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Sampling framework to examine processes affecting habitat stability in lowland streams (WP2 task 2.2, 3.1 and 5)

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Partners:
Task 2.2: ALTERRA, BOKU, NERC, CNR, MasUniv, SLU, UDE, UNIBUC-ECO
Task 3.1: ALTERRA, NERC, MasUniv, UDE
Task 5: ALTERRA, UDE, UNIBUC-ECO, SLU

Introduction

To reach a most cost efficient approach within the study of hydromorphological features of (restored) lowland streams the tasks 2.2, 3.1 and 5 are combined into one protocol. If you are only performing certain tasks you can select the respective necessary methods. In general, where possible methods can be combined at selected sites to reach an optimal performance.

Objectives and hypotheses

Objective task 2.2
To establish the habitat preference of indicator species.

Objective task 3.1
To establish the relationship between discharge dynamics, habitat stability and the population density of indicator species.

Objective task 5
To determine the effects of hydromorphological measures on the functioning and structure of the instream communities, this to establish the effects of natural development of the floodplain and/or of adding woody debris on the cause-effect-chain under different discharge regimes.

Hypotheses
- Indicators prefer specific habitats, either sand, detritus or gravel.
- Discharge peaks initiate disruption e.g. through shifting sand, whirling/moving detritus patches or rolling gravel.
- Indicators become more or less abundant if the habitat is disrupted
- Recovery depends on habitat recovery time and thus time between extreme events
- Restoration strives for the recovery of the habitat and return of the indicators
- Discharge peaks prevent recovery to take place.

Combined overview of methods and materials for all tasks

Introduction
The following paragraphs provide descriptions of methods and materials to meet the objectives of all tasks listed. Dependent on the tasks you are going to perform you can select the respective methods.
To study the habitat mosaics, the hydromorphological processes of erosion and sedimentation, the disturbance by extreme flow events and the potential recovery by restoration measures a number of parameters can be monitored:

√ discharge
√ current velocity profile
√ depth profile
√ substrate pattern
√ substrate dynamics
√ vertical substrate composition
√ macroinvertebrates

Sampling site

Some important criteria for the sampling site selection are:

- near natural, small, sandy bottom streams
- easy accessible and not too far from your lab to make regular visits possible
- the presence of a gauging station as continuous discharge data are necessary
- a width between 1 and 3 meters (20 - 100 km^2 catchment) makes the monitoring more easy but that depends on your possibilities
- land use is mostly the cause of differences in discharge pattern but when selecting sites the riparian zone should be comparable between sites with different hydrological stress
- if possible, different tasks are combined which, for example, can be a gradient of a near natural stretch, a semi-natural stretch (e.g. channalised but with wooded banks), and a straightened stretch without semi-natural banks are preferred

Discharge

Continuous discharge measurements

Discharge is measured in each stream stretch that differs in discharge pattern/regime e.g., a channalised stretch versus a semi-natural and/or natural one. Discharge is recorded continuously by using an automated water level registration equipment, that preferably is linked to measure weirs.

In fact, the equipment does not measure discharge but measures the water level continuously (often in interval of 15 minutes), using data loggers. These data loggers can be constructed within a metal pipe which is situated in the river bank (Figure 1). A transversal pipe ensures the horizontal connection with the water column of the stream. Water moves from the stream in this pipe. The data logger measures the pressure of the water in the pipe, the higher the water level the higher the pressures down in the pipe. The water level data can later be transformed in discharge data by using data collected from the transversal current velocity profile of the stream or from a measuring weir. It is most easy and reliable to place such a weir in the stream to create a fixed profile. Some partners will do these measurements by themselves, others will use data from water authorities.

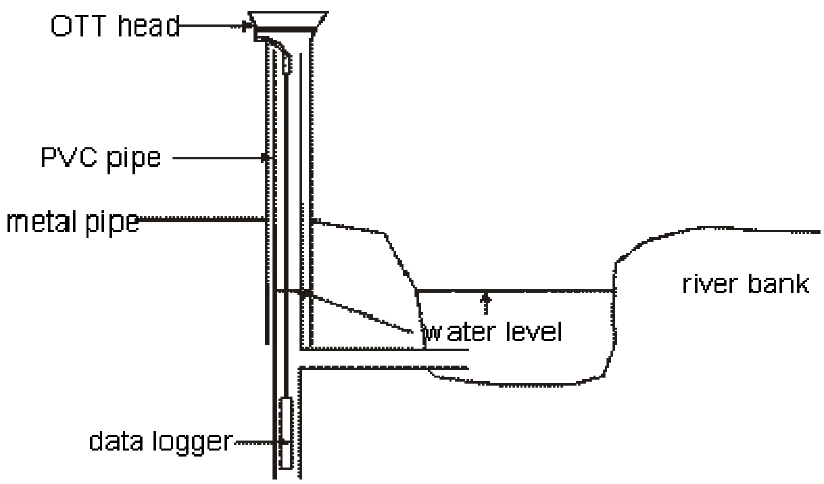

Figure 1. Water level measurement.

Extreme events

Extreme flows are moments of extra measurements. Therefore, if possible a quick response system is needed. An online connection to the discharge stations would have the advantage that you can respond immediately to extreme events.

Current velocity and depth

Current velocity profile

At different discharge events transversal current velocity profiles are taken at each discharge station. This to calibrate discharge measurements. At each 10 cm along the transversal profile (Figure 2), preferable in a fixed profile in the stream close to the water level data logger, current velocity is measured (e.g., using a Sensa RC-2 current velocity recorder or another current velocity device) at each 5 to 10 cm (depending on the overall stream depth) depth.

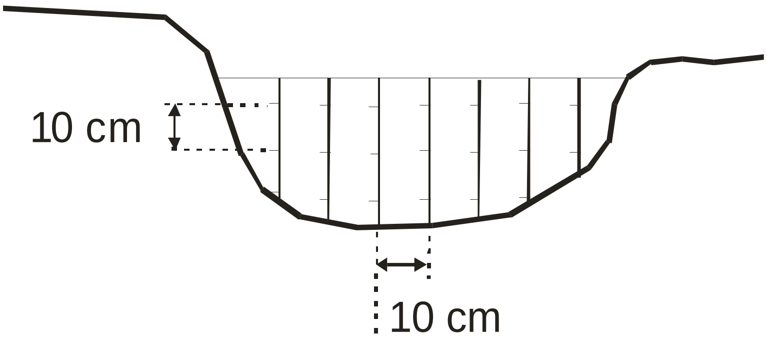

Figure 2. Scheme to measure a current velocity profile.

Depth profile

To monitor bottom erosion or deposition a depth profile is taken each two to five weeks. To establish a depth profile the following measurements are done (Figure 3):

1. The distance between the left pole to the left waterline (left is looking towards the source of the stream).
2. The distance between the right pole to the right waterline.
3. The distance between the measuring-rod and the terrestrial bottom at each 10 cm at the left and right side between poles and waterlines.
4. The distance between the measuring-rod and the water surface in the middle of the stream.
5. The distance between the water surface and the stream bottom at each 10 cm along the wet transversal stream profile.

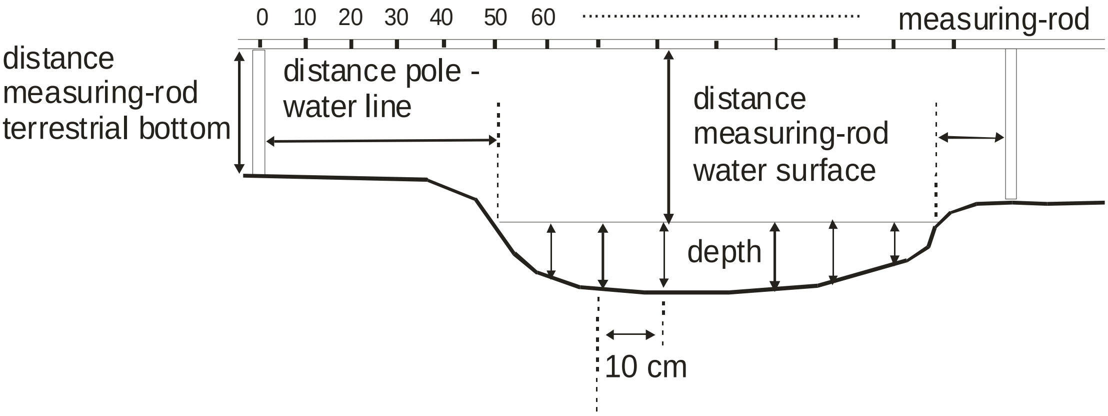

Figure 3. Scheme to measure a depth profile using a measuring-rod along fixed poles.

Substrates/habitats

Substrate dynamics measured through recording regularly the substrate pattern

Each two (preferred) to four weeks a substrate pattern can be recorded. The potential substrates and substrate categories are listed in Table 1.

Table 1. Substrate types and categories.

substrate	**description**
coarse gravel	> 6 mm
fine gravel	2 - 6 mm
sand	0.125 - 2 mm
clay and mineral silt	mineral not recognizable particles < 0.125 mm
fine detritus, organic silt	fine, not recognizable parts and organic material with particles < 2mm
coarse detritus, branches, twigs, roots, leaves	coarse, recognisable organic material, particles > 2 mm
macrophytes	living plants

The substrate is recorded, by estimating the percentage cover per substrate over stretches of 5 m. To do so, the substrate (habitat) mosaic of the stream bottom is mapped. Therefore, a grid is used (Figure 4). The length of the stretch to be measured as well as the grid density depends on the specific stream type and site.
Example: Two metal poles each of 5 meters length (tent poles that can be shifted into each other are practical) are attached to poles that are placed in both stream banks at 0, 2.5, and 5 m. A measuring rod is placed over the metal poles (it rests on both poles), so the measuring rod is lying transversally over the stream. Along the rod, the start and end of each habitat (substrate) is recorded and noted on a paper with grids of 10 * 10 cm in reality (1 * 1 cm on paper). UDE e.g. uses a grid of 20x20 cm. This procedure is repeated each 0.5 m along the longitudinal profile, following the metal poles (each half meter is indicated on these poles). Afterwards these recorded field substrate maps can be digitalized. For each grid cell the substrate is known for each date of measurement. This makes it possible to study the stability of each grid cell in a stretch (how often changes the substrate?) and the habitat diversity (how many different substrates are there and what is the surface area for each substrate?). The recommended substrates are given in Table 1, but of course they can differ per studied stream.

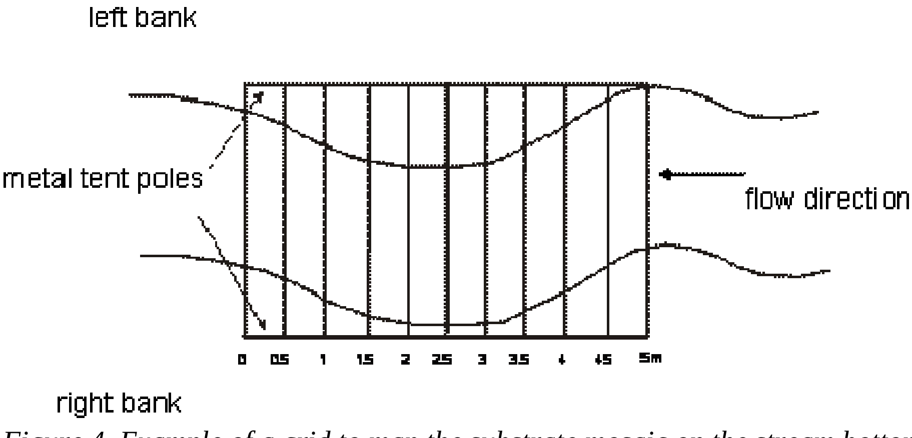

Figure 4. Example of a grid to map the substrate mosaic on the stream bottom.

<u>Substrate dynamics measured through sediment transport</u>
An alternative method to measure substrate dynamics is through an indirect cumulative collection of transported material.
Substrate dynamics must go parallel with a transport, either of suspended or moving material. We devised two methods, one to collect moving sediment and one to collect suspended material. Moving sediment is the bottom material that is rolling or sliding over the stream bottom, while the suspended material floats/whirls in the water column. The cumulative collection of suspended and moving mineral and organic material together tells about the (in)stability of the stream, not per habitat but per whole stream stretch. In this way, various

stream stretches with different discharge regimes can be compared and the amount of material transported will be related to discharge.
The mineral and organic material collector (MOC) is devised according to the principle of extracting a small part of the stream water layer, including its suspended material, and leading it through an almost still reservoir that allows material to deposit (Figure 4). The bottom sediment collector is devised to collect the moving and rolling sand that is not suspended in the water layer (Figure 5).
Both collectors are emptied every 2 weeks.

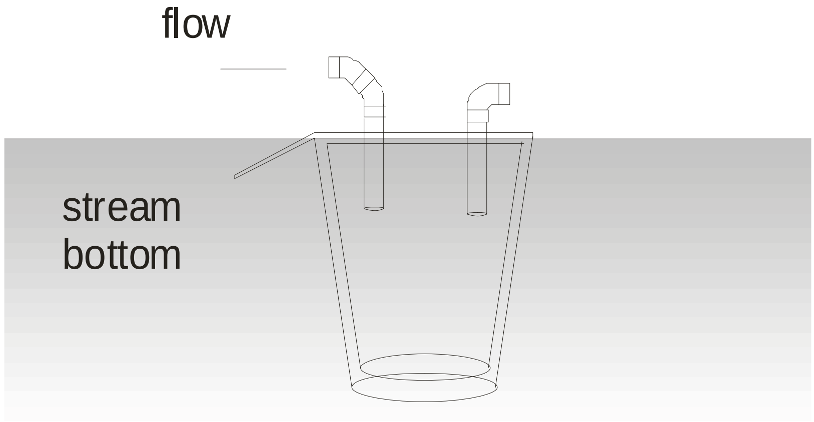

Figure 4. Scheme of the mineral and organic material collector.

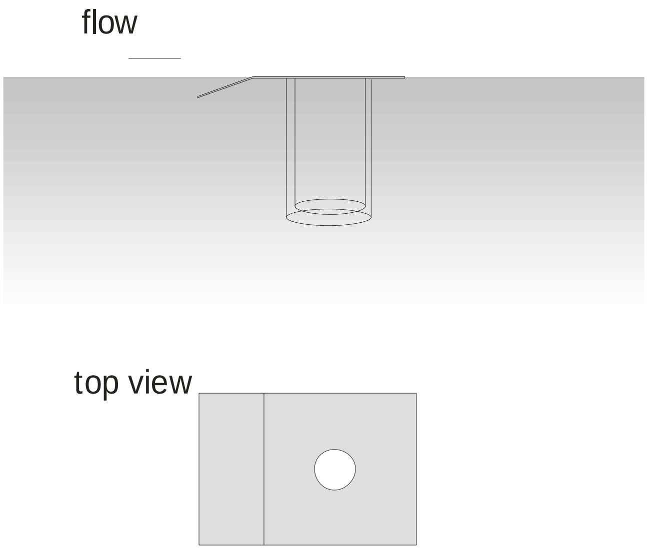

Figure 5. Scheme of the bottom sediment collector.

Potential indicators
We intended to focus on taxa related to both sand and detritus. A number of taxa were listed and discussed as potential indicators. The choice of your indicators will depend on the selection of indicators done in task 2.2. Still, as an example UDE and Alterra discussed the following:
<u>Sand:</u>
Suited but hard to collect in the NL and often very rare are *Cordulegaster boltoni*, *Atrichops crassipes* and *Ephemera danica*. More suitable are *Sericostoma personatum, Prodiamesa olivacea* and some other chironomids (e.g., *Polypedilum breviantennatum, P. scaleanum*).
<u>Detritus:</u>
These are more easy to collect and to observe in the field, especially because the trichopterans such as *Glyphotaelius pellucides* and *Limnephilus rhombicus* can be more abundant. Others

are *Pedicia sp.*, though a genus and *Nemurella pictetii* Suited but not identifiable in the field are *Pisidum casertanum* and *P. nitidum*.

Hydromorphological gradient

The taxa will also be tested whether they are suited for lab experiments.

Especially, to monitor a hydromorphological gradient also other potential species were discussed: *Gammarus pulex, Ephemera danica, Leuctra sp., Nemoura sp., Orectochilus villosus Lv., Halesus radiatus, Glyphotaelius pellucidus, Potamophylax rotundipennis, Simulium sp., Pisidium sp., Elodes sp. Lv., Amphinemura, Hydropsyche.* In the degraded sites: *Limnius volckmari Lv., Hydropsyche sp., Chironomidae* and *Hirudinea.*

Besides the presence of species also population size is important. A large population size ensures that differences can be detected in streams with different discharge fluctuations.

It is nor really necessary to always count indicators in the field. Especially, bottom inhabiting species can not be seen and must be sampled. Thus, alternatively small samples can be taken and indicators can be counted in the lab. The disadvantage is the representativeness of the samples which is often less known. While sorting these samples, we can also only look for the respective dominant species and label it afterwards as indicator. This makes the use of chironomids more feasible. Secondly, more often in sand bottoms only one or a few species are present and dominant. So, these can be counted easily. A problem with sampling is the regular disturbance of the site. Sampling outside the stretch would rise the risk of uncomparability.

Macroinvertebrate sampling

For substrate/habitat sampling a small sampling devise is preferred. This can be a shovel (10x15 cm) or a tube of 10 cm diameter or a small handnet (preferably 15 cm in width).

Example: In the Netherlands the macroinvertebrates will be sampled with a micromacrofaunashovel (10 cm width, 10 cm high, 15 cm length, 0.5 mm mesh size) according to Tolkamp (1980). The shovel is made of stainless steel, on the top and the rear there are openings covered with nylon gauze. On the sides, adjustable wings are screwed, which decide the depth of the sample. This depth will be fixed at 2 cm. The shovel is pushed into the substrate at an angle of 30-45^{o} and brought in a horizontal position when it reaches its 2 centimeters depth. At the same moment the shovel is pushed through the substrate over a distance of 15 cm, tilted backwards and lifted above the water surface. The sample is transferred into a bucket. Thus, an area of 15 cm^2 is sampled.

All substrate-type/habitat samples will be kept separate.

A multihabitat approach by sampling the dominant (occurrence > 5%) habitat types in proportion to their frequency of occurrence in the stream reach will be used. At most of the sites fine gravel, sand, fine detritus, coarse detritus and leaves will be sampled in such way.

Taxa-poor substrates/habitats will be sampled 2-3 times (area of 30-45 cm^2).

The sample is processed in the laboratory by rinsing the sample over two sieves (mesh size 1 and 0.25 mm), placing the residue in a white tray, and sorting the animals alive.

Frequency of measurement

Not everything can or needs to be measured each time at each site.

Task 2.2 focuses on the habitat requirements of indicators. This implies an inventory of habitats and its inhabitants in your stream.

Steps in the field work:

- Selection of sampling sites in unpolluted rivers with different hydromorphological characteristics (hydromorphological gradient natural, semi-natural and degraded stretch)
- Identification of key processes (stressors) in the catchment

- Identification of key habitats
- Determination and documentation of existing habitats in the field
- Sampling on the habitat scale according to the sampling protocol (three replicates per habitat)
- Field work takes place in 2005

Example: For the Dutch Springendalse stream we take 2-3 shovel samples per habitat and each site had about 5-6 major habitats. The number of major habitats present (e.g. major is defined as substrates with a cover percentage > 5%) will depend on the local environmental conditions. Preferably, samples are taken in spring and autumn to include seasonal differences. The number of sites depends on the resources available.

Task 3.1 focuses on the relationship between discharge dynamics, habitat stability and the population density and growth of indicator species in the field. Steps in the field work:

- Selection of sensitive and tolerant indicators (species indicative for direct effects of increasing discharge dynamics or indirect effects via habitat loss)
- Selection of sites along a gradient from reference to extreme discharge dynamics
- Selection of two representative stretches per site
- Discharge measurement
- Habitat/substrate mapping
- Monitoring of indicators
- Field work takes place in 2005 and 2006

Task 5 focuses on the effects of hydromorphological measures on the functioning and structure of the instream communities. Steps in the field work:

- Selection of sites/stretches related to the measures studied according to a Before-After-Control-Impact (BACI) design, and per moment in time and stretch:
    - Discharge (continuous measurements)
    - Current velocity and depth profile (at different discharge events)
    - Substrate pattern and dynamics (each two to five weeks)
    - Vertical substrate composition (one to two times a year)
    - Macroinvertebrate sampling (multihabitat sampling; one to two times a year)
    - Field work takes place in 2005 and 2006

Indicative table of frequencies of measurement:

√ discharge current velocity profile: continuous
√ depth profile: a few times under different discharge conditions (low, moderate, high, extreme discharge events in winter and summer conditions)
√ substrate pattern: regularly each two to five weeks
√ substrate dynamics; regularly each two to five weeks for both MOC or pattern recording
√ vertical substrate composition: once or twice a year
√ macroinvertebrates: once or twice a year up to once in five years in restoration monitoring