

# Repositioning a Spa in Space and Time: the Bagnères-de-Bigorre Spa (Hautes-Pyrénées, France)

Laurent COSTA

Research Engineer at the French National Centre for Scientific Research (CNRS) – PhD, The Huma-num Paris Time Machine (PTM) Consortium MSH Mondes, 21, allée de l'Université, 92023 Nanterre Cedex.  
laurent.costa@cnrs.fr

Richard SABATIER

Government-accredited Architect (DPLG), Chairman of the Observatory for Archaeology and Heritage in Haute-Bigorre (OAPHB), 6, rue Gambetta, 65200 Bagnères-de-Bigorre. oaphb65@gmail.com

**Abstract:** From 2016 to 2020, the archaeological survey of an ancient underground collecting tank in the spa district of Bagnères-de-Bigorre in the Hautes-Pyrénées (France) updated the narrative surrounding the extraordinary history of this site, thanks to the input of new technologies and participatory science.

Directly established on the spring that supplies its thermal mineral waters, Bagnères-de-Bigorre developed its spa activities long before the advent of the spa industry during the Second Empire (1850). An ancient bathing area discovered in 1823 bears witness to this development, as do the municipal archives. From the 1660s-1670s onwards, local civil society began to develop the town's balneotherapy industry, establishing close links with the private residences of the Bourbon monarchy and the great Academies.

The research we are carrying out shows that this balneotherapy industry is also closely linked to the irrigated pastoral production systems that structure the local mountain environment. From the mountain pastures to the spa town and beyond, via the terroirs, the barns, the villages and the fields, a veritable 'water supply edifice' irrigates the crops and serves the homes of local residents and associated structures.

In Bagnères-de-Bigorre, in the early 2000s, the abandonment of the old gravity-fed catchments in favour of the extraction of thermal waters through the use of deep boreholes completed a cycle of some fifty years during which the distribution of water had been radically redesigned and rebuilt for reasons of efficiency and hygiene. Through this process, the waters once present were literally erased from the urban landscape, although they have been maintained higher up in the mountains.

Together, the Observatory for Archaeology and Heritage in Haute-Bigorre (OAPHB) in partnership with UMR *Archeologies & Sciences de l'Antiquité* (ArScAn) and the French Club Alpin of Bagnères-de-Bigorre, are running participatory GIS workshops. Via cross-generational knowledge sharing, vector map representations of the water systems giving structure to the landscapes of the local valleys have been developed, while the skills needed to manage them by gravity have brought together a number of local associations. Going back to the sources, again and together, thus offers possibilities.

**Keywords:** *spas, thermal cures and balneotherapy, water systems, geohistorical GIS, collaborative sciences.*

## Introduction

Like many European spa towns, the Roman origins of Bagnères-de-Bigorre were alleged at a very early point in the historical record. From the turn of the 17th century, publicity given to the discovery of scattered objects, including two votive altars, attested to a Roman presence in the area. With these few material facts fuelling the imagination, antiquarians have extrapolated a history for this spa town dating back to Roman antiquity (Jazé-Charvolin 2016; Carribon 1999). A short while later, during the construction of the municipal thermal baths in the 1820s, the partial uncovering of an ancient bathing area provided spectacular evidence that the hot springs had indeed been used since Antiquity. In the 2000s, with the epigraphy of a votive altar having proved authentic, the town's major new spa complex was named *Aquensis*, thus reiterating this extrapolation of historical context.

From 2016 to 2020, the archaeological survey of an ancient collecting tank in Bagnères-de-Bigorre<sup>1</sup> gave new impetus to this issue by raising the question of how these springs and this system were integrated into the urban fabric over the long term. The study of this hot water collecting tank, and then the extension of this approach to include the cold surface water irrigation systems, channels and ditches, has driven our team to consider the Grands Thermes area of Bagnères-de-Bigorre as one single integrated unit with its vast forest and pastoral thermal park opening out onto mid-mountain ranges. The aim was to shift the perspective and observe all the gravity-fed water supply systems

<sup>1</sup> Works described in *Cahiers Archéologie en Haute-Bigorre* [Notebooks on Archaeology in the Haute-Bigorre region]: Notebook 1 (2015-2016): An ancient canal in Bagnères-de-Bigorre; Notebook 2 (2017-2018) Water systems and balneotherapy; Notebook 3 (2019-2021). Sharing our natural waters. Media library of the Community of Municipalities of Haute-Bigorre.

taking in and releasing natural waters *in situ*, in order to create a new research subject that would enable us to assess the resilience of these systems over the long term. Because of the water supply complex that gives it its structure, Bagnères-de-Bigorre – a spa and then a spa town – forms part of the layering of irrigated landscapes in the Haut-Adour Valley, which is in itself a vast water supply edifice made up of water catchments, streams, channels, ditches, basins, fountains, baths, etc., but also of people who have developed practices and know-how, and of the biotopes and biocenoses associated with them. These run-off waters make the Haut-Adour a place with a history and longevity that is due as much to its natural aspects as to the social elements they create, by catalysing cooperative projects ranging from transition to tourism to pastoral micro-farms (Letang and Knauf 2022; Bouneau 2005).

Such a return to our roots raises a number of questions of substance and form that this article sets out to address. Whether it be in the spa town, proposing to free thermal mineral springs from the now useless straitjacket of their catchments, or in pastoral units that inhabitants are seeking to re-establish with the support of farmers, the aim here is to apply an approach based on research and action<sup>2</sup> and to establish a knowledge development project based on a contributory and participative dynamic. Here, archaeology, as an integral part of a digital humanities approach, is no longer simply a means of gathering information before destroying landscapes, but becomes rather a means of achieving synergy for the redeployment of possible transformations, possible points of ecological resilience, possible economic development and, above all, a shared knowledge of the terrain (Lamothe 2021).

### Hydrogeological context of thermal mineral waters

Bagnères-de-Bigorre is a spa town that has its origins in a very limited hydrogeological complex in which rainwater collected at the summit of a small mountain massif adjoining the town (Mont Bédât) emerges hot at the base of its slopes and through the alluvial soil on which urban settlements have developed. At a distance of fifteen hundred metres, a second resurgence point is located away from the centre, deep in the park in the Salut Valley. (Figure 1)

This circulation of water takes place through a system of syncline folds made up of Jurassic and Cretaceous limestone. After conveying the captured rainfall very deep into the earth, this system returns those waters at a temperature of between 50°C and 30°C, loaded with calcium sulfate principles that they have collected by dissolving Triassic gypsum and anhydrite (Nartet and Soule 1986) during their underground journey. This

hydrogeological system corresponds to the spa town's rural setting. The slopes of the Monné, Tucou and Bédât peaks combine to form a small basin that feeds the Aygo Tebio ('warm water') stream, which rises deep in a nearby valley.<sup>3</sup> At the mouth of this valley, its thalweg widens and joins the Adour after running parallel to the river for 8 kilometres. Resulting from a vauclosian-type spring, the stream sometimes swells after heavy rainfall to the point where it begins a second resurgence. The town centre and its spa district were flooded to a height of 1.50m during the 100-year flood. A recent flood in July 2023 is a perfect illustration of this type of event.<sup>4</sup> The hot springs bubble up from the diastolic rocks of the foothills and through the alluvial deposits on which the town centre and its spa district have developed. Although the epicentre of the hot springs (50°C) and the baths have been closely linked since at least Antiquity<sup>5</sup>, it was not until the early medieval Renaissance that the town was established and developed directly around its thermal mineral resources and the infrastructure it inherited. (Figure 2)

### Historical and societal context of a spa town

From the diaclases overlooking the town or through the alluvial deposits on which it is built, the technical methods used to capture the hot waters have shaped the long history of this spa and then spa town, which has been developing since ancient times, well before the advent of the spa industry. To collect water through the limestone, horizontal tunnels had to be dug to reach the main source of a spring and bring the water by gravity to a bath or fountain. These water catchments, located in the Reine district above and behind the main thermal bath complex (Grands Thermes), were mainly used by religious and consular institutions. Drawing water from beneath the town and its surroundings through the gravel and peat of the alluvial soil was easier and less costly than digging a tunnel in the rock. These catchments are in the form of either lower-pressure columns or emergence pools. Like a well, the water compressed by the subsoil finds a means of expansion and rises to the surface to feed pools or underground basins.

It is interesting to note that it is at the junction of these two types of catchment – at the point where the water is warmest – that the site of the ancient spa is located,

<sup>2</sup> <https://hal.science/hal-01490609>

<sup>3</sup> The Aygo Tebio is fed by a small watershed measuring 3.29km<sup>2</sup> located upstream of Bagnères-de-Bigorre town centre. Cf. Report presenting the Risk Prevention Plan (RPP), Hautes-Pyrénées Prefecture, March 2010.

<sup>4</sup> <https://www.ladepeche.fr/2023/06/04/hautes-pyrenees-les-orages-provoquent-des-inondations-a-aste-et-bagneres-de-bigorre-11240910.php>

<sup>5</sup> As demonstrated by the partial discovery of a bathing area in 1823 during the construction of the Grands Thermes thermal bath complex.

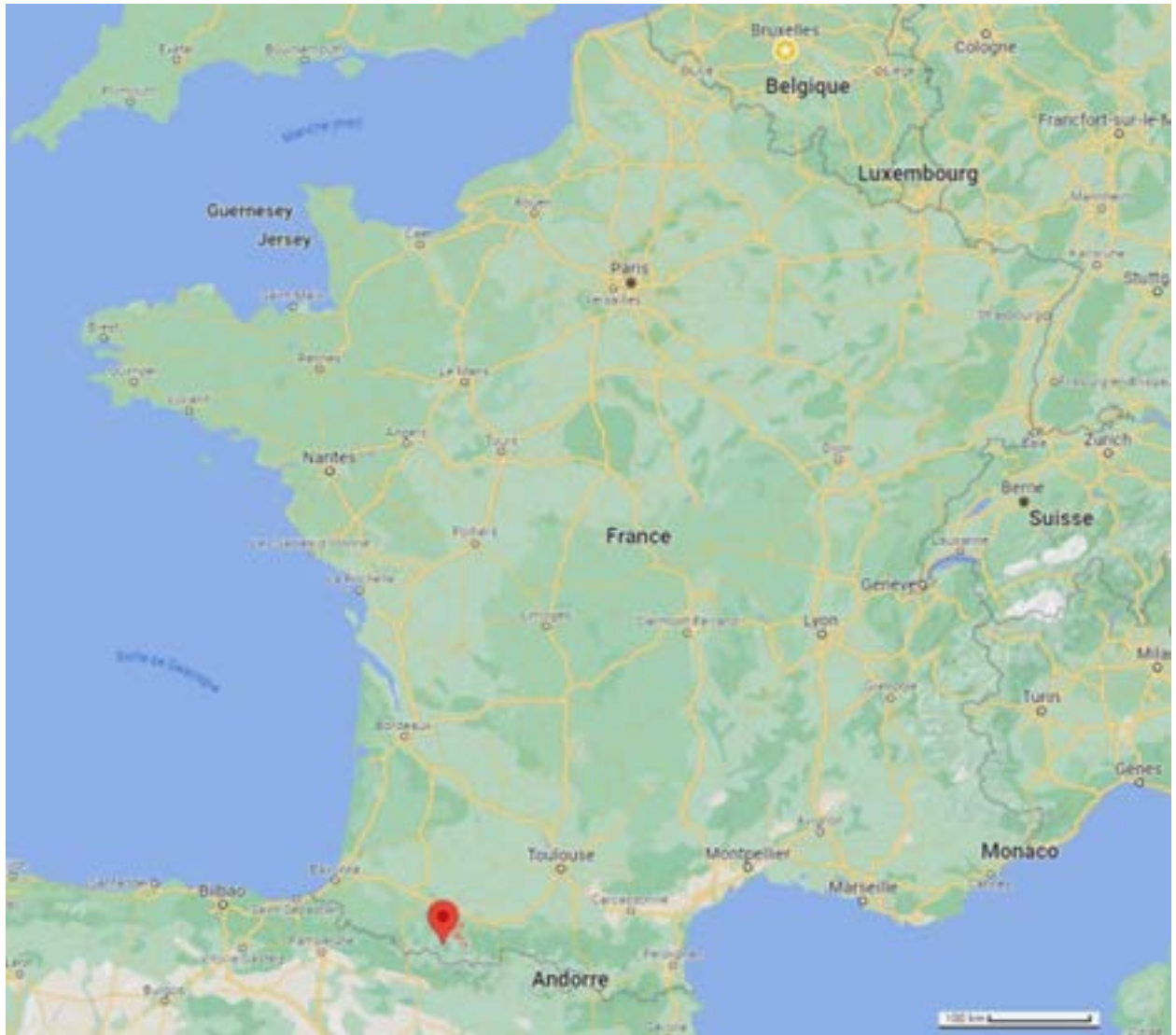


Figure 1: Location of Bagnères-de-Bigorre (France). Google maps. © Google map

as is the Grands Thermes municipal complex today (Figure 3).

A bird's-eye view from 1668<sup>6</sup> shows the baths in the form of rectangular pools in the open air inside and outside the town. The municipal archives have preserved medieval edicts that sought to regulate the use and customs of these pools, which catered for everyone, including domestic animals. As far as we know, from the 16th century onwards, vaulted baths equipped with one or two bathtubs supplemented and then replaced these open-air pools in order to satisfy a desire for modesty and comfort for an urban clientele who came to experience the waters. (Figure 4)

The relative simplicity of catchment through alluvial deposits led to an increase in the number of private establishments. By the end of the 18th century, there were more than thirty. Most were owned by doctors who sought to set themselves apart from the competition by advertising their waters as suitable for curing a particular pathology. One prominent man, whose family has produced several mayors, bought a former public bathhouse and renovated it to increase its capacity. This would become the Bains de Salut. In this same pre-revolutionary period, the consuls asked the engineer from the Public Highways Office of the Pays d'État de Bigorre to design a new bath as a gift for the first-born son of King Louis XVI.<sup>7</sup>

<sup>6</sup> 'Sent to Mr Coignet to present to Monseigneur Colbert, Minister of State', 1668, Vincennes Archives.

<sup>7</sup> The Bain des Pauvres was replaced by the Bain du Dauphin, now known as the Bain du Roi de Rome. This small establishment with two swimming pools was designed by Louis Moisset, an engineer with the Public Highways Office. It was inaugurated in 1781.

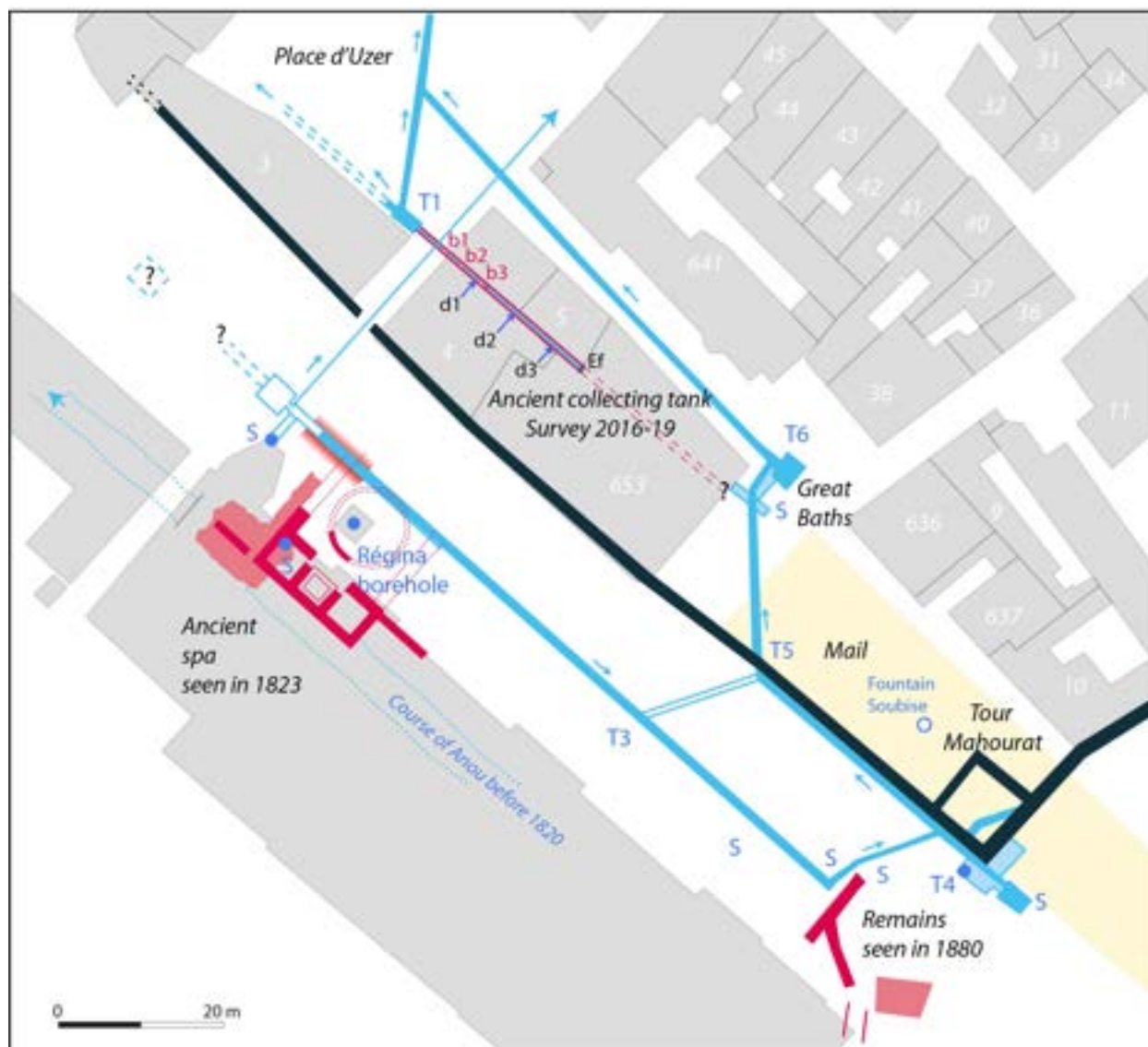


Figure 2: Plan of the ancient baths based on a repositioning of the Milestone outline. © OAPHB 2020

At the dawn of the French Revolution, Bagnères-de-Bigorre was a highly socially structured spa town, attracting a select clientele (Roux 2008-2009). The arrival of Madame de Maintenon and the recovery of the Duc du Maine, whom she accompanied, are described as the inaugural moment in this boom, which would be sustained by the links that figures in local society forged with renowned spa visitors and by the decision to place some of the town's children in service in the private residences of the King and Queen.<sup>8</sup> From the end of the 17th century, people from the area held positions such as private secretary to the King, chambermaid or bodyguard to the Queen. In return, they sent doctors, botanists, geographers, and fountain builders ... and these monarchical influences

<sup>8</sup> The Cuilhé and Bertholet-Campan families, including Mrs Campan, Dumoret, Dufourc d'Antist, etc.

survived the Revolution. The current Grands Thermes bath complex in Bagnères-de-Bigorre was inaugurated in 1828 by the Duchess of Berry (1798-1870), daughter-in-law of King Charles X.

Designed using a range of industrial arts and applied sciences, this large establishment, bringing together some forty public springs, would eventually mean the disappearance of the private baths that were once the feature of the spa district, and beyond. From this point on, the municipality controlled the hot springs, while the local community continued to welcome and entertain visitors seeking thermal cures in the spa.<sup>9</sup> The

<sup>9</sup> However, no grand hotel was ever built, despite a last, belated attempt in the period between the World Wars. Hotel capacity continued to be boosted by civil society, which was expanding and renovating its stock, while customers with more modest means found accommodation through rental companies and in a number of



Figure 3 : Photo of the ancient collecting tank. © R. Sabatier 2016

first gaming hall was opened in the early years of the 18th century. Arrangements were then made for the development of promenades. Around 1780, the upper reaches of the stream leading to the new Bains de Salut were transformed into a Rousseauist promenade under the name Vallon de Salut, while lines of trees were planted to provide shade for the paths and tracks leading up to the mountain pastures. The development of promenades continued in the 19th century. Guides to the region's health resorts at the time praised the scenery and the rest areas set up near springs and in farms where people drank milk in the cool shade of centuries-old chestnut trees. A ferruginous spring

(mineral spring waters containing salts of iron) transformed into a neoclassical bar dedicated to the Duke of Angoulême was also inaugurated in 1828 by his wife. Linked to an avenue on the plain, the development of which combined a new district administrative office, a convent, a grand hotel and villas with surrounding grounds, a new promenade was laid out on Mont Bédât to provide a route to the spa district. These developments are the expression of a romantic approach to natural phenomena, in which the worship of natural springs is a response to a Christian conception of nature and its wonders, although it does not exclude an interest

---

religious institutions.



Figure 4: View of one of the private baths and a small bowl. © R. Sabatier 2017

in vernacular practices,<sup>10</sup> which will continue to be threatened by modern changes.<sup>11</sup> (Figures 5a y 5b).

This *cultural and medical* balneotherapy (Scheid *et al.* 2015) would become an industry under the Second Empire.<sup>12</sup> As in Spa in Belgium, these promenades to the springs are the legacy of a time when people did not know exactly what to do with their waters: should you bathe in them, shower in them, drink from them or even inhale their vapours? By this time, the academies of the Age of Enlightenment had undertaken a classification of

their curative principles: soda waters, sulphur waters, sulphate waters, etc. But while technical devices were increasingly conditioning the way in which bodies came into contact with the waters, the use of springs was not abandoned. In Bagnères-de-Bigorre, as numerous views and photographs show<sup>13</sup>, moorland and summer pastures dominated the small mountains that support the hydrogeological setting of the spa. The Second Empire's Law on the Restoration of Mountain Land<sup>14</sup> (RTM) was the means by which the small massif was

<sup>10</sup> John Scheid, Archaeologist, Teacher at the Institut de France, *Religion, institutions and society in Ancient Rome*. 12 lessons given at the Collège de France (2017-2016).

<sup>11</sup> Bagnères-de-Bigorre, with its poet Philadelphie de Gerde (Claude Duclos, 1871-1952), would be one of the anchor points of the Félibrige movement (focussed on protecting and promoting Occitan language and culture).

<sup>12</sup> It was in this pioneering spa that an industrial concept of balneotherapy was born and developed during the Second Empire. In the 1860s, the town fulfilled the requirements of the new laws regulating spa resorts. The railway station was inaugurated in 1865, and the Grand Casino – equipped with a 'neo-thermal' swimming pool – in 1885 by Monaco's Société des Bains de Mer (SBM), while the Grands Thermes thermal bath complex dating from 1828 was already being updated by hydraulic engineer François de Neufchâteau.

<sup>13</sup> In particular, the watercolour view by Louis-Denis Leleu, Land Registry Officer, preserved in the Hautes-Pyrénées Départemental Archives.

<sup>14</sup> *Restaurer la montagne*. Exhibition catalog, Comissioner Benoît Coutancier, Museon Arlaten, Musée départemental d'ethnographie d'Arles, France. 2004. In France, the 'restoration of mountain land' (RTM) was an operation to stabilise and restore soil on mountain slopes. Because of the specific context and risks involved, it calls on specialised civil engineering, plant engineering and ecological engineering techniques adapted to different environments (steep slopes, cold, temperate, hot or tropical climates). The department of the same name responsible for carrying out these operations was created in the 19th century within the Water and Forestry Service, and still exists at the beginning of the 21st century within the National Forestry Service.



Figures 5a : View of the spa district of Bagnères in the 19th century and today. Here, the main thermal bath complex in 1828, when it was inaugurated. François DANDIRAN, milieu XIXe siècle © Médiathèque Bagnères-de-Bigorre



Figure 5b : The main complex in 2023. © R. Sabatier 2020. © R. Sabatier 2020

afforested, and the company Ramond<sup>15</sup> took advantage of this to fund the Association for the Restoration of the Bigorre Mountains. Nurseries were set up by members of the association, supported by the Water and Forestry Service. The summits of Mont Bédât and Mont Olivet are then covered by a mixed wood forest planted with various species of trees. Near a grotto, a discreet Fairy Fountain was created, with an inn next door. And, as the plantings expanded, new paths were created. With the mountains being regenerated through the forest and protection of water resources, the promenade, now understood as a means of oxygenating the body, added the curative action of the air and sun<sup>16</sup> to that of the water. At the time, the company Ramond was in contact with the very pioneers of forest ecology,<sup>17</sup> who were also working on the afforestation of Mont Aigoual, in the Massif Central, where the summit was to be the site of a weather station from 1885. Ten years earlier, Ramond had itself embarked on the construction of a high-altitude weather station, which was to become the Observatoire du Pic du Midi de Bigorre.

In Bagnères-de-Bigorre, from the end of the 17th century onwards, a close relationship was forged between the growth of the spa industry and the development of the natural sciences.

### From natural to industrial waters

The last major cholera epidemics in Paris – in 1832 and again in 1854 – provided scientific evidence of a cause-and-effect relationship between water pollution and health. The Imperial Decree of 1853 on the creation of the Compagnie Générale des Eaux was in line with these developments. For spas investing in industrialising their activities, the Law of 14 July 1856 on *the conservation and development of mineral water springs*<sup>18</sup> made their accreditation subject to a number of conditions.

For Bagnères-de-Bigorre, the 1864 Small Channel Plan<sup>19</sup> reflects the need to update water management on

<sup>15</sup> This learned society was founded in 1865 by: Emilien Frossard (1802-1881), the pastor who re-founded Protestant worship in the Hautes-Pyrénées, Charles Packe (1826-1896), British officer, and Henry Russel-Killough (1834-1909), Irish explorer, who were joined by Farnham Maxwell-Lyte (1828-1906), photographer. Several of these members had previously been among the founders of the London Alpine Club (1853).

<sup>16</sup> This afforestation of the thermal and pastoral promenades of Bagnères-de-Bigorre inspired a project to build a sanatorium and then a mountain hotel, also promoted by Ramond.

<sup>17</sup> Charles Flahault (1852-1935), Botanist, Professor at the Université de Montpellier, and Georges Fabre (1844-1911), Forestry Engineer and Meteorologist.

<sup>18</sup> The Law of 14 July 1856 on the conservation and development of mineral water springs relates to the declaration of public interest and the scope of protection of springs, inspections, and the general operating conditions of spa establishments.

<sup>19</sup> Kept by the town's Technical Services Department, the Small Channel Plan, dated 1864, takes the form of an atlas including a general layout plan and 23 land use plans at a scale of 500. Scanned by the OAPHB, can be accessed online via the Haute-Bigorre GIS

a regular basis. While the small service channels and drains in the middle of the streets disappeared, the fountains, gutters in the new pavements and irrigation systems in the English-style parks and gardens increased in number. While losing its medieval appearance, Bagnères-de-Bigorre was to become the 'Venice of the Pyrenees'. Laying underground pipes in the streets to supply spring water fit for drinking and distributing it to forty public fountains cut the underground routes of the small channels running along the streets or passing from block to block to supply private homes with service water. It was therefore necessary to record and represent their underground routes so that the impact of the works could be measured and solutions identified. This precaution on the part of local councillors with regard to the 'water rights'<sup>20</sup> associated with these works is highly expressive of a culture of water and the conditions conducive to its evolution and its revolutions. At the time, water was everyone's business.

As far back as the 16th century, Salluste de Bartas noted the skill of the people of Bagnères in managing both hot and cold waters closely and separately.<sup>21</sup> The abundance of water in this mountainous region and the power of its flow led successive societies to use it to irrigate the land, supply houses with service water, power the mills and clean the streets, while the hot springs were reserved for medical care. These multiple uses were not *the prerogative of the spa town, but of the whole valley*, from the communal summer pastures to the fields on the plain, from the pastoral enclosures in the mid-mountains to the resort and beyond, via the market town and the villages. In the new urban promenades, in the new parks and resort gardens, and in the renovated streets, everyone saw the allegory of the living, sparkling, whispering waters of the mountains.

The new drinking water standards decreed in 1914 and implemented by local authorities between the wars, followed by public health policy from the 1970s onwards, were to revolutionise this water culture and profoundly change the spa atmosphere of the town.

### From the silence of a city of water... to an approach based on water supply chains

In the mid-1970s, when you got off the train at the station, you would walk up the avenue and arrive in

(<https://oaphb.fr/sig/>).

<sup>20</sup> Water rights are perpetual rights attached to the water intake and not to the structure conveying the water to that point. As such, these works are covered by perpetual water rights for a specific use and are therefore exempt from any authorisation or renewal procedure (Wikipedia).

<sup>21</sup> 'And although there is little space between his flow, as cold as ice, and the pain-relieving bath, he holds back his nature, and will not in the slightest mix his cold with his fire', Salluste de Bartas (1544-1590) *Les Œuvres poétiques*, volume 1, page 248, about Bagnères-de-Bigorre.



Bagnères-de-Bigorre on a hot summer's afternoon to gradually become aware of the new silence of this spa town.

Some fifty years on, the final year projects of **two architecture students** (Dedieu and Vertallier 2015), **whose aim was to set up a participatory workshop open to local residents as part of their degrees**, revealed the residents' recurring nostalgia in relation to the loss of this close link between waters and town. At the same time as this study, the rediscovery of an ancient collecting tank under the spa district resulted in an inventory survey of this underground structure.<sup>22</sup> This survey enabled the establishment of a research team, which was first created as a branch of the company Ramond in 2017 and then became independent in 2018 in the form of the Observatory for Archaeology and Heritage in Haute-Bigorre (OAPHB)<sup>23</sup>.

In 2015, a 'Natural Waters' workshop was set up with the local authority to bring together stakeholders and experts to discuss this issue. It was followed by a second in 2016. These two sessions provided an insight into the current state of thermal mineral management at the resort<sup>24</sup>, and more specifically the abandonment of the old gravity-fed catchments in favour of the installation of deep boreholes to secure the use of hot water. Like in other spa towns, such as Bath in England's Somerset, the town centre of Bagnères-de-Bigorre, including its spa district, was built and developed in direct contact with the resurgence of thermal mineral waters. These deep boreholes make it possible to control piezometric disruptions linked to the risk of interference with the underlying water table during the final phase of the ascent of hot water. Indeed, the current urban layout, which has evolved since the Middle Ages, is characterised by the absence of cellars, apart from the old semi-buried private baths. This situation is particularly indicative of the activity of the hydrogeological substrate.

At the beginning of the 2000s,<sup>25</sup> in accordance with the requirements imposed by the Ministry of Health, Bagnères-de-Bigorre drilled two deep wells to replace

the gravity-fed catchments that had previously supplied the town. The consequence of this advance was a modification in the monitoring of these waters, which now circulate under pressure from the hydrogeological subsoil to the various points where they are used. However, the fact that the old water catchments were no longer in use did not mean that they were obsolete, since they remained direct monitoring points for the thermal mineral aquifer. At the end of the drilling work, Antéa Group submitted a memorandum to the town emphasising this new state of neglect of the springs owned by the municipality<sup>26</sup> and pointing out two areas requiring vigilance<sup>27</sup>, while at the same time a major spa was being added to the town's treatment establishments<sup>28</sup>:

- To ensure that *'currently neglected springs are brought into and maintained in compliance with (...) the conditions necessary for safeguarding the quality of thermal mineral water ...'*
- To maintain *'these flows at defined, fixed levels to ensure that a balance is maintained between the pressure of the thermal water and that of the other aquifers, a guarantee of safety for the protection of the quality of the resource'*.

For our observatory, this question of the neglect of the springs was a key issue at the time of its creation. The hydrogeologists' recommendations sought to protect the town from the loss of corporate memory inevitably associated with this upheaval in the management of its thermal mineral resource. The staff assigned to maintenance and surveillance now had to refocus their tasks on the contingencies of the new water supply installation storing and transporting hot water under pressure, which is now more prone to bacteriological development.<sup>29</sup> Although rare in the case of spa resorts in France<sup>30</sup>, this risk of outbreak is nevertheless feared because of its catastrophic impact on the reputation of spa resorts.

<sup>22</sup> <https://oaphb.fr/wp-content/uploads/2021/01/Prospection-Inventaire-Bagne%CC%80res-de-Bigorre-2016-Drac-Occitanie.pdf>

<sup>23</sup> <https://oaphb.fr/>

<sup>24</sup> The first two sessions of this workshop were held in 2015 and 2016, bringing together the Fountains Department of the Château de Versailles National Estate and the companies Antéa Group and Eiffage.

<sup>25</sup> According to the Ministry of Health and Prevention: *'The water used for therapeutic purposes in a spa must be natural mineral water (...) It is defined by its original purity and is distinguished from other waters by the nature and stability of the essential physical and chemical elements it contains (minerals, trace elements). Since the 2000s, strict microbiological requirements have been laid down by regulations, relating to the resource and to the points of utilisation in the spa establishment (Decree of 19 June 2000 amending the Decree of 14 October 1937, as amended, relating to the monitoring of mineral water springs)'* In: *Eaux thermales, eaux minérales naturelles utilisées à des fins thérapeutiques dans un établissement thermal [Thermal waters: natural mineral waters used for therapeutic purposes in a thermal spa]* (website updated in January 2021).

<sup>26</sup> *Protection de la ressource hydrothermale / Etat de délaissement des sources minérales du patrimoine communal [Protection of hydrothermal resources / State of neglect of municipal mineral springs]*, Antéa Group / Town of Bagnères-de-Bigorre, July 2002. This memorandum is based in part on the description of water catchments provided by BRGM under the title 'Département des Hautes-Pyrénées / Stations thermales et sources thermo-minérales' (Département of Hautes-Pyrénées / Thermal spas and mineral springs) by Marie Nartet and Jean-Christophe Soulé, Ministry of Industrial Redeployment and Foreign Trade, December 1985.

<sup>27</sup> *Ibidem*, page 20.

<sup>28</sup> Since the early 2000s, the deep boreholes have supplied the main municipal Grands Thermes thermal baths complex, the Thermes de la Reine private spa (bought by the town in 2020), the Aquensis spa and the Functional Rehabilitation Centre at Bagnères-de-Bigorre Hospital (which terminated its contract with Semetherm in 2019).

<sup>29</sup> Decree of 22 October 2013 on health monitoring and surveillance analyses of packaged waters and natural mineral waters used for therapeutic purposes in a spa establishment or distributed in public refreshment areas.

<sup>30</sup> In France, only 1% of spas are affected by such a situation.



Figure 6 : view of the valley and irrigation channels in the mid-mountain region. Photo by R. Sabatier 2021

But this visible loss of a corporate memory<sup>31</sup> relating to the extensive overhaul of water management was not confined to thermal mineral waters. It also affected all the water supplies that once brought life to the ‘Venice of the Pyrenees’, inherited from the embellishments designed by the Public Highways and Mines engineers of the Second Empire. The recent neglect of the springs and their catchments was compounded by the removal of water gutters on pavements and the drying up of fountains and ditches along promenades, parks and gardens in the town. Although mountain water remained free, this decline in the urban spa landscape was partly due<sup>32</sup> to the delegation of the drinking water service to private companies from the 19th century onwards, and then to the fact that its distribution and potability became chargeable during the 20th century. In addition to the disappearance of natural water runoff in the fountains, pools and gutters of the spa district, we had to add the fact that we had forgotten about the flooding of the Aygo Tebio. Today, the discontinuation of maintenance of the cofferdams protecting the thresholds of the houses here demonstrates the lack of transmission of local knowledge between old and new occupants. This is the most worrying as these thresholds have lost some of their height as a result of the roadway being raised to bring it into line with the Disability Law. With neither pavements nor gutters, the

<sup>31</sup> Corporate memory, or organisational memory, refers to all the knowledge and know-how within an organisation taken as a whole: managers and employees, whether this relates to a region, a company, an association, etc.

<sup>32</sup> The other cause of this subsidence is the withdrawal of the pastoral production system historically associated with the resort’s large thermal park.

urban fabric of the town centre means that the ground floors of houses and businesses are now more exposed to the hazards of flooding, making it all the more important to update our knowledge of natural gravity-fed water systems. Could what the engineers of the Second Empire achieved to improve the resort, based on the gravitational principle of the natural path of a drop of water, not be applied differently today? This has led us to focus our work not only on learning about a heritage that has been forgotten, but also on the dynamics of the landscapes of a valley where the many water-based systems – whether dormant or active – are still generating know-how and projects that seek to appreciate the water that falls from the sky or bubbles up from the depths of the rocks and to manage this resource economically in order to irrigate the valley once again through its many small streams (Figure 6).

### The resilience of the living waters of the Haut-Adour

We observed that further up the valley, local associations had been working for some time to take over from local authority workers in the upkeep of mid-mountain pastures, maintaining an infrastructure and the associated know-how. While the archaeological survey undertaken in 2016 enabled us to gain a better understanding of the complexity of the water supply substratum providing the structure for the town of Bagnères-de-Bigorre<sup>33</sup>, from 2019 our work would extend to the gravity-fed water supply systems of channels and ditches irrigating the land and mountain pastures of the Haut-Adour. This extension of our studies enabled us to see that the old irrigation systems for the mountain pastures and meadows also established the structure of the town of Bagnères-de-Bigorre, its districts, its promenades, its vast thermal park, etc.

With this in mind, in 2021 our team brought together a small team of residents for a consultation to discuss the current situation of the springs in that thermal park. From this first formal exchange, it emerged that because it accommodated the catchment field for the hydrogeological cycle of the thermal mineral waters, this large thermal park was directly involved in the spa town’s thermal cure economy. This economy cannot be reduced solely to the efficiency of the mechanical extraction system installed some twenty years ago in the spa town. The natural waters, grasslands and woods that make up the resort’s vast thermal landscape are essential to its redeployment in the light of our current

<sup>33</sup> Archaeological survey carried out as part of the Observatory for Archaeology and Heritage in Haute-Bigorre, initially within Ramond and then from November 2018 as part of an association under the Law of 1901 (OAPHB) in order to meet the development and management expectations of the Collective Research Programme *Water Systems and Balneotherapy in Occitania* (2018/2020). Refer to the association’s website: <https://oaphb.fr/Qui-sommes-nous>.

climate and, above all, to the fact that the inhabitants of these areas play an active part in this overall system. In Bagnères-de-Bigorre, the environment of the springs in the town and in the thermal park is now in decline, with car parks now even being installed at some resurgence points. This is why we felt it was necessary to set up a laboratory of springs with the following three objectives:

- Describing the water systems of the spa town and its vast park as corollaries to those of the pastoral valley;
- Acknowledging the importance of springs as both societal and ecosystem locations;
- Proposing to local residents that they once again become partners in the protection and maintenance of this tangible and intangible heritage.<sup>34</sup>

Since we can no longer claim that the upkeep and development of our habitats can be ensured by delegating services alone, we need to come together at a spring, to share our knowledge and the associated vicissitudes, so as to anchor our scientific and societal questions in the reality of the local landscape's economy. We knew that, in the common sense, a spring is a place where water emerges naturally from the ground after an underground journey, and that journey will dictate its quality: potable, mineral, thermal or even unfit for consumption. In a spa resort such as Bagnères-de-Bigorre, most of the springs have been collected and channelled into reservoirs, fountains, pools and baths, as well as gutters and sometimes drinking troughs. The small Spring Laboratory team therefore decided to begin its work at the Fontaine des Fées fountain in the Bédât woods near the town, in an attempt to appreciate the site *in situ* and thus explore this past in a different way. We worked together at this spring, watching, measuring, surveying, smelling, listening, naming the things seen, showing them to others, discussing them and listening to each other in this way ... and by hearing each other, building a new narrative. The team was lucky enough to include a number of young professionals: a landscape architect, an archaeologist, an archivist, an artist in residence, a visual artist and a historian ... Along the way, despite their professional commitments, each of them – based on his or her individual skillset – took the time to go and draw up a survey or a sketch, take photos, grab maps, write, and glean some archive information.

A programme of weekly meetings and session reports was then put in place. Following the ten meetings held

between April and October 2021<sup>35</sup>, it emerged that all the springs contributing to the context of the listed site of Mont Bédât and Vallon de Salut had been updated by the Regional Environment Office in 2007<sup>36</sup>, and above all those new perspectives had been identified with the development of participatory workshops based on a new tool: the Haute-Bigorre Geographical Information System (GIS)<sup>37</sup>. This tool was developed as part of a partnership between the OAPHB and the Huma-num Paris Time Machine (PTM) Consortium<sup>38</sup>. The various participatory workshops we organised involved both a group of secondary school students<sup>39</sup> and members of five local associations<sup>40</sup>, both active and retired, all

<sup>35</sup> A report on this first 2021 session of the Spring Laboratory can be found in Notebook 3, *Archéologie en Haute-Bigorre* (Archaeology in the Haute Bigorre region), published by the OAPHB in the chapter 'Des eaux naturelles, des herbages, des bois' – *En héritage, le grand parc thermal de Bagnères-de-Bigorre* (Natural waters, grasslands and woods' – A legacy, Bagnères-de-Bigorre's vast thermal park) p. 143 to 190 (<https://oaphb.fr/publications/>).

<sup>36</sup> The Mont Bédât and Vallon de Salut site was listed in 2007 by the Regional Environment Office (DREAL) with the aim of 'raising awareness of the picturesque and historic character for which this site is renowned, particularly in the history of Pyrenean thermal baths'. Its 244-hectare perimeter overlaps the catchment area of the thermal mineral resource.

<sup>37</sup> The Haute-Bigorre GIS was set up in 2020 as part of a CNRS programme to develop research infrastructures. Run jointly by the OAPHB and the Huma-num Paris Time Machine (PTM) Consortium, with the support of the Geomatics team for the Département of Hautes-Pyrénées – which has provided access to the databases of the National Institute for Geographical and Forestry Information (IGN) – this geographical information system contextualises the data acquired by the OAPHB's research by comparing it, using geolocation, with a series of maps and plans, drawings and photos, both old and new, documenting the Haut-Adour Valley. This geohistorical GIS can be accessed in a modulated way. A public version is available on the OAPHB website. Like Google Maps, the Haute-Bigorre GIS gives you access to maps that allow you to find your way around in everyday life and to travel back in time: you can currently see the town of Bagnères-de-Bigorre in 1771 (Plan Terrier, a property map with agricultural use illustrated), in 1791 (topographical plan), in 1810 (Napoleonic land register), and in 1864 (Small Channel Plan) for the time ...

<sup>38</sup> The Huma-Num Paris Time Machine Consortium has become the Time Machine Projects (<https://paris-timemachine.huma-num.fr/>) and is a consortium funded by the CNRS Huma-Num research infrastructure. It is managed by the UMR 7041 ArScAn (<http://www.arscan.fr/>). Members of these two workshops can access the Haute-Bigorre GIS using a personalised code giving them expert access. The work in progress can be consulted on the OAPHB website under the GIS heading (<https://oaphb.fr/sig/>) and on the website of La Fabrique Numérique du Passé (<https://www.fabriquenumeriquedupasse.fr/pages/homepage/?flg=fr>) where the *Bagnères-de-Bigorre, historical milestones* tab gives access to the set of data already georeferenced.

<sup>39</sup> This group is made up of eight students from the Lycée Victor-Duruy in Bagnères-de-Bigorre, accompanied by two of their teachers, one of whom is the Academic Contact for Digital Technology for the Académie de Toulouse.

<sup>40</sup> In addition to the eight students from the Lycée Victor-Duruy in Bagnères-de-Bigorre, the other participants are members of the associations for Pierre des Esclozes (<https://www.campan.fr/vivre-a-campan/associations/patrimoine/pierre-des-esclozes/>), Rigoles de Gaye (<https://www.campan.fr/vivre-a-campan/associations/patrimoine/les-rigoles-de-gaye/>), Sentiers de Campan (<https://www.campan.fr/vivre-a-campan/associations/patrimoine/les-sentiers-de-campan/>) the Grange Foraine barn site located in the Lesponne valley in Bagnères-de-Bigorre (<https://grangeforaine.com/contact/>) and the French Club Alpin of Bagnères-de-Bigorre (<https://www.caf-bagneres-bigorre.com/>).

<sup>34</sup> The concept of 'intangible heritage' emerged at the end of the 1980s and deals with traditional cultures. In this case, this relates to the usages and know-how associated with the gravity-fed management of natural waters.

of whom are working to maintain the mid-mountain landscape.

This initiative is part of an open science and participatory science approach in which digital humanities are the preferred medium for building and sharing knowledge. The workshops are structured around:

- Small channels underlying the town centre of Bagnères-de-Bigorre, based on a land register atlas prepared in 1864 for the installation of forty public fountains;
- Mid-range mountain irrigation systems which, until the inter-war period, supported the valley's pastoral production system based on intensive grassland farming.

The idea was to take two very different levels of the valley landscape as a starting point, to work with local people to highlight the gravitational water supply systems that take water from rivers at their source, through channels and ditches, and carry it to the land, the villages and the town, before returning it to its natural course.

From a formal point of view, we then supervised two teams based respectively on the work of two students supervised in Haute-Bigorre by the OAPHB<sup>41</sup> to carry out two workshops:

- The GIS workshop on 'Irrigation in mid-mountain areas', which brings together a dozen active members from six associations, is working on the seasonal pastoral habitat of the Haut-Adour region, linking the mountain pastures to the grasslands via irrigation channels and ditches. In the light of the detailed studies (Buisan 2001-2012) carried out on the *courtaous*<sup>42</sup>, the team intends to develop a topographical description of this extensive pastoral system. For the time being, the aim is to define and test methods for recording and describing both the routes of the channels and all the associated structures. At the end of the first sessions, there were already numerous potential projects: reactivating a pastoral unit using gullies that have now been abandoned, continuing to maintain the irrigation of a residential area, rebuilding shepherds' huts, re-opening paths, etc. All of these projects have

the potential to contribute to the revival of local pastoral production and to the transition of the tourism offering.

- The 'Small Channels' workshop, which began in 2022 and will be continued in 2023, is currently enabling teams of secondary school students from the Lycée Victor-Duruy to learn about GIS while at the same time learning how to read under-used historical documentation (old maps). For two hours a week from October to February, with field trips and video-conferences, the students are accompanied by a team of history and mathematics teachers from the school, two members of the OAPHB, a member of the Time Machine Projects consortium, an architect and a divisional engineer. During the first session, which started at the beginning of September, a presentation of the 1864 Small Channel Plan was made in the offices of the town's Technical Services Department. This was followed by two excursions during which the pupils were able to meet local residents and a garden historian from the Versailles Fountains Department. They then set about digitising all the water supply chains represented in the Small Channel Plan to create a database that can be used in current digital systems. This cross-disciplinary and interconnected approach to education, which is highly compatible with the expectations of this generation, is proving to be very promising. In particular, it makes it possible to combine an appreciation of the local environment and its history with current issues in the subject areas in which secondary school pupils are learning the fundamentals. A second session is planned for 2023, and this will add other aspects to the database.

This cross-generational, cross-social, cross-neighbourhood and cross-terroir approach to the valley is in some ways an expression of the resilience of the landscape (Robert 2021). Far from expressing a defensive or protective reaction against the inevitable erosion of time, these perspectives represent a move towards possible transformations, possible *ecological resilience* (Robert 2021). Indeed, for the new generations, it is no longer a question of conserving and safeguarding, but of doing, acting and undertaking. (Figure 7)

### Age of service water supply to private homes in town

The complete survey of the town's water supply structure in 1864 provides an initial overview of the unique systems specific to each of the four districts making up the walled town as seen by Louis de Froidour in the 17th century (circa 1625-1685). This late meeting point – for which we have no assurance as to its

<sup>41</sup> In 2021, a geomatics student worked on the Bagnères-de-Bigorre 1864 Small Channel Plan as part of his placement. In 2020, an architecture student studied the water supply chains in the Haut-Adour mid-range mountains as part of her final qualification.

<sup>42</sup> In the Haut-Adour region, a *courtaou*, or *courtaú*, generally refers to a more or less large group of pastoral enclosures used for rearing cattle in summer pastures. Each of these enclosures generally includes a hut and a yard with a lean-to and a stable. Cooled by a spring or stream, a *leyté*, a stone shelter for storing milk from milking, was associated with each *courtaou*.



Figure 7 : view of the Small Channel Plan after vectorisation. By OAPHB / ArScAn 2023

completeness – brought together four districts, each represented by two consuls sitting as a college under the authority of the Count of Bigorre (Sabatier 2015). According to historiographical tradition, it was the Bourg-vieux and Bourg-neuf areas that served as the original basis for the foundation of the contemporary town by the Comte de Bigorre (11th/12th century), followed by the two adjoining suburbs: *Caouteres*<sup>43</sup> and *La Hount*<sup>44</sup>. (Figure 8)

<sup>43</sup> Caouteres, steam rooms in Gascon, according to Jean-François Lenail, archivist-paleographer, former Director of the Hautes-Pyrénées Départemental Archives. This district, formed at the gates of the old town, led to the hot springs and steam baths.

<sup>44</sup> La Hount, Gascon for 'fountain', named after a large drinking water

fountain in this suburb. These four neighbourhoods are clearly distinguishable by their plot structure and the water systems that run through them. You can see the regular layout of the old and new towns, for which the 'padlock'<sup>45</sup> shape is characteristic of the foundations laid in the time of the Count. Those of the two suburbs are more irregular, and one incorporates a first market place. In

fountain in this suburb.

<sup>45</sup> In the foothills of the Pyrenees, the foundations of the market towns resulting from the first medieval revival (10th/11th century) are characterised by a street serving deep strips of land on either side. At each end of the street is a gate. The market is located outside the town. The advent of the 'bastide' movement (13th/14th century) integrated commercial functions at the heart of urban planning.

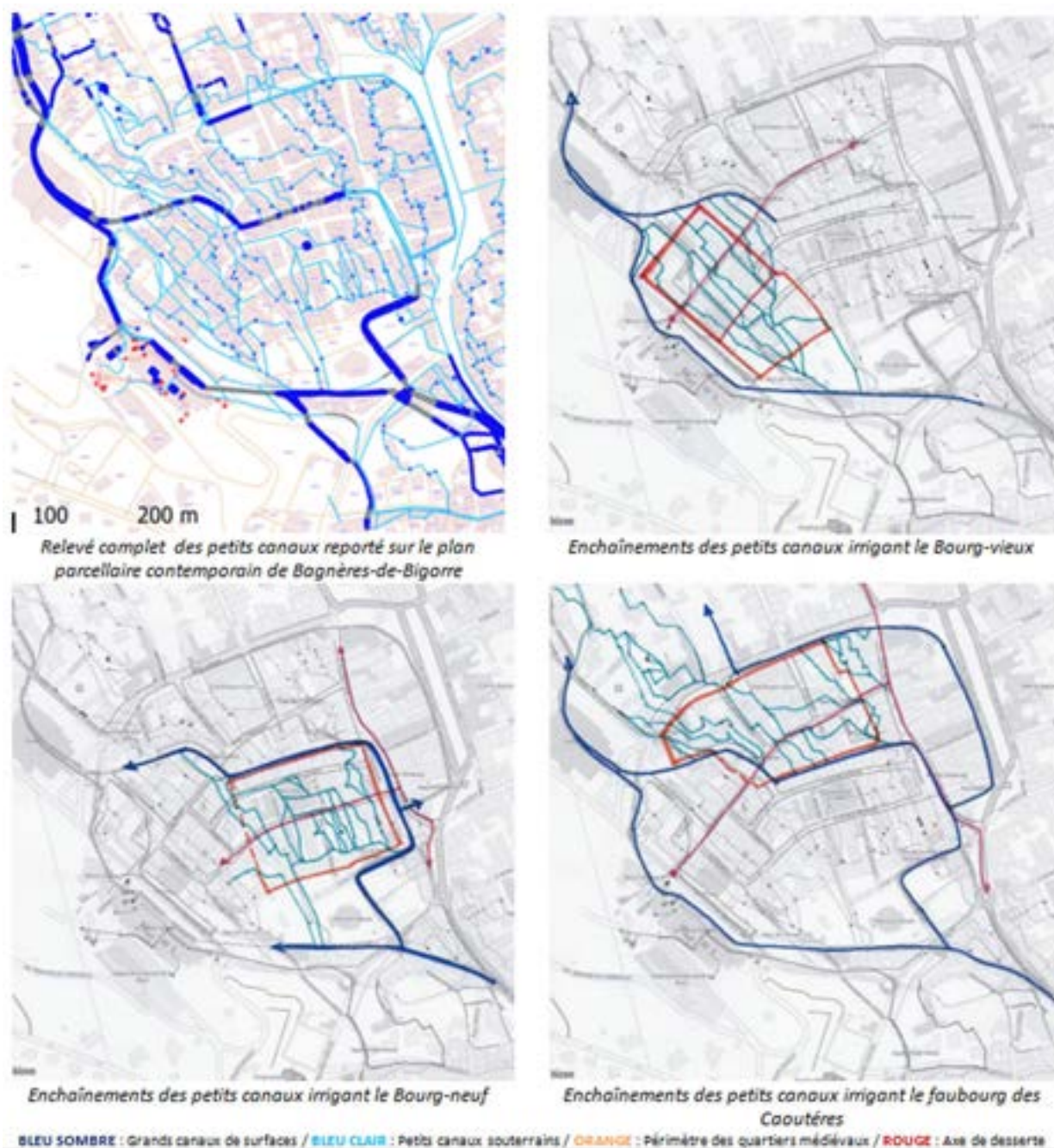


Figure 8 : The organisation of three of the four districts of Bagnères-de-Bigorre. © OAPHB / ArScAn 2023

the absence of an in-depth morphological analysis, the layout of the boundaries remains approximate. What is quite clearly visible, however, are the large surface milling channels that clearly outline the shape of the town and its surrounding walls. This reading leads us to wonder about the rampart, which was paid for by the consuls and was completed very late (if at all), and about the layout of the channels, which seems to us to be earlier. Indeed, the shape of these channels (narrow and shallow) makes them unsuitable for use as moats, and they are also easy to walk through, but they are

perfectly suitable for supplying mills and houses with service water.

We have then spoken on numerous occasions about water supply sequences, as the small channels do not – strictly speaking – form a network in the strict sense of the term, but rather successive sequences running from a water intake on an upstream channel to an outlet. Reading the database, we can therefore see the assemblies and probable phases in which these sequences of underground channels, troughs and

manholes are formed, arranged organically or planned so as to serve the blocks of a single district. The most regular, orthonormal groups correspond to the first two planned districts. The water system links serving the blocks of the two suburbs are more random in form, as if developed piecemeal in an attempt to avoid the obstacle of a rampart, which can then be guessed at. The result is a water distribution system based on gravity, either in the form of a bundle or a comb cutting more or less perpendicularly through the service axis of each of the districts. The water supply network connected to the plots is also distinct from the road network. It was not until the installation in 1864 of the first network, in the strict sense, to supply the forty public fountains that the water distribution route and the public roads became one and the same.

The structure of the series of small channels serving the old town is particularly noteworthy as it is laid out as a whole parallel to the axis of the large ancient collecting tank that we surveyed. This straight ancient collecting tank, which has proportions identical to those of the Gard aqueduct, has its current water course at around three and a half metres below the current surface of the town, namely at paleosol level. It runs for around three hundred metres parallel to the course of the Aygo Tebio, irrigating a thalweg with hot springs on which ancient baths have been built. The small channels in the old town, on the other hand, are located at minus eighty centimetres, and thus at the level presumed to be the ground in the medieval period. However, their routes follow the general direction of the stream rectified by the collecting tank built by the ancient engineers.

### **Conclusion: Working together to develop tools for interpreting the shapes of the town and the shapes of water**

In addition to their social dimension, these workshops have produced (and will continue to produce) original data that can be used to identify the key features of the town's landscape. As demonstrated by the way in which plots of land and roads were laid out, the layout of the small channels that ran beneath the town until the 1970s reveals how this *spa town*<sup>46</sup>, which developed its baths in Antiquity and then at the end of the Middle Ages, and became a spa resort in the 19th century, had inherited a culture of sharing water, with the shape of the town and the shape of the water intertwined. To this we must add rights and duties, which in this case are one and the same. In fact, what this work reveals is that it is not about the register of land ownership, or about the register of publicly owned land, but about

the necessary building of solidarity between residents, block by block, district by district, market towns and suburbs, and about the gradual construction of an urban fabric over the long term.

In this case, the use of digital tools to build interactive workshops has made it possible to vectorise the various water system objects and integrate a number of old sources into an accessible application that anyone can use today. In these historical sources, which give us a glimpse of the successive states of the land, these particular water system objects – the small channels – which can be identified on the fine scale of the plot of land and are described in detail in the 1864 Small Channel Plan, have helped to provide a unique image of all the surface milling channels, small underground channels distributing service or household water to private containers, roadside gutters, catchments and supply points for thermal mineral waters, including reservoirs and basins, as well as an initial pipe-based supply network for forty drinking water fountains.

This document describes the culture of hydraulic engineers and surveyors in 19th-century France, enabling us to capture the very peak of the spa town's beautification and a status inherited from the construction of these water supply systems. This idea of the omnipresence of water in the urban and agropastoral landscape of Bagnères-de-Bigorre disappeared from the 1970s onwards because of the need to comply with health standards and to make way for the car and property developments that restricted areas for water expansion in the town. The consequences of this disappearance are now being assessed in terms of their impact on the resort's thermal environment and its resilience in the face of climate hazards, which are all the more sensitive given that part of Bagnères-de-Bigorre town centre lies directly in the Vaucluse floodplain of the Aygo Tebio stream, and the town is directly exposed to climate hazards that are now set to increase in frequency and volume. In this case, the proposal put forward in this article clearly falls within the field of digital humanities and makes it possible to reactivate a memory for shared engagement that carried this thermal landscape, at once urban and natural. This is a memory which is currently perhaps not lost but at least reduced to a single technical approach, one that misinterprets the medical and cultural scope of balneotherapy. So how can we consolidate, or even retie, this thread?

The archaeological surveying of an ancient collecting tank, part of an underground water supply to the thermal district, combined with the study of surface irrigation systems, channels and ditches, led the team to make these hydraulic systems used to take in and then release natural water locally its subject of research. It

<sup>46</sup> *Vicus aquensis*, spa town, name attributed to the ancient town of Bagnères when it appeared engraved on an ancient votive stone. *Vicus aquensis* is not its name, but the generic designation of an administrative category of territorial management at the time, on a par with *civitas aquensis*, Aachen in Westphalia.

is at the point of delivery of water from a spring – a fountain, a bath, a shower – just as it is at the point of delivery of water taken from a river – a meadow, a pond, a basin, a street – that complex heritage and environmental objects are now anchored, nourished and deployed in search of a future: a former private spa, an urban promenade dominated by the car, a park leading to abandoned farms and mountain pastures, and so on.

In Bagnères-de-Bigorre, although the natural spring and river waters continue to replenish the old, abandoned water catchments, percolate through the soil and sometimes flood the thermal district, they are constrained by the accumulation of successive occupations of the thermal mineral site. In the Place des Thermes, the stratigraphy overlying the paleosol of the Aygo Tebio thalweg is estimated at around 3.50 metres. As a counterpoint, the resilience of the natural waters observed in the mid-mountain pastures of the Haut-Adour Valley questions a form of balneotherapy where post-war medicalisation has not prevented rampant discrediting, a situation that still weighs heavily on resorts that have nevertheless regularly improved their facilities and invested in climate control systems and then in *thermoludisme* (the use of the properties and benefits of thermal water to rest, restore vitality and well-being)<sup>47</sup>. Its considerable archaeological and hydrogeological potential, as well as its accessibility to the public within the framework of the thermal park, offer the opportunity to experiment with the capacities of thermal mineral springs to reconstitute biotopes and biocenoses. To this end, an in-depth survey is under way to gain a better understanding of the interface between the old concrete catchments, now no longer in use, and the rocky facies of the resurgences they cover. In conjunction with a number of official bodies, the aim will be to propose a process of reconstruction and deconstruction that could help to release some of these emergences.

Secondary school students are beginning to understand the significance of open waters, which, from the very beginnings of agriculture and animal husbandry, have generated one of the earliest forms of law. These are forms that have continued to evolve since the development of their driving forces, from mills to the industrialisation of all our activities, and in particular the balneotherapy industry. The members of several

associations, working together and with support, are already collaborating on projects to record and map the fine networks of streams, channels and gullies that make up the headwaters of the Haut-Adour watershed. Returning to our roots, once again and together, is the right place to start.

## Bibliography

- Bouneau, Chr. 2005. *La mise en valeur de l'équipement thermal pyrénéen du Second Empire à la crise des années trente: l'hygiénisme au service d'une nouvelle économie montagnarde*. Presses universitaires de Perpignan, 305-325. Licence OpenEdition Books. <https://www-cairn-info.inshs.bib.cnrs.fr/revue-internationale-d-intelligence-economique-2022-2-page-43.htm>
- Buisan, G. 2001-2012. *Des cabanes et des hommes: Vie pastorale et cabanes de pâtres dans les Pyrénées, La vie montagnarde* (2011) and *Hier en Vallée de Campan* (2012), CAIRN.
- Carribon, C. 1999. Un panorama de l'histoire du thermalisme en France: A. Authier and P. Duvernois 1997. *Patrimoine et traditions du thermalisme*, Toulouse, Edit. Privat. In *Annales du Midi: revue archéologique, historique et philologique de la France méridionale*, vol. 111, n°226, 1999. By D. Porté (ed) *Saint-Sernin de Toulouse à la fin du Moyen Age. Des reliques et des hommes*, 272-274.
- Dedieu, L. and A. Vertallier 2015. *Réinventer ensemble un territoire. Une ville du Haut-Adour, Hautes-Pyrénées*. End-of-studies project at the Ecole Nationale Supérieure d'Architecture (Ensa) de Versailles under the guidance of Richard Sabatier, Government-accredited architect (DPLG), DEA EHES, teacher and researcher; February 2015 session; presentation brochure, Documentation and Information Centre (CDI), Ensa Versailles. <https://oaphb.fr/wp-content/uploads/2020/12/Re-inventer-ensemble-un-territoire-EnsaV-2015-BD.pdf>
- Jazé-Charvolin, M.R. 2016. *Les stations thermales: de l'abandon à la renaissance. Une brève histoire du thermalisme en France depuis l'Antiquité*, In situ [Online], 24 | 2014, online since 11 August 2016, accessed on 14 September 2023. DOI: <https://doi.org/10.4000/insitu.11123>
- Lamothe, M. 2021. *Lectures patrimoniales du thermalisme: quand le patrimoine culturel immatériel et le patrimoine architectural et paysager se nourrissent réciproquement*, Les Cahiers de Framespa [Online], 38 | 2021, available online since 25 October 2021, accessed on 13 September 2023. URL: <http://journals.openedition.org/framespa/11943>; DOI: <https://doi.org/10.4000/framespa.11943>.
- Letang, P. and A. Knauf 2022. L'implantation d'un complexe thermal comme facteur d'attractivité : rôle et enjeux de l'intelligence territoriale, *Revue internationale d'intelligence économique* 14, n°2, 43-61.

<sup>47</sup> While the 1947 Ordinance recognises spa treatments as therapeutic, and subject from that point to reimbursement by the social security system, spa literature, dictionaries and other encyclopedias show that the Academies, still waiting for tangible proof, continue to use the conditional to qualify the therapeutic capacities of thermal waters. Today, according to the Ministry of Solidarity and Health, 'a spa is an establishment that uses water from one or more legally authorised mineral springs, or sludge and gases derived therefrom, on site or by direct supply, for the internal or external treatment of spa visitors'. Public Health Code, Article R. 1322-52, 2021.



- Nartet, M. and J-C. Soule 1986. *Département of Hautes-Pyrénées / Thermal spas and mineral springs*, Geological and Mining Research Office (1986), Ministry of Industrial Redeployment and Foreign Trade.
- Robert, S. 2021. *La Résilience: persistance et changement dans les formes du paysage*, Interdisciplinarity, Sciences and Humanities Collection, ISTE éditions.
- Roux, L. 2008-2009. *Le thermalisme européen au XVIIIe siècle: Etude comparative de quelques villes d'eaux, France, Angleterre, Belgique, Suisse, Italie, Allemagne*. Master 2 Humanities and Social Sciences thesis. Specialism: History of international cultural relations and exchanges. Université Pierre Mendès-France. Grenoble.
- Sabatier, R. 2015. *Un édifice dans son paysage*, Newsletter of the company Ramond.
- Scheid, J., M. Nicaud, D. Boisseuil and J. Coste (eds) 2015. *Le Thermalisme: Approches historiques et archéologiques d'un phénomène culturel et médical*, Paris. CNRS.