How Many Soil Moisture Measurements Do I Need?

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Soil moisture is variable so we need statistics

- Mean – the expected value of the variable (soil water content)
- Standard deviation – a measure of dispersion about the mean. There is a 68% chance that a given measurement is within ±1 std. dev. of the mean; a 95% chance of it being within ±2 std. dev.

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Example

- We measure a water content of 27%
- We know (or assume) the water content standard deviation is 3%
- The mean or expected value of the soil water content is therefore likely (95% chance) between 21 and 33%

What if we need a more accurate value?

- Sample multiple values of water content
- Compute the average water content

$$s_m = \frac{s}{\sqrt{n}}$$

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Another example

- 100 samples give an average of 28%
- Std. dev. of mean = 3/10 = 0.3%
- The mean or expected value of the soil water content is therefore likely (95% chance) between 27.4 and 28.6%

How many samples do I need?

- What accuracy do you need?
- What is the std. dev.
- Accuracy = ± 2 std. dev. of mean

$$n = \left(\frac{s}{s_m}\right)^2 = \left(\frac{2s}{e}\right)^2$$

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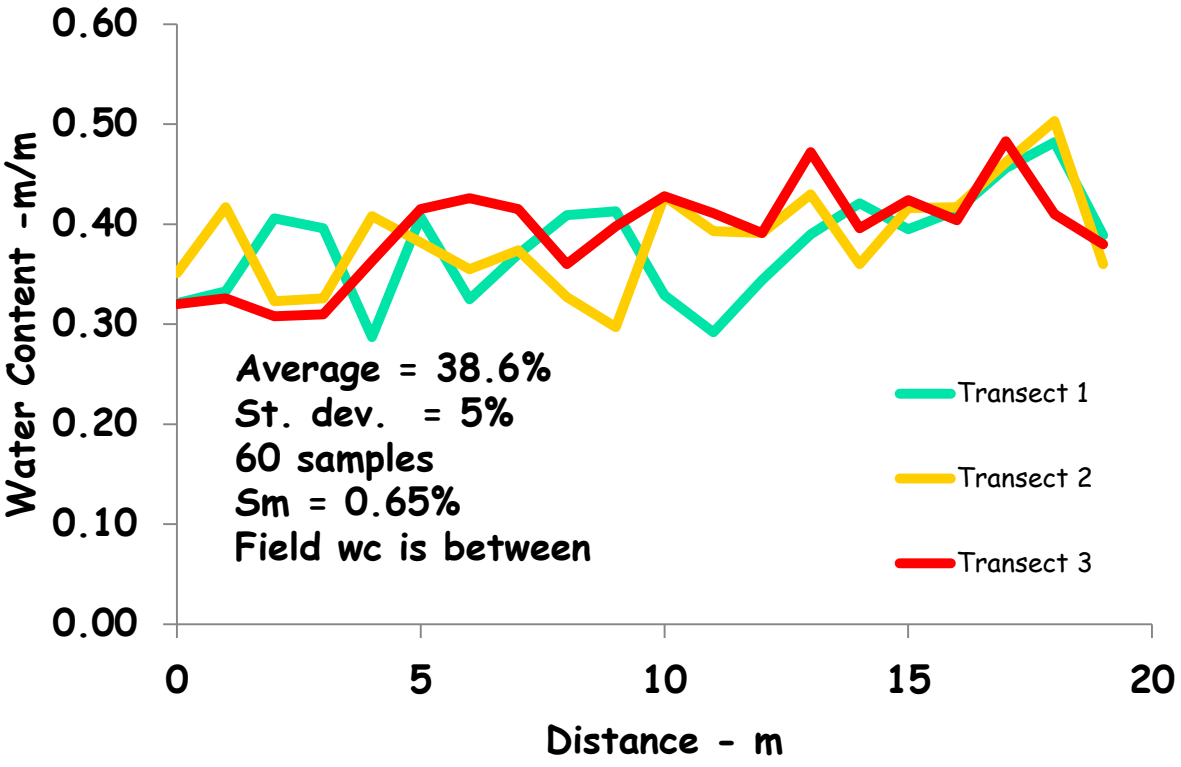
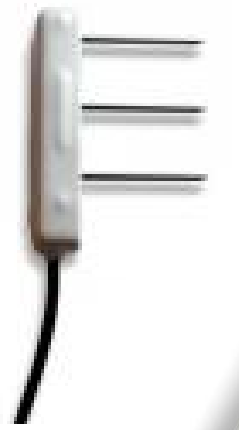
Number of samples - calculation

- How many samples would we need to know water content within 1%?
- Std. dev. is 3%, ε = 1%,
  $n = (2x3/1)^2 = 36$

Field data – 3 transects, 1 m spacing





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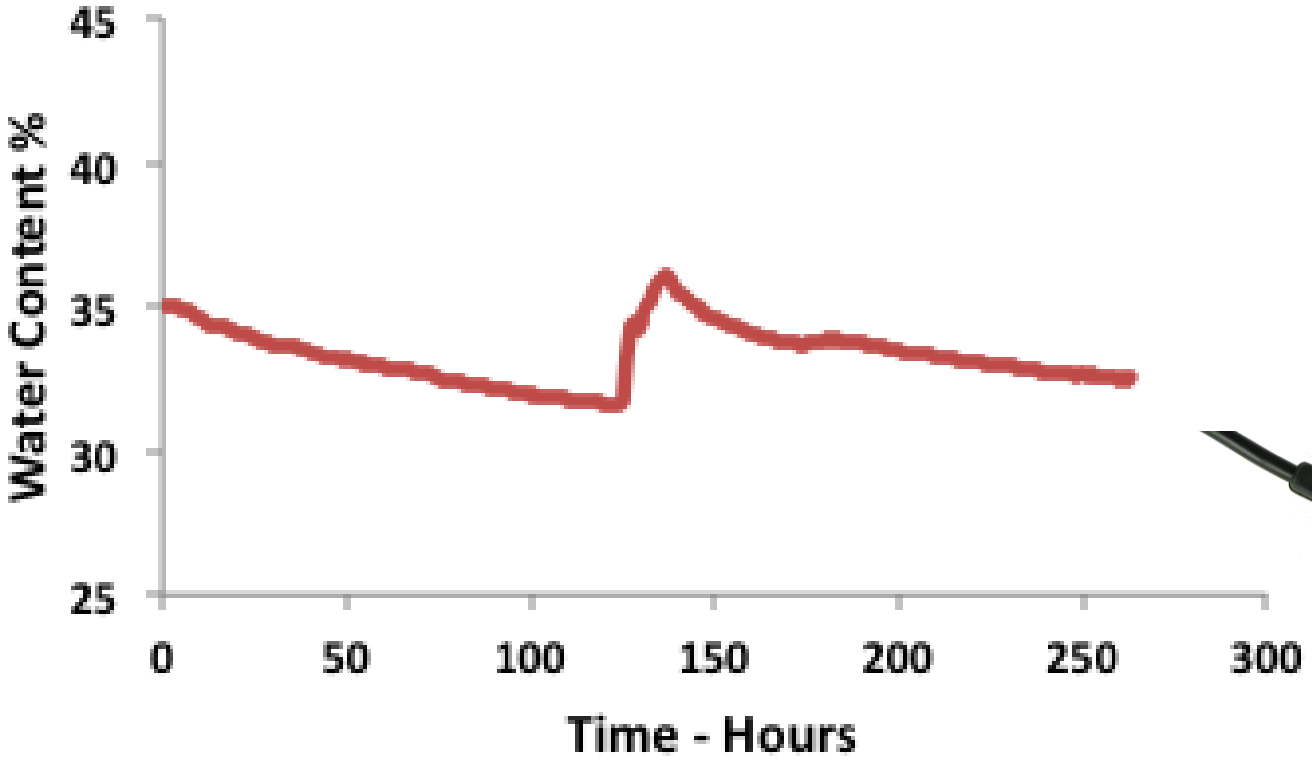
Drydown/wetup of a single, installed sensor



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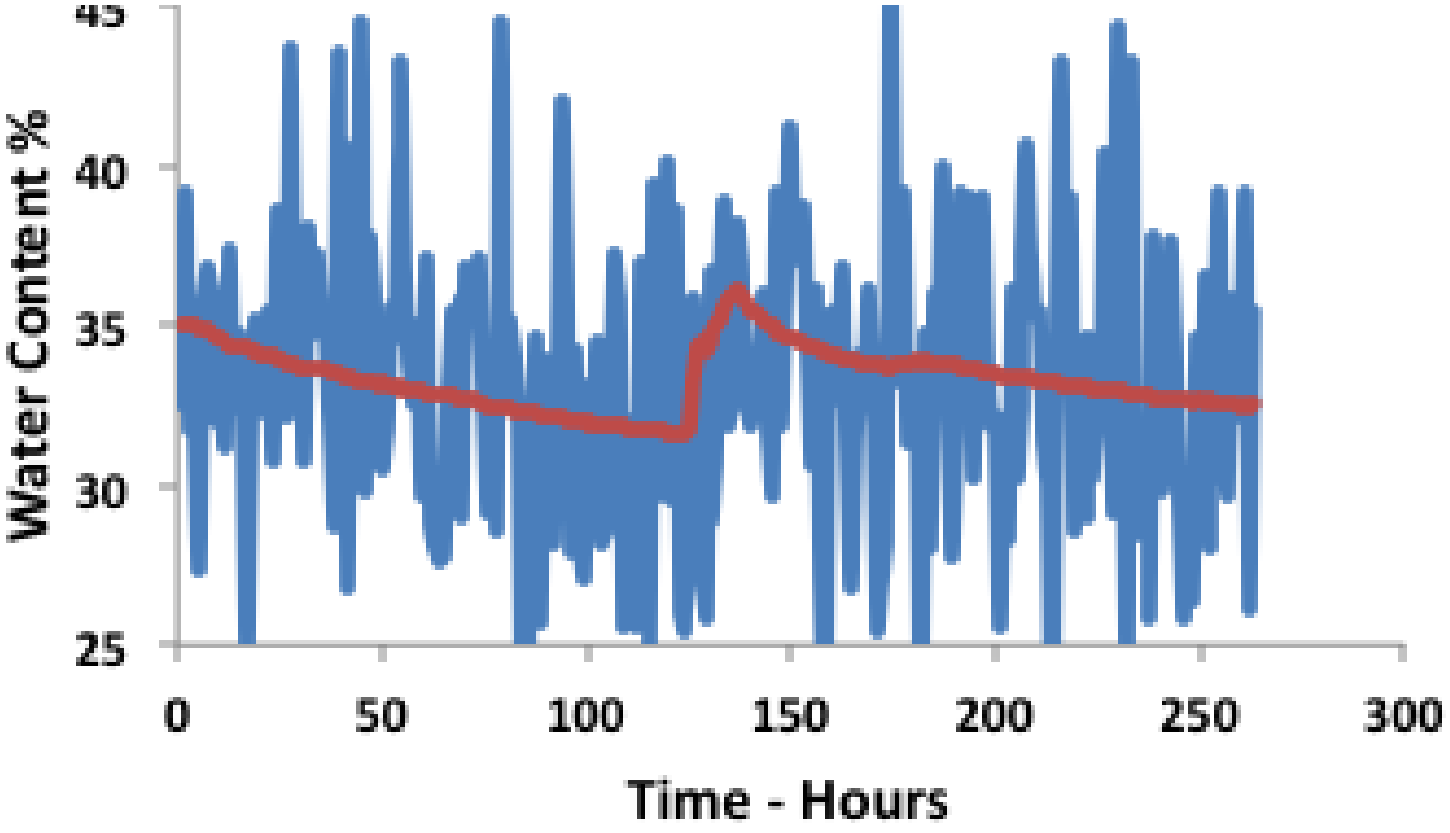
One sample per hour



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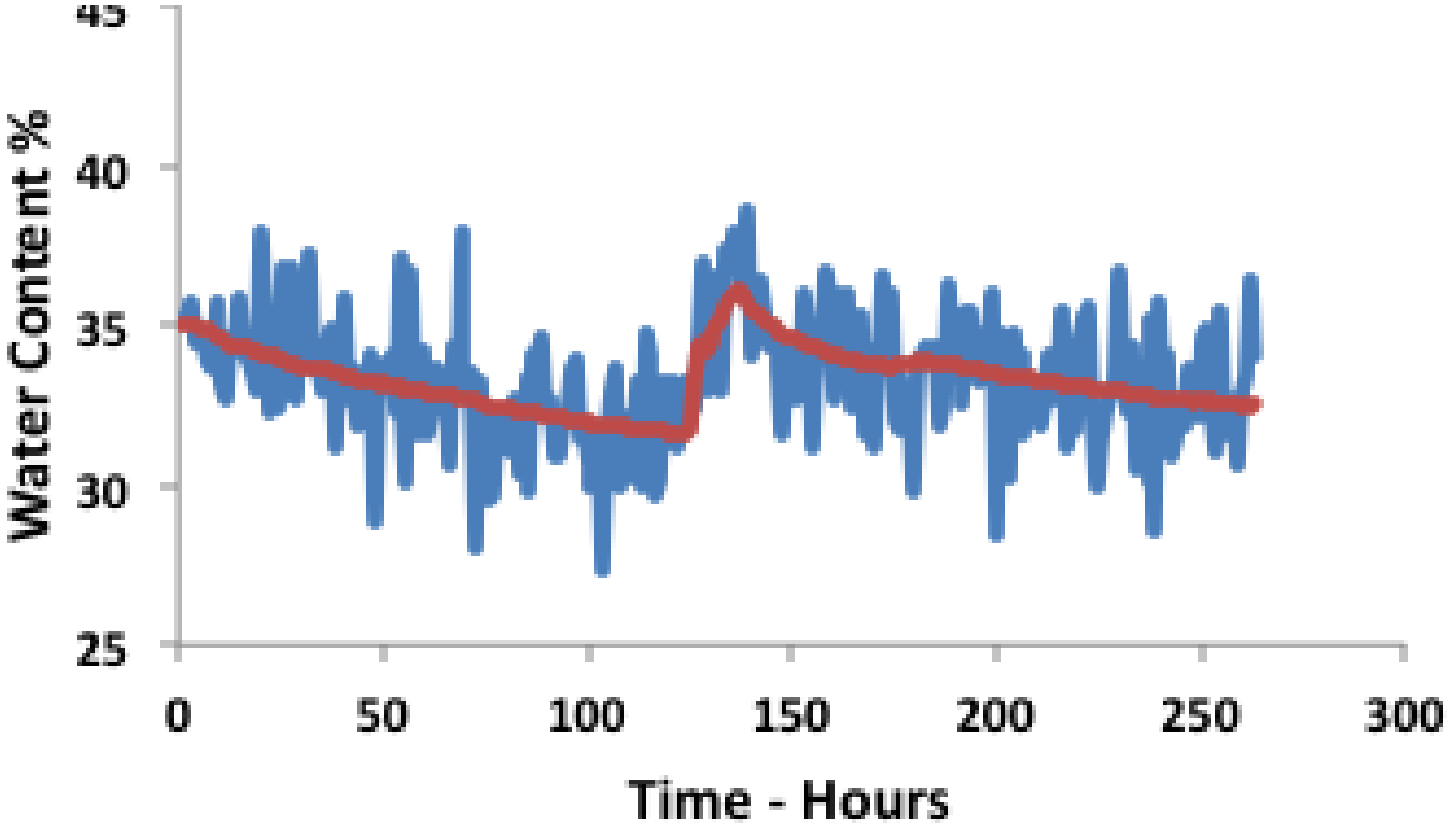
10 samples per hour



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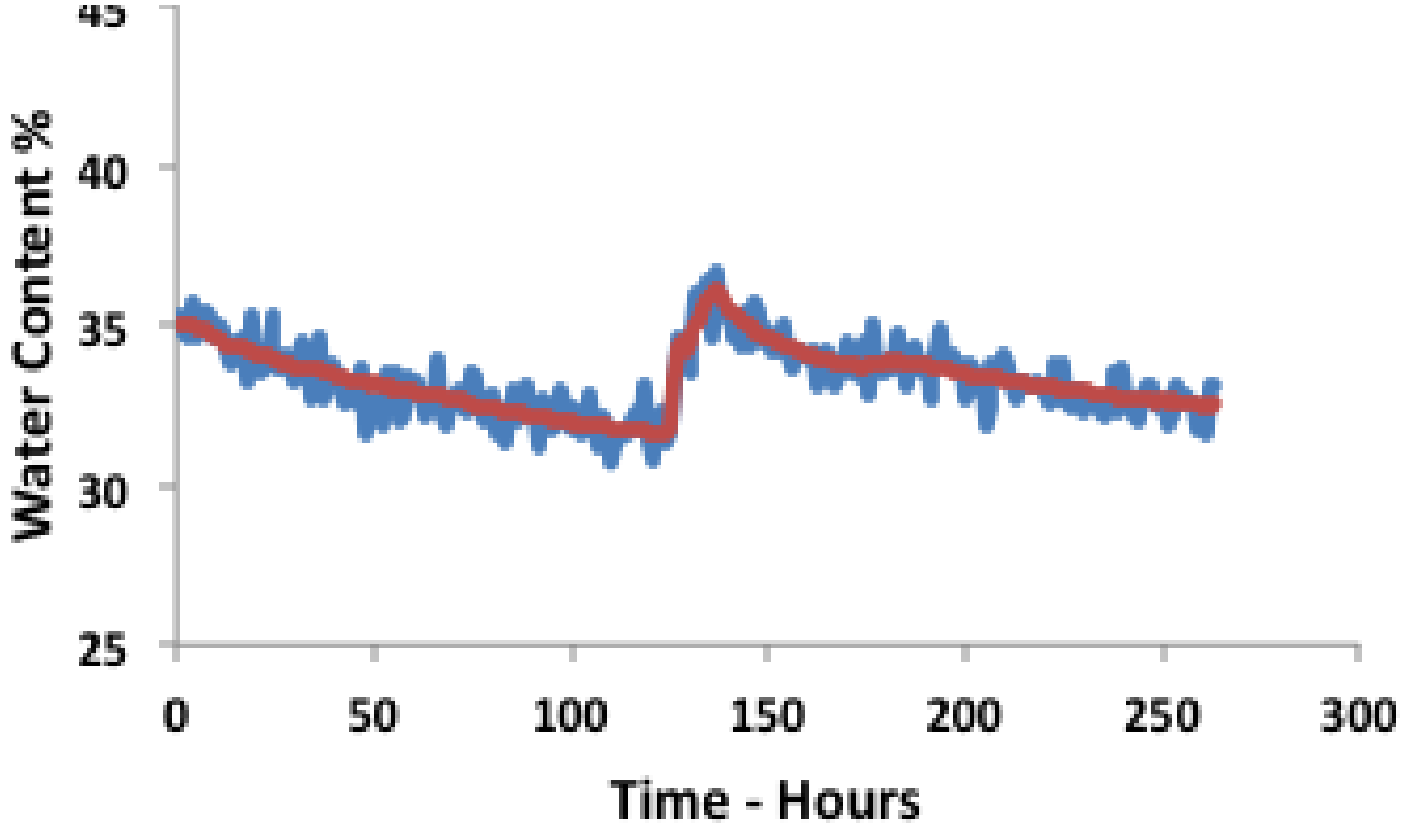
100 samples per hour



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Conclusions

- Soil water content varies from place to place
- We usually need to average several measurements to know what the water content is – and then we don't know it very well
- We usually can't afford enough sensors to "know" what the water content is

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Conclusions

- But - for many purposes you just need to know if water content changed, not what it is, exactly.
- You can get around many effects of spatial variability by monitoring *in situ*

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