Winter 2011

THE OHIO STATE UNIVERSITY OARDC

CENTER Carbon sequestration

C-MASC 2010 Visiting Scholars

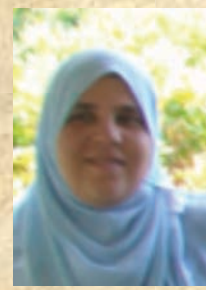
C-MASC had the unique privilege to host 16 scholars from around the world in 2010. They shared their knowledge and experience with us and conducted research on themes of mutual interest. Upon return to their home institution, they continue to collaborate with C-MASC.


I. Ortas, Turkey


M.S. Kahlon, India


V. Srinivasan, India


M.K. Khosa, India


H. Yehia, Egypt

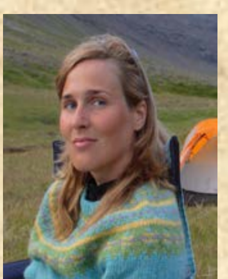

C. Singla, India


A. Lenz, Germany


A. Datta, India


M. Gelaw, Ethiopia


K. Bandyopadhyay, India

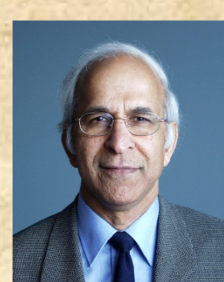

O. Vilmindardotir, Iceland


S. Veerssamy, India


G. Gísladóttir, Iceland


M. Liu, China


H.P. Maheswarapp, India


B.R. Singh, Norway


O.M. Aishwath, India

Inside:

CONTACT: C-MASC; 2021 Coffey Rd., 210 Kottman Hall Columbus., OH 43210 colson.6@osu.edu (614) 292-9049

ENR-671

Environmental Soil Physics

Winter 2011
Room # KH 333C
(5 credit hours)
Lecture: M T W F 11am-11:48am
Lab: Th 10am-12pm

Course Objectives

The course is designed to provide a comprehensive understanding of the relationships in basic soil physics and its applications to environment quality and sustainable use of natural resources. The syllabus meets the curriculum needs of students in Soil Science, Environmental Sciences, Natural Resources, Agricultural Engineering, Horticulture and Crop Sciences, Forestry, Geology, Climatology and Civil Engineering

Learning Outcomes

1. Gain a working understanding of soil's physical, mechanical, hydrological and rheological properties in relation to environment quality and sustainable management of terrestrial ecosystems.

2. Learn applications of soil physical properties and processes will be discussed with regards to the following special topics:
   (i) Greenhouse effect, global C cycle, gaseous emissions and C sequestration,
   (ii) wetland management, hypoxia, drainage, irrigation and salinity,
   (iii) soil erosion, land degradation and food security,
   (iv) biofuels and residue management, among others.

This course in designed for undergraduate and graduate students
There are no specific pre-requisites, please contact Dr. Lal for any questions.

Instructor
Dr. R. Lal
422B Kottman Hall
292-9069
lal.1@osu.edu

CENTER Carbon sequestration

ENR 871

Soils and Climate Change

WINTER 2011

3 credit hours

Monday and Wednesday 1:30-3:00 pm (Room KH 333C)

This course will be jointly taught by Dr. Rattan Lal, School of Environment and Natural Resources and Dr. Berry Lyons, School of Earth Sciences. The following will be covered:

- Atmospheric chemistry, major and trace gases and their radiative properties
- Radiative forcing and global warming potential
- The global carbon cycle over geologic time
- Biogeochemical processes control the geologic carbon cycle
- Past climate changes, abrupt climate change
- Sources and sinks of greenhouse gases in today's world
- The current global carbon cycle
- Anthropogenic perturbation of the global carbon cycle, and fossil fuel emissions
- Coupled cycling of C, H_2O, N and other elements
- Soil erosion and the carbon cycle
- Fate and transport of carbon in aquatic ecosystems
- Permafrost and the global carbon cycle and the feedback due to global warming
- Carbon sequestration strategies
- Terrestrial , geologic and oceanic sequestration: potential and challenges
- Processes and practices affecting soil carbon sequestration
- The bio fuel conundrum
- The bio char carbon
- Soil carbon and soil quality
- Trading carbon credits: practice and policy
- Past climate changes, abrupt climate change

This course in designed for undergraduate and graduate students.

There are no specific pre-requisites, please contact Dr. Lal for any questions.

Instructors:

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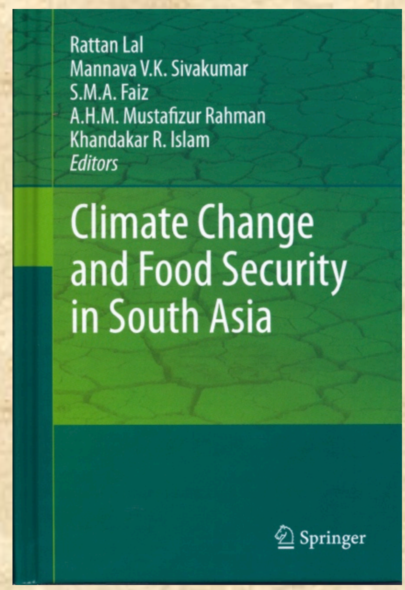
422B Kottman Hall
292-9069
lal.1@osu.edu

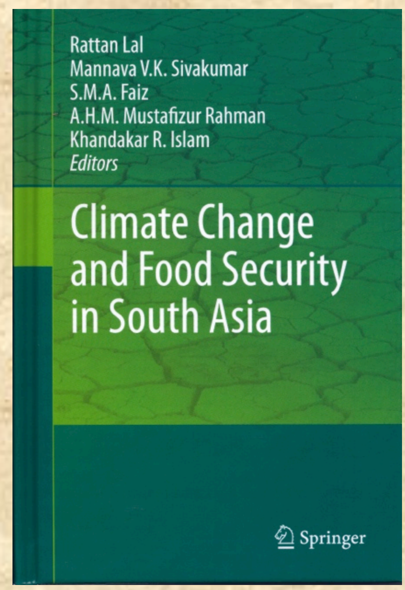
Dr. W.B. Lyons
School of Earth Sciences
688-3241
lyons.142@osu.edu

Books Published



South Asia (SA) includes the region surrounded by Western Asia, Central Asia, Eastern Asia, Southeastern Asia and the Indian Ocean. It consists of Iran, Afghanistan, Pakistan, India, Nepal, Bangladesh and Sri Lanka. The region is also referred to as the Indian Sub-Continent or the Sub-Himalayan region, because of its unique and distinct geographical and physiographic setting. It was once a small continent which collided with mainland Asia about 50 to 55 million years ago, giving rise to the Himalayan mountains and the Tibetan Plateau. The SA region has diverse climate and terrains ranging from glaciers and tropical rainforest, the highest rainfall in the world to desert, and flat alluvial plains to hills and undulating terrains. The region has a population of 1.62 billion (24% of the world's population) living in 642 million hectares or 5% of the world's geographical area. The region is developing rapidly, both industrially and economically. Yet, there is a widespread problem of poverty, hunger and malnutrition. As much as 75% of the poor and malnourished people live in rural areas and are dependant on subsistence and small scale agriculture. Yet, globalization has accelerated economic growth. By 2007, the regions GDP growth had reached 9%/yr which extended to all countries of SA. The growth rate in 2009 was 5.6%, which was the smallest decline compared with all other regions of the world. Climate change is a major concern in SA because of alterations in temperature and precipitation, rise of sea level, melting of the Himalayan glaciers, and degradation of natural resources and the environment. According to the Fourth Assessment Report of the IPCC (2007), future projections of climate indicate that SA is very likely to warm during the 21st century. Also, the fresh water availability is projected to decrease and coastal areas will be at greatest risk due to increased flooding at the sea and rivers. In some SA countries, a substantial decrease in crop yields from rainfed agriculture could occur. Additionally, dramatic changes in land use patterns in SA compound the problem of climate change. To cope with climate change more effectively in SA, it is necessary to identify integrated adaptation and mitigation options for a range of agroecosystems so as to enable a favorable policy environment for the implementation of Regional Climate Change Adaptation Network. Majority of the poor people in SA are at risk because of the increase in frequency of extreme events, and especially the drought, floods and variability in climate. Glacier melting is a cause of concern because of its impact on the availability of water, and thus agronomic productivity. Climate change may also impact the on-set, distribution and amount of monsoons, as was the case in 2009 when monsoons failed in India. It is also feared that crop yields and agronomic production will be adversely affected, thereby exacerbating the food insecurity. The U.N. Millennium Development Goals, especially of cutting hunger and poverty by half, may not be met by 2015. *Continued…page 6*

Books Published Continued…



Therefore, an international symposium entitled **"Climate Change and Food Security in South Asia"** was organized. The symposium was held from 25-30 August 2008 at the University of Dhaka, Bangladesh, and was jointly sponsored by the Ohio State University, World Meteorological Organization, University of Dhaka, Economic and Social Commission for Asia and Pacific, and Food and Agriculture Organization of the U.N. The objectives of the symposium were:

- To provide a central forum to develop an improved understanding and assessment of the climate change impacts on agriculture and the associated vulnerability in South Asia;
- To identify and discuss integrated mitigation and adaptation win-win options for the agricultural sector in different agroecosystems of South Asia;
- To discuss and propose a regional Agricultural Mitigation and Adaptation Framework for Climate Change in South Asia;
- To discuss and recommend policy and financial innovations to enable smooth implementation of the regional framework and it's integration into the sustainable development planning of SA countries, and
- To discuss appropriate options for strengthening information exchange on climate change impacts and cooperation on agriculture mitigation and adaptation actions among SA countries.

The Symposium was attended by more than 250 participants from 17 countries. The symposium was opened by His Excellency, Dr. Iajuddin Ahmend, President of Bangladesh, and closed by His Excellency Dr. Ólafur Ragnar Grímsson, President of Iceland. All presentations were organized into nine technical sessions. Papers submitted for publications were reviewed and revised for publication in this volume.

C-MASC Presentations for SSSA Meetings

Drs. A. Kadono, S. Kumar, K. Lorenz, R. Shrestha, and D.A.N. Ussiri

Modelling of Soil Organic Carbon Dynamics in Grassland and Agricultural Ecosystems in Ukraine

Atsunobu KADONO
School of Environment and Natural Resources, Ohio State University, Columbus, Ohio
Shinya FUNAKAWA
Graduate School of Agriculture, Kyoto University, Kyoto, Japan
Takashi KOSAKI
Graduate School of Urban Environmental Sciences, Tokyo Metropolitan University, Hachioji, Japan

For the better understanding of the dynamics of soil organic matter (SOM) in the natural grassland and agricultural ecosystem, a simple process-based model is proposed and validated using the values of whole soil respiration (WR) and the microbial soil respiration (MR) measured in Chernozem and Kastanozem soils in Ukraine. Measured input values for the validation were light fraction C (LFC), clay content and plant biomass including shoot and root biomass, daily soil temperature and volumetric water content at 15 cm depth and daily air temperature and precipitation. As an influx of C to the soils, NPP was calculated by Chikugo model using annual temperature and precipitation. For the measured whole soil respiration rate, estimated WR value without root respiration showed close fitting under the drier conditions, probably because of the restricted root respiration. Under the wetter conditions, c.a. 50% of the WR would be attributed to root respiration. For the measured microbial respiration rate, the model estimation fitted well with measured values. These results suggested that the proposed model successfully simulated the decomposition processes in the natural grassland and agricultural ecosystems.

Predicting Spatial Distribution of Organic Carbon Pool In Soils of Ohio Using Four Statistical Approaches

Sandeep Kumar, Ohio State University, Columbus, OH
Rattan Lal, The Ohio State University, Columbus, OH
Desheng Liu, Department of Geography, Ohio State University, Columbus, OH

Assessment of spatial variability of soil organic carbon (SOC) pool at state and regional scale is constrained by extensive soil sampling. A wide range of methods and tools are thus used to estimate the SOC pool at these scales. Since, SOC is influenced by different environmental and anthropogenic variables, and the interaction among them. A better estimation of SOC pool can be made by considering the relationship among these variables and by using geographical information systems (GIS) modeling which can enhance the understanding of the global C cycle. Thus, the specific objective of the study was to estimate the SOC density (C stock per unit area) to 1-m depth for soils of Ohio. Four predictive GIS models used were: ordinary kriging (OK), multiple linear regression (MLR), regression kriging (RK) and geographically weighted regression (GWR). Analytical data for a total of 1424 soil profiles were extracted, of which 80% were used for calibration and 20% for validation. A total of 20 variables (except in OK) including terrain attributes, climate data, bedrock geology, and land use data were used for estimating the SOC density. Four approaches were compared and observed that the GWR provided better predictions with lowest (3.81 kg m^{-2}) root mean square error (RMSE) followed by RK (3.85 kg m^{-2}), MLR (3.90 kg m^{-2}), and OK (4.70 kg m^{-2}). The relative improvement (RI) values showed that predictions with GWR, RK and MLR approaches were 79, 53, and 49% higher compared to those with OK. Total estimated SOC pool for soils in Ohio ranged from 727 to 742 Tg. The Data show that GWR approach, a local spatial statistical technique, enhances the precision for predicting the SOC pool compared to other global spatial techniques (e.g. MLR and RK).

Apex Model Simulation of Runoff and Sediment Losses From Agroforestry Buffers for Watersheds Under Pasture Management

Sandeep Kumar Ohio State University, Columbus, OH
Stephen Anderson Univ. of Missouri, Columbia, MO
Ranjith Udawatta Univ. of Missouri, Columbia, MO
Ashish Mudgal Univ. of Missouri, Columbia, MO

Hydrologic simulation models assist in predicting the effects of buffers on runoff and sediment losses from small watersheds. The objective of this study was to calibrate, validate the APEX (Agricultural Policy/Environmental eXtender) model and simulate runoff and sediment losses from small watershed comparing values for agroforestry buffer watersheds versus control watersheds (no buffers). The experimental design consisted of four watersheds under pasture management which were monitored from 2002 through 2008; two with agroforestry buffers (AgB) and two control watersheds (CW). The model was calibrated from 2002 to 2005 and validated from 2005 to 2008. The r^2 and Nash and Sutcliffe (NSE) values for the calibration and validation period of the runoff varied from 0.52 to 0.78 and 0.50 to 0.74, respectively. The model did not predict sediment loss well probably due to insufficient number of measured events and low measured sediment loss. Measured runoff was 57% higher for CW watersheds compared to AgB watersheds. Measured sediment loss was 95% higher for CW watersheds compared to AgB watersheds. After calibrating and validating the model, it was run for long-term scenario analyses for 10 years from 1999 to 2008. Buffer width had an influence on runoff. Simulated runoff decreased 24% when buffer width was doubled compared to losses associated with the measured buffer width. Simulated runoff from the CW watersheds was 11% higher with double stocking density (relative to measured density) compared to AgB watersheds with double stocking density. With half stocking density (relative to measured density), the AgB watershed had 18% lower runoff compared to CW. Results from this study imply that establishment of agroforestry buffers on grazed pasture watersheds reduce runoff and sediment losses.

Long-Term Land-Use Effects on Soil Organic Carbon Sequestration

Klaus Lorenz
Rattan Lal
Carbon Management and Sequestration Center, School of Environment and Natural Resources, The Ohio State University, 2021 Coffey Road, Columbus, OH 43210-1085, USA

Soils sequester large amounts of atmospheric carbon dioxide (CO_2) in the soil organic carbon (SOC) pool. Soil carbon (C) sequestration implies increase in the pool of organic compounds with long mean residence time (MRT) over time per unit land area. However, major unknowns in the terrestrial C cycle are whether land use and management affect the MRT of SOC, and how SOC sequestration in soil profiles can be strengthened to mitigate atmospheric increases in CO_2 and adapt to the projected climate change. Thus, the objectives of this study is to compare the amount and stabilization of the SOC pool to 0.5-m depth in soil profiles at long-term forest, pasture and no-till corn (*Zea mays* L.) plots at the North Appalachian Experimental Watershed (NAEW), Coshocton, Ohio. The data from the long-term field experiment show that the SOC pool in forest soil is 28.5, 13.2, and 16.9 Mg C ha^{-1} in 0-15, 15-30, and 30-50 cm depths, respectively. Similarly, SOC pool in pasture soil is 37.5, 15.2, and 9.3 Mg C ha^{-1}, and that under no-till corn is 28.1, 16.8, and 11.2 Mg C ha^{-1} in 0-15, 15-30, and 30-50 cm depths, respectively. These data indicate that pasture stored more SOC than no-till corn and forest (62.0 vs. 56.1 and 52.9 Mg C ha^{-1}, respectively) to 0.5-m depth. However, only 21% of the SOC pool to 0.5-m depth under pasture was chemically stabilized as indicated by oxidation with disodium peroxodisulfate ($Na_2S_2O_8$). In contrast, 25% and 27% of the SOC pool under forest and no-till corn, respectively, was resistant to oxidation with $Na_2S_2O_8$. Thus, although pasture can store more SOC than soil under other land uses, the higher percentage of labile SOC may enhance the positive feedback of the SOC pool to the atmosphere under pasture in response to climate change.

Greenhouse Gas Emissions In a No-till Chronosequence

Raj Shrestha- CMASC, Ohio State University, Columbus, OH
Pierre-Andre Jacinthe -Department of Earth Sciences, Indiana Univ. - Purdue Univ. at Indianapolis (IUPUI), Indianapolis, IN
Sindhu Jagadamma Oak Ridge National Laboratory, Oak Ridge, TN
Serdar Bilen - The Ohio State University, Wooster, OH
Warren Dick - The Ohio State University, Wooster, OH
Rattan Lal – CMASC, Ohio State University, Columbus, OH

No-till (NT) farming has gained wider acceptance in the US and world agriculture, and has yielded various environmental quality benefits including topsoil retention and carbon sequestration. However, long-term effects of NT on nitrogen dynamics and greenhouse gas emissions (GHG; CO_2, CH_4, and N_2O) are not well documented. This study conducted in a NT chronosequence (ranging from 9 to 48 years) under corn-soybean rotation across Ohio examined the effects of NT on GHG emissions and nitrogen dynamics in comparison to conventional tillage (CT) and forest soils. Preliminary data (September 2009 to May 2010) indicated an increase in CO_2 and N_2O emissions and CH_4 consumption with an increase in NT duration. Greater CO_2 emissions were recorded at the forest than at the cropland sites with minor differences between tillage treatments. While CH_4 consumption was observed at almost all the study sites, uptake rate was higher under NT than at the sites under CT. The difference between tillage practices was even clearer when soil drainage class was considered. For example, at sites under NT for 48 y, uptake rate at a well-drained site was 10-12 times than that at a poorly-drained site. At the younger NT sites, N_2O emissions did not differ with CT sites. Soil ammonium-N increased with NT duration, especially at the surface (0-10 cm) soil layer. In the 0-5 cm layer, nitrate-N was higher under NT than CT in most sites of the chronosequence. These results will be discussed in relation to the evolution of various soil physical and biological properties under NT farming.

Tillage and compaction effects on greenhouse gases emission from corn-soybean-oats rotation in Ohio

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Carbon Management and Sequestration Center
School of Environment and Natural Resources
The Ohio State University
2021 Coffey Rd, Columbus, OH 43220.

Green house gases produced by anthropogenic activities have been linked to the observed and predicted warming trends in global climate. Land management practices, soil properties and climatic factors are major regulators of greenhouse gases from farmland. The study was conducted to investigate the effects of compaction, tillage management and crop rotation on CO_2, N_2O and CH_4 emission on Crosby silt-loam soil in southern Ohio. Three levels of compaction 0, 10 and 20 tons were superimposed on no-till and conventional till management. Crop rotation was corn-soya bean-winter oat. Polyvinyl chloride chambers were installed (15 cm diameter) were installed in each plot in between plant rows. Vented chamber lids, fitted with sampling port were used to close the chambers during sampling and air samples were obtained at 0, 30 and 60 minute intervals and analyzed for CO_2, CH_4 and N_2O concentration by gas chromatography. Gaseous fluxes were measured at 2 to 4 weeks intervals for three years. In addition, soil moisture of the top 10 cm, and soil temperature at 5, 10 and 20 cm soil depth were determined for each sampling date. Significantly higher GHG fluxes were observed in spring (March-June) compared to other seasons of the year. The N_2O fluxes from corn were generally higher than from winter oats and soybean during growing period, probably due to N fertilizer application. Generally, annual CH_4 and N_2O fluxes increased with increase in compaction, but there were no discernable trends for CO_2 fluxes.

Upcoming Workshops

Recarbonization of the Biosphere
20-22 March 2011 at IASS Potsdam, Germany

The Institute for Advanced Sustainability Studies (IASS) was founded in February 2009 in Potsdam, Germany, on the initiative of the German Federal Ministry of Education and Research (BMBF) in coordination with the Alliance of German Scientific Organizations. One of the objectives of IASS is to organize strategic dialogue and unlock critical potential in its focal areas of research into climate change, Earth system dynamics and the sustainable development of the human habitat.

Klaus Töpfer (Executive Director IASS) and Rattan Lal (Member IASS Scientific Advisory Council) together with The Organizing Committee are convening a workshop entitled 'Recarbonization of the Biosphere' to be held on the 20-22 March 2011 at IASS Potsdam. This workshop will involve 15-20 scientists to discuss the current understanding of the role of ecosystems in the carbon cycle, and future perturbations of carbon cycling in the biosphere and its interaction with the Earth-Human System. Articles presented at the workshop will be published as a book by Springer Verlag.

The State of Brandenburg made the premises of the Kleist-Villa situated in Berliner Strasse 130 and the office building in Helmholtzstrasse 5 available to the IASS. Berlin´s borough of Zehlendorf "extends" along Berliner Strasse towards Potsdam's borough of Berliner Vorstadt. The area is surrounded by world heritage sites such as the Park Babelsberg and Neuen Garten and is a well established residential area of Potsdam. This part of the city has recently experienced a "rejuvenation" with the Cultural Centre Schiffbauergasse. After the re-unification of Germany, Potsdam´s new cultural centre was built on the former military and industrial area – which houses amongst others, the Hans-Otto Theatre, the Dance Theatre Fabrik, T-Werk, Fluxus Plus Museum and Waschhaus.

In Memoriam – George Stanley Taylor

George Stanley Taylor (1920-2010)

George Stanley Taylor, 89, of Columbus, Ohio, passed away Thursday, October 7, 2010. He was professor of soil physics at the Ohio State University from 1951 to 1985. George was born November 29, 1920 to George and Maude Taylor and raised in Northampton County near Jackson, North Carolina. He served in the United States Navy during WWII as an Officer on the USS LSM 38 in the Pacific theater. George received a B.S. in 1943, an M.S. in 1949 from North Carolina State University, and the PhD from Iowa State University in 1950 with a major in soil physics and mathematics. Dr. Taylor joined The Ohio State University as a faculty member in the Agronomy Department in 1951, and he was a Visiting Professor at the University of California from 1958 to 1959. His principal research interests involved the physics of water flow in porous media, soil characteristics which affect drainage, the impacts of drainage on crop growth, and septic tank effluent disposal. The latter was supported by a grant from National Institute of Health. George made pioneering contributions to the development of both analog and computer simulation models to study water flow in soils with tile drains. He published 52 papers in refereed national journals and 14 in popular journals. He mentored numerous graduate students from around the world, and traveled to India, Nigeria, Israel, and Thailand to assist with the development of academic institutions. Dr Taylor was member of the Soil Science Society of America, and the American Society of Agronomy. He retired as Professor of Soil Physics in 1985. He was a devoted husband and father; and an avid swimmer, tomato grower, and bridge player with a Life Master status.

Carbon Management & Sequestration Center

NO - TILLAGE

BEST WISHES FOR 2011

Sincere thanks for your kind support and cooperation. We envisage to strengthen the coopertation on thematic topics of mutual interest during 2011 and beyond.

Wishing you and your family a very happy, healthy, peaceful and professionally rewarding 2011.

Rattan Lal
Columbus,OH

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