overlap	More than 50% sidelap
Returns	Up to 4
Laser pulse length	3.5 ns
Density	8–10 pulses/m^2
Horizontal accuracy	$\sigma \leq 0.15$ m
Vertical accuracy	$\sigma \leq 0.08$ m
Beam divergence	0.5 mrad
Pulse repetition	150 kHz
Laser wavelength	1556 nm
Footprint size	0.8 m (r = 0.4 m)

Table S2. Description of eight LiDAR-derived variables.

Parameters	Description	References
Intensity	"Intensity" is a relative measure of the integration of received power over time for given return signals (0–255)	[1]
Elevation	Above average sea level (m)	[2]
Slope	The first derivative of the elevation (°)	[2]
Aspect	Counter-clockwise from East to North and to West (°)	[2]
WI	Topography wetness index is an indicator for presenting soil properties and wetness in different landscapes	[3]
RSP	Relative stream power index is directly related to the stream power	[4]
STI	Sediment transport index is used to recognize the process of soil erosion	[3]
TC	The second derivative of the surface slope	[3]

Table S3. Nine scale candidate models with Akaike information criterion (AIC).

GR		1.5 m	10 m	50 m
MWS	**Var.**	**AIC**	**AIC**	**AIC**
3 × 3	SOM	304	317	324
3 × 3	TotalN	−128	−115	−110
3 × 3	pH	66	76	71
3 × 3	Depth	370	371	368
3 × 3	AvaP	398	399	399
5 × 5	SOM	311	319	324
5 × 5	TotalN	−124	−111	−108
5 × 5	pH	72	73	74
5 × 5	Depth	372	374	360
5 × 5	AvaP	399	397	398
7 × 7	SOM	317	322	328
7 × 7	TotalN	−117	−111	−104
7 × 7	pH	73	75	75
7 × 7	Depth	373	371	362
7 × 7	AvaP	399	397	398

Note: GR means grid resolution. MWS means the moving window size of average resampling method. Bold words mean the optimum scale was selected to predict responding topsoil property.

Table S4. Proportion of variance explained by each selected predictor in Table S3.

Variables	SOM (%)	Total N (%)	pH (%)	Depth (%)	AvaP (%)
Intensity	63.6	62.6	7.0	17.2	
Elevation	1.4	0.7	38.3	2.7	
Aspect					0.9
TC			1.8	0.3	4.4
RSP	1.3	2.5		4.5	
STI				14.5	4.9
WI				7.2	

Table S5. Pearson correlation analysis result of nine scale intensities.

	Int [a]	**Int [b]**	**Int [c]**	**Int [d]**	**Int [e]**	**Int [f]**	**Int [g]**	**Int [h]**	**Int [i]**
Int [a]	1.00	0.89	0.88	0.88	0.84	0.82	0.89	0.86	0.80
Int [b]	0.89	1.00	0.92	0.93	0.87	0.89	0.97	0.91	0.86
Int [c]	0.88	0.92	1.00	0.91	0.94	0.94	0.92	0.97	0.94
Int [d]	0.88	0.93	0.91	1.00	0.88	0.91	0.97	0.90	0.89
Int [e]	0.84	0.87	0.94	0.88	1.00	0.94	0.89	0.96	0.94
Int [f]	0.82	0.89	0.94	0.91	0.94	1.00	0.90	0.97	0.99
Int [g]	0.89	0.97	0.92	0.97	0.89	0.90	1.00	0.90	0.88
Int [h]	0.86	0.91	0.97	0.90	0.96	0.97	0.90	1.00	0.97
Int [i]	0.80	0.86	0.94	0.89	0.94	0.99	0.88	0.97	1.00

Note: Int means Intensity. [a] represents scale with 1 m gird resolution and 4.5 m neighbor extent; [b] represents scale with 10 m gird resolution and 30 m neighbor extent; [c] represents scale with 50 m gird resolution and 150 m neighbor extent; [d] represents scale with 10 m gird resolution and 30 m neighbor extent; [e] represents scale with 10 m gird resolution and 50 m neighbor extent; [f] represents scale with 10 m gird resolution and 70 m neighbor extent; [g] represents scale with 50 m gird resolution and 150 m neighbor extent; [h] represents scale with 50 m gird resolution and 250 m neighbor extent; [i] represents scale with 50 m gird resolution and 350 m neighbor extent.

Table S6. Proportion of each topsoil property explained by each variable in optimal scale models and baseline scale models.

	SOM (%)	Total N (%)	pH (%)	Depth (%)	AvaP (%)
Intensity	63.6 [a]	62.5 [a]	7.0 [a]	17.2 [b]	
Intensity	63.6 [a]	62.5 [a]	7.0 [a]	26.2 [a]	
Elevation	1.4 [a]	0.7 [a]	38.3 [a]	2.7 [b]	
Elevation	1.4 [a]	0.7 [a]	38.3 [a]		
Aspect					0.9 [c]
Aspect					0.8 [a]
TC			1.8 [a]	0.3 [b]	4.4 [c]
TC			1.8 [a]		4.1 [a]
RSP	1.3 [a]	2.5 [a]		4.5 [b]	
RSP	1.3 [a]	2.5 [a]			
STI				14.5 [b]	4.9 [c]
STI					4.7 [a]
WI				7.2 [b]	
WI					
R^2	66.3 [a]	65.7 [a]	47.1 [a]	46.2 [b]	10.2 [c]
R^2	66.3 [a]	65.7 [a]	47.1 [a]	26.2 [a]	9.6 [a]

Note: [a] represents the scale of the selected variable is 1.5 m grid resolution and 4.5 m neighbor extent; [b] represents the scale of the selected variable is 50 m grid resolution and 250 m neighbor extent; [c] represents the scale of the selected variable is 10 m grid resolution and 70 m neighbor extent.

Table S7. Comparison of the optimal scale model and the baseline scale model for each topsoil property.

Dep.	AIC	Weight	R^2	Adj.R^2	Selected Variable
SOM [a]	304	0.037	0.663	0.646	Intensity Elevation RSP
SOM *	304	0.037	0.663	0.646	Intensity Elevation RSP
Total N [a]	−128	0.037	0.657	0.640	Intensity Elevation RSP
Total N *	−128	0.037	0.657	0.640	Intensity Elevation RSP
pH [a]	66	0.062	0.471	0.453	Intensity Elevation TC
pH *	66	0.062	0.471	0.453	Intensity Elevation TC
Depth [b]	357	0.121	0.464	0.413	Intensity Elevation TC RSP STI WI
Depth *	370	0.047	0.262	0.250	Intensity
AvaP [c]	397	0.031	0.102	0.062	Aspect TC STI
AvaP *	398	0.021	0.096	0.056	Aspect STI

Note: * represents the baseline scale model for each topsoil property; [a] represents the scale of the selected model is 1.5 m grid resolution and 4.5 m neighbor extent; [b] represents the scale of the selected model is 50 m grid resolution and 250 m neighbor extent; [c] represents the scale of the selected model is 10 m grid resolution and 70 m neighbor extent.

Table S8. Pearson correlation analysis result of nine scale Elevations.

	Ele [a]	Ele [b]	Ele [c]	Ele [d]	Ele [e]	Ele [f]	Ele [g]	Ele [h]	Ele [i]
Ele [a]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [b]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [c]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.999
Ele [d]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [e]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [f]	0.999	0.999	0.999	0.999	0.999	1.000	0.999	0.999	1.000
Ele [g]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [h]	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	0.998
Ele [i]	0.998	0.998	0.999	0.998	0.998	1.000	0.998	0.998	1.000

Note: Ele means elevation. [a] represents scale with 1 m gird resolution and 4.5 m neighbor extent; [b] represents scale with 10 m gird resolution and 30 m neighbor extent; [c] represents scale with 50 m gird resolution and 150 m neighbor extent; [d] represents scale with 10 m gird resolution and 30 m neighbor extent; [e] represents scale with 10 m gird resolution and 50 m neighbor extent; [f] represents scale with 10 m gird resolution and 70 m neighbor extent; [g] represents scale with 50 m gird resolution and 150 m neighbor extent; [h] represents scale with 50 m gird resolution and 250 m neighbor extent; [i] represents scale with 50 m gird resolution and 350 m neighbor extent.

Table S9. Pearson correlation analysis result of nine scale RSPs.

	RSP [a]	**RSP [b]**	**RSP [c]**	**RSP [d]**	**RSP [e]**	**RSP [f]**	**RSP [g]**	**RSP [h]**	**RSP [i]**
RSP [a]	1.00	−0.06	−0.07	−0.07	−0.06	−0.09	−0.07	−0.06	−0.12
RSP [b]	−0.06	1.00	0.39	0.97	0.99	0.22	0.97	0.98	0.12
RSP [c]	−0.07	0.39	1.00	0.36	0.39	0.94	0.36	0.47	0.64
RSP [d]	−0.07	0.97	0.36	1.00	0.98	0.20	1.00	0.97	0.10
RSP [e]	−0.06	0.99	0.39	0.98	1.00	0.23	0.98	0.99	0.12
RSP [f]	−0.09	0.22	0.94	0.20	0.23	1.00	0.19	0.33	0.82
RSP [g]	−0.07	0.97	0.36	1.00	0.98	0.19	1.00	0.97	0.09
RSP [h]	−0.06	0.98	0.47	0.97	0.99	0.33	0.97	1.00	0.20
RSP [i]	−0.12	0.12	0.64	0.10	0.12	0.82	0.09	0.20	1.00

Note: RSP means relative stream power index. [a] represents scale with 1m gird resolution and 4.5 m neighbor extent; [b] represents scale with 10 m gird resolution and 30 m neighbor extent; [c] represents scale with 50 m gird resolution and 150 m neighbor extent; [d] represents scale with 10 m gird resolution and 30 m neighbor extent; [e] represents scale with 10 m gird resolution and 50 m neighbor extent; [f] represents scale with 10 m gird resolution and 70 m neighbor extent; [g] represents scale with 50 m gird resolution and 150 m neighbor extent; [h] represents scale with 50 m gird resolution and 250 m neighbor extent; [i] represents scale with 50 m gird resolution and 350 m neighbor extent.

Table S10. Pearson correlation analysis result of nine scale WIs.

	WI [a]	**WI [b]**	**WI [c]**	**WI [d]**	**WI [e]**	**WI [f]**	**WI [g]**	**WI [h]**	**WI [i]**
WI [a]	1.00	0.23	0.41	0.32	0.26	0.40	0.27	0.29	0.38
WI [b]	0.23	1.00	0.65	0.57	0.89	0.53	0.67	0.83	0.46
WI [c]	0.41	0.65	1.00	0.22	0.74	0.89	0.31	0.78	0.82
WI [d]	0.32	0.57	0.22	1.00	0.43	0.11	0.97	0.37	0.07
WI [e]	0.26	0.89	0.74	0.43	1.00	0.62	0.54	0.97	0.56
WI [f]	0.40	0.53	0.89	0.11	0.62	1.00	0.19	0.65	0.98
WI [g]	0.27	0.67	0.31	0.97	0.54	0.19	1.00	0.46	0.14
WI [h]	0.29	0.83	0.78	0.37	0.97	0.65	0.46	1.00	0.58
WI [i]	0.38	0.46	0.82	0.07	0.56	0.98	0.14	0.58	1.00

Note: WI means topographic wetness index. [a] represents scale with 1 m gird resolution and 4.5 m neighbor extent; [b] represents scale with 10 m gird resolution and 30 m neighbor extent; [c] represents scale with 50 m gird resolution and 150 m neighbor extent; [d] represents scale with 10 m gird resolution and 30 m neighbor extent; [e] represents scale with 10 m gird resolution and 50 m neighbor extent; [f] represents scale with 10 m gird resolution and 70 m neighbor extent; [g] represents scale with 50 m gird resolution and 150 m neighbor extent; [h] represents scale with 50 m gird resolution and 250 m neighbor extent; [i] represents scale with 50 m gird resolution and 350 m neighbor extent.

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