APPLICATION OF DEMs OF LIDAR DATA IN HYDROLOGY MODELING

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ABSTRACT

In recent years, LiDAR(Light Detection and Ranging) data has been widely used to prepare digital elevation models(DEMs) with the high spatial resolution of centi-meters. This paper investigated possible applications of LiDAR-derived DEMs in surface hydrology modeling, such as characterizing flow direction, identifying sub-basins in a watershed, and calculating variables like upstream contribution area. The results were compared to the results of the DEMs from conventional topographic maps.

KEY WORDS: LiDAR, Hydrology modelling, DEM

1. INTRODCUTION

The past decade has seen a steady increase in quantity, precision, and accuracy of digital spatial data products. In recent years, airborn LiDAR technology has been employed to develop high accuracy digital elevation models(DEMs) with horizontal resolution on the order of a few meters. Light Detection and Ranging (LiDAR) in the simplest description is the use of lasers to determine distance from the instrument to some target. Terrain representation , scale, and hydrologic modelling compare using LiDAR(Christopher & Ashton, 2004).

High resolution elevation datasets are among the most demanded products, and are necessary for well-funded application ranging from shoreline erosion to flood hazard mapping(Moore et al., 1991; Hutchinson & Gallant, 1999). This study is concerned with the employment of high spatial resolution LiDAR-derived elevation data for surface hydrology modelling. LiDAR ground returns are especially affected. In many lands capes riparian area are both of primary hydrological interest and are density forested. This study use of LiDAR-derived DEMs in surface hydrologic modelling application , such as characterizing flow direction and sub-basin in a watershed, and WI(wetness index). We compare results using conventional 10m DEMs and 3cm LiDAR for a high relief study are and a low relief study area.

2. MATERIALS AND METHODS

This study area is two landscape type of a high relief study area(normal landscape, 2004) and low relief study area(forest fire, 2005).

2.1 Study area

We shoes portions of two watershed in South Korea for this study : Mt. Yumyeong upper left 127 29 0.19380E, 37 36 16.43433N, and lower right 127 30 1.10E, 37 35 42 94N around and Yangyang County (Figure 1).

2.2 Study materials

2.2.1 LiDAR data

LiDAR data has 3cm spatial resolution acquired on 3,000m altitude Mt. Yumyeong at April 2004 and Yangyang county at April 2005.

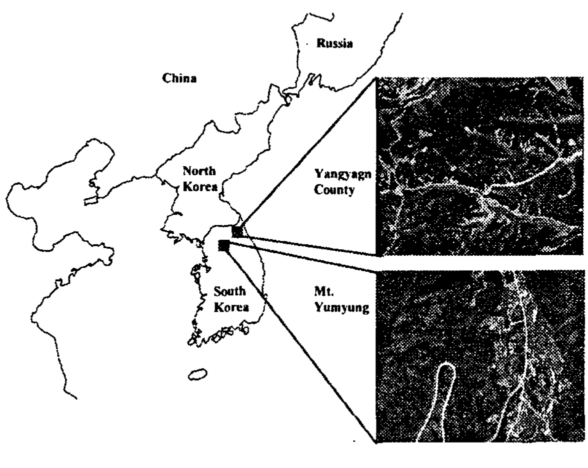


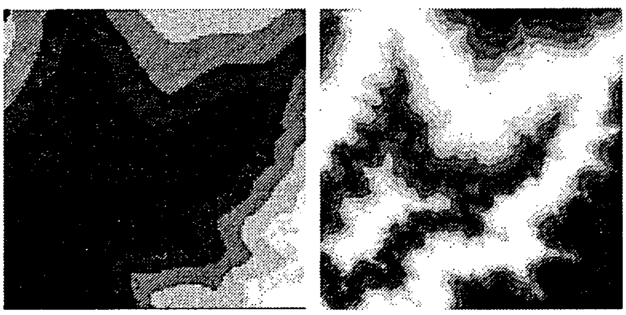
Figure 1. Study area

Figure 2. LiDAR data

LiDAR x, y , and z points were generated by combining laser range and aircraft attitude data collected using an optech airborne laser terrain mapper with position data collected using geodetic quality GPS airborne and ground based receivers(Figure 2).

Figure 3. DEM for LiDAR

LiDAR point data convert to LiDAR TIN and ground surface(Figure 3).



(a) (b)
Figure 4. Compare of DEM
(a)Normal DEM (1:25,000), (b)DEM using LiDAR

We combined LiDAR point data to produce a DEM that covers the area from Mt. Yumung and Yangyang county(Figure 4).

2.2.2 Thematic maps

This study using maps that soil map(RDA : rural development administration, 2005), rainfall map(KMA:korea metrological administration, 2005), slope map(MOE:ministry of environment republic of korea, 2004) , land using map(MOE), and slop length map.

2.3 Methods

All processing was done using Arc GIS9.0(ESRI, 2004). Each of the two DEMs were projected to UTM using interpolation to resample to 3cm spatial resolution.

2.3.1 Hydrological modeling

These were used to calculate flow accumulation and wetness index , as well as delineate basins and extract channels. Wetness index is defined on a cell by cell basis as :

$$WI = \ln(a/\tan b) \qquad (1)$$

where $a \neq$ upstream cells by cell side (meters)
$\tan b =$ slope in degrees

The statistical analysis of three flow determination algorithm on the DEM is performed. SFD(single flow direction), MFD(multi flow direction), and DEMON(digital elevation model networks) .

2.3.2 Soil loss

The primery method of estimating soil loss from rainfall and runoff is an empirical equation called the USLE(universal soil loss equation). The USLE was developed by statistical analysis of many plot-years of rainfall, runoff, and sediment loss data from many small plots located around the contry.

$$A = RKLSCP \qquad (2)$$

where
A = average annual soil loss in tons per acre per year
R = rainfall energy factor
LS = slope length factor
C = cover and management factor
P = supporting conservation practice factor

3. RESULTS

3.1.1 Hydrological

Slope appears to be moderately affected by source, since 3cm LiDAR DEMs had somewhat higher values , but greatly affected by spatial resolution. The sensitivity of slope, and sink. Wetness index show a similar relationship with respect to source and resolutions.

table 1. Mt. Yumung of sink

	min	Max	mean	Std

LiDAR	0.5	0.8	0.6	0.1
Normal	0.4	0.9	0.7	0.4

table 2. Yangyang county of sink

	min	Max	mean	Std
LiDAR	0.6	0.7	0.6	0.1
Normal	0.3	0.8	0.6	0.3

3.1.2 Soilloss

The topographic factors L and S are used to adjust the erosion rated based upon the length and steepness of the slope. The erosivity of runoff increases with the velocity of the runoff water .

table 3. Mt. Yumung of soil loss

	min	Max	mean	Std
LiDAR	0	0.8	0.5	0.3
Normal	0	0.9	0.7	0.4

table 4. Yangyang county of soil loss

	min	Max	mean	Std
LiDAR	0	0.8	0.6	0.2
Normal	0	0.9	0.7	0.4

4. DISCUSSION

The resolution issue of various soil moisture prediction parameters such as wetness index.

The statistical analysis of three flow determination algorithm on the DEM(normal DEM and LiDAR DEM)

The upslope are associated with SFD algorithm appear to more sensitive than the parameters of the other algorithm(MFD, DEMON). The wetness index shows relatively less variation both in spatial resolution and the calculated procedures in LiDAR –derived DEM.

As high spatial resolution LiDAR DEMs become more broadly available, they will be incorporated into hydrologic analysis in place of 30m or coarser coverage.

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