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The dimensions of soil security

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ABSTRACT

Soil security, an overarching concept of soil motivated by sustainable development, is concerned with the maintenance and improvement of the global soil resource to produce food, fibre and fresh water, contribute to energy and climate sustainability, and to maintain the biodiversity and the overall protection of the ecosystem. Security is used here for soil in the same sense that it is used widely for food and water. It is argued that soil has an integral part to play in the global environmental sustainability challenges of food security, water security, energy sustainability, climate stability, biodiversity, and ecosystem service delivery. Indeed, soil has the same existential status as these issues and should be recognized and highlighted similarly. The concept of soil security is multi-dimensional. It acknowledges the five dimensions of (1) capability, (2) condition, (3) capital, (4) connectivity and (5) codification, of soil entities which encompass the social, economic and biophysical sciences and recognize policy and legal frameworks. The soil security concept is compared with the cognate, but more limited, notions of soil quality, health and protection.

1. Introduction

A number of large existential environmental challenges have been recognized for the sustainable development of humanity and planet Earth. These are Food Security, Water Security, Energy Security, Climate Change Abatement, Biodiversity Protection and Ecosystem Service Delivery (Bouma and McBratney, 2013). They all have similar characteristics; namely, they are global, they are complex and difficult to resolve, and they are inter-related. They all are addressed using a combination of dimensions with a focus on servicing mankind. The need to provide food and have water available to support the predicted world's population of over nine billion (Godfray et al., 2010) requires the provision of enough that is of good quality and is readily available. The provision of reliable and affordable energy while minimizing the impact on climate will depend on continued energy supply and its alternatives that do not result in increased greenhouse gas emissions (Janzen et al., 2011). These pursuits will all impact on ecosystem services and present a continuing challenge to preserve the global biodiversity.

When one analyses these environmental challenges we can recognize that soil has a part to play in all of these (Herrick, 2000), yet many exploratory models that are used to investigate these global challenges at best incorporate limited soil expertise (Bouma and McBratney, 2013). Indeed it can be said that soil underpins these and the degradation of the soil resource may have grave impacts. It has been reported that there is currently a decline in soil functions, listed in Fig. 1, which will affect its ability to provide ecosystem services and goods (Lal, 2010a). Soil degradation such as, erosion, fertility loss, salinity, acidification, soil carbon decline, and compaction have long been reported and are recognized as threats by the European Union (CEC, 2006). These have detrimental consequences for agricultural productivity, provision of water, increased greenhouse gases and loss of biodiversity (Koch et al., 2013). Without secure soil we cannot be sure of secure supplies of food and fibre, of clean fresh water, or of diversity in the landscape. We also reduce the potential of soil to act as a sink in the carbon cycle, and we remove a core platform for the production of renewable energy sources.

Because of this the security of soil in itself should be promoted to the status of a global existential challenge (Koch et al., in press). To do so we can define Soil Security as in McBratney et al. (2012) as being concerned with the maintenance and improvement of the world's soil resource to produce food, fibre and freshwater, contribute to energy and climate sustainability, and maintain the biodiversity and the overall protection of the ecosystem. In this definition, security is used in the same sense that it is used for food, water and energy. To frame this concept a set of dimensions need to be established and defined and, as with other concepts such as food and water security, these dimensions should account for the quantity, quality and accessibility of the soil. It is also essential to recognize that this concept is not being developed in vacuo and that similar concepts of soil quality, soil health and soil protection have also been proposed to address the need to maintain and manage

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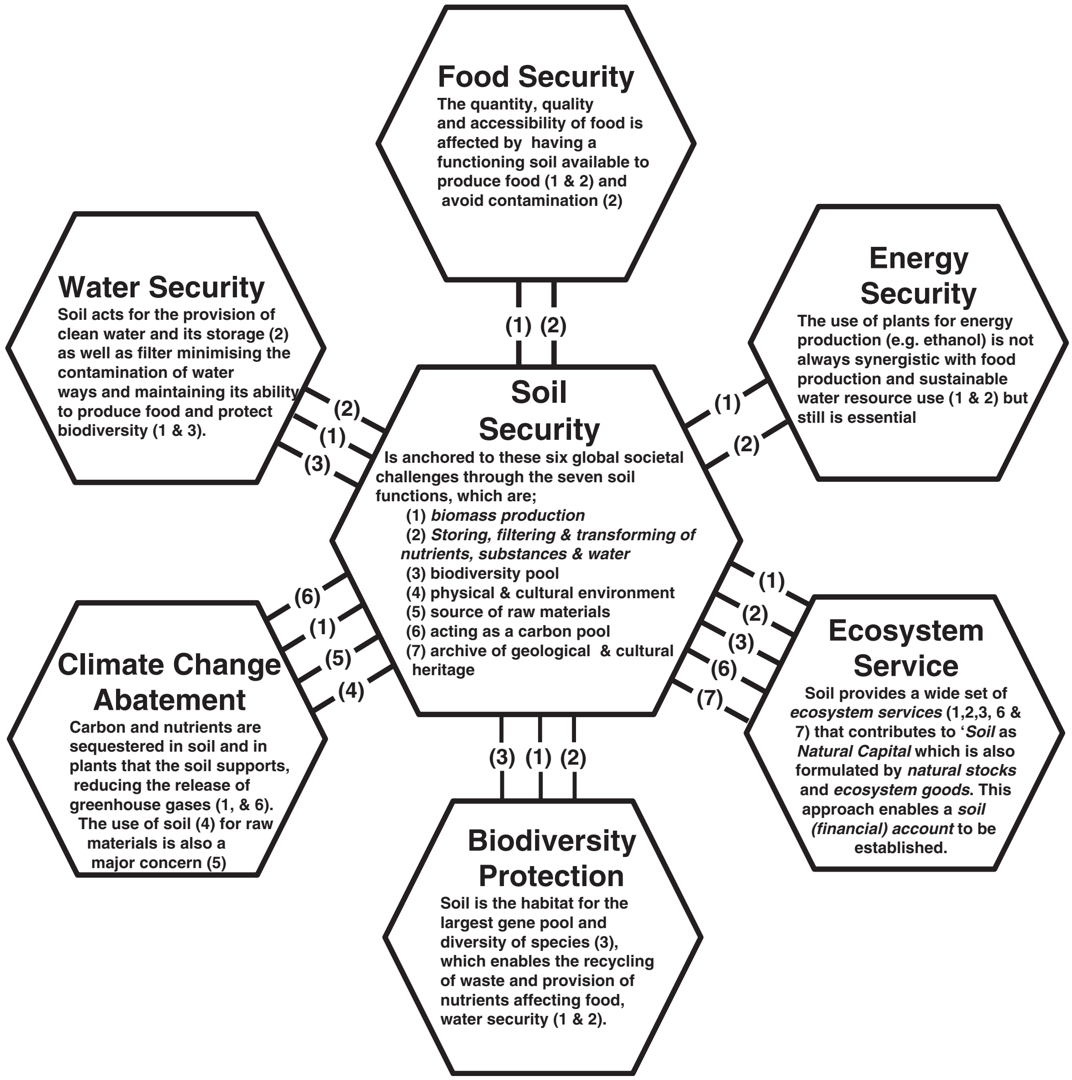

Fig. 1. Aligning the established scientific concept of soil functions (CEC, 2006) as listed under *Soil Security* in order (read left to right, or top to bottom) of their relative immediate impact for each of the major societal challenges.

the condition of the soil (Doran and Ziess, 2000; Karlen et al., 2001; Bouma and Droogers, 2007).

So we think that a sustainable development concept for soil termed *soil security* similar in scope to those above is worthy of investigation and development. The aim of this paper is to develop this concept further.

2. Characteristics of the six global existential environmental challenges

Various communities have investigated the six previously recognized global existential environmental challenges. Various characteristics or dimensions of each have been recognized for their description, assessment and eventual amelioration. It is instructive to examine these with a view to revealing a set of characteristics or dimensions for delineating, evaluating and facilitating soil security.

2.1. Food security

The projected need to feed 9 billion people by 2050 can partly be met by closing the yield gap and increasing the production limits of agriculture (Godfray et al., 2010). Access to good quality soil combined with soil conservation, the knowledge for best management and adoption of technologies (Fedoroff et al., 2010) should contribute to maximizing the yield potential (Pretty et al., 2011). The growing challenge of not being able to identify sources of soil amendments, e.g. phosphorus used to maintain or improve fertility is increasing (Cordell et al., 2009).

Food security is built on three pillars of *availability*, *access* and *use*. Essentially, food availability is referring to having sufficient quantity and a reliable source of food supply, and access focuses on having the resources to obtain high quality and nutritious food (Pinstrup-Anderson, 2009; Godfray et al., 2010). Food use describes having the knowledge of basic nutrition, as well as access to non-food inputs of adequate water and sanitation or lack of contamination (World Health Organization, 2012). These concerns have stimulated efforts to ensure food security by improving yield and quality, minimizing loss of productivity by land degradation, pollution, and urbanization, as well as, the need for water supply and storage (Chen, 2007; Godfray et al., 2010).

As illustrated in Fig. (1) the functions soil provides in this domain are biomass production along with its ability for filtering, storing and transforming of nutrients, substances and water (Lal, 2010b; Scherr, 1999; Stocking, 2003).