Coalition Clean Baltic

For protection of the Baltic Sea environment

River monitoring

Manual for public environmental monitoring

APPENDIX 1. General river characteristics

After primary inspection of the river segment under examination, it should be useful to identify hydrological and hydrometric characteristics of the river, which give a reasonably full idea of the character, form, dimensions, and length of the water bodies, and certain physiographic properties of their water catchment area.

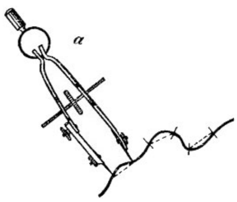
§ 1. Measurement of the river length

Measurement of the entire length of a river is not always practicable because prior to holding a complex study of a river, participants should select a particular segment of the river which they are mostly interested in. Nevertheless, if there is a need to measure the entire length of a river, the survey should be based on large-scale maps (1:10000, 1:25000, 1:50000, 1:100000[1]).

***Equipment**:* large-scale map, divider, curvimeter[2] or thread, ruler.

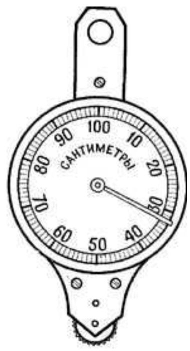
Measurement:

Measuring the river length with a divider:



Span (“step”) of the divider should be set so that it corresponds to an integer number of kilometers. One of the divider’s pins should be set at the initial point, while the second one put onto the line measured. Revolving the divider in turns around each of the pins, one “marches” along the route. Its total length amounts to the number of steps multiplied by the span of the divider’s step plus the excess measured by a linear scale.

Measuring the river length with a curvimeter:



A curvimeter is particularly convenient for measuring curved and long lines. The device is equipped with a roller attached to a gearing system with a hand. For measuring a distance with a curvimeter, set its hand to the zero mark and then roll the roller along the route so that the scale indications go upwards. Multiply the obtained value in centimeters by the scale; the result will show the distance on the ground.

Measuring the river length with a thread:

1. The thread should be wetted otherwise it would be difficult to place it on the paper.

2. Put the thread onto the curved line (the river line from its source to the mouth) so that it follows all the river bends.

3. Point down (with fingers or pincers) the source and the mouth on the thread (you can carefully clip the thread at these points).

4. Straighten the thread, apply the marked (or cut-off) segment of the thread to a ruler, and measure the number of centimeters. Multiply the result of your measurements by the number of kilometers on the ground for the scale applied. (You can apply the thread to the linear scale on the map and read the length of the river right away.)

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[1] *Our Care to Smaller Rivers: a Practical Manual for Environmental School Clubs /* edited by V.N. Zuyev. – Minsk, Medisont, 2014. – 120p.

[2] A curvimeter is a device for metering curved lines, most often, on maps, graphics, and blueprints.

§ 2. Measuring the sinuosity coefficient (*Ksin)*)

The sinuosity coefficient of a river is the ratio between the curvilinear factual length of the river or its segment, L (km), which is identified with consideration of its sinuosity, to the length of a straight line *e* between the end points of the segment:

$$K_{sin}=\frac{L}{e}.$$

For further analysis of water quality, keep in mind that the velocity of water flow reduces in areas with significant sinuosity, which may, in particular, impact the character of vegetation and setting velocity of polluting substances.

§3. Measuring the river gradient

The velocity of the river flow goes up with the increase of the river gradient. Significant expansion of vegetation is quite possible at segments with small gradient and weak flow.

To identify the river gradient, one should pinpoint elevation points of the water levels for particular segments of the river. The difference between the elevation points at the start H1 and the finish H2 of a segment is called the river fall H. The ratio of the gradient H to the length of the segment L gives the average gradient for this segment:

$$i=\frac{H1-H2}{L}=\frac{\Delta H}{L}$$

The river gradient is routinely presented in the form of a decimal number and sometimes in permille (i.e., parts per thousand) and in percentage.

§ 4. Measuring the river width

1. The easiest way to measure the width of a river is to take a meter tape and stretch it from bank to bank.

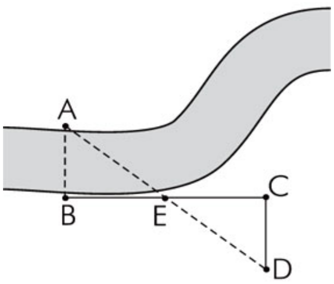
2. If the width of the river is no more than 30–35m, it can be measured using a cord loaded at the end. To do the measurement, throw the load onto the opposite bank of the river and then measure its width from one bank to another.

3. The width of a small river can be measured with the step method based on drawing triangles with two equal sides.

Equipment*:* peg, tape measure or yard measure.

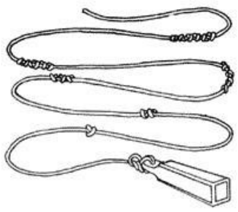
Measuring:

1. Take position near the river facing the opposite bank; point B.
2. Pinpoint a particular landmark on the opposite bank, e.g., a tree; point A.
3. Turn right and count 50 steps.
4. Put the second landmark, e.g., a peg, as point E.
5. Make another 50 steps in the same direction: point C.
6. Turn right again trying to keep precisely the 90 degree angle.
7. Start moving looking out at both A and E landmarks.
8. When the landmarks are in line, stop: this is point D.
9. Tape the length of one step.
10. The number of steps from point C to point D transferred to meters will be the river width.



§ 5. Measuring the depth of the river bed

Equipment*:* water gauge, coasting lead, boat (if there is no bridge across the river), meter-calibrated cord, survey form for measuring the depth of the river bed.



Measuring:

It is preferable to measure the depth in several points, at stretches of water and natural bars. The easiest way to do measuring is from a bridge across the river.

The depth of a river can be measured by direct measurements using a water gauge or a coasting lead in case of substantial depths. Depending on the river width, measurements can be done every 1, 2, 5 or 10 meters. If there is no bridge, a boat should be used for the measurements. To do this, a calibrated cord is drawn across the river bed; well-observable marks should be spaced at one meter intervals. Moving along the cord (along the river range), put down the ranging pole or the gauge to measure the depth at fixed intervals.

These measurements should be registered in the river bed measurement survey form (Table 1). The type of bottom soil and water vegetation should be registered in the same form.

Table 1.

Survey form for measuring the depth of the river bed

Range № ______ Reference __________________

Point number	Distance from the range opening, m	Distance between the points, m	Depth, m	Soil	Vegetation

Based on the survey data, a transverse profile of the river bed, i.e., a water cross-section, can be drawn. To identify the average depth at a range, divide the cross-sectional area by the width of the river. The cross-sectional area is calculated as a sum of elementary geometrical figures formed by measuring verticals from survey points (Fig.1).The geometrical figures will be right-angled trapeziums and right triangles; the area of each trapezium is the product of the arithmetic mean of the lengths of the two parallel sides and the height, while the area of each triangle amounts to one half of the product of its legs.

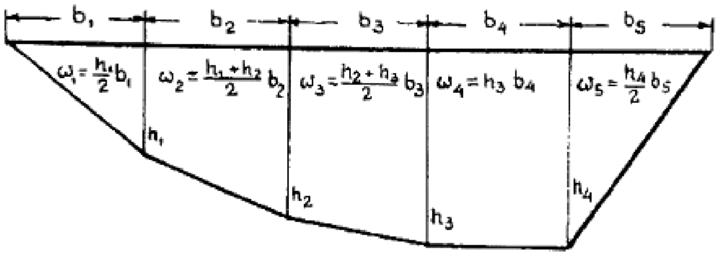


Fig.1. Calculation of the area of the cross-section of a river bed by its decomposition into geometrical figures

Measuring depth through the entire river range is often not possible. In such case, an approximate estimate of the area of the water cross-section can be made by the formula

$\omega = BH_{max}$,

where B is the width of the river and H_{max} is its maximal depth.

§ 6. River flow velocity and discharge rate

***Equipment**:* surface and/or subsurface floats (drift bottles), a string, tape, stop watch, river site map

Measuring:

In field conditions, the river flow velocity is measured by surface and subsurface floats. The easiest way to do this is with surface floats; however, it is applicable only in case of low wind. Routinely, the maximal permissible wind speed is 6 m/s. Fragments of dry wood or kindling wood can be used as surface floats.

Subsurface floats can be easily made of two bottles with caps. One of the bottles is filled with water and tied up with the other one with the rope (Fig. 2).

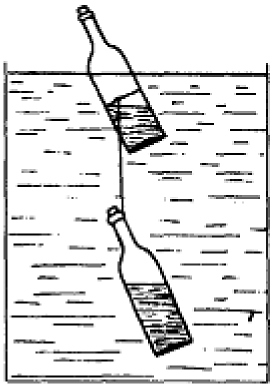


Fig.2. Subsurface floats.

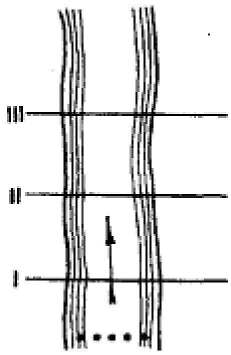


Fig. 3. The velocity measuring segment

The float (bottle with water) allows to make judgement on the river flow velocity in the depth.

1. At the segment of flow rate measurement, three ranges are laid out: the upper (starting) one, the middle (intermedium) and the lower one. Distances between the ranges are measured by the tape. Ranges are marked on the scheme.

2. The floats are set off upstream the starting range.

3. The stop watch marks the time of floats passing through each range. These data are registered in Table 2 of the Measurement log for measuring the river flow velocity.

4. Based on the data from 4-5 floats, the average velocity is calculated for the lower range.

5. The direction and magnitude of the flow rate are marked on the map. (Fig. 3).

6. It is also necessary to outline the status of the river bed at the segment (clear, partly vegetated), the weather character, wind features (calm, low, moderate, strong, with the stream, against the stream, from bank to bank), choppy water, waves.

Table 2.

Measurement log for measuring the river flow velocity

Number of the float	Distance, m	Start time, s	Passing time		Time difference, s	Velocity, m/s
			Medium range, s.	Lower range, s.		

Flow rate is the total volume of water (cubic meters) that flows past a fixed point in a river per time unit (1 second).

To measure the flow rate in a river, the average velocity of the flow should be multiplied by the cross-sectional area of the stream:

$$Q = V_{av}\omega,$$

where Q is the river flow rate, V_{av} is the average flow velocity, and ω is the cross-sectional area of the stream (see para 5).

Conclusions

Having completed primary hydrological and hydrometric studies of the selected river segment, participants of the survey can make initial conclusions about the water flow. In particular, the velocity and character of the river flow influence the level of pollution, sediments of hazardous substances on the bottom and river banks, and the biogenic system of the river.

Besides this, primary studies allow to identify features of the bottom soils and relief of the river segment, occurrence of waste on the bottom, water vegetation, etc. Based on the results, initial conclusions can be made about the general condition of the river segment examined.