Accurate quantification of trace and ultra-trace concentration levels of total selenium and selenium species in environmental samples and South African food products by IC-ICP-MS

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Introduction

- Speciation analysis has developed rapidly within the past decades. It has been used in various research areas including environmental health, toxicology, and nutrition [1]. The abrupt development has been encouraged by toxicological investigations, which clearly indicate that different species of the same element can exhibit largely different adverse and/or essential effects [2].
- Over the past years, determination of the total analyte concentration has been used. However, the total concentration data is not adequate to provide a suitable understanding of the analyte behaviour and transformation in the environment. Selenium (Se) is an essential micronutrient for all forms of animal life that have nervous systems. High Se concentrations in animals and humans are toxic, whereas very low concentrations result in a chronic and sometimes fatal deficiency [3].
- Se enters the food chain through the metabolic transformation from soil to plants. In biological systems it acts as an antioxidant, regulates thyroid hormone metabolism and facilitates cell growth. In many parts of the world, selenium concentration is very low in the soil, resulting in severe disease in domestic livestock, which has also been observed in humans [4].
- South Africa (SA) is one of the countries known to have low and heterogeneous Se distribution in soils [5]. The NMISA is expanding its capabilities in the analysis of trace and ultra-trace levels of toxic and minor elements in environmental samples, with a special focus on soils to support University of Pretoria projects in the field of veterinary geology for the One Health Platform .
- This study focuses on the life cycle study for selenium in parts of SA, e.g. the Northern Cape to determine possible causes of low levels of selenium in soils, which has detrimental health effects on the animals. This paper presents a review of the state of the art for total selenium and selenium speciation analysis in South Africa.

Literature Review

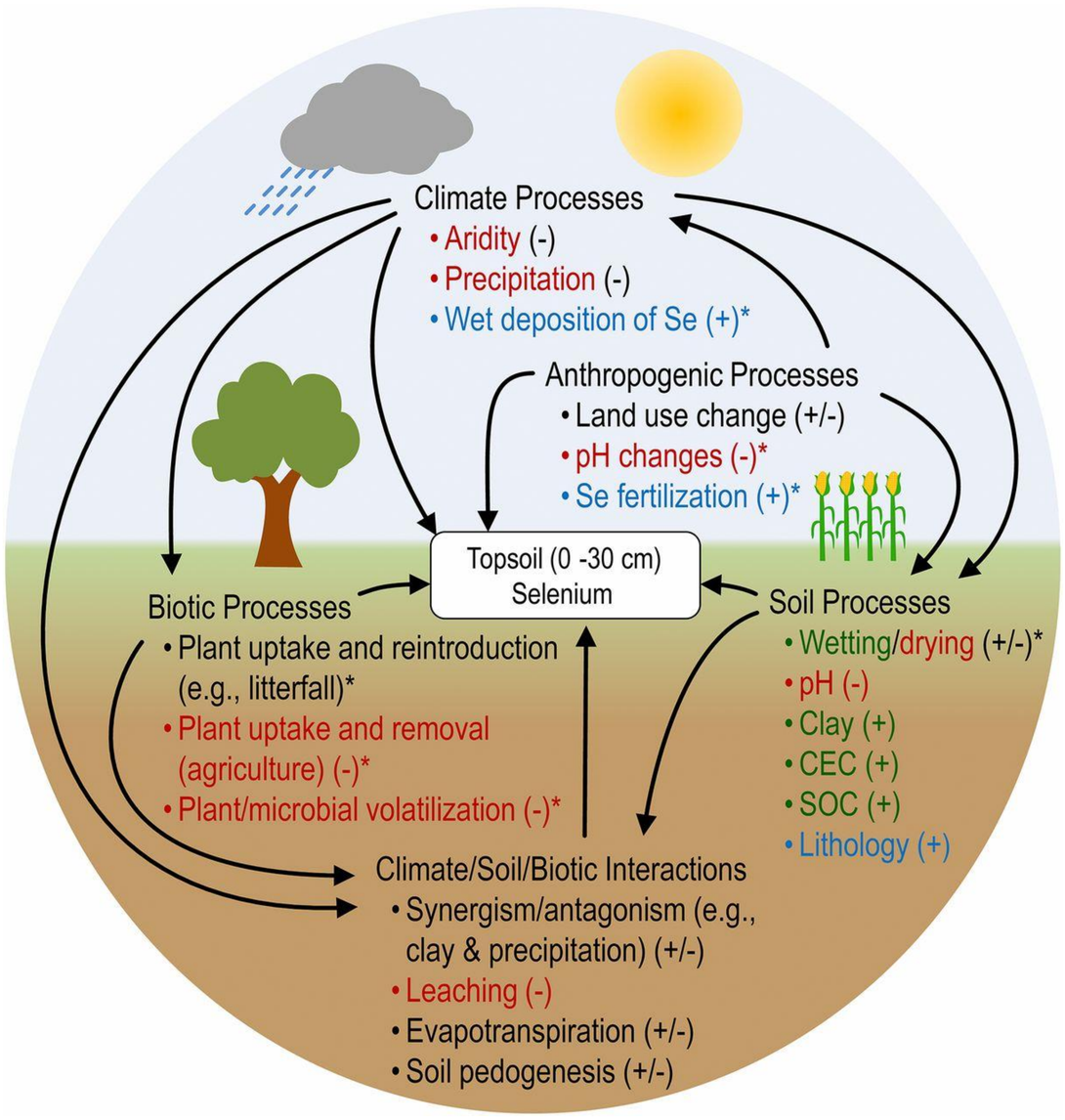

Fig 1 : Processes governing soil Se concentrations. Dominant processes (and bulleted examples) governing soil Se concentrations are indicated. Text coloured in red, green, and blue indicates processes affecting soil Se losses, retention, and sources/supplies, respectively [6].

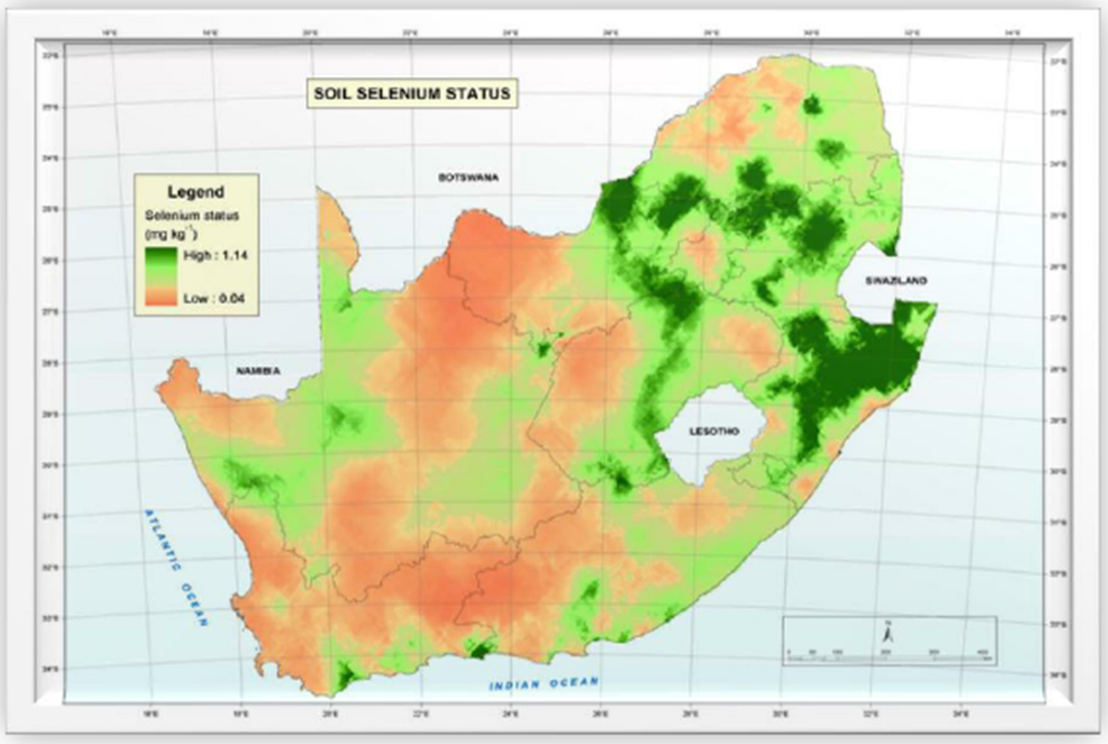

Fig 2 : Map of soil selenium status (mg/kg) in South Africa [7].

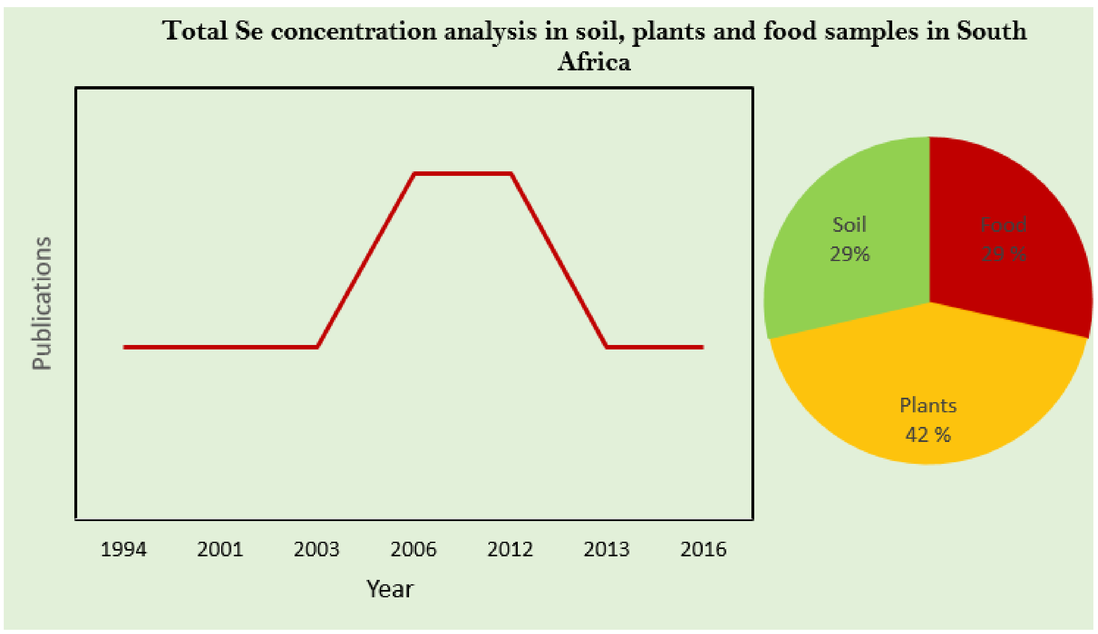

Fig 4 . Literature trends in total concentration analysis of Se in soil, plants and food samples in South Africa.

- The chemical form of Se in soils is an important determinant of the availability of selenium to plants and hence the concentration found in the food chain.
- However, there is limited literature on speciation analysis of Se in soils, plants and food matrices in South Africa.

Conclusion & Recommendation

Limited data on concentration of total Se and Se species in South African soils, plants and food requires;

- development and validation of robust analytical methods & techniques for separation & detection.
- studying the transformation of Se from soils, plant and food products.
- establishing the root cause of the low concentration of Se in South African soils.

These studies will lead to risk maps for South Africa, which will be useful to plan necessary interventions in the respective areas.

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