# Experiment of the use of geosynthetics for the drainage in place of draining masks – Hydraulic properties and sustainability

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ABSTRACT: An experimental site was chosen to compare hydraulic properties of a geosynthetic and granular materials used for the drainage in earthworks to ensure slopes stability with draining masks. This paper presents the way the instrumentation was installed, and how this experimental site was monitored in order to follow the behavior of the geocomposite, the evolution of the flow during seasons, with respect to the traditional way, and to appreciate potential clogging. First results are available and consistent: they show both techniques protect grounds below from rain infiltration and frost, that water occurrences are drained, with a distinction between the two techniques. Those conclusions are so far only based on five months data, so the experiment must be followed further months to appreciate behaviors regarding to different seasons, and several years in order to appreciate clogging and stability problems.

*Keywords: geocomposite, drainage, flow rate, water content, clogging*

## 1 INTRODUCTION

Transport infrastructures (roads, airports and trains) are using several thousands tons of materials for their construction. The quality of these materials may vary a lot, and therefore there is a great concern to optimize their use. This is particularly the case on train infrastructures where the network is very quickly several hundreds kilometers long. Furthermore, in order to prevent the use of granular materials and to limit the number of vehicles movements and related $CO_2$ emissions, the environmental concern for a sustainable use of material resources and environmental construction impact can be more acute. This is specifically the case for excavation situations, with large and high slopes. Such configuration is chosen for safety reasons to avoid landslide in case of water occurrence. In these cases, the traditional construction will go for the use of large amounts of materials with draining masks.

There is also an alternative that Réseau Ferré de France (RFF), the entity in charge of the French train network, accepted to experiment. It is based on the use of a geocomposite drainage layer, covered by treated marls on a slope, partially high of clearing, on the high-speed train line (LGV in French) site, near Morhange (north Est of France). The geocomposite provides a directional flow capability, which ensures the stability of slopes. Identified drawbacks are the issues about the lifetime of such solution, the geocomposite and small drains clogging.

An experimental site was then chosen to test this alternative and perform tests to answer those questions. The main objective is to control the stability of the system, and its hydraulic performances, compared to the traditional solution with granular material.

This paper presents the way the instrumentation was installed, and how this experimental site was monitored in order to follow the behavior of the geocomposite, the evolution of the flow during seasons, with respect to the traditional way to treat slopes with coming water, and to appreciate potential geocomposite clogging.

## 2 ELABORATION OF EXPERIMENTAL PARTS

The main difficulty of the choice was to find a bank remotely located from rail tracks, in its high part (requirements for safety measures), and with water occurrences to allow the comparison. This choice is illustrated on Figures 1 and 2.

Figure 1: site global view

Figure 2: water occurrences (dark areas)

Experimental parts have a surface of 525 m² each (15mx35m) and were elaborated in April 2013, with Eiffage, in charge of earthworks. The traditional part consisted in aggregates provided by the infrastructure owner, with a thickness of 50 cm. As shown on figures 3 and 4, ditches were created down below each testing area, in order to collect water occurrences.

Figure 3: traditional experimental part

Figure 4: geocomposite experimental part

The geocomposite layer used consisted in an AFITEX product, Somtube 750 FTF2 d25, composed as shown on Figure 5, by:

- a filtering blanket,
- a draining blanket,
- perforated mini pipes of 25 mm diameter, with a 50 cm space,
- a filtering blanket.

Figure 5: section of geocomposite

The dimensioning parameters are:

- maximum pressure applied on the geocomposite,
- slope inclination,
- descending gradient of the slope,
- nature of topsoil, here 50 cm of marls, treated on site.

## 3 INSTRUMENTATION AND ASSOCIATED MEASUREMENTS

In addition, many instruments were installed, such as ones providing soil water content probes, temperature ones and water flow measurements. Rainfall is also recorded on site. The figure 6 shows the implantation of the different probes and instruments.

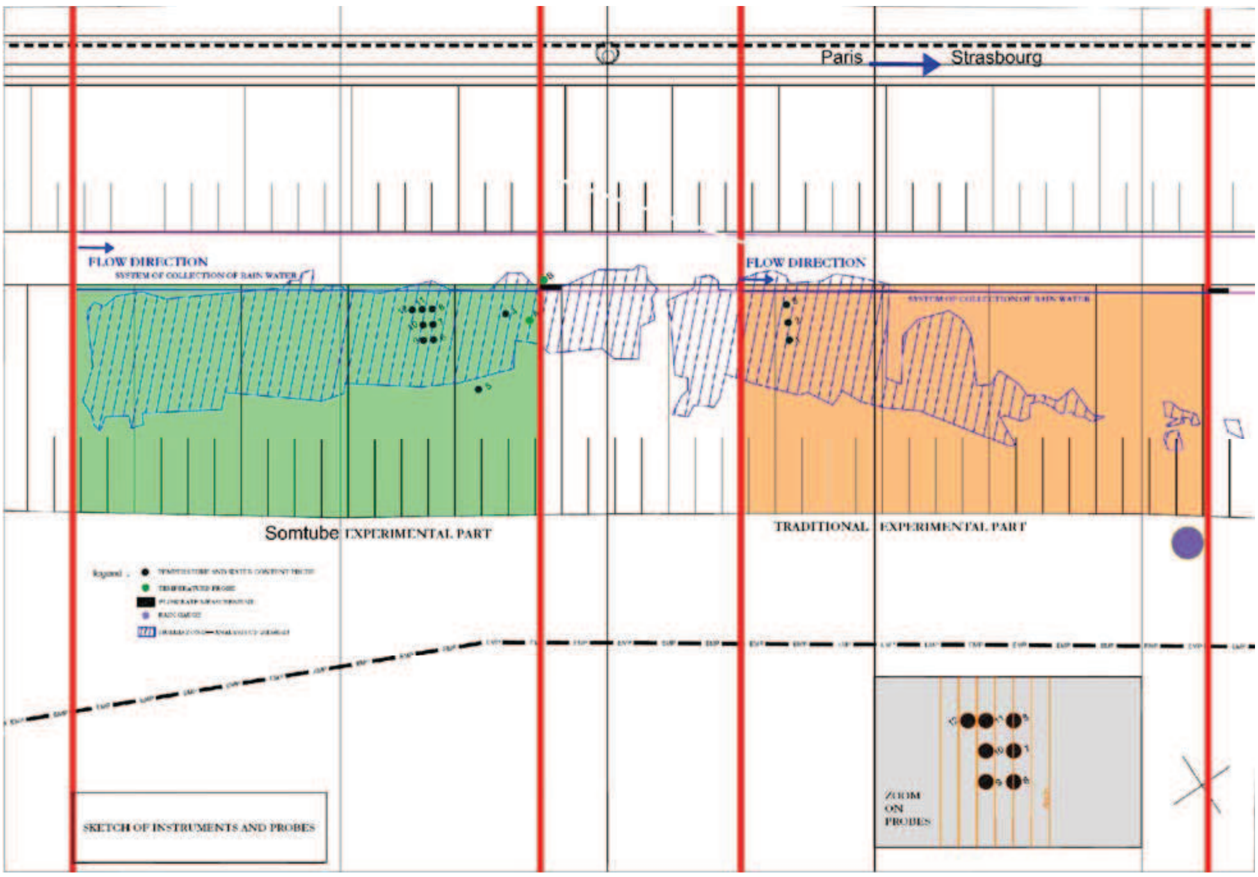


Figure 6: instrumentation implantation

The idea is to monitor water contents at the interface between the aggregates or the geocomposite and the ground, to improve the data safety with a redundancy based on a small tank of the appropriate size for water collection, and ultrasonic level probes with a 0.5 mm sensitivity to cope with weak water flows. This will allow a greater characterization of water "bleeding" from the slope after a rainfall, and then the respective evolutions of water flows in both technical solutions (large amounts of materials versus the geocomposite). A water flow gauge was installed downstream of the trench collecting water of the slope. Nine probes determining soil water content and temperature (were located at the interface between the slope and the draining system (three right below small draining devices, numbers 6,7 and 8 on the Figure 6, three between them at three different depths, numbers 9, 10 and 11,and three at specific locations such as identified incoming water points, 4 and 12, or a dry place, 5). A temperature probe was also installed within one small draining device, A, while another monitors temperature in the chamber, B ; this chamber shelters instruments from adverse weather conditions. All dataloggers where the instruments are connected to were left on the site with an energy supplier for their autonomy. Illustrations of this instrumentation are provided on Figures 7 and 8.

Figure 7: temperature and water content sensors

Figure 8: chamber with flow rate measurement

## 4 FIRST RESULTS

After some riskiness of worksite and instrumentation delaying the availability of the measurements and generating missing data (data logger issues, electrical power supply, drowned data logger), first results are available and consistent. Figures 9 to 13 are giving measured parameters as a function of time with the corresponding rainfall conditions.

### 4.1 *Water contents*

There were some interruptions in the acquisition, due to battery or acquisition failures. But, with over 5 months of data recording, first tendencies are now observable.

With respect to interfaces between aggregates and natural ground, the three observed variations indicated constant values (Figure 9).

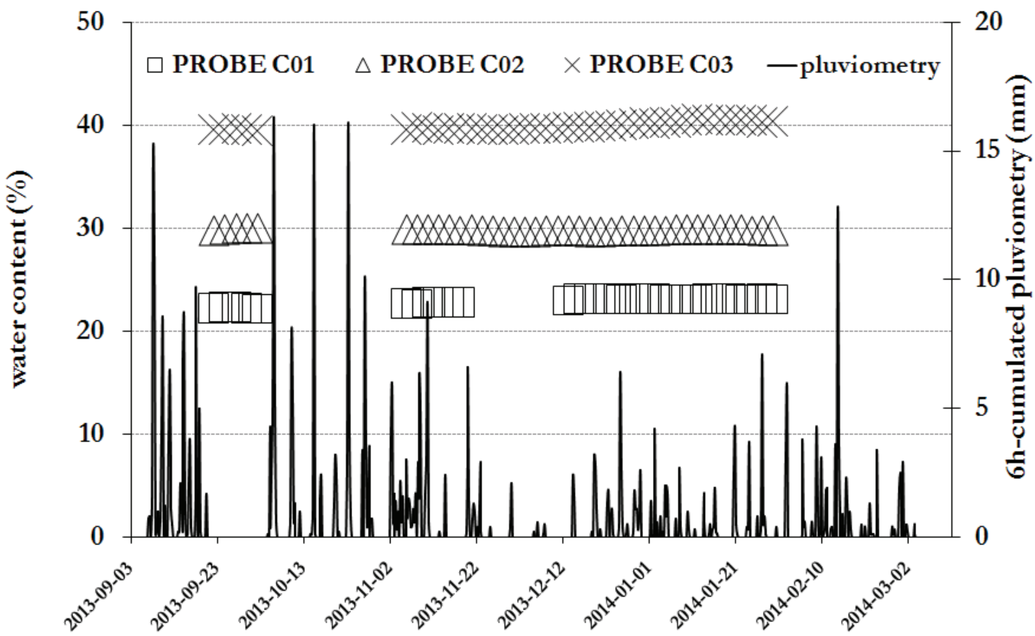

Figure 9: water content on traditional part

With respect to the geocomposite, several variations were observed (Figure 10):

- Constant values, or with no significant variations,

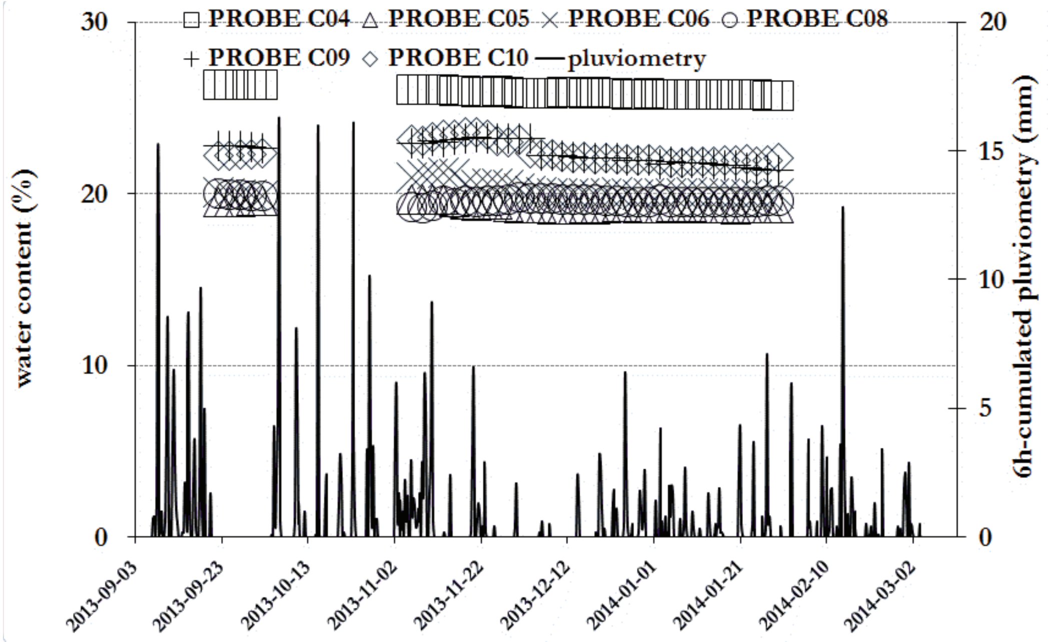


Figure 10: water content on geocomposite part

- Values with quick and large variations to significant rain episodes either in intensity and/or duration, with similar profiles (Figure 11). There are then two hypotheses: either the probes are defective, or materials in which there are embedded are contain a greater amount of aggregates.

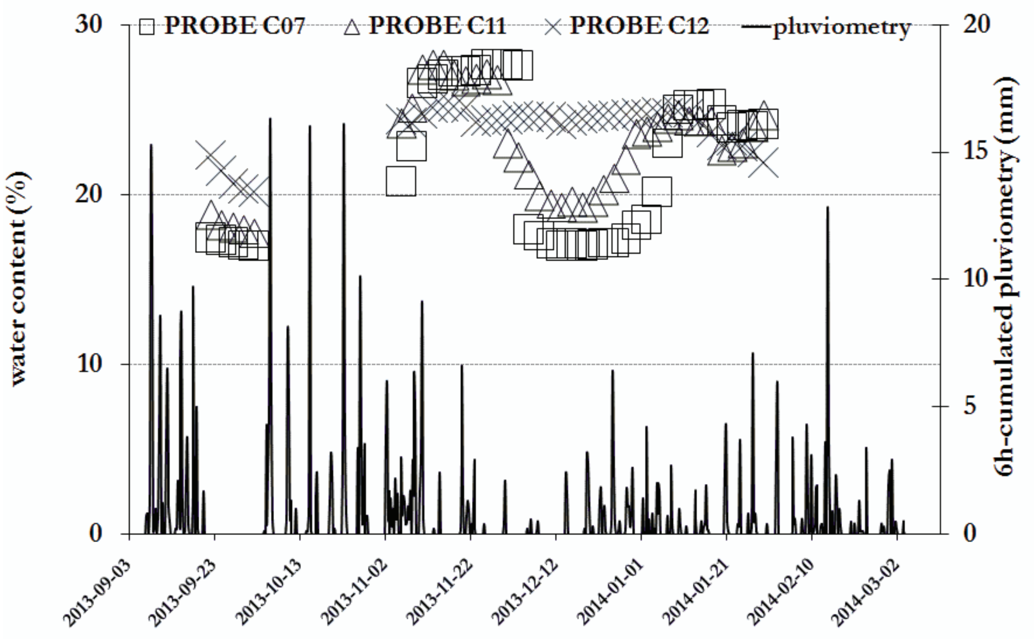


Figure 11: water content on geocomposite part

4.2 *Flow rates*

Data was available between 2013-09-19 and 2014-03-14 for the water flow on the traditional solution, and between 2013-11-21 and 2014-01-31 for the geocomposite technique.

Flow rates increases were observed for both experimental parts, almost immediately in the traditional case (Figure 12) and with a delay in the case of geocomposite (figure 13). From November 2013, flow rates values did not exceed 0,0864 $m^3$. New adjustments on data loggers will be implemented to solve this issue.

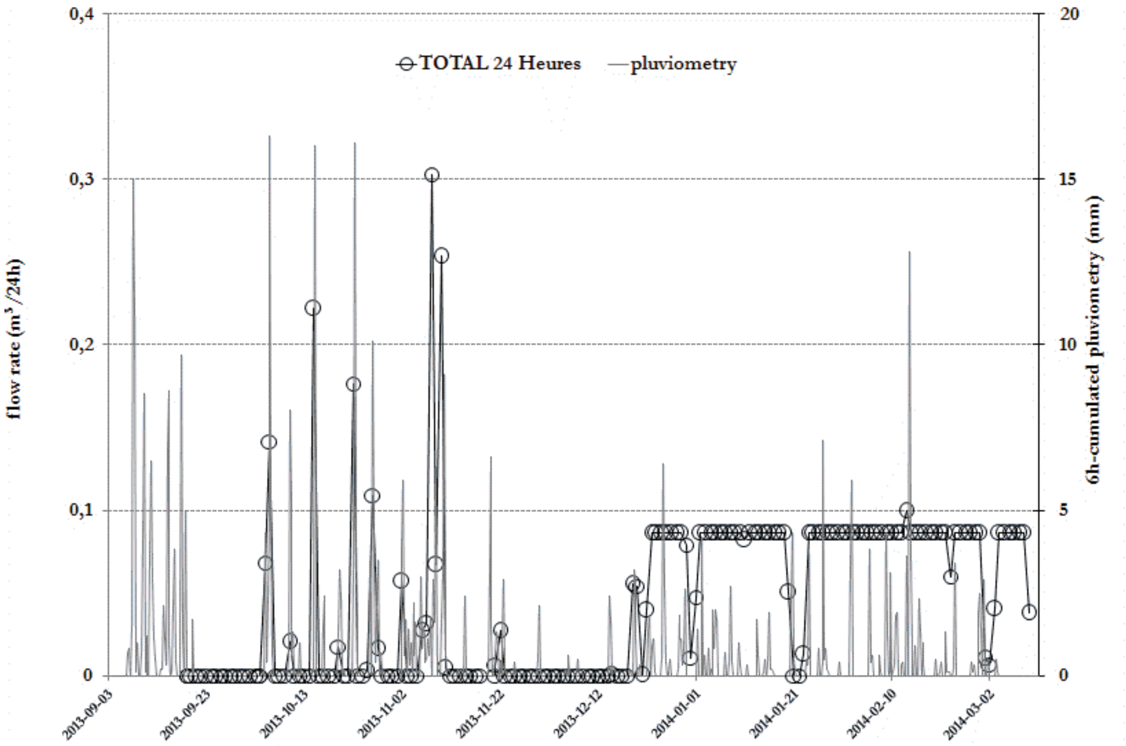


Figure 12: flow rate on traditional part

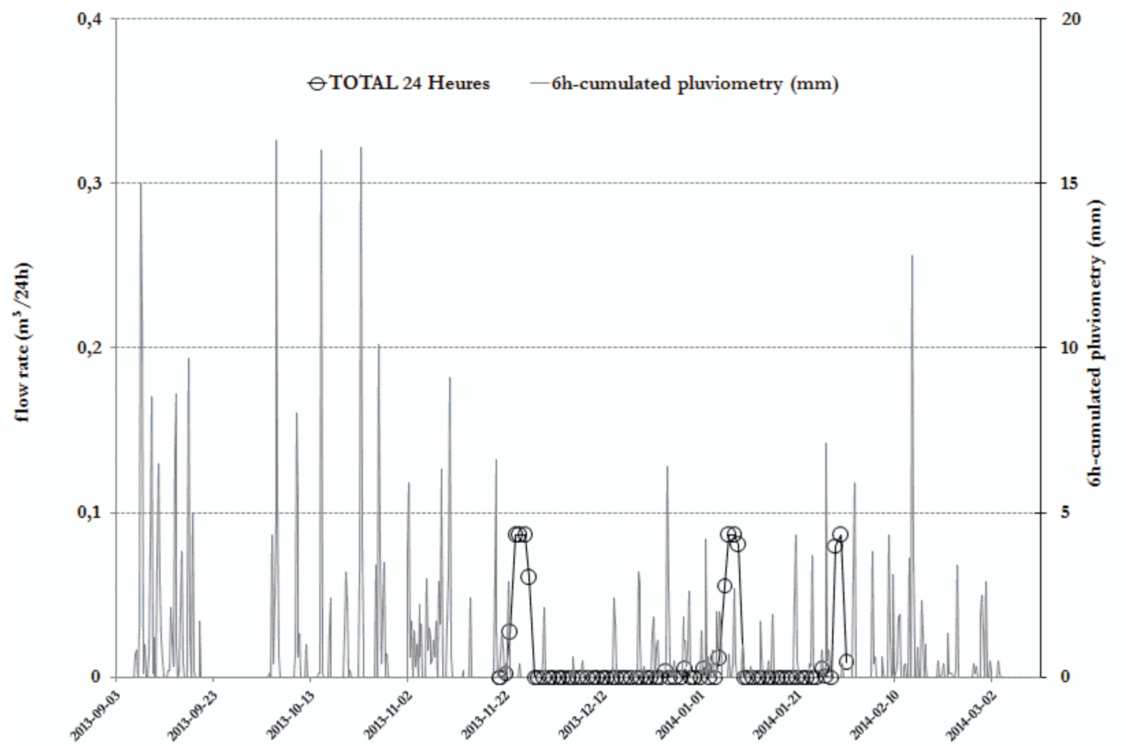


Figure 13: flow rate on geocomposite part

## 4.3 *Temperatures*

All temperatures recorded were positive for both traditional and geocomposite parts, in the pipe, or in the chamber (Figure 14). The temperature profiles at the interface between the natural soil and the draining part are similar, whatever the solution was (granular materials or geocomposite).

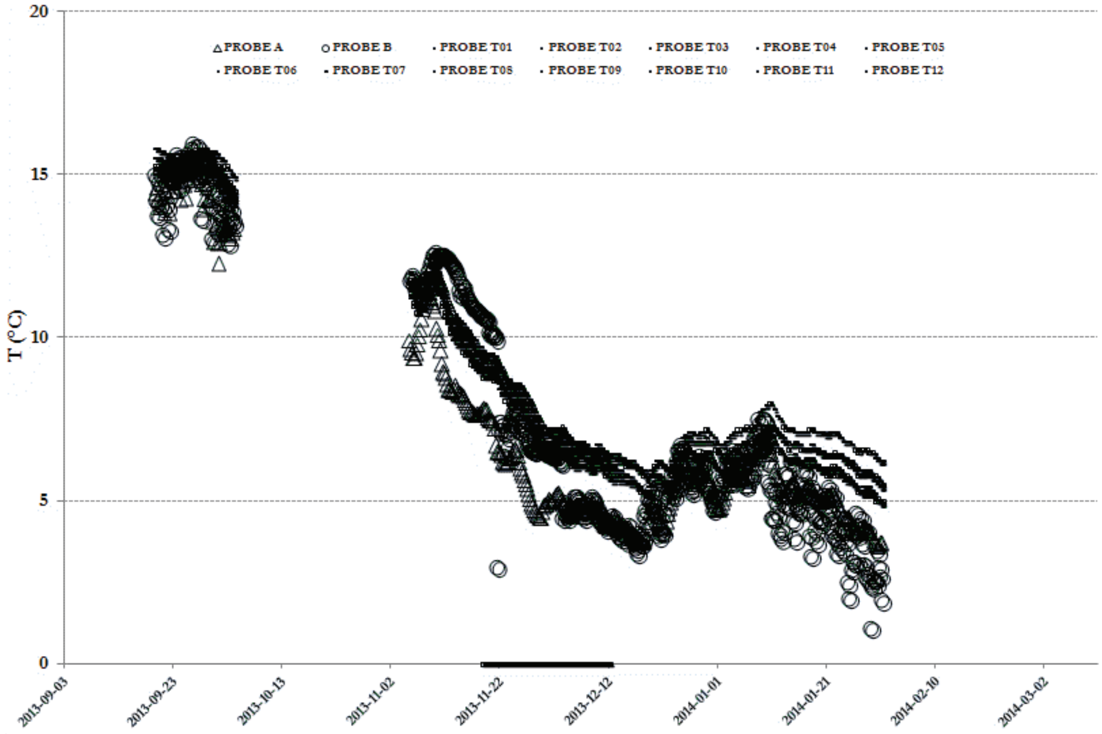


Figure 14: temperatures

# 5 CONCLUSIONS

Despite site constructions and instrumentation hazards, this experiment provides usable data. It nevertheless needs to be followed in order to conclude about the evolution of the hydraulic properties and the slope stability.

First of all, both techniques seem to protect soil below from rain infiltrations, because of the non-evolution of the water contents on most of the points. Other fluctuations may be due to variations of the constant water occurrences. Protection against frost seems also to be assured.

Measurements seem consistent with respect to the probes implantation. The sensor of the dry place gave the lowest values, and those low implanted gave the highest ones.

We chose to put data loggers into chambers in order to hide them and not to expose them in full public view; the excess of humidity, rodent presence, do not grant a long life for the material. So the site construction is now closed. Cases will be created out of the ground to protect the data loggers and the batteries against frost and water.

About flow rates, the two technical solutions appear parallel ones, allowing water evacuation, however in a different manner. Exploitation of the data has just begun, and need at least, four seasons background in order to appreciate different behaviors, and several years in order to likely clogging. To be continued …