Giant cane

(Arundo donax)

Experiment on a mechanical technique to rapidly eliminate giant cane

Board for the Hérault River basin (SMBFH)

- The board was created in 2009 and awarded the status of a public river-basin territorial agency (EPTB) in 2011.
- It is the managing entity for the SBMP (sub-basin management plan) and acts as the driving force in coordinating the work and studies to provide complete and balanced management of water and aquatic environments in the basin of the Hérault River, a basin spanning 2 500 square kilometres and 166 towns in the Gard and Hérault departments.
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Concept.Cours.d'EAU (C.C.EAU)

- C.C.EAU is an environmental consulting firm specialised in riparian vegetation and invasive plants, with its head-quarters in the Savoie department.
- Concerning invasive species, the firm focusses on:
- formulating management strategies;
- developing assessment methods based on an evaluation of the invasion stages;
- R&D in management techniques;
- managing work sites to remove invasive plant species;
- information and training.
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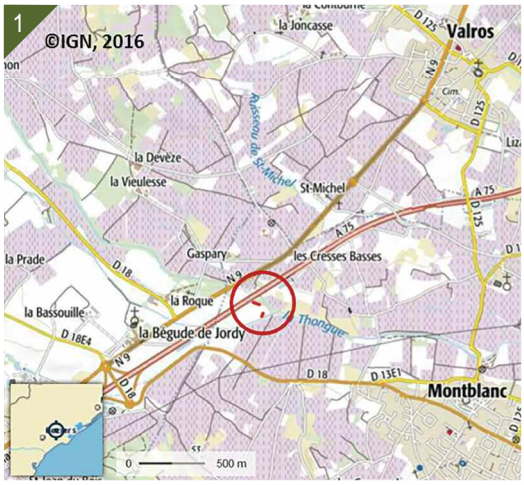
Intervention site

- This experiment was made possible by the Pays de Thongue intermunicipal association, the project owner.
- The Thongue and the Lène are two rivers with typical Mediterranean hydrological regimes. They flow into the Hérault River just a few kilometres upstream of the point where the latter flows into the Mediterranean Sea. They have undergone considerable development work and the banks along almost half of their total length are covered with giant cane.
- The site of the experiment comprises two large cane beds[1] that have existed for about 12 years at the confluence of the two rivers along formerly farmed fields that were abandoned following the construction of the A75 motorway, in the town of Montblanc (Hérault department):
- cane bed A, 500 square metres (50 m long and 10 m wide). The bed is located along the ditch draining flows from the discharge installation for the floodplain under the motorway;



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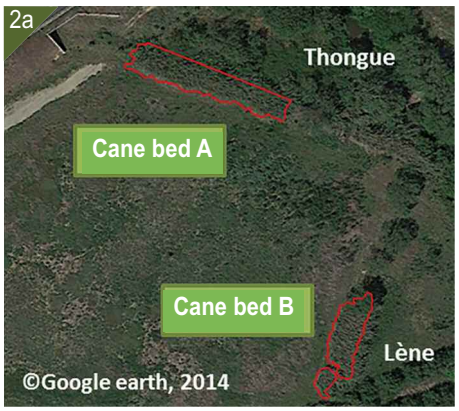


1. Map showing the site.
2a. 2b. Aerial photos of the site before (2014) and after (2016) the work.

- cane bed B, 230 square metres (30 m long and 10 m wide). The bed is located on a mound positioned perpendicularly to the flow in the floodplain.

1. In this document, the term "cane bed" designates a stand of giant cane.

Disturbances and issues involved

■ Giant cane creates large, very dense clumps of plants along river banks that have a significant ecological impact on riparian vegetation. The density of the woody stalks (several dozen per square metre) and their height (6 to 7 metres) mean that they can compete with the local vegetation. In addition, the accumulation of non-decomposed plant litter on the ground hinders the sprouting of other species.

■ The woody stalks uprooted during floods can contribute to worsening flood conditions and disturb flows by forming vast obstacles of plant matter in rivers. Cane beds must therefore be preventively cleared to avoid these risks, which results in high maintenance costs for local governments. Their presence also complicates and increases the costs of ecomorphological-restoration work in rivers (grading the banks to form slight slopes, recreating meanders in formerly rectified riverbeds, restoration of riparian vegetation, etc.).

3. Arundo donax.

Interventions

■ The objective of the project was to test an easy mechanical technique to eliminate the cane beds. The technique is a spin-off of the "grinding-tarping" process that has proven effective for Asian knotweeds, another invasive plant producing rhizomes (see the management report at http://www.onema.fr/sites/default/files/EN/EV/publication/EEE/vol2/Reynoutria-spp2.pdf). Given that the rhizomes of giant cane lie closer to the surface than those of knotweed, the tested technique did not include excavation work.

■ The technique consists of grinding the infested soil in order to break up the rhizomes and destroy their root system, then covering the treated soil with a sheet of black plastic to prevent the sprouting of the rhizome fragments.

■ This technique was tested under different conditions (watering the soil to accelerate decay and scraping the soil to different depths to enable greater penetration of the grinder). The "grinding-tarping" process alone was sufficient to produce satisfactory results, which explains why the other test conditions (with essentially the same results) are not discussed here.

Experimental system

■ A total of 17 plots, each approximately two square metres in size, were subjected to different treatments in order to determine the effects of grinding and tarping times on rhizome destruction.

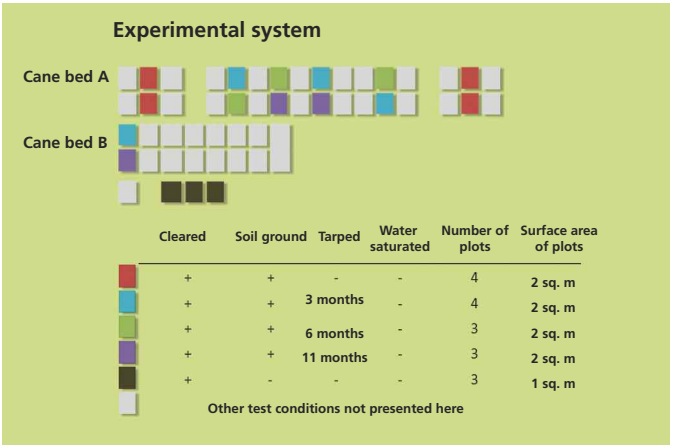


Diagram of the experimental system.

■ Soil grinding

■ The project took place from 13 to 17 April 2015.

■ In order to grind the soil to the greatest possible depth, the plots were first cleared and all plant litter and debris were removed. The waste was deposited in the colonised area that was not treated, next to the plots.

■ The soil was ground three times by a stone grinder at a very low speed (100 metres per hour for the first passage and 200 m/h for the next two).

■ Tarping

■ The plots were covered with two layers of black, plastic tarp (200 microns) held in place by sand bags.

Different tarping durations (3, 6 and 11 months) were tested.

■ Monitoring and assessment

■ Three pedological trenches were dug to determine the depth and position of rhizomes and the overall depth of the plant's root system.

■ The depth of grinder penetration was measured.

■ Following grinding, 20 of the fragmented rhizomes were removed and grown in flower pots for 50 days.

■ The site was visited four times, in July and October 2016 and March and September 2016, in order to:

- count the number of plants starting to grow again in each plot;
- measure the height of the stalks in view of determining the amount of aerial biomass produced using the equation proposed by Spencer et al., 2006;
- dig into a number of plots (over a surface area of approximately one square metre and to a depth of 30 cm) to look at the rhizomes. This work, made necessary because some stalks were eaten, provided information on the mortality rates of rhizomes in the plots where no regrowth was visible.

Results and assessment

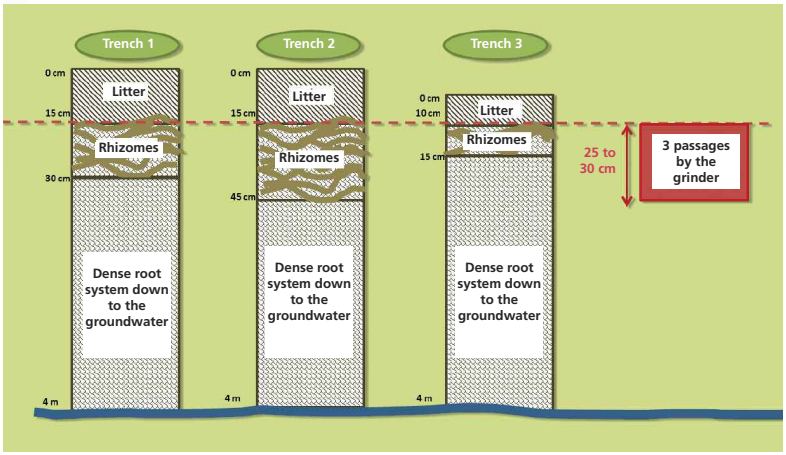
■ Grinder effectiveness in reaching the rhizomes

■ The three pedological trenches revealed:

- an undulating layer of thick, caespitose rhizomes located at depths of up to 30 cm below the plant litter;
- a fine and very dense root system descending to the saturated zone located approximately four metres below the ground level of the site.

■ Following removal of the plant litter, the soil was ground three times to a depth of between 25 and 30 cm. In each case presented here involving grinding, it succeeded in fragmenting the rhizome layer.

4. Fragmented rhizomes following the first passage of the grinder. Average length = 6.3 cm (SD = 2 cm, N = 150).
5. Clearing the plots using a flail-cutter set up on an excavator.
6. Removal of plant waste after clearing.
7. Soil grinding using a stone grinder mounted on a tractor.
8. Tarped, experimental plots.



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Grinder penetration and rhizome depths.

■ Effects of clearing alone

■ Clearing alone did not reduce the numbers of giant cane. In the plots that were simply cleared, no reduction in the number of stalks was noted after a single growing season following the work.

■ However, the aerial biomass produced after two growing seasons was divided by a factor of three compared to the cane bed prior to the work. The stalks had not yet reached their maximum height.

■ Effects of grinding alone

■ Grinding alone resulted in high mortality levels in the rhizomes. The number of sprouts in the ground plots was ten times lower than on the plots that were simply cleared and the biomass produced was also much lower. These results were confirmed by tests attempting to grow the rhizomes. Out of 20 ground rhizomes, only six had produced sprouts after 50 days.

■ However, grinding alone is not sufficient to eliminate giant cane. According to our results, in a cane bed equivalent in size to bed A (500 square metres), grinding alone will result in approximately 1 000 sprouts the following year.

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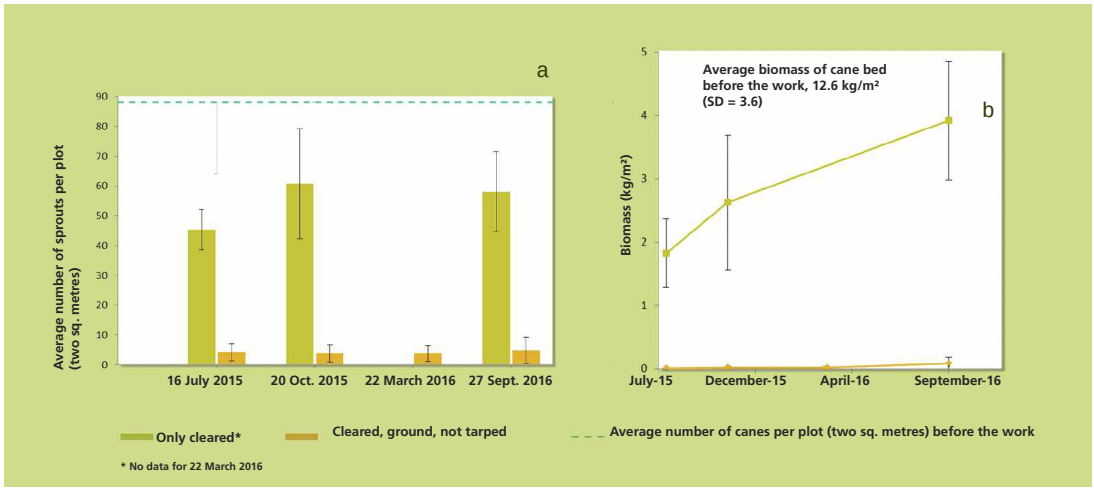


Effects of clearing and grinding alone on the numbers of sprouts and on biomass.

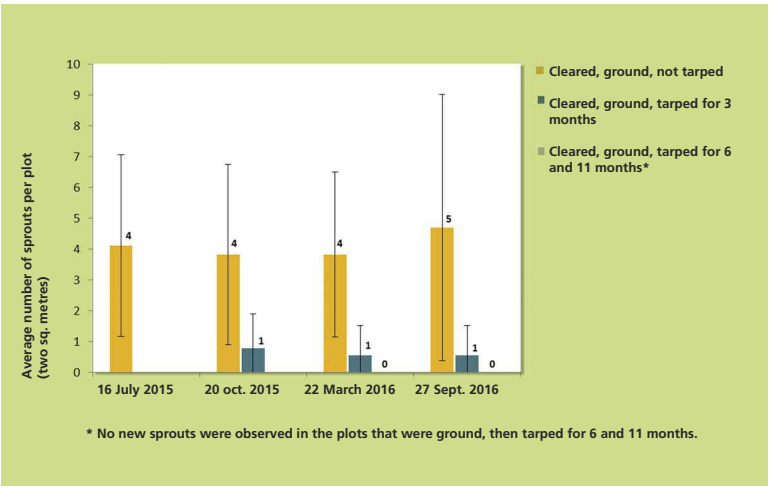
Effects of tarping alone

The plant was still alive after tarping of non-ground plots for 11 months.

Effects of grinding and tarping

Placing tarps over the ground soil significantly reduces the number of new sprouts:

- after three months of being tarped, only a single sprout was observed on average in the plots (two sq. metres each). However, three months are insufficient given that, according to our results, the number of sprouts would still be approximately 250 in a cane bed of 500 square metres;
- no new sprouts were observed in the plots (two sq. metres) that were tarped for 6 and 11 months. Consequently, superficial grinding of the soil at the start of the growing season followed by tarping for at least six months resulted in a 100% mortality rate among the rhizomes.



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Effects of tarping durations on the numbers of sprouts.

An investigation of the three plots ground and tarped for six months confirmed the 100% mortality rate among the rhizomes. This is a reliable result in that an average of 307 dead rhizomes were counted per square metre of soil (SD = 126) and no live rhizomes were observed.

Treatment	Plot	Number of sprouts	Estimated density of rhizomes per sq. metre	Length of rhizomes (cm)	
				Average	Standard deviation
Cleared, ground	1	0	440	4	1
and tarped 6 months	2	0	190	5	1
	3	0	290	4	1

9. After 11 months of tarping, the rhizomes were still alive in a plot that had not been ground.
10. Dead rhizomes collected in the experimental plots after six months of tarping.

Assessment

■ The experiment demonstrated conclusively that it is possible to rapidly eliminate cane beds using an easily implemented technique. Success depends above all on the depth of penetration of the grinder in the soil. For this reason, it is essential to:

- first clear the cane bed and remove all plant litter;
- grind the soil at least three times;
- run at very slow speeds to avoid clogging the grinder;
- check that the soil is ground to a depth that includes the rhizome layer, which can be more or less difficult depending on the type of soil.

■ The period during which the experiment was carried out probably played a major role in its success in that the six months of tarping took place during the growing season with high temperatures during the summer. According to observations on the site, it would appear that the rhizomes first started to rot, then dried. If similar work is carried out during other periods of the year, it may be necessary to tarp the soil for a longer period.

Total cost of the experiment.

Phases	Cost (ex VAT)	Duration
Preparation Bibliographical survey Find a site and a willing land owner Initial visit to the site Drafting of the experimental protocol Description of the type and quantity of work to be done	3 200 €	3 years
Work Clear the cane beds and remove the plant litter Dig the pedological trenches with the excavator Set up the plots (excavator) Grind the soil (stone grinder) and other work Tarping	12 000 €	5 days
Monitoring the work Continuous monitoring in order to improve the technique Attempt to grow the rhizomes	6 400 €	5 days
Monitoring the results Removal of the tarps and monitoring of the plots over two growing seasons (calculation of sprout numbers, measurement of stalk heights, digging up of rhizomes, etc.) Collection of rhizomes and attempts to grow them to determine the rotting process and its impacts Analysis of the results and drafting of a technical report	4 500 €	11 months
Total cost of project	26 100 € Cost ex VAT 31 320 € Cost incl. VAT	

■ Estimation of technical costs

■ Depending on the constraints weighing on a given site, unit costs under real worksite conditions (non-experimental conditions) may vary from 15 € per square metre to 75 €/m^2 (ex VAT, not including management costs) for cane beds ranging from 5 000 to 500 square metres respectively. The highest costs correspond to any additional expenses due to difficult access, the need for earth-working to arrange embankments and river banks, or the need for simple bio-engineering work. The prices per square metre mentioned above do not include work to replant river banks or the removal of plant waste from the site.

Information on the project

■ The project was discussed during a visit to the site by river technicians from the region.

■ Information on the project is available on the internet site of the Pays de Thongue intermunicipal association: http://www.cc-pays-de-thongue.fr/Experimentation-sur-la-Canne-de.html

Outlook

■ On the basis of the results obtained, the proposed technique consists of:
- in the spring, clearing the cane bed, removing the plant litter, making three runs with the stone grinder at low speed and checking the grinding depth, then installing a black, plastic tarp and weighing it down with sand bags;
- monitoring the tarp or setting up a fence (to avoid damage to the tarp by large animals);
- removing the tarp after six months.

■ The experiment demonstrated that 11 months of tarping alone are not enough to destroy the plants. Grinding of the soil is required, however longer tarping times could possibly do the job.

■ The risk of sprouting by stalk fragments cut and removed from the cane bed prior to grinding the soil was not investigated in this study. Given that this risk is theoretically very low during the proposed work period, storage of the plant waste on site should be possible on the condition that checks on sprouts be run and that the waste be removed if sprouts do occur. Another possibility would be to chop the cleared stalks and to lay the chopped waste on the soil prior to tarping. This process will require specific study because it was not investigated during the experiment. Finally, if it is deemed necessary to remove the stalks from the site, the different waste-management techniques must be studied on a case-by-case basis.

■ The proposed technique offers a number of possibilities for the rapid restoration of riparian vegetation in the Mediterranean region, e.g. work on the cane beds in the spring, removal of the tarps in the fall and immediate replanting of the banks.

■ However, a number of practical aspects concerning the actual implementation must still be worked out. They have to do essentially with the depth achieved by the stone grinders and adaptations required depending on the type of soil in order to make sure that the rhizome layer is reached.

■ Monitoring of the work under real-life, worksite conditions is still required to validate the technique and to more precisely determine the costs of the potential conditions encountered on river banks and elsewhere.

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Pour en savoir plus

■ Internet site of Concept.Cours.d'EAU: www.cceau.fr

■ Internet site of the Board for the Hérault River basin (SMBFH): www.fleuve-herault.fr

■ Spencer, D. F., Liow, P. S., Chan, W. K., Ksander, G. G., and Getsinger, K. D. 2006. Estimating Arundo donax shoot biomass. Aquatic Botany, 84(3), 272-276.

This management report was drafted in January 2017 by the work group for biological invasions in aquatic environments, set up by the French biodiversity agency and IUCN France, in addition to those already presented in the second volume of the book titled "Invasive alien species in aquatic environments, Practical knowledge and management insights", in the Knowledge for action series published by Onema.(http://www.onema.fr/sites/default/files/EN/EV/cat7a-EEE-vol2.html).

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