

Improvement of cellulose anaerobic digestion

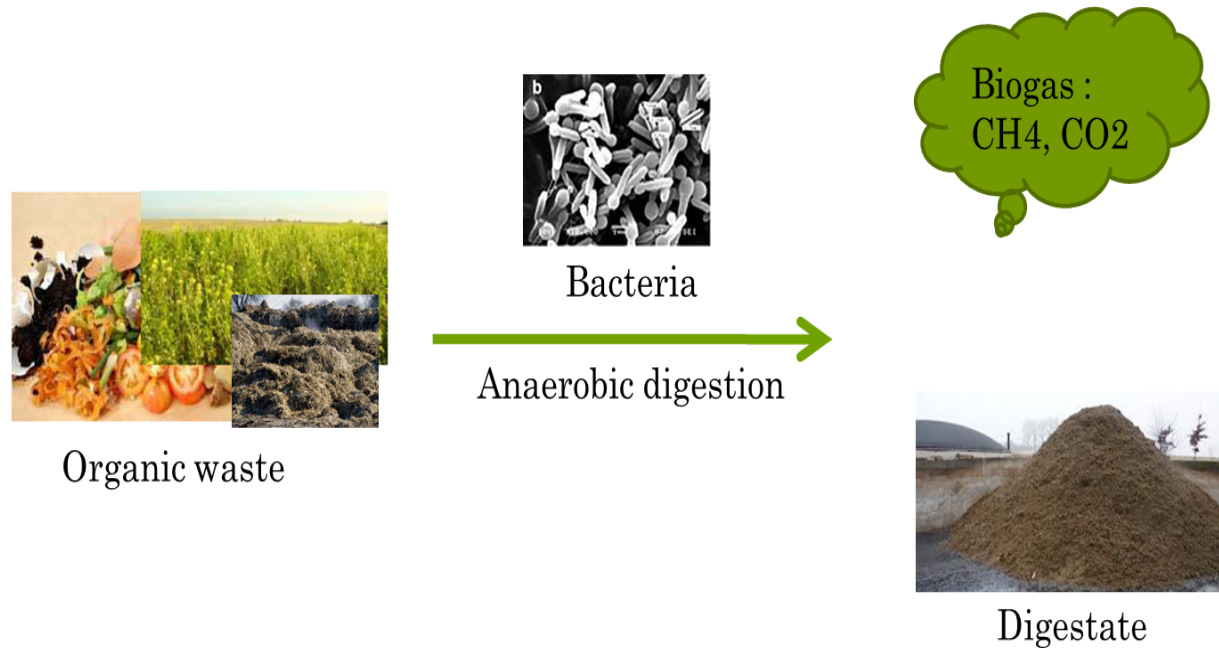
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Context and objectives

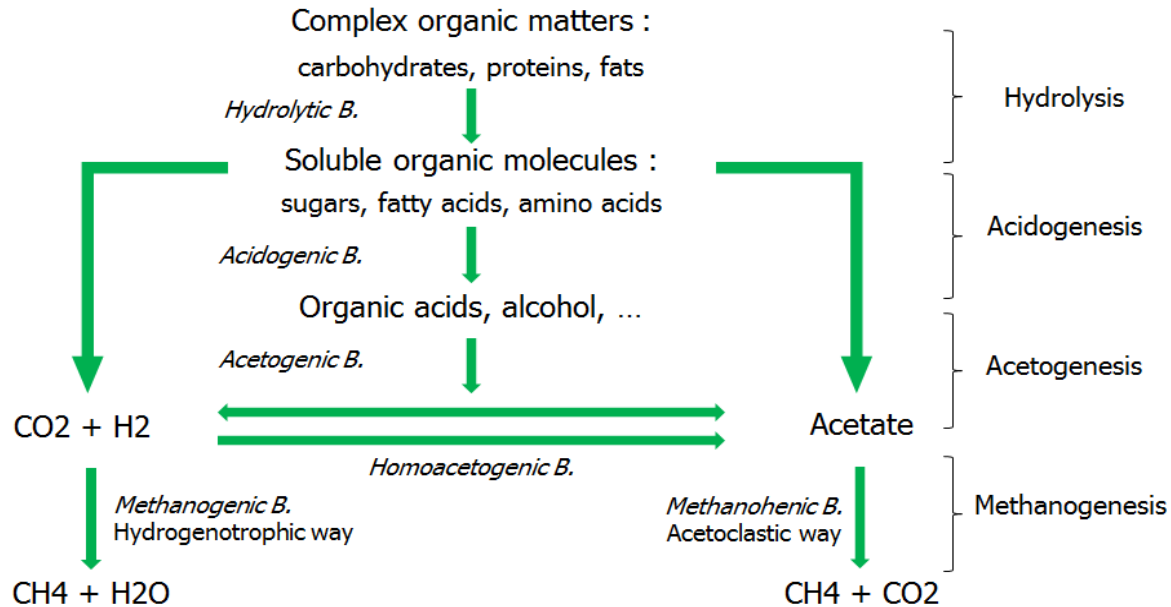


Hydrolysis of cellulosic substrate = Limiting step



Development of an anaerobic cellulolytic consortium to improve anaerobic digestion

Context and objectives



Hydrolysis of cellulosic substrate = Limiting step



Development of an anaerobic cellulolytic consortium to improve anaerobic digestion

Isolation of microbial consortium

Enrichment culture

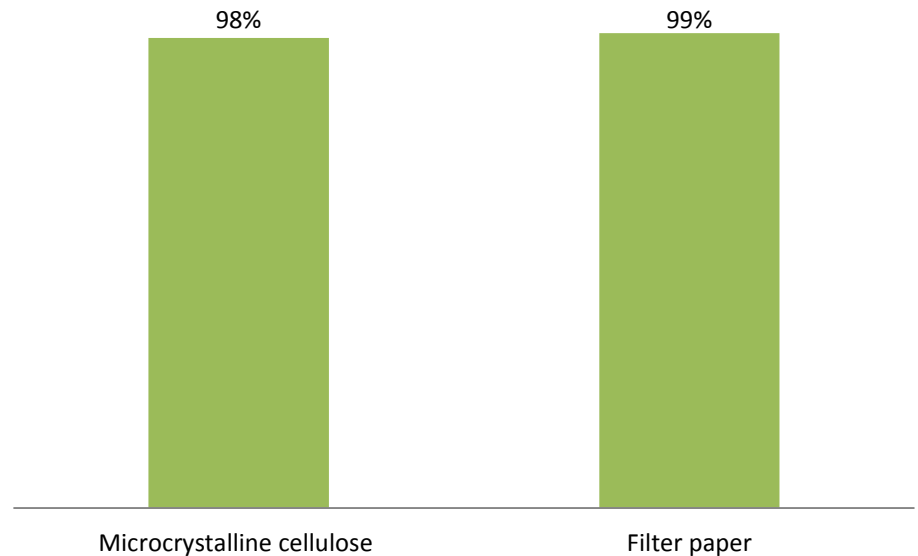


Survey of different microbial sources



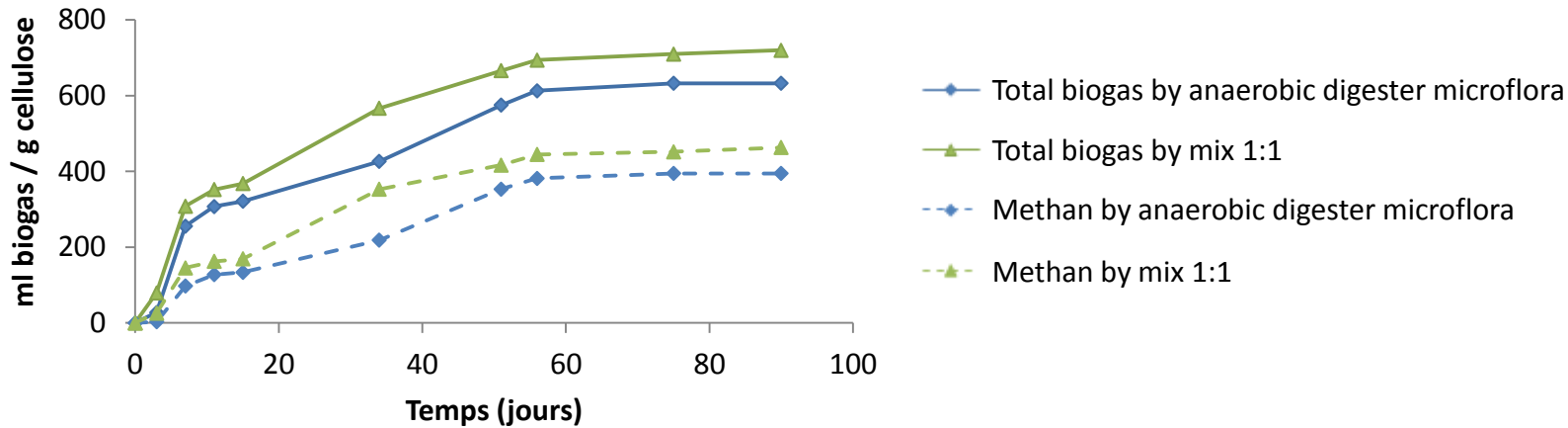
Compost = most efficient

Anaerobic cellulose degradation

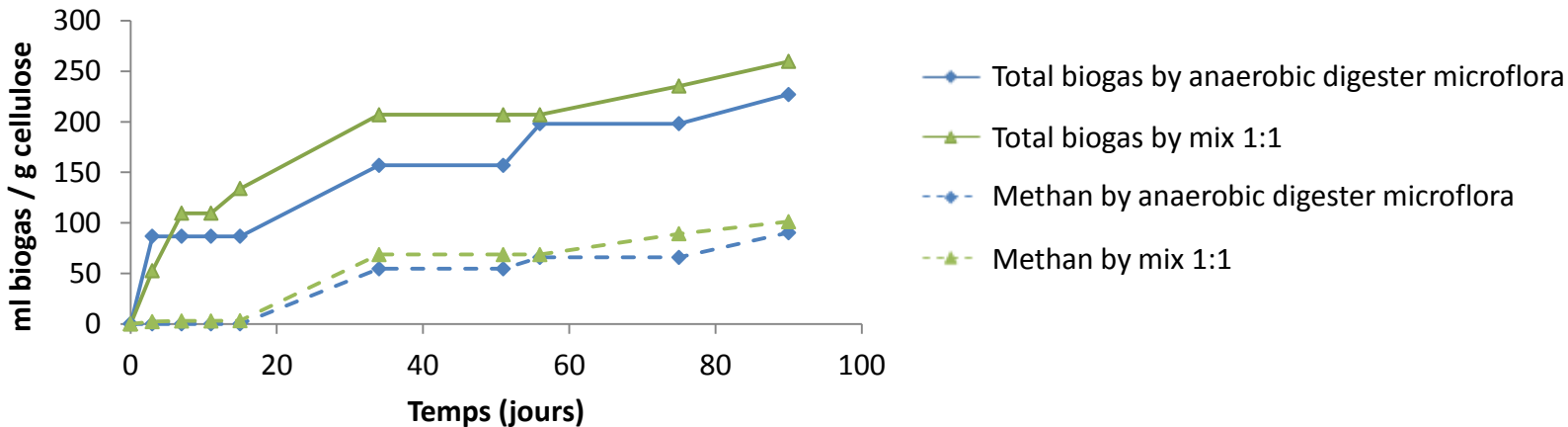


Impact on anaerobic digestion – Biogas production

➤ Cellulosic substrate



➤ Lignocellulosic substrate



- ➔ **positive impact on biogas and methane production**
- ➔ **gain of 14% in both cases for biogas production and respectively 20% and 12% for methane**

Impact on anaerobic digestion – Microbial ecology

Three key questions :

1. Who is there?
2. In which proportion?
3. Community stability?

Control of Microbial
process involving
complex population

Metagenomic

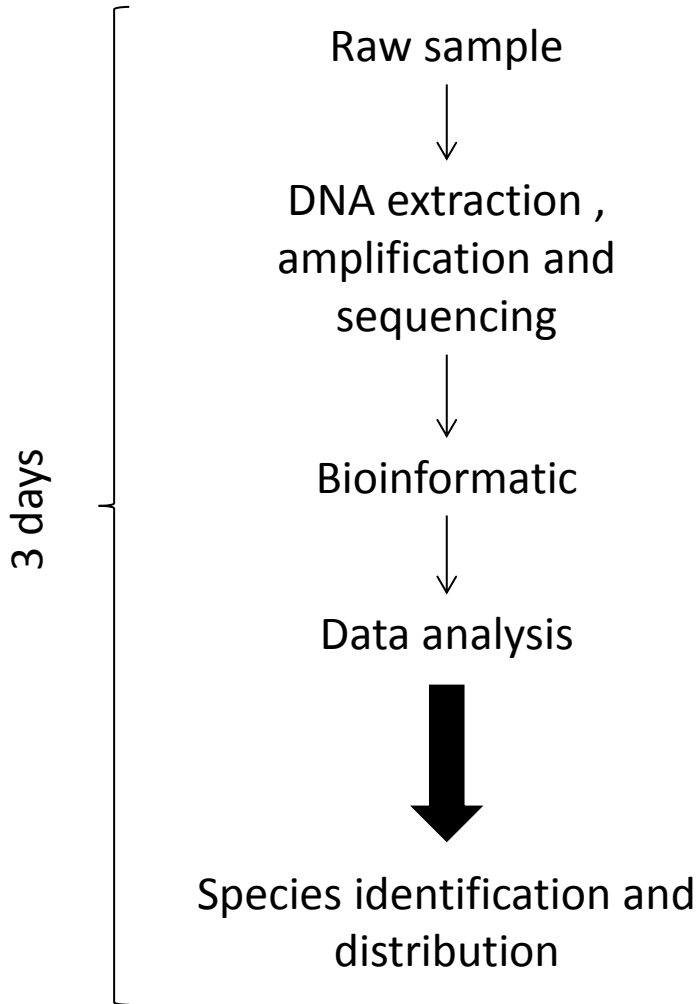
Flow cytometry

Microbial ecology

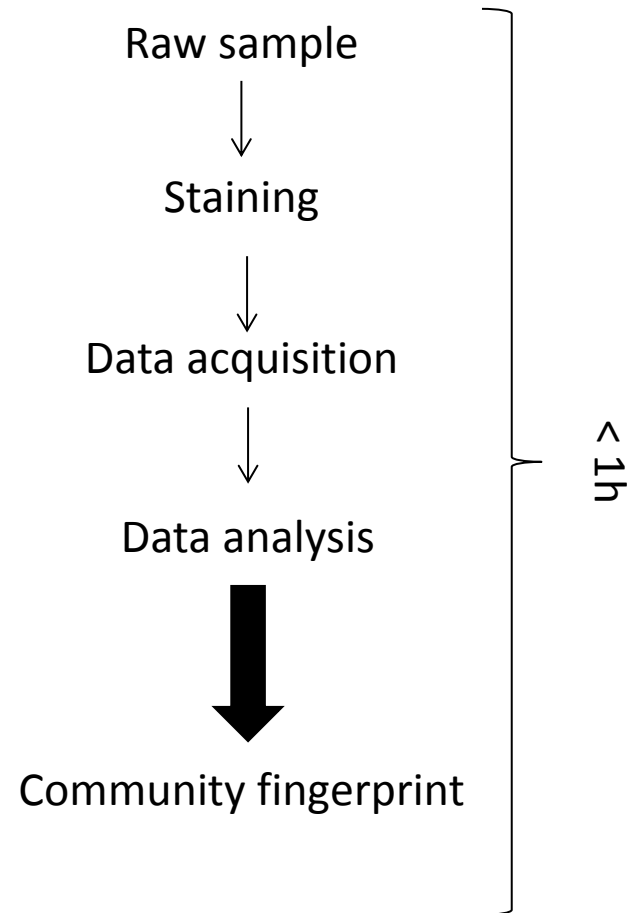
Metagenomic	Flow cytometry
Species identification	Routine analysis of Community stability

Impact on anaerobic digestion – Microbial ecology

Metagenomic analysis



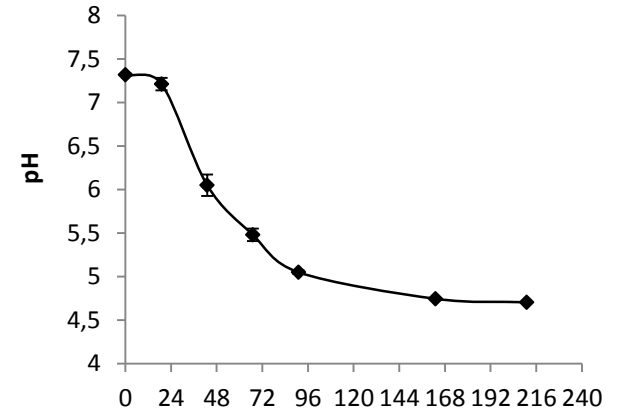
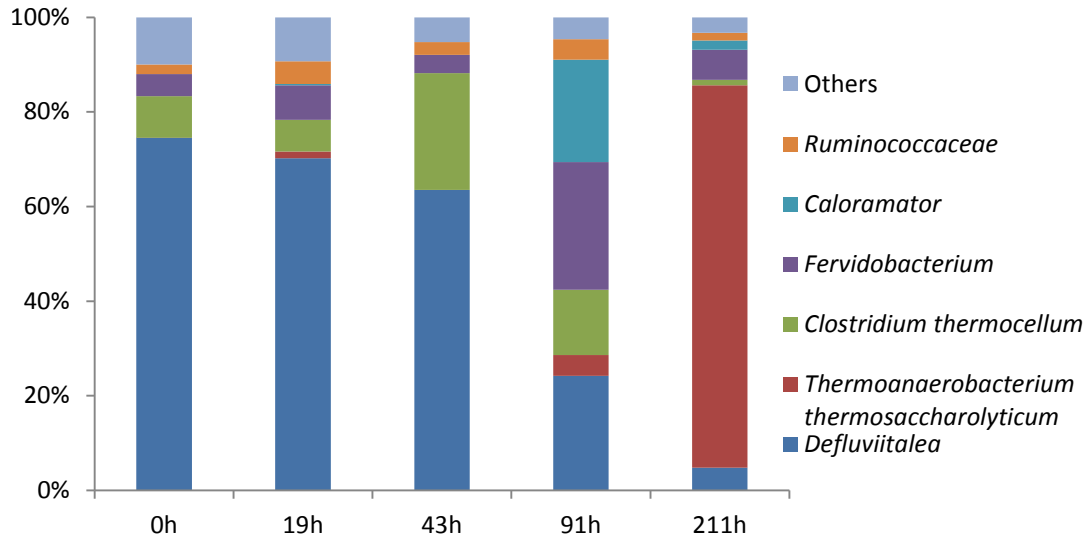
Flow cytometry



Impact on anaerobic digestion – Microbial ecology

Metagenomic analysis

➤ Consortium population during cellulose anaerobic digestion

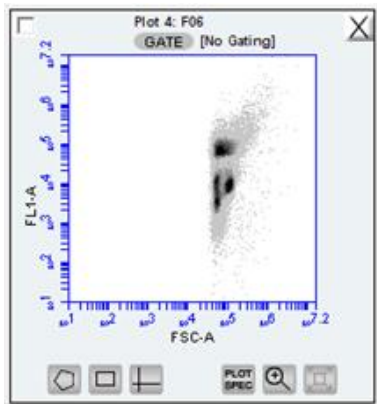


Sampling (hours)	0	19	43	91	211
Observed OTUs	29	25	19	24	30
Shannon's equitability	0.33	0.39	0.38	0.58	0.26
Change (%)	0.0	0.2	3.4	40.6	96.0
Rate of change (%.h ⁻¹)		0.01	0.17	0.76	0.70

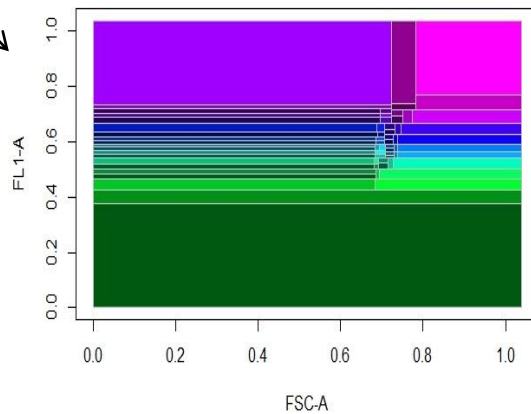
Impact on anaerobic digestion – Microbial ecology

Flow cytometry – Data analysis

Raw data

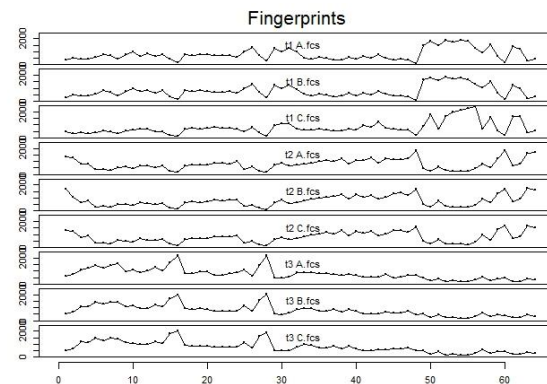


Model



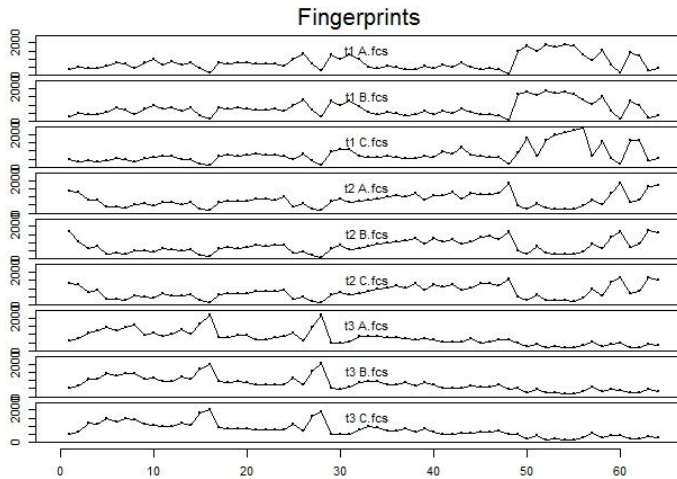
FlowFP R package

Fingerprint

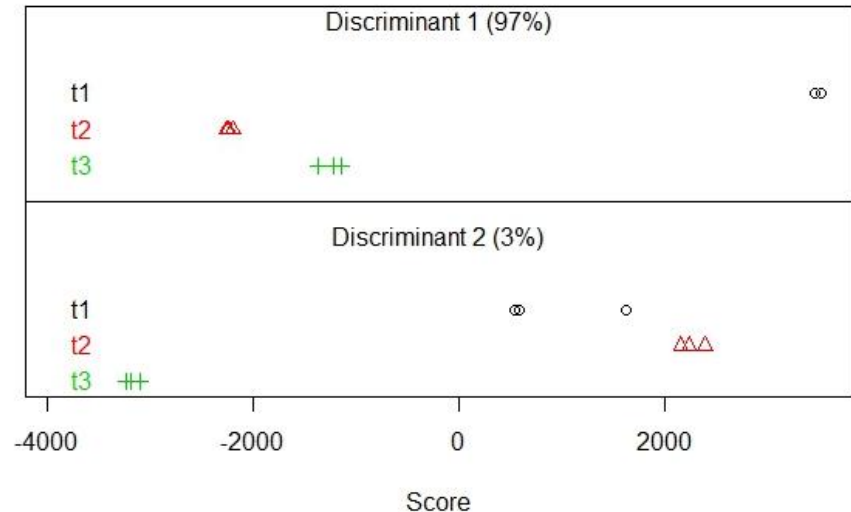
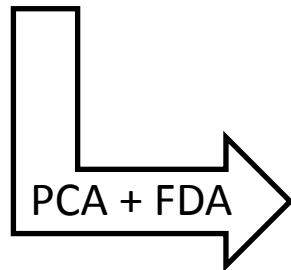


Impact on anaerobic digestion – Microbial ecology

Flow cytometry – Data analysis



- Cellulose anaerobic digestion
- 3 sampling times
- 3 replicates



Conclusion

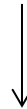
- Isolation of efficient cellulose degrading consortium from compost
- Positive impact of consortium on anaerobic digestion of cellulosic substrate
- Species identification and distribution thanks to metagenomic analysis
- Fast community fingerprint by flow cytometry

Perspective

- Correlate flow cytometry fingerprint to metagenomic fingerprint
- Full scale experiment in landfill

Full scale application – Improvement of anaerobic digestion in landfill

Consortium injection in landfill section presenting ~10 % of residual cellulose



Biogas production and landfill microflora monitoring

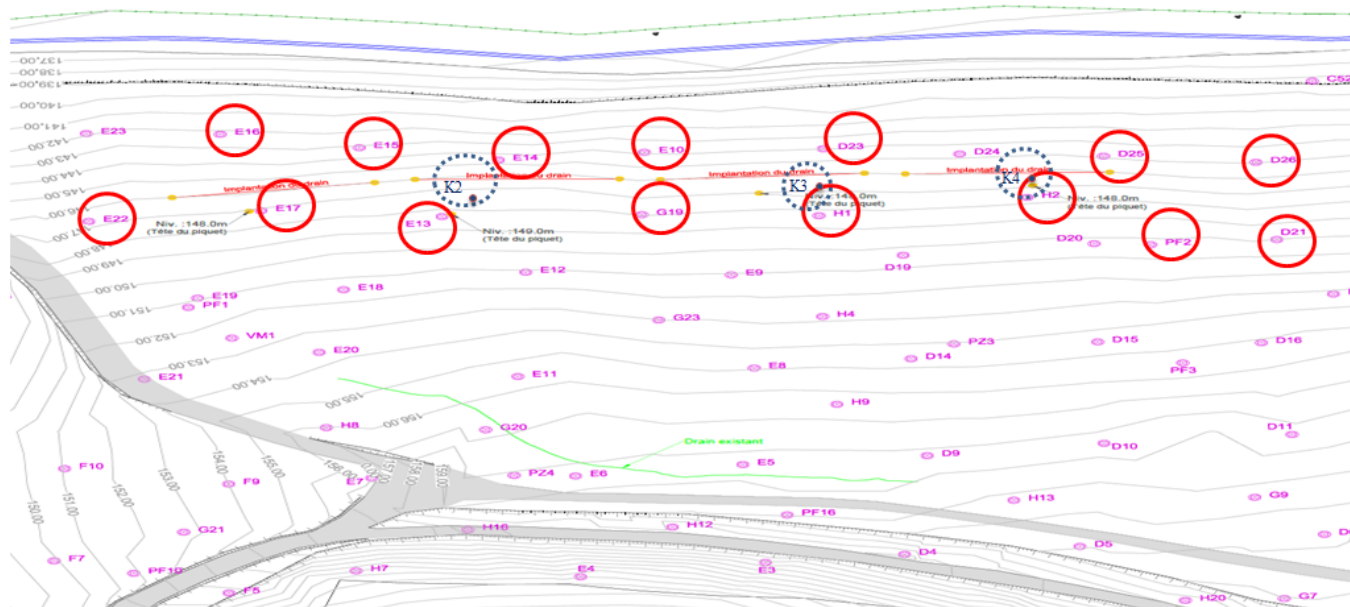


Figure 3 : localisation des drains de recirculation et des puits de dégazage conventionnels (15 puits monitorés). Zoom de la carte de la Figure 1.

En cercles plein : puits de dégazage conventionnels. En cercles pointillés, puits de dégazage issus des forages d'août 2012 (monitoring en phase gazeuse et liquide)

Vanne non localisée pour les puits pour E23 et D24 (non monitoré), (Source : Shanks SA, 2014)