Frequently Asked Questions about the INRAE Streamgauging Ruler

October 2025 – J. Le Coz, M. Lagouy (INRAE, UR RiverLy)

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1 General questions about the streamgauging ruler

1.1 How to obtain information, how to find practical tools?

The main source of information is this webpage: https://riverhydraulics.riverly.inrae.fr/eng/tools/instrumentation/streamgauging-rulers

It points to the main tools and documents associated with the streamgauging ruler. CATER Calvados Orne Manche also provides interesting information and resources from this webpage: https://www.cater-com.fr/dossiers-thematiques/hydromorphologie/regle-a-jauger.html

Feel free to contact us (mickael.lagouy /at/ inrae.fr and jerome.lecoz /at/ inrae.fr) with any questions. We can also add your address to the user mailing list, through which we communicate updates on the calculation spreadsheet or the Qràj mobile application (Qfield projects).

1.2 What are the limits of use (depth/velocity)?

The limits of use of the INRAE streamgauging ruler are due to the configuration of the instrument, its calibration and operating conditions, and the stability and safety of the operator in the flow. It is difficult to provide precise acceptable conditions, and it is often the combination of various factors that matters more than each factor considered separately. However, the following ranges can be provided: depth from 3 to 70 cm (height of the fixing brackets of the rulers), velocity from 20 to 120 cm/s.

In practice, the main limitation is that of low velocities: below 20 cm/s, the head becomes too low (a few mm) to be measured precisely, which can lead to significant errors in velocity and discharge measurements. Therefore, the majority of the flow must be at a velocity greater than 20 cm/s.

Beyond 100 or even 120 cm/s, the velocity rating is no longer verified. The ruler may also be difficult to maintain, and the flow depth and head may be difficult to read precisely (due to level oscillations). In shallow flows, the water level downstream of the ruler may reach the bottom of the watercourse. High velocities associated with low depths are therefore problematic, and in the case of high depth, the push on the operator and their ruler can become too strong.

An irregular, non-uniform flow (upstream or downstream of an obstacle, for example) can lead to significant measurement errors in velocity. The same applies if a significant flow occurs between the bottom of the ruler and the bed (in the case of a very coarse substrate, for example).

The ruler must be placed on the bottom of the watercourse. An irregular bottom can lead to significant errors in measuring depths and their interpolation between the measurement verticals, especially when depths are low. On a regular (or even flat) bottom, it is possible to measure in depths less than 3 cm, which would be unsuitable for traditional current meters. In slow and flat streams, it may be advantageous to deploy the streamgauging ruler on broad-crested weirs (such as mill races) to achieve sufficient velocities (>20 cm/s) and a regular bottom profile (the shallow depth does not hinder measurements if the depths are measured precisely and the bottom profile is regular between the verticals).

1.3 How to obtain a streamgauging ruler, and how much does it cost?

The company AAIS (Sassenage) produces and sells INRAE streamgauging rulers (for its own account) and also handles shipping. There is no commercial agreement between INRAE and AAIS, but we are in contact for technical implementation. Here is a product description.

To obtain a quote, here is their email address: contact /at/ aais.fr

If you cannot pay by credit card, here are the social and banking details for opening a supplier account: https://drive.google.com/drive/folders/1Q9DRrc3NgCP27ocNUdeyKHEkl0L0Hp06
The price is around €200 excluding VAT, plus shipping and carrying bag if required.

Please let us know if you place an order (mickael.lagouy /at/ inrae.fr and jerome.lecoz /at/ inrae.fr), and we will add your email address and that of anyone else who wishes to the user mailing list, through which we communicate updates on the calculation spreadsheet or the Qràj mobile application (Qfield projects).

1.4 Can I make the ruler by myself, how, and are there patents / rights?

It is entirely possible and allowed to make an INRAE streamgauging ruler by oneself. The cutting and precise engraving of the graduations require suitable equipment, as well as the printing of parts in 3D.

There are no patents or rights, and all technical details of the instrument are published. The ruler models and .stl files for 3D printed parts are provided as additional information in the following open-access scientific article:

Le Coz, J., Lagouy, M., Pernot, F., Buffet, A., Berni, C. (2024). The streamgauging ruler: a low-cost, low-tech, alternative discharge measurement technique. Journal of Hydrology, 642, 131887.

Keep us informed about your manufacturing experience: we are interested!

1.5 Who uses the streamgauging ruler?

Engineering companies, river boards, agricultural boards, hydrometric services, Environment Police officers (OFB), city councils, universities, teachers, cavers, explorers, and many others… Generally, the streamgauging ruler allows both professional and non-professional stakeholders who do not have a large budget and/or significant experience in hydrometry to equip themselves for gauging small streams.

Here is a map of the distribution of streamgauging rulers worldwide: https://www.google.com/maps/d/edit?hl=en&mid=1xiIfwv6PItw7nNAVwD0unEE1Ii5JYWY&ll=10.362789157427716%2C-45.68474775000004&z=3

There may already be one near you!

1.6 What is the reference document to cite in a scientific publication, for example?

The following scientific article, available in open access:

Le Coz, J., Lagouy, M., Pernot, F., Buffet, A., Berni, C. (2024). The streamgauging ruler: a low-cost, low-tech, alternative discharge measurement technique. Journal of Hydrology, 642, 131887.

2 Questions about deploying the ruler

2.1 What can distort the depth measurement? How to measure the depth of turbulent flow?

Oscillation and/or deformation of the water surface against the ruler, aligned in the direction of flow, can cause flow depth measurement errors, especially when the velocity is high. It is preferable to read the depth from the graduations positioned downstream of the flow, or by positioning one of the movable rulers at the water surface level, in the center of the ruler, before removing the ruler from the water for reading. The objective is to measure the water level that would occur in the absence of the ruler and the wave created by its bow.

If the water level oscillates, a time-averaged measurement should be taken (up to a maximum of 40 seconds). In cases of very turbulent flow, it may be helpful to use a hand in the water to position a ruler at the average water level.

Remember to keep the ruler as vertical as possible, using the small level bubble. Keep in mind that a relative error (in %) in depths will lead to the same relative error in the wetted areas and thus in the discharge estimate. A depth error of 5 mm is negligible if there are 50 cm of water (1% error), or huge if there are only 2 cm of water (25% error). A systematic overestimation or underestimation of depths will have a direct impact on discharge error, while random errors can compensate each other.

2.2 What can produce velocity measurement errors?

When reading the head through the plexiglass, out of the water, the ruler must be perpendicular to the operator’s line of sight. Otherwise, parallax error can distort the head reading, resulting in larger relative velocity errors, especially when the flow is slow, as the head is then small. Depending on the operators, this head reading error can be systematic (which is even more penalizing). It is useful to perform reading comparisons of the same head between different operators to detect any biases, related to arm positioning, for example.

If your fine ruler is graduated on the top, reading from the top will be better than reading through the plexiglass, as there will be no parallax error (the cursor being in contact with the ruler).

Choppy water (oscillation of the water level that increases with velocity) can be a source of poor head reading. It is important to try to average the value, for a duration of up to 40 seconds if necessary. The velocity error associated with this effect is often less than what users fear due to the better sensitivity of the head at higher velocities.

Remember to keep the ruler as vertical as possible, using the small level bubble.

An irregular, non-uniform flow (upstream or downstream of an obstacle, for example) can lead to significant measurement errors in velocity. The same applies if a significant flow occurs between the bottom of the ruler and the bed (in the case of a very coarse substrate, for example).

2.3 At what distance from an obstacle can I measure velocity?

To measure a head (and thus a velocity), the flow on either side of the ruler must be free (allowing for 10-15 cm of unobstructed space on each side, from the edges of the ruler). Otherwise, the conversion of the head read into velocity is likely to be biased.

2.4 Can I measure an oblique flow?

The streamgauging ruler cannot measure oblique flows, let alone recirculating (negative) currents (unlike most current meters and velocity meters, which measure the velocity component along their measurement axis). One could orient the ruler facing the oblique flow to measure the velocity magnitude correctly, but it is the velocity component perpendicular to the measurement cross-section that should be used in the discharge calculation: one would need to know the angle of incidence of the velocity and calculate this projection (which the streamgauging ruler's processing tools do not allow yet). Therefore, gauging should be done on a section where the flow is more or less perpendicular to the measurement transect, especially where the majority of the discharge passes.

2.5 What should I measure at the banks?

For the first and last measurement verticals taken at the banks (edges of the flow), only the abscissa and depth should be measured, not the head. The velocity between the edge and the nearest measurement vertical will be extrapolated using an edge coefficient. The depth at the edge can be zero (in the case of a triangular edge) or not (rectangular or trapezoidal edge).

The start and end of the gauging transect are measured at the edges of the flowing water body, which may be located at a non-zero distance from the bank if there is a non-flowing area. Including non-flowing areas in gauging is not a good idea, as a non-zero velocity will likely be extrapolated there, leading to an overestimation of the discharge.

2.6 How many measurement verticals should there be, and where should they be placed?

The same problem arises for any velocity-area discharge measurement technique, with any type of current meter or velocity meter. The number and position of verticals across the section should be wisely placed to best describe the transverse profiles of depth and velocity, prioritizing where the flow is greater, in order to minimize discharge interpolation errors between the verticals. This is a fundamental skill for the experienced field hydrologist.

It is reasonable to aim for a minimum of 12 to 15 verticals to describe a cross-section of an ordinary natural stream, but fewer can be used (for a section and flow that are very variable laterally) or more (in the opposite case). ISO748 standard and hydrometry manuals recommend that the partial discharge calculated around each vertical does not exceed 5% to 10% of total discharge for each vertical (except for sections less than 1.5 m wide).

In the calculation tools associated with the streamgauging ruler (spreadsheet and Qraj app), a vertical is displayed in green, yellow, or red if the partial discharge is between 0 and 10%, 10% and 15%, or greater than 15% of total discharge, respectively. This indication is important: efforts should be made to insert additional verticals to minimize these discharge shares, even after an initial crossing and initial processing.

In practice, one should aim for a given number of verticals N, and divide the width of the section by N+1 to estimate an average space step to maintain between the verticals. It is strongly discouraged to space the verticals equally, with a constant step, without consideration. On the contrary, verticals should be placed closer together where the discharge is stronger (there's no need to multiply verticals in areas contributing little to total discharge), and where depth and/or velocity vary more rapidly (notably near banks and around breaks in slope or changes in roughness).

It is important not to lose sight of the cross-section and flow profiles that one seeks to describe with the verticals, and to visualize their interpolation in the field. It is therefore useful to observe the flow and cross-section to be measured carefully, especially during an initial crossing, before starting measurements, which is also helpful for verifying the quality of the measurement cross-section or even slightly modifying it (by moving obstacles, blocking lateral flows, straightening oblique flows, etc.).

2.7 Can we space the measurement verticals closer than the width of the ruler in a narrow cross-section?

In a narrow cross-section (width less than 1.5 m, typically), the width of the ruler (9.85 cm) and the distance to obstacles that must be respected (counting 10-15 cm from the edge of the ruler) can make it difficult to measure a sufficient number of verticals to well describe the variation of the bottom and velocity across the section.

The question then arises regarding the minimum spacing between measurement verticals and whether this spacing can be less than the width of the ruler. We do not exactly know the velocity measurement volume of the ruler, and it is likely that very closely spaced velocity measurements do not provide additional information about the already smoothed lateral velocity profile. However, additional velocity measurements are not detrimental (and even provide an interesting redundancy), while additional depth measurements can be very useful for better describing the geometry of the cross-section, especially if it is complex. It therefore seems advantageous to add verticals, even very close together, rather than gauging with a very small number of verticals.

2.8 Can I take measurements on a weir?

Yes, you can take measurements on a broad-crested weir. This would be discouraged with ordinary current meters and propellers, due to the low depths (these instruments must be submerged at least 3 to 4 times their vertical dimension) and due to the unusual vertical velocity profile (non-uniform flow). This effect does not seem to distort the average velocity measurement on the vertical directly provided by the streamgauging ruler.

On flat and slow rivers, it is often advantageous to deploy the streamgauging ruler on broad-crested weirs (like mill races), to achieve sufficient velocities (>20 cm/s) and a regular bottom profile (the low depth does not hinder this if depths are measured accurately and the bottom profile is regular between the verticals).

2.9 How to monitor flow variation during measurement?

By recording the water level on a reference point, at least at the beginning and end of the gauging, and if necessary during the gauging. This reference will ideally be a permanent staff gauge (for example, that of a hydrometric station) or a temporary one (installed on the bank for gauging). If not, any stable visual reference can be suitable (trunk, stake, rock, etc.), with a measurement using a tape measure or… with the streamgauging ruler.

2.10 Can I take measurements with aquatic vegetation or algae in the water

Yes, you can; it does not seem to affect the measurement, and there are no moving parts (no propeller, in particular).

3 Questions about entering measurements and calculating discharge

3.1 Is there a tool for entering measurements and calculating discharge?

Yes, you can freely use at least three tools specifically designed for streamgauging ruler measurements:

- The Qràj mobile tool for smartphones (QField project), developed by CATER COM
- The Moulinet web application (no installation required), developed by INRAE (UMR G-EAU Montpellier) for the OFB
- The spreadsheet (Excel/LibreOffice Calc), developed by INRAE (UR RiverLy)

These easy-to-use tools will allow you to calculate the discharge and its uncertainty. These tools are freely available on the internet, see this web page:

https://riverhydraulics.riverly.inrae.fr/eng/tools/instrumentation/streamgauging-rulers

It is also possible to enter and analyze the measurements in any software that allows doing so for other types of current meters or velocity meters. You'll have to enter the measured velocities directly (the formula for converting head into velocity is generally not available in existing software). The discharge calculation is indeed traditionally done using the velocity-area (or mid-section) method (see ISO748 standard and hydrometry manuals).

3.2 What are the abscissas?

The abscissa column corresponds to the positions read on the decameter (rule tape) stretched across the section (no need to offset or invert, just note the position read).

3.3 What are the beginning/end water levels?

The beginning and end water levels refer to the water level (read from the staff gauge of the station or any other vertical reference available) at the beginning and end of the gauging, in order to check for any changes in flow during the measurement time. This is not a water depth but an altitude (elevation).

3.4 What should be entered for the edge verticals?

The first and last rows of the entry table must contain the measurements taken at the banks (at the water's edge or at the edge of the flowing water body, if there is an area without flow). For these edge verticals, only the abscissa and depth are recorded (not the head). Therefore, the first and last rows should not have a head value (cell empty), but a value for the edge coefficient used to extrapolate the velocity must be entered. The average velocity assigned to the rectangular panel cut between the bank and the halfway distance of the nearest vertical is equal to the velocity measured at that vertical, multiplied by the coefficient.

Typical values for this coefficient are (see the comment on the "Coefficient" cell): 0.67 (natural sloped bank), 0.91 (smooth vertical wall, concrete), 0.86 (intermediate situations). Other values, typically between 0.5 and 1, are possible. A good method to adjust this is to visualize the lateral velocity profile on the section graph of the spreadsheet and ensure that the extrapolated profile (in dashed lines) is realistic.

4 Questions about result quality and uncertainty

4.1 My discharge measurements are not good, why?

This can be due to measurement conditions (depth, velocity, measurement section), and/or errors in measuring depths and velocities, and/or poor description of depth and velocity profiles with too few verticals, or poorly placed verticals. Please refer to the questions in this FAQ related to these problems.

Manipulation errors can also occur, notably:

- reading inversion between head (in mm) and velocity (in cm/s) on the wide ruler;
- unit errors during measurement entry (e.g., heads in cm, depths in meters, etc.);
- holding the ruler upside down (no, we haven't encountered that yet…).

4.2 What uncertainty should I expect? How to estimate discharge uncertainty?

The spreadsheet provides an estimate of discharge uncertainty using ISO748, Q+ (Le Coz et al., 2012, 2015), and Flaure (Despax et al., 2016) methods, as well as the associated uncertainty budgets (relative contributions of different sources of uncertainty in the total variance). These uncertainty budgets are useful for knowing which factors to adjust to reduce gauging uncertainty. For example, increasing the number of verticals if the uncertainty of lateral interpolation is significant. The three uncertainty methods obviously provide different estimates of uncertainty (sometimes close, sometimes quite far apart).

By default, we recommend considering the Q+ uncertainty (the one that the Qraj app provides exclusively), as it is an improvement of the ISO748 method (the Flaure method is also, but it can encounter issues when the number of verticals is very low). The Q+ method is the one implemented in the Barème and Jacinthe software of the French national hydrological services, and its adaptation to the streamgauging ruler case is described in the following article:

Le Coz, J., Lagouy, M., Pernot, F., Buffet, A., Berni, C. (2024). The streamgauging ruler: a low-cost, low-tech, alternative discharge measurement technique. Journal of Hydrology, 642, 131887.

This same article shows, based on the comparison of about a hundred discharge measurements with a reference discharge, that the expected flow uncertainty in the majority of cases is around 10%, provided that the average flow velocity is greater than 20 cm/s. Below that, the uncertainty can increase rapidly to 30%, 50%, or more.

4.3 What references can I use to defend my measurement? Can the ruler be used for "official" gauging?

The principle of gauging is the same as with any current meter, propeller, or velocity measurement system: it is the velocity-area method defined by the ISO 748 standard (let's recall that ISO standards are not mandatory in hydrometry) and many hydrometry manuals and guides. As is the case of many other current meters used for gauging rivers, the streamgauging ruler is not described in a normative document. However, several documents can serve to justify the measurement method and the expected quality of results, particularly the scientific articles by Pike et al. (2016) and Le Coz et al. (2024), which document the results of numerous comparative velocity and discharge measurements validating the streamgauging ruler. Therefore, there is no specific reason not to use it for "official" gauging, on par with other current meters or gauging techniques, while remaining transparent about the limitations of use and precision of the technique.

5 References

ISO 748:2021. Hydrometry — Measurement of the flow of free-surface flows — Methods for exploring the velocity field using point velocity measurement.

Le Coz, J., Lagouy, M., Pernot, F., Buffet, A., Berni, C. (2024). The stream streamgauging ruler: a low-cost, low-tech alternative discharge measurement technique. Journal of Hydrology, 642, 131887.

Pike, R., Redding, T., Schwarz, C. (2016). Development and testing of a modified transparent velocity-head rod for stream discharge measurements. Canadian Water Resources Journal, 41(3):372–384.