SAFL

St. Anthony Falls Laboratory

University of Minnesota

Summer Undergraduate Research

Mechanics of Complex Materials

Evaluation of Photosieving as a Rapid Alternative to Pebble Count

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Abstract

Grain size is the most fundamental physical property of sediment. This property is used to accurately measure individual particle sizes, to determine frequency distribution, and calculate statistical description of the sediments.

In this project we are going to use the grain-size measurements to identify the surface composition of the Sandy River, Oregon. The measures of surface composition will be used after the Marmot Dam removal to identify changes in surface composition of the river caused by the displacement downstream of the sediment that is behind of the Marmot Dam. To carry out these grain-size measurements in the fieldwork, we will use the methods of pebble count and photo sieving to measure surface composition of the river, which measures the different grain sizes of the river bed. This research consists of making comparisons between the methods of pebble count and photo sieve. Photo sieving is new method developed to use digital photographs and Digital Gravelometer software to characterize individual particle size without measuring each individual particle.

After finalizing the comparison of the data collected in the fieldwork using the methods of pebble count and Digital Gravelometer, we have reached the conclusion that the pebble count method is more precise and reliable than the method of the Digital Gravelometer.

Marmot Dam, Sandy River

Ceremony of the Marmot Dam Removal

Marmot Dam Removal

Background

The objectives of a grain-size analysis are to accurately measure individual particle sizes, to determine their frequency distribution, and to calculate a statistical description that adequately characterizes the sample (USGS, 2007).

Grain size measurement is complicated because the three-dimensional size of the grains is not constant and the sectioning plane will cut through the grains at random. Grain shape also varies, particularly as a function of grain size (Stewart, 2007). For these reasons the techniques and equipment used for particle-size analysis must be fast, accurate, and yield highly reproducible results. The accuracy of these measurements is limited by sampling techniques, storage conditions, analytical methods, equipment, and, especially, the capability of the operator (USGS, 2007).

In this project we are going to use the grain-size measurements to identify the surface composition of the Sandy River. To carry out these grain-size measurements in the field we used the pebble count method and photo sieving. To process the photo sieving data we used the Digital Gravelometer software developed by Sedimetrics Company.

Objectives

To investigate if this new method for grain size measurements, photo sieving, developed to use digital photographs and Digital Gravelometer software to characterize individual particle size without measuring each individual particle, has the same or greater precision than pebble count method.

Multicultural Summer Research Opportunities Program

Methods

Pebble Count Method

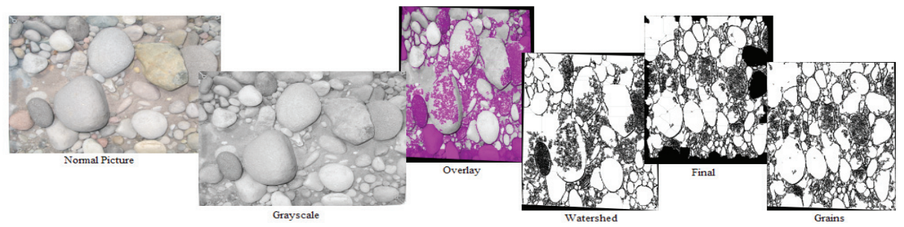
The method of pebble count was developed by M. Gordon Wolman in 1954. It's commonly used to sample the surface particle size distribution of Gravel-bed Rivers. In this process, 100 random particles are selected from the streambed and the nominal diameter of each particle is measured.

The process to select the 100 random particles from the streambed in the fieldwork consisted of extending a tape measure 100 meters and then picking up the rock that is in exactly each meter of the tape. The nominal diameter or b-axis is defined as the diameter of a sphere with the same volume and thus corresponds to sieve size; to measure this property in the field we used gravelometers.

Digital Gravelometer

Digital Gravelometer is software for Windows® developed by Sedimetrics Company that enables you to measure unconsolidated gravel sediments from digital photographs. It's based on proven technology that has been published in the highly respected academic journals *Water Resources Research* and *Mathematical Geology*.

In addition to basic size-distribution parameters, Digital Gravelometer produces customizable reports containing a host of statistical parameters along with graphical grain-size distribution curves and histograms.

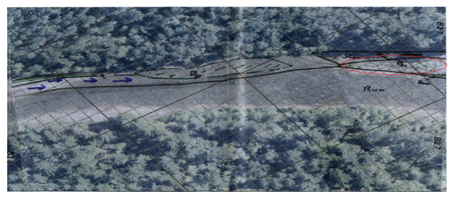


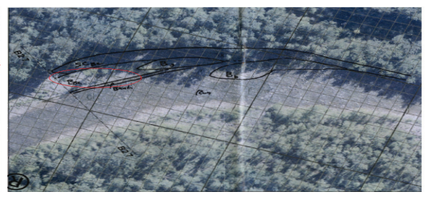
Stages in the grain identification

Results

Greg's Island
Reach: B2
Facies: Bsc
Sediment Mapping:

Map: 7-8



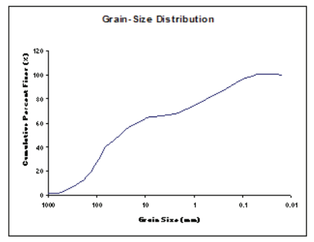


Pebble Count

B-axis	B-axis (mm)	Count in Class	Percent in Class (%)	Cumulative Percent Finer (%)
>1m	1024	5	1.71	1.706484642
.5-1m	512	1	0.34	2.04778157
256-.5m	256	18	6.14	8.19112628
180-256	180	15	5.12	13.3105802
128-180	128	18	6.14	19.45392491
90-128	90	31	10.58	30.03412969
64-90	64	28	9.56	39.59044369
45-64	45	16	5.46	45.05119454
32-44	32.5	15	5.12	50.17064846
22-32	22	18	6.14	56.31399317
16-22	16	10	3.41	59.72696246
11-16	11.25	7	2.39	62.11604096
8-11	8	8	2.73	64.84641638
2-8	2	11	3.75	68.60068259
Sand	0.0625	91	31.06	99.65870307
Mud	0.015625	1	0.34	100

Wentworth size classes	Percent in Class
Boulder (>256 mm)	2.05
Cobble (64 mm - 256 mm)	27.99
Pebble (4 mm - 64 mm)	38.57
Sand (<2 mm)	31.4

Grain-Size Distribution Plot

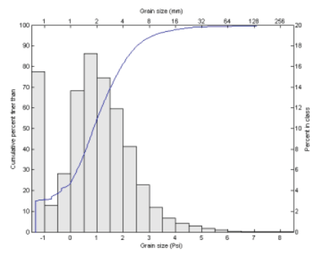


Digital Gravelometer

Size (finer than / passing sieve)			Count in class	Percent in class	Cumulative percent finer than
mm	Phi	Psi			
0.35	1.50	-1.50	0.00	0.00	0.00
0.50	1.00	-1.00	10316.00	15.53	15.53
0.71	0.50	-0.50	1710.00	2.57	18.10
1.00	0.00	0.00	3732.00	5.62	23.72
1.41	-0.50	0.50	9057.00	13.63	37.35
2.00	-1.00	1.00	11443.00	17.22	54.57
2.83	-1.50	1.50	9885.00	14.88	69.45
4.00	-2.00	2.00	7902.00	11.89	81.35
5.66	-2.50	2.50	5485.00	8.26	89.60
8.00	-3.00	3.00	3015.00	4.54	94.14
11.31	-3.50	3.50	1572.00	2.37	96.51
16.00	-4.00	4.00	877.00	1.32	97.83
22.63	-4.50	4.50	575.00	0.87	98.69
32.00	-5.00	5.00	381.00	0.57	99.26
45.25	-5.50	5.50	235.00	0.35	99.62
64.00	-6.00	6.00	133.00	0.20	99.82
90.51	-6.50	6.50	63.00	0.09	99.91
128.00	-7.00	7.00	27.00	0.04	99.95
181.02	-7.50	7.50	24.00	0.04	99.99
256.00	-8.00	8.00	6.00	0.01	100.00
362.04	-8.50	8.50	1.00	0.00	100.00

Wentworth size class	Percent in class
Boulder (>256 mm)	0.00
Cobble (64 mm - 256 mm)	0.18
Pebble (4 mm - 64 mm)	18.47
Granule (2 mm - 4 mm)	26.77
Sand (<2 mm)	54.57

Grain-size distribution plot



Conclusions

After making a detailed analysis of the different results we have found several faults and limitations using the Digital Gravelometer software.

- The process of taking photographs in the fieldwork is a complicated one, since the photos must be taken within the area indicated by the frame and as perpendicular as possible to the surface under study. This does not allow the operator of the camera to see in the display the area that is going to be taken in the photograph, forcing the operator to take random photos until obtaining the height, the place and the perfect position for the area under study in the photo.
- Due to the limitations in the area that can be taken in digital photos, the Digital Gravelometer does not take into consideration the true percent that exists of boulders and cobbles studied in the area.
- When the software processes the photos, it takes the undulations on rocks like small grains and interstices and not like individual rocks. This explains the great percent of sand and the low presence of boulders and cobbles in the obtained results. These discrepancies were reflected clearly in the form of the Grain-size Distribution Plots obtained with the Digital Gravelometer Method in which it can clearly be observed that these are *poorly graded soils*.

The results of the Digital Gravelometer did not agree with the classification made with the respective areas studied by the analysis of Sediment Mapping. However the results of percents of wentworth size class and grain-sizes distribution plots that obtained by the Pebble Count Method were very similar to the classifications made of the grain sizes by the Sediment Mapping Process in the studied areas.

After analyzing all the obtained results of both methods and comparing them with the work made of the Sediment Mapping in the Sandy River, we can conclude that the Pebble Count Method is more precise and reliable than the Digital Gravelometer Method.

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