GRAIN SIZE DISTRIBUTION ALONG AREAS OF SAND DEPOSITION OF HIJI RIVER

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1. Introduction

This study aimed at estimating grain size distribution along areas of sand deposition of Hiji River. Hiji River is located in Ozu City, Ehime Prefecture (Northwestern part of Shikoku Island) in Japan. It has the catchment area of 1210 square kilometres with river length of 103 kilometers and annual rainfall of 1800 mm. Hiji River is well known for its tributaries and narrow mouth resulting in frequent flooding as shown in Figure 1. The river is also a tourist destination except in events of natural disasters such as floods. There is area of sand deposition at the left side of the river as shown in Figure 2. In order to achieve the main objective of this study, an efficient method to accurately estimate the distribution is proposed.

Figure 1: Narrow Hiji River mouth

Figure 2: Sand deposition and selected points at Hiji River

2. Methodology

The current study used an image processing technique to accurately estimate grain size distribution where image analysis is on the basis of estimation of each particle using BASEGRAIN which is a code in MATLAB software developed by Detert and Weitbrecht (2012). The grain size distributions estimated by the image processing technique is discussed by comparing with the screened results of excavated sand and gravel. Aerial photographs were taken by a drone, which is equipped with a digital camera and a GPS logger. For measurements, 3 shooting points were selected in the deposition area of Hiji River and four positions for drone height were chosen at 1m, 2m, 3m and 4m. Effects of resolution and accuracy of grain size distribution were discussed. The image analysis procedure of the grain size distribution is shown in Table 1. The procedure covers five steps.

Table 1 image analysis procedure of the particle size distribution

(1) Data import An appropriate resolution is adjusted from the images taken by the drone. The ratio in mm is determined for pixel. Checking the actual geographical coordinates from the position information of latitude and longitude by the GPS.
(2) Pre-processing Specify a region consisting of a square located in the captured image. Specify the actual coordinates in the several captured images repeating about 5 times.
(3) Parameter adjustment Adjust parameter for gaps of gravel. Clarify area around the gaps of gravel. Evaluation of long axis and short axis of each gravel
(4) Post-processing Correction of the excessive segmentation of the particle for incorrectly divided particles.
(5) Particle size distribution analysis. Examination of effectiveness of the particle size distribution analysis

3. Results and Discussion

Analyzed data and survey data comparison are presented by Figure 3 showing an image of riverbed surface at shooting point 2 in Figure 2. The results analysis found by BASEGRAIN is shown in Figure 4. Gravel is well indicated by longest axis and shortest axis directions. Nevertheless, minor sand particles are undetectable due to the limitations of spatial resolution. The verification of grain sizes obtained by the above image analysis is discussed by comparing with data generated by the volumetric method. The latter was obtained from field

surveys conducted by Ministry of Land, Infrastructure and Transportation of Japan. The shooting effects at fixed point is obtained from survey point 1 in Figure 2 as point 1 was selected in order to discuss the effects of different shooting heights accurately for grain size distributions. The results shown in Table 2 were obtained by the above mentioned procedure. The resolution of the analyzed image decreases over the range from 1m to 4m in height. As expected, the image resolution is lower at the higher shooting height, and is highest at the lowest height. Mean grain diameter and minimum diameter are shown for each height. Figure 5 is a comparison of estimated grain distributions at different heights (1m to 4m). The grain size distributions from 1m and 2m heights have similar profiles. In addition, minor differences are observed in the case of 3m and 4m heights, about 0.064 and 0.14 respectively, and that is because of progressive lower resolution. Different shooting positions effects are also discussed. By so doing, the analyzed results are applicable for estimation of grain size distributions. In Figure 6, image analysis results for all the shooting points are at the height of 4m. Finer grains are not detected for the highest position, consistent with lower resolution at the highest of the shooting position.

Figure 3: Shooting image on bed surface at point 2.

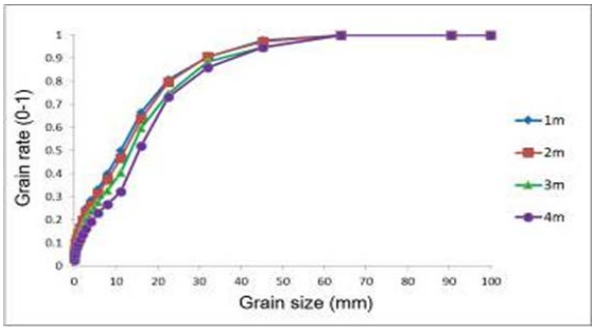

Figure 5: Analyzed results for different shooting height and different position.

Figure 4: Analyzed result of image calculated by means of BASEGRAIN.

distribution for 3 shooting points with survey one (2m)

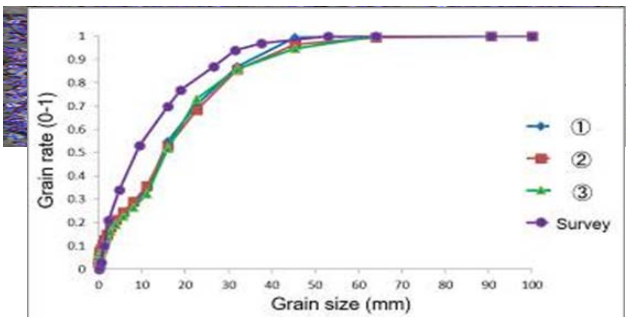

Table 2 Resolution due to different height at fixed point

Height (m)	Resolution (mm/pix)	Mean Size (mm)	Minimum Size (mm)
1	0.7732	20.9955	10.007
2	0.9016	21.0597	10.0012
3	1.4164	23.8002	10.0203
4	1.9275	25.0933	10.0371

Figure 6: Comparison of analyzed grain size distribution for 3 shooting points with measured by field survey (4m).

4. Conclusion

An efficient method to accurately estimate grain size distributions from the analysis of surface images of a sand deposition area in a river was used. For accuracy, analysis was evaluated by using field measurements by excavation and the applicability of the method was discussed.

5. Reference

Detert, M. and Weitbrecht, V. (2012). Automatic object detection to analyze the geometry of gravel grains, a free stand-alone tool. River Flow 2012, Murillo (Ed.).