4.15. Space4Agri

Project	Space4Agri (S4A): how to involve stakeholders and younger generations in Earth Observation research and support the agro-food sector in Lombardy
Organisation	Three different research institutions of the Italian National Research Council (CNR) collaborate: the Institute for Electromagnetic Sensing of the Environment (IREA), the Institute of Industrial Technologies and Automation (ITIA) and the Institute for the Dynamics of Environmental Processes (IDPA)
Research location	Milan, Italy
Cooperation partners	Collaboration with the Regione Lombardia and Arpa Lombardia
Team	Eleven senior researchers
Funding sources	IREA Funding
Website	http://space4agri.irea.cnr.it/ and a smartphone app

ORGANISATIONAL BACKGROUND

IREA-CNR is the Institute for Electromagnetic Sensing of the Environment of the National Research Council of Italy. Most of the employees have a background in natural and environmental sciences. The Institute seeks to link research to communication. RRI is a new theme in their public communication efforts. There is a small unit comprising people with a social science background who are working on communication and RRI. They aim to link the practice of communication with the theory. The unit is part of a network of people specialising in communication at other research institutes, with whom they exchange ideas. Collaboration takes place on a project basis. The organisation is structured in clusters, and the communication platform seeks to connect the different clusters. For this project, eleven senior researchers belonging to three different research institutions of CNR are collaborating. These are from IREA (six researchers) ITIA (three researchers) and IDPA (two researchers); many of these are young researchers and another six non-permanent staff have also joined the project. There is also collaboration with the Regione Lombardia. ITIA is the Institute of Industrial Technologies and Automation, which is focused on carrying out research and innovation into enabling technologies, processes and products, integrated in a factory-level framework, in order to enhance knowledge in manufacturing. IDPA is the Institute for the Dynamics of Environmental Processes and aims to

understand the “global change” of the environment and climate, on different spatial scales, its effects on the area, its evolution over time and the possible “remedies” and the influence of human behaviour. The Regione Lombardia is involved in helping further implementation among the agro-livestock in the Po Valley in Italy.

FUNDING

The main research activities were planned within the framework of the S4A work package for which a specific budget was addressed; the activities with schools had no budget and were a bottom-up initiative within the S4A project with an experimental approach.

PROBLEM BEING ADDRESSED

S4A aims to find solutions to some of Lombardy’s specific needs:

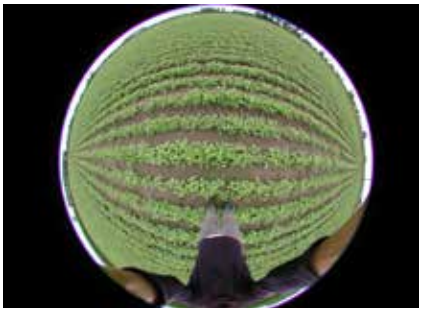
- to get reliable and updated information on the agricultural system of Lombardy, such as crop mapping and monitoring of plant phenological stages, anomalies or stresses (diseases, water);
- to share such knowledge with all the actors in the agro-food chain in order to manage critical situations;
- to integrate different types of data (field, satellite observations, weather, information collected by volunteers) and make them easily accessible to public and private end-users through an interoperable spatial data infrastructure;
- to promote adoption of smart technologies and sustainable management tools by regional agricultural enterprises.

These aims required robust interaction with stakeholders and scientists. Another aim of S4A was to get younger generations interested in scientific research and promote innovation in Lombardy through educational activities involving students and professionals.

RESEARCH DESIGN AND SOLUTION

S4A uses aerospace technologies, such as satellites and drones, and ICT technologies, to help local authorities and farmers monitor and manage the agro-food sector better. S4A refers to Lombardy, the premier Italian Region for agriculture, with more than 80,000 farmers who are responsible for a large proportion of Italy’s agricultural land and produce 42% of Italian rice and milk. A sub-set of these farms are involved in the Space4Agri study: their cultivation is being monitored by CNR-IREA researchers for scientific purposes and specific field measurements have been regularly taking place in the area for many years. The project adopts a multidisciplinary approach in which scientists engage with a wide range of stakeholders and sections of the public in an R&I process using satellite images, maps, drones and smart technologies.

The project is organised into three areas: Space, Aero and In-Situ ICT. Space focuses on the development of methodologies using satellite and in-situ data for mapping of crops, monitoring of their state of development and identification of possible states of stress. A series of optical and radar satellites were used to achieve this. In Aero, the DroneAGE prototype software was developed. For In-Situ ICT, the team created an interoperable spatial data infrastructure consisting of a geo-catalogue for research data and a geo-portal for viewing, return and customised



analysis of data and products (images, maps, time series of indicators) of interest to agricultural sector stakeholders (farmers and regional operators). The infrastructure is completed by Smart App S4A, available for free in the Google Play marketplace, which was developed for "smart" data collection in situ. The project was piloted during the summer cropping seasons in 2014 and 2015, in collaboration with three farms "District Lands of Lomellina" and regional operators of ARPA (Agenzia Regionale per la Protezione dell'Ambiente) and DG-Agriculture.

GRAND CHALLENGE BEING ADDRESSED

The agricultural sector is facing increasingly serious challenges due to continuing pressure from the global demand for food, and to the increase of price competition connected with the globalisation of markets and price volatility.

To meet the demand for food, the production of major cereals (maize, rice, wheat, soybeans) is expected to grow by 60% in 2050. In addition to its primary function of producing food, agriculture has further important roles: to protect the environment and the territory; to preserve biodiversity; to manage sustainable utilisation of resources and to contribute to the socio-economic survival of rural areas. The interest in sustainable agriculture combined with production output has received increasing attention from various stakeholders throughout society. The challenge is to combine the various viewpoints into a useful opportunity to understand the main challenges affecting society and the way in which science and technology can contribute towards answering them.

RESPONSIBLE RESEARCH AND INNOVATION

The research team has collected requirements from multiple stakeholders. S4A adopted an inclusive approach from the beginning of the project, involving farmers, agro-food entrepreneurs, agronomists, consultants and local authorities, making them co-design a part of the research and evaluate the main products. This procedure improved the project's socio-economic, environmental and technological impacts in terms of sustainability and acceptance.

The S4A engagement process also included science education activities that got schools and researchers involved in participative workshops during which they looked in depth at research questions such as: Can Earth Observation services support agriculture monitoring? How can a smart App be useful in an R&I project? How to prevent crop damage using modern research and technology? Students also implemented small research tasks encouraging a new form of science co-production involving Research and School. The researchers first identified the main target users and explored their "external needs". Thanks to the information provided by the respondents, a second round of more in-depth interviews was then conducted and further (new) beneficiaries were identified.

These two rounds of interviews gave the S4A researchers the chance to collect useful elements: the three domains of the Project reconstructed the state of the art based on their work, researchers gathered information on users' requirements and planned a co-designed workflow to meet the needs of the different stakeholders as far as possible.

During the research cycle, a second category of needs referred to as "internal", emerged and information on these was collected. These requirements emerging from mutual interactions between the three scientific domains revealed interesting issues relating to communication within and outside the scientific community and the perception of project co-design by all partners.

Experimentation took place on activities appealing to the younger generation through the proposal Researchers go to School (RgS): for two years 160 Lombardy high school students and ten teachers followed S4A (its steps, subjects, tools, activities) through participative workshops. Every school, depending on its specific area of study and interests, addressed one of the thematic areas of the project. This created an opportunity for researchers to be open to the general public and experience new languages: the whole proposal brought together students, farmers and researchers' points of view. The different perspectives on science, agriculture and innovation enriched the research procedures. In the months that followed, volunteer farmers and students were selected, trained and involved in collecting field data using the S4A smart App. In particular, they involved three secondary schools in technical and agricultural aspects through a series of meetings and lectures and through active participation by students in field testing the App S4A during the 2015 season. Further follow-up is through other IREA projects and a new H2020 proposal.

The methodology followed an iterative approach and involved many interactions and feedback sessions among partners and external beneficiaries. The tools of qualitative analysis in social research were used: in-depth interviews, supported by semi-structured questions with open answers, which were processed in interpretative grids. Communication to the stakeholder groups was directly through interaction with the stakeholders involved in the research and to a wider audience mainly via the S4A website. This provides open access to publications, services (app and geoportal), resources and a network. This platform was created to engage in simple, transparent communication to all stakeholders describing the research process, its activities, tools and objectives and it was updated over the course of the project. The aim was not to merely give an account of the products and results but also to describe the ongoing research activities and field campaigns. The information presented on the project's website has also been complemented with: a calendar of project events and outreach activities such as open days, workshops, demonstrations; regular bimonthly newsletters; presentations, workshops, and speeches given by the researchers and finally multimedia materials (photographs, audio, video) concerning the research events or products. Specifically the S4A researchers produced a video manual that introduces the S4A smart App and explains its functionalities; it was shown to students and to the general public at conferences, events and demonstrations.

EVALUATION AND DISSEMINATION

The research project is well designed with various researchers from different disciplines. The research group is moderately large and is well embedded with researchers from multiple research institutions. The research approach of S4A can be replicated for other projects based on environmental operations and services to assess environmental risks or natural resources management (e.g. water monitoring, emergencies). The findings of the research are relevant to farmers' organisations, policymakers, environmental managers and will benefit citizens in general. The research team has generated 38 publications in all. These included two international journal publications in *Journal of Science Communication,* five book chapters and 31 conference proceedings.