User Manual

Version 2.0.1

September 2024

About MapStream

MapStream is a QGIS plugin available at the url mesohabsim.isprambiente.it ("Resources" area, zipped folder "**MapStream plug-in v2.0.1**"). The software allows the hydro-morphological data collection for the application of the MesoHABSIM methodology in perennial and temporary rivers.

MapStream converts the signal received from a laser rangefinder in georeferenced points and polygons, and allows the collection of physical habitat attributes of each Hydro-Morphological Units (HMUs). The recorded data are organized and formatted to be correctly uploaded in the SimStream-Web service.

To guarantee to all users the freedom to utilize and modify the software, MapStream applies the terms of the GNU GPL v3 license.

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1. Starting and using MapStream

MapStream (v2.0.1) is a plugin of the QGIS software (version from 3.16.3 to 3.16.10) and can be downloaded from “Resources” area of the SimStream-Web service (mesohabsim.isprambiente.it, zipped folder “**MapStream plug-in v2.0.1**”). For the plugin installation, the user can follow the instructions reported in the file *“MapStream 2.0.1 - README.pdf”*, available in the zipped folder.

MapStream successfully communicates with laser rangefinders belonging to the TruPulse series (TruPulse 360B or TruPulse 360R, Laser Technology Inc., Colorado, USA). Nevertheless, users can eventually modify the source code and establish communication protocols with other commercial types of rangefinders.

After the installation, the MapStream Graphic User Interface (GUI) consists of four main components, accessible as "*tabs*" from the plugin homepage. A description of these components is presented below.

2. Homepage

In the MapStream *"Home"* page (Figure 1), the user can either create a new work by clicking on the related tab (*"Create new work"*) or open a previous work by clicking on the *"Open"* button and select a C*onfig.mhs* file from a previous project.

In the bottom part of the homepage (Figure 1) a device scanning facility is available to connect the laser rangefinder (e.g., TruPulse 360B, Laser Technology, Inc., Colorado, USA) to the user field computer via Bluetooth. The appropriate serial port (COM) can be selected from the drop-down menu. Switching off all others Bluetooth devices may avoid communication issues between the laser range finder and the field computer.

Figure 1: MapStream Homepage.

3. Create new work

By clicking on the *"Create new work"* tab, a new work session can be created (Figure 2). River name, date of the survey, and Coordinate Reference System must be entered. It is possible to save the new work on the file system by clicking on the *"Save"* button. By saving the new work, automatically four editable shapefiles (3 point- and 1 polygon-type shapefiles) are created and added to the QGIS Layers panel. These four shapefiles are properly formatted for data collection, following the MesoHABSIM methodology protocol:

- *1 point-type shapefile **STATION***;
- *1 point-type shapefile **VERTEX***;
- *1 point-type shapefile **MEAS***;
- *1 polygon-type shapefile **HMU***.

Note that, in Figure 2, the correct serial port has been selected (COM3, bottom of Figure 2) to establish a Bluetooth connection between the TruPulse 360RB laser rangefinder (Serial Number TP360B-0457) and the field computer of the user.

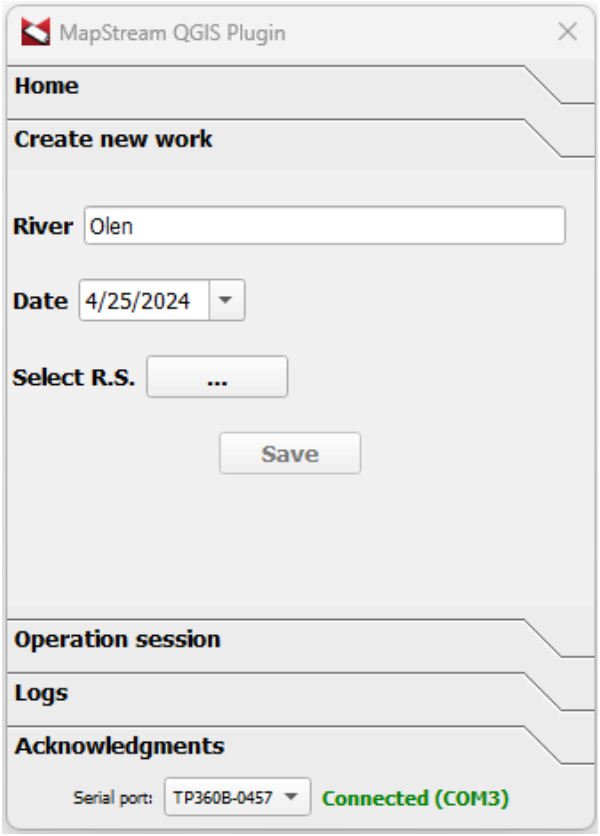

Figure 2: Create new work tab.

4. Operation session

In the operation session, the user can choose the type of points to be collected, by flagging the desired point-type shapefile (Figure 3):

i. *Shapefile **STATION***: the collected point is assigned to the station position shapefile;

ii. *Shapefile **VERTEX***: the collected point is assigned to the shapefile containing the polygon's vertices, which are used to draw the polygons of the Hydro-Morphological Units (HMUs);

iii. *Shapefile **MEAS***: the collected point is assigned to the shapefile containing the measurements of water depth, flow velocity and substrate.

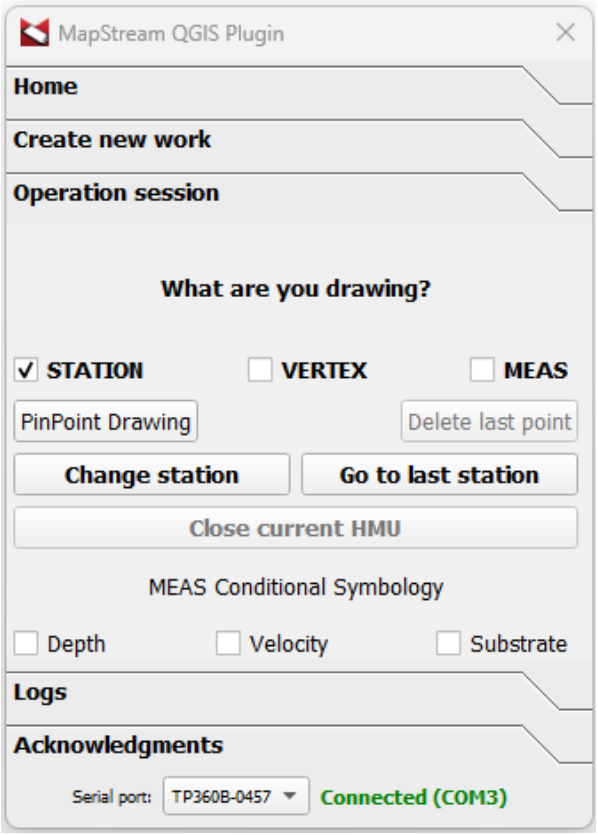

Figure 3: Operation session tab.

By clicking on the *"PinPoint drawing"* button, the user can manually draw a *"STATION"* or a *"MEAS"* point even without the use of the laser rangefinder. It is also possible to delete the last collected point of any shapefile, by clicking the *"Delete last point"* button.

The *"MEAS Conditional Simbology"* option allows the user to visualize the *"MEAS"* points with different colors depending on the collected measurements of water depth, flow velocity and substrate. In fact, by flagging the right box, the points will be coloured depending on the frequency class which the points belong to. In the table of contents, a legend will be shown by expanding the *"MEAS"* layer.

To change the survey station position, the user can select in QGIS the desired point of the *"STATION"* shapefile and click on the *"Change station"* button. To move to the last collected *"STATION"* point, the user can press the *"Go to last station"* button. Finally, the button *"Close current HMU"* can be used to connect a series of vertices and add a polygon feature to the *"HMU"* shapefile.

5. Logs

This section lists messages, warnings or errors while running the MapStream QGIS plugin (Figure 4).

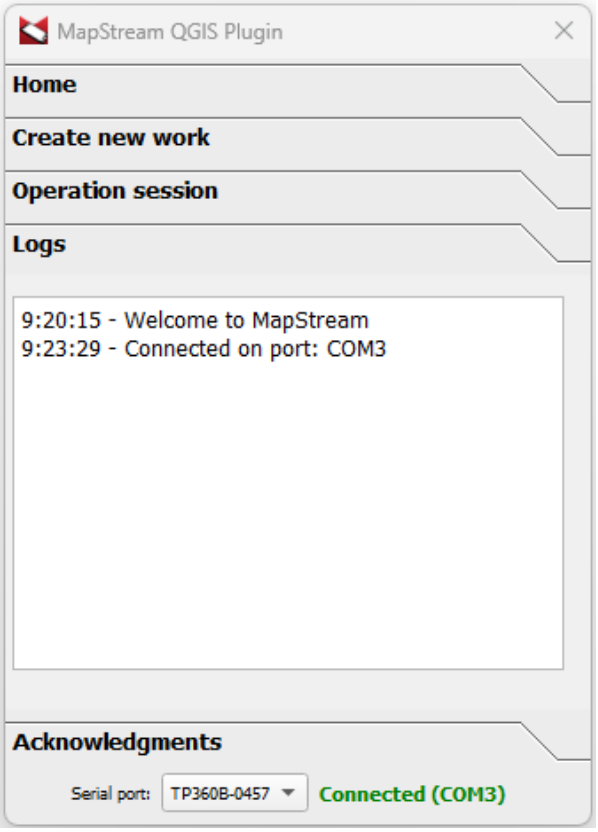

Figure 4: Logs tab.

6. Example of a hydro-morphological survey carried out with the MapStream QGIS plugin

For the plugin installation, please follow the instructions reported in the file *"MapStream 2.0.0 - README.pdf"*. If the plugin is correctly installed, the MapStream icon shows up in the Toolbar of QGIS GUI (Figure 5, red arrow and circle).

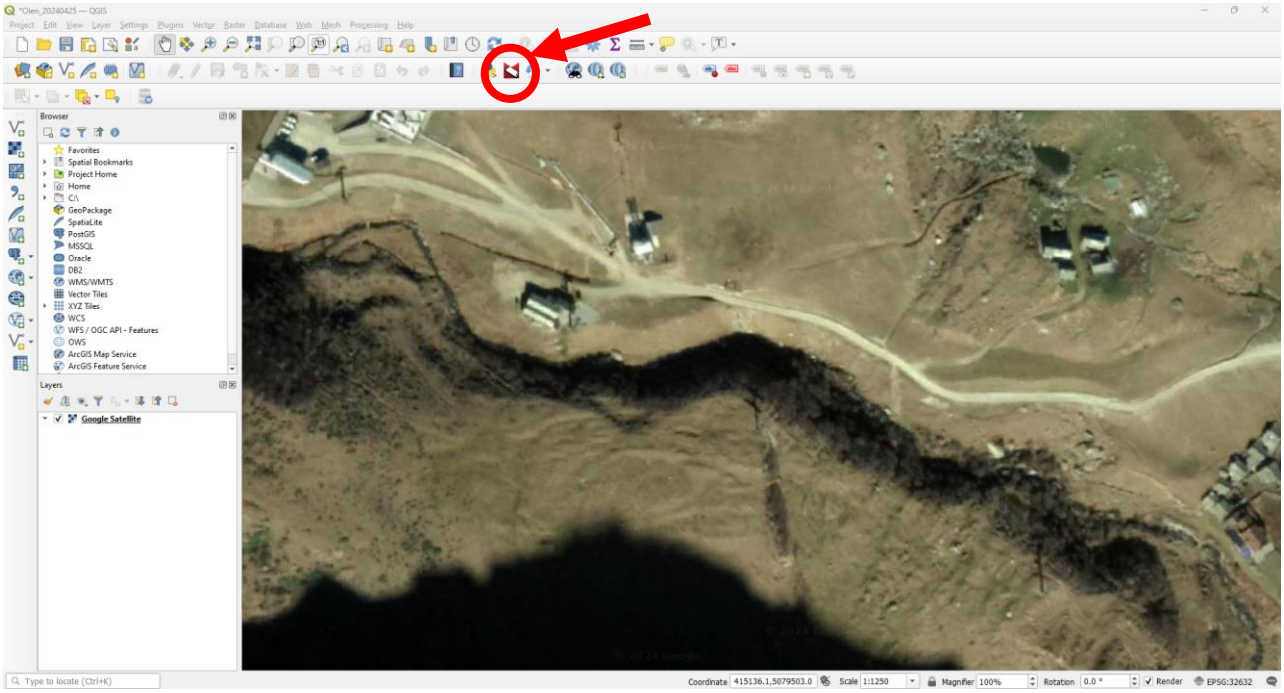

Figure 5: QGIS Toolbar showing the MapStream icon, indicated with a red circle and arrow.

To open the MapStream plugin (Figure 6) the user can

- click on the menu item *"Plugins"* and select MapStream in the list of the installed plugins;
- click on the MapStream icon in the Toolbar of QGIS GUI.

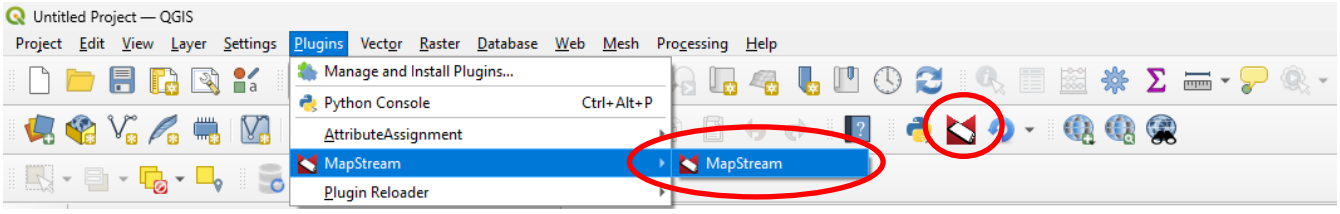

Figure 6: Procedure to start the MapStream plugin.

In the *"Create new work"* section, the user can enter the river name, the date of the survey and the Coordinate Reference System (Figure 7). By clicking on the button "[…]", the Coordinate Reference System can be selected in a separated dialog box (*"Coordinate Reference System Selector"*). By choosing a Reference System, the previously mentioned button "[…]" will display the name of the selected Coordinate Reference System (e.g., WGS 84/UTM 32N, Figure 8). By clicking the *"Save"* button, a further dialog box is opened, allowing the user to save the data in the desired folder of the file system.

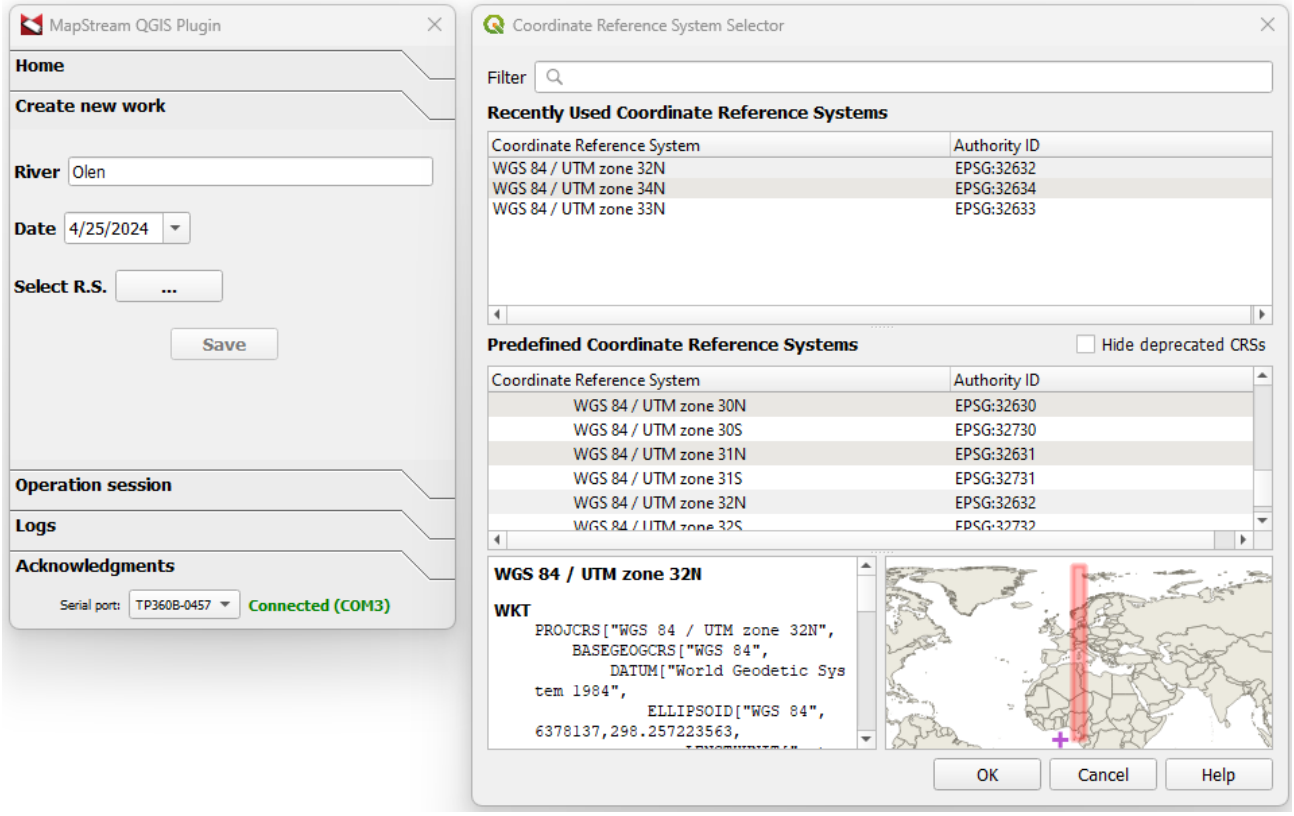

Figure 7: Settings for a new work.

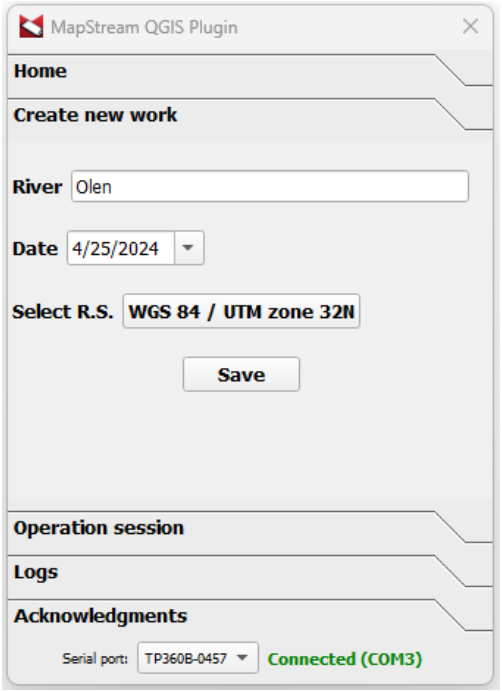

Figure 8: Selected reference system for the new work..

A folder named River_YYYYMMDD is therefore automatically saved in the selected path of the file system, where River is the name of the river, whereas YYYY, MM, and DD are the year, the month and the day of the selected date, respectively. The *Config.mhs* file, containing the project summary data, is created within the same folder. By clicking on the *"Open"* button in the *"Home"* section, this file can also be used to retrieve project data if necessary.

Assuming that the survey is carried out on 25 April 2024, in the municipality of Alagna Valsesia (Vercelli, Italy), in a reach of the Olen stream, the created folder is called *Olen_20240425* and the *Config.mhs* file contains the following information and paths:

RIVER: OLEN
DATA: 25/04/2024
C:\User\Desktop\Olen_20240425\Olen-HMU-20240425.shp
C:\User\Desktop\Olen_20240425\Olen-VERTEX-20240425.shp
C:\User\Desktop\Olen_20240425\Olen-MEAS-20240425.shp
C:\User\Desktop\Olen_20240425\Olen-STATION-20240425.shp

After saving the project, the following four shapefiles are automatically generated in the destination folder and uploaded into the QGIS Layers panel (Figure 9):

i. *Shapefile **VERTEX***, containing the vertices of the HMU polygons;
ii. *Shapefile **STATION***, containing the station points;
iii. *Shapefile **MEAS***, containing point measurements of water depth, flow velocity and substrate;
iv. *Shapefile **HMU***, containing polygons representing the HMUs.

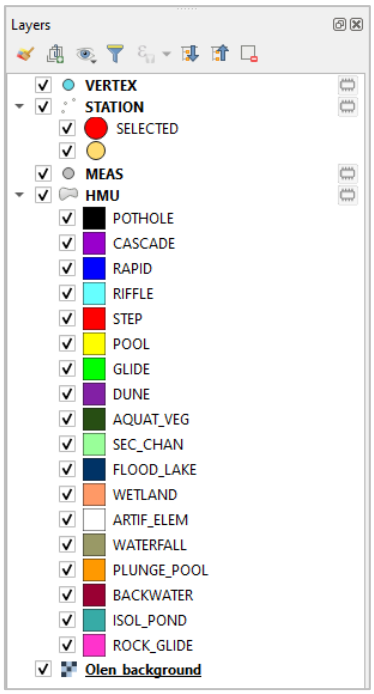

Figure 9: Vertex, Station, Meas and HMU shapefiles automatically generated and uploaded into the QGIS Layers panel.

To start the data collection, the field computer has to be connected to the laser rangefinder via Bluetooth. To do that, the user can use the device scanning from the drop-down menu at the bottom of the MapStream plugin GUI and choose the device to be connected. An indication of the connected serial port shows up if the connection is established (e.g., "Connected (COM8)", Figure 8).

By clicking on *"PinPoint drawing"*, the first station point can be entered manually as a ground control point clearly visible on the georeferenced background image (Figure 10). To confirm the station point acquisition, the user can click "*OK*" on the displayed dialog box. The dialog box is equipped with an automatic counter of the station numbers and offers the possibility to the user to associate comments to each acquired entity. The station is represented by a black point on the background image (Figure 10).

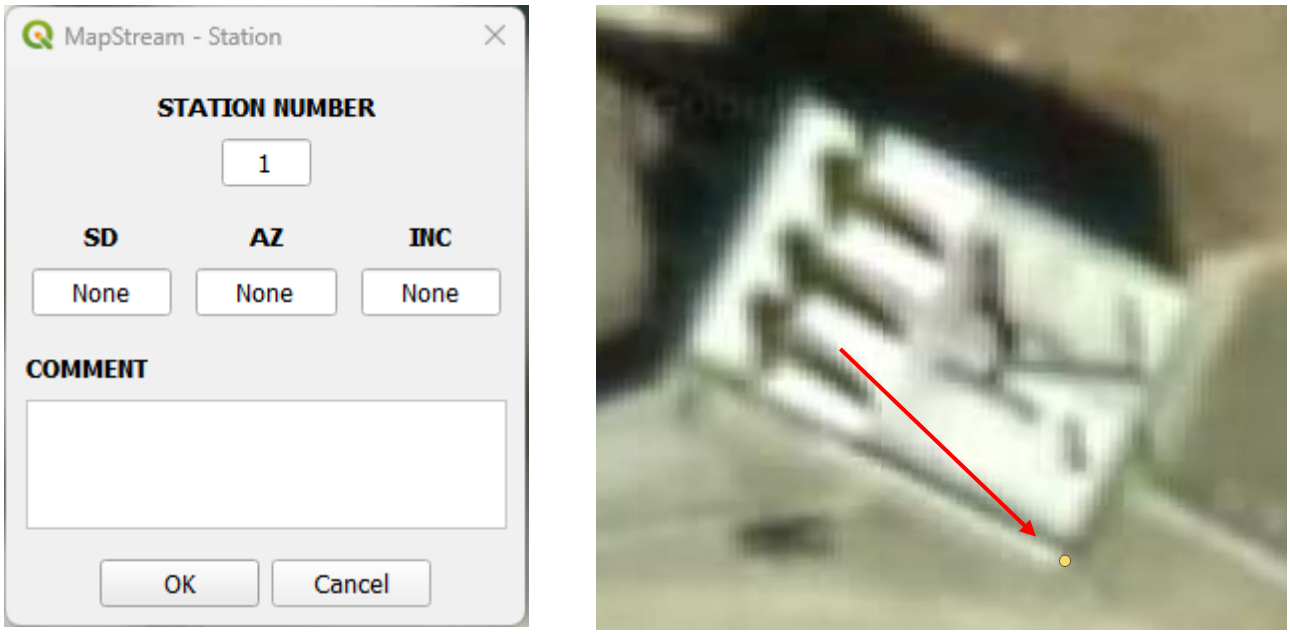

Figure 10: STATION dialog box (left) and an example of a ground control point represented in black (right).

By clicking on the *"Go to last station"* button, the entered point is converted to the reference station point for data acquisition with the laser rangefinder. The collected station point increases in size and turns red (Figure 11).

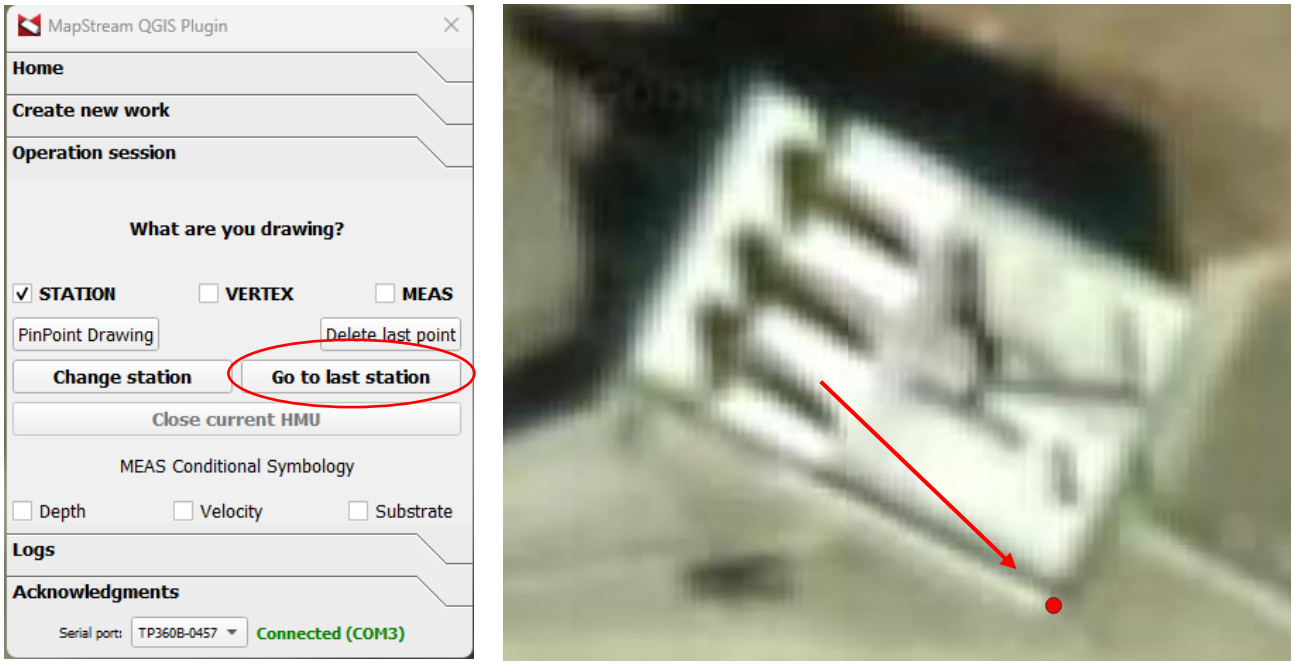

Figure 11: Starting station point highlighted by clicking the "Go to last station" button.

The laser rangefinder can now be used to add a second station point. The coordinates of the new, measured point are automatically recorded and the user can move to the new station point by clicking the *"Go to last station"* button.

To draw the perimeter of an HMU, the user can flag the *"VERTEX"* box and triangulate the position of each vertex of the HMU polygon by using the laser rangefinder (Figure 12). Be sure that the laser TruPulse is set to Slope Distance (SD) when measuring a new "*STATION"* or "*VERTEX"* point. Other settings may generate errors in the Bluetooth data transfer.

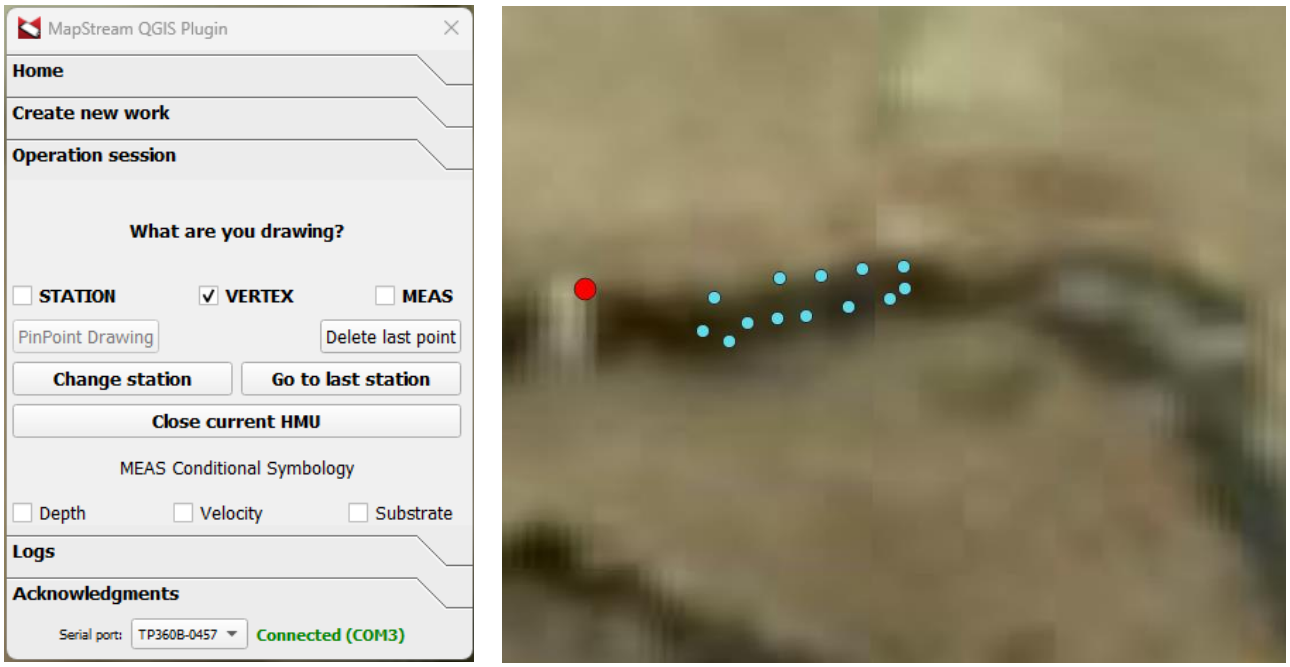

Figure 12: HMU vertices in green recorded in the "VERTEX" shapefile.

Once the vertex data collection is finished, the user can click on *"Close current HMU"* to add a new polygon entity to the *"HMU"* shapefile. A dialog box is automatically opened (Figure 13), showing the progressive HMU number, the total difference in height of the water free surface, the area and the perimeter of the HMU. The user can select the HMU type from a drop-down list, and record the presence of covers (or shelters) for the fauna. By clicking on the *"OK"* button, the polygon entity is then added to the *"HMU"* shapefile.

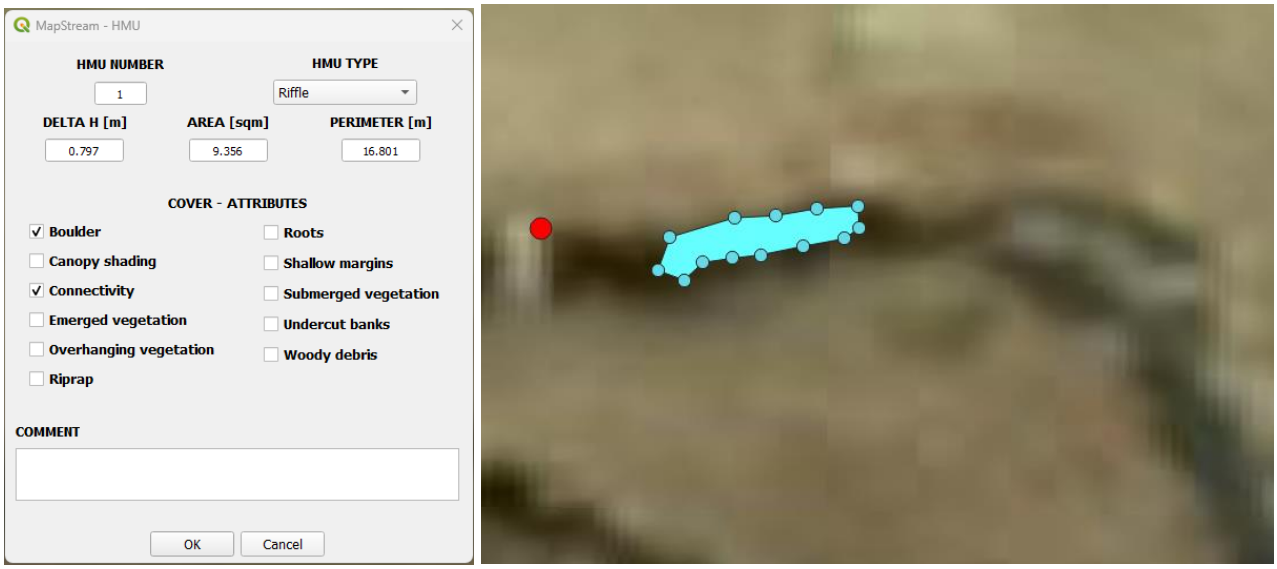

Figure 13: HMU dialog box (left). After clicking the "OK" button a new polygon is added to the HMU shapefile (right).

To add a point measurement of water depth, flow velocity and substrate, the user can put the checkmark on *"MEAS"* and select the HMU of interest (after selection, the colour of the HMU polygon entity turns yellow). Once a point measurement is recorded through the laser rangefinder or the *"PinPoint drawing"* function, a dialog box is automatically displayed. The user can now enter values for water depth, flow velocity and substrate at the measured point (Figure 14).

Important notes: the depth value must be a positive integer (non-zero value), expressed in centimetres [cm]; the depth values will be automatically saved in meters [m], as requested by the SimStream-Web service. The velocity value must be a positive floating-point number, using point (.) as decimal separator. Flow velocity is expressed in meters per second [m/s]. The selection of the substrate is achieved from a drop-down list.

By clicking on *"OK"*, the point measurement is saved in the *"MEAS"* shapefile. The procedure can be repeated to complete the point measurement data collection for the considered HMU (Figure 15).

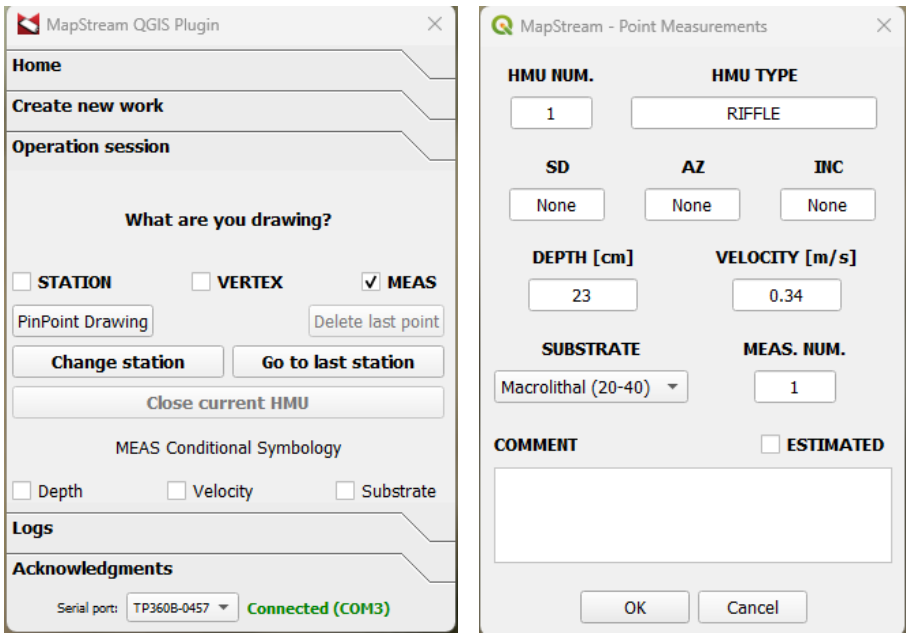

Figure 14:Dialog boxes to record point measurement entities.

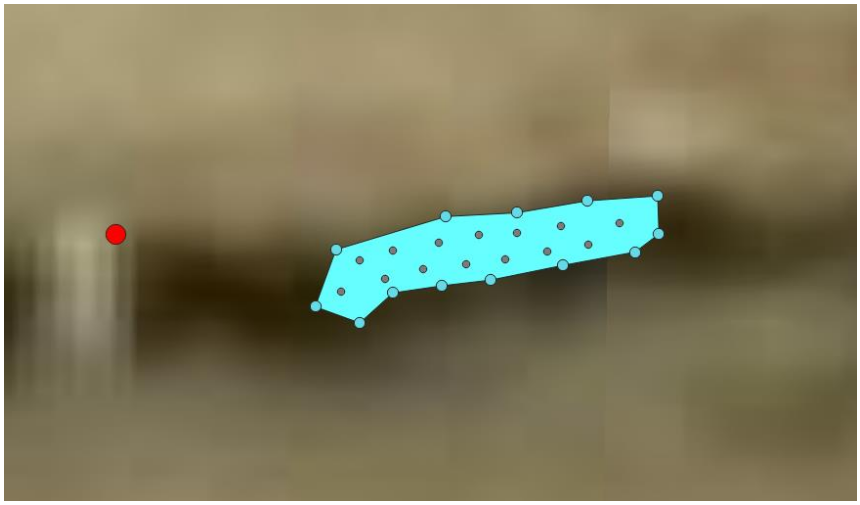

Figure 15: First HMU survey completed.

By flagging one of the option of the *"MEAS Conditional Symbology"* function, it is possible to visualize the acquired measurement points coloured according to the classification suggested from the MesoHABSIM methodology in terms of depth, velocity or substrate composition (e.g. Figure 16).

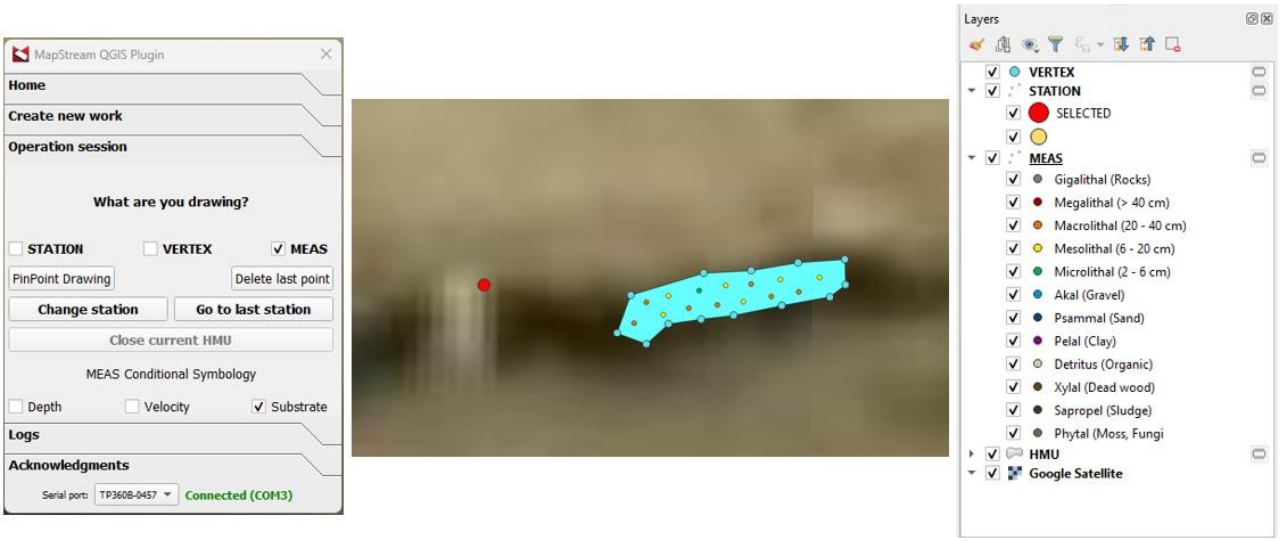

Figure 16: Visualization of measurement points according to the classification of substrate type. On the left, the substrate box is flagged, on the right the legend is shown in the table of content.

By repeating the described survey procedure, the user can map the HMU mosaic in the analysed river reach (Figure 17).

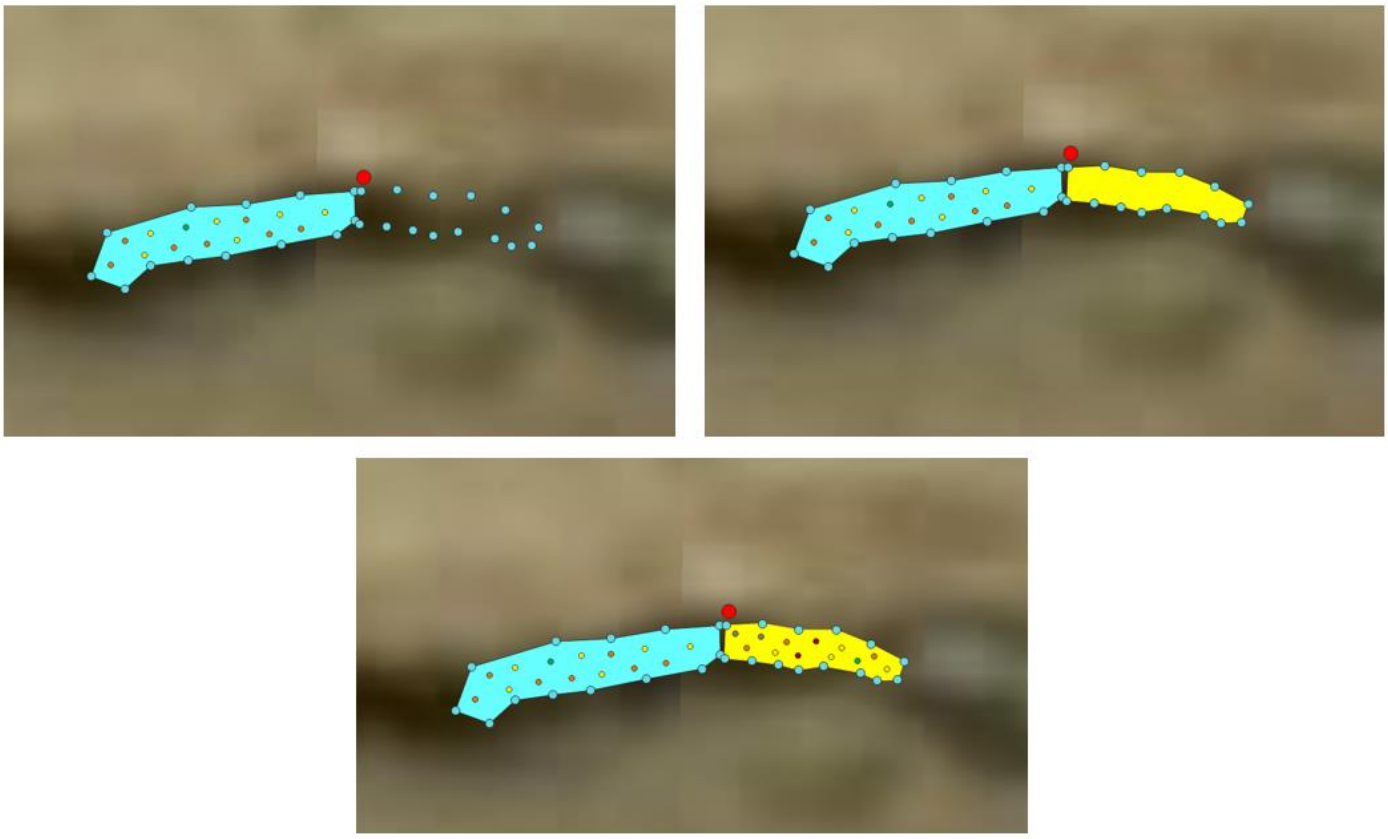

Figure 17: Sequence of two surveyed hydro-morphological units (HMUs). The procedure can be repeated to describe the HMU mosaic in the analysed river reach.