

Soil quality indicators to monitor recovery and assess functionality of degraded soils in semi-arid ecosystems

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Ecosystem services can be seriously altered in disturbed environments such as those resulting from mining activities. Approximately 80% of ecosystem services can be linked to soil functions, hence, restoration of degraded ecosystems should aim to not only recover soil capacity to support vegetation but also to restore ecosystem functions and services. Although natural disturbances such as fire can alter soil structure and functioning, ecosystems affected by fire will often recover without intervention. However, in a context of global environmental change and constant land degradation, it is crucial to understand the recovery of soil properties as a fundamental and linked process in the resilience, function, and restoration of these disturbed ecosystems. Here, we present two case studies in the Pilbara (NW Australia) using soil physicochemical and microbiological indicators to a) evaluate within intact ecosystems short- and long-term recovery of soils after wildfire and b) to assess within a post-mining restoration site the status of soils restored with alternative substrates (stockpiled topsoil and overburden material). The first study was conducted across a wildfire chronosequence spanning sites recently burnt through to 14-years after fire in a semi-arid hummock grassland ecosystem. Our results showed that microbial indicators, e.g. fungi to bacteria ratio and microbial quotient, were significant indices reflecting soil recovery processes after fire. In our second study, we found a positive effect of vegetation on reconstructed soils and a recovery of soil functionality in overburden material to levels similar to those in topsoil once vegetation was established. The use of the 1-day CO₂ (solvita) test proved to be an alternative cost- and time-effective method to measure microbial activity and assess functionality of restored soils. The approach and methods followed in this research could be effectively translated to other areas and applied in a broad range of restoration projects in arid and semi-arid environments.