

Chapter 1

Soil Quality Assessment Using Analytic Hierarchy Process (AHP): A Case Study

Uttam Kumar

*Indira Gandhi Krishi Vishwavidyalaya,
India*

V. N. Mishra

*Indira Gandhi Krishi Vishwavidyalaya,
India*

Nirmal Kumar

*National Bureau of Soil Survey and
Land Use Planning, India*

R. K. Jena

*National Bureau of Soil Survey and
Land Use Planning, India*

ABSTRACT

Fields with rice-based cropping systems are unique from other wetland or upland soils because they are associated with frequent cycling between wetting and drying under anaerobic and aerobic conditions. This alters the C and N transformations, microbial activities and their diversity, and soil physical properties, depending on the other crop in rotation with rice. This chapter aims to compare the soil quality of vertisols of central plains of Chhattisgarh under rice-wheat and rice-chickpea cropping systems. Soil quality index was developed using analytical hierarchy process (AHP). Five soil quality indicators were selected under minimum datasets including soil organic carbon, mean weight diameter, available water content, available phosphorous and zinc. The results indicated that the rice-chickpea cropping system shows improved soil quality than that of rice-wheat cropping system.

DOI: 10.4018/978-1-5225-7784-3.ch001

INTRODUCTION

Agricultural soil quality refers to the condition and capacity of soil for purposes of production, conservation, and environmental management and its assessment is essential for making decisions that will improve crop production and environmental sustainability. Soil quality assessment has been suggested as a tool for evaluating sustainability of soil and crop management practices. Several methods of soil quality assessment have been developed, such as soil health card and test kits, visual soil assessment, and soil quality index methods (Karthikeyan *et al.*, 2015). However, the most popular method for assessing soil quality is calculating soil quality index – a quantitative method – which needs identifying minimum soil properties as soil quality indicators and, scoring and integrating these indicators to get soil quality indices (SQI) (Karlen *et al.*, 2004 and Andrews *et al.*, 2002).

The methods for identifying a set of soil quality indicators from several soil properties, called minimum dataset (MDS), include Principal component analysis (PCA) and experts' opinion (EO). PCA is the most used method for identifying MDS as it is quantitative and objective method (Andrews *et al.*, 2002; Rezaei *et al.*, 2006; Govaerts *et al.*, 2006; Masto *et al.*, 2008; Sinha *et al.*, 2014; Cherubin *et al.*, 2016; Vasu *et al.*, 2016; Karthikeyan *et al.*, 2015). The other method i.e., EO, are equally effective and suitable (Cherubin *et al.*, 2016) and sometimes overweighs the results obtained by the PCA approach (Vasu *et al.*, 2016). The EO method for selecting MDS is also preferred, as the effects of some factors are not easily demonstrated by numeric equations (Richey *et al.*, 1985; Kangas *et al.*, 1998; Marggraf, 2003). Further, the PCA method will easily produce errors of inference in cases of small sample size (Kumar *et al.*, 2017). The EO method allows working with small sample size.

After identification of MDS, these indicators are then normalized and integrated using preferably a weighted additive method (Karlen and Stott, 1994). The variance explained by each indicator during PCA is used as weight of that indicator (Andrews *et al.*, 2002; Rezaei *et al.*, 2006; Govaerts *et al.*, 2006). In case of EO based MDS selection, the weighing scheme based on EO would be more pragmatic in practice. However, the EO method requires expert knowledge of the system and direct assignment of weights may be subject to disciplinary biases (Andrews *et al.*, 2002; Cherubin *et al.*, 2016). To check the biasness, Analytical Hierarchical Process (AHP), introduced by Saaty (1980), has been suggested to generate weight for each indicator in the MDS (Kumar *et al.*, 2017, 2018). AHP generates weights of each indicator in the MDS according to the expert's pair-wise comparisons of the indicators. In addition, the AHP checks the consistency of the decision maker's evaluations, thus reducing the bias in the decision making process. AHP can handle small to large samples with indicators of both quantitative and qualitative nature.

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