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MONALISA
Using science and
technology to monitor
environmental parameters
in the Alpine region

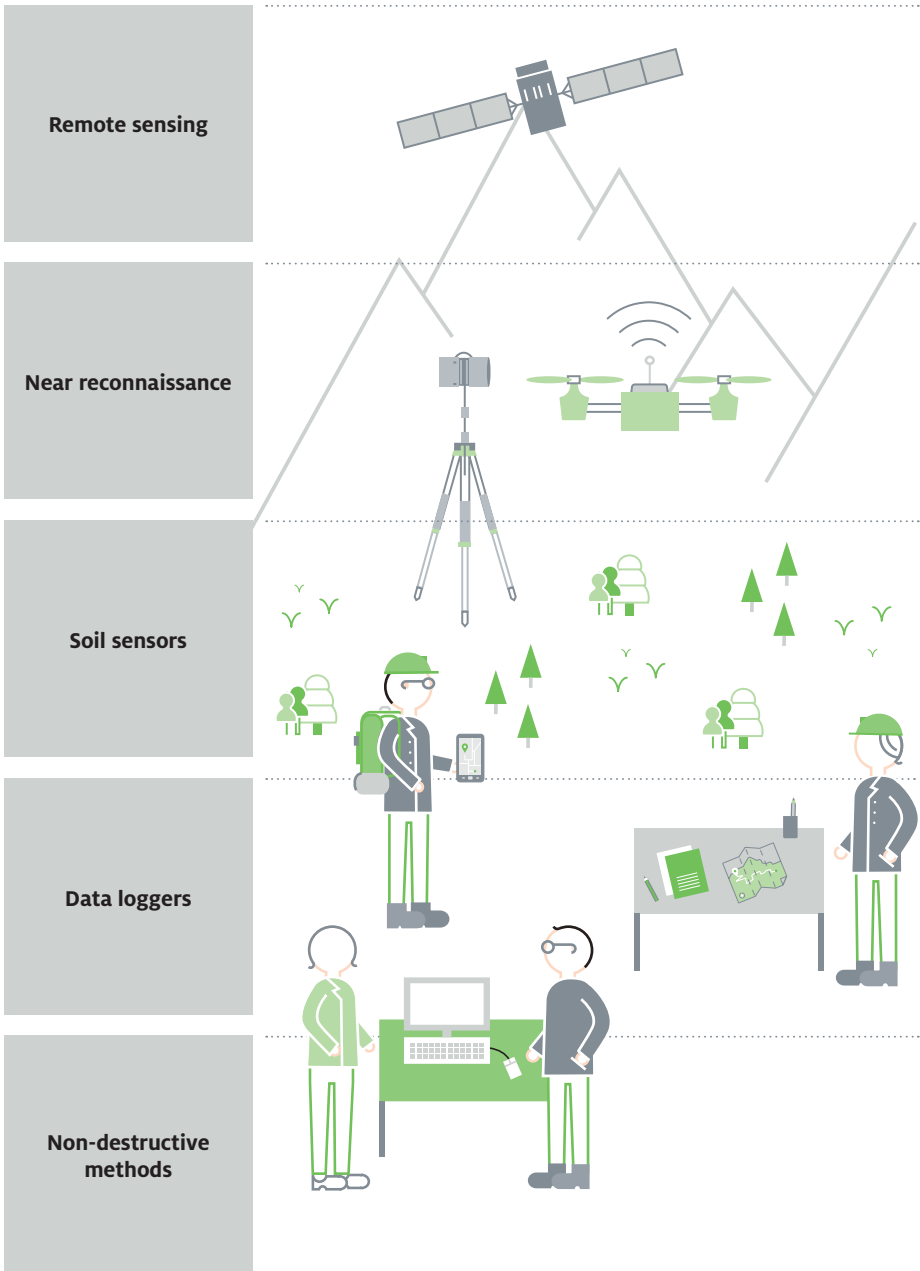
Everything under control: environmental monitoring from the orchard to the individual apple

The technological possibilities of environmental monitoring have developed enormously over the past few years. The MONALISA Project has combined the potential of various technologies and has gathered data for South Tyrol at different levels, from the smallest scale of the individual apple, to the whole orchard and all the way to data covering the whole of South Tyrol.

Thanks to this all-embracing monitoring, research is now able to gain new insights into the interrelationship between climate and environment, allowing farmers and foresters to plan ahead with greater efficiency. This is all the more important in a mountainous area such as South Tyrol, as the economic activity of the population is highly dependent on environmental conditions.

Observation from every angle: why MONALISA is so innovative

- earth observation satellites are regularly transmitting data giving us **information covering the condition of the entire region**, for example snow coverage, state of the vegetation, soil moisture
- drones allow **small-scale surveys of agricultural and forest areas**, for example tree heights, state of the vegetation or evaporation
- a whole network of sensors with 27 stations enable **constant observation of soil moisture and state of the vegetation** at a local level
- sensors in farm and forestry equipment **make it possible to monitor operational processes**
- after harvest, **the quality of the harvested products and their development during storage** can be investigated using the latest non-destructive procedures



Complete data cycle: quality control, processing, distribution etc.

What has changed as a result of MONALISA: improvements in five key areas

1. Water and carbon

Water is life. Especially in the Alps, the water cycle plays a very important role. Precipitation collects in the mountains and feeds the large rivers which provide water for the valleys and plains. Precipitation in the winter accumulates as snow which is then released in spring, when the vegetation requires water most. Researchers have examined parts of these processes in the MONALISA project. They gathered data on precipitation and soil moisture using a comprehensive network of measuring stations. They analysed the duration of snow cover, soil moisture and evaporation using satellite data and compared these with data from the measuring stations and various models. The results include methods and data which can be used to describe and analyse the dynamics of the water and carbon cycle in the whole of South Tyrol.



Analysis of the water and carbon cycle for the whole of South Tyrol

2. Soil and vegetation

Plant growth and yield in agriculture and forestry are closely linked to climatic conditions and exhibit wide seasonal variations. Extreme climate events such as a very hot and dry summer and the effects of climate change have a great influence on plant growth. In MONALISA researchers have developed methods with which they can make improved observations of the current status and the development of the vegetation over the course of a year (phenology). To this effect they used large-scale satellite data in order to investigate the phenology of the whole Alpine region. They employed a remote controlled drone to map the vegetation at high definition; a network of permanently installed cameras allowed them to observe vegetation development in real time. In addition they developed a system for investigating various forest parameters such as tree height and mass using laser-scanning data. Thanks to these methods, scientists will in the future be able to improve their understanding of vegetation growth and of how climate extremes and vegetation are linked.



Analysis of vegetation growth over the course of a year
in the entire Alpine region

3. Operational monitoring

Monitoring agricultural and forestry activities is highly complex, because there are courses of actions to be decided on and planned for systematically, which are frequently carried out at different points in time and cover a wide area. This operational monitoring can be automated by using digital business registers. These are electronic registers which record which pieces of machinery have been used and thus make it possible to track operational procedures. As part of the MONALISA project, researchers

have developed monitoring solutions for agriculture (fruit and wine growing) and forestry. Using these systems obviates the need for manual data entry. This in turn leads simultaneously to fewer mistakes and more rapid and efficient procedures. By managing and storing large amounts of business information one develops a 'historical memory' of the business, which is the basis for a modern and qualitatively high-value agriculture and forestry industry.



Development of prototypes for faster and more efficient operational monitoring

4. Fruit quality

South Tyrol has a long tradition of fruit growing, and the cultivation of apples has become the driving force for the industry over the years. With an annual production of around 1 million tonnes, South Tyrol is the largest contiguous apple growing region in Europe. For the producers it is essential that they constantly maintain the highest standards of quality. Using non-destructive methods they can for example analyse individual apples, remove damaged fruit and sort apples for selling by weight, shape and colour. With the latest technologies experts will in the future also be able to measure how crisp, juicy or mealy an apple is. As part of the MONALISA project, scientists have got South Tyrol apple producers to sit down together with the largest European producers of quality control machinery and to swap ideas about how best to exploit their individual competencies in order to meet the demands of the consumers for high quality produce.



Application of non-destructive methods for the quality control of apples

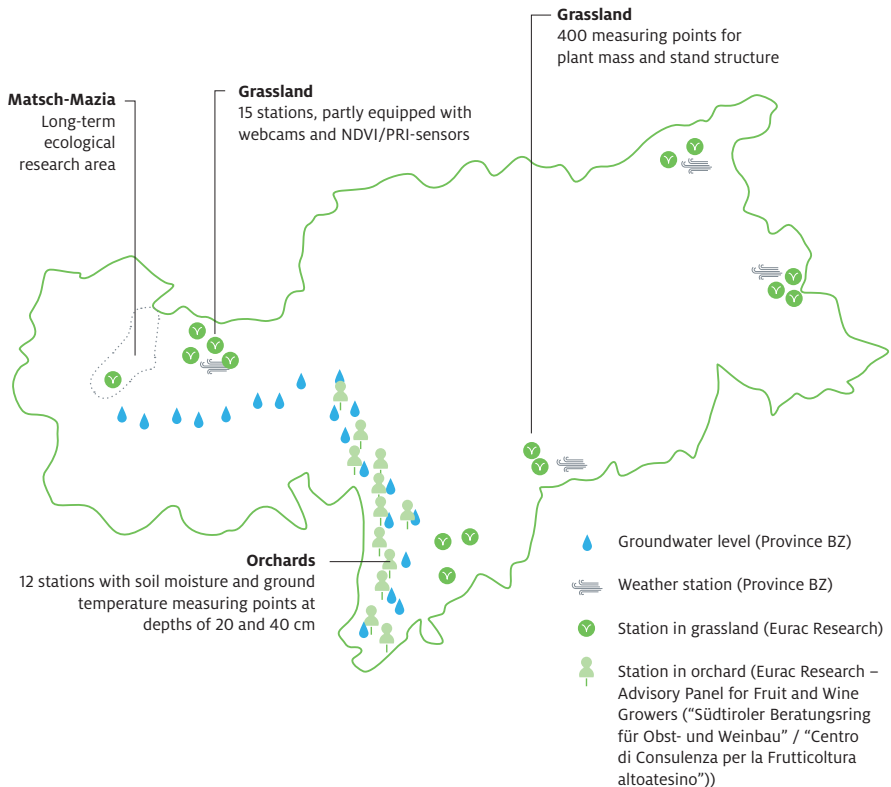
5. Database

The organisation and management of data is one of the research fields of the MONALISA project, and simultaneously the place where all the results of the other areas of the study are gathered. After collection, the data need to be organised, edited and made accessible. As part of the MONALISA project, scientists have developed a data infrastructure and an environmental database which make use of open-source technologies. They correspond to the international standards and protocols, they are mutually compatible and freely accessible. The environmental database can accommodate any kind of observation, including data from ground-based sensors as well as from laboratory tests. At the same time, data readings from apples in the orchard can for example be compared with the fruit once it has been harvested.



Development of a freely accessible database with a multitude of data gathered using different methods

MONALISA locations



Who is benefiting from MONALISA. A selection of specific case studies

The scientists are able to present the results of their research in a way that will make them immediately accessible to the various target groups: public administration, farmers, manufacturers of quality control machines for fruit. The project brings together various technologies, thus closing some of the gaps in environmental monitoring. At the same time, the relevant information is more precise and reliable for the end user.

Here are some examples:

- **South Tyrol Advisory Panel for Fruit and Wine Growers (“Südtiroler Beratungsring für Obst- und Weinbau” / “Centro di Consulenza per la Frutticoltura altoatesino”)**
Using the measured values obtained by Eurac Research, experts from the Advisory Panel were able to review their estimated values for soil moisture. This enabled them to improve their advice to farmers as to when and how much they should irrigate.

- **Hydrographic Office of the Autonomous Province of Bolzano-Bozen**

The monitoring network of the classic environmental parameters has been improved (e.g. temperature, precipitation, wind, snow covering). From now on, the Hydrographic Office has much more data to work on which, besides, is now more accessible and can therefore be additionally used to reinforce its measures for civilian protection.

Bridging the gap between research and business

Several local businesses have already explored new market sectors for innovative products and have invited other research partners to join them for further development. MONALISA partners are: CISMA, Mountaineering, Geco Sistema, TerritoriumOnLine.

The collaboration between these partners developed initially between one individual business and the Research Institute. As for intellectual property rights, the partners involved were granted the right to use the results, as well as publish or exploit them commercially. In addition, several events around experts and workshops involving end users were organised in order to secure further business and research partners for projects and to appeal to a wider public.

The future – in the Technology Park

The huge innovative potential of MONALISA rests firmly with the established pathways and the collected data. Right from the development stage, the scientists have been working closely with the end users, such as the South Tyrol Advisory Panel for Fruit and Wine Growers, with the farmers and the cooperatives. Many of the technologies in question have been adapted in conjunction with South Tyrol's businesses and then developed further. This collaborative approach is due to be continued in the future. The NOI Technology Park will be the venue for the partners of MONALISA to continue their collaboration with other businesses in developing innovative technologies.

Some of the project outcomes – especially those relating to the data base – will be fully incorporated in the field of activity of the Techpark following the establishment of the Laboratory for Environmental Sensor Technology by Eurac Research. The aim of the laboratory is to process high quality services in the area of environmental monitoring and to deliver technological solutions which in turn will benefit various social and economic aspects such as Alpine Technology, agriculture, natural disasters and tourism.

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