Report on the final hydrogeological and agricultural conditions of the Italian site (after the realization of the mitigation interventions)

Deliverable D_3.1.5

Contributing partners:

PP1 – CNR IGG

LP – UNIPD DICEA

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1. Introduction

MoST WP3.1 Action (Venice coastal plain) aims at characterizing the Italian site in terms of hydrogeological conditions after the realization of the mitigation strategies. Specifically, a sub-irrigation system through drainage pipes was established along a sandy high-permeable paleo-channel crossing the farmland.

This report includes a) data and observations on the salt-water contamination condition of the phreatic aquifer interested by the mitigation system and on the stratigraphic architecture surrounding the pipe in order to evaluate the impact of the intervention; b) agricultural conditions (i.e., soil productivity) before and after the drain pipe installation and first year of functioning .

2. Study area

The study area is located in a low-lying farmland just south of the Brenta and Bacchiglione rivers at the southern Venice lagoon margin (Fig. 1).

The area is characterized by Holocene deposits containing sandy paleo-channels and paleo-coastlines forming surficial high permeable sandy lenticular geomorphological bodies (see Doc MoST-CNR 3.2-005), representing preferential flow pathways. For this reason, a tidal paleochannel crossing in NNE-SSW direction the farmland has been chosen to host a freshwater sub-irrigation pipe (see Doc MoST-CNR 4.2-008; Fig. 2).

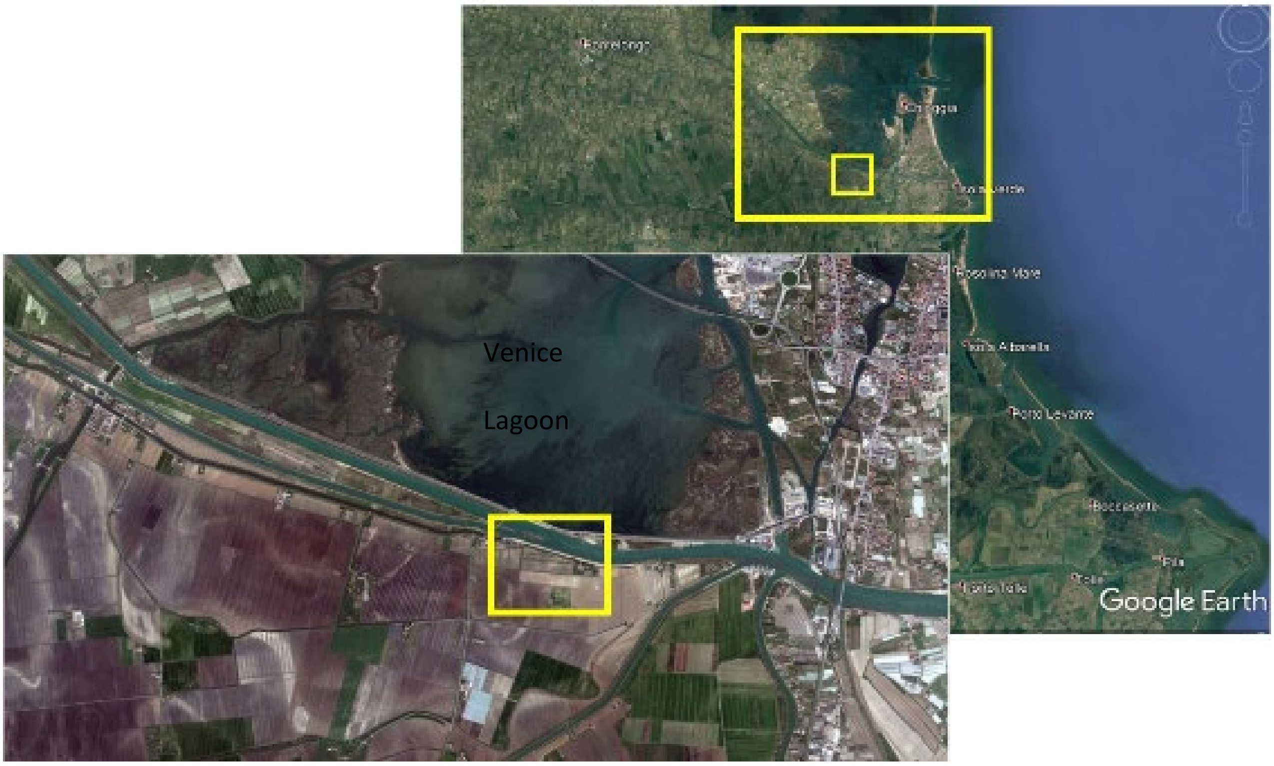

Fig. 1 - Location of the study area and the pilot test site.

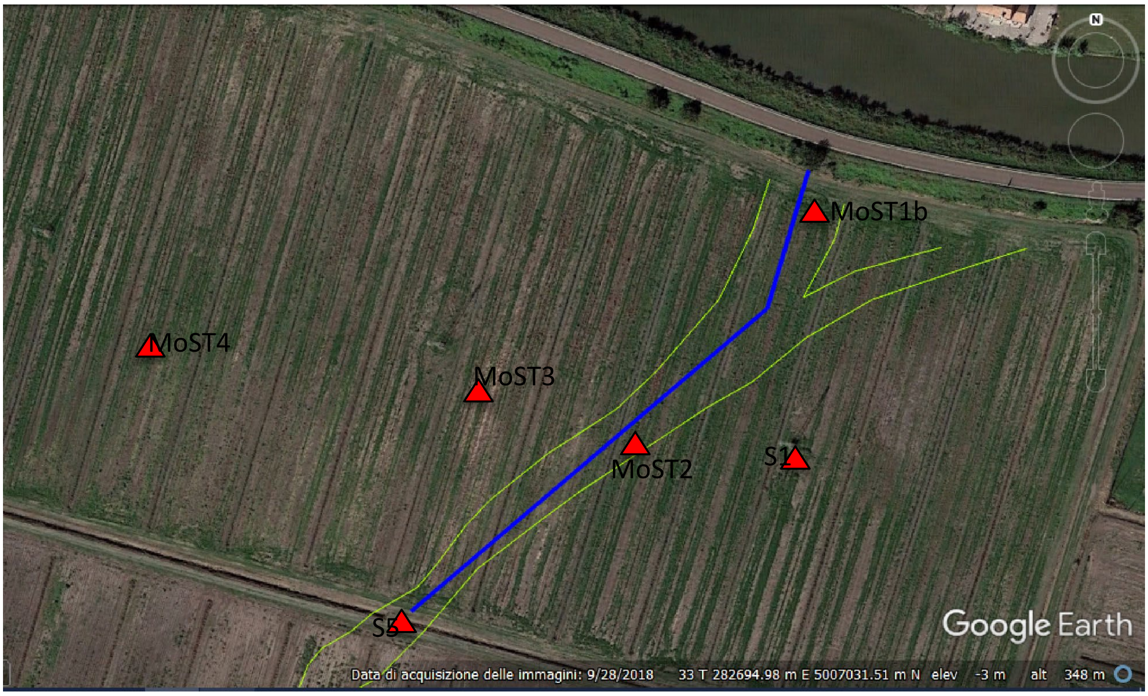

Fig. 2 - Location of the sub-irrigation pipe (blue line). The geomorphological structure is indicated by green lines. The red triangles indicate the wells monitored to characterized the salt-water contamination of the phreatic aquifer after the installation of the pipe.

3. Installation of the drainage pipe

The works for the installation of the drainage pipe started in October 2020 and finished at the beginning of November 2020 (Fig. 3).

A trench around 2 m deep has been excavated along the selected path, around 220 m long. The pipe has been located at a depth of 1,7 m from the ground level. T The functioning and the mitigation effectiveness of the mitigation infrastructure has been preliminary tested in November 2020, March 2021 and Summer 2021. For further information see DOC n. MoST-CNR 4.2-008.

Fig. 3 – Excavation of the trench and positioning of the pipe.

4. Salt-water intrusion condition of the phreatic aquifer

The Salt-water contamination in the phreatic aquifer, after the installation of the sub-irrigation pipe, has been monitored through periodic measurement of EC vertical profiles in piezometers located in the surrounding of the intervention. Fig. 4 to Fig. 9 reported the measurements obtained between January 2021 and October 2021 (see Fig. 2 for the localization of the selected wells).

MoST1b is the northernmost well potentially influenced by the installation of the pipe. It is located at the northern end of the pipe, next to the water catchment on the Canal Morto. The EC recorded in this well roughly varies between 22 and 47 mS/cm, showing lower values at the top and higher values at the bottom of the aquifer.

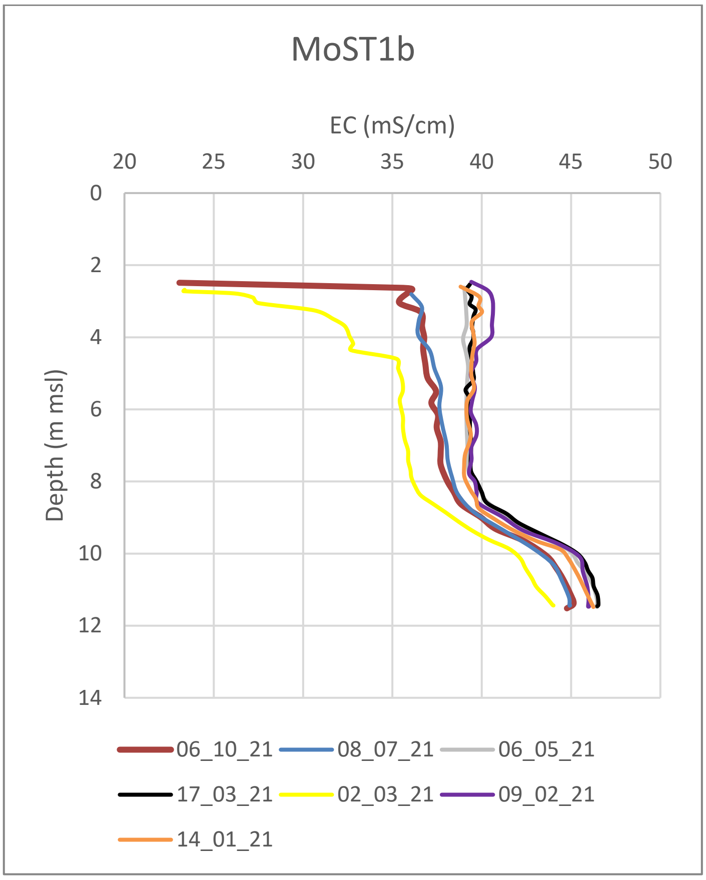

Fig. 4 – MoST1b EC vertical profiles recorded between January and October 2021.

MoST2 well is located along the path of the sub-irrigation pipe. The EC values recorded in this well varies between about 5 and 40 mS/cm, presenting the fresher water in the first meter of the aquifer, configuring a freshwater lens.

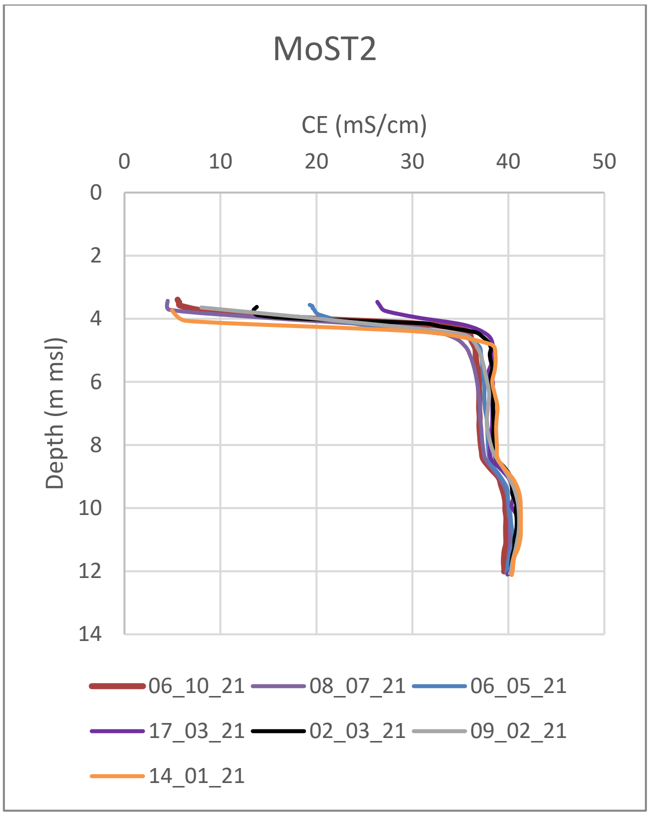

Fig. 5 – MoST2 EC vertical profiles recorded between January and October 2021.

MoST3 well is located about 50 m to the west in respect to the sub-irrigation pipe pathway. The EC recorded in this well show values between 25 and 35 mS/cm without showing a vertical stratification.

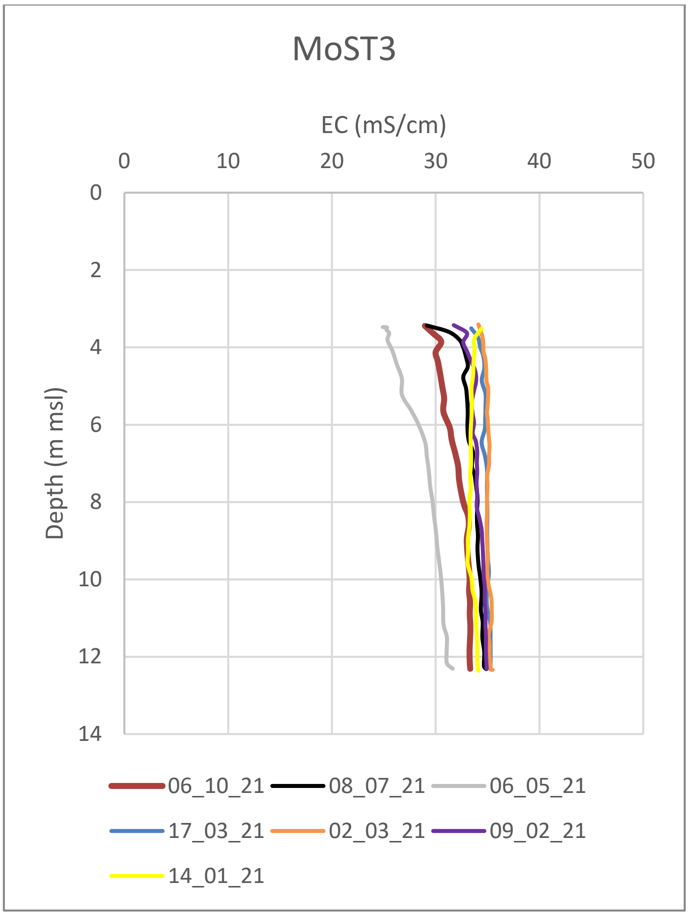

Fig. 6 – MoST3 EC vertical profiles recorded between January and October 2021.

MoST4 is the farthest well from the pipe, considered to analyze the hydrogeological conditions of the site. It shows EC values roughly between 25 and 33 mS/cm, without showing a vertical stratification.

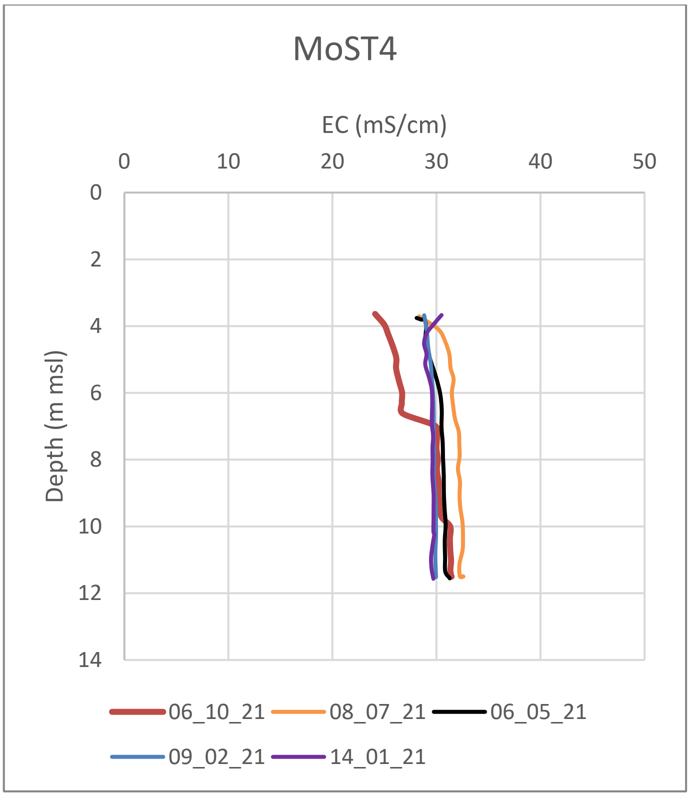

Fig. 7 – MoST4 EC vertical profiles recorded between January and October 2021.

S1 well is located around 50 m to the east of the sub-irrigation pipe. The EC recorded show values between 40 and 50 mS/cm without showing a clear vertical stratification.

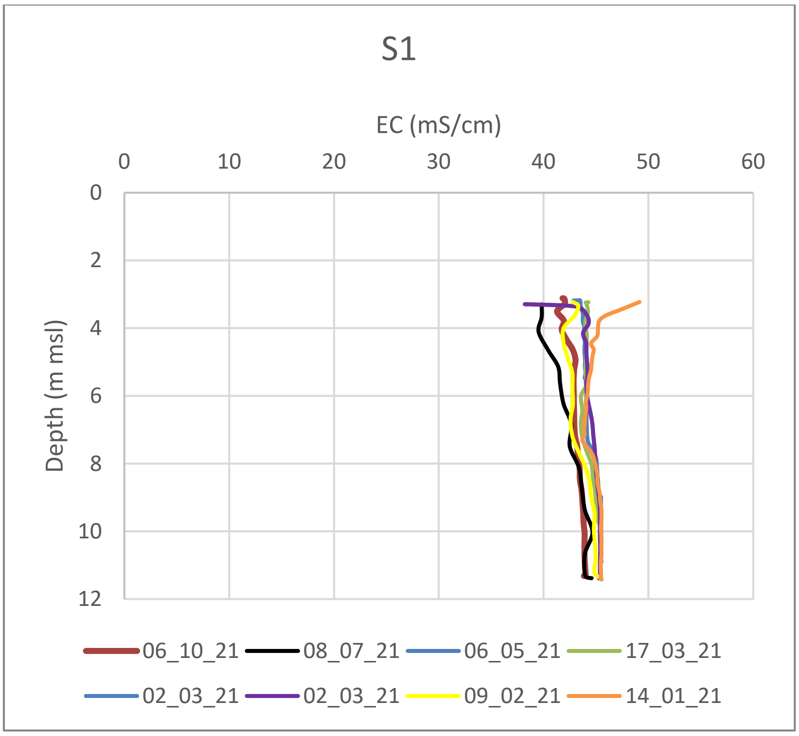

Fig. 8 – S1 EC vertical profiles recorded between January and October 2021.

S5 is the southernmost well considered to characterized the hydrogeological conditions of the Italian site after the installation of the pipe. It is located beyond the cut-off wall at the southernmost end of the sub-irrigation system. The EC show values around 25-27 mS/cm without a vertical stratification.

The collected EC data testifies a salt-water contamination condition of the phreatic aquifer comparable with the conditions existing before the installation of the pipe (see Doc MoST-CNR 3.1-009). The variability recorded in some piezometers (i.e. MoST1b and MoST2) is considered to be related to seasonal variability in freshwater input (i.e. leakages from the Canal Morto, precipitation events).

In conclusion, according to the dataset acquired after the installation of the mitigation intervention, the latter one does not have a significant impact on the hydrologic condition of the phreatic aquifer.

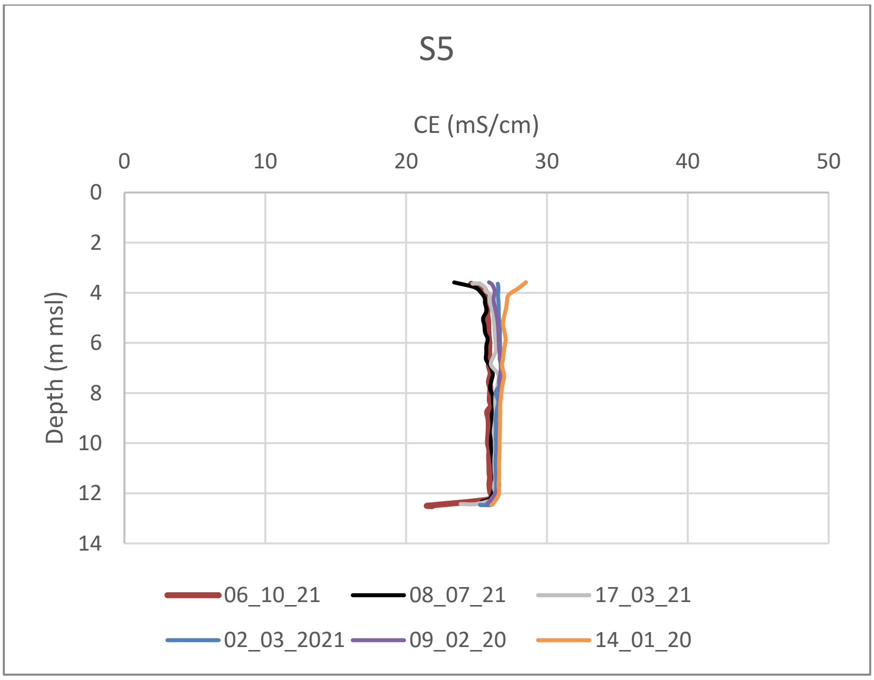

Fig. 9 – S5 EC vertical profiles recorded between January and October 2021.

5. Architecture of the subsoil before and after the installation of the sub-irrigation pipe

The stratigraphy of the pilot test area and, in particular, of the surroundings of the selected pathway for the installation of the sub-irrigation system has been studied through sedimentological analyses of the sediment cores and field observation and investigations realized directly during the excavation of the trench (see Doc MoST-CNR 3.2-005).

The stratigraphic architecture of the first 1.8 m of the subsoil is reported in Fig.10, before and after the mitigation intervention.

On the left the stratigraphy before the installation of the pipe has been sketched. The subsoil is composed by the superposition of 3 main sedimentary bodies, interpreted as facies associations (see Doc MoST-CNR 3.2-005), described in the following from the bottom to the top:

- FA5 is a sand body with abundant shells and shell fragments and vegetal remains interpreted as littoral sands.
- FA 6: sand to silty sand with vegetal remains, particularly abundant at the base, and rare shells and shell fragments. This unit corresponds to the surficial geomorphological sandbody, and it is interpreted to be deposited in a lagoon environment, specifically within a tidal channel.
- FA7: discontinuous deposits of the uppermost subsoil layer, comprising the arable land. It contains sand, silt, peat, peaty clay layers or clay levels with abundant vegetal remains. This facies testifies the occurrence of the marsh environment existing in the area before the hydraulic reclamation, occurred at the beginning of 20th century.

On the right of Fig. 10 the same stratigraphic section has been sketched, considering the works carried out for the excavation of the trench and the positioning of the pipe. The original stratigraphic architecture has been completely mixed up by the digger, as a result, the stratification of the subsoil in the surrounding of the pipe ended up being obliterated.

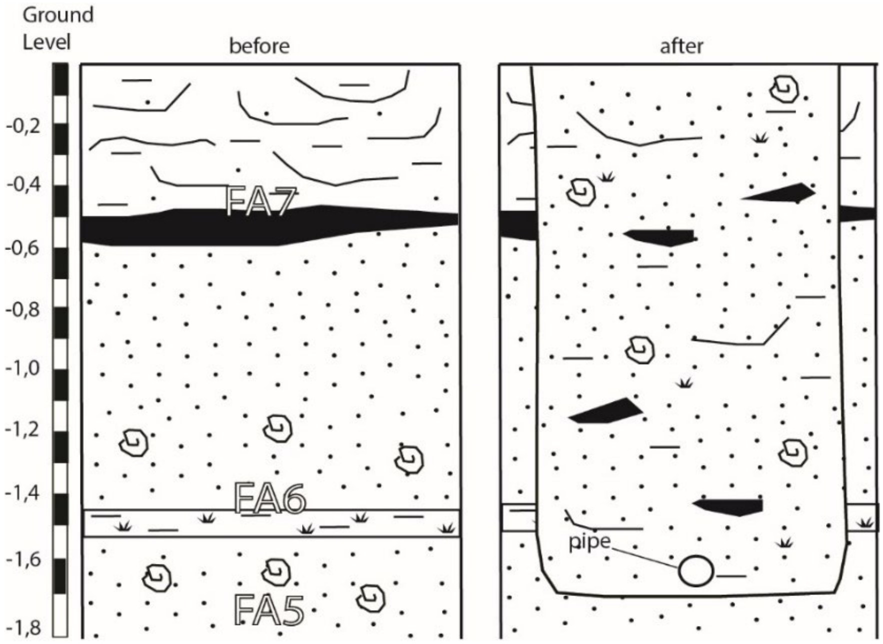

Fig. 10 – Sketch of the first 1.8 m of the subsoil in the surrounding of the selected pathway of the sub-irrigation system, before and after the installation of the pipe.

6. Agricultural conditions

Yield data were recorded using the Claas yield monitoring system mounted on a Lexion 750 TT combine harvester. Yield sensors measured yield and grain moisture while geographic coordinates were recorded using GPS satellite data. The yield points were automatically up-loaded into a cloud platform (Telematics) and a point layer was obtained by using a geo-graphical information system (GIS). Geostatistical tools (kriging) were then used to obtain a continuous map. Yield maps (Fig. 11) show some similarities: for example, low production was gained in the red area located in the southwest part of the experimental site because of the high sand content and deep groundwater. On the contrary, the highest productions were always gained in the blue central-east part of the site. The average dry yield was quite similar in 2019 and 2020 with 8.1 t/ha and 8.4 t/ha, respectively, while it decreased in 2021 with an average of 6.3 t/ha.

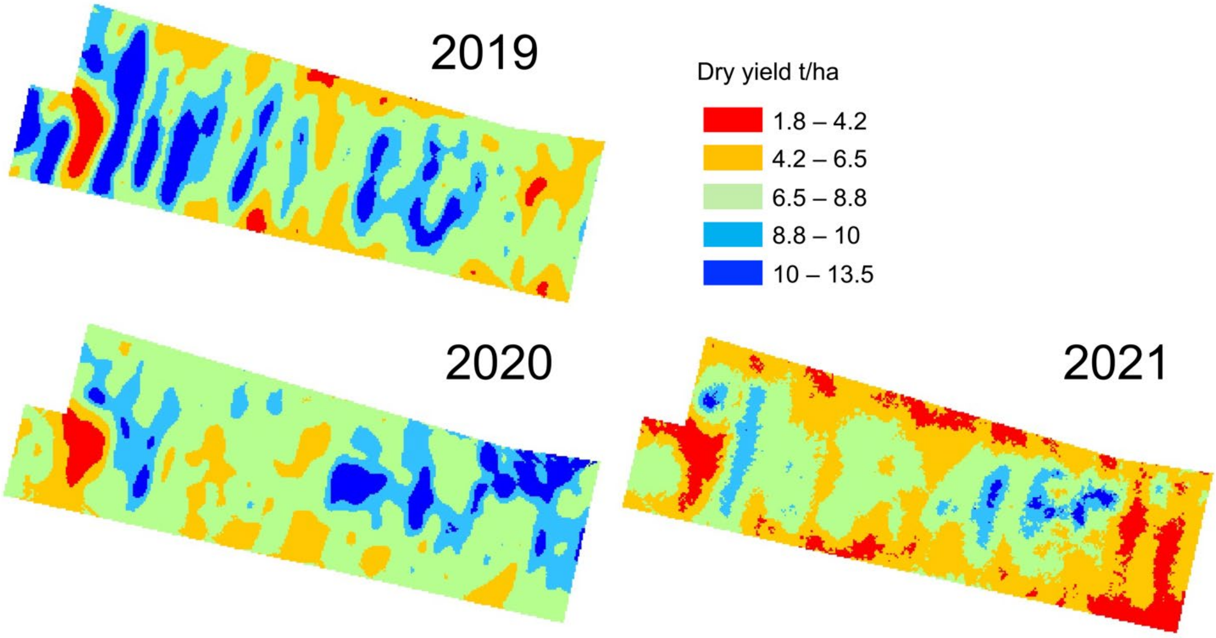

Fig. 11 – Yield maps of 2019, 2020 (before the drain pipe installation), and 2021 (after the drain pipe installation).