

PHAM Seminar Summary (Day 2 – 20th November 2009)

This summary aims to incorporate the most relevant aspects that have been discussed during the second day meeting. Five different manuscripts were emailed to the different participants a month before attending to the meeting, and sessions were chaired to organise the discussion and conclusions from each of the proposed topics. Following, we summarise the most important issues that were discussed for each of the proposed topics. Twenty seven people attended to this meeting on the 20th of November 2009 in the University of Cantabria, Santander, Spain.

Session 1. Indices or characterisation protocols for physical habitat assessment in rivers?

Information on river habitats is collected with different purposes, being the largest interests expressed by water agencies, regional governments and research projects of different kinds. All levels, from a local to an international scale are involved in the gathering of data from river habitats.

There are two main actors capturing information from river habitats, the first one are research centres and universities, which they are interested in the characterisation of physical habitat attributes with different research objectives and in the development of methodologies for the assessment of river habitat attributes and/or the integrity of river habitats. The second, and not less important actor are water agencies and regional and national environmental agencies, which are mainly concerned with the application of river habitat assessment methods in order to report the state of the ecosystem/environment. Finally, consultancies are also an important actor, and they are mainly concerned with the application of different methodologies to assess river habitats, and to a minor extent they could also be involved in the development of new methodologies.

Depending on actors different information regarding river habitats needs to be delivered, however, there is always a strong need for clear information. In this regard, consistency on the reporting of environmental information at different local, regional and national levels would help a lot and, for example, efforts are being made towards a standardization of reporting at a European level. Despite this, there are a number of conflicting matters that may obscure the delivering of clear information. One of these issues is the legislation constraint, what means that legislation has different requirements and thus environmental information should be adequate to account for the objectives of each law or directive. In this regard, river habitat assessment methods should comply with the related legislation requirements. Other conflicting issue is that administration competencies are not always at the same local to international level. For example, national water agencies in Spain are in charge of the application of the WFD, but the management of some catchments are transferred to regional governments, while the application of the Habitats Directive is only dependant on regional governments. Finally, there is also conflicting interests related to different river uses, for example fisheries management and biodiversity conservation, which might also influence the need for different environmental information regarding river habitats.

Another important aspect of the information gathered from river habitat assessments is the level of confidence of the results. Some river habitat assessment

methods provide basic level of knowledge while other methods could deliver higher level of knowledge. In this regard, indices are designed to give an evaluation of the integrity of the whole or different aspects of the river habitat, while characterisation protocols count with a more extensive database to which you can always get back in search of information. Moreover, if the information is gathered in the first place, characterisation protocols allow derivation of different river assessment methods from the same database. It is highly desirable to determine which is the minimum information we need to gather regarding river habitat assessment protocols, so that we assure a high degree of efficiency in river management from a local to an international level. In this regard, the river habitat characteristics described in the European CEN standard for assessing river hydromorphology could be taken as a minimum, however, more research needs to be done for the identification of the key physical habitat attributes that need to be assessed for adequate river management. There are a number of questions that are far from being resolved, that might help to identify those key habitat characteristics:

- What are the effects of hydromorphological impacts on river physical habitat attributes and river biota?
- What's the role being played by hydromorphological pressures on the biological classification (quality) of water bodies regarding the WFD?
- Which are the key river habitat requirements for the different species and vegetation communities included in the annex II of the Habitats Directive?
- How do we relate river habitat characterization to environmental economics?
- What is the role of physical habitat attributes in biodiversity?
- What is the role of physical habitat attributes in river functioning and river processes?

In summary, characterisation protocols and quantification of physical habitat attributes are preferred than indices approaches as they provide more objective measures, the possibility of regional modifications, a database for further developing and the possibility of establishing comparisons.

Session 2. The importance of spatial scale and river networks for river habitat assessment

Rivers are ecosystems with a highly structured spatial hierarchy that goes from the large-scale events at the watershed to the process that take place on the top of a cobble, being all levels of the hierarchy important in determining physical habitat attributes. Moreover, river physical habitat attributes are also highly influenced by the nature of the river network and its characteristics. Thus, a basic and important step when characterising and/or assessing the integrity of river habitats is to take into account the spatial scale at which we are working and the relatively homogeneous “units” in which we divide the river network.

Different methods are used for extracting theoretical river networks from Digital Elevation Models (DEM) or from remote sensing techniques such as airborne Light Detection and Ranging data (LIDAR). The most precise the data we depart from the best are the river networks constructed and LIDAR are now getting quite a lot of attention in this regard. These methods are the most common used methods and are considered a top down approach on constructing and dividing river networks. There are

also bottom up approaches, although results and comparisons between both approaches are still not well documented.

Most methods of river network extraction have an automatic process to delineate catchments and to divide the river network into segments and its associated subcatchments, being able to define the smaller segment size you want to consider. However, there are not a single method that divides river segments into reaches and, in fact, the limit of a river reach is somehow elusive, although theoretically a river reach is quite well described. For example, Frissell et al. (1986) described it as a length of a stream segment lying between breaks in channel slope, local valley side slopes, valley floor width, riparian vegetation and bank material. Moreover, mesohabitat sequences within reaches are supposed to be relatively homogeneous, and river reaches within a river segment should have similar mesohabitat sequences.

Thus, when characterising physical structures from a river reach it is desirable to cover the “functional length” in which most characteristics appear and that length is quite variable depending on which is the position in the river network. On the other hand, when carrying out an assessment of the integrity of the river habitat it might be preferable to have a fixed length so that we can compare the results per unit of length surveyed. Physic geographical studies use on average a length of 9 km per river segment and a variable length of 100-200 m for river reaches. Other methods that aim to characterise physical habitat attributes from rivers use a fixed length of up to 500m (e.g. River Habitat Survey).

It is also necessary to estimate the degree of spatial variation taking into account the size of the catchment and its geological and hydroclimatic settings. There might be really large catchments that have small contrasts on climate, topography and geology, and, thus, a poor diversity of channel-reach types and associated physical habitat attributes, while smaller catchments could have a much larger variability on both. Thus, it might be sensible to account for the effect that basin size and its geological and hydroclimatic settings have on physical habitat attributes.

It is highly recommended for studies and surveys developed in relation to the application of different regional, national or European legislation, that divisions of the river network are all structured following the “real” divisions of the network and not merging segments or reaches in order to create artificial management units with no ecological or geomorphological identity. Moreover, it is also important to identify which is the most relevant spatial scale in order to carry out habitat assessment surveys so that it is relevant to the spatial scale of human intervention. In this regard, river restoration projects might need to characterize functional lengths of river reaches, plus physical habitat attributes turnover rates at the mesohabitat and reach scales, in order to set appropriate objectives, while monitoring the integrity of river physical habitat attributes might only need a “fixed” length, so that results can be comparable.

Many other questions related to the importance of the spatial scale and the configuration of river networks remain still unresolved, and this topic promises to be an interesting topic of future research. Among others, some interesting questions are:

- Could LIDAR models be used to automatically divide river reaches?
- Do the spatial scales (catchment, segment, reach, mesohabitat and microhabitat) conform to all river systems/types?
- Which is the spatial rate of change of large/small scale variables?
- Are there fluvial systems with higher spatial heterogeneity than others? At which spatial level are the most important controlling factors?

- How good will be the use of theoretical river networks in accounting for the new conceptual frameworks such as the network dynamic hypothesis or the RES (Riverine Ecosystem Synthesis)?

Session 3. Relationships between river physical habitats and biological communities. The importance of methodological approach and scale based sensitivity

There is a strong need to establish causal relationships between communities and river habitat features and processes. Most of the studies on the relationships between habitat characteristics and species/communities are mainly statistical and they tend to generate rather than test hypotheses. Moreover, these studies have detected that species tend to relate to features/processes acting at the same spatial and temporal scales and, thus, the scale at which communities are defined is likely to influence the scale of the habitat features statistically associated to them, but not always. Survey design can also introduce bias in the statistical relationships found. Another important aspect to bear in mind is that habitat features can have a direct or indirect effect on species/communities what might complicate the finding of relationships.

Taking into account the recent literature on the functioning and structure of river ecosystems, river habitats can be defined at the same spatial and temporal scale as geomorphological processes and, also, at the scale of target communities in space and time. Thus, we can follow a different approach to link river habitat characteristics to species. In this regard, we could build the model first from our assumptions about the way rivers function and interact with species/communities and, then test these models by gathering data at the appropriate scale. Different mathematical methodologies could be used, but Structural Equation Modelling and Partial Least Square Path Modelling have demonstrated good performance in this field.

Thus, the steps we could follow in order to establish casual relationships between physical habitat attributes and species/communities are:

- Identify a theoretical framework for studying habitat species relationships
- Choose target communities
- Build causal models a-priori
- Gather data at appropriate scale and test models
- Revise hypotheses

These steps represent a knowledge acquisition cycle, that could be reviewed and improved as new analytical tools or the ecosystem conceptual framework evolve.

Session 4. River types and habitat assessment methods: the definition of a reference condition

Classification of river segments into types has been attempted from many disciplines such as geomorphology, fluvial ecology or hydrology. Many studies have studied the link between river types and biological communities; however, few have looked into how good river classifications were in partitioning the variability of in-channel characteristics and physical habitat attributes. What is almost certainly true is that a river typology will not conform to all biotic assemblages and river habitat

characteristics. In fact, hardly any studies have tried to elaborate a classification of river types following a bottom-up approach, which is yielding really good results for biological assemblages.

The evaluation of the integrity of river physical habitat attributes needs to compare the actual situation with a previous one or with a reference, what is commonly known in bio-assessment as the reference condition approach. River restoration projects will also benefit if physical habitat attributes at different spatial levels could be defined for different river types, as project objectives will be more realistic with the potential conditions for a river reach. In this regard, reference condition criteria for physical habitat attributes from different parts of the river ecosystem (channel, riparian vegetation and floodplains) should be set.

Criteria for the selection of river segments or reaches for the establishment of reference conditions on physical habitat characteristics should incorporate the following:

- The hydrological regimen must be minimally disturbed
- Reference sites should be located in catchments scarcely affected by intensive land use.
- Riparian and floodplain vegetation minimally impacted
- River morphology unchanged by engineering works (e.g., reinforcement, resectioning, etc.)

In many river catchments there will be river types that do not count with river segments that meet the above criteria. In that case, modelling might be the best available tool for setting physical habitat attributes reference conditions. It is really important to remark the reality that many European rivers do not count altogether with pristine or unaltered river types, and thus, what we might be observing might just be the highest natural potential but not the natural condition. It is then, extremely important to be aware of this, so that true reference conditions could be set, instead of comparing the actual habitat integrity to a situation which is already degraded.

Session 5. Towards a unified method for characterizing river habitats; Database development and future action

If scientific advances in river functioning are to unravel the interactions between hydrological, geomorphological and ecological processes they will need a new focus – one that overcomes the frequent mismatch in the nature and spatio-temporal resolution of available hydrological, geomorphological and biological data, which stems from different primary purposes for data collection. Although there are now many methods for assessing river habitat characteristics, none of them covers all the aspects of river habitats in which a water regulator or government agency might be interested. In fact, the objectives and priorities of different water agencies may well be different (e.g. more/less developed country or region), but progress can be made if a common approach to river habitat assessment is adopted. In this regard, few efforts have been made to reach a consensus on river habitat characterisation, although we count now with a European standard for assessing the hydromorphological characteristics of rivers (CEN, 2002) and there are different national initiatives that unify methodologies, as for example in the UK (River Habitat Survey), France (SEQ-Physicque), Germany

(LAWA) or Australia (river habitat assessment methodology within the Australian River Assessment System: AusRivAS).

The scientific consensus on which methods to use and which river features to monitor is also far from being achieved because many fundamental questions relating hydrological, chemical and biological characteristics to river habitats remain unanswered. However, river habitat assessment methods would be greatly improved if community-supported, geographically focused, and application-oriented systems of analysis were developed. For example, the use of tools to analyse dissimilar catchments in a similar way can promote common methodologies, vocabularies, and problem-solving techniques, serving to increase communication and collaboration between scientists, agencies and other agents.

Cause-effect relationships can be elucidated with a proper spatial framework and experimental design; however, few databases have been designed with that specific purpose. In this regard, complex databases that integrate long-term hydrological, geomorphological, chemical and biological characteristics need to be developed, so that complex ecological responses at different spatial scales can be determined. The development of such databases is extremely important for the advance of aquatic sciences but it needs coordination between research efforts and the needs of policy makers and administrators. For example, it would be difficult to analyse long-term data sets from different countries with different policy requirements because environmental and biological data are not often gathered using the same protocols and at the same spatial and/or temporal scales. Thus, the number and type of hypotheses that can be tested are quite limited. Some European legislation such as the WFD (CE/2000/60) and the HD (CE/1992/43) or the Clean Water Act (CWA; US Government 1977) or the Endangered Species Act in the USA (ESA; US Government 1973), could provide a good framework for gathering data in a standardized way, but it will require a concerted effort between the scientific community who should reach a consensus on which are the best methodologies to use and governmental agencies which enforce water and biodiversity legislation.

During this session we were asked to answer four questions related to this topic. Following, we will compile the main arguments and ideas that were delivered in each of the questions.

1. What is understood by a 'unified method'? How do we work towards achieving this?

The view and definition of a unified method is not completely clear. However, it is believed that methods for charactering and/or assessing river habitats could share structure and objectives, so that easy comparisons across different administrative borders could be established. It is also considered that, more than a unified method, a list of basic attributes should be established and, in this regard, the European CEN standard could constitute a start. It is also important to promote certain homogeneity on which are the attributes recorded at different regional, national and European levels, specially because of administration needs to report to different legislation. Some concerns were raised, that a unified method might hamper the diversity of research options in the future.

2. Do we need to develop databases that integrate hydromorphology, chemistry and biology? How do we work towards achieving this?

This has been identified as a really important action. Different efforts are being done at national levels. For example in Spain, they are currently working on assembling a national database with hydromorphological, physicochemical and biological data, which are received from the monitoring programs of different water agencies. They have identified important drawbacks and problems regarding the assemblage of hydromorphological, physicochemical, and biological data derived from different field protocols and methods and also from different taxonomic level resolution.

3. Does the database structure given in Annexes 1 and 2 help in summarizing the state of knowledge on river habitat assessment methods? How should we complete this database and how should we use this?

The database structure is considered as a good start to review the state of knowledge of river habitat assessment methods with some minor corrections being made to include some attributes not reflected in the version handed. Interested government agencies and research institutions could complete the forms online through the web page: www.riverhabitats.org.

4. Do we need a long-term series of regular seminars/workshops on physical habitat assessment? How would they be organized?

Many of the participants agreed that a permanent seminar on river habitat assessment methods could be highly interesting and productive, however there was not an agreement on frequency of organization neither future topics were arranged. COST EU financial scheme was pointed out as one of the possible ways to find funds for such events at a European scale. Discussion forums could also be organised at different levels (regional to European). The development of new meetings, workshops, seminars or discussion forums will be explored in the proximate future.