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Soil fauna and the provision of ecosystem services: a systems approach

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The relationship between soil organisms and soil functioning has been studied for very long. Perhaps scientifically awakened by Darwin's interest in earthworm 'mould' and substantially increasing in research volume from an interest to understand and overcome soil-borne pests in agricultural production systems in the post-war decades (check), applied ecology of soil fauna (organisms) has since developed to mostly cover the beneficial aspects. Here again from agronomic and forestry drives, research has been traditionally focussed on decomposition and nutrient cycling processes, soil formation and regulation of soil structure. More recently further developments have come to include belowground-aboveground interactions, disease suppression and regulation of greenhouse gasses. Surprisingly few (quantitative) studies have been conducted on soil fauna mediation of water percolation and drought tolerance of soils and cropping systems. In terms of ecosystem services as described in the Millennium Ecosystem Assessment, soil organisms predominantly are associated with supporting and regulating services, and less with provisioning and cultural services. Whilst most soil organisms are cryptic in morphology, they are thus also obscure as functional entities as perceived by direct beneficiaries in society. While a large body of literature is available to document the importance of soil life for the quality and functioning of soils, and thus for the provision of ecosystem services that society expects from "healthy soils", there are still two main obstructions from implementing soil biodiversity into legislative frameworks for conservation and sustainable development. First, an unambiguous understanding in quantitative terms of the relationship between functional biodiversity, soil functioning, and the provision of ecosystem services. Second, thorough knowledge of how these relationships can be managed to enhance ES provision under sustainable use of soils, understanding feedbacks and trade-offs between services in terms of costs and profits for landowners and stakeholders at different spatial scales of involvement. In order to enhance a scientific underpinning of soil policy, the European Commission has implemented several integrated projects under 6th and 7th

Framework Programmes, focusing on development of these relationships. At the same time, other research funds have endeavoured on programmes aiming to develop practical measures for land owners and managers to increase ES provision within frameworks of sustainable land use, developing research and implementation projects with intensive stakeholder participation. Some examples will be shown (EcoFINDERS, ECOSOM, FAB). This is nothing new to soil fauna ecology, however. Long before the term ‘ecosystem services’ was coined, large-scale research programs had been conducted with similar scientific and societal objectives. What is different now, however, is that with the ecosystem services concept as a “language translator” there is nowadays a wider willingness amongst policymakers, land owners and stakeholders alike to take interest and raise awareness on biological soil quality, convert from non-sustainable management practices, and indeed, to discuss, value and pay for ecosystem services resulting from healthy soils. The present timeframe forms the best ever opportunity for the research community in soil fauna ecology to aggregate and evaluate knowledge, integrate into multidisciplinary approaches with economic and social sciences, and effectuate a much deeper and effective application of our science into policy and land management. So how to proceed? In my view it is urgent to focus on compilation and evaluation of literature on functional biodiversity and management scenarios by review and meta-analysis; to further develop general rules from this into predictive modelling tools; and to conduct socioeconomic valuation studies of soil biodiversity and ecosystem services at system level (i.e. landscape, watershed, and higher levels).