MULTI SENSOR SOIL SENSING TOOL

For Farmland in Spain

F.M. van Egmond, R.L. Koomans, Medusa Explorations BV www.medusa-online.com

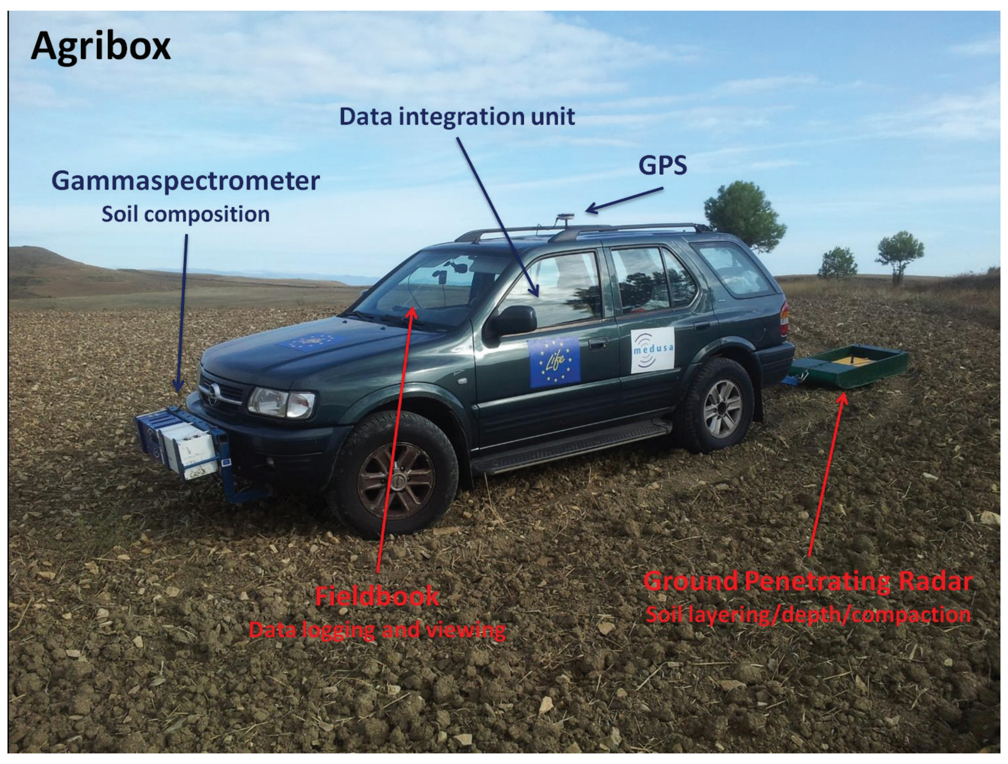
Crops for better soil

GEO INFORMATION

Agribox

A fast, efficient, flexible and robust setup for mapping farmlands.

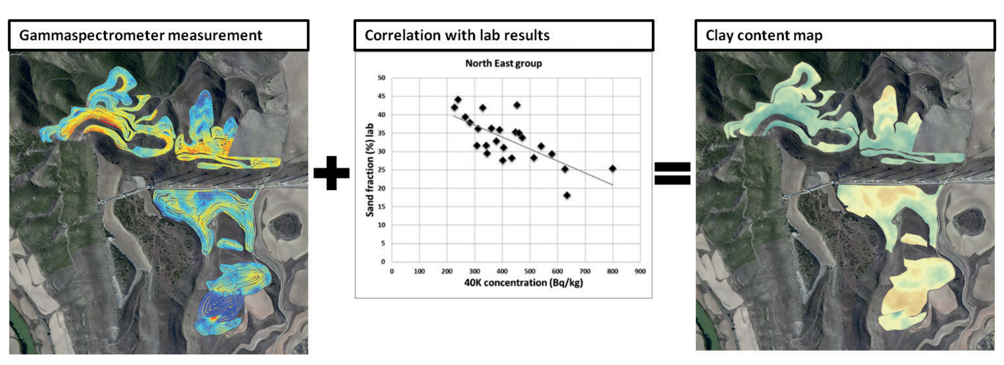
- Gammaspectrometer MS4000 (4L CsI Medusa)
- GPR (500 MHz ZOND)
- GPS
- Data integration unit
- Fieldbook



Geo-information for farmlands in Spain

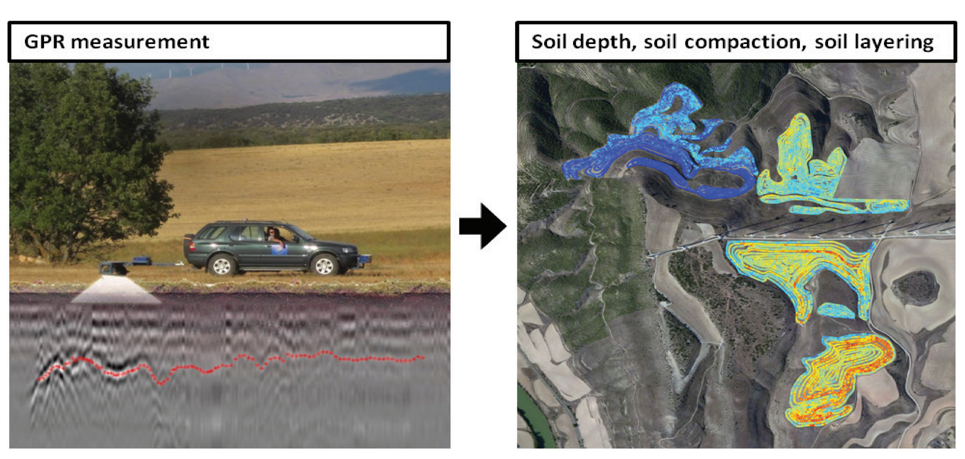
Gammaspectrometer for clay and sand content

Calibrated nuclide data (full spectrum analysis[1] using Gamman software) correlates to lab results of soil sampling on representative locations (R^2 0.5-0.8) per provenance group[2,3]. We have 4 groups of 11 to 25 samples each.

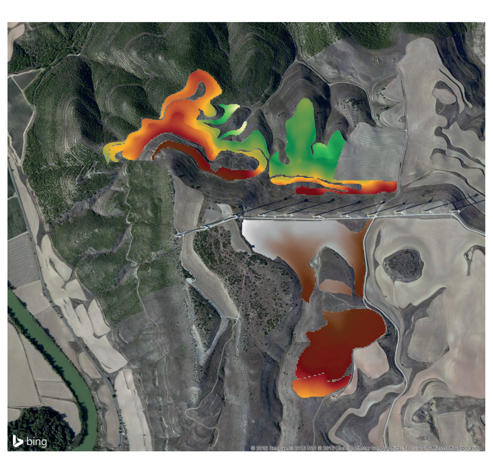


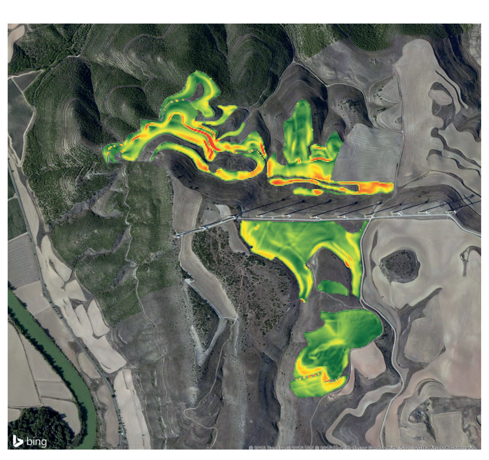
Ground Penetrating Radar (GPR) for soil rooting depth, compaction, layering

Time slice analysis of topsoil and subsoil aided by GPR imagery, gammaspectrometer results, field observations during measurements and open data (LIDAR based DEM, geology, BING imagery).



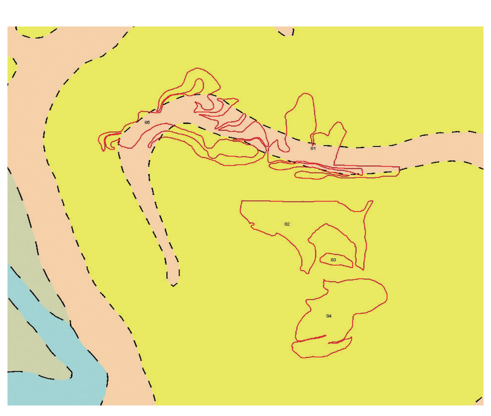
Open Data supplied by IGME[4]


DEM Falces


Slope Falces

Open Data

- Digital Elevation Model (DEM) MDT05-LIDAR
- MAGNA 50 geological maps
- Derived maps (slope, lithology, age)
- Aerial imagery


Geology Falces

UNDERSTANDING SOILS

Generating geo-information is a first step in the process of generating knowledge on soil properties. The information forms a good basis for communication with experts, farmers and agronomists.

Field validation

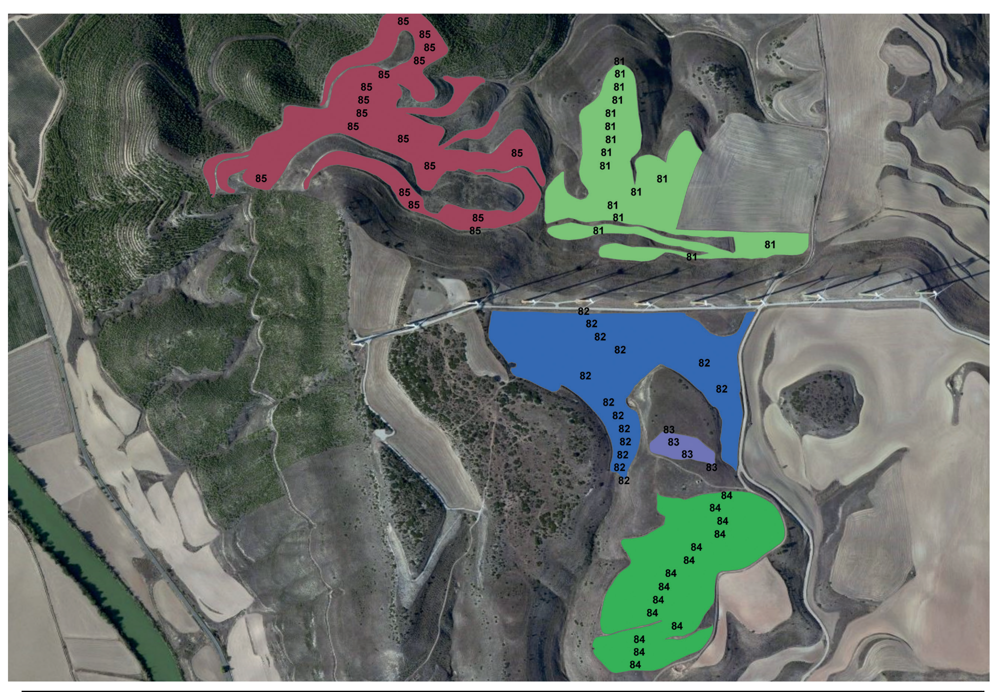
Adding information from local soil pits, quantifies the geo information with knowledge of soil experts. The locations of these pits are selected based on the anomalies found in the geo-information.

Expert knowledge

Knowing the history of the field (management) and its characteristics as experienced by the farmer improves interpretation. Discussions between geo and soil experts and field experts (farmers) help both to understand the variations in the maps.

Local assessment

Qualitative information from the user and quantitative geo-information are explicitly incorporated in the analysis and communication. As a result the user will understand and trust the result and qualify the data as a true representation and quantification of his field. He is therefore more likely to use the data for management decisions in smart farming (precision agriculture). It allows him to enter his knowledge in his (GIS based) farm management system and use it in eg. task maps.
As a result of the analysis the information is summarised in a table which links to the maps with an id.



region	Navarra	Navarra	Navarra
area	Falces	Falces	Falces
farmer	Jesus Aranda Torres	Placido Tainta Ausejo	Jesus Aranda Torres
years organic 2012	20	5	20
field	81	82	85
slope	Level	Level	Flat
max slope	Steep	Moderately steep	Steep
geology	limestone with marls	limestone with marls	limestone with marls
texture	25-35 % clay	25-30 % clay	25-35 % clay
texture variation	more clayey uphill; freshly eroded sediments?	more clayey uphill	more clayey uphill; freshly eroded sediments?
changes in texture	no major differences	no major differences	no major differences
differences structure topsoil	rel. denser topsoil; patterns comparable	differences perhaps related to compaction	topsoil/ subsoil patterns are the same
differences structure subsoil	in NW part of the field geologic layer at 120-80 cm	middle of the fields has accumulated soil	some geologic layers visible
compaction	perhaps	little	little
compaction increased	-	probably not	-

OUTLOOK

We showed that soil mapping is not only about generating geo-information, but that generating knowledge of agricultural fields also requires effective communication.
Maps of soil properties can be a tool for communicating about farmlands. The GIS-based knowledge of soils has an added value application in various types of land management, varying from vineyards, (irrigated) high-value crops, field trials and agroforestry to organic crop lands.

SOIL FOR BETTER CROPS

The methodology was developed and applied within the 'Crops for better soil'[5] EU LIFE+ project LIFE10/ENV/ES 471.

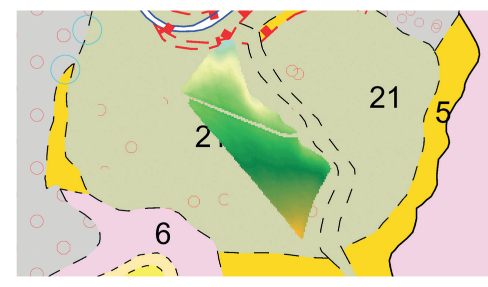
The aim of the project (2011– 2016) was to demonstrate sustainable farming on 400 ha of land in the north of Spain. This was achieved by changing to organic farming, by introducing traditional crops suitable for local conditions and by enhancing crop rotation. This required a thorough understanding of the soil and fields and its crop growth possibilities.

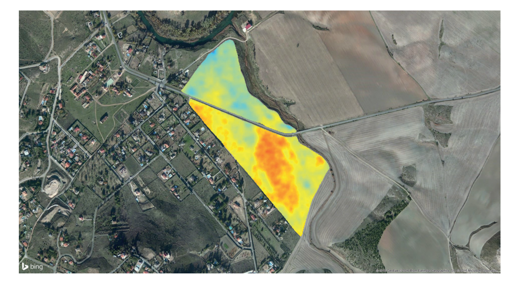
The results of the project are promising and show how farmers can improve financial yields and soil quality at the same time.

Application example: Illana

(Guadalajara, Castilla-La Mancha, Spain)

The main maps of two neighbouring fields in Illana are analysed on soil characteristics





The DEM/DTM (left) shows a slight decline northward but no steep slopes. The geology (left) of the fields and parent material is equal. The aerial photograph (right) shows a small river flowing to the north of the field.
The texture (40K, right) shows a consistent pattern on both sides of the road. The red colours on the texture map indicate a higher concentration of 40K which is a proxy of a lower sand fraction and a higher clay content. The southern field contains more clay in the topsoil than the northern field.

The soil structure marked yellow ("time slice") shows higher reflection values in the 0-20 cm topsoil (left) in the north of the southern field. This corresponds with a higher concentration of stones, continuing below 20 cm depth. At the north-eastern part of the field higher values correspond to compaction of the soil. The subsoil (right) on the southern field is more compacted than the topsoil and comparable to the subsoil at the northern field. This is expected based on the geology. On the northern field we also observed more stones at the soil surface, thus explaining the higher reflections in the topsoil timeslice.

OUTLOOK LIFE PROJECT

The project developed an approach for sustainable organic farming in semi-arid conditions (Spain). Key in this approach is the methodology for fast, efficient and detailed soil mapping.

A business case successfully demonstrated how sustainable farming increases financial benefits for farmers and as a result, one farmer is converting 500 ha to organic farming and will continue experimenting.

REFERENCES

1. Hendriks, P.H.G.M., J. Limburg, R.J. de Meijer. [2001] Full-spectrum analysis of natural Gamma-ray spectra. *Journal of Environmental Radioactivity*, 53, 365-380
2. Van der Klooster, E., F.M. van Egmond, M.P.W. Sonneveld. [2011] Mapping soil clay contents in Dutch marine districts using gamma-ray spectrometry. *European Journal of Soil Science*, 62 (5) 657-764.
3. Van Egmond, F.M., E.H. Loonstra, J. Limburg. [2010] Gamma-ray sensor for topsoil mapping; the mole. In: R.A. Viscarra Rossel, A. McBratney & B. Minasny (eds.): *Proximal Soil Sensing*. Springer, Dordrecht, 323-332.
4. IGME http://mapas.igme.es/Servicios/default.aspx
5. www.traditional-crops.com / www.cultivos-tradicionales.com

VISIT US IN BOOTH 10!

F.M. van Egmond, R.L. Koomans, Medusa Explorations BV, Verlengde Bremenweg 4, 9723 JV GRONINGEN, The Netherlands
www.medusa-online.com Ronald@medusa-online.com

medusa