Technical note

Construction and installation *in situ* of a 1m^2 metallic frame for characterisation of hydraulic properties, soil detachment by rainfall simulation or under natural rainfall

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A - Interests of the measures at 1m² scale

Measurements under simulated rainfall or natural rainfall across 1m² scale (Figure 1) allows precise characterization of hydrological processes and an understanding of the mechanisms that determine the sharing of rain at the soil-atmosphere interface (Chaplot et al., 2011; Hai An Phan et al., 2012; Issa et al., 2011; Janeau, Bricquet, Planchon, & Valentin, 2003; Janeau et al., 2014; Janeau, Grellier, & Podwojewski, 2015; Ribolzi et al., 2011). We also use this scale to characterise soil biology, vegetal cover versus infiltration (Brown, Scholtz, Janeau, Grellier, & Podwojewski, 2010; Janeau, Mauchamp, & Tarin, 1999; Jouquet et al., 2012; Mauchamp & Janeau, 1993; Savary & Janeau, 1986).

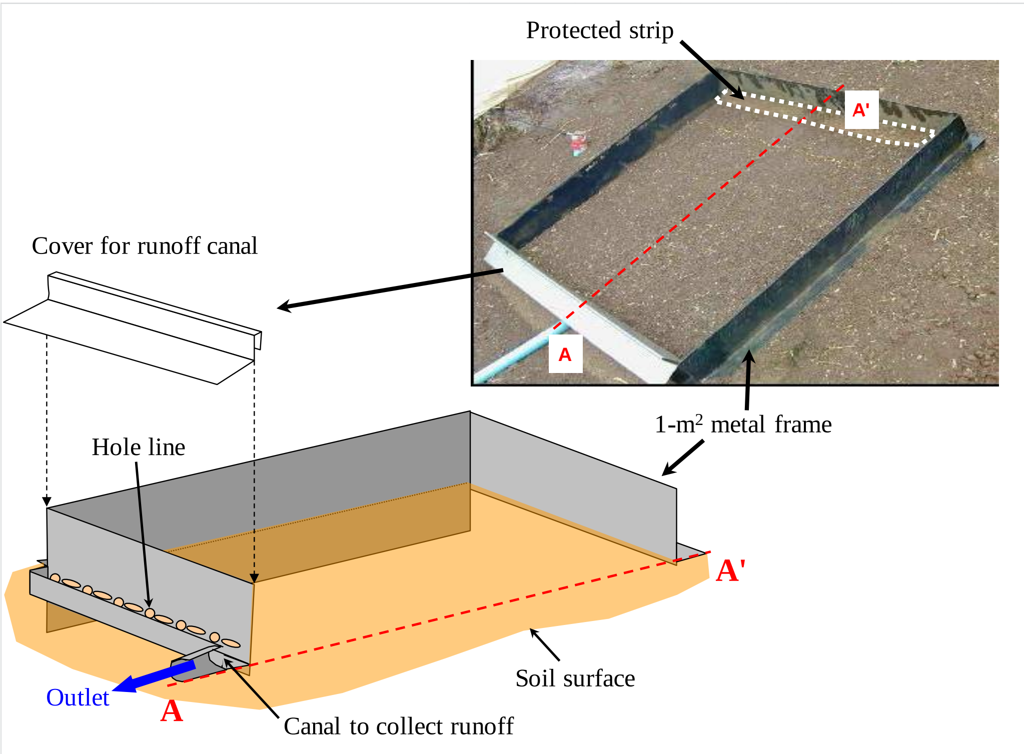


Figure 1. Overview of the 1 m² metallic frame "Microplot".

Considering the complexity of the agro-ecosystems, the 1m² scale measurements provides repeatability of the measurements and tests of a large number of land uses in a time limited both in natural habitats and cultivated (Podwojewski et al., 2011; Podwojewski, Janeau, & Leroux, 2008; Podwojewski, Orange, et al., 2008; Poulenard, Podwojewski, Janeau, & Collinet, 2001). This fine scale allows covering a large geographic and spatial variability of environments.

Observations across the square meter are also useful in understanding the process at the catchment scale. They allow to parameterize hydrological models for flow forecasting on a larger scale. Many hydrological models exists (conceptual, empirical specialized in soil erosion) using data obtained under simulated rainfall or under natural rainfall (Bajracharya, Elliot, & Lal, 1992; Duiker, Flanagan, & Lal, 2001; Mugler et al., 2019; Mügler et al., 2021; Patin et al., 2012; Pudasaini, Shrestha, & Riley, 2004; Wang & Smith, 2004).

To measure hydraulic properties, soil detachment and roughness of the soil surface we are using a metallic frame of a square meter, so called "Microplot", down from 10 to 20 cm deep in the soil described below.

B - Description

The metal frame (Figure 2 and annexes) must have specific inner dimensions (100 cm x 100 cm). The metal should be resistant enough to possible deformation due to the sledgehammer used to insert the frame into the ground. Steel plates of 2 mm thickness (or 3 mm in rocky/stony ground) are used to build the vertical sides of the frame. The protective cover of the canal that collects runoff is made of galvanized steel or stainless steel with a thickness < 1 mm. The side reinforcements (angle corners made of steel) should be 3 to 4 mm thick. Areas where the pieces have been welded must be treated carefully to avoid breaking during insertion of the frame into the ground. Drain holes runoff are usually 10 mm in diameter. The row of holes may be regularly spaced with 10cm between each hole or irregularly spaced with 10 mm holes placed 30 mm apart.

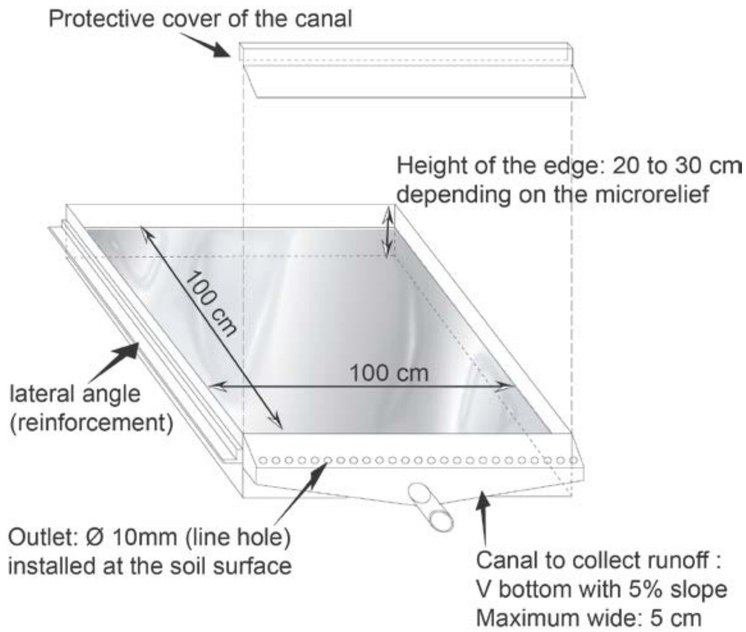


Figure 2. Diagram of the 1 m^2 metallic frame.

C- Installation

1. Install the frames along the same contour line to ensure homogeneity of the slope gradient (Figure 2a & 2b). However, 2 or 3 contour lines can be used if many plots need to be installed, e.g. for 6 plots distributed on two slope gradients the plots could be placed on two contour lines of 2 x 3 plots.

Figure 2a. Installation of the 1m^2 frame on a single contour line in pastures in South Africa. The collection tanks are protected by barbed wire.

Figure 2b. Installation of the 1m^2 frame on two contour lines in crop area with steep slope in Laos.

2. Depending of the hardness of the ground, insert the plots after cutting the soil with a machete, a blade or a knife (a grinder for very hard soil). If the soil is not too dry, it is possible to insert the frame with a sledgehammer into the ground. Be careful: do not bend the edges, hit them with an insertion frame built with 4 reversed iron angles (or use a plank or a branch). The lateral angles that are welded to the half of the height of the iron frame must sit on the soil surface: 20 cm of total edge plate gives 10 cm in the ground.

3. Ensure that the canal for collecting runoff water does not receive "undesirable" runoff; generally this runoff comes from the lateral sides of the plot;

4. Whatever the micro-relief of soil surface, carefully set the horizontality of the canal for optimal drainage runoff (Figure 3);

5. Make sure that the line of holes is clear and that it is at the soil surface (maximum 1/2 of the hole into the soil) – this can be adapted as a function of the roughness of the surface (Figure 4);

Figure 3. Frame installed on a highly patterned surface, Isan, northeastern Thailand.

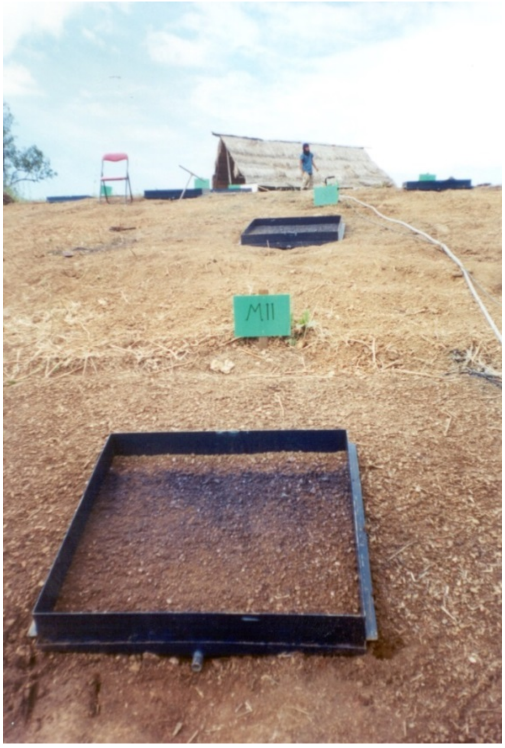


Figure 4. Frame installed on gravelly soil (coarse micro-relief soil), Phrae province in northern Thailand.

6. Do not forget to protect the runoff canal collector from the rain with a protective cover;

7. The size of the receiving tank must be adapted to the heaviest storms expected in the region. Considering a millimeter of rain on one square meter = one liter, the tank capacity should range from 60 to 120 liters to capture 100% runoff from a storm ranging from 60 to 120 mm (Figure 5a & 5b).
   - ✓ Place the tank about 70 to 100 cm away from the plot to prevent water that has seeped into the $1m^2$ plot running out the holes into the tank - connect the tank to the canal collector by a PVC elbow-ending pipe.
   - ✓ Place a large stone on the top of the tank or install an iron bracket that prevents the tank floating up if water runs into the hole where the tank is (in other words, reduce the buoyancy of the tank). Where the soil has a low drainage capacity, a drainage channel must also be excavated to evacuate excess water runoff from the tank hole.
   - ✓ Be careful to avoid having rainwater collecting on the lid of the tank and then running into the tank.

Figure 5a. Plot set-up on degraded grassland in South Africa. A trench drain was dug to prevent the tank floating.

Figure 5b. Plot set-up on crop area. An iron tank was installed to prevent the bucket floating.

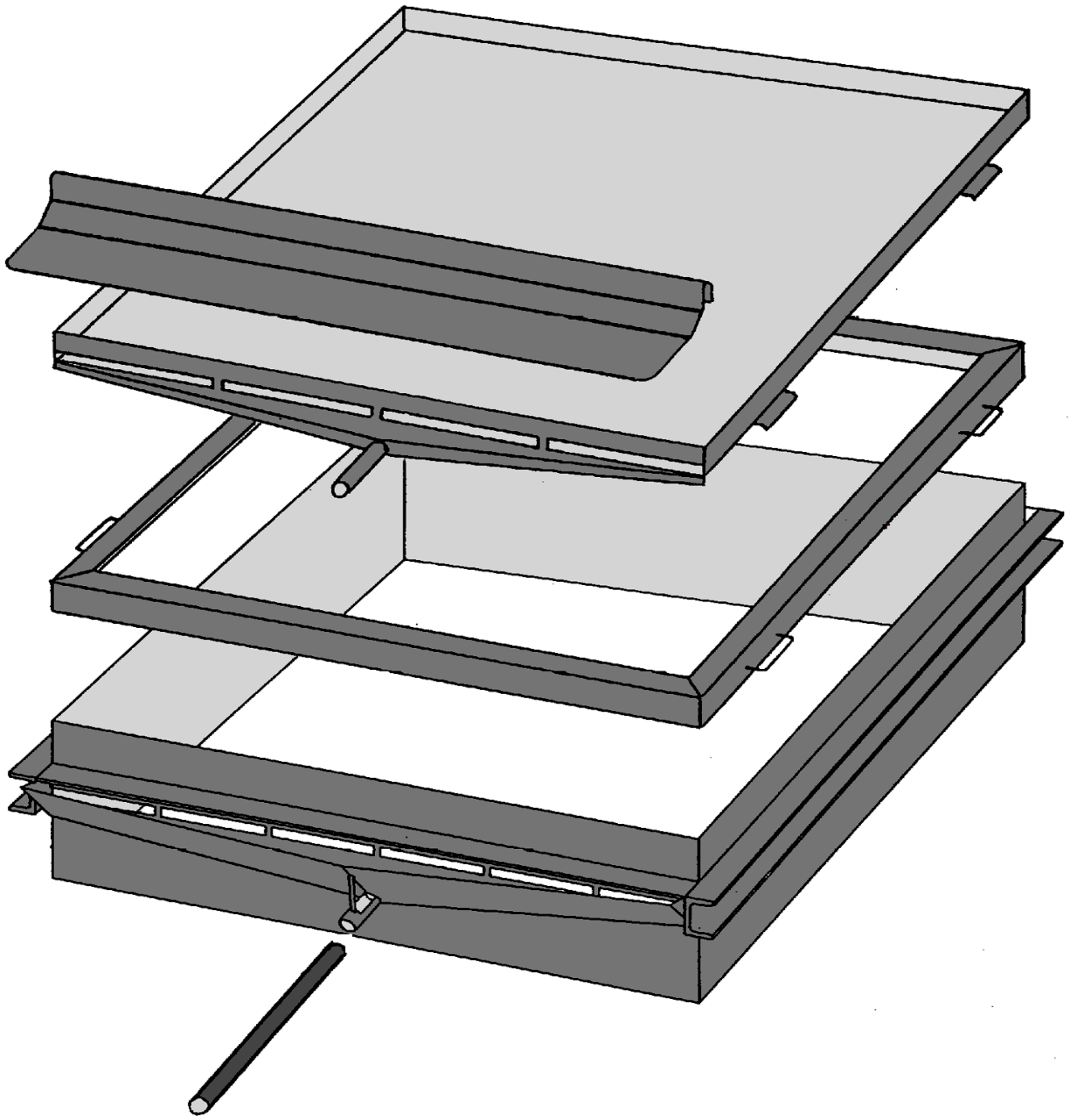
8. If using specific crop treatments check that the number of plants in the plot is the same as in the entire field and the farmer is not more “active” in the $1m^2$ plot studied than in the entire field.

Annexes

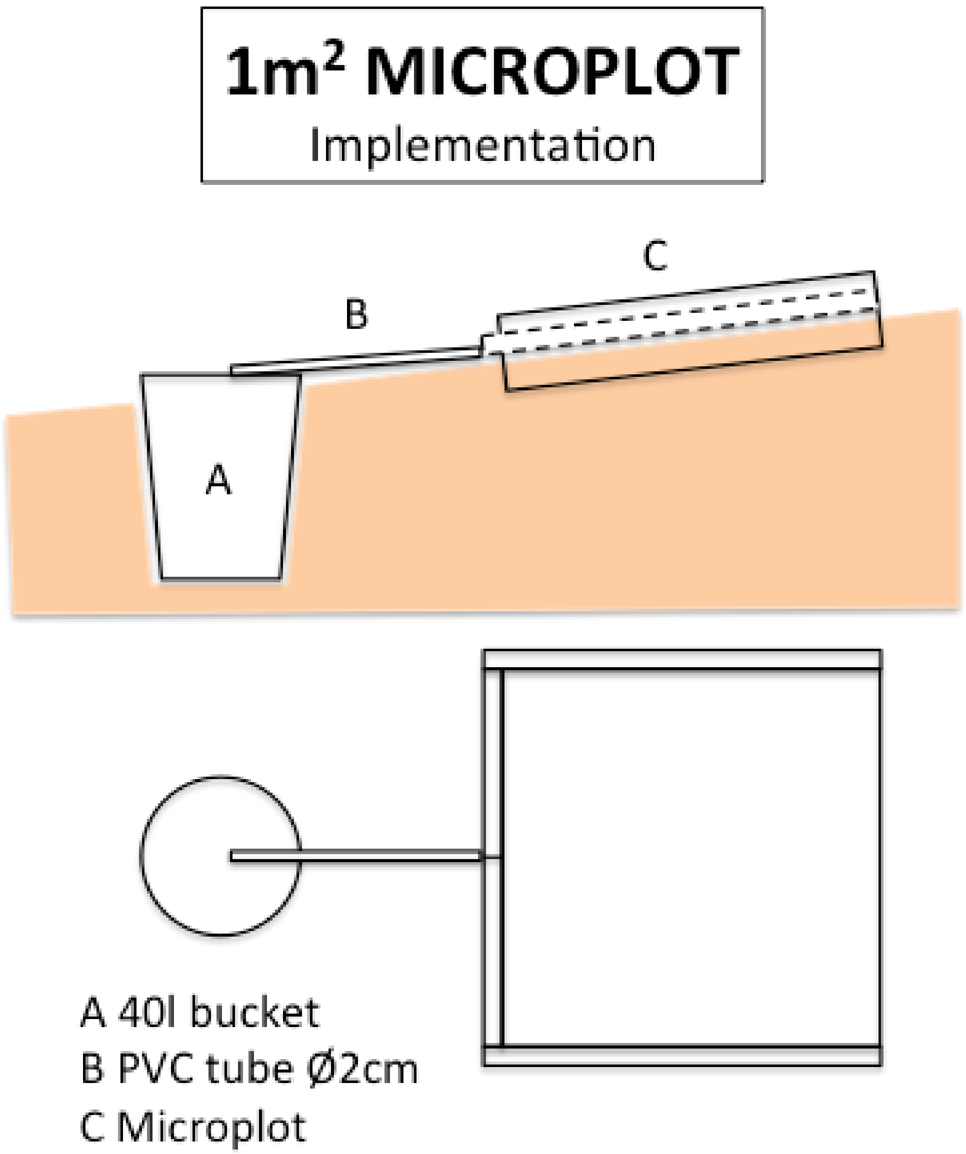
Top position = Calibration frame

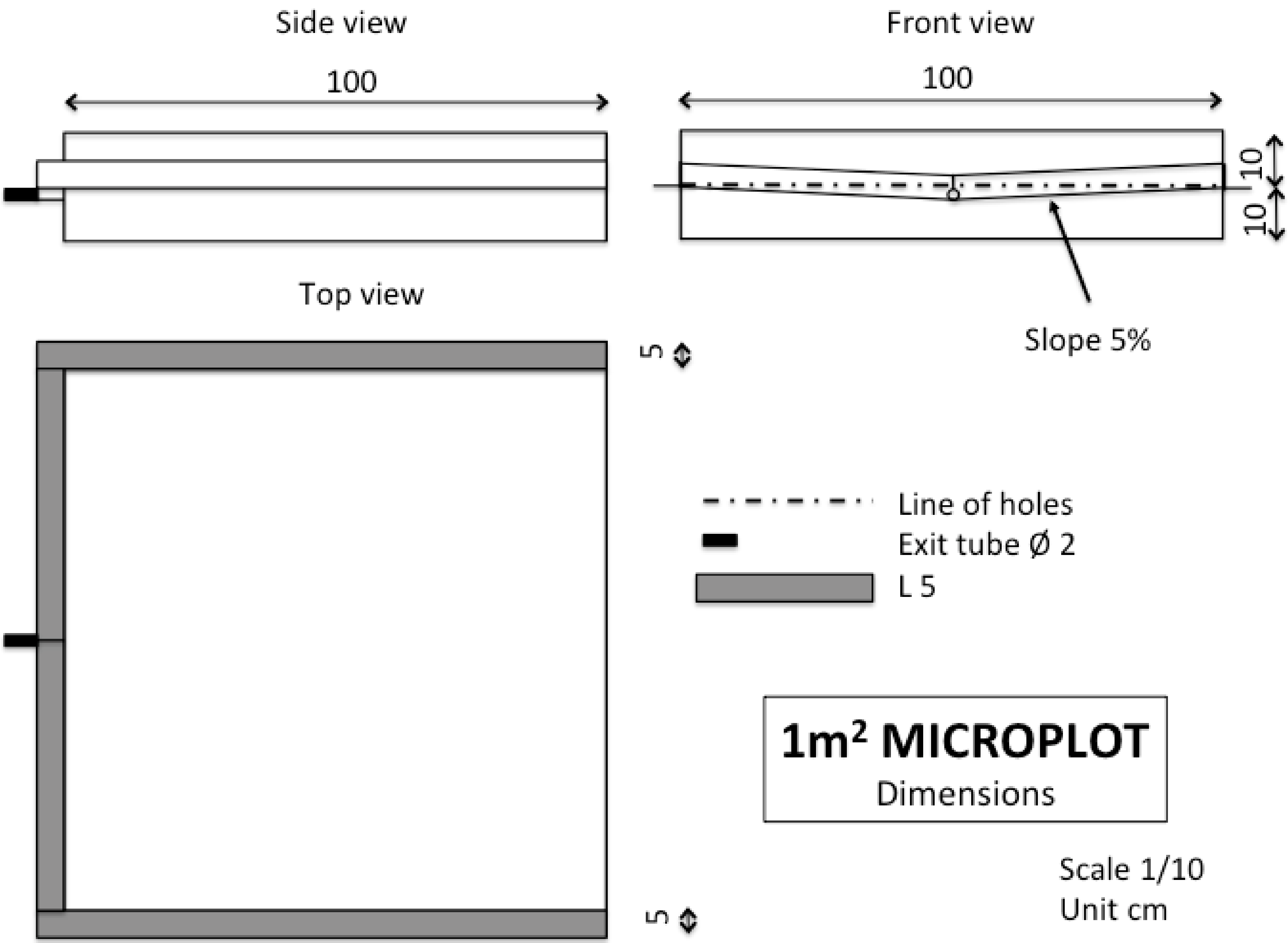
Middle position = frame for driving into the ground

Down position = metallical frame 1m^2



Detailed implementation and dimensions




Side view
100
Front view
100
10
10
Slope 5%
Top view
5
5
Line of holes
Exit tube Ø 2
L 5
1m² MICROPLOT
Dimensions
Scale 1/10
Unit cm

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