Wagenet, R. J., and J. L. Hutson. 1997. Soil quality and its dependence on dynamic physical processes. Journal of Environmental Quality 26:41-48.

This position paper advocates consideration that "soil is a dynamic system" and SQ indexing has two major shortcomings: "First there is always the question of the functional relationships of the components of the index. Should they be additive, multiplicative, or some more complicated combination of the assumed soil characteristics? How should they be weighted, and what influences the weighting? Esentially, any index of soil quality is limited by the attempt to represent a complex, interacting system as a composite of discrete parts. This fundamental difference between reality and the index seems to be almost forgotten.
Second, soil quality indices are estimators of changes in the soil condition that have occurred since the last time the index was measured. They use soil characteristics measured at several times to estimate long-term trends. The characteristics are static, instantaneously measured (by comparison with a process, which operates continuously over time) manifestations of soil quality. Using indices, trends in soil quality are thereby estimated by looking from the current condition backward to the previous conditions. This retrospective approach allows estimation of the impact of previous management practices upon the current soil characteristics, but does not indicate future soil conditons that may result from the accumulative effects of those management practices over time ...." (p.42).

Walker, J., and D. J. Reuter. 1996. Indicators of catchment health: a technical perspective, CSIRO Publishing, Collingwood , Australia.

This publication gives information for the identification of the most useful indicators for assessing the impact of farming practices on catchment health. The 4 sections (12 chapters) deal successively with: the indicator approach (1 paper); key indicators (1 paper); the report card (a case study from New South Wales, Australia, 1 paper); and technical considerations (9 papers covering indicators of farm productivity, product quality, soil health, water quality, landscape integrity). --*CAB Abstracts.*

Wander, Michelle M., and G. Bollero. 1999. Soil quality assessment of tillage impacts in Illinois. *Soil Science Society of America Journal* 63: 961-971.

36 sites of ND, CT & NT practices in Illinois are compared, at Field-scale; tested in the 1995 & 1996 growing seasons. Soils were sampled from 100m x 100m plots, & lab-tested on 23 parameters, using analysis of variance (ANOVA) & principal component analysis (PCA). A detailed outline of tests is given, so the research demonstrates reliable & replicable testing, in this static study. It identifies minimum data sets for analysis of the most significant parameters: SOM (as C) & practices = No-till. There is rational use of numerical indexing methods, & complex data sets analyses. It would be difficult for farmer-based use (needs expertise to interpret & apply the statistical procedures.--(ch notes).

Wander, Michelle M., and L. E. Drinkwater. 2000. Fostering soil stewardship through soil quality assessment. Applied Soil Ecology 15: 61-73.

Wander, Michelle M., Gerald L. Walter, Todd M. Nissen, German A. Bollero, Susan S. Andrews, and Deborah A. Cavanaugh-Grant. 2002. Soil quality: Science and process. Agronomy Journal 94, no. 1 (Jan/Feb): 23-32.

This paper provides an outline/summary of the Illinois Soil Quality Initiative. Inputs, (corn) crop yield responses, minimum data sets, soil attribute selection for SQ indexing, & monitoring of soil ecosystem functions are discussed. On-farm research occurred in 1995 & 1996 on 36 farms, with conventional tillage & no-till practices were compared to adjacent benchmark samples from grassways, roadways, woodlots, or yards. --Multivariate analysis to data grouping/ranking; Vertical sampling on multiple soil properties; incorporated farmer SQ assessments (Table 12, p.28). --Focus groups of farmers used to determine soil functions to rank measures on: available N, available P, K, SOC, & pH, soil water retention, residue, porosity, aggregate stability, C, macropores, POM/SOC ratio, bulk density, penetration resistance, C & pH. --Ranges of scores summed & treatments (CT, NT or ND) presented (Table 2, p.29). --Then radar graphs are used to represent the scores, to represent SQ indices for inherent soil properties & SOM, with each axis depicting a soil indicator & showing mean scores. -- "Index" = mean score from data range of individual samples, aggregated & summed; No indication how data sets were normalized in this paper, except graphically (--ch notes).

Wang, C., B. D. Walker, and H. W. Rees. 1997. Establishing a benchmark system for monitoring soil quality in Canada. Chapter 15 In: *Soil quality for crop production and ecosystem health*. E. G. Gregorich, and M. R. Carter, 323-337. Amsterdam: Elsevier.

Wang, C., B. D. Walker, H. W. Rees, L. M. Kozak, M. C. Nolin, W. Michalyna, K. T. Webb, D. A. Holmstrom, D. King, E. A. Kenney, and E F. Woodrow. 1993. Benchmark sites for assessing soil quality change. Section 5 In: *A Program to assess and monitor soil quality in Canada: Soil quality evaluation program summary (Interim report)*; Pp. 5-1 to 5-8. D. F. Acton, editor. Ottawa: Centre for Land and Biological Resources Research, Research Branch, Agriculture Canada.

Wang, XiaoJu, and ZiTong Gong. 1998. Assessment and analysis of soil quality changes after eleven years of reclamation in subtropical China. *Geoderma* 81, no. 3/4: 339-355.

> A method for assessing and mapping soil quality changes in time and space in small watersheds is presented. It was developed and used to evaluate the changes in soil quality after 11 years of reclamation at Qian-Yan-Zhou experimental station (QYZES) in subtropical China. Changes in soil quality were assessed and analysed for cropland, citrus orchards, pasture land, grassland, sparse weed land, artificial forests, natural forests, bare land, and other land uses. The Qian-Yan-Zhou Soil Quality Information System (QYZSQIS) was developed using ARC/INFO and FOXBASE software. Two concepts of **Relative Soil Quality Index (RSQI)** and its difference (DELTA RSQI) were introduced and used in the evaluation and analyses. By combining the QYZSQIS with databases of soil properties for different time periods, the system provided an effective method for evaluating soil quality changes in time and space in small watersheds. The RSQI provided a standard for comparing regional soil quality and the DELTA RSQI a standard for evaluating soil quality changes over time. After 11 years of reclamation, there was a decrease in the area of both low quality and high quality soils, while medium quality soils increased. In terms of land use systems, the soil quality in paddy fields, vegetable fields, and citrus orchards was mainly improved, whereas fuel woods, sparse weed land, and bare land were mainly degraded. Annual grass played an important role in the conservation and improvement of soil quality in the area. These results also showed that it was of equal importance to improve soil quality in degraded locations and to sustain it in high quality areas. --*CAB Abstracts.*

Warkentin, Benno P. 1995. The Changing concept of soil quality . Journal of Soil and Water Conservation 50, no. (May-June): 226-228.

Webster, R. 1993. Dealing with spatial variation. In: Soil monitoring : Early detection and surveying of soil contamination and degradation; Pp. 295-307. Schulin. R., A. Desaules, R. Webster, and B. von-Steiger, editors. Basel, Switzerland: Birkhauser Verlag.

———. 1996. What is kriging? Aspects of Applied Biology 46: 57-65.

> Using a single farm assessment, the use of statistical multivariate analysis to test prediction for sparse measurement of a single soil factor --Potassium content-- is discussed.

Weil, Raymond. 2001. Soil quality research at University of Maryland. From URL: http://www.nrsl.umd.edu/faculty/weil/sqwebpage.htm

> "We have integrated a number of these properties into **several types of Soil Quality Indices (SQI)** based on values of soil properties relative to those in a **regional data set**. We are seeking to progress toward simple analyses that correlate with these SQIs so that farmers and others can assess soil quality in a soil-testing mode."

Wendroth, O., P. Jurschik, K. C. Kersebaum, H. Reuter, C. Van Kessel, and D. R. Nielsen. 2001. Identifying, understanding, and describing spatial processes in agricultural landscapes—four case studies. Soil Tillage Research [Amsterdam, The Netherlands: Elsevier Science B.V.] -- Special Issue: Landscape Research—Exploring Ecosystem Processes and Their Relations at Different Scales in Space and Time 58, no. ¾ (Mar): 113-127.

Wick, B., R. F. Kuhne, K. Vielhauer, and P. L. G. Vlek. 2002. Temporal variability of selected soil microbiological and biochemical indicators under different soil quality conditions in south-western

Nigeria. Biology and Fertility of Soils 35, no. 3: 155-167.

We evaluated the temporal variation of microbial biomass C, beta-glucosidase, acid phosphomonoesterase (acP), alkaline phosphomonoesterase (alP), and protease activity over 18 consecutive months. The likely causes for the seasonal variability at a non-degraded and a degraded site in south-western Nigeria were identified. Microbial biomass, alP, and beta -glucosidase activity were sensitive indicators of soil quality changes over time. Microbial biomass C correlated significantly with soil moisture conditions and soil organic matter-related parameters. AlP and beta -glucosidase activities were not controlled by climatic conditions over the course of two rainy seasons and one dry season but were temporally related to microbial biomass C and total C and N. Due to the steadiness of the alp activity over time the enzyme is considered a suitable indicator with which to monitor long-term changes of soil quality. Single sampling during the course of a year is adequate. *--CAB Abstracts, excerpt.*

Wick, B., R. F. Kuhne, and P. L. G. Vlek. 1998. Soil microbiological parameters as indicators of soil quality under improved fallow management systems in south-western Nigeria. Plant and Soil 202, no. 1: 97-107.

Agriculture at Ibadan, Nigeria, on a well-drained Alfisol belonging to the Egbeda-Iwo series. Sampling sites were selected with varying degrees of degradation from 3 long-term experiments (WB1, D2 and WB3 in order of degradation severity). Soil microbiological and soil biochemical parameters (pH, exchangeable basic cations, inorganic and organic phosphorus pools, total organic carbon and total nitrogen, microbial biomass carbon, acid and alkaline phosphatase, beta -glucosidase and protease activity) were identified as indicators of soil quality under improved fallow management systems. *--CAB Abstracts, excerpt.*

Wilkins, D. E., W. F. Buchele, and W. G. Lovely. 1977. A Technique to index soil pores and aggregates larger than 20 micrometers. Soil Science Society of America Journal 41 , no. 1 (Jan/Feb): 139-140.

Winder, Jody. 2003. Soil quality monitoring programs: a Literature review. Edmonton, AB: Alberta Agriculture, Food & Rural Development. --A comprehensive bibliography of assessment programs for soil quality monitoring from around the globe, with applicability for Alberta.

Wirth, Stephan J. 2001. Regional-scale analysis of soil microbial biomass and soil basal CO2-respiration in northeastern Germany. In: *Sustaining the global farm*—Selected papers from the 10th International Soil conservation Organization Meeting (ISCO99); Pp. 486-493. D. E. Stott, R. H. Mohtar, and G. C. Steinhardt, editors. West Lafayette, IN: International Soil Conservation Organization in cooperation with the USDA and Purdue University. From URLs: http://topsoil.nserl.purdue.edu/nserlweb/isco99/pdf/isco99pdf.htm ; **Reference at:** http://www.oecd.org/dataoecd/28/27/1890358.htm

World Agroforestry Centre [USA]. 2002. Sensing soil quality [web page]. ICRAF. From URL: http://www.worldagroforestrycentre.org/sites/program1/specweb/home.htm

"**Sensing Soil Quality** is a technological approach for rapid assessment and large area surveillance of soil condition. The technology is based on rapid screening of soil quality using a portable reflectance spectrometer. Soil properties and soil quality indices are predicted from spectral libraries, using calibrations based on few samples. Spectral libraries constructed from soils sampled from geo-referenced locations are then used in conjunction with remote sensing imagery to map out soil quality and soil constraints over entire river basins. We also present spectral libraries for African soils and organic (plant litter) resources." Includes Links to: Sensing Soil Quality in Lab and Field; Spectral Library of African Soils; Spectral Library of Organic Resources; Sensing Soil Functional Attributes; Sensing Organic Resource Quality

World Bank. 2003. World Development Indicators 2003. From web site at URL: http://www.worldbank.org/data/

Information and selected samples from the WDI2003 publication, the World Bank's premier annual compilation of data about development.

Yakovchenko, V., L. J. Sikora, and D. D. Kaufman . 1996. A Biologically based indicator of soil quality. *Biology & Fertility of Soils* [Berlin, Germany: Springer Verlag] 21, no. 4: 245-251.

Soil quality indices are attempts to classify soil conditions and to compare these conditions to their historical use. From this information it may be possible to determine which uses of soils are better for the long range goals of agriculture and society. With many factors involved in the profitable production of safe foodstuffs without significant degradation of the environment and soils, an indicator that represents a broad biological perspective of quality is appropriate. Among a group of biological indicators, the ratio of crop N uptake to mineralized N as determined by microbial respiration plus net mineralized N found over a growing season is an useful indicator of soil quality. An evaluation of the 12 year old Farming Systems Trial at the Rodale Institute Research Center indicated that soils in plots that had been conventionally managed were of lower quality than soil treated with manure or planted with legume cash grain crops. *--Agricola 1998-2003 database.*