The Abdus Salam
International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

IAEA International Atomic Energy Agency

smr2163

College on Soil Physics

Soil Physical Properties and Processes under Climate Change

30 August - 10 September 2010

(Miramare, Trieste, Italy)

Directors

Donald GABRIELS *Department of Soil Management*
UNESCO Chair on Eremology, Ghent University
Belgium

Donald NIELSEN *Department of Land, Air and Water Resources,*
University of California, Davis, USA

Ildefonso PLA SENTIS *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*

Edward SKIDMORE *U.S. Department of Agriculture, Manhattan, Kansas, USA*

Local Organizer

GianCarlo GHIRARDI *University of Trieste and ICTP, Trieste, Italy*

BOOK OF ABSTRACTS

web-page: http://agenda.ictp.trieste.it/smr.php?2163

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PREFACE

How it started!?

In 1980, Donald Gabriels, a soil physicist and Professor at the Department of Soil Management of Ghent University, Belgium and Edward Skidmore, a former research leader at the USDA-ARS Wind Erosion Unit, Manhattan, Kansas, USA gave lectures at the ICTP Autumn Course on Physics *of Flow in the Oceans, Atmosphere and Deserts*.

During that course the late Professor Abdus Salam, Nobel laureate in Physics and founder and director of ICTP, Trieste, Italy, asked Donald Gabriels about his main activities. Salam thought that Donald Gabriels had said that his major field of interest was '*solar*' - not '*soil*' physics. In fact the two words '*solar*' and '*soil*' have something in common; just refer to '*el sol*' *(*Spanish for '*sun*') and *'le sol*' (French for '*soil*').

The encounter with some misunderstandings of terminology between Donald Gabriels and Abdus Salam, which took place 30 years ago, and the support of Edward Skidmore, confirming the idea of organizing a soil physics course, was the start of one of ICTP's most successful activities: the *College on Soil Physics,* in which, over time, have participated more than 700 scientists, 80% of whom are from more than 50 developing countries.

After a first college in 1983, prepared and directed by Donald Gabriels and Edward Skidmore and co-directed by the local organizer Professor GianCarlo Ghirardi (ICTP consultant and University of Trieste), a number of colleges were organized every two or three years.

After the first colleges, Prof. Ildefonso Pla Sentis (previously at Universidad Central de Venezuela, at present with Universitat de Lleida, Spain), and Prof. Donald Nielsen, a former dean of the University of California, Davis, USA, joined the team of directors.

The College of Soil Physics celebrated in 2003 its 20th anniversary (see *'News from ICTP*' #104, Spring 2003).

".....the first College"

From left: **Edward Skidmore, Donald Gabriels, Giancarlo Ghirardi, Ildefonso Pla Sentis and Donald Nielsen**

What does soil physics mean?

Edward Skidmore defined it in simple terms as *'the study of the physical characteristics of soil' or 'as the study of the physical laws of nature governing the behavior of soil'*. The study and potential applications of soil physics involve an understanding not only of physics, but of biology, chemistry, hydrology, engineering and land use management. Donald Nielsen added that soil physics also involves understanding some present critical issues as food security, but also drinking, domestic and industrial waters, pollution of waters and soils, and also natural disasters as flooding, erosion and landslides and the effect of climate change on complex processes as water flow in soils, erosion and runoff, solute and gas transport.

The present book is a compilation of abstracts from presentations of participants of the College on Soil Physics 2010 focusing on '*Soil physical aspects and processes under climate change'*. It once again strengthens the existing links between soil physicists throughout the world by the support and programs of the Abdus Salam International Center for Theoretical Physics. It is a testimony of the original vision of its founder Abdus Salam to foster the growth of advanced studies and research in physics and soil physics in developing countries.

Donald Gabriels
Edward Skidmore
Ildefonso Pla Sentis
Donald Nielsen
GianCarlo Ghirardi

Co-directors

ICTP College on Soil Physics 2010
(30 August -10 September 2010)
Trieste, Italy

P R O G R A M M E

(as of 23 August 2010)

The Abdus Salam
International Centre for Theoretical Physics

College on Soil Physics: Soil Physical Properties and Processes under Climate Change

Organizer(s): Directors: D. Gabriels, E. Skidmore, D. Nielsen, I. Pla Sentis. Local Director: GC Ghirardi.
Trieste - Italy, 30 August 2010 - 10 September 2010

Venue: Leonardo da Vinci Building Main Lecture Hall

Preliminary Programme

Monday, 30 August 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Gabriels

08:15 - 09:15 (Room: Leonardo da Vinci Building, Lobby)
--- Registration ---

09:15 - 10:15 **Welcome Session: Introduction to the College by the Organizers. Self-presentation of participants.**

10:15 - 10:45 **Ildefonso Pla Sentis** / *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*
Soil Physics and Climate Change

10:45 - 11:00 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

11:00 - 12:00 **Miroslav Kutilek** / *Czech Technical University, Prague, Czech Republic*
Paleopedology and paleoclimate: False hypopthesis?

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Miroslav Kutilek** / *Czech Technical University, Prague, Czech Republic*
Paleopedology and paleoclimate: Consequences for soil physics

15:20 - 18:00 --- Free time to visit Trieste town centre ---

18:30 - 21:00 (Room: Leonardo da Vinci Building Cafeteria)
--- Welcome Reception ---

Tuesday, 31 August 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Nielsen

08:30 - 09:50 **Ildefonso Pla Sentis** / *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*
Soils and their physical properties

09:50 - 10:10 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

10:10 - 11:30 **Marcello Pagliai** / *Istituto Sperimentale per lo Studio e la Difesa del Suolo, Firenze, Italy*
Soil texture, soil structure, soil porous system

11:30 - 12:00 **Presentations by participants**

Effects of rock fragments on water movement and solute transport in a Loess Plateau soil (ZHOU Beibei - Institute of Soil and Water Conservation, Yangling, P.R. China) 15'

Saline water use to sustain fresh water ecology in the southern marshes (ALDALLI Hazim A.A. - Ministry of Environment, Baghdad, Iraq) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Marcello Pagliai** / *Istituto Sperimentale per lo Studio e la Difesa del Suolo, Firenze, Italy*
Soil structure stability and soil surface sealing and crusting

15:20 - 15:40 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

15:40 - 16:40 **Presentations by participants**

Soil water erosion risk assessment in V aniversario watershed from Cuyaguateje River, west of Cuba (ALONSO BRITO Gustavo - Universidad Agraria de la Habana, Havana, Cuba) 15'

Variability of hydromorphic soils: a state space approach (AQUINO Leandro Sanzi - Federal University of Pelotas, Pelotas, Brazil) 15'

Average ground contact pressure and stress distribution to predicting compaction under tracks and tyres (ARAUJO JUNIOR Cesar Francisco - Agricultural Research Institute of Parana, Londrina, Brazil) 15'

A new heat pulse sensor for measuring soil profile evaporation (ZHANG Xiao - China Agricultural University, Beijing, P.R. China) 15'

Wednesday, 1 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Edward Skidmore

08:30 - 09:50 **Donald Gabriels** / *Department of Soil Management, UNESCO Chair on Eremology, Ghent University, Belgium*
Flow of water in saturated soils: Darcy's law

09:50 - 10:10 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

10:10 - 11:30 **Ildefonso Pla Sentis** / *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*
Flow of water in unsaturated soils: infiltration, soil water potential and retention

11:30 - 12:00 **Presentations by participants**

Lysimeter to estimate real-time evapotranspiration under field conditions (ARISTIZABAL BOTERO J.A - Universidad Nacional de Colombia, Medellin, Colombia) 15'

Soil quality and productivity influenced by land use and topography in semiarid regions (ASADI Hossein - University of Guilan, Rasht, Iran) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Klaus Reichardt** / *Universidade de Sao Paulo, Piracicaba, Brazil*
Climate and Soil Water Balance: principles

15:20 - 15:40 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

15:40 - 17:00 **Klaus Reichardt** / *Universidade de Sao Paulo, Piracicaba, Brazil*
Climate and soil water balance: Spatial/temporal variability of components

Thursday, 2 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Ildefonso Pla Sentis

08:30 - 09:50 **Donald Nielsen** / *Department of Land, Air and Water Resources, University of California, Davis, USA*
Theoretical and practical aspects of solute transport

09:50 - 10:10 (Room: Leonardo da Vinci Building, Lobby)
--- Coffee Break ---

10:10 - 11:30 **Donald Nielsen** / *Department of Land, Air and Water Resources, University of California, Davis, USA*
Geostatistical analysis of landscape properties

11:30 - 12:00 **Presentations by participants**

Modeling of western boundary currents (BALOG Irena - Institute for Meteorology, University of Belgrade, Serbia) 15'

Saturated hydraulic conductivity of a Typic Haplustert as influenced by solutions of anionic series (BARDHAN Gopali - Central Rice Research Institute, Cuttack, Orissa, India) 15'

12:00 - 12:15 --- Group Photograph ---

12:15 - 14:00 --- Lunch break ---

14:00 - 15:30 **Presentations by participants**

Are cover crops a water competitor in semi-arid agro-ecosystems? (BODNER Gernot - University of Natural Resources and Applied Life Sciences, Vienna, Austria) 15'

Physical properties and mineralogical composition of some representative soils from Argentina (BRESSAN Emiliano M. - INTA-CIRN, Buenos Aires, Argentina) 15'

Assessment of the Cambisol structure sustainability under different land uses systems in Western Amazon (CARUANA Paula - Federal University of Lavras, Brazil) 15'

A method to mapping the spatial variability of soil physical quality (CEDDIA Marcus Bacis - Universidade Federal Rural do Rio de Janeiro, Brazil) 15'

Modern techniques for assessing soil degradation using remote sensing and GIS (DARWISH MOSTAFA K.M. - National Research Center, Cairo, Egypt) 15'

Estimation of soil hydraulic properties through pedotransfer function approach and its applications in various landscape scale (SANTRA Priyabrata - Central Arid Zone Research Institute) 15'

15:30 - 17:30 --- Visit to Miramare Castle ---

Friday, 3 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Gabriels

08:30 - 09:50 **Luis Carlos Timm** / *Federal University of Pelotas, Brazil*
Applied time/spatial series analysis in soil physics

09:50 - 10:10 --- Coffee Break ---

10:10 - 11:30 **Klaus Reichardt** / *Universidade de Sao Paulo, Piracicaba, Brazil*
Dimensional analysis and scaling in soil physics

11:30 - 12:00 **Presentations by participants**

Climatologic water balance for a central pivot 15 N fertirrigated coffee crop (BORTOLOTTO Rafale P. - Universidade de Sao Paulo, Piracicaba, Brazil)) 15'

Adapting soil loss using rusle for a watershed in Trinidad, West Indies (BALKISSOON Stasha Katrina - University of the West Indies, St. Augustine, Trinidad) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Donald Nielsen** / *Department of Land, Air and Water Resources, University of California, Davis, USA*
Autoregressive analyses of soil attributes

15:20 - 15:40 --- Coffee Break ---

15:40 - 16:40 **Presentations by participants**

A new wet sieving approach for various land uses under a semi-arid climate (DEVIREN SAYGIN Selen - University of Ankara, Turkey) 15'

Determination of thermal properties of some Bulgarian soils using indirect methods (DONEVA Katerina Y. - N. Pushkarov Institute of Soil Science and Agroecology, Sofia, Bulgaria) 15'

Gravimetric sampling density for accurate crop water use calculation of Gezira clay soil, Sudan (ELSHEIKH Eman Rahamtalla - Agricultural Research Corporation, Khartoum, Sudan) 15'

Modeling water flow in undisturbed soil columns by breakthrough curves of chloride (ERSAHIN Sabit - Karatekin University, Cankiri, Turkey) 15'

Monday, 6 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Nielsen

08:30 - 09:50 **Ildefonso Pla Sentis** / *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*
Land degradation processes

09:50 - 10:10 --- Coffee Break ---

10:10 - 11:30 **Donald Gabriels** / *Department of Soil Management, UNESCO Chair on Eremology, Ghent University, Belgium*
Factors affecting water erosion

11:30 - 12:00 **Presentations by participants**

Dunes as waves vs. waves on Barchan dunes (EL BELRHITI Hicham - Université Moulay Ismail, Errachidia, Morocco) 15'

Characterization of the preferential water flow and contaminant transport in structured soils (FER Miroslav - Czech University of Life Sciences, Prague, Czech Republic) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Donald Gabriels** / *Department of Soil Management, UNESCO Chair on Eremology, Ghent University, Belgium*
Desertification and aridity and drought

15:20 - 15:40 --- Coffee Break ---

15:40 - 16:55 **Presentations by participants**

Short-term effect of organic residues from bioenergy production on soil properties: implications on soil fertility and soil C sequestration (GALVEZ PEREZ Antonia - Instituto Andaluz de Ciencias de la Tierra, Granada, Spain) 15'

Investigation of rainwater chemistry and wet deposition at the EMEP site in Armenia (GEVORGYAN Lusine - Environmental Impact Monitoring Centre, Yerevan, Armenia) 15'

Soil temperatures in Australia and El Niño and southern oscillation (HAKEEM Shaik H. - Bureau of Meteorology, Darwin, Australia) 15'

Use of saline water as a source of irrigation (IBRAIHI Mohammed A. - University of Kerbala, Kerbala, Iraq) 15'

Short-term tillage effects on soil aggregate distribution and fungal abundance in an arable field (JAHANGIR M.M.R. - Bangladesh Agricultural University, Mymensingh, Bangladesh) 15'

Tuesday, 7 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Ildefonso Pla Sentis

08:30 - 09:50 **Moacir de Souza Dias Junior** / *Universidade Federal de Lavras, Brazil*
Soil mechanical properties processes

09:50 - 10:10 --- Coffee Break ---

10:10 - 11:30 **Moacir de Souza Dias Junior** / *Universidade Federal de Lavras, Brazil*
Soil compaction

11:30 - 12:00 **Presentations by participants**

Soil quality improvement on highly weathered dry land soils of Jaffna Peninsula, Sri Lanka (JEGAJEEVAGAN Kanagaratnam - University of Jaffna, Jaffna, Sri Lanka) 15'

Effect of salinity and sodicity on crop production atkotkashmir (Lakki Marwat) (KHAN Aftab Ahmad - Global Change Impact Studies Centre, Islamabad, Pakistan) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Filippo Giorgi** / *ICTP, Trieste, Italy*
Climate change: from global to regional scales

15:20 - 15:40 --- Coffee Break ---

15:40 - 16:40 **Presentations by participants**

Groundwater study of a subtropical small-scale wetland (GaMampa wetland, Mohlapetsi River catchment, Olifants River basin, South Africa) (KOGELBAUER Ilse - University of Natural Resources and Applied Life Sciences, Vienna, Austria) 15'

Modern technologies of monitoring and forecasting on lands of the agricultural purpose in condition limited resource (LISNYAK Anatoliy - Institute for Soil Science and Agrochemistry Research, Kharkov, Ukraine) 15'

Surface runoff generation under different land uses in a Mediterranean mountain catchment (LOAIZA USUGA Juan Carlos - National University of Colombia, Medellin, Colombia) 15'

Analysis of water movement in soils under no tillage management in Argentina (LOZANO Luis Alberto - National University of La Plata, Buenos Aires, Argentina) 15'

Wednesday, 8 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Edward Skidmore

08:30 - 09:50 **Ildefonso Pla Sentis** / *Departament de Medi Ambient i Ciencias del Sol, Universitat de Lleida, Leida, Spain*
Soil salinity and irrigation requirements

09:50 - 10:20 --- Coffee Break ---

10:20 - 11:50 **Presentations by participants**

The soil degradation and desertification in the central southern of Vietnam (NGUYEN Ha Manh - Institute of Geography, Hanoi, Vietnam) 15'

Development of early warning system for soil quality changes under tropical conditions (OKON Paul Bassey - University of Calabar, Nigeria) 15'

Assessment of the suitability of anthill soil as earthen water reservoir lining material (OLADIPO Isaac Olaposi - Federal Polytechnic, Ado Ekiti, Nigeria) 15'

Estimation of above and below ground carbon stocks in selected land use patterns in Mt. Marsabit ecosystem (OUKO Caroline A. - Centre for Training and Integrated Research in Arid and Semi-Arid Land Development, Nanyuki, Kenya) 15'

Properties of soils derived from different parent materials in the Stolowe Mountains National Park (PIEPRZKA Roman - Institute of Soil Science and Environmental Protection, Wroclaw, Poland) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 17:00 --- Visit to the Grotta Gigante ---

Thursday, 9 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Gabriels

08:30 - 09:50 **Edward Skidmore** / *U.S. Department of Agriculture, Manhattan, Kansas, USA*
Wind erosion processes and prediction

09:50 - 10:10 --- Coffee Break ---

10:10 - 11:30 **Edward Skidmore** / *U.S. Department of Agriculture, Manhattan, Kansas, USA*
Dust emissions and climate

11:30 - 12:00 **Presentations by participants**

Assessment of susceptibility to mass erosion by logistic regression and Bayesian networks in mountainous landscapes of north-central Venezuela (PINEDA SOCORRO Maria C. - Universidad Central de Venezuela, Maracay, Venezuela) 15'

Evaluation of the spatial variability of beryllium-7 fallout in Piracicaba-SP, Brazil (PINTO MERIGUETTI Victor - University of Sao Paulo, Brazil) 15'

12:00 - 14:00 --- Lunch Break ---

14:00 - 15:20 **Gunay Erpul** / *University of Ankara, Turkey*
Inclined rainfall and wind and water erosion processes

15:20 - 15:40 --- Coffee Break ---

15:40 - 16:40 **Presentations by participants**

Growth and carbon storage of three young timber species in the Yungas of Bolivia (QUISPE MAMANI J.C. - Technical Unit of International Relations, La Paz, Bolivia) 15'

Soil physical and hydraulic properties by different soil tillage systems (SCHOLL Peter - University of Natural Resources and Applied Life Sciences, Vienna, Austria) 15'

The effect of time-variable soil hydraulic properties in soil water simulations (SCHWEN Andreas - University of Natural Resources and Applied Life Sciences, Vienna, Austria) 15'

Interactive effects of rising temperature and lowering moisture on soil water chemistry: An experimental growth-chamber approach (MAYMO HERNANDO Ana C. - Centro de Investigaciones sobre Desertificacion, Albal, Spain) 15'

Friday, 10 September 2010 (Room:Leonardo da Vinci Building Main Lecture Hall)
Chairperson: Donald Nielsen

08:30 - 09:45 **Presentations by participants**

Uncertainty: a problem to rank desertification indicators (FUZZY-MCDM Methods) (SEPEHR Adel - University of Isfahan, Iran) 15'

Soil sustainability in relation to soil erosion in Shiwaliks of Lower Himalayas (SINGH Manmohan Jit - Punjab Agricultural University, Ludhiana, India) 15'

Land degradation by erosion: Samanalawewa catchment, Sri Lanka (UDAYAKUMARA E.P.N. - Asian Institute of Technology, Pathumthani, Thailand) 15'

Historical changes in the environment of the Chinese Loess Plateau (WANG Li - Institute of Soil and Water Conservation, Shaanxi, P.R. China) 15'

Effectiveness of IWK biosolids application on growth of rubber in the nursery (YAHYA Abd Karim - Malaysian Rubber Board, Selangor, Malaysia) 15'

09:45 - 10:30 --- Coffee Break ---

10:30 - 12:00 **Presentations by ICTP Associates**

Application of stable isotopes and soil geochemistry for understanding soil formation and paleoclimate (ACHYUTHAN Hema - Anna University, Chennai, India) 30'

Basis for soil carbon sequestration in Africa (ADENIYI M.O. - University of Ibadan, Nigeria) 30'

An evaluation of the spatial variability of soils of similar lithology under different land use types and degradation risks in a savannah agro-ecology of Nigeria (EZEAKU Peter I. - University of Nigeria, Nsukka, Nigeria) 30'

12:00 - 14:00 --- Lunch Break ---

14:00 - 14:45 **Donald Nielsen** / *Department of Land, Air and Water Resources, University of California, Davis, USA*
Soil Physics - some of the past and today's opportunities

14:45 - 15:30 **Closing Session and Farewell**

T I T L E S O F P R E S E N T A T I O N S

in alphabetical order

(as of 23 August 2010)

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TITLES OF PRESENTATIONS BY PARTICIPANTS

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Modeling of western boundary currents

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Dunes as waves vs. waves on Barchan dunes

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Gravimetric sampling density for accurate crop water use calculation of Gezira clay soil, Sudan

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Surface runoff generation under different land uses in a Mediterranean mountain catchment

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Estimation of soil hydraulic properties through pedotransfer function approach and its applications in various landscape scale

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The effect of time-variable soil hydraulic properties in soil water simulations

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A B S T R A C T S

O F

P R E S E N T A T I O N S

B Y P A R T I C I P A N T S I N

T H E

COLLEGE ON SOIL PHYSICS

SOIL PHYSICAL PROPERTIES AND PROCESSES UNDER CLIMATE CHANGE

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APPLICATION OF STABLE ISOTOPES AND SOIL GEOCHEMISTRY FOR UNDERSTANDING SOIL FORMATION AND PALEOCLIMATE.

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Application of stable isotopes of C and O and soil geochemistry are often used to understand the processes that affect whole ecosystem scale. Soils form an integral part of the landscape and since plants preferentially use $^{12}CO_2$ in photosynthesis, the CO_2 left behind in the atmosphere is enriched in $^{13}CO_2$. At the same time, plants and all other organisms in the ecosystem are always respiring, or using oxygen and producing CO_2 to maintain metabolic processes. Terrestrial plants fix atmospheric CO_2 by two main photosynthetic reaction pathways: the Calvin- Benson, or C_3, and the Hatch- Slack, or C_4. C_3 plants convert atmospheric CO_2 to a phosphoglycerate compound with three C atoms while C_4 plants convert CO_2 to dicarboxylic acid, a four –C compound. Carbon isotopes are strongly fractionated by photosynthesis and the C_3 and C_4 processes involve different isotopic fractionation, with the result that C_4 plants have higher delta ^{13}C values ranging from -17‰ to-19‰ with a mean of -13 ‰ relative to PDB, while C_3 plants show delta values ranging from -32‰ to -20‰ with an average value of -27‰. Most terrestrial plants are C_3, all forest communities and most temperate zone plant communities of all kinds being dominated by C_3 plants. C_4 plants are characteristically found in hot, arid environments: a selective advantage of C_4 photosynthesis is more efficient use of water.

In this presentation soil geochemistry and stable isotope data of camborthid soils and laminar petrocalcic horizons from the Thar desrt Rajaasthan are presented. Several short camborthid soil profiles and laminar petrocalcics hoizones have been analyzed for the stable isotope data and geochemistry. The results indicate that the camborthid soil are found in an arid and semiarid climate.

Stable isotope data of the laminar petrocalcics horizon vary between -5.91‰ to -1.71‰ indicating their formation at – near surface (capillary fringe), probably supporting a thin column of soil. Spatial distribution, mineralogy and geochemical composition of the calcretes indicate that they have formed under poorly drained conditions probably within the capillary fringe in topographic lows. The source of most of the calcite was ground water; however calcite nodule formation was largely dependent on pedogenic processes associated with evaporation, evapotranspiration and/ or micro environmental changes in pH and CO_2 partial pressure. However, dust is also a major source for the carbonate precipitation.

BASIS FOR SOIL CARBON SEQUESTRATION IN AFRICA

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Most African countries are not part of the Annex I countries according to Kyoto Protocol but CO_2 emission is increasing annually. The increase can be linked with reductions in the amount of carbon stored in terrestrial ecosystems. The rate of soil carbon sequestration through the adoption of Recommended Management Practices (RMPs) on degraded soils ranges from 100 kilograms per hectare (kg/ha) per year in warm and dry regions to 1,500 kg/ha per year in cool and temperate regions.

Biomass and population data in Africa were collected from the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831-6335. Estimated population data prepared by US Census Bureau was also used. Different authors have estimated soil organic carbon (SOC) stock in Africa using different organic soil database and digital data. They came out with different but close results (about 30% difference). SOC stock data were extracted from Henry, 2009 who used the harmonized world soil database.

The various factors that can affect CO_2 emission and carbon storage were reviewed. Soil organic carbon was correlated with biomass content in the various countries in Africa, actual biomass content was compared with potential biomass content by calculating the percentage error (PE). Population trend was also found for the countries in Africa.
Correlation coefficient of 0.5 was found between SOC and biomass content. Average percentage error of 40.5% was found between the potential and actual biomass content in Africa. The highest soil carbon stock and biomass content were found in central Africa. Congo has the highest SOC of 8.2 $kgCm^{-2}$ and biomass content of 344 t/ha with 8% PE between actual and potential biomass; Gabon with SOC of 3.62 $kgCm^{-2}$, biomass content 339 and 9% PE. Lower amount of SOC were found in the northern and southern Africa (Libyan Arab Jamahiriya SOC 0.41, and Western Sahara 0.40 SOC, biomass figures not available). The following countries have the PE between the potential biomass and the actual biomass greater than 50%: Burundi, Gambia, Ghana, Malawi, Nigeria, Rwanda, Sierra Leone, Togo and Uganda. There is room for sequestration with high PE.

Population trend was found positive in all the countries in Africa. The following slopes were obtained: Angola-1.3; Burundi-51.6; Ethiopea-12.4; Gambia 29.4; Ghana-15.6; Nigeria 24.4; Rwanda-64.7 to mention a few. High population density (people per square km) and high rate of increase in population density (people per square km per year) were associated with low SOC. Burundi has an average population density of 213.3 with the increase rate of 51.6 (2.6 $kgCm^{-2}$ SOC); Gambia has an average population density of 94.2 with increase rate of 29.4 (1.18 $kgCm^{-2}$ SOC). Low population density (people per square km) and low rate of increase of population density (people per square km per year) were found to have a direct link with high SOC. Congo has an average population density of 6.6 with increase rate of 4.7 (8.2 $kgCm^{-2}$ SOC); Central African Republic has an average density of 4.7 with increase rate of 1.1 (4.42 $kgCm^{-2}$ SOC).

Soil carbon in the northern and southern parts can increase with appropriate selection of vegetation type and land management practices. The central Africa that has high SOC content cannot be seen as saturated since actual biomass is less than potential biomass (Cameroon has PE of 29.3% and Chad has PE of 31.7%). It is time to sequester the lost carbon back into the soil in Africa. Effort should be made to increase the area of closed forests in the various countries of Africa. Also carbon releasing activities should be reduced through legislation.

Saline Water Use to Sustain fresh Water Ecology In The Southern Marshes

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This year 2010 is the fourth coming year of continuous drought in Iraq and also in the region, the lack of rainfall and snow with the problems with the upper countries made the situation more sophisticated. In the process of tackling such problem the need was urgent to maintain the flooding parts of the southern Marshes especially the (Alhammar) which it had long periods of drought (since late 80's) and depend on its resources on the Euphrates which is already has its own shortage problems. The idea to use a saline water to sustain a historically fresh water ecology is not new but in our case it will be a matter of life or death so all the precautions are needed. The project had now a 6 months from Its start and the results showed multiple situations first the positive reactions from the biodiversity side and the other is the negative results from the water quality and soil degradation.

The quality results showed a clear correlation between the water salinity and the plant coverage in the area ,it also showed decrease in water quality within time and in the far areas in the project that have no outlets and poor circulation especially with wide flat areas.

The need is high now to determine the combine interactions between the water in the surface with the top soil, root zone, and with the ground water means that the water feeding, percolation, and capillary upward move combined with the nutrients and salt movement, so it can be used to enhance the water quality and sustain the biodiversity in the project area.

"Soil Water Erosion Risk Assessment in V Aniversario watershed from Cuyaguateje River, west of Cuba"

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ABSTRACT

Cuba as tropical country has 70% of the arable land affected by degradation processes, among which water erosion is one of the principals. The Cuyaguateje watershed is the most important one in western Cuba and is severely affected by erosion problems. The high level of sediment yield measured in the outlet show the importance of to delineate the areas with a high erosion risk. The use of erosion models together with Geographic Information Systems (GIS) and its applications are efficient tools to analyze the erosion phenomenon and to develop soil and water conservation programs. To know the erosion risk by runoff, mean purpose of this research, it was necessary to determine the hydro-geomorphologic parameters of the study area, based on a digital elevation model (scale 1:25000) and using GIS tools. On the basis of the hydrological characteristics several aspects of risk related to potential erosion were determined. Based on the empirical model RUSLE the interrill and rill erosion risk was obtained. Study thorough of the erodibilty factor K, belonging to above mentioned equation, was carried out through rainfall simulation experiments and it's relationships with some soil properties. The gully erosion risk was established through of it's relationships with a sediment transport capacity index. According to a sediment entrainment distribution model (SEDD) was determined the sediment delivery ratio (SDR) risk, which was related to erosion criteria. The interrill and rill erosion risk map showed that 7038.90 ha have a very high erosion risk, 3084.39 ha a high erosion risk and 3.42 ha a moderate risk. Also the area with high gully erosion risk and elevated SDR risk was delineated.

Key words: erosion, model, GIS

Variability of hydromorphic soils: a state space approach

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Soil land leveling are techniques used in low land areas and have the objective to improve agricultural use to facilitate the management of water both for irrigation and drainage operations, for the establishment of agricultural practices and crop harvest. However, they cause changes in the physical environment where the plant grows, and many studies have sought to identify the effect of this practice on the structure of soil spatial variability and in the relationship between the hydric-physical and chemical soil attributes. Thus, the objective of this study was to identify and characterize the structure of spatial variability of these soil attributes of a lowland soil, before and after land leveling, and to study the relationship between them through an autoregressive state space model. In an experimental area of 0.81 ha that belongs to the Embrapa Clima Temperado Institute situated in the Capão do Leão county, state of Rio Grande do Sul, Brazil, a regular grid of 100 points spaced 10 m apart in both directions was established. At each point, soil disturbed and undisturbed samples were collected at the depth of 0-0.20 m, before and after land leveling, to determine the following soil attributes: clay, silt and sand contents, soil macroporosity, soil microporosity and soil total porosity, soil bulk density and soil water content at field capacity and permanent wilting point, soil organic carbon and cation exchange capacity. All data sets were organized into a spreadsheet in the form of a spatial transect consisting of 100 points and they were ordered following the gradient slope area resulting from soil land leveling. Autocorrelograms and crosscorrelograms were built to evaluate the structure of spatial correlation of all soil attributes having served as a subsidy for the selection of variables in each autoregressive state-space model. The results show that the soil land leveling changed the structure of soil spatial dependence of all variables and between them as well. The soil cation exchange capacity and soil microporosity variables were the variables that made up the largest number of state space models, before and after soil land leveling. The contribution of the each variable at position i-1 to estimate its value at position i increased for sand content, silt content, soil bulk density, soil microporosity, soil macroporosity, soil water content at permanent wilting point, soil organic carbon and cation exchange capacity variables and decreased for soil water content at field capacity after land leveling. Soil land leveling improved the state space model performance for soil organic carbon content, sand content, soil bulk density, soil total porosity and soil water content at field capacity and permanent wilting point variables. The worst state space model performances, after soil land leveling, were found taking silt content, soil microporosity and cation exchange capacity variables as response variables. The best state space model performance, before land leveling, was obtained taking the soil total porosity as the response variable.

AVERAGE GROUND CONTACT PRESSURE AND STRESS DISTRIBUTION TO PREDICTING COMPACTION UNDER TRACKS AND TYRES

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Soil-machines interactions are essential to understanding the soil compaction process and this can be only achieved with fundamental work on the inter-relationship of wheel and soil parameters. The objectives of this study were: a) to quantify the load, contact area and average ground contact pressure (AGCP) applied for each wheel of two types of Forwarder; b) to analyze the stress distribution under each wheel for the Forwarders. Field experiment was carried out in Belo Oriente County, Minas Gerais State, Brazil in a Red Yellow Latosol (Oxisol) with clay texture, at water contents close to field capacity. Two Forwarder model 890.3 (6 x 6 - power: 150 kW; unloaded mass 16,800 kg) and (8 x 8 - power: 150 kW; unloaded mass 19,100 kg) used in the final logging were assessed. Inflation pressures were adjustment according tyres manufactures at the moment of the traffic. Metal tracks were used to cover the tyres – axle 2 and axle 3 of the Forwarder (model 6 x 6) and all axles of the Forwarder (model 8 x 8). The characteristics of the tyre 750/55-26.5 under the tracks were: diagonal cross-ply cord laid crosswise: Tyre type: terra; tyre height/tyre width ≤ 0.6. Tyre width: 70 cm. The outer diameter without load is equal to 184 cm. The mass in each wheel (WM) was measured with mobile, flat-bed wheel-load scales (Alfa Instrumentos®) that can record mass of 12,5 Mg. The contact area, average ground contact pressure and stress distribution were obtained using the Tyres/Track and Soil Compaction-TASC program. The results showed that the average ground contact pressure increases with increasing mass wheel. This behavior is probably due to the increases in the elastic deformations of the tyres with the increase mass. Through the equation AGCP = 0,096 WM + 0,90 (R^2 = 0,99**) average ground contact pressure might be obtained as a function of wheel mass for the Forwarder 890.3 (6 x 6 and 8 x 8). It was observed that as depth and distance of pressure application increases the vertical stress decreases and result in a smaller soil deformation at greater depths. Although the vertical stress decreases in greatness, the extension of the affected areas is possibly larger. Besides of this, it's possible to notice that vertical stress had similar distribution under all wheels.

Lysimeter to estimate real-time evapotranspiration under field conditions.

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Measuring evapotranspiration (ET) consist of quantitatively express the loss of soil-water through evaporation and plant transpiration in a given time period. For this purpose, it is necessary to have a system that allow to determine accurately all inputs and outputs of soil-water system and thus to estimate the ET rate.

Direct measurement of ET is time-consuming and expensive and requires sophisticated instrumentation. Given these difficulties to estimate of ET is carried out through indirect methods or by models, however, which in many cases, not all variables are available.

In Colombia there are not ET data real of different crops therefore, ET values are estimated from the Kc obtained in climate conditions quite different to this country.

Based on a hydraulic lysimeter designed by Khan and Gil (1998) we developed the instrumentation required to estimate ET in real time. The development of this instrumentation was based on three stages: 1) choose and calibrate a sensor capable of displaying variations large enough to power small mechanical variations occur in the lysimeter 2) take the electrical signal and to condition the sensor through a micro controller, scheduled to be transmitted wirelessly to the computer data from the lysimeter. 3) take the incoming data to the computer and transform them into quantity of water surface variations, considering the precipitation or irrigation inputs and outputs water. This last stage has the development of software using the Java API, which is obtained by plotting the variation of water surface in time, such a change is obtained by calibrating the sensor, which was performed by applying a water depth of 100 , 200, 500 ml equivalent to 0.42mm, 0.84mm and 2.1mm of laminates according to calculations by the lysimeter.

Figure 1 shows the calibration curve that relates the ET and the answer of the program. With the results showed that the sensor can detect small variations, less than 1 mm of water surface. The equation obtained was used in software development, showing graphically the variation of water within the soil-plant-climate every second. One of the tools designed software has the ability to store data in a text document, which can be used for tracking the development of the crop.

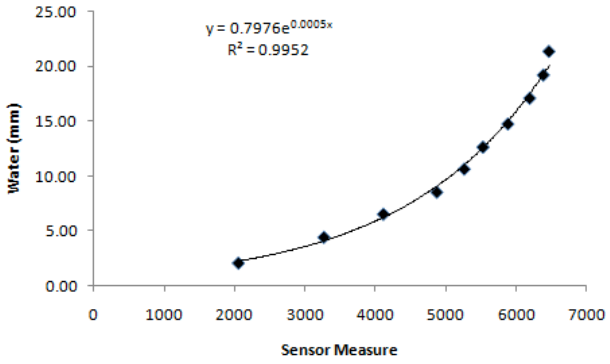

Figure 1. Sensor calibration applying 2.1mm of water

Soil quality and productivity influenced by land use and topography in semiarid regions

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Erosion rate and reduction in soil quality and productivity depend on many factors, including land and crop management, slope steepness and position, and climate condition. Erosion is very severe in the dry farming areas and rangelands in semiarid regions. More than 60% of farming lands in Iran consist of drylands, with grain crop farming, especially wheat. Up-down tillage is the conventional method of cultivation in most of the cultivated fields. Rangelands cover about 55% (90 million ha) of the country area. More than 85% of the rangelands are subject to heavy, uncontrolled grazing pressure, and the production capacities of these lands are gradually decreasing. This study was to evaluate the impact of land use and slope position on soil quality and agronomic productivity on two sets of calcareous soil samples from semiarid regions of Iran in a greenhouse experiment. Twelve soil samples were taken from two hillslopes (36° 22′ 35″ N, 49° 35′ 02″ E and 36° 22′ 00″ N, 49° 36′ 27″ E) in Kuhin region, with mean annual precipitation and temperature of 325 mm and 12.5^{o}C, respectively. Three paired soil samples were collected from up, middle and foot slopes of each hillslope, one sample from dry farm and the other from adjacent rangeland. In Tarhan, as second region, eight soil samples (four pairs) were taken from four slope positions of a dry farm and adjacent rangeland on a hillslope (33° 30′ 12″ N, 47° 12′ 18″ E). Mean annual precipitation and temperature of the second region are 376 mm and 15.8^{o}C, respectively. Soil samples were analyzed for their physical and chemical properties. A factorial experiment of completely randomized design was used to compare the effect of land use, slope position, water stress and fertilizer on yield and yield component of wheat (as soil productivity index) for the soil samples of each region separately.

In the case of Kuhin region, saturated hydraulic conductivity (K_s), total N, available K, total organic matter (OM) and field capacity of the soil were all lower in the farmland than in the grassland. OM, total N and available K were higher at the foot slope than the upslope. However the equivalent calcium carbonate was higher at the upslope than mid and foot slope. In the case of Tarhan region, soil had higher fertility and quality, i.e. the higher OM, nutrients and cation exchange capacity and lower carbonates, on the dry farmland than the adjacent degraded rangeland especially at the upper slope positions. Also, foot slope was enriched in OM and nutrients (N, P and K), had higher CEC and relatively depleted from carbonates. The results of both greenhouse evaluations showed that all investigated factors have significant effects on wheat yield. Agronomic productivity was higher in the rangeland than the dry farming field and in the foot slope than the up slope for Kuhin soils. In the Tarhan case however, soil samples of dry farm had higher productivity than the adjacent rangeland. These results show that land and cultivation management have important impact on potential productivity of the soil and on soil degradation. There was also some interaction between land use and slope position in both cases. Mineral and organic fertilization increased crop production and crop resistance to water stress. On the other hand, the effects of land use and slope position were hidden under water stress condition. In the arid and semiarid regions thus soil degradation and productivity reduction may not be detect on their early stages.

ADAPATING SOIL LOSS USING RUSLE FOR A WATERSHED IN TRINIDAD, WEST INDIES.

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In 2005, soil erosion cost tropical countries over US $40 million and destabilised the economy of certain developing countries. Soil erosion is mostly caused by water in the tropical region. Trinidad and Tobago is a tropical developing twin island state that lies between 10° 2' and 11°12' North latitude and 60° 30' and 61° 56' West longitude. Soil erosion causes a strain on the country's Gross National Product (GNP) through natural disasters such as landslides and flooding which directly impact the agricultural industry. To date there is no quantitative approach to determine soil loss in Trinidad and Tobago. Therefore, there is a need to assess soil loss quantitatively and to understand the mechanisms of soil loss in order to implement effective soil conservation practices to protect arable land.

This project proposes to assess soil loss in a catchment using an empirical model. The empirical model that would be used is Revised Universal Soil Loss Equation (RUSLE). This model is applied worldwide and can adapt for a tropical mountainous catchment area such as Maracas / St Joseph Watershed. From preliminary analysis of the area there was substantial visible evidence of soil erosion and exposure of parent rock. The RUSLE factors would be developed from using 10years of local rainfall, topographic, soil and land use data. The local rainfall data which consist of 6 pluvial stations in the watershed will be correlated the TRMM data that will help to formulate an erosivity layer. This layer will incorporate the synoptic bi modal precipitation and orographic lifting. The soil map that will be used to calculate the *k* factor of the watershed area is digitalized soil map from the Department of Geomatics Engineering and Land Management at the University of the West Indies. The model will be used to quantify the average soil loss of the region for the 10 years period and produce an erosivity map that detects different levels of soil erosion. The method that will be verification and accuracy of the soil loss map is the comparison between the actual soil loss and the predicted soil loss from the model. This will be a beneficial tool for land use management and soil conservation practice in that area.

Keywords: Tropical watershed, erosivity, RUSLE, soil erosion.

Modeling of Westerm Boundary Currents

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Western boundary currents are warm, deep, narrow, and fast flowing currents that form on the west side of ocean basins due to western intensification. They carry warm water from the tropics poleward. Examples include the Gulf Stream, the Agulhas Current, and the Kuroshio which, will be described here, in highly idealized model. Main focus of this work is to seek better understanding of ocean-atmosphere interaction, basic formulation and numerical analysis of these currents.

In this work for our problem we used The **P**rinceton **O**cean **M**odel. POM is a ocean model code that is able to simulate a wide-range of problems: circulation and mixing processes in rivers, estuaries, shelf and slope, lakes, semi-enclosed seas and open and global ocean. This model is based with a sigma coordinate, free surface and primitive equation ocean model with embedded turbulence and wave sub-models, and wet-dry capability. It has been one of the first coastal ocean models freely available to users.

For our problem of dynamics of western boundary currents, we modify POM in a two-dimensional, rectangular tank model which is surrounded by walls time dependent, primitive equation, flat bottomed basin numerical model of ocean with centred scheme and simple wind stress. Water in modeled tank is initialised with uniform salinity and temperature. It is forced by a surface input of water of the same temperature and salinity as the water in the basin and with a steady atmospheric pressure field.

Acording to this model and numerical analysis it will be presented how wind stress effect on the streamlines and elevation of ocean surface. This highly idealized problem offers a very useful geophysical test for numerical model that boundary layer must exist at one of the sides, which turns out to be western boundary. We will see that our model allow streamlines to close on the western boundary, as it is the Gulf Stream one of nature's more dramatic example. And finally, we will see that up above hypothesis of western currents are precisely.

Saturated hydraulic conductivity of a Typic Haplustert as influenced by solutions of anionic series

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Sustainable agricultural production is a great challenge on irrigated Vertisols and other associated soils. Use of poor and marginal quality waters for irrigation in arid, semi-arid and coastal India makes the challenge more complex. Despite the severity of the problem, systematic data are not available on Vertisols. Therefore, a laboratory study was carried-out to evaluate the dependence of saturated hydraulic conductivity (Ks) of Typic Haplustert on relative concentration, composition and proportion of Na, Ca and Mg under chloride, carbonate and sulphate series. Soil samples (< 2 mm) were equilibrated using three total electrolyte concentration (TEC) levels i.e. 10, 20, 30 me L^{-1}; and three sodium adsorption ratio (SAR) i.e. 10, 20 and 30 $mmol^{1/2} L^{-1/2}$ at Ca:Mg =1:2, 1.5:2 and 1:1. The Experiment was carried out using chloride, carbonate and sulphate as independent anionic series. Pure AR grade chemicals were used to prepare the various quality waters. Equilibrated samples, after air drying, were repacked in 5-cm diameter stainless steel rings and Ks was determined in a constant head permeameter. Values of Ks were considerably influenced by changes in TEC and SAR of equilibrating solution irrespective of anionic series. In general, at a fixed SAR value, Ks increased with increase in TEC of equilibrating solution, and at a fixed TEC value, Ks decreased with increase in SAR of equilibrating solution. In all the three anionic series it was not possible to determine Ks when soil samples were equilibrated with dilute solutions of highest SAR i.e. TEC 10 meL^{-1} and SAR 30 $mmol^{1/2}L^{-1/2}$ due to very high dispersion. Chloride and carbonate series produced intermediate and least Ks values at fixed TEC and SAR levels. However, Ks values in sulphate series were highest, except in Ca: Mg=1.5:2. Relative dominance of Ca and Mg over each other influenced Ks values that varied with anionic series. In chloride and sulphate series, Ks values increased with increase in the proportions of Mg over Ca. On the contrary, Ks values declined with increase in the proportion of Mg over Ca in carbonate series. Changes in Ks with relative dominance of Ca and Mg were mainly due to their efficiency to flocculate and deflocculate the soil clay. Dominance of Ca in low SAR solutions resulted in high degree of flocculation and low dispersion of soil silt and clay particles. Multiple regression analysis showed that Ks depends largely on dispersion of soil silt+clay; and solution characteristics. Both total concentration of solutes in the flowing solution and the relative proportions of anions and cations have strong bearing on saturated hydraulic conductivity of Typic Haplustert. The results of this study demonstrated that the physical structure and hydraulic conductivity of Typic Haplustert was highly affected by applied chloride series than the carbonate and sulphate series. Excess magnesium relative to calcium in the soil induces loss of soil structure. Therefore irrigation with high magnesium waters relative to calcium leads to soil structure breakdown. Without considering the water quality parameters and hydraulic behavior on these Vertisols, it is not possible to practice the irrigated agriculture on sustainable basis.

ARE COVER CROPS A WATER COMPETITOR IN SEMI-ARID AGRO-ECOYSTEMS?

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Cover crops are frequently used agro-environmental elements in crop rotations to reduce nitrate leaching, soil erosion and to increase soil organic carbon stocks. Although farmers in semi-arid regions frequently express concern on potential cash crop yield reduction due to soil water depletion by cover crops, there are still few studies dealing with cover crop water use and its impacts on the water balance.

The objective of the study was to estimate the risk of maize yield losses due to cover crop water consumption under temperate central European semi-arid climatic conditions. For this purpose the plant growth and soil water components of the soil-plant-atmosphere model DAISY were calibrated and validated for a mustard cover crop vs. bare soil followed by maize as cash crop. Measured and simulated plant growth and soil water content time series were compared by RMSE and Index of Agreement ($0 \leq d \leq 1$). Subsequently the model was run with ten years of weather records from the site to estimate the range of potential impact.

Modelling results gave a satisfactory reproduction of the observed growth pattern and soil water content in the profile. RMSE for biomass growth ranged from 263 kg ha^{-1} (calibration) to 517 kg ha^{-1} (validation), index of agreement was 0.99 and 0.93 respectively. For profile water content, RMSE was 7.9 mm m^{-1} for fallow (d=0.94) and 3.7 mm m^{-1} for mustard (d=0.99).

Over a ten years average, evapotranspiration of a mustard cover crop with a biomass accumulation during autumn (20 August - 15 December) around 3.500 kg ha^{-1} dry matter was 34 % higher compared to fallow (132 mm vs. 87 mm). Still, only minor differences in simulated maize yield occurred, being 9.0 Mg ha^{-1} after fallow and 8.6 Mg ha^{-1} after mustard in average. This can be explained by the fact that precipitation input during cover crop growth and winter rainfall were sufficient to refill the profile water content until spring and thus reducing differences in soil water availability when seeding the subsequent maize crop to only 4 %. Using the modelling results, it could be shown that cash crop yield was unaffected by autumn evapotranspiration, while its height depended largely on actual rainfall input over its growing period. Even in a dry year such as 2002/2003 with low winter precipitation and a prolonged dry period during maize growth, yield was not influenced significantly by distinct evaporative losses during autumn.

Two main conclusions were drawn from this research. First we could show that cover crops have high water use efficiencies. Even for aboveground dry matter formation before winter of up to 5.000 ka ha^{-1}, the low evaporative demand of the atmosphere during the cover crop growing period limits the cost of water for this biomass production.

Second we confirmed that in an input-driven agro-ecosystem cash crop yield is mainly a function of actual precipitation input. Favourable rainfall distribution with summer maxima for cash crop growth in semi-arid temperate Central Europe reduces the impact of distinct soil water depletion levels by a preceding cover crop. This is likely to differ from a storage driven ecosystem with a summer-dry climate where crop growth and yield formation are largely determined by the available soil water reserves.

Our study could show that there is only minor risk of yield losses due to cover crop induced soil water depletion under Central European climate conditions. Therefore benefits of cover cropping to the environment as well as for sustainable soil productivity should largely be exploited in farming systems. Simulation models such as DAISY are valuable tools for site specific impact analysis and could further be used in management optimization.

CLIMATOLOGIC WATER BALANCE FOR A CENTRAL PIVOT ^{15}N FERTIRRIGATED COFFEE CROP

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The coffee crop covers several Brazilian regions with different climatic, soil and thechnology characteristics which are related to productivity, among them those that use central pivot fertigation. The water balance is an essential tool for the correct management of the crop and its establishment, being however costly and time consuming when all of its components are measured directly in the field. Climatological water balances that involve practically only meteorological data, collected by automatic stations, are an advantageous option. However, due to their limitations, their viability is here tested for the case of a coffee crop managed at a high technological standard, involving central pivot fertigation, growing on a flat area of a sandy soil in the west of the Bahia State, Brazil. In this study the sequential water balance was used to estimate evapotranspiration by the Thornthwaite (TH) and Penman-Monteith (PM) methods, using soil water retention properties of the soil, and climatologic data from automated weather stations located nearby. The main goal is the estimation of fertilizer N leaching through water balance calculations, using ^{15}N as a tracer for two fertilizer rates: 400 (T_{400}) and 800 (T_{800}) kg ha^{-1} of N. A sequential water balance was established with the aid of a program for 5 day intervals over the period of one year. Runnoff was considered zero due to the relief that is very flat, essentially with 0% slope, so that the water excess calculated by the balance after the available water capacity reached 100% was considered as the deep drainage below the 1 m depth. This depth was considered as the lower boundary of the elementary volume because it contains more than 95% of the active root system. To estimate the concentration of N and its isotopic abundance soil solution was extracted monthly with aid of porous cup extractors installed at the 1 m depth below the irrigated coffee plants. This allowed the calculations of the nitrogen derived from the fertilizer (Ndff) present in soil solution and of the total quantity of fertilizer N (QNdff) leached below the root zone. Monthly values of soil solution concentration were multiplied by the monthly values of deep drainage calculated from the water balance to obtain total N leaching, and using respective Ndff values the monthly values of QNdff were estimated. Results indicate that there are differences between the deep drainage estimated through the water balance when estimating evapotranspiration through the two methods mentioned above, however, the procedure of using the sequential water balance program was viable and it is concluded that it can be used for regions of similar climate and soil characteristics. With an annual total of 2232.3 mm of rainfall plus irrigation, values of deep drainage (Q) of 891.7 and 1010.5 mm were obtained, respectively, for the TH and PM methods. QNddf for TH for T_{400} was 11.7 and for T_{800} 86.7 kg ha^{-1} of N, which corresponds to 2.9 and 10.8% of the applied rate, respectively. Since values of Q were greater for PM, the respective values for QNdff were T_{400} 14.7 and T_{800} 104.5 kg ha^{-1} of N, corresponding to 3.7 and 13.1%, respectively. Since there was no possibility to establish statistical differences between these leaching values, and PM is considered superior in relation to TH, this study adopts the values calculated through PM as more consistent to be used as estimates of fertilizer leaching in this region of Brazil.

Key-words: Thornthwaite, Penman-Monteith, available water capacity, evapotranspiration.

College on Soil Physics: Soil Physical Properties & Processes under Climate Change

"Physical properties and mineralogical composition of some representative soils from Argentina¨

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Abstract

The physical and physicochemical characteristics of soils depend largely on the composition of their inorganic fractions. The mineralogy of the fine and coarse fractions of soil influences the structure, porosity, expansion-contraction processes and water dynamics. The fundamental physical and chemical characteristics of soils as the ion exchange capacity, the proportion of bases in the exchange complex and the pH also depend on its texture and mineralogical composition.

The working group of the Mineralogy and Micromorphology Laboratory of the Institute of Soils, INTA Castelar, has within its objectives to characterise the mineral composition of representative soils from Argentina and to establish its relationship with the morphology and micromorphology and other physical properties.

To accomplish this objective profiles of different soil series from Argentina are being studied. One of the regions selected to study in more detail was the Rolling Pampa which concentrates a high proportion of farming and livestock. In this region various soil series in the positive positions of the landscape have been described. These soil series have different features originated from a different mineralogical composition and texture. Physical, physico-chemical and mineralogical data of the different horizons of these soils are being analysed. The physical measurements chosen for each horizont were: texture, structural stability, water retention, water content at field capacity and permanent wilting point, saturated hydraulic conductivity, bulk density, total porosity, textural and the structural porosity, Atterberg indices, coefficient of linear extensibility (COLE) and cracking pattern. The chemical and physico-chemical analyses studied are those related to organic carbon content and the exchange complex (CEC, base exchange, pH).

The mineralogical study of the different size fractions is performed by X-ray diffraction on powder samples, oriented natural, saturated by ethylene glycol and heated at 520 º C for 2 hours. The measurement of magnetic susceptibility on low and high frequency is carried out on soil samples taken every 10 cm deep with the purpose to study the magnetic fraction of soils. Besides, micromorphological analyses of thin sections using optical microscopy are being performed on selected samples. Micromorphometric analysis of the total porosity is carried out by point counting and by image analysis techniques. The total porosity is determinated and discriminated according to size, shape and orientation of pores greater than 50 um.

Preliminary results show an increase in some of the studied properties (water retention, relationship micropores / macro + mesopores and plasticity) in soils with a higher proportion of interstratified minerals illite / smectite. We are analyzing how these properties among others vary depending on the content and type of clay. Statistical analysis of the data will be carried out by regression analysis (simple and multiple) and principal component analysis.

It is our purpose to obtain a more detailed information of the mineralogical composition of soils in different areas of Argentina. This is an important requirement for the basic and applied soil science to assess the processes of formation as well as the direct influence of the physical properties in the use, management, fertility, degradation and pollution of soils. We believe that this information should be incorporated to improve the existing simulation models in order to obtain a better understanding of the importance of the role of the soil in the water dynamics, flow of pollutants, erosion processes and climate change.

Assessment of the Cambisol structure sustainability under different land uses systems in Western Amazon

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The adequate use of the soil is important for the preservation of the natural resources and for a search of a sustainable agriculture. However, its inadequate use promotes degradation of the soil altering its physical, chemical and biological properties. In order for the soil management happens in a sustainable way it is important to diagnose through efficient methods which impacts these managements can provoke in the soil structure from the soil physics view. Thus, this study had as objectives: a) assess the sensibility of the bulk density and total porosity to quantify the Cambisol structure alterations in different land uses systems; b) to develop a load support capacity models of a Cambisol under the use systems of young secondary forest, old secondary forest, forest, pasture, crop and agro forestry c) to determine, through the use of these models, the influence of the different use systems in the Cambisol structure in three depths and d) to determine through these models for each depth, which use systems preserved or cause degradation of the Cambisol structure. The samplings were accomplished in three depths (0 - 3, 10 - 13 and 20 - 23 cm), being 10 undisturbed soil samples collected by depth in the following use systems: young secondary forest, old secondary forest, forest, pasture, crop and agro forestry. The undisturbed soil samples were used in the uniaxial compression test. It was also determined texture, particle and bulk densities and total porosity. The load support capacity models for the Cambisol are function of the preconsolidation pressure and moisture, being expressed by the equation $\sigma p = 10^{(a + b U)}$. The soil bulk density and total porosity were not appropriate in the quantification of the Cambisol structure degradation. In general, in a same use system the depth 0-3 cm was the one that presented larger structure degradation. The depth of 10-13 cm was the one that suffered smaller structure degradation in the young secondary forest, old secondary forest, pasture and agro forestry (for moisture larger than 0.35 kg kg^{-1}). The depth of 20-23 cm was the one that suffered smaller structure degradation in the forest (for moisture smaller than 0.46 kg kg-1), crop and agro forestry (for moisture smaller than 0.35 kg kg^{-1}). In the 0-3 cm depth the use system that more degraded the Cambisol structure was pasture. In the 10-13 cm depth, in general the Cambisol structure degradation decreased in the following order: crop > old secondary forest and forest > agro forestry > young secondary forest and pasture. In the 20-23 cm depth, it was only evident the greater structure degradation of the old secondary forest and the smaller degradation of the crop (for moisture content greater than 0,40 kg kg^{-1}).

A method to mapping the spatial variability of soil physical quality

ABSTRACT

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The SIPA (Agro ecological Production and Research Integrated System) is an experimental farm located in the municipality of Seropédica-Rio de Janeiro State/Brazil. The farm, created in order to developing agro ecological technologies, was implanted in 1993 and encompasses an area of 59 hectares, being 6.24 hectares used to policultive. Since the beginning, one of the greatest demands was to developing a method to correlate soil physical properties and crop production. In order to organize the dataset generated during the experimentation, a georreferenced database was organized in ARCGIS, and one of these themes stored was spatial variability maps of physical attributes. Recently, the Least Limiting Water Range (LLWR) has been proposed and used as an index of soil physical quality for crop growth (Silva et al., 1994), since it integrates the effects of soil aeration, resistance to penetration, and soil water retention on crop growth into a single attribute. Despite the advantage of using this index, the LLWR measurement process in a specifical site is too much expensive and time consuming, especially in projects aiming to mapping the spatial variability of soil physical quality in precision agriculture. Considering this limitations, the objective of this work was to propose a method to mapping the spatial variability of soil physical quality. Basically, the method consisted on mapping the spatial variability of Easily Available Water (E.A.W.), Air Filled Porosity (P.A.) and soil Penetration Resistance (P.R.), using geostatistics, and a standard vector classifier ($P = [EAW\ PA\ RP]$), to integrate the physical attributes and classify the Soil Physical Quality (S.P.Q.). The studied site was an area of 6.24 ha pertaining to APRIS, where an regular georreferenced grid was used to assess and determine the physical attributes E.A.W., P.A. and P.R., respectively, at 0.10, 0.20 and 0.30 m soil depth. EAW and PA were calculated by the expressions, E.A.W. = (θ_{10kPa}- θ_{80kPa}) and P.A. = ($\theta_{total\ porosity}$ - θ_{10kPa}), respectively. P.R. was determined in 169 grid points, using a penetrometer of impact developed by Stolf (1991). Geostat (Vieira et al., 1981) software was used to calculating the semivariograms of the physical attributes, as well as to perform the cross validation of analytical model fitted to experimental semivariograms. The kriged estimation of EAW, PA and P.R., in each soil depth, were used to classify the Soil Physical Quality (SPQ) as: 1- Restrictive (E.A.W.<3.9 mm, and/or P.A.<10%, and/or R.P.>2mPa), 2- Suitable (E.A.W. = 3.9-5.5 mm, and P.A. = 10-20%, and R.P.=1-2 MPa) and, 3- Optimum (E.A.W. > 5.5 mm, and P.A.>30%, and R.P.< 1MPa). The integration of each soil attribute (EAW, PA and PR) on classes of SPQ was performed on Matlab software, using the Euclidian distance of each point in relation to a standard vector (Restrictive, Suitable and Optimum). All physical attributes presented spatial dependence with fitted spherical (E.A.W. and P.A.) or exponential (R.P.) semivariograms models. Most of the area was classified as restrictive, at all the three depth for the sake of low E.A.W., followed by suitable and Optimum, respectively. The proposed method was efficient to classify the S.P.Q. of the study site, and must be tested in different environmental conditions and classification systems applied to digital soil mapping.

Modern Techniques for Assessing Soil Degradation using Remote Sensing and GIS

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Abstract

"**Land degradation**" means reduction or loss of the biological or economic productivity and complexity of rainfed & irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns.

Irrigated agriculture represents the most intensive and productive forte of primary land use in Egypt and serves as a vital supplement to crop production to satisfy the growing food needs of the increasing population. The water logging and soil salinity are of the most eminent processes of agricultural lands degradation in Egypt due to poor water management in the domain of agriculture, which follows the conventional surface irrigation.
Combating land degradation in irrigated lands should be conceived in an integrated approach to sustainable agriculture and rural development in dry-lands. Therefore, the information about soil properties provides a basis for assessing soil risks and hazards.

In the recent five years, there has been considerable evolution in the methods and techniques used in the evaluation of land degradation. **Quantitative, up-to-date information** is needed to support policy development for food and water security, environmental integrity, and economic development. However, land degradation is a contentious field; crucial questions that must be answered in a scientifically justifiable way. The remote sensing data, geophysical survey, and Geographic Information System (GIS) are the most commonly used tools and techniques in this issue.

The use of satellite images and digital elevation model (DEM) is very important in elaborating the physiographic – soil maps. They facilitate the linkage between the soil properties and physiography on the bases of data extrapolation, and then, they offer a good tool for mapping the degradation risk. On other hand, Geographic Information Systems (GIS) provide indispensable tools for decision-makers. It provides right opportunity for much desired integration of remote sensing data with the collateral data.

The Mediterranean desertification and land use project (MEDALUS) develop a methodology for mapping Desertification Quality Index (DQI) and Environmentally Sensitive Areas (ESAs) to Desertification, which depend on the weighting factors of four broad categories defining the qualities of soil, vegetation, climate and management. The Environmental Sensitivity Index (ESI) to desertification of an area can also be seen as the result of the interactions among elementary factors (information layers) that are differently linked to direct and indirect degradation or desertification phenomena. Four layers can be produced to assess desertification sensitivity (DSI) and for mapping the environmentally sensitive areas (ESA,s). These layers can be created in a geographic information system (GIS) using the spatial analyst tool.

The spatial analysis is a useful tool in the geographic information system (GIS), which allows creating of thematic layers in a raster format. This data structure can provide the most comprehensive modeling for layers analysis for special purposes i.e. assessing the desertification sensitivity index and mapping the sensitive areas. The assessment of desertification sensitivity is rather important to plan combating actions and to improve the employment of natural resources. The quantitative aspect of desertification sensitivity demonstrates a clearer image of the risk status, thus, reliable priority actions can be planned.

This article is an attempt to offer and provide the modern methods and techniques used in the area of land degradation assessment, to communicate with these methods and techniques.

Keywords: land degradation, irrigated agriculture, remote sensing, GIS.

A new wet sieving approach for various land uses under a semi-arid climate

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Soil aggregate stability is directly related to soil degradation and primarily controlled by aggregate breakdown mechanisms. A great many methods to measure the soil aggregate stability have been defined in the literature. The reason for that could be explained by the fact that there is no satisfactory sole methodology to express aggregate stability which applies to all soils in any circumstance. Selection of the methods or treatments applied on the soil sample to measure of the aggregate breakdown and interpretations of results mostly depend on the purpose of the measurement. The major objectives of stability tests are to give a reliable description and to classify the behavior of soils under the effect of water, wind and management. Even though so many methods have been used to define soil aggregate stability with varying success, they do not make the situation less complicated for comparable data interpretation. Each one mainly refers to the different wetting conditions, applied destructive energy or aggregate size used for selected method. In this study, we have compared five different breakdown mechanisms or methods of measuring aggregate stability under wet sieving conditions and evaluate them in terms of their ability to simulate physical processes that cause aggregate instability in the soil system. Selected soil samples were taken from a semi-arid catchment area under four different land uses which were forest, grassland and agricultural uses on alluvial and colluvial flat areas. The results indicated that among the methods evaluated, only one could make distinction among four different land uses ($p<0.05$). Others were unable to discriminate different land usages from each other in terms of the aggregate stability. In the light of the results, it was observed that the more soil aggregate sizes were taken into consideration, the more reliable was the method in distinguishing the effects of the landuse on the soil sample stability. By the proposed new approach, initial sieve sizes of the selected soil aggregates varied between 5 and 8 mm, and natural distribution of the soil aggregates under wet sieving process was measured by the soil aggregates of 5, 4, 2, 1, 0.5, 0.25, 0.125 and 0.063 mm. After the wet sieving process, the collected soil aggregates from different sieve openings were oven-dried, and the Mean Weight Diameter (MWD) values of soil samples were finally calculated.

Key words: soil aggregate stability, wet sieving methods, the Mean Weight Diameter

Determination of thermal properties of some Bulgarian soils using indirect methods

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In recent years the question concerning climate changes is discussed more and more as well as the effect of temperature on different factors in biological, agricultural sciences and industry. In my PhD work titled: "Thermal properties and thermal regime of some Bulgarian soils" the close relation between soil thermal and other physical properties was investigated; indirect methods for calculating soil thermal properties were used. Thermal diffusivity was determined by an indirect method on the basis of data received from standard soil temperature measurements. The theoretical model based on the heat conduction equation was used. For this purpose data from the standard measurements of soil temperature at depths of 0.02 m and 0.20 m in 17 meteorological stations of the National Institute of Meteorology and Hydrology (NIMH) of Bulgarian Academy of Sciences, were used. The main soil properties were determined experimentally in the laboratories of Institute of Soil Science N. Poushkarov.

Indirect methods require experimental data for temperature, soil water content, bulk density, particle size distribution, soil organic matter. A complex method for determination of soil thermal properties: thermal conductivity λ, volumetric heat capacity C_v and thermal diffusivity a with relation to moisture, density, temperature, particle size distribution and water potential of the soil was suggested by Usowicz (1993) and was used in my work. The error of the estimation doesn't exceed $\pm 10\%$ of the measured values in the developed statistical-physical model of thermal conductivity and de Vries formulae for heat capacity of the soil C_v.

An algorithm was suggested for determining soil thermal conductivity using de Vries model (1963) and has been tested with experimental data for thermal conductivity that has been received by Ilieva and Krasteva (1973). These data are for two soils with different particle size distribution - leached cinnamonic forest soil (Voikovo village, Sofia region) and leached smolnitza (Bojurishte, Sofia region) and were obtained in laboratory conditions at wide range of water content and bulk density of the investigated soils. Obtaining of new experimental data in the conditions of contemporary climate for undisturbed soils in laboratory conditions and in field will allow calibration of the model with new data. The suggested algorithm for soil thermal conductivity determination applying de Vries model (1963) permits to be determined two other thermal properties and their course at different levels of moisture is investigated.

I am interested in making comparison of results obtained from direct measurements with these calculated by indirect methods. The received experimental data of soil physical properties will permit to evaluate changes in soil water and thermal properties as a result of climate changes and different land use, comparing cultivated soil and grassed ground.

I would like to assimilate new methods for obtaining data about soil physical properties (especially soil thermal properties) and also studying models for predicting soil thermal properties in the conditions of climate change. So it is important to determine soil water and thermal properties applying direct methods (e.g. TDR and KD2-Pro device - gives an opportunity for measuring soil thermal properties at different levels of soil moisture) and to compare the results with those received by indirect methods, different models. I would like to learn more about modelling, determination and practical use of soil thermal properties. Models for thermal and water balance and required input data set are also an object of interest.

DUNES AS WAVES *VS* WAVES ON BARCHAN DUNES

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Very few barchans in a dune field exhibit the prescriptive smooth crescent shape similar to those simulated in models; they rather display more complex substructures. The back and horns of barchans generically present surface oscillations which can become high enough to induce air flow separation and thus secondary avalanche slip faces. These phenomena have so far been interpreted as small dunes climbing onto large ones, but this is in contradiction with our direct field investigation, during which we have followed the birth, growth, propagation and further evolution of these structures. By studying over more than 100 barchans, we have identified two situations under which the dune surface gets destabilised: changes of wind direction and collisions. We have precisely investigated the actual nature of these oscillations on five dunes displaying well-defined patterns. With the help of fixed markers, we have observed that the oscillations propagate downwind on the back of the dune at a velocity $c \approx 2$ m/day, which is typically ten times larger than that of the dune itself. Their wavelength and amplitude do not vary much in the course of their motion. We have measured the variations of height δh and sand flux δq along a barchan horn. These quantities are proportional, which demonstrates that these oscillations behave as plane propagating waves.

The nucleation and propagation of such waves on a sand bed is governed by the interaction between its profile, which modifies the air flow, and the sand transport, which controls the erosion and deposition processes. Along the upwind side of a hump, the streamlines converge yielding an increasing wind and thus an increasing flux, so that erosion takes place. Conversely, the flux decreases on the downwind side causing accretion, which in total means that the bump translates downwind. However, the accretion does not start precisely at the crest but is shifted upwind, so that the bump gets amplified. This instability mechanism is directly related to the asymmetry of the wind flow, which originates in the non-linear inertial term of the Navier-Stokes equations. So far, no length scale is involved as the atmospheric boundary layer is fully turbulent, and the mechanism therefore predicts an unconditional instability at all wavelengths. There is however a small-scale cut-off for the instability related to the saturation transient of the sand flux. The flux reaches its equilibrium value, determined by the wind strength, over a characteristic distance L called the saturation length. This effect shifts downwind the position at which the flux q is maximum and thus stabilizes small bumps.

Gravimetric sampling density for accurate crop water use calculation of Gezira clay soil, Sudan

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The Gezira area is part of the central Clay Plain of Sudan covering about 30,000 square kilometers. The central clay plains of Sudan are of special importance to the economy of the country as it hosts most of the important agricultural schemes. Part of these central clay plains that falls between the Blue and White Niles is called Gezira.

Soils of the Gezira have been developed in a semi - arid to arid climate, with annual rainfall of approximately 200 mm in the north to 450 mm in the south, most of the rain falls between July and October. The mean temperature is about 25 ˚C with mean maximum of 37 ˚C and minimum of about 20 ˚C. Although the physical properties of these soils play a major role in their productivity, they received little attention in the past.

Many Studies were conducted in Gezira clay soils to examine the different moisture content in the field during the end of the dry season. The cracks of dry soil are an important property of Vertisols development, and have profound effect in its hydrologic behavior. Soil cracks allow deep water percolation and enhance better water conservation, where as insufficiently treated cracks require significant amount of initial irrigation .A process of high relevance to irrigation scheduling.

Cracks are also a reason for a considerable increase in the irrigation water requirements of crops in the first irrigation.

Although gravimetric soil moisture content (MC) method is destructive, time consuming, and laborious, it is considered as one of the most accurate methods. The method is widely used in the central cracking clay plain which covers about 26 million ha in central Sudan to monitor the soil moisture regimes pertinent to studies of crop water requirements (CWR). The water balance equation has been used in Gezira area due to its simplicity and the soil has no deep drainage, capillary rise and runoff losses. The purpose of this study is to provide more information on the spatial variability with respect to different irrigation regimes and at various depths as well as to determine minimum number of sample required at two level of accuracy. The experiments were conducted at Gezira Research Station Farm during the summer seasons of (2004- 2005), using a Sorghum crop, variety Wad Ahmed. The experimental design was randomized complete block design RCBD with three irrigation intervals (every week (W1), every two weeks (W2) and every three weeks (W3). Intensive gravimetric samples (9 to 12) were taken from an area of about 50 to 96m2 two to three days after each irrigation and on weekly basis until next irrigation cycle starts. The results showed that the actual soil moisture content varied most in depth from 40 - 80 cm and the variation was not consistent from depth to depth in the profile. Sampling density requirements increased a lot at the accuracy level of ± 1% compared to a level ± 2.5%. Soil moisture varied with depth, the irrigation intervals and between the post and pre samples. It was concluded that the calculation of crop water use has to be based on careful irrigation and intensive soil moisture monitoring. The study finally indicated that soil sampling has to be more intensive for the wetter conditions

Modeling Water Flow in Undisturbed Soil Columns by Breakthrough Curves of Chloride

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ABSTRACT

Breakthrough curves (BTC) are widely used to characterize hydraulic properties of porous media. The objective of this study was to develop a novel methodology to evaluate BTCs alternatively for the purpose of predicting hydraulic conductivity (K) by BTCs in undisturbed soil columns. Miscible displacement tests of Cl were conducted on undisturbed soil columns with 8.0 cm id and 13-30 cm length. The resultant BTCs were divided into about 30 segments, and the segments were ordered in increasing order, the first segments being the one with the lowest value of dimensionless relative concentration (C_r). The model was based on calculating conductivity of group of effective capillaries corresponding to each segment and summing up the resultant K-values to calculate conductivity of column at given cumulative mobile water content (θ_{mc}). For each segment, amount of mobile water (θ_m) needed to transport amount of chloride corresponding to that segment was calculated as $\theta_m = \Delta C_r x \Delta P_r$, where ΔC_r is the difference in dimensionless concentration and ΔP_r is the difference in dimensionless pore volume. Also, travel time (t) corresponding to that segment was calculated by time elapsed from the beginning of the test. Variables θ_m and t were used with Darcy Equation to calculate K corresponding to a particular segment. The cumulative mobile water content of the column (θ_{cm}) corresponding to a segment was calculated as cumulative of all

segments with a $C_r \leq$ for that segment. For example, The value for θ_{cm} corresponding 25th segment was calculated as $\theta_{cm} = \sum_{i=1}^{25} \theta_{mi}$. Similarly, conductivity of the column at a particular θ_{mc} was calculated, summing up values for K corresponding to all segments of which values of θ_m were added up. The value of model to simulate K was evaluated; comparing laboratory measured and predicted values of K at saturation. Hydraulic conductivity of the column at saturated water content (K_s) was calculated, summing up calculated K-values for all the segments. The correlation analysis conducted between measured and simulated values of K at saturation resulted in a correlation coefficient of r= 0.90. In general, the procedure developed in this study overestimated K_s somehow. Values of the columns studied for θ_{mc} at saturation (θ_{mcs}) ranged from 1.5 to 45% and K_s-measured from 27.57 to 0.012 cm h^{-1}, and values for K_s-simulated ranged from 38.81 to 0.032 cm h^{-1}. There was no significant correlation between values for θ_{mcs} and either for K_s-measured or for K_s-simulated. Pore size distribution of the column should be known to interpret inconsistence between K_s and θ_{mcs}. Therefore, further research is needed to analyze K-θ_{mc} relations against different values of θ_{mc}.

Key words: Breakthrough curves, mobile water content, hydraulic conductivity, miscible displacement, chloride, undisturbed soil columns.

An Evaluation of the Spatial Variability of Soils of Similar Lithology under Different Land Use Types and Degradation Risks in a Savannah Agro-ecology of Nigeria.

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Research Synopsis

Variability of soils under seven land use types (LUT): yam/cassava, maize/cowpea, orange orchard, oil palm plantation, cocoyam, plantain/banana and fallow at Agyaragu, and yam/cowpea, maize/millet, cashew/orange orchard, rice, plantain/banana, bambo and fallow at Shabu, all in savannah agroecology of Nigeria were evaluated with a view to ascertain the degree of spatial variability of the soil properties, determine the influence of soil quality variability on management of the land use types, provide knowledge of the potential soil quality degradation rates, and to suggest appropriate management practices for sustainable management. The locations were divided into 0.1km grids and 8 grids were randomly chosen for soil sampling covering these land uses. The characterization induced information based on texture, description of current land use, crop management and physiographic features were done. Auger samples were collected at two depth intervals; surface: 0-15cm; subsurface: 15-30cm; and 0-20cm and 20-45cm, respectively, for arable crops and plantation crops in both locations. Core samples were collected at 0-20 cm depth. Soil samples collected were subjected to laboratory analyses for physical (bulk density, Ksat and texture) and chemical (soil pH, OC, total N, Exch. Cations - Ca, Mg, K – and available P) properties. The values obtained were used to regress the LUT management practices. Based on established rating scheme, the values of bulk density, Ksat, texture, soil pH, SOM and CEC values were used to determine the degradation rates (SDR) of the soil qualities in each location. The result of site characterization indicated that the LUTs were located in upland, midslope or lowland physiographic units with varying management practices. The LUTs had no effect on soil texture, being predominantly sandy loam, a reflection of similarity in lithological origin (parent material: Cretaceous sand stone). Silt/clay ratio varied spatially within the LUTs from less than unity to greater than unity, suggesting degrees of weatherability. Bulk density and Ksat values varied from low to high, suggesting light to heavy textures with high and low water permeability, respectively. Soil chemical results revealed spatial variations from one location to another and within the LUTs. Soil quality interactions with management practices were found significant at either P=0.05% or P=0.01%. The soils at Agyaragu appear to have better soil qualities, an indication of high input requirement to sustain crop production in soils of Shabu. The results of soil degradation rates showed best soil qualities in a decreasing order of pH (H_2O) (SDR = 1)> bulk density and Ksat (SDR = 2)> texture and available P (SDR = 3)> SOM, total N and CEC (SDR = 4). Best soil quality had a value of 1 and least had a value of 5 corresponding to vulnerability levels. The soils at Ayaragu are more prone to resist degradation (mean SDR = 3.0) than those of Shabu with higher vulnerability potential (mean SDR = 3.4) to degradation. Recommended management practices ranged from mulching and returning crop residues for building of carbon stocks, through early warning signals and monitoring tools for assessment of status of soils, to adoption of land evaluation decision support system (Micro-LEIS DSS) package for developing specific management strategies according to the spatial and temporal variability of soils and related resources in each particular site. The necessity is to improve agricultural land use, its planning and its management, in order to achieve a sustainable development. (E-mail: ezeakup@yahoo.com; pezeaku@ictp.it)

Characterization of the preferential water flow and contaminant transport in structured soils

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Soil structure and preferential flow is increasingly being solved subject of many scientific papers. Influence of preferential flow can not be neglected, because they severely affect transport processes in the soil, as well as the many studies undertaken by the Department of Soil Science and Soil Protection. Transport processes in soil are affected not only the pore structure, but also the composition organomineral coatings that may be present in soil aggregates. Organic-mineral complexes to aggregates formed by shifting most substances from higher layers of the soil.

Hypotheses are that a presence organomineral coating in soil structure significantly influences the movement of water and preferential flow. As a result, layered structures and generally lower porosity and lower hydraulic conductivity of coatings delays the transfer of water and dissolved substances between regions of macro pores and other pores. Preferential flow, its occurrence and intensity given by mutual hierarchy and connectivity of the macro pores can be described both experimentally and mathematically. Objectives of my research are to assess the impact of organic matter from different origins to transport processes, describe the structure and transport properties of coatings organomineral and describe the influence organomineral coatings on preferential flow both experimentally and by mathematical modeling.

Transport processes and comprehensive information on the pore environment, micro and macro scale is found using an infiltration experiment in the presence of colored tracers (Brilliant Blue FCF). After the infiltration, soils both in field and also in laboratory condition cut into thin layers (sections) are photographed. These photos will be processed by Image Analysis. Transport properties of soil will be studied both in the laboratory (soil sample volumes of 1125 cm^3) and in the field (infiltration areas of 1x1 m). Additional information on the hydraulic properties are obtained using 100-cm^3 samples in Tempe cells and using a disk Guelph permeameter in the field. Organic-mineral coatings will be examined in terms of mineralogical composition, micro morphological structure (using micro morphological images), and transport properties (sorption method). Retention curve of the aggregates with and without coatings are measured. Substantial part of the doctoral thesis is a mathematical analysis of monitored data characterizing the water or transport. Color tracers in both field and laboratory conditions. For this analysis HYDRUS-1D and HYDRUS-2/3D models are used.

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Short term effect of organic residues from bioenergy production on soil properties: implications on soil fertility and soil C sequestration

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Currently the potential threat of climate change represents one of the main environmental concerns worldwide. Amongst the measures agreed internationally and encapsulated within the Kyoto Protocol, the reduction of greenhouse gases (GHG) emissions associated with agriculture and organic waste management, and the enhancement of the C sink capacity of soils are seen to be of particular importance. Furthermore, soil organic matter fulfils several important functions in determining soil fertility such as improving its physical properties or supplying nutritional elements and enhancing their uptake. Hence, the use of organic wastes as soil amendment is a ‘‘win–win’’ strategy since, besides the direct reduction of GHG emissions associated with waste treatment or disposal, it also brings benefits related to the increase in soil organic matter.

The intensification of bioenergy production as substitute to fossil fuels has increased the production of bioenergy residues. These residues could be effectively used as soil amendments or fertilizers. However, due to the recent availability of these residues, very limited research has been done to determine how their agronomical utilization would influence soil quality. The aim of this work was to investigate the effects of different bioenergy residues and soil characteristics on C and N mineralization, element availability and microbial size and activity of amended soil and compare them to other more commonly used organic amendments.

Two alkaline soils, an agricultural soil and a degraded soil from an old iron mine, were amended (0.5% w/w) with four different bioenergy residues (anaerobic digestate, rapeseed meal, bioethanol residue, biochar) and three other organic residues commonly used as organic amendments (wastewater sludge and two composts) and incubated at 20 °C in the laboratory for 30 days. During incubation soil CO_2 evolution was measured every 4 hours by means of an automatic chromatographic system. After 2, 7 and 30 days of incubation, soil samples were analysed for K_2SO_4-extractable NO_3^-, NH_4^+ and P, microbial biomass C and five enzymatic activities (protease, β-glucosidase, arylsulfatase, alkaline and acid phosphatase).

Soil addition of the different residues led to a general increase in soil respiration, available N and P and microbial content and activity, but with remarkably different dynamics and values. The only exception was represented by biochar that did not cause any significant variation with respect to the control. According to their impact on soil properties the residues can be ranked as follows: rapeseed meal, bioethanol residue > anaerobic digestate, wastewater sludge > composts > biochar. Rapeseed meal, bioethanol and anaerobic digestate were found to be best suited as organic fertilizers, while biochar was more suited for the enhancement of soil organic matter in degraded soils and to promote soil C sequestration. This study clearly indicates that organic residues from bioenergy production may represent an effective alternative to usual amendments to improve the physical and chemical properties of amended soils and contribute to offset climate change.

Investigation of rainwater chemistry and wet deposition at the EMEP site in Armenia

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Rainwater chemistry and wet deposition study is important for discussing their possible effects on soils, surface and ground waters and planet life as well as for its interest as source of nutrients for crops.

The aim of present work is to demonstrate long-time trends of rainwater chemistry and wet depositions of major inorganic ions in samples which were collected at the EMEP (The Cooperative Programme for Monitoring and Evaluation of the long- range Transmission of Air Pollutants in Europe) site in Armenia. EMEP site is located at the representative area (in accordance with general guidelines of EMEP) for monitoring background concentrations of air pollutants in Armenia. This observation station was operated in 2008 and 93 individual rain events were recorded from September 2008 to May 2010 from which 52 events are discussed in the present work, with 325.4 mm rainfall amount.

Rainwater samples were collected using wet-only precipitation sampler and analised for major inorganic composition, viz. Cl^-, NO_3^-, SO_4^{2-}, Na^+, K^+, Mg^{2+}, Ca^{2+} and NH_4^+, including pH and conductivity. Inorganic anions, Cl^-, NO_3^-, SO_4^{2-} were measured using Ion Chromatography method. Cations, Na^+, K^+, Mg^{2+}, Ca^{2+} detection was performed using Inductively Coupled Plasma Mass Spectrometry. NH_4^+ concentrations were analysed by Spectrophotometric method, pH and conductivity of rainwater were measured by pH- and conductivity meter, respectively.

Analysis data were used for calculation Volume-Weighted Mean concentrations (VWM) and Wet Deposition (WD) of rainwater components. The Volume-Weighted Mean concentrations of ionic constituents in rainwater have been calculated using:

$$VWM\,(\mu eq.l^{-1}) = \sum_{i=1}^{N} C_i P_i \,/\, \sum_{i=1}^{N} P_i$$

where C_i is the ionic concentration for each element in μeq.l^{-1}, P_i the precipitation amount for each rainy event in mm, and N is the total number of samples. Wet Depositions (WD) during this period were calculated by multiplying VWM by the total rainfall amount and expressed in μeq.m^{-2}.

During this study period, the VWM concentrations of pH is close to 7.02 and only three acid rain events were detected with pH below to reference pH value 5.6; 5.3, 5.1 and 4.6, respectively. From this pH values it's clear that rain events aren't acidic at the EMEP site of Armenia and there isn't risk of soils acidification by transbouandary air pollutants in Armenia. Calculated value of VWM and WD of components are presented in the table. Evaluated results of VWM concentrations of rainwater components show that among the cations, Ca^+ was the most abundant ion with a mean concentration 140.04 μeq.l^{-1} and SO_4^{2-}, among the anions with VWM concentration 62.88 μeq.l^{-1}. Another ions concentrations were changed in this order $NH_4^+ > NO_3^- > Mg^{2+} > Cl^- > Na^+ > K^+$.

Calculated values of VWM and WD of rainwater components in 52 samples.

Component	Ca^{2+}	SO_4^{2-}	NH_4^+	NO_3^-	Mg^{2+}	Cl^-	Na^+	K^+
VWM (μeq.l^{-1})	140.04	62.88	59.89	30.74	16.71	13.71	12.83	9.01
WD (μeq.m^{-2})	45568	20461	19489	10001	5437	4461	4174	2933

Even though wet depositional loading caused by long-rang transmission of air pollutants in Armenia isn't acidic but it may impact on soils chemistry. Unfortunately luck of soils monitoring data doesn't allow to investigate loaded ions behavior and possible changes in soils at the present time but they should take into account for discussing possible effects on soils and vegetation.

Keywords: Rainwater; Chemical composition; Wet deposition

Soil temperatures in Australia and El Niño and Southern Oscillation

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Abstract

The current study aims at understanding the soil temperature characteristics in Australia and their relation with weather phenomenon such as Southern Oscillation Index (SOI) and the Pacific Ocean sea surface temperature index NINO 3.

Soil temperature observations from six different locations in Australia for the past ten years were used in the current study. The stations were chosen to represent the length and breadth of the Australian Continent. Melbourne from the south, Cairns from northeast, Darwin from North, Alice Springs and Orange from the central parts and Perth from the southwest were chosen to represent the spatial variations over the continent. NINO 3 anomalies and SOI data were obtained from Bureau of Meteorology archives.

Soil temperature and SOI data were normalised using the mean and standard deviation values. Time series representing the seasonal analysis were subjected to filtering by moving average method to elimination annual cycle. Seasonal and monthly analyses were carried out using the data.

Monthly variations of soil temperatures at most of the stations indicated a similar type of year to year trend. Exception to this was Perth where the soil temperatures have shown different pattern to the others. Soil temperatures at Orange station from 1976 to 2009 were presented in the time series. After removing the annual cycle, the series has shown considerable year to year variation over the period. The linear trend indicated a decrease in monthly soil temperatures. However, the past ten year period at Perth the soil temperature data has shown an increasing trend.

The relationship between soil temperatures and the SOI was studied. The main factors influencing the rate of rise and fall of the soil temperatures were the rate of absorption of solar radiation and the temperature of the air. Depending on the location, the soil temperature variations responded to the fluctuations in weather parameters such as atmospheric pressure. SOI was basically calculated using the mean sea level pressures and hence may show correlation with soil temperatures.

The temperatures have shown correlation with the SOI and ENSO indicators such as NINO 3 index (related to Pacific Sea Surface Temperature). Most of the stations have shown a positive correlation with NINO 3 index.

Most of the stations have shown a good correlation with the SOI index. The change in SOI is proportionate with the change in soil temperatures. SOI index and NINO 3 index could be used to anticipate the change in soil temperatures. Darwin and Orange soil temperatures have shown a good correlation with SOI.

The indicators such as SOI and NINO 3 have proven strengths to monitor the climate variability. The correlation studies between these variables and the soil temperatures may enhance the skills of climate predictability in general.

Use of Saline Water as A source of Irrigation Water for Broad Bean Production

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A field experiment was carried out at the fields of Kerbala province, during 2008-2009 and 2009 -2010 growing season. The aim of this study was to determine the influence of irrigation with saline water 4.7 and 7.8ds.m^{-1}for the first season and 4.3 and 7.6ds.m^{-1}for the second season and control 1.8and 1.7 ds.m^{-1} (river water) for tow season respectively assigned in the main plots on the some growth characteristics and yield of three broad bean cultivar Local cv , Luz De Otono cv and Zaina SGARAVATi assigned in the subplots .The The experiment was arranged as split–plot with in randomized complete block design RCBD. means were compared using LSD at p= 5%. Results could be summarized as follow :

Irrigation with saline water significantly reduced plant growth ,yield and its components in comparison to the control .However ,the reduction in the yield considerably increased in treatment received saline water more than 4.7ds.m^{-1}.The Luz De Otono cv and Zaina SGARAVATi gave the highest seeds yield in all treatments especially with irrigation by river water 5681 and 5406 kg/h respectively for the first season and(5977and 5942 kg/h) respectively for the second season. The highest percentage of determination of coefficient was obtained from number of pods per plant which were 93 , 89 and 50% for 1.8 , 4.7 and 7.8 ds.m^{-1} respectively for first season and 91 , 90 and 79 % respectively for second season .Soil salinity increased in all treatment received saline water .

According to the results it can be recommend to grow Luz De Otono cv and Zaina SGARAVATi and using a pods per plants as a best selection indicator for high seeds yield under saline water irrigation .In case of using saline water for irrigation should be companied by leaching requirement of river water.

Short-term tillage effects on soil aggregate distribution and fungal abundance in an arable field

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Abstract

Twenty seven intact soil cores by Kopecky ring (5 cm x 5 cm) and 27 additional samples by augering were collected at 10 cm depth from 3 different tillages; reduced tillage (RT; harrowing to 10 cm depth), no tillage (NT; harvesting only) and conventional tillage (CT; ploughing thoroughly) with 3 replications from a silt loam soil of temperate arable land to investigate soil aggregate size distribution and microbial community abundances. The land was under RT system for long time and then $1/3^{rd}$ was brought under NT and $1/3^{rd}$ under CT in the last 15 years leaving the rest $1/3^{rd}$ under RT. Soil bulk density in NT was significantly higher than in RT and CT ($p<0.05$ and $p<0.001$, respectively). Soil total pore volume (TPV) and water filled pore space (WFPS) were significantly higher in RT than in NT and CT. Smaller water-stable aggregate size (<2 mm) fractions were higher in CT than in RT ($p<0.01$) and NT ($p<0.01$) whereas the later two were identical. Aggregate mean weight diameter was significantly different in three tillages ranking as RT>NT>CT. The mean bacterial PLFA-C ranged from 0.15 in CT to 0.29 (μg g^{-1} dry soil) in RT, and fungal PLFA-C ranged from 0.02 in CT to 0.06 (μg g^{-1} dry soil) in RT. The CT tillage caused significantly lower bacterial and fungal PLFA-C than RT ($p<0.01$) and NT ($p<0.05$). The fungi: bacteria ratio was significantly higher in RT than CT ($p<0.05$) and NT ($p<0.01$). The results suggest that reduced tillage is more favourable to soil aggregation and microbial community abundance and functions.

Soil quality improvement on highly weathered dry land soils of Jaffna Peninsula, Sri Lanka.

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Soil is one of the most important natural resources available to the people of Sri Lanka. In the rural sector, agriculture is the main means of sustenance of its population (nearly 50% labour forces) and soil utilization plays a major role in their socioeconomic development. The soil and water resources of the Jaffna Peninsula are both related to the limestone geology of the land. The soils are formed on the marine deposits and sediments under the influence of sea waves and winds on limestone.

The complexity of Jaffna soils is not well understood. Few works were carried out until 1980's and there is a significant gap in our present knowledge and understanding the complexity of soils in Jaffna. Due to the difficult political and security situation in the Peninsula over the last three decades there has been no systematic research in soil management or recommendation, which results human-induced land degradation and poor soil quality in the region. The indiscriminate rates of fertilization and pesticides have lead to leaching of nitrates and heavy metals via the highly permeable soil and contamination of the groundwater (limestone aquifers) in Jaffna region. Recent investigations on groundwater chemical parameters in domestic and agricultural wells by different teams have shown that the nitrate concentrations of groundwater were greater than the threshold value given by the WHO (10 mg / l of nitrate N). The same was true for salinity levels.

During the year 2005 an attempt was made to investigate on variations in soil properties of major four agricultural potential soil series namely Inuvil, Chankani, Vaddukodai and Uppu Aru in variable landscapes at Jaffna Peninsula. The representative profile pits were formed and the soil profiles' colour plates were obtained. The four soil profiles of selected soil series were separately characterized. The infiltration rates were determined with three replicates. The bulk density, soil texture, moisture characteristics, pH, and EC measurements were carried out for major layers of four soil profiles. The top profile layers of Inuvil, Chankani, Vaddukodai and Uppu Aru soil series' available moisture content in volumetric basis were as 14.7, 18.1, 21.6 and 33.5 respectively. The first three layers of Uppu Aru seemed to be saline, the EC ranged in between 12.7 – 7.6 dS/m but the Inuvil and Chankanai series EC was within 0.01 – 0.12 dS/m. The Inuvil and Chankanai soil series showed the higher infiltration rate of 29.5cm/hr and the lowest level of 0.5cm/hr was observed in Uppu Aru soil series.

A variety of research has shown that biochar gives positive responses when applied to highly weathered soils, such as improved water holding capacity, reduced soil strength and retain applied fertilizer against leaching because of higher surface charged area of biochar. The addition of biochar in soil thus also seems to be very promising in combination with materials such as crop residues and manure or composts on soil quality improvement. This will allow higher yields with minimal external inputs, and reduce nutrient losses from permeable soils, reducing environmental pollution problems. Additionally more organic carbon will be sequestered in soil.

For the forthcoming research study, the biochar will be produced from three types of locally available organic materials, namely rice husk, coconut nutshells and Palmyra nutshells (*Borassus flabellifer L.*) at Jaffna. The addition of biochar with organic amendments on highly weathered Jaffna soils may enhances the overall soil quality and fertility. This will investigated with following treatment combinations: control treatment, combination of mineral fertilizer and organic manures, combination of mineral fertilizer and biochar, combination of organic manures and biochar under pot experiment.

EFFECT OF SALINITY AND SODICITY ON CROP PRODUCTION ATKOTKASHMIR (LAKKI MARWAT)

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Field study conducted to evaluate the effect of salinity and water logging on crop production and cropping pattern and soil properties at Kot kashmir which is the worst effected unit of Bannu SCARP programme, Pakistan.The study was conducted with this purpose to launch some reclaimatory and Biosaline approaches in this worst zone for better crop management, production and to increase the irrigation economy of marginal farmers. The other purpose of study in hand is to assess the actual situation regarding soil salinity, sodicity, infiltration rate, hydraulic conductivity and soil texture of the soil and their impact on crop production and cropping pattern in the study area of Bannu SCARP . Self study was conducted by dividing the study area into three sub units, i.e, head, middle and tail sectors of study area in order to see the changes in salinity ,soil texture ,hydraulic conductivity, infiltration rate and sodicity on associated cropping pattern and crop production. In this study farmers of each sectors were questioned through questionnaire proforma and collected their socio-economic data and collected information on adverse impact of the above mentioned parameters on their agrarian economy. fifteen Composite soil samples were collected five from each sub unit through auger.. The samples were collected from representative field in each unit coupled with physical appearance and conditions of fields. The collected samples were taken to the laboratory in plastic bags and were over dried , After drying the samples were crushed and passed through 2mm sieve and stored for analysis for EC and SAR and determining soil texture in the labortatory.. The water samples were collected in glass bottles from selected tube wells and canals. similarly infiltration test and hydraulic conductivity test were conducted in each field to observe the infiltration rate and under ground water movement using double ring infiltrometer and auger hole method. Statistical trend analysis and coefficient of determination were used in the study. The results concluded were, ECe of top 0-30 cm soil layer was in the range of 3.5 to 11 dS/m .Similarly SARe values ranged from 7.53 to 24.15. Majority of the soil samples were in the category of saline and saline-sodic soils. Five fields were non-saline, six saline and four saline-sodic. The highest watermelon and maize % cropped areas were at the lowest soil salinity of 3.5 dS m-1. Wheat area increased with decreasing trend in soil salinity. Rabi season fallow area increased with rising

trend in soil salinity with ECe as high as 11 dS m-1 and the lowest (7%) at ECe 3.5 dS m-1. Fields with higher soil salinity levels (>10 dS m-1) were found 100 % fallow in Kharif season. The maize and watermelon production dropped sharply beyond soil salinity of 4.6 dS m-1. The wheat yield decreased about 35 % at soil salinity of 11dS m-1. Wheat yield potential of the high saline soils was about 65%. The very low (< 2.5mm hr-1) and low infiltration rates (2.5-12.5 mm hr-1) were noted for the saline–sodic fields. It had negative correlation with increase in % clay and % silt and positive correlation with % sand in the soil. The steady state infiltration rate of well-managed fields was higher than badly managed fields. Similarly inverse correlation existed between hydraulic conductivity and high silt content as well as depth to water table. Salinity levels of water samples collected from tube wells and canal showed that these were in permissible range except saline ground water of two fields with shallow water table depths. The study is importance in the sense the thee problems seventy % of agriculture production and estimation of these parameters will be helpful for progressive farmers to decide about crop grown, its leaching requirements if any and other precautionary measures and interventions may be taken for further improvement of soil and water quality and maximum production per unit of water and land holding.

Groundwater study of a subtropical small-scale wetland

(GaMampa wetland, Mohlapetsi River catchment,
Olifants River basin, South Africa)

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Abstract. Wetlands are unique ecosystems because of their hydrological conditions and high biodiversity. They are therefore highly vulnerable towards unsustainable environmental pressures affecting their ability to provide ecological and hydrological functions as well as livelihood functions to support local livelihood. The GaMampa wetland at the Mohlapetsi River in the Olifants River basin in South Africa faces the pressures of drainage, desiccation and subsequent decrease of natural vegetation due to increasing agriculture. The local farmers have been forced to intensify the cultivation in the wetland to compensate their loss in crop production. Activities in the wetland have an impact on the hydrological and ecological functions, in particular on the groundwater of the GaMampa wetland. For this reason the groundwater state from November 2005 to July 2007 of the GaMampa wetland is analysed based on groundwater level monitoring of piezometers. Seasonal groundwater tables and groundwater flow patterns are generated in ArcView GIS by applying different interpolation methods to evaluate their verification. The interaction between the groundwater of the surrounding catchment, the groundwater of the wetland and the Mohlapetsi River flow is captured by a simple water balance approach. The potential seasonal groundwater discharge capacity from the wetland contributing the Mohlapetsi River flow is determined by the highly variable soil hydraulic properties and the predominant shallow hydraulic gradient of the groundwater. Consequently, it is subjected to be marginal and thus localized groundwater inflow from a deeper groundwater aquifer is most probably the main contributor of the Mohlapetsi River. In the view of achieving sustainable and ecological management a conceptual approach of an ecological performance indicator (EPI) is established to be implemented in a sustainable management tool. Therefore the hydrological processes in particular the groundwater level are linked to the vegetation distribution and patterns of the wetland. Such a management tool is necessary to achieve a trade off between supporting the local livelihood to cover current and future food demand by the livelihood functions of the wetland while maintaining its ecological state and functional capability.

MODERN TECHNOLOGIES OF MONITORING AND FORECASTING ON LANDS OF THE AGRICULTURAL PURPOSE IN CONDITION LIMITED RESOURCE

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Both soil reaction (pH-value) and content of available forms of phosphorus and potassium in the soil belong to the basic agrochemical parameters, which markedly influence the soil fertility. The largeness of the fields, the number of soil samples taken from one field and the relief of landscape has the meaning effect on the results that the farmers receive. Especially in hilly country where the relief and slope of the fields are very heterogeneous inside of very small area there is necessary to consider the variability of mentioned soil parameters. Thanks to the application of the uniform rations of fertilizers for the whole field it is coming to the increasing of these soil parameters variability.

From both economical and ecological point of view the fertilizers should be applied only on those areas of the field, which requires such a measure. This is especially actual on large fields with great spatial variability of basic soil chemical parameters. The system of farming that works on the principle of geographical information system (GIS) and is mostly known as „precision farming and/or agriculture“ is the solution of this problem.

The research was made on 11-hectares field in the north-eastern part of the Ukraine. The spatial variability of the soil pH-value, content of available forms of phosphorus and potassium and of the winter wheat yield were observed. The soil samples were taken from the places that are 50 m away from each other.

The extraordinary high spatial variability of mentioned chemical soil parameters has a great influence on the unevenness of growing plants yield obtained. The winter wheat yield ranges in the interval from 2,60 to 3,28 tons per hectare. When compare with the minimal yield found, the maximal one is by 26 % higher. There is an assumption that such differences within relatively small field will increase in larger areas and also when growing various plants the differences in the yields will be more distinct.

The available phosphorus content in the soil ranges from the 2 to 52 mg per kg of soil, available potassium content ranges between 58 and 166 mg per kg of soil. For both nutrients it means that their supply in the soil is on the one side in the category of very low content (the minimal values), on the other side in the category of middle content (the maximal found values). The content of mentioned nutrients occurs in three categories of nutrient supply.

The soil pH-value occurs even in four categories of classification – from extremely acid (pH less than 4,5) to low acid (pH from 5,6 to 6,5).

The highest coefficient of variation was found for the content of available phosphorus (37,37 %), whereby that for the soil pH-value has reached 7,43 % and for the winter wheat yield - only 5,41 %. It indicates an extraordinary high variability of phosphorus content in the soil. The high significant correlation between winter wheat yield and soil pH value (r=0,645) and between winter wheat grain yield and content of available phosphorus in the soil (r=0,588) was found. The significant correlation between winter wheat yield and content of available potassium was not found.

The significant correlation between soil pH-value and phosphorus content in the soil was not found, although it is generally accepted that with low soil pH-value the content of available forms of phosphorus in the soil should also be lower.

The economisation of inputs into the soil is one of the most urgent necessities of present agricultural production. On the base of finding of basic chemical soil properties spatial variability it is possible to apply the lime and mineral fertilizers only where the growing plants require them the most, and in the case of high nutrient content in soil the fertilization should be skipped to avoid the excessive nutrient uptake. It has an extraordinary meaning in present conception of both soil and whole environment protection.

SURFACE RUNOFF GENERATION UNDER DIFFERENT LAND USES IN A MEDITERRANEAN MOUNTAIN CATCHMENT.

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Abstract.

A study was conducted at Ribera Salada Catchment, on the Pre-Pyrenean Mountains in Catalonia (NE Spain). The catchment covers an area of 222.5 km^2, which is being affected by an abandonment of agriculture since the 1950_s, with a replacement of pastures and tillage by forests. This dynamic change is typical for all Spanish mountainous areas. Currently the predominant land use is forestry (oak and pine), from brook forest to sub-alpine and sub-Mediterranean vegetation. Agriculture consists of potatoes, alfalfa and cereal with a low level of nitrogen fertilization and high mountain grasslands with low technologic level and low trampling. The aim of this study is to determine the components of soil water fluxes under different land uses, specially the runoff generation. Over an eleven year period (1999-2008) for soil moisture and a five-year period (2004-2008) for infiltration, runoff and percolation were monitored in seven plots under different combinations of land uses and soil types on a mountainside. Field monitoring consisted of precipitation and ET measurements, surface and subsurface water collection with runoff boxes and open lysimeters, continuous soil water measurement with capacitance probes, throughfall pluviometers and stem flow rings. During the 5 years of study (2004 - 2008) the annual precipitation fluctuated between 445 and 922 mm. The results obtained showed that surface runoff ranged between 0.24 - 1.21 % of the total rainfall. The infiltration depended on the cover type, being from 48 % - 99 % of the total rainfall. The drainage water constitutes 11 - 77 % of the total infiltration water, and 6 – 43 % of the total rainfall. The maximum and minimum interception values for a rain event during the studied period were: *Quercus ilex* 26.4% - 43.8 %, *Pinus nigra* 6.5% - 60.5%, *Pinus sylvestris* 31.2% - 72.3 % and brook forest 17.8% - 72.3 % of total rain. Moreover, soil water content had two dry and wet peaks of soil moisture throughout the year. The results obtained showed that the largest part of the inputs goes to infiltration, evapotranspiration, interception and drainage (in order of importance). The surface runoff values are very low and therefore their influence in the water balance have low signification. Regarding soil moisture, we conclude that this is an important reference parameter, having in most of the cases values closer to wilting point in the central part of the catchment, that increase until intermediate moisture condition in higher altitudes. This study also shows that the net change in soil water (ΔSW) is low during most part of the year, reaching critical values in the dry months. Soil moisture recharge occurs only partially during the wet season and the depletion water that is not sufficiently replenished by precipitation contributions. This is especially important in Mediterranean mountain zones, where slight changes in rainfall or temperature can cause changes in the soil water balance and increase the annual soil water deficit.

Keywords: Rainfall, Infiltration, Soil moisture, Runoff, Water balance.

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Analysis of water movement in soils under no tillage management in Argentina

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Worldwide, no tillage (NT) area has been increasing continuously in the last few years. Currently this soil management system occupies 1,000,000 km^2 of the global area with one-half of it located in South America. In Argentina, 200,000 km^2 (about 70% of the entire cultivated area of the country) is under NT. The massive application of this management practice was carried out without carefully evaluating its impacts on soils. Surface laminar structure, a potential impediment for water entry into soils, has been reported in soils under NT by some authors. Anisotropy of saturated hydraulic conductivity (Ks) is generally due to the structure of the soil, which may be laminar or platy thus exhibiting a pattern of macropores with a distinct directional bias. Some authors have studied Ks anisotropy in soils with different results. In this research, we examined Ks anisotropy in a silty loam typic Argiudoll under conservation and no-till treatments by taking laboratory measurements of samples extracted from the field at different depths (0-15 cm and 15-30 cm) in vertical (Ksv) and horizontal (Ksh) directions. The studied plots had a history of seven years under the treatments. The climate in the region is temperate (the temperature seldom goes below 0 ºC) and the approximate annual rainfall amounts to 1,100 mm. The experimental design was completely randomized, with two treatments: (a) no tillage (NT), (b) conservation tillage (CT), where a yearly loosening practice was carried out. In CT a wheel-mounted eight blades machine for working with hydraulic rear lift system was used. It worked the soil down to about 0.30 m into small fragments without major modifications of the natural structure thus keeping the mulch on the surface. Weeds were controlled with Gliphosate in both treatments. Inspection of soil structure in the field revealed the presence of horizontally oriented platy aggregates in the first cm in both treatments. For both treatments, Ks was anisotropic at the soil surface (0-15 cm) with values of horizontal Ks larger than those of vertical Ks (NT, Ksv: 1.03±0.56 $cm.h^{-1}$, Ksh: 7.39±4.07 $cm.h^{-1}$; CT, Ksv: 1.98±1.31 $cm.h^{-1}$, Ksh: 9.48±5.77 $cm.h^{-1}$). Below the soil surface (15-30 cm) in both treatments, Ks was isotropic (NT, Ksv: 1.38±0.67 $cm.h^{-1}$, Ksh: 1.71±0.68 $cm.h^{-1}$; CT, Ksv: 1.07±0.70, Ksh: 0.51±0.27). Soil surface laminar structure was observed in field, and quantitatively verified by smaller vertical Ks values.

Interactive effects of rising temperature and lowering moisture on soil water chemistry: An experimental growth-chamber approach

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Climate change and its consequences has become a topical issue in recent years. In this context, while it is recognized the importance of soil-mediated responses to global climate change, the nature and magnitude of these responses are not well understood.
Below-ground processes play a key role in the global carbon (C) cycle because they regulate storage of large quantities of C (Pendall et al., 2004; Ryan and Law, 2005). Soil organic matter is the second biggest carbon pool in the planet after the oceans, and below-ground processes regulate fluxes to the atmosphere that are approximately 10 times the current anthropogenic CO2 loading rate (Chapin et al., 2002). Soil processes include C allocation below-ground via roots; microbial and mycorrhizal processes; SOM pool sizes and turnover rates; and soil microbial and rhizosphere respiration rates (Pendall et al., 2008). All have distinct responses to environmental change drivers, although availability of C substrates will regulate all the responses (Pendall et al., 2004).
Increasing evidence has shown that climate change components (e.g., elevated CO_2, O_3 and reactive N inputs) can significantly alter rhizosphere processes through modifying root and microbial growth and below-ground allocation of carbon (Paterson *et al*. 1997; Zhang *et al*. 2005). The resulting changes in rhizosphere physiochemical environments may affect the displacement, and/or bioavailability of nutrients. The magnitude, trend and long-term implications of climate change effects on soil cations are not well documented and neither the underlying mechanisms.
We examined during a year period the dynamics of soil cations and anions of intact soil cores after experimental warming and decreased precipitation using growth chamber facilities.
Ten undisturbed soil columns were extracted from two experimental field stations (La Concordia: 39º 41'N; 0º 25' O and Porta-Coeli: 39º 45' N; 0º 43' O). These are two permanent field stations placed near Valencia (East Spain). To study the effects of warming and drought, cores were incubated under two environmentally-controlled conditions. One chamber was kept with current climatic Mediterranean conditions (control) and the other with altered climatic conditions. In the forced conditions average air temperature was raised 3 ºC; relative humidity was lowered by 15% and irrigation was reduced by 10%. Within each chamber, pots were assigned to two treatments: a plant-free treatment; and a plant treatment where each pot was maintained with 3 seedlings of *Pistacia lentiscus* L. The systems were irrigated regularly to collect leachate through the bottom of the pots. This simulates the natural processes of movement of nutrients and fine humus through the soil profile in the tubes. Leachate samples were analyzed for pH, alkalinity and conductivity. Soluble cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} and NH_4^{+}) and anions (Cl^{-}, NO_2^{-}, NO_3^{-} and SO_4^{2-}) were analyzed by ion chromatography.

Chemical balances of individual cations were evaluated. In the case for planted pots where warming and drought conditions were simulated, cations such as Na^{+} and Ca^{2+} increased their concentration in the leachate. Nitrates where easily leached at the beginning of the experiment but lately leachate concentration was stabilized. On the contrary, sulphates showed a steady trend to increase. This results in a progressive increase of soil salinity during the experimental period. Moreover, some soil physical properties were also altered as it was shown by leachate outflow values.

Our results showed the interconnections of some soil properties (soil structure, hydraulic properties and cation exchange capacity) as affected by climate induced changes. They also showed the sensitivity of soil structure in the planted pots to humidity and temperature variations.

THE SOIL DEGARADATION AND DESERTIFICATION IN THE CENTRAL SOUTHERN OF VIETNAM

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Desertification is "*land degradation (= soil loss productivity) in arid, semiarid and dry sub-humid areas due to various factors, including climatic variations and human activities*" (UNCCD). According to the geo-synthesize, the soil degradation and desertification are resulting from the loss of the ecological balance by the natural processes and socio-economical activities, and the soil degradation is main cause of desertification in these areas.

In the Central Southern of Vietnam, the conditions of soil form are upon the monsoon of the tropical climate with the dry reason has 6-9 months, in some areas the dry reason have 8-9 months as the same the characteristic of the semi-arid area. The total area of the region is about 45000 km^2, including 65,000 ha of the upland; and 265,000 ha of sand-dune and sand beach. Its soil layer structure is complicated and has 10 soil groups with 20 types.

The cause and process of the soil degradation are high and strong in everywhere in the Central Southern of Vietnam; however, the dominant types are upon the climate and the soil cover characteristics. Such as, the erode soil is cause of the run-off is developing in the sloppy area, the soil degradation are cause of the wind is appearing in the coastal sandy area, the salt soil is encroaching in the coastal area and the laterization is expanding in the up-land etc. According to our research, the average of the soil loss is ranging from 400-800 ton/ha per year by run-off, even it is up to 1,000 ton/ha per year in some place. So that, the thick of soil layer is below 30cm that are approach 48% of the up-land and the light soil is cover 30% of the lowland. Consequently, the soil capacity hold water is decrease, so desertification is increase in this region.

According to the classification of the UNCCD and UNDP, the Central Southern of Vietnam can be divided into 4 types of desertification, as following:

- Sandy desertification: this type is occupied about of 260,000 ha, and it is concentrated in Binh Thuan, Ninh Thuan and Binh Dinh provinces;
- Rocky/Stone desertification: This type has about of 100,000 ha; it is distributed in Quang Ngai, Binh Dinh, Khanh Hoa, Ninh Thuan and Binh Thuan provinces;
- Dust desertifation: this type is appropriate 290,000 ha. It is developed in the infertile land with gray soil or erode are with high gravel coverage in the soil. They are distributed along the foot of the Truong Son mountain chain to near the coastal line, range from Quang Ngai to Binh Thuan provinces;
- Salt desertification: It is about of 49,000 ha and concentrated in Ninh Thuan and Binh Thuan provinces.

The characteristics of the distribution of the desertification are created two the desertification bands, one is along the coastal line and other is lied in the foot of the Truong Son mountain chain. The trend of the soil degradation and desertification are quicker, stronger and spreading out. Vietnamese government should be built the suitable action and strategic plans to mitigation soil degradation and control desertification in the Central Southern of Vietnam.

DEVELOPMENT OF EARLY WARNING SYSTEM FOR SOIL QUALITY CHANGES UNDER TROPICAL CONDITIONS

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Using a range of environmental data describing climate, soil, biotic and contemporary land use conditions, the research seeks to develop a model of soil quality which has sufficient sensitivity to provide a warning of potential rapid decline in soil quality. The study will require field data together with regionally recorded climatic and soil data and will seek to utilize established models such as DSSAT, CENTURY, IPCC-Soil Carbon Tool, Soil Par and Soil Water Characteristics. The major goal is to develop an early warning tool that shall be used to monitor changes in soil quality as a result of climate and land use change. The methods include the inventory of soil quality indicators in five selected ecosystems as they change from tropical rainforest (benchmark) to savannah, wetland, arable or perennial farming systems. The change in ecosystem is based on changes in soil carbon stocks as the land cover and land use changes from native ecosystem/soil type. Within specified class limits, ten years of regionally recorded (day-to-day, month-to-month and year-to-year) weather data shall be observed and analyzed for values correlated with changes in land use, land cover, soil carbon and soil type. Climatic indicators to be used shall include rainfall, temperature, relative humidity, solar radiation and pan evaporation. To establish soil quality at any particular time, five groups of indicators shall be integrated – visual, climatic, physical, chemical and biological. For each group, at least four easy-to-measure parameters are selected for quantification. The soil quality indicators will be analyzed in the laboratory using routine soil-quality methods of SQI-USDA. The parameters will be monitored for the two tropical seasons, wet and dry. The results so collected will be incorporated into models and simulated from -50 to 100 years (i.e., one lifespan) to predict changes from those parameters which are most important. Based on published class limits and simulated outputs, new tropical soil quality indices/equations shall be established. Using these new soil quality indices, and established minimum and maximum tolerable limits, an Early Warning System (model) shall be developed. After its development, a computer program could emanate a warning of impending dangerous changes in soil quality analogous to the function of indicators on the dashboard of a car for its proper use and management. The Early Warning System is envisioned as a valuable tool to sustain land management in Nigeria as well as in other tropical environments.

Assessment of the suitability of anthill soil as earthen water reservoir lining material

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Abstract
This paper reports the investigation of the suitability of anthill soil for lining earthen water reservoir and small pond. Samples of anthill soils and adjoining soils collected with shovel/digger and auger respectively from the Southern, Middle and Northern zones of Southwestern Nigeria were subjected to laboratory analysis. The specific gravity (measured with density bottle system) of anthill soil averaged 2.13 kg/m^3 as against that of adjoining natural soil of 2.15 kg/m^3, while the sieve analysis showed that 82 % of the anthill soil and 74 % respectively concentrated at the low particle size zone. The consistency analysis showed the average liquid limit values for anthill and adjoining natural soils were 36.4 and 43.8 respectively. The permeability (measured with falling head permeability instrument) of the anthill soil and adjoining soil were 0.174 and 0.80 respectively. The work concluded that the anthill soil had higher bulk density and lower permeability than the adjoining soil. It therefore inferred that anthill soil will be suitable for lining earthen reservoir and small pond. The measured parameters for the different zones showed that the Southern zone had higher value of 2.17 kg/m^3 bulk density whereas the sample from the hinterland had 2.09 kg/m^3 specific gravity. The liquid limit similarly showed that the sample gotten from Southern zone was 31.7 while that from the hinterland was 41.0. The permeability test for the samples from the southern zone was 0.176 while that from the hinterland was 0.171. The results showed that the characteristics of anthill soil can be influenced by temperature and hence by extension, climate change.

Keywords: Anthill soil, Consistency limit, climate change, earthen reservoir, triaxial analysis

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ESTIMATION OF ABOVE AND BELOW GROUND CARBON STOCKS IN SELECTED LANDUSE PATTERNS IN MT. MARSABIT ECOSYSTEM

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Intensified agricultural practices lead to a reduction in ecosystems carbon stocks. This is mainly due to removal of aboveground biomass as harvest with subsequent burning and/or decomposition and loss of soil carbon as carbon dioxide and soil through erosion. The effects of forest conversion and subsequent cultivation on carbon stocks and soil properties were monitored in demarcated land use types along transects in Mt. Marsabit ecosystem. The main objective of this study was to develop a practical understanding of the impact of deforestation and the mitigation measures being put in place on soil properties with emphasis on carbon stocks.

Two hundred and twenty two soil samples were augured from the 0-20 cm and 20-50 cm depths. Four hundred and twenty seven soil samples were obtained using core rings in soil profiles laid in each land use type, to a depth of 150 cm at 5 cm intervals. The soil samples were used to estimate the belowground carbon. The collection of litter was done at 90 points using a 0.5×0.5 m quadrant. The litter was dried and weighed as part of the aboveground carbon. The diameter at breast height (DBH) was measured from 161 trees selected randomly in the forest for use in calculating the standing aboveground carbon.

The carbon stocks declined by 47.4% and 45.6% in cropped and pastureland sites relative to the forest site. Belowground carbon tended to be almost constant at 100 cm forest, 80 cm in pasture land and 60 cm in cropped land probably because soil carbon contents generally decrease with depth, as organic inputs are primarily deposited on the soil surface or occur in the topsoil where most of the turnover of fine roots occurs. In general, however, decomposition processes were slower down the soil profile and the carbon stocks that existed below the topsoil were better protected from physical disturbance by vegetation roots and they were likely to change more slowly after land use change. Also, the rooting system of the trees in the forest was dense compared to the bushes in the pastureland and the crops in the cropped land use systems.

PROPERTIES OF SOILS DERIVED FROM DIFFERENT PARENT MATERIALS IN THE STOLOWE MOUNTAINS NATIONAL PARK

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KEY WORDS: parent rocks, The Stolowe Mountains National Park, forest and mountain soils

ABSTRACT

The Stolowe Moutains National Park (SW, Poland) is one of the most interesting areas in Poland. It was established in 1993 and is protected with regard to virtues of inanimate nature. Its amazing geological structure and relief are its attributes.
In the small area there are soils derived from different parent rocks. These rocks are: granites, marls and sandstones with different genesis. Different parent materials had and have significant influence on formation of properties of investigated soils.
Most of soils belongs to Cambisols or Podzols.
The aim of research is trial of comparison of soil properties and clay minerals composition between soils derived from different parent rocks and their complex assessment in terms of vulnerability on weathering processes. Analysis of actual soil properties in chosen points in the Stolowe Mountains National Park will give us interesting information about directions of changes physical and physicochemical properties of soils in dependence on parent rock.
The main reasons of investigations are the presence of uncompleted publications about soils made from different parent rocks in the Stolowe Mountains National Park region, the lack of assessment of influence of parent rock on development of soil properties in Stolowe Mountains and unfinished soil examinations in investigated region.
Research involved soils of the Stolowe Moutains National Park (PNGS) derived from wastes of different parent materials. The fundamental elements of geological structure of PNGS are sedimentary rocks which are localized in central part of this region and occur in two forms (sandstones and marls). Granite occur in the south-west part of investigated area and conglomerates appear in the north-east part of park.
The selection of localization of samples collecting was based on geological maps of the Stolowe Mountains National Park. Soil samples were taken from all horizons to laboratory analyzes. Basic physical, physicochemical (A) and chemical (B) properties are determined in the collected soil samples as well as mineralogical composition of <0.002mm fraction (C).
A. Physical and physicochemical properties:
- Soil texture by Bouyoucos' method in Casagrande and Prószyński's modification;
- Soil reaction in water and KCl.

B. Chemical properties:
- Sorption properties of soil profiles;
- Hydrolytic acidity by Kappen's method;
- Exchangeable acidity and aluminum by Sokolow's metod;
- Content of macroelements in soil profiles;
- Content of organic carbon and nitrogen total, C:N ratio.

C. Mineralogical composition of <0.002mm fraction by XRD method.
In selected objects there was determined thickness of soil horizons and there was prepared floristic records.
The first results of our investigation indicate that analyzed forest soils have a lot of common attributes and their parent rocks influenced on their physical, physicochemical and chemical properties.
We can conclude that in this area the bigger amount of soil samples is characterized by texture of sands, what is caused by character of dominating parent materials (sedimentary rocks- sandstones) and its weathering. These soils are characterized by low soil reaction and slight content of macroelements. All of investigated soils belong to acid or very acid soils and have high exchangeable and hydrolytic acidity. ECEC is very low as well as nitrogen total content and organic carbon.

Assessment of susceptibility to mass erosion by logistic regression and Bayesian networks in mountainous landscapes of north-central Venezuela

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Abstract

Mass erosion is the result of the interaction between intrinsic variables and activating ones. The spatial variation of the intrinsic variables determines the geographic distribution of the susceptibility to mass erosion. In this study, an inventory of mass-erosion scars (214 mass-erosion scars observed on the aerial photographs and subsequently validated in the field) was compared with thematic maps of intrinsic variables, to infer susceptible areas to mass erosion at the Caramacate River watershed in Venezuela. The intrinsic variables included: a) categorical variables derived from the geomorphologic map, like litho-geomorphologic units and the types of relief (ridges or hillsides); b) morphometric variables computed from the DEM including: altitude (m), slope gradient (m/m), slope aspect (radians), profile curvature (m/m^2), plane curvature (m/m^2), curvagrid or land form (relation between the plane of curvature and profile curvature), catchment area (local upslope area in m^2 draining to each specific cell), and the topographic wetness index computed as ln(As/tan β) where As is the catchment area and tan β is the local slope in degrees; c) distance to the drainage network obtained from de DEM by generating contour lines every 50 meters from every drain line; d) vegetation cover and the normalized difference of vegetation index (NDVI) determined from the satellite image. Logistic regression and Bayesian networks were applied to relate the intrinsic variables to susceptibility to mass erosion. The logistic regression produced the following equation with a 80.8 % prediction power: $\hat{g}(EM) = -17.788 - 0.238(CD) - 0.015(RD) + 0.15(IH) - 13.353(NDVI) - 2.367(FT_{(1)}) - 21.857(FT_{(2)}) + 21.39(N5_{(1)}) + 19.958(N5_{(2)}) + 21.768(N5_{(3)})$ where CD = curvagrid or slope form, RD = distance to the drainage network, IH= topographic wetness index, NDVI = normalized difference vegetation index. $FT_{(1)}$, $FT_{(2)}$ y $N5_{(1)}$, $N5_{(2)}$ y $N5_{(3)}$ correspond to codes of the categorical variables N5 (litho-geomorphologic unit) and FT (type of relief). The occurrence of mass erosion decreases as the values of CD, RD, and NDVI increase and the value of IH diminishes. For the discrete variables the regression model indicates that the occurrence of mass erosion is higher in the litho-geomorphologic unit “Metatobas of El Chino - El Caño” (N54) and in the hillsides (FT3). The Bayesian network model with the highest prediction power uses the variable FT fixed as the root node. The probability of mass erosion is higher near the drain lines (<50 m) on the hillsides of the litho-geomorphologic unit “Metatobas de El Chino - El Caño”. The logistic regression correctly classified 80% of the observed values in the validation data set while the Bayesian network correctly classified 87.5% of those values. Both the logistic regression model and the Bayesian network showed that in the study area, the attributes most associated with the occurrence of mass erosion are: the land shape or curvagrid, the distance to drain lines, the topographic wetness index, the NDVI (as an indicator of vegetation cover), the type of relief and the litho-geomorphologic unit. The results obtained from the application of both techniques are complementary. The Bayesian network model showed more clearly the interaction between the intrinsic variables related to mass erosion; while the results of the logistic regression model can represent the spatial distribution of the susceptibility to mass erosion. Overall, the study area shows a high or very high susceptibility to mass erosion.

Key Words
Geographic information system, factors of instability, maximum likelihood analysis, WEKA

Evaluation of the spatial variability of beryllium-7 fallout in Piracicaba-SP, Brazil

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The cosmogênic radionuclide beryllium-7 (^{7}Be) is produced in the atmosphere by cosmic particles reactions and it is being used as a tracer in soil erosion and climatic process research. After the production, ^{7}Be bonds to aerosols particles in the atmosphere and is deposited in the soil surface with the other existing species of radionuclides by rainfall. ^{7}Be has little translocation in the soil profile, presenting the highest concentration in the most superficial soil layer (of about 2 mm). Because of the good connection with soil particles this radionuclide participate of the erosion process and can be used as a tracer to evaluate the sediment transport that occur during single rain events, especially in sheet soil erosion and sediment redistribution studies. A key assumption for the erosion evaluation through this radiotracer is the uniformity of the spatial distribution of the ^{7}Be fallout. The uniformity of ^{7}Be deposition is fundamental for the method validation and would be evaluated for different study areas. The variability of the climatic process according to the geographic position can be responsible for big changes in the formation and movement of ^{7}Be atoms from atmosphere to soil surface. Therefore ^{7}Be fallout homogeneity must be taken as a hypothesis which has to be checked before the application of the methodology. The main objective of this study is to evaluate the ^{7}Be spatial distribution with direct measurements of its concentration in rain water in twelve collecting points distributed in an experimental area of about 590 m² located at the São Paulo University Campus in Piracicaba. ^{7}Be concentration in some prepared soil samples will be occasionally determined for specific rain events in nine positions of the experimental plot in order to compare with the ^{7}Be concentrations observed in the water from the rain collectors. The ^{7}Be activity is being determined by a gamma-ray spectrometer with 53% of relative efficiency. The preliminary ^{7}Be concentrations determined in rain water in 2010 presented values ranging from 0.41 to 0.81 Bq/L for an autumn rain event and from 0.77 to 1.38 Bq/L for a summer ending event. These values are considered low when compared with a single rain event of middle summer which presented 4.45 Bq/L. Further determinations of rain water ^{7}Be concentrations are still necessary for summer and spring wet seasons in order to better evaluate the ^{7}Be fallout spatial variability distribution. This is the first ^{7}Be study in São Paulo state and the results related to the amount of ^{7}Be deposited and deposition uniformity will give support for future studies using the ^{7}Be technique in the region.

Key Words: ^{7}Be fallout, soil redistribution, cosmogênic radionuclide.

Growth and carbon storage of three young timber species in the Yungas of Bolivia

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Nowadays all the world is worried for the climatic change which is present in all the ecosystems around the world. The ecosystems are being destroyed little by little as a result of global change. One way to mitigate those changes around the world is through atmosphere carbon sequestering by afforestations and reforestations. As a consequence of the utterances mentioned above the present investigation has the following objective: Growth determination and carbon sequestering in three timber species. The work was realized into the "Siempre Unidos" Colony, "Carrasco la Reserva" *Canton,* which belongs to "Caranavi" Province, La Paz region (Bolivia). I have worked with three young timber species: Mahogany (*Swietenia macrophylla*), Cedar (*Cedrela fissilis*) and Oak (*Amburana cearensis*); it was applied a random design with 8 repetitions; in order to obtain the biomass of the species data was analyzed through minimal square analysis according to the most known mathematical model that is used in biomass measures which have a potential function: $M = a D^b$. On the last measure (November 2009) three species grew with an average in terms of height of 5.34 ± 0.56 m in mahogany, cedar have reached an average of 4.31 ± 0.23 m and oak 5.29 ± 0.78 m; in terms of DBH (diameter at breast height) cedar have reached an average of 4.63 ± 0.84 cm, mahogany a value of 4.33 ± 0.63 cm and oak have reached an average of 4.17 ± 0.69 cm. The three timber species have sequetered carbon that is similar statistically at the age of 4 years, cedar (*Cedrela fissilis*) sequestered an average bigger than the other two dicotyledonous, obtaining a value of 2.31 kg C, mahogany (*Swietenia macrophylla*) and oak (*Amburana cearensis*) resulted in 2.02 and 1.90 kg C per plant respectively. In general forests are a worldwide reservoir of carbon, so it is important to evaluate the dynamics of carbon as a system, taking into account all the elements into the system. Another important element into the forest is the soil, because universally it contains approximately two third of total carbon stored in vegetation (Argyro et al 2005).

Estimation of soil hydraulic properties through pedotransfer function approach and its applications in various landscape scale

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Abstract

Accurate assessment of the soil water regime is an important step in making water management decisions at various landscape scales. Most hydrological models and solute transport models require soil hydraulic properties as critical inputs, which are not always readily available at the desired scale. Two major soil hydraulic properties are the water retention characteristic (relationship between volumetric water content, θ and matric potential head, *h*) and hydraulic conductivity. Direct measurement of hydraulic properties at multiple locations even within an agricultural field is time-consuming and costly. An alternative is the indirect estimation of soil hydraulic properties using the pedotransfer functions (PTFs), which relate hydraulic properties to more easily measurable soil properties. We developed a set of Point PTF for K_s and parametric PTFs for the parameters of van Genuchten water retention model from a limited number of soils collected from a hilly watershed located in the Western Catchment of the Chilika Lake, Orissa, India. All these three PTFs showed the best performance or similar performance to established PTFs when applied to external soils databases. Significantly, it was also showed that robust PTFs may be developed from a limited number of soil samples provided there is sufficient variability in soil properties. Over the last two decades, several studies have demonstrated that basic soil properties of surface soils may be rapidly estimated by measuring soil spectral reflectance. Therefore, we also evaluated a PTF approach to use proximal spectral reflectance over the visible, near-infrared, and shortwaveinfrared (VIS-NIR-SWIR) region (350-2500 nm) as predictor variable in place of basic soil properties. These new transfer functions are called spectrotransfer functions (STF). The performance of the STFs indicated that the proximal spectral reflectance of soil may be used for rapid estimation of soil hydraulic properties in a large area with accuracy comparable to PTFs. Spatial distribution of water content at field capacity (FC) and permanent wilting point (PWP) at different zones of a farm governs the available water for plant growth. Suitable PTFs were utilized to generate the map of water content at FC and PWP of an agricultural farm through coupling regression based PTFs with prepared surface map of basic soil properties. Evaluation of flow and transport processes in a watershed-scale requires that the watershed be divided into homogenous spatial units referred to as hydrologically similar units (HSU). We developed a fuzzy inference system to classify saturated hydraulic conductivity (K_s) and two van Genuchten water retention parameters α and *n* into fuzzy logic-based soil hydrologic classes (FSHC). This new hydraulic property based discretization scheme using the SWAT modeling environment showed better performance than the soil series-based discretization approach. Keeping in mind the constraints of portability of PTFs even with different climatic regions within India, we also developed a set of PTFs to estimate $\theta_{1/3bar}$ and θ_{15bar} for hot arid agroecological region of India. Future application of these new PTFs was demonstrated through translation of soil survey reports on basic soil properties to surface map of soil water retention. The prepared surface maps of soil hydraulic properties may help the end users for irrigation scheduling at farm scale, for hydrological modeling at watershed scale, and for cropping pattern planning at regional scale and thus may achieve the target of proper utilization of scare water resources.

Soil physical and hydraulic properties by different soil tillage systems

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Evaluation of management impacts on soil water resources is becoming increasingly important for crop production. The present study analyses the influence of three tillage systems (conventional, reduced, no-tillage) on soil water dynamics. The objective is to determine whether changes in soil hydraulic properties or effects of residue cover are more relevant for the soil water regime and yield formation under the different tillage treatments.

Methodology

In the semi-arid region of Eastern Austria (soil type: Chernozem, silty loam) three tillage systems from a long term tillage trial were evaluated, i. e. conventional tillage with plough (CT), reduced tillage with chisel (RT) and no-till (NT). Soil water content under winter wheat was measured continuously using capacitance probes. Surface hydraulic properties (0-5 cm) were obtained by inverse fitting of van Genuchten parameters to field tension infiltrometer measurements (Simunek et al., 1998), while for deeper layers pressure plate analysis was used. With the CropSyst model (Stöckle et al., 2003) the impact of distinct hydraulic properties with and without consideration of mulch effects on water balance components and their potential impact on yield were simulated and evaluated.

Results and discussions

Significant differences in hydraulic properties where found between treatments, particularly in the surface near soil where hydraulic parameters were derived from in situ tension infiltrometer data. Plant available water (PAW) increased from 11.0 vol.% to 12.5 vol.% and 13.0 vol.% in CT, RT and NT respectively. Saturated hydraulic conductivity (K_s) was 8.4, 5.8 and 6.6 cm h^{-1} in the respective treatments. Including a mulch layer in the simulation had visible effects on modelled water contents for the NT treatment, while the lower residue cover in the RT treatment did not modify the average water content in the upper 40 cm, and only slightly in the top 10 cm (data not shown). Although for NT the mulch layer slightly increased the modelled water contents.

The mulch layer substantially reduced the amount of water losses due to surface evaporation. The ratio of transpiration to total evapotranspiration increased from 0.48 for CT to 0.57 for NT when considering the effect of a mulch layer. If only differences in soil hydraulic properties are taken into account, RT and NT even had higher unproductive losses as the higher water availability and better continuity of pores in the upper soil layers increase water transport to the evaporation surface. After plough, this is avoided by intense soil loosening and breaking of capillarity, while the other treatments could only avoid continued losses by reducing the evaporative energy by an isolating residue cover. The improved allocation of available water towards plant transpiration with mulch increased yield.

Conclusion

Reduction of tillage intensity increased plant available water in chisel and no-till systems, while K_s was higher under ploughing. Enhanced water storage in the upper soil layers together with high capillary continuity under reduced and no-till can increase evaporation losses. Only when including the isolating effect of a mulch layer, these systems allocate a higher proportion of water to plant transpiration. Simulation analysis thus suggests that the residue effect in reduced and no-till systems is more important than the change in hydraulic properties for yield formation in water limited agro-ecosystems.

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The Effect of Time-Variable Soil Hydraulic Properties in Soil Water Simulations

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Abstract
For many applied questions in the fields of crop production and agronomy, soil water dynamics are of fundamental importance. Modeling can be a valuable tool to optimize its management. However, such soil water modeling requires an accurate description of soil hydraulic properties, i.e. the soil water retention characteristics and hydraulic conductivity functions. These constitutive functions are assumed to be unchanged over time in most simulation studies. However, there is extensive empirical evidence that soil hydraulic properties are subject to temporal changes particularly in the near-saturated range where soil structure essentially influences water flow characteristics. The structure of soil top layers is subject to changes during time, caused by wetting and drying, solution composition, agricultural operations, and biological activity. Soil tillage is used to improve soil structural properties by changing the soil pore-size distribution (PSD). The impact of cultivation is expected be largest for conventional tillage (CT), where the soil is ploughed after harvest every year. In the present study, the temporal variability of the hydraulic properties of differentially cultivated topsoils was quantified by infiltration measurements and used to parametrize a soil water simulation afterwards.
Field measurements were done on a long-term agricultural investigation site near Vienna, Austria, with three different cultivation methods, conventional tillage (CT), reduced tillage (RT), and no-tillage (NT). To quantify the temporal variability of the water retention and conductivity properties of the topsoil, repeated infiltration measurements were conducted since August 2008 using tension infiltrometry (Soil Measurement Systems, USA; diameter of the disc: 20 cm). The software HYDRUS 2D/3D was used to fit the retention model of Kosugi (1994) inversely to the infiltration measurements. The resulting parameters were used to calculate the PSD for every time of measurement.
A numerical model was used to simulate the water movement and storage in the soil over the time of observation. The Richards' equation was solved numerically using COMSOL Multiphysics (COMSOL AB) with MATLAB (The MathWorks Inc., USA). The model geometry was a 2D soil column (width: 1.00 m, depth: 1.20 m) with three layers according to the observed soil horizons. Simulations were made with constant and time-variable retention parameters in the topsoil layer for all analyzed cultivation techniques. Since the time-variable effect of cultivation was expected to be negligible, the hydraulic properties were set to be constant in the lower horizons. For calibration of the model, data of the soil volumetric water content measured directly in the field were available.
The evolution of the PSD determined by the infiltration measurements showed distinct differences between the applied soil cultivation. The PSD at the CT site shifted towards smaller mean pores after mouldboard tillage, and the change of the PSD is mostly dominated by the soil cultivation. The determined PSDs for RT and NT show a smaller shift during time and a smaller total porosity. Moreover, the shift of the PSD is slightly towards larger pores. This effect might be caused by biological activities, such as earthworm burrows and plant root development.
Since now, we implemented a model approach that enables the flexible definition of the soil hydraulic properties. The implementation of the Kosugi retention model allowed the definition of the soil retention properties strongly connected to the PSD of the soil. However, until now we used only empirical fitted functions for the time-development of the retention parameters. Recently, we began work on the adaptation of a suitable PSD-evolution model.

Uncertainty; a Problem to Rank Desertification Indicators

(FUZZY-MCDM Methods)

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Abstract:

Desertification assessment and monitoring studies have focused on providing reliable data and information sources, to underscore the understanding of the causes of desertification, in order to forecast and combat future desertification, as well as to mitigate the effects of on-going processes. Seems whatever have most important in all of desertification studies is selecting, ranking, scoring and preference of desertification indicators to develop desertification indicators system which is guideline to apply management projects to combat desertification process. Ranking objects is a simple and natural procedure for organizing data. It is often performed by assigning a quality score to each indicator according to its relevance to the problem at hand. Ranking is widely used for indicator selection, when resources are limited and it is necessary to select a subset of most relevant objects for further processing. In real world situations, the object's scores are often calculated from noisy measurements, casting doubt on the ranking reliability. Uncertainty is one of the main problems to select, rank and integrate indicators to preference them. In this paper have been introduced a Fuzzy-MCDM method for assessing the influence of uncertain levels on the ranking reliability. This paper tries to illustrate MCDM method for selection, scoring and preference of desertification indicators. In the first step, were identified the main desertification indicators based on main criteria. Then, to reduce uncertainty a triangular fuzzy set was applied for weighting borders of indicators. Ultimately a MCDM algorithm based on outranking method ELECTRE was developed. Results indicated that selection of fuzzy borders can be a reliable way to reduce uncertainty. Also Outranking method of decision making is a suitable tool to rank indicators.

Keywords: ELECTRE, Fuzzy, MCDM, Uncertainty, Desertification Indicators

Soil sustainability in relation to soil erosion in Shiwaliks of Lower Himalayas

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Soil erosion by water is a serious problem in Shiwaliks of Lower Himalayas and at present approximately 2.14 million hectares of land in the region is suffering from this menace. As soil erosion is a major factor responsible for the soil degradation, there is a need to develop physical indicators of soil quality in relation to soil erosion. Soil quality indices based on soil characteristics can be used to assess the sustainability of soil and to assist in soil management decisions. The present study was conducted to evaluate various approaches for quantifying soil sustainability in relation to soil erosion. The first approach is based on principal component analysis (PCA) technique that can generate relationships among many correlated variables into a few principal components (PCs) and was used to identify dominant soil characteristics in relation to soil erosion. The second approach is based on the sustainability index (SI) developed from the relative value of soil physical characteristics in relation to their threshold value, a conceptual framework developed by Gomez et al. (1996). The third approach is by Shukla et al. (2004) based on the identification of the critical levels of soil attributes by assigning a relative weighing factor to assess the sustainability of land use. A field experiment was conducted under both natural and simulated rainfall conditions with four land uses - barren, cultivated, grassland and forest at four locations in Lower Himalayas to evaluate soil erosion and to assess soil physical and physic-chemical characteristics.

Soil erosion varied from 12.9 to 32.4 t ha^{-1} under different land uses and was higher than threshold value of 12.5 t ha^{-1} indicating that the soils of the area are highly erodible and are prone to erosion risk. The PCA was performed on 22 physical and chemical soil characteristics, which grouped these soil characteristics into five distinct PCs. These five PCs namely soil hydraulic factor, density factor, structural factor, sand factor and cation factor, explained 86 per cent variability in data. These PCs also explained 51, 88 and 93% variability under natural rainfall conditions and 86, 73 and 77% variability under simulated rainfall conditions in relation to runoff, soil loss and soil erodibility, respectively. Soil structural factor consisting mean weight diameter can be considered as dynamic soil quality indicator. According to the SI approach only the forest land use system is sustainable with respect to soil erosion and SI values varied from 0.68 to 1.42. The SI was observed to be highly correlated with the respective soil erodibility values under natural ($r = -0.83$) and simulated ($r = -0.87$) rainfall conditions. The cumulative rating (CR) obtained by adding the ratings of each measured soil attribute varied from 24 to 34 and no land use was found either highly sustainable ($CR < 20$) or fully unsustainable ($CR > 40$). The CR had a significant positive correlation with soil erodibility both under natural ($r = 0.75$) and simulated ($r = 0.81$) rainfall conditions.

The soil structural characteristics like mean weight diameter can be used to monitor temporal and spatial changes in soil quality. The sustainability index approach was found to be more suitable for assessing the sustainability of the system in relation to soil erosion as it requires less soil inputs as compared to the cumulative rating index. The results are very promising with respect to formulation of soil conservation strategies like selection of sustainable land use, cropping pattern, management practices including agronomic, soil and engineering measures. The use of indices may help policy makers, development agencies, researchers and farmers to take decisions on these aspects, to monitor the changes in soil physical quality and to assess soil sustainability.

Key words: Barren, cultivated, forest, grassland, land use, natural rainfall, principal component analysis, simulated rainfall, soil erodibility, soil erosion, sustainability.

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Land Degradation by Erosion: Samanalawewa Catchment, Sri Lanka

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Soil erosion is an important concern when considering food security and environmental conservation in Sri Lanka. However, the dearth of baseline information on soil erosion in many watersheds of Sri Lanka, is a major hindrance for monitoring soil erosion and mitigating its effects. In order to provide such data for a critical watershed, the Samanalawewa watershed, which contains one of the main hydropower generating reservoirs in Sri Lanka, was selected for this study. The key objective of research was to detect and map soil erosion rates.

To detect and map soil erosion rates, remote-sensing (RS) and geographic information system (GIS) based modeling and field experiments data were employed. Results indicated that the current rate of soil erosion ranges from 0 to 289 t $ha^{-1}yr^{-1}$, and that the average rate of soil erosion has been declining from 19.8 to 4.3 t $ha^{-1}yr^{-1}$ during 1986 to 2008. The current rate of soil erosion, however, is about 14 to 33 times greater than the natural soil formation rate.

Socioeconomic factors and people's perception with regard to soil erosion and soil conservation measures were examined using the data collected through a household survey (n=201). Out of eighteen covariates of socioeconomic characteristics, multiple regression analysis yielded eleven socioeconomic variables (R^2=0.923 and $p<0.05$) viz. household size, farm labor, education, security of land tenure, conservation cost, training, memberships of organization committees, professional competencies, income, distance, and financial capital as the predictor variables of soil erosion.

Further, adoption of conservation measures, their effectiveness and impact on ecosystem services were also examined. Soil and water conservation measures have been practiced in the study area since late 1980s. These conservation measures fall in four major categories, namely agronomic (e.g. mulch, organic manure, soil surface/subsurface treatments), vegetative (e.g. tree, shrub and grass cover and Sloping Agriculture Land Technology or SALT), structural (e.g. terraces, bunds and ditches) and management (e.g. changing species composition of crops, controlling cropping intensity and fallow period). Based on the respondents' perception, each of these measures showed specific application for specific erosion types. Through the respondents' opinions on effectiveness of each measure for controlling soil erosion was calculated. The computation of effective index shows that agronomic measure with an index value of 0.722 ranked highest implying the best soil conservation measure in the area followed by structural (0.686) and vegetative (0.686) as the second effective and the management measure (0.333) as the least effective.

The impact of conservation measures on ecosystem services, namely productivity, ecological, and sociocultural services, were also assessed. The agronomic, vegetative and structural conservation measures showed similar effectiveness displaying positive impact on all the ecosystem services. Management measures, however, were not perceived to have any impact on ecological and sociocultural services.
The results of this assessment are imperative in order to implement better management practices of natural resources in the catchment due to the paucity of reliable and updated natural resources related information.

Keywords: Samanalawewa catchment, soil erosion, soil conservation, determinants soil erosion.

Historical changes in the environment of the Chinese Loess Plateau

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Abstract: Historical records from the past 2000 years indicate that the vegetative cover of the Loess Plateau has declined significantly with time. The decline in vegetative cover seems closely related to increased rates of soil erosion as well as the increased frequency of natural disasters such as floods, droughts and dust storms. The results showed that the total forest area in the Loess Plateau steadily declined in the centuries that followed. Until 1949, only 3.7million ha of forestland remained in the region, mostly in mountainous areas. This represented just 6.1% forest coverage of the total area of the Loess Plateau. Since 1820 the increase in the population has corresponded to more increased amount of erosion. The population growth in the region that has occurred since the middle of the Qing dynasty (1800 A.D.), had a significant effect on soil erosion, remarkably through unreasonable land-use practices such as slope cultivation and vegetation devastation. And accelerated erosion rates caused by human activity have damaged the ecology of the region, leading to the unsustainable use of the land resources. We think that deforestation and the depletion of water resources, especially those that occurred after the Qing dynasty (1644–1911 A.D.), would be responsible for the deterioration of the ecological conditions in the Loess Plateau. The condition of the environment and its relationship with development is a serious problem as the Chinese government searches for ways to improve the living standard of people in the region. The purpose of this study is to outline historical changes in the vegetation and environmental conditions of the Loess Plateau. Although we believe that current population pressure of the Loess Plateau is becoming unsustainable, our objective is not to be overly pessimistic in regards to the future development of the region. Instead, our purpose is to increase the awareness of environmental conditions in the region and to encourage the implementation of policies that will promote sustainable development of the Loess Plateau.

Keywords: Sustainable development; Loess Plateau; Dust storm; Environment deterioration

EFFECTIVENESS OF *IWK* BIOSOLIDS APPLICATION ON GROWTH OF RUBBER IN THE NURSERY

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ABSTRACT

Biosolids are valuable resources containing high proportions of organic matter and nutrients essential for plant growth. The product contains major and minor elements, but the main benefits come from the inherent nitrogen and phosphorus. Based on the above information, an experiment was carried out the evaluate the potential of IWK biosolids to be used as a source of nutrients for rubber.

The nursery experiment was conducted using Randomised Complete Block Design (RCBD) with 6 Treatments x 4 Replicates x 30 Trees / replicate with a total of 720 plants of PB350 clone. Planting distance in the nursery was 4 x 4 feet apart.

Results showed that the incorporation of 20% to 60% into soil also proved to have beneficial effect on plant height and girth as compared to soil. Significant different were found for height and girth compared to 100% soil. Higher mean for biomass including leaves and twigs, stem as well as root were recorded for biosolids mixture treatments. Healthy growth of trees were observed with very low casualties (<1%) were recorded as most of them dead due to dieback.

Results from the experiment also showed that biosolids is a potential source of nutrients in rubber plantation. The availability of nutrients in biosolids could reduce the amount of chemical fertilizer used e.g. phosphorus and nitrogen in rubber plantation. The rate of fertilization could be reduced into half or less especially for crop that need less than 6 months to be in the nursery. No CIRP or less CIRP is needed in the nursery as the availability of phosphorous is very high. Results from pre-treatment analysis show that biosolids has nearly 150 times more than the soil.

The potential of producing biosolids blended or mixture is needed to balance the nutrients ratio or content in the mixture. The mixture should be fortified with other nutrients, for example potassium as the value is low.(0.01 me% K). The mixture should be formulated based on requirement i.e. nursery, immature rubber, mature rubber, forest species etc.

Based on above experiment, it was calculated that the use of 2.5 kg biosolids is equivalent to nitrogen supplied by conventional fertilizer and capable of reducing 30% the amount use of phosphate fertilizer leaving biosolids as a future potential source of nutrients for suitable plantation crops.

A New Heat Pulse Sensor for Measuring Soil Profile Evaporation

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Soil water evaporation is a critical component of the hydrologic cycle and surface energy balance. As a soil surface dries, the evaporation front extends deeper into the soil. At present most evaporation measurements and models do not consider near-surface soil water evaporation processes. Studying near-surface soil water evaporation can help to clarify and quantify land-atmosphere water exchange processes. Recently a 3-needle heat-pulse sensor has been used successfully to monitor subsurface soil water evaporation dynamics. Due to the limite size, however, several sensors are required at different soil depths to measure subsurface evaporation, which introduces difficulties in sensor installation and errors in the measurements. In this study, an improved 11-needle heat-pulse sensor, including four heating needles, is designed to determine soil water evaporation dynamics with depth and time in the 0- to 5-cm soil layer. The experiment was conducted on a sandy soil where soil temperature and thermal properties were monitored continuously after an irrigation event. Evaporation rates at different soil layers were then calculated following the sensible heat balance theory. The results showed that peak evaporation rate (0.21 mm h^{-1}) appeared in the 4- to 10-mm soil layer four days following the irrigation. After six days, peak evaporation rate in the 10-17 mm soil layer was 0.27 mm h^{-1}, and the evaporation front propagated to a depth of 23 mm. After seven days, significant evaporation appeared in the 17-23 mm soil layer with a peak evaporation rate of 0.18 mm h^{-1}. We concluded that the 11-needle soil heat pulse sensor was able to measure the depth and time dynamics of subsurface soil water evaporation.

Effects of Rock Fragments on Water Movement and Solute Transport in a Loess Plateau Soil

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Abstract: The rock fragments in the Loess Plateau(>2mm), as a result of dissolution of calcium minerals in the presence of carbonic acid formed during the wet and humid weather of the summer and autumn from plant residues, are leached by percolating rain water to lower depths where they are concentrated, coalesce, and dry out to form the calcium carbonate concretions. Processes such as uplifting and cultivation have subsequently redistributed these concretions, or rock fragments, within the upper soil profile where they can influence water movement and solute transport. The presence of these small rock fragments can have a great impact on soil bulk density, structure and water storage properties as well as on soil water movement and solute transportes. We studied the effects of different gravimetric rock fragment contents in a soil (R_w) (0, 10%, 20%, 30%, 40%, 50%, and 60%) on infiltration, saturated hydraulic conductivity (K_s) and solute transport in one disturbed soil columns(height 50 cm, inner diameter 20 cm)and each treatment was carried out in three replications. Both infiltration rates and the saturated hydraulic conductivity measured independently under steady-state flow conditions using measured values of hydraulic potential gradients and water flux density initially decreased with increasing rock fragment content to minimum values for R_w = 40%, and then increased. The Peck-Watson and Bouwer-Rice equations predicted Ks for low rock fragment contents but failed to forecast the observed trends. Cumulative infiltration over time was described

well by a power function. Solute transportes, determined using $CaCl_2$ as a tracer, were accurately described by both the convection-dispersion equation (CDE) and the two-region model (T-R) although the T-R model fitted the experimental data a little better than the CDE, which is possibly more convenient to use. When R_w was about 40% solute transport parameters indicated that relatively more advection occurred in this mixture where immobile regions occupied the greatest proportion of the columns.

Key words: Rock fragment content; Cumulative infiltration; Saturated hydraulic conductivity; Solute transport