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Abstract
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Best Practices for Capacity Building in Field Spectroscopy: Lessons Learned from the EXPERT Project

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Challenge

The increasing availability of spaceborne hyperspectral data acquired by missions such as PRISMA, EnMAP, DESIS, and the upcoming Copernicus CHIME, significantly intensifies the demand for reliable in situ reference data. Field spectrometers remain indispensable tools for calibration/validation campaigns and for targeted observations supporting research. As field teams have a limited operational coverage compared to satellites, a network of operators is needed to collect reliable reference data across Europe. This would also help to introduce hyperspectral applications to new communities. This requires widespread knowledge transfer regarding the effective use of field spectrometers including instrument handling, campaign planning, acquisition strategies, data processing and quality control and intercomparison methods with satellite observations. We present first results of the Horizon Europe EXPERT project (Grant Agreement No. 101160059), a framework for knowledge transfer and joint research activities between the Romanian Space Agency (ROSA), the Italian Space Agency (ASI), and the German Aerospace Center (DLR).

Capacity Building in EXPERT

ASI & DLR provide capacity building activities for ROSA, addressing the full hyperspectral remote sensing chain, from theoretical fundamentals to satellite tasking, advanced data analysis, and field validation. Training activities are organised in two levels. Initial training focused on the physical principles of reflectance spectroscopy, instrument characteristics, sources of uncertainty, and laboratory and field acquisition of spectral measurements for vegetation, soils, and synthetic materials. Subsequently, the ongoing advanced capacity building combines presential training sessions, remote tutorials, and joint working activities. These actions directly flow in the development of research use-cases in agriculture, cultural heritage, and mining, applying the newly acquired skills in real scientific workflows.

Advanced Training in Field Spectroscopy

Advanced capacity building in ground-based field spectroscopy is coordinated by DLR and implemented through guided field campaigns jointly conducted at several sites in Romania by ROSA, ASI and DLR. These measurements addressed agricultural, cultural heritage, and mining research use-cases, allowing participants to actively plan and execute relevant field work. Measurements were designed to be temporally aligned with PRISMA and EnMAP overpasses whenever feasible. Additionally, soil and vegetation samples at different phenological stages were collected at various sites to support validation and application development. UAV-based RGB and LIDAR measurements were additionally used where required to prepare the development of measurement strategies and to facilitate the interpretation of

the measurements. The collected datasets were finally evaluated and prepared for scientific exploitation during two joint online sessions organised by DLR, and ASI, respectively.



Figure 1. Guided field spectroscopy training, illustrating instrument setup and reference panel usage.

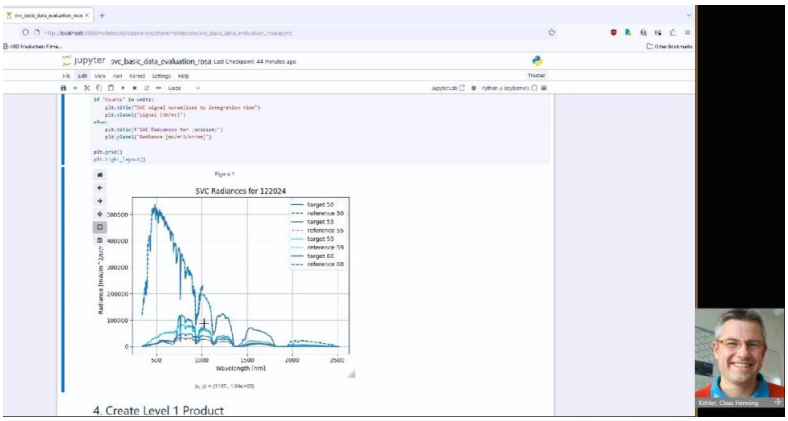


Figure 2. Example of remote tutorial: joint analysis of field spectroscopy measurements.

At this point of the project, ROSA team successfully demonstrated and consolidated the newly acquired capabilities during several field campaigns, which the team conducted autonomously with minimal remote assistance. From the training activities and field campaigns, some best practices for capacity building in field spectroscopy emerged: alignment of measurements with satellite sensor characteristics; inclusion of soil and vegetation sampling to support validation; flexibility of field protocols to account for constraints; and a rapid post-campaign data review to improve subsequent acquisitions. In the upcoming second half of the project, participants from ROSA will be introduced to the planning and execution of airborne hyperspectral campaigns, including considerations on atmospheric conditions, flight-line design, and ground coverage. This will enhance the ability to relate field, airborne, and satellite observations within a consistent analytical framework.

Discussion and Conclusions

The EXPERT experience demonstrates that capacity building in field spectroscopy is a living process, which gets stronger through repetitions of practical activities and constant learning. The shared use of repositories for training materials, scripts, and example datasets supports reproducibility and lasting expertise beyond the project lifetime. The move from supervised to autonomous field campaigns, keeping expert feedback in the process, has significantly accelerated skill building for the receiving institution. The best practices identified are transferable to other capacity building initiatives, particularly in preparation for upcoming hyperspectral missions such as CHIME.