XLIII ONTA MEETING
Coimbra, PORTUGAL, 4-9 September 2011

Coimbra, 8th September 2011

Composting for wood bark heat treatment to control the pinewood nematode

Research/Technical Enterprises Involved
- Alfarroxo
- Leal & Soares
- Madeca

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LNEG
Laboratório Nacional de Energia e Geologia, I. P.


Thermal composting is o biological process where conditions are created to the developing of bacteria in order to make the temperature of the materials in the compost pile to rise above 60 °C.

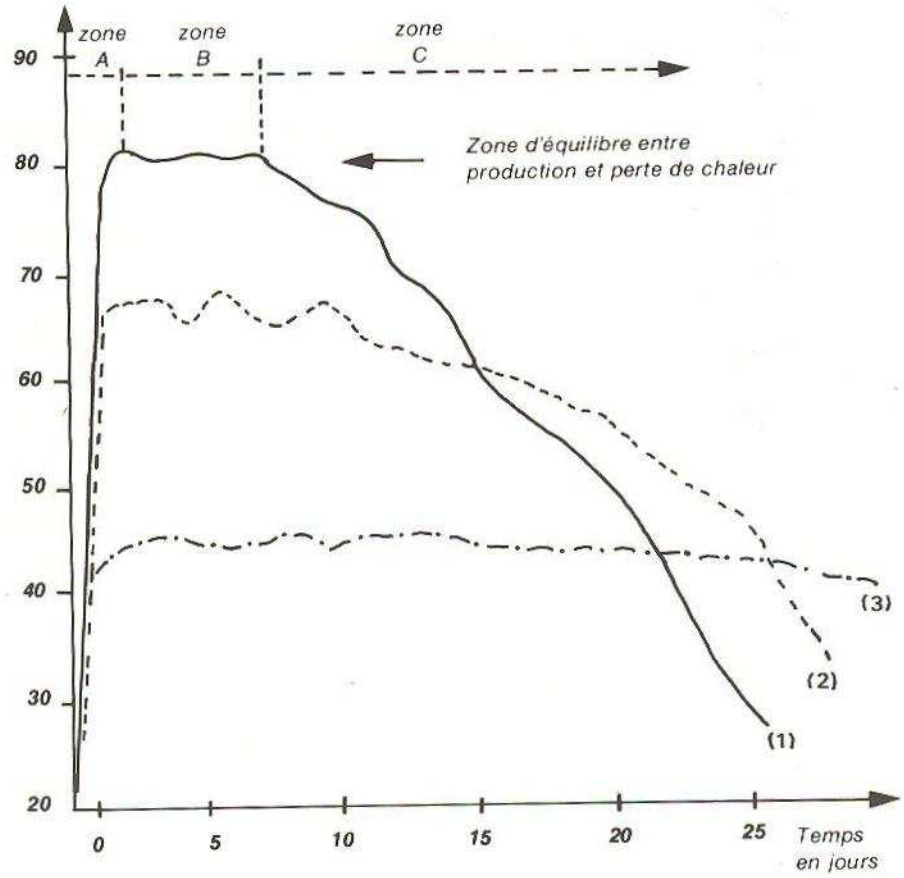
Advantage of composting

1. Pine bark is higher in acid than most of other mulches. Composting pine bark reduces the acidic level of the bark and makes the resulting material pH neutral.

2. Composting is an economic process concerning energy consumption and machinery investment.

3 . The first phase of composting process develops the temperatures needed to kill the nematodes.

Theory of composting



Zone A : La production de chaleur est active et supérieure aux pertes.

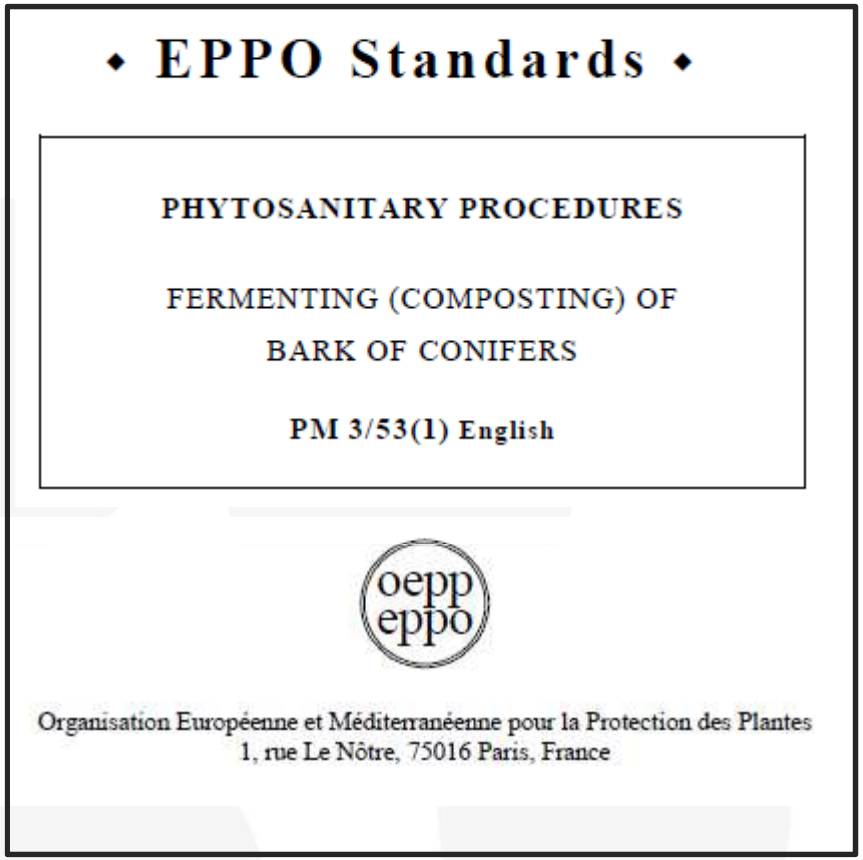
Zone B : Zone d'équilibre : Plateau thermique.

Zone C : Les déperditions deviennent prépondérantes, la température diminue...

—— Courbe 1 : **substrat très fermentescible**

- - - - - - Courbe 2 : **substrat moyennement fermentescible**

-.-.-.-.- Courbe 3 : **substrat peu fermentescible**



International references

FAO standard - ISPM nº15.

ISPM - International Standards for Phytosanitary Measures

Quarantine heat treatment by natural processes can provide temperatures that exceed the internationally accepted standard of 56 ºC for 30 minutes throughout a bark heap.

When a bark heap commences thermophilic activity, temperatures rise very rapidly to >60 ºC, but distribution of temperature is not homogeneous.

Ministério da Agricultura, do Desenvolvimento Rural e das Pescas

Composting as heat treatment to eliminate pine nematode in pine bark

DGADR
Direcção-Geral de Agricultura e Desenvolvimento Rural

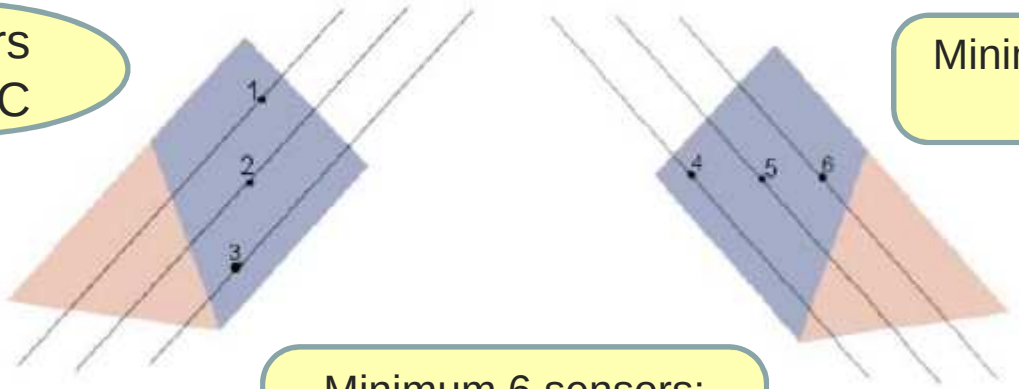
Versão 5 (07/07/2011)

REQUISITOS TÉCNICOS PARA TRATAMENTO TÉRMICO DE CASCA ISOLADA DE CONÌFERAS

Introdução

O processo de eliminação do nemátodo da madeira do pinheiro em casca isolada de coníferas é o tratamento pelo calor, submetendo o material vegetal a uma temperatura

6 hours
> 60 ºC



Minimum volume
500 m3

Minimum 6 sensors;
depth of 1.2 m

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Ref. :
Chapter 3
Composting of Bark and Wood Chips
Hugh Evans

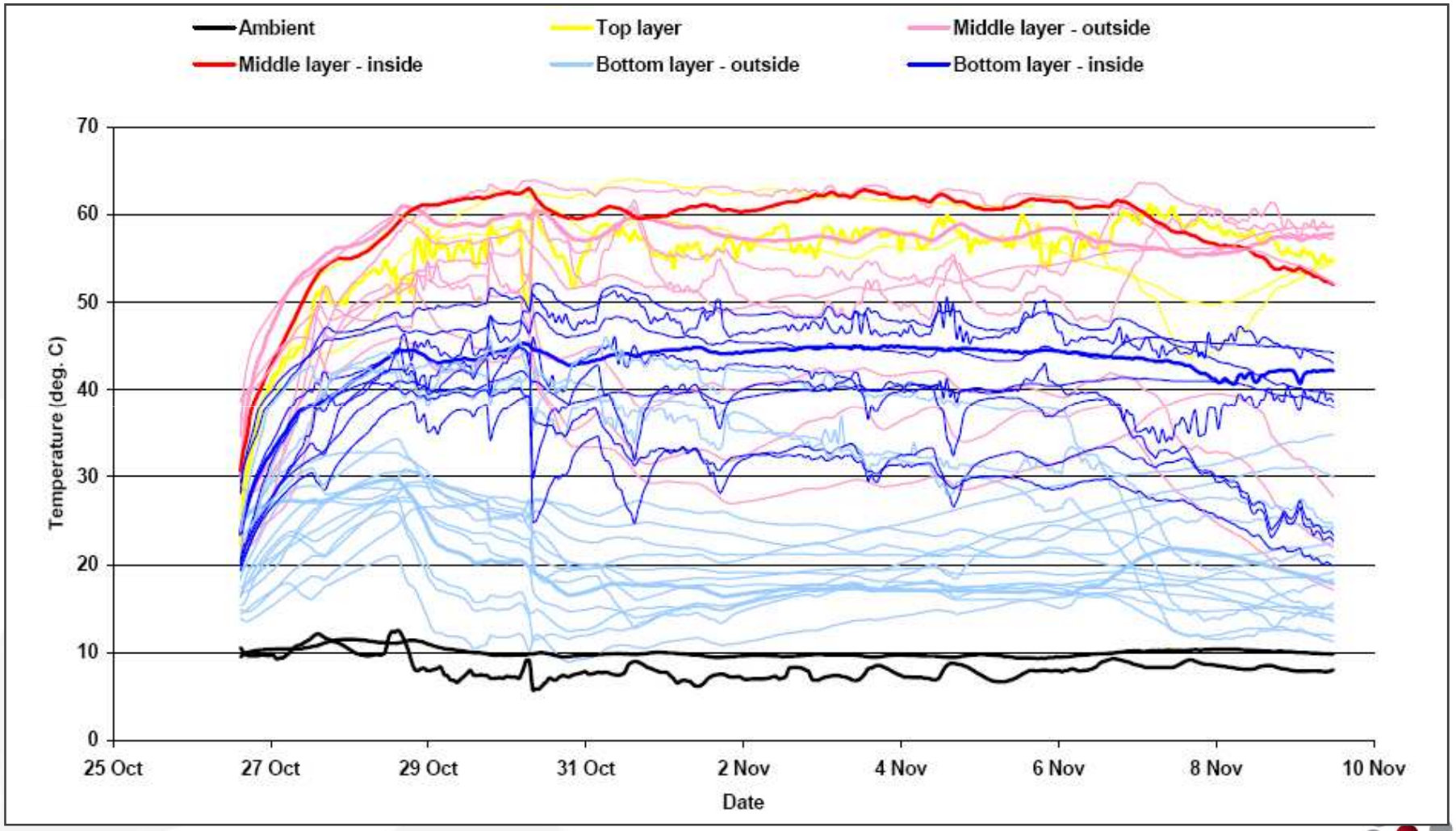
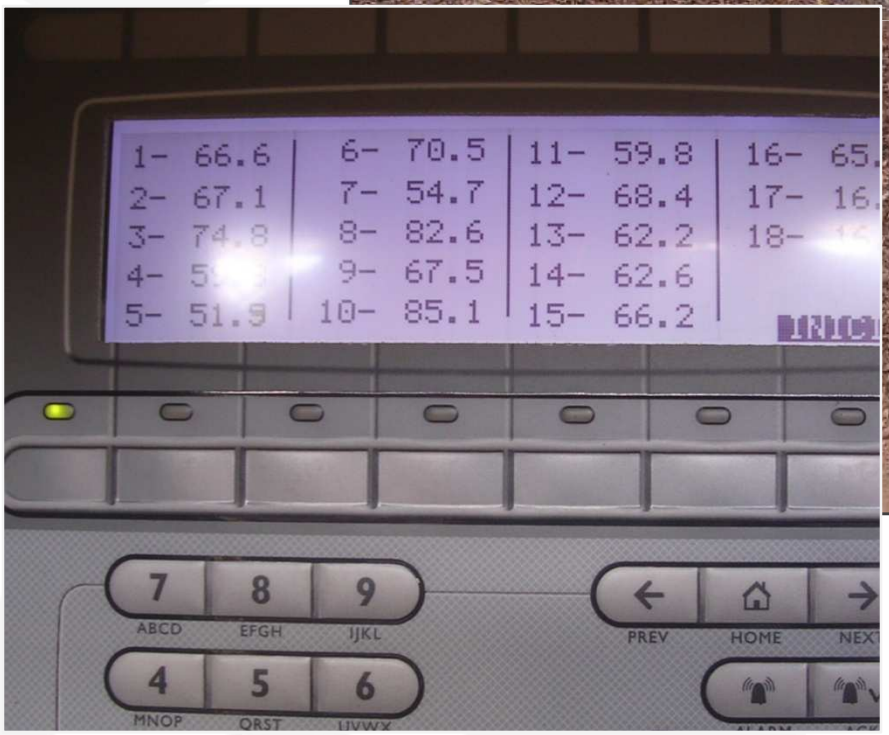


Figure 12: Temperature profiles of bark heap with basal measurements of 6m x 4m.

Composting temperatures



Courtesy: Madeca

Running studies

Composting temperature monitoring

Large scale outdoor experiments are being performed in three companies in three different locations :

- Alfarroxo – Figueira da Foz;
- Leal & Soares - Mira;
- Madeca - Alqueidão.

Bark heaps with 4 to 5 m height, about 20 m long and 12 meters width, corresponding to a volume between 720 and 1200 m^3

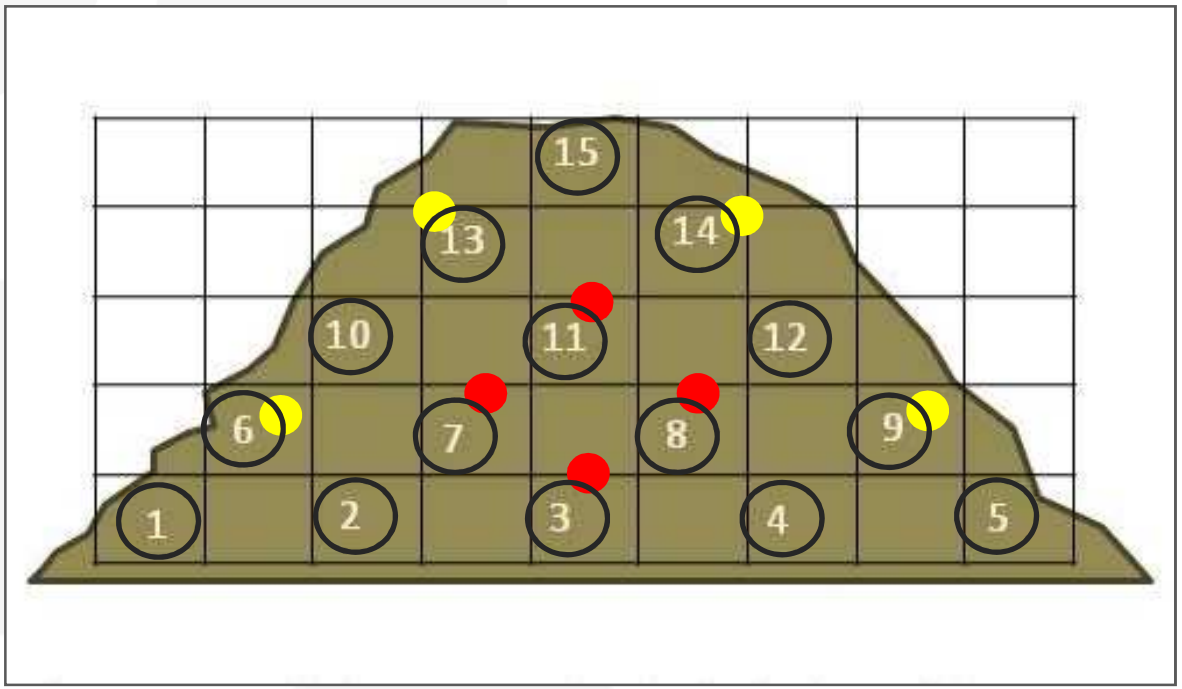
Tests in: April 2011
September 2011
January 2012

Each bark heap will be treated in four heating cycles, one in the initial heap and the others after three turnings of same material.

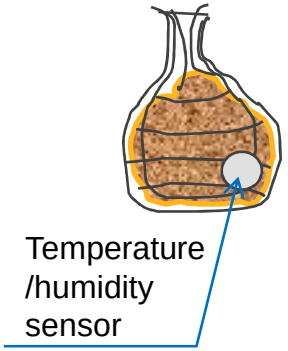
Two to three weeks each treatment.

Controlling parameters

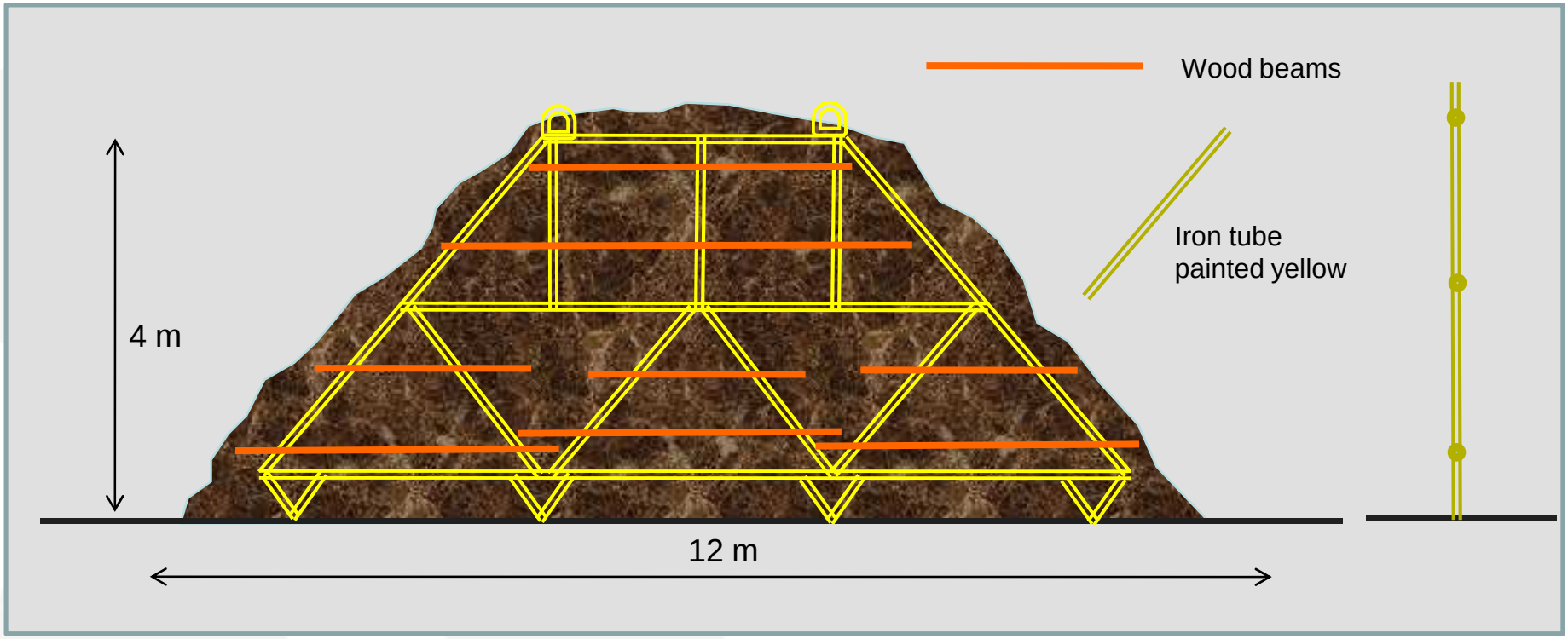
- Temperature in 15 different places: 1 - 15
- Relative humidity in three different places: 3 -11 -14
- Eight bags (4 outside layer + 4 inner layer) containing wood chips and bark pieces from infected trees (2000 g) will be placed in eight different probe positions: 3-6-7-8-9-11-13-14



Temperature
Relative humidity
Mesh bags with 250g
Infected bark



Grid to support temperature and moisture sensors inside bark heap



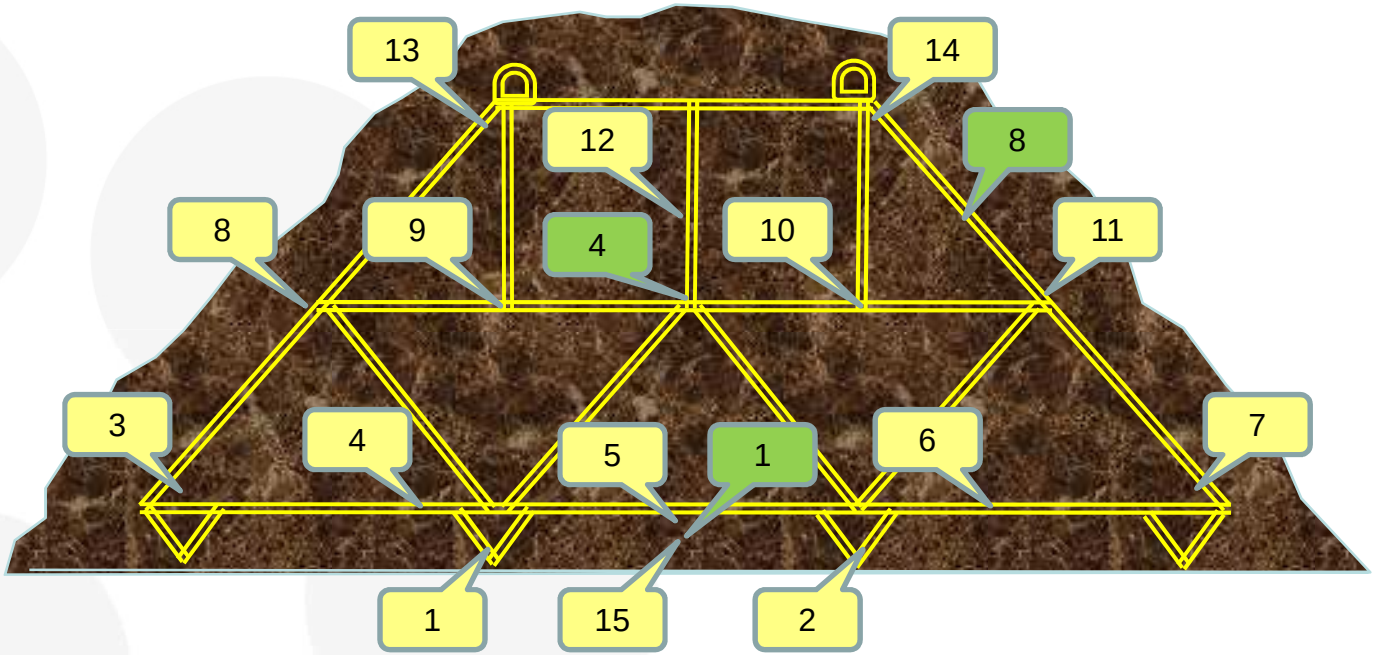
Temperature sensors support grid

Prototype fabricated at Leal & Soares

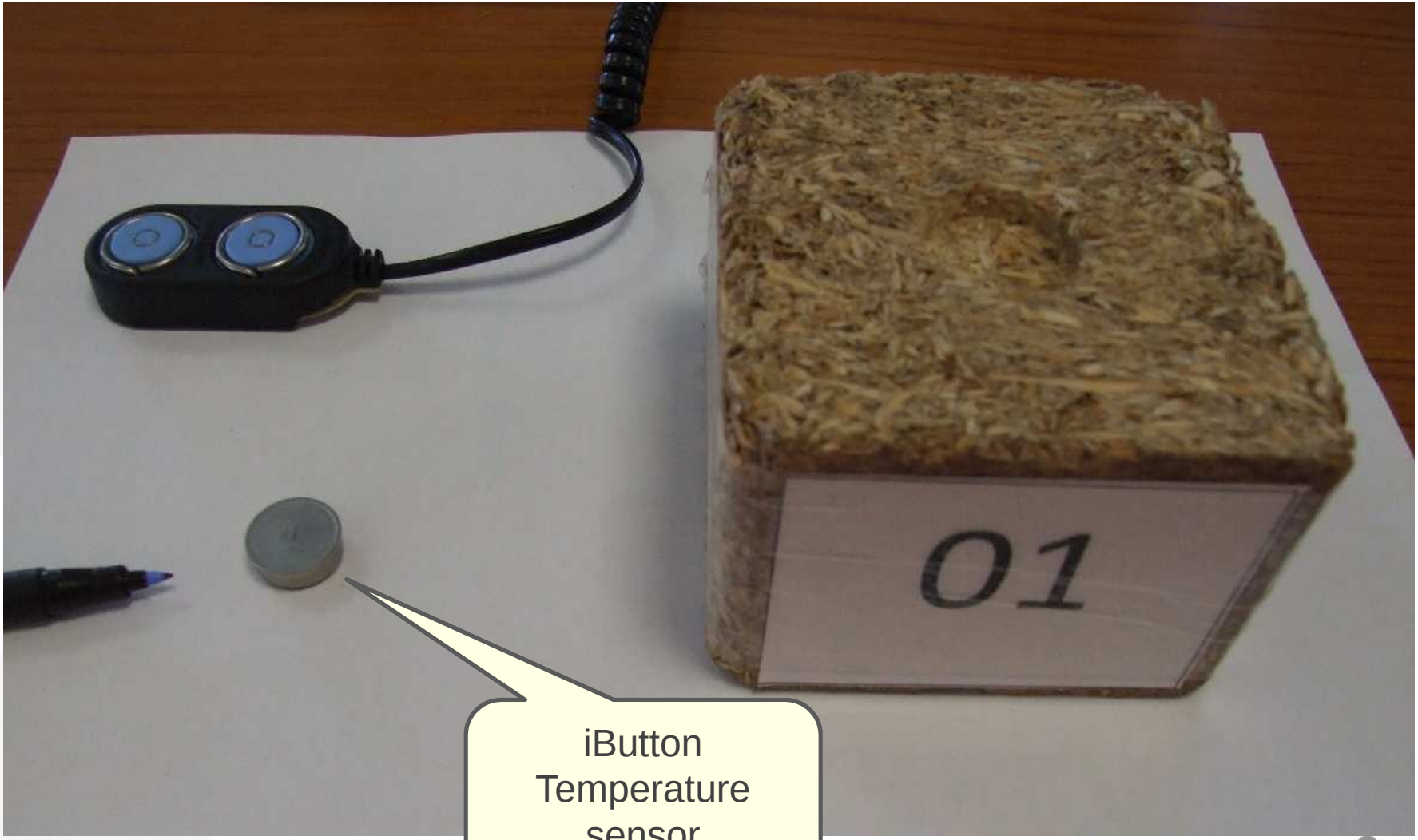
Results of temperature monitoring in composting

Test protocol

Sensor positions



Alfarroxo



iButton
Temperature
sensor
Wireless data logger

Courtesy: Alfarroxo

Courtesy: Alfarroxo

Courtesy: Leal & Soares

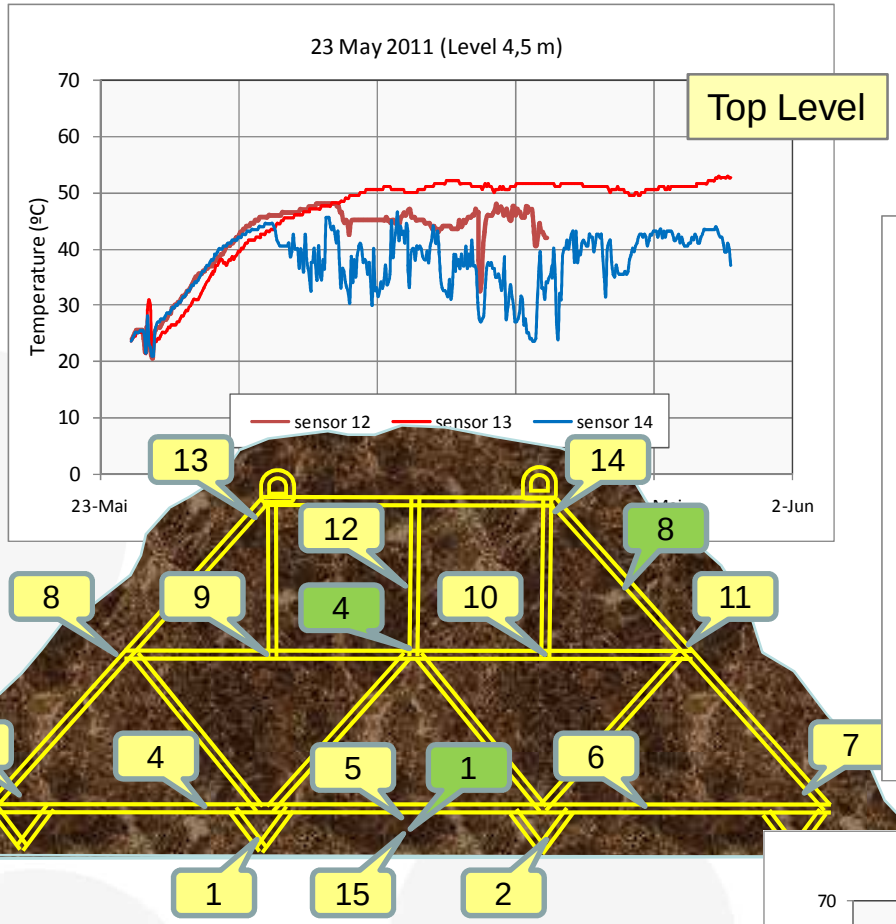
Mounting the grid

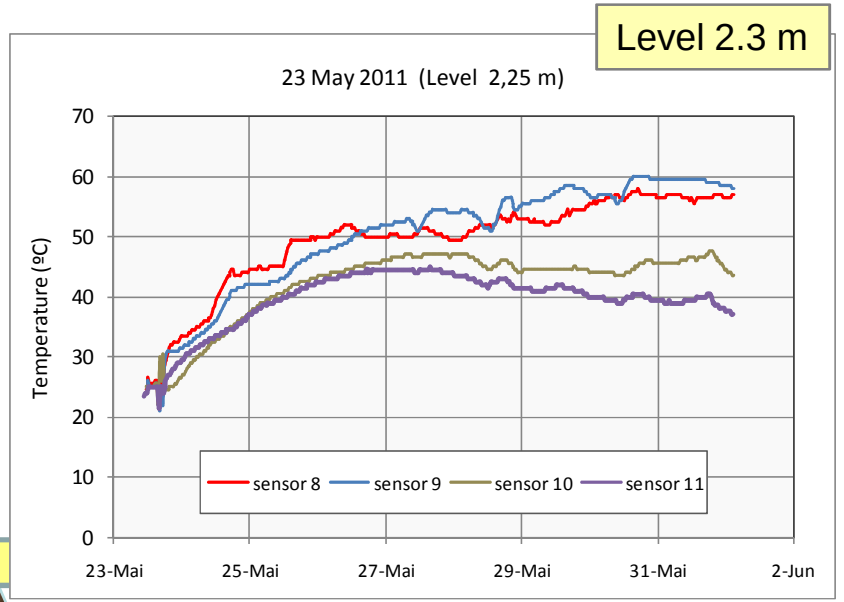
Courtesy: Alfarroxo

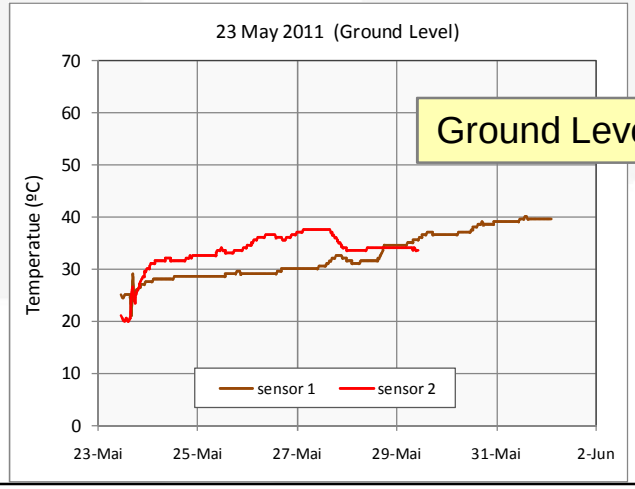
Difficulty in removing the grid

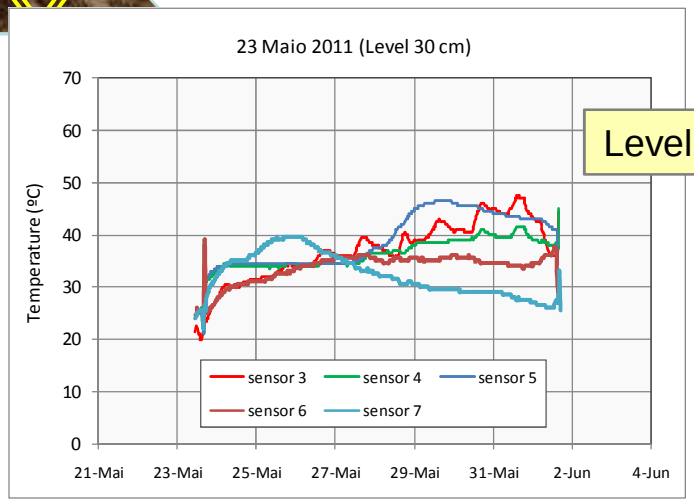
Courtesy: Leal & Soares

Alfarroxo









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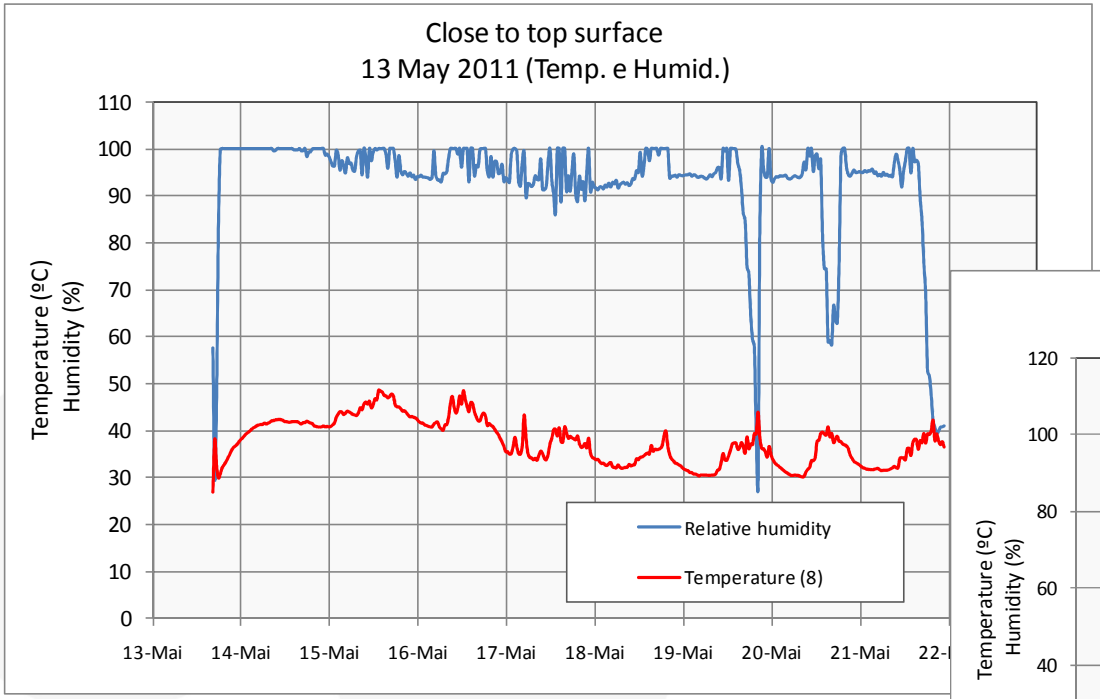
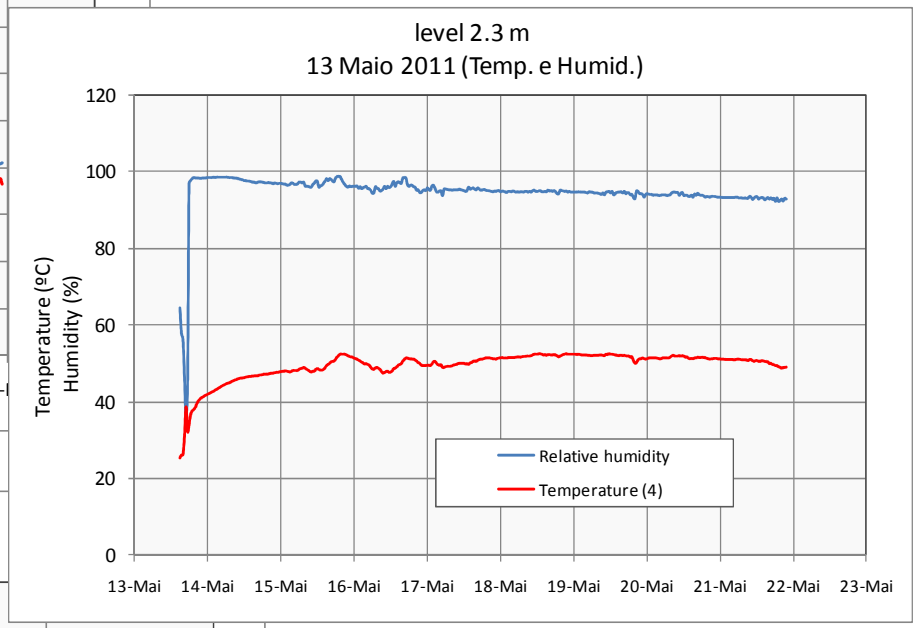
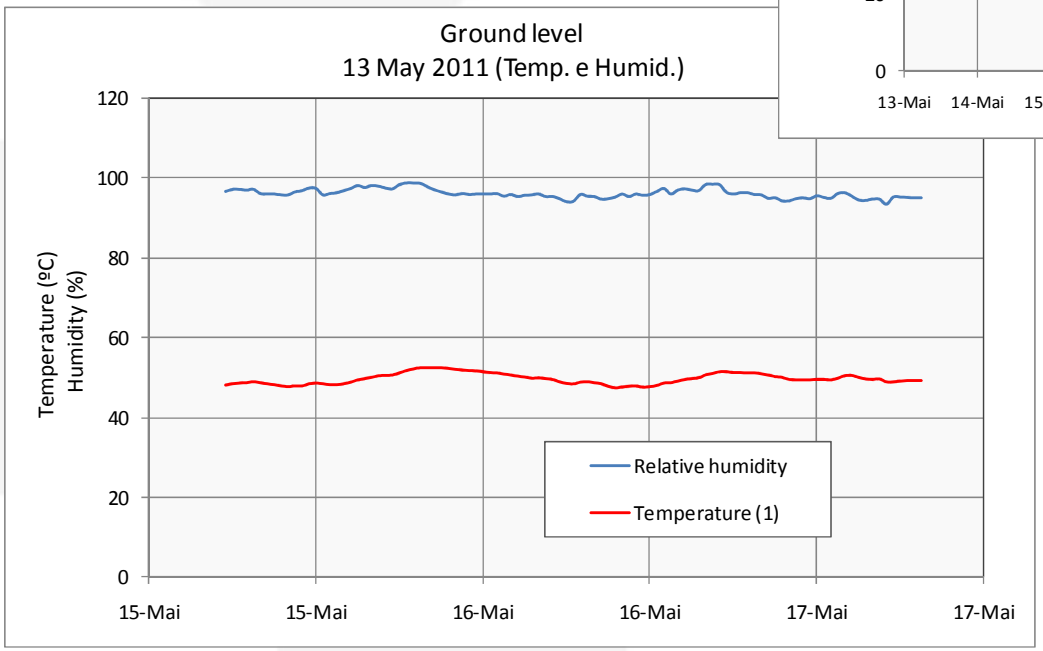


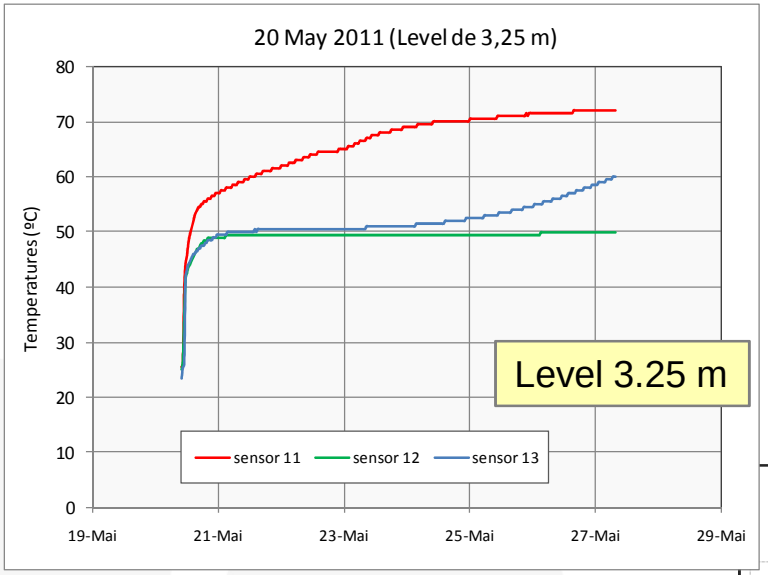


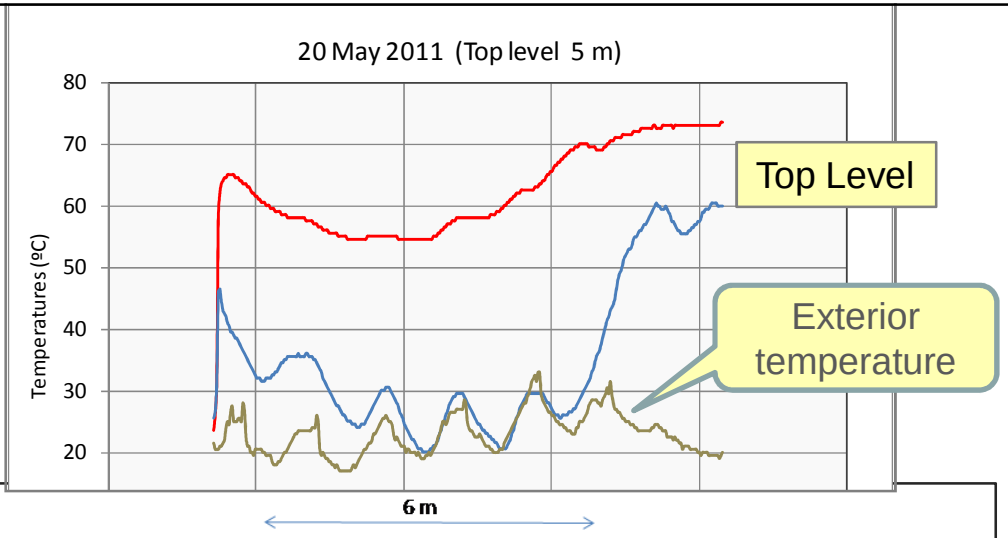


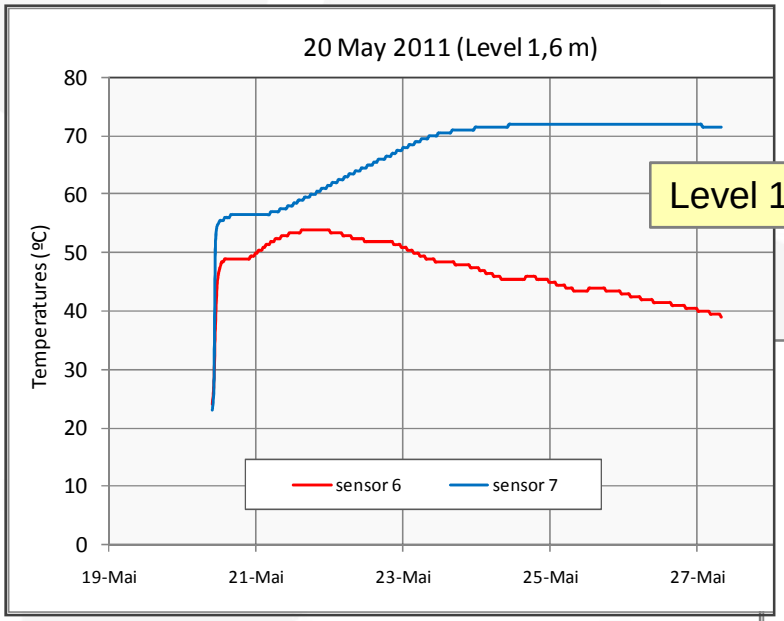
Leal & Soares

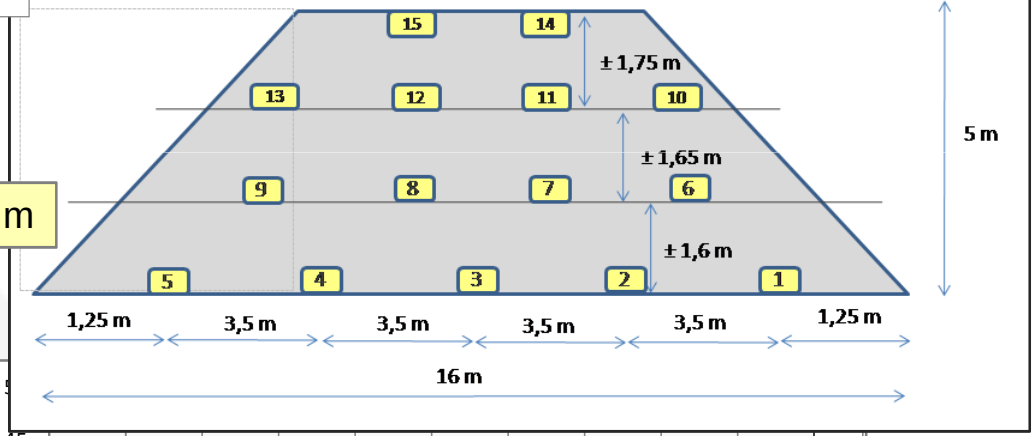
LNEG

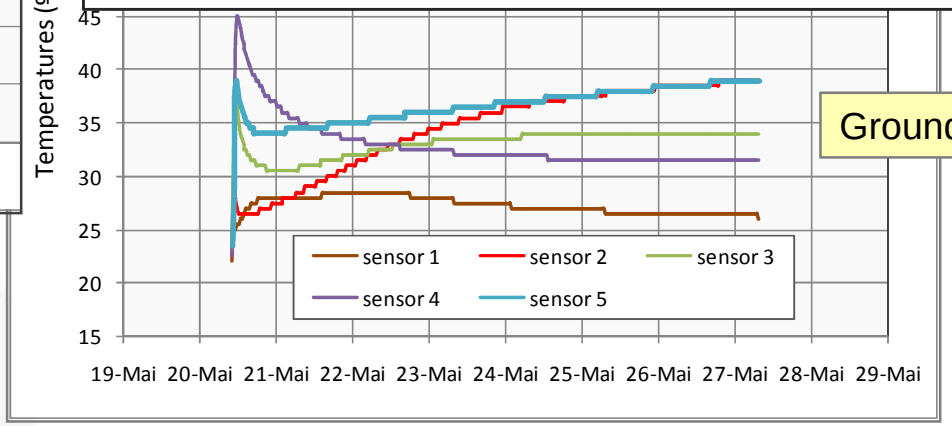
Sensors enclosed in end pipe plugs


20 May 2011 (Level de 3,25 m)
Temperatures (ºC)
sensor 11
sensor 12
sensor 13
Level 3.25 m


20 May 2011 (Top level 5 m)
Temperatures (ºC)
Top Level
Exterior temperature
6 m


20 May 2011 (Level 1,6 m)
Temperatures (ºC)
sensor 6
sensor 7
Level 1.6 m


15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
±1,75 m
±1,65 m
±1,6 m
5 m
1,25 m
3,5 m
3,5 m
3,5 m
3,5 m
1,25 m
16 m


Temperatures (ºC)
sensor 1
sensor 2
sensor 3
sensor 4
sensor 5
Ground Level

Madeca

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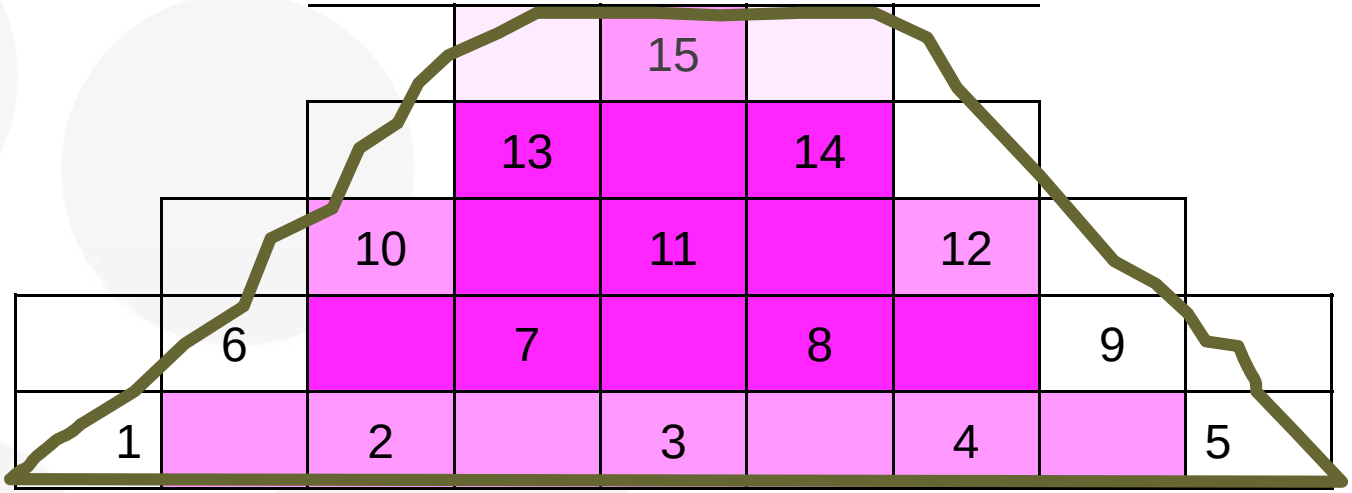
15
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1
2
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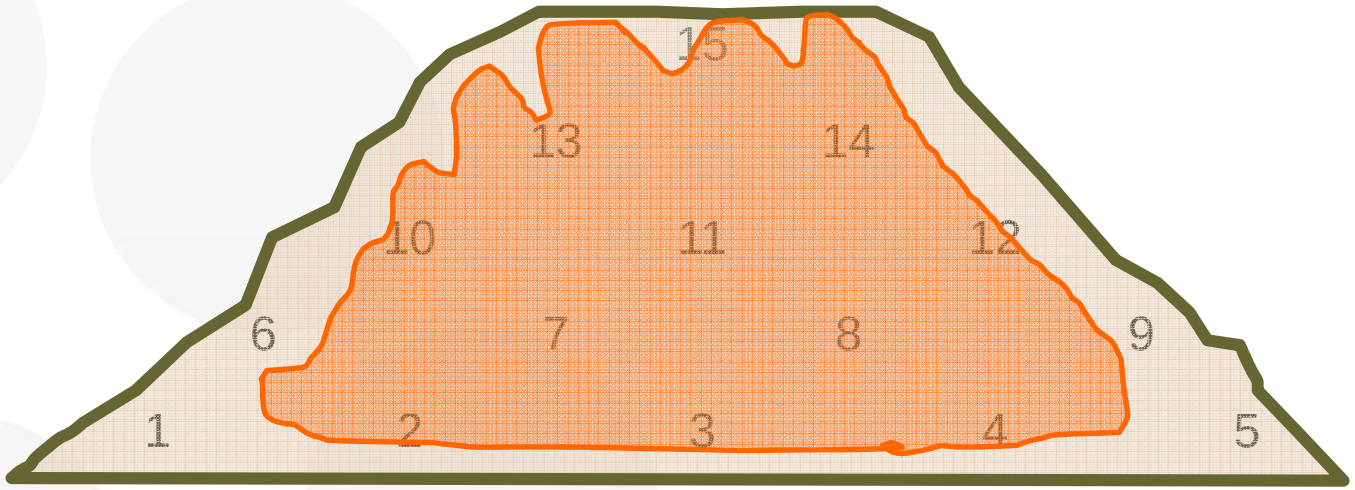
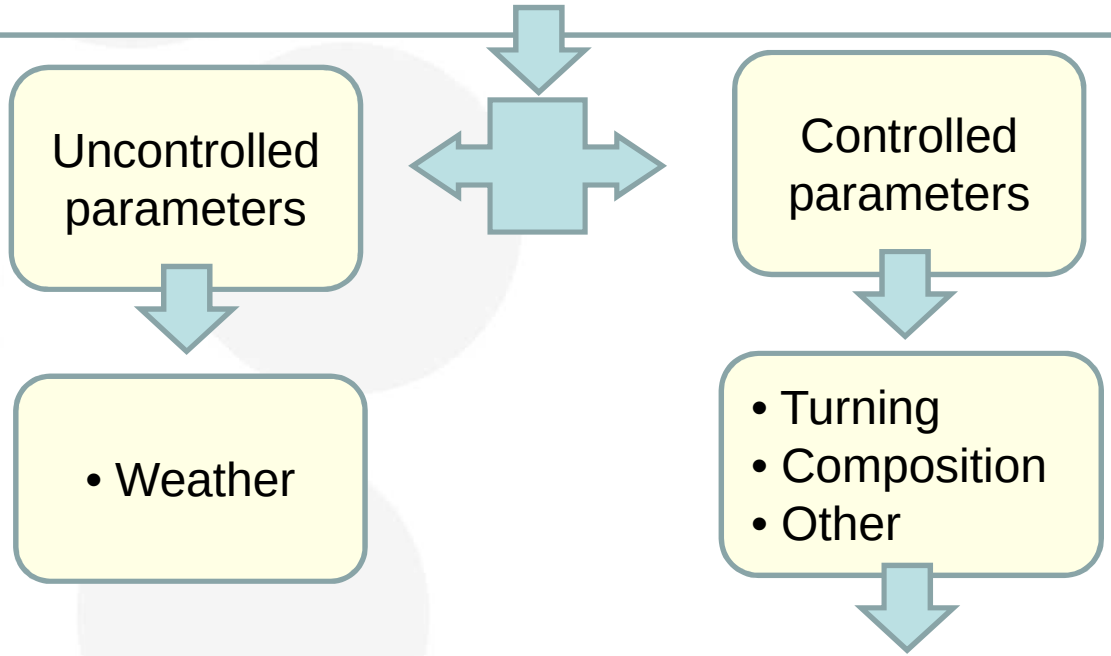
4
5


15
13
14
10
11
12
6
7
8
9
1
2
3
4
5

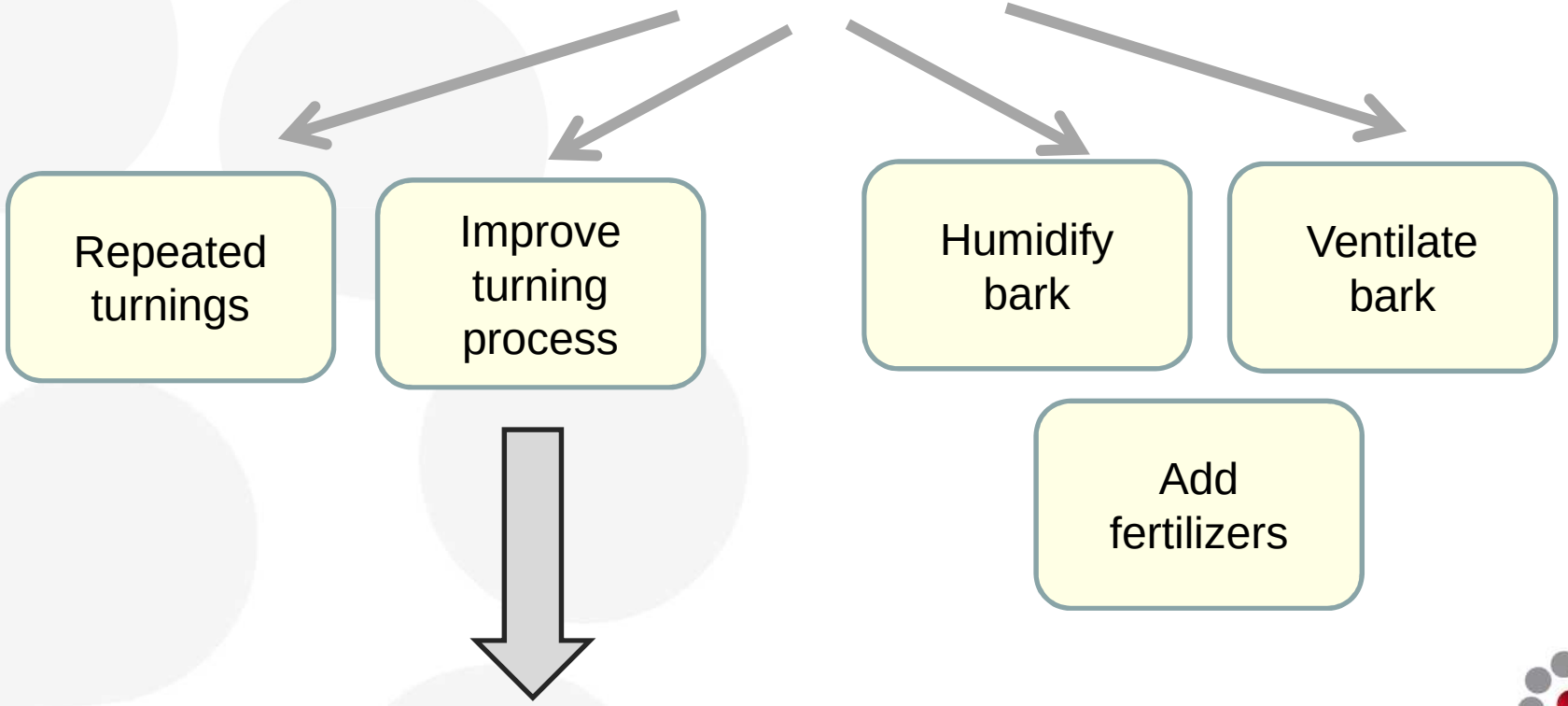
General considerations

Composting limitations

1. Difficulty to reach the treatment temperature in some locations – lateral surface and bottom.
2. Temperature heterogeneity on the top surface.
3. Temperature depend on weather conditions + heap composition (size of bark or forest residues).
4. Treatment duration depending on the climate conditions (specially air humidity).

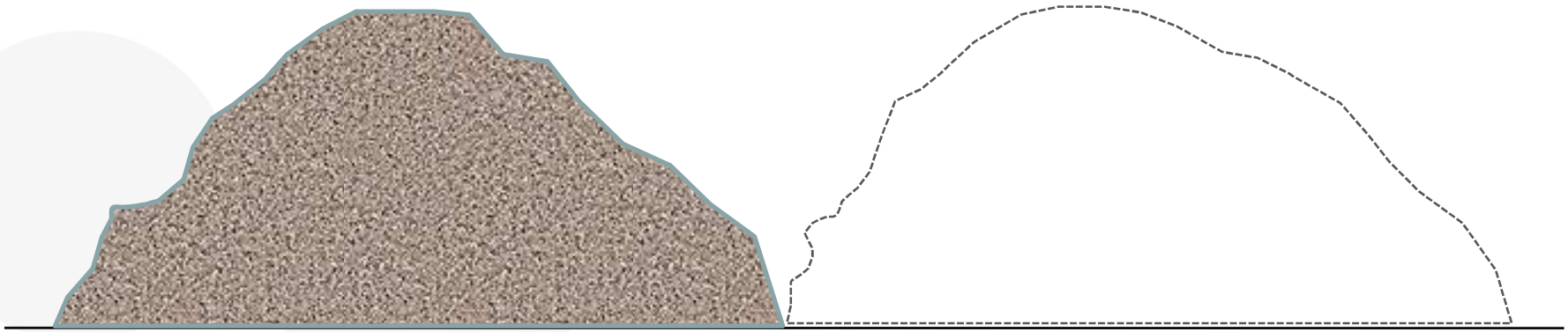


New approaches to improve composting efficiency - increase the temperature



Routine processing P1

Original heap



Original heap

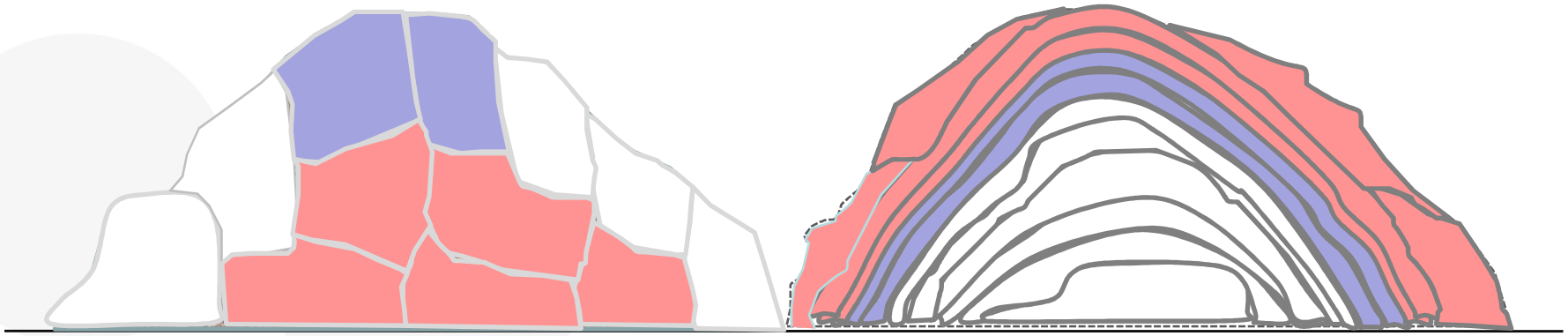
Turned heap

Courtesy: Madeca

Summary

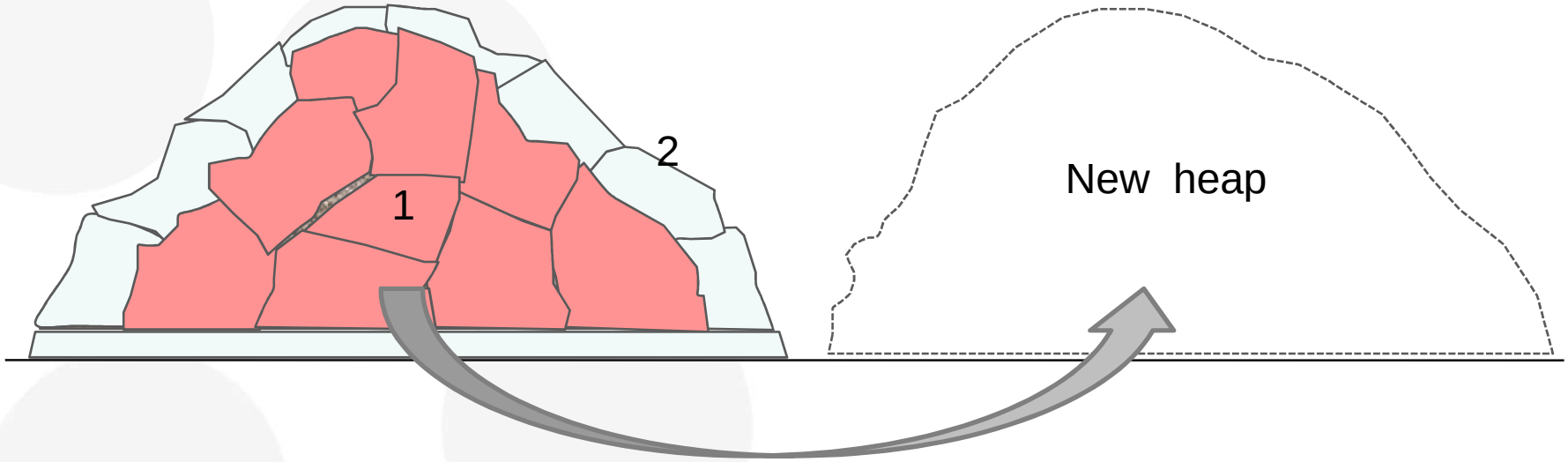
Original heap

Turned heap

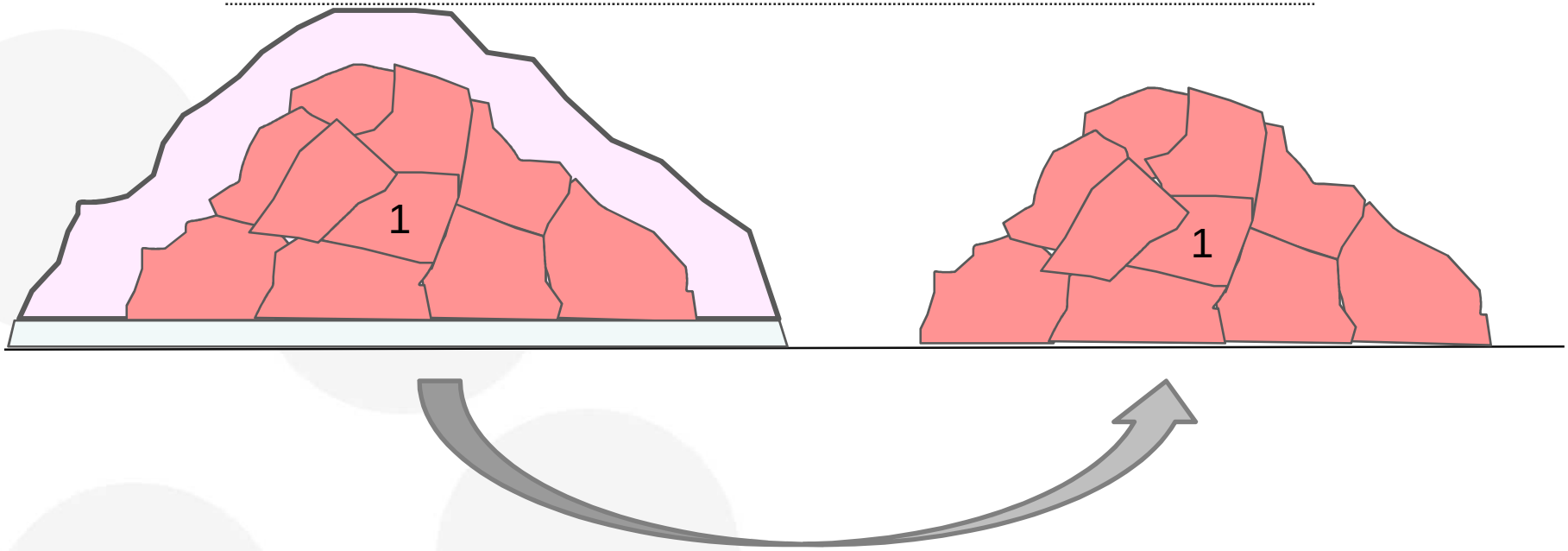


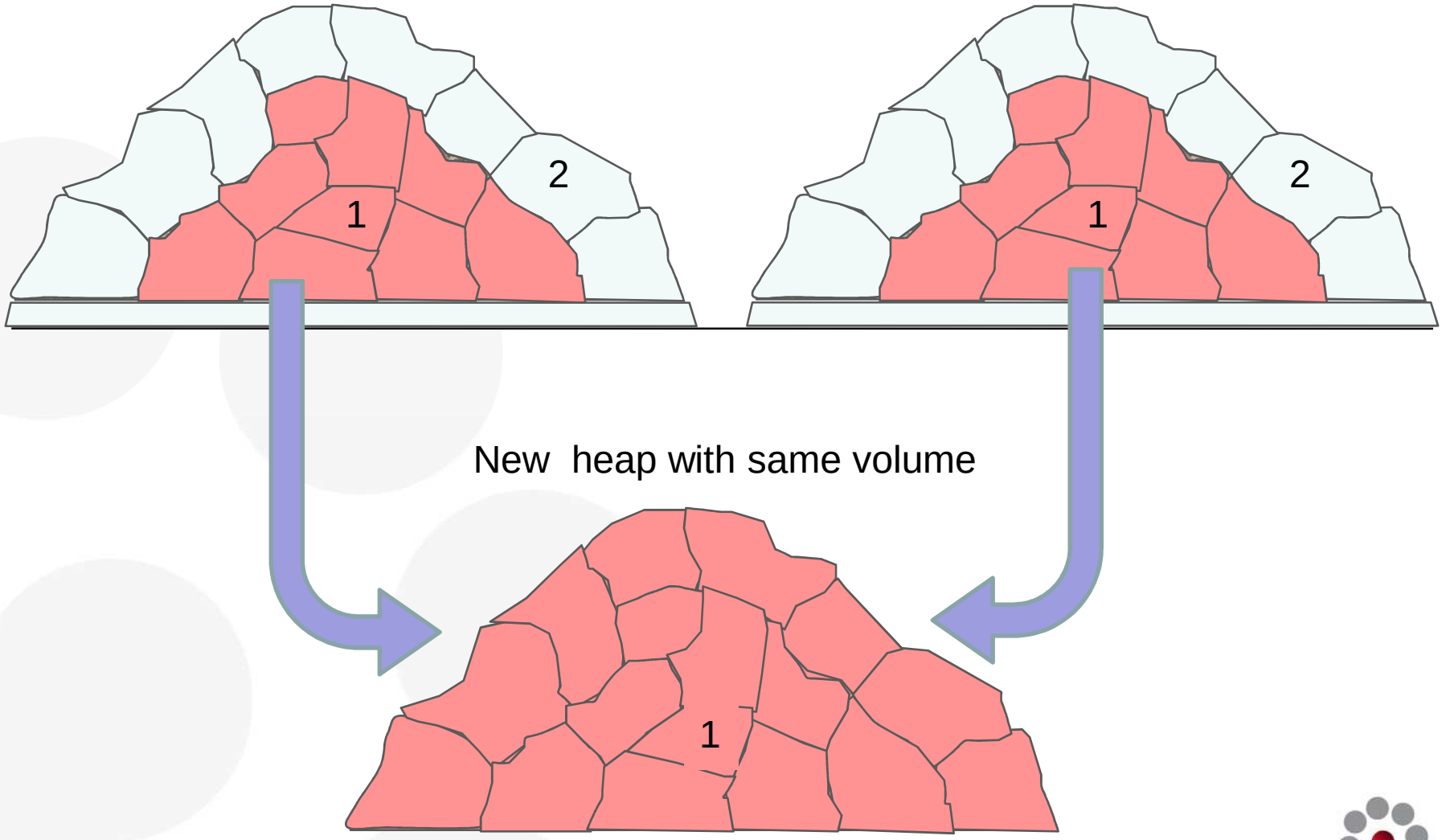
Alternative processing A1

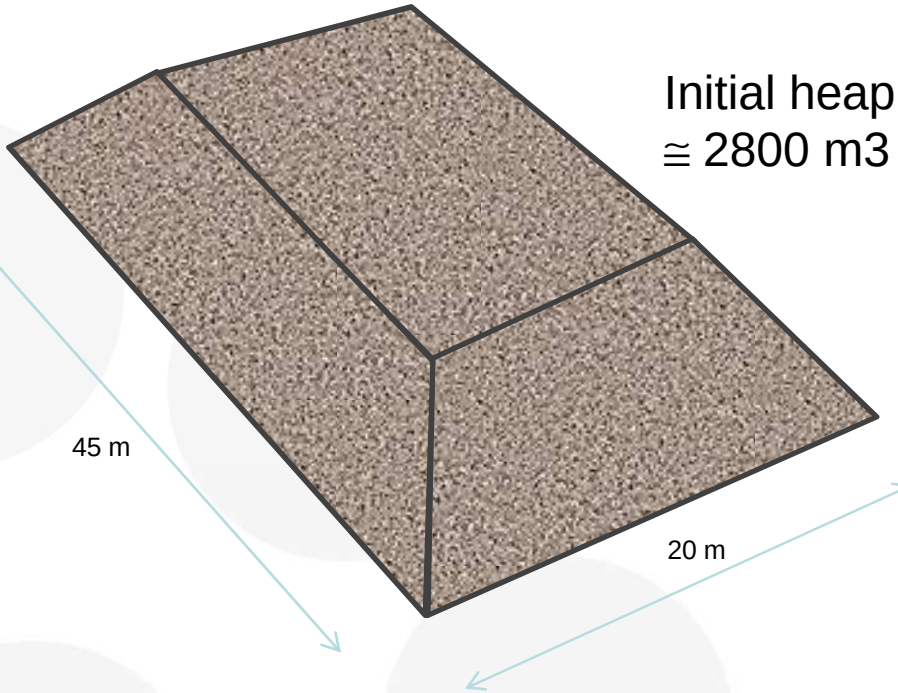
Form a new heap only with
hot material from previous heap



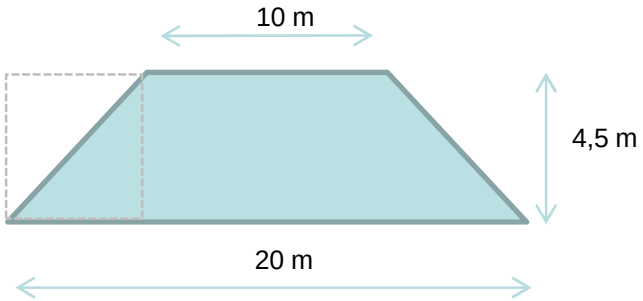
New heap ± 60% of volume



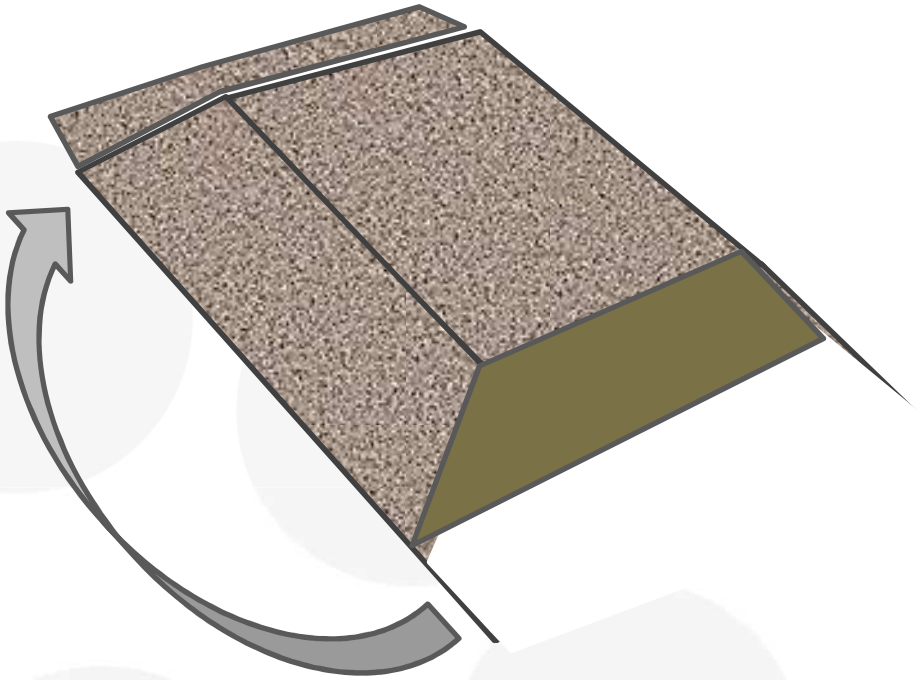

2
1
2
1
New heap with same volume
1



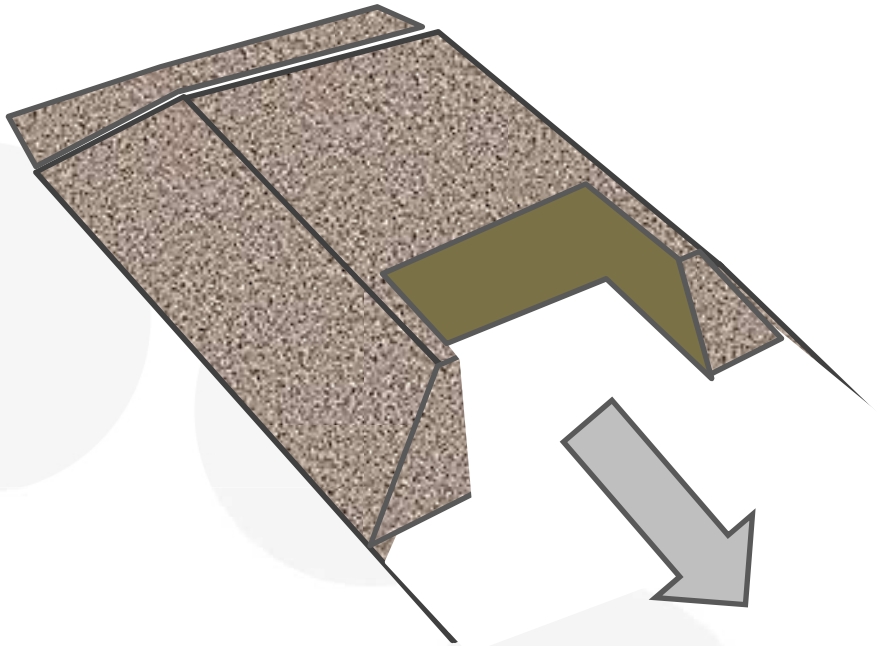
Initial heap
≅ 2800 m3



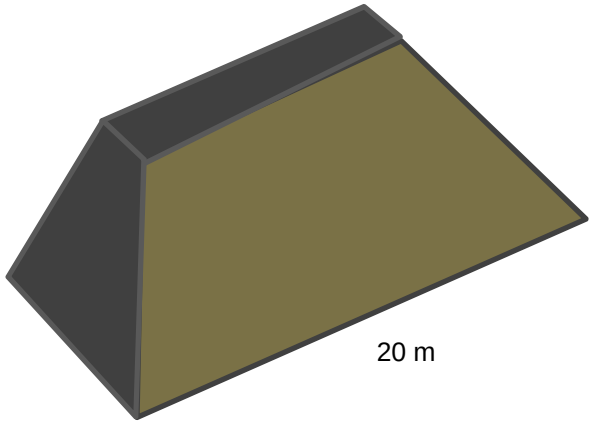
(45-4,5)x(20-4,5)x4,5=2825 m3

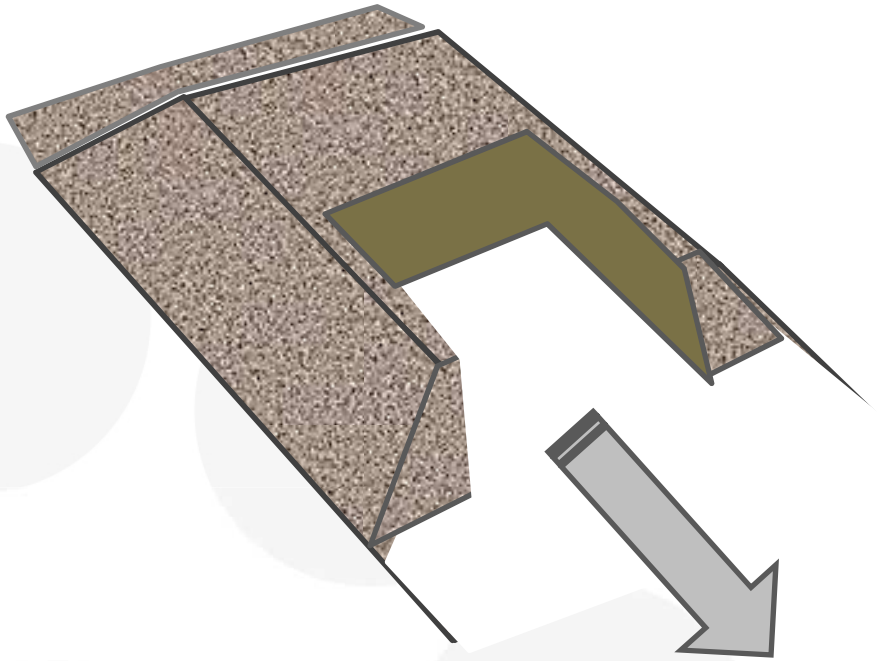


1 - Retirar a frente da pilha e colocar atrás.

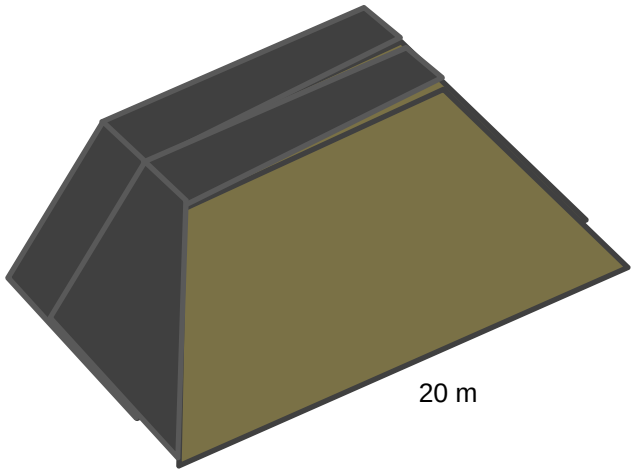


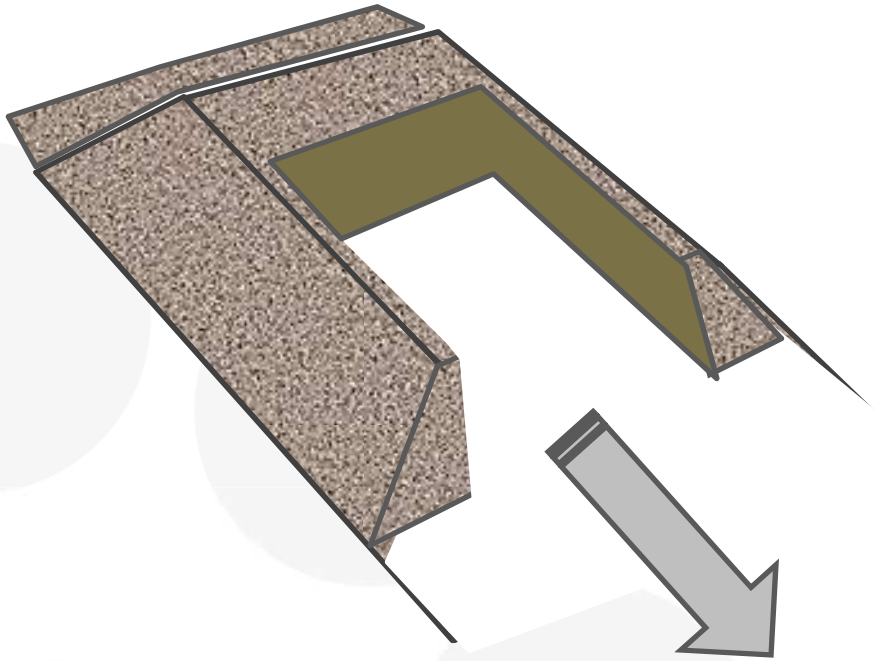
1 - Retirar a frente da pilha e colocar atrás.
2 – Retirar o miolo da pilha e fazer nova pilha.



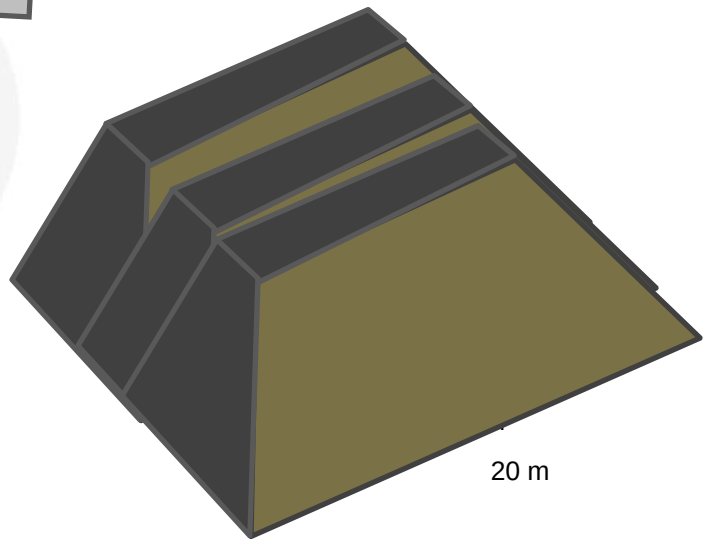


1 - Retirar a frente da pilha e colocar atrás.
2 – Retirar o miolo da pilha e fazer nova pilha.
3 – continuar …



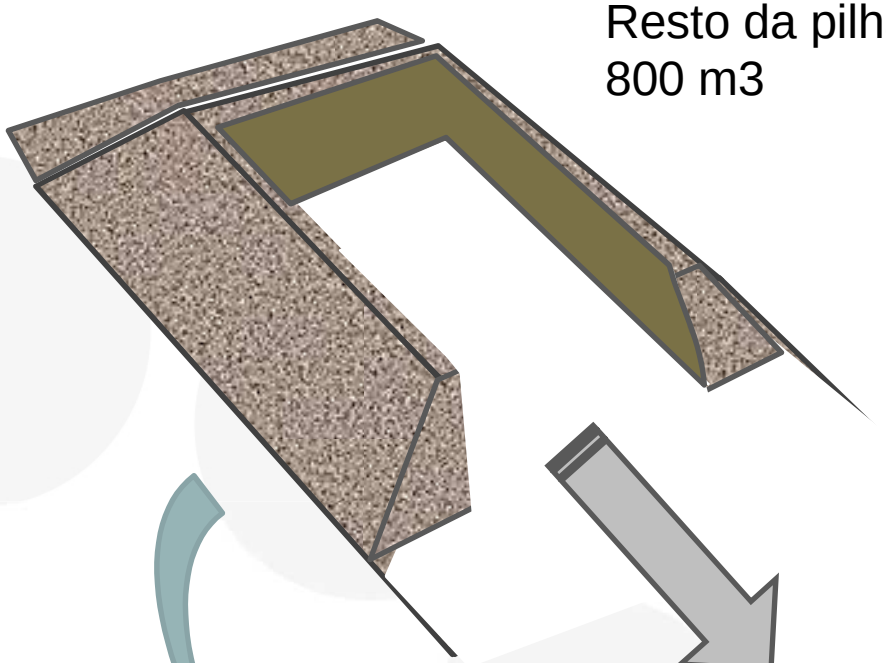


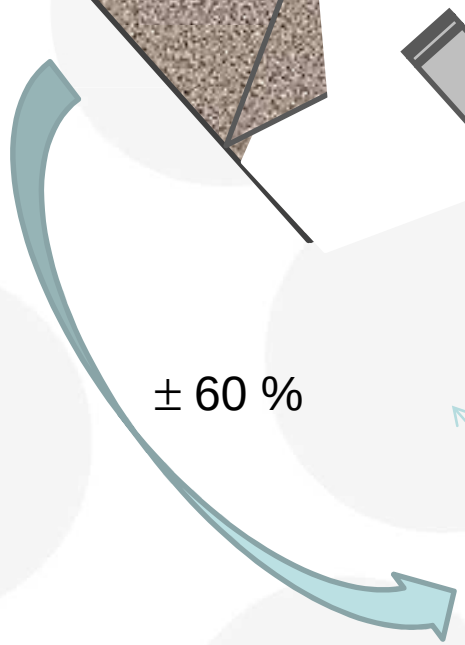
1 - Retirar a frente da pilha e colocar atrás.
2 – Retirar o miolo da pilha e fazer nova pilha.
3 – continuar …



Resto da pilha inicial
800 m3

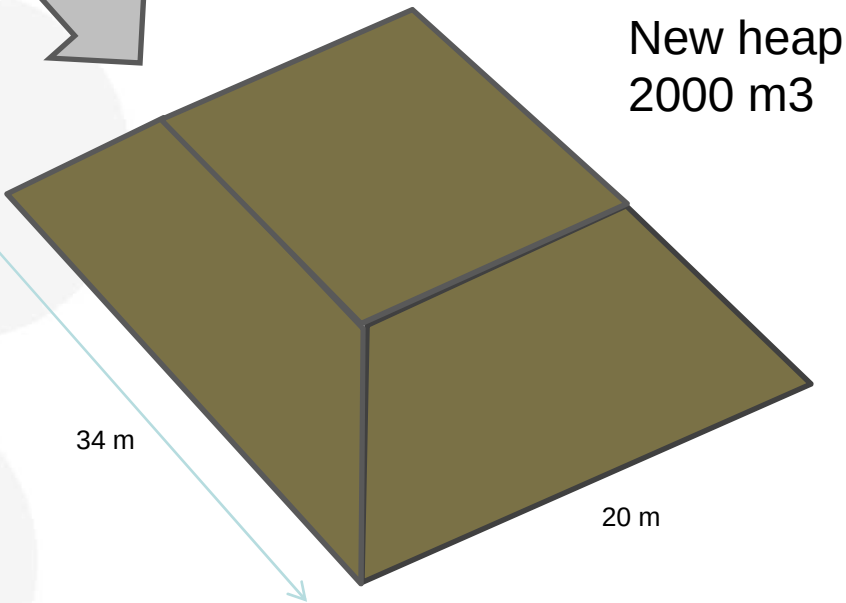
1 - Retirar a frente da pilha e colocar atrás.
2 – Retirar o miolo da pilha e fazer nova pilha.
3 – continuar …





± 60 %

New heap
2000 m3



Temperature on top of the heap

Courtesy: Madeca

Ministério da Agricultura, do Desenvolvimento Rural e das Pescas

DGADR
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Versão 5 (07/07/2011)

REQUISITOS TÉCNICOS PARA TRATAMENTO TÉRMICO DE CASCA ISOLADA DE CONÌFERAS

Introdução

O processo de eliminação do nemátodo da madeira do pinheiro em casca isolada de coníferas é o tratamento pelo calor, submetendo o material vegetal a uma temperatura mínima de 60ºC. Atendendo à natureza do material em causa o processo de tratamento térmico que melhor se adapta é o tratamento por compostagem ...

…

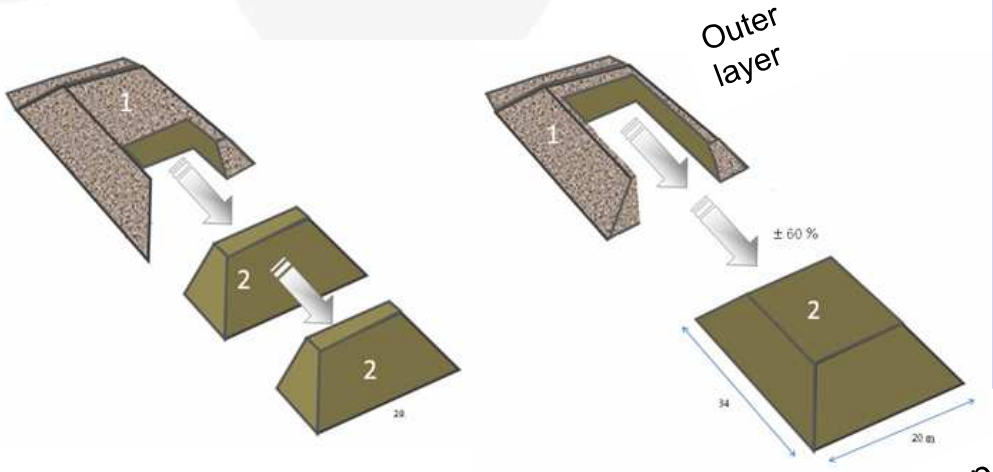

Fig. 3 – Turning with separation.

1 – Minimum 6 hours at temperature > 60ºC in the interior of initial heap;
- New heap with “separation”;
2 - Simple turning after > 6 hours temperature > 60 ºC;
3 - Simple turning after > 6 hours temperature > 60 ºC;
4 - Simple turning after > 6 hours temperature > 60 ºC;

New heap only with bark from the interior

LNEG

Energy efficient process

If this process were not used, the heat treatment should be made consuming energy.

The amount of energy saved for 1 cubic meters of bark would be equivalent to 200 kg of steam per hour (13 kW-h /m3).

The amount of bark exported is estimated in more than 200 000 m3/year, saving > 2 600 000 kW-h. of energy.


Pine forest
Compost pine bark installation
Image © 2011 GeoEye
© 2011 Tele Atlas
©2010
39°39'58.80"N 8°36'20.89"O elev 181 m
Altitude de visualizaçã

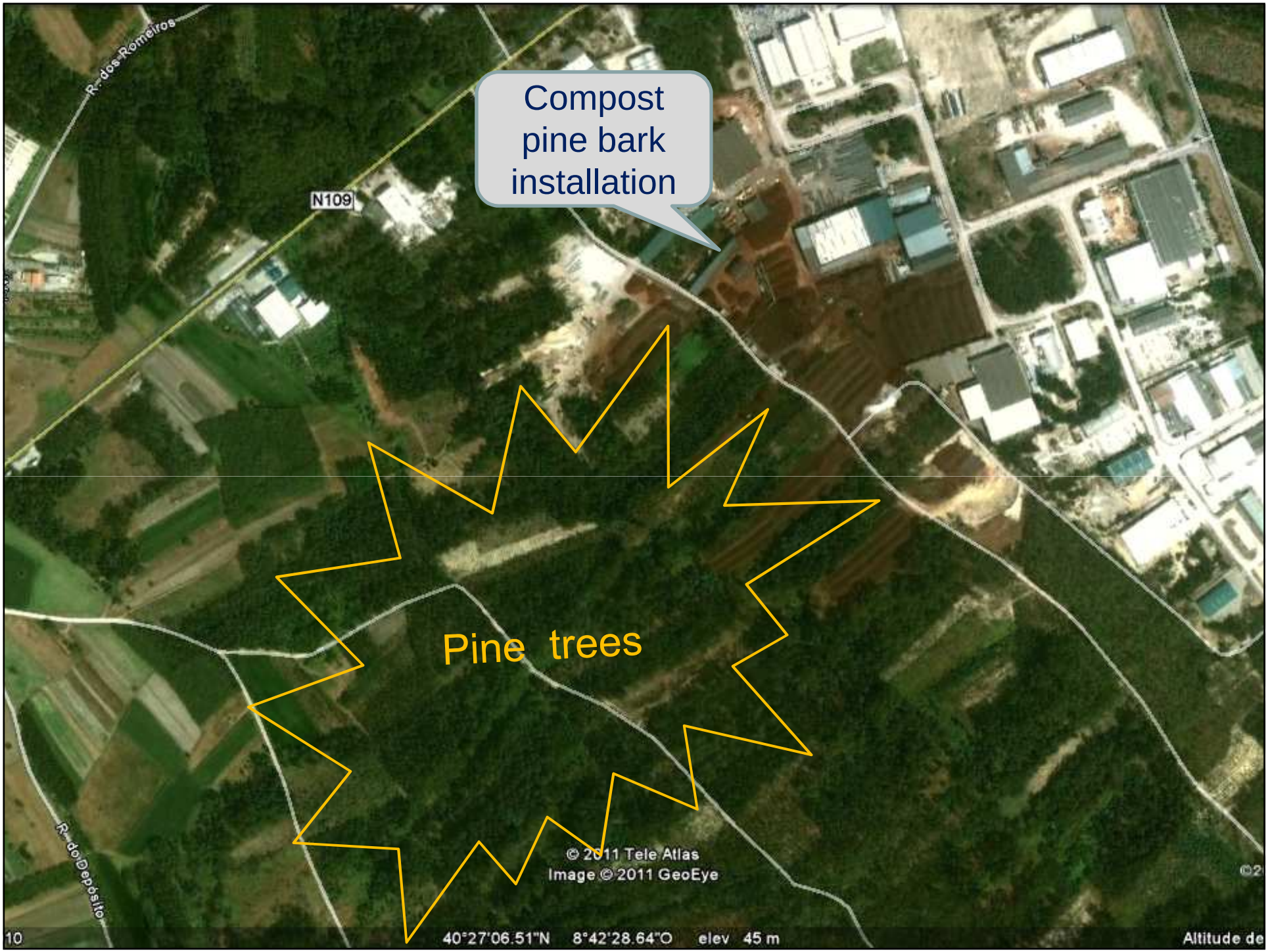
Compost pine bark installation
Pine trees
R. dos Romeiros
N109
R. do Depósito
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Image © 2011 GeoEye
40°27'06.51"N 8°42'28.64"O elev 45 m
Altitude de


Compost pine bark installation
Pine forest
© 2011 Tele Atlas
Image © 2011 GeoEye
imagens: 29 Jul 2009
40°06'34.44"N 8°51'17.99"O elev 16 m

Thank you
for you
attention