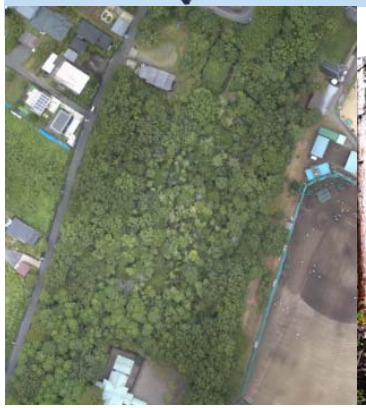

WRF2017Session 1: Measuring and showcasing resource efficiency

Forest carbon stock assessment by a UAV technique: case study in Japanese forest

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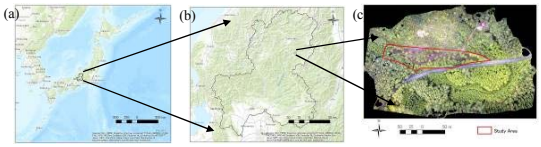
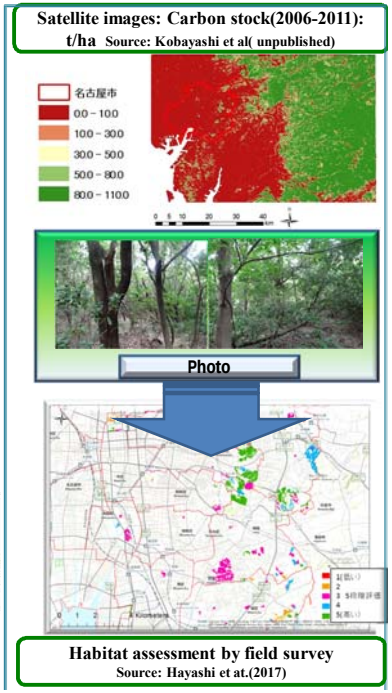
OBJECTIVE

- Development of forest ecosystem service (ES) assessment with low cost, high resolution methods.
  - Compared with on site field survey, satellite data
- As a first step
  - UAV (Unmanned Aerial vehicle)
  - Plantation forest with strength thinning for easy identification of individual tree
  - Several forest sites: Cypress forest, Cedar forest, Deciduous broad-leaved forest, etc.



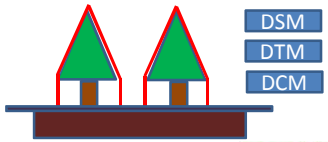
Study site: (a)Japan, (b)Gifu Prefecture, and (c)Takayama hinoki sites

Source: Katada et al. 2017



METHOD

- UAV images
- SfM:
  - DTM, DSM, DCM development
- Tree height estimation based on DCM
- **Field survey on trees**
  - Height, DBH
- Comparison of two data sets
- Tree volume estimation
- **Ecosystem service(ES) supply potential estimation**



On site field survey
- DBH, tree height (by Laser550AS NICON)
- N=102 (1 Nov.16, 20 June 17)

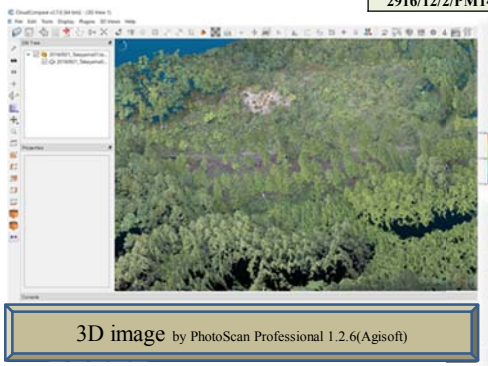
ES(ecosystem service) supply potential estimation
- **Carbon stock:** Inoue and Kurokawa (2001) formula
- Forest volume
- Canopy crown coverage: Voronoi division method rLiDAR of R software (Free software)
- **Aesthetic tree beauty: Cherry trees, autumn leaves**
- Recreation : Onsite visual investigation

A Part of assessment methods was detailed in Katada et al. 2017

Note: SfM(Structure from Motion), DTM(Digital Terrain Mode), DSM(Digital Surface Model), DCM(Digital Canopy Model), DBH(Diameter at breast height),

RESULT

Date (Takayama Hinoki site)	Photos	AGL(m)	Wind(m/s)
2016/9/21/PM16-17(leafing stage)	129	80	1.4
2016/11/2/AM11-13(autumn leaves stage)	1029	40, 50, 60	1.2-0.2
2916/12/2/PM14-15(falling leaves stage)	743	60	3.3



3D image by PhotoScan Professional 1.2.6(Agisoft)

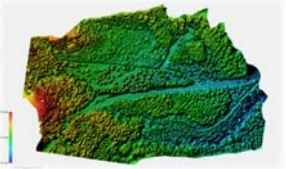
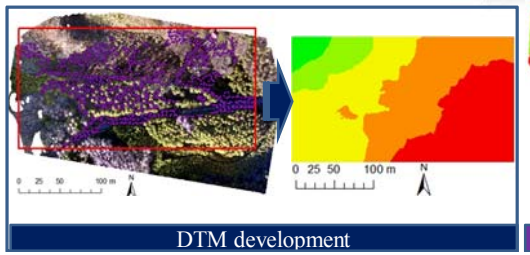
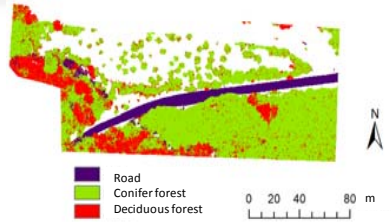


Fig. DSM (2016/09/21)

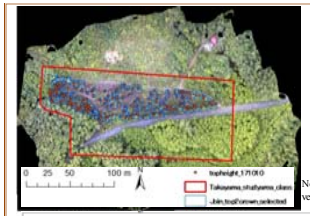
Fig. Orthophotos (2016/09/21)



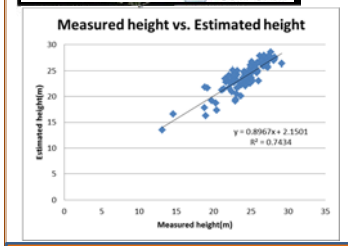
DTM development



Forest classification by supervised method (tentative)



Note: by rLiDAR ver. 0.1 on R ver.3.3.1(Silva et al., 2015)



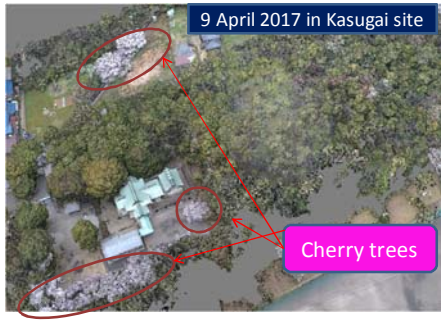
Tree height accuracy(N=102)

Table. Results of the ES estimation

ESs		Indicators	Unit	Estimated value
Supporting Services				
a)	Carbon stock	Carbon stock	(tC/ha)	65.3
Regulating Services				
b)	Climate regulation	Tree volume	(10^4m^3/ha)	7.8
c)	Air purification	Surface area of crown	(10^4m^2/ha)	1.8
d)	Water regulation	Crown coverage	(%)	36.8
e)	Soil erosion	Soil erosion power	(kN/m^2)	31.8

Carbon stock: estimated from stem volumes (>5 m) with expansion factor by National Institute for Environmental Studies (2014)
Tree volume: from DCM using Surface Volume tool of ArcGIS with the heat-reduction effect based on Hiruta and Ishikawa (2012)
Tree crown surface area: based on Tadaki (1990) by DCM using Surface Volume tool of ArcGIS. (Tree crown surface area shows a relationship with leaf area (Itoh et al., 2008))
Crown coverage: calculated from the projection crown area referring to Yoshida and Hashimoto (1998).

Source : Katada et al, 2017



CONCLUSION and REFERENCES

- Relatively high accuracy of tree height estimation
- DTM is key for tree height estimation
- Seasonal images are useful for ES assessment
- Future issues
  - Classification of forest type
  - Dense forest assessment
  - Variety of ES assessment

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Note: J: in Japanese

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