Citizen Science Projects (MOOC) 2.9

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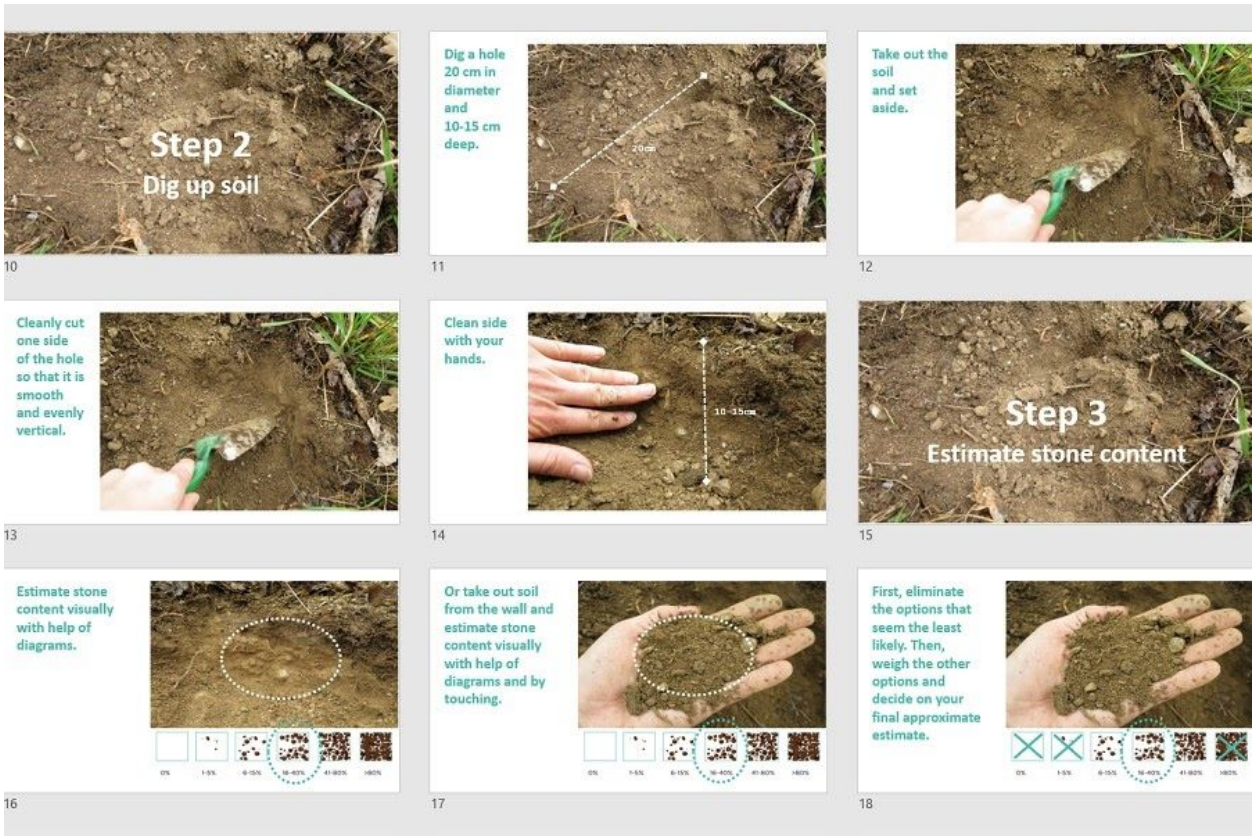

In the previous steps, you learned about how to ask good research questions, how to choose which data to collect, and how to select observations that will answer those questions. In this step, we will look at how to set up your observation protocols.

##Protocols and method validation

No matter what you are measuring, all measurements should follow a tested and validated protocol that outlines what is being measured, how to measure it and suitable measurement conditions to follow. Your protocol depends on what you want to find out and what options are available for taking measurements. You will need to consider elements like the technology, skills, resources and time available to do the observations.

For scientific work, including citizen science, it is important to use valid methods, provide accurate measurements, and carry out observations in a repeatable way. All these factors influence the reliability of methods and measures.

A method has a high reliability if it produces results that are as close as possible to the actual values of what is being measured. For example, consider these questions:

If you observe or measure an unchanging parameter multiple times (for example, field size, slope angle) under the same conditions (for example, at the same time of day or from the same viewpoint), do you get the same results? This question refers to the concept of repeatability.

If someone else does the same observation, will they get the same result? If you do the observations, but at different times of day when daytime should not affect your observed parameter, do you get the same results? This refers to the concept of reproducibility.
You can also validate your protocols and measurement methods and determine their accuracy and margin of error by comparing your results with results from established methods. For example, you can validate a low-cost sensor by comparing its data with data from professional sensors used under the same conditions.

To come up with a good protocol, you need to consider the following questions:

###Do you want to observe change over time by taking continuous measurements and identifying patterns or trends?

If so, it's important to set an appropriate timeframe and intervals, tailored to the anticipated time needed for the change to happen, or for trends and patterns to unfold.

For example, soil moisture is a crucial soil component, relevant to soil health, fire risk, flood and drought resilience, climate buffering and more.

Soil moisture changes over time, due to short-term weather events and seasonal changes in temperature, light and precipitation. Land management practices can also influence soil moisture. So, you could observe variations in soil moisture over 24 hours (looking at changes in temperature and air humidity), over a month (looking at weather events like rainfall or dry spells), over a year (understanding longer-term changes across seasons), or over a decade (linking to climate change effects).

###Do you want to understand a single, relatively stable feature, or something at a specific point in time?

If so, it's essential to understand when and where to measure, and how precise measurements need to be. Often, this is done to establish an inventory, to plot a measure against a target or threshold, or to establish the initial state of a parameter. Examples of this include measuring soil texture, the population size of a bird species during the breeding season, or the amount of plastic pollution on a beach after a storm from the west.

###Do you want to measure the effect of a specific intervention or treatment?

You may want to investigate what happens to your yield when you add compost to a vegetable garden, for example. So, you would need to consider replication and control, which are strategies in experiment design to make sure you can link the effects you observe with your interventions.

In our example, you'd need two plots – one treatment (adding compost) and one control (no compost) plot. Adding compost should be the only difference between the plots. Everything else should be the same (or as close as possible). This would include measures like:

+ Location, size and shape of each plot
+ Type(s) of crop grown
+ Number of plants or seeds added
+ Spacing and arrangement of plants/seeds
+ How you prepare and manage the plot (for example, watering, removing weeds or raking soil)
+ Shade or light levels
+ Soil type

To make sure your unique results are not a matter of chance, you should replicate the experiment many times under the same circumstances, and compare those results. This is sometimes a problem which citizen science – many people doing science together – can help to solve!

###Do you need additional information to interpret your primary data?

Collecting additional, contextual data helps you to understand your observation results comprehensively. Two critical contextual factors are time and location information.

Imagine trying to interpret soil moisture data without knowing what the weather was like, or if someone managed the land, or what soil texture the sensor was placed in. You could still see how soil moisture developed over time, but it would be hard to interpret the data. Was the sudden increase of soil moisture related to irrigation or rainfall? Was the fast decline of moisture due to high temperatures, very sandy soils, or both? Given a steady decline in moisture over time, wouldn't it be good to know if a heatwave or a rainy period was coming up?

Or, imagine if you placed air quality sensors measuring NO2 along a heavily-trafficked street but that these were placed at different heights, and you didn't have a recording of their location or their height. You could still determine an average NO2 measure for the street, but it would be impossible to compare or infer insights from the measurements you collect.

In the next step you will get a chance to try a protocol yourself.