Atelier international
« Morphodynamique fluviale et paléoenvironnements alluviaux »
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Research in progress on the Allier river (France) : present and past dynamics of former channels
- Focus on hydrological processes -

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UMR 6042

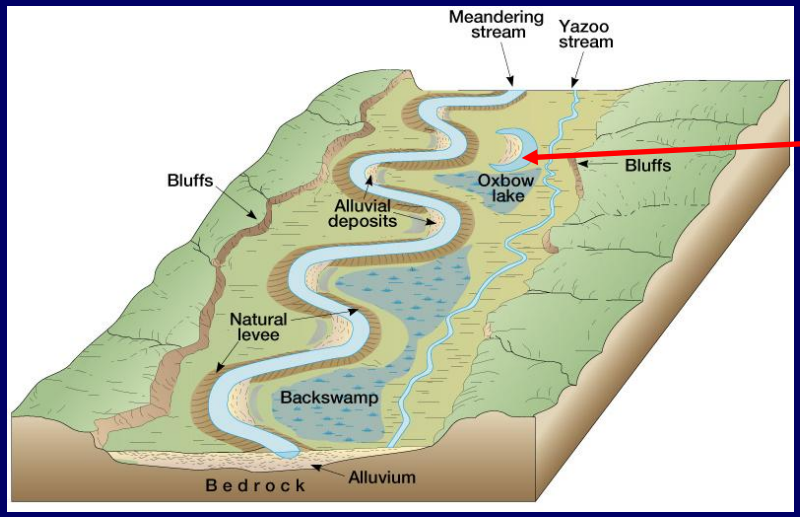
http://www.univ-bpclermont.fr/LABOS/geolab

I. Scientific context

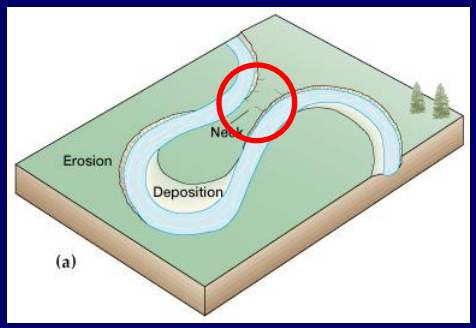
The main objective of this research is to study **present and past dynamics of abandonned channels** in an interdisciplinary approach linking geomorphology, hydrology, hydrogéology, ecology, and more recently social sciences (policy and economy)

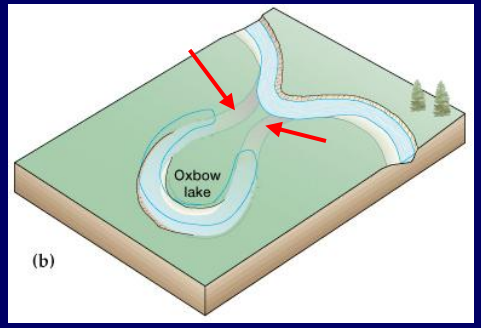
Model studied : Allier River

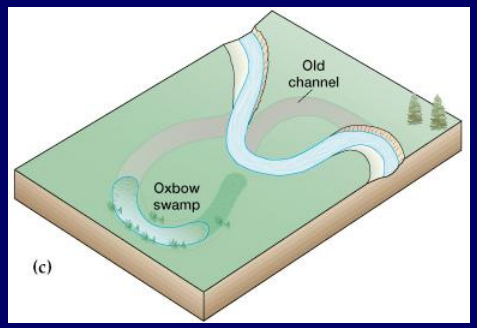
- gravel-bed river
- stream order. : 6
- slope : 0.0015-0.001
- fluvial pattern : meandering
- mean Annual Discharge : 30 to 100 $m^3.s^{-1}$
- 10 years Flood : 470 to 830 $m^3.s^{-1}$

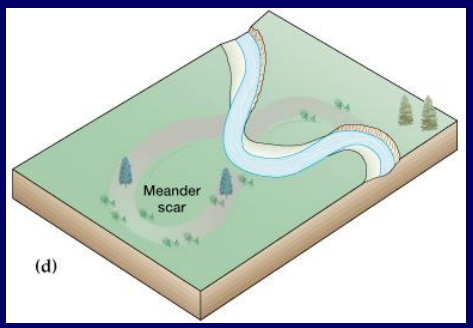


Former channel









Cutting → Connectivity lowering → Silting → Filling → time

Two life-time stages of former channel are studied

Present

Former channels connected by their downstream end to the Allier R.

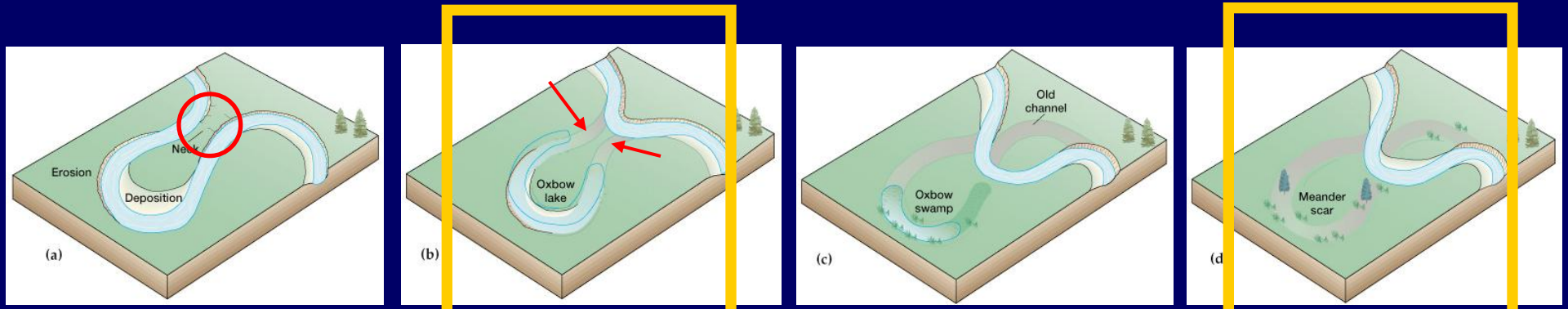
Geomorphological, hydrological, ecological functioning and ecological services

Special focus on linkages between Present and Past :
sedimentometers sampling pollens, diatoms, sedimention rates…

Past

Oxbows completely filled with sediment and which are several century to milleniums old

Fluvial palaeodynamics, palaeohydrology & palaeoecology by studying sedimentary archives



Cutting → Connectivity lowering → Silting → Filling

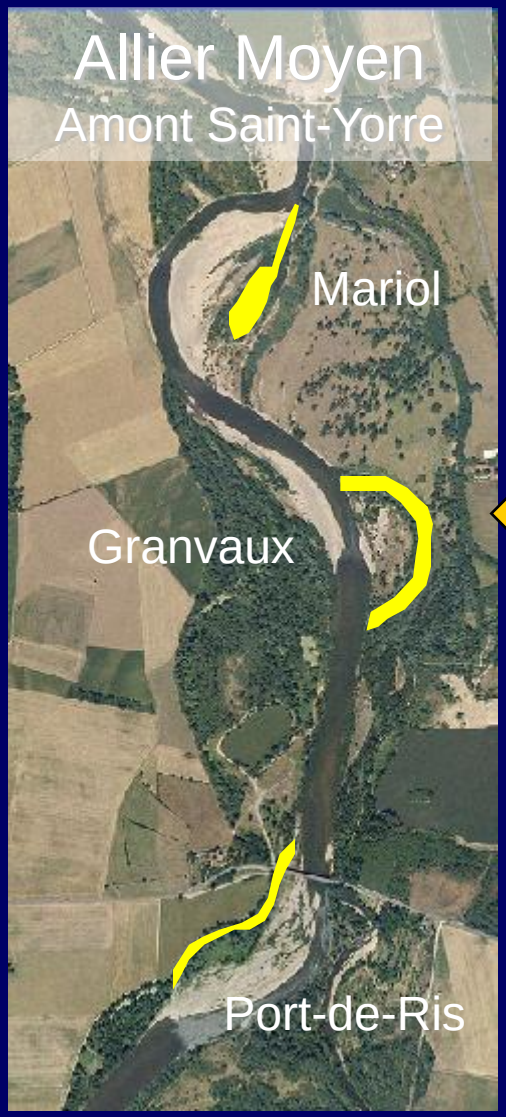
A. Research teams involved

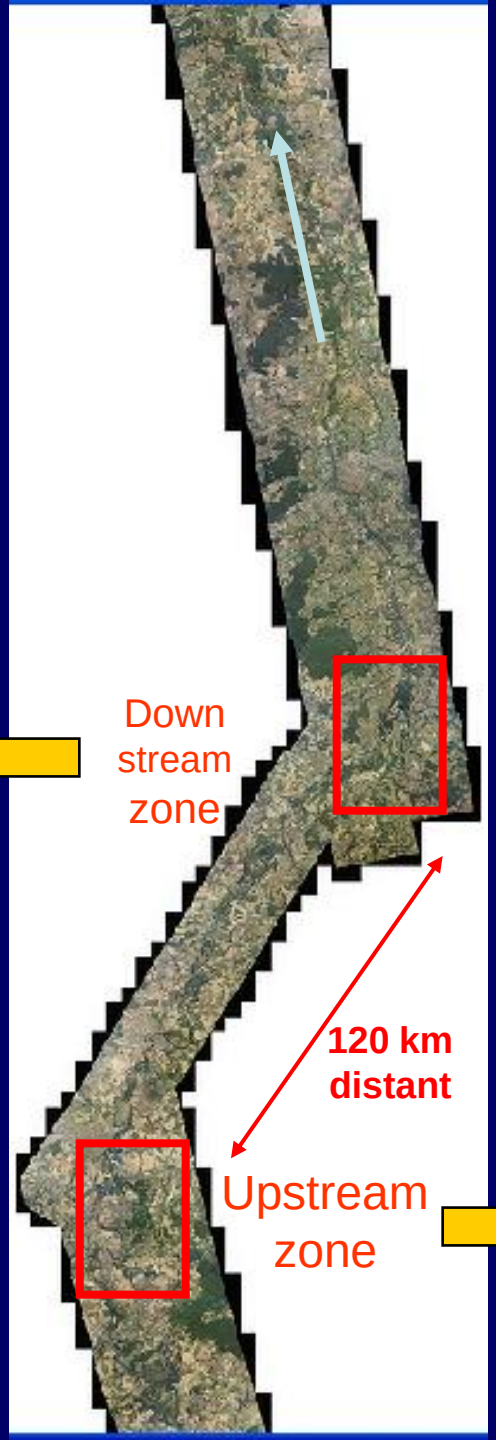
- Teams « Hydrosystèmes » et « Géoarchéologie et Paléoenvironnements » from UMR 6042 GEOLAB (Laboratoire de Géographie Physique et Environnementale) ;
- Team « Diversité spécifique et fonctionnelle des réseaux trophiques aquatiques » from UMR 6023 LMGE (Microorganismes, Génome et Environnement)
- Team « Environnement et géologie appliquée » from UMR 6524, LMV (Laboratoire Magmas et Volcans).
- Research-scientists in social sciences working on environnement - UMR 1273 METAFORT (Mutations des activités, des espaces et des formes d'organisation dans les territoires ruraux) ;
- L'Institut des Herbiers Universitaires de Clermont-Ferrand with people working in botanic and vegetation ecology

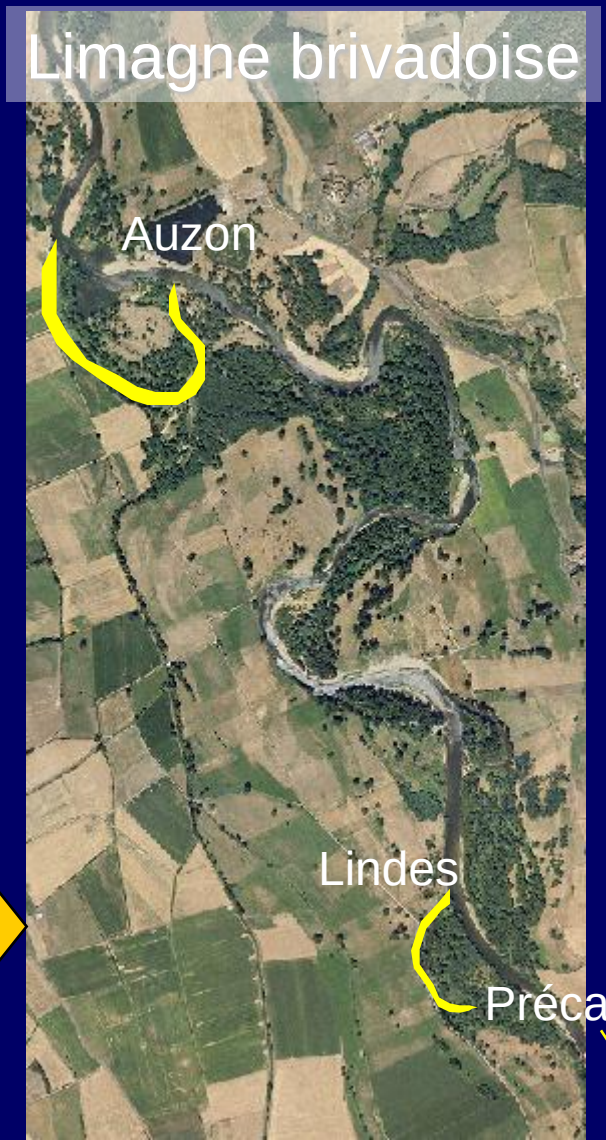
AgroParisTech-Cemagref-Inra-VetAgroSup

B. Fields studied

PRESENT

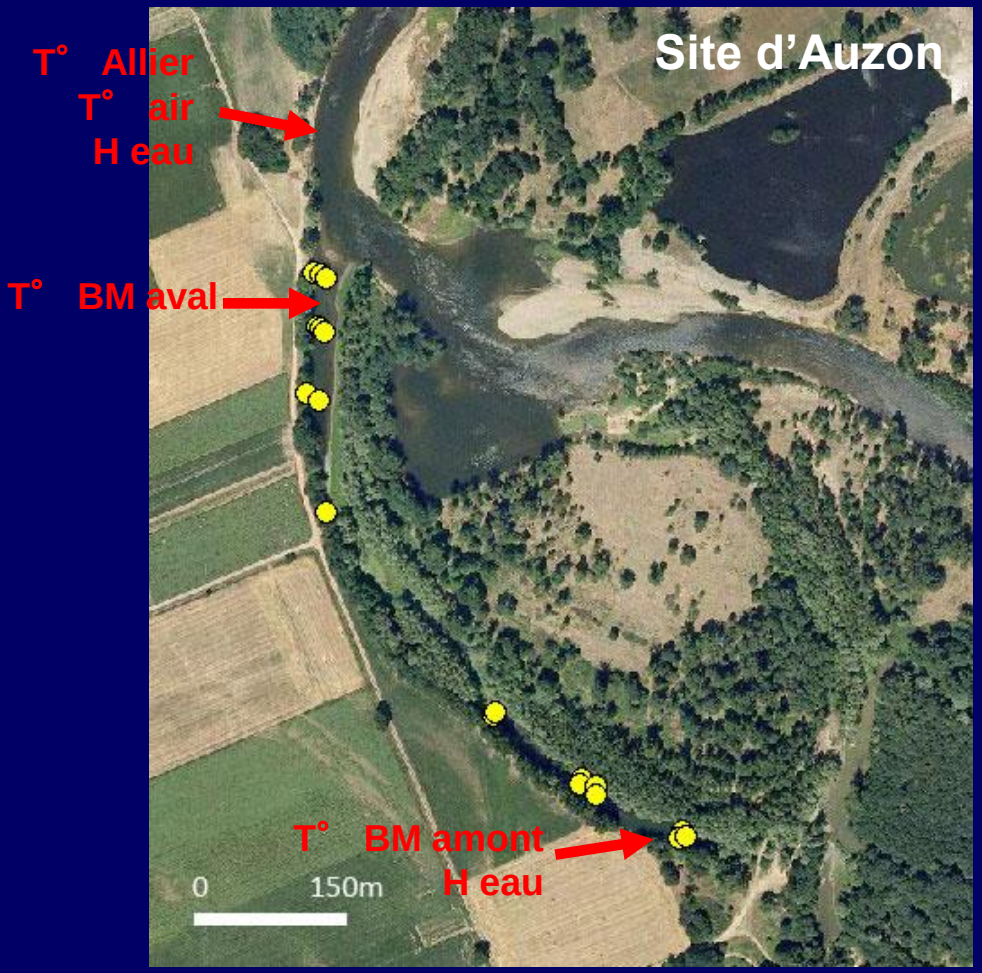






PRESENT

Sampling strategy for every site



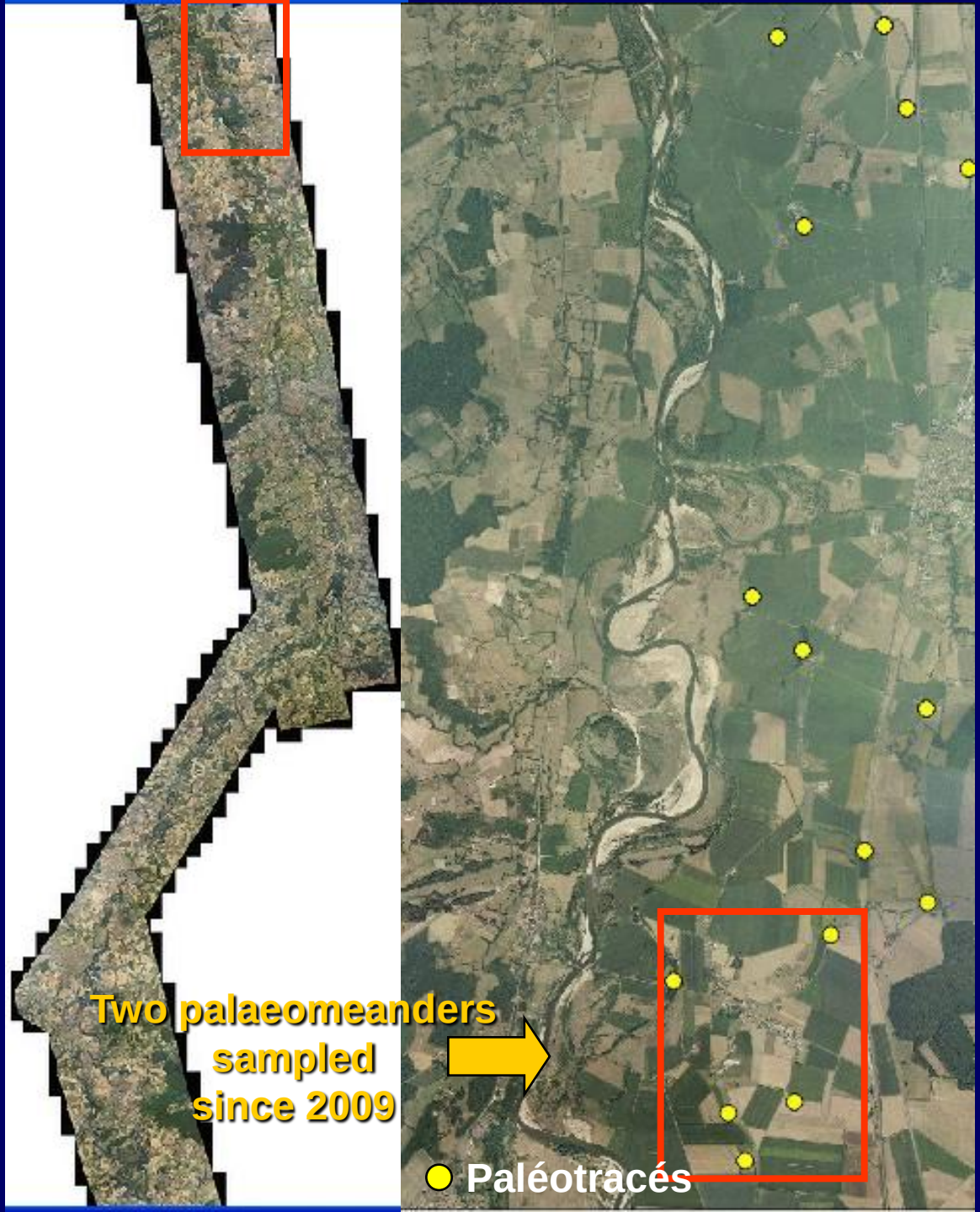
Functionnal characteristics

Caractéristiques	Sites amont	Sites aval
Recently abandonned	Auzon	Port-de-Ris
Strongly silted	Précaillé	Granvaux
Impacted : artificially dug	Lindes	Mariol

Fields studied

PAST

Lower Allier,
where a large set of paleomeanders are well preserved due to the western lateral migration and the lowering of the *alluvium* through time

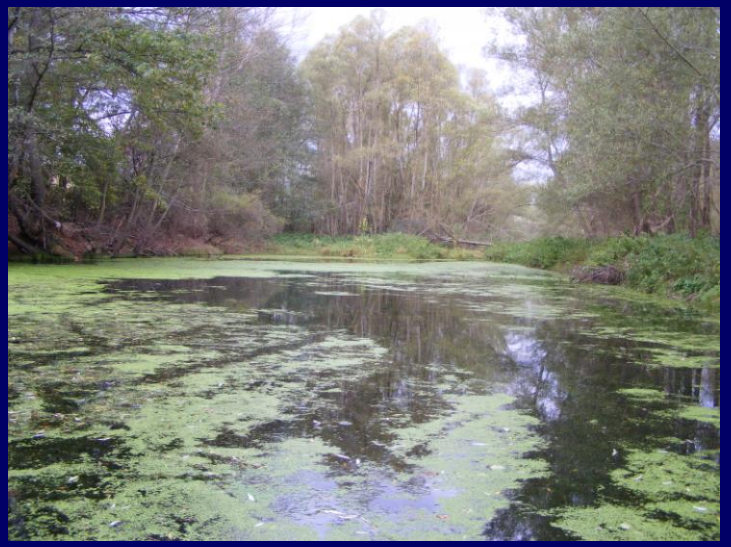


II. Main research objectives et means

PRESENT

On a same type of geomorphological features and in a same time…

1. To study trophic processes and interactions between communities in the trophic network (cyanobacteries, zoo and phytoplancton, macroinvertebrates, fishes)
2. To survey and quantify sedimentary, hydrological and hydrogeological processes and water quality, and better understand the physical and ecological functionning
3. To monitor and model water temperatures and water quality to better understand the characteristics of this kind of ecosystems and their ecological potentialities in the context of climate change (low flow longer and deeper, water temperature hotter)
4. To have present data on proxies which are frequently studied in research on past (spatial distribution of grain size, sediment rates, pollens and diatoms assemblages) and linked to physical and ecological conditions



Objectives and means

PRESENT

Water levels and water temperatures according to hydrometeorology

Hydrogeology

Water quality, physico-chemistry, major ions and isotopes

Fluvial dynamics and geomorphology (i.e. bathymetry)

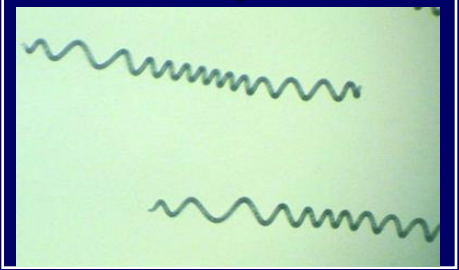
Sediments : thickness, O.M, grain size, sed. rates

Fishes in their different stage of life

Diatoms and macroinvertebrates (coupling and spatial distrib.)

Zooplanctonic dynamics

Cyanobacteries development



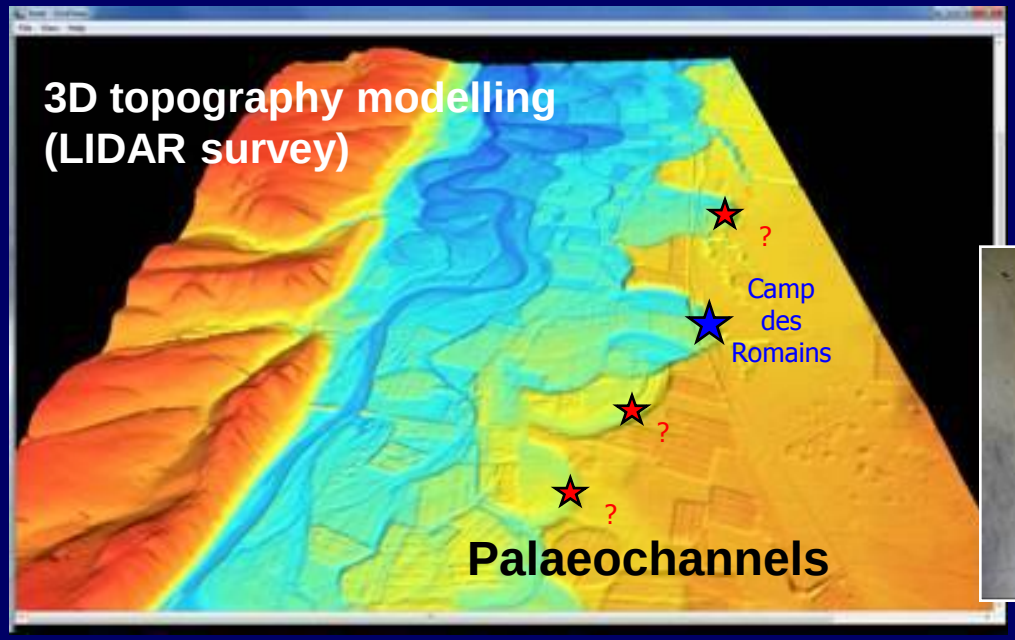
PAST Palaeochannels

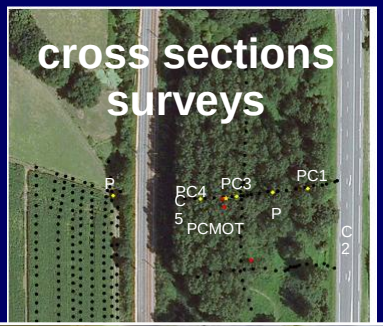
Palaeochanels

1. To characterize human and climatic conditions and variations through time and their incidence on fluvial dynamics and paleochannel evolution
2. To characterererize the biogeographical ambience of the fluvial corridor through time
3. To study the paleobiodiversity of this kind of ecosystems and their possible links with changes in :
   - Land uses
   - Human setlement
   - And/or climate and geomorphological dynamics ;

Time investigated :	**Multidisciplinary approach** :
–Holocene time –High temporal resolution	= crossing palaeoecological, geomorphological, archaeological, historical data etc.

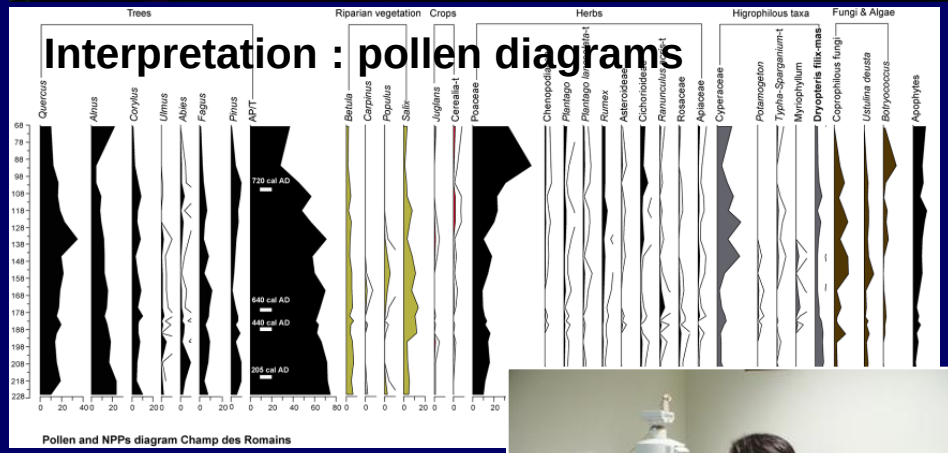
Fields studied

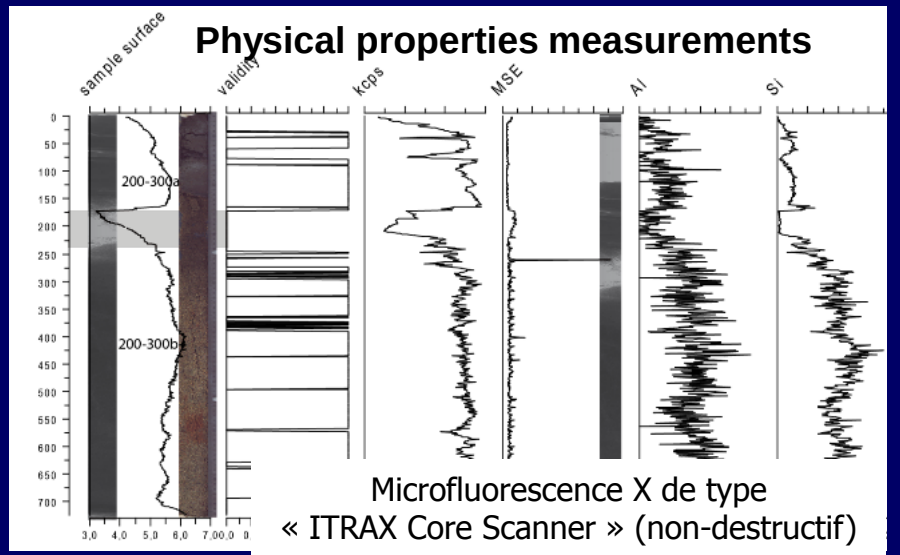




Palaeoindicators

- pollens & NPP
- diatoms
- cladocera
- charcoals
- ^{14}C dating
- texture
- physical properties
- geochemistry
- MO (content, age)





III. First results on physical processes

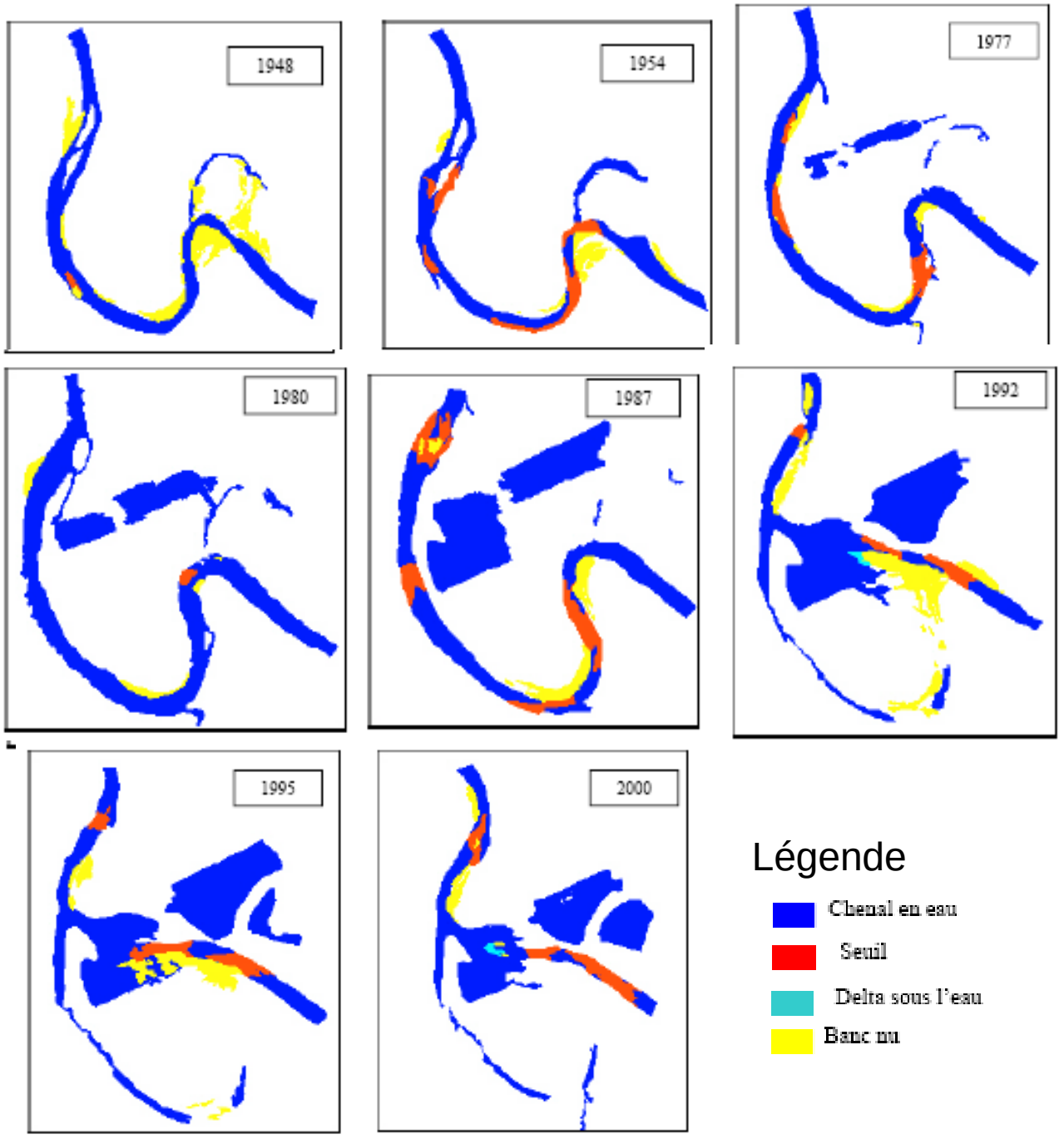
- **GEOMORPHOLOGY**

Geomorphology before and after cutting is surveyed by air photographs or former maps

EX. AUZON

Allier channel captured by a gravel pit in 1989 during a flood

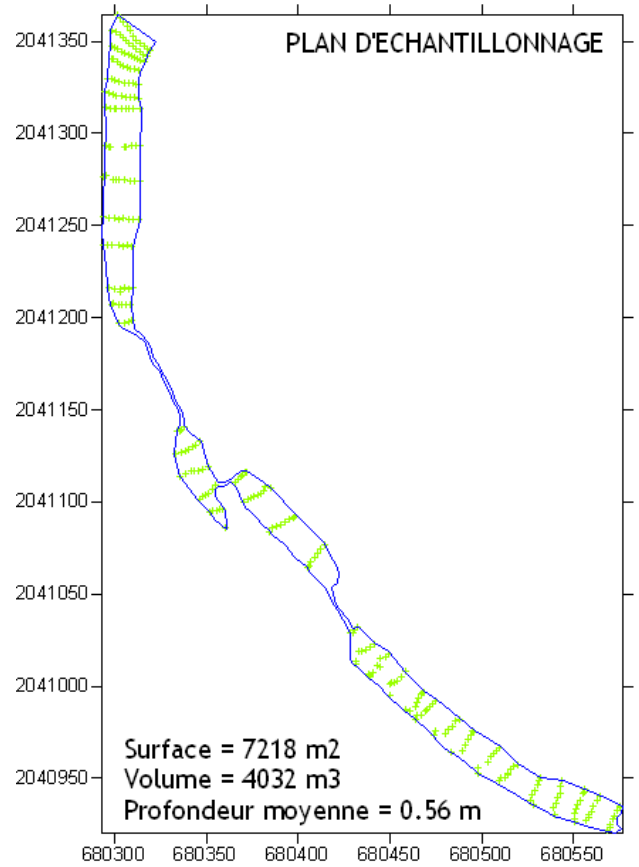
Landscape changes can be easily quantified on a GIS

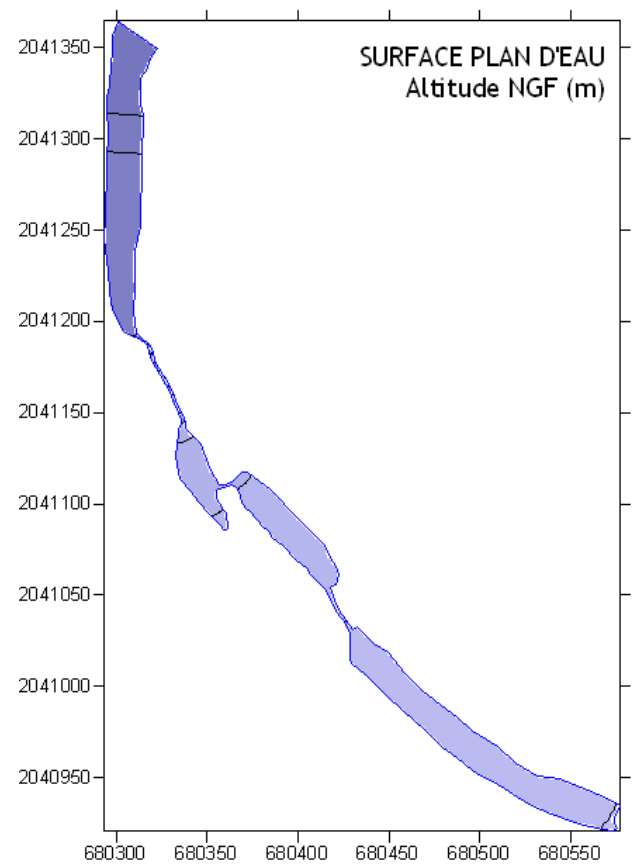


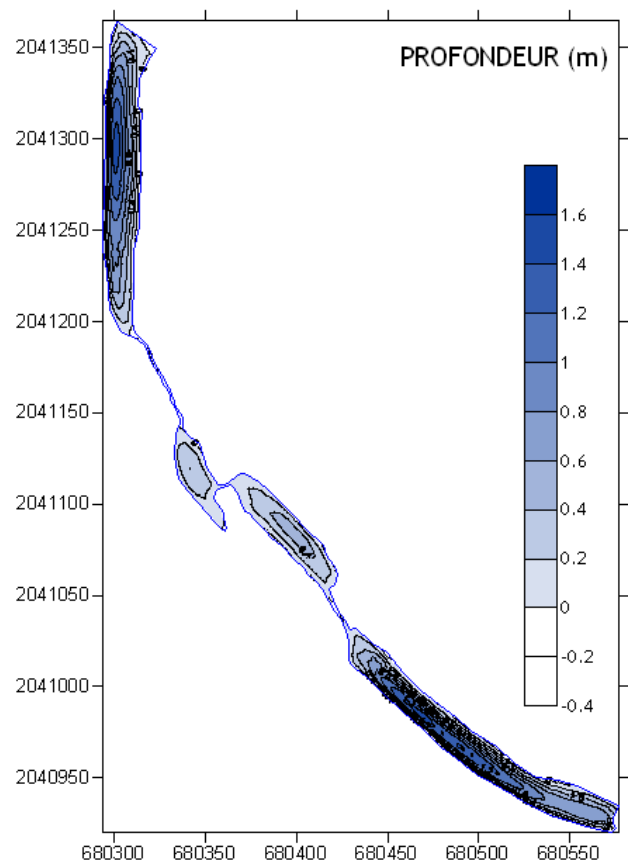
Source : V. SIMON, 2003

• BATHYMETRY SURVEYING AND DIGITAL ELEVATION MODELLING

Bras mort d'Auzon, juin 2009







three other sites are surveyed

Physicochimie de l'eau

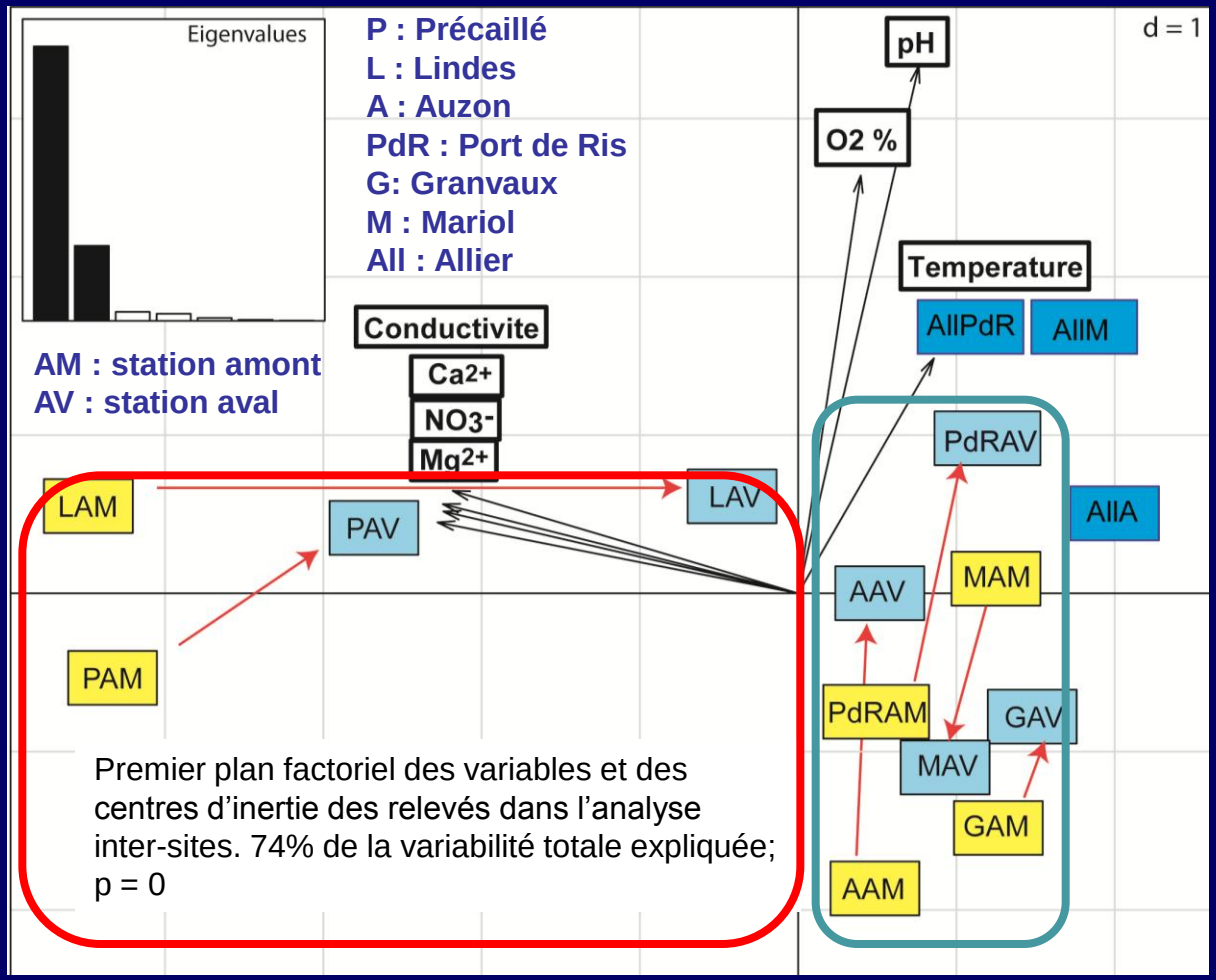
• WATER QUALITY CHARACTERIZATION

- 15 monthly samples on 6 former channels (upstream and downstream points) and 3 samples on Allier R.
- Data on T_W, C, pH, O_2 and major ions (chromatography)

	Conductivité ($\mu S.cm^{-1}$) À 25°C	pH (Unité pH)	O2 (%)	NO_3^- ($mg.l^{-1}$)	Cl^- ($mg.l^{-1}$)	Mg^{2+} ($mg.l^{-1}$)	Ca^{2+} ($mg.l^{-1}$)
Allier R.	109 ± 14	7.7 ± 0.2	72 ± 6	2 ± 1	10 ± 1	8 ± 4	26 ± 11
Précaillé AM	763 ± 13	6.9 ± 0.1	47 ± 20	57 ± 2	56 ± 3	45 ± 3	95 ± 6
Précaillé AV	685 ± 32	7.4 ± 0.2	61 ± 38	28 ± 4	50 ± 5	37 ± 2	88 ± 8
Auzon AM	307 ± 40	6.9 ± 0.2	29 ± 16	1 ± 0.2	38 ± 13	12 ± 1	49 ± 8
Auzon AV	338 ± 99	7.3 ± 0.1	61 ± 4	2 ± 1	28 ± 11	16 ± 5	56 ± 16

Précaillé = meander cutting 80 years old, poor connection, strongly sedimented
Auzon = meander recently abandonned (1990), good dowstream connexion, geomorphological feature (riffle between two pools)

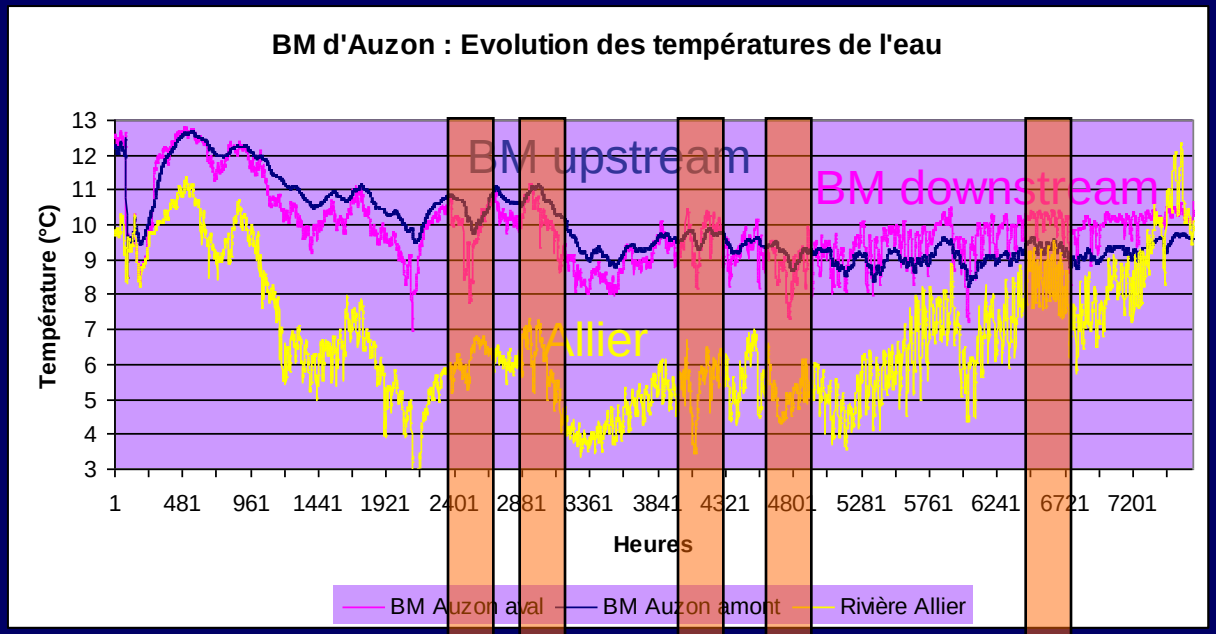
- Water quality from dead arms always very different by comparison to the Allier R. (G.W. influence)
- On several abandonned channels, G.W.supply strongly influences water quality, including very close to the downstream connection (very strong gradient of w. quality) ;
- Pollutants from agriculture can strongly affect the water quality of dead arms due to the ground water supply, impacting ecological processes, like eutrophication.



Hydrométrie et suivi des températures

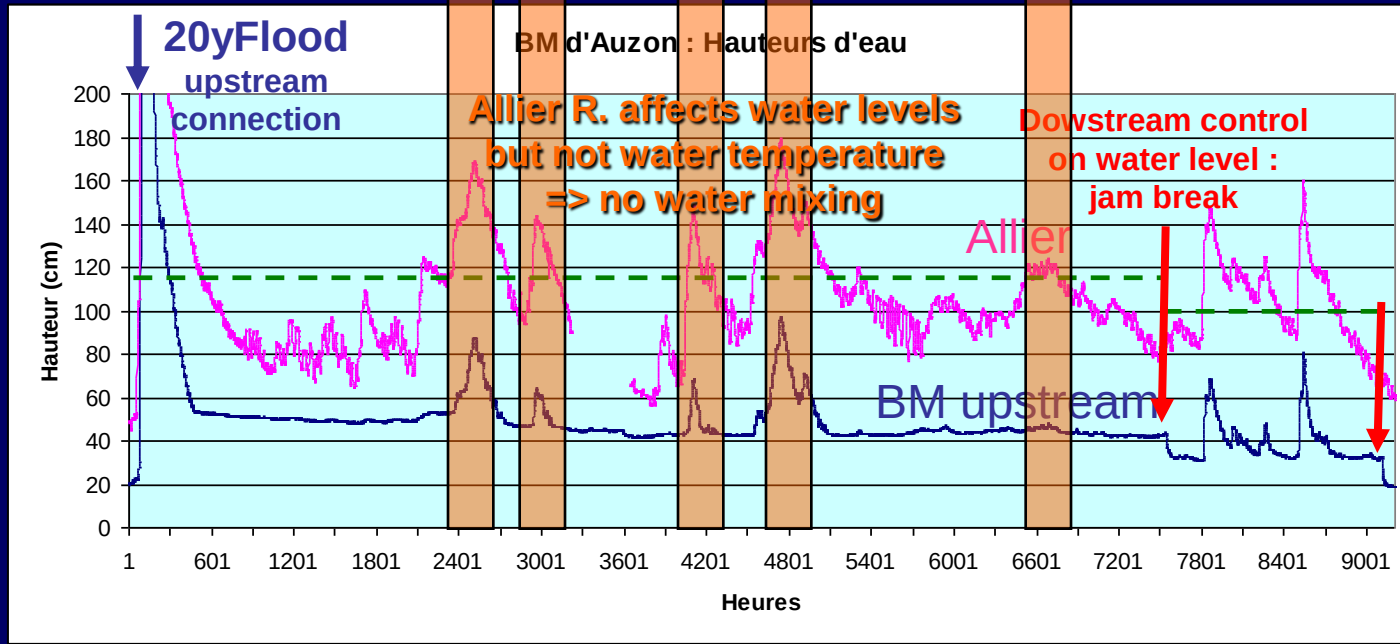
Auzon monitoring : winter and spring 2009
(21/10/2008 to 11/05/2009)

• DOWNSTREAM CONNECTIVITY AND INUNDATION



Water tempe-ratures

Water levels in the Allier R. *versus* water levels in the upstream end of Auzon

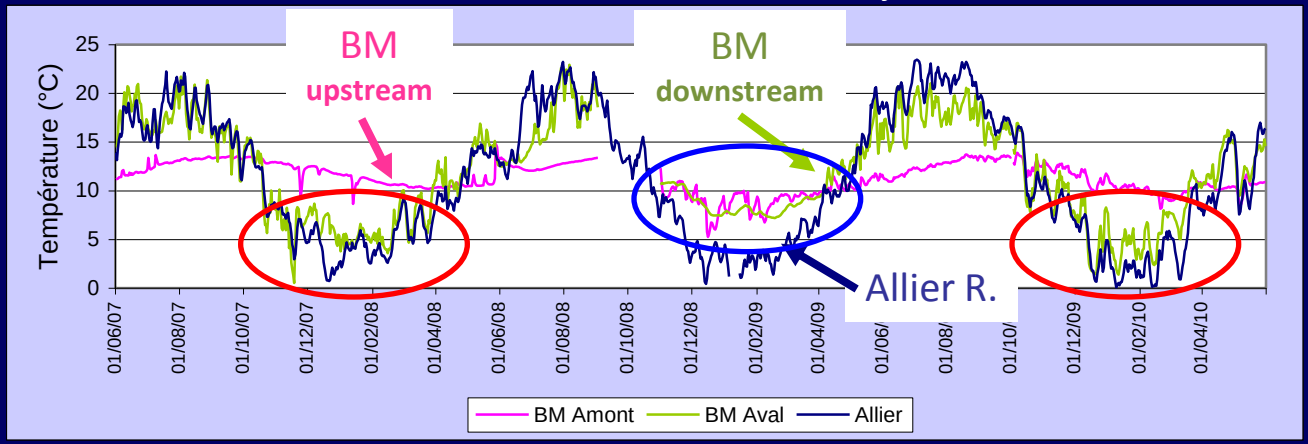


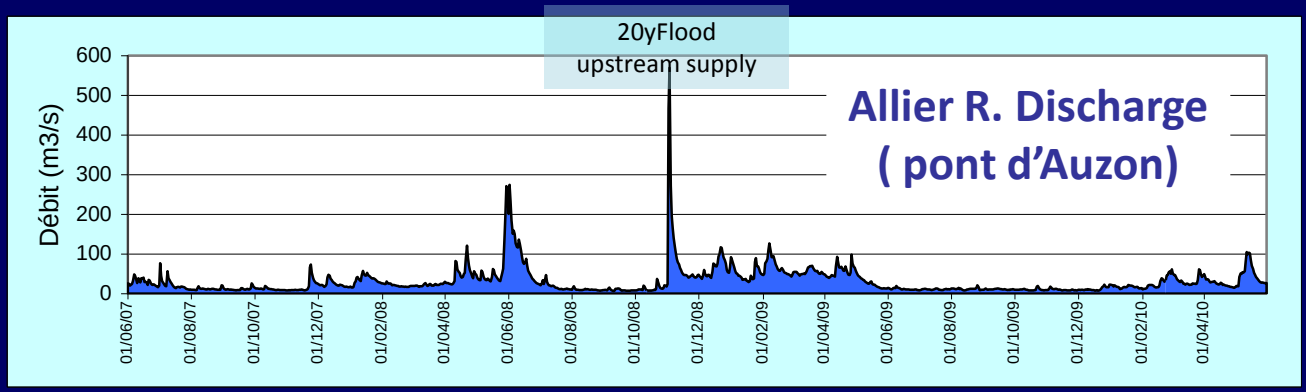
• WATER TEMPERATURE DYNAMICS ON THREE ANNUAL CYCLES

1er juin 2007 au 31mai 2010

BM de PRECAILLE
Water temperature

- T° Allier is relating to hydrometerology
- T° upstream are smoothed and very regular (ground water supplies are not affected by short term hydrometeo-rological variations)
- T° downstream are close to Allier T° excepted the second winter





Water temperature modelling

Results (multiple regression) (R^2)	Précaillé amont	Précaillé aval	Auzon amont	Auzon aval
$T_{BM} = f(T_{air} ; T_{Allier})$	**0.550**	**0.929**	**0.517**	**0.969**
$T_{BM} = f(T_{air} ; .T_{\text{air lissée t-30j}}) ; T_{Allier})$	**0,739**	0.954	**0.720**	0,970

IV. Short term perspectives on physical processes

• To study the spatial distribution of sediment (core sampling) and sediments rates for different geomorphological, hydrological and artificial conditions (remember table on functional characteristics) : *thickness, texture of mineral particles, organic content, chemistry of the organic matter, deposition rates and rythmes through year...*

→
• 20 sedimentometers are installed in two former channels since July 2010
• A master student is analysing the two first sets of data (oct. 2010 and March 2011.
• Sediment were taken for studing pollen and diatoms « rainfall » in sedimentometers

• To compare data on physical and ecological processes, more specifically, diatoms and macroinvetebrates in a first time (postdoc. Aude BEAUGER, Febr. 2010 to June 2011) ; cyanobacteries, zooplancton and fishes communities in a second time

• To install several piezometers in the floodplain (automn 2011) in order to improve our knowledge on linkages between ground water flows and dead arm hydrology, and to get additional data for the water temperature modelling.

Merci de votre attention