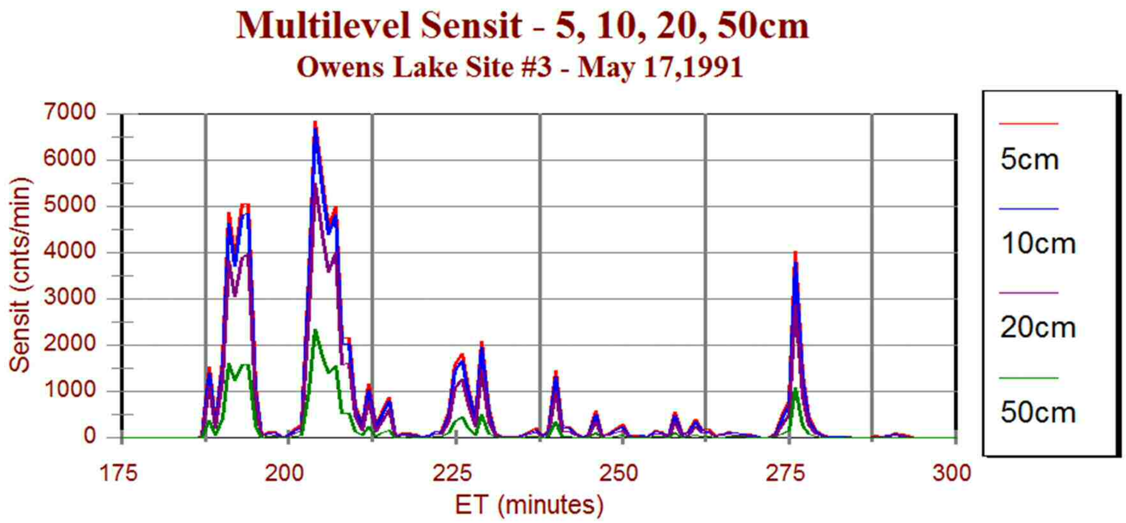
Tech Note 5

April 24, 2013

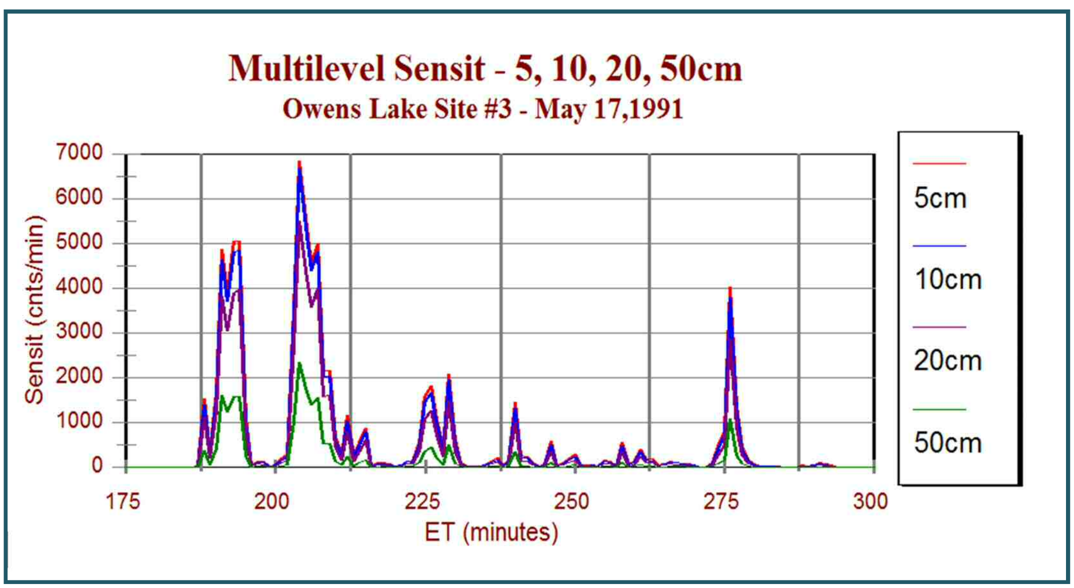
Multi-Level Data & Data Logger Counting Considerations



Rare Sensit H11-LIN 4–Level Data Taken at a Sensit Field Site

5 Level Sensit Erosion Sensor 1991

Data – Multilevel

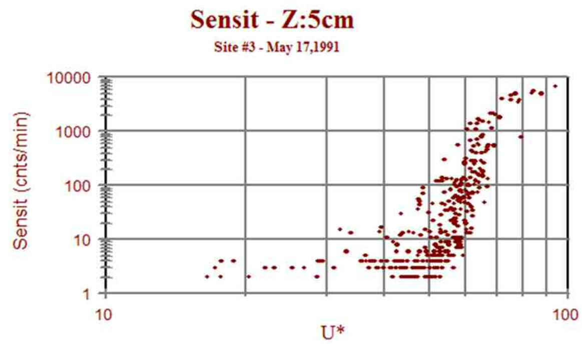


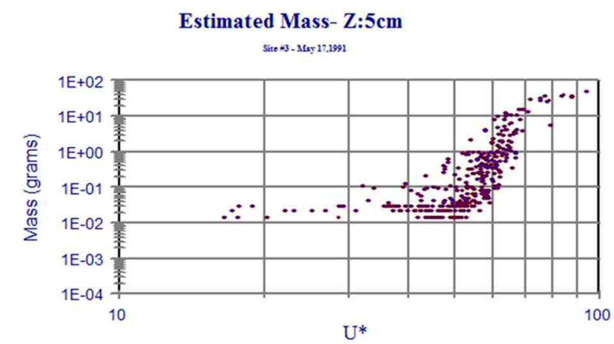
The data graph above was acquired using a 4 level Sensit located at Owens Lake on May 17, 1991. The multi-level sensor is comprised of four separate Sensits housed in a single enclosure where the crystal sensors are mounted vertically on a single post. This simultaneous data was taken at a sampling period of 60 seconds.
This graph of raw data is a time series of the May 17, 1991 Owens Lake at the North end. The legend indicates sensor height.

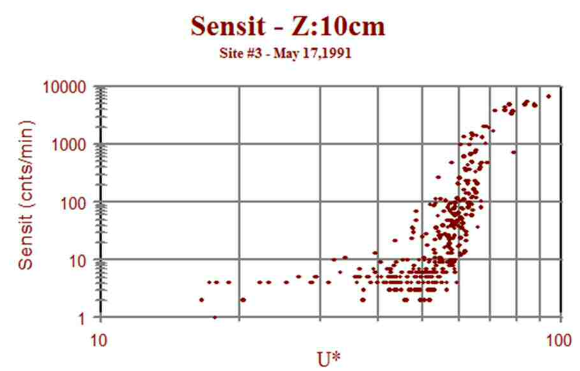
Sensit Graphed Multi-level Data

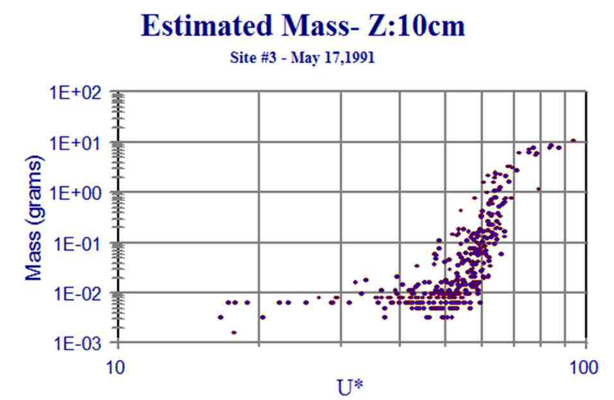
The following graphs are a series of Sensit data vs. U* graphed at 4 different heights. On the left side of the page is raw Sensit KE output data vs. U*. On the right is this data after processing the Sensit KE output into units of mass. After processing the data, the sum of the Sensit calculated mass data now equals the total mass collected in the BSNE catcher for the same event. This process is responsible for establishing units for an "estimated" mass per data point. Non-dimensional values and site variables affected by natural and unpredictable conditions become valid and understandable data by the use of the very real reference to catcher mass. The catcher mass is the ultimate truth.

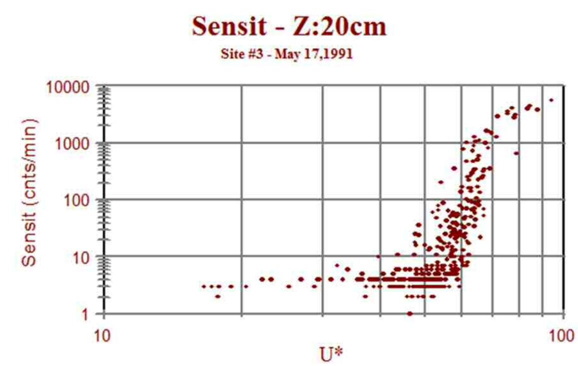
U* is used here as a non-dimensional particle velocity in calculating mass (via the Sensit kinetic energy output data - $\frac{1}{2} mv^2$). We are using a general rule-of-thumb to assume most particle velocities are proportional to the driving force of the wind (U*). This proportionality is an assumption of course but is generally accepted as the best method available to reconstruct values for particle velocities.
Sensit KE data, after being process to be proportional to the estimated mass was done by using the simple field cal method.
The Sensit energy response strongly indicates the response to kinetic energy. The particle speed increases with height while mass decreases.
Threshold is difficult to discern. This is why I advocate recording the particle count (PC) at 15 second or less intervals to provide a clear graphic representation where threshold can accurately be determined.

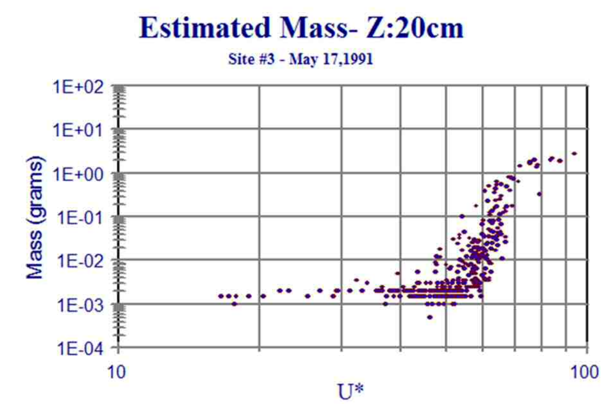

Sensit - Z:5cm
Site #3 - May 17,1991
Sensit (cnts/min)
10000
1000
100
10
1
10
100
U*

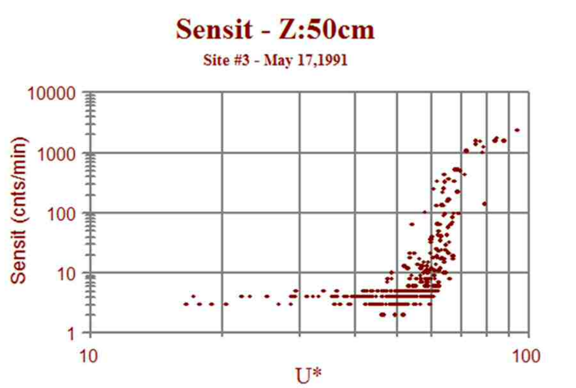

Estimated Mass- Z:5cm
Mass (grams)
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
1E-04
10
100
U*

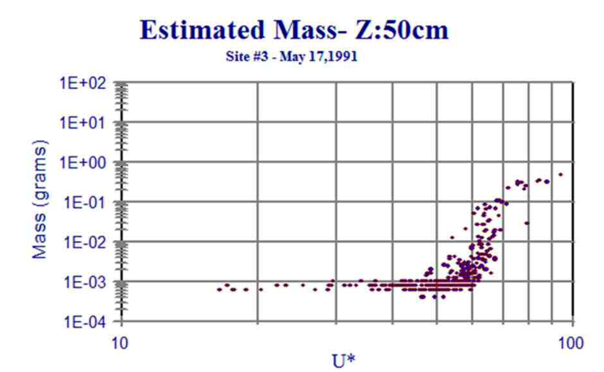

Sensit - Z:10cm
Site #3 - May 17,1991
Sensit (cnts/min)
10000
1000
100
10
1
10
100
U*


Estimated Mass- Z:10cm
Site #3 - May 17,1991
Mass (grams)
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
10
100
U*


Sensit - Z:20cm
Site #3 - May 17,1991
Sensit (cnts/min)
10000
1000
100
10
1
10
100
U*


Estimated Mass- Z:20cm
Site #3 - May 17,1991
Mass (grams)
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
1E-04
10
100
U*


Sensit - Z:50cm
Site #3 - May 17,1991
Sensit (cnts/min)
10000
1000
100
10
1
10
100
U*


Estimated Mass- Z:50cm
Site #3 - May 17,1991
Mass (grams)
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
1E-04
10
100
U*

Multi-level data displays a rare look at the vertical profile of simultaneous erosion activity. Log scaling is used to compress highly scattered data. The lowest value data values are Sensit output counts of 1, 2, 3etc. so they appear as a line across the graph. This is just the effect of resolution.

The response of the sensors is similar; data from the 5, 10 or 20cm appear to indicate non-linearity at the upper end. But, saturation is not probable since the 50cm height data displays the same shape. The "bend" at the top of each graph is due to source limited mass.

Data - Avoiding Saturation

There is no saturation in the data sets shown. And is not likely you will ever encounter data saturation. This can only occur if the particle concentration is so high that coincident impacts are hitting the sensor's active surface. This surface area is very small compared to saltation special concentration. Furthermore, as impacts occur axially off-center about the cylindrical surface, the energy transferred decreases more or less as the cosine of the angle of impact. This effectively further reduces the active surface. It would be extremely difficult to experience saturation however, if it were to happen, the graphed data would show a flat top on the response.

If (and again I don't believe this can happen) graphed data indicates saturation may be occurring there are two quick solutions:

One solution may be to cover one half of the sensors active surface with one-inch diameter heat shrink tubing. This will reduce the sensor's active area reducing the possibility of impact coincidence. As this rate decreases, the stretched output pulse (described above) will not run into itself thus releasing the effect of saturation.

Another solution is to mount the sensor a little higher. If this is done remember to relocate the reference mass catcher at the new height.

Data Logger Considerations

FYI: Sensit Output Pulse Widths

S/N	PC	KE
001->219	640uS	4uS (varies with energy)
220->379	1-3mS	1–3mS
380->400	500uS	500uS
400->968	260uS	350uS
968->999	260uS	800uS
1000->1099	250uS	550uS
1100->1199	250uS	650uS
1200->1299	250uS	750uS

Note: All Campbell data logger users are have been able to get their data loggers to count the Sensit outputs one way or another. The newer data logger say made later than 1990 or so, can count pulses as narrow as 4uS. The old data loggers had a de-bounce resister and capacitor to avoid contact bounce from reed switch contacts from instruments such as anemometers, tipping rain gages and the like.

The Sensit outputs are TTL/CMOS compatible positive pulses. The pulse widths are nominally PC: 700uS and KE: 250uS. These are ideal pulses for any TTL/CMOS hardware. If there is a counting problem, it is always a data logger programming error.

-----Example Programming Routines-----

The Programming instruction 3 (P3) with our data logger is what enables the pulse input to be read by the data logger. P3 is written as follows:

01: Repetitions
02: Pulse channel of Control Port number for measurement
03: Configuration code (type of measurement - switch closure etc.)
04: Input location
05: Multiplier for sensor output
06: Offset for sensor output

When programming the Campbell data logger use their data logger support software PC208W. The programmer is prompted with the options to select in order to complete each line of the program. Use programming instruction 3 when acquiring counting input data.

-----CR510 Data logger-----

Number of Pulse channels (P1, P2, P3): 3
P1 and P2 measure switch closure, high frequency pulse, and low level AC input at up to 2000Hz
P3 measures switch closures only at up to 40 Hz
Minimum pulse width is 2 microseconds

-----CR10X Data logger-----

Number of Pulse channels (P1, P2, C6, C7, C8): 5
P1 and P2 measure switch closure, high frequency pulse, and low level AC input at up to 2000Hz
C6, C7 and C8 measure switch closures only at up to 40 Hz
Minimum pulse width is 2 microseconds

-----CR23X Data logger-----

Number of Pulse channels (P1, P2, P3, P4, C5, C6, C7, C8): 8
P1, P2, P3 and P4 measure switch closure, high frequency pulse, and low level AC input at up to 2000Hz
C5, C6, C7 and C8 measure switch closures only at up to 40 Hz.
Minimum pulse width is 1 microsecond

-----Multiplexers-----

We also offer a multiplexer named SDM-INT8. The multiplexer uses a C1, C2, C3, 12V and ground from the data logger and enables 8 additional pulse channels. The specifications of the SDM-INT8 are those of the data logger that you are using with the multiplexer.

Data – Things to Remember

All Sensits made after February 2001 have PC output pulse widths of >= 500uS and KE output pulse widths of 240uS. This allows a maximum Sensit output data rate of 2000 pulses per second.
Maximum anticipated output data rates for extreme erosion (sand sheet):

KE - 100 pulses per second.
PC – 1000 pulses per second.

Data – Use of the Particle Count Output

Always remember... The particle count output was never intended to provide a qualified value of impacts because there is an unavoidable electronic threshold which the particle impact signal must be exceeded to trigger one PC pulse out. And most importantly this electronic threshold is triggered by kinetic energy data. This means nothing can be said about the particle size producing the PC output. Therefore the PC output is intended to only provide data allowing the identification and tracking of the threshold of movement.