



## Head water streams, a critical issue for water resources

*Seminar organised by Onema with the help of the International Office for Water and in partnership with the ministry for ecology, the Loire-Bretagne and Rhin-Meuse Water Agencies, the Wetland Transfer Units, the permanent assembly of the French chambers of agriculture and the French National Forestry Board.*

The “Head water streams – How to reconcile the issues affecting these exceptional territories?” symposium, organised by Onema, was held in Paris on 4 and 5 March 2015. The 200 participants brought together for this occasion took part in interesting debates on the issues, knowledge and actions undertaken in these territories. This symposium on head water streams forms part of the actions of the 2014-2018 National Plan of action for Wetlands.

Relatively overlooked by man, head water streams, dense in small streams, ponds and wetlands, are nonetheless crucial territories for the functioning of the water cycle. These territories, the boundaries of which can sometimes be difficult to identify, account for nearly 75% of the length of the river system. The source of the streams is formed in these head water streams, supplied by groundwater, rain-fall and water run-off. These small basins fulfil numerous functions, including water flow regulation (flood plains, low water flow regulation, etc.), physical and biogeochemical functions (protection against erosion, water purification, etc.) or ecological functions (habitat for many endemic species).

These territories, formed by man over the past few decades, are vulnerable. Numerous alterations related to urbanisation, farming and forestry practices have rendered these head water streams vulnera-



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Ramp and fence built for cattle watering in a stream

**Pauline Choucard, Joint syndicate for the water planning and management scheme (Sage) of Couesnon**

The 2015-2021 Loire-Bretagne water planning and management scheme (Sdage) features the preservation of the head water streams as one of the challenges for restoring good water status. The Sage Couesnon joint syndicate therefore decided to include this provision in its regulations and its sustainable development and management plan (PAGD) which was under development at the time. However, difficulties emerged in terms of how to address the issue: lack of technical information, inappropriate mapping and the need to prioritise the head water streams given their large number in the territory. In this context, two studies were carried out to gain further insight, an inventory of the head water streams in this territory and the proposal of a prioritisation method according to the ecosystem services provided and the type of pressure encountered. As a result of these studies, and in an effort to protect the head water streams, six specific provisions were incorporated into the PAGD, approved by prefectural order of 12 December 2013.

ble, which are also sensitive to the effects of climate change. In light of the services provided by these water systems, their preservation and restoration are a major issue that requires reconciling environmental, economic and social interests. The objective of the symposium was threefold. Firstly gain better insight into the issues and operation of water streams and wetlands in head water streams. Secondly highlight ambitious territorial projects designed to combine water preservation with biodiversity and socio-economic activities. Finally, demonstrate that it is possible to reconcile different national and European regulations.

**Multiple functions fulfilled by these territories**

The head water streams, veritable water towers for our country, are a crucial concern in terms of quality and quantity of water resources. The way these territories operate is not dissimilar to that of a natural sponge which receives, stores and releases water. This network of drainage basins and wetlands plays a predominant role in low water replenishment, flood regulation and groundwater recharge. These head water streams constitute a sub-water system essential for downstream water flow and sediment transport. It has multiple and diverse characteristics which depend on the geology, climate, slope system but also vegetation. *“On these head water streams, two very different systems should also be considered: the watershed which produces water and the river which transfers and carries the*

*water from upstream to downstream”*, points out Chantal Gascuel, head of research at Inra. Each of these systems has specific controls: lateral transfer functions for the watershed, and longitudinal flows for the river. The multitude of small streams which have their source in these territories are also characterised by *“a hydraulic gradient dynamic that fluctuates all year round depending on seasonal events and rainfall patterns. This is a clear reflection of the watershed’s ability to produce water for rivers downstream”*, adds Chantal Gascuel.

The head water streams also have physical and biogeochemical functions, protecting banks from erosion and purifying various substances such as phosphorus, nitrates or certain heavy metals. *“While pesticides are instrumental in purifying an excessive amount of toxic products in these environments results in the accu-*

*mulation of pollutants and water resource imbalance”*, indicated Pierre Caesstecker from Onema. These areas, which receive and generate sediments, also significantly contribute to the degradation and transformation of organic matter via microbial activity (notably fungi), combined with the action of invertebrate shredders. These stages, which help provide nutrients that can be absorbed by other organisms, *“are a key process in the ecological functioning of the head water streams”*, highlights François Guérol, from the French National Centre for scientific research (CNRS) and the University of Lorraine.

Finally, the head water streams have an ecological function as they serve as a habitat for fauna and flora specific to these milieus: sundew, white-clawed crayfish, freshwater pearl mussel, etc.

**Presence and impact of economic activities on the head water streams**

With regard to the services provided and practices in these water territories, the head water streams involve major economic challenges. *“For example, our different head water streams, in light of the conditions and relief, essentially feature livestock, mixed farming and forestry”*, explains Bertrand Dury, national expert and agri-environmental advisor to the Chamber of agriculture of the Saône-et-Loire department. These activities and their intensification can however lead to a transformation of head water streams and can have a potential impact. For



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**Luc Servant, Permanent assembly of the Chambers of agriculture of Poitou-Charentes**

Actions designed to restore and preserve the head water streams are effective when the agricultural community is genuinely involved. This however requires clear, legible, understandable and sustainable policies. Economic aid must also be more sustainable.

In these territories, the only tools available are agri-environmental measures (AEM), forcing farmers to maintain natural grassland and implement grass strips. Unfortunately these measures are not long-term tools, only lasting five years, after which new criteria are established.

example, in agriculture, the trampling of the streambanks by cattle releases sediments into the stream or the installation of drains can dry out the milieu. From 1970 to 2000, drained surfaces in the Seine Basin have continually increased. *“This point is cause for major concern: the ratchet effect of drainage, i.e. the slow but irreversible transformation of how hydrosystems work in the head water streams”*, stresses Marc Benoît, head of research at Inra. The head water streams are also very sensitive to the presence of pesticides which lead to dysfunctions. *“All the more so as the flows carried by drainage systems represent significant quantities compared with the flow of small streams”*.

With help from the chambers of agriculture, farmers must therefore reconcile environmental and economic issues to achieve balanced management. This balance must also be a pivotal concern for forestry stakeholders who use the forest resources of these territories. The repeated passage of construction vehicles, the planting of softwood or timber overexploitation can also cause serious ecological damage. Yet maintaining forestry and farming activities is essential to the ecological vitality and richness of these territories. A novelty for a lot of farmers, the notion of head water streams can be difficult to comprehend, hence the need to enhance and share knowledge. The problem is often to identify and understand these challenging areas on their land. *“With the geographical information at our disposal,*

*we are however very close to superimposing a map identifying the head water streams over the landscapes, which would subsequently help examine the condition and dynamic of these head water streams in relation to the dynamic of agricultural territories”*, believes Marc Benoît.

*“It is also important to understand how these agricultural, forest and urban territories are being rebuilt, to identify restorative action possibilities with a view to reversing negative trends”*.

To guide project sponsors, Onema has created a national collection of examples listing different types of stream restoration actions. *“For the head water streams, one should never lose sight of the diagnostic and dimensioning phases and the choice of restoration techniques according to the different cases encountered”*, emphasised Mikaël Le Bihan from Onema.

## The need to preserve and restore

Restoring the good ecological status of water bodies goes hand in hand with the preservation and restoration of the head water streams. Aware of the ecosystem services provided by these territories, a number of stakeholders (associations, local authorities, farmers, etc.) have mobilised to this end. The River Basin management plan of Loire-Bretagne (Sdage 2016- 2021) includes a specific guideline: “Preserve the head water streams”, which emphasises the need to adapt public policies to the specific nature of the head water streams and raise awareness of the beneficial role of these milieus. For the past few years, the Loire-Bretagne basin has been undertaking preservation and res-

toration actions targeting the head water streams, notably via the implementation of the 2007- 2013 Loire Grandeur Nature Plan. This multi-regional plan supported 72 dossiers on the head water streams for 23 separate projects, representing more than €13 million in funding. As part of the preparation of the 2014-2020 Loire Plan, the head water streams remained a focal point with a view to sustaining the efforts implemented, completing the processes initiated and enhancing networking. “We demonstrated in the previous plan that synergy helped unite and stimulate the energy of the different stakeholders to work on a joint project with a number of actions with the same objective”, stressed Lucien Maman from the Loire-Bretagne Water Agency.

Supported by the Loire plan, the Vienne Amont territorial contract (2011-2015) helped build this synergy between the different territorial players. This contract also referred to as ‘Sources in action’ programme, covers 125 municipalities in the Vienne basin, 3,700 km of streams and 25,000 hectares of wetlands. 17 project leaders with complementary skills (municipalities, river syndicates, fishing associations, environmental associations, etc.) are involved in this process. *“For a programme of this magnitude, with 17 project leaders and more than 500 actions (€7.5 million) over 5 years, coordination was reinforced by the Regional Natural Reserve of Millevaches in the Limousin region and the local public basin institution (EPTB) of the River Vienne. This also involved a key stakeholder mobilisation phase”*, pointed out Cédric Malmaison from the EPTB of the River Vienne. Results after three years included 100 km of banks restored, 25 obstacles installed or removed, 95 drinking troughs put in place, etc.

**Philippe Goetghebeur, Rhin-Meuse Water Agency**

For very small, 30 cm wide streams at the head water streams, local authorities and municipalities must be mobilised as they have already worked on small, medium and large streams. For drainage basins, it is imperative to implement various and composite projects to continue solving low-flow, flooding and water resource quality issues. For head water streams located in semi-mountainous regions, discussions and technical solutions are simple and often linked to abandonment of farmland. Streams with flat head water streams should not be overlooked, i.e. those in plains with extensive crops and very limited slopes, with high percentages of drained areas. It is in these sectors that challenges are most significant and technical discussions are not as important as arbitrations relating to the reconciliation of multiple uses (agriculture, floodplains, biodiversity, etc.).

## Communicate and raise awareness to mobilise

To initiate restoration and preservation projects for the head water streams, the different territorial stakeholders must be mobilised, which notably involves communication and awareness raising actions. In the catchment basin of the River Somme and as part of the Somme plan, the Ameva joint syndicate (a local public basin institution including the Somme, Aisne and Oise departmental councils, 34 public institutions for inter-municipal cooperation (EPCI), 13 authorised joint associations (ASA) and 41 isolated municipalities) helps public survey managers monitor the works, raise awareness and inform. *“It is very important to communicate before, during and after the works, as local residents’ approval is crucial”*, underlined Bilal Ajouz from Ameva. During the removal of a hydraulic structure which helped reopen 20% of the stream length in 2012, local residents were at first vehemently opposed to this restoration. *“They have now become the ambassadors of stream restoration”*.

This need to communicate is crucial to make headway on projects designed to preserve and restore the head water streams. In the catchment basin of the River Doue, in the Périgord-Limousin Regional Natural Reserve (RNR), the myriad of interdependent ponds (260 over 55 km<sup>2</sup>) strongly affects the qualitative and quantitative aspects of head water streams. To undertake these removal operations, the owners had to be informed of the issues with the ponds and their impact, and encouraged to act. *“Despite the very poor condition of certain water bodies, the owners are reluctant to part with them as they historically represent significant assets within the territory”*, explained Marc Pichaud from the Périgord-Limousin RNR.

To carry out these communication, awareness and of course restoration actions, various tools can be used such as listed and classified sites, prefectural orders for the protection of biotopes or national natural reserves. The streams and wetlands of the Bruche valley, in the heart of the Vosges mountains, adopted an original approach: the community of municipalities used the *Association Fon-*



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**Fanny Colas, Paul Sabatier**  
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The different addresses during this symposium related to how to reconcile the two principal visions of head water streams, the environmental and the economic visions. Despite the importance of ecological issues, the economic vision remains largely prioritised for these systems, resulting in significant damage, most often caused with complete impunity. It is often easier from a regulatory viewpoint to alter these milieus than to restore them, all the more so as the fines issued as a result of degradations seldom lead to administrative or judicial proceedings and penalties. Furthermore, the administrative procedures linked to restoration operations are very burdensome. This is why these actions should be facilitated, harmonised, supervised and monitored. Moreover, scientists lack visibility over the operations conducted, thereby undermining the support of this process.

*cière Pastorale* (AFP or association of land owners) to unite a number of private owners within the same structure to undertake a joint development project. *“In this valley, the primary purpose of the project was to restore space and light in certain areas, but also to contribute to enhancing every territory according to its capacity and the resources available”*, explained

Jean-Sébastien Laumond from the Community of municipalities of the Bruche valley. Out of 21 AFPs in operation in this territory, 7 associations initiated actions in the alluvial flat, 5 on the tributaries of the Bruche and 5 on thalwegs and depressions with wetlands.

## Agriculture, balanced land management

With a predominant presence in head water streams, the farmers, increasingly aware of the benefits provided by these territories, have a preservation obligation. This requires adapting the practices to aim for a form of management combining the preservation of the head water streams with the maintenance of economic activities. *“Since the second national wetlands action plan (2010-2013), many chambers of agriculture have become involved in territorial actions promoting the balanced management of these areas”*, recalled Bertrand Dury, national expert and agri-environmental advisor to the Chamber of agriculture of the Saône-et-Loire department. As part of this plan, an *“agriculture and wetlands”* agreement, signed between the Permanent Assembly of chambers of agriculture and the ministry for ecology, has helped launch 18 large-scale territorial actions, covering approximately 2,500 farmers from all over France. Furthermore, in some regions (Rhône-Alpes, Bourgogne, etc.), technicians from the chambers of agriculture



**Nicolas Galmiche**, Morvan RNR, coordinator of the Life ecological continuum initiative

The streams in the Morvan are host to a broad variety of exceptional fauna such as pearl mussels, white-clawed crayfish or bullheads. However, the disruptions to these streams have caused a decline in these protected species.

Impacts essentially include the alteration of water quality, the degradation of habitats and the cut-off of access between habitats.

The Morvan RNR has been striving for years to restore dynamic rivers, bursting with life, notably as part of the Life Stream (2004-2009) and Life Ecological Continuum (2011-2015) initiatives.

While these restoration actions are effective, the response time of the ecosystem remains slow...

and farmers can benefit from specific training. Ten chambers of agriculture (essentially in the Haute-Marne, Vienne, Pays de la Loire or Bourgogne regions) are also helping farmers identify issues related to wetlands on their land.

In Alsace, the regional chamber of agriculture is working with the Rhin-Meuse Water Agency and the river service of the Bas-Rhin Departmental Council on an action plan to manage mudslides.

In addition to impact on the aquatic environments (water quality and stream bed degradation, silting, etc.), these mudslides result in the loss of agricultural potential for the farms, as well as housing damage. Solutions are available, such as the construction of structures (dikes, retention basins, dams across the slope, raised paths, etc.) or the implementation of agricultural measures. "For these measures, we focus on prevention by organising meetings with the farmers. The objective is to distribute winter and spring crops in a patchwork pattern. We define where winter crops should be positioned in relation to the water courses in order to curb potential mudslides caused by spring crops", clarifies Rémy Michael from the Regional Chamber of agriculture of Alsace. No-tillage is another technique which leaves residue on the surface to reduce run-off. In terms of results, concerted crop rotation and no-tillage help reduce the risk of mudslide by 50%. "This is therefore high-



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ly effective in the catchment basin but requires coordination, organisation and planning", added Rémy Michael. Other systems, essentially curative, have also been put in place such as grass strips and fascines<sup>1</sup> in strategic locations.

## Restore the low-water replenishment of water streams

This need to preserve head water streams is also consistent with forestry objectives. Requirements, linked for example to the PEFC certification, include severe restrictions on plant protection products, the management of forest residue<sup>2</sup> and intervention periods on wetlands. "Beyond good practices, specific measures are in place such as regular coppice-with-standards management to guarantee continuous vegetation cover in sensitive areas or the development of a transport plan (road network to remove wood from a forest) which includes the creation of permanent or temporary structures for the crossing of watercourses", points out Patrice Mangin Le Creux from the French Forestry Office. As timber exploitation may have affected the landscapes of these head water streams over the past decades, restoration actions must also be carried out.

In the Forest of Chauv, France's second largest deciduous forest, the objectives of the 2005-2009 Life Stream programme,

led by the Morvan RNR and the University of Franche-Comté, were to restore the low-water replenishment of forest streams and improve the biological potential of streams. In the 1950s, logging led to the straightening of 80% of water courses, resulting in the loss of biodiversity, headward erosion and diminishing water reserves. Over a total distance of five kilometres, restoration works on four tributaries of the River Clauge consisted of returning the streams to their former beds by finding the old meanders, based on field investigations.

In addition to impact on the aquatic and topographical surveys, and the creation of stone crossings. Monitoring mechanisms subsequently helped assess the effects of these operations, such as the increase in submergence periods in winter and spring, soil stabilisation and the initial return of fauna, with the *Petit damier des joncs*, a checkerspot butterfly species indicative of functional wetlands.

In addition to restoration actions, Research & Development must be intensified, focusing on mechanisation – which has increased since the storm of 1999 – to limit soil compaction. "If traffic covers the entire plot, 60% of the surface will be compacted, between the first and third passage", indicated Pascale Mercier from the French Forestry Office. It is therefore imperative to carefully organise the work according to the sensitivity and humidity of the soil. Finally, alternative wood

<sup>1</sup> Bundle of brushwood.

<sup>2</sup> Remains of non-compliant branches and trunks left in the forest by foresters because of their lack of commercial value.

## Head water streams and regulations

The preservation and restoration of head water streams feature prominently in regulations, including those relating to the application of the Flood directive and the framework directive on water (FDW). “*Even though the notion of head water streams is not mentioned in the FDW as such, it must be interpreted and taken into account to achieve the objectives in terms of the good status of water and aquatic environments*”, stressed Stéphane Grivel from the French ministry for ecology.

It should be pointed out that the fauna-flora-habitats directive defines head water streams as genuine reservoirs of biodiversity. In addition to these directives, a number of public policies refer to or integrate head water streams, such as the regional ecological coherence schemes (SRCE), a regional version of the green and blue belt, or the national action plan for the restoration of the ecological continuum (PARCE).



hauling<sup>3</sup> methods must be developed, more adapted to certain contexts (over-head wiring for peat bogs) but which involve additional costs.

## Knowledge, funding and territorial stakeholders

To preserve, manage and restore head water streams, knowledge of water streams is essential for undertaking these actions, as these water courses must be characterised, and their status and functions must be identified.

The issue of funding is also important to initiate the mobilisation of all the different stakeholders in terms of head water streams. “*We must ensure that financial public aid is enough to initiate actions by local authorities. The goal is to guarantee 80% aid in collaboration with all partners*”, highlighted Philippe Goetghebeur from the Rhin-Meuse Water Agency.

To enable project completion, work needs to be done on acceptability and social ownership, as was highlighted by the different feedback during this symposium. In most cases, the main obstacle does not relate to funding or technique, more so to the perceptions and representations of territorial stakeholders. Involving all stakeholders in the project, from the design phase and throughout its realisation, is a way to guarantee that the results will correspond with their expectations.

Finally, the technical and social evaluation of projects should be implemented more systematically to ensure their pertinence and assess their effects. ■

### For more information

**Presentations of the day:**

<http://www.colloque-tete-de-bassin.oieau.fr/>

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<sup>3</sup> Operation consisting of transporting felled trees from the place of felling to the storage location, near a road.