SHARING INFORMATION TO ACCELERATE IMPLEMENTATION OF RECLAMATION AND IMPROVEMENT OF DEGRADED LANDS: THE EXPERIENCE OF WASWAC

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Degraded lands are lands that have become inferior in quality, essentially in terms of crop productivity. The degradation may be due to either natural or human-induced causes - acid soil, saline soil, mine tailing, waterlogged land, eroded land, land in dry environments, to cite just a few, and the way to correct each type of degraded land is quite different from one to another. To make use of degraded lands profitably, one needs to study about the causes and how they can be restored to a suitable fertility status. Two main components needed for this to achieve are research and extension (R & D). Previously, it was the matter of land conservation and improvement that occupied researchers' mind – but since 20-30 years ago, the interest had shifted to the point that people paid more interest to the matter of causes of degradation and how to correct them. It thus seems to be a decent way to implement any program concerning soil or land. For the research part, there have been many projects and programs that do research on land degradation today, the executors of which are universities, government agencies, research institutes, etc. From doing research, there are a lot of results that are produced each year. The next step is to present the research findings that researchers go to attend conference at various venues. There is one series of meetings, i.e. International Conference on Land Degradation (ICLD) that meets every 2-3 years in different parts of the world. Also, there is a series of meetings called ISCO (International Soil Conservation Organization) that meets every 2-3 years at various places too. An organization that is dealing strongly with land degradation is COMLAND (Commission on Land Degradation and Desertification), which is a part of the International Geographical Union (IGU). The organization has coordinated several COMLAND meetings in many parts of the world, and has produced many good publications. Apart from that, there are several other meetings that feature land degradation as an important theme, such as those organized by the ESSC (European Society for Soil Conservation), WASWAC (World Association of Soil and Water Conservation), IECA (International Erosion Control Association), SWCS (Soil and Water Conservation Society) and many other national societies of soil and water conservation. For the implementation part, the noted work to combat land degradation commenced in USA by the agency called Soil Conservation Service (SCS), which later changed its name to Natural Resources Conservation Service (NRCS). This agency is a part of the United States Department of Agriculture (USDA). Many visitors from abroad go to learn soil conservation techniques and take back to apply in their own countries – often with certain degrees of adaptation. However, there has been a big gap in

the success in technology research and application in developed and developing countries. Research being done in cooperation between researchers in developing and developed countries during past 30 years has brought about several findings, the very important of which would be the Participatory Approach, which is almost the only way to assure the success of technology application in the farmers' fields. At the same time, the technologies involved in mitigating land degradation have been refined so much and can be classified into several categories – with different amount of costs, which suit the land of different terrains and people of differing wealth levels. Since 1983, the World Association of Soil and Water Conservation (WASWAC) was born out of the need to have a forum for soil and water conservationists in various parts of the world to work together. For two decades the association was operating from USA, a first world country, but it proved less than being suitable at a later stage. So it moved out to locate in the People's Republic of China since 2003, where it can handle and create many activities that serve members from both north and south countries very well. With good management, it is hoped that WASWAC will function properly in bonding people who take care of the health of the land, with a result that most of the world's population will lead their lives normally and far away from hunger. The paper describes the activities that WASWAC has been operating during the past decade, which from a solitary task of producing quarterly newsletter, now the association is able to handle almost one dozen activities, as well as function as a forum where people living in different environments can contact and work together through the new technology – internet – which has become available just in time to enhance the association to expand its sphere and make itself more useful to people living anywhere in the world.

Key words: Degraded lands, WASWAC, dry environments, COMLAND, ISCO, USDA

USE OF MARGINAL QUALITY WATERS FOR SUSTAINABLE CROP PRODUCTION

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Existing high quality water supplies are not sufficient to sustain irrigated agricultural production in arid and semi arid regions. Use of marginal quality waters and reuse of agricultural drainage waters and treated municipal waste waters are currently the only economic options for maintaining production in these regions. Marginal quality waters are characterized by one or more of the following; elevated salinity, sodicity, pH, alkalinity, dissolved organic matter and toxic elements such as boron and selenium. These water characteristics have a potentially adverse impact on crop productivity as well as soil physical properties. However, these waters can generally be used with proper management considerations. Model simulations of irrigation with saline waters confirms field data indicating that existing leaching guidelines overestimate water quantities needed for salinity control in the root zone. Leaching recommendations must also consider efficient water use, costs of water, nutrients and disposal of drainage water as well as crop production. The sodicity hazard associated with application of saline water has been generally overlooked, due primarily to lack of consideration of the adverse impact of even small quantities of rain on physical properties of the soil surface. Recent long term studies on infiltration of degraded waters indicate that the sodicity hazard to soil physical properties is greater than currently considered, and that surface addition of gypsum may need to be more generally utilized. The utility of computer modeling as an aid to irrigation management is further demonstrated by the simulation of intermittent use of high B waters currently deemed unsuitable for irrigation. Future salinity research is critical to meet food demands of arid and semi-arid regions of the world, especially for development of new varieties improving the salt and boron tolerance of sensitive species and improved prediction of plant production under conditions of multiple stresses (salinity water nutrient and toxic element).

Key words: Marginal quality, elevated salinity, efficient water use, computer modeling, multiple stress, USDA

SOIL SALINITY MODELLING, APPROACHES AND KEY ISSUES

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Soil salinity can be described as a high concentration of ions in the soil solution, a condition that is very restrictive for plant's growth, due to the high osmotic potential of the solution that difficults the plant water uptake, and also due to the plant toxicity produced by specific ions. This definition of soil salinity centered in the plant differs from the used in soil classifications that are more exigent in features permanently recognizable in a profile, those allow classifying a soil as saline (or alkaline). Salinization is a progressive soil and water degradation process, human-caused, affecting aquifers and the most productive agro-ecosystems under irrigation in arid and semiarid regions, representing an increasing environmental concern. Because salinization can be induced in a soil even with only an irrigation event with low quality waters, an environmentally sound land management should take advantage from the most advanced tools for adjusting irrigation application, taking into account leaching requirements. Modelling the reactive transport in soil uses simplified representations of the reality, but can reveal complex interrelations of properties of the system under study, and is best suited for drawing scenarios for investigating "what-if..." questions. Each modelling effort tries to give answer to a particular question formulated, hence the input information required for running the models, ranges in complexity as does the data acquisition efforts. The scale of application, geometry of the system, biological, chemical and physical processes represented, as well as the capability of representing an evolving system, are main differences among models. Some aspects important under normal agricultural practices are not well reproduced by some codes nowadays. Management practices, geometry of irrigation and evaporation, sinks of solutes (plant uptake) and interaction of fertilizers with soil components, are incorporated in an uneven way in the available codes, and should be further developed. It is a desideratum that models become more and more mechanistic, this requiring very intensive effort in research. There are uncertainties associated to the values of the input parameters, to the computation procedure or to the inaccurate description of the system. The parameters estimation, analysis of sensitivity and validation procedures is refinements applicable to most models. This paper gives an overview of different modelling approaches, discusses the limits of application of models and develops a study case.

Keywords: Salinity, reactive transport, modelling, management practices, computation procedure.

LAND USE PLANNING AND POLICY IMPLICATION – BRIDGING BETWEEN SCIENCE, POLITICS AND DECISION MAKING

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Land use planning aims at the harmonision of the 6 main uses of soil and land, such as the production of biomass in agriculture and forestry, the filtering, buffering and transformation between the atmosphere, the ground water and the plant cover, strongly influencing the water cycle at the land surface as well as the gas exchange between terrestrial and atmospheric systems, the soil as a biological habitat and gene reserve, and in addition to this, soil uses linked to technical, industrial and socio-economic activities, such as soil as a physical basis for infrastructure, e.g. housing, transport routes etc., soils as a source of raw materials, e.g. delivering clay, sand, gravel and minerals, e.g. for construction, and last but not least, soils as a geogenic and cultural heritage, concealing and protecting palaeontological and archaeological treasurers of importance for the understanding of our own history and that of the earth. In this context, land use planning tries to set priorities and to avoid problematic competition between the different uses, minimizing irreversible ones by balancing all uses simultaneously in space and time. However, land use planning is not a scientific but a political issue, which has to be solved by politicians, decision makers or stakeholders, by a top-down or bottom-up approach. Scientists only have the possibility to develop scenarios and to explain, which causes and impacts may occur when different options are exercised. The basis of those scenarios are indicators, which help politicians and decision makers as well as land use planners and stakeholders to understand the complexity of the system and to choose the right options. Indicators for this purpose were developed in by the Organisation of Economic Cooperation and Development (OECD), Paris, and later by the European Environment Agency (EEA), Copenhagen, distinguishing between Driving forces (D), Pressures (P), State (S), Impact (I) and Response (R). This DPSIR-Framework Approach can be easily understood and used by land use planners as well as by politicians, decision makers and stakeholders. In the key note examples will be given, to show how this indicator framework functions for land use planning, bringing knowledge from those who have it to those who need it, and thus achieving a sustainable use of land and soil resources.

Key words: Biomass, agriculture, land use planning, policy, decision makers,terrestrial system, DPSIR Approach.

DEMANDS ON SOIL CLASSIFICATION AND SOIL SURVEY STRATEGIES

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Classifying soils (for a particular purpose) involves the ordering of soils into groups with similar properties and for potential end uses. The classification of soil is a terrific conceptual and practical challenge, especially in arid environments. It may spur or it may deter scientists or end users with an interest in soils. If a classification system proves to be relevant and user-friendly, it stimulates and encourages further work because it is recognised for its inherent capacity to create order and enhance the useful understanding and mapping of soils. General-purpose internationally recognised soil classification systems such as Soil Taxonomy and the World Reference Base and other nationally recognised classification systems (e.g. Australian or South African) have proved tremendously useful for soil classification and advancing understanding of soils across the world. However, because these general-purpose classifications require considerable expertise and experience there is the need for complementary special-purpose classification systems specifically tailored to particular environmental problems, land uses or local regions and using plain language names for soil types. For example, general-purpose classification systems often do not yet incorporate new terminologies, such as subaqueous soils, monosulfidic and hypersulfidic materials, required for classification of acid sulfate soils in the Murray-Darling Basin, Australia to assess environmental hazard and management options. In addition, new challenges face general-purpose soil classification systems, especially in response to the following questions most frequently asked by soil users: to the following questions most frequently asked by soil users:

- What soil properties are changing, vertically and laterally in the landscape and with time?

- What are the most suitable approaches for characterising, monitoring, predicting and managing soil changes for environmental impact assessments, pollution incidents, waste management, product development and technology support.

- What soil measurements and user-friendly soil classifications are required to make suitable predictions about changing soil and landscape conditions and about sustainable land use?

These three inquiries can easily be addressed by using process-based technical classification systems that incorporate three or four dimensional soil–landscape relationships (mechanistic toposequence models) to develop strategies to predict and manage spatial and temporal soil changes. This will often involve the development of special-purpose or more technical soil classification systems using plain language names for soil types for potential users with a range of

practical needs. In turn, these technical classifications must be so constructed that they are able to contribute to modification of the general-purpose international and national classifications. In this paper, new ideas and concepts are presented through a wide range of case studies to illustrate the importance of special-purpose technical soil classification systems to predict and solve practical problems among the following areas:

- Aquatic environments: Special-purpose soil classification systems that describe temporal and spatial changes in soil and water characteristics of natural, drained and re-flooded soils of the Mesopotamian marshlands in Iraq (anthropogenic modified environments) and River Murray and Lower Lakes region in South Australia (changing climatic and anthropogenic modified environments).

- Mineral exploration: Geochemical sampling medium for mineral exploration, based on a special-purpose soil classification system to identify specific types of Acid Sulfate Soils overlying mineralised zones.

- Engineering: Special-purpose soil classification to minimise soil damage from shrink-swell soils and soil corrosion to the Australian telecommunication optic fibre cable network.

- Forensic soil science: Special-purpose soil classification to assist police to locate buried objects in complex terrain.

Key words: Subaqueous soils, Murray-Darling Basis, mineral exploration

RECENT ADVANCES IN SALINITY ASSESSMENT AND MANAGEMENT STRATEGIES IN INDIA

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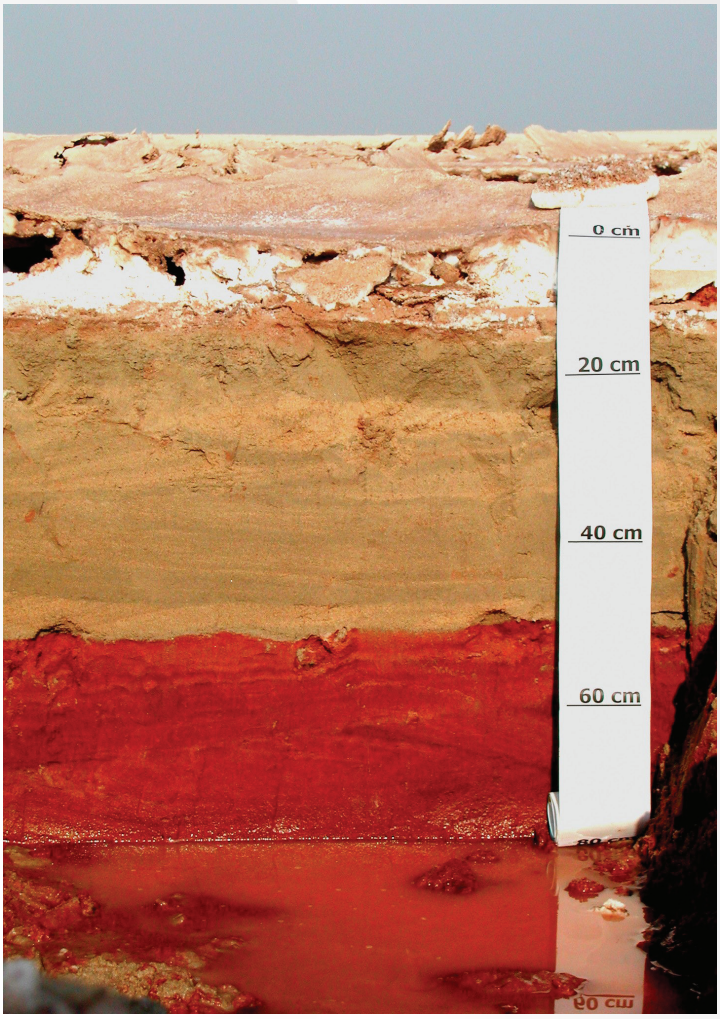
Over-exploitation and mismanagement of natural resources in the under developed and developing world is posing a serious threat to food and nutritional security. Out of 329 mha total geographical area of India, 120.7 mha is constituted by the degraded lands. Introduction of canal irrigation without provision for adequate drainage to take out excess seepage and irrigation water is bound to result in ground water rise and associated problem of salinity in arid and semi-arid region. Already, 6.73 m ha area has been affected by salinity and sodicity in India. The state of Gujarat followed by Uttar Pradesh has the maximum area under salinity and sodicity. Under the Indra Gandhi Nahar Priyojana (IGNP) water was introduced to bloom the Indian Thar desert. No doubt, irrigation increased the productivity several fold during the initial years, but unscientific and over use of water resulted in rise in watertable and salinity. Already a sizeable area has gone out of cultivation and several villages have been abandoned due to severe problem of salinity. The recent estimates indicate that if the present trend of salinity development continues, India will have to face salinity problem in about 11.7 m ha by 2025. Similarly, about 25% of the ground water resources in the country particularly in arid and semi-arid regions are either saline or brackish or both. States like Rajasthan and Haryana have 84 and 62%, respectively of the ground water resources of poor quality. Continuous use of such water for irrigation to agricultural crops always run the risk of sodicity/salinity development in soil.

The major area affected by soil alkalinity in the states of Panjab, Haryana and UP has been reclaimed with the application of gypsum. The B:C ratio and IRR for sodic soil reclamation have been worked out as 1.42 and 21.40%, respectively. About 1.8 million ha sodic lands have been reclaimed during last four decades. The sub-surface drainage technology developed by the institute has been applied to reclaim about 50000 ha saline waterlogged soils in different states of the country. High initial cost, requirement of community effort, problems associated with disposal of drainage effluent and a need for continuous maintenance of the drainage system are some of the limitations which restrict the wide spread application of this technology. As alternate/supplement to the sub-surface drainage for lowering the water table and keeping salinity out of the rooting zone, biodrainage has been tried in selected canal command areas. In this technique, trees like Eucalyptus tereticornis which have high transpiration rate are planted to intercept seepage from the canals. Several studies revealed, that depending upon agroclimatic conditions, soil characteristics, planting density, age and evaporative demand of

the atmosphere a Eucalyptus tree can transpire between 30 to 80 litres water/day. The technology has more relevance for preventing salinity build-up but however, has limited scope where high salinity has already developed. For location specific situations where waterlogging and salinity exist in patches, pond based technology with major emphasis on saline aquaculture is being tried. Lessons learnt from this kind of integrated farming system approach in the Sharda Sahayak command and elsewhere are discussed. Information on the use of highly salt affected soils underlain by poor quality ground water (which cannot be used for raising normal agricultural crops) for growing biomass to generate energy/electricity is also cited. The information is discussed under the following sub-heads: i) classification and distribution of salt affected soils in India, ii) approaches for reclamation of alkali/sodic soils, iii) reclamation of waterlogged saline soils, iv) bio-drainage, v) use of poor quality waters, vi) saline aquaculture and multi-enterprise agricultural options, vi) biosaline agriculture and viii) lessons learnt and future strategies for reclamation of salt lands in India.

Key words: Salinity assessment, strategies, Haryana,drainage effluent, India.

SESSION – I



Soil Survey and Classification Strategies and Use in Different Agroecological Zones

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LAND EVALUATION INTERPRETATIONS - SOIL SURVEY OF ABU DHABI EMIRATE

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The Soil Survey of Abu Dhabi Emirate has generated an enormous amount of primary soils data that is now available to land use planners and decision makers in the Emirate. The soil information provides Emaratee land managers with baseline information upon which they can base future land use and environmental management decisions and policies. As such, the information can be regarded as a great asset for future generations. The information is stored in the Abu Dhabi Soil Information System (ADSIS) database that has been designed to provide ready online access to users. In its raw form, the majority of the soil data is only usable by specialist soil scientists and geoscientists. Land evaluation methods provide a mechanism for the soil information to be synthesized, simplified, interpreted and presented to a far wider audience. This paper will present a history of the development of land evaluation methodologies internationally and how they can be applied in the Abu Dhabi context. It will then highlight the land evaluation interpretations undertaken by the Soil Survey of Abu Dhabi Emirate and discuss their practical application to land use decision makers in the Emirate. Finally, suggestions for future analysis of the comprehensive data set will be discussed.

Key words: Soil survey, ADSIS, land evaluation, Abu Dhabi Emirate, decision makers.

TOPOSEQUENCE CONCEPTUAL MODELS TO SUPPORT SOIL SURVEY AND LAND EVALUATION

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Soil maps are used to portray the spatial variation of soils in landscapes by indicating what soils, their proportion and their soil properties are likely to occur at a particular location or in a soil map unit. Soil surveyors intuitively understand this soil variation and how it may occur by reading the landscape. However, soil maps are often too technical and not easily understood or readily converted into land use decisions to be used by land managers and decision makers. This presentation demonstrates how soil toposequence conceptual models can be used to: 1) describe (supporting soil survey map data and reports), 2) explain (providing an understanding of the processes), and 3) predict (supporting land evaluation) soil spatial variability in a range of complex landscapes. Case studies using information from the Soil Survey of Abu Dhabi Emirate and other international surveys in Kuwait, Iraq, Brunei and Australia are provided to illustrate how soil toposequence models have added value to understand, predict and solve practical land use problems. These models provide the following critical data to support land evaluation and management decisions,: illustrates soil properties that are changing with time and space - which is especially important in salt-affected soils (e.g. seasonal and climate changes in occurrences of salt efflorescences); what are the most suitable approaches for characterising, monitoring, predicting and managing soil changes for environmental impact assessments, pollution incidents, waste management and technology support; what tools or soil assessment manuals can be provided to make suitable predictions about sustainable land use and support the land evaluation process.

Key words: Toposequence, conceptual models, land evaluation, soil variation, pollution incidents.

DIGITAL SOIL MAPPING USING SPECTRAL AND TERRAIN PARAMETERS AND STATISTICAL MODELING INTEGRATED INTO GIS: EXAMPLES FROM THE NORTHWESTERN COASTAL REGION OF EGYPT

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The increasing demand for new land in Egypt necessitates an intensive soil mapping activities throughout the unmapped 90% of the total area favorably at scales of 1:25,000 and 1:50,000. As traditional soil surveys are expensive and time-consuming, there is a growing demand for considering predictive Digital Soil Mapping (DSM) concept by involving remotely sensing (RS) data and statistical models to speed-up and refine soil mapping in Egypt. The most frequently statistical model used for spatial prediction of soil categorical classes is the multinomial logistic regression model. This study examines DSM approach for the production of soil maps by using multinomial logistic regression on soil and terrain information from pilot areas in the Northwestern Coastal region of Egypt. The aim is to reproduce the original map and predict soil distribution in other similar landscapes located in different zones. Reference soil maps produced by conventional methods were used. Following parameters derived from an ETM image and a SRTM DEM were considered: Green Vegetation Index (GVI), Slope gradient, Stream Power Index (SPI), Multi-resolution valley bottom flatness index (MRVBFI) and Topographic Wetness Index (TWI). The logit models of the soil classes as expressed by the spectral and terrain attributes were calculated and predicted soil class's maps were produced. IDRISI/SAGA platforms were used. The accuracy of the predicted soil maps was determined by using error matrices where map accuracy indicators was calculated. The probability models were then tested to predict the spatial distribution of the soil classes at adherent unvisited sites. The developed methodology could contribute to the allocation and to the digital mapping and management for new expansion sites in the remote desert areas of Egypt.

Key words: Digital soil mapping, RS, statistical models, multiple logistic regressions, spectral and terrain parameters, northwestern coastal region, Egypt

FUNDAMENTAL STEPS OF SOIL SURVEYING METHODS AIMED FOR REGIONAL AND COUNTRY LEVEL DATA BASE ESTABLISHMENT

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To establish a powerful database, soil surveys must be executed related with all environmental attributes. After establishing of soil and landform legislation in a broad environmental context soil surveys should be involved with following fundamental steps. A: Cycle of distinguishing the processes which define the soil population distribution; 1) Landscape stratification; this step is done by considering the geologic diversity, geomorphic knowledge, land use and vegetation cover of study area. For better stratification of area, geomorphic taxonomy is one of the most needed subjects. This step could be done by traditional and pedometric methods. In pedometric methods terrain attributes are also used; 2) Sampling scheme landscape stratigraphy; the geologic (tectonic, fault, etc.) and paleoclimatic history of the area in detail should be considered in the formation of different soil layers. In this step, different kinds of paleosoils and their formation should be defined; 3) Landscape evolution; in this step the relative dating of landforms formation is established and defined. B: Cycle of distinguishing the soil evolution pathways and processes of soil formation in each geomorphic unit; 1) Pedodiversity analysis; calculating the shannon entropy index to find whether landforms have convergence or divergence evolution and is there any need for complimentary sampling or not; 2) Complementary sampling. C: Cycle of predicting soil patterns in the study area; 1) Execution of survey; the interpolation of soil classes and attributes could be executed by using Soil Survey Manual or quantitative pedometric models; 2) Data base, to describe all these steps a case study which is done in Isfahan area would be mentioned in detail.

Key words: Database, landform legislation, geomrphic taxonomy, pedodiversity, complementary sampling.

SOILS IN ARID AND SEMI-ARID REGIONS: THE PAST AS KEY FOR THE FUTURE

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Growing populations and technological advances may soon lead to intensifying land use in semi-arid and arid countries, namely the spread of irrigated agriculture. Improved water harvesting and desalinization technology, coupled with higher efficiency of regenerative energies, might allow to widely extending irrigated areas. While this is a positive development in the light of growing demands for water and food, it presents challenges for land use planners. Negative examples like Lake Aral make clear that a careful analysis is required before embarking on large-scale irrigation projects. Soils are central for assessing the impacts of irrigation in the desert. For long-term projects as outlined above, it is insufficient to consider only the present soil distribution. It should also be considered how soils will change under irrigation. In this context, the past is a key for the future, since the modeling of future soil development can be calibrated using reconstructions. Soil surveys which consider the archival role of soils and sediments can partly be used to understand the landscape history and identify risk areas. Paleosols can be evaluated as indicators how changes of moisture availability will affect soil properties, and which time-frames are involved. This can be coupled with modeling of future soil development. A major methodological challenge for this approach is the use of different parameters and time-frames in reconstruction and modeling, which have to be "translated" using experimentally determined relationships. Long-term, large-scale irrigation in arid regions will mean a significant change of the environment and a departure from the conservative idea of sustainability, towards a concept which has been named "progressive development". Its success chances depend largely on our understanding and correct prediction of the consequences of man-made changes of the environment.

Key words: Land use, water harvesting, regenerative energies, soil surveys, arid regions, reconstruction modeling.

THE SOIL SURVEY FOR THE STATE OF KUWAIT

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In 1999, the Government of Kuwait in collaboration with international consultant (AACM) conducted a soil survey project at two levels: Reconnaissance survey at scale 1:100,000 and a Semi-detailed survey at scale 1:25,000. The objective of the project was to provide a comprehensive and useable soil information and classification for the entire State of Kuwait, excluding the urban, industrial and restricted areas. The reconnaissance soil survey was carried out with a total number of 8,400 sites with average sampling density of one observation per 200 hectares. Sites were located with global positioning system (GPS). At the sites holes were dug and the sequence of natural layers or horizons was described. Soil samples were collected from soil pits, air-dried and processed for storage in soil sampling archive. Laboratory data was obtained from 105 profiles to confirm the soil classification made during the field survey. Seventy five map units, 24 soil classes and three miscellaneous units were described following USDA procedures and according to the protocols for fourth order soil surveys. The outcomes of the reconnaissance soil mapping were used to select the semi-detailed study area. A criterion was established to select 200,000 hectares of soils most suited to irrigated agriculture to be re-surveyed at a semi-detailed scale. Some 207,309 hectares were actually surveyed and 16,276 augerhole sites described (approximately 1 per 12.7 hectares). Ninety three map units, 39 soil series and 6 miscellaneous units were established and described. By combining the soil suitability for irrigation with the deep drainage information obtained from the drilling program, an assessment of irrigation suitability was made to define the most suitable areas into which irrigated agriculture could expand in the future. A soil information system (SIS) was developed for the survey that combined the spatial information management capabilities of a GIS with the attribute information management of a relational database system. The GIS was used for the storage, manipulation, analysis and presentation of spatial data. The Soil Survey for the State of Kuwait has been valuable to a wide range of land managers and planners, as well as those involved in agriculture.

Key words: Reconnaissance survey, semi-detailed soil survey, Kuwait, soil characteristics, soil mapping, database, GIS.

DO THE EMERGING METHODS OF DIGITAL SOIL MAPPING HAVE ANYTHING TO LEARN FROM THE GEOPEDOLOGIC APPROACH TO SOIL MAPPING AND VICE VERSA?

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The use of soil maps and the feasibility of the existing soil survey procedure are often questioned by both surveyors and users. Thanks to the advances in the fields of remote sensing (RS) and geographic information systems (GIS), a new trend, digital soil mapping, is emerging which might have answers to some of the questions. With a glance to some of the definitions and concepts, such as "what is a soil?" and "what is the content of a soil map?", we intend to highlight the complexity of the soil and its mapping. At the same time we apply some of the geopedologic-oriented techniques of the digital terrain modelling to soil mapping in order to show the role of geomorphology in the mapping. The exercise was carried out as case studies in several areas in Thailand. Various soils (USDA Soil Taxonomy 1975) at subgroups levels (Fluventic, Arenic, Aquic, Aeric, Ultic, Ustic, Vertic) belonging to the soil orders Entisols, Mollisols, Inceptisols, Alfisols, and Ultisols occur in different geomorphic surfaces, following as well the physiographic set up of the landscapes. The case studies demonstrate the conventional predictive mapping (the ITC approach), and the geopedologic approach to soil survey, based on parameterization of the soil forming factors and their integration; in one case through applying decision trees, followed up by a statistical validation, and in another case by means of Artificial Neural Network (ANN). We hope to open up a discussion, which should lead to: 1) clarifying the term 'digital soil mapping', 2) to find out whether or not the shortcomings of the conventional approach of soil mapping can be recovered using the new trend?, and 3) does the new trend suggests changes in the current definitions and concepts?

Key words: Digital soil mapping, predictive soil mapping, geopedological approach, soil survey, GIS.

CHARACTERIZATION, CLASSIFICATION AND SUITABILITY EVALUATION OF THE SAVANNA SOILS OF OYO NORTH OF NIGERIA

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A detailed soil survey of about 100ha of Savanna ecoclimatic region of Oyo North of Nigeria was carried out to characterize and classify the soils and assess the agricultural suitability potential of the area. Five soil units were identified and delineated. Selected physical and chemical characteristics were determined and used for Soil Taxonomy, FAO/UNESCO legend, USDA land capability classification and Smith Monthmogery series classification. The soils were classified as Typic Haplustaulfs, Arenic Haplstaulfs, Typic Kandiaplic Haplustalfs, Udic Kanhaplustalfs and Psaumentics (USDA-NRCS Keys to Soil Taxonomy of 2003) and Albic Luvisol, and Haplic Luvisol (FAO/UNESCO 1994) and Makun, Iregun, Egbeda, Jago and Apomu (Smith and Montmogery 1962). Sand content dominates both at surface and subsurface. The exchangeable bases were generally low and the exchange sites were dominated by calcium. Total N and organic matter (OM) contents were generally low. The soils were found to be marginally suitable for the crops (cassava, maize etc.) that are commonly grown in the area. Limitations to agricultural production include soil fertility (Cation Exchange Capacity-CEC and OM), poor texture and climate (rainfall and Length of dry season).

Key words: Savanna soils, Oyo region, limitations, agricultural potentials, characterization, Nigeria.

SOIL CLASSIFICATION OF THE STATE OF QATAR

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The most important nonrenewable resources of a country are land and water which are gift of nature and must not be mismanaged. It is moral duty of all nations to conserve these resources in their original status and inherit as such to the future generations. However, it is not possible unless the exact nature and their utilization are well understood. The classification of soils into naturally occurring groups is the pre-requisite for this purpose. The State of Qatar took wise steps in this regard and Ministry of Municipal Affairs (MMA) awarded the task of soil classification and land use study jointly to JENA-GEOS Germany and Awiplan Qatar. The appropriate utilization of these resources was to be consequently addressed. The classification studies by these agencies indicated that all the soils of the state belong to only two orders; Aridisols and Entisols (USDA-NRCS Soil Taxonomy). Gypsids and calcids are the suborders under Aridisols while psamments and orthents are the suborders of Entisols. The surface diagnostic horizon identified for soil categorization is ochric epipedon only except the eroded and/or truncated top soils. Many other surface features like; desert pavement, desert varnish, wind blown mulches, silt or sand or even biological coats or crusts and cracks were observed. The cambic, calcic/petrocalcic, gypsic/petrogypsic or aquic and/or salic subsurface diagnostic horizons were found in the study area. The soils of the entire area of Qatar were categorized into 19 soil mapping units but three of these; gypsids (24.5 %), lithic haplocalcids (21.1 %), haplocalcids (18.6) covered 64.2 % area while typic aquisalids (5 %), haplocalcids (3 %) and calcids (2.8 %) were also encompassing further 10.8 % soils making the total as 75 %. The land suitable for agriculture was found to be 44444 ha with suitability class S3 (limitations; physical, topographic, soil texture and salinity) which is 3.9% of the total area, in addition to 40511 ha that have already been converted into farms. However, only 7628 ha (18.8 %) are moderately to marginally suitable for agriculture even within present farms.

Key words: Qatar, soil classification, aridisols, entisols, calcids, gypsids and salids

CLASSIFICATION OF THE TOPSOIL FABRICS IN ARID SOILS OF CENTRAL ASIA

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The existing micromorphological data on aridic soils are quite sparse. In the present study , we examined micromorphological features of a wide spectrum of arid soils in Russia, Uzbekistan, Kazakhstan and Mongolia in order to develop the diagnostic criteria for the new substantive-genetic soil classification systems. The diversity, functioning and resilience of arid soils are basically determined by the properties of their topsoil, which reflects the recent environment, whereas subsoil is supposed to reflect the paleoenvironment. Each of three upper horizons in the new Russian system of soil classification (2006) which can be found in arid soils - the light humic, eluviosolonetzic and xerohumic - has the same micromorphological features in different soils. However, present study shows that, in a sequence of soils, there are some specific micromorphological properties that indicate the increasing aridity. In a soil sequence with increasing aridity, the diagnostic horizons and properties are combined in a regular way corresponding to the changes in environmental conditions and soil-forming processes; at the same time, the sequence is in good agreement with diagnostic elements of substantive Russian and WRB classification systems. Thus, the arid soils form two groups: with a distinct light humic horizon, and with a xerohumic horizon composed of crusty and subcrusty subhorizons. These groups correspond to two types of pedogenesis, respectively. The micromorphological properties of the topsoil make it possible to identify the mechanisms of some phenomena: aeolian deposition, structural rearrangement, dynamics of secondary carbonates, and cryptosolonetzic manifestations.

Key words: Fabrics, micromorphology, aridic, paleoenvironment, xerohumic, Russia.

INTERNATIONAL CLASSIFICATION (WRB, 2006) FOR SOIL DIVERSITY ASSESSMENT IN SUB-ARID REGIONS OF WESTERN SIBERIA (RUSSIA)

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As a result of the researches during 2000-2008, the arid regions of Western Siberia were to receive new data on the structure of a soil cover, properties of its components, their genesis and ecology. It has allowed to detail modern representations about a variability of soil components in sub-arid region of Western Siberia and to fill an existing gap in fundamental knowledge in this area. New data have been obtained on their genesis, properties, landscape and environmental conditions of formation and the classification diversity has been shown as well. Basic types of soil cover disturbances, and main reasons of its limited use have been considered at the example of the valley under study. As zonal soil types dominate Chernozems, Kastanozems and Phaeozems (WRB, 2006). These soil types are located in higher relief position and a deep groundwater level. At slope positions are located Gleyic Chernozems and in depressions by high groundwater level - saline soils: Mollic Solonchak, Gleyic Solonchak and Mollic Solonez. The Mollic Solonchak contains water soluble salts in high amounts, sometimes gypsum. Soluble salts come from groundwater with ascending water and after evapotranspiration salts are precipitated and accumulated in upper soil horizons. Gleyic Solonchak contains high amounts of salts that is toxic for plants. Solonetz is a soil, which contains a huge amount of exchangeable Na in the humus horizon. Basic types of soil cover disturbances and main reasons of its limited use have been considered at the example of the valley under study.

Key words: Soil diversity, arid regions, western Siberia, solonchaks, solonetz, aridity.

USAGE OF SOIL SURVEY DATABASES FOR PROBABILISTIC EVALUATION OF TRANSFORMATION OF SOIL COVER

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There is a problem of statistically proved quantitative estimation of transformations of soils as a result of natural and anthropogenic processes due to high natural variability of soils at different hierarchical levels. Analysis of probability distributions gives us information about two structural levels. One of them characterizes condition and behavior of separate independent elements, and another holistic property of systems which is defined quite unequivocally and is characterized by means of probability distribution function (pdf). The initial data for this research were results of some large-scale (1:25000) soil surveys, which were conducted at different times in 20th century at significant part (approximately 1.6 million ha) in southwest of Kulunda steppe located in the south of Western Siberia. The region is characterized by droughty continental climate. Soils significantly vary in texture, from loose sands to loams, which is a result of the ancient Quaternary limnetic alluvial genesis of the territory. The predominant soil is loamy sandy chestnut soil. All received data were entered into database and grouped. Each sample represented the data concerning one soil property (humus contents, contents of texture fractions and others) of one soil variety in one soil horizon or a layer at separate time period. Standard procedures of checking of hypotheses about affinity of investigated statistical distribution to theoretical one frequently do not give satisfactory unequivocal answer. Therefore we applied new approach, which have allowed identifying pdf with very high reached probability value. As a result we received bank of pdf of soil properties. The carried out analysis of dynamics of pdf has shown, that frequently simultaneously two opposite tendencies to decrease and increase of soil property take place under nature or anthropogenic processes. As a rule there is a prevailing tendency. For adequate quantitative estimation of changes of soil properties we used mathematical value of divergency of pdf.

Key words: Probability distribution function (pdf), transformations, chestnut soil, database, anthropogenic, divergency.

THE SUITABILITY OF THE SOILS OF NORTHERN STATE OF SUDAN TO IRRIGATED AGRICULTURE

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A semi-detailed soil survey was carried out during July to November 2004 on both banks of the river Nile between the third and fourth cataracts, at an extent of approximately 400 km, in the Northern State, Sudan. The total surveyed area amounts to 390,857 ha (930,438 feddans) between longitudes 30°20' and 31°50' and latitudes 17°45' and 19°45'. This area lies within the desert climatic zone of Sudan. The main objectives of this soil survey are: characterization of the soils and landscape; assessment of the land suitability for irrigated agriculture; provide guidance to agronomists and irrigation engineers considering the feasibility of proposed developments. Anticipating a low level of management/investment, land suitability for gravity irrigation with emphasis on mechanized cultivation by smallholders for a range of crops i.e. wheat, broad beans, vegetables, alfalfa, sorghum, maize, citrus and date palm was fairly discussed. It became apparent during the survey that the amount of land suitable for this land use type was limited; hence, considerable land remained potentially irrigable by sprinkler and/or drip irrigation methods. Of 8,457 soil augers holes sites, 3,403 sites were sampled for salinity and sodicity, 137 soil profile pits with full chemical analyses and infiltration tests from 122 profile pits formed the basis for this soil survey and land suitability assessment. The total number of soil units that were defined, classified and mapped were 36 grouped into five main units. Within each group the soils were differentiated according to their content of secondary calcium carbonate, top soil texture and particle size composition. Recent and sub-recent Nile alluvial soils are deep, i.e. comprise more than 2.0m of permeable material. The soils are of variable texture and are generally non-saline and non-sodic. The soils lack any significant carbonates accumulation and cover 12% of the survey area. Nile High Terrace soils - the old - high terrace - alluvium tends to have significant calcium carbonate concretions and a calcic layer below 1.0m, and to be strongly sodic and often saline, too, in many areas; gypsum occurs locally. In the Seleim and Wadi Khowi areas the High Terrace soils are mainly very sandy. Elsewhere, they tend to be loamy and clayey. The soils are always deep and cover 26% of the survey area. Desert Plain soils - The Desert Plain is not a continuous landform but is a series of basins, old wadis and coalesced fans forming a complex depositional landscape of low relief. The relief is now so subdued that it is difficult to identify the different landforms. Soil units on the Desert Plain have been recognised on the basis of the presence or absence of significant secondary carbonates and gypsum and secondly on the dominant textural class. The soils are very variable, especially in their texture and depth. Textures range from sandy to clayey and depth can vary from less than 0.5m to well over 2.0m. Salinity and sodicity, too, are variable. The soils cover 29% of the survey area. Nubian Formation soils - Low Nubian plateaux

and outcropping low hills with predominantly shallow soils, and extremely gravely ridges and terraces a top Nubian rocks, together cover 17% of the survey area. Two soil units have been identified - a lithic (i.e. <50cm deep) soil overlying hard rock and an extremely gravelly soil developed from old (Nile) gravely alluvium. These gravels mostly overlie sandstone or mudstone within 2.0m and in many cases the gravels have been cemented by calcium or silica. The Nubian soils are frequently strongly saline and sodic. Soils of recent windblown sand and wadi deposits - are deep sandy and/or gravely soils and include sand dunes, sand plains and major wadi lines. Together, these soils cover 16% of the survey area. Soil properties with regard to irrigation method such as infiltration, permeability and available water capacity, soil structure, soil fertility, soil salinity and soil sodicity were highlighted. The land suitability for the intended land utilization types which were gravity, sprinkler and drip irrigation methods. Lastly recommendations on the reclamation of the salt-affected will be presented.

Key words: Suitability for irrigated agriculture, salinity, sodicity, reclamation, soil survey, Sudan.

SOIL THEMATIC MAP OF DUBAI EMIRATE USING REMOTE SENSING AND GIS

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The soils of Dubai were mapped using remote sensing satellite data (IRS- P6 LISS IV) at scale of 1: 25,000. The soils of the study area were classified up to series level and their associations as per the USDA-NRCS Keys to Soil Taxonomy of 2003. In Dubai area 26 soil series have been identified and 13 soil series were identified in Hatta area. The soils of Dubai area are generally coarse textured, sandy, highly calcareous and undeveloped. Soils in the coastal area, low-lying areas and depressions are highly saline. The soils of the inland areas are either saline or sodic. The Hatta area is characterized by mountains with steep side slopes, which are devoid of vegetation. Almost all the hills are barren (80-90%) and rocky without any soil cover. The soils in the hills are shallow to very shallow, skeletal in nature, and highly calcareous. The soils have been evaluated for land capability classes and it was found that 17 % of the total study area was under land capability class IV, with the major limitations of climate and soil. These soils are suitable for marginal agriculture only with the support of assured irrigation. The dominant land capability class identified in Dubai is class VI which occurs in 65% of study area. The dominant land capability class in Hatta is Class VIII and accounts for 85.3 % of the study area. Thus, the soil have major limitations of climate and soil which can be improved by adopting various soil conservation measures like sand dune stabilization, shelter belts, afforestation etc.

Key words: Dubai, thematic maps, soil series, Hatta, soil capability class.

THE SAND LAND SOIL SYSTEM PLACEMENT (TAXONOMY) AND SOCIETY

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Arid soils of the world, including Latterites of the African savannas, Xeralfs and Xererts of the Mediterranean basin, Argids, Orthids, and Ortents of Asian deserts have unique characteristics necessitating different strategies for optimum utilization of land when the delicate balance between annual climatic cycles and general trends toward desertification predominate. Arid lands are an irreplaceable natural resource covering one-third of global land surface and harbor within them the potential to elevate the standards of living of more than two billion people. Arid soils are also the main source and sinks of atmospheric CO_2, with potential to earn Carbon Credits in world markets if classified and correlated according to the standards of internationally accepted soil classification systems. However, the soils of arid areas are being degraded due to adverse natural and anthropogenic activities and are seriously underutilized due to insufficient rigorous scientific classification and evaluations coupled with inadequate public knowledge. Currently, mountains of data are produced via sustainable development programs, food security projects on randomly selected sites, and assessment of land degradation by powerful computers and satellite imagery techniques. This voluminous data is severely underutilized and counter- productive when not coupled with field work because of non- replacement of representative soils/farmland units, based on soil taxonomic standards. In a modern age of precise measurements and categorization available for efficient utilization of science to benefit the population, it is time to use the available tools to greatly enhance the productivity and use of the soil system in general, and arid soils in particular. Quantification of multiple ecosystems within arid regions through detailed and correlated studies of soils on an applicable scale can provide opportunities for land users to diversify agro-ecological systems and for food security and environmental programs to establish project sites based upon well defined representative soil units in each region. Thus, soil scientists would have the ability to extrapolate the results of studies and promote national productivity and the regional economy. Failure to do so would inevitably lead to a self-destructive practice of fueling regional economies detrimentally in the short term by consuming capital and degrading natural ecosystems, consequently accelerating the depletion of their most valuable natural resources. In this study, selected soils in various arid environmental and ecological regions of countries such as Ghana, Jordan, and Iran have been investigated and analyzed based upon field and laboratory characteristics on the basis of USDA Soil Taxonomy Standards to the level of Soil Series/Farmland Units on applicable scales. Data for the study was gathered and completed primarily by the author as the FAO of the UN, World Bank consultancy missions; U.S Fulbright Regional Scholar in Middle East assignments; and Shiraz University Academic Research and Teaching Programs. The obtained data on classifying soils and preparing Soil Survey Reports

in each country will be presented and discussed at Abu Dhabi during the International Conference on Soil Classification and Reclamation of Degraded Lands.

Key words: Soil system, arid regions, soil taxonomy, society, FAO, World Bank.

CARTOGRAPHY AND MAPS OF ABU DHABI SOIL SURVEY

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Abu Dhabi Emirate recognized the need for a Soil survey to provide foundation for the effective management of its natural resources. Cartography is the knowledge associated with the art, science, and technology of maps. This soil survey was implemented in two phases, the first is an extensive soil survey at a scale of 1:100,000 for the entire emirate, while the second is to conduct an intensive survey for the selected area of 400,000 hectares in scale 1:25,000 based on results of the first phase. Soil, vegetation, land use and other thematic maps were produced at various scales and in different map series and nominal sizes (A0 to A3). The entire emirate of Abu Dhabi laid in one sheet A0 size at a scale of 1:500,000, 4 sheets A0 size at a scale of 1:250,000, 29 sheets A1 size, and 113 sheets A3 size at a scale of 1: 100,000. While in the second phase of the project, the intense survey, 46 sheets A1 size at a scale of 1:25,000 were produced. These maps were developed for cartographic standard for publication according to the Unites States Department of Agriculture; Natural Resources Conservation Service; National Soil Survey Handbook part 647.09, map finishing (USDA, 2005). The standard by which these maps were produced has been used for Abu Dhabi Coastal soil Survey and other soil maps produced by Kuwait Institute for Scientific Research (KISR 1999) for the State of Kuwait.

Keywords: Cartography, maps, Soil Survey, Abu Dhabi Emirate, UAE.

PROPERTIES AND CLASSIFICATION OF SOME AGRICULTURAL SOILS IN NORTH OF EGYPT

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The influence of soil types on their properties and classification were investigated in this study. Twenty soil profiles varying widely in their origin and properties were selected from north of Egypt. The studied soils were representing the main soil orders, i.e., Entisols (developed on fluvial, lacustrine, marine, sandy, fluvio-sandy and fluvio-marine deposits) and Aridisols (calcareous deposits). The diverse geological nature of these deposits is reflected in the wide variation of morphological description, clay content, cation exchange capacity, carbonates content, and all the forms of Fe, Al, Si and Mn oxides. All soils were alkaline with average pH values ranging from 8.2 to 9.2. Soil salinity differs widely between the studied soils and ranged from 0.66 to 64.8 dSm^{-1}. Clay content ranged from an average of 62 to 456 g/kg (6.2 to 45.6%). Cation exchange capacity ranged from 8.0 to 55.0 cmolc/kg, organic matter content from 5 to 25 g/kg (0.5 to 2.5%), total calcium carbonates equivalent from 11 to 276 g/kg (1.1 to 27.6%) and active calcium carbonates equivalent from 6 to 126 g/kg (0.6 to 12.6%). Total Fe, Al, and Mn concentrations differed greatly between soils. The majority of Fe and Mn existed in crystalline forms. On the other hand, Al oxides mainly existed in amorphous form especially in the clayey soils. Values of total free Si were similar to or exceeded those of amorphous Si in all soils except for the calcareous ones. Consequently, the great differences in these properties were expected to affect the classification of studied soils. The studied fluvial soils were classified as Vertic Torrifluvents, Typic Torrifluvents, Fluvaquents and Typic Ustifluvents. Lacustrine deposits were classified into Typic Xerfluvents and fluvaquents. Marine deposits were classified as Typic Xerpsamments. Sandy soils were classified as Typic Torripsamments. Calcareous soils were classified as Typic Calciorthids.

Kew words: Soil types, Soil Taxonomy, physico-chemical properties, Aridisols, Entisols, Egypt.

SOIL CLASSIFICATION AND GENESIS IN PART OF KHORASAN PROVINCE

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Saline and sodic soils occupy an important part of Iran including the vast area in Khorasan province. Also due to salinization of some arable lands, the amount of salt-affected soils are increasing every year incredibly. In order to characterize the soils in terms of physico-chemical properties and eventually to classify the soils this study has been conducted. The preliminary study of the area was completed through aerial photo interpretation. Based on different physiographic units dominantly, piedmont alluvial plains and flood plains separated according to airphoto characteristics and topographic map, then 30 soil profiles were dug and studied. Following the field study, soil samples were collected from each genetic horizon for physico-chemical analyses and eventually some pedons were selected for detailed studies. The samples were analyzed according to the USDA standard methods. The soil moisture and temperature regimes were calculated as aridic and thermic, respectively. The results showed that the parent material originating from gypsiferous and saliferous marls, in probably as the main factor for soil salinization in this region. Topography, wind and human influences are also considered as factors of soil salinization. Micromorphological studies showed that secondary gypsum and calcium carbonate has accumulated in some pedons, forming gypsic and calcic horizons respectively. The soils were classified according to the USDA-NRCS Keys to Soil Taxonomy of 1994. The soils revealed to fit with Aridisols and Entisols orders and calcids, salids, gypsids, cambids, fluvents and orthents suborders, accordingly. The new subgroup of Sodic Torrifluvents was also proposed.

Key words: Classification, genesis, saline and sodic soils, horasan province

SOILS OF THE STATE OF QATAR: ORIGIN, GENESIS AND CHARACTERISTICS

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The soils are very important component of the total land resources of a country because these form the basis of agriculture. With the development of limited soilless agriculture in the present century, importance of soil has not lessened even fractionally. Agriculture is prime even in industrial or oil producing countries because food security is one of the most important issues of a nation for its safe existence and sovereignty. The exact understanding of the nature and characteristics of soils of the country is of paramount importance for modernizing and equipping its agriculture with current technologies. Topographically, the State of Qatar is a relatively flat to undulating desert plain. However, distinct hills are present in the Dukhan region. The country is a part of the Arabian Peninsula and therefore major parent material originated from ocean. The dominant arid climate, lateral erosion and aeolian activity are the dominant soil formation processes. The majority of wadi-like channels or small rims have been filled by accumulation of colluvial material generated by flash floods combined with deposition of aeolian transported sand and dust. Because soil aridity was specifically dominating, therefore, Qatari soils are mainly calcareous ($CaCO_3$ = 31 %). The content of gypsum averages as 7.8 % that classifies these soils as Gypsids. The soils are generally saline, moderately alkaline (pH = 8.0) with gravelly light texture. Organic matter content and cation exchange capacity (CEC) are characteristically low (OM = 0.55% and CEC = 3.2 meq $100g^{-1}$). Most of these soils are poor in their fertility lacking nitrogen and available phosphorus while potassium is adequate. The micronutrients are also low in their availability. Topography, soil texture, salinity and availability of water are the main limitations to lower suitability of these soils for agriculture. However, some of the soils can be developed by removing limitations categorizing presently a part of these as marginally suitable or currently unsuitable.

Key Words: Parent material, soil texture, salinity, alkalinity, fertility, organic matter, CEC, and Qatar.

ASSESSMENT OF CHANGES IN THE SOIL COVER OF THE CHECHEN REPUBLIC IN 1988 AND 1998

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Considerable changes in the soil cover of desert territories take place under the impact of both natural and anthropogenic factors. Human activity on these territories depends on the economic feasibility of land exploitation. Remote-sensing (RS) materials obtained in different years make it possible to trace the dynamics of changes in the soil cover. The problem is to find appropriate indicators of soils on the images, which requires ground-truth data. We developed the system of soil indicators on the basis of the soil map of the Chechen Republic compiled in the 1980s on a scale of 1:200 000. First, it was necessary to correct geometric distortions on the original map. For this purpose, a GIS containing the georeferenced topographic base map in raster and vector formats was created. The digital elevation model (DEM) was developed on its basis, and morphometric parameters of the relief were calculated. The initial soil map was digitized and corrected with the use of the DEM. Satellite images from Landsat and other satellites were added to the GIS. On their basis, the original soil map was revised, and the new soil maps for 1988 and 1998 were developed. The comparison of these two maps made it possible to trace changes in the soil cover in the period from 1988 to 1998. The following areas were delineated on the resulting map: 1) stable territories with good land quality; 2) stable territories with poor land quality; 3) unstable territories with irregular changes in the soil cover; 4) territories with a tendency for the improvement of soil conditions (subdivided into three groups with respect to the degree of improvement) and; 5) territories with a tendency for the deterioration of soil conditions (also subdivided into three groups). In general, minimum changes (stable territories) took place in the soils of the mountainous part of Chechnya. Plowed lands of the republic were unstable and characterized by a generally low quality. Desert and semi desert territories were subjected to strong anthropogenic impacts leading to the soil cover degradation. The areas with insignificantly, moderately, and strongly changed soil conditions were delineated. Large areas of abandoned agricultural lands were also shown on the resulting map.

Key Words: Chechen republic, soil cover, digital elevation model, remote sensing, soil map.

DIGITAL MAPPING OF GYPSIC HORIZON MORPHOTYPES AND SOIL SALINITY OF TIAN SHAN OLD ALLUVIAL PIEDMONT PLAIN

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The digital maps of soil salinity, gypsum content and forms of gypsum pedofeatures in soils (Gypsic Calcisols, Gypsisols and Solonchaks) of the Dzhizak Experimental Station (Uzbekistan) were developed on the basis of the analysis of detailed soil survey materials 1980 and 2008, digital elevation model (DEM), and remote sensing data. The studied area represents a part of the Golodnaya Steppe piedmont plain to the north of the Turkestan Ridge. The macro- and micromorphological descriptions of gypsic horizons made it possible to distinguish between three different morphotypes of these horizons. The morphological parameters of gypsic horizons were classified, and the map of their distribution was developed with the use of GIS technologies. The spatial distribution of different morphotypes of gypsic horizons showed distinct correlations with the soil salinity, the groundwater level, and the character of soil water regime. It was suggested that the presence of different gypsic horizons should be taken into account in the new substantive-genetic classification of Russian soils at the high taxonomic levels. Studies performed after 20 years, when the groundwater level dropped by about 1 m, showed that the gypsum content in the soils decreased insignificantly and the soil salinity decreased more. The major morphotypes were preserved. However, micromorphological investigations demonstrated certain changes in the microfabric of gypsum pedofeatures. Thus, fine dispersed crystals of gypsum disappeared from the soil profiles, and the number of pseudomorphic substitutions of calcite for gypsum crystals increased significantly attesting to the progressive calcification of the soil profiles.

Key words: Gypsic, morphotypes, micromorphology, pedofeatures, pseudomorphic substitution.

STUDENTS' ESTIMATION AND DETERMINATION OF SOIL TEXTURE

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Determining soil texture helps to understand many soil physical and chemical properties. Descriptions of soil texture can be determined in the laboratory or estimated by hand in the field (feel method). The accuracy of description is high in the laboratory determination due to the fact that the field estimation depends mainly on the person's skill and experience. Accurate and quick field estimations of some soil properties may be useful techniques for soil engineers in comparison to laboratory procedures. Laboratory procedures, such as mechanical analysis to determine soil particle proportions, is a time and efforts consuming. In this study, 11 students were trained for three weeks in using their feeling skills to estimate clay and sand particles percentages and soil textural class as well as determining soil texture class in the laboratory using the hydrometer method. The study results showed that the students were able to estimate the samples' clay and sand contents almost two thirds of the time. When the students' results were fitted to the laboratory results, the students' estimates predicted the actual clay and sand percentages with high degree of accuracy. The results also showed that a high variation between students in estimating soil texture in the laboratory. Estimation of sand fraction is slightly more difficult than clay particles. This study suggests that students require more practice to be able to estimate soil textural class accurately. We recommend using reference samples that may help to improve students' skills. Because of the importance of field estimation, soil texture estimation has to be considered and given more attention in teaching soil science classes.

Key words: Soil texture, feel method, hydrometer, student skills, soil science.

CHARACTERIZATION AND EVALUATION OF THE POTENTIAL IRRIGABLE LANDS BETWEEN ELKAWA TOWN AND ESSIREHA VILLAGE ALONG THE EASTERN BANK OF WHITE NILE, SUDAN

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The present study aims at characterization and land evaluation of irrigable soils between Elkawa town and Essireha village on the eastern bank of the White Nile. These soils may contribute significantly to the improvement of agricultural production of these poor areas. The total area is about 65000 hectares. Soil Characterization and land evaluation processes were completed following the FAO system of land evaluation that has been adapted to suit the local conditions. Ten soil profiles and more than 5,000 soil samples were analyzed to characterize the established soil series and to study the salinity and sodicity of the area. Six different soil series were identified based on variability of their position on the landscape, soil texture, soil reaction (pH) and vertisolic characteristics. Four soils belong to the order Vertisols and the other two to the order Aridisols. The current land suitability for irrigated agriculture of the identified land units ranges from moderately suitable (56.1% of the total area) to marginally suitable lands (43.9%). The predominant limitations that hinder the agricultural production in these lands include high content of smectitic clays (vertisolic limitations), salinity, sodicity, and wetness conditions which is invariably associated with the relatively lowlying areas on which two main soil mapping units were identified. The study revealed that the soluble salts are concentrated mainly on the top 30 cm of the soil profile and constitutes more than 50% of the total area. The salinity classes in the area are mainly slight to moderate whereas the strongly saline classes are of a limited extent (1%) and mostly associated with lowlying areas. Soils with sodicity in the top soil (0-30cm) occupy about 30.4% of the total area. However, sodicity increases with depth to account for 32.4% of the total area. The strongly sodic soils comprise about 5% of the total area.

Key words: Characterization, FAO land evaluation framework, irrigable soils, vertisols, aridisols, sodic soils.

EXPLORING SUBSURFACE RESOURCES THROUGH DEEP DRILLING IN THE SOIL SURVEY OF ABU DHABI EMIRATE

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The drilling program provided information to assist development of thematic maps and in providing additional information on subsoil conditions in the four intensive soil survey sub-areas. In addition it provided information on potential resource sources within the Emirate. 700 bores were made across the four sub-areas represented by the intensive soil survey area, 600 bores to five meters depth and 100 to 10 meters. The boreholes represented transects of various lengths together with a few groupings of bore holes not aligned as transects. At each borehole a comprehensive range of landscape and soil properties were recorded. The data was entered into the project database for analysis and 300 samples were collected and processed for analyses for gypsum and carbonate content or soil mineralogy. Information collected at each borehole included location, elevation; site ID, texture classes and depths, occurrence of gravels, water tables and gypsum content. The logs were also used to generate schematic cross-sections through the landscape The borehole data supported the intensive soil survey results that identified significant short range variability in soil type, particularly in the Ghayathi sub-area. Within the Madinat Zayed sub-area virtually no soil variability was found by the drilling data that described deep sands to 10 metres. East of Jabal Hafit uniformity in soil texture was identified in the bore data for transects close to Jabal Hafit mountain. Throughout the area gravels were a common feature of all sites. At As Sila', the presence of gypsum throughout the soil profile to the full depth again confirmed intensive soil survey results.

Key words: Deep drilling, Abu Dhabi, intensive survey, bore hole, gypsum.

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SESSION – II

Advances in Soil Salinity Mapping, Monitoring and Reclamation

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments
17-19 May, 2010 Abu Dhabi City, United Arab Emirates

EFFECTS OF PLANTS ON SOIL FORMING PROCESSES: CASE STUDIES FROM ARID ENVIRONMENTS

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The soil survey of Abu Dhabi Emirate supports the view that dwindling supplies of sand since the last sea level rise have resulted in deflation progressively working its way inland. As a result older linear dune systems become inverted with vast quantities of dunal and interdunal sand piled up on basement highpoints and old mega dunes. The stratigraphy of rubified and non rubified sands within such formations suggests that aridity has varied and that land currently submerged in the Arabian Gulf has acted as a major source of these classes of sand. While it is known that rubification is promoted by warm temperatures, oxidizing conditions and periodic presence of moisture, the precise mechanisms underpinning the phenomenon have yet to be specified. Recent studies of eucalypts inhabiting a dune in semi-arid southwestern Australia show that iron can be hydraulically uplifted from ground water via deeply penetrating tap roots and then exuded into upper, drier soil layers via the lateral root systems (see Pate and Verboom, 2009 & Verboom and Pate (in press). Hydraulic lift has also been suggested for *Acacia tortilis* on East African savanna (Ludwig et al, 2003) but the quantities of mineral elements transported in these fluids was not defined. A prime reason for suspecting a causative association between large woody species such as *Acacia tortilis* and rubification processes in the United Arab Emirates (UAE) is their co-occurrence on the down wind ends of mobile dune fields blowing in from the gulf. We would suggest that definitive studies of iron uptake and translocation in this ecosystem will lead to a better understanding of rubification process in current and paleoenvironments of the region. Additionally, nightly uplift of deep groundwater by trees such as *Acacia tortilis* will clearly have important implications for net primary productivity of arid ecosystems concerned and should have flow on benefits for agriculture if methods to reduce the competitive interactions between parent tree and planted understorey beneficiaries can be developed.

Key words: Dwindling supplies, rubification, iron, acacia tortilis, paleoenvironments, arid environments, Abu Dhabi.

THE RECLAMATION EFFECTS SHOULD BE CONSIDERED FOR SALINE SOIL CRITERIA IN SOIL CLASSIFICATION SYSTEM

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It is well known that most saline soils have salts accumulation in the surface and are formed under evaporation of salty ground water. The criteria for classifying soil as saline taxon are different in different soil classification systems. In Chinese Soil Taxonomy (CST), the soil has a salic horizon that starting within 30 cm from the soil surface is named Orthic Halosol. In World Reference Base (WRB) the soil has a salic horizon that starting within 50 cm from the soil surface is named Salchak. In USDA-NRCS Soil Taxonomy (ST) the soil has a salic horizon that starting within 100 cm from the surface is named Salid. In China, there is large area of saline soils that were reclaimed for crop planting in arid and semiarid area. This paper studied some soil profiles that were classified into saline taxon in CST, WRB and ST before reclaimed, to see if these soils were still classified into saline taxon after long history of irrigation in the three soil classification systems. The results showed that the salts were leached into certain depth, there were not salic horizon that starting within 50 cm from the soil surface in some soil profiles, and these soil profiles were not classified into saline taxon in CST and WRB, but still were classified into saline taxon in ST. With long irrigation history, the depth of salic horizon is related to the amount of irrigation water and irrigation models. The more water was irrigated once time, the deeper the salts was leached. The surface irrigation leached the salts into more deep then the drip irrigation did. According to our study, we suggested that the criteria of ST should be taken for keeping reclaimed saline soils in the saline taxon, i.e. soil classification should not be changed by irrigation. We also suggest that more soil survey should be taken for discovering how much water used in normal irrigation models and how deep the salts was leached under such normal irrigation models. Through analyzing large amount of data, especially those data coming from reclaimed saline soils, the depth and index for salic horizon should be re-defined for keeping the reclaimed saline soils in the saline taxon of soil classification systems.

Key words: Saline soils, Chinese Soil Taxonomy, World Reference Base, USDA Soil Taxonomy, salic horizon, irrigation history.

SPATIAL ANALYSIS USING A PROPORTIONAL EFFECT SEMIVARIOGRAM MODEL

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The assumption of zero trend seems unlikely for many soil properties that change systematically across the landscape. Removal of a trend may result in a bias in estimating the semivariogram and in many studies has not resulted in apparent improvements in kriging estimates. The objective of this study was to use a proportional effect semivirogram model approach for handling a region with a pronounced trend aside from trend removal. To demonstrate this approach soil samples (0-0.3 m depth) were collected along four transects and analyzed for the electrical conductivity (EC) of the 1:5 extracts. The 50-m long transects centered on the points (x_j) were from four sub-regions with maximum contrast in salinity means [$m(x_j)$]. Fractile diagrams and goodness-of-fit analysis at the 0.05 significance level indicated that the normal distribution function fitted the EC values of the four transects. Except for transect T(x_1) a lognormal distribution function might also be accepted. A proportional effect stationary semivariogram model: $\gamma_e(h,x_j) / \Phi[m(x_j)] = \gamma_s(h)$ was fitted to the local experimental semivariograms $\gamma_e(h,x_j)$ by the steepest descent optimization method. The predicted local dispersion variances were reasonable when compared with the experimental variances thereby supporting validity of the proposed model. Statistical analysis of cross-validation (kriging) results confirmed the adequacy of the stationary semivariogram model and the validity of the estimated parameters. The assumption of quasi-stationary instead of stationary along the transect improved predictions of true kriging variance. The proportional effect quasi-stationary semivariogram models may offer a possible approach for krig handling a regionalized variable having a pronounced trend without the need for trend removal.

Key words: Spatial analysis, semivariogram, kriging, fractile diagram, proportional effect quasi-stationary (PEQS).

MAPPING SOIL SALINITY USING GIS AND REMOTE SENSING TECHNIQUE

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Soil salinity in semi-arid environments is a major concern for the sustainability of agriculture and water management worldwide. In this study GIS and Remote Sensing technique were used to get soil salinity information in a chosen area of the narrow strip in Sinai Peninsula which extends along the Suez Canal and apart of Suez Gulf in Egypt. In 23 surface soil samples the electrical conductivity (dSm^{-1}) was determined, and the Landsat TM image acquired in 1991 with a 30-m resolution covering the same area was used to measure the mean reflectance pixel values at these specific samples ground locations. Landsat TM data was preprocessed (geometrical and radiometrical). Forty bands ratios were developed from the 6 TM original bands to select the band or bands required for this particular need. A correlation matrix was developed using SPSS statistical software to measure individual correlation to all developed bands and lead to select the best regression model to represent a soil salinity map. Significant correlation was shown between the inverse of 3 reflectance TM bands and the premeasured EC values (r=0.77, 0.56, 0.59 at 0.01 level for inverse of TM1, TM2, TM4 respectively). Linear regression model: $y = c1+c2\ (1/TM1)+c3(1/TM2)+c3(1/TM4)$ with correlation of determination $R^2 = 0.669$ was developed for soil salinity mapping. Thus by applying this equation to the inverse of 1, 2, and 4 Landsat bands a soil salinity map was prepared. Finally it can be concluded that remote sensing technique is useful and can be considered as reliable, cost-effective and timely method needed to determine the extent of soil salinity, hence offering several advantages over conventional ground methods, and helping the decision makers to plan remotely actions needed in potential and use of land soil survey and water managements.

Key words: Remote sensing, GIS, soil salinity, Landsat TM, Sinai, Egypt

GEOGRAPHICAL DISTRIBUTION OF SOIL SALINITY, ALKALINITY AND CALCICITY WITHIN FAYOUM AND TAMIA DISTRICTS, FAYOUM GOVERNORATE, EGYPT

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Surface and subsurface soil samples were collected from 81 sites at Fayoum and 84 sites at Tamia Districts, Fayoum Governorate, Egypt accorrding to a grid system at a log distance of 2 kilometers using a GPS. Geographical distribution of soil salinity, alkalinity and calcicity in addition to soil texture and organic matter contents throughout the study area (about 770 km^2) were identified and mapped using the GIS system and ILWIS format on the basis of their levels in soil. Data obtained showed that soil salinity in terms of ECe values ranged between 1.22 and 22.4 dSm^{-1} in Tamia and from 1.03 to 97.1 dSm^{-1} in Fayoum District soils within the top layers. About 89 % of Tamia soils and about 56.5% of Fayoum Distict soils had ECe values >4 dSm^{-1}. The obtained salinity maps presented the distribution of salt-affected soils throughout the study area. About 92% of Tamia soils and only 30% of Fayoum soils contained more than 10% $CaCO_3$ equivalents,this was due to the nature of parent material in the study area with respect to soil pH of the top 30 cm layer, only about 3% of Tamia soils had pH values >8, however about 73% of Fayoum District soils were of pH > 8. Soils of pH values >8.5 represented 3.6% of Tamia soils and 9.53% of Fayoum District soils. The organic matter contents did not exceed 0.8% for Tamia and 1.5% for Fayoum soils. Resultes obtained also included the particle size distribution of all the studied soils. The present investigation provides GIS maps, scientific and geographic information that could help both decision makers and researchers for proper land use planning.

Key words: Salinity, alkalinity, calcicity, ILWIS, GIS, Fayoum, Egypt.

TEMPORAL VARIABILITY MEASUREMENT OF ELECTROMAGNETIC INDUCTION BY EM38

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The Huang-Huai-Hai Plain is one of the most important agricultural regions in China facing challenges of water shortage, salt accumulation and drought. Precision agriculture offers the possibility for site specific application of irrigation water and fertilizer to mitigate these problems. To obtain the required soil information, samples are commonly taken for laboratory analyses - a time consuming, laborious and expensive procedure. Interestingly, the EM38 sensor can be used to map field variability based on real time electromagnetic induction. It is fast, non-invasive, and able to measure at variable depths. The EM38 measurements can be used as a tool to determine soil properties such as type, water content, and salinity. A substantial amount of previous work has been carried out to use EM38 for characterization of soil types and to quantify the salinity in soils where it is the major influencing factor. However, for in situ determination of these parameters in non-saline soils, factors influencing the measurement need to be quantified. In the present study, a survey of apparent electrical conductivity (ECa) was used to create high resolution soil maps at three different times to gain information on its temporal variation. The experiment was conducted in Wuqiao on the North China Plain. The EM38 was used both in horizontal and vertical dipole modes together with global positioning system (GPS). The repeated recordings reveal that the absolute values of ECa varied over time, depending on varying soil moisture and temperature. Therefore, in order to get stable ECa information, the mean values of three measurements were calculated and the mean ECa map was created. Thus the short term fluctuation of the EM38 signal, as caused by factors like soil water content or temperature can be reduced by repeated measurements. Finally, the attained ECa can be used to manage site specific water supply to avoid over-irrigation and salt accumulation.

Key words: EM 38, precision irrigation, electromagnetic induction, North China Plain, ECa.

TECHNOLOGICAL ADVANCES IN SOIL SALINITY ASSESSMENT AND MONITORING

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Soil salinity is the most discussed issue through centuries globally from both agriculture and land degradation perspectives. In both cases the soil resource quality is declined to provide agricultural and environmental services to their full potential unless the problem is clearly understood and quantified and proper actions taken. Understanding of salinity problem is very complex as the salinity issue is not static but dynamic and changing temporally and over a period of time. Many plants either fail to grow in saline soils or their growth is retarded significantly. However, few plants grow well on saline soils; therefore, soil salinity often restricts options for cropping in a given area. This suggests that the understanding of salinity in agricultural farms is of prime importance if we want agricultural farms to be productive and soil quality conserved. Temporal understanding of soil salinity helps understand subtle difference across the landscape and agricultural fields, and allows their precise management and uses, monitoring offers understanding salinity over a period of time. There exists a number of conventional (gravimetric method, EC measurement of soil solution/extracts), and modern methods to assess/measure soil salinity, these are electromagnetic induction (EMI) characterization (EM38); EC Probes; using RS imagery and Geographical Information System (RS/GIS); in-situ automatic salinity measurement through sensors technology and salinity logging on smart datalogger; submicroscopic investigation and micro-chemical analyses using Scanning Electron Microscopy (SEM) and Electro Probe Micro Analyses (EPMA). The choice of the technique depends on the purpose, available resources, area to be investigated, accuracy required and frequency of determination. In this presentation, above techniques and their results will be discussed with participants to allow them appreciate technological advances and how these can be used in their work to help farming community in improving their livelihood through improving crops and farm income.

Key Words: Salinity; electromagnetic; temporal; agricultural; in-situ

RECLAMATION OF SALINE SOIL BY AGROFORESTRY SYSTEM FOR CENTRAL PLAIN ZONE OF UTTAR PRADESH, INDIA

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Land degradation by the accumulation of excessive salts in the root zone of crop due to impermeable hard pan at a soil depth of 60 cm to 120 cm is major problem of India which decreases the production and productivity of crops. By this factor a large area of arable land is suffering due to salinity and alkalinity in semi-arid areas. These soils are reclaimed by chemical and mechanical means which is costly and beyond the reach of a common farmer. The permanent reclamation of saline soils is only possible by agroforestry in which trees and crops are planted together. Keeping in view the seriousness of salinity and alkalinity problem an experiment entitled, "Reclamation of saline soil by Agroforestry system for Central Plain Zone of Uttar Pradesh, India" was undertaken during the year 1989-90 at C.S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. The experiment comprised of ten multi purpose tree species (MPTS) namely *Azadiracta indica, Dalbergia sissoo, Albizia procera, Terminalia arjuna, Eucalyptus hybrid, Leucaena leucocephala, Acacia nilotica, Acacia catechu, Morus alba* and *Cassia siamea* and in between the two rows of trees, agricultural crops were planted during Kharif and Rabi seasons. The initial average soil pH, organic carbon and EC was 10.5,0.41% and 0.73 dSm^{-1}, respectively. It is revealed from the experimental finding that planting of multipurpose trees has improved the soil condition by raising organic carbon upto 0.59% and reducing the soil pH and EC upto 8.10 and 0.31 dSm^{-1}, respectively after 8 year experimentation. The agricultural crop rice in Kharif (rainy season) and wheat in Rabi (winter season) was found suitable with trees. Among trees, Eucalyptus hybrid reduce soil pH and EC more as compared to other MPTS whereas organic carbon was improved by the Leucaena leucocephala followed by Dalbergia sisso and Morus Alba.

Key words: Reclamation, agroforestry, chemical, mechnaical, India

MONITORING AND MAPPING OF SALT-AFFECTED SOILS USING RS AND GIS APPROACH FOR RECLAMATION IN CANAL COMMAND OF JAMMU (J AND K), INDIA

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Salt-affected soils and waterlogging are the two main soil limitations of irrigated lands. Soil degradation by salinization/ waterlogging is a major concern for irrigation in many arid and semi-arid regions. Timely and accurate information regarding soil properties in relation to soil problems for their proper management is perhaps the modern farmers' most valuable resource. Geographic Information Systems (GIS) in the form of fine resolution remote sensing technology is being widely used for quick assessment of land and soil resources. This technology has been used in mapping, delineating, and monitoring of salt-affected and waterlogged soils and has shown great promise of enhanced speed, accuracy, and cost effectiveness. Mapping of salt-affected soils of India was undertaken by National Remote Sensing Agency and associates in 1996 and reported an area of 67,27,468 ha. These maps do not show any salinity problem in areas of Jammu (J and K State). However, recently and due to the development of agriculture and irrigation, there is a shift in the land uses that led the emergence of salinity in Jammu. There were some reports from farmers and experts regarding the emerging salinity in some pockets in Jammu region. Therefore an attempt was made to assess the extent and nature of salinity and related problems in the soils of the Jammu. The climate is sub-tropical and average annual rainfall and average annual evapo-transpiration rates are 964.4 mm and 862.2 mm, respectively. The Ravi-Tawi canal was started in year 1978 and irrigates about 66700 ha area. Due to the introduction of canal system for irrigation, resulted in tremendous increase in productivity and food grain production in Jammu region of North India. But, because of unscientific management of soil, water, and crops in the area, obstruction of natural drainage systems disrupted the balance of inflow and outflow of water causing waterlogging and salinization. The salt-affected soils in the canal command area have been identified, demarked, and mapped using Landsat MSS data in the imagery scale of 1:250,000. Field survey was conducted for ground truthing and to characterize the salt-affected soils under Ravi-Tawi canal command. The study area covers an arable area of 75 thousand hectares out of which 25.67 thousand hectares have turned unproductive as a result of salinization/waterlogging. The alkaline soils of the region are characterized by the dominance of exchangeable sodium throughout the profile depth with values of 9.9, 25.30 $(mmoles/l)^{0.5}$ and 78.41 for pH, SAR and ESP respectively. The soil pH varied from 7.50 to 9.80 and EC from 0.10 to 0.48 dSm^{-1}. Exchangeable Ca, Mg, K and Na ranged from 3.9 to 8.23, 1.50 to 3.20, 0.20 to 1.01 and 0.22 to 8.70 cmol (+) kg^{-1}, respectively. Amongst cations, Na was dominant followed by Ca, Mg

and K and exchangeable Na varied from 3.87 to 47.49 cmol (+) kg^{-1} and highest ESP was recorded in Tarore soils with Ustic and Aquic moisture regimes associated with hard crust on surface, columnar to prismatic structure and calcic and nitric sub-surface. On farm experiments conducted for reclamation and management of these soils indicate that application of gypsum @100 % gypsum requirement increased the yields of rice and wheat crops to the tune of 43.3 and 86.9 percent. A noticeable change in the properties of soil was recorded as pH decreased from 9.70 to 8.84, bulk density decreased slightly from 1.52 to 1.48 Mg m^{-3} and infiltration rate improved.

Key word: Monitoring, mapping, salt-affected soils, salinization, waterlogging, India

MAPPING SALT-AFFECTED SOILS USING ETM DATA AND GIS CASE STUDY: EASTERN PLAIN OF ESFAHAN, IRAN

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Remote sensing techniques are used in various applications including agriculture, forestry, oceanography and environmental studies, etc.. In the recent years, methods for studying soil salinization have developed greatly from geographical analysis alone to the application of remote sensing analysis, from visual interpretation of satellite images to computer processing, and from single-source satellite images to the combination of remote sensing data with non-remote-sensing data. In particular, it is becoming increasingly popular to combine a remote sensing method with a geographic information system (GIS) to solve complex problems. Salinization and alkalinization are the most common land degradation processes, particularly occurring in arid and semi-arid regions, where precipitation is too low to maintain a regular percolation of rainwater through the soil. Under such climatic condition, soluble salts are accumulated in the soil, influencing soil properties and environment which declines soil productivity. The consistent identification of the processes is essential for sustainable soil management. The aim of this work has been to carry out salinity mapping within Roodasht plain in east of Esfahan, Iran, where soil salinity appears to be a major threat to agricultural production. In this study, 85 soilsalinity data elements were used to assess mapping method based on a combination of ground measurements and remote-sensing data (regression method from classification and salinity index images). The ETM images of landsat were used to produce salinity map of the region. After derivation of DNs of all six bands in every points of sampling a stepwise regression was established between soil salinities and DNs by SPSS software. It was seen that there was a good regression between EC and band 3 and 7 of the image. A model was deduced as EC = 33.309+0.91b3-0.642b7, where b3 and b7 were DNs of the sampling points in bands of 3, 7 respectively. On the basis of this model the salinity map of the region was produced and classified. The accuracy of the predictions was tested using a validation set of 24 points.

Key words: Mapping, ETM data, GIS, RS, salinization, Iran.

MAPPING THE RISK OF SOIL SALINIZATION: APPLICATION OF ELECTROMAGNETIC INDUCTION AND NON-PARAMETRIC GEOSTATISTICS

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For a better management of salt-affected soils, the knowledge of the magnitude, the spatial extent and the evolution with time of soil salinity is required. Soil salinity is determined conventionally, by measuring the electrical conductivity of a saturated past extract (ECe). However, given the spatio-temporal variability of the salinity, numerous samples are necessary, which makes the conventional procedure laborious and expensive. As an alternative, the apparent electrical conductivity of soil (ECa) can be measured in the field by the use of the electromagnetic induction (EMI). This procedure is fast and allows making an extensive sampling in space and monitoring in time. The study area covers 2060 ha in the irrigation district of Tadla, Central Morocco. Twelve samples were taken for the determination of ECe while about hundred ECa measurements were realized with the Geonics EM38 instrument. The pairs of ECe-ECa values allowed establishing the calibration equation permitting to convert the ECa into ECe values. This equation was used to convert the other ECa values for which there was no measure of ECe. Then, geostatistics was used for the establishment of the maps of the risk of soil salinization. First of all, a threshold for risk of soil salinization was determined and indicators were built. Then, the spatial variability of these indicators was described and modelled using the variogram. Finally, the maps were generated based on a non-parametric method of geostatistical interpolation, i.e., indicator kriging. The results showed that the study area presents various degrees of soil salinization risk. In the centre of this area, the risk is low; the major part of the study area has a moderate risk while the south and north western parts have a high risk. In conclusion, the combined use of the electrical conductivity, electromagnetic induction and geostatistics allowed establishing a reliable soil salinization risk map. This information could serve as a basis for any rehabilitation effort of salt-affected soils, in the future, according to their actual risk of salinization and not by considering the average risk of the whole study area.

Key words: Mapping salinity, Geonics EM38, electromagnetic, geostatstics, Morocco.

MANAGEMENT OF SALINE LANDS IN OMAN

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Soil salinity has emerged as the most significant problem of present agriculture of the Sultanate of Oman. Scanty rainfall coupled with high temperature is always conducive for accumulation of salts. These conditions are predominantly found in Oman. However, human activities of the past proved as a driving factor and secondary soil salinity has increased very rapidly due to the persistent use of saline groundwater, the concentration of which is increasing with time because of increased pumping in Batinah region. The region has been the most important area of agriculture in Oman encompassing an area of 80,000 ha. The balance existing between total pumping and annual recharge before the 1990s has been greatly disturbed resulting in reduction of crop yields in the beginning and abandoning of lands gradually. Sea water intrusions are also present in some areas of the region that are nearer to sea as a result of over-pumping. The estimated values for salt-affected lands are 44% of the total geographical area and 70% of the agriculturally suitable area of the country. The annual losses due to salinity have been reported in 2005 as 7.31 to 13.97 million Omani Rials (1 Omani Rial equal to about 2.6 USD) (2005 data). When the lands go out of cultivation, the owners of salt-affected lands become unemployed. This is another problem of socio-economic nature with so many negative impacts on the society. Thus, salinity problem is a huge threat to the sustainability of agriculture in Oman, especially in Batinah. Under the situation presented above, a research project "Management of Salt-Affected Soils and Water for Sustainable Agriculture' was prepared and approved subsequently with funding from the HM Strategic Research Fund so that the research on different aspects of the salinity problem can be conducted and techniques may be evolved to mitigate soil and water salinity. Appropriate solutions which are environmentally sustainable are to be identified and promoted. There was need to utilize land and water resources of the country that are of marginal quality. The project focused on four approaches: soil rehabilitation, biosaline agriculture, fodder production, and integration of the fish culture into crop production that could have compensatory economic returns to farmers. The project aimed at developing management guidelines which are scientifically sound for farmers: a) to sustain economically viable agricultural production in salt-affected areas with saline groundwater; b) improve food security of Oman and; c) combat desertification. Finding from the trials confirmed that; salt-tolerant varieties of tomatoes, barley, sorghum and pearl millet can be grown successfully in conditions prevailing at Rumais; mulching surface soil with a thin layer of shredded date palm residues resulted in lesser salt accumulation in the soil resulting in more crop yield than other methods; fodder grown in saline soils with saline water has no negative impact on growth or meat quality of goats; incorporation of aquaculture in saline areas was proven feasible and profitable. The three years project was completed in 2009.

Key words: Saline lands, management, sustainable agriculture, Strategic Research Fund, Oman

MARGINAL-QUALITY WATER USE AS AN AMELIORANT FOR TILE-DRAINED SALINE-SODIC SOILS IN A RICE-WHEAT PRODUCTION SYSTEM

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Appropriate crop rotation(s) and management interventions have the potential to transform saline-sodic soil and water resources from an environmental burden into an economic asset. The 2-years field studies were carried out in the Indus Basin of Pakistan to evaluate different irrigation and soil management options of using saline-sodic waters and soils for reclamation and for growing salt tolerant cultivars of rice (SSRI-8) and wheat (SIS-32). These soils have variable levels of salinity and sodicity (ECe 9-44 dSm^{-1} and Sodium Adsorption Ratio-SAR of 83-319 $(mmoles/l)^{0.5}$. The treatments on both sites were the same and consisted of: 1) Irrigation with saline-sodic water (SSW); 2) Irrigation with freshwater (FW); 3) Soil application of gypsum at 100 % gypsum requirement (GR) of soil + SSW (G + SSW); 4) G + one irrigation with SSW and one with FW (G + 1SSW + 1FW); 5) G + two irrigations with SSW and one with FW (G + 2SSW + 1FW); 6) Farm manure at 25 Mg ha^{-1} each year before rice + one irrigation with SSW and one with FW (FM + 1SSW + 1FW) and; 7) FM + two irrigations with SSW and one with FW (FM + 2SSW + 1FW). After harvesting final wheat crop, maximum decrease in bulk density and increase in infiltration rate was observed with G + 1SSW + 1FW while FM + 1SSW + 1FW treatment affected higher decrease in ECe. Significantly the highest decrease in SAR occurred at both sites with G + 1SSW + 1FW. Maximum yields of rice and wheat were generally observed with G + 1SSW + 1FW. The crop yield and economic benefits with treatments showed a positive correlation with that of improvement in soil physical and chemical properties. Overall, the greatest net benefit was obtained from G + 1SSW + 1FW treatment. It was found that the farmers' management skills were crucial in the overall success to improve crop yields during reclamation of saline-sodic soils. Based on the results, it is proposed that saline-sodic water could be used to reclaim saline-sodic soils by using a rice-wheat rotation and a site-specific combination of soil amendments and water application strategies.

Key words: Salt leaching, economic benefit, reclamation, chemical properties, Pakistan.

IMPACT OF GYPSUM, FARM MANURE, AND HUMIC ACID ON THE RECLAMATION OF SALINE-SODIC SOIL

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Soil degradation such as salt-affected soil in arid and semi-arid regions limits sustainable crop production. This is due to the presence of either excessive amount of soluble salts, exchangeable sodium (Na^+) and/or both. Removal of exchangeable Na^+ with certain amendments is, thus, necessary from soil for economic return. Therefore, the field experiment (Typic Haplocambids) was conducted at Experimental Farm of the Bahauddin Zakariya University, Multan, (longitude: 71°, 30.79' E; Latitude: 31°, 16.4' N; altitude: 128 m) Pakistan. Gypsum at the rate of zero (control), 50%, 75%, and 100% gypsum requirement (GR) was applied with 25 tones per hectare (t ha^{-1}) farm manure and 10 kg ha^{-1} humic acid. Thus, total treatments combination was eight (08) and triplicated. Rice was grown during reclamation. Treatments significantly ($p \leq 0.05$) lowered electrical conductivity of soil saturation extrcat (ECe), sodium adsorption ratio (SAR), and soil reaction (pH). The root density/length was significantly ($p \leq 0.05$) impacted with treatments. Gypsum, farm manure, and humic acid also significantly improved the water stable aggregates (WSA), geometric mean diameter (GMD), and mean weight diameter (MWD) of aggregates.

Key words: Gypsum, reclamation, saline-sodic, water stable aggregates, Pakistan.

THE NEW MAP OF SOIL SALINITY IN RUSSIA

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New results of studies on the salt-affected soils in the arid territories of Russia and new satellite imagery determined the need for creation of new soil salinity map in Russia. The first layer of this digital map conclude information about saline, deeply saline, and potentially saline soils (the degree of salinization), the second layer reflect the data of chemistry of soil salinization and the share of moderately and strongly saline soils in the soil cover, and the third layer display solonetzes and solonetzic soils spread in steppe, dry steppe and semi-desert zone in the different hydromorphism degree. The most part of the salt-affected soils in Russia accounts for solonetzes and solonetzic soil types that bear different danger signs along the salinity. The digital soil salinity map has formed the basis for a unified computer database of soil salinity in Russia, and also enables to count the areas of salt-affected soils. The total area of salt-affected soils in the 1st meter of soil profile in the European part of Russia is 23.3 %, and 15.4 % of them is the area of solonetzes. Also the database concludes more than 1000 soil profiles of salt-affected soils.

Key words: Soil salinity map, salt-affected soils, solonetz, hydromorphism, Russia.

SPATIAL VARIABILITY OF SOIL SALINIZATION AS JUDGED FROM THE COMPARISON OF SOIL MAPS AND REMOTE SENSING MATERIALS FOR DIFFERENT YEARS

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The high variability of soil salinity is a well-known fact. Various methods are used to assess the salt status of particular territories for the given time. These are field surveys and sampling, soil mapping, and remote sensing. The methods of quantitative assessment of the temporal variability of soil salinity have yet to be developed. At present, they are based on the comparison of point-size data for several years (regular observations and sampling in the same point), or on the comparison of soil salinization maps developed in different years. Both methods have their drawbacks. In the case of point-size data, it is difficult to extrapolate them on large territories. In the case of comparison of two soil maps obtained in different times, the problem of temporal extrapolation of the data arises. We developed the method of quantitative assessment of the dynamics of soil salinization based on the comparison of multiple maps obtained from the interpretation of remote sensing materials with ground-truth calibration. A system of such maps was compiled for the territory of the Usman Yusupov farm in the Golodnaya Steppe of Uzbekistan. Remote-sensing materials on this territory were obtained for the years 1983, 1985, 1986, 1988, 1989, 1990, 2000, and 2008. On their basis, eight separate maps of soil salinization were developed for the area of 80 km^2. A comparison between them made it possible to develop a series of maps of soil salinization dynamics. These are the maps of major trends of soil salinization and the map of soil salinization dynamics. The separation of the areas with stable soil salinity status upon the comparison between the maps of soil salinization for different years proved to be very informative. In general, the degree and characteristics of soil salinization in each particular area within the 25-year-long period varied considerably. The areas with stable soil salinity status comprised no more than 1.5% of the total area for the whole investigated period (25 years) and about 25% of the total area for two consecutive years. Quantitative data on soil salinization dynamics made it possible to outline certain drawbacks in soil reclamation procedures and to suggest the ways of their optimization.

Key words: Spatial variability, salinity maps, temporal variability, point-size data, Uzbekistan.

SOIL SALINITY MAPPING IN ARID REGIONS OF EUROPEAN RUSSIA USING FINE-RESOLUTION QUICKBIRD IMAGERY

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A procedure of large-scale soil salinity mapping in the south of European Russia has been developed on the basis of remote sensing data and methods of digital soil mapping. The area of the RAS Dzhanybek research station located in the north of the Caspian Lowland served as a test plot. The soil cover is represented by soil associations (solonetzic complexes) consisting of solonetzes (or sodic soils), light chestnut soils and chernozem-like soils. The soils are very contrasting in terms of salt content. Computer-based analysis of the Quickbird imagery (2.4-m resolution) was performed using ILWIS, Image and Statistica programs. First, the image was subjected to Fourier analysis in order to reveal the anisotropy of the image. The main factor of anisotropy is the type of land use: a) settlements; b) plowlands; c) abandoned plowlands; d) forest shelterbelts; e) overgrazing and; f) hayfields. The second step is discriminant analysis. The training set includes the data on 14 soil transects. The variables are spectral parameters of the image: brightness in near infrared, red, green, and blue bands, and NDVI. Digital elevation model is not used as the amplitude of heights within the study area (65 km^2) as it does not exceed 2 m. It was found that the blue band is not informative for soil discrimination and it was excluded from the further analysis. According to discriminant functions, the soils were automatically delineated at the image. The accuracy of interpretation is dependent on the type of land use: the highest accuracy (about 70%) is obtained at the rangelands; at the other land uses, accuracy is below 50%. Information on salinity of the virgin and anthropogenic soils of the study area was obtained from 150 soil pits. Soil salinity decreases under plowlands and forest shelterbelts. The data on soil salinity was included as the attributive component of the map. The final soil salinity map contains information on: 1) anthropogenic land use; 2) soil types; 3) content and composition of soil associations; 4) salt content and; 5) composition of salts. The study was supported by the Russian Foundation for Basic Research (grant No. 07-04-00136).

Key words: Salinity mapping, digital soil mapping, quickbird imagery, ILWIS, NDVI, Fourier analysis.

QUANTIFICATION OF THE SALT CONTENT OF SOILS UNDER DIFFERENT CLIMATE CONDITIONS ON A NATIONAL SCALE

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The effect of rainfall, evaporation, and aridity on salt accumulation in the soil, on a national scale, is not straightforward and other factors such as geology, position in the landscape, and previous climatic conditions should be considered. It should also not be assumed that all salt-affected soils will always show definite and predictable associations with present day climate. The relationship between climate and salt-affected soils is made more difficult to determine, because practically all areas have suffered climates in the past different from those prevailing at present. Although data verification was previously done on most samples, much effort was devoted to data cleaning. Of the more than 40,000 original data points, only 22,404 data points were used due to the stringent cleaning protocol. Good decisions for the management of salt-affected soils on a national scale require good information, derived from raw data. Such data must be generated with specific goals in mind, and it must be stored properly in a format that is easy to access and process. Like any basic resource, the data environment must be managed meticulously. A forward selection stepwise regression was used to simplify the various models. In a stepwise regression, variables are added or removed from a regression model one at a time, with the goal of obtaining a model that contains only significant predictors, but does not exclude any useful variables. The accuracy with which electrical conductivity (EC), Exchangeable Sodium Percentage (ESP), and pHwater was predicted with stepwise multiple linear regression relationships on a national scale is surprising, considering that the various models included all "outlier" values. The R-squared statistic indicated that the models as fitted explained the variability in EC and ESP much better for the low rainfall class (<550 mm annual rainfall), than for the high rainfall class (>550 mm annual rainfall). For EC, the <550 mm annual rainfall class in the model explains 58% and for the >550 mm annual rainfall class 39 % of the variability. Values for ESP are 85% for the <550 mm annual rainfall class and 52% for the >550 mm annual rainfall class.

Key words: Salt content, stepwise regression, cleaning protocol, regression model, outlier values.

EFFECT OF IRRIGATION ON SALT DISTRIBUTION PROFILE AT UMJAWASIR FARM IN THE NORTHERN STATE, SUDAN

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This work was carried out at Umjawasir irrigated farm in the Northern State, Sudan. It aimed to assess the salts distribution pattern within the root zone to predict secondary soil salinity development, which causes a risk for sustainability of production. The irrigation water was analysed and rated by monitoring average root zone salinity and soil structure stability using ECi and SARi. Three sites: I (irrigated for eight years), II (irrigated for three years) and III (bare soil, as control) were studied. Soil samples were collected in 2003, every 25 cm to a depth of 125 cm for each site. The soils' ECe, Na, Mg and Ca content, Exchangeable Sodium Percentage (ESP), Sodium Adsorption Ratio (SAR), Organic Carbon (OC) and N content were determined. In order to investigate the possibility of transient salinization, regression analyses were carried out. The results showed that the soil salt content was lower at site I than sites II and III at the soil surface (25-50 cm), and at the depth of 75 cm, sites I and II had higher ECe compared to site III. Sites I and II showed significant (P= 0.05) differences in ECe with depth. The results indicated that there was washing of salts from the soil surface and accumulation at depths greater than one metre. Therefore, the hazard of development of transient salinity is expected. Further detailed investigations of the leaching factor and soil physical properties need to be done to make recommendation for suitable irrigation and cultivation practices for sustainable crop production under these conditions.

Keywords: Soluble salts, accumulation, secondary salinity, irrigated farm, Sudan.

SOIL SALINIZAION ASSESSMENT AND MONITORING AT BO KLUEA DISTRICT, NAN PROVINCE, NORTHERN THAILAND

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As soil and land resources have been an important factor in agricultural production, however, many land use areas in Thailand have been changed in the five decades due to the rapidly burgeoning population, land use pattern change and introduction of modern technologies in particular. The changes were encroachment of natural forests, using marginal lands and mismanagement of soil and water which resulted in deteriorated soil and water resources. It is estimated that degraded soils cover 31 million hectares or 60 percent of the total land area of the country, comprising six major soil problems, i.e., acid sulfate soils, peat soils, sandy soils, soil erosion, soil after mining and saline soils. Among these marginal lands, saline soils are the oldest and one of the most important environmental problems of mankind. They cover a total area of 3.5 million hectares. It is a form of degraded land that has become causative factor for low agricultural productivity in the Northern region, Northeastern region, the Central Plain and along the coastal areas of the country. The assessment and monitoring of soil salinization has been done at Bo Kluea district, Nan province, Northern Thailand. A set of methodologies was developed to facilitate the assessment and monitoring of salinization. The methodologies are geophysical method including resistivity meter, ground based survey using measurement with EM34 and EM38, laboratory analysis of soil and water samples and determination of vegetation and plant growth. The result showed that the occurrence of salt on soil surface has derived from soil salinization as a natural phenomenon. The area where the source of salt was found that locates along the fault in east – west direction of Bo Kluea formation. Salinized soils have been found to coincide with shallow depth or exposure of Bo Kluea formation.

Key words: Marginal lands, degraded soils, saline soils, environmental problems, Thailand.

SOIL SALINITY MAPPING USING MULTI-TEMPORAL SATELLITE IMAGES

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Almost 50 percent of the irrigated lands in the Central Asia are affected by soil salinity of different levels. The heavily saline lands are abandoned and the moderate saline lands produce low crop yields. Rehabilitation of the saline lands is a strategic approach, which could bring a positive change in the environment. The assessment of the trend and the scale of salinity is crucial element for developing salinity remediation strategies. The traditional approaches for soil salinity assessment are not any more relevant due to their high cost and low accuracy. By analysis of vegetation stress from multi-temporal remote sensing data can be created very detail soil salinity maps for the large irrigated areas.

Key words: Salinity mapping, multi-temporal satellite, saline lands, remediation strategies, vegetation stress.

HYDROLOGICAL ASPECTS OF ELECTROMAGNETIC (EM) SURVEYS

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Electromagnetic induction (EM) techniques have now largely replaced previous descriptive, and largely subjective, techniques used for soil salinity surveys. The question then is a matter of how to interpret the EM data. A very clear linkage exists between Apparent Electrical Conductivity (ECa) and the total soluble salts in the upper soil profile. This, in turn, can be interpreted as reflecting the degree of vertical/lateral leaching of soluble salts, or of salt accumulation in the profile. Topography, depth to groundwater and groundwater salinity also appear to affect ECa, although they are not suited to rapid survey techniques and do not necessarily have a direct relationship with either the total salt content of the upper soil profile or the ECa values. The interpretation of isoconductivity maps in terms of the degree of leaching of the soil profile from point to point provides an added hydrological management perspective to EM soil salinity surveys.

Key words: salinity, electromagnetic induction (EM), topography, depth to groundwater, groundwater salinity.

MICROMORPHOLOGICAL PROPERTIES OF SALT AFFECTED SOIL AS RELATED TO SALINIZATION PROCESS IN EL FAYOUM DEPRESSION EL FAYOUM GOVERNORATE, EGYPT.

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Salt affected soils exhibit considerable areas are, especially within the arid and semi-arid climates. El Fayoum Region comprised a closed depression without natural drainage outlet except the internal lakes. The insufficient drainage system creates shallow water table level, where evaporation is high and salt concentrations developed. Salt affected soils show considerable diversity in their biological, physical, chemical, and micromorphlogical characteristics. A micromorphological study was carried out along El Fayoum depression consulting the different mechanisms of salinization processes, where salinity problems have been a cute. The present study aimed at providing detailed data for better agricultural land use planning. The pattern of salinity distribution within soil profiles depend largely on the salinization process and to some extent soil texture grades. The most reasonable factors affecting salinization process were the unique drainage system, inherited salinity from parent material, and the use of saline irrigation water. The studied soils composed of Aridisols (Lithic Naterargids, Aquollic Salortheds, Typic Salorthids) and Entisols (Vertic Fluvaquents and Lithic Psammaquants). Their microstructures are different due to the difference in their texture. Compact grain and bridge grain structures are common in sandy-textured soil whereas channel and subangular blocky structures are common in the clayey soils. Quartz and runi-quartz grains are common as skeleton materials, but are present in different sizes and amounts. Halite and calcite formations occurred in voids and matrix of soils at different locations.

Keywords: Fayoum Depression, micomorphology, salinity, land use, Aridisols, and Entisols.

WATER USE EFFICIENCY FOR LEACHING SALINE SODIC CLAYEY SOILS

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Egypt lies in a virtually rainless zone. About 86% of the total area is classified as hyper-arid and 14% as arid. Therefore, one of the main objectives of the water management strategies is to measure the water use efficiencies in relation to the different development projects. In Egypt, saline-sodic clayey soils represent approximately one hundred and nine thousands hectares. At present these areas are of low quality mainly due to occurrence and development of salinity and sodicity problems, which hinder realization of the results of any agricultural reclamation inputs. In the North of Sinai Peninsula (Tina Plain Area) there are about 6,300 hectares of problematic saline-sodic clayey soils. It is one of the three regions of the reclamation areas under El-Salam canal project. It is representing the first region of the project. This project envisages the reclamation of an estimated 170,000 hectares. Therefore it is important to measure the water use efficiency for leaching saline-sodic clayey soils in this area to evaluate the agro-economic value of this project. The study was conducted in an experimental field of saline-sodic clayey soils in Tina Plain Area. The area of the experimental field is 25 hectares. The main characteristics of this field are the saline heavy clay texture of the soil, poor drainage, shallow groundwater tables and the presence of about 30 cm of salt layer on the surface. It was clear that the most appropriate strategy for this stage of reclamation in the experimental area is to apply intermittent leaching and surface drainage. This strategy succeeded to remove the salt layer within 6 months of leaching. The experimental study was extended for one year. The results indicated that about 1.6 tons of salts were leached for each hectare per day with irrigation water quantity of 238 m^3. The soil salinity before leaching was equal to about 400 dSm^{-1} for the surface layer of the soil and 300 dSm^{-1} for the subsurface layers. It was decreased to about 100 dSm^{-1} with leaching efficiency of 75% for surface layer and 150 dSm^{-1} with leaching efficiency of 50% for sub-layers. The water table depth below ground surface was increased from 16 cm to about 86cm below ground surface. Moreover, the physical properties have been improved due to leaching process.

Key words: Leaching, water management, reclamation inputs, salin-sodic, Egypy.

SOIL CLASSIFICATION AND RECLAMATION OF DEGRADED LANDS IN EGYPT

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Egypt has land area of over one million square kilometers of which only narrow strip along the Nile River Valley and /delta area of approximately 34,500 square kilometers or 3.4 percent is arable. This small arable area must support a population of about 80 million, growing about 2.3 percent per year. The land area per capita is decreasing quite sharply. This has its negative consequences both on providing employment and income for the large portion of the population and on the country's self sufficiency. Key issues in the sector include; 1) low productivity of agriculture; 2) below potential agriculture exports; 3) land degradation and; 4) interregional disparities. The total water resources now available to Egypt is estimated at 73.8 billion cubic meters per annum including the natural and non-traditional resources. The average annual precipitation ranged between 120-200 mm concentrated in narrow band along the northern coastal areas. The majority of the salt-affected soils are mostly in the Northern – Central part of the Nile Delta and on its Eastern and Western sides. Previous studies indicate that the soils having various degrees of salinity, alkalinity, and/or waterlogging cover an area of about one million hectares. The causes of soil salinity can be divided into two main categories, natural and human induced causes, inundation of soil by sea and lake salty water over a long time is major cause of salinization, beside the tidal effect and salty soil solution. The reclamation of salt-affected soils including the constructional stage during which all constructional work including land leveling, construction of irrigation and drainage system, roads, buildings, are completed; the leaching stage during which the excess salts are leached to a level and depth that permits the start of cropping; the leaching improved fertilizer management in salt-affected soils can be of significance because it ensures balanced plant nutrition which prevents deficient or excessive application of fertilizers. Incorporating organic matter into the soil has been applied, particularly in sodic soils for improvement of soil permeability and release of carbon dioxide and certain organic acids during decomposition; Green manure has a similar effect on soil properties and as a source of nutrients as organic matter.

Key words: Soil classification, degraded lands, salt-affected soils, salinity, waterlogging.

INTEGRATED RECLAMATION APPROACH FOR DEGRADED AGRICULTURAL LANDS

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The shortage of good quality water necessitates the use of marginal waters such as saline/brackish and/or sodic waters to offset the crop water requirements in irrigated agriculture. The improper use and mismanagement usually lead to increase soil salinity and sodicity and therefore, degrade agricultural lands. If the problem of salinity and sodicity is not clearly understood and timely managed, the problem may reach to a level where degraded soils are unable to perform to their full capacity; therefore, these soils require careful identification of the problem and proper formulation of site specific reclamation procedures to improve soil physical and chemical conditions. This is the proper way to improve soil quality for maximum benefits. According to a very careful estimate 20% of irrigated lands are salt-affected and 60 % of which are saline-sodic or sodic, the rest 40% are saline. There is no single technique to rectify these problems; a combination of techniques (integrated approach) is always the best choice for successful solution. Integrated approach of soil reclamation includes hydrological (irrigation methods, leaching, flushing and drainage), physical (leveling, salts scraping, deep ploughing, tillage, subsoiling and sanding); chemical (use of amendments) and biological (organic amendments, serial biological concentration approach and biosaline agriculture) methods. The latter also includes phytoamelioration of saline-sodic and sodic soils. This will also be discussed to counter the chemical reclamation using gypsum and acids to rectify sodicity problem. However, such technique is only feasible for saline-sodic or sodic soils which are also calcareous, on non-calcareous soils the use of phytoamelioration to rectify soil sodicity is a reckless exercise. In this presentation principles and procedures of above methods of soil reclamation will be shared with participants and results discussed to allow participants understand the techniques for application in their work and transfer of technology to the end user the farming community.

Key words: Integrated, soil recalamtion, physical, chemical, hydrological, biological.

RECLAMATION OF DEGRADED VERTISOLS UNDER CASSAVA IN ARID ENVIRONMENTS OF INDIA

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Cassava (*Manihot esculenta Crantz*), one of the most important tropical root crops, yields an energy of 250,000 cal ha^{-1} day^{-1} compared to maize (200,000), rice (176,000) or wheat (110, 000). It is the most important root crop and fourth most important source of food calories in the tropics, which is a staple for more than 800 million people. In India, cassava is consumed as a secondary staple along with the staple, rice and many rural poor consume it as the staple in different forms of preparations. Approximately 300,000 tons of sago and starch are also manufactured from cassava roots by nearly 1200 factories. In 1996, India exported 31,000 tons of cassava products earning 141.30 million Indian rupee (INR) of foreign exchange. Cassava adapts well to very poor soil and since it is grown mostly by resource poor farmers with little or no inputs, the soils growing cassava get degraded. Cassava is grown mostly in Vertisols in Tamil Nadu, India in poorly managed fields that has resulted in deterioration of the land leading to problems such as reduced yield, incidence of tuber rot, very poor fertility status, poor soil physical conditions and many other related problems. In order to reclaim these arid lands and to increase the yield and profitability of the farmers, very successful technologies have been developed based on on-farm experiments conducted during the past seven years since 2002. Different on-farm experiments were conducted to study the problems and to develop a sustainable reclamation strategy. Major components of the technology include adoption of deep tillage with a chisel plough, application of neem cake, application of biofertilizers such as N fixer, P solubilising bacteria and AM fungi and biocontrol agents like *Trichoderma* and *Pseudomonas*. Besides this, a balanced fertilizer schedule based on site specific nutrient management (SSNM) approach have also been developed to address the problems due to imbalance in nutrient applications by farmers in those arid environments. Studies have shown that these technologies have resulted in improving the soil health and soil quality, yield, and income as well as input use efficiency.

Key words: Cassava, staple, poor farmers, vertisols, India.

EFFECTS OF TWELVE YEARS RICE – WHEAT CROPPING SEQUENCE AND INTEGRATED NUTRIENT MANAGEMENT ON SOIL PROPERTIES AND CROP PRODUCTIVITY IN A SODIC SOIL

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Efficient nutrient management is an integral part of any crop production technology. The fertility status of sodic soils is generally poor. Crop yields invariably remain low in first few years of reclamation. A long term fertilizer experiment was therefore conducted during 1994-2003 on a gypsum amended sodic (Aquic Natrustalfs) soil at the farm of Central Soil Salinity Research Institute, Karnal, The objectives were to evaluate the effect of using organic manures in conjunction with inorganic fertilizers on the productivity of rice – wheat system in gypsum treated sodic soil and prevention of sodification. The experimental soil had pH2 8.7, ESP 18.0, organic carbon 0.32%, available P 11.8 kg ha^{-1}, available K 220 kg ha^{-1}, DTPA Zn 0.79 mg kg^{-1}, DTPA Mn 3.7 mg kg^{-1} and DTPA Fe 4.5 mg kg^{-1}. The treatments consisted of: T_1 (control); T_2 (N_{120} kg ha^{-1}); T_3 (N_{120} P_{26} kg ha^{-1}); T_4 (N_{120} P_{26} K_{42} kg ha^{-1} at 100 % recommended) ; T_5 (N_{60} P_{13} K_{21} kg ha^{-1} at 50 % recommended); T_6 ,T_5 plus dhaincha green manuring before rice ; T_7, T_4 plus dhaincha green manuring before rice ; T_8, T_5 plus FYM @ 10 Mg ha^{-1} before rice; T_9, T_4 plus FYM @ 10 Mg ha^{-1} before rice and T_{10} (N_{180} P_{39} K_{63} kg ha^{-1} at 150 % recommended). The farmyard manure (FYM) was applied 15 days before transplantation of rice. In situ Sesbania aculeta was grown as green manure (GM) crop every year and incorporated before rice transplanting. Standard agronomic practices were followed for raising rice and wheat every year. Results showed that both rice and wheat responded significantly to fertilizer N and P. Application of integrated use of organic and inorganic fertilizer decreased the sodification and increased the organic carbon. Increasing the dose of NPK from 50to 100and 150% recommendation significantly enhanced the yield of rice. However, there was no significant difference in the yield of wheat amongst 100 and 150% NPK. Highest yield of both crops was obtained with 100 % NPK combined with GM or FYM. The results further showed that rice and wheat yields could be maintained even at 50% of the NPK dose when used in conjunction with FYM or green manuring (GM). Incorporation of green manure or FYM resulted in build-up of soil organic carbon and available N, P, K and Zn. The results suggest that integrated nutrient management is extremely important for sustaining rice-wheat system and prevention of sodification of salt-affected soils.

Key words: Nutrient management, sodic soil, Aquic Natrustalfs, farm yard manaure, India.

AGRICULTURAL LAND SOIL SALINITY IN THE CENTRAL ARID-REGION OF IRAN (ESFAHAN PROVINCE)

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Salt accumulation in the soils of Iran Central Arid-Region is mainly related to a dry climate, salt-rich parent materials, insufficient drainage and saline groundwater or irrigation water. Esfahan Province is located in the central arid region of Iran where an arid climate prevails. It covers 10.5 Million hectares of which about 0.5 Million hectares is used for crop and fruit productions. Among the major obstacles which prevent the achievement of high crop yields is the soil and water salinity. The soil has been developed in various situations and classified as Entisols and Aridisols. Top soil salinity distribution in 9 physiographic land forms namely; mountains, Hills, Plateau, Piedmont plain, Alluvial plain, Low Land, Flood plain, Colluvial Fan and, Alluvial Fan were delineated. Salinity data were obtained from soil survey reports during last decade. The electrical conductivity of soil saturation extrcat (ECe) of soils vary to a large extent. The highest and lowest average salinity were 38.3 dSm^{-1} in lowland and 0.6 dSm^{-1} in mountains area, respectively. The lowland area in the south east of province with higher evaporation rate and high groundwater tables is more susceptible to salt accumulation. High precipitation in mountain area of west, low temperature and evaporation rate cause higher salt leaching from soil profile. The ECe values are moderately high to extremely high in East part of Zayanderud River plain due to fine soil texture and poor drainage. In river plain irrigation often causes secondary soil salinization depending on a variety of factors including the salt content and composition of irrigation waters. Depth of water table raised by excessive irrigation and conveyance losses and insufficient drainage or water scarcity hampering effective leaching. More data on the salinity status of soils are needed in order to further describe the causes and spatial extent of the salinity problem in the area. According to the results the salinity distribution is highly variable in arid central Iran and in different physiographic unit of land area. Development of agriculture and industry in each landform should consider the present and future soil salinity potential. Given the importance of irrigated agriculture and the shortage of water supply, more ground-based soil and groundwater salinity monitoring schemes are needed as a prerequisite of land use in region.

Key words: Salt accumulation, Esfahan, lowland area, secndary salinization, physiographic units, Iran.

SPATIOTEMPORAL VARIABILITY AND MAPPING OF GROUNDWATER SALINITY IN TADLA: GEOSTATISTICAL APPROACH

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Agricultural productivity may be constrained by water scarcity, soil degradation and the use of marginal quality water. In Moroccan conditions, the main degradation process occurring under irrigated area are;i) "on-site" impacts such as soil salinization, and/or alkalinization; and ii) "off-site" impacts such as increased load of salt and nitrate in the groundwater. The overuse of surface and groundwater in the irrigated perimeter of the Tadla (Morocco), coupled to intensive cultivation, induced both soil and groundwater quality degradation. Indeed, if the secondary salinization and alkalization already affect important surfaces of the perimeter, the groundwater nitrate and saline pollution begin to be apparent. The ORMVAT, Public Irrigation Agency since 1995 has installed a network of the soil and groundwater monitoring. The sampling sites of water and soil were selected on the basis of the spatial representativeness in the perimeter, the main soil types and the main hydrogeological variants. The observed parameters for soils are salinity, alkalinity, and sodicity; and for the groundwater are salinity, nitrates, and level. The aim of this study is to analyze the spatiotemporal variability of the groundwater salinity. The choice of this parameter was dictated by the fact that farmers increasingly use supplemental irrigation using a poor quality groundwater. A good understanding of its evolution in space and time will make possible to obtain reliable models for prediction, estimation of the missing data, cartography and in the long term the delimitation of the risk zones. The spatiotemporal analysis of the groundwater salinity showed strong spatial dependence and a weak temporal dependence. The spatiotemporal dependence of the residues is very weak, and is primarily consisted of the random fluctuations. Consequently, a simple model was adopted, containing two components: a space component explaining more than 56% of the total variability of groundwater salinity, and a temporal component explains almost 77% of the remaining variability. Thus, this model makes it possible to explain more than 90% of total variability. Cartography of average groundwater salinity was also established by using the kriging. To this end, we should calculate the space variograms on the basis of averages per site. The space variogram of the northern area was adjusted by a Gaussian model characterized by a still of 3 ds /m and a range of 12,526m, while the southern area was adjusted by a Gaussian model with a still of 0.2 ds /m and a range of 9674 m with an nugget effect of 0.06 ds^2/m^2.

Key words: Spatiotemporal variability, water scarcity, groundwater, cartography, Gaussian model.

CONTROLLING SODIC SOIL EROSION BY ELECTROLYTES AND POLYACRYLAMIDE APPLICATION

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The anionic polyacrylamide (PAM) is recently used to rehabilitate saline and sodic soils. It is also applied to control soil erosion. The research on the effectiveness of anionic PAM along with gypsum or lime application on soil erosion is poorly documented. Therefore, an experiment was conducted to study the effects of anionic PAM with or without gypsum on the erosion of soils under saline/sodic conditions. For this purpose a clay loam soil was prepared to achieve three levels of exchangeable sodium percentage (ESP) - 0.5, 9.9 and 25.5 with an appropriate solution of salts. Soil samples were air-dried and packed in the trays. Powdered PAM, gypsum or a mixture of both were applied to the salt treated soils. Thereafter the soils were subjected to simulated rainstorm of 40 mm h^{-1} by a fixed rainfall simulator. Saline waters with different levels of electrical conductivity (ECw): 0.1, 2, 5, 8 dSm^{-1} were used for simulated rains during the study. The PAM amendment substantially controlled the erosion of the soils. The exchangeable sodium percentage (ESP) was directly associated with the soil erosion and runoff. Among the treatments the resistance to soil erosion was developed in the order of PAM > gypsum ≈ saline water > PAM mixed with gypsum ≈ PAM mixed with saline water. The magnitude of runoff water was reduced both by gypsum and saline water whereas it was enhanced by PAM application. The mixed addition of PAM with gypsum or salts exacerbated water erosion of soils.

Key words: Gypsum, saline water, simulated rainfall, runoff, polyacrylamide (PAM)

BACTERIAL EXO-POLYSACCHARIDES: A BIOLOGICAL TOOL FOR RECLAMATION OF SALT- AFFECTED SOILS

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Accumulation of salts on the soil surface and in the root-zone damages physico-chemical and biological properties of salt-affected soils severely. The exo-polysaccharides (EPS), the polymers of mono-saccharides, are synthesized and released in soil by micro-organisms inhabiting rhizosphere and roots of the plants. The bacterial EPS are considered responsible for build up and stability of soil micro-aggregates, the factor that ensures fertility of the cultivated soils. However, diversity and the role of the EPS-producing bacteria in improving fertility of the salt-affected soils have rarely been investigated. A project at Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, Pakistan, therefore, was initiated to isolate and identify the EPS-producing bacteria and explore the role of the EPS in fertility and productivity of the salt-affected soils. Using the RCV-sugar media, BIOLOG and API methods, a number of EPS-producing bacteria were isolated and identified from salt-affected soils and roots of crop plants grown on there. Effect of EPS-producing bacterial inoculation on soil aggregation around roots, cation (Na^+, K^+, Ca^{+2}) uptake, growth of roots and shoot biomass and grain yields of wheat grown in a salt-affected soil was studied under greenhouse while interaction of purified bacterial EPS with clay fraction for aggregate stability was studied ***in vitro*** conditions. Results showed the EPS-producing *Bacilli* were more frequent and abundant in salt-affected than normal soil. A substantial increase in soil aggregation around roots, growth of roots, soil water uptake, K/Na ratio and impact on soil aggregate stability suggested the EPS-producing bacteria and the EPS could be a useful tool for reclamation and amelioration of fertility of the salt-affected soils. However, considerations about economic feasibility, huge task of field inoculation and its success hinder the use and applicability of the biological tool in the field. The paper provides an account of biochemical aspects of mechanism of interaction of the bacterial EPS with soil constituents and the strategies which could help accelerate and enhance the process and extent of EPS at the field level by native EPS-producing bacteria.

Key words: Exo-polysaccharides, reclamation, micro-aggregate stability, NIAB, Pakistan.

RICE PRODUCTION IN SALT AFFECTED SOILS USING DIFFERENT RECLAMATION TECHNIQUES

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A large area of Pakistan is suffering from salinity problem. Being situated in the arid and semi-arid regions, process of salinization/sodification remains in progress. At the same time agricultural use of these areas is essential to meet the food requirement of growing population. To generate comprehensive technology for reclamation of these soils, field experiments were conducted to grow the rice crop in salt-affected soils using different amendment technologies. The treatments used were T1 = Control, T2 =100 % gypsum requirement (GR), T3 = 50% GR with wheat straw @ 2t ha^{-1}, T4 = 50% GR with rice straw @ 2t ha^{-1}, T5 = 50% GR with rice and wheat straw @ 2t ha^{-1} in the ratio of 50:50. The NPK was applied @100-80-60 kg ha^{-1}. Fertilizer sources were Urea, Triple Super Phosphate (TSP) and Sulfate of Potash (SOP) respectively. Canal water was used to irrigate the crop till maturity according to crop requirement. The results revealed that rice biomass and paddy yield was increased significantly in all treatments over the control. The yield of 14.60 t ha^{-1} and 3.50 t ha^{-1} were achieved in T_2 (100% GR) as compared to control values of 7.22 and 1.62 t ha^{-1} respectively. The yield in treatments of rice + wheat straw (T_5) were close to highest yield in T_2. Post harvest soil analysis indicated the decrease in electrical conductivity of soil saturation extract (ECe), pH and Sodium Adsorption Ratio (SAR) values in all the treatments with relation to control.

Key words: Salt-affected soils, reclamation, rice, gypsum requirement, post harvest.

SOIL SALINITY IN SUBBOREAL DESERTS OF ASIA AS RELATED TO CLIMATIC INDICES

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Subboreal deserts of Mongolia (the Gobi deserts), China (Junggar and Tarim basins), and Uzbekistan and Turkmenistan (the Karakum and Kyzylkum deserts and their surroundings) differ in terms of continentality and aridity of climate and the regime and quantity of precipitation. The highest aridity is characteristic of the deserts in the south of Mongolia and south of Xinjiang (extremely arid deserts of Gobi and the Tarim basin), the lowest aridity is observed in Middle Asian deserts. The transitional position is occupied by true deserts of Mongolia and northern Xinjiang (the Junggar basin). A comparison of soil salinity indicates that there is no correlation between the aridity of climate and the areas of salt-affected soils. The differences in soil salinity in the automorphic landscapes of subboreal deserts of Asia are mainly related to the paleogeographic history of the landscapes, the presence of salt-bearing deposits of the past geological epochs, and the activity of the eolian transport of salts from their potential sources (shores of drying salt lakes). The aridity of climate regulates the modern salt accumulation in hydromorphic landscapes: the higher the aridity, the stronger the accumulation of salts in the upper horizons of salt-affected soils. The aridization of the climate may have different effects on the degree of soil salinity and on the distribution of salts in the soil profiles in dependence on their initial salinity and on the degrees of aridity and continentality of the climate and the regime of precipitation. Hydromorphic soils subjected to active modern salinization may be more sensitive indicators of climate changes than automorphic soils.

Key words: Subboreal desert, aridity, soil salinity, automorphic landscape, paleographic landscape, geological epochs.

USING REMOTELY-SENSED SOIL CONDUCTIVITY TO MONITOR RESTORATION ACTIVITIES ON VERNAL POOLS, NORTHERN GREAT BASIN, USA

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The sagebrush-steppe of the Northern Great Basin, USA, receives twelve to fifty centimeters of precipitation per year. Clay horizon formation in these semi-arid/arid Pleistocene-lake landscapes allows development of seasonal wetlands (vernal pools) that are recognized critical habitat for several native animal species. Most pools were dugout to create water holes for livestock in the early and mid 1900's. Restoration efforts are underway to restore these ecosystems. This study was undertaken to evaluate the pre and post restoration hydrology of several re-graded vernal pools. Prior to restoration activities during the dry season, two pools with dugouts were mapped using a Geonics EM38 electromagnetic induction meter to measure soil conductivity at 50 and 100-cm depths. Sites were subsequently re-graded to fill in dugouts and redistribute spoil piles. Soil conductivity was re-measured one year later. Pre-restoration measurements indicate that conductivity was highest in the dugout region of the playa. Patterns of higher conductivity also occurred on the spoil piles; however, readings were tens of milliSiemens less than the dugout areas. Conductivity patterns of the dugout vernal pool suggest that the hydrology is directed towards the low areas; salts are concentrated in the dugout and left behind through evaporation. Conductivity patterns post-restoration show a marked difference in conductivity with a broadening out of the high concentration area and a decreased difference between the former dugout area and surrounding area. This pattern after one year of hydrologic activity suggests that re-grading allows the water to spread across a larger area and has resulted in the redistribution of salts across the vernal pool. This new hydrology likely reflects the pre-disturbance hydrology. The sites have been developed to monitor restoration vegetative response with and without grazing. Results of this study will refine understanding of vernal pool hydrology and ecology for the region.

Key words: Sagebrush-steppe, seasonal wetlands, restoration, EM38, dugout area.

DETERMINING DEGRADED SOILS OF SOUTHERN KAZAKHSTAN THROUGH ASSESSING STABILITY OF SOIL AGGREGATES

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The Arys Turkestan Canal command area is one of the driest areas of Southern Kazakhstan and has problems with soil compaction and poor soil permeability. Cotton crop dominating on the irrigated land in this area has poor above ground growth and week root systems that drastically reduce yields. Farmers abandon their land where the physical properties of soils declined to a level that the growing of crops is no longer economically viable. This studies carried out between 2004-2007 found that poor physical properties of the soils is caused by the conventional furrow irrigation practices resulting in low yields of cotton and degradation of soils. However, there is no locally adopted method to assess soil degradation level. This study suggests that soil degradation level can be estimated through determining water stable aggregates in the top-soil. The results of these studies clearly show a trend of reduction of soil stable macro-aggregates under irrigation practices applied in the Arys Turkestan Canal zone. Stable macro-aggregate index (SMAI) was found most suitable to specify highly dispersive soils. The SMAI values of less than 10% are found to be indicative of soil that is highly dispersive. The analysis of the farmer practices on these areas indicated that alternate furrow irrigation is one of the methods to improve poor soil physical properties. The experience of innovative farmers from the study area shows that alternate furrow irrigation reduces pressure on dispersive soils and that way prevents further degradation of soil properties.

Key words: Soil compaction, degradation, stable aggregates, SMAI, innovative farmers.

MAPPING OF RESIDUAL SALINITY IN A DESSICATED SALT LAKE USING ELECTROMAGNETIC INDUCTION

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In natural or managed ecosystems, differences in soil texture, permeability, drainage condition, deep of phreatic layer, topographic position, microclimate, vegetation, can lead to a complex pattern of salinity distribution. As water is the transport vector for solutes, differences in centimeters in altitude along a landscape, cause to appear subtle gradients of salinity, whose limits often are impossible to distinguish by remote sensing or direct exploration in the field. This study was performed in a desiccated salt-lake, inland in Alicante, Spain. It is the bottom part of an endorreic watershed with dolomites of the Cretacic and gypsum of the Triassic, whose is the natural source of soluble ions that accumulate in the lake, over impervious layers of the Keuper. The climate is semiarid, with mean annual temperature of 14 °C, annual rainfall of 300 mm and potential evapotranspiration of 950 mm. The lake was desiccated due to the agriculture extension in neighbouring areas that produced a decrease of the piezometric level of the aquifer. In the forties of the 19th century, a salt exploitation was established in the center part of the lake. After abandonment of the salt exploitation, the area has a residual salinity, that impedes the agriculture and even the recolonisation by halophytes. The electromagnetic induction (EM) is a low cost useful technique for quick measurement of secondary magnetic field induced in a volume of soil. The response signal provides very useful information about soil conditions (salts concentration, soil moisture and texture) for different depths. The apparent soil electrical conductivity (ECa) measured with EM, can be related to ECe of the soil saturation paste extract at particular depths, through statistical calibration. An intensive survey has been performed for the whole zone, measuring soil bulk ECa with a Geonics EM38 meter, both in vertical and horizontal mode, each measurement positioned with GPS WAAS-enabled. The statistical analysis of the EM survey data allows discrimination of different sub-environments, providing data of the actual bulk soil conductivity at every point measured, revealing subtle gradients of salinity along the landscape, showing if salinity is concentrated in the topsoil or in the bottom soil. Also the information mapped shows that topsoil salinity is more heterogeneous that bottom soil salinity, and is useful for relating the present vegetation (halophytes) to soil salinity conditions.

Keywords: Salinity, electromagnetic induction, 3D mapping.

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SESSION – III

Land Use Planning and Policy Implications

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments
17-19 May, 2010 Abu Dhabi City, United Arab Emirates

SOIL SURVEY – ITS APPLICATION IN LAND USE PLANNING AND POLICY DEVELOPMENT

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Chair of the National (Australian) Committee on Soil and Terrain

Soils have a crucial role in addressing some of the key issues of our time, such as food security and climate change, and provide a key natural resource asset underpinning sustainable development. Many countries have a long history of soil survey, and soil and land classification. This information is extremely useful in identifying opportunities and risks of land use, and can help direct government policy towards sustainable and profitable use of the soil and land resource. The scale, quality and consistency of the information play a major role in its value in planning and policy applications. This information, however, is often underutilised. A key challenge for government is to utilise the wealth of useful information that a soil survey provides into developing appropriate land management and soil policy at a national level. To be successful this process needs to engage government, academia, private industry and the community. This is an undertaking that Australia and many other countries are currently pursuing. This paper will investigate the current trends in the use of soil and land information, drawing on experience from within Australia and neighbouring countries and developments globally, and discus the opportunities offered by the new comprehensive soil survey information now available for the Emirate of Abu Dhabi.

Key words: Sustainable development, soil survey, land classification, soil policy, national level.

CHARACTERIZATION OF ENVIRONMENTAL PROPERTIES OF SOILS AND LAND SUITABILITY ASSESSMENT IN THE NORTH EAST BOTSWANA

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The study was undertaken to carry out soil surveys and physico-chemical properties of soils in the proposed Uranium mining in Botswana. The objective was to characterize the baseline data prior to mining for use in the mitigation of possible environmental harzards as well as problems arising from potential land use conflicts in the mining leased area. The FAO Framework of Land evaluation (FAO, 1976) was employed to assess the land suitability for arable, pasture/grazing and forestry uses. It was found that various soil types (FAO, 1988) occur in the proposed area and most soils are sandy loam to clays with relatively higher base saturation thus indicating good fertility of the soils. Most soils are relatively deep with effective depth of at least a metre, deep enough to support plant life (appropriate, rooting depth and anchorage, waterholding capacity). The waterholding capacities for most soils were favourable for the sustenance of most agronomic crops and pasture/grazing. Further the proposed area was found to be marginally to moderately suitable for arable farming and grazing. The most limiting factor to arable crop uses was poor drainage and toxicity (salinity) of soils and rainfall for arable crops, while poor quality of vegetation species and rainfall were the major constraints to pasture and forestry uses. The assessment for suitability for forestry use was found to be marginally suitable, with rainfall as the main constraint. The overall land capability classification shows that most area is occupied by grazing/pasture, with few pockets for forestry use although the proposed area is ideally suitable for arable farming and grazing/ pasture than forestry uses.

Key words: Physico-chemical properties, land suitability, FAO land evauation framework, arable farming, pasture, forestry use, land use

PARTICIPATORY SOIL AND LAND EVALUATION MAPPING: AN ALTERNATIVE APPROACH TO IMPROVE SOIL AND LAND EVALUATION INFORMATION USEFULNESS TO DECISION MAKERS

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Results of soil and land evaluation survey and mapping, which were expected to be essential to land use and management planning, most of the time are not adequately used by their potential users and rarely reach the decision makers. This may reflect the poor communication between the main actors of the land use planning process (e.g. soil surveyors, farmers and rural extensionists) and inappropriate language of the presented results. When following traditional methods, there is a risk that questions may be answered that have no relevance, and/or these questions may not be answered properly according to the community expectation. Therefore, it is important to change the strategies of communication and language of the results to make information more useful to the decision makers. In this context, the objective of this work was to test a participatory soil survey and land evaluation methodology to make the information more useful and consequently more used by the decision makers. The work was developed in three different regions of Santa Catarina State, southern Brazil, where traditional soil and land evaluation maps and reports are available and were barely used. The study started with meetings, interviews and questionnaires with local community, and one of the main demands raised was the need for area expansion and management improvement of pastures for milk production. But, instead of giving them information showing soil types with technical language, and a general information about land evaluation, the presented information shows what they want to know, namely spatial location of potential new areas for pasture, what pasture type is better for different conditions (e.g. pastures resistant to moist conditions) and what soil management is recommended for each area. In the final stage of the study, participants positively evaluated the presented information, considering it very useful to help them to make decisions.

Key words: Participatory land evaluation, potential users, poor communication, decision makers, pastures.

SUSTAINABLE DEVELOPMENT AND MANAGEMENT POLICIES FOR SOIL AND WATER CONSERVATION EGYPT - A CASE STUDY

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Sustinable development and mangement polices to soil and water conservation in Egypt pose a dilemma to develop irrigation strategies for irrigated agriculture to reduce and control its negative environmental impacts, an inevitable consequence of irrigation. The salinity problem becomes more sever when approaching the Mediterranean coast and around the north lakes where soils are extremely saline. The total soluble salts in general increase with depth, due to the effect of the ground water. For proper irrigation management one should; 1) improve the accuracy of the soil water balance components to calculate a reliable estimate of the leaching fraction; 2) estimate the leaching requirements and add that to the irrigation requirement; 3) consider the water distribution uniformity to decide which part of the field should receive at least the leaching fraction for salinity control; 4) take into account that leaching salts periodically is more practical than every irrigation; 5) consider that there is no need to increase irrigation frequency to control salt concentration (as explained before) except for drip irrigation and; 6) monitor the root zone salinity, especially prior to the times of periodic leaching. Appropriate irrigation system may be necessary on more difficult soils .i.e., sprinklers are well adapted to sandy and loamy soils but less so to heavy or clayey soils while drip or trickle irrigation system are better adapted to loamy or clayey soils and apply water through many small outlets (emitters) at a rate of 2 to 4 litters per hour. Moreover, drip irrigation provides a greater opportunity for using saline water. The policy of the Egyptian Government is to use drainage water up to salinity of 4.5 dSm^{-1} after it is blended with fresh Nile water, if its salinity exceeds 1.0 dSm^{-1} to form blended water of a salinity equivalent to 1.0 dSm^{-1}.

Key words: Sustainable development, irrigation strategies, water balance, leaching requirements, root zone salinity.

AGRICULTURAL LAND CONVERSION: APPLICATION OF LAND CAPABILITY CLASSIFICATION IN LAND USE PLANNING. A CASE STUDY ON A VILLAGE EMBADERHO

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Land reallocation and distribution for settlement purpose is based on land capability. Newly prepared land-use plans for Eritrean villages do not seem to promote this idea. A case study is conducted in "Embaderho" village, located near Asmara, the Capital City of Eritrea, to ascertain if land capability classification is utilized in the process of land-use planning. The study assesses how much fertile agricultural land is converted to urban use – total and in terms of land capability classes and whether competition between land-use for agriculture and housing is leading to landlessness. The land is undulating and gently slopping terrain with arable areas of gentle slopes and plains in between. Assessment is made for the period of 1995 to 2003 for which land-use/cover maps are available and land capability map of 1995 is used to appraise the conversion in terms of capability classes. Land-use/cover change is analyzed by overlapping the corresponding maps with each other using grid transparent papers. Leading farmers, local leaders, and agriculture experts in the area are interviewed for information on land-use change and its impact on farmers' arable land possession and on their livelihood. Area of land owned by a household is calculated by dividing total crop land area by total number of households in the village. The results of the study indicate that about 23 % of the highly and moderately potential crop land is converted to urban use, inclusive of 38.5 % of capability class I land, best arable area, being allocated for settlement. One household's cultivable land area possession is reduced from an average of 1 ha to 0.35 ha. Available land capability classification system is not properly practiced in the process of land-use planning. The land conversion has caused land fragmentation and landlessness in the village affecting the livelihood of majority.

Key words: Agricultural land, arable land, land capability classification, land conversion, land reallocation, land-use/cover change, land-use planning and urban use.

INTEGRATED FRAMEWORK FOR LAND USE PLANNING IN UNITED ARAB EMIRATES

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This paper aims to present a framework for analyzing and evaluating land use planning, to address growing land use pressures, within an integrated framework taking into account the socio-economic, and environmental aspects, and the effect of land use change on water resources. Land use planning is used to associate solutions for present problems with the planning towards long-term conservation and sustainable use of land resources. The work presented here identifies areas of land that have high value for conserving water resources, due to planning activities by different local governments. A general spatial modeling framework using GIS capabilities, and based on land use suitability units is used for evaluating how planning alternatives could affect water resources, and best satisfies defined policies. The framework contains analysis of alternative scenarios as well. The framework is applied to United Arab Emirates as a case study. This framework is important for making decisions about land and water resource use, managing growth, growing land use pressures and cumulative effects, reconciling competing demands for land, and integrating land-use policies. It is anticipated that planners, decision makers, and engineers can get benefit from the results obtained.

Key words: Land use planing, sustainability, environment, socio-economic, planning, water resources, policy.

SOIL USE PLANNING AND DECELERATING CROP PRODUCTIVITIES: POLICY IMPLICATIONS FOR INDIAN PUNJAB

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Soil is the prime natural and economic resource of any nation. Soils are heterogeneous and based on texture, climate, and topography. Soils of the Indian Punjab have been classified as Flood Plain (Alluvial) - suitable for the cultivation of paddy, wheat, sugarcane and vegetables; Loamy Soils - most important, fertile and productive soil group, are intensively cultivated for wheat and paddy crops; Sandy Soils - capable of producing cotton, citrus, oilseeds, wheat and fodder crops; Desert Soils - suitable for the cultivation of cotton, moth, citrus, wheat, Bajra and other Kharif fodder; Kandi Soils - badly eroded and less productive and are suitable for dry farming etc. Different soils are suitable for cultivating various specific crops. Owing to the major technological breakthrough in terms of Mexican wheat and Philipino rice cultivars along with the availability of well developed irrigated network, adequate marketing infrastructure and price support policy led to predominantly a monoculture of rice – wheat rotation in the state. The technology encompassing intensive cultivation restricted to these two crops only, has resulted in manifestation of several adverse effects on soil use efficiency resulting into the fast crop productivities deceleration. The fertility of Punjab soils has diminished over the years with deficiency in nitrogen and phosphorus. This was soon followed by deficiency of zinc during 70's and other nutrients like potash, manganese and sulphur during 80's. Above all, the deficiency of copper was also visualized since 90's. The high nutritional requirements of rice and wheat and the major crop rotation in the state have exhausted the nutrients of the soil. Resultantly, Punjab state which has just around 3 percent of cultivated area accounts for about 10 percent of total chemical fertilizer consumption in the country. The state is adding 1299 thousand tonnes of nitrogen, 354 thousand tonnes of phosphorus and 39 thousand tonnes of potash fertilizers to the soil annually. The use of chemical fertilizers in the state has gone up many times from 213 thousand tonnes in 1970-71 to 1698 thousand tonnes in 2007-08. More of the basic elements of the soil have been extracted than what has been added. Hence the present farming system in the state is not proved to be sustainable as the soil is consistently becoming deficient of all the micro and macronutrients and depleted, therefore, calling for pragmatic soil/land use planning in terms of crop diversification by identifying the soil pockets suitable for particular crops coupled with favorable policy measures, making alternative crops more remunerative through building strong research base and various economic incentives in terms of technical support, efficient marketing, assured prices, etc..

Key words: Soil use planning, technological breakthrough, monoculture, irrigated network, alternative crops.

LAND USE PLANNING FOR SUSTAINABLE DEVELOPMENT USING GEOINFORMATICS: POLICY IMPLICATIONS FOR DRYLANDS

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Land, which forms the basis for agricultural production, has reached a critical point by the burgeoning population in dry lands. This calls for optimal utilization of land resources and increase in system productivity without further degradation. This requires an integrated approach towards land use planning after taking into account the precarious environmental conditions. Remote sensing and GIS based geoinformatics technologies have been applied to generate sustainable development plan for an area, which is optimally suitable to the terrain and to the productive potential of the local resources so that the level of production is sustained without decline over time. The present study area is a part of middle Ganga plain in India. The sustainable land use plan has been made by using the prevailing geo-environmental condition of the study area. The land use/cover analysis of kharif and Rabi season was made by using the remote sensing data. The analysis of kharif season land use/cover data reveals that only 40.8 per cent area is under agriculture use. The 18.7 per cent of the total area is affected by flood during this season and northern part along river Ganga is severely affected by flood resulting reduced cropland and increase fallow land and waterlogging in this area. The analysis of Rabi season land use/cover data shows that approximately 55 per cent of the total area is under agriculture use. The analysis of remote sensing data in both season shows that the maximum area is under crop land, it may be double or single crop. The main reason is alluvial plain and the irrigation facility of the Son canal system. There are approximately 26 per cent area is under single crop (kharif or Rabi), should be treated for the optimum use. Approximately 14 per cent areas are under the fallow land and these can be used for alternate land use system. The remote sensing based study shows that there is approximately 16 per cent land cover under forest and among these 50 per cent forest land is degraded as open or scrub forest. These degraded forest land should need the proper management. The analysis also reveals that the most of the crop land along rivers are affected by flood during the monsoon season and due to low lying areas and improper drainage system, increase the waterlogging area that affect the kharif crop as well as the Rabi crop. There is a need for proper drainage system that can drain the excess flood water into the river or any water harvesting structure. The geo-environmental condition of the study area along with land use/cover analysis show the large potentiality of land resource. There are approximately 75 per cent of the land can be used for the agricultural and horticulture or both use to increase the productivity of the land on the sustainable manner and would reduce the wasteland from 24 per cent to 0.6 per cent. The analysis reveals that the double crop area would increase upto 66 per cent and maximum potential area found in the alluvial plains. Horticulture land would increase from 0.4 per cent to 3 per cent and maximum potential land is found in the hilly terrain in the south of the study

area. Forest cover would increase from 7 per cent to 16 per cent by afforestation and gap filling of new plantation. So the remote sensing coupled with GIS and GPS are playing a vital role in near real time mapping of the land use/cover and integrated land management. The alternative land use systems like horticulture, agro-horticulture, silvipasture, and integration of livestock enterprises with the agriculture system, has been suggested for land resources management. These land resource development plan can increase the productivity of land for sustainable development and reduce the wasteland. The present study will contribute required input for policy makers and other agencies for planning the best use of the available resources in order to improve the socio-economic and environmental conditions of the dry and arid region.

Key words: Land use planning, geoinformatics, sustainabl land management, policy implications, India.

SEMI ARID SOILS OF EASTERN INDONESIA: SOIL CLASSIFICATION AND LAND USE PLANNING

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Despite the generally high (2000 to 5000 mm) annual rainfall in Indonesia, 3.3 million ha area of East Nusa Tenggara (NTT) Province has annual rainfall between 1000 to 2000 mm with 5-8 dry (<100 mm rainfall) months and about one million ha area has <1000 mm annual rainfall with 8-10 dry month. About 1.7 million ha land is mountainous (>30% slope) and 1.5 million ha is hilly (15-30% slope). The steep slope coupled with the high intensity rainfall during the rainy season causes high erosion and sedimentation. This results in >1 meter soil depth at the valley bottom dominated by Haplustepts and Haplustolls, but <30 cm soil depth, dominated by Ustorthents in the upper slope. The soil is slightly acid to neutral with pH of 6.0-7.6; low to moderate organic C of 1.2-5.4%, high to very high 25%-HCl extractable P and K; moderate to high exchangeable cations of 18-41 cmol(+)/kg and a saturation of the exchange sites by basic cations. About 2.4 million ha land is suitable for agriculture consisting of 0.5 million ha in the <1000 mm; 1.7 million ha in the 1000-2000 mm; and 0.2 million ha in the >2000 mm annual rainfall areas. Those areas have been evaluated for their suitability for annual, including paddy rice, and perennial crops. Given the low rainfall, commodities that will be developed should be tailored to the availability of water. For annual crops, adjustment of the planting time with the rainfall distribution will be suggested, whereas the prospective perennial crops will be those requiring several months of dry period, such as cocoa, cashew nuts, and Jatropha.

Key words: Steep slope, sedimentation, Haplustepts, Haplustolls, Ustorthents, planting time.

LAND USE PLANNING FOR CONTROLLING LAND DEGRADATION IN KUWAIT

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Land degradation is a process which lowers the current and/or the potential capability of land to produce goods or services (quantitatively and/or qualitatively). Soil degradation, deterioration of the physical, chemical, and biological characteristics of soil, is one facet of land degradation since soil is generally an integral component of land. Land degradation occurs in any climatic zone (arid or humid). However; its causes, short and long term consequences and rate differ from a climate zone to another. Arid and semi-arid 41% of world regions (especially Africa) are the most vulnerable for land and soil degradation. Several land degradation indicators were recognized in Kuwait; these are: soil loss by wind and/or water; deterioration of vegetation cover and its biodiversity; soil crusting, sealing, and compaction; soil contamination by oil; soil salinization, and hydrological degradation. Aeolian processes, as manifested by soil deflation and drifting sand and migrating dunes, may be considered as one of the primary causes of soil degradation in Kuwait. The main driving factors of these processes include: scarcity and irregularity of rainfall, prevalence of strong northwesterly winds during the dry season (May–September). Exposure of loose surface sediments to these natural forces due to overgrazing, military operations, quarrying, camping and off-road vehicle traffic enhances soil drifting and, therefore, soil degradation. In the present study a simplified sedimentomorphic landform map of Kuwait, using satellite data and field investigation is prepared and compared with the recently published soil map. An interrelationship between the soil classes and prevailing landforms is established. An assessment of the vulnerability of the various soil types in Kuwait to aeolian processes, particularly soil loss by deflation, is carried out. Differences in the magnitude of potential impacts of aeolian processes on various soil classes are recognized. Causes and consequences are discussed. A land use plan for mitigation of identified potential impacts and measures for soil maintenance are recommended.

Key words: Land degradation, biological characteristics, climatic zone, biodiversity, sedimentomorphic landfom map, Kuwait.

LAND USE PLANNING AND POLICY IMPLICATION

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80% persons of Malagasy population are peasants and practise agriculture. Because of the increasing demography, they need more and more soil to cultivate. However, there is a big problem of soil lack. That is the reason I chose the topic « Land use planning and policy implication». The Malagasy government gives much importance for agriculture development. Its objectiv is to seek new soil to exploit and to diversify the kind of agriculture. According to my experience, the practice which can contribute to solve the problem of soil is the use of fertilizers. Because of the high price of chemical fertilizer and its bad impact in our environment, our center is promoting the lombrica compost, a very beneficial fertilizer, good quality, good price and easy to make. Besides the exploitation of lombrica involves many opportunities such as: income generating activites and contribute enormly to the amelioration and protection of our environment.

Key words: Malagasy, peasants, demography, land use planning, lombrica compost.

LAND RESOURCES GOVERNANCE: IMPACTS IN TERMS OF RURAL DEVELOPMENT AND SUSTAINABILITY

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Land based resources are natural capital at the disposal of societies as an ingredient in development choices. The ways in which natural capital is managed – including the rules which govern who gets to use which land resources under which conditions – is central to development outcomes in many societies. This is mainly true where financial capital is scarce, meaning that peoples' welfare is more directly reliant on the management of natural capital. However, lack of access to natural capital, not only constrains development opportunities at the level of the individual, but also has macro-economic effects at the national scale. There is particularly true with regard to land resource as there is a confirmed and a strong positive correlation between equity of ownership of land for a baseline date and subsequent national economic growth rates. Hence good governance of land based resources means positive outcomes of land and related policy in terms of equity, efficiency and environmental sustainability. In addition, land use planning is becoming a necessity to weigh up and identify best bet options, at various scales and in the short- and long-term, taking into account the range of stakeholders and social, economic and environmental tradeoffs and externalities. On the other hand, pro poor land governance is also crucial to addressing rural poverty, environmental degradation and climate change, and legal exclusion of the poor. Such a governance system entails policies to enhance secure access to land, equitable access to markets and services especially for smallholder farmers in the developing countries (the ultimate objective is for small farmers to increase production and reap economic benefits from rising food prices). Secure tenure should also prevent looming expropriation, forced migration and restrictions that may result from enclosure of increasingly valuable land for conservation, biofuel production, mechanised farming, urban/industrial or touristic zoning. Although the need for tenure security for development is no way new, the urgency of the issue has perhaps never been greater, especially in the context of poverty alleviation policies and Millennium Development Goals (MDGs). Land governance is, therefore, likely to remain a key area of national and international engagement in the near future. In the context of climate change and food crisis, access to land is becoming ever more pertinent for livelihood enhancement, food security and reduction of rural poverty. The poor land governance and policies that undermine tenure security, such as periodic land redistribution as used in some countries, often tend to diminish investments and encourage unsustainable practices of land management that to generate short-term gains at the cost of environmental health. Based on this, pro-poor, democratic and sustainable governance solutions are urgently required that respect and strengthen the tenure rights and security for smallholder farmers, pastoralists, forest dependent people and indigenous people. This

paper reviews the key issues in regard to the land governance and its dimensions in terms of sustainability and rural development. It explains the links between these areas and the related policy implications. It concludes by recommending priority actions which are needed at the global and country level to move the land governance agenda forward within the perspective of promoting sustainability and development of the rural areas and people, especially in a context marked by many challenges such as climate change, water and energy shortage, food insecurity, etc..

Key words: Land Governance, land Policy, climate change, equity, tenure rights, rural development, sustainable development.

ADDRESSING GREEN PLAN AND RECLAMATION OF DEGRADED LANDS IN MOROCCO

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According to the celebration of the World Day to Combat Desertification, the total cost of land degradation in Morocco amounts to around US$ 1Bn, that is 1.7 of the GDP. Some 93% of Morocco's dry-weather (arid to sub-humid) areas are vulnerable to desertification due to overexploitation of natural resources. Morocco's lands also undergo a degradation of forest cover, estimated at 31,000ha per year, particularly due to excessive firewood harvesting, overgrazing, land clearing, fires and urbanization. It is also owed to hydric and wind erosion, silting-up, the salinity and the rise of groundwater that affect roughly all large irrigated areas. To address the phenomenon, Morocco has taken several measures designed to reverse the situation and mitigate its effects. They include the construction of more than 100 dams to mobilize over 15.5 billion cubic meters destined for irrigation, drinking water and the production of hydroelectric energy. They also include developing agriculture and pastoral areas (270,000 ha), conserving the sustainable development of forest resources (reforestation of about 624,000ha), developing catchment basins on about 560,000 ha, and combating silting-up. As regards rural development, the strategy aims to redress imbalances affecting rural areas, combat drought and develop natural resources. Measures also include legislation providing for the preservation and the sustainable management of forest resources along with awareness-raising campaigns. The Green Plan aims to almost triple Morocco's gross domestic income from agriculture to 100 billion dirhams (nine billion euros) a year by 2020, compared to the current 38 billion dirhams. It allows for regions to specialise their production depending on their soil and climate, with cereals and citrus fruit in the verdant north, red meat in central Morocco, olives in the south and goat and camel's cheese in the Sahara. The implementation of the Green Morocco Plan, divide the country into 16 agricultural sectors, with 1,500 priority projects identified.

Key words: Green plan, desertification, firewood harvesting, hydroelectric energy, rural development.

ASSESSMENT OF LAND USE PLANNING AND DEVELOPMENT IN NIGERIA: THE JOURNEY SO FAR, CHALLENGES AND POLICY IMPLICATIONS ON AGRICULTURE

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The world community is presently struggling with widespread symptoms of poor management of land, water and waste products which have existed for many years. The growing problems of land use and the design of effective and efficient management systems to combat land degradation has attracted international, national and local attentions. This study presents a comprehensive land use plan by looking at the past and present land use planning and management practices in Nigeria identify the land uses that are most vulnerable to change in the urban areas and identify how to improve it. The findings revealed that, land transformation is presently being experienced in every parts of Nigeria. The rising costs of land and accessibility to urban land in Nigeria like most developing countries, has become a serious issue in urban areas of the country. Land use management has been wholly concerned with the granting of statutory right of occupancy and approval of plans to use land for different purposes, without adequate monitoring of its outcomes. This has been attributable to a number of factors including corruption and lack of interests to adopt alternative land use systems. Thus, for land use management to flourish and more importantly to create convenient and conducive environment for present and future generations, there is a need for a more fundamental rethinking of land use control mechanism, policy and action. Laws on land use should be aggressively enforced by policy makers and their agents, albeit effective implementation to accentuate the correlation between a healthy ecosystem, a healthy human population and a healthy economy in Nigeria. All stakeholders should be involved during the process of environmental planning, so that their interests and opinions can be considered and represented openly and fairly.

Key Words: Land use planning, land management, development, challenges and policy implication

SPATIAL MAPPING AND ANALYSIS OF INTEGRATED AGRICULTURAL LAND USE AND INFRASTRUCTURE IN MHLONTLO LOCAL MUNICIPALITY EASTERN CAPE – SOUTH AFRICA

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The study spatially mapped and analysed agriculture land use and infrastructure requirements in Mhlontlo Local Municipality linked to ASGISA-Eastern Cape's agrarian transformation and rural development initiatives. Emphasis was placed on informing ASGISA-Eastern Cape's broader rural infrastructure programme in support of agrarian transformation and rural development for the Eastern Cape Province. The study approach was participatory, extensively involving discussions with stakeholders, visits to project areas, internal and external workshops and document analysis. The results show municipality has a huge potential for agriculture that still needs to be realised as well as improved utilisation of available arable agricultural land. The poor state of basic infrastructure for economic and social service delivery remains a key constraint to sustainable and productive agricultural land use and rural development in Mhlontlo Local Municipality. This finding tends to hamper the contributions of the rural labour force to productive agricultural enterprises as well as limiting the knowledge base of rural people. The study also showed that active involvement of end-users is a key to sustainability of any agricultural land use and infrastructure projects. This study recommends an integrated approach to rural agricultural transformation in Mhlontlo requires infrastructure investments with a broader scope that transcends agricultural land use developments. For example, direct agricultural infrastructural investments and activities need to be complemented by investments in social services aimed at reducing poverty and stimulating socio-economic growth and development of the local municipality.

Key words: Agriculture land use, rural development, Mhlontlo Local Municipality, sustainability, infrastructure

MANAGEMENT OF NATURAL RESOURCES IN THE UAE WITHIN THE CONTEXT OF LAND USE PLANNING AND POLICY

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During the last three decades, UAE has offered a successful model for land use planning and development in the arid region, particularly in terms of agriculture development and environmental improvement and protection. However, presently sustainable agriculture development is facing several major challenges including groundwater depletion and water and soil salinization. The present article is discussing the following: a) the historical development in the agricultural land use; b) major challenges facing the sustainable development of these resources and; c) management and policies alternatives for the sustainable development of water and soil resources.

Key words: Natural resources, land use planning, sustainable development, policies alternatives, UAE.

MINIMUM SET OF SOIL QUALITY INDICATORS FOR THE SAHEL REGION

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Desert margin areas such as the Sahel (200 to 600 mm/year) are of great importance for Africa, particularly for their potential for agro-pastoral activities and carbon sequestration. Traditional land use system is based on the variability of landscape and soil types with cropping systems mainly on old dunes and pastoral activities in the rest of the landscapes (recent dunes, glacis and valley bottoms). Soils are mostly *Arenosols, Leptosols, Lixisols, Solonetz* and *Gleysols* types (WRB), with a severe trend to the loss of their quality in terms of productivity and ecosystem services. In this context of desertification trend, few soil indicators easily identifiable during soil survey have been proposed to characterize the status of land quality and health and the level of biodiversity: i) soil structure and types of soil surface in relation with the presence or absence of crusts; this is in connection to water infiltration; ii) water erosion features (gullies, sheet erosion, sediments) as a factor of important soil loss or gains; iii) wind erosion impacts characterized by the presence of islets of fertility and sandy placates; iv) the content and quality of nutrients (NPK) with respect to soil productivity; v) the soil depth and facility for roots penetration; vi) the amount of organic matter and features of biological activity; vii) human global impact which is a new concept including all forms of direct and indirect human interventions (deforestation, hunting, ploughing, bush fires, grazing, effect of trampling) on the environment. The Visual Soil Assessment (VSA) tool and light Kit laboratory analysis could be used for the determination of such indicators for rapid appraisal of soil suitability, status of land degradation and identification of land care technological options.

Key words: Trasitional land use, agro-pastoral, desertification trend, Visual Soil Assessment, Sahel region.

COMMON LAND RESOURCES - THE PRESENT STATUS AND NEED FOR ITS CONSERVATION: A STUDY OF NORTH INDIA

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The common land resources as the name implies have "common access" to all for use in various economic gains. They include forest, pastures, barren land, uncultivated land other than current fallow land and cultivable wastelands. The forests provide timber, pastures support the livestock and the uncultivated and barren lands support the construction of houses etc.. Agro-forestry and social forestry is also practiced. The "common access" to these resources has led to unchecked and rampant use leading to degradation of these resources. In general they account for a substantial share in income, socio-economic development and sustainable livelihood of the poor and landless farmers. Over the last fifty years the population explosion, urbanization and industrialization has lead to excessive utilization of the resources especially those having "common access". Considering the share of common land resources in the income, socio-economic development and dependency of livelihood of poor and landless farmers there is a need to manage these resources in a judicious way. Thus the present study was undertaken in order to analyze the present status and temporal change in the common land resources. The study was carried in the State of Uttar Pradesh, India having 70 districts having an area of 24,201,586 kms^2. The share of Common Land Resources in 1950-51 was found to be 34.28%. Since then there is a continuous decrease in the Common Land Resources. The need of the time is formulation of suitable and effective policies by the Government in order to prevent the degradation and extinction of the Common Land Resources.

Key words: Land resources, common access, agroforestry, socio-economic, India.

LAND USE PLANNING FROM PARTS OF SOUTH INDIA USING REMOTE SENSING AND GIS: IMPLICATIONS TO NATURAL RESOURCES ASSESSMENT

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Anthropogenic changes in land use are being increasingly recognized as critical factors influencing global change. Land use is often shaped by human, socio-economic, and political influences on the land. Remote Sensing (RS), integrated with Geographic Information System (GIS), provides an effective tool for analysis of land use and land cover changes at a regional level. The geospatial technology of RS and GIS holds the potential for timely and cost –effective assessment of natural resources. The techniques have been used extensively in the tropics for generating valuable information on forest cover, vegetation type, and land use changes. Therefore, we have used RS and GIS to study land use land cover patterns in Pulivendula - Sanivaripalli area of south India. With this in view, the present work has been taken up to study and assess some of the natural resources and environmental potential of Pulivendula – Sanivaripalli area of south India. A total of three thematic maps such as land use and land cover, drainage and slope maps were prepared based on image interpretation studies with limited checks. The land use-land cover pattern fall under the broad categories of agricultural land, forest land, and waste land. The Agricultural land is further subdivided into dry and wet agricultural land. Forest land has been classified based on the USGS Land use and land cover classification system in the present study with remote sensing data as dry and wet agriculture land. Further the forest land has been classified into reserve forest and waste land vegetation. Social forestry program include plantations and development of pasture land, arrest of soil erosion by afforestration has been suggested. In the study area, most of the land (60%) is unused for neither cultivation nor settlements so the land can be suggested for industrialized and urban planning.

Key words: Anthropogenic changes, land use, natural resources, thematic maps, India.

SESSION – IV

Use of Marginal Quality Water in Agriculture and Landscaping

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments
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WATER QUALITY OF MEDJERDA WADI USED FOR IRRIGATION PURPOSE (EASTERN ALGERIA)

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Water of Medjerda wadi catchment (eastern Algeria) are one of the most important resources in Algeria. In this basin, water is used for irrigation purposes. However, they collect domestic and industrial sewages and irrigation effluents exposing surface and groundwater to significant pollution. The monitoring of water quality in Medjerda wadi has been carried on. Longitudinal profiles of water quality were done using data from fourteen sites. All sewages; agricultural and industrial discharges were included. Analyzed parameters were nutrients (NO_3^-, N_2O^-, NH_4^+ and PO_4^{3-}), biochemical oxygen demand after five days (BOD_5), chemical oxygen demand (COD), dissolved oxygen (DO) and metals. Chemical results showed that waters in the Medjerda wadi are extremely polluted, especially, at the confluence with domestic releases of Souk-Ahras city and downstream of industrial discharges and present therefore a serious risk for irrigation. This pollution is characterized by an increase in indicators of pollution (COD, BOD, NO_2^-, NO_3^- NH_4^+ and PO_4^{3-}), a very low rate of dissolved oxygen and high concentrations of heavy metals particularly iron.

Key words: Medjerda wadi, Water quality, Pollution, Irrigation, BOD, COD, Algeria.

ENHANCES THE QUALITY OF TURFGRASSES BY IRRIGATING WITH SALINE GROUNDWATER IN A MEDITERRANEAN ENVIRONMENT

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Australia is listed under group II which represents countries that face economic water scarcity in 2025. Groundwater resources are the main source of water supplies for 30% of the world's population. We have studied the use of saline groundwater to grow four turfgrass species (*Paspalum vaginatum, Sporobolus virginicus, Distichlis spicata* – three halophytes; and *Pennisetum clandestinum* – a nonhalophyte) over two years under saline irrigation (13dS m^{-1}) groundwater or with fresh water, both at approximately 60% replacement of net evaporation. Soil salinity was assessed with the EM38 and by soil sampling, a strong correlation was found between the two methods (r^2=80%). Irrigation with saline water reduced turfgrass colour (i.e. 'greenness') in *Pennisetum clandestinum* whereas it was not affected in *Distichlis spicata, Paspalum vaginatum* and *Sporobolus virginicus*. Growth, represented by turf height increased by3, 10 and 3 cm under saline irrigation for *Paspalum vaginatum, Sporobolus virginicus, Distichlis spicata,* respectively, whereas decreased by 1 cm for *Pennisetum clandestinum*. Na^+ concentration in leaf tissues increased 3 fold more in *Pennisetum clandestinum* compared with the halophytic grasses. Elucidation of quantitative relationships between growth, root-zone salinity and water content will improve basic knowledge on the functioning of halophytes managed for turfgrass and contribute to the sustainable management of these species on under saline irrigation conditions. This paper illustrates the potential use of the halophytic grasses as high quality turfgrasses.

Key words: Halophytes; mechanisms of salt tolerance, ion regulations, salinity and sodicity, leaching fraction, groundwater.

PROSPECT OF CROP AND FORAGE PRODUCTION IN COASTAL SALINE SOILS

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Bangladesh has a total coastal area of about 2.83 million hectares (Mha) out of which about 1.0 Mha are under salinity of different levels. In monsoon season, it is possible to grow rice in those soils due to rainfall induced natural leaching in the cultivation zone. In case of dry season with negligible rainfall, soil salinity increases in soil profile due to; 1) upward flux of saline groundwater in the cultivation zone from high surface evaporation, and 2) negligible natural leaching during the season. Thus, the entire coastal saline belt remains fallow in the dry season. Considering this, Dubai based International Center for Biosaline Agriculture (ICBA) has initiated a project in collaboration with Bangladesh Agricultural Research Institute (BARI) for growing cash and forage crops using irrigation technology and soil-water management techniques. In 2007-2008, pilot testing was done in the Satkhira district where the soil texture varied from silty clay to clay. The pH and bulk density of the soil ranged from 6.8-7.6 and 1.3-1.38 g cm^{-3}, respectively. The soil salinity reached up to 11 dSm^{-1} in March-April (driest months of the year). Tomato, cowpea and barley were the tested crops. For tomato, drip irrigation with rain harvested water in raised bed with mulch produced 55-66 tons ha^{-1} of yield i.e. about 3.13-3.36 times more than the control treatment (flat lands with traditional can irrigation). The net return was also found to be US$ 2658 to US$ 3559 per hectare (about 5.76 to 5.92 times more than the control treatment). However, the hose pipe irrigation in raised bed with mulch produced net returns of US$ 2696 to US$ 3610 per hectare (i.e. about 5.84 to 6.00 times more than the control treatment) that were higher than those of drip irrigation due to less irrigation setup cost. Fodder crops (cowpea and barley) were also found profitable. These were irrigated by both fresh and saline water using hose pipes with different irrigation scheduling. The net returns of cowpea and barley were found to be about 4.00-4.23 and 2.11-2.60 times more than the control treatment, respectively, in various locations. The study results indicate that about 770,000 hectare land (salinity: ≤12.0 dSm^{-1}) can fairly be utilized for crop and fodder cultivations by proper irrigation and soil management practices.

Key words: Costal saline soils, leaching, upward flux, cultivation zone, Bangladesh.

BIOLOGICAL REHABILITATION OF SALINE SOILS THROUGH REVEGETATION OF HALOPHYTES

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Two pot experiment were carried out in the halophytic green house of the National Research Centre, Dokki, Giza to study the mutual influence of soil salinity (5 initial soil salinity levels referred as S_1, S_2, S_3, S_4 and S_5 in addition to the control) on growth, physiological aspects, some cations content, and biomass production of *Leptochloa fusca* and *Sporobolus virginicus* plants. Moderate levels of initial soil salinity significantly increased most of the growth characters in both seasons. The S_2 treatment in the first season and S_3 treatment gave the highest values for all the previous characters. The results indicate also that there were improvements in the growth characters of plants in the second season due to improving the initial soil salinity. On the other hand, leaf / stem ratio increased with increasing the initial soil salinity. However the previous results were valid for both seasons. Increasing initial soil salinity significantly increased Na^+, soluble carbohydrates and proline concentration in the plant tissues. On the other hand K^+, K^+/Na^+ ratio and Ca^{2+} content insignificantly decreased with the same treatment as compared with control. No clear effects were recorded for Mg^{2+}. At harvest, S_3 treatment for *Leptochloa fusca* and S_4 for *Sporobolus virginicus* in both seasons gave the highest productivity. As for the effect of successive growing of *Leptochloa fusca* and *Sporobolus virginicus* on the soil quality, cations, anions (except for HCO_3^-), SAR, and electrical conductivity EC (dS/m) decreased in the soil analysis by the end of the first season and reached its lowest values by the end of the second season, this may be due to the leaching and to the accumulation of salts as halophyte plants are capable of accumulating salts into their leaves' vacuoles. Leptochloa fusca had more pronouncing effects on improving soil quality more than *Sporobolus virginicus*.

Key words: Leptochloa fusca, sporobolus virginicus, soil salinity, growth, yield, biological restoration.

AGRICULTURE USE OF MARGINAL WATER IN EGYPT: OPPORTUNITIES AND CHALLENGES

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Currently, Egypt is facing several fundamental problems: an ever-increasing population, a limited supply of cultivable land and a limited supply of water resources. These problems intensify the importance of developing efficient natural resource use strategies. The future of Egypt depends on the water stored in the Nasser Lake reservoir for all purposes. There is strong evidence that governmental policies in the agricultural sector have led to an inefficient allocation of resources in general and water resources in particular, the latter being the focus of this study. These policies should be examined within sound economic frameworks, and policy alternatives should be tested to insure the efficient use of water resources. The last drought in Africa brought attention to the need for optimal intertemporal allocation of this vital resource. There are three major marginal-quality water sources that can be used in Egypt: wastewater, saline and sodic agricultural drainage water, and brackish groundwater. At present wastewater is reused in many areas sometimes diluted but mostly without enough treatment. Also, farmers use saline drainage water in areas which suffer from irrigation water shortage especially at the end of irrigation canals. Still others irrigate with saline or brackish groundwater, either exclusively or in conjunction with higher quality surface water. Many of those farmers cannot control the volume or quality of water they receive. Wastewater often contains a variety of pollutants: salts, metals, metalloids, pathogens, residual drugs, organic compounds, endocrine disruptor compounds, and active residues of personal care products. Any of these components can harm human health and the environment. Farmers can suffer harmful health effects from contact with wastewater, while consumers are at risk from eating vegetables and cereals irrigated with wastewater. Application of wastewater has to be carefully managed for effective use. This paper will discuss the challenges and opportunities of marginal water use. It will focus on the marginal water use considerations technically (including space, time, quantity and quality), economically, environmentally (including northern lakes ecology, delta salt balance and pollution concentration, and health risks), socially (including acceptance and practice), legally and institutionally.

Key words: Irrigation water, marginal water, saline water, agriculture production, efficient water use, water management.

ATRIPLEX PRODUCTION UNDER SALINE SOILS AND SALINE IRRIGATION PRACTICES

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This study aims to use some of the varieties of Halophyte plants and can be staged to live in the land of high concentrations of salt, which can not be any species of plant life and adapt to economic crops as it has been used in this study of six varieties of Atriplex to measure their ability to address saline land and rehabilitation without resorting to repeated washing and waste more water as it fills in the gaps in food, feed and pasture for the animals. The study was conducted in Bari, Italy, using six species of Atriplex (*Atriplex halimus, Atriplex nummularia, Atriplex Lentiformis, semibaccati, Atriplex Cansences*) durable signed salts of the impact of these species proved its high removal of the salts of these land in the area where the root of the plant it with the use of these plants for several seasons whereas using these plants in the same place, they had a great ability to rid the Earth of nearly half of the salt concentration also proved a good crop for animal feed, including a high crude protein content of the plant for the animals and need a little quantity of water through the irrigation process and we use some saline water in irrigation with normal soil not saline soil to study the effect of saline irrigation practices and study the behavoir of these varieties with saline irrigation we found the same results these plants uptake a lot of salts and no effect of the saline water irrigation on the soil with this plants whereas uptake the salts so we consider this solution is a good solution to reclamation salt affected soils.

Key words: Halophytes, economic crops, salts, animal feed, BARI Italy.

IRRIGATION PRACTICES FOR MANAGING SOIL SALINITY IN ROOT ZONE

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Maintaining desired salt-water balance in the root zone is the key factor for growing agricultural, forestry and landscaping plants under saline soil conditions. Appropriate irrigation management is one of the practices that can assist to achieve such goal. In fact, irrigation methods along with better irrigation scheduling can manage well the wetting front movement and salt accumulation in the root zone. Usually micro-irrigation methods are the desirable ones under water scarcity situations for water saving and managing soil salinity. In order to verify above, field experiments on different emitters spacing in different layouts were evaluated with regards to salt-accumulation pattern in the root zone at ICBA experimental farm. The experiments were conducted in 2008 and 2009 by using two layout patterns; 1) triangular and; 2) square. In this experiment three emitter spacing 25, 50 and 75 cm were tested. Results show the triangular pattern of drippers minimizes salt accumulation in the rootzone (0-50 cm depth) more than the square pattern. This is due to the overlapping of wetting-fronts and subsequent salt-leaching from the rootzone. Similarly, closer spacing of drippers also overlaps wetting fronts, and that helps in reducing salt accumulation. The results of these findings will be shared with the conference participants. We believe the above findings will help developing suitable irrigation management practices for growing different plants under saline soil conditions.

Key words: Irrigation, salt-accumulation, drippers, wetting-front, dripper-spacing

SUSTAINABLE MANAGEMENT OF SALT AFFECTED SOILS AND POOR QUALITY GROUND WATERS FOR ENHANCING CROP PRODUCTION

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Two major types of salt-affected soils may be distinguished: the saline and alkali (sodic) soils. Saline soils have an excess of neutral soluble salts such as chlorides and sulphates of Na^+, Ca^{2+} and Mg^{2+}. Plant growth is adversely affected due to reduced water uptake and ionic imbalance and/or nutrient stress. Alkali soils, on the other hand, have Na_2CO_3 and $NaHCO_3$ which upon hydrolysis produces alkalinity; 1) $NaHCO_3 + H_2O = Na^+ + OH^- + H_2CO_3$; 2) $Na_2CO_3 + 2H_2O = 2Na^+ + 2OH^- + H_2CO_3$. This leads to high pH and ESP and also the reduction in the availability of several essential plant nutrients. Crops grown on these soils invariably suffer nutritional disorders resulting in low yields. Reclamation of these soils can be accomplished by partial or complete removal of exchangeable Na by application of suitable amendments and following a package of cultural practices. The reclamation technology involves integrated use of amendments preferably gypsum based on gypsum requirement of soil for rice based cropping system, balanced and integrated use of chemical fertilizers and organic/green manures which helps in maximizing and sustaining yields, improving soil health and input use efficiency. The results have demonstrated that amelioration of sodicity is the logical first step and a pre-requisite for sustainable reclamation and improving the chemical fertility of sodic/alkali soils. In saline soils, leaching with good quality water and establishment of sub-surface drainage to lower the depth of water table and suitable cropping system is essential. Therefore, proper diagnosis of fertility problems and their management is essential for effective utilization of salt-affected soils and sustaining crop production. Salinity and sodicity of underground irrigation water coupled with nutrient deficiencies and/or specific ion toxicity pose a serious problem for sustaining crop productivity in the country. The use of poor quality ground water constitutes about 30-80 per cent of total ground water development. The management practices for optimal crop production with saline and sodic water irrigation must aim at preventing the build-up of salinity/sodicity and toxic ions in the root zone to levels that limit the productivity of soils, control the salt balances in soil-water system as well as minimize the damaging effects on crop growth. Efficient, balanced and integrated nutrient management strategies are extremely important to increase yields to match the potential yields obtained under good quality irrigation water. Therefore, we focus on the ionic interactions and nutrient dynamics as influenced by salinity/sodicity of irrigation water and discuss how these issues relate to the nutritional problems and suggest long-term remedial measures to utilize poor quality waters for improving and sustaining crop productivity.

Key words: Sustainable management, salt-affected soils, gypsum requirement, reclamation technology, ion toxicity.

IRRIGATION MANAGEMENT UNDER SALINE CONDITIONS USING WETTING FRONT DETECTOR (WFD)

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Determination of drainage water salinity can be a useful tool for managing the leaching fraction, especially when irrigating with saline water. Assuming quasi-steady state conditions no bypass flow, the leaching fraction can be estimated by measuring drainage water salinity. Wetting Front Detectors were used to passively collect drainage water at depths of 0.9 and 1.8 m in irrigated pistachio orchards of north Ardakan, Yazd province, IR. Iran. Leaching fractions were estimated as a ratio of EC, Cl^- and Na^+ in the irrigation water and in solution samples collected from the Wetting Front Detectors. The results were used in simulation models to estimate mean root zone salinity and concentration of soluble ions. Predictions were compared to measurement of mean root zone salinity. Based on the results, predicted (WatSuit model and conventional equation) mean root zone salinity and concentration of soluble ions was permanently higher than measured ones. This finding confirms that initial assumptions of these models such as soil profile homogeneity, were not met under these circumstances and they can not be used to predict the fate of solutes in the root zone. Alternatively WFD can simply collect the actual leached water which can be used to determine the actual leaching fraction (LF) in terms of salinity. The measured LF in combination with determination of wetting front's depth can be implemented as a management tool to determine the sufficiency of salinity control practices. Considering the poor quality of irrigation water in this case average LF of about 0.40 during growth season, which was measured using WFD, seems to be essential to successfully control root zone salinity.

Key words: Root zone salinity, pistachio, Ardakan, leaching fraction, wetting front detector.

RESPONSE OF IRRIGATION WATER SALINITY AND LEACHING ON SAFFLOWER YIELD

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Salinity is one of the most important problems which reduce agricultural production and gradually decrease the area under cultivations. One of the effective methods of reducing the salinity hazard is the application of leaching and leaching management. Salinity of soil and water resources especially in arid and semi-arid regions of the world such as central part of Iran effectively decreases crop production. To determine the effects of irrigation water salinity and leaching fraction on Safflower yield, a field experiment was conducted at Rudasht, south east of Isfahan, central part of Iran. In this study three irrigation water salinity consisted of; 3.4, 8.8 and 11.2 dSm^{-1} and two leaching fraction (without leaching and leaching based on 75% potential yield) using a Randomized Complete Block Design in split plot arrangement with four replicates. The results showed that as the irrigation water salinity increases the total plant weight and seed weight ($kgha^{-1}$) decreases. The total plant weight and seed weight in irrigation water salinity of 8.8dSm^{-1} comparing to 3.4 dSm^{-1} were reduced to 44.3 and 39.4 percent respectively. Similarly, in water salinity of 11.2 dSm^{-1} comparing to 3.4 dSm^{-1} total plant weight and seed weight decreased 71.14 and 67.43 percent respectively. Leaching increase in the three water salinity was 5.5,17 and 3.2 percent respectively. Increased total plant weight and seed weight ($kgha^{-1}$). This increase for water salinity 3.4 dSm^{-1} were 16 and 7 percent, for water salinity 8.8 dSm^{-1} were 20 and 12.6 percent and for water salinity 11.2 dSm^{-1} were 15 and 26 percent respectively. Also, plant height increased by applying leaching. The linear regression analysis of the relationship between relative safflower seed yield and average ECe during growth period resulted in salinity threshold value of 6.4 dSm^{-1}. The percent yield depression per unit of salinity (dSm^{-1}) was equal to 11.82.

Key words: Safflower, threshold value, irrigation, salinity, leaching.

PLANT RESPONSE TO IRRIGATION WITH SALINE WATER IN A SICILIAN VINEYARD: RESULTS OF A 3-YEAR FIELD INVESTIGATION

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Water demand is increasing worldwide. In regions affected by water scarcity such as those located in the Mediterranean region, water supplies are already degraded, or subjected to degradation processes, which worsen the shortage of water. In such regions, competition for scarce water resources among users will inevitably reduce the supplies of freshwater available for crop irrigation. Use of saline water for crop irrigation, and the accompanying potential crop yield reduction and environmental risk of using these waters, is of major concern in a number of world regions. The situation has become acute in recent years, due to increasing shortage of good quality water that can be used for irrigation, and by climate change indicating a decrease in rainfall and increase in maximum evapotranspiration. Sicily is a typical Mediterranean country in which conditions of water scarcity and drought, as well as increasing use of saline water for irrigation are taking place. Management options suitable to prevent salinization, while maintaining acceptable levels of crop productivity, need to be developed. Wine grape (Vitis vinifera) is the world's most important fruit crop both in terms of crop production and economic value. For most crops, water deficit stress has negative implications for production and quality. For wine grape, however, vegetative growth is more sensitive to water-deficit stress than fruit growth. Thus, moderate water-deficit can positively influence the quality of wine produced from grapes harvested from vines grown under regulated (water) deficit irrigation (RDI) and partial root zone drying (PRD) conditions. The objective of this paper was to investigate plant response to deficit irrigation under irrigation with saline water in a Sicilian vineyard (Mazara del Vallo, Trapani). Research monitored soil water content and soil salinity, crop transpiration, stomata conductance and net photosynthesis in the course of a 3-year investigation carried out in the frame of the CLIMESCO project.

Key words: Water demand, Mediterranean region, scarce water, climate change, vegetative growth.

GROUNDWATER QUALITY AND IRRIGATION PRACTICES AT AZRAQ BASIN, JORDAN

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Jordan is considered as one of the four poorest countries in water resources as the share per capita per year is less than 145 cubic meters. Jordan suffers from shortage in water resources to meet its increasing demands for water consumption by different sectors. The need for additional water supply has put tremendous pressure on the groundwater resources to the degree that some of the basins are suffering from over exploitation such as Azraq basin. The long-term return flow as environmental parameter impact on groundwater quality regarding salt translocation in Azraq Basin was investigated in this study. Four farms were selected, the first two were using surface irrigation system (Farms 1 and 3) and the other two were using drip irrigation system (Farms 2 and 4) with total area of about 250 hectares. Four experimental locations in the surface irrigated farms were selected with one of them acting as a control point (non-irrigated). Another two locations in drip irrigated farms were also selected with one of them as a control point. About 116 soil samples were collected in order to analyze the following parameters: electrical conductivity (EC); pH value; Na; Ca^{2+}; K^{+}; Mg^{2+}; Cl^{-}; SO_4^{2-} NO_3^{-}; and HCO_3. The empirical analysis demonstrated that the salts translocations were basically confined within the effective root zone (50-75 cm). Hence, and as the groundwater is over 40 meters deep, it could be stated that no translocation of salts into the groundwater is occurring, due to the investigated irrigation practices. Nevertheless, this study recommends the use of appropriate irrigation practices in other areas within the Azraq basin, which is primarily located in the vicinity of Azraq Wetlands, where the water table is fairly shallow (1-2 m).

Key words: Jordan, Azraq basin, salt translocation, return flow, groundwater.

MECHANISMS OF SALT TOLERANCE OF SOME HALOPHYTIC SPECIES WITH POTENTIAL INTEREST IN FOOD CROPS AND RECLAMATION OF SALINE SOILS: GROWTH, WATER RELATIONS, MINERAL CONTENT AND ANATOMICAL ADAPTATIONS

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Considering the interest for arid and semi-arid regions to improve biosaline agriculture by domestication and sustainable use of halophytic plants in salt-affected regions, the present work propose to study diverse ecophysiological mechanisms of several promising candidates such as *Batis maritima, Sporobolus spicatus, Spartina alterniflora, Sesuvium portulacastrum, Beta vulgaris ssp. maritima* and *vulgaris* and *Aster tripolium*. They all share a high economic potential, the ability for reclamation of salt-affected lands and to survive at high salinities. Seawater was used as the source of saline water at different dilutions with fresh water: 0% (control: fresh water), 25%, 50%, 75% and 100% seawater salinity were provided in the substrate coastal sand. The plants were cultivated in an automated irrigation and drainage system under highly reproducible greenhouse conditions (Quick check system; Koyro, 1999). The aim of this study was to correlate basic parameters such as growth and the threshold of salinity tolerance with special investigations of the water relations and morphological/anatomical adjustment to get a network of information determining the salt tolerance of these plants. The salt tolerant species survived at all salinity treatments and maximal growth of most of them occurred in low and moderate salinities (25 and 50% seawater). Beyond the optimal growth treatment, a progressive growth decrease took place. However, the threshold of salinity tolerance differed from one species to another and depends on the degree of salt tolerance of each species which is again related to the ability to generate osmotic adjustment by the regulation of minerals and water uptake from culture medium. Therefore, the increase of the seawater salinity induced a decrease of the leaf water and osmotic potential. To avoid toxicity of excess ion accumulation, halophytic plants have developed morphological and anatomical adaptations at the scale of the whole plant. Some plants (excluders and excreters) exclude toxic salts from the leaves through special structures (salt glands, vesicles and hairs) and/or through roots and avoid excessive accumulation of salts. Other species (includers) adjust their osmotic potential by the accumulation of high amount of salts in leaf cells vacuoles and generate succulence. The Na^+ and Cl^- were the dominant ions and their concentrations increased with the increase of seawater concentrations in culture medium while K^+ concentration decreased. However the degree of NaCl and the maintenance of K^+ accumulation differed between species. One similarity of all halophytes was the unaffected Ca^{2+} uptake and transport through the plants.

The supply of additional Ca^{2+} to the seawater lead even to an enhanced plant growth. Results from above experiments will be presented and discussed in the conference.

Key words: Halophytes, seawater irrigation, salinity tolerance, compatible solutes, gas exchange regulation, metabolic regulation, physiological regulation.

PERFORMANCE OF CHENOPODIUM QUINOA UNDER SALT STRESS

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Salinization is a well known problem on a global scale. It is more pronounced in arid and semi arid areas. Morocco, which is part of these areas, is also threatened by this problem. Indeed, more than 87,000 ha of irrigated land have become saline. The aim of our work is to study the morphological and physiological responses of *chenpodium quinoa* for its use in regions affected by salinity, since it produces edible seeds which are rich in proteins compared to wheat. To achieve this objective, *C. quinoa* seedlings were cultivated in coastal land irrigated with fresh water as control and 4 sea water (SW) dilutions (20%, 30%, 40% and 50%) in a quick check system under green house conditions. The plants have survived in all the treatments. However, the presence of high levels of salts in the culture medium led to a reduction of biomass. Indeed, the maximum biomass was registered in 20% sea water (SW) treatment and the threshold tolerance to salinity has been noted in 30% SW treatment. The root to shoot ratio increased with the increase of salinity in the culture medium, while the relative growth rates (RGR) decreased significantly. Seeds from control were treated with aqueous solutions of 15%, 20%, 25% and 30% NaCl and the germination percentage was strongly affected by salinity such that only 45% seeds germinated in 30% NaCl. The ionic analysis of vegetative organs and seeds revealed variations in the concentrations of ions Na^+, K^+, Mg^{2+}, Ca^{2+}, total nitrogen and total phosphorus. In general, concentrations of Na^+ and K^+ increased in all organs tested, while the Ca^{2+} decreased significantly. Mg^{2+} concentration, nitrogen and phosphorus uptake were not affected by the presence of salt in the culture medium.

Key words: Salinization, physiological response, edible seeds, biomass, Morocco.

MARGINAL WATER IN AGRICULTURE AND FOOD CRISIS IN SUB SAHARA AFRICA

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Sub-Sahara Africa (SSA) accounts for 25% of the global figure of chronically undernourished. The region simply does not produce enough food to adequately feed its population, and food production per capita is declining. If nothing changes in Sub-Saharan Africa, the absolute numbers of poor in the region will continue to increase. Unless African Governments is supported by the international community, take the lead in confronting the factors that cause nutrient depletion and land degradation, deteriorating agricultural productivity will seriously undermine efforts to bring about food security and to strengthen the foundations of sustainable economic growth in SSA. The paper reviews the current state of knowledge related to the condition of Sub-Sahara Africa land water resources, and highlights the importance of linking degraded land and water management at local and landscape scales in order to address pressing issues of food crisis in the region. There has been less agricultural water development to date in Sub-Saharan Africa than in any other region. Water management is usually the key to increasing the productivity of arid and semi-arid lands. The dominant water resources management challenge over the coming generations is how to secure water to cover food demands of a rapidly expanding population. Promising technologies available to farmers in sub Sahara Africa include: conservation tillage, rainwater harvesting and integrated soil and water conservation. Intensifying agricultural production has in the past often been carried out with negative side effects in terms of land and water degradation. Therefore, legislation that will safeguard a water reserve and efficient water productivity improvements that will make it the region to achieve the Millennium Development Goals (MDGs) and thus long-term sustainability in agricultural productivity is recommended.

Key words: Water management, land degradation, food crisis, Sub-Sahara, Africa, promising technologies.

PRACTICAL, PRODUCTIVE, AND ENVIRONMENT FRIENDLY UTILIZATION OF DIFFERENT CATEGORIES OF SALT-AFFECTED SOILS IN ARID AND SEMI-ARID REGIONS OF PAKISTAN

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Saline soils in Pakistan are of three types. The first of the three types (4.79 Mha) are located in irrigated areas which are porous saline and saline-sodic soils with electrical conductivity ranging between 10-15 dSm^{-1}. These soils can be cultivated with salt tolerant crops including wheat. A short duration and short stature wheat line (SSt) was developed for such areas which is also resistant to lodging that may occur as a consequence of irrigation. The second types of soils (1.5 Mha) are those that are beset with twin problems of salinity and desertification. These soils are located in water deficit areas of southern Punjab and parts of Sind where annual rain fall ranges between 0.91-32 mm and EC between 6-10dSm^{-1}. A high yielding drought tolerant wheat line (DTL) was developed for these areas, which combines tolerance for salt, drought and high temperature. The DTL can be grown with only pre-sowing irrigation with grain yield production up to 6000$kgha^{-1}$ compared to the latest commercial drought tolerant wheat variety Tatara. The third type of soils (11 Mha) are located in Cholistan, Thar, Thal and Kharan areas that are beset with high rate of evaporation and strong winds. Water is most critical and limiting factor that prohibits agriculture production under such areas. Wheat line 'DURUGEN'' was developed for these soils which combines salt and water deficiency tolerance: It can be cultivated in desert areas for production of green biomass which can be used; i) as fodder to raise sheep and goats; ii) to provide green cover to barren lands thereby improving both land and the environment and; iii) to help providing lively hood to the poor natives. Our practical success made us believe that there exists an approach and strategy for every type of saline soils which can be implemented at will.

Key words: Salt-affected soils, irrigated areas, short stature wheat, water deficit, tolerance.

RELATIVE SALINITY TOLERANCE OF 35 *LOLIUM* SPP. CULTIVARS FOR URBAN LANDSCAPE AND FORAGE USE

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Increasing population growth is resulting in critical potable water shortages for both agriculture and rapidly growing urban centers worldwide, a trend progressively worsening due to droughts related to global climate change. Demand on limited potable water resources is resulting in fresh water shortages. To counteract existing water crises, many governments are restricting use of fresh water sources for irrigation. In the urban setting, governments are requiring use of reclaimed wastewater or other secondary saline water sources in leiu of fresh water for landscape irrigation. *Lolium spp.* (ryegrasses) are widely used for forage as well as in urban turf landscapes. Relative salinity tolerance of 35 *Lolium spp.* cultivars were determined in solution culture by measuring changes in total shoot canopy weight, root weight, rooting depth, and leaf canopy % green leaf area, relative to control (non-salinized) plants. There was a wide range in salinity tolerance of the tested cultivars, ranging from salt tolerant (ex. cv. Paragon) to salt sensitive (ex. cv. Midway). All shoot parameters were highly correlated, being mutually effective predictors of salinity tolerance. Root dry weight, significantly correlated with all shoot quality and growth parameters, was also effective in predicting relative salinity tolerance. However, rooting depth was not correlated with other parameters, and therefore not effective in predicting relative salinity tolerance. Based on these results, it was concluded that salt tolerant cultivars exist within Lolium spp. for agricultural forage and urban landscape use.

Key words: Salinity tolerance, Lolium spp., urban landscape, forage.

DISTICHLIS SPICATA – A SALT AND DROUGHT TOLERANT PLANT SPECIES WITH MINIMUM WATER REQUIREMENTS FOR SUSTAINABLE AGRICULTURE IN DESERT REGIONS AND BIOLOGICAL RECLAMATION OF DESERT SALINE SOILS

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Desertification of arable lands due to urbanization, global warming, and low rainfall mandates water conservation and use of low quality/saline waters for irrigation. Using low quality irrigation water imposes more stress on plants which are already under stress in these regions. Thus, there is an urgent need for finding salt/drought tolerant plants to survive under stresses. Since the native plants are growing under such conditions and are adapted to these stresses, they are the most suitable candidates for use under harsh arid conditions. If stress tolerant native plant species are identified, there would be a substantial savings in inputs in using them under stressful conditions. Our studies on saltgrass (*Distichlis spicata L.*), a euhalophyte, have shown it to have excellent drought and salinity tolerance, making it well adapted to harsh desert conditions, with great potential for use in urban landscape and agricultural settings to combat desertification and reclaim arid saline soils. The objectives of this study were to find the most drought tolerant of various saltgrass genotypes for use in arid regions where limited water supplies coupled with saline soils result in drought and salinity stresses, for use in sustainable desert agriculture, urban landscapes, and in biologically reclaiming desert saline soils. Various saltgrass genotypes were studied to evaluate their growth responses under progressive drought stress. Though all the grasses showed a high level of drought tolerance, there was a wide range of variations observed in their stress tolerance levels. Superior stress tolerant genotypes were identified which could be recommended for sustainable production under arid regions and combating desertification. Saltgrass proved to not only have a satisfactory growth under the harsh desert conditions, but also to substantially reduce salinity level of the rhizosphere, which indicates that saltgrass can effectively be used for biological salinity control or reclamation of desert saline soils.

Key words: Salinity stress, drought, arid region, saltgrass, urban landscapes, sustainable agriculture, combating desertification, saline soil reclamation

SUSTAINABLE UTILIZATION OF LOW QUALITY WATER AND SALINE PRONE LANDS UNDER ARID CLIMATE CONDITIONS IN ARAL SEA BASIN

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Salt-affected lands in Central Asian region demonstrate the most characteristic features of natural continental (not marine/coastal) salinization, sodication and alkalinization. Low organic matter (< 1.0%) and high accumulation of salts and poor water holding capacity render these soils unproductive. The predominant salinity type is sulphate-chloride. Sodium and magnesium are the dominating cations. Total nitrogen (N_2) and phosphorus (P) contents usually ranged between 0.7-5.5 mg kg^{-1} and 10.0-18.26 mg kg^{-1} respectively. Available potassium (K^+) content is classified as low or moderate. The dominant cation is Na^+ and the dominant anion is SO_4^{2-}. Mapping of halophytic vegetation and domestication of economic valuable halophytes showed that the soil salinity types, moisture and sodium ion content were the major factors responsible in the cover vegetation changes. Vegetation richness, botanic species diversity, plant biomass were also well integrated with soil salinity calculated for sodium ion accumulation. Most species exhibited clear distribution patterns and their abundance varied significantly along salinity gradient and aridity of climate. A linear regression equation between soil electrical conductivity (measured by EM38) and quantitative ion Na^+ accumulation both for the 0-150cm (r^2 = 0.84) and 0-75cm (r^2=0.82) soil profiles has been calculated, which allowed us to identify the proportional contribution of each plant community of saline prone landscape. The optimal integrated agroforestry – farming system comprising 12-15% of tree cover, 58% of alfalfa and 27-30% of annual forage crops provides satisfactory drainage control of these salt-affected marginal lands preventing salts accumulation at the root zone area. Trees/shrub plantations were deeply planting (sticks tap into the water table) through seedlings transplanting in early spring or late autumn seasons. A limited irrigation with low quality water has been applied during the initial stage of growth before sole reliance on available drainage water (higher salinity; EC 4.5 -12, 3 dSm^{-1}) resource become possible. Soil salinity at root zone was about 45 dSm^{-1}. The most promising were *Haloxylon aphyllum, Populus euphratica, P.pruinosus, P.nigra var. pyramidalis, Elaeagnus angustifolia, Robinia pseudoacacia, Tamarix hispida, T. androsowii, Salix babylonica, Armeniaca vulgaris, Dyospyros virginiana,* and among shrubs *Atriplex canescens, A. nitens, A. undulata, Hippophae ramnoides* and *Ribes niger,* including stands of native rangeland halophytes grown alone, or mixed with various traditional salt tolerant fodder crops.

Key words: Central Asia, salinization, sulphate-chloride, domestication, vegetation richness.

EFFECT OF SALINITY AND BENTONITE ON THE CHARACTERISTICS OF MINERAL SOIL. STUDY THE BEHAVIOR OF THE LEGUMINOUS PLANTS (VICIA FABA L.)

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In the objective to rehabilitate the degraded soils and improve the agricultural production, especially leguminous plants (*Vicia Faba L.*) in the sandy soils countries, we take an interest in the use of bentonite to ameliorate the physical and chemicals properties of these soils. To value the ecological advantage of this clay in these countries, it is proposed to study the effect of increasing amounts of bentonite on the physical and chemical characteristics on sandy soils by analysing pH, EC (electrical conductivity), total calcareous, active calcareous, total phosphorus, organic carbon, organic matter, total nitrogen and cation exchange capacity in the sand bentonite mixture soils samples. In Algeria, the drought has caused a rise of salts to the rhizosphere particularly encountered in soils of semi-arid and arid. The objective of this study is to provide as elements of the response of leguminous plants (*Vicia Faba L.*) to different increasing concentrations of salt and the combined action of the bentonite / salt to understand the variability of certain metabolic activities, mineral result and morpho-physiological behavior of the plant response to this abiotic stress. Results show that variability exists in the physico- chemical characteristics and morphological growth of the plant according to the bentonite amount mixed in the sandy soil sample.

Key words: Bentonite, salty soil, physical and chemical characteristics, rehabilitation , leguminous plants (Vicia Faba L.).

SUITABILITY OF SURFACE WATER OF MOUILLAH WADI FOR IRRIGATION PURPOSES

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Salinity is one of the most severe environmental factors limiting the productivity of agricultural crops. In this work, the evaluation of water quality of Mouillah Wadi was carried out in order to identify its suitability for irrigation purposes. Mouillah wadi is a subasin of Tafna watershed which is situated in the North-West of Algeria. It feeds the Hammam Boughrara dam with a capacity of 177HM^3. This wadi has important sources of pollution contaminating water whose quality deterioration is a direct consequence of the discharge of the effluents of all categories in surface water (industrial and urban wastes). In order to achieve this objective, chemical parameters were determined and the quality of water is evaluated using various tools, such as residual sodium carbonate (RSC), the magnesium hazard (MH), the permeability index (PI), the US Salinity Laboratory Salinity Classification, the Wilcox diagram and seasonal variation diagrams. Conductivity values show that the dam waters are considered marginal. Those of Mouillah wadi are of poor to harmful quality according to Wilcox classification. The calculated values of SAR and % Na plotted on SAR and Wilcox diagrams versus conductivity indicate a good to doubtful use of the dam water for irrigation. High salinity, %Na, Mg-hazard and RSC values at Mouillah wadi limit the use for agricultural purposes. All PI values are lower than 25%: water samples belong to Class-III, i.e., unsuitable category.

Key words: Mouillah wadi, Water quality, Irrigation suitability, Algeria.

THE ROLE OF ANTIOXIDANTS IN IMPROVING SUNFLOWER CULTIVARS' PERFORMANCE GROWN UNDER SALINE CONDITIONS

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A field experiment was executed to study the influence of salinity, antioxidant application and cultivars (Euroflor, Vidoc and Sakha53) yield and yield quality. The experimental design was layed out during two successive seasons at three different sites of salinity levels (3.98, 6.92 and 12.54 dSm^{-1}) at the experimental farm of Faculty of Agriculture, Fayoum University, Egypt. Plants were sprayed with three types of antioxidants (salicylic, ascorbic and oxalic acids) at two levels 100 and 200 ppm. Also predictive models were used to predict sunflower yield when increasing the concentration of antioxidants up to 300ppm. Furthermore models were used to reduce the harm effect of salinity and improve Sunflower potential yield by reducing soil pH by 0.3 through applying organic manure either by using the same amount of water or conserving some. The results showed that sunflower yield and yield quality were significantly reduced. Sakha 53 proved to be the most tolerant among tested cultivars and oxalic acid at 200ppm level was the most effective in ameliorating the damage caused by soil salinity on sunflower growth and yield. Modeling revealed that reducing soil pH under high salinity level improved Sunflower yield when using oxalic acid by 57.14%.

Key words: Sunflower cultivars, soil salinity, antioxidants, yield, prediction equation, modeling

INDUCING PEA PLANTS FOR CONQUERING ADVERSE CONDITIONS OF SALINE RECLAIMED SOILS WITH SOME SUPPORT APPLICATION

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The possibility of improving growth and yield of pea plants grown under reclaimed soil conditions which having salinity level of about 5,000 ppm was investigated in a private Farm, Fayoum, Egypt, during the two successive seasons of 2007/2008 and 2008/2009. To achieve this aim, the calcium paste treated-seeds of pea were sown in beds fecundated with ground sunflower heads. The producing pea plants were sprayed with ascorbic acid at the rates of 0, 100, 200, 300, and 400 mg L^{-1}. Significant positive influences of calcium paste plus ground sunflower heads applied alone or in combination with all ascorbic acid treatments used under this study were observed on growth, yield of green pods and seeds as well as the tested chemical constituents. In comparison with untreated seeds sown in non-fecundated beds, the plants producing from the calcium paste treated-seeds sown in beds fecundated with ground sunflower heads represented significant increases in growth traits (i.e. plant height, number of branches per plant and shoot dry weight per plant) and green pods yield and its components (i.e. number of green pods per plant, pod weight and green pods yield per feddan) as well as green seeds yield and its components (i.e. number of green seeds per pod, 100-seed weight and green seeds yield per feddan). In addition, the concentrations of some chemical constituents (i.e. total chlorophyll, total carotenoids, ascorbic acid, free proline, total soluble sugars, total phenols, N, P, K, Ca, Ca/Na ratio, Fe, Mn and Zn in shoots of plants besides, starch % and protein % were increased with the shortage in total soluble sugars % in green seeds). As for ascorbic acid foliar application, plants sprayed at all studied rates (i.e. 100, 200, 300 and 400 mgL^{-1}) revealed significant increases in all investigated parameters (i.e. growth traits, green pods and seeds yields and their components as well as chemical constituents of plant shoots and green seeds) as compared with untreated plants. Ascorbic acid treatment at the rate of 300 mgL^{-1} combined with calcium paste treated-seeds sown in beds fecundated with ground sunflower heads proved to be the best and may counteracted the inhibitory effects of salinity on pea plants. In view of above mentioned results, it has been concluded that spraying pea plants "cv. Master-B", producing from calcium paste treated-seeds sown in beds fecundated with ground sunflower heads, with ascorbic acid at the rate of 300 mgL^{-1} could be counteracted the adverse conditions particularly, salinity up to 5,000 ppm and consequently, economic green pods and seeds yield is obtainable.

Key words: Pea, calcium paste, ascorbic acid, growth, yield, chemical constituents

USE OF MARGINAL WATER FOR SAMPHIRE (*SALICORNIA BIGELOVII*) PLANTING IN THE UAE

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At present, available fresh water is not enough to meet the ever increasing demand for agriculture. That is why agriculture scientists are looking for different ways to use saline water as an alternative to fresh water to grow various crops. Samphire is one of the best options for such plants that can be grown using highly saline water. It has high culinary value and can be consumed either cooked or raw. The plant can also be used as feed for different domestic animals. Since its seed contains high quality unsaturated oil (30%) and protein (35%), it can be used to make biodiesel and as animal feed. At International Center for Biosaline Agriculture (ICBA), Dubai, UAE, 24 different lines of *Salicornia bigelovii* were planted in the fields and were irrigated with pure sea water. As a whole, most of the *Saliconia* lines studied grew well and gave good performance. To evaluate their performance data was recorded from 200 individual plants from each line during flowering and at the time of maturity. Data on 21 different both quantitative and qualitative characteristics of spikes and plants were studied. The range for plant height varies from 43.4 to 62.0 cm. For plant dry weight minimum was 73.2g while the maximum was 163.7g. The lowest seed weight per plant recorded was 1.23g and the highest was 6.51g. The results indicate that highly valuable samphire can be grown successfully in arid regions like UAE where sea water is available. That will help to reduce the demand of fresh water in agriculture.

Key words: Fresh water resources, samphire, biodiesel, salicornia, UAE.

THE COMPARISON OF SUNFLOWER, TURNIP AND FORAGE CORN IN UPTAKE OF SOME ESSENTIAL ELEMENTS AND CADMIUM IN CONDITION WASTEWATER IRRIGATION

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The objective of the present study is to investigate the plant potential to concentrate and accumulate essential elements and cadmium from lands under wastewater irrigation. The study was performed in the farmer fields in 2005 at Varamin region located in south of Tehran-Iran. The soil is a Shahr-e-Ray Series belonging to soil subgroup Typic Haplogypsids (USDA-NRCS Soil Taxonomy). The crops were sunflower, turnip and forage corn under wastewater irrigation. The experiment was conducted in a randomized block design (RBD) with three replications. The sunflower, turnip and forage corn were sampled in 2005 and separated into roots and above ground material. The three crops were analyzed for nitrogen (N), phosphorus (P), potassium (K), nitrate (NO_3), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) and cadmium (Cd). The results of the experiment showed that the highest concentration of nitrogen (N), phosphorus (P), Zinc (Zn), copper (Cu) and cadmium (Cd) were 6.05%, 1.27%, 97.27 ppm, 22.84 ppm and 0.54 ppm in sunflower respectively, and the most accumulation of nitrogen (N), phosphorus (P), Zinc (Zn) and copper (Cu) were in the grain and for cadmium was in the leaf. The most concentration of potassium (K) and nitrate (NO_3) were 5.79% and 8.26% in turnip respectively, and the most accumulation of potassium (K) and nitrate (NO_3) were in the leaf. Finally, the most concentration of iron (Fe) and manganese (Mn) were 335.25 and 114.78 ppm in forage corn respectively, and the most accumulation of iron (Fe) and manganese (Mn) were in root and leaf respectively. Based on the results of this experiment, lands under wastewater irrigation with excessive amount of essential elements and cadmium can cultivate sunflower for uptake excessive content of nitrogen (N), phosphorus (P), Zinc (Zn), copper (Cu) and cadmium (Cd), turnip for uptake excessive content of potassium (K) and nitrate (NO_3) and forage corn for uptake excessive content of Iron (Fe) and manganese (Mn) without any yield decrease.

Key words: Wastewater, elements concentration, soil remediation, sunflower, forage corn, turnip

QUALITATIVE CLASSIFICATION OF SOME OILSEED CROPS (SUNFLOWER, SAFFLOWER, SOYBEAN AND SESAME) FOR CULTIVATION IN SALINE LANDS OF ALIABAD REGION USING GIS

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The objective of this research is to conduct land suitability evaluation (qualitative classification) for some oilseed crops included sunflower, safflower, soybean and sesame in Aliabad region (Guillan province) of northern Iran using GIS. This study carried out in an area including 5,500 hectares in the form of semi-detailed soil survey level. The soils were classified on the basis of USDA-NRCS Keys to Soil Taxonomy of 2006, in two orders of Inceptisols and Entisols. In addition, in the study area 6 soil series and 6 phases were identified. Suitability classes by means of Simple Limitation Method (SLM), Limitation Method regarding Number and Intensity (LMNI) and Parametric Method (PM) such as square root and Storie methods were determined using climatic data, soil information and Landscape qualities such as topography map. Finally, the maps of suitability classes of land units were determined with combination of available data for the considered crops using the procedures proposed by Sys et al., (1991 a, b and 1993) and ArcGIS. Results of different methods revealed that the largest parts of the study area were classified as highly and moderately suitable for investigated crops due to physical and chemical soil parameters such as topography and soil fertility. So that, the most limiting chemical factor being considered in this area is soil salinity. However, the land suitability classes for sunflower and sesame were S1, S2 and S3 while these classes for safflower were N1, S1, S2, and S3. In addition, the land suitability classes for soybean were S2 and S3. According to the comparison of different methods of quantitative land suitability evaluation, it can be concluded that the parametric methods, espacially the Storie parametric method, will lead to more reasonable results.

Key words: Landfill, Agadir, Morocco, arid climate, local plants, reclamation, management.

MECHANISMS OF SALT TOLERANCE OF SOME HALOPHYTIC SPECIES WITH POTENTIAL INTEREST IN FOOD CROPS AND RECLAMATION OF SALINE SOILS: GAS EXCHANGE, WATER USE EFFICIENCY AND METABOLISM PROTECTION

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The aim of this study was the acquisition and comparison of data related to the physiological, ecological and biochemical mechanisms involved in the adaptation of *Batis maritima, Spartina townsendii, Sesuvium portulacastrum, Beta vulgaris ssp. maritima* and *ssp. vulgaris, Aster tripolium, Leptochloa calla* and *Sporobolus virginicus* to high salinities. With the exception of the seabeet all of the selected species were salt tolerant with distinct potentials to become food or fodder crop halophytes in arid and semi-arid regions. These plants can survive in saline conditions by a range of adaptations and regulations at molecular, cellular and whole plant level. Our data indicate multigenic regulation mechanisms showing the overall picture of either salt avoiding, resisting and/or excessive accumulating plants. A coordinated regulation of gas exchange, ion-selectivity,-transport and compartmentalization together with a balanaced synthesis of compatible solutes contribute to long term survival in saline environments. These results support the recommendation for the use of the halophytes as promising species for the valorisation of coastal lands and strongly salted zones under saline irrigation. In these regions a high diversity of halophytes has evolved.

Key words: Halophytes, seawater irrigation, salinity tolerance, compatible solutes, gas exchange regulation, metabolic regulation, physiological regulation.

RECLAMATION OF THE LANDFILL OF AGADIR, MOROCCO

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Household waste management is a relatively recent preoccupation in Morocco. Nevertheless waste disposal has become a serious problem in terms of public health and environment. Waste dumping without management may be dangerous for health and causes land degradation in terms of ecology and economy. Moroccan populations perceive waste dumping as an environment non sound activity, especially because it has been done without any management. In Agadir, household waste has been dumped in a site that has become inside the urban perimeter because of the expansion of the city. After several studies, the council of Agadir has decided to create a new site for waste disposal and to reclaim the actual site which covers an area of 24 hectares. A number of aspects had to be studied in order to achieve an environmentally acceptable reclamation. Site characteristics were studied in order to establish a good diagnosis of the situation: topography, waste composition, earthy fraction and top soil characterization (texture, organic matter and mineral composition). Three profiles representing the site were dug and subsamples were taken and analyzed. The biggest fraction was represented by earth (45.33%) followed by stones (22.66%), plastics (13.66), paper and paperboard (9.66%) and other elements (8.66%). Given the arid climate of the region (hardly 230 mm/year) and the rapid disappearance of the natural vegetation, it has been decided to choose local plants for the re-vegetation of the site. However the option of planting some well adapted exotic plants has not been neglected. A pilot site was created in 2007 in order to experiment several plant species for their adaptation to the local conditions. The plants were planted in planting holes filled with top soil of average fertility and drip irrigation was designed to supply water. The main local plants were *Argania spinosa* and 6 of its accompanying species (*Atriplex halimus, Lycium intricatum, Nerium oleander, P eriploca laevigata, Senecio anteuphorbium* and *Withania frutescens*). The exotic species comprised trees (*Brachychiton populneum, Schinus molle*) and shrubs (*Acalypha wilkesiana, Buddleja madagascariensis, Hibiscus rosa-sinensis, Lantana camara, Tecoma stans*). All plants grew well during the first year due to regular watering and maintenance. However a part of the plot where fish industry rubbish was dumped, high levels of salinity showed up after episodes of rain increasing salinity at the level of the planting holes. Results of water samples collected revealed electrical conductivities ranging from 18 to 55 dSm^{-1}. As a result even plants with a good tolerance to salinity were heavily affected and died. This was the case of some specimens of *A. halimus*. Other plants, more sensitive to salinity, survived showing that they were out of the effect of salt accumulated by surface runoff. The

paper will present detailed data and will explain how experimental results are being used to orientate the reclamation and management of the site.

Key words: Landfill, Agadir, Morocco, arid climate, local plants, reclamation, management.

BIOLOGY AND PHYSIOLOGY OF *AVICENNIA MARINA* IN THE COASTAL CONDITIONS OF SOUTHERN MOROCCO

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The objective of this work is to study the possibility of introducing the mangrove *Avicennia marina* in some bays and estuaries of Southern Morocco. *A. marina* is among the mangroves most tolerant to salinity and can therefore represent a good opportunity to create greenery and biomass in areas where the only available water is seawater. As a matter of fact, the southern part of Morocco is subject to a sub desert climate with saline underground water and very little rainfall. Water in estuaries is mainly seawater mixed in some instances with wastewater. These conditions represent constraints to the establishment of conventional plants and the local halophytes are of very little economic interest. This is the reason for envisaging the utilization of *A. marina* for planting in such environments as it will provide shelter and food for marine fauna and wood for the use of local populations. In order to achieve this goal a good knowledge of the plant under Moroccan conditions is necessary, especially since 2 planting attempts in the bays of Dakhla and Agadir have completely failed. Experiments are being conducted to propagate *A. marina* by air-layering and by cuttings in order to develop the best vegetative way of propagation. In parallel to these experiments, seedlings grown from propagules are observed under greenhouse conditions for growth parameters (height, leaf production, stem thickness, etc). Other seedlings are subjected to different salinity treatments ranging from fresh water to 150% seawater. An irrigation and drainage system called "Quick Check System" enables to apply the required seawater treatment to sets of plants. *A. marina* has been reported to have its threshold for salinity tolerance above 100% seawater. All experiments are conducted in a greenhouse especially designed for halophytes. In order to understand the responses of *A. marina* to salinity, a number of morphological and physiological parameters are being studied in the different treatments. Densities of stomata in the adaxial and abaxial parts of the leaves are evaluated; osmotic potential is also determined. Proline content and ionic composition of plants are studied as well. Results of these experiments will be presented and discussed in the conference.

Key words: Agricultural, conservation, conventional, cost of production, optimum, pragmatic approach

SOIL AND WATER CONSERVATION THROUGH INTRODUCTION OF CONSERVATION TILLAGE SYSTEM IN SEMI ARID REGION TO ENSURE STAPLE FOOD SECURITY

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To help abridge the widening gap between food supply and food demand, Pakistan requires an optimum, high growth strategy for the agriculture sector. Investments need to be made in agricultural research, extension, education, soil and water resources and allied infrastructural development which will lead to increase the food production. Introduction of soil and water conservation is the prerequisite in wheat-rice cropping systems in Pakistan particularly in late maturing fine-rice varieties grown areas. Late-season harvesting of the rice crop and the use of conventional land preparation practices leads to significant delay in sowing time of wheat resulting reduction in wheat yields, as well as extra usage of irrigation water and preparatory tillage operations, which not only increases the cost of production but disturb the soil structure. Conservation of soil and water by conservation tillage technology has allowed the earlier planting of wheat. It improves the water use efficiency when compared with conventional tillage practices both in canal and ground water. The comparative study of soil and water conservation among four wheat varieties was tested in randomized complete block design (RCBD). Analysis of variance revealed significant differences in all noted parameters. The graphic representation showed that yield contributing traits behaved best in conservation tillage practice. Among four experimental wheat varieties, the variety Inqalab-91 proved best yielder in across environments. Additionally the energy conservation was also done by adopting an integrated, holistic and pragmatic approach to ensure staple food especially in competitive areas of semi arid regions.

Key words: Agricultural, conservation, conventional, cost of production, optimum, pragmatic approach

THE GENOTYPIC BEHAVIOR OF SUNFLOWER (*HELIANTHUS ANNUUS L.*) UNDER SALINE SOIL CONDITIONS

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To cope with the growing population, effective utilization of problematic and marginal soils has become imperative. The genetic potential and varietals differences with respect to salt tolerance are of great practical interest when introducing new crop varieties in a saline area. This emphasizes on the screening of different crop varieties of great demand for their salt tolerance. Therefore, a lysimeter study was planned in the green house to identify high yielding sunflower cultivars which has potential to tolerate salinity. The experiment was quadruplicated using completely randomized design (CRD) in factorial arrangement. Three salinity levels, control, 9 and 12 dSm^{-1} were developed by the additions of NaCl salt and tested on three sunflower genotypes (SF-187, S-287and HYSUM-33) for a period of 90 days. The tap water was used for irrigation having EC 2.01 dSm^{-1} and RSC 2.5 meL^{-1}. The data on various growth parameters like plant height, shoot fresh weight, relative growth rate, leaf analysis for Na^{+}, K^{+}, Ca^{2+}+Mg^{2+}, leaf area, chlorophyll contents, flower diameter, flower weight, and selective transport capacity of Na^{+} and K^{+} in plants leaves and stem was recorded and analyzed statistically using standard procedures. Due to increase in salinity stress there was maximum decrease in all growth parameters, however, variations were observed among all the genotypes. There was maximum decrease in biomass, leaf area and chlorophyll contents where EC was 12 dSm^{-1}, but the HYSUN-33 and SF-187 had better growth and ionic relations compared to genotypes S-287. The low rate of Na^{+} transport along with high rate of K^{+} and better ability to restrict Na^{+} in the leaf and stem was main reason of genetic variation among different genotypes, especially, when growth characteristic did not vary significantly under salt stress. This was most prominent in Hysun -33 regarding the characteristics of salt tolerance.

Key words: Microbial, ethylene production, maize, endogenous, PGPR.

MITIGATING THE DEPRESSING EFFECT OF BRACKISH WATER ON THE GROWTH AND YIELD OF MAIZE THROUGH MICROBIAL ACC-DEAMINASE BIOTECHNOLOGY

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Plants irrigated with brackish water suffer from stress resulting in inhibitory levels of endogenous ethylene production. The 1-aminocyclopropane-1-carboxylic acid (ACC)-deaminase is the enzyme which is present in some strains of plant growth promoting rhizobacteria (PGPR) which can promote plant growth by lowering the endogenous level of stress ethylene along with some other mechanisms. Experiments were conducted under axenic and pot conditions to evaluate the potential of PGPR containing ACC-deaminase (S_1 and S_2) for improving growth and yield of maize crop irrigated with synthetic brackish water [EC 5dSm^{-1}; SAR 10 (mmol L^{-1})$^{0.5}$]. The first experiment was conducted under axenic conditions with N_0 (throughout normal water), Bo (throughout brackish water), C (alternate normal and brackish water) and D (2 normal water irrigations followed by 1 brackish water) and two PGPR strains (S_1 and S_2) using CRD factorial design. The application of brackish water significantly reduced the maize growth but the alternate irrigation of normal and brackish water or 2 normal water irrigations followed by 1 brackish water appreciably enhanced the growth. The bacterial isolates significantly reduced the inhibitory effect of brackish water on maize growth but with different degrees of efficacy however, PGPR strain S_2 was the efficient one in all the treatments. However, the results were more pronounced under salinity stress as compared to normal water treatment. The S_2 inoculation increased the root length, root fresh weight, root dry weight, shoot length, shoot fresh weight and shoot dry weight of maize seedlings grown with brackish water by 124, 210, 87, 32, 101 and 206 %, respectively, compared with the respective un-inoculated control. In the pot trial, the treatments include N (throughout normal water), B (throughout brackish water), NB (normal water during vegetative growth and brackish water during reproductive growth) and BN (brackish water during vegetative growth and normal water during reproductive growth) with same PGPR strains (S_1 and S_2). Apparently, the inoculation seems to have improved the growth of maize irrigated with brackish water however, numerical data will be recorded on harvest at maturity. These PGPR strains have already proved their worth for inducing salt tolerance and consequently improving the growth and yield of maize in salt affected fields.

Key words: Microbial, ethylene production, maize, endogenous, PGPR.

SUSTAINABLE AGRICULTURE THROUGH INTEGRATED SOIL FERTILITY MANAGEMENT ON DEGRADED LANDS

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According to FAO, in sustainable agriculture, land, water, plant and animal genetic resources are conserved, the environment is protected, and is economically practical and socially acceptable. Thus the use of natural resources to meet people's requirements currently and in the future is sustainable agriculture. Considerable development in the efficiency of agricultural systems is required to sustain the growing rural and urban populations in the developing world. Often the only way to increase agricultural production is by intensification of existing production systems involving increasing cropping intensity and by increased use of external inputs. The main concern is whether, these agricultural production systems can be sustained in many developing countries. This is because a major portion of the currently cultivated land is being lost through soil degradation. This degradation involves soil erosion, nutrient depletion, desertification, deforestation, salinization or overgrazing. As agricultural areas become even more crowded, arable land has come under increasing pressure. Agricultural yields could fall because soil is becoming more degraded, putting the livelihoods of millions of subsistence farmers at risk. Integrated soil fertility management (ISFM) is the key in raising productivity levels while maintaining the natural resource base. The main objective of this integrated approach is to replenish soil nutrient pools, maximize on-farm recycling of nutrients, reduce nutrient losses to the environment and improve the efficiency of inputs. Soil fertility can be built up by progressive and steady modification of the natural resources including soils, vegetation and water by crop fallowing, grazing, selecting crop species, deep ploughing to break the plough pan, sub-soiling, organic fertilizing, transferring crop residues and fodder. Integrated soil fertility management will result in gradual conversion of waste lands into productive land. It will allow farmers to continuously achieve high yields on the same land for many years, eliminating the need for clearing new lands and lead the way to develop low input agriculture based on making better use of organic materials available on-farm to build up soil organic matter.

Key words: New trends, land degradation, UNCCD, DLDD, CST, DesertNet International (DNI).

YIELD AND GROWTH RESPONSES OF AUTOCHTHONOUS PEARL MILLET ECOTYPE (*PENNISETUM GLAUCUM* (L.) R. BR.) UNDER SALINE WATER IRRIGATION

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Saline water irrigation (SWI) is one way of water saving processes in the limited water resources regions. This process allows preserving drinking water for other use and permit to produce in marginal zone. As a consequence, significant reduction of production costs was recorded. In Tunisia, pearl millet (*Pennisetum glaucum* (L.)R.Br) is mainly cultivated in irrigation conditions in the arid and saline areas; so selection of tolerant genotypes to water deficit is very important. The SWI was applied to autochthones pearl millet ecotype native from Kairouan (arid and saline zone) to detect its performance. The results obtained showed significant variation of crop responses through a wide range of saline water. Only severe salinity (up to 7g/l) decreases growth and yield and its components. Results showed also that ecotype may be used to preserve genetic variability in arid and saline zones.

Key words: New trends, land degradation, UNCCD, DLDD, CST, DesertNet International (DNI).

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SESSION – V

Research and Development/ Innovations in Soil Classification and Reclamation

International Conference on Soil Classification and Reclamation of Degraded Lands in Arid Environments
17-19 May, 2010 Abu Dhabi City, United Arab Emirates

NEW TRENDS IN LAND DEGRADATION AND DESERTIFICATION RESEARCH AND THE ROLE OF THE ASSOCIATION DESERTNET INTERNATIONAL IN SHARING KNOWLEDGE AND PROMOTING SUSTAINABLE LAND MANAGEMENT

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Efforts of the international and national organisations to halt or reverse land degradation have produced mixed results. Problems are much accentuated in the drylands due to their natural fragility coupled with human induced pressures and further exacerbated when land degradation is combined with naturally occurring drought. It is for these reasons that the recent terminology adopted by the United Nations Convention to Combat Desertification (UNCCD) involves Desertification, Land Degradation and Drought (DLDD). But confusion still exists to make a distinction between soil/land degradation and/or desertification and this hampers actions from decision makers. For worst, maps and databases often do not make a clear division between potential risks or present status of degradation. Soil databases could remedy these shortcomings, but this should be supported by further soil surveys to update obsolete soil information, especially in the developing countries. Following the recommendations of the 1st Scientific Conference of the Science and Technology Committee (CST) of the UNCCD COP 9 held at Buenos Aires in September 2009, the new era of desertification research will be based on 10 pillars, and the trend is to support sustainable land management rather than simply focusing on combating land degradation. The positive outcomes of this paradigm shift include enhanced soil carbon sequestration and soil biodiversity, improved crop yields and farm income, and adaptation to climate change. However, soils only could not solve degradation problems unless their impact is estimated at the larger context of the ecosystem approach considering both biophysical and socio economic aspects of environmental stability, including policy implications of land use planning and management. It is for these reasons that knowledge management and information sharing is another important component of the new UNCCD strategy. However, the enormous wealth of scientific knowledge accumulated over the last decades has not produced the required results "on the ground" due to lack or poor communication between stakeholders and especially between policy/decision makers and the scientific community. One recent organisation, formed on the grounds of the European DesertNet is the Association DesertNet International (DNI) that aims to enhance stakeholder cooperation and to translate scientifically sound knowledge for

improved land management of the drylands. As a non-governmental scientific entity composed of biophysical and socio-economic scientists, DNI is open to all of them that have interest in land degradation/desertification research.

Key words: New trends, land degradation, UNCCD, DLDD, CST, DesertNet International (DNI).

PRELIMINARY INTERPRETATION OF ENVIRONMENTAL ISOTOPES DATA IN THE TAFILALET AREA, SOUTH-EAST OF MOROCCO

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IAEA Project - INT/5/144 on the durable use of the saline groundwater and wastelands, for the agricultural production, has through the production of the plants tolerance to the salinity, and more particularly the evaluation of the water resources by application of environmental isotope complemented by hydrochemistry in the South-eastern zone of Morocco (Tafilalet) and more precisely at the place says Ain el Atti to the South-east of the Kingdom of Morocco in the zone presaharienne South-Atlasique. It is undertaken within the framework of a close cooperation with the Regional Office of Agricultural Development of Tafilalet of which the zone of action attend on a total surface of 77.500 km^2 including four large basins: Gueris, Guir, Maider and Ziz. Measurements of stable isotopes (^2H and ^{18}O) and radioisotopes (^3H and ^{14}C) will assist in determining the origin of water salinity in different aquifers (layers), possible groundwater recharge, the transit times through the layers. Integrated interpretation of isotope and chemical data together with available hydrological information would yield the conceptual model of water flow in the basin. Methodological approach for measuring in-site costs of desertification when empirical data is not available.

Key words: IAEA, salt tolerance, isotopes, hydrochemistry, aquifer, Morocco.

METHODOLOGICAL APPROACH FOR MEASURING IN-SITE COSTS OF DESERTIFICATION WHEN EMPIRICAL DATA IS NOT AVAIBALE

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When it comes to data availability on land degradation and its economic consequences both at global and national level, the issue of "data reliability" arises. Decision-makers at country level, donors and international cooperation are not fully convinced about the extent of the problem and its economic consequences because of the lack of reliable data and also of a methodology to estimate the economic losses of land degradation. The existing global assessments on land degradation carried out between 1997 and 2003 present general data in different formats and scales and in a way that leads to some exaggerated conclusions, which sometimes are far from the reality. This has been impacting negatively the decision-making process and also the investments in sustainable land management. In this regard, it is fundamental to develop methodological tools and to collect empirical data that can be used to estimate the economic losses derived from soil erosion and its impact on water resources in order to allow the development of sound policies and incentives related to sustainable land management. However, in the majority of the developing countries, empirical data related to soil erosion and water resources degradation is not available. The paper presents a methodology based on the use of the Universal Soil Loss Equation (USLE) combined with other simple tools to estimate the economic losses from soil erosion and it's impacts on water resources availability in situations where there is no available empirical data. An exercise has been conducted in eleven Latin American countries in 2003/2004 and the results are also presented in the paper. The methodology can be easily replicated and its results can offer decision-makers the opportunity to estimate the cost of inaction in facing land degradation.

Key words: Desrtification, empirical data, data reliability, economic losses, USLE.

MANAGING THE HAZARDS OF DROUGHT IN DRY LANDS: THE CASE OF KUWAIT

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Dry lands which cover about 41% of the global terrestrial areas are characterized not only by low average annual rainfall but also by large variations in rainfall. Drought is a common and serious natural hazard in Kuwait and other surrounding countries. During the last forty years, Kuwait experienced a number of dry seasons when rainfall was below average recorded level (about 110mm/year). During 2007/2008 and 2008/2009 dry seasons, when total rainfall was 35mm and 65mm respectively, drought consequences were; 1) massive wind erosion (soil losses and drifting) amounted 750-1000 cubic meters/hectare in west Managish area in July 2008; 2) severe sand encroachment even in areas protected for decades, e.g. KISR Experimental Station at Kabd 3) long lasting sand and dust storms, e.g. May-September 2008 and July-August 2009 and; 4) depletion of soil moisture and dryness of natural vegetation resulting degradation of rangelands in almost all open desert areas in Kuwait. Under the harsh environmental conditions of Kuwait, sustainable land use planning is the first defensive measure to mitigate the consequences of drought and thereby fight land degradation. During the last 15 years, significant changes in land use were observed in Kuwait. Some of these changes have positive ecological and environmental impacts while others have destructive effects. Establishment of the buffer zone (15 km width and more than 200 km length) between Iraq and Kuwait in 1993-1994 enhanced vegetation cover, biodiversity and soil conditions .While digging border trenches (about 3m depth and 5m width, hundreds km long) and constructing berms (about 2-3 m high, 3-5m width and hundreds km long) have negative impact on soil, surface water and natural vegetation. Sustainable measures to mitigate the consequences of drought are not well adopted in Kuwait. Based on the long experience of KISR in managing dry lands, five programs are proposed for managing the hazards of drought under the environmental conditions of Kuwait. These programs are: rainwater harvesting (watershed management; mitigating hydrological drought (restoration of degraded watersheds; managing the hazards of shifting sands; setting up sustainable land use plans and; rehabilitation of degraded terrains). Outlines of Drought Preparedness Plan (DPP) for the State of Kuwait will be presented. This plan focuses on a wide variety of items, examples of which are; setting up drought response options (contingency actions) of different scenarios for different drought conditions; building up institutional capacity to cope with drought by promoting risk management approach. The overall objective of this study is to adopt an integrated approach for drought mitigation and to develop a guiding framework for a drought preparedness plan for Kuwait.

Key words: Drought hazards, rainwater harvesting, hydrological drought, hazards of shifting sands, sustainable land use plans and rehabilitation of degraded terrains.

INNOVATIONS IN SOIL CHEMICAL ANALYSES – NEW ECe AND TOTAL IONS RELATIONSHIP IN ABU DHABI EMIRATE SOILS

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The electrical conductivity of soil saturation extract (ECe) is an indirect standard measurement of soil salinity. The soluble ions (Na, Ca and Mg) are used to calculate Sodium Adsorption Ratio (SAR = Na/[(Ca + Mg)/2]$^{0.5}$ to quantify Exchangeable Sodium Percentage (ESP). The USDA suggests a general relationship between ECe and total soluble salts (Total salts meq/l = ECe dS/m x 10). In many laboratories of developing world with limited analytical resources, the USDA relationship is widely used for simplicity and to save resources and Na is determined by difference (Na meq/l = [(ECe x 10) – (Ca + Mg)], all ions are in meq/l, and very often, it is considered or assumed that soluble K is insignificant in soil solutions and therefore, will not affect SAR. This is common in even water quality analyses. In this study, attempt was made to test the hypothesis "that same relationship exists between ECe and total ions on soils of Abu Dhabi Emirate as that of USDA and this relationship can be used in Abu Dhabi Emirate". To test the hypothesis, correlation between ECe and total ions (from diversity of soils i.e., salids, gypsids, calcids, psamments and orthents) is developed by using SigmaPlot graphing software from Systat. The log-log graph (two-dimensional graph of numerical data that uses logarithmic scales on both the horizontal and vertical axes) was used for plotting ECe and total ions values, and simple scatter-Regression was used to develop correlation. It is revealed from comparison that total ions/ECe relationship vary at different ECe values, ranging from 10 to 16 (from ECe 1 to 200 dS/m USDA relationship) and ranging from 10 to 12 (from ECe 1 to 500 dS/m) in Abu Dhabi soils. The overall relations found in Abu Dhabi soils are ($y = 11.349x$ and $r^2 = 0.9711$ for total cations and ECe) and for total anions and ECe ($y = 12.852x$ and $r^2 = 0.9577$), compared with USDA relationship between total salts and ECe ($y = 12.8521x$ and $r^2 = 0.9577$), where x = ECe dSm^{-1} and y = total cations or anions in meq/l. However, the range of these ratios significantly differs at higher ECe levels 16 vs 12. It is concluded that a different relationship exists in Abu Dhabi soils compared with those of USDA over a range of ECe values, therefore, a different relationship curve for soils under investigation are to be used, or, a complete analyses is carried out for correct prediction of soil or water sodicity levels.

Key Words: chemical analyses; ECe; relationship; sigmaplot; Abu Dahbi Emirate

ANHYDRITE FORMATION ON THE COASTAL SABKHA OF ABU DHABI, UNITED ARAB EMIRATES

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A fluvial marine sabkha along the coastal area of Abu Dhabi, United Arab Emirates stretches over 400 km. This coastal area is hypersaline from evaporative losses of ground water originating from rain, sea water intrusion, lagoons that border the sabkha, and inland groundwater sources. Anhydrite ($CaSO_4$) is present in these soils, regarded as both a neoformed mineral and as a product of gypsum transformation. Six pedons (designated 1 to 6) were described, sampled and characterized from a 13 km transect across the sabkha in order to better understand the distribution of soils in the area and evaluate mineral formation. All pedons were weakly developed and light colored. Soils were highly saline with EC (2:1) ranging from 11 to 167 dSm^{-1}. Evaporative minerals identified by x-ray diffraction (XRD) include calcite, gypsum, halite, aragonite, and anhydrite. Together, salts, gypsum, and anhydrite composed 5 to 100% of the mineral matter of sabkha soils. Anhydrite was identified in the two sites (pedons 5 and 6) most distant from the coast, ranging up to 43% of the mineral matter and occurring in thicknesses of 8 and 55 cm, respectively. Soluble salts were the other dominant mineral constituent in horizons with anhydrite, with small amounts of carbonates. Horizons with anhydrite generally had higher percent silt (ranging from 23 to 81%), lower bulk density (0.96 to 1.65 g cm^{-3}), and greater SO_4 and total S than other pedons in the study. This mineral is present as aggregates of silt-sized particles and/or lath-shaped sand-sized grains. Anhydrite appears to form at the capillary fringe zone above the water table where salts concentrate within the profile. These data suggest that conditions currently exist for on-going anhydrite formation, especially further distance from the coastline where sabkha sediments that are less influenced by tidal surge and/or lagoon or seawater intrusion.

Key words: Fluvial marine, anhydrite formation, coastal sabkha, hypersaline, evaporative, Abu Dhabi, UAE.

SOIL SURVEY QUALITY ASSURANCE-USDA PERSPECTIVE OF THE SOIL SURVEY OF ABU DHABI EMIRATE

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Soil scientists from USDA-Natural Resources Conservation Service were invited by the International Center for Biosaline Agriculture (ICBA) and Environmental Agency - Abu Dhabi (EAD) to participate in a quality assurance review of the extensive Soil Survey of Abu Dhabi Emirate. The review was of interest to USDA not only due to the application of the U.S. soil survey mapping and classification standards, but the emphasis on developing soils within the Emirate into useful and productive agricultural areas. Meetings were conducted with scientists of ICBA and EAD and the soil survey management team of GRM International (Australian mapping contractor) to review various aspects of soil mapping, soil survey documentation, and day-to-day operational procedures. Field visits included examination of representative polygons of pre-selected map units with on-site investigation by backhoe and hand dug pits traversing a widely diverse set of landscapes and landforms across several regions of the Abu Dhabi Emirate. Processes for soil pedon examination, recording of soil properties, classification of soils, mapping procedures, and determination of map unit composition were evaluated and additional methods used within the U.S. were presented for consideration when conducting future soil surveys. Laboratory procedures used in the analysis of soil samples were based primarily on USDA-NRCS methods and derivations unique to the Abu Dhabi soil survey were reviewed. In support of on-going cooperative efforts between the agencies of USDA, ICBA, and EAD soil samples were collected for detailed analysis in an effort to develop new methodology for identification and quantification of anhydrite ($CaSO_4$), as well as elucidate the mechanism and controlling factors for the formation of this mineral in soils of the region. Field and laboratory methods, standards, and procedures implemented by the project team (both ICBA/EAD and GRM) with their high level of technical skills, knowledge, and experience has ultimately yielded an array of high quality soil survey products greatly enhancing the wise use of one of the region's most precious natural resources-its soil.

Key words: Quality assurance, USDA perspectives, extensive soil survey, Abu Dhabi Emirate, UAE.

ANHYDRITE SOIL, AN INNOVATION IN SOIL TAXONOMY

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A soil rich in anhydrite ($CaSO_4$) was discovered and delineated as a separate map unit during the soil survey of Abu Dhabi Emirate. This mineral, with a unique occurrence in the soil vadose zone above the water table, has a X-ray diffraction (XRD) spectra that clearly shows the predominance of anhydrite over gypsum. Field observations of anhydrite indicate that it occurs as massive clayey material, soft nodules, and seams. Soil Taxonomy recognizes only gypsum ($CaSO_4.2H_2O$) but not anhydrite ($CaSO_4$) in its family mineralogy classification, although the latter mineral naturally occurs in large areas. The objective of this study is to differentiate and discuss properties of gypseous and anhydrite soils mapped in the coastal lands of Abu Dhabi and to present the proposal submitted to the USDA for a change in Soil Taxonomy. Results revealed major differences between gypseous and anhydrite soils that warrant their separation: 1) anhydrite soils, unlike gypseous soils, occur under moist conditions; 2) anhydrite soils are characterized by a greasy texture, while gypseous soils are abrasive; 3) XRD confirmed anhydrite as the dominant mineral in these coastal sabka soils, with the absence of gypsum; 4) gypseous soils have gypsum crystals on the surface but not anhydritic soils; and 5) The anhydrite layer is very sticky and very plastic but not gypsic layers. As the current edition of Soil Taxonomy does not recognize anhydrite soils, a proposal was submitted to the USDA to recognized soils that are rich in anhydrite under 3 levels of classification: 1) anhydritic diagnostic horizon; 2) anhydritic soil mineralogy class, and 3) at the subgroup level as Anhydritic Aquisalids and Anhydritic Haplosalids.

Keywords: Anhydrite, gypsum, Soil Taxonomy, Abu Dhabi Emirate, UAE.

MODELING OF SOIL CONTAMINATION AND REMEDIATION BY IN SITU FLUSHING

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The consequence of industrialization and other development activities have led to serious environmental degradation of land and water. In recent times people have started paying attention to these problems and remediation of soil or land recovery has become an important issue. Remedial measures to be applied appropriately and efficiently and the nature of contaminant transport and its adsorption and desorption characteristics should be properly studied. In the present study the contaminants (both organic and inorganic) have been considered, and their movement through the soil together with adsorption and desorption characteristics as well as chemical/biochemical degradation have been studied. The transport of these compounds has been described by a set of equations. These equations have been numerically solved with different boundary conditions to represent several scenarios experienced in several cases in arid environment. The modeling has been confined to one dimension with the assumption that the soil is homogeneous and isotropic. Contaminant transport such as transport situation may be visualized in many ways. Two specific cases are considered here. First the movement of leachate form soil waste dumping to ground, where toxic organic and inorganic chemicals were also dumped. Second is the case of a large-scale spillage of some toxic chemicals/oil/chlorinated solvents/non chlorinated solvents on the soil and its subsequent movement through the soil. There can be several variations of these scenarios. The paper considers some of these variations with respect to rainfall in the area followed by dry seasons. This paper presents an analysis of the site restoration techniques that may be employed in a variety of contaminated site cleanup programs. It is recognized that no single specific technology may be considered as a panacea for all contaminated site problems. An easy-to-use summary of the analysis of the important parameters that will help in the selection and implementation of one or more appropriate technologies in a defined set of site and contaminant characteristics is also included.

Key words: Soil contamination, modeling, environmental degradation, adsorption and desorption, transport situation.

IMPROVEMENT OF DESERT SANDY SOIL THROUGH USING RHIZOSPHERE BACTERIA, FERTILIZER AND MYCORRHIZAL FUNGI IN UAE

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Desert sandy soils are less fertile due to low clay and organic matter contents, and have low water holding capacity and behave like hydroponics. Therefore, there is a need to improve soil quality through improving plant beds for better crop production for food security and livestock production. To improve soil quality a number of inorganic and organic based materials are available in the market, such as compost, rhizosphere bacteria, mycorrhizal fungi and fertilizers etc.. These have been included in the present study with the objective to test various materials (compost, Rhizosphere Bacteria, Fertilizer and Mycorrhizal Fungus) and determine if compost alone or in combination with above materials enhance the growth of economically important crop Sweet Corn (*Zea mays var. rugosa*). Sandy calcareous soil (Typic torripsamments, carbonatic, hyperthermic) from ICBA experimental station was selected for the present experiment. The soil analyses were carried out in the Central Analytical Laboratory (CAL) of ICBA, as well as in two German laboratories at Leipzig and Berlin. Experiments were conducted in greenhouse to determine the growth rate of Sweet Corn at higher temperature (average temperature 35.5° C). The pots were filled with; 1) sand (control); 2) sand-mixed with 3% organic material, rhizosphere bacteria, fertilizer and mycorrhizal fungus (Mixture 1) and; 3) mix of sand with 3% of compost material from local sources (Mixture 2). The Mixture 2 is the common practice in the UAE for farms or landscape beds. The treatments were quadruplicated and the pots have holes at the base for drainage. Results showed that the treatment (Mixture 1) increases the growth of Sweet Corn plants over the growth in other treatments. The plant fresh weight was 4 to 5 times higher in mixture 1 than in control soil or mixture 2, similar results were recorded for shoot length. The increased growth with mixture 1 over other mixtures clearly revealed that the quality of the native desert sandy soils can be improved for agricultural purposes. Further field experiments will be conducted to verify the greenhouse experiment results, as well as detailed soil investigation (physical, chemical, nutritional and microbiological) will be carried out to understand the mechanism by

which the interaction between Rhizosphere Bacteria, Fertilizer and Mycorrhizal Fungus, the plant roots and soil took place to enhance both soil properties and plant growth under Arid conditions of UAE.

Key words: Soil improvement, UAE, organic material, rhizosphere bacteria, fertilizer, mycorrhizal fungus.

THE ROLE OF MYCORRHIZA IN RECLAMATION OF DEGRADED LANDS IN ARID ENVIRONMENTS

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Land disturbance and degradation in more arid regions of the world became a serious concern especially this phenomenon is directly connected to human challenges such as poverty, social and economic well-being, as well as environmental protection. One of the regions threatened by this phenomenon is the Arabian Gulf region (e.g. United Arab Emirates) which lies in a water-scarce environment with extremely sensitive ecological balance. Revegetation is one of the most effective means for controlling soil degradation and for reclaiming abandoned agricultural lands in arid and semiarid regions. However, the low availability of soil moisture due to scarce and irregular precipitation and frequent drought is a major obstacle to the successful revegetation of these regions. Ambitious programs have been launched by the governments of the Arabian Gulf countries for afforestation, landscaping within urban and rural contexts, as well as intensive agricultural production. These programs have been based on utilization of the limited water resources mainly ground water. Continued use of groundwater for irrigation to meet agricultural activities has led to declining of water quality (e.g., becomes saline) and hence the salinization of many soils and make it unfit for agricultural use. Dust storms and land erosion are becoming increasingly numerous where there is increase in soil salinity. Long-term success in establishing plant growth under arid or semi-arid environments can only be seen by development of strategies and tools for sustainable use of land and water resources, preserving the ecosystem and protecting the biodiversity. There was a general consensus that biotechnology can be used as a valuable tool to mitigate water scarcity and land reclamation. Microbial technology, e.g. use of mycorrhizal fungi as a biofertilizer and bioprotectant has been considered a valuable tool in the rehabilitation of disturbed and degraded lands. Mycorrhizal fungi are an association between plant roots and soil fungus that is found in most environments and in the majority of plant species. This association is particularly important in arid environments. Mycorrhizal fungi play a crucial role in plant nutrient uptake, water relations, ecosystem establishment, plant diversity, and productivity of plants. Mycorrhiza also protects plants against root pathogens and abiotic stresses such as drought and salinity, and improve soil structure by enhancing soil aggregation and water-holding capacity. The fundamental importance of the mycorrhizal association in restoration and to improve revegetation of disturbed lands is well recognized. However, the use of mycorrhizal biotechnology in land reclamation and revegetation of disturbed sites is not well practiced in many parts of the world (e.g., Arabian Gulf region). The destruction of mycorrhizal fungal network in soil system is the vital event of soil disturbance, and its re-installation is an essential approach of habitat restoration. Successful revegetation of severely disturbed lands can be achieved by using "biological tools" mycorrhizal fungi inoculated tree seedlings, shrubs, and grasses… etc. The full paper of this abstract and the presentation at ICSC2010 will discuss different types of

mycorrhizas, which play an essential function in altering disturbed lands into productive lands, the mechanisms by which disturbed ecosystem benefits through symbiotic associations and their interactions in the rhizosphere. The importance of re-installation of mycorrhizal systems in the rhizosphere is emphasized and their impact in landscape regeneration and in bioremediation of degraded soils will be discussed.

Key words: Land disturbance, environmental protection, revegetation, mycorrhizal fungi, biotechnology.

APPLICATION OF A SCREENING MODEL TO EVALUATE PESTICIDE CONTAMINATION IN SOIL AND GROUNDWATER FOR SUSTAINABLE AGRICULTURE IN OMAN

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In recent years agricultural activities have increased significantly in Oman that has led to an expansion in the use of pesticides. Consequently, soil and groundwater quality is likely to deteriorate. In this presentation at ICSC 2010 we present results of a project conducted at Sultan Qaboos University (SQU) on predicting pesticides movement through the unsaturated zone to groundwater. The outcomes may help decision makers in assessing the likelihood of soil and groundwater contamination in Oman under various land use practices. A model (PESTAN) based on the analytical solution of 1-D advective dispersive reactive transport equation is used to estimate the vertical migration of the dissolved organic solutes. The PESTAN model is used for conducting initial screening assessment of the potential for contamination of soil and groundwater. The PESTAN calculates the movement of organic chemicals with a linear isotherm, first-order degradation and hydrodynamic dispersion. Input data include; soil, chemical and management practice parameters. Data on Omani soil, climatic and irrigation practices as well chemical parameters of most common pesticides used in Oman are required for modeling. Reliable assumptions were made to compensate for missing data. The main target of the project was to model the top 10 pesticides used in Oman for 5 years, in order to calculate the time each particular pesticide would take to reach the water table that is estimated to be at 10 m under ground surface. Three scenarios were developed, after selecting 3 variables which mainly contributes to pesticides' fate: recharge, soil texture and application rate of pesticides. For each variable maximum and minimum values were modeled to be compared with a base run describing the recommended conditions. Our results suggest that the more the recharge and application rates, faster the pesticides reach groundwater. In coarse textured soil the pesticides penetrate faster through the soil profile. Overall, the simulations demonstrated that most of the 10 pesticides are not reaching the water table within 5 years by assuming a single application, where application frequency is concerned. Farmers are actually applying pesticides much more often than once. The PESTAN results can be interpreted in the following manner: reducing irrigation norms and increasing the organic matter content of the soil will help reduce groundwater contamination.

Key words: Screening model, pesticides, groundwater, PESTAN, SQU Oman.

UNIQUE OBSERVATIONS ON THE VEGETATION LOSS IN THE AL SAMMALIAH ISLAND OF ABU DHABI EMIRATE

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The Al-Sammaliah Island covers an area of about 14 km^2 and is situated in the Arabian Gulf about 12 km north-east of Abu Dhabi City. It is an onshore island and is being developed as a heritage and environmental education facility and presents large areas of artificial intertidal wetlands. The Island is a natural reserve containing high biodiversity, particularly mangrove (*Avicenna marina*) growing throughout the coast. Its geomorphology is characterized by flat desert surface with small artificial sandy hills and dispersed coastal sabkha especially in the low lands along the shoreline. The Island is characterized by its hyperarid climate; mean annual rainfall is less than 50 mm/year, while the mean monthly temperature is above 30°C. The soils are sandy, with surface salts reaching 31.5%, giving a white color to the soils of the Island. The Researchers working on the Island during their vegetation inventory observed a peculiar way of vegetation loss, which to their knowledge have never been seen in the Island and perhaps reported elsewhere, and therefore, form the focus of this paper to share these unique information with international scientific community. Vegetation losses under arid conditions could be due to many reasons, such as aridity, overgrazing and other natural and anthropogenic factors leading to land degradation. However, in Al Sammaliah Island of Abu Dhabi Emirate we found *Zygophyllum qatarense* (ZQ) in large area is completey taken over by the overgrowth of gypsum crystals ($CaSO_4.2H_2O$), the gypsum crystals radiating over ZQ branches to appear as bottlebrush type feature, which lead the ZQ vegetation to completely dried out and dead. It is visualized that Ca and SO_4 rich solution in subsurface through evaporation moved to the ZQ vegetation and with time spread to entire vegetation in the area. Similar bottlebrush type morphological forms were also found between the ZA vegetation.

Key Words: Al Sammaliah Island; Abu Dhabi; zagophyllum qatarense; gypsum

ASSESSMENT OF SOIL DEGRADATION IN THE NORTHERN PART OF THE NILE DELTA, EGYPT USING REMOTE SENSING AND GIS TECHNIQUES

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The present work aims at monitoring soil degradation process within the last two decades in the northern part of Nile Delta. The investigated area lies between longitudes 31° 00' and 31° 15' E and latitudes 31° 00' and 31° 37' N, covering an area of about 344584.01 feddans (10 feddan = 1 hectare). Detecting soil degradation and recognizing its various types is a necessity to take the practical measures for combating it as well as conserving and keeping the agricultural soil healthy. Land degradation was assessed by adopting new approach through the integration of GLASOD/FAO approach and Remote Sensing/GIS techniques. The main types of human induced soil degradation observed in the studied area are salinity, alkalinity (sodicity), compaction and waterlogging. On the other hand water erosion because of sea rise is assessed. The obtained data showed that, areas that were affected by compaction increment have been spatially enlarged by 40.9% and those affected by compaction decrease have been spatially reduced by 22.6% of the total area, meanwhile areas that have been unchanged were estimated by 36.5% of the total area. The areas that were affected by waterlogging increase have been spatially enlarged by 52.2% and those affected by waterlogging decrease have been spatially reduced by 10.1% of the total area, meanwhile the areas which have been unchanged were represented by 37.7% of the total area. Areas that were affected by salinity increase have been spatially enlarged by 31.4 % of the total area and those affected by salinity decrease have been reduced by 43.3% of the total area. An area represented by 25.2% of the total area has been unchanged. Alkalinization (sodicity) was expressed by the exchangeable sodium percentage (ESP). Areas that were affected by sodicity increase have been spatially enlarged by 33.7 %, meanwhile those affected by sodicity decrease have been spatially reduced by 33.6 % of the total area. An area represented by 32.6% of the total area has been unchanged. Multi-dates satellite data from Landsat TM & ETM+ images dated to 1983 and 2003 were used to detect the changes of shoreline during the last two decades. The obtained results showed that, the eroded areas were determined by 547.4 feddans, meanwhile the accreted areas were detected by 476.5 feddans during the twenty years period. Soil improvement program was adopted in the investigated area.

Key words: North Nile Delta, soil degradation, water erosion, soil improvement, remote sensing, GIS.

SPATIAL MONITORING OF SOIL SALINITY AND PROSPECTIVE CONSERVATION STUDY FOR SINNURIS DISTRICT SOILS, FAYOUM, EGYPT

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Mapping, updating and managing soil salinity are considered difficult tasks due to the large spatial and temporal variability of the salinity phenomena. GIS, RS and field studies are integrated in the present study to monitor soil salinity development through 7 years in Sinnuris District soils, Fayoum, Egypt. Soil salinity problems were recorded in 29.5% out of 52542.84 feddans, investigated arable land. The recorded saline soils were classified as, Typic Aquisalids, Typic Haplosalids and Typic Salitorrerts. Based on the updated studies for soils, ground water and Digital Elevation Models (DEM), a strategic future management plans supported with GIS spatial maps were suggested to improve salinity conditions and to overcome the future challenges of water scarcity in the area. Semi-detailed GIS maps were provided for the different main soil characteristics. Future prospective GIS maps were produced to simulate drainage condition, ground water level and to improve salinity conditions in the study area. The study is considered of vital importance for decision makers and for the management of natural resources in Fayoum Governorate.

Key words: Salinity, Fayoum soils, Egypt, DEM, RS, and GIS.