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Soil system studies along climatological gradients: lessons learned and challenges

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The transect approach has been an important strategy in the natural sciences and it is especially useful for establishing conditions in an explarotory situation. Classic soil system studies along climatological transects are well documented from Russia, The USA, Israel, Australia Africa and South America. In about 1990 the approach began to be used as a kind of analogue study for climate change alongside models. The author had the opportunity to be involved in many such studies for example in Morocco, Spain, Columbia, Bolivia but in fact wherever one happens to be investigating the soil system differences along climatological transects could be studied.

The first challenge to be addressed related to complexity, scale and time. What we observe and describe by means of indicators are things responding to processes that are complex and not completely or hardly understood. What soil indicator should we use to assess how soil systems are functioning? How can we evaluate how they are being affected by the causes of degradation? Many insights have been obtained by measuring soil aggregation and soil stability indicators, soil chemical characteristics including water soluble salts. Organic matter was found not to be such a good indicator. The amount of biological activity in the soil as indicated for example by the number of growing days per year is significantly correlated with soil stability.

On the positive side, it has long been known that the aridity of the soil is affected by the lithology and how the soil system, and the creatures whose habitat it is, convert into as system that can provide them with moisture, nutrients and space. So it was known from Israel that the sensitivity of ecosystems to degradation and therefore also the resilience is relatred to the rock type.

A challenge is that soil erosion is often an emergent process that occurs when the soil system processes have been deregulated. It is often useful to think of the soil s being in a state in which the present situation can maintain itself by means of negative feedbacks that restore conditions. However, the actual causes or explanations for the deregulation or loss of system capacity are sometimes obvious (trampling, salt accumulation, herbicides) but in most cases unknowable without detailed investigations.
The reality is therefore that along a climate transect similar or different causes may have similar consequences so that the state of many indicators is too similar to be discriminatory. This is particularly true in agricultural systems where the same crops are grown irrespective of climate.

An important lesson is that the most vulnerable systems are those near locations that have thresholds which influence the capacity of the soil to provide a kind of soil and water regulation function by retaining water when it rains. The critical water requirements of the existing vegetation along a climatological transect are important but the issue in 1600 all water was used by natural systems but that today maybe 60 per cent by agriculture. So degradation and aridification are mainly caused by agriculture. There is simply less water to flush out salts from the soil. Erosion processes cause hot spots of high salinity and toxicity. Where there is less than 350 mm of rain the soil system has behavioral properties strongly dominated by salt.

An important research goal would be to use the data collected along transects as a baseline to evaluate what has changed during the last 15 -20 years.