Development of an Assessment System to Evaluate
the Ecological Status of Rivers in the Hindu Kush-Himalayan Region
Funded by the European Commission, 6th Framework Programme contributing to priority "Specific measures in support of international co-operation (INCO)", A.2.1. Managing humid and semi-humid ecosystems".
Contract number: INCO-CT-2005-003659

Manual for the application of the ASSESS HKH site protocol

Version 1 February 2006

Based on the manual of the AQEM site protocol 1.0 (2002) and the guidance manual of the River Habitat Survey (1997)

Compiled and adapted by: Thomas Korte & Otto Moog

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Introduction

A site protocol describes a sampling site. It contains both site and sample related information. It serves the following purposes:

- to give an impression of river and floodplain morphology, hydrology and vegetation
- to ensure that the site can be precisely re-located in the field
- to document the process of biological sampling (sample related information)

The site protocol specified here has been developed for practical fieldwork. It mainly serves the documentation of the biological sampling and provides some additional information, which can be easily quickly recorded in the field.

Data sheets

The site protocol consists of three data sheets. The site name, sampling date, sample code and the name of the investigator must be recorded on the top of every page to avoid problems, in case individual sheets are separated or copied. Most of the data must be recorded in the field. The first site of the protocol gives the exact locality of the sampling site and provides detailed information on reach, catchment and hydrological characteristics. This section should mainly be filled in the laboratory (up to 24) as most of the parameters can be taken directly from maps, usually topographic maps (preferably with a scale 1:50,000) or hydrological reports. Some data have to be measured, e.g. distance to source, stream order, and slope of the valley floor. To obtain these data, maps of the whole catchment upstream of the sampling site are necessary. Some data may sometimes require specific maps, e.g. geological maps.
If you are not sure which of the indicated possibilities you shall mark you should leave this point without entry. Never make an entry when you are not sure.

Equipment

Besides the sampling gear for the biological sampling the following equipment is necessary to complete the site protocol:

Obligatory:

- soft-leaded pencil and/or a waterproof pen
- clip board
- paper
- meter rule

- tape measure
- (digital) camera, films

Optional:

- stopwatch
- flow meter
- Polaroid glasses (sometimes helpful to assess the substrate types)
- binoculars (to observe features on the opposite river bank and in the floodplain)
- Global Positioning System (GPS)

Equipment necessary for recording physico-chemical parameters:

- conductivity meter
- oxymeter
- pH-meter
- if sampling in remote areas: field labs or Hach test kits

The latter devices must be calibrated before use in accordance with the manufacturer's instructions. Temperature, pH value, conductivity and oxygen content and saturation are to be measured in flowing sections of the site, usually in a riffle. Please consider that it is the policy of many laboratories not to measure these parameters in the field.
Please note that most data can be recorded from the riverbanks. Those site protocol data, which require wading in the streambed, must be collected after the biological sampling in order to avoid disturbing the fauna. It is generally highly recommended not to wade in the stream before the biological sampling has been completed.

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Site protocol parameters

1 country
Hindu Kush - Himalayan member state the site is located in.

2 federal state
Territory or federal state the site is located in. Also name nearest village.

3 river name
Name of the stream, preferably taken from topographic map.

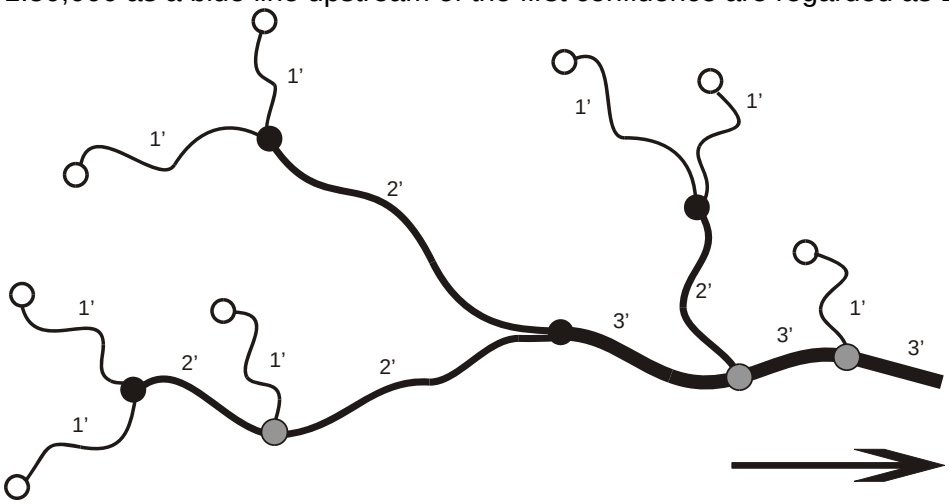
4 terrestrial ecoregion name and code (WWF; e.g.: IM 0115)
According to World Wildlife Fund (WWF) name the ecoregion site is located in. You may check coordinates of sampling site with digital database (ArcView Shapefile) provided by WWF at: http://www.worldwildlife.org/science/data/terreco.cfm

5 river system (river flowing into the sea)/subsystem
The main river catchment the stream belongs to (e.g. Ganga, Hindu).
Subsystem: Also name another big river in which the observed river is flowing in. Normally this bigger river flows into the main river.

6 catchment area
Use Geographical Information Systems (GIS), topographic map or hydrologic atlas if available. Indicate the catchment area at the sampling site, not the total catchment area of the stream.

7 map code
Registration no. of the map used for 6.

8 stream order (Strahler system)
Preferably based on map 1:50,000; please indicate, if you have used another map.
Stream order is based on so-called confluence points (see figure). Only streams with a mean annual discharge of > 32 l/s are regarded. Stream sections upstream of this point are neglected. The so-called ‘blue line method’ is to be used: all streams shown on a map 1:50,000 as a blue line upstream of the first confluence are regarded as 1st order streams.



9 distance to source [km]
Preferably taken from a map 1:50,000 or from GIS. If a map is used: the stream starts at the point where it is shown as a blue line.

10 longitude (decimal degree)
Preferably derived from Global Positions System (GPS); mind default settings for coordinates specification.

11 latitude (decimal degree)
Preferably derived from Global Positions System (GPS); mind default settings for coordinates specification.

12 altitude [m above sea level]
Preferably taken from a map 1:50,000 or from GIS. However, specify method used.

13 catchment geology (at 10% steps)
Information should be taken from geological maps or GIS, if available. The catchment area at the sampling site, not the total catchment area of the stream, should be considered.
Categories:
acid silicate rocks = magmatic and metamorphic silicate rocks, e.g. granites, granodiorites, monzonites, gneisses, schists, amphibolites, quarzites incl. volcanics i.e. ryolites, dacites, andesites, trachytes, tuffites
mafic silicate rocks = mafic and ultramafic magmatic and metamorphic rocks, e.g. diavases, peridotites, dunites, pyroxenites, gabbros, spilites, pillow lavas, ophiolithes in general, incl. volcanics i.e. basalts
carbonate rocks = marbles, limestones and dolomites, karst
flysch and molasse = post-tectonic sediments in Alpine rock regions: Eocene – Oligocene conglomerates, sandstones, clays, marls
alluvial deposits = recent sediments (quaternary and neogene)
lacustrine deposits = recent sediments (quaternary and neogene)
terrestrial deposits (Moraines) = recent sediments (quaternary and neogene)
terrestrial deposits (Sander) = recent sediments (quaternary and neogene)
marine deposits = recent sediments (quaternary and neogene)
organic formations, e.g. marshland = recent sediments (quaternary and neogene)
loess = recent sediments (quaternary and neogene)

15 catchment land use
Information to be taken from maps or GIS; only categories covering > 10 % of the catchment area are considered. The catchment area at the sampling site, not the total catchment area of the stream, should be considered.

16 mean annual discharge (MQ)
If gauging sites are available close to the section examined.

17 mean annual low discharge (MNQ)
If gauging sites are available close to the section examined, from which mean minimum discharge data are available over a period of years. If the gauging site is remote from the study section, you may calculate the MNQ based on the catchment area (in geological homogeneous areas).

18 high annual discharge (HQ1)
If gauging sites are available close to the section examined, from which maximum discharge data are available.

19 hydrological classification
Categories:
permanent = not drying out or only in extreme years
periodic = in ‘normal’ years drying out in a predictable period, usually either in summer or in winter
episodic = drying out in intervals, which beginning, end and length are not predictable
tidal influence = indicate if the river is influenced by tides and estimate the relative effect

20 feeding system
Preferably taken from maps. Depending on the feeding type rivers have a characteristic discharge regime. E.g. rivers that are snow fed may have high discharges during the snowmelt in summer. Rain fed rivers are exclusively fed by the monsoon rain. During the post monsoon season they normally dry out.

21 lakes/reservoirs in the stream continuum upstream of sampling site
Preferably taken from maps. Estimate distance from sampling site.

22 width of the floodplain
Only applicable if a distinct floodplain is present (not applicable for many types of lowland streams). In mountainous areas the edges of the floodplain can usually be obtained from maps. 'Floodplain' is defined as the area regularly inundated under natural conditions (without the influence of dams and impoundments).

23 valley slope [%]
Data should be taken from maps. The length of the floodplain stretch considered should be reasonable, but not shorter than 1 km. The sampling site should be located in the centre of the floodplain stretch considered. The distance between two elevation lines must be measured without considering the course of the stream (e.g. meanders) in the floodplain mid.

24 slope of river course (thalweg) [%]
Data should be taken from maps. The length of the floodplain stretch considered should be reasonable, but not shorter than 1 km. The sampling site should be located in the centre of the stream stretch considered. The distance between two elevation lines must be measured along the course of the stream (considering meanders) in the stream mid.

25 valley shape
canyon: the stream is deep-cutting; hillslopes are almost vertical.
V-shaped valley: no floodplain existing. Sediment arising from the hillslopes is not completely transported by the stream (small streams only).
trough ('Muldental'): Sediment arising from the hillslopes is only partially transported by the stream.
meander valley: a distinct floodplain is present. The valley itself is meandering.
U-shaped valley ('Sohlental'): a distinct floodplain is present accompanied by hillslopes.
plain floodplain: (partly) in lowlands: no valley present.

26 floodplain land use
Information to be taken from maps or GIS; only categories covering > 10 % of the catchment area are considered. The sampling site must be located in the centre of the floodplain stretch considered. Lowland streams: 'floodplain' = riparian zones = 10 x stream width. You may fill this section alternatively in the field.
- forest = woodland containing trees > 6m in height
- deciduous forest = broad leaves
- coniferous forest = pin leaves e.g. pine trees, fir trees
- wetland = dominated by tall grasses (knee height and taller) on muddy ground
- silviculture = bigger coherent areas of wood which are cultivated. Often detectable by a symmetrical order of the individual trees. Planted in rows.
- open grass-/bushland (natural): dominated by grasses and scrubs (thicket, bracken) on dry ground
- meadows: dominated by smaller grasses; not used for cattle farming
- naturally unvegetated: due to regular occurring strong floods floodplain is completely flushed and mineral substrata removed and relocated. Often present at big mountainous rivers where floodplain is characterized by boulders and cobbles
- alpine heath: mountainous zone above the natural limit (altitude) of tree establishment dominated by herbaceous plants
- standing waters: indicate if there are standing water bodies in the floodplain (e.g. small ponds, side arms, etc.)
- terraces: tillage land that has been built artificially through land modification in hilly area.
- crop land: tillage land in lowlands
- pasture: grass or herb land that is used for cattle feeding
- partial cutting: partial clearing of firewood from scrub and trees and small scale harvesting of grasses and herbs for cattle feeding

- clear-cutting: large scale deforestation

27 channel form

Anastamosing: multi-thread channel where the flow is deep, and split by rock outcrops or mature islands. A fairly stable system, often with steep banks.
Braided: multi-thread channel where the flow is often shallow, consisting of riffles and rapids, and is split by mid-channel bars. An unstable system, often with eroding banks.

28 presence of standing water bodies in the floodplain

The floodplains surface is constructed by the river as a result of sedimentation deposition during lateral shifting and overbank flooding.
- side arms fully connected to river: due to lateral activity a side arm was built that is still permanently connected to the main channel
- side arm partly connected to the river: side arm is spatial and/or temporal only partly connected to the main channel. Temporal connected = only connected to the main river during floods (e.g. cut-off meanders)
- ponds: due to overbank flooding
- flood channels: only present during high floods; build by the river or by high groundwater levels during floods; during dry season these channels dry out completely.

29 mean depth

To be calculated from several replicates measured.

30 shading at zenith (foliage cover)

Seen as a projection from the mid of the streambed at times of full foliage cover (20 % steps).

31 width of wooded riparian vegetation

Woody riparian vegetation is significantly affecting habitat composition through roots, leaves and wood. Indicate the width; if the width is > 20 m indicate just '> 20m'.

32 removal of mineral bed material

You may find hints if you compare substrata of riverbed material from reference sites of the same stream type with current investigated site. In addition you may ask residents and look for rounded stones used for house or fence building.

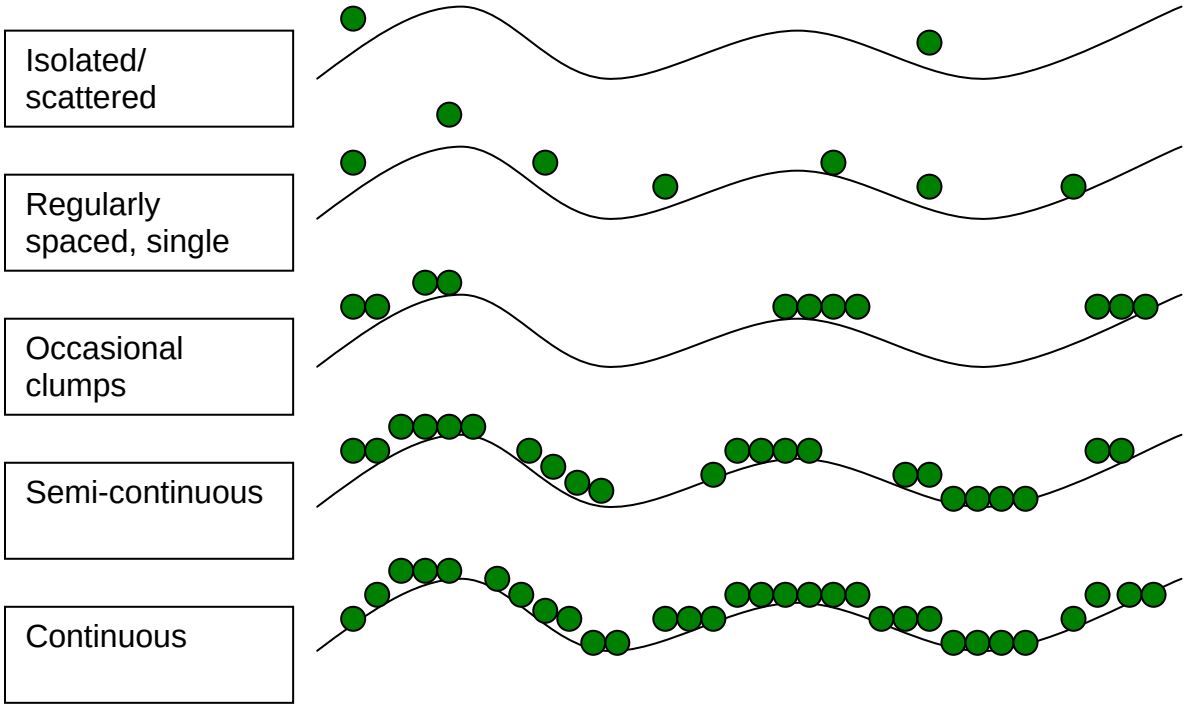
33 number of debris dams (wood and POM accumulations > 0.3 m^3)

Number of debris dams/accumulations; debris dam defined as POM-accumulations > 0.3 m^3 (estimated by width, length, and height).
POM = particulate organic matter (e.g. leaves).

34 number of logs (> 10 cm diameter)/100 m section

Logs > 10 cm maximum diameter at least partly located in the active channel.

35 average density of wooded riparian vegetation



36 dams at sampling site 37 other transverse structures

All weirs, dams or other transverse structure to control river flows/levels likely to obstruct migration of aquatic organisms and thus affecting the study reach must be counted.

38 bank fixation (at 10% intervals)

Indicate, to which degree the banks at the study site are fixed by artificial or living materials. Categories:
- concrete without seams: a solid concrete structure without interstices
- concrete with seams: concrete plates with interstices
- stones: e.g. riprap
- wood: dead wood
- trees: if trees (e.g. alders) have apparently been planted to prevent stream movements.
- other materials

39 bed fixation (at 10% intervals)

Indicate to which degree the stream bed at the study site are fixed by artificial or living materials. Categories:
- concrete without seams: a solid concrete structure without interstices
- concrete with seams: concrete plates with interstices
- stones: e.g. riprap
- wood: dead wood
- trees: if trees (e.g. alders) have apparently been planted to prevent stream movements.
other materials

40 stagnation

Indicate, if the stream at the study site is artificially stagnant (usually, if a dam is present downstream).

41 torrent modification

Only applicable for alpine and mountainous areas.

42 channelling for navigation

Only applicable for large rivers, which are (or have been historically) used for navigation.

43 straightening
Artificial indicated by human activity e.g. bank fixation.

44 removal of course woody debris
Removal of coarse woody debris may significantly alter habitat composition. May be indicated by a low number of logs inside the channel, existing data or be directly observed.

45 cut-off meanders
Presence of cut-off meanders (either intact of filled) in the floodplain.
Cut-off meanders build by natural processes are not to be considered. Only cut-off meanders that are built due to human activity should be mentioned here. A meander is a bend in a river course which curve is greater than 90°. When a meander gets cut off from the main stream body it is called a cut-off meanders.

46 scouring [m below surface]
Indicate, if the channel is significantly deep-cut (depth should be given as the average over the stretch). Scouring may limit the channels ability to move and its habitat composition. Natural incision (e.g. at sand stretch) is not to be considered.

47 culverting
Indicate if the channel is partly culverted in the sampling site section. Culvert = arched channel or pipeline for carrying water beneath a road, railway, etc.

48 water abstraction with pulse releases
Indicate if the sampling site is affected by pulse releases of upstream weirs.

49 residual flow
Length of the river stretch where water is abstracted for various purposes. If no water is abstracted the value is 0.

50 purpose of water abstraction

51 impoundments at sampling site
Longitudinal dams or impoundments are present.

52 removal/lack of natural woody floodplain vegetation
Indicate whether or not the woody riparian vegetation has been (at least partly) removed.

53 non-native woody floodplain vegetation
Indicate whether or not the woody riparian vegetation is (at least partly) replaced by non-native species.

54 source pollution
E.g. purification plants upstream, drains u/s the sampling site.

55 non-source pollution
E.g. intense agriculture in catchment.

56 sewage overflows
To be derived from maps, existing data or specific technical structures/buildings.
Examples: combined sewer overflow sewage plant.

57 eutrophication
E.g. caused by purification plants or intense agriculture.

58 acidification
May be indicated by pH-measurements at the study site or existing data. Make sure that the stream is not naturally acid (e.g. peat bogs, organic stream beds with Sphagnum).

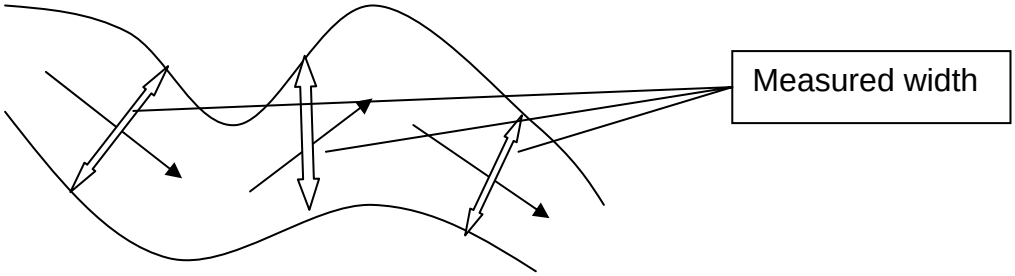
59 liming
Liming activities in catchment if significantly affecting water chemistry.

60 mining
Mining activities in catchment if significantly affecting water chemistry.

61 toxic substances
From existing data, if available.

62 stream width

Measured from the actual shorelines (see figure).



63 relation riffles / pools

Estimated for a stretch 20 times length of the average stream width or a length of at least 100 meters, whichever is longer. The share of pools in this stretch has to be noted, e.g. “40%”.

64 discharge [l/s] (actual, estimated)

The discharge at the sampling date has to be estimated (roughly) according to the categories given in the protocol. Discharge [l/s] = mean width * mean depth * mean flow velocity* 10^3.

65 riverbed visible

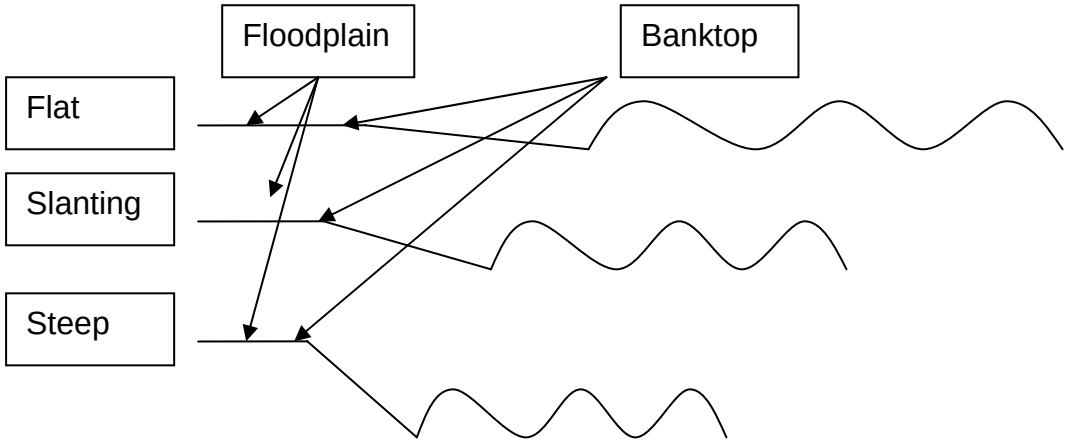
66 water level at sampling site

high: high water level may de detected by comparison of current water level with banktop height. The banktop is defined as the point where the river spills onto the floodplain. Usually the banktop (except some types of lowland streams) is indicated by distinct edges of the bank. High water levels may be also detectable by turbid water conditions.
low: low water level may be indicated by: – date of sampling, e.g. midsummer or pre-Monsoon season; - macrophytes which normally occur submerged are entirely present above the water surface.

67 water uses

68 bank structure

The angle of the vertical bank line from water level to bank top (see figure).



embanked: Embankment created to artificially increase the banktop height.

69 flow type

- pool: a distinct natural feature of deeper water. In dry-weather conditions, there is no perceptible flow. Back currents may be present. Pools should occupy most of the wetted channel width.
- slack: laminar flow. Moving water without a disturbed surface.
- riffle: shallow, fast-flowing water with a distinctively disturbed surface. Unbroken standing waves are dominant. Unbroken standing waves = water with a disturbed surface which has upstream facing wavelets which have not broken. White water may occur as crest waves, not as breaking waves.
- run: generally fast-moving water with rippled surface but no other mayor features of turbulence. Often associated with a high-velocity feature (e.g. rapid or riffle) just upstream or where the channel narrows and therefore speeds up the flow. Also, where relatively narrow channel has a moderate, even gradient. Rippled = No coherent pattern in relation to flow direction, i.e. no waves. These ripples are symmetrical and only a centimetre or so high.
- rapid: best identified from the whitewater broken standing waves, normally over a cobble boulder or bedrock substrate, with a steep gradient. Broken standing waves = white water tumbling wave must be present for the wave to be described as broken.
- waterfall: a feature of bedrock channels. Free fall flow which separates from rock.

70 waste disposal

Indicate if waste is affecting the sampling site.

71 water colour

Indicate natural occurring colours e. g. brownish by humid acids as well as artificial altered colours e. g. like whitish by organic pollution.

72 odours

Odours indicating pollution, e.g. H_2S, sewage, phenolic substances.

73 foam

Only foam indicating pollution must be mentioned, not foam resulting from humid acids or other natural sources like pollen, rotten exuviae. To distinguish foam from air bubbles transfer water into white tray. Air bubbles will burste.

74 pH-value

To be measured in the field with a pH-meter.

75 conductivity [µS/cm]
To be measured in the field with a conductivity-meter.

76 reduction phenomena (ferrosulfides below stones)
Indicate if a black layer indicating reduction phenomena is present on the lower site of stones or other coarse matter in the streambed. You may smell sulphide (like rotten eggs) on observed substratum.

77 turbidity
Note if turbidity can be seen within the water body.

78 dissolved oxygen content [mg/l]
To be measured in the field with an oxymeter (D0-meter).

79 oxygen saturation [%]
To be measured in the field with an oxymeter (D0-meter).
Temperature
To be measured in the field with an oxymeter (D0-meter).

80 mean depth
To be calculated from the several replicates measured (use ruler). If sampling site is not entirely wadeable but riverbed is entirely visible assume mean depth. If not entirely wadeable and not visible skip but note.

81 maximum depth
To be calculated from the several replicates measured (use ruler). If sampling site is not entirely wadeable but riverbed is entirely visible assume maximum depth. If not wadeable and not visible skip but a note.

82 mean current velocity
To be calculated from the several replicates measured.

83 maximum current velocity
To be calculated from the several replicates measured.

84-93 chemistry
Preferably to be measured in the laboratory. If sampling sites are located in remote areas, the parameters may be measured in the field (especially during the summer months), e.g. using portable spectrophotometers, Hach test kits, etc.
cfu = colony forming units

94 comments
Write down any notes that characterize and describe the sampling site in addition to the parameters already observed by the site protocol. Or you may give a more precise description of one or some parameters as they influence the sampling site extraordinary, e.g. huge amounts of waste.

95 sketch of sampling site
Integrate remarkable features of the sampling site, e.g channel features as bars, position of macrophytes stand, exposed boulders, etc.

96 temperature
air: Measurable with a oxiymeter (DO-meter).
water: Measurable with a oxymeter (DO-meter).

97 minimum current velocity
To be calculated from the several replicates measured.