Joint ICTP-IAEA Workshop on the Use of Cosmic Ray Neutron Sensor for Soil Moisture Management and Validation of Remote Sensing Soil Moisture Maps

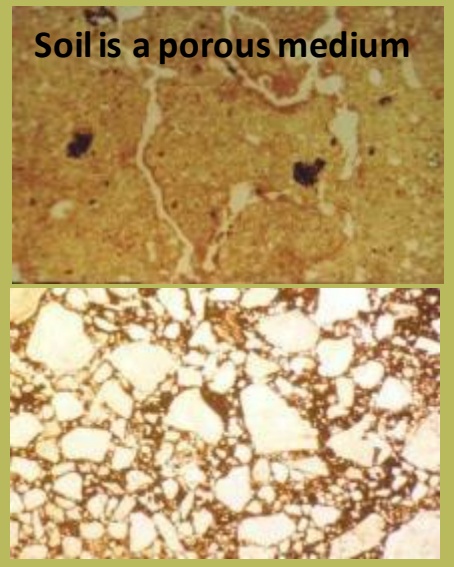
10, 12, 14, 17, 19 May 2021
An ICTP - IAEA Virtual Meeting
Trieste, Italy

Joint FAO/IAEA Centre
Nuclear Techniques in Food and Agriculture

The Abdus Salam International Centre for Theoretical Physics
www.ictp.it
Trieste, Italy

Importance of soil moisture

- Soil moisture is a component of water cycle:
  - Water distribution and movement in soil as a porous medium is very complex
  - Soil is major medium for growth of terrestrial plants and food production for human society
  - Heterogeneity of soil moisture is crucial for plant and crop and its shortage or excess are most important limiting factors



Gravimetric method

Indirect methods - point sensors

Neutron probe

Soil moisture measurements

Very easy achievable: weighting wet soil - heating - weighting dry soil (**gravimetric method**)

Disadvantages: labour intensive, invasive, low representativeness

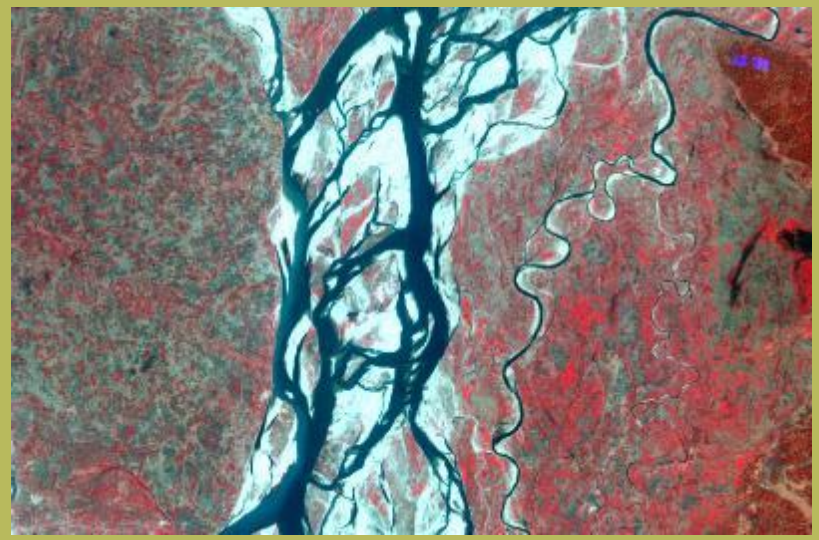
Indirect methods: electromagnetic sensors (TDR, FDR, capacitance sensors), thermal sensors, pressure sensors (**point sensors**)

Disadvantage: number of technical obstacles, low representativeness

Nuclear technology: neutron probe, cosmic ray neutron sensor, gamma ray sensor

Remote sensing: infrared, microwave

Cosmic ray neutron sensor



Remote sensing

Role of nuclear technology

Neutron probe: emitting neutrons; footprint of several tens of centimeters; disadvantages: security issues

Cosmic ray neutron sensor: detecting natural neutrons (cosmic ray interaction with atmosphere); footprint of several hundreds of meters; disadvantages: low depth penetration (few tens of centimeters)

Gamma ray spectrometer: detecting gamma radiation; footprint of several tens of meters

Major challenges of soil moisture measurement: soil disturbance, spatial microvariability and representativeness

Gravimetric method: soil disturbance, point scale

Most point sensors: soil disturbance, point scale

Some point sensors (capacitance sensors): access tube, point scale

Neutron probe: access tube, footprint of several tens of centimeters

Gamma ray spectrometer: non-invasive, footprint of few tens of meters

Cosmic ray neutron sensor: non-invasive, footprint of tens of meters, penetration depth of few tens of centimeters

Remote sensing: non-invasive, footprint of few hundreds of meters - few tens of kilometers, penetration depth of few centimeters

Activities of IAEA

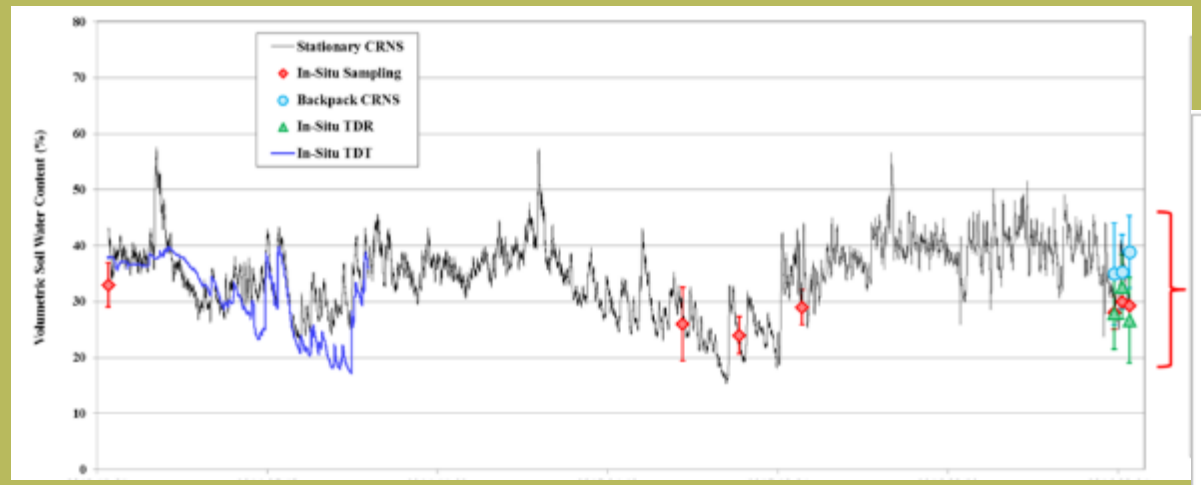
Promoting nuclear techniques in science and technology

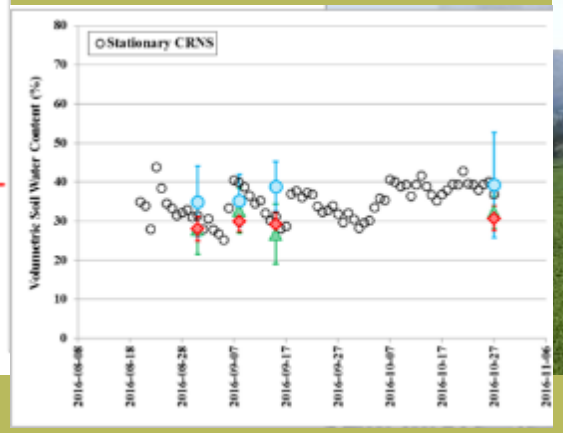
Coordinated Research Project: **Enhancing agricultural resilience and water security using Cosmic-Ray Neutron Sensor (D12014)**; developing new nuclear techniques

Technical cooperation projects: transferring new nuclear techniques to member states

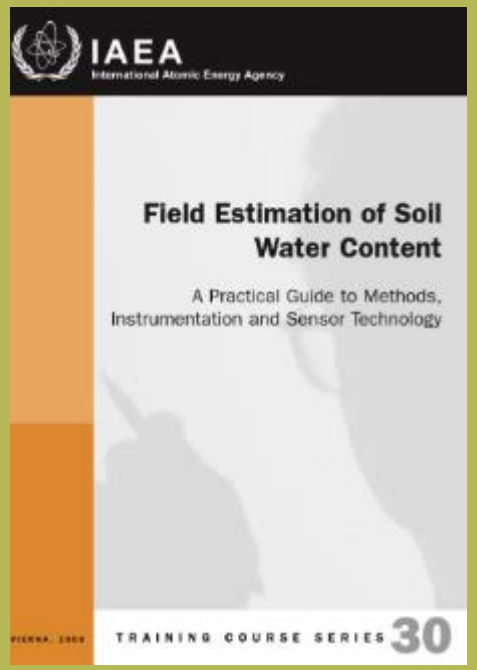
Own research of Soil Lab

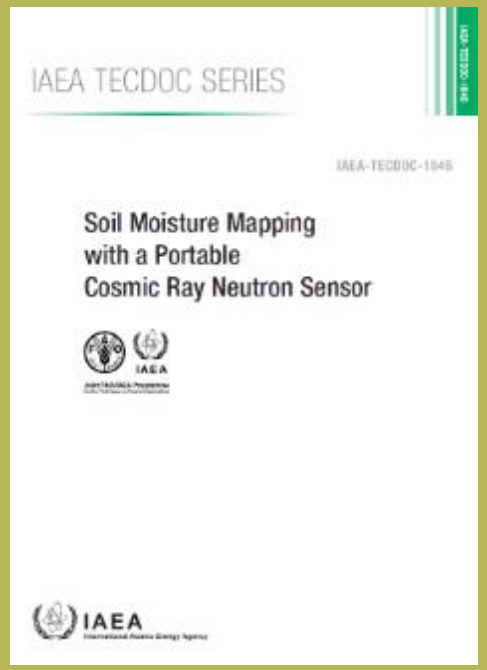
Publishing methodological literature

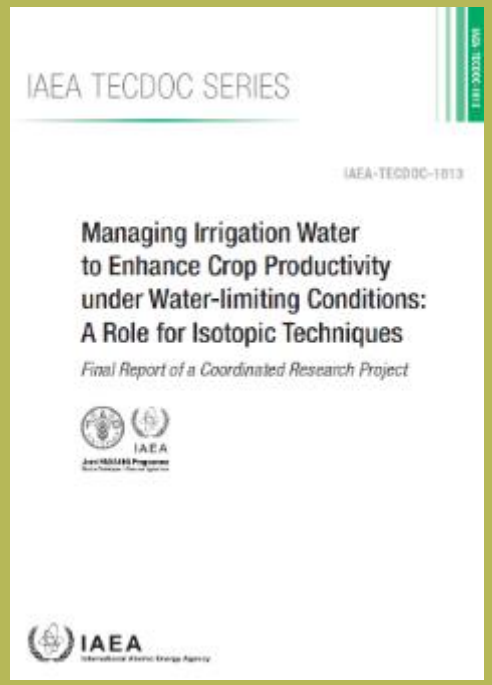


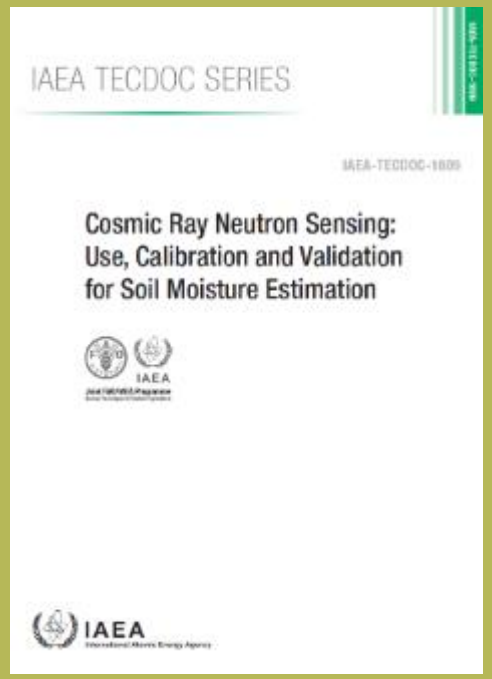


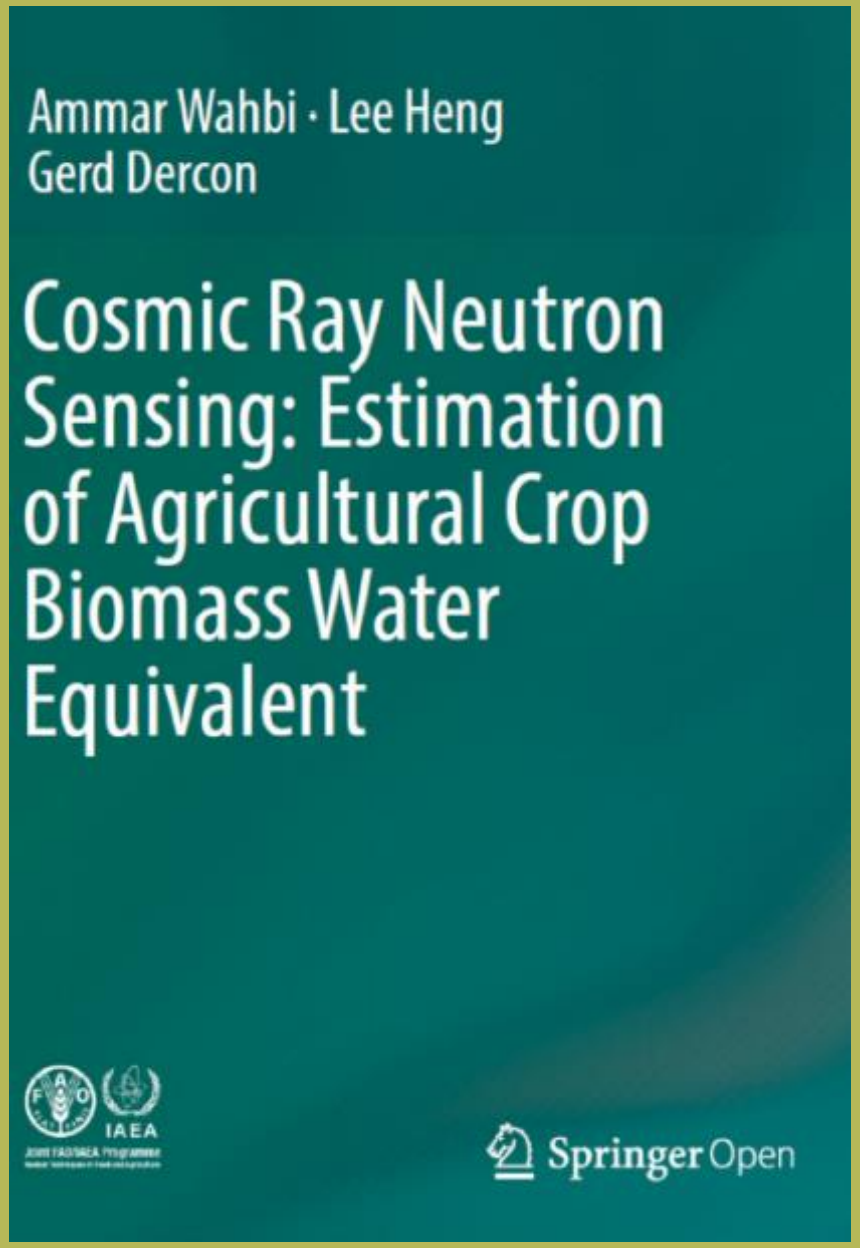
Published handbooks





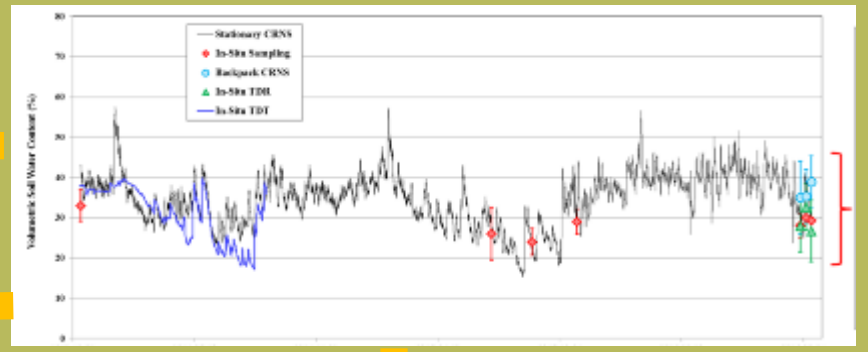


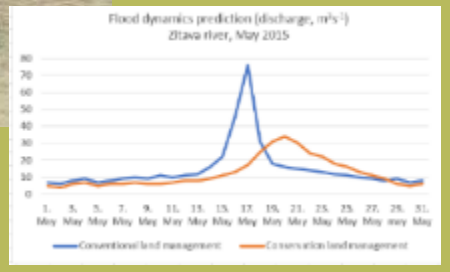


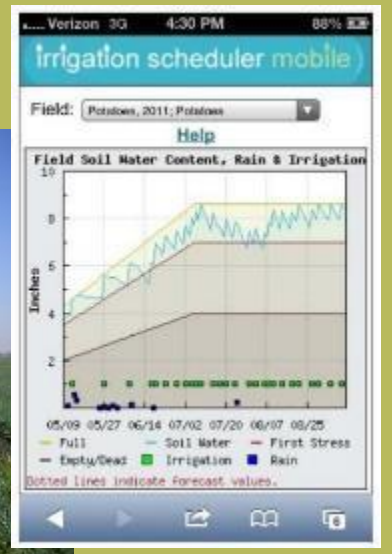


Enhancing agricultural resilience and water security using Cosmic-Ray Neutron Sensor (D12014)

- Developing new approaches of soil moisture assessment based on CRNS, GRS, remote sensing and hydrological modelling
- Soil moisture products: root zone soil moisture, precipitation estimation, etc.
- Use of soil moisture data for agricultural and environmental applications: rainfed land management irrigation scheduling, drought management, flood prediction, etc.







Role of remote sensing

Remote sensing has potential to assess soil moisture

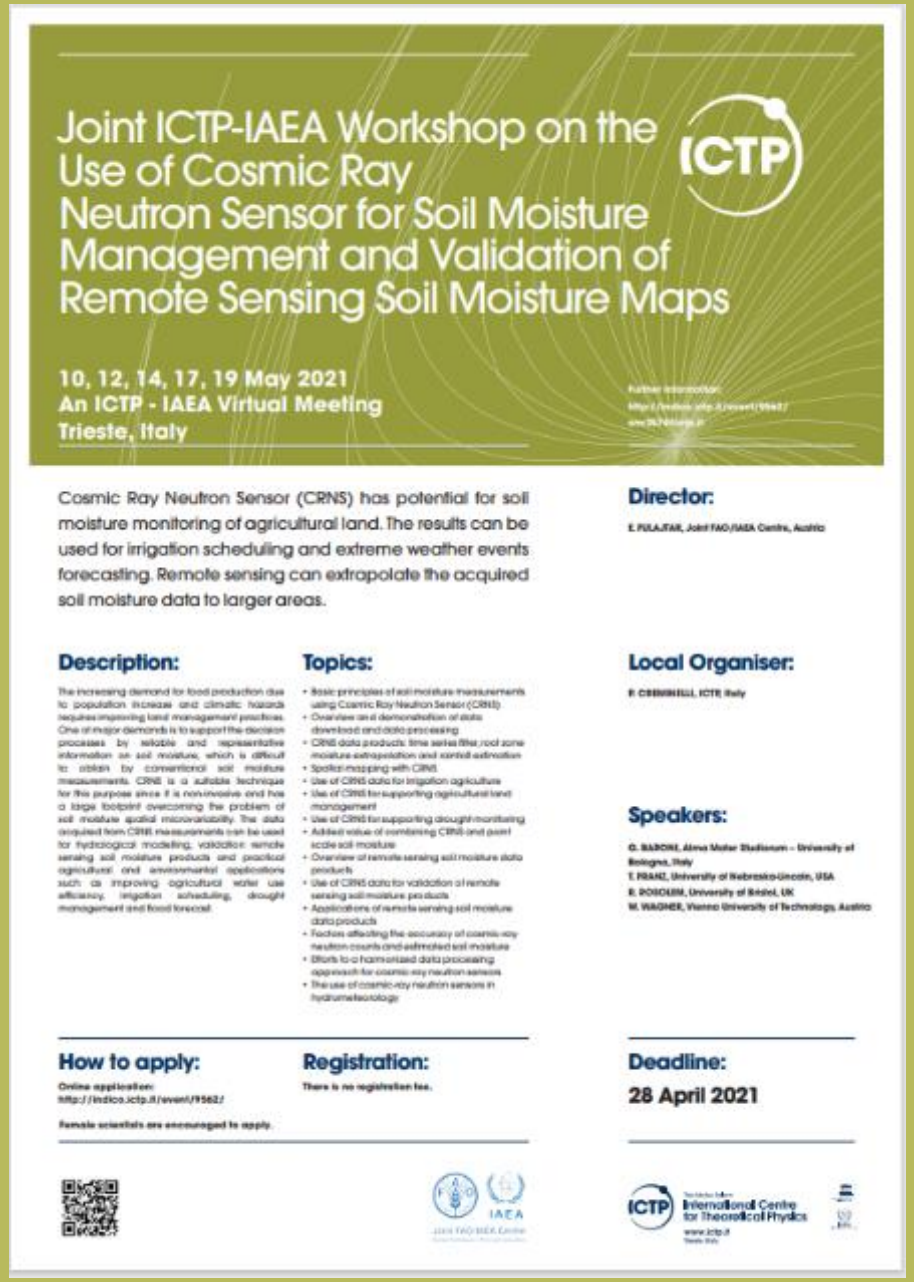
Major advantage: extrapolating information to large areas

Limiting factor: reliable calibration (limited representativeness of soil moisture point data)

CRNS can solve the problem of remote sensing calibration

Cooperation with ICTP

Organizing Joint ICTP-IAEA Workshop smr3574



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Cosmic Ray Neutron Sensor (CRNS) has potential for soil moisture monitoring of agricultural land. The results can be used for irrigation scheduling and extreme weather events forecasting. Remote sensing can extrapolate the acquired soil moisture data to larger areas.

Director:

E. FULAJTAR, Joint FAO/IAEA Centre, Austria

Description:

The increasing demand for food production due to population increase and climatic hazards requires improving land management practices. One of major demands is to support the decision processes by reliable and representative information on soil moisture, which is difficult to obtain by conventional soil moisture measurements. CRNS is a suitable technique for this purpose since it is non-invasive and has a large footprint overcoming the problem of soil moisture spatial microvariability. The data acquired from CRNS measurements can be used for hydrological modelling, validation remote sensing soil moisture products and practical agricultural and environmental applications such as improving agricultural water use efficiency, irrigation scheduling, drought management and flood forecast.

Topics:

- Basic principles of soil moisture measurements using Cosmic Ray Neutron Sensor (CRNS)
- Overview on a demonstration of data download and data processing
- CRNS data products: time series filter, root zone moisture extrapolation and rainfall estimation
- Spatial mapping with CRNS
- Use of CRNS data for irrigation agriculture
- Use of CRNS for supporting agricultural land management
- Use of CRNS for supporting drought monitoring
- Added value of combining CRNS and point scale soil moisture
- Overview of remote sensing soil moisture data products
- Use of CRNS data for validation of remote sensing soil moisture products
- Applications of remote sensing soil moisture data products
- Factors affecting the accuracy of cosmic-ray neutron counts and estimated soil moisture
- Efforts to a harmonized data processing approach for cosmic-ray neutron sensors
- The use of cosmic-ray neutron sensors in hydrometeorology

Local Organiser:

R. CIERNIEWSKI, ICTP, Italy

Speakers:

G. BARONE, Alma Mater Studiorum – University of Bologna, Italy
T. FRANZ, University of Nebraska-Lincoln, USA
R. POSCOLIERI, University of Bristol, UK
W. WAGNER, Vienna University of Technology, Austria

How to apply:

Online application:
http://indico.ictp.it/event/9562/

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Deadline:

28 April 2021

ICTP International Centre for Theoretical Physics
www.ictp.it

TOPICS of Joint ICTP-IAEA Workshop

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- The use of cosmic-ray neutron sensors in hydrometeorology


I wish you fruitful workshop