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Soil survey data rescued by means of user friendly soil identification keys and toposequence models to deliver soil information for improved land management

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ABSTRACT

In many countries there is a large source of soil survey information that could be used to guide land management decision. This soil information is commonly undervalued and underused, because it is usually not in a user-friendly format that non-soil specialists who generally make land management decisions can readily apply, nor are soil specialists always immediately available to conduct the interpretation required.

The aim of this work was to develop an approach to convey soil survey information by means of special-purpose soil classifications and conceptual toposequence models in order to improve land management decisions. The approach: (i) salvages and reinterprets valuable soil survey legacy data from the plethora of detailed published soil survey technical reports and their numerous appendices of quantitative and qualitative data, and (ii) delivers complex or intricate soil survey information to non-soil specialists using a vocabulary and diagrams that they can understand and have available to apply when they need it.

To illustrate the wide applicability of this approach, case studies were conducted in three different parts of the world – Kuwait, Brunei, and Australia, each of which exhibit vastly different landscapes, climates, soil types and land use problems. Pedologists distilled published soil survey information and identified a limited set of soil properties related to landscape position which enabled non-soil specialists to determine soil types by following user-friendly approach and format. This provides a wider audience with information about soils, rather than always relying on a limited number of soil specialists to conduct the work.

The details provided in the case studies are applicable for the local area that they were prepared for. However, the structured approach developed and used is applicable to other locations throughout the world outside of: (i) Brunei, especially in tropical landscapes, (ii) Kuwait, especially in arid and semi-arid landscapes and (iii) Australian winter rainfall landscapes, especially in Mediterranean landscapes – in order to establish similar local classifications and conceptual models.

1. Introduction

In many countries legacy soil survey data comprise a plethora of large published soil survey technical reports with numerous maps, soil and map unit descriptions, analytical data and appendices of qualitative and quantitative data. These are valuable sources of soil information to help guide land management decisions, but are commonly undervalued and underused.

Construction of the soil survey reports and maps is not an explicit process, particularly with regard to describing soil variation [11,45]. Therefore disaggregation cannot be easily automated and requires the skills of an experienced soil surveyor to conduct in the first instance and place in a framework that others can understand and use.

The link between soil information and good decisions about land use and management needs to be improved. On the world stage, most soil survey data are more than thirty years old and may not be in a form applicable to answer current questions; also, many of those who have the ability to apply and interpret the data are being pensioned off [21].

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1.1. Soil information is important

Soils provide vital ecosystem services that support human needs for food, fibre, fuel and water [17,19,20], e.g., soils shelter seeds, provide physical support for plants, moderate the water cycle, and retain and deliver nutrients to plants. Soil information is traditionally associated with food and fibre production, but can also be applied to a number of other important ecosystem services that affect the quality of human life. These include water quality, the carbon cycle and locating sources of building and road construction materials, all of which require improved understanding of the distribution and properties of soil types. Soil knowledge can contribute and provide an effective linking role for sustainable development and land related issues [7].

Human activities on landscapes need to be carefully planned and managed. Inefficient and inappropriate use of soil resources increases the risk of land degradation and reduces future opportunities. Land degradation includes irreversible deterioration of soil quality through intensification of soil acidity, salinity, soil structure and loss of soil organic matter and biodiversity [58]. Total land area is fixed and our finite soil resources need to be optimally used and managed to sustain current capacity and to meet future demand from the projected increasing human population [24]. Climate change is also likely to stress agricultural land areas through droughts and more intense rain storms [12]. Good management decisions require correct and understandable soil information for a location; confusing and inappropriate data can lead to suboptimal practices. Uncertainty about appropriate management arises because soils are highly variable both spatially (horizontally and vertically) and temporally [4,5,59].

1.2. How soil information is used

Land management decisions are generally made by non-soil specialists who require soil data to be evaluated and presented by soil experts in an interpreted or user-friendly format. However there is a growing shortage of trained pedologists, the people who have the skill and experience to reinterpret legacy soil survey data or to obtain new data [21,3,53]. Therefore approaches need to be developed to provide soil information in a form that a wider audience can understand and apply without the need for re-interpretation by soil specialists for each specific application.

Soil information as a commodity does not have value unless it is interpreted and applied to a particular question to support a decision. Knowledge of soil helps the site-specific management of agricultural inputs, such as seed rate, fertiliser, agrochemicals and irrigation. Soil knowledge also improves selection of appropriate crop types, land uses, infrastructure development or environmental management requirements. This in turn helps increase profitability of crop production, improves product quality, protects the environment, and promotes the best use of natural resources. Drohan et al. [22] suggests that soil information delivery and education must use modern information delivery techniques, coupled with simple landscape-based presentations of interpreted data.

Digital soil mapping is a developing area of research that has accelerated significantly in recent years due to advances in information technologies [49] and offers the potential to map soil properties from broad to detailed scales [37]. Digital soil mapping uses numerical models to spatially predict variations of soil properties based on soil and environmental related information [42]. However, this method of mapping has rarely been used for routine production mapping or addressing land management questions; it is still very much used in a research setting to improve data acquisition, the development of analytical tools and processes that could be applied. The technologies are not readily available or affordable, and the skills required to use it are not yet widespread [16]. However, in time this will become a very important part of the soil surveyor's tool kit and approach.

While digital soil mapping offers much promise, it does not provide a solution for the current issue that requires immediate delivery of soil data, or to deal with historical soil survey reports where primary data is not necessarily available or to deal with reinterpretation and applying it to land management decisions.

1.3. Delivery of soil survey data

The aim of this work was to deliver soil information to improve land management by developing an approach and framework to convey soil survey information by means of special-purpose soil classifications and conceptual toposequence models.

This approach bridges the gap between complex or intricate technical soil survey information and provides it in a user-friendly format for non-soil specialists, by using vocabulary and diagrams that they can understand and apply. The soil information is delivered in a way that is directly applicable to pressing land use decisions, affordable, and readily available to be used by a wide

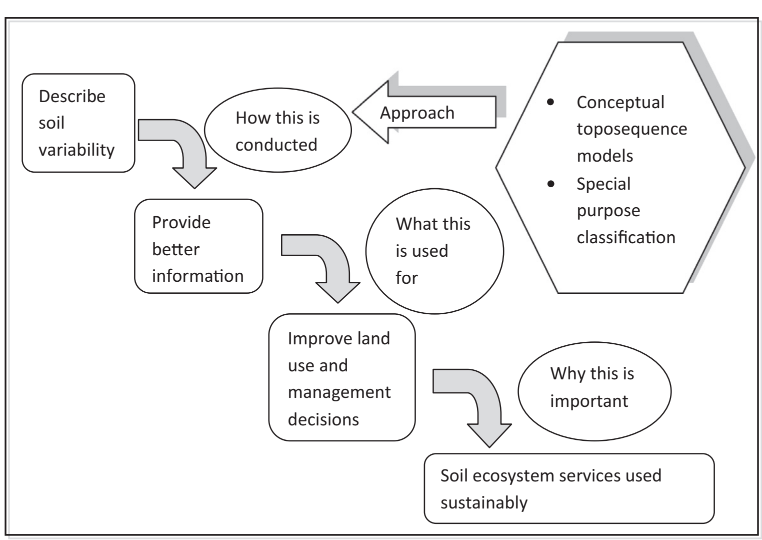

Fig. 1. How the approach links soil data, providing soil information to enhance soil ecosystem services.