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To Our Readers

Schematic diagram of pollutants from agriculture in an agro-ecosystem environment

We are pleased to report the activities of the Soil and Water Management and Crop Nutrition (SWMCN) Subprogramme in the last six months. With the start of the new IAEA Technical Cooperation (TC) cycle, we are busy implementing 53 active TC projects, with several coordination meetings taking place to kick-off these projects. The SWMCN team has two inter-regional projects (INT5153 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions' and INT0093 on 'Use of Nuclear Techniques in Nutrient and Water Management for Small Island Developing States (SIDS)'); we report here on the coordination meeting of both projects.

We are pleased also to announce the 4-year agreement with the International Institute of Tropical Agriculture (IITA), as part of the 'Consortium for Improving Agriculture-based Livelihoods in Central Africa' (CIALCA) project, funded by the Belgian Government. This agreement is focusing on improving cassava agronomy, specifically on the management of cassava varieties, planting time and nutrient supply to better adapt to the adverse effects of drought spells. The role of the SWMCN Laboratory (SWMCNL) will be to use laser isotope technology to separate evaporation from transpiration above cassava stands, to improve water use efficiency and to use stable carbon isotope ratios to measure nutrient uptake and root yield storage for different cassava varieties under various soil management practices.

The SWMCN Subprogramme again joined the IAEA in the 'Long Night of Research', an event held in the evening of 22 April at the IAEA Headquarters. The objective of this series of events, initiated by the Austrian government, is to promote interest in science and research amongst all age groups, especially children. The SWMCN Subprogramme team presented several innovative ideas in very simple ways, such as using colourful water pearls to represent different isotopes in tracing the movement and pathways of pollutants in water. Approximately 1600 visitors came to the Vienna International Center for this event to see the 14 booths showcasing various applications of nuclear science and technology.

The SWMCN participated in several events in the past six months. Joseph Adu-Gyamfi was at the FAO Global Symposium on Soil Pollution (GSOP18) in Rome on 2-4 May 2018, presenting an oral paper on 'Applying nuclear techniques to assess the sources and transport of antibiotics from intensive agricultural areas to the environment through soil and water', highlighting the role of soil and water as major vectors where antimicrobials move from the agroecosystems to the environment, and the potential role of nuclear techniques (stable isotopes) to trace the sources and movement of these antimicrobials. He also presented a poster on 'Multi-isotope fingerprints to identify agricultural contaminants from soil to water'. Meanwhile Janet Chen from the SWMCNL was invited to speak at a youth forum on "A Youth Initiative for the Sustainable Development Goals of the United Nations", as part of the popular Chinese youth reality TV show 'Keep Running', which broadcast an episode on the 17 Sustainable Development Goals of the United Nations recorded at the Vienna City Hall.

The SWMCN continued to be very productive in terms of publications. Two documents on cosmic-ray neutron sensors (CRNS) were published recently, one of them the Springer book on 'Cosmic Ray Neutron Sensing: Estimation of Agricultural Crop Biomass Water Equivalent', which provides detailed step-by-step practical instructions for three different methods of Biomass Water Equivalent (BWE) estimation and includes detailed use of cosmic-ray neutron sensors (CRNS) as an innovative detector of BWE. The SWMCNL also works with the Technical University of Vienna in comparing soil moisture from CRNS with satellite-borne datasets.

The SWMCN Subprogramme was again very active at the annual European Geosciences Union (EGU) General Assembly, held in Vienna, with a total of 18 oral, poster and PICO presentations, covering topics such as climate change impact analysis, new radionuclide tracers for soil erosion investigation, carbon and nitrogen cycling, area-wide soil moisture screening, and decision-support software for nuclear emergencies.

We welcome Sergey Fesenko, Elke Vandamme and Leo Mayr as consultants, joining the SWMCNL in the last few months. Sergey comes from the Russian Federation and assists in the development of a document on sampling techniques in agriculture during nuclear emergencies and on soil-to-plant transfer experiments performed at the SWMCNL. Elke will support the CIALCA project on research activities into the effects of drought stress on cassava. Elke is currently based in Kigali, Rwanda. Leo, a former staff member, is working on the production of ^{15}N labelled nitrous oxide and its measurement, as well as on the installation of a high-temperature conversion system to measure $^{18}O/^{16}O$ ratios in NO_3^- and SO_4^{2-} by isotope ratio mass spectrometry (IRMS). Similarly, we welcome Neng Iong Chan and Jie Zhang as our new interns. Neng Iong will be involved in research on oxygen isotope in phosphorus to trace P pollution from soil to water, while Jie Zhang will be working on cosmic-ray neutron sensor for area-wide soil moisture monitoring.

During the coming months, three research coordination meetings (RCM) will be held in Vienna, Austria. These are the final RCMs of D1.20.12 on 'Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems' and D1.20.13 on 'Landscape Salinity and Water Management for Improving Agricultural Productivity', and the first RCM of D1.50.18 on 'Multiple Isotope Fingerprints to Identify Sources and Transport of Agro-contaminants'. We will also host a consultants meeting on 'Improving Irrigation Management through the Assessment of Soil Moisture Dynamics with the Aid of Cosmic Ray Neutron Sensor, and Remote Sensing'. The second RCM of D1.50.17 'Nuclear Techniques for a Better Understanding of the Impact of Climate Change on Soil Erosion in Upland Agro-ecosystems', was held in Rabat, Morocco. More information on these CRPs are reported in this Newsletter.

Finally, I would like to take this opportunity to thank all our readers for their continuous support.

Sincerely,

Lee Heng
Head
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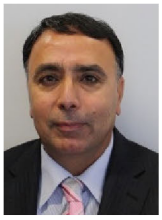
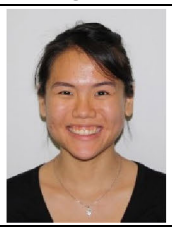
			
L.K. Heng	M. Zaman	E. Fulajtar	J. Adu-Gyamfi
			
M. Zaczek	K. Ajvazi	G. Dercon	L. Mabit
			
A. Wahbi	J. Chen	M. Heiling	C. Resch
			
G. Weltin	A. Toloza	R. Gruber	N. Jagoditsch
			
J.M. Mletzko	L. Mayr	S. Fesenko	A. Lee-Zhi-Yi
			
J. Slaets	H. Zhang	R. Falcao	N. Chang
			
J. Zhang	E. Vandamme		

Staff News

Neng Iong Chan (China) joined the SWMCNL as an IAEA intern in May 2018 for six months. He will be involved in research to further improve the purification of inorganic phosphate in soil prior to analysis of the oxygen isotope abundance to track P pollution from soil to water. Neng Iong is currently a PhD candidate at Arizona State University (USA) studying the sustainability of phosphorus management, particularly in agriculture and waste water treatment. He also has expertise in freshwater and ecosystem ecology and life cycle assessment. He holds an MSc in Bioenvironmental System Engineering from National Taiwan University, where he did research on wetland restoration.

Sergey Fesenko (Russian Federation) joined the SWMCNL in May 2016 as a consultant. His assignment is to contribute to the development of documents on sampling techniques in agriculture and to advise on soil to plant transfer experiments being performed at the Laboratory. Sergey is the research deputy director of the Russian Institute of Radiology and Agroecology. His field of research relates to the mitigation of impacts of radiation accidents (e.g. Kyshtym, Chernobyl and Fukushima). From 2004 to 2017, Sergey worked at the IAEA. Within this period, he published fifteen documents on environmental monitoring, environmental impact assessment and remediation. He was awarded the State Prize of the Russian Federation in 2002 and the IAEA Superior Achievement Award in 2017.

Leo Mayr (Austria) joined the SWMCNL in May as a consultant for five months. He was a staff member of the SWMCNL until his retirement in 2014. He has more than 30 years of experience in the use of isotopes in agriculture research and measurement of isotope ratios using IRMS and laser isotope analysers. In his current assignment he works on the thermal decomposition of ammonium nitrate to produce ^{15}N labelled nitrous oxide and the subsequent measurement with IRMS. He also works on the installation of a high-temperature conversion system to measure $^{18}O/^{16}O$ ratios in NO_3^- and SO_4^{2-} by IRMS.

Jie Zhang (China) joined the SWMCNL as an IAEA intern in May 2018 for one year. During his internship at the SWMCNL, he will be involved in research and development activities in the field of cosmic-ray neutron sensor technology for area-wide soil moisture monitoring. Jie is currently a PhD student at the China Agriculture University, Beijing, in soil physics, focusing on the improvement of soil moisture measurements using cosmic-ray neutron sensors and on the effects of soil crack dynamics on soil water infiltration and solute transport.

Elke Vandamme (Belgium) joined the SWMCNL in May 2018 to support research activities within the 'Consortium for Improving Agriculture-based Livelihoods in Central Africa' (CIALCA), a project in which SWMCN is a partner. The research within this partnership is aimed at better understanding and mitigating the effects of drought stress on cassava. Elke is a research consultant currently based in Kigali, Rwanda, but will be working in SWMCNL from July. She obtained her PhD in Bioscience Engineering from the University of Leuven in Belgium in collaboration with the Tropical Soil Biology and Fertility Institute of CIAT in Kenya in 2013, after which she joined the Africa Rice Center in Benin and Tanzania until 2017. Her work has been focusing on the sustainable resource management in maize- and rice-based systems.

Feature Articles

Validation of spaceborne soil moisture products using a cosmic-ray neutron sensor in Petzenkirchen, Austria

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Reliable measurements of soil moisture are of great use for many geoscientific applications. For example, soil moisture data are useful for monitoring flood risk and drought conditions and can assist in planning mitigation measures. Contrary to traditional soil moisture probes, which provide point measurements sensitive to a soil volume of several cubic decimeters at most, Cosmic-ray Neutron Sensors (CRNS) provide soil moisture estimates over a much larger area (about 20 hectares). Hence, the CRNS technique provides valuable information on field scale soil moisture, which is a big advantage over traditional sensors as most geoscientific applications require area-representative soil moisture data. For this reason, CRNS soil moisture data can also be expected to be particularly useful for validating satellite soil moisture data.

Microwave remote sensing techniques have matured up to the point that several satellite-based soil moisture data services have become available in a fully operational manner in recent years. These services are based on passive and active microwave missions such as National Aeronautics and Space Administration's (NASA) Soil Moisture Active Passive (SMAP) mission, European Space Agency's (ESA) Soil Moisture and Ocean Salinity (SMOS) mission, European Organisation for the Exploitation of Meteorological Satellites's (EUMETSAT) Advanced Scatterometer (ASCAT) on board the series of MetOp satellites, Japan Aerospace Exploration Agency's (JAXA) Advanced Microwave Scanning Radiometer 2 (AMSR2), and the Synthetic Aperture Radar (SAR) on board the Copernicus Sentinel-1 satellites. These satellite missions provide daily soil moisture observations on a global scale at a coarse spatial resolution, ranging from ~1 km for SAR to ~40 km for passive microwave missions. Data quality is typically best over grassland and agricultural areas, and degrades with increasing vegetation density. Soil moisture cannot be measured when the soil is frozen or covered by snow. Validation of these satellite-based soil moisture datasets keeps on being pivotal to produce reliable datasets that can be used by stakeholders. The CRNS technique provides soil moisture measurements on a spatial scale more comparable to the satellite observations than traditional point based techniques, e.g. Time Domain Transmission, Time Domain Reflectometry and gravimetric sampling.

In a collaboration between IAEA, Vienna University of Technology (TU Wien) and Federal Agency of Water Management (BAW), Petzenkirchen, a stationary CRNS was installed in the Hydrological Open Air Laboratory (HOAL) in Petzenkirchen, Lower Austria *(Blöschl et al., 2016)*, to collect field soil moisture data since December 2013 *(Franz et al., 2016)*. The CRNS soil moisture data have been compared to satellite data and the network of point measurements by conventional methods, e.g. gravimetric sampling, and Time Domain Transmission (TDT) measurements distributed within the CRNS footprint. As illustrated in Figure 1 comparing the CRNS data to satellite soil moisture retrievals from ASCAT (25 km resolution), Sentinel-1 (1 km resolution) *(Wagner et al., 2013)* and the network of point data averaged for the Time Domain Transmission (TDT) sensors that fall within the CRNS footprint, the four data sources compare in general well. Despite the negative bias between CRNS and the other data sets, the correlations between all data sets is relatively high. Temporal correlation as indicated by Pearson's correlation coefficient is 0.75 between point data and ASCAT, 0.65 between TDT and CRNS, and 0.49 between CRNS and ASCAT. For Sentinel-1 correlation coefficients of 0.59 and 0.51 were found with TDT and CRNS respectively. When calculating the correlations between the soil moisture anomalies, the temporal correlation increases for ASCAT and Sentinel-1 with: 0.68 and 0.55 between TDT and ASCAT and Sentinel-1, 0.53 and 0.61 between CRNS and ASCAT and Sentinel-1 and 0.69 between CRNS and TDT. The high anomaly correlation coefficients values reflect the fact that all soil moisture data sources capture rainfall events very well. Despite vegetation impacts the CRNS and satellite measurements *(Vreugdenhil et al., 2016; Wahbi et al., 2018)*, the fact that in general no seasonal biases or other artefacts can be observed in both time series suggests that vegetation is treated correctly in the CRNS and satellite estimates over the HOAL. However, during the summer of 2016 the bias between CRNS and the other data sets, which

is overall negative, decreased and higher soil moisture values were measured with CRNS (Figure 2). This was possibly caused by the presence of corn within the CRNS footprint, which has a high vegetation water content. The high correlations between CRNS and both the satellite and TDT data, for absolute values and anomalies, emphasizes the high potential of the CRNS technique for monitoring of field-scale soil moisture. Nonetheless, further research to study scaling effects and the impact of vegetation and soil properties is still needed.

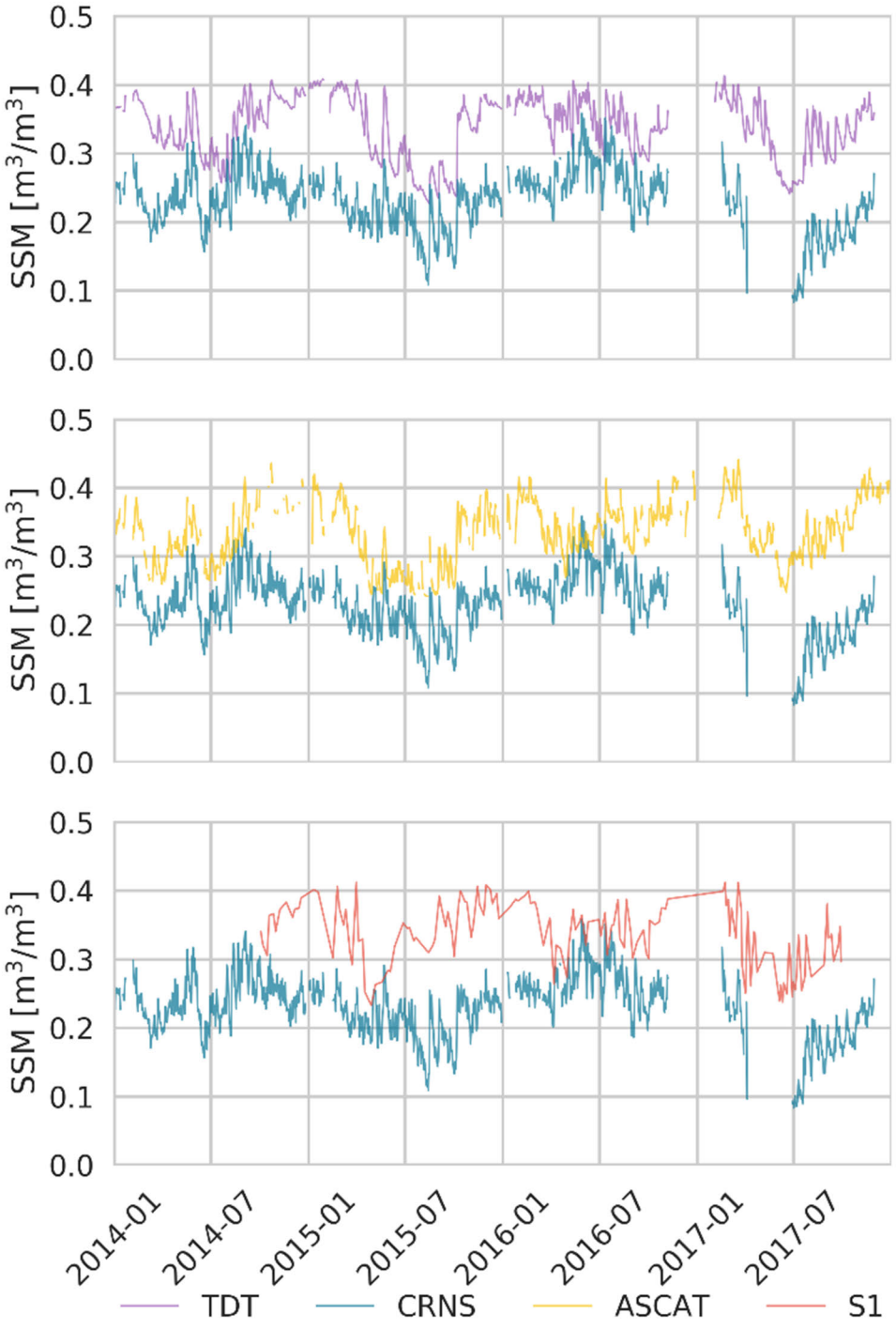

Figure 1. Time series of CRNS, ASCAT, Sentinel (S1) and averaged TDR data on soil moisture (SSM) from December 2013 to December 2016. The ASCAT and S1 data, which are available in relative units, were scaled using the mean and standard deviation of the in-situ time series

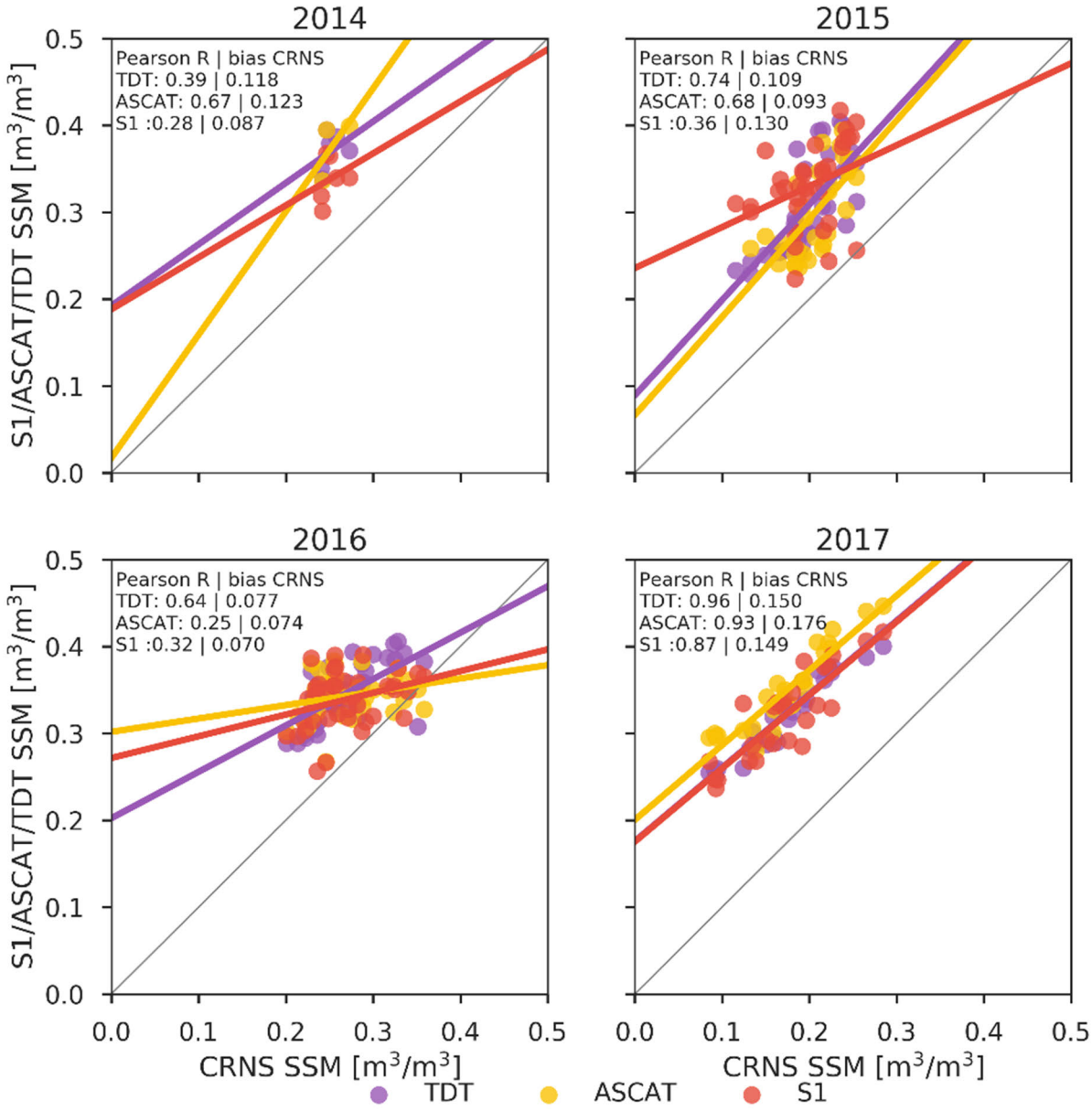

Figure 2. Scatterplots of CRNS, ASCAT, Sentinel-1 (S1) and TDR data on soil moisture (SSM) for every year. Temporal correlation as indicated by Pearson R and bias between CRNS and the three data sets are calculated for every year

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Compound-specific ^{13}C fingerprinting to identify major sediment sources of six contrasting catchments

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This feature article is a summary of the paper that was recently published in the international journal *Agriculture, Ecosystem and Environment (Brandt et al., 2018)*, based on data collected through the Coordinated Research Project (CRP) entitled 'Integrated Isotopic Approaches for an Area-wide Precision Conservation to Control the Impacts of Agricultural Practices on Land Degradation and Soil Erosion (D1.20.11)'.

Challenges

The loss of fertile topsoil due to soil degradation and erosion not only threatens crop productivity, but also induces sedimentation in aquatic systems and leads to social, economic, and environmental problems in many regions of the world. More than three quarters of the total agricultural land area affected by erosion is situated in Africa, Asia and Latin America. Informed soil conservation strategies require knowledge on the main sediment sources in a catchment. But accurate identification of soil erosion hot spots using traditional fingerprinting techniques has proven to be challenging. Compound-specific stable isotope (CSSI) fingerprinting, based on $\delta^{13}C$ values of plant derived biomarkers (e.g. fatty acids (FA), *n*-alkanes), allows identifying hot-spots of soil erosion, particularly with regard to assigning sediment sources to actual land uses *(Gibbs, 2008)*.

Principles

The compound specific stable isotope (CSSI) technique uses land cover-dependent differences in the $\delta^{13}C$ isotopic signatures of organic compounds to estimate the proportional sediment contributions of different land use types. Due to their origination in above-ground plant biomass and microorganisms and ability to form associations with clay minerals, lipid biomarkers are suitable indicators for linking sediments to specific land use types. An important criterion for the use of long-chain fatty acids (FAs) having the aliphatic chain comprising of 12-24 carbon atoms with no double bounds (i.e. C12:0–C24:0) as erosion bio-tracers is their individual $\delta^{13}C$ isotopic signature, which is influenced by the vegetation cover. Hence, the CSSI approach is a major advance in determining source-sink relationships at the catchment level *(e.g. Alewell et al., 2016; Upadhayay et al., 2017; Bravo-Linares et al., 2018)*.

Experimental design

To test the CSSI-fingerprinting approach under conditions of different agro-ecological zones we used a harmonized protocol to discriminate sediment sources of six contrasting catchments from the northern and southern hemisphere (i.e. Chile (2), China (1), Morocco (1), Russia (1), Vietnam (1)). The CSSI-fingerprinting approach was first tested on the basis of major land use categories (i.e., forest, cultivated and non-cultivated land) as potential sediment sources in the studied catchments. These land use categories were then further resolved into specific land use types (e.g., cassava and maize fields, orchards) to assess the potential resolution threshold of the CSSI technique. An aligned sampling procedure, based on *Gibbs (2014)* was developed for this CRP and applied at all study sites. Generally, topsoil (0-2 cm) samples of each individual land use type were collected and combined to a composite sample. Similarly, top sediment layers (0-2 cm) were obtained by combining sub-samples to ensure a representative sample.

Main results

The results of this work have shown that the types of land use most at risk of erosion are those whose soils are intensively cultivated and at least temporarily without soil cover. The main sediment sources are maize and cassava cultivation in Vietnam, wheat cultivation in Morocco and Russia and unpaved forest roads and channel bank erosion in Chile. The results of the Xinzheng catchment in China did not allow a clear statement, which is probably due to the isotopic similarity of the land uses in the study area. The erosion risk is particularly high in Vietnam, where monocropping of maize is practiced on steep slopes (Figure 1). We showed across most catchments that the grouping of individual land use types in major land use categories was critical for reliable detection of sediment sources. The use of land use types to characterize various vegetation types as sediment sources was specifically applicable when all land use categories were represented in each catchment or when both C_3 and C_4 vegetation were present. The resolution limit of the CSSI technique to distinguish land use types was, however, reached when catchments were very small and characterized by highly heterogeneous land use types with a long history of frequent land use changes.

Figure 1. Erosion and sedimentation in an upland catchment in Vietnam

Conclusion and perspective

Merging catchment-specific land use types with broader land use categories made it possible to determine inter-catchment comparisons of isotopic signatures due to significant differences in $\delta^{13}C$ values of fatty acids when cultivated land was present. Notably, no correlations were found between different catchment sizes, agro-ecological zones, number and type of land use types, or soil organic carbon concentrations and the number of significant $\delta^{13}C$ fatty acid values of the various land use types. The adoption and use of the CSSI technique as catchment sediment management tool within a regulatory framework would be an effective approach to provide a solid information base for the design and implementation of targeted soil conservation strategies, sediment mitigation planning, and aquatic habitat management policies.

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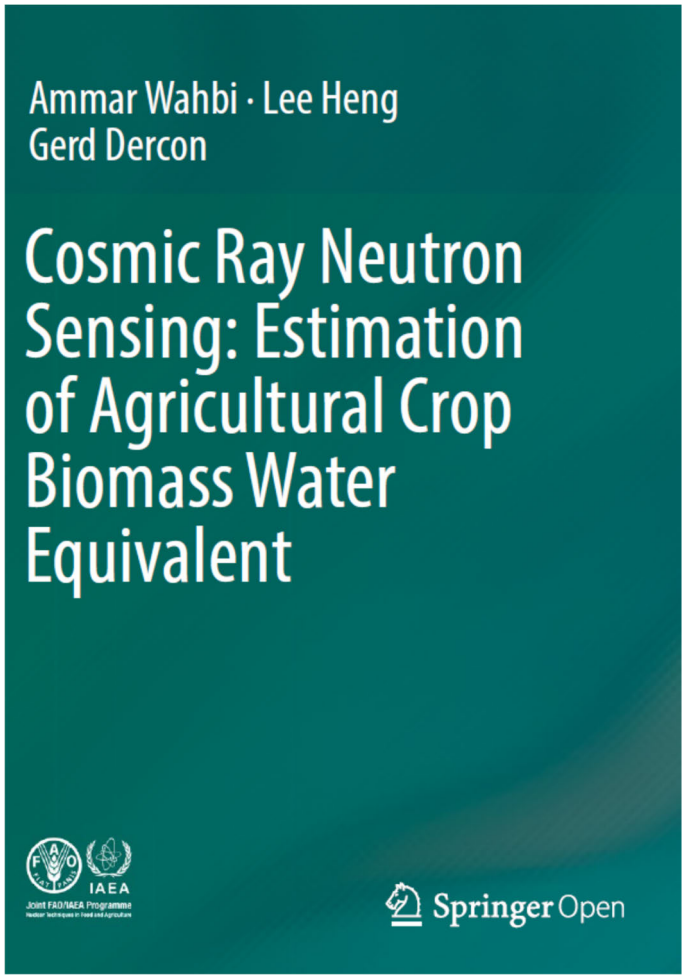
Announcements

New FAO/IAEA Publications

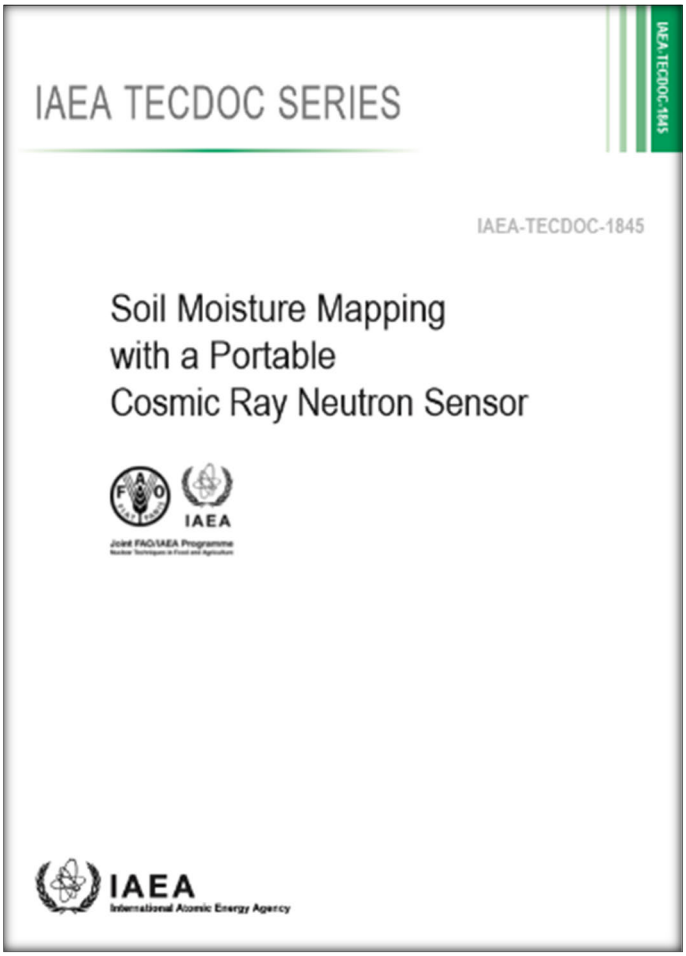
Cosmic Ray Neutron Sensing: Estimation of Agricultural Crop Biomass Water Equivalent

This open access book provides methods for the estimation of Biomass Water Equivalent (BEW), an essential step for improving the accuracy of area-wide soil moisture by cosmic-ray neutron sensors (CRNS). Three techniques were explained in detail: (i) traditional in-situ destructive sampling, (ii) satellite based remote sensing of plant surfaces, and (iii) biomass estimation via the use of the CRNS. The advantages and disadvantages of each method are discussed along with step by step instructions on proper procedures and implementation.
https://link.springer.com/book/10.1007%2F978-3-319-69539-6



Soil Moisture Mapping with a Portable Cosmic Ray Neutron Sensor (IAEA-TECDOC 1845)

This publication is an informational guide for soil moisture mapping at landscape level through a portable 'backpack' cosmic-ray neutron sensor. This recently developed device monitors soil water content in a non-invasive way using background neutron counts. It is used to measure water content in the topsoil over wide areas, covering approximately 20 hectares with one single measurement. Through its mobility and combining series of measurements, this provides the spatial variability of the soil water content for better agricultural water management. The publication provides scientists, technicians and students the necessary information, guidance and steps to calibrate, validate and the deployment of this portable cosmic-ray neutron sensor.
https://www-pub.iaea.org/books/IAEABooks/12357/Soil-Moisture-Mapping-with-a-Portable-Cosmic-Ray-Neutron-Sensor



Highlights

Long Night of Research

On 13th April 2018, about 1600 visitors participated in the "Long Night of Research" at the IAEA Headquarters in Vienna. This event, initiated by the Austrian government and the second of its kind hosted at the IAEA, is intended to promote interest in science amongst all age groups, with special attention to children.

The Agency presented 14 booths showcasing various applications of nuclear technology in the rotunda of the Vienna International Center. Topics ranged from safeguards inspection practices to nuclear technology applications in plant breeding for disease resistant coffee crops.

The Soil and Water Management & Crop Nutrition Subprogramme prepared three exhibits on the use of stable isotope techniques in agriculture. Visitors were provided the opportunity to learn about tracing pathways of agricultural pollution from various sources, efficient water and nutrient management, as well as the importance of healthy soils for crops and water quality.

Visitors learning about the importance of soil and water management in food and agriculture

Staff members from SWMCNL providing explanations to young visitors on using nuclear isotopes as a tracer in agriculture

Success stories

Farmers in Brazil Use Legumes to Reduce Costs, Greenhouse Gas Emissions
https://www.iaea.org/newscenter/news/farmers-in-brazil-use-legumes-to-reduce-costs-greenhouse-gas-emissions

NEW CRP: Multiple Isotope Fingerprints to Identify Sources and Transport of Agro-Contaminants (D1.50.18)
https://www.iaea.org/newscenter/news/new-crp-multiple-isotope-fingerprints-to-identify-sources-and-transport-of-agro-contaminants-d15018

How to Win a Fight Against Soil Erosion: Nuclear Science Helps Farmers in Morocco
https://www.iaea.org/newscenter/news/how-to-win-a-fight-against-soil-erosion-nuclear-science-helps-farmers-in-morocco

Technical Cooperation Field Projects

Country/Region	TC Project	Description	Technical Officer(s)
Afghanistan	AFG5007	Enhancing Wheat Productivity Through Best Nutrient and Water Management Practices Under Rainfed and Supplemental Irrigation Systems	M. Zaman
Algeria	ALG5030	Contributing to the Implementation of the National Agricultural Development Programme Through Strengthening Soil, Water and Nutrient Management Practices Including Food Safety Using Nuclear and Related Techniques	M. Zaman in collaboration with FEP
Bangladesh	BGD5029	Evaluating Promising Abiotic Stress Tolerant Crop Mutants/Varieties and Measuring the Suitable Management Practices for the Promotion of Sustainable Production at Saline, Submergence and Drought Prone Areas	A. Wahbi
Benin	BEN5012	Enhancing legume production in cereal-livestock cropping systems for food, wealth and soil health through the use of bio fertilizers (inoculum) in Benin	J. Adu-Gyamfi
Bolivia	BOL5021	Strengthening the Strategic Development Plan for Quinoa Production through Improved Use of Organic Manure, Soil and Crop Management	M. Zaman
Brazil	BRA5059	Strengthening Strategies of Soil and Water Conservation at the Landscape Level in Natural and Agricultural Ecosystems	E. Fulajtar and G. Dercon
Burkina Faso	BKF5019	Improving food and nutrition security using integrated isotopic and breeding mutation on Sorghum, Rice, Cowpea, Bambara nut and sesame in Burkina Faso	J. Adu-Gyamfi in collaboration with PBG
Burundi	BDI5001	Improving Cassava Productivity through Mutation Breeding and Better Water and Nutrient Management Practices Using Nuclear Techniques	M. Zaman in collaboration with PBG
Central African Republic	CAF5011	Building National Capacities for Improving the Efficiency of Biological Nitrogen Fixation for Food Security, Fertility Restoration and Rehabilitation of Degraded Soils	M. Zaman
Cambodia	KAM5005	Enhancing Soil, Water and Nutrient Management for Sustainable Rice Production and Optimized Yield	J. Adu-Gyamfi
Costa Rica	COS5033	Assessing and Implementing Biochar Use in Climate Smart and Environmentally Friendly Pineapple Production Using Isotopic Techniques	M. Zaman in collaboration with FEP
Costa Rica	COS5035	Building Capacity for the Development of Climate-Smart Agriculture in Rice Farming	M. Zaman
Dominica	DMI0002	Building National Capacity for the Use of Nuclear Applications in Relevant Sectors	J. Adu-Gyamfi
Gabon	GAB5003	Building National Capacities for Monitoring Sedimentation of Dams and Harbors and the Management of Remediation Operations	E. Fulajtar
Indonesia	INS5043	Intensifying Quality Soybean Production in Indonesia to achieve self-sufficiency	J. Adu-Gyamfi in collaboration with PBG
Interregional project	INT0093	Applying Nuclear Science and Technology in Small Island Developing States in Support of the Sustainable Development Goals and the SAMOA Pathway	J. Adu-Gyamfi
Interregional project	INT5153	Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions	G. Dercon
Iran	IRA5013	Investigating the Effects of Deforestation and Afforestation on Soil Redistribution	M. Zaman

Country/Region	TC Project	Description	Technical Officer(s)
Iraq	IRQ5020	Restoring Biomass Productivity of Range Land by Using Nuclear Techniques and Advanced Technology	A. Wahbi
Jamaica	JAM5012	Optimizing Irrigation Water Management to Improve Crop Output and Water Quality Control	L. Heng
Kuwait	KUW5004	Improving Production and Water Use Efficiency of Forage Crops with Nuclear Techniques	A. Wahbi
Laos	LAO5004	Enhancing National Capability for Crop Production and Controlling Trans-Boundary Animal Diseases	M. Zaman in collaboration with APH
Lesotho	LES5008	Improving Soil Fertility for Enhanced Cereal Production in Lesotho	J. Adu-Gyamfi
Madagascar	MAG5025	Biocontrol of Striga asiatica (L.) Kuntze through the development of tolerant rice and maize lines and its impact on microbiological and ecological functioning of soil	J. Adu-Gyamfi in collaboration with PBG
Malawi	MLW5003	Developing Drought Tolerant, High Yielding and Nutritious Crops to Combat the Adverse Effects of Climate Change	E. Fulajtar in collaboration with PBG
Malaysia	MAL5031	Establishing an Environmentally Sustainable Food and Fodder Crop Production System	E. Fulajtar in collaboration with PBG and APH
Mali	MLI5028	Improving Water Use Efficiency, Soil Fertility Management Practices and the Resilience of Cultures to Climate Variability and Change	L. Heng
Mauritania	MAU5006	Contributing to the Improvement of Rice Crop Yields through the Application of Nuclear Techniques to Water Management and Soil Fertility	M. Zaman in collaboration with PBG
Myanmar	MYA5027	Monitoring and Assessing Watershed Management Practices on Water Quality and Sedimentation Rates of the Inle Lake - Phase II	L. Heng
Namibia	NAM5016	Developing Drought Tolerant Mutant Crop Varieties with Enhanced Nutritional Content	J. Adu-Gyamfi in collaboration with PBG
Oman	OMA5006	Using Isotopes and Nuclear Techniques in Integrated Water, Soil and Nutrients Management to Optimize Crop Productivity	J. Adu-Gyamfi
Pakistan	PAK5051	Developing Isotope-Aided Techniques in Agriculture for Resource Conservation and Climate Change Adaptation and Mitigation	M. Zaman
T.T.U.T.J of T. Palestinian A	PAL5008	Reducing Soil Degradation by Improving Soil Conservation using Fallout Radionuclides (Phase II)	E. Fulajtar
Philippines	PHI5034	Applying Nuclear Techniques in the Attenuation of Flood and Natural Disaster-Borne Contamination	E. Fulajtar
Qatar	QAT5007	Improving Productivity of Ikhlas and Berhi Date Palm Varieties	A. Wahbi
Regional project Africa	RAF0046	Promoting Technical Cooperation among Developing Countries through Triangular Partnerships and Sustaining Regional Ownership of the AFRA Programme [Bilateral TC project between Morocco and Côte d'Ivoire]	L. Mabit
Regional project Africa	RAF5075	Enhancing Regional Capacities for Assessing Soil Erosion and the Efficiency of Agricultural Soil Conservation Strategies through Fallout Radionuclides	E. Fulajtar and L. Mabit
Regional project Africa	RAF5079	Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for increased Food Production and Income Generation (AFRA)	L. Heng
Regional project Asia	RAS5070	Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques (RCA)	M. Zaman in collaboration with PBG

Country/Region	TC Project	Description	Technical Officer(s)
Regional project Asia	RAS5073	Climate Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications, Phase II	L. Heng in collaboration with PBG
Regional project Asia	RAS5080	Developing Sustainable Agricultural Production and Upscaling of Salt-Degraded Lands through Integrated Soil, Water and Crop Management Approaches - Phase III	M. Zaman
Regional project Asia	RAS5083	Reducing greenhouse gas emissions from agriculture and land use changes through climate smart agricultural practices	M. Zaman
Regional project Asia	RAS5084	Assessing and improving soil and water quality to minimize land degradation and enhance crop productivity using nuclear techniques	J. Adu-Gyamfi
Regional project Latin America	RLA5076	Strengthening Surveillance Systems and Monitoring Programmes of Hydraulic Facilities Using Nuclear Techniques to Assess Sedimentation Impacts as Environmental and Social Risks (ARCAL CLV)	E. Fulajtar
Regional project Latin America	RLA5077	Enhancing Livelihood through Improving Water Use Efficiency Associated with Adaptation Strategies and Climate Change Mitigation in Agriculture (ARCAL CLVIII)	L. Heng
Regional project Latin America	RLA5078	Improving Fertilization Practices in Crops through the Use of Efficient Genotypes in the Use of Macronutrients and Plant Growth Promoting Bacteria (ARCAL CLVII)	J. Adu-Gyamfi
Senegal	SEN5039	Supporting Eco-Intensification of Agriculture in Small-Scale Farming Systems by Improving Water and Nutrient Management	M. Zaman
Serbia	SRB5003	Strengthening the Capacities for Soil Erosion Assessment Using Nuclear Techniques to Support the Implementation of Sustainable Land Management Practices	E. Fulajtar
Seychelles	SEY5011	Supporting Better Sustainable Soil Management as Climate Change Adaptation Measures to Enhance National Food and Nutrition Security	L. Heng
Sudan	SUD5037	Application of nuclear and related biotechnology techniques to improve of crop productivity and lively hood of small scale farmers drought prone areas of Sudan	J. Adu-Gyamfi in collaboration with PBG
Togo	TOG5002	Improving Crop Productivity and Agricultural Practices Through Radiation Induced Mutation Techniques	E. Fulajtar in collaboration with PBG
Zambia	ZAM5031	Improving the Yield of Selected Crops to Combat Climate Change	L. Heng in collaboration with PBG
Zimbabwe	ZIM5021	Assessing and Promoting Sustainable Agricultural Production in Communal and Newly Resettled Farms	L. Mabit in collaboration with PBG

Forthcoming Events

FAO/IAEA Events

Training Course of Interregional Technical Cooperation Project INT5153 on 'Methods for Assessing Impacts of Climate Change on Soil and Water Resources in Polar and Mountainous Regions', 25 June – 6 July 2018, Seibersdorf and Rauris, Austria

Technical Officers: G. Dercon and J. Slaets

1st Research Coordination Meeting of Coordinated Research Project D1.50.18 on 'Multiple isotope fingerprints to identify sources and transport of agro-contaminants', 2-6 July 2018, Vienna, Austria

Project Officers: J. Adu-Gyamfi and L. Heng

Final Research Coordination Meeting of Coordinated Research Project D1.20.13 'Landscape Salinity and Water Management for Improving Agricultural Water Productivity', 9-12 July 2018, Vienna, Austria

Technical Officer: L. Heng

Training Course of Regional Technical Cooperation Project RAS5084 on 'Application of FRNs and Stable Isotopes for Soil Quality and Soil Erosion Investigation', 6-19 August 2018, Da Lat, Viet Nam

Technical Officer: J. Adu-Gyamfi

Training Course of Regional Technical Cooperation Project RLA5078 on 'Management of biofertilizers to increase yields on field conditions', 6-14 September 2018, Guadalajara, Mexico

Technical Officer: J. Adu-Gyamfi

1st Training Course of Regional Technical Cooperation Project RLA5076 'Strengthening Surveillance Systems and Monitoring Programmes of Hydraulic Facilities Using Nuclear Techniques to Assess Sedimentation Impacts'**,** 17-28 September 2018**,** Lima/Piura, Peru

Technical Officer: E. Fulajtar

Consultants' meeting on "Improving Irrigation Management through the Assessment of Soil Moisture Dynamics with the Aid of Cosmic Ray Neutron Sensor and Remote Sensing", 1-4 October 2018, Vienna, Austria

Project Officer: E. Fulajtar

2nd Coordination Meeting of Regional Technical Cooperation Project RAF5075 on 'Enhancing Regional Capacities for Assessing Soil Erosion and the Efficiency of Agricultural Soil Conservation Strategies through Fallout Radionuclides', 8-12 October 2018, Cotonou, Benin

Technical Officer: E. Fulajtar

1st Coordination Meeting of Regional Technical Cooperation Project RAF5079 on 'Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for increased Food Production and Income Generation'**,** 8-12 October 2018, Gaborone, Botswana

Technical Officer: L. Heng

3rd Regional Training Course of Technical Cooperation Project RAF5075 'Enhancing Regional Capacities for Assessing Soil Erosion and the Efficiency of Agricultural Soil Conservation Strategies through Fallout Radionuclides', 4-15 November 2018, Cairo, Egypt

Technical Officer: E. Fulajtar

Training Course of Regional Technical Cooperation Project RAS5084 on 'Application of Fallout Radionuclides and Stable Isotopes to Soil Quality and Soil Erosion Research', 5-9 November 2018, Sydney, Australia

Technical Officer: J. Adu-Gyamfi

Final Coordination Meeting of Interregional Technical Cooperation Project INT5153 on 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions', 12 – 16 November 2018, Vienna, Austria

Technical Officers: G. Dercon and J. Slaets

Training Course of Regional TC Project RLA5077 on 'Enhancing Livelihood through Improving Water Use Efficiency Associated with Adaptation Strategies and Climate Change Mitigation in Agriculture (ARCAL CLVIII)", 19-23 November 2018, Santiago, Chile

Technical Officer: L. Heng

The FAO Agricultural Innovation Symposium for Family Farmers: Unlocking the Potential of Agricultural Innovation to Achieve the Sustainable Development Goals, 21-23 November 2018, FAO Rome, Italy https://umr-innovation.cirad.fr/content/download/62140/348104/version/1/file/Concept+Symposium+FAO.pdf

Non-FAO/IAEA Events

21st World Congress of Soil Science, 12-17 August 2018, Rio de Janeiro, Brazil. http://www.21wcss.org/

Global Water Security Conference, 3-6 October 2018, Hyderabad, India. http://asabewater.org/

2nd Annual Congress on Soil and Water Sciences, 22-23 October, 2018, Berlin, Germany. https://soilscience.insightconferences.com/

Soil Security and Planetary Health Conference, 4-6 December 2018, University of Sydney, Australia. https://globalsoilsecurity.com/:

Past Events

FAO/IAEA Events

United Nations Youth Forum on Sustainable Development Goals: the episode for Chinese television show "Keep Running", 6 March, 2018, Vienna, Austria

Technical Officer: J. Chen

This year the popular Chinese youth reality TV show "Keep Running" filmed an episode on the 17 Sustainable Development Goals of the United Nations at Vienna Headquarters. In a feature segment filmed on 6th March, seven famous Chinese celebrities as well as United Nations employees were invited to speak at a youth forum, "A Youth Initiative for the Sustainable Development Goals of the United Nations". This segment was filmed at Vienna City Hall in front of over 100 audience members. One of our members from the Soil and Water Management and Crop Nutrition laboratory, Janet Chen, was invited to discuss the Joint FAO/IAEA Programme's contribution to Sustainable Development Goals 1 and 2 on no poverty and zero hunger.
The TV episode delivered our key message, "We are using atoms to better the lives of people all over the world" and the forum provided the platform to discuss how nuclear and isotopic techniques are being used to improve agricultural yield and quality, thus increasing food availability and the livelihood of farmers, and the hungry and malnourished people. Success stories from Sudan and Bangladesh were used as examples of how nuclear techniques are supporting farmers to decrease water use and increase crop yield. To date the YouTube episode of Keep Running has been viewed over 5.3 million times. To view the episode, go to:
https://www.youtube.com/watch?v=xXUdsQuUhGY

A screenshot image of Janet Chen discussing the Joint FAO/IAEA Programme's efforts to contribute to the Sustainable Development Goals of the United Nations. To view the episode, go to:
https://www.youtube.com/watch?v=xXUdsQuUhGY

1st Coordination Meeting of TC Project RLA5077 'Enhancing Livelihood through Improving Water Use Efficiency Associated with Adaptation Strategies and Climate Change Mitigation in Agriculture', 5-9 March 2018, San Jose, Costa Rica

Technical Officer: L. Heng

Lee Heng and Scarlett Ihlau, Programme Management Officer (PMO) attended the first coordination meeting of the new RLA5077 project, held at the Universidad de Costa Rica in San Jose. Welcome remarks were given by Ms Lilliana Solic (ARCAL representative), Ms Lizette Brenes (Vice-chancellor of Research UNED), Mr Octavio Ramirez (FAO Costa Rica), as well as by the TO and the PMO. Ms Cristina Chinchilla from Costa Rica is the Designated Team Member (DTM) of the project.
The meeting was attended by 15 participants from 14 Member States from Argentina, Bolivia, Brazil, Chile, Costa Rica, Cuba, Ecuador, Dominican Republic, Mexico, Panama, Paraguay, Peru, Uruguay and Venezuala. The objective of the meeting was to discuss work plan and acivities, both at the regional and national levels, to define effective project management to ensure timely information sharing on the activities, the efficiency of implementation of resources and the annual evaluation of the various performance indicators.

Scientific Coordination Meeting of INT5153 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions, 9-12 April 2018, IAEA, Vienna, Austria

Technical Officers: G. Dercon, and J. Slaets

Twenty-two researchers studying soil, sediment and glacier dynamics met at IAEA headquarters to discuss the INT5153 project results from the seven benchmark sites, and the implications of these results for stakeholders. The meeting took place in conjunction with the 2018 European Geosciences Union (EGU) General Assembly, a conference bringing together over 15 000 geoscientists from 106 countries. The project results were thus disseminated through 22 posters and six oral presentations. INT5153 participants hosted a well attended session at EGU on "Soil, water and sediment tracing for unravelling climate change dynamics in proglacial areas". Questions from the audience showed the strong interest of the wider scientific community, for example regarding streamwater chemistry monitoring in Elbrus, Russian Federation, and

how this information could be used to protect downstream communities' water quality.
The scientific coordination meeting resulted in the following achievements:
(i) an evaluation of the implemented activities during this phase of the project and scientific results of the expert missions; (ii) dissemination of project results to the scientific community through EGU 2018, including a collection of abstracts from the EGU session on "Soil, water and sediment tracing for unravelling climate change dynamics in proglacial areas" and (iii) finalization of the project sharing platform, which will allow both the methodological and scientific work done by the project to be used by others in the future.
Ultimately, combining the results of seven geographical locations and different disciplines will enable an improved understanding of the impact of climate change on fragile high altitude and high latitude regions at local and global scale for their better management and conservation.

Participants of the INT5153 meeting during a poster session

Regional training course of RAS5070 on Nuclear Techniques in Soil, Water and Nutrient Management under Marginal Land, 9-13 April 2018, Islamabad, Pakistan

Technical Officer: M. Zaman

The RTC consisted of lectures and hand on training on: Climate Smart Agricultural practices at the advanced level to address key issues of: a) poor soil fertility, quality and health, b) low nutrient and water use efficiencies on farm, and c) low crop productivity under marginal land. The RTC also covered best strategies to enhance biological N fixation, soil C storage, technologies to harvest rainwater, efficient methods of irrigation systems, and the role of isotopic techniques, field demonstration of ^{15}N fertilizer application, and moisture neutron probe. The training was attended by participants from Bangladesh, Cambodia, China, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Philippines, Thailand, and Vietnam and included presentations and hands on training on the subject. The participants acknowledged IAEA, Pakistan Atomic Energy Agency and Nuclear Institute for Food and Agriculture, Peshawar for hosting and organizing this training and committed to share their experience and knowledge with fellow colleagues for further capacity building.

Participants of the RAS 5070 with Chairman of Pakistan Atomic Energy Agency

Model United Nations Conference on Environment and Sustainable Development (MUNESD), 22-27 April 2018, Vienna, Austria

Technical Officers: J. Adu-Gyamfi and L. Heng

The Soil and Water Management & Crop Nutrition (SWMCN) contributed to the MUNESD Conference 2018. Food security in regard of biodiversity, pollution, water and degradation of soil were the crucial topics addressed. The SWMCN made two presentations, '*Nuclear techniques for food security and environmental sustainability*' and '*Nuclear and Isotopic Techniques for Environment and Sustainable Development'* on 23 April 2018 that was well received by the young scientists. The delegates discussed and wrote a resolution towards a pollution free planet, addressing the issues of water and degradation of soils. For more information on the workshop, please visit the website: http://munesd-vienna.com/about-the-conference/

A section of the participants at the MUNESD conference

1st Coordination Meeting of Regional Technical cooperation Project RLA5076 "Strengthening Surveillance Systems and Monitoring Programmes of Hydraulic Facilities Using Nuclear Techniques to Assess Sedimentation", 23-27 April 2018, Habana, Cuba

Technical Officer: E. Fulajtar

The objective of this meeting was to develop the work plan and detailed implementation strategy for the first phase of the RLA5076 project. Major challenge of this project is the integration of three groups of nuclear techniques (fallout radionuclides, CSSI and water isotopes). The integrated implementation of these techniques is very demanding

regarding the selection of the studied sites for national case studies and proposing optimal study and sampling sesigns. The project will focus significant part of attention and resources on collecting and analysing well representative sample sets and assembling data sets enabling statistical processing and comprehensive interpretation.

Discussion during 1st Coordination Meeting of RLA5076

The RLA5076 project is a follow up of earlier regional TCP aimed on follout radionuclide methods and CSSI. The project partners have already basic skills and experience in using nuclear techniques for erosion ans sedimentation studies. The Programme Management Officer together with TO coordinated the discussion on the budget planning and procurement request mainly for sample analyses. The meeting also involved a technical excursion to experimental site of the host institute.

Global Soil Pollution Symposium, 2-4 May 2018, Rome, Italy

Technical Officers: J. Adu-Gyamfi and L. Heng

The Soil and Water Management & Crop Nutrition (SWMCN) Section of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (AGE) participated and contributed to the FAO's Global Symposium on Soil Pollution (GSOP18) in Rome, Italy, from 2–4 May 2018. The symposium had plenary and parallel thematic sessions, on (1) soil pollution on agricultural fields and other land uses; (2) the impact of soil pollution on food production and safety, (3) the environment and overall human well-being; (4) remediation of polluted sites, and (5) developing policies and setting thresholds for addressing soil pollution. The SWMCN in collaboration with Animal Production and Health Division (AGA), Land and Water Division ((CBL) made an oral presentation '*Applying nuclear techniques to assess the sources and transport and degradation of antibiotics from intensive agricultural areas to the environment through soil and water*', highlighted on the role of soil and water as the two major vectors where antimicrobials move from the agroecosystems to the environment, and potential role of nuclear techniques (stable isotopes) to trace the sources and movement of the antimicrobials. The SWMCN also presented a poster '*Multi-isotope fingerprints to identify agricultural contaminants from soil to water'* that featured on the use of integrated multiple stable isotope techniques to provide information on the origins and pathways of agro-pollutants and hence facilitate more accurate and appropriate mitigation. A summary of the symposium and recommendation were compiled into a final FAO document "Soil Pollution: a Hidden Reality" to present key messages and the state-of-the-art of soil pollution and its implications in relation to achieve food safety and sustainable development. http://www.fao.org/3/I9183EN/i9183en.pdf.
More information on the symposium can be found at the following website:
http://www.fao.org/about/meetings/global-symposium-on-soil-pollution/en.

Regional training course of RAS5080 'Developing Sustainable Agricultural Production and Upscaling of Salt-Degraded Lands through Integrated Soil, Water and Crop Management Approaches - Phase III', 6-11 May 2018, Amman, Jordan

Technical Officers: M. Zaman

The International Atomic Energy Agency (IAEA) in collaboration with the Government of Jordan through the National Center for Agricultural Research and Extension (NCARE) organized a one week RTC to provide advanced knowledge and skills to participants on the role of isotopic technique of ^{15}N to better understand and manage nitrogen under saline conditions. This RTC was attended by participants from Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia and Yemen.

Technical cooperation workshop of Interregional Tehnical Cooperation project INT0093 on the 'Use of Nuclear Techniques in Nutrient and Water Management for Small Island Developing States (SIDS)', 14-25 May 2018, Vienna and Seibersdorf, Austria

Technical Officer: J. Adu-Gyamfi

Small Island Developing States (SIDS) are a group of small island countries that tend to share similar sustainable development challenges, including small but growing populations, limited resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks, excessive dependence on international trade, and fragile environments. A workshop on the use of nuclear techniques in nutrient and water management for the SIDS was organized in Vienna and Seibersdorf from 14 to 25 May 2018. Twelve participants from six countries including Antigua and Barbuda, Bahamas, Haiti, Jamaica, Suriname, Trinidad and Tobago (Latin America and the Caribbean), and two from Mauritius (Africa) attended the workshop. Welcome address was delivered by the Directors of TC Africa (DIR-TCAF), TC Asia and Pacific (DIR-TCAP), TC Latin America and the Caribbean (DIR-LAC) and Nuclear Techniques in Food and Agriculture (DIR-NAFA). Ms Eriko Hibi (FAO Sub Regional Representative for the Pacific Islands) delivered a keynote speech on FAO Activities in the Pacific SIDS via Skype. There were presentations from the regional bodies namely

South Pacific Community, the Caribbean Agricultural Health and Food Safety Agency (CAHFSA) and the Caribbean Agricultural Research and Development Institute (CARDI). Training on the use of stable isotopes for (1) sea water intrusion, salinity and soil management, (2) soil fertility and crop nutrition, (3) soil water measurements using Cosmic Rays Neutron Sensor was organized. At the closing ceremony, the participants were highly impressed about the workshop and promised to implement the agreed country workplans. The workshop also provided networking among the scientists.

Group photo of the INT0093 participants

INT0093 participants during a tour to the glasshouse

Scientific Visitors

Mr Hiroshi Takemiya, a counterpart from the Japanese Atomic Energy Agency (JAEA) visited the SWMCNL in Seibersdorf on 12 to 13 March 2018. The purpose was to collaboratively work on the IAEA Technical Document (TECDOC) on data management and visualization challenges and solutions in nuclear emergency response.

Mr Trenton Franz, University of Nebraska-Lincoln, USA visited the SWNCNL from 21 to 24 April 2018. His visit started with a field trip to Illmitz (Austria) to finalize the development of soil moisture mapping techniques using a mobile cosmic-ray neutron sensor (CRNS) (see for more information in the section on "Developments at the Soil and Water Management and Crop Nutrition Laboratory"). Further, the future use of CRNS technology was discussed and essential research and development activities identified.

T.Franz and A. Wahbi in field

Mr Franck Albinet and Mr Lazar Adjigogov visited the SWMCNL on 23, 26 and 27 April 2018 to further work on the DSS4NAFA system, which is in its final stages before beta release in Q3 of 2018. Additional features and modules of the system that may be implemented in the upcoming CRP were also discussed.

Mr Takuro Shinano and Mr Tetsuya Eguchi of the National Agriculture and Food Research Organization (NARO) in Japan visited the SWMCNL on 7 May 2018 as part of the practical arrangement agreed during the 2016 Joint FAO/IAEA-NARO Technical Workshop on Remediation of Radioactive Contamination in Agriculture. Discussions were held on the further steps of the agreement, including upcoming scientific visitor exchanges and planning of the next NARO-FAO/IAEA joint workshop on remediation in 2021.

Ms Cho Cho Win from Forest Research Institute, Yezin, and **Ms Ngu War Nwe** from Mandalay Technological University, counterparts from Myanmar projects MYA5025 and MYA5027 on 'Monitoring and Assessing Watershed Management Practices on Water Quality and Sedimentation Rates of the Inle Lake -Phase I and II' visited the SWMCN Section and Laboratory for a week from 14 to 18 May. The purpose was to discuss project update, review work plan and to learn new isotopic techniques relating to soil and water management.

Coordinated Research Projects

Project Number	Ongoing CRPs	Project Officer
D1.20.12	Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems	Mohammad Zaman
D1.20.13	Landscape Salinity and Water Management for Improving Agricultural Productivity	Lee Heng and Joseph Adu-Gyamfi
D1.50.15	Response to Nuclear Emergencies Affecting Food and Agriculture	Gerd Dercon and Lee Heng
D1.50.16	Minimizing Farming Impacts on Climate Change by Enhancing Carbon and Nitrogen Capture and Storage in Agro-Ecosystems	Mohammad Zaman and Lee Heng
D1.50.17	Nuclear Techniques for a Better Understanding of the Impact of Climate Change on Soil Erosion in Upland Agro-ecosystems	Lionel Mabit and Lee Heng
D1.50.18	Multiple isotope fingerprints to identify sources and transport of agro-contaminants	Joseph Adu-Gyamfi and Lee Heng

Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems (D1.20.12)

Project Officer: M. Zaman

This CRP is in its final year and the final RCM will be held on June 18 to 22 in Vienna. The main objective of the project is to enhance food security and rural livelihoods by improving resource use efficiency and sustainability of integrated crop-livestock systems under a changing climate. The specific objectives are to: (1) optimize water and nutrient use efficiency in integrated crop-livestock production systems, (2) identify the potential for improving soil quality and fertility in integrated crop-livestock systems, (3) assess the influence of crop - livestock systems on GHG emissions, soil carbon sequestration and water quality, (4) assess socio-economic and environmental benefits of crop-livestock systems, (5) strengthen the capacity of the Member States to use isotopic and nuclear techniques as tools for improving the management of crop-livestock systems, and (6) develop soil, water and nutrient management options for use in integrated crop-livestock systems so that they can be adopted by farmers. The CRP began in July 2013 with nine research contract holders from eight countries (Argentina, Brazil (2), China, India, Indonesia, Kenya, Uganda and Uruguay) and three agreement holders from France, Nigeria and the United States of America. The final RCM will be held in the second quarter of 2018. Key results of the project over the first four years are described below:

- The carbon isotopic signature data in Argentina field trials showed that C3 plants (soybean and pasture) led to more carbon storage in soil than that of C4 plants in integrated crop-livestock farm ICLS and continuous cropping system (CCS). These results suggest that rotation with legumes could contribute to more carbon accumulation than pasture.
- The three years field data in Brazil showed that integrated crop-livestock system have the most potential to reduce N_2O emission from soil., even more when trees are included (ICLFS, integrated crop-livestock-forest system), possibly due to a shade effect on decreasing average soil temperature and thus N_2O production. Additionally, managing N fertilization also reduced N_2O emissions.
- Agricultural soils in Uganda are severely degraded mainly due to poor soil fertility and subsistence farming. Integrated livestock cropping system led to improvement in soil fertility, increased crop productivity and livelihoods of the farmers in the studied region compared to traditional farming system. For example, the production cost for maize has been reduced by 72% from Uganda shs 900000 to Uganda shs 250000 Per ha. The gap in yield of maize to a fertilized garden is only 14% per ha from 3.44 t/ha for fertilized garden at recommended rate and 2.99 t/ha for maize-cow rotation.
- The field studies in India showed that integrated crop-livestock system led to a significant increase in organic carbon content in the soil, making it healthier and better for growing crops. Organic carbon content increased in three out of the four project locations; in the Kancheepuram area, for example, the organic carbon content increased from 0.18% to 0.73%. Livestock reproductive performance has also gone up, including a 15% increase in the cattle's milk production as well as increase in the size of goats.

- In Kenya, potential farm practices for improving soil nutrient and water use efficiencies in crop-livestock systems for adoption by farmers have been identified. Socio-economic and environmental benefits of crop-livestock systems have also been assessed. Stakeholders' capacity to use nuclear techniques in soil water management has been strengthened.

Landscape Salinity and Water Management for Improving Agricultural Productivity (D1.20.13)

Project Officer: L. Heng

This CRP will be having the final research coordination meeting (RCM) in the IAEA HQ in Vienna, Austria from 9-12 July 2018 to present the final results. The CRP has eight research contract holders from Bangladesh, China (two participants), Iran, Korea, Pakistan and Vietnam (2 participants), with agreement holder from USA, who will participate in the RCM. The results obtained throughout the implementation of the project (2013-2018) will be reviewed and discussed, and the main achievements will be evaluated in accordance with the project objectives. The CRP has the following objectives: a) to identify ways to improve crop productivity and sustainability through water and salinity management, b) to define approaches and technologies to assess and monitor soil water content and salinity at field and area-wide scales, c) to reduce the impacts of climate change and variability on the widespread increase in landscape.

Response to Nuclear Emergencies Affecting Food and Agriculture (D1.50.15)

Project Officers: G. Dercon. and L. Heng

CRP D1.50.15 is in its final year of implementation. The objectives of the project are to enhance capabilities of relevant authorities when responding to nuclear or radiological emergencies specifically affecting food and agriculture. The project has two major outputs – (1) protocols for sampling and analysis of food and agriculture during a nuclear or radiological emergency, and (2) an decision-support system to improve and optimize sampling and decision-making processes during routine monitoring and emergency response.

On March 12-13, Mr Hiroshi Takemiya, a research contract holder counterpart from the Japanese Atomic Energy Agency (JAEA) visited the SWMCNL in Seibersdorf. The purpose was to collaboratively work on the IAEA Technical Document (TECDOC) on data management and visualization challenges and solutions in nuclear emergency response. IT tools developed by the JAEA in response to the Fukushima incident are presented as a case study in this TECDOC.

Mr Takuro Shinano and Mr Tetsuya Eguchi visited on May 7 as part of the practical arrangement agreed with the National Agriculture and Food Research Organization (NARO) of Japan, signed at the 2016 Joint FAO/IAEA-NARO Technical Workshop on Remediation of Radioactive Contamination in Agriculture. Discussions were held on the development of countermeasures to reduce uptake of radiocesium by crops.

The knowledge gained in this CRP will also be disseminated through a Special Issue in the Journal of Environmental Radioactivity. A virtual special issue titled "Sampling, analysis and modelling technologies for large-scale nuclear emergencies affecting food and agriculture" has been approved in principle by IAEA and work is underway to collect paper submissions from contributing project experts and counterparts.

The DSS4NAFA system was presented at EGU 2018 and received positive feedback from the attendees. The beta release of DSS4NAFA is planned for July 2018.

In preparation for the next phase of the CRP, Mr Sergey Fesenko, a radioecology expert, joined the SWMCNL as a consultant from May-August to lead the drafting of a guideline for sampling and radioactivity measurement of foodstuff, including agricultural and livestock products for radiological monitoring and emergency response purposes. An experiment is planned to be initiated in tandem to explore the accumulation of Cs-134 in rice plants at different growth stages for optimized decision making.

Minimizing Farming Impacts on Climate Change by Enhancing Carbon and Nitrogen Capture and Storage in Agro-Ecosystems (D1.50.16)

Project Officers: M. Zaman. and L. Heng

This CRP is in its fourth year of implementation. The objective of the CRP is to mitigate the effects of nitrous oxide (N_2O) emissions and minimize nitrogen (N) losses from agricultural systems, whilst enhancing agricultural productivity and sequestering soil carbon (C). Ten Member States are participating in this CRP, including seven research contract holders, one each from Brazil, Chile, China, Costa Rica, Ethiopia and Pakistan, two agreement holders from Estonia and Spain, and one technical contract holder from Germany.

After the first RCM, which was held on 3 to 7 November 2014 in Vienna, Austria, all CRP participants have established field trials to assess the effects of applying N process inhibitors (urease and nitrification) on N_2O emission, and also on C sequestration under differing agro-climatic conditions. Measurements of N_2O emissions and collection of soil and plant samples for chemical analyses are going on for over 2 years. Data on N_2O emissions from different cropping systems were presented earlier, during the second RCM, which was held on 23 to 27 May 2016, at Justus-Liebig University Giessen, Germany. Seven research contracts and one technical contract were renewed in October, 2017 based on their project progress reports and renewal proposals. The third RCM held in the Technical University, Madrid from 7-11 October 2017. Assessed the results obtained since the beginning of this CRP. The field data of Brazil, China, Chile, Iran and Pakistan showed that N_2O emissions from different N

inputs were reduced by approximately 50% by adopting best soil nutrient management practices. In Ethiopia, the soil carbon and nitrogen stocks decreased by 23% and 40%, respectively, in conversion of natural forest to crop field. However, after 17 years of afforestation, the crop field showed no change of C or N stocks. In addition, agroforestry was estimated to contribute to mitigating 27±14 t CO_2 equivalents ha^{-1} y^{-1} at least for the first 14 years after establishment. The ^{15}N technique identified 2 more microbial processes of N_2O production which include co-denitrification and conversion of organ N to mineral N. These results were presented in European Geosciences Union (EGU) conference held in Vienna in April, 2018. This provided us more insights on how to exert more control on N_2O production processes to reduce its emission from soil to the atmosphere. The GHG manual (IAEA TECDOC-674) has been initiated and is underway. The first updated chapters have been submitted and are currently being revised.

Twelve research papers on the effects of land use changes and farm management practices on emissions of greenhouse gases and soil quality have been published in scientific journals. Five more manuscripts on the effects of farm management practices are being currently under preparation. These manuscripts will be submitted to peer-reviewed journals by February 2018. The CRP is expected to continue for five years (2014–2019).

Nuclear Techniques for a Better Understanding of the Impact of Climate Change on Soil Erosion in Upland Agro-ecosystems (D1.50.17)

Project Officers: L. Mabit and L. Heng

This CRP is in the beginning of its third year of implementation. Its two research objectives are: (i) To further develop nuclear techniques to assess the impacts of changes in soil erosion occurring in upland agro-ecosystems, and (ii) To distinguish and apportion the impact of climate variability and agricultural management on soil resources in upland agro-ecosystems.

Several packages of nuclear techniques are being used to achieve these objectives, including fallout radionuclides (FRN) such as ^{137}Cs, ^{210}Pb, ^{7}Be and $^{239+240}Pu$, Compound-Specific Stable Isotope (CSSI) techniques as well as cosmic-ray neutron sensor.

The first Research Co-ordination Meeting (RCM) was held in Vienna, Austria (25-29 July 2016) and the second RCM took place at the Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN) in Rabat, Morocco, from 16 to 20 April 2018.

During the first two years of its implementation, significant progress related to the first objective of the CRP was made in developing and refining fallout radionuclides (FRN) and CSSI techniques to deepen our understanding of erosion processes affecting upland agro-ecosystems.

The main milestone of the first-year activity of the CRP was the development of the new and unique FRN conversion model MODERN. During the second year, significant progress was made in testing and validating the use of plutonium isotopes ($^{239+240}Pu$) as soil tracer versus other more mature FRN techniques (e.g. ^{137}Cs and $^{210}Pb_{ex}$) under different agro-environments (i.e. Switzerland, South Korea, Austria).

The second RCM put emphasis on the second objective of the CRP and major efforts will be performed by the CRP team to test the ^{137}Cs resampling approach which appears be one of the most suitable technique to fulfil this challenging objective.

Since its start in March 2016, the CRP team has already published 12 peer-reviewed publications acknowledging the CRP D1.50.17 and we are in the process of developing guidelines for supporting its two scientific objectives.

The IAEA mid-term review of the CRP will take place during the first quarter of 2019. The third RCM is expected to be held in Vienna at the end of third or beginning of fourth qarter of 2019.

Participants of the 2nd Regional Coordination Meeting at CNESTEN, Rabat

New CRP "Multiple isotope fingerprints to identify sources and transport of agro-contaminants" (D1.50.18)

Project Officer: J. Adu-Gyamfi

This first research coordination meeting (RCM) of this coordinated research project (CRP) will be held on 2 to 6 July 2018 in Vienna, Austria. Fifteen-member states are participating in this CRP including eight research contract holders from Cambodia, China, Ghana, India, Morocco, Romania, Sri Lanka and Viet Nam, six agreement holders each from Austria, France, Germany, Ireland, Japan and Switzerland, and one technical contract holder from Australia. The objectives of the CRP are to (1) develop protocols and methodologies for using multiple stable isotope tracers to monitor soil, water and nutrient pollutants from agriculture, (2) establish proof-of-concept for an integrated suite of analytical stable isotope tools, and (3) create guidelines to adapt the new toolkit to a variety of agricultural management situations. A combined stable isotope (δ^2H, $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$ and $\delta^{34}S$) techniques will be used. The objective of the first RCM is to develop protocols, methodologies and workplans.

Developments at the Soil and Water Management and Crop Nutrition Laboratory

Sharing SWMCNL's research progress at the 2018 European Geosciences Union (EGU) General Assembly in Vienna, Austria

Lee Zhi Yi, A.

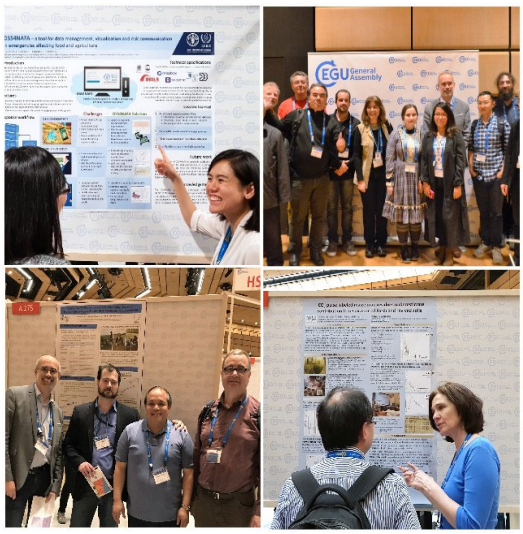
Soil and Water Management and Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

A bout 15,000 scientists from 106 countries came together at the European Geosciences Union (EGU) 2018 General Assembly held in Vienna, Austria on 8-13 April. Close to 17,300 oral, poster and PICO (i.e. Presenting Interactive COntent™) presentations were shared in 666 topic sessions in this unique opportunity for scientific sharing and global networking.

The SWMCN Subprogramme's activities were reported in 18 oral, poster and PICO presentations covering topics such as climate change impact analysis, new radionuclide tracers for soil erosion investigations, carbon and nitrogen cycling, area-wide soil moisture screening and decision-making software for nuclear emergencies.

The SWMCNL, in collaboration with INT5153 'Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions', hosted one EGU session titled 'Soil, water and sediment tracing for unravelling climate change dynamics in proglacial areas' which had 6 oral and 21 poster presentations from project experts and counterparts.

All contributions from the SWMCN Subprogramme can be found in the publication list at the end of this Newsletter while more information regarding EGU 2018 can be found at: http://www.egu2018.eu. The EGU 2019 General Assembly will take place again in Vienna from 7 to 12 April 2019.



Eight members of the SWMCN Subprogramme attended the 2018 EGU General Assembly to share the results from 2017

Using a carbon dioxide carbon isotope analyser for climate-smart agriculture

Chen, J., Resch, C., Mayr, L.

Soil and Water Management & Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

SWMCNL has developed methods using a carbon dioxide carbon isotope analyser to identify agricultural practices that promote climate-smart agriculture by optimizing soil organic carbon sequestration. These methods along with an example case study are now being compiled into a TECDOC that will guide users in the operation of the laser carbon dioxide carbon isotope analyser as well as in data analysis that can, ultimately be used to evaluate soil management practices. Specifically, the TECDOC will describe: 1) creating reference gases for gas isotope analysis, 2) measuring with the laser carbon dioxide carbon isotope analyser in continuous basic-free flow mode, 3) measuring with the laser carbon dioxide carbon isotope analyser in injection/batch mode, 4) correcting data collected with the laser carbon dioxide carbon isotope analyser, and 5) a case study measuring carbon loss of mulch applied in a soil incubation experiment. In contrast to existing information on the use of these analysers, this TECDOC will provide step-by-step instructions on how to perform analyser measurements and data analysis with illustrations for guidance. The goal of this TECDOC is to guide users in the use of laser carbon dioxide carbon isotope analysers to ultimately evaluate the potential of soil management practices to optimize soil organic carbon sequestration for climate-smart agriculture.

New research on compound-specific stable isotope (CSSI) techniques for the determination of sediment sources in the watershed of Petzenkirchen, Austria

Falcao, R.[1], Toloza, A.[1], Strauss, P.[2], Mabit, L.[1]

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[2] Institute for Land & Water Management Research, Federal Agency for Water Management Petzenkirchen

The SWMCNL recently developed a novel application of CSSI techniques to investigate on-site sediment origins across small-scale cultivated fields *(Mabit et al., 2018)*.
Based on the lesson learned from this study, new research and development activities have been initiated in collaboration with the Austrian Institute for Land and Water Management Research, to apply CSSI techniques for determining the origin of sediment transported and deposited in larger Austrian agricultural watersheds.
For this new phase of studies and tests, the experimental and instrumented site of Petzenkirchen was selected. This site is located at about 100 km west from Vienna, and has been and is still being studied for several agro-environmental purposes by different Austrian research institutions *(Blöschl et al., 2016)*. The climatic conditions of the Petzenkirchen area can be characterised as temperate with continental influences and a mean yearly temperature of 9.5˚C and averaged precipitation of 823 mm. The dominant soil types are Cambisols and Planosols *(Blöschl et al., 2016)*.
A sampling strategy such as the one applied in Mistelbach was selected to determine the origin of the sediment produced at the outlet of the Petzenkirchen basin (66 ha). The contributing area of the basin to its exit has been set to close to 50 ha considering the connectivity of the catchment and the sources that were most likely to contribute to the sediment at the outlet. Indeed, considering (i) the geomorphology of the site and the flow of the runoff, (ii) the significant interaction of roads, (iii) the distance and connection of the sources to the outlet, some parts of the basin were excluded (Figure 1).

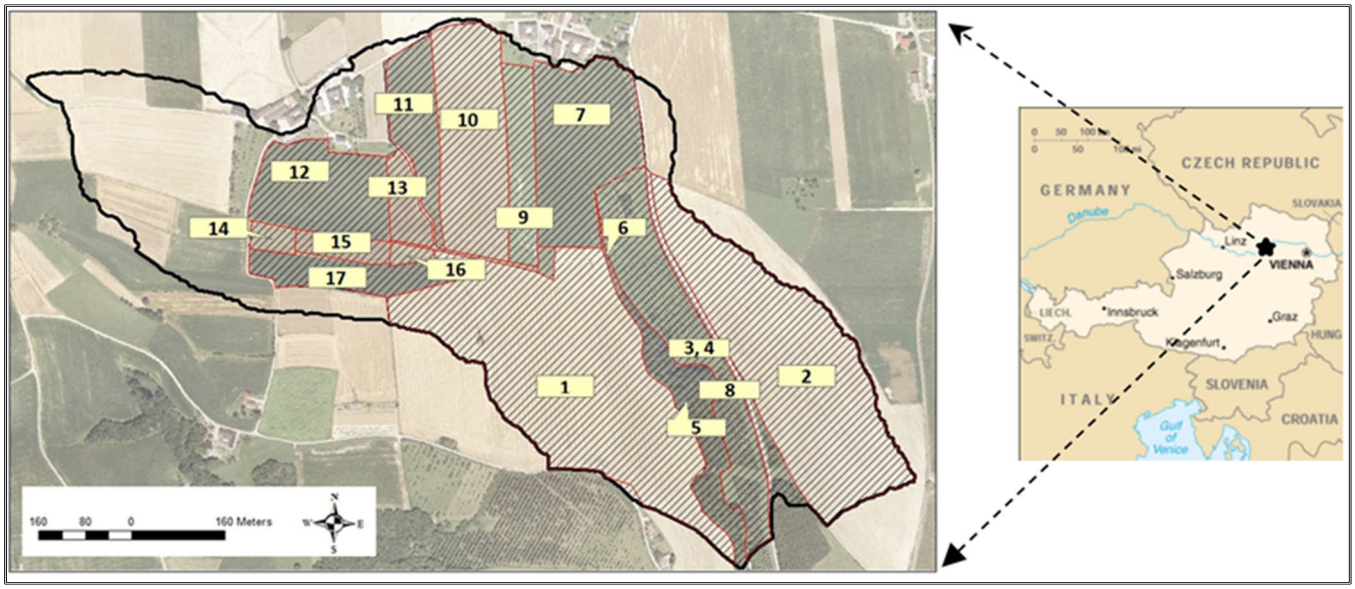

Figure 1. Location of the Petzenkirchen watershed and the various potential sediment sources investigated. The outlet is located at the southernmost point of the watershed

Based on the existing land-use records, the agricultural fields are dominated by a rotation of winter wheat (C_3 plant) followed by maize (C_4 plant) cultivation. As highlighted by *Mabit et al. (2018)*, agricultural fields having different mid-term historical records may present significant differences in the delta ^{13}C isotopic signature of their long chain saturated fatty acids (FAs) and in some cases as well in their bulk delta ^{13}C signature. Therefore, to avoid any missing source, each individual agricultural field was considered as an independent and potential source. At a later stage, depending on the results obtained, some of these sources may be grouped if having similar isotopic fingerprints.
Field work associated with the sampling strategy consisted of the collection of composite samples (sampling procedure repeated 15 to 20 times at several intervals across the sampling area of each specific source) at each potential sediment source (Figure 2). In total twelve agricultural sediment sources and four additional potential sources (i.e. streambank, riparian zone (wetland), pasture, forest) were identified. Finally, the sediments deposited at the outlet of the watershed were collected.

Figure 2. Sampling of potential sediment sources within the Petzenkirchen watershed (on the left agricultural field sampling; on the right streambank sampling)

All samples were prepared and homogenized at the SWMCNL and then sent to the National Institute of Water and Atmospheric Research of New Zealand for extraction of FAs and determination of their delta ^{13}C signature.

These activities are carried out under the ongoing CRP D1.50.17 'Nuclear Techniques for a Better Understanding of the Impact of Climate Change on Soil Erosion in Upland Agro-ecosystems'.

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Controlling air ^{13}C-CO_2 with a laser spectroscope to homogeneously label plant material

Slaets, J., Resch, C, Mayr, L., Heiling, M., Weltin, G., Gruber, R., Jagoditsch, N., Dercon, G.

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To produce homogeneous ^{13}C labelled plant material, the SWMCNL developed a continuous labelling process whereby the air ^{13}C-CO_2 signature in a walk-in growth chamber is controlled through a laser spectroscope (Figure 1). Labelled plant material can be used to trace carbon and nitrogen cycling in agroecosystems, increasing our understanding of the effect of cropping practices on C sequestration and greenhouse gas emissions. Current ^{13}C labelling methods largely fall into two categories: pulse and continuous labelling. When pulse labelling, the stabile and labile fraction of the plant do not end up with the same isotopic signature, which makes quantitative tracing impossible. This issue is resolved with continuous labelling, typically done in small plexiglas chambers. The challenge here is keeping the environmental conditions, including the air isotopic signature constant. The advent of laser spectroscopy opens the frontier to fully control the ^{13}C-CO_2 levels in the chamber air.

The SWMCNL has therefore pioneered the use of a laser spectroscope (Los Gatos Research) to control the air ^{13}C-CO_2 isotopic signature in a walk-in growth chamber. The controlling of the gas mixture automatically keeps the ^{13}C signature in the CO_2 of the air between pre-defined threshold values (in this case, 394 and 400 $\delta^{13}C$), ensuring the production of high-quality homogeneous labelled material. A first successful run with maize was conducted from 4 April until 9 May 2018. Dual labelling (C and N) of the material was achieved by using ^{15}N labelled fertilizer in a fertigation system.

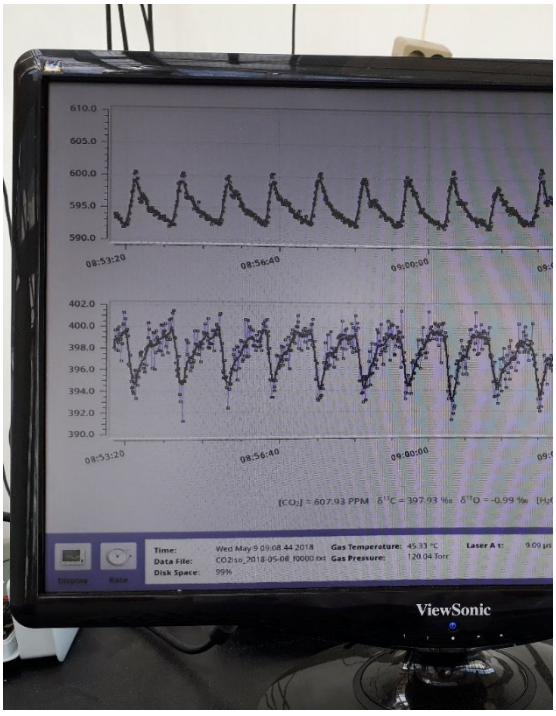

Figure 1. Keeping ^{13}C-CO_2 signature constant between 394 and 400 $\delta^{13}C$ in the growth chamber by controlling the gas mixing with a Los Gatos Research laser spectroscope

The next step will be to test the isotopic signature of the maize for spatial variability within the chamber, and heterogeneity within the plant, between older and younger parts and labile and stabile fractions. During the harvesting, the maize roots were also collected to assess homogeneity of above and below ground labelling. This distribution is particularly important to explore potential for labelling of root crops in the future. Overall, the advancements will enable the SWMCNL to produce homogeneous ^{13}C and ^{15}N labelled plant material, which can be used by Member States for increased understanding of C and N cycling in their agroecosystems.

Developing new mobile soil moisture monitoring techniques with cosmic-ray neutron sensor backpack at the National Park Neusiedler See Seewinkel (Austria)

Wahbi, A. [1]***, Franz, T.*** [2]***, Dercon, G.*** [1]

[2] *Soil and Water Management and Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture*
[2] *School of Natural Resources, University of Nebraska-Lincoln, Lincoln, USA*

The SWMCNL team has finalized the first stage of the development of new soil moisture monitoring techniques using the cosmic-ray neutron sensor (CRNS) backpack. For this purpose, a series of field measurements were conducted at the National Park Neusiedler See Seewinkel, Austria, in close collaboration with the University of Nebraska-Lincoln. The tests consisted of seven measurements from September 2017 to April 2018 to capture the entire dry-wet cycle in this area. The selected study area (Figure 1) is suitable for this kind of tests, as the difference between the lowest and highest soil moisture contents is large and soil texture changes at short distance.

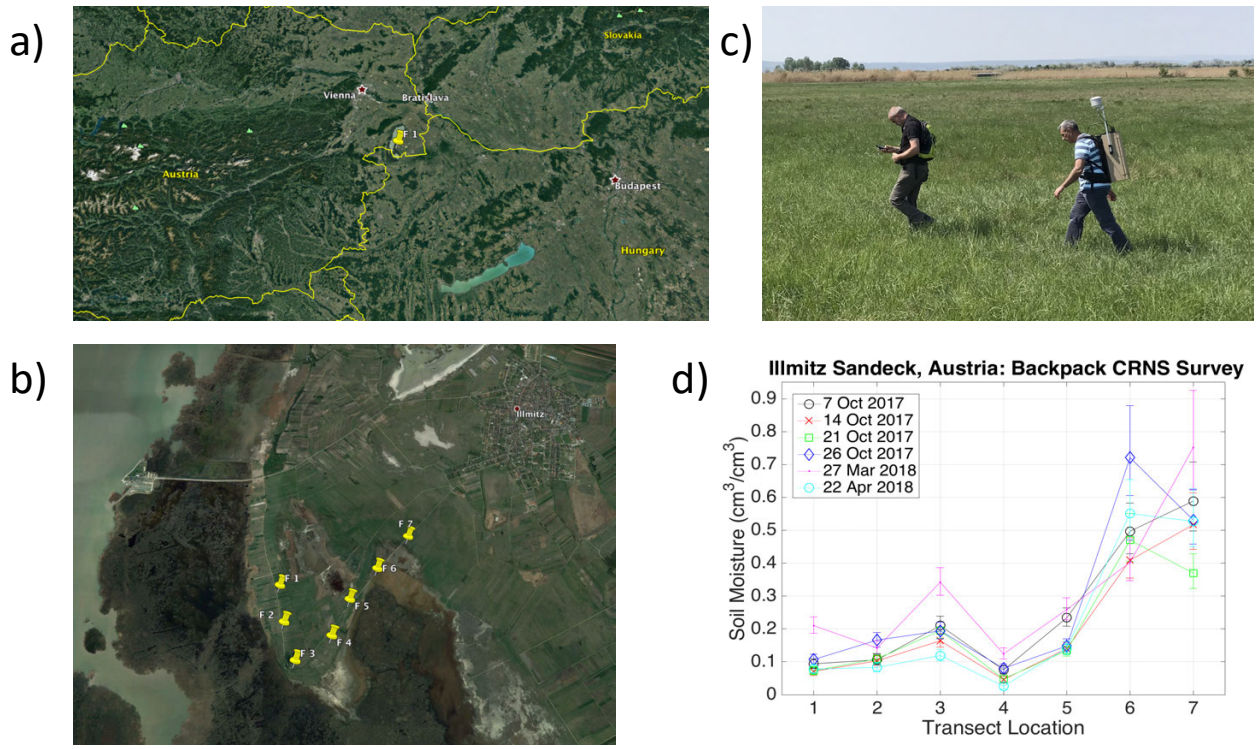

Figure 1. a) Location of National Park Neusiedler See Seewinkel, b) location of seven points along the transect spaced ~400 m apart, c) CRNS survey in progress, and d) soil moisture results of seven field surveys in Fall 2017 and Spring 2018

For each measurement a transect of about 3 km was walked with the backpack CRNS. On the way out, the backpack was placed on the ground for 30 minutes at seven points, 400 m apart from each other. The same transect was then walked back at a continuous pace for comparison of the different data resolutions (continuous versus stop and go). The backpack records every minute the low-energy neutron counts and the location for subsequent data processing. A total of 500 to 1000 neutron counts is desired for each location to reduce uncertainty in estimating soil moisture (IAEA-TECDOC 1845, 2018). Different size CRNS have different masses and counting rates, and can be customized depending on the need, cost and site specifics for the project study. Here the backpack CRNS was used to show how a one-dimensional transect could be collected for use in practice. Figure 1 illustrates a) location of the National Park Neusiedler See Seewinkel, b) the transect locations west from the village of Illmitz, c)

a backpack survey in progress, and d) the results of the seven measurements dates and locations. Figure 1d proves the consistent reading of the detector across the transect (very sandy and dry for points 1-4 and more clayey and wet for points 5-7) and over the different seasons. The results show consistent reading across location and season where soil moisture changes due to recent rainfall and lake level conditions. However, the continuous measurements showed much higher variability and require further attention. More details about the use of CRNS can be found in TECDOC-1809 https://www-pub.iaea.org/MTCD/Publications/ PDF/TE-1809_web.pdf and upcoming TECDOC 1845 https://www-pub.iaea.org/books/IAEABooks/12357/Soil-Moisture-Mapping-with-a-Portable-Cosmic-Ray-Neutron-Sensor

Testing the efficiency of N_2O removal from nitrate containing water samples with N_2-purging for improving the bacterial denitrifier method

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The bacterial denitrification method to measure the $\delta^{15}N$ and $\delta^{18}O$ signatures of nitrate containing water samples is getting more popular because of the advantages it offers such as the small sample volume, no addition of toxic chemicals, and the ability to measure even low concentrations of nitrates. In this method, bacteria are used to convert nitrates to N_2O gas which is then measured by laser isotope spectroscopy. But water samples can contain dissolved primary N_2O, which must be removed prior to bacterial conversion of nitrates, otherwise it would affect the quality of the results of the targeted nitrate isotope analysis.

One essential step of the bacterial denitrification method is purging the bacterial broth with N_2 before adding the water sample to it (Figure 1). Such purging also could be used to remove primary N_2O in water samples, before the bacterial conversion is carried out. To proof the efficiency of such purging, the SWMCNL conducted an experiment in which 35 ml N_2O gas with known $\delta^{15}N$ isotope signature was injected into distilled water and into a nitrate solution. Four different purging times were applied, i.e. 1/2 hour, 1 hour, 2 hours and 3 hours. The preliminary results showed that all tested purging times were sufficient to reduce the N_2O concentrations but the isotopic signature of $\delta^{15}N$ of N_2O proved that only 2 and 3 hours purging led to complete removal of N_2O. Two hours purging could be an effective and cheap way to remove N_2O in water samples. In the future, real field samples will be collected to test the efficiency of purging.

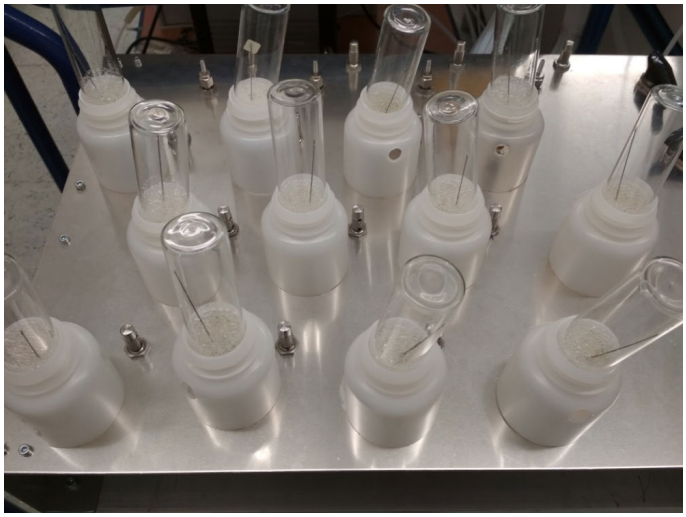

Figure 1. Purging water samples with N_2 to remove trapped N_2O

Using a carbon dioxide carbon isotope analyser for climate-smart agriculture

Chen, J., Resch, C., Mayr, L.

Soil and Water Management & Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

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Counteracting the effects of drought on cassava productivity

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[2] Division of Soil and Water Management, Faculty of Bioscience Engineering, University of Leuven, Belgium
[3] Université Catholique de Bukavu, Democratic Republic of the Congo
[4] International Institute of Tropical Agriculture (IITA), Bukavu, Democratic Republic of the Congo
[5] International Institute of Tropical Agriculture (IITA), Nairobi, Kenya

An agreement between the International Institute of Tropical Agriculture (IITA) and the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has been issued to focus on improving the understanding of cassava agronomy, more specifically with respect to how variety, planting time and nutrient supply can be managed to counteract the adverse effects of drought spells on the productivity of cassava. The agreement is part of the project CIALCA (Consortium for Improving Agriculture-based Livelihoods in Central Africa), funded by the Belgian Government, which started recently in October 2017 and has a duration of 4 years.

Cassava (*Manihot esculenta* Crantz) has been considered for a long time as just being a food security crop, but this is rapidly changing due to an increasing interest in cassava from the food industry. Contract farming is becoming more and more important to ensure that cassava planting times are spread in such way that supply is guaranteed. However, spreading planting times is in practice often difficult due to long dry spells. A right choice of varieties, correct planting time and optimal nutrient supply should provide better protection against drought stress and thus guarantee a more continuous cassava productivity (root yield and starch content).

The Soil and Water Management and Crop Nutrition Laboratory (SWMCNL) will use innovative stable isotope and related methods to measure Water Use Efficiency (WUE) for different cassava varieties and diverse soil management practices, including the combination of stable carbon isotope ratios, nutrient uptake and storage root yields and the use of laser isotope technology to separate evaporation from transpiration above cassava stands. Soil, water and plant samples will be taken from on-going and planned field experiments in the Democratic Republic of the Congo (DRC), Rwanda, Burundi, Tanzania and Nigeria for stable isotope analysis (^{13}C, ^{18}O and D measurements). In combination with crop modelling this will allow to improve yield predictions for staggered planting times. Finally, the translocation of photosynthetic products will be monitored by growing plants in an enriched ^{13}C-CO_2 atmosphere (walk-in growth chambers of the SWMCNL), to understand genotypic differences in response to drought and/or the application of specific nutrients.

The project will be implemented by the SWMCNL with support of IITA staff active in the CIALCA project. A PhD student enrolled at the University of Leuven, Mr. Damas Rutega Birindwa, will conduct his research in close collaboration with the SWMCNL-CIALCA team. Between 3 and 11 May 2018, meetings were held in Rwanda, Burundi and DRC to make work plans for the upcoming activities (Figure 1).

Figure 1. Planning meeting at IITA, in Kigali, Rwanda

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Websites and Links

- Soil and Water Management and Crop Nutrition Section:
  http://www-naweb.iaea.org/nafa/swmn/index.html
- Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture:
  http://www-naweb.iaea.org/nafa/index.html
  http://www-naweb.iaea.org/nafa/news/index-ss.html
- Food and Agriculture Organization of the United Nations (FAO):
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- New communication materials outlining successes in the area of nuclear techniques in food and agriculture:
  http://www-naweb.iaea.org/nafa/resources-nafa/IAEA-success-Stories-3.pdf
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  http://www-naweb.iaea.org/nafa/resources-nafa/LabBrochure-2014.pdf

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