



Joint FAO/IAEA Programme  
Nuclear Techniques in Food and Agriculture

# Soils Newsletter



<http://www-naweb.iaea.org/nafa/index.html>

ISSN 1011-2650

[http://www.fao.org/ag/portal/index\\_en.html](http://www.fao.org/ag/portal/index_en.html)

Vol. 37, No. 2, January 2015

## Contents

To Our Readers	1	Technical Cooperation Projects	15	Activities of the Soil and Water Management and Crop Nutrition Laboratory, Seibersdorf	32
Staff	3	Forthcoming Events	20	Publications	36
Staff News	5	Past Events	21	Websites	40
Feature Articles	6	Status of Coordinated Research Projects (CRPs)	28		
Announcement	13				

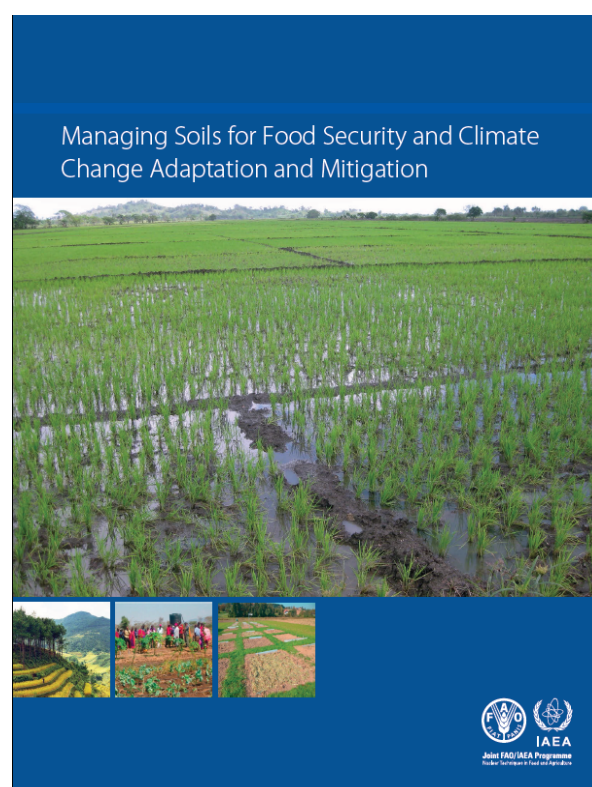
## To Our Readers

The last few months have seen great transition in the Soil and Water & Crop Nutrition (SWMCN) section. Mr Minh-Long Nguyen, the former Section Head, retired at the end of June. Long has served almost ten years in the section and has left a legacy of hard work for us to follow. We all wish Long and his family the very best of health, happiness and success for the future. Mr Leo Mayr, Senior Laboratory Technician also retired after nearly 39 years of excellent service in the SWMCN laboratories. Nevertheless, the team has worked seamlessly to deliver our commitments and to meet all deadlines and demands, including the publication of a TECDOC on the use of fallout radionuclides (FRNs). This publication provides step-by-step guidance and up to date information on the use of FRNs, such as caesium-137 ( $^{137}\text{Cs}$ ), lead-210 ( $^{210}\text{Pb}$ ) and beryllium-7 ( $^7\text{Be}$ ) to assess soil erosion rate in agricultural land for developing management practices that can minimize land degradation and improve land productivity and environmental sustainability.

On 29 September, IAEA Director General Yukiya Amano was joined in Seibersdorf by representatives of Member States and the Food and Agriculture Organization of the United Nations (FAO), as well as IAEA staff members, to break ground on the Renovation of the Nuclear Applications Laboratories (ReNuAL) project, and to celebrate the 50th anniversary of the FAO/IAEA Joint Division of Nuclear Techniques in Food and Agriculture. The IAEA Board of Governors Chair Ms Marta Ziakova and FAO Deputy Director General and Coordinator for Natural Resources Ms Maria Helen Semedo, also attended the event and delivered remarks in support of ReNuAL and the achievements of the Joint Division.

There were over 200 participants, with 48 Member States attending the Ceremony.

ReNuAL is an initiative to modernize the eight laboratories in Seibersdorf that belong to the IAEA's Department of Nuclear Sciences and Applications.



*FAO/IAEA Proceedings on Managing Soils for Food Security and Climate Change Adaptation and Mitigation*

The project calls for the construction of a new Insect Pest Control Laboratory (IPCL) to replace the existing IPCL, and a new Flexible Modular Laboratory (FML) to house three additional laboratories, by the end of 2017.

The subprogramme can look back with pride over its achievements in the past 50 years with major milestones accomplished. These include the development of nitrogen-15 labelled fertilizer technique for nitrogen use efficiency; the nitrogen-15 isotope dilution method for assessment of biological nitrogen fixation in particular with common beans in Latin America; the development of FRNs to assess soil erosion; the utilization of phosphate rock sources through the use of phosphorus-32 for agricultural production; the comparison of the soil moisture neutron probe with other soil moisture sensors and the publication of a practical guide on methods, instrumentation and sensor technology and the application of oxygen-18 stable isotopic technique for evapotranspiration separation for improving water use efficiency in cropping systems. Recently, we also embarked on the use of compound specific stable isotope (CSSI) technique for assessing sediment and soil erosion transport and their sources, and the use of cosmic ray neutron probe for area-wide soil water monitoring.

The SWMCN subprogramme also celebrated the First World Soil Day on 5 December. A poster entitled “Soils: Foundations for Family Farming” was displayed at the IAEA Headquarters to mark the occasion. An article entitled “Nuclear Techniques Help Address Land Degradation” was also uploaded on IAEA website: <http://www.iaea.org/newscenter/news/nuclear-techniques-help-address-land-degradation> to highlight the importance of land degradation and its mitigation.

The FAO/IAEA Proceedings on Managing Soils for Food Security and Climate Change Adaptation and Mitigation is finally published. Thanks to many of you for your contributions. If you have not received a hard copy, please write to us, otherwise you can download it from our website: <http://www-naweb.iaea.org/nafa/swmn/public/proceedings-swmcn.html>.

Finally, as 2014 is coming to an end, I would like to take this opportunity to thank all of our readers, staff and colleagues for their continual support in our work. We have many challenges ahead of us, such as the great demand for food and the need for sustainable use of land and water resources, the issues of soil fertility and land degradation and pollution; water scarcity and the increasing occurrence of extreme weather events due to climate change. Nevertheless, there are also tremendous opportunities for us to assist Member States through the safe and appropriate use of nuclear and related technologies in addressing these challenges. I look forward to being part of this vibrant and collaborative team to deliver what are expected of us.

**Lee Heng**

**Head  
Soil and Water Management and  
Crop Nutrition Section**

**STAFF**  
**Soil and Water Management and Crop Nutrition**  
**Subprogramme**

			
<b>L. K. Heng</b>	<b>K. Sakadevan</b>	<b>M. Zaman</b>	<b>K. Ajvazi</b>
			
<b>K. Makovicky</b>	<b>G. Dercon</b>	<b>L. Mabit</b>	<b>A. Wahbi</b>
			
<b>M. Aigner</b>	<b>M. Heiling</b>	<b>G. Weltin</b>	<b>C. Resch</b>
			
<b>A. Toloza</b>	<b>N. Jagoditsch</b>	<b>J. M. Mletzko</b>	<b>Leo Mayr</b>
			
<b>A. Krukke</b>			

## Soil Water Management and Crop Nutrition Subprogramme

<http://www-naweb.iaea.org/nafa/index.html>  
<http://www.fao.org/ag/portal/age-index.html>

*Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture  
 Vienna International Centre, P.O. Box 100, 1400 Vienna, Austria  
 Tel.: (+43 1) 2600 + ext.; Fax: (+43 1) 2600 7  
 Email: [Official.Mail@iaea.org](mailto:Official.Mail@iaea.org)*

*Soil and Water Management and Crop Nutrition Laboratory (SWMCNL)  
 A-2444 Seibersdorf, Austria*

### Staff Soil Water Management and Crop Nutrition Subprogramme

<b>Name</b>	<b>Title</b>	<b>Email</b>	<b>Extension</b>
Qu LIANG	Director	<a href="mailto:Q.Liang@iaea.org">Q.Liang@iaea.org</a>	21610
<b>Name</b>	<b>Title</b>	<b>Email</b>	<b>Extension</b>
Lee Kheng HENG	Section Head	<a href="mailto:L.Heng@iaea.org">L.Heng@iaea.org</a>	26847
Karuppan SAKADEVAN	Soil-Water Ecophysiologicalist	<a href="mailto:K.Sakadevan@iaea.org">K.Sakadevan@iaea.org</a>	21613
Mohammad ZAMAN	Soil Scientist / Plant Nutritionist	<a href="mailto:M.Zaman@iaea.org">M.Zaman@iaea.org</a>	21645
Ksenija AJVAZI	Team Assistant	<a href="mailto:K.Ajvazi@iaea.org">K.Ajvazi@iaea.org</a>	21646
Kyoko MAKOVICKY	Team Assistant	<a href="mailto:K.Makovicky@iaea.org">K.Makovicky@iaea.org</a>	21647
<b>Name</b>	<b>Title</b>	<b>Email</b>	<b>Extension</b>
Gerd DERCON	Laboratory Head	<a href="mailto:G.Dercon@iaea.org">G.Dercon@iaea.org</a>	28277
Lionel MABIT	Soil Scientist	<a href="mailto:L.Mabit@iaea.org">L.Mabit@iaea.org</a>	28677
Ammar WAHBI	Technical Officer	<a href="mailto:A.Wahbi@iaea.org">A.Wahbi@iaea.org</a>	28726
Martina AIGNER	Senior Laboratory Technician	<a href="mailto:M.Aigner@iaea.org">M.Aigner@iaea.org</a>	28212
Maria HEILING	Senior Laboratory Technician	<a href="mailto:M.Heiling@iaea.org">M.Heiling@iaea.org</a>	28272
Georg WELTIN	Senior Laboratory Technician	<a href="mailto:G.Weltin@iaea.org">G.Weltin@iaea.org</a>	28258
Christian RESCH	Senior Laboratory Technician	<a href="mailto:C.Resch@iaea.org">C.Resch@iaea.org</a>	28309
Arsenio TOLOZA	Laboratory Technician	<a href="mailto:A.Toloza@iaea.org">A.Toloza@iaea.org</a>	28203
Norbert JAGODITSCH	Laboratory Attendant	<a href="mailto:N.Jagoditsch@iaea.org">N.Jagoditsch@iaea.org</a>	28406
Joanna Malgorzata MLETZKO	Team Assistant	<a href="mailto:J.Mletzko@iaea.org">J.Mletzko@iaea.org</a>	28362
Leo Mayr	Consultant	<a href="mailto:L.Mayr@iaea.org">L.Mayr@iaea.org</a>	
Agneta KRUKLE	Intern	<a href="mailto:A.Krukle@iaea.org">A.Krukle@iaea.org</a>	



## Staff News



**Lee Heng** was appointed Head of the Soil and Water Management and Crop Nutrition Section in October 2014, following the retirement of former Head Mr Minh-Long Nguyen in June 2014.



**Leo Mayr** joined the SWMCN in December 2014 for two months. He will be working on the development and validation of protocols on the use of laser isotope analyzers for stable isotope (nitrogen-15) characterization in greenhouse gases (such as N<sub>2</sub>O). His work is related to CRP D1.50.16 on Minimizing Farming Impacts on Climate Change by Enhancing Carbon and Nitrogen Capture and Storage in Agro-Ecosystems. Leo worked until June 2014 as a Senior Laboratory Technician for the SWMCN Laboratory in Seibersdorf.



**Christian Resch** was promoted to Senior Laboratory Technician. Christian will play an important role in the development and adaptation of isotope and nuclear techniques for improving land and water management and crop nutrition and analytical facilities at the SWMCN Laboratory.



**Agneta Krukle** joined the SWMCN on 1 December 2014 as an intern for four months to work on the measurements of stable isotopes using Isotope Ratio Mass Spectrometry and Isotopic Laser Analyzers with Christian Resch. Agneta studied engineering in food technologies at the Latvian University of Agriculture, Jelgava, Latvia and engineering in food safety and quality management at the University of Natural Resources and Life Sciences, Vienna, Austria.



**Cristina Romero Trigueros** joined the SWMCNL in August 2014 as a consultant for three months. She worked on the validation of a new stable isotope (Oxygen-18) technique for better understanding of phosphorus dynamics at landscape level. Her research was related to CRP D1.20.12 on Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems. We congratulate Cristina on completing her work and great dedication and wish her every success in future endeavours.



**Hui Xu** joined the SWMCNL in September 2014 as a consultant for two months, to work on the validation of stable isotope (Carbon-13 and Nitrogen-15) techniques for assessing soil organic carbon stability under mulch-based and zero-tillage cropping systems. Her research was related to CRP D1.50.12 on Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-Based Cropping Systems in Sub-Saharan Africa, using soils from Belgium and Austria. Hui completed her work in the lab with dedication and we wish her all the best in future work.

**Xu Chen** joined the SWMCNL in April 2014 as an intern for nine months. Xu received training on fallout radionuclide and compound-specific stable isotope techniques with a major focus on the use of Caesium-137 to assess soil erosion and develop soil conservation measures.

## Feature Articles

### Is $^{239+240}\text{Pu}$ the new tracer for soil erosion assessment in mountain grasslands?

Christine Alewell<sup>1\*</sup>, Katrin Meusburger<sup>1</sup>, Gregor Juretzko<sup>1</sup>, Lionel Mabit<sup>2</sup> and Michael E. Ketterer<sup>3</sup>

<sup>1</sup>Environmental Geosciences, University of Basel, Switzerland

<sup>2</sup>Soil and Water Management & Crop Nutrition Laboratory, IAEA, Austria

<sup>3</sup>Chemistry Department, Metropolitan State University of Denver, Colorado, USA

\*corresponding author

Soil erosion is a major threat to mountain ecosystems worldwide. However, there has been limited scientific interest in this significant environmental problem. Minimal attention has been given towards its mitigation by policy makers. Limited information in this area is partly due to the difficulty of quantifying soil erosion in mountain environments having un-ploughed soils, steep, complex topography, and harsh climates. In many environments, fallout radionuclides (FRNs) have been widely used to quantify soil particle movement and net erosion rates. A wide variety of artificial radionuclides have been deposited globally *via* nuclear weapons testing, nuclear accidents, nuclear weapons fabrication, and nuclear fuel reprocessing. Large-scale atmospheric tests of thermonuclear weapons resulted in the injection of debris into the stratosphere; following which isotopes such as  $^{137}\text{Cs}$ ,  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  deposited relatively uniformly on a local scale. While it is unfortunate that these isotopes were released into the environment, it is at the same time fortuitous that these FRNs can serve as valuable tracers of recent earth surface processes, including assessing soil erosion.

Decades of soil erosion studies have utilized  $^{137}\text{Cs}$ . However, in our work in mountain environments, we were confronted with unusually high variability of  $^{137}\text{Cs}$  reference inventories, which resulted in unacceptable large uncertainties in calculating erosion rates. Such large heterogeneity in localized environments is most likely due to two important contributors of  $^{137}\text{Cs}$ : a) uniformly deposited 1950's–1960's stratospheric fallout and b) non-uniform tropospheric deposition from the 1986 Chernobyl accident. In many European locations, Chernobyl-derived  $^{137}\text{Cs}$  is the dominant source; this complicates the potential use of  $^{137}\text{Cs}$  because Chernobyl fallout was deposited by a small number of specific rain events, as much of the terrain was covered with snow at the time of the accident. FRNs after snow melting were subsequently redistributed via runoff. In our study, we evaluated an alternative tracer,  $^{239+240}\text{Pu}$ . In Switzerland, Pu is expected to originate exclusively from 1950's–1960's stratospheric fallout, as all previous studies indicate that Chernobyl Pu, associated with non-volatile fuel particles, was distributed

in limited regions of Eastern Europe and Scandinavia. We measured  $^{137}\text{Cs}$  and  $^{239+240}\text{Pu}$  activities in soils collected in two alpine valleys of Switzerland (Ursern Valley, Canton Uri, Central Swiss Alps and Val Piora, Ticino, Southern Alps; Figure 1). We sampled both reference and potentially eroding sites in transects along both valleys (Figure 1).  $^{137}\text{Cs}$  and  $^{239+240}\text{Pu}$  measurements were performed with a Li-drifted Germanium detector and quadrupole ICP-MS, respectively.

As expected, inventories of  $^{239+240}\text{Pu}$  at our reference sites exhibited a more homogenous distribution than  $^{137}\text{Cs}$  inventories (Figure 2). The coefficient of variance (CV) for reference sites was 32% for  $^{137}\text{Cs}$  distribution in the Ursern Valley (n=6) and 98% in the Val Piora (n=7). In contrast, reference  $^{239+240}\text{Pu}$  values exhibited CV's of 13 and 17% for the reference sites at Ursern Valley (n=6) and Val Piora (n=7), respectively. We concluded that Pu is a suitable tracer for soil erosion assessment in alpine grasslands. The  $^{137}\text{Cs}$  data showed large variations and CV of > 30% is considered problematic in using FRN for soil erosion assessment. Compared to gamma spectrometric determinations of  $^{137}\text{Cs}$ , mass spectrometric measurements of  $^{239+240}\text{Pu}$  have advantages with respect to sample size and analytical throughput. Further, mass spectrometry offers the capability of source attribution via atom ratio measurements; our  $^{240}\text{Pu}/^{239}\text{Pu}$  results identified 1950's–1960's thermonuclear tests as the sole Pu source, ruling out the presence of any significant Pu contributions from Chernobyl. The relatively long half-lives of  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  also ensure the long-term efficacy of plutonium as a soil erosion tracer.

Using  $^{239+240}\text{Pu}$  as a tracer, we found large local differences in net erosion and deposition rates. In the Ursern Valley, net deposition rates ranged from 0.9 to 6.4 t ha<sup>-1</sup>yr<sup>-1</sup> and net erosion rates were between 2.6 and 21.8 t ha<sup>-1</sup>yr<sup>-1</sup>. Net deposition rates were 0.7 to 77 t ha<sup>-1</sup>yr<sup>-1</sup>, while net erosion ranged from 1 to 5.3 t ha<sup>-1</sup>yr<sup>-1</sup> at Val Piora. Our study represents a novel, successful application of  $^{239+240}\text{Pu}$  as a tracer of soil erosion in a mountain environment, and points to significant potential for its application in similar environments elsewhere.

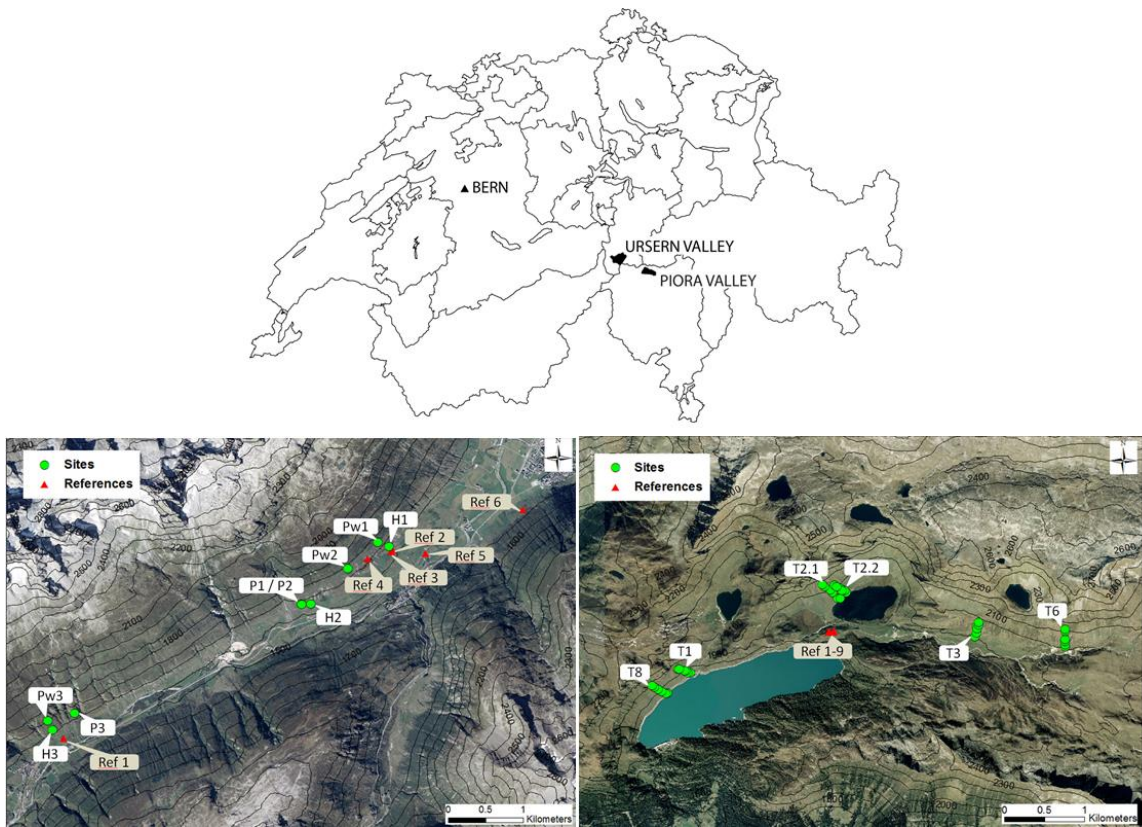


Figure 1. Location of the investigated sites within Switzerland. Lower panels: Ursern Valley (left) and Val Piora (right). Ref = reference sites. P = pastures. Pw = pastures with dwarf shrubs. H = hayfields. T = sampling transects

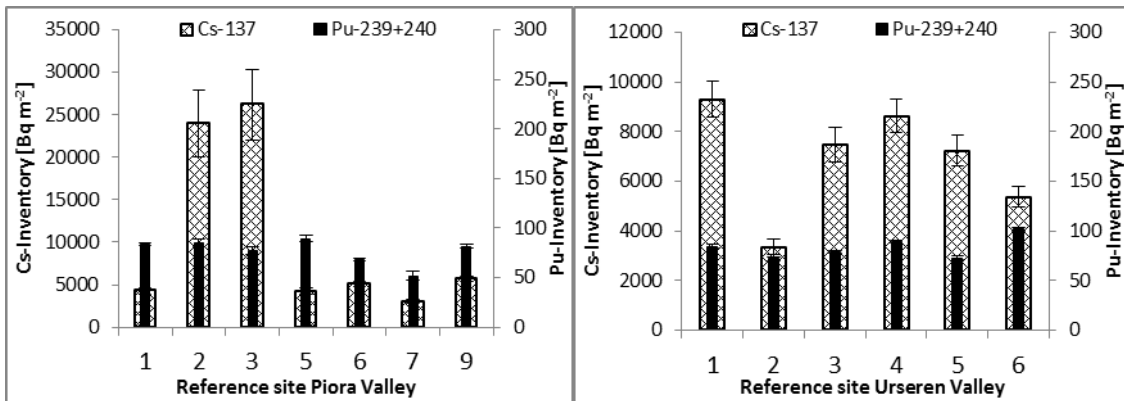


Figure 2. Comparison of  $^{137}\text{Cs}$  and  $^{239+240}\text{Pu}$  inventory change (top) and reference inventories for the Val Piora (bottom left) and Ursern Valley (bottom right)



## N<sub>2</sub>O isotopomers and N<sub>2</sub>:N<sub>2</sub>O ratio as indicators of denitrification in ecosystems

Ülo Mander<sup>1</sup>, and Mohammad Zaman<sup>2</sup>

<sup>1</sup>Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Estonia

<sup>2</sup>Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna, Austria

### Introduction

The world is experiencing climate change and variability due to increased greenhouse gas (GHG) emissions. The main GHG's of concern are nitrous oxide (N<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Agriculture contributes approximately 14% of the world's GHG emissions. Nitrous oxide is one of the key GHG and ozone (O<sub>3</sub>) depleting gas, constituting 7% of the anthropogenic greenhouse effect. On a molecular basis, N<sub>2</sub>O has a 310- and 16-fold greater global warming potential than each of CO<sub>2</sub> and CH<sub>4</sub>, respectively, over a 100-year period. Nitrous oxide can be produced through both chemical and biochemical pathways. They occur during denitrification (the stepwise conversion of nitrate (NO<sub>3</sub><sup>-</sup>) to nitrogen gas (N<sub>2</sub>) and during nitrification by ammonia-oxidizing archaea (bacteria) during the oxidation of hydroxylamine (NH<sub>2</sub>OH) to nitrite (NO<sub>2</sub><sup>-</sup>) which is then reduced to N<sub>2</sub>O and N<sub>2</sub> by nitrifier denitrification or heterotrophic denitrification (Fig. 1).

and also to identify their microbial source. The N<sub>2</sub>O site-specific <sup>15</sup>N signatures from bacterial denitrification and the NH<sub>2</sub>OH to N<sub>2</sub>O pathway of nitrification are clearly different, making this signature a potential tool for identifying the bacterial or other source of N<sub>2</sub>O (Sutka et al., 2006). The majority of past studies have been dedicated to the analysis of the  $\delta^{15}\text{N}$  and  $\delta^{18}\text{O}$  isotopomers ( $d^{15}\text{N}^{\alpha}$  and  $d^{15}\text{N}^{\beta}$ ) in relation to the production of N<sub>2</sub>O, with only a limited number of studies being dedicated to the analysis of dissolved N<sub>2</sub>O in groundwater (Well et al., 2012).

Only a limited number of studies have quantified N<sub>2</sub> fluxes and calculated the N<sub>2</sub>:N<sub>2</sub>O ratio (an important indicator of the denitrification process), the latter varying from 0.8 to 55 in typical agricultural soils, from 0.3 to 261 in soils under natural vegetation, and from 3 to 250 in wetlands and recently flooded soils (Butterbach-Bahl et al., 2013). The objective of our study was to quantify N<sub>2</sub>O and N<sub>2</sub>, and their isotopic signatures in wetland.

### Methods

The analysis of stable isotope abundances ( $\delta^{15}\text{N}$ ,  $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ) of atmospheric gases present in trace amounts (specifically N<sub>2</sub>O and CH<sub>4</sub>) can be used with the coupling of a pre-concentration unit interfaced with a gas-chromatograph isotope ratio mass spectrometer (IRMS) (Fig. 2). For the isotopologue signatures of N<sub>2</sub>O in water, i.e.  $\delta^{18}\text{O}$  ( $\delta^{18}\text{O}-\text{N}_2\text{O}$ ), the average  $\delta^{15}\text{N}$  ( $\delta^{15}\text{N}^{\text{bulk}}-\text{N}_2\text{O}$ ) and  $\delta^{15}\text{N}$  from the central N position ( $\delta^{15}\text{N}^{\alpha}$ ), can be analyzed after cryo-focusing using IRMS. Thus, in Mander et al., (2014), the analysis was conducted using a Delta XP IRMS, which allowed simultaneous detection of mass to charge ratio (m/c) 30, 31 for N<sub>2</sub>O fragments and m/c 44, 45, and 46 for the intact N<sub>2</sub>O molecules. The IRMS was connected to a modified Precon (Thermo-Finnigan, Bremen, Germany) equipped with an auto-sampler (model Combi-PAL CTCAnalytics, Zwingen, Switzerland).

<sup>15</sup>N site preference (SP; ‰) was obtained as:

$$\text{SP} = 2 * ({}^{15}\text{N}^{\alpha} - {}^{15}\text{N}^{\text{bulk}} - \text{N}_2\text{O})$$

The isotopologue ratios of a sample (R<sub>sample</sub>) were expressed as the deviation from the <sup>15</sup>N/<sup>14</sup>N and <sup>18</sup>O/<sup>16</sup>O ratios of the reference standard materials (R<sub>std</sub>), atmospheric N<sub>2</sub> and standard mean ocean water (SMOW) respectively:

$$\delta X = (\text{R}_{\text{sample}}/\text{R}_{\text{std}} - 1) * 1000$$

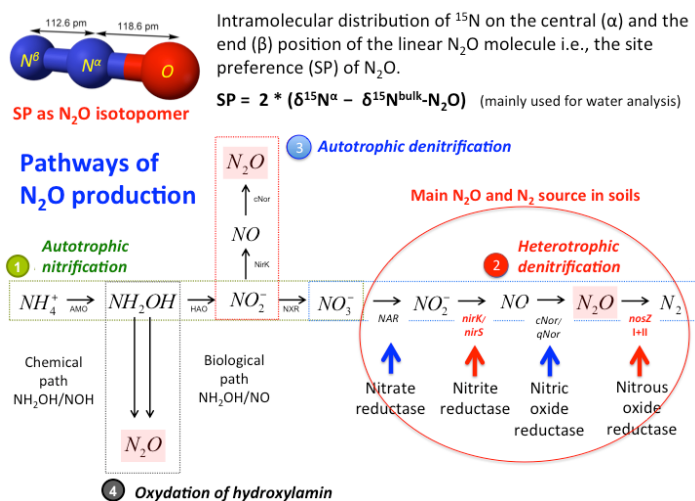


Figure 1. Site preference (SP) as N<sub>2</sub>O isotopomer and main pathways of N<sub>2</sub>O production

The conversion of N<sub>2</sub>O to N<sub>2</sub>, which depends on the abundance and expression of the *nosZ* gene of bacteria in sediments (Ligi et al., 2014), and is influenced by soil pH. The disruption of this step results in incomplete denitrification meaning N<sub>2</sub>O emissions rather than di-nitrogen (N<sub>2</sub>) (Zaman et al., 2012).

Apportioning N<sub>2</sub>O to its source processes is still a challenging task. However, the use of methods involving stable isotope labeled <sup>15</sup>N precursors offers the best opportunity for quantifying both N<sub>2</sub>O and N<sub>2</sub> products



where  $X = {}^{15}\text{N}^{\text{bulk}} - \text{N}_2\text{O}$ ,  ${}^{15}\text{N}^{\alpha}$ ,  ${}^{15}\text{N}^{\beta}$  or  ${}^{18}\text{O}$ . Typical analytical precision was 0.6%, 0.9% and 0.9% for  $\delta^{15}\text{N}^{\text{bulk}}$ ,  $\delta^{15}\text{N}^{\alpha}$  and  $\delta^{18}\text{O}$  respectively. The detection limit for  $\text{N}_2\text{O}-\text{N}$  was 1.5 ppb.

In Fig. 2, we show a  $\text{N}_2$  flux measurement system, one which is an upgraded prototype of the systems used by Butterbach-Bahl et al. (2002).

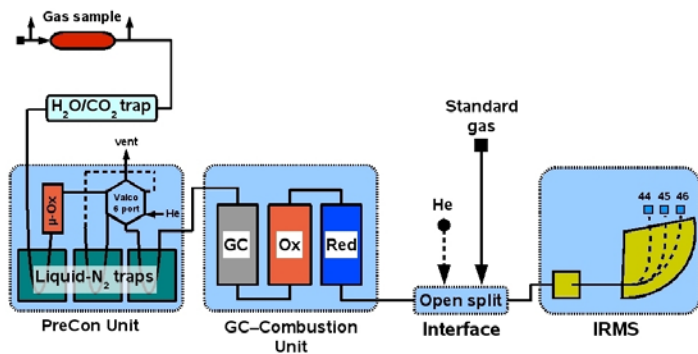


Figure 2. The instrument couplings used for the substance specific determination of N, O and C stable isotope abundances ( $\delta^{15}\text{N}$ ,  $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ) of atmospheric trace gases (specifically  $\text{N}_2\text{O}$  and  $\text{CH}_4$ ) in a natural abundance range

## Results and Discussion

In a study conducted on a horizontal subsurface flow (HSSF) in a constructed wetland (CW) designed specifically for municipal wastewater treatment (Mander et al., 2015), the isotopologue signatures of  $\text{N}_2\text{O}$  in the HSSF water suggest that the main source of  $\text{N}_2\text{O}$  was denitrification. This is supported by high SP values and a significant positive correlation between the  $\delta^{18}\text{O}-\text{N}_2\text{O}$  vs  $\text{SP}-\text{N}_2\text{O}$  (Fig. 3B). In comparison with the results from groundwater (Koba et al., 2009; Well et al., 2012) or sediments (Mothet et al., 2013), the results from the HSSF water are in good agreement. For example, the values of a  $\delta^{18}\text{O}-\text{N}_2\text{O}$  vs  $\delta^{15}\text{N}^{\text{bulk}}-\text{N}_2\text{O}$  plot are somewhat higher than those values observed in groundwater by Koba et al. (2009), though they are still in the range of presumable denitrification process values (Fig. 3A).

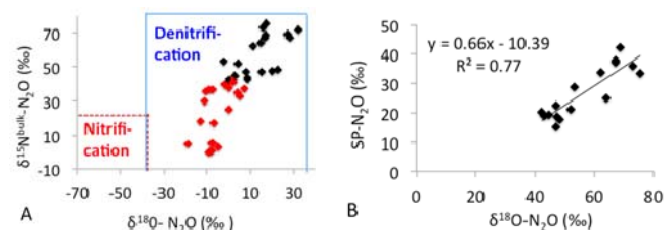


Figure 3. Isotopologue relations in the HSSF bed of a CW for wastewater treatment of a schoolhouse. Red diamonds, data from Koba et al. (2009); black diamonds, data from Mander et al. (2015). Presumed borders of nitrification and denitrification are adapted from Koba et al. (2009)

The reduction of  $\text{N}_2\text{O}$  to  $\text{N}_2$  leads to an increase in  $\text{SP}-\text{N}_2\text{O}$  and  $\delta^{18}\text{O}-\text{N}_2\text{O}$  in the residual  $\text{N}_2\text{O}$ . In groundwater

this has a wide range for both  $\delta^{18}\text{O}-\text{N}_2\text{O}$  and  $\text{SP}-\text{N}_2\text{O}$  (Well et al., 2012). Moreover, this leads to a close correlation between both “signatures”, where the slope of  $\text{SP}-\text{N}_2\text{O}$  vs.  $\delta^{18}\text{O}-\text{N}_2\text{O}$  has been shown to vary between 5 (Koba et al., 2009) and 0.8 (Well et al., 2012). It should be noted that the lower values were obtained in groundwater with intense denitrification. These values are typical for denitrifying groundwater, and they result from isotopologue values of initially produced  $\text{N}_2\text{O}$  by bacterial denitrifiers with  $\text{SP}-\text{N}_2\text{O}$  values below 0‰ (Sutka et al., 2006) and  $\delta^{18}\text{O}-\text{N}_2\text{O}$  values below 30 ‰, with a subsequent increase in  $\delta^{18}\text{O}-\text{N}_2\text{O}$  and  $\text{SP}-\text{N}_2\text{O}$  in the residual  $\text{N}_2\text{O}$  during the progressive reduction to  $\text{N}_2$ . In the current study, the same pattern was evident, together with a close correlation of  $\delta^{18}\text{O}-\text{N}_2\text{O}$  and  $\text{SP}-\text{N}_2\text{O}$  (slope of 0.67), although there was a large range of SP values (Fig. 3B). A similar range of SP values were found by Mothet et al. (2013) for river (0–10‰) and lagoon sediments (-7 to 25‰), whereas there was a significant correlation between the nitrate reduction rate and the site preference values.

There have been recent advances in metagenomics, facilitated through high throughput sequencing, but these advances have not yet been utilized for  $\text{N}_2\text{O}$  emission studies. Possible reasons for this situation appear to include the argument that it is not necessary to understand which specific members of the denitrifier or ammonia oxidizer communities are actually present (and/or active) in response to, for example, a change in environmental conditions (Butterbach-Bahl et al., 2013).

Nonetheless, some relationships have been found between the functional genes of denitrifiers and dinitrogen fixers. Also, it appears that there is a causal relationship between the  $\text{N}_2\text{O}$  flux and the abundance of *nosZ* genes - which control  $\text{N}_2\text{O}$  reduction to  $\text{N}_2$ . These relationships provide incentive for further investigations at the molecular level (Fig. 4). Similar “causal” relationships also appear to occur between several functional denitrification genes, *nirK*, *nirS* and *nosZ* and environmental variables in wetland ecosystems (Ligi et al., 2014).

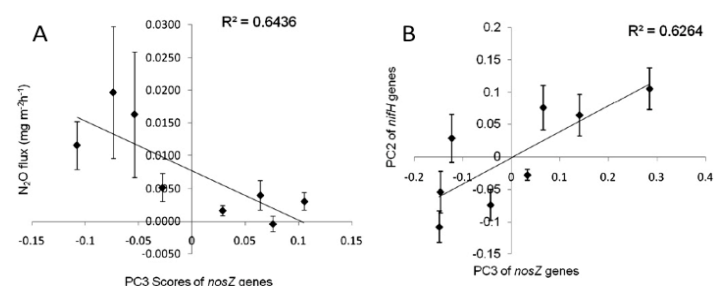


Figure 4. (A) Relationship between  $\text{N}_2\text{O}$  flux rate and the composition of the denitrifying community, as estimated from T-RFLP data of *nosZ* genes. (B) Relationship between the denitrifying (PC3 of *nosZ* genes) and  $\text{N}_2$ -fixing communities (PC2 of *nirH* genes). Error bars are one standard deviation of the mean. Adapted from Singh et al 2011

## References

- Butterbach-Bahl, K., Baggs, E.M., Dannenmann, M., Kiese, R., Zechmeister-Boltenstern, S. (2013). Nitrous oxide emissions from soils: how well do we understand the processes and their controls? *Phil. Trans. Royal Soc. Biol. Sci.* 368, 1–13.
- Butterbach-Bahl, K., Willibald, G., Papen, H. (2002). Soil core method for direct simultaneous determination of  $N_2$  and  $N_2O$  emissions from forest soils. *Plant Soil*, 240, 1, 105–116.
- Koba, K., Osaka, K., Tobari, Y., Toyoda, S., Ohte, N., Katsuyama, M., Suzuki, N., Itoh, M., Yamagishi, H., Kawasaki, M., Kim, S. J., Yoshida, N., Nakajima, T. (2009). Biogeochemistry of nitrous oxide in groundwater in a forested ecosystem elucidated by nitrous oxide isotopomer measurements. *Geochim. Cosmochim. Ac.* 73, 11, 3115–3133.
- Ligi, T., Oopkaup, K., Truu, M., Nõlvak, H., Preem, J.K., Mander, Ü., Mitsch, W.J. (2014). Next-generation sequencing based characterization of bacterial communities in soil and sediment of created riverine wetland. *Ecol. Eng.* In press. doi: 10.1016/j.ecoleng.2013.07.015
- Mander, Ü., Maddison, M., Soosaar, K., Koger, H., Teemusk, A., Truu, J., Well, R., Sebilo, M. (2015). The impact of a pulsing water table on wastewater purification and greenhouse gas emission in a horizontal subsurface flow constructed wetland. *Ecol. Eng.* In press. doi: 10.1016/j.ecoleng.2014.09.075.
- Mander, Ü., Well, R., Weymann, D., Soosaar, K., Maddison, M., Kanal, A., Lõhmus, K., Truu, J., Augustin, J., Tournebize, J. (2014). Isotopologue ratios of  $N_2O$  and  $N_2$  measurements underpin the importance of denitrification in differently N-loaded riparian alder forests. *Enviro. Sci. Technol.* In press. doi: 10.1021/es501727h
- Singh, B.K., Tate K, Thomas, N., Ross, D., Tate, K., Singh, J. (2011). Differential effect of afforestation on nitrogen-fixing and denitrifying communities and potential implications for nitrogen cycling, *Soil Biol. Biochem.* 43, 7, 1426–1433.
- Mothet, A., Sebilo, M., Lavermann, A.M., Vaury, V., Mariotti, A. (2013). Is site preference of  $N_2O$  a tool to identify benthic denitrifier  $N_2O$ ? *Environ. Chem.* 10, 281–284.
- Sutka, R.L., Ostrom, N.E., Ostrom, P.H., Breznak, J.A., Gandhi, H., Pitt, A.J., Li, F. (2006). Distinguishing nitrous oxide production from nitrification and denitrification on the basis of isotopomer abundances. *Appl. Environ. Microbiol.* 72, 1, 638–644.
- Well, R., Eschenbach, W., Flessa, H., von der Heide, C., Weymann, D. (2012). Are dual isotope and isotopomer ratios of  $N_2O$  useful indicators for  $N_2O$  turnover during denitrification in nitrate-contaminated aquifers? *Geochim. Cosmochim. Acta* 90, 265–282.
- Zaman, M., Nguyen, M.L., Šimek, M., Nawaz, S., Khan, M.J., Babar, M.N., Zaman, S. (2012). Emissions of Nitrous Oxide ( $N_2O$ ) and Di-Nitrogen ( $N_2$ ) from Agricultural Landscape, Sources, Sinks, and Factors Affecting  $N_2O$  and  $N_2$  Ratios. In: *Greenhouse Gases - Emission, Measurement and Management.* (Ed. Guoxiang Liu). pp. 1–32. Intech ISBN 978-953-51-0323-3.Croatia.

## Soil nitrous oxide and methane fluxes in integrated crop-livestock systems in subtropics

Jeferson Dieckow<sup>1</sup>, Maico Pergher<sup>1</sup>, Jonatas Thiago Piva<sup>2</sup>, Cimélio Bayer<sup>3</sup> and Anibal de Moraes<sup>4</sup> and Karuppan Sakadevan<sup>5</sup>

<sup>1</sup>Soil Science Department and <sup>4</sup>Crop Science Department, Federal University of Paraná, Curitiba, Brazil <sup>2</sup>Campus Curitibanos, Federal University of Santa Catarina, Curitibanos, Brazil

<sup>3</sup>Soil Science Department, Federal University of Rio Grande do Sul, Porto Alegre, Brazil

<sup>5</sup>Soil and Water Management & Crop Nutrition Section, International Atomic Energy Agency, Vienna, Austria

Integrated crop-livestock (ICL) system is an agricultural practice in which crop-pasture rotation is carried out in the same field over time. In Brasil, ICL associated with no-tillage farming is increasingly gaining importance as a soil use strategy that improves food production (grain, milk and beef) and economic returns to farmers. Integrated crop-livestock-forestry (ICLF) is a recent modification of ICL in Brazil, with the inclusion of trees cultivation aiming at additional wood production and offering thermal comfort to livestock (Porfirio-da-Silva & Moraes, 2010). However, despite the increasing importance of ICL, little information is available on how this system may affect soil-atmosphere exchange of nitrous oxide (N<sub>2</sub>O) and methane (CH<sub>4</sub>).

Nitrous oxide emissions from pastoral soils after fertilizer nitrogen (N) application may be associated with both nitrification and denitrification. Nitrogen fertilizer application has been reported to significantly increase N<sub>2</sub>O emissions in grasslands of Europe (Velthof & Oenema, 1995) and of the Great Plains in UAS (Liebig et al., 2006). Pastoral soils may emit CH<sub>4</sub> if water saturated, but under aerobic conditions they also consume CH<sub>4</sub>, (Saggar et al., 2008).

Field studies were carried out to quantify N<sub>2</sub>O and CH<sub>4</sub> emissions under six year old ICL systems in subtropical Brazil (Ponta Grossa, 25°07'S; 50°02'W; altitude of 973 m) with an annual precipitation around 1500 mm. The soil was classified as sandy clay loam Ferralsol for the site. The following three cropping systems were used.

1. Annual continuous crop (CC) with black oat (*Avena strigosa*) plus annual ryegrass (*Lolium multiflorum*) as winter cover crops, and soybean (*Glycine max*) or maize (*Zea mays*) as summer cash crops.
2. Integrated crop-livestock system (ICL) with black oat plus annual ryegrass grazed at three to four cycles per winter, by "Purunã" steers.
3. Integrated crop-livestock-forestry system (ICLF): similar to the previous, but eucalyptus (*Eucalyptus* sp) and grevillea (*Grevillea* sp) trees arranged on rows distant 14-m from each other.

During the soybean cycle (November to April), N<sub>2</sub>O fluxes were < 30 µg N m<sup>-2</sup> h<sup>-1</sup>, but tended to be higher in CC (Figure 1a). Six days after application of 90 kg N ha<sup>-1</sup> (urea) to oat+ryegrass, a peak was observed in CC, ICL and ICLF of 70, 38, 21 µg N m<sup>-2</sup> h<sup>-1</sup>, respectively (Figure 1a). Two weeks later, fluxes returned to background levels and remained over the rest of oat+ryegrass and beginning of maize seasons, until the application of 200 kg N ha<sup>-1</sup> to maize, when a second emission peak emerged (Figure 1a). The highest flux was in CC (223 µg N m<sup>-2</sup> h<sup>-1</sup>), the intermediate in ICL and lower in ICLF.

Measurements of N<sub>2</sub>O fluxes over the 450-day assessment was summarized in the cumulative emission and showed maximum for CC (2.2 kg N<sub>2</sub>O-N ha<sup>-1</sup>), followed by ICL (1.3 kg N<sub>2</sub>O-N ha<sup>-1</sup>) and ICLF (0.5 kg N<sub>2</sub>O-N ha<sup>-1</sup>) (Figure 1a). Higher fluxes in CC were attributed to higher water filled pore space (WFPS) (data not shown) and the associated creation of microsites favorable to anaerobiosis and denitrification (Linn & Doran, 1984). More crop residue on surface of CC soil at the end of the winter season (6.7 Mg ha, vs. 3.7 in ICL and 3.1 in ICLF) had possibly contributed to higher water filled pore space (WFPS) in summer CC. Additionally, the lowest N<sub>2</sub>O emission in ICLF was attributed to the lowest soil temperature (data not show) due to trees shade, which suggests a positive effect of this system at mitigating N<sub>2</sub>O emissions.

Findings of this study differs from studies of Piva et al. (2014) in the same region which showed higher N<sub>2</sub>O emission in ICL than in CC (4.26 vs. 1.26 kg N ha<sup>-1</sup>) suggesting the need for more studies on this issue.

The effect of fertilizer-N on increasing N<sub>2</sub>O emission, although concentrated in a very few days, was significant. Increases of N<sub>2</sub>O emissions after N application is widely reported (Zanatta et al., 2010) and attributed to nitrification and denitrification processes induced by increase of inorganic N (NH<sub>4</sub><sup>+</sup> or NO<sub>3</sub><sup>-</sup>) in soil (Velthof & Oenema, 1995). However, we found no significant correlation between N<sub>2</sub>O flux and NH<sub>4</sub><sup>+</sup> or NO<sub>3</sub><sup>-</sup> concentrations (data not shown).



Soil acted as a  $\text{CH}_4$  sink for most of the time (Figure 1b), which is logical assuming that the aerated condition of this soil certainly favoured oxidation of  $\text{CH}_4$  into  $\text{CO}_2$  by methanotrophic bacteria (Saggar et al., 2008). Nonetheless, three emission peaks were observed and the two most expressive followed urea-N applications. Possibly the higher soil  $\text{NH}_4^+$ -N concentration after application inhibited methane-oxidizers and therefore constrained  $\text{CH}_4$  consumption (Hütsch, 1996). Overall, during the 450-day period, soils of the three management systems consumed  $\text{CH}_4$ , but no significant difference in

the cumulative consumption occurred between them ( $-1.0$  to  $-1.6 \text{ kg C ha}^{-1}$ , ns) (Figure 1b).

Integrated farming systems mitigated soil  $\text{N}_2\text{O}$  emission compared to continuous cropland. In the particular case of ICLF, mitigation might be due to shade effect on decreasing average soil temperature and thus  $\text{N}_2\text{O}$  production. However, further studies on integrated systems and soil greenhouse gas emissions are still needed to support consistent conclusions.

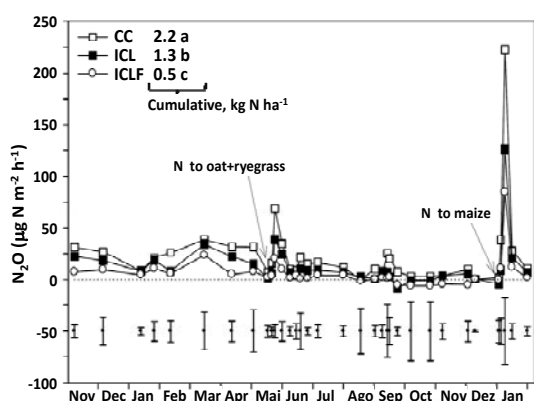
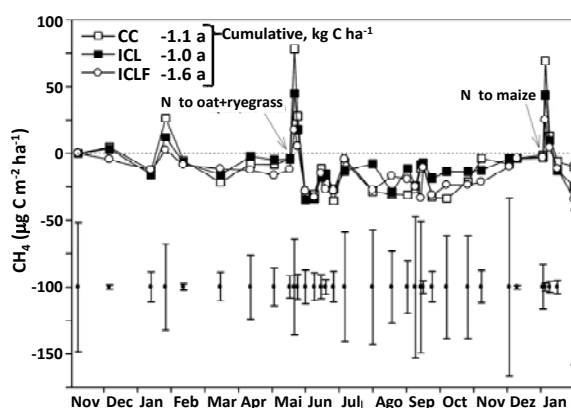
(a)  $\text{N}_2\text{O}$ (b)  $\text{CH}_4$ 

Figure 1. Nitrous oxide (a) and methane (b) fluxes and cumulative emissions from soils under annual continuous crop (CC), integrated crop-livestock system (ICL), and integrated crop-livestock-forestry system (ICLF) during a 450 day study. Vertical bars comparing fluxes and letters comparing cumulative emissions denote the LSD Tukey ( $p < 0.05$ )

## References

- Hütsch, B.W. (1996). Methane oxidation in soils of two long-term fertilization experiments in Germany. *Soil Biol. Biochem.* 28, 773–782.
- Liebig, M.A., Gross, J., Kronberg, S.L., Hanson, J.D., Frank, A.B., Phillips, R.L. (2006). Soil response to long-term grazing in the northern Great Plains of North America. *Agric. Ecosyst. Environ.* 115, 270–276.
- Linn, D.M., Doran, J.W. (1984). Effect of water-filled pore space on carbon dioxide and nitrous oxide production in tilled and nontilled soils. *Soil Sci. Soc. Am. J.* 48, 1267–1272.
- Piva, J.T., Dieckow, J., Bayer, C., Zanatta, J.A. (2014). De Moraes, A.; Tomazi, M.; Pauletti, V.; Barth, G., Piccolo, M.D.C. Soil gaseous  $\text{N}_2\text{O}$  and  $\text{CH}_4$  emissions and carbon pool due to integrated crop-livestock in a subtropical Ferralsol. *Agriculture, Ecosystems & Environment.* 190, 87–93.
- Porfirio-Da-Silva, V., Moraes, A. (2010). Sistemas silvipastoris: fundamentos para a implementação. In: PIRES, A.V., ed. *Bovinicultura de Corte*. Piracicaba, FEALQ. 1421–1461.
- Saggar, S.; Tate, K.R.; Giltrap, D.L., Singh, J. (2008). Soil-atmosphere exchange of nitrous oxide and methane in New Zealand terrestrial ecosystems and their mitigation options: A review. *Plant Soil.* 309, 25–42.
- Velthof, G.L., Oenema, O (1995). Nitrous oxide fluxes from grassland in the Netherlands: II. Effects of soil type, nitrogen fertilizer application and grazing. *Eur. J. Soil Sci.* 46, 541–549.
- Zanatta, J.A., Bayer, C., Vieira, F.C.B., Gomes, J., Tomazi, M. (2010). Nitrous oxide and methane fluxes in South Brazilian Gleysol as affected by nitrogen fertilizers. *Rev. Bras. Ci. Solo,* 34, 1653–1665.

# Announcement

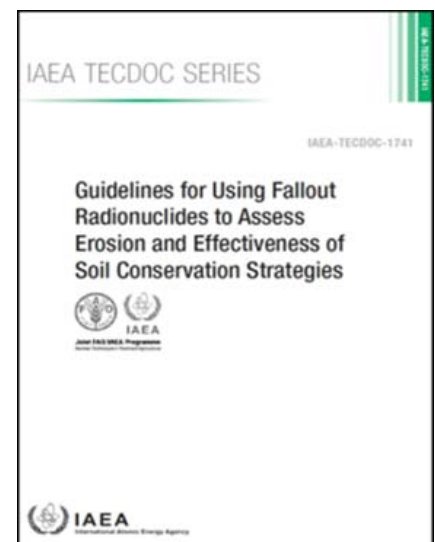
## Publication of the Guidelines for Using Fallout Radionuclides to Assess Erosion and Effectiveness of Soil Conservation Strategies (IAEA TECDOC No. 1741)

*Technical Officers: Lionel Mabit and Gerd Dercon*

The conservation of soil and water resources has become a major concern for ensuring global food production. Soil erosion is a worldwide threat and represents the main mechanism of land degradation in both developed and developing countries. To control soil erosion, there is a need to monitor the impacts of land use changes and assess the effectiveness of specific soil conservation technologies. Fallout radionuclides (FRNs) have proven to be a cost effective tool to trace soil redistribution due to erosion within the landscape from plot to basin scale and can complement the information provided by conventional erosion measurements and modelling.

The International Atomic Energy Agency (IAEA) has played a key role in these methodological developments and applications. The Soil and Water Management and Crop Nutrition (SWMCN) Sub-programme of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has strengthened national capacities for using these nuclear-based techniques and has disseminated them through international co-operation in research, training and other outreach activities in FAO and IAEA Member States. A new publication by the Joint FAO/IAEA Division on the use of FRNs to assess soil erosion magnitude in agricultural land has recently been released. This publication provides step-by-step guidance and up to date information on the use of FRNs, such as caesium-137 ( $^{137}\text{Cs}$ ), lead-210 ( $^{210}\text{Pb}$ ) and beryllium-7 ( $^7\text{Be}$ ) to a wide range of researchers and extension workers to assess soil erosion rate in agricultural land for developing management practices that can minimize land degradation and improve land productivity and environmental sustainability.

<http://www-pub.iaea.org/books/IAEABooks/10501/Guidelines-for-Using-Fallout-Radionuclides-to-Assess-Erosion-and-Effectiveness-of-Soil-Conservation-Strategies>



## Scientific Visitors

- Dr Abdulwahid Abdullah Saif, from National Atomic Energy Commission (NATEC), Yemen visited the SWMCN laboratory, Seibersdorf from 11 to 15 August 2014 to discuss the work plan of the TC project YEM5013 (Technical Officer: Ammar Wahbi).
- Mr Victor Manuel Martínez from Centro de Investigación de los Recursos Acuáticos de Nicaragua (CIRA), Universidad Nacional Autónoma de Nicaragua (UNAN) visited the SWMCN Section from 6 to 10 October 2014 (Technical Officer of NIC2009: Karuppan Sakadevan).

## Obituary

Jean-Claude Fardeau passed away on 15 July 2014. He worked for most of his career in the laboratory of radio-agronomy at the Atomic Energy Agency in Cadarache, France, where he was finally Deputy Director of the Agronomy and Environment Division of INRA in Paris.

Jean-Claude was well known for his phosphorus work in soil-plant system using  $^{32}\text{P}$ . We will miss him; however his legacy will remain with us for the rigorous P work that he did using nuclear techniques.



# Technical Cooperation Projects

## Operational Projects and Technical Officers Responsible for Implementation

Project Number	Title	Technical Officer(s)
ALG5026	Increasing the Genetic Variability for the Improvement of Strategic Crops (Wheat, Barley, Chickpeas and Dates) for Enhanced Tolerance to Biotic and Abiotic Stresses and the Development of Biotechnology Capacities	A. Wahbi in collaboration with Plant Breeding and Genetics Section
ALG5028	Preserving Arid and Semi-Arid Agro-Ecosystems and Combating Desertification by Using Advanced Isotopic Techniques, Developing Decision-Making Tools and Supporting Sensitization of the Local Population on the Needs of Desertification Control	G. Dercon and L. Mabit
ANG5011	Monitoring Soil Fertility in Pasture Areas for Their Improvement and Maintenance	L. Heng
BDI0001	Supporting Human Resource Development and Nuclear Technology Support including Radiation Safety	A. Wahbi
BEN5007	Soil, Crop and Livestock Integration for Sustainable Agriculture Development through the Establishment of a National Laboratory Network	L. Heng in collaboration with Animal Production and Health Section
BGD5028	Assessing Crop Mutant Varieties in Saline and Drought Prone Areas Using Nuclear Techniques	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
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
BKF5009	Improving Voandzou and Sesame Based Cropping Systems through the Use of Integrated Isotopic and Nuclear Techniques for Food Security and Poverty Alleviation	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
BKF5010	Enhancing Crop Productivity through Small Scale Irrigation Technologies for Peri-Urban Agriculture to Improve the Income and Livelihood of Farmers	L. Heng
BOL5020	Evaluating Soil Fertility Loss by Water Erosion in the Area and Valleys of Intersalar Boliviano, Using Nuclear Gamma Spectrometry and Environmental Radionuclides	G. Dercon
BOT5012	Improving Soil and Water Management Options to Optimize Yields of Selected Crops	K. Sakadevan
CAF5006	Improving Cassava Production through High Yielding Varieties and Sustainable Soil Fertility Management by Using Isotopic and Nuclear Techniques to Ensure Sustainable Farming	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
CHI5050	Using Isotope Techniques to Quantify the Contribution of Agriculture in Greenhouse Gas Production	M. Zaman

Project Number	Title	Technical Officer(s)
CMR5020	Improving Maize Based Cropping System Productivity through the Efficient Management of Organic Matter, Water, Nitrogen and Phosphorous Fertilizers	M. Zaman
COS5029	Strengthening of Good Agricultural Practices (GAP) for Food Safety and Security and Environmental Protection	G. Dercon in collaboration with Food and Environmental Protection Section
COS5031	Consolidating a National Reference Laboratory for the Measurement of Greenhouse Gases	M. Zaman
DOM7004	Developing Human Resources and Supporting Nuclear Technology for Addressing Key Priority Areas including Biodiversity and Environmental Conservation	L. Heng
ECU5028	Consolidating Food Security and Environmental Sustainability in Palm Oil Production Using Nuclear Applications	L. Heng in collaboration with Food and Environmental Protection Section
INS5039	Enhancing Food Crop Production Using Induced Mutation, Improved Soil and Water Management and Climate Change Adaptation	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
INT5153	Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountainous Regions	G. Dercon and M. Zaman
IRQ5019	Utilizing Nuclear Techniques to Increase Water Use Efficiency and to Improve Soil Management of Degraded Soil	A. Wahbi
IVC5033	Contributing to Food Security and Combating Poverty by Improving the Productivity of the Coconut Palm, Plaintain and Leafy Vegetables by Means of Studying the Effects of Organic and Mineral Fertilizers	K. Sakadevan
KAM5001	Improving Soil Fertility and Crop Management Strategies in Diversified Rice Based Farming Systems	L. Heng
KAZ5003	Increasing Micronutrient Content and Bioavailability in Wheat Germplasm by Means of an Integrated Approach	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
KEN5035	Using Nuclear Techniques for Validation of Integrated Soil Fertility and Water Management Technologies for Increased Agricultural Productivity and Climate Change Adaptation in Arid and Semi- Arid Areas	L. Heng
LAO5001	Enhancing Food Security through Best Fit Soil-Water Nutrient Management Practices with Mutation Induction for Drought Resistant Rice	M. Zaman
MAG5019	Improving the Use of Agricultural Resources and Combating Soil Erosion by Optimizing Conservation Agriculture and Developing Strategies for Its Dissemination	M. Zaman and L. Mabit

<b>Project Number</b>	<b>Title</b>	<b>Technical Officer(s)</b>
MAG5023	Promoting Climate Smart Agriculture to Face Food Insecurity and Climate Change with regard to Basic National Foods (Rice and Maize)	M. Zaman and L. Mabit
MEX5030	Improving Phosphorus Use Efficiency and Agricultural Sustainability in the Acidic Soil of the P'urhepecha Plateau, Michoacan	M. Zaman
MLI5024	Enhancing Sustainable Intensification and Diversification of Sorghum Production Systems in the Southern Zone by an Integrated and Participatory Approach, Phase 2	L. Heng
MLI7003	Assessing Erosion, Sedimentation and Water Resources in River Basins by Using Isotope Techniques	L. Mabit
MOZ5004	Improving Nitrogen and Water Use Efficiency of Maize Varieties in Conservation Agriculture under Smallholder Farming Systems	M. Zaman and G. Dercon
MYA5020	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	M. Zaman in collaboration with Plant Breeding and Genetics Section
MYA5023	Evaluating Nitrogen Use Efficiency Using Low Nitrogen Tolerant Rice Varieties	K. Sakadevan
MYA5025	Monitoring and Assessment of Watershed Management Practices on Water Quality and Sedimentation Rate of Inle Lake	L. Heng and M. Zaman
NAM5012	Developing High Yielding and Drought Tolerant Crops through Mutation Breeding	L. Heng in collaboration with Plant Breeding and Genetics Section
NIC5009	Introducing Integrated Environmental Management in the Watershed of the Nicaraguan Great Lakes and the San Juan River: Responding to Future Challenges with Nuclear Techniques	K. Sakadevan
OMA5001	Producing Forage Crops Tolerant to Salinity and Drought	K. Sakadevan
RAF5063	Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security	L. Mabit
RAF5071	Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for Increased Food Production and Income Generation (AFRA)	L. Heng
RAS5055	Improving Soil Fertility, Land Productivity and Land Degradation Mitigation	M. Zaman



<b>Project Number</b>	<b>Title</b>	<b>Technical Officer(s)</b>
RAS5056	Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
RAS5064	Enhancing Productivity of Locally Underused Crops through Dissemination of Mutated Germplasm and Evaluation of Soil, Nutrient and Water Management Practices	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
RAS5065	Climate Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications	L. Heng in collaboration with Plant Breeding and Genetics Section
RAS5068	Developing Effective Practices for Combating Desertification (ARASIA)	M. Zaman
RAS5069	Complementing Conventional Approaches with Nuclear Techniques towards Flood Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia	L. Heng and K. Sakadevan in collaboration with Plant Breeding and Genetics, Animal Production and Health and Isotope Hydrology Sections
RLA5064	Strengthening Soil and Water Conservation Strategies at the Landscape Level by Using Innovative Radio and Stable Isotope and Related Techniques (ARCAL CXL)	G. Dercon
RLA5065	Improving Agricultural Production Systems Through Resource Use Efficiency (ARCAL CXXXVI)	K. Sakadevan
SEN5034	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	G. Dercon in collaboration with Plant Breeding and Genetics Section
SEY5007	Increasing Crop Production through Effective Management of Soil Salinity in the Coastal Area using Nuclear and Related Techniques	L. Heng
SUD5033	Enhancing Productivity of Major Food Crops (Sorghum, Wheat, Groundnut and Tomato) under Stress Environment Using Nuclear Techniques and Related Biotechnologies to Ensure Sustainable Food Security and Well-being of Farmers	L. Heng in collaboration with Plant Breeding and Genetics Section
THA5051	Evaluating Soil Erosion-Deposition and Soil Quality using Isotopic and Nuclear Techniques in Agricultural Areas Affected by Flooding	M. Zaman
THA5054	Increasing Adaptability for Adverse Environment Tolerance in Rice Germplasm Using Nuclear Techniques	K. Sakadevan
THA5055	Using Isotope Tracer and Fingerprint Techniques for the Assessment of Sediment Processes	M. Zaman

<b>Project Number</b>	<b>Title</b>	<b>Technical Officer(s)</b>
YEM5013	Evaluating Selected Wheat Varieties for Greater Agronomic Characteristics Using Carbon Isotope Discrimination and Improved Soil and Water Management	A. Wahbi
ZAI5020	Assessing and Improving the Assimilability of Natural Phosphates Composted with Organic Matter in Marginal Soils through the Use of Isotope and Nuclear Techniques for Improved Crop Nutrition	M. Zaman and G. Dercon
ZAM5029	Evaluating the Impact of Nitrogen and Water Use Efficiency in Upland Rice	K. Sakadevan
ZIM5015	Developing Drought Tolerant and Disease/Pest Resistant Grain Legume Varieties with Enhanced Nutritional Content Using Mutation Breeding and Novel Techniques, Phase II	L. Heng in collaboration with Plant Breeding and Genetics Section
ZIM5020	Optimizing Water Use and Soil Productivity for Increased Food Security in Drylands (Phase II)	L. Heng

## Forthcoming Events

### FAO/IAEA Events

**Third Research Coordination Meeting of the CRP D1.50.13 on Approaches to Improvement of Crop Genotypes with High Water and Nutrient Use Efficiency for Water Scarce Environments, 9–13 March 2015, Mexico City, Mexico**

*Technical Officer: Karuppan Sakadevan*

**Training Course on Nitrogen Management, 4–15 May 2015, Seibersdorf, Austria**

*Technical Officer: Mohammad Zaman*

The nitrogen (N) training course will focus on the use of N-15 technique to assess N use efficiency in soil-plant interface as well as emission of nitrous oxide (N<sub>2</sub>O) to the atmosphere. The aim is to provide knowledge and training on the use of nuclear technique for developing effective soil-water management and cropping practices to address issues of low fertilizer use efficiency as well as greenhouse gas emissions to the atmosphere. Twenty fellows from Member States either under their national or regional TC will be accepted for the training. For further details, please contact Zaman ([M.Zaman@iaea.org](mailto:M.Zaman@iaea.org)) via e-mail:

**Training Course on Water Management and Use of AquaCrop Simulation Model, 26 May–12 June 2015, Seibersdorf, Austria**

*Technical Officer: Ammar Wahbi*

This training course will target fellows from TC projects funded by the IAEA, in the area of soil water management. Approximately 20 fellows can be accepted.

For further information regarding this course, please contact Ammar Wahbi ([A.Wahbi@iaea.org](mailto:A.Wahbi@iaea.org)) of the Soil and Water Management & crop Nutrition Laboratory.

**Third Research Coordination Meeting of the CRP (D1.50.12) on Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-based Cropping Systems in Sub-Saharan Africa, second quarter 2015, Harare, Zimbabwe**

*Technical Officer: Mohammad Zaman*

### Non-FAO/IAEA Events

**Agriculture and Climate Change: Adapting Crops to Increased Uncertainty, 15–17 February 2015, Amsterdam, The Netherlands**

<http://www.agricultureandclimatechange.com/index.html>

**3<sup>rd</sup> Global Science Conference on Climate Smart Agriculture, 16–18 March 2015, Montpellier, France**

[http://www.food-security.nl/sites/default/files/case/save\\_the\\_date\\_climate\\_smart\\_agriculture\\_conference.pdf](http://www.food-security.nl/sites/default/files/case/save_the_date_climate_smart_agriculture_conference.pdf)

**7<sup>th</sup> World Water Forum 2015, 12–17 April 2015, Daegu & Gyeongbuk, Republic of Korea**

The 7th World Water Forum will discuss issues including: (1) Application of e-governance, Information and Communication Technology for Water governance, (2) Development of Social and Entrepreneurial Models of wastewater management, (3) Climate Change impacts and implications, and (4) Enhancing Education and Capacity Building.

**European Geosciences Union (EGU) General Assembly, 12–17 April 2015, Vienna, Austria**

The EGU General Assembly 2015 will bring together geoscientists from all over the world to one meeting covering all disciplines of the Earth, planetary and space sciences.

**Global Soil Week 2015, 19–23 April 2015, Berlin, Germany**

The event will bring together global, regional and local forces to raise awareness of the importance of soil for sustainable agricultural development, ecosystem protection and land governance. The major focus will be to put soils and land on the global sustainable development agenda.

**Global Soil Security Symposium, 19–21 May 2015, Texas A&M University, USA**

<https://globalsoilsecurity.tamu.edu>

## Past Events

### Meetings at the IAEA

#### **First Coordination Meeting and Workshop on Strategies and Protocols for Climate Change Impact Assessment in Polar and Mountain Regions for the 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, 2–6 June 2014, Vienna, Austria**

*Technical Officers: Gerd Dercon, Mohammad Zaman, Lionel Mabit and Ammar Wahbi*

Under the new Interregional Technical Cooperation Project INT5153, the First Coordination Meeting and Workshop on Strategies and Protocols for Climate Change Impact Assessment in Polar and Mountain Regions was held from 2 to 6 June 2014 at the IAEA's Headquarters to a) discuss targets of the project and the implementation plan, develop strategies and protocols for investigations in benchmark sites; and b) define roles and responsibilities of participating countries and their respective contributions towards achieving results of the project.

The meeting resulted in a detailed implementation plan and was attended by 43 participants from 16 Member States and four international organizations including FAO/IAEA, IAEA, UNEP, UNU and EC.

Discussions at the meeting focused on achieving the following Target milestones of Year-1:

- Characterization of benchmark sites
- Identification of qualitative and quantitative indicators for impact of climate change on cryosphere and land-water-ecosystem quality.
- Start of compilation of data (targeted for each core benchmark site) based on isotope analysis and complementary techniques
- Agreement on database/platform for data management
- New data sets from benchmarks

The project INT5153 aims to improve the understanding of the impact of climate change on fragile polar and mountainous ecosystems at the local and global scale for their better management and conservation. During four years, the following areas will be developed:

- Specific strategies to minimize adverse effects of climate change, and adapt to, reduced seasonal snow and glacier covered areas on land-water-ecosystem

quality in polar and mountain regions across the world.

- Interregional network of laboratories and institutions capable of assessing climate change impacts on the cryosphere (including glaciers, snow cover and permafrost) and land-water-ecosystem quality using isotopic and nuclear techniques.
- Training of young scientists in the use of isotope and nuclear techniques to assess the impact of climate change on the cryosphere and land-water-ecosystem quality in polar and mountainous ecosystems.
- A platform or database with global access for continuing work and monitoring of impact of climate change on fragile polar and mountainous ecosystems at local and global scale, and communicating findings to policy makers and communities.
- Improved understanding of the effects of climate change disseminated through appropriate publications, policy briefs, and dedicated internet platform.
- Methodologies and protocols for investigations in specific ecosystems and conservations or adaptation measures for agriculture areas.

The project involves scientists from 23 countries (Argentina, Austria, Belgium, Bolivia, Brazil, Canada, Chile, China, Finland, Germany, Japan, Kyrgyzstan, Norway, Peru, Russian Federation, Spain, Sweden, Switzerland, Tajikistan, Tanzania, United Kingdom, United States of America and Uruguay) representing 13 benchmark research sites for assessing the impact of climate change on land-water-ecosystem quality in polar and mountain regions, and six international organizations (FAO/IAEA, IAEA, UNU, UNEP, EC and ICIMOD).

#### **First Research Coordination Meeting (RCM) of the CRP D1.50.16 on Minimizing Farming Impacts on Climate Change by Enhancing Carbon and Nitrogen Capture and Storage in Agro-Ecosystems 3–7 November 2014, Vienna, Austria.**

*Technical Officer: Mohammad Zaman*

The purpose of the first RCM was to develop individual experimental plan of the seven research contract holders in line with the objectives of the CRP and to provide them technical guidelines for the next 18 months. The objective of the CRP is to mitigate nitrous oxide (N<sub>2</sub>O) emission and minimize nitrogen (N) losses from agricultural systems whilst enhancing agricultural productivity and sequestering soil carbon (C). The use of <sup>15</sup>N isotopic technique at natural abundance and enriched levels will help to identify the source of N<sub>2</sub>O production from soil



microbial processes which will lead us to design proper mitigation tools for N<sub>2</sub>O emission. In addition, both <sup>15</sup>N and <sup>13</sup>C at natural abundance levels will be used to unveil C-N interactions to optimize both C and N capture as well as to reduce GHG. The CRP consists of seven research contract holders from Brazil, Chile, China, Costa Rica, Ethiopia, Iran and Pakistan, two agreement holders from Estonia and Spain, and one technical contract holders from Germany. The CRP is expected to continue for five years (2014–2019).



*Participants at the first RCM of CRP D1.50.16 with the DDG NAFA at the IAEA's Headquarters in Vienna*

**Experts Meeting to Finalize Protocols for the Benchmark Sites under the Interregional Technical Cooperation Project INT5153 on Assessing the Impact of Climate Change and its Effects on Soil and Water Resources in Polar and Mountain Regions, 10–13 November 2014, Vienna, Austria**

*Technical Officers: Gerd Dercon, Maria Heiling and Ammar Wahbi*

An experts meeting of the Interregional Technical Cooperation Project INT5153 was held from 10 to 13 November at the IAEA Headquarters to finalize protocols for addressing the drivers of scientific investigations in benchmark sites and to prepare common research protocols (sampling and analytical protocols).

Three protocols were targeted to identify specific research questions:

Protocol A:

“What is the impact of climate change on soil and soil organic carbon in polar and mountainous regions?”, with major emphasis on temperature sensitivity of soil organic carbon, quality, stability along topo-sequences in mountain regions and the active layer vs permafrost in polar regions, as a base for the better understanding of positive feedback mechanisms.

Protocol B:

“What is the impact of climate change on (i) water availability and (ii) soil-sediment redistribution processes in polar & mountainous regions?”, with major emphasis for instance on: (soil) water availability monitoring, biomass production due to induced drought or increased water availability, soil-sediment redistribution processes at field-slope-catchment level in mountain (intervened and not-intervened areas) and polar regions.

Protocol C:

“How is the cryosphere affected by long-term and current climate change?”, with major emphasis for instance on: glacier area/volume, soil temperature in topo-sequences at different depths (linked with question 1), glacier mass balance, sediment cores and dating for paleo-climatic assessment

The meeting consisted of scientific presentations, discussions of the draft protocols through working groups and plenary sessions. These protocols will be published together with INT5153 project booklet, after full validation and use in the project.

The meeting resulted in developing detail protocols and was attended by 14 participants from nine Member States.



## Consultants Meeting on Soil Fertility and Quality Enhancement Using Cover Crops and Strategic Fertilizer and Animal Manure Applications: Role of Nuclear Techniques, 17–20 November 2014, Vienna, Austria

*Technical Officers: Mohammad Zaman and Lee Heng*

A consultant meeting was held from 17 to 20 November at the IAEA's headquarters in Vienna to develop a new Coordinated Research Project (CRP). Five consultants, one each from Canada, the Netherlands, Italy, China and India attended the meeting. The CM suggests changing the title of CRP to "Enhancing Soil Productivity through Conservation Agriculture in Cereal-based Cropping Systems under a Changing Climate: the Role of Nuclear Techniques". The proposed CRP is aimed to maximize crop productivity, resource use efficiency and profitability through sustainable cropping intensification following the principles of conservation agriculture. This will be done by a number of Member States in Asia to establish comprehensive experiments to test the effects of crop intensification, tillage systems and ground cover management on crop productivity, resource use efficiency, and resilience to climate change. Nuclear and isotopic techniques will be used to quantify nutrient and water use efficiencies in different cropping systems under different management practices.



*Participants at the consultant meeting on developing new CRP at the IAEA's Headquarters in Vienna*

## Duty Travel

### Nepal: To facilitate the Regional IAEA/RCA Workshop on the Establishment and Maintenance of the Database of Compound Specific Stable Isotopes (CSSI) and Fallout Radionuclides (FRNs) for the Asia/Pacific Region (RAS5055), 8–12 September 2014, Kathmandu, Nepal

*Technical Officer: Mohammad Zaman*

The Technical Officer (TO), together with Mr Long Nguyen (the former Section Head of SWMCN) and the lead country coordinator, Mr Henk Heijnis, organized the five-day regional workshop from 8 to 12 September 2014, in Kathmandu, Nepal, to establish and maintain a regional data base for CSSI and FRNs. The workshop was attended by 19 participants from Australia, Bangladesh, China, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, South Korea, Sri Lanka, and Vietnam. The workshop was opened by the Secretary, Ministry of Science, Technology and Environment, Nepal. The TO and Mr Nguyen described the objectives of the meeting, the need for an effective data base on CSSI and FRNs, and discussed the achievements made since previous meeting held in Vietnam. Participants from each Member States presented their project activities, CSSI and FRN data generated, and described local and regional networking each Member State developed under the RAS5055 project. A template for data base management was developed and then discussed among all participants. The TO also had meetings with individual counterpart to discuss field activities and future needs within the project framework.

### China: To organize the Second Research Coordination Meeting (RCM) of the CRP D1.20.13 on Landscape Salinity and Water Management for Improving Agricultural Water Productivity, 8–12 September 2014, Beijing, China

*Technical Officer: Lee Heng*

The technical officer travelled to Beijing, China for the second RCM of the CRP D1.20.13 on Landscape Salinity and Water Management for Improving Agricultural Productivity. The CRP aims to: a) identify ways to improve crop productivity and sustainability through water and salinity management; b) define approaches and technologies to assess and monitor soil water content and salinity at field and area-wide scales; and c) reduce the impacts of climate change and variability on the widespread increase in landscape water and soil salinity on food production. The meeting was hosted by the China Agricultural University (CAU) in Beijing, China, with Mr Li Baoguo (Professor of Soil Science) and Mr Shi

ChianJu as the local organizers. Counterparts from Bangladesh, China (Chinese Academy of Agricultural Sciences [CAAS] in addition to CAU), Iran, Pakistan and Vietnam (2), Spain and USA participated in this meeting.

The five-day meeting discussed the results obtained since the first RCM in July 2013, with participants presented their individual results. The Technical Officer presented the objectives of the CRP and the work plan developed during the first RCM. The CRP covers a wide range of topics in landscape salinity and water management, from isotopic applications dealing with seawater inclusions in the Red River and Mekong Delta in Vietnam for rice production, to the use of soil moisture neutron probe for monitoring saline irrigation water for salt-tolerant barley, rice and wheat crops. Data on landscape soil water contents measured by cosmic ray probe and the deep profile soil water content and bulk electrical conductivity using a new profile TDR method of Waveguide-On-Access-Tube (WOAT) system were presented. A field demonstration on the WOAT sensor was carried out in the experimental plot of CAU followed by a short visit to the CAU soil physics laboratories. A short training on the use of HYDRUS 1-D model for simulating soil water and salt movement and balances was also conducted.

#### **FAO: To participate in Committee on Agriculture (COAG) exhibit, 26 September – 2 October 2014, Rome, Italy**

*Technical officer: Ammar Wahbi*

Mr Ammar Wahbi travelled to FAO headquarters in Rome, Italy from 26 September to 2 October 2014 to participate in the COAG exhibition organized by the FAO. COAG is one of the Governing Bodies of the FAO, and one of its main functions is to review specific matters relating to agriculture, food and nutrition.

The objectives of the participation were:

1. To provide information to Member States and FAO colleagues on the use of isotopic techniques in soil, water and nutrient management and the work carried out by the Joint FAO/IAEA Division (NAFA).
2. To demonstrate a vacuum distillation tool developed by the Soil and Water Management and Crop Nutrition Laboratory in Seibersdorf.

During the exhibition, delegates from Member States and FAO staff showed keen interest in our work using isotope techniques in soil-water management, crop nutrition and land degradation.

#### **Oman: To review project progress, revise work plan and develop new activities for 2014-2015 for the technical cooperation (TC) project OMA5001 on Producing Forage Crops Tolerant to Salinity and Drought, 26 September – 2 October, 2014, Muscat, Oman**

*Technical Officer: Karuppan Sakadevan*

The Technical Officer (TO) visited the Directorate General of Agricultural & Livestock Research, Ministry of Agriculture, Muscat, Oman to (1) review project progress, (2) support the counterpart for analyzing results of salinity and drought studies carried out for the selection of alfalfa crop accessions, and (3) provide technical advice on the implementation of field studies to assess water and nutrient use efficiencies under alfalfa. The Technical Cooperation Project OMA5001 was started in January 2012. The main objective of the project is to improve the production of forage crop (alfalfa) tolerant to salinity and drought through appropriate soil, water and crop management practices. Being one of the most water scarce and salt-affected countries in the Arabian Peninsula, water management is a major challenge to agricultural production in Oman.

The TO met the project counterpart Mr Salim Abdullah Rashid Alrasbi, Senior Soil and Crop Scientist, Directorate General of Agricultural and Livestock Research and other team members of the project. During this meeting, the project team and the TO discussed project achievements in the last two years and future work plan. This includes glasshouse studies for selecting alfalfa accessions for salinity and drought and human resource development in the area of soil, water and crop management.

The TO gave two presentations to the staff at the institution on the application of isotopic and nuclear techniques for assessing soil, water, crop and nutrient interactions to provide project participants further skills, knowledge and understanding on the subject.

The TO, project counterpart and participants developed work plan for 2015. The field studies to evaluate alfalfa accessions tolerant to salinity and drought will be implemented in November 2014 and will continue until May 2015.

#### **Regional Training Course on Conservation Agriculture and How Fallout Radionuclide Based Techniques Can Support its Effectiveness to Protect Soil and Water Resources, 6–10 October 2014, Harare, Zimbabwe**

*Technical Officer: Lionel Mabit*

The third regional training course of the Regional Technical Cooperation Project RAF5063 was organized in Harare, Zimbabwe, from 6 to 10 October 2014.

The purpose of this one-week regional training course was to train participants using conservation agriculture to ensure sustainable agricultural practices, a key concept for the optimization of soil and water resources in Africa. The use of nuclear techniques (i.e. FRNs), with a focus on <sup>137</sup>Cs and to some extent <sup>7</sup>Be was presented as a package for supporting long-or short-term decision making tool



for effective conservation agricultural practices. Twenty two participants from Africa (i.e. Algeria, Benin, Cote d'Ivoire, Madagascar, Mali, Morocco, Senegal, Tunisia, Uganda and Zimbabwe) attended this training course.

Dr Emil Fulajtar (Soil Science and Conservation Research Institute, National Agricultural and Food Center, Bratislava, Slovakia) and Dr Rachid Moussadek (Institut National de la Recherche Agronomique (INRA), Rabat, Morocco), were the lecturers.

Dr Chikwari Emmanuel from the Chemistry and Soil Research Institute, Department of Agriculture Research and Extension Services (AREX), Harare, Zimbabwe, was the local coordinator and course director.

### **Regional Group Fellowship Training on Biosaline Agriculture under RAS5068 on Developing Effective Practices for Combating Desertification (ARASIA), 12–23 October 2014, Dubai, UAE**

*Technical Officer: Mohammad Zaman*

The two-week training course was organized by the IAEA in cooperation with the Government of the United Arab Emirates through the International Center for Biosaline Agriculture, Dubai, United Arab Emirates, under the Regional Project RAS5068 on Developing Effective Practices for Combating Desertification (ARASIA) using both isotopic and conventional techniques. The aim of the training was to provide advanced knowledge and skills on the understanding of salinity, field diagnostics of soil salinity (visual observations as well as laboratory diagnostic methodology), salinity management, nutrients and water management, and the use of different irrigation systems. The training was attended by 15 scientists from ARASIA (Iraq, Jordan, Lebanon, Oman, Syria, Yemen, and UAE).

### **Burundi: National Training Course on Analytical Chemistry—Analysis of Pesticides Residues, 12–19 October 2014**

*Technical Officer: Ammar Wahbi*

A one-week training course was held in Bujumbura, Burundi from 12 to 19 October 2014 to train staff members of the ISABU (Laboratoire de Chimie Agricole) to analyze pesticides residues by gas-chromatograph-MS, Dr Albert Nguyen Van Nhien and Dr Rajbir Sangwan from the Université de Picardie Jules Verne, France, provided the training. The aim of this training was to enhance the analytical skills of the laboratory staff of the ISABU to be awarded ISO 17025 accreditation for analysis of pesticide residues in fruits, vegetables and soil. The course covered sampling, chemical analysis, data generation, and interpretation and legislation.

### **Uruguay: To organize the Regional Training Course on the Application of Isotopic and Nuclear Techniques to Improve the Capacity of Professional and Technical Officers for Assessing Biological Nitrogen Fixation and Nitrogen Use Efficiency of Different Cropping Systems, Land and Crop Management Practices, 13–17 October 2014, Montevideo, Uruguay.**

*Technical Officer: Karuppan Sakadevan*

The Technical Officer (TO) organized the regional training course with Mr Carlos Perdomo (Facultad de Agronomía; Universidad de la República, Uruguay), Mr Takashi Muraoka (Universidade de Sao Paulo, Brazil) and Mr Patrick Inglett (University of Florida, USA). The training course was carried out as part of the regional technical cooperation project RLA5065 on Improving Agricultural Production Systems through Resource Use Efficiency (ARCAL CXXXVI). Twenty one participants from ten countries attended the training. The training was carried out over two weeks (6–17 October 2014). During the first week, the training focused on nutrient cycling, soil fertility and plant nutrition. During the second week, the TO provided training on the application of nitrogen-15 stable isotopic technique for the assessment of biological nitrogen fixation (BNF). This included: (i) BNF assessment in different legume based cropping systems; (ii) case studies; and (iii) group exercises.

As part of the training, participants were provided with opportunities to be involved in group activities to solve practical exercises in BNF and nutrient use efficiency. The data for these practical exercises was collected from different agro-eco regions and cropping systems. At the end of the training, a written test was carried out. The test results showed that three scored more than 80% and three with 100%. In general, the training course provided opportunities for professional scientists from National Agricultural Research Systems and Universities to develop and enhance skills, knowledge and understanding of  $^{15}\text{N}$  for BNF and nitrogen use efficiency.





**Chile: To develop field experimental design for measuring greenhouse gases of the Technical Cooperation (TC) project CH 5050, 13–17 October 2014, Santiago, Chile**

*Technical Officer: Mohammad Zaman*

The purpose this travel was to meet the project team for providing technical assistance in setting up field trials to measure greenhouse gases including nitrous oxide (N<sub>2</sub>O), ammonia (NH<sub>3</sub>), carbon di oxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) as influenced by land management practices. Technical Officer (TO) provided an update on the project objectives and different activities for 2014–15 to Ms Maria Adriana Nario, Mr Gabriel Antonio Cartes Sanchez and Mr Jaime Salas Kurte, Executive Director of Chilean Nuclear Commission. A presentation on using conventional and nuclear techniques to quantify GHG, identifying their sources in soil and applying possible mitigation options was made by the TO to the counterpart and her ten research team members, followed by detailed discussion on protocol for GHG measurements, data collection, experimental design, and visit to two field sites in Santiago.

**Kuwait: To provide technical assistance to the project design for K UW2014002 on the Application of Nuclear Techniques for Improving Production and Water Use Efficiency of Some Forage Crops for TC cycle 2016–2017, 19–23 October 2014, Safat, Kuwait**

*Technical officer: Ammar Wahbi*

Ammar Wahbi travelled to Kuwait from 19 to 23 October 2014 to provide technical assistance to the counterpart on the design of a TC project K UW2014002 on the Application of Nuclear Techniques for Improving Production and Water Use Efficiency of Some Forage Crops planned for TC cycle 2016–2017.

Kuwait faces the challenge of managing its water resources in a sustainable way. To meet this challenge, Kuwait Institute for Scientific Research (KISR) aims to focus on improving water use efficiency using nuclear techniques. In the new TC cycle of 2016–17, discussions focused on designing of the new project K UW2014002. The Technical Officer (TO) made a presentation on using nuclear and conventional techniques to study a range of soil and water management issues for sustainable agriculture. The TO also had meetings with Dr Nader Al-Awadi (NLO), Dr Habibah Al-Menaie (Counterpart) and other staff members involved in the project, visited a laboratory and field experiments at KISR.

**Egypt: To participate in the Regional Training Course of RAF5071 project on Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigated Systems for Increased Food Production and Income Generation, 20–28 October 2014, Cairo, Egypt**

*Technical Officer: Lee Heng*

Ms Lee Heng travelled to Cairo, Egypt to attend the first two days of the Regional Training Course on Photo-Irrigation and Fertilizer Management, and Soil and Plant Sampling for Evapotranspiration Study. This regional training course was hosted by the Egyptian Atomic Energy Authority (EAEA), in Cairo, and was attended by participants from RAF5071 project including Algeria, Benin, Botswana, Cameroon, Cote d'Ivoire, Egypt, Ethiopia, Ghana, Kenya, Mauritius, Mali, Morocco, Niger, Nigeria, Senegal, Seychelles, Sudan, Uganda, United Republic of Tanzania and Zimbabwe. The purpose of the course was to introduce the participants to: i) innovative photo-irrigation technology and the use of solar systems for water pumping in association with drip irrigation design and installation; ii) the use of N-15 isotopic technique in nitrogen management under fertigation study; iii) concepts and methods of evapotranspiration estimation, and iv) soil and plant sampling for oxygen-18 and deuterium isotopic signature for evapotranspiration study.

The Technical Officer gave a presentation on the use of nuclear and isotopic techniques for irrigation and fertilizer management. She met and discussed with Prof Dr Atef Abdel-Fattah, the Chairman of EAEA, on current and future IAEA Technical Cooperation projects. Dr Abdel-Fattah emphasized the severity of water scarcity and the importance of irrigation in food security for Egypt. A field trip to the Nuclear Research Center (NRC) located in Inshas, north of Cairo, was organized to visit the solar system installation and its operation for water pumping. A large pilot-study drip irrigation system and soil moisture measurement using nuclear techniques were also demonstrated.

## **Regional Training on Separating Evapotranspiration (ET) into Evaporation (E) and Transpiration (T) Using Isotopic and Conventional Techniques under RAS5068 on Developing Effective Practices for Combating Desertification (ARASIA), 2–6 November 2014, Dubai, UAE**

*Technical Officer: Mohammad Zaman*

This one week training course consisted of lectures, discussions of case studies and field experiments on using nuclear techniques of  $^2\text{H}$  and  $^{18}\text{O}$  for separating evapotranspiration (ET) water losses into evaporation (E) and transpiration (T) through the novel Cavity Ring Down Spectroscopy (CRDS) Analyzer. The training was attended by 15 fellows from ARASIA countries and also focused on water budget and introduction of the best farm management practices to enhance water use efficiency of salt affected land under different irrigation systems.



*Quantifying water losses through nuclear techniques of  $^2\text{H}$  and  $^{18}\text{O}$  in the field using CRDS Analyzer*

## **Kenya: To organize the Second RCM of the CRP D1.20.12 on Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems, 17–21 November 2014, Nairobi, Kenya**

*Technical Officer: Karuppan Sakadevan*

The Technical Officer (TO) travelled to Nairobi, Kenya to organize the second RCM of the CRP D1.20.12 to review progress made for the CRP since July 2013, identify project constraints and gaps, and to develop work plan for the next three years. The meeting was attended by research contract holders from Argentina, Brazil (two participants), China, India, Indonesia, Kenya, Uganda and Uruguay. Four additional participants from Kenyan Agriculture and Livestock Research Organization (KALRO) also attended the meeting. The local organizer for the meeting was KALRO. The meeting was officially opened by Regional Director of KALRO based in Katumani.

The TO provided an introduction on sustainable intensification of food production through climate smart agriculture and the role of integrated crop-livestock production for such intensification. He reiterated the overall and specific objectives of the CRP and the work plan and activities developed for all national projects during the first RCM. The first two days of the meeting focused on the presentation of data and information obtained from field studies carried out by counterparts to evaluate the impact of different soil, crop and livestock management practices on crop and livestock production, soil characteristics, greenhouse gas emissions and soil erosion. Field visits to two farmers' field and KALRO research stations were organized on day-3 to provide participants on Kenya's approach to agricultural intensification using crop rotation, livestock and legumes in agricultural production systems.

## **Cambodia: To review project progress and revise work plan for the Technical Cooperation (TC) project of KAM5001 on Improving Soil Fertility and Crop Management Strategies in Diversified Rice-Based Farming Systems, 1–3 December 2014, Phnom Penh, Cambodia**

*Technical Officer: Lee Heng*

The purpose of the travel was to meet the project team consists of the General Directorate of Agriculture (GDA) and the Cambodia Agricultural Research and Development Institute (CARDI), and to review and evaluate project progress, discuss challenges faced and identify key activities to be implemented. The Technical Officer (TO) visited the laboratories of both institutes and field sites where experiments of rice production are being conducted. The counterparts of both institutes presented the work done and results to-date. The work plans of the project were discussed and updated. The TO also assisted in the training workshop organized by a visiting soil water expert in the interpretation of soil water data for soil water management and irrigation scheduling.

The TO visited the Cambodia Development Research Institute (CDRI) and gave a presentation on the use of nuclear and isotopic techniques in soil and water management to the staff and visitors at CDRI. Counterparts of CARDI and GDA also attended this presentation. A meeting after the presentation was held to discuss potential collaboration between CDRI, GDA and CARDI on research, knowledge dissemination and capacity building. The TO met the new Executive Director of CDRI, Dr Rethy Chhem who previously worked as Director at the IAEA Division of Human Health.

## Status of Coordinated Research Projects (CRPs)

### Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-Based Cropping Systems in Sub-Saharan Africa (D1.50.12)

*Technical Officers: Mohammad Zaman and Gerd Dercon*

This Coordinated Research Project (CRP) is now entering its third year of implementation. The overall objective of this CRP is to improve the livelihoods of farmers with low socio-economic development and rural communities in a region that is dominated by a savannah ecosystem in its natural state. Fifteen participants, with seven research contract holders from Benin, Kenya, Madagascar, Mauritius, Mozambique, Pakistan and Zimbabwe, three technical contract holders from China, the Czech Republic and the United Kingdom, and five agreement holders from Austria, Belgium, Kenya, New Zealand and United States of America attended the first Research Coordination Meeting (RCM) at the IAEA's headquarters in Vienna, Austria, from 30 January to 3 February 2012. The second RCM was held in Antananarivo, Madagascar, from 14 to 18 October 2013 to review each participant's project work plan and research progress, to ensure the accomplishment of the CRP objective. All research contract holders completed their two years of field work and their progress reports are being evaluated for renewal contracts. The third RCM will be held in the second quarter of 2015 in Harare, Zimbabwe. The mid-term review was completed in November 2014. The results so far indicated that applying mulch for two years under Sub-Saharan soil and climate conditions have the potential to improve soil quality, retain nutrients and moisture, and stimulate microbial activity which can then lead to increased crop productivity. However, low soil fertility due to subsistence farming and continuous nutrient mining, nutrients imbalance and toxicity due to low soil pH, residue removal, mono-culture cropping system and more importantly the low quantity (less than 1 ton ha<sup>-1</sup>) of biomass production and quality (high C:N) have been identified as the major factors affecting mulch efficacy. Therefore enhancing soil fertility, correcting nutrient imbalance and toxicity through regular lime application, practicing mixed cropping rotation are the first step to produce enough biomass to be applied as mulch. In addition, enhancing biological N fixation through rhizobium inoculum to minimize dependence on costly chemical fertilizers, strategic use of manure and chemical fertilizers are also needed to increase C sequestration as well as improving crop productivity.

The SWMCN Laboratory team has initiated a series of research activities to support this CRP. A long term field

experiment of over 15 years at Gross Enzersdorf (BOKU Research Station, 8 km east of Vienna) was selected to assess carbon sequestration and the stability of organic carbon using <sup>13</sup>C and <sup>15</sup>N techniques. Two additional experiments were also initiated to validate <sup>13</sup>C and <sup>15</sup>N techniques for assessing carbon sequestration in: (i) the Austrian Agency for Health and Food Safety (AGES), west of Vienna, and (ii) greenhouse column studies within the SWMCN Laboratory. Soil samples collected from three long-term field trials in Belgium, Kenya and China have been analyzed for <sup>13</sup>C and <sup>15</sup>N in the SWMCN Laboratory. The two growth chambers installed by SWMCN Laboratory team in 2013 are being used for labelling plant materials with <sup>13</sup>C to better understand soil organic carbon dynamics under a changing climate and to support research activities for improving climate-smart agriculture in Member States.

### Approaches to Improvement of Crop Genotypes with High Water and Nutrient Use Efficiency for Water Scarce Environments (D1.50.13)

*Technical Officers: Karuppan Sakadevan and Pierre Lagoda*

The CRP was started in December 2011 and the first RCM was held in Vienna, Austria from 12 to 16 December 2011. The overall objective of this CRP is to increase crop productivity and food security by developing improved crop varieties and soil, water, nutrient and crop management technologies and making them available to farmers, to improve cropping systems resilient to biotic and abiotic stresses in water scarce environment. The CRP is in its third year of implementation. Ten research contract holders (Bangladesh, China, Kenya, Malaysia (two participants), Mexico, Pakistan, Peru, Uganda and Vietnam), one technical contract holder (Peru) and one agreement holder (South Africa) participated in the meeting. The specific objectives are to:

- increase the productivity of crop varieties tolerant to environmental stresses under existing soil and climatic conditions, and
- enhance nitrogen and water use efficiencies of crops tolerant to environmental stresses through best practice soil, water, crop and fertilizer management practices.

The second RCM was held in Malaysia from 24 to 28 June 2013 and all participants attended the meeting. Key output from second RCM include:



- (1) Results of field studies evaluating improved varieties of rice, ground nut, mung bean and sesame under saline conditions in Bangladesh.
- (2) Yield, fertilizer use and information on economic benefits of ratooning rice cultivar Jiafuzhan was evaluated in Fujian Province, China.
- (3) Field studies established to evaluate sorghum varieties tolerance to acidity and drought stress in two locations in Indonesia and soil and plant data have been collected for further analysis.
- (4) In Kenya, four pre released varieties of English Potato were evaluated in four different locations for their response to the application of manure at different rates.
- (5) Information on yield, water and nutrient use efficiencies of three varieties and one advanced mutant line of barley, and five improved genotypes of quinoa suitable for high altitude which were evaluated in three different locations was provided for Peru.
- (6) Plant morphological characteristics and water and nutrient use for two improved mutant lines of rice adapted to aerobic conditions were evaluated in three locations in Malaysia.
- (7) Preliminary soil characteristics completed for two different agro-eco systems in Mexico and thirty two improved genotypes of Amaranthus were evaluated for assessing plant morphological characteristics from which varieties will be selected and evaluated for water and nutrient use efficiencies.
- (8) Preliminary field studies at two agro-ecological regions in Pakistan for quantifying wheat yield, nitrogen uptake and nitrogen use efficiency of improved varieties of wheat which has been developed for improved water and nutrient use efficiencies.
- (9) Screening for mutant lines tolerant to UG99 and drought have been carried out for wheat in South Africa.
- (10) Five different genotypes of wheat were evaluated for yield response to different rates of fertilizer application in five locations in Uganda.
- (11) The effect of different levels of fertilizer application on yield and nutrient use for five soybean varieties was evaluated in three locations under two different cropping seasons in Vietnam.

The research contracts for all projects have been renewed based on project progress reports and renewal proposals in October 2014. Data on yield, nutrient uptake and soil water have been collected from field studies involving improved crop varieties of rice, wheat, barley, quinoa, potato, amaranthus, soybean and groundnut. The data is currently being analysed and will be presented by counterparts during the third RCM, which will be held in Mexico from 9 to 13 March 2015.

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

*Technical Officers: Gerd Dercon and Lee Heng*

This CRP aims to develop and assess systems of innovative data collection, management and geo-visualization platforms that can be used for both routine monitoring and also in emergency response to nuclear and radiological incidents that could affect food and agriculture. Through this CRP network, institutions and governments involved in nuclear emergency response for food and agriculture will be strengthened. The CRP will also assist in compiling Standard Operating Protocols (SOPs) for actions required in case of a nuclear emergency affecting food and agriculture, as well as sampling analytical SOPs for activity measurements. The objectives of the CRP are:

- (1) To identify sampling and analytical strategies in nuclear emergencies affecting food and agriculture
- (2) To determine how online geo-visualization tools can influence emergency response strategies, approaches to learning from nuclear accidents, and end-users ability to generate future short-term and long-term scenarios about the impact of nuclear accidents on food and agriculture
- (3) To ensure that systems use common or standardized protocols that can be shared across different software platforms
- (4) To produce low-cost computer-based platforms that are robust and can be used both routinely to monitor everyday sampling as well as in nuclear emergency situations
- (5) To produce decision support tools that will help rapid analysis of the situation in radionuclide contamination of food stuffs.

The first RCM was held from 16 to 20 December 2013 in Vienna. Four research contract holders from China, Morocco, the Russian Federation and Ukraine, two technical contract holders from France and Macedonia and three agreement holders from Japan (2) and India attended the RCM.

To date, a detailed draft of the first protocol for data collection, management and visualization for the emergency phase (food restriction phase) has been developed by the technical contract holders in close collaboration with IAEA experts. The protocol aims to optimize the response time of Member States regarding decision making on food restrictions and food safety communication strategies in case of nuclear or radiological emergencies. To make rapid, timely decisions whether food restrictions need to be enforced, simple procedures/protocols for collecting samples, managing minimal sample's attributes and minimal sample's laboratory result attributes and geo-visualization for effective emergency communication are needed.



Based on the above protocol, an information system linking data management and visualization is currently being developed and validated by the CRP participants. This system will be developed in such a way that it can be linked with existing data exchange platforms (compatibility) of the IAEA, such as the Unified System for Information Exchange on Incidents and Emergencies (USIE) and International Radiation Monitoring Information System (IRMIS) managed by IEC. The system will allow international organizations to follow up on the nuclear emergency response for food safety for advice purposes on food restrictions when requested at national and international level. The CRP has also initiated the formulation of policy guidelines on nuclear emergency response in food and agriculture for competent authorities of IAEA-FAO Member States. Both the proposed Information System and Policy Guidelines will help Member States to be better prepared for nuclear emergencies affecting food and agriculture.

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

*Technical Officers: Mohammad Zaman and Lee Heng*

The objective of this CRP is to mitigate nitrous oxide emissions (N<sub>2</sub>O) and minimize nitrogen (N) losses from agricultural systems whilst enhancing agricultural productivity and sequestering soil carbon (C). This CRP was formulated on the basis of the recommendations of a consultants' meeting held at IAEA headquarters, Vienna from 7 to 11 April 2014. The first Research Coordination Meeting (RCM) was held in Vienna, Austria from 3 to 7 November 2014 to review individual experimental plan of the research contractors in line with the objectives of the CRP and to provide them technical guidelines for the next 18 months. Ten participants, with seven research contract holders from Brazil, Chile, China, Costa Rica, Ethiopia and Pakistan, two agreement holders from Estonia and Spain, and one technical contract holder from Germany attended the RCM. The CRP is expected to continue for five years (2014–2019).

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

*Technical Officers: Karuppan Sakadevan*

The project was started in July 2013 and the first RCM was held in Vienna, Austria from 22 to 26 July 2013 and seven research contract and two agreement holders participated in the meeting. The overall objective of the CRP is to enhance food security and rural livelihoods through improving resource use efficiency and sustainability of integrated crop-livestock systems under a

changing climate. The specific objectives are to: (i) optimize water and nutrient use efficiency in integrated crop-livestock production systems, (ii) identify the potential for improving soil quality and fertility in integrated crop-livestock systems, (iii) assess the influence of crop-livestock systems on greenhouse gas (GHG) emissions, soil carbon sequestration and water quality, (iv) assess the socio-economic and environmental benefits of crop-livestock systems, and (v) develop soil, water and nutrient management options in integrated crop-livestock systems for potential adoption by farmers.

Nine research contract holders from Argentina, Brazil (2), China, India, Indonesia, Kenya, Uganda and Uruguay, and three agreement holders from France, International Institute for Tropical Agriculture in Nigeria and the United States of America, participated in this project. Since the first RCM all participants have established field studies and preliminary information has been collected, particularly on physical and chemical characteristics of sites and agro-climatic conditions. The first renewal for all research contracts have been completed based on the research progress. The second RCM was held in Nairobi, Kenya from 17 to 21 November 2014. All participants presented data and information collected from field studies carried out to evaluate different soil, crop and livestock management practices on crop and livestock production, soil characteristics, greenhouse gas emissions and soil erosion. These include:

- (1) Crop and livestock production and soil fertility (nitrogen, phosphorus, pH and organic carbon) of no-tillage summer crops and integrated crop-livestock system (ICLS) with a history of seven years and involving same productions system were assessed and compared for two adjacent farms located in Argentina's wet pampas.
- (2) The effect of grazing intensity and method on livestock and crop (soybean and maize) performance in small holder crop-livestock system under continuous and rotational stocking methods, and the potential of integrated crop-livestock systems for minimizing greenhouse gas (methane and nitrous oxide) emissions were assessed for Rio Grande do Sul and Parana States in Brazil.
- (3) The effect of different types of small holder crop-livestock production systems including wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.) are major crops in the rotation with soybean (*Glycine max* (L.) Merr.), Rape (*Brassica Napus* L.), sweet potato (*Ipomoea batatas* L.) and sheep the main livestock) on soil erosion, water and nutrient use efficiency were assessed in the Nanwang Farm, Pucheng, Shaanxi, China.
- (4) The impact of integrated crop-livestock systems that involved rice and two forage crops (a legume and grass) were assessed for crop and livestock

production and soil quality in four different agro-eco regions in southern state of Tamil Nadu, India.

- (5) Three agricultural rotation practices that involve soybean/maize, soybean/maize fed with manure and maize/gliciridia legume fed with manure were assessed for yield, nutrient content and soil characteristics in integrated crop-livestock production systems in Bogor, Indonesia.
- (6) Field trials established in Machakos County in eastern Kenya to select the best crop rotation among cereal crop (maize), legume food crop (cowpea) and a forage legume for crop-livestock integration.
- (7) Soil characteristics (pH, Soil Organic Matter, nitrogen, potassium, phosphorous and texture), water quality (pH, DO, EC, Turbidity, True color, Apparent color, Alkalinity, TSS, Turbidity, Ca, Mg, Cl, NO<sub>2</sub>, NO<sub>3</sub>) and feed quality assessments were carried out for two parishes at the Mukona district, northeast of Kampala, Uganda.
- (8) Field studies established to assess agronomic (two tillage and two rotation practices) and environmental effects of integrated crop-livestock production systems under different tillage and crop rotation practices in Uruguay.

salinity at field and area-wide scales, c) reduce the impacts of climate change and variability on the widespread increase in landscape.

The second RCM was held in Beijing, China from 8 to 12 September 2014, where results obtained since the first RCM were presented. The CRP covers a wide range of topics in landscape salinity and water management, from isotopic applications dealing with seawater inclusions in the Red River and Mekong Delta in Vietnam for rice production, to the use of soil moisture neutron probe for monitoring saline irrigation water for salt-tolerant barley, rice and wheat crops. The results on landscape soil water contents measured by cosmic ray probe and the WOAT (Waveguide-On-Access-Tube [WOAT] system) were also presented. A demonstration on the WOAT sensor was carried out in shown during the RCM in China. In addition, a short training on the use of HYDRUS 1-D model for simulating soil water and salt movement and balances was also conducted.

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

*Technical Officers: Lee Heng and Karuppan Sakadevan*

This project is in its second year of implementation. The project was started in July 2013, with the first RCM held from 15 to 19 July 2013 in Vienna, Austria and seven research contract holders from Bangladesh, China (2), Iran, Pakistan and Vietnam (2), two agreement holders from Spain and USA, and two technical contract holders from Czech Republic and USA, participating in the project. The CRP aims to: a) identify ways to improve crop productivity and sustainability through water and salinity management, b) define approaches and technologies to assess and monitor soil water content and

# Activities of the Soil and Water Management and Crop Nutrition Laboratory, Seibersdorf

## FAO/IAEA Interregional Training Course on the Use of Fallout Radionuclides and Compound-Specific Stable Isotope Techniques for Precision Soil Conservation, 6–31 October 2014, Seibersdorf, Austria

Lionel Mabit<sup>1</sup>, Gerd Dercon<sup>1</sup>, Thomas Bauer<sup>2</sup>, William Blake<sup>3</sup>, Ruby Cueto<sup>4</sup>, Alexander Eder<sup>2,5</sup>, Max Gibbs<sup>6</sup>, César A. Quilodrán Casas<sup>7</sup>, Christian Resch<sup>1</sup>, Tim Stott<sup>8</sup>, Arsenio Toloza<sup>1</sup>, Kristof Van Oost<sup>9</sup>, Georg Weltin<sup>1</sup>

<sup>1</sup>Soil and Water Management & Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Seibersdorf, Austria

<sup>2</sup>Federal Agency for Water Management, Institute for Land and Water Management Research, Petzenkirchen, Austria

<sup>3</sup>School of Geography, Earth and Environmental Sciences, University of Plymouth, Plymouth, United Kingdom

<sup>4</sup>Seibersdorf Facilities Management Section, Division of General Services, Department of Management, Seibersdorf, Austria

<sup>5</sup>Institute of Hydraulic Engineering and Water Resources Management, Vienna University of Technology, Vienna, Austria

<sup>6</sup>National Institute of Water & Atmospheric Research (NIWA), Hamilton, New Zealand

<sup>7</sup>Universidad Austral de Chile, Valdivia, Chile

<sup>8</sup>Liverpool John Moores University, Liverpool, United Kingdom

<sup>9</sup>Catholic University of Louvain, Earth and Life Institute, Louvain-la-Neuve, Belgium

A one-month FAO/IAEA Interregional Training Course on the Use of Fallout Radionuclides (FRNs) and Compound-Specific Stable Isotope (CSSI) Techniques for Precision Soil Conservation was held at the Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) from 6 to 31 October 2014 at Seibersdorf, Austria.

The main focus of the training was to provide the fellows advanced knowledge in using independently and conjointly FRNs and CSSI techniques for investigating soil degradation and assessing soil conservation effectiveness.

This advanced training course was intended for participants from four different continents (i.e. Africa,

Europe, Latin America and Asia) with academic background in soil science, environmental chemistry, agricultural or related sciences, and demonstrated practical experience in soil erosion or land degradation studies using FRNs and/or CSSI techniques.

Twenty two fellows from 16 Member States (Brazil, Chile, China, Cote d'Ivoire, Cuba, Madagascar, Mexico, Morocco, Peru, Russian Federation, Tajikistan, Thailand, Tunisia, Uruguay, Venezuela and Vietnam) participated in the training.

The course focused on the latest developments of the use of FRNs (weeks 1 and 2; with the lectures contribution from the SWMCN team and two external lecturers i.e. Dr Quilodrán Casas and Dr Blake) and CSSI techniques (week 3; with the contribution of one external lecturer i.e. Dr Gibbs), with emphasis on their integrated use at watershed level, and advanced FRN data modelling, analysis, mapping and interpretation (week 4; with the contribution of one external lecturer i.e. Dr Van Oost).

Through this training, the integrated and combined use of FRNs and CSSI techniques was introduced for the first time on a world wide scale. This will allow improving the cost-effectiveness of soil conservation at catchment level, and placing soil erosion control measures where most needed (precision soil conservation).

Through such training course, scientists will further strengthen their national and regional networks which fit well as preparatory activity of the International Year of the Soil 2015.

The training was funded by the IAEA Technical Cooperation Department through one interregional Technical Cooperation Project (TCP) (i.e. INT5153 on Assessing the Impact of Climate Change and its Effects on Soil and Water Resources on Polar and Mountainous Regions), three regional TCPs (i.e. RAF5063 on Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security; RAS5055 on 'Improving Soil Fertility, Land Productivity and Land Degradation Mitigation; RLA5064 on Strengthening Soil and Water Conservation Strategies at the Landscape Level by Using Innovative Radio and Stable Isotope and Related Techniques) and one national TCP (i.e. THA5051 on Evaluating Soil Erosion-Deposition and Soil Quality using Isotopic and Nuclear Techniques in Agricultural Areas Affected by Flooding). In addition, keynote speakers were invited to present the latest development in the field of gamma spectroscopy (i.e. Dr Lafranco from



Canberra), generation of digital elevation models for soil erosion studies (i.e. Dr Eder and Dr Bauer) and sampling stream suspended sediment in proglacial zones (i.e. Prof Stott).

A self-assessment at the end of the training activity gave the organizers an opportunity to validate the effectiveness of the training course. Feedback from the participants showed that this advanced interregional training course was highly appreciated and valued.



*Participants of the Interregional Training Course organized by the SWMCN Laboratory*

## **Sampling Campaign in Rauris, National Park Hohe Tauern, benchmark site for the 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, 7–9 October 2014, Rauris, Austria**

*Martina Aigner, Maria Heiling, Georg Weltin and Gerd Dercon*

The purpose of this travel was to carry out field sampling in the benchmark site of Rauris. Under the planned Coordinated Research Project on Soil and Water Conservation for Climate Change Adaptation in Agricultural Uplands, the SWMCN Laboratory of the Joint FAO/IAEA Division of Nuclear Techniques for Food and Agriculture will assist in implementing a long-term benchmark site in the National Park Hohe Tauern located in the high Austrian Alps. This work will be carried out in close collaboration with University of Vienna and University of Graz, National Park Hohe Tauern, Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Federal Agency for Water Management, and Austrian Research Centre for Forests. This benchmark site is also part of the INT5153 project. Over 40 soil samples were taken including two undisturbed cores for chemical analyses and isotopic signatures of carbon-13,

N-15 and FRNs. The information gained from this project will help to assess and better understand the impact of climate change on soil and agricultural water in the European Alps. Such information will also help farmers to better adapt best land and water management practices to combat the negative effects of climate change.



*Summer meadows at the benchmark site in the European Alps (National Park Hohe Tauern)*

## **Update on $^{13}\text{C}$ -labelling of plant materials through the use of walk-in growth chambers**

*Christian Resch, Georg Weltin, Leo Mayr and Gerd Dercon*

In 2013, the SWMCN Laboratory installed a pair of walk-in growth chambers, each chamber of 12 m<sup>3</sup> in volume. These growth chambers with controlled temperature, relative humidity and carbon dioxide (CO<sub>2</sub>), are being used in labelling plant materials with  $^{13}\text{C}$  to support research activities for improving climate-smart agriculture in Member States.

Each growth chamber was tested for CO<sub>2</sub> leakage using elevated CO<sub>2</sub> (about 3 000 ppm) and monitored for changes in CO<sub>2</sub> concentration over time. The test indicated a gas leakage of 25% per day through the supply and cooling tubes which was fixed by putting silicone glue. The CO<sub>2</sub> gas inlet was modified to introduce a mixture of (a) pure CO<sub>2</sub> at natural abundance level and (b) CO<sub>2</sub> with 99 atom%  $^{13}\text{C}$  (Sigma Aldrich) into the chamber for a period of 15 seconds. The flow rates of the two gases (200 ml/min and 2 ml/min) were controlled by mass-flow-controllers to ensure  $^{13}\text{C}$  enrichment of about 350 ‰ over the crop growing period (continuous labelling).

Following this, an automatic drip irrigation system was placed in each of the growth chambers to provide plants with water and nutrients, avoiding the need of entering into the growth chambers during the  $^{13}\text{C}$ -labelling of plant



materials. A gas absorber bag was put in the growth chamber to remove the growth inhibitor ethylene.

Initially CO<sub>2</sub> with 99 atom% <sup>13</sup>C was introduced into the growth chamber at a flow rate of 2 ml/min for 16 minutes to reach <sup>13</sup>C enrichment of about 350 ‰. The CO<sub>2</sub> level was set to 600 ppm afterward.

From April to June 2014, 36 pots with 2 to 3 maize plants per pot were labelled in each growth chamber set at 22°C temperature and 50% humidity. After one month, the temperature was increased to 25°C to stimulate the plant growth.

Maize plants were harvested at flowering stage. The results indicated that maize plant had <sup>13</sup>C enrichment of 340 ‰.

Future experiments will focus on using various inert growth substrates to optimize growth conditions in the chambers and to minimize CO<sub>2</sub> contributions from soil.

This research has been conducted to support CRP D1.50.12 on Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-Based Cropping Systems in Sub-Saharan Africa.



Walk-in growth chambers with labelled maize plants prior to harvest

## External Quality Assurance: Annual Proficiency Test on <sup>15</sup>N and <sup>13</sup>C isotopic abundance in plant materials

Martina Aigner

Worldwide comparison of stable <sup>15</sup>N and <sup>13</sup>C isotope measurements provides confidence in the analytical performance of stable isotope laboratories and hence a valuable tool for external quality control.

The 2014 Proficiency Test (PT) on <sup>15</sup>N and <sup>13</sup>C isotopic abundance in plant materials, jointly organized by the University of Wageningen, the Netherlands, and funded by the IAEA SWMCN Laboratory was successfully completed. The Wageningen Evaluating Programs for Analytical Laboratories (WEPAL, <http://www.wepal.nl>) is accredited for the organization of Interlaboratory Studies by the Dutch Accreditation Council. In total ten stable isotope laboratories participated in this round of PT.

Every year, one <sup>15</sup>N-enriched plant test sample is included in one round of the WEPAL IPE (International Plant-Analytical Exchange) programme. A bulk amount of uniformly <sup>15</sup>N-enriched plant material is produced by the FAO/IAEA Soil Science Unit and sent to the WEPAL for processing. This <sup>15</sup>N-enriched material is sent out together with 3 other non-enriched plant samples. Participants are invited to perform analysis of any determined offered in the WEPAL IPE scheme including <sup>15</sup>N (enriched and/or natural abundance level), total N (N-elementary), Kjeldahl-N, <sup>13</sup>C and total C (C-elementary). A special evaluation report for IAEA participants on the analytical performance in the isotope analysis is issued and sent to the participants together with a certificate of participation additionally to the regular WEPAL evaluation report.

Participants registered in the PT scheme were provided with the WEPAL test sample set IPE 2014.2 consisting of four test samples, each sample of 20 g plant material. In total ten laboratories reported isotope abundance data: Africa (1): Morocco, Asia (3): Pakistan and Philippines (2 labs), Europe (4): Belgium, France, Germany and Italy, Latin America (2): Brazil and Chile. Seven out of ten laboratories participating in the nitrogen analysis reported <sup>15</sup>N-data within the control limits for the enriched plant sample (Fig.1) and seven out of nine participating laboratories in carbon analysis reported <sup>13</sup>C isotopic abundance results within the control limits for this test sample (Fig.2).

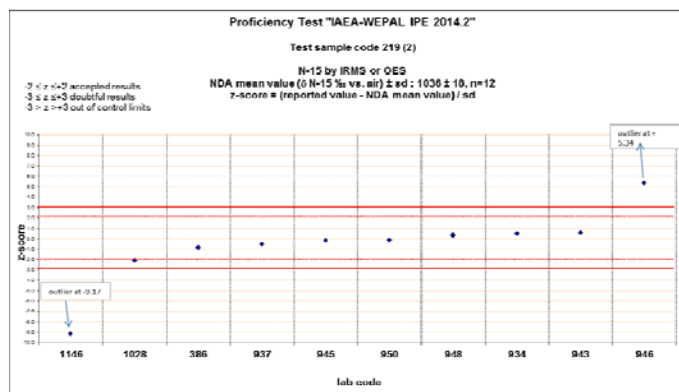


Fig.1. Z-score evaluation of the <sup>15</sup>N analysis

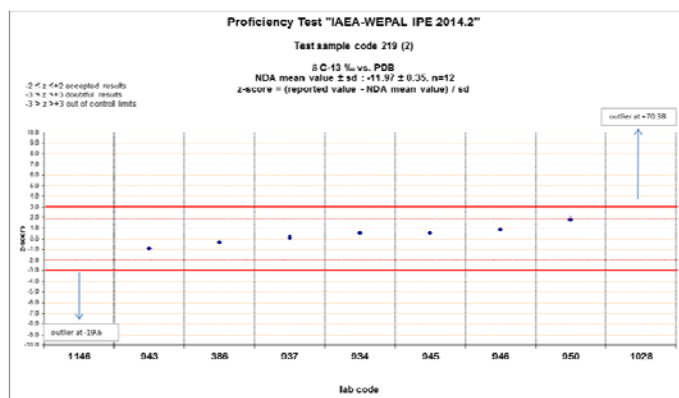


Fig.2. Z-score evaluation of the <sup>13</sup>C analysis

## Installation of a sensor network for soil moisture, temperature and water potential monitoring at the Soil Water Management and Crop Nutrition Laboratory (SWMCNL) field site, Grabenegg, Austria

*Georg Weltin and Ammar Wahbi*

Under the CRP D1.50.12, the SWMCN Laboratory has been conducting supportive research at a field site in Grabenegg, Lower Austria, in collaboration with the Austrian Agency for Health and Food Safety (AGES). An iMetos™ weather station (Pessl Instruments) installed in 2011 has been upgraded by adding additional soil sensor network for assessing soil matric potential, water retention, and soil temperature in the top soil (0–15 cm) (with and without mulch).



*Installation of soil moisture cable network at the Grabenegg experimental station*

## CSSIAR v1.0 Software – a new tool to improve soil conservation at catchment level

*Sergio de los Santos-Villalobos<sup>1</sup>, Claudio Bravo-Linares<sup>2</sup>, Roberto Meigikos Dos Anjos<sup>3</sup>, Renan Pereira Cardoso<sup>3</sup>, Max Gibbs<sup>4</sup>, Lionel Mabit<sup>5</sup> and Gerd Dercon<sup>5</sup>*

<sup>1</sup>*Instituto Tecnológico de Sonora, Mexico*

<sup>2</sup>*Universidad Austral de Chile, Chile*

<sup>3</sup>*Universidade Federal Fluminense, Brazil*

<sup>4</sup>*National Institute of Water and Atmospheric Research, New Zealand*

<sup>5</sup>*Soil and Water Management & Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Austria*

Under the Regional Technical Cooperation Project RLA5064 on Strengthening Soil and Water Conservation Strategies at the Landscape Level by Using Innovative Radio and Stable Isotope and related techniques, a new software, called CSSIAR, have been developed to assess soil erosion apportionment using data obtained from Compound-Specific Stable Isotope (CSSI) analysis. The CSSI technique allows assessing soil redistribution in agricultural landscapes and forest plantations, as well as identifying hotspots of soil erosion. This will help researchers and policy makers to enhance the cost-effectiveness of soil conservation measures at the catchment level. This technique is based on the measurement of carbon-13 isotope signatures of specific organic compounds in the soil profile (e.g. fatty acids derived from a specific land use).

CSSIAR v1.0 has been created because of existing limitations of current software to assess soil apportionment and to identify hot spots of land degradation. CSSIAR v1.0 enables the analysis of larger sets of data and gives more detailed statistical information (including uncertainty) about the proportion of sediment contribution from different land uses in a catchment. This software runs on R, which is free and can be downloaded on the R website (<http://www.r-project.org/>). CSSIAR v1.0 will be soon available for downloading from the IAEA website.

The software has been presented and tested during the Interregional Training Course on the Use of Rallout Radionuclides (FRNs) and CSSI Techniques for Precision Soil Conservation, held in October 2014 at Seibersdorf, Austria.

# Publications

## List of Publications in 2014

- Adu-Gyamfi, J.J., Aigner, M., Linic, S., Gludovacz, D. (2014). Phosphorus Acquisition from Sparingly Soluble Forms by Maize and Soybean in Low- and Medium-P Soils using  $^{32}\text{P}$ , pp. 91–95, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Adu-Gyamfi, J.J., Dercon, G. (2014). Overview of FAO/IAEA Coordinated Research Project on Crop Genotypes Tolerant to Low N and P Soils, pp. 43–48, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Alewell, C., Meusburger, K., Juretzko, G., Mabit, L., Ketterer, M.E. (2014). Suitability of  $^{239+240}\text{Pu}$  and  $^{137}\text{Cs}$  as tracers for soil erosion assessment in mountain grasslands. *Chemosphere*, 103, 274–280.
- Alewell, C., Meusburger, K., Juretzko, G., Mabit, L., Ketterer, M.E. (2014). Suitability of  $^{239+240}\text{Pu}$  and  $^{137}\text{Cs}$  as tracers for soil erosion assessment in Swiss mountain grasslands. In: *Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014*. Abstract EGU2014-2935.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-2935.pdf>
- Arata, L., Meusburger, K., Bissig, N., Mabit, L., Alewell, C. (2014).  $^{137}\text{Cs}$  re-sampling as a method for soil erosion assessment in Alpine grasslands. In: *Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014*. Abstract EGU2014-3360.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3360.pdf>
- Asare, D.K., Larteh, I.T., Frimpong, J.O., Yaro, M., Banson, K.E., Ayeh, E.O., Heng, L.K. (2014). Yield, Water and Nitrogen Use by Drip-irrigated Cabbage Grown under Different Levels of Applied Water, pp. 297–301, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Aulakh, M.S., Garg, A.K., Manchanda, J.S., Dercon, G., Nguyen, M.L. (2014). Biological Nitrogen Fixation by Soybean and Fate of Applied  $^{15}\text{N}$ -Fertilizer in Wheat under Conservation Agriculture, pp. 215–221, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Bampa, F., Aksoy, E., Guicharnaud, R.A., Hiederer, R., Jones, A., Lugato, E., Macaigne, P., Montanarella, L., Nocita, M., Panagos, P., Tóth, G. (2014). Soil Organic Carbon Preservation and Sequestration in European Agricultural Soils: An Overview, pp. 223–229, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Bayuelo-Jiménez, J.S., Paredes-Gutiérrez, L.C., Pineda-Pineda, J., Patrón-Ibarra, J.C., Adu-Gyamfi, J.J. (2014). Acquisition Efficiency by Maize Landraces in Acid Soils of Mexico, pp. 83–90, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Benmansour, M., Mabit, L., Owens, P.N., Tarján, S., Walling, D.E. (2014). The use of excess  $^{210}\text{Pb}$  ( $^{210}\text{Pb}_{\text{ex}}$ ) as a soil and sediment tracer. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 79–104. IAEA-TECDOC-1741. IAEA publication.
- Benmansour, M., Nouria, A., Mabit, L., Bouksirate, H., Moussadek, R., Mrabet, R., Duchemin, M., Zouagui, A., Iaaich, H. (2014). Combined use of  $^{137}\text{Cs}$  and  $^{210}\text{Pb}_{\text{ex}}$  to assess long term soil redistribution in a small agricultural field in Morocco. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 149–160. IAEA-TECDOC-1741. IAEA publication.



- Blake, W., Taylor, A., Abdelli, W., Gaspar, L., Al Barri, B., Ryken, N., Mabit, L. (2014). Evaluating uncertainty in  $^7\text{Be}$ -based soil erosion estimates: an experimental plot approach. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union—General Assembly 2014. Abstract EGU2014-10651.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-10651.pdf>
- Chalk, P.M., Inácio, C.T., Magalhães, A.M.T. (2014). From Fertilizer to Food: Tracing Nitrogen Dynamics in Conventional and Organic Farming Systems using  $^{12}\text{N}$  Natural Abundance, pp. 339–348, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Dang, D.N., Duong, H.S., Khuong, M.C., Heng, L., Nguyen, M.L. (2014). Water Use Efficiency of Coffee (*Robusta*) under Mulch and Drip Irrigation on the Tay Nguyen Plateau, Viet Nam, pp. 303–307, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Dercon, G., Gibbs, M., Rasche, F., Brandt, C., Cadisch, G., Boeckx, P., Bodé, S., Hancock, G., Blake, W., Walling, D.E., Mabit, L., Benmansour, M., Lam, N., Lobb, D., Schuller, P., Golosov, V., Zhang, X., Li, Y., Froehlich, W., Asfary, A., Nguyen, M.L. (2014). Compound-Specific Stable Isotope Techniques for Improving Soil Conservation Strategies: An Overview of the Lessons Learned from and FAO/IAEA Coordinated Research Project, pp. 149–151, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Fereres, E., Heng, L.K. (2014). Enhancing the Contribution of Isotopic Techniques to the Expansion of Precision Irrigation, pp. 259–261, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Gong, D., Mei, X., Shi, J., Hao, W., Heng, L. (2014). Partitioning Wheat Transpiration and Soil Evaporation with Eddy Covariance, Stable Isotope and Micro-Lysimeter Methods in the North China Plain, pp. 263–268, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Gonsalves, B.C., Darby, I.G., Toloza, A., Mabit, L., Kaiser, R.B., Dercon, G. (2014). Assessing soil erosion at landscape level: A step forward in the up-scaling of  $^{137}\text{Cs}$  measurements through the use of in-situ lanthanum bromide scintillator. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union—General Assembly 2014. Abstract EGU2014-1996.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-1996.pdf>
- Heng, L.K., Nguyen, M.L., Gong, D.Z., Mei, X.R., Amenzou, N. (2014). Separating soil evaporation and crop transpiration to improve crop water use efficiency. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union—General Assembly 2014. Abstract EGU2014-1934.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-1934.pdf>
- Heng, L., Hsiao, T.C., Williams, D., Fereres, E., Cepuder, P., Denmead, T., Amenzou, N., Dhan, N., Duong, H., Kale, S., Li, B.G., Mahmood, K., Mei, X.R., Phiri, E., Zingore, S., Nguyen, M.L. (2014). Managing Irrigation Water to Enhance Crop Productivity under Water-limiting Conditions: A Role for Isotopic Techniques, pp. 323–329, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Iurian, A.R., Mabit, L., Cosma, C. (2014). Uncertainty related to input parameters of  $^{137}\text{Cs}$  soil redistribution model for undisturbed fields. *Journal of Environmental Radioactivity*, 136, 112–120.
- Leifeld, J., Heiling, M., Hajdas, I. (2014). Age and thermal stability of particulate organic matter fractions indicate the presence of black carbon in soil. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union—General Assembly 2014. Abstract EGU2014-12777.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-12777.pdf>
- Mabit, L., Benmansour, M., Abril, J.M., Walling, D.E., Meusburger, K., Iurian, A.R., Bernard, C., Tarján, S., Owens, P.N., Blake, W.H., Alewell, C. (2014). Fallout  $^{210}\text{Pb}$  as a soil and sediment tracer in catchment sediment budget investigations: A review. *Earth-Science Reviews*, 138, 335–351.
- Mabit, L., Benmansour, M., Blake, W.H., Taylor, A., Tarján, S., Toloza, A., Walling, D.E. (2014). The use of  $^7\text{Be}$  as short term soil redistribution tracer. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 105–124. IAEA-TECDOC-1741. IAEA publication.



- Mabit, L., Benmansour, M., Dercon, G., Walling, D.E. (2014). Use of  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}_{\text{ex}}$  and  $^7\text{Be}$  for documenting soil redistribution: The future. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 203–208. IAEA-TECDOC-1741. IAEA publication.
- Mabit, L., Chhem-Kieth, S., Dornhofer, P., Toloza, A., Benmansour, M., Bernard, C., Fulajtar, E., Walling, D.E. (2014).  $^{137}\text{Cs}$ : a widely used and validated medium-term soil tracer. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 27–77. IAEA-TECDOC-1741. IAEA publication.
- Mabit, L., Meusburger, K., Iurian, A.R., Owens, P.N., Toloza, A., Alewell, C. (2014). Sampling soil and sediment depth profiles at a fine-resolution with a new device for determining physical, chemical and biological properties: the Fine Increment Soil Collector (FISC). *Journal of Soils and Sediments*, 14(3), 630–636.
- Mabit, L., Meusburger, K., Iurian, A.R., Owens, P.N., Toloza, A., Alewell, C. (2014). Fine Increment Soil Collector (FISC): A new device to support high resolution soil and sediment sampling for agri-environmental assessments. In: *Geophysical Research Abstracts, Volume 16, European Geosciences Union– General Assembly 2014*. Abstract EGU2014-1992.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-1992.pdf>
- Mabit, L., Zapata, F., Benmansour, M., Bernard, C., Dercon, G., Walling, D.E. (2014). Assessment of soil erosion and sedimentation: the role of fallout radionuclides. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 3–26. IAEA-TECDOC-1741. IAEA publication.
- Mahmood, K., Ishaque, W., Heng, L.K. (2014). An Improved Vacuum Distillation Method for Extracting Soil Water for Stable Isotope Analyses, pp. 361–364, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Mao, Y.L., Heiling, M., De Clercq, T., Resch, C., Aigner, M., Mayr, L., Vanlauwe, B., Thuita, M., Steier, P., Leifeld, J., Merckx, R., Spiegel, H., Cepuder, P., Nguyen, M.L., Zaman, M., Dercon, G. (2014). Soil organic matter stability in agricultural land: New insights using  $\delta^{15}\text{N}$ ,  $\delta^{13}\text{C}$  and C:N ratio. In: *Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014*. Abstract EGU2014-3321.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3321.pdf>
- Mayr, L., Aigner, M., Heng, L. (2014). Improving Yield and Water Use Efficiency of Wheat (*Triticum aestivum* L.) by Regulating Plant-Available Water during Crop Development under Semi-arid Conditions in Pakistan, pp. 289–296, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Meusburger, K., Alewell, C., Konz, N., Schaub, M., Mabit, L. (2014). The combined use of  $^{137}\text{Cs}$  and stable isotopes to evaluate soil redistribution in mountainous grasslands, Switzerland. In: “Guidelines for using Fallout radionuclides to assess erosion and effectiveness of soil conservation strategies”. pp. 181–201. IAEA-TECDOC-1741. IAEA publication.
- Meusburger, K., Leitinger, G., Mabit, L., Mueller, M.H., Walter, A., Alewell, C. (2014). Soil erosion by snow gliding - a first quantification attempt in a sub-alpine area, Switzerland. *Hydrology and Earth System Sciences*, 18, 3763–3775.
- Meusburger, K., Leitinger, G., Mabit, L., Mueller, M.H., Walter, A., Alewell, C. (2014). Soil erosion by snow gliding - a first quantification attempt in a sub-alpine area, Switzerland. *Hydrology and Earth System Sciences Discussions*, 11, 3675–3710.
- Mueller, M.H., Meusburger, K., Leitinger, G., Mabit, L., Alewell, C. (2014). The interaction of soil, vegetation and snow - results of a case study in the Central Swiss Alps. In: *Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014*. Abstract EGU2014-7032-2.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-7032-2.pdf>
- Nguyen, M.L. (2014). Towards Sustainable Land Management for Enhancing Food Security While Mitigating Climate Change Impacts: The Role of Nuclear and Isotopic Techniques, pp. 11–18, In: *Managing Soils for Food Security and Climate Change Adaptation and Mitigation*. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.

- Phiri, E., Heng, L., Sinda, L.M. (2014). Evaluation of Evapotranspiration and Production of Paprika (*Capsicum Annum* L.) using the Soil Water Balance Approach under Variable Irrigation Water Applications, pp. 331–336, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Porto, P., Walling, D.E., Alewell, C., Callegari, G., Mabit, L., Mallimo, N., Meusburger, K., Zehring, M. (2014). Use of a  $^{137}\text{Cs}$  re-sampling technique to investigate temporal changes in soil erosion and sediment mobilisation for a small forested catchment in southern Italy. *Journal of Environmental Radioactivity*, 138, 137–148.
- Sakadevan, K., Shalmani, M.A.M., Nguyen, M.L. (2014). Wetland Water and Nutrient Budgets for Improving Irrigation Performance in Caspian Low Lands. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014. Abstract EGU2014-10651.pdf.  
<https://meetingorganizer.copernicus.org/EGU2014/EGU2014-1853.pdf>
- Sakadevan, K., Heng, L., Nguyen, L. (2014). Water Conservation Zones in Agricultural Catchments for Biomass Production, Food Security and Environmental Protection, pp. 155–160, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Shalmani, M.A.M., Sakadevan, K., Khorasani, A., Piervali, N., Feiziasl, V., Rudsari, M.K. (2014). Large Scale Evaluation of Water Conservation Zones for Water Quality Improvements and Biomass Production in Northern Iran, pp. 191–196, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Vanuytrecht, E., D. Raes, P. Steduto, T.C. Hsiao, E. Fereres, L.K. Heng, M. Garcia Vila and P. Mejias Moreno (2014). AquaCrop: FAO'S crop water productivity and yield response model, *Environmental Modelling & Software*  
<http://dx.doi.org/10.1016/j.envsoft.2014.08.005>
- Vreugdenhil, M., Weltin, G., Heng, L., Wahbi, A., Oismueller, M., Dercon, G. (2014). Cosmic Ray Neutron Probe Soil Water Measurements over Complex Terrain in Austria In: Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014. Abstract EGU2014-3702.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3702.pdf>
- Wahbi, A., Allo, M.A., Aldarir, A.N., Arslan, A., Al Shaaban, A.S. (2014). Yield and Carbon Isotope Discrimination for Wheat, Barley and Lentil under Different Crop Sequences and Water Treatments in Northern Syria, pp. 309–314, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Wahbi, A., Miwak, H., Singh, R. (2014). Effects of Conservation Agriculture on Soil Physical Properties and Yield of Lentil in Northern Syria. In: Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014. Abstract EGU2014-3280-1.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3280-1.pdf>
- Zaman, M., Nguyen, M.L. (2014). Mitigating Nitrous Oxide Emissions from Agricultural Landscape: The Role of Isotopic Techniques In: Geophysical Research Abstracts, Volume 16, European Geosciences Union–General Assembly 2014. Abstract EGU2014-10651.pdf.  
<http://meetingorganizer.copernicus.org/EGU2014/EGU2014-3546-1.pdf>
- Zaman, M., Barbour, M.M., Turnbull, M.H., Kurepin, L.V. (2014). Influence of Fine Particle Suspension of Urea and Urease Inhibitor on Nitrogen and Water Use Efficiency in Grassland using Nuclear Techniques, pp. 29–32, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.
- Zupanc, V., Šturm, M., Lojen, S., Maršić-Kacjan, N., Adu-Gyamfi, J., Bračič-Železnik, B., Urbanc, J., Pintar, M. (2014). Environmental Sustainability of Vegetable Production above a Shallow Aquifer, pp. 279–282, In: Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Heng, L.K., Sakadevan, K., Dercon, G., Nguyen, M.L. (Eds), FAO, Rome.

## Websites

- 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):  
<http://www.fao.org/about/en/>
- FAO/AGL (Land and Water Development Division):  
[http://www.fao.org/nr/water/landandwater\\_what.html](http://www.fao.org/nr/water/landandwater_what.html)
- New communication materials outlining successes in the area of nuclear techniques:  
<http://www-naweb.iaea.org/nafa/resources-nafa/IAEAsuccessStories-2014.pdf>  
<http://www-naweb.iaea.org/nafa/resources-nafa/ProgBrochure-2014.pdf>  
<http://www-naweb.iaea.org/nafa/resources-nafa/LabBrochure-2014.pdf>

### Impressum

#### Soils Newsletter Vol. 37, No. 2, January 2015

The Soils Newsletter is prepared twice per year by the  
Soil and Water Management & Crop Nutrition Section,  
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and  
FAO/IAEA Agriculture & Biotechnology Laboratory, Seibersdorf.

International Atomic Energy Agency  
Vienna International Centre, PO Box 100, 1400 Vienna, Austria  
Printed by the IAEA in Austria, January 2015

14-50731

### Disclaimer

This newsletter has not been edited by the editorial staff of the IAEA. The views expressed remain the responsibility of the contributors and do not necessarily represent the views of the IAEA or its Member States. The use of particular designations of countries or territories does not imply any judgement by the publisher, the IAEA, as to the legal status of such countries or territories, of their authorities and institutions or of the delimitation of their boundaries.