AIRBORNE REMOTE SENSING FOR RIVER ENVIRONMENTAL ASSESSMENT

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ABSTRACT:

In Japan, the National Environmental Census of Riverside Areas has been conducted over the 109 river systems under the supervision of the national government since 1991. This environmental census is comprised of three parts: biological survey, river survey, and river space utilization analysis. The census covers many assessment topics, keeping on accumulating various kinds of detailed information related to large river areas in the nation. This study shows that river environmental information such as vegetation heights and plant vigor can be extracted objectively and quantitatively by making full use of digital data being obtained from the rivers under the supervision of the national government.

1. BACKGROUND AND OBJECTIVE

In Japan, the National Environmental Census of Riverside Areas has been conducted every year over the 109 river systems under the supervision of the national government since 1991. This environmental census is comprised of three parts: biological survey, river survey, and river space utilization analysis. The census covers many assessment topics, keeping on accumulating various kinds of detailed information related to large river areas in the nation.

The river survey is conducted with the aim of studying on habitats of animals and plants in each riparian area. So far, the river survey has required a tremendous amount of time for interpretation of aerial photographs and conducting the site survey and documental researches. The rivers subject to the National Environmental Census of Riverside Areas correspond to the rivers for which aerial laser survey was performed for a period of two years from 2005 to 2006. Digital aerial photography was also used for some rivers along with airborne laser-based observations.

This study examines whether aerial laser survey data and digital aerial photographs are to be utilized for more expeditious assessment of vegetation in the river areas. The items to be examined are river environment classification, tree heights, and plant vigor of reeds.

2. STUDY AREA

The study covers the river basin about 100 kilometres along the Lower Tone River, which is the second longest river in Japan. Topographically, the selected river basin is almost flat with widths ranging from 600 to 1,000 meters. Figure.1 shows the coverage of the study area.

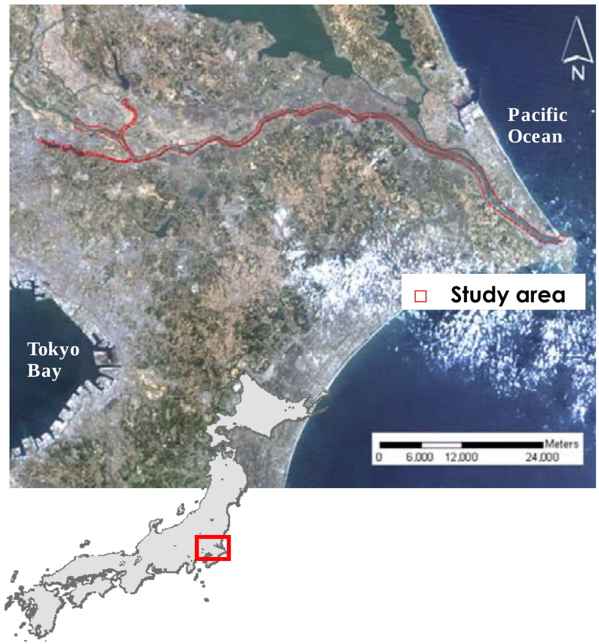

Figure.1 Study Area

3. DATA USED

Aerial laser measurements and digital aerial photographing were performed to obtain necessary output. Aerial photographing was conducted on August 6, 2006 using Intergraph's Digital Mapping Camera (DMC) system with ground resolution set to a level of 10 centimetres. The obtained digital images were transformed into ortho-images both in the visible and the near-infrared band by using the aerial laser survey data. EnerQuest's Remote Airborne Mapping System (RAMS) was used for the aerial laser survey, which was conducted in June 2006. In this survey, observation points were distributed at a density of one point per square meter. By using the resulting survey data, meter-mesh digital surface model (DSM) and digital elevation model (DEM) were generated. Additionally, existing vegetation maps were used as available reference documents. Table.1 shows the specifications of data used. Figure.2 shows DMC RGB colour image and CIR image.

Airborne laser ：RAMS System (EnerQuest)	
Laser Type	Near-Infrared （ wave-length 1.064μm） Class4
Nominal Ground Sample Density	1point／1m^2
Date of Observation	2006/06
Digital Mapping Camera System：DMC(ZI Imaging)	
Main Camera Assembly	4 high-resolution 7kx4k PAN camera heads 4 multispectral 3kx2k camera heads
Radiometric Resolution	12 bit
Date of Observation	2006/08/06
Altitude	5,000 ft
Ground Resolution	10cm

Table.1 Specifications of Data Used

Figure.2 DMC Image (RGB , CIR)
RGB:R=red,G=green,B=blue
CIR:R=Infra-red,G=red,B=green

4. CONTENTS OF STUDY

The study contents are set-up as follows. The procedure of the study is shown in flow chart of analysis of Figure.3.

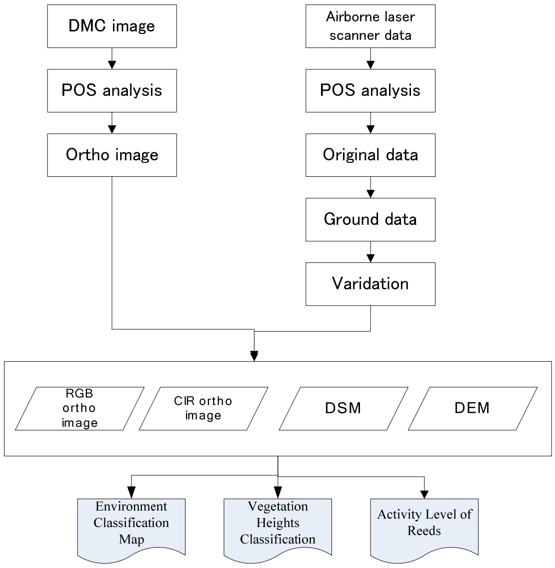

Figure.3 Flow chart of analysis

a) Digital aerial photographing and aerial laser measurement
b) Creating digital ortho image, DEM, DSM
c) Creating environment classification map
d) Classifying vegetation heights
e) Analyzing plant vigor of reeds

5. RESULTS

5.1 Environment Classification Map

The environment classification groups river area into classes according to their physical characteristics such as vegetation conditions and land use. Classification data were generated using the infrared color images and RGB color images obtained by using the Digital Mapping Camera (DMC) system and the vegetation height data (figure.4). After synthesizing the DMC color images with four bands beforehand, they were registered against and superposed on Normalized Difference Vegetation Index (NDVI) images, distributed into two groups: vegetation and non-vegetation, then classified by maximum likelihood estimation. The existing vegetation map data was used for supervised classification approach. Since vegetation maps are usually represented by plant community and association, the supervised region was adjusted by visual discrimination of color tones on the image. The likelihood or probability efficiency in the supervised region was calculated for the items for which valid supervised classifiers could have been acquired. As a result, the items classified by maximum likelihood classification were: reeds and herbaceous plants, trees, bamboo groves, plowed fields, paddy fields, planted grasslands, artificial bare lands, man-made structures, and water surface.

Reeds, herbaceous plants and trees were put together once and then reclassified into four classes according to the height: short weeds (less than 1 meter), short weeds (1 to 2 meters), shrubs and tall grasses, and trees. Reed colonies, which are the characteristic vegetation of the lower Tone River, were included in the group of short weeds according to the environment classification map.It was shown by the subsequent site survey that our classification by maximum likelihood classification as mentioned above was virtually appropriate and valid, although there were some individual tall willows sporadically as well as some grasslands with circumference of 1 meter or more that had not been detected during automatic classification. The classified results of paddy fields, planted grasslands and short weed lands held good.

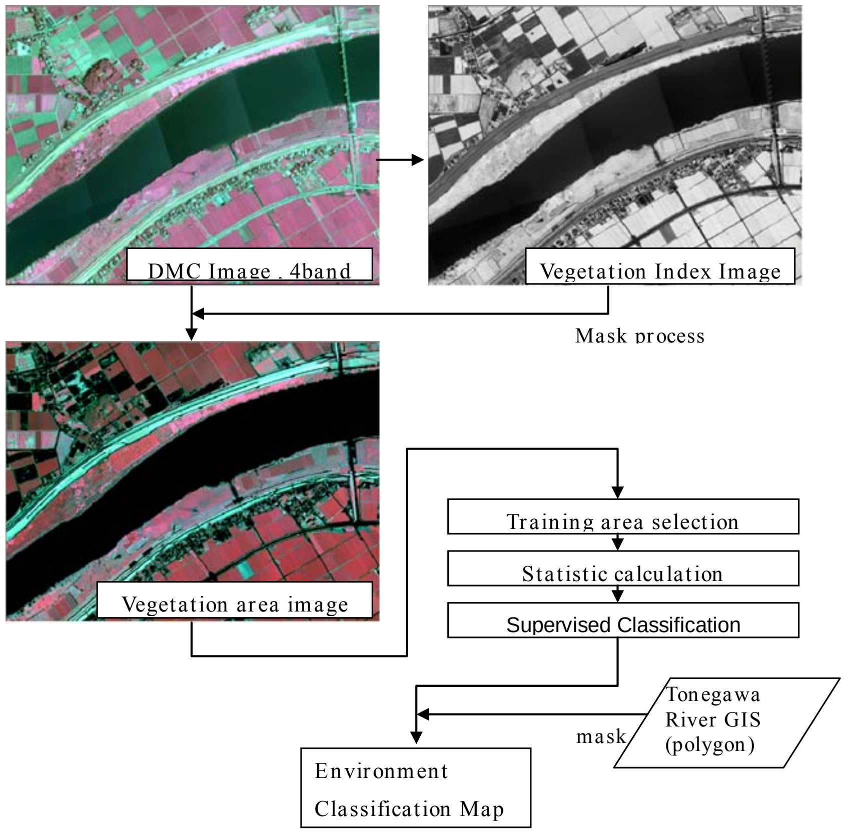

Figure.4 Environment Classification Map

5.2 Vegetation Heights Classification

To obtain vegetation heights, laser scanner data were registered against and superposed on the environment classification map (figure.5). By using the laser scanner data, meter-mesh digital surface model (DSM) and digital elevation model (DEM) were generated. The heights of all real world objects existing in the study area, either natural or artificial, were calculated based on the differential values between the two models. Then, the vegetation distribution zones were extracted from the environment classification map images and superposed on the object height data. The resulting data indicated that the vegetation in the study area included plants having a height to even 9 meters. To verify the obtained results by visual checks, site survey was conducted and it became clear that the colonial distributions of broad-leaved trees and short weeds, among others, were substantially consistent with the calculation results. In some places where individual shrubs are sporadically distributed in the middle of tall grasses, the calculated values were sometimes smaller than the actual height values.

The distribution area of reeds was extracted by using the DMC environment classification map images and the existing vegetation map. As mentioned above, reeds were included in the group of short weeds as it is difficult to distinguish them from other herbaceous plants in the automatic maximum likelihood classification because their spectral reflectance characteristics are very similar.

5.3 Plant Vigor of Reeds

As above therefore, reed colonies defined as same in the existing vegetation map and at the same time, defined as short weeds by the automatic maximum likelihood classification. NDVI was calculated for the distribution area of reeds, and the resulting value was defined as their plant vigor.

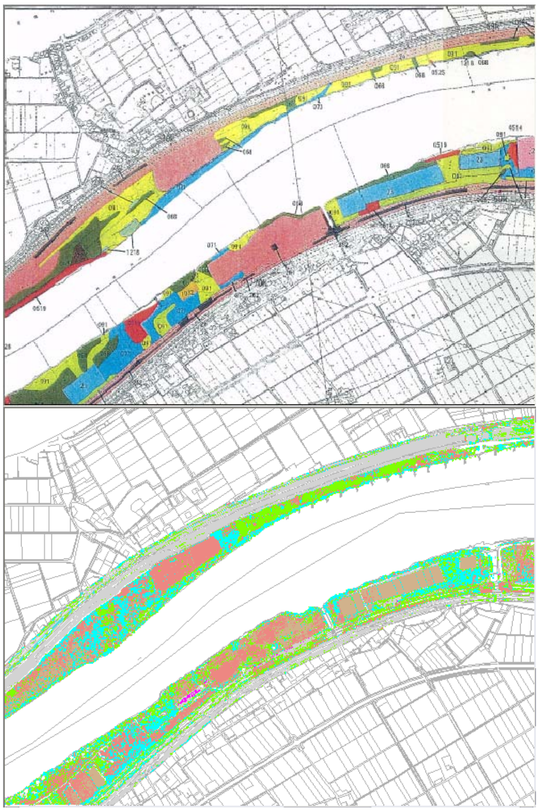

Figure.5 Vegetation Map and Environment Classification Map

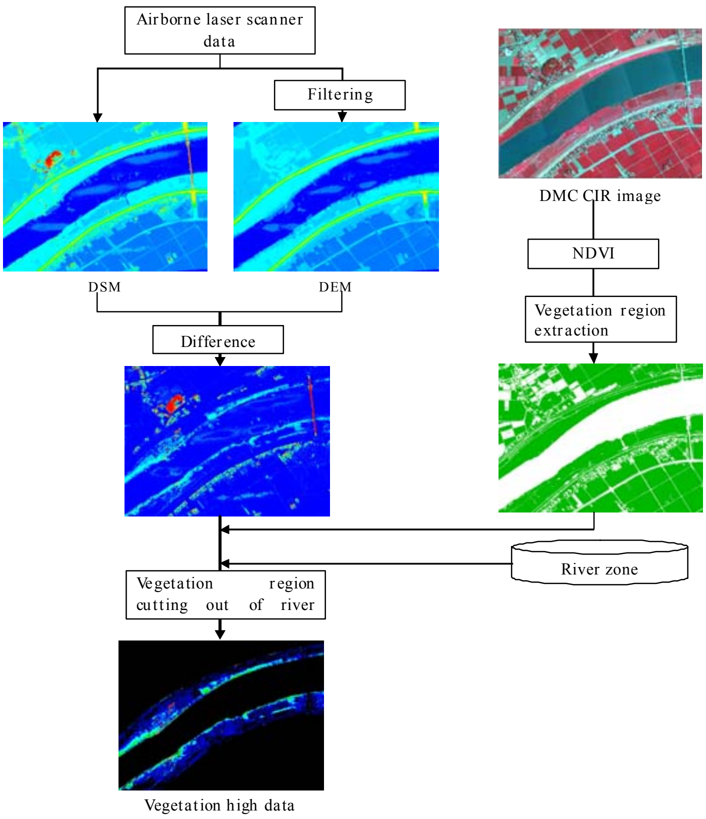

Figure.6 Vegetation Heights Classification

6. CONCLUSIONS

The river environmental information such as vegetation heights and plant vigor were extracted through the combined use of digital airborne images, laser scanner data and existing vegetation maps. So far, the vegetation and land cover classifications, which are the essential information for environmental and ecological assessment in the river field, required a tremendous labor because photographic interpretation and plotting the site survey results on paper plain view were done all by hand.

This study shows that river environmental information can be extracted objectively and quantitatively by making full use of digital data being obtained from the rivers under the supervision of the national government.