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Water in Dry Catalonia

Historical Water Usage and Perspectives for Present-day Evaluation: Case Study of the Municipality of Torrebesses, (Segrià, Western Catalonia), in the Area of Vall Major

On the basis of the heritage conserved, the oral testimonies and the historical documentation, it shows how the inhabitants of drylands from Torrebesses (Western Catalonia) have developed through time strategies for harnessing rain water, surface and groundwater that have allowed them to move forward with a diverse range of agricultural production and related activities and have made it possible for the subsistence of a relatively dense network of local communities.

Sobre la base del patrimoni conservat, els testimonis orals i la documentació històrica, l'article explica com els habitants dels secans de Torrebesses (Segrià) han desenvolupat al llarg del temps estratègies per a l'aprofitament de l'aigua de pluja, la de superfície i la de la capa freàtica, fet que els ha permès seguir endavant amb una ampli ventall de productes agrícoles i activitats relacionades, i que ha possibilitat la subsistència d'una xarxa relativament densa de comunitats locals.

Keywords: Drylands, hydraulic, irrigation, Catalonia

Paraules clau: secans, hidràulic, regadiu, Catalunya

In spite of the pejorative connotation the dominant discourse of our day attributes to dry lands, throughout history they have been economically and culturally vibrant territories, and this vitality has been associated with the presence of water. A good example would be the dry lands of the Segrià district in Catalonia, and especially the municipality of Torrebesses studied here. These dry lands have developed strategies over time to benefit directly from rains and resultant usable groundwater, used for a diversity of agricultural production and for other productive activities, besides meeting the direct water consumption needs of local inhabitants.

In this paper we set out to analyze knowledge, infrastructures and systems related to water conservation, as contextualized by hydro-geological reality and socio-economic dynamics. In doing so, the study begins with an inventory of infrastructures and material features that are relevant for the regulation of the water cycle in dry lands. This goes along with a systematic summary of historical knowledge related to the water cycle, both in terms of scientific and technical observations, and in relation to water management

practices as related to various activities and conservation initiatives. Together they have all come to make up part of the Ethnological Heritage Inventory of Catalonia.

At the same time, and despite the fact that this study brings together only the main conclusions, a hydro-geological evaluation has been made of how the water cycle works in the dry lands of the Les Garrigues district, both in terms of the quantity and quality of the resource, and in relation to its distribution and condition. An assessment has been carried out of the reuse, renovation and reconversion of existing constructions and facilities through the Technological Institute of Lleida (Institut Tecnològic de Lleida), a participant in the program, and itineraries have been designed for heritage observation, education and promotion, as well as water cycle management in dry lands.

For the reasons here indicated, a multidisciplinary team participated in the study, with the intervention of University of Lleida professors Ignasi Aldomà, a geographer, Enric Vicedo, a historian and Josep Carles Balasch, a geologist, along with geographers Marina Guillén, Joan Ferrer and Josep Ramon Mòdol and the agricultural engineer



■ Water drawn from a well with a pulley was enough to fill the adjacent trough. Animals drank from them, gardens were watered, and it was even possible to do the washing, maximizing usage of water resources (Maials district limits). MUNICIPAL ARCHIVE OF TORREBESSES.

Manuel Murillo, Carles Pubill and Carles Labèrnia participated from the Technological Institute of Lleida, while Josep Preixens and Mateu Esquerda were the lead researchers in developing the inventory.

Dry Lands and Water Shortage Management

Over time the inhabitants of Les Garrigues have adapted and have learnt to benefit from the water available in their own territory. Les Garrigues is a dry land, though it is not a desert; water is abundantly present and many opportunities are available for its utilization.

Material and intangible testimonies in the present speak to us of the local population's capacity for adaptation and knowledge acquisition in relation to the possibilities afforded by the water cycle.

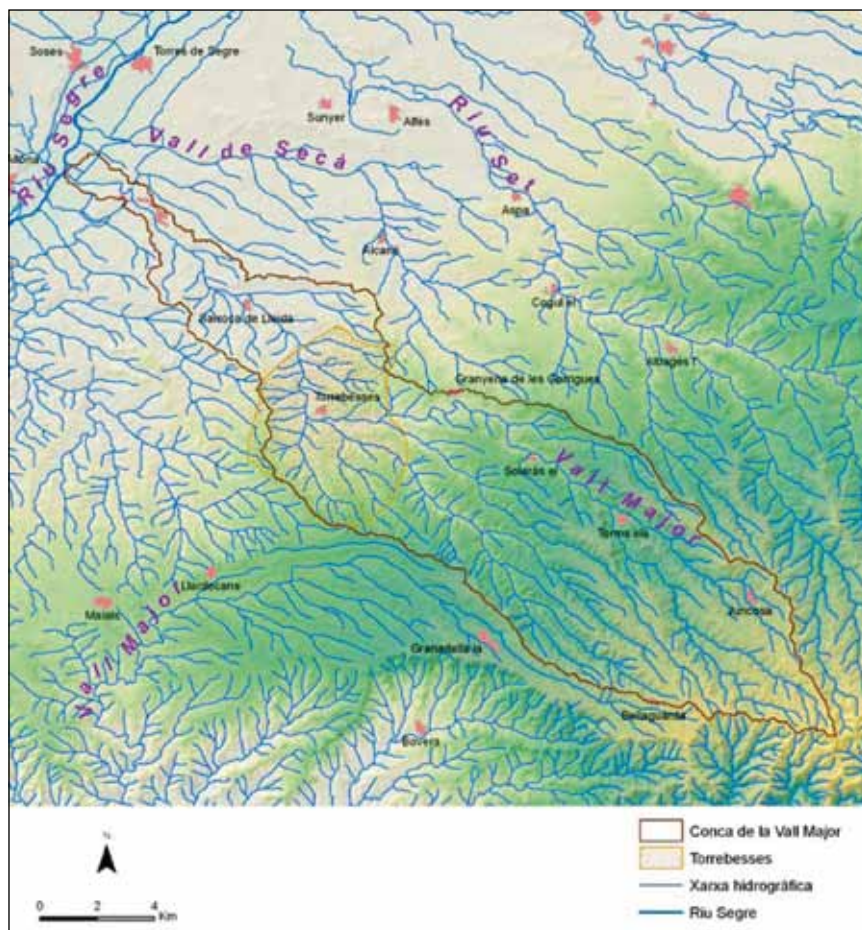
As Torrebesses is found in an inland area set off from the main watercourses flowing down from the Pyrenees, the population and activity of the town and of other municipalities in the district historically depended on rainwater. Precipitation falls on surfaces that are not in principle ideal for water absorption, as occurs with the presence

of Oligocene substrates with a very low porosity; a proof of this is the absence of important natural springs on the high planes and on the hills that characterize most of the region. The only surface of any consideration with the capacity for water retention and storage is found at the bottom of valleys, where we find rather deep alluvial or colluvial substrates.

The annual average infiltration feeding the aquifer of the Vall Major allows us to acknowledge that there was enough water available for historical consumption needs. Water use has been adapted

MAP 1

Torrebeßes and Vall Major as contextualized in the hydrographical system of the Ponent plains.



The abundance of water at the valley floors of the main watercourses Set and Vall Major directly rely upon the size of their capitation areas. This explains the hydrological pre-eminence at Torrebeßes of the two main valleys in the municipal limits, above all Vall Major (Great Valley), whose name clearly describes it.

agricultural water use practices, above all related to the area that accumulates the resources or main reserves, at the valley floor. On the other hand, in the rest of the territory, represented by hills and high plains, technical and infrastructure development is motivated by the need to meet the requirements of people and animals, which is done by direct utilization of rainwater. As we shall see, there is no strict separation between them. There is, however, a rather significant difference between the water supply for crops found at the valley floor and provision for drinking water on the hills and on the high plains, with the accompanying development of specific infrastructures in each given area (see attached figure).

The total sum of heritage related to water in the inventory, beyond the strict confines of the town centre, comes to 313 heritage sites, each defined by the main feature characterizing it. It should be kept in mind that in some cases these sites have additional features or facilities that complement the main feature, so that the total number of facilities comes to 342 (see attached table), without taking into account basins, sinks and other small, more or less mobile features.

to the needs of the moment, and increasing consumption, along with the emergence of new conservation infrastructures, has gone along with the process of human settlement of the territory. The structural hydric deficit was not considered until quite recently, in the 1980s and 1990s, when projects were developed for mass pumping of irrigation water from aquifers at the valley floor.

Water Management as the Basis for Human Settlement

Over the years the enhancement of the overall percentage of the surface area dedicated to agriculture would lead to greater needs for manual labour and

animal assistance, with simultaneous food, water and service requirements across the board. In order to meet the water needs of people, animals and crops, a full-fledged program of water management and usage of the limited hydric resources found locally would be developed, leaving in its wake a vast quantity of material heritage and knowledge, constituting the central purpose of the study.

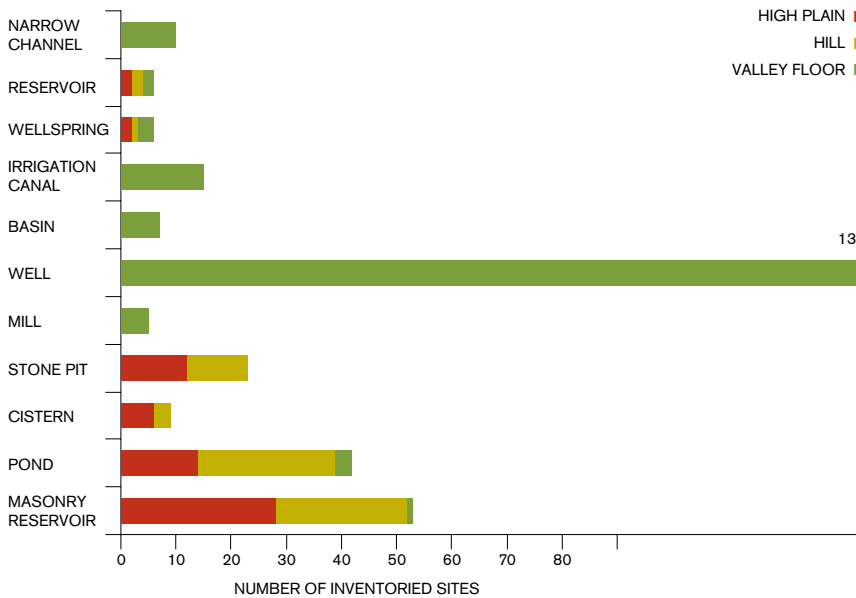
As seen in this study, responsible water consumption involves two clearly differentiated areas set apart by priority water uses, in line with the dual hydrological nature of the analyzed territory. On one hand there are strictly

The most frequent facilities found are wells, which do not raise considerable classification doubts and number about two per family. The density of wells over the entire territory of the municipality is 5 per square kilometre, though this figure rises to one per hectare when considering the main valley floors where they are mostly found. Along with these wells there are other facilities for gathering and storing water (supply galleries, water tanks, water-drawing mechanisms, and so on) that highlight the wells' economic and heritage value.

Ponds, pits dug into bedrock, masonry reservoirs (known as *aljubs*) and cis-

GRAPHIC 1

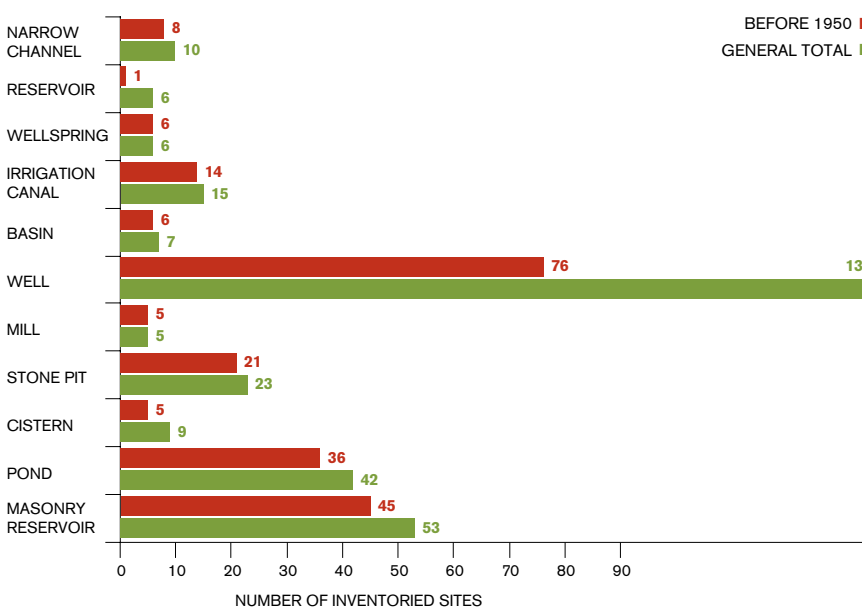
Characteristic features of built water-related heritage, according to physical placement, 2010 inventory.



SOURCE: elaborated by the author from the inventory of construction in the municipality. The numbers refer to sites, as defined by the most characteristic facility (see note in accompanying table).

GRAPHIC 2

Characteristic features of built water-related heritage, according to construction period, 2010 inventory.



SOURCE: elaborated by the author from the inventory of construction in the municipality. The numbers refer to sites, as defined by the most characteristic facility (see note in accompanying table). From amongst all elements in the inventory it is important to differentiate between those built in recent decades and those from the first half of the 20th century and beforehand, as these latter are significantly different in terms of form and materials. In recent decades a significant number of new wells have been built, as well as some ponds, larger more historical reservoirs and water deposits.

terns (the term includes more recent examples and those with more unique typologies and materials) are different types of storage methods for rainwater falling on the hills or high plains, used mainly for human and animal consumption. These four typologies, which have a similar storage function, together comprise a quantity of examples that is close to the number of wells; their density and spread throughout the territory is thus remarkable. Furthermore, there are other reservoir features like tanks and deposits that are more modern, and others whose function is not related to maximizing rain water usage.

Irrigation canals, for their part, have a significant heritage and economic interest in many dry lands. In Torrebesses this interest is related to their size and their importance in constructive terms. The structure of irrigation canals has made it possible to irrigate a good part of the valley floor, and along with these major canals we find bridges, tunnels, ponds, splitter walls, narrow banked channels and other common water storage features that accent their potential and interest.

Finally, in the generic section of well-springs, there are a few natural springs and their corresponding stone fountains, with the inventory also including three historical flour mills and two older olive oil mills, all with quality water management facilities.

It should be said that the inventory carried out does not fully cover all water-related heritage. There are unique features in the territory with an important artistic or heritage interest, such as basins and stone-lined channels, which for their mobile nature or smaller size have not been explicitly included in the inventory. Besides this, there are still remains of sinks and other water management systems related to existing facilities or to specific crops that

are not large enough or do not have particularly special traits. As such, they have not been included in the inventory, spread out as they are throughout the study area or with a limited “constructed” size. All of these details are in any case considered here within our general analysis of water management in dry lands.

The Valley Floor as a Key Area in Water Cycle Usage

In the geomorphology of the Les Garrigues district, valleys function as channels, cutting the high lands in direction SE-NW and E-W, and then ending up in two or three main valleys that flow into the Segre or Ebro rivers. The valley floor is a natural drain, channelling rainwater runoff and water accumulated in the alluvial sediments at variable depth. Towns in the region were generally founded along the valley floors, accompanied by smaller fields, irrigated crops and mills, and other features. The spread of hydraulic heritage and the constructed merit of the features found along the

valley floors, clearly demonstrate the economic interest of surface water in this dry territory, which could today seem to be and in fact really be suffering from water shortages.

The main irrigation canals, which we can consider to be central since they constitute fundamental infrastructure running down the middle of the valley floor, are the area’s largest and most important construction projects. These canals originally appeared for the purpose of draining the valley floor, channelling excess rainwater and reducing risk of erosion and destruction of fields and their edges. Thus the river in Vall Major is essentially the irrigation canal of Vall Major, appearing in present-day topographic maps as a creek or ravine. The irrigation canal regulates this historical function of water runoff, its seasonal importance shifting in function of rains, with more activity in the spring and autumn, and with a summer drought between. Currently it is rather infrequent to see water running through Vall Major, fundamentally

because the aquifer at the valley floor is overexploited and rainwater never manages to refill it.

The main supply lines were done with lateral canals branching out from the main irrigation canal. These lateral canals, which are smaller and of a lower construction quality than the main one, are also in a worse state of conservation, even though many can be perfectly well identified. With the exception of the occasional starting section of a lateral canal, the smaller ditches are dug into the earth, with the clay typical of the area ensuring optimal sealing conditions. Their profile denotes a minimal slope, gaining in altitude over the floor of the valley so as to be able to use the water for mills or agriculture, taking advantage of the effects of gravity; thus on a map these ditches appear at the valley edges and fit into the adjoining hillsides.

The greatest demand is in summer when water is scarcer and when surface water most typically disappears. In

TABLE 1
Water heritage in the municipality of Torrebesses, 2010 inventory (1)

	HERITAGE FROM BEFORE 1950	TOTAL HERITAGE	COMPLEMENTARY FACILITIES	FACILITIES DENSITY	FACILITIES PER FAMILY
Masonry Reservoir	45	53	0	1,9	0,4
Pond	36	42	3	1,7	0,3
Cistern	5	9	0	0,3	0,1
Stone Pit	21	23	7	1,1	0,2
Mill	5	5	0	0,2	0,0
Well	76	135	2	5,0	1,0
Basin	6	7	17	0,9	0,2
Irrigation channel	14	15	0	0,6	0,1
Natural Spring	6	6	0	0,2	0,0
Deposit	1	6	0	0,2	0,0
Narrow Channel	8	10	0	0,4	0,1
GENERAL TOTAL	223	311	29	12,5	2,4

SOURCE: elaborated by the author from the inventory of construction in the municipality. (1) A distinction is made here between inventoried places and facilities, in that inventoried places, with different registries in the heritage inventory, sometimes include more than a single feature or facility. Thus the wells are accompanied by some kind of deposit for water, which could mean basins or larger troughs, included as such when larger than 2 m². (2) Instead of indicating numbers of homes the choice was made to refer to numbers of families, since there are homes that are connected and work collectively. While in documentation from the end of the 19th century and the early 20th century there were 78 owners with ploughing animals and 208 homes in the census, and early agrarian censuses gave a maximum of 147 farms (1972), the choice has been made to use 140 as the reference for numbers of farms in establishing an indicator of facilities per family.

these circumstances the main reserve of water was found in colluvial terrains running along the valley floor, previously fed by rainwater or by seepage from the main irrigation canals. At certain points the aquifer is so near to the surface that the water is close to swelling out in natural springs, as is the case with the natural spring water fountains found at either end of the municipal limit, or with the *town fountain* found nearby, at the confluence of the Major and Siscars river valleys. Still, in most cases it was necessary to drill into the earth to access groundwater through wells.

We cannot establish dates from existing remains so as to clearly identify the construction period of the wells now found. However, the construction materials used do allow us to pose a few hypotheses. From the oldest, simplest and most shallow wells dug into the ground itself to the most recent, which are deeper and complex, using metallic tubing, there is a gradual shift in construction materials with their corresponding techniques, setting apart the successive periods in well construction. Historically, after simple earth-lined wells, we find those made of stone, mostly non-mortared stone, while into the 20th century we begin to find brick wells and, after them, those done first with cement piping and then with metallic tubes.

Direct Use of Rainwater. Ponds, Pits and Reservoirs

Nowadays, when the outskirts of rural towns seem practically empty, it is difficult to appreciate how not so long ago human presence and activity were dense and constant. Only such human presence can explain the amount of constructed features spread out over areas like the municipal limits of Torrebesses, meeting not only agricultural needs but also those of seasonal residents. We are in fact dealing with environments and landscapes with

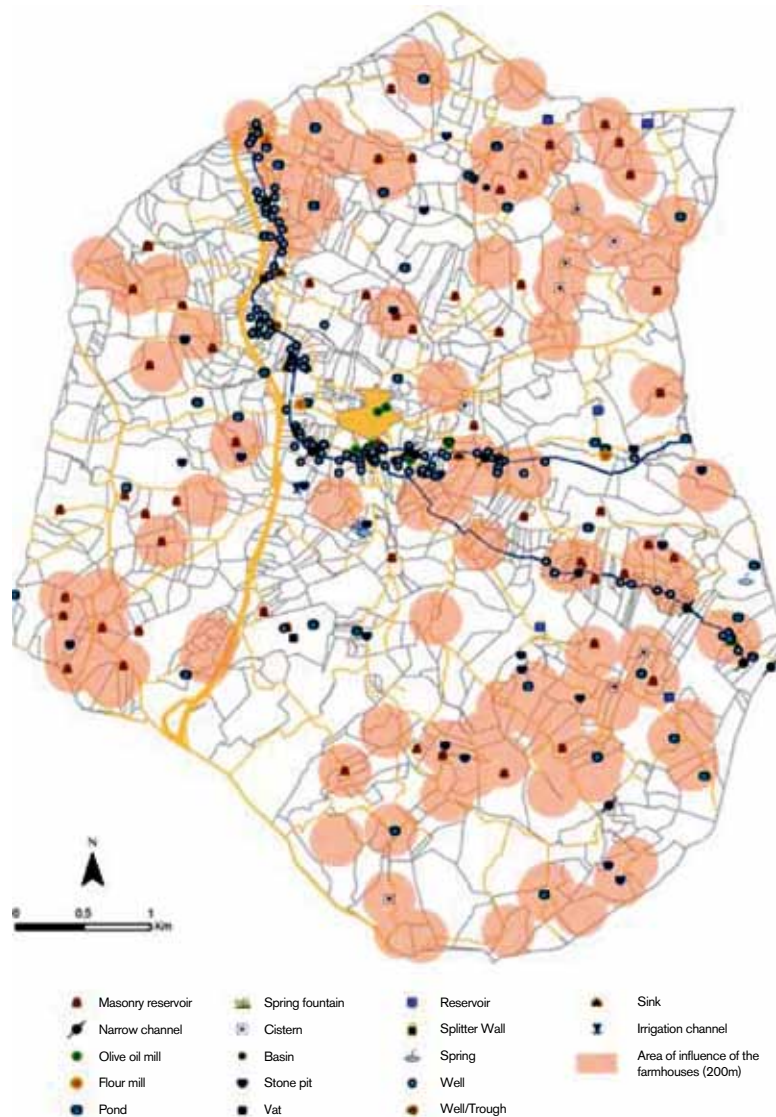
an intense human presence, where the water requirements of the outlying areas of the municipality almost matched the needs of the town centre. This is what fundamentally explains the rich constructed heritage related to water usage spread out over the entire municipality.

Once above the main valley floors, water was obtained from rain runoff, which was channelled into various types of deposits. Ponds were dug

where the ground was softer, and stone pits and masonry reservoirs appeared in areas with harder rock surfaces. Rainwater was directed towards these generally rounded deposits using lined waterways freed of brush and kept clean, with the idea of draining more or less larger capitation basins. These features were called *aigüeres*, referring to drainage systems, and they were also used to bring water to the fields, in some cases making use of existing paths used for walking.

MAP 2

Water heritage map of the municipal limits of Torrebesses, 2010 inventory.



Source: elaborated by the author from the inventory of construction in the municipality. See the concentration of wells in the valley floor, near irrigation canals, while ponds, masonry reservoirs, stone pits and other water-retention systems are found on the hills and on the high plains.

Different types of water deposits are found all over the high plains and hills in the area. Their task was to ensure drinking water for people and animals during the periods spent working in the fields. It is not unusual, therefore, to find that a good part of these facilities are near to or related to cabins and farmhouses used as temporary residences. Besides this, water stored in different locations in the municipal limits could also be used for the occasional irrigation of a specific crop, besides serving as a complement to domestic consumption if circumstances so required.

The presence of ponds, stone pits and masonry reservoirs, found throughout the municipality, can be related to the agricultural settlement of the territory. There was most likely a particularly intense period of settlement in the 18th century, when agriculture grew rapidly to the detriment of more generally common economic activity in the forest, or with livestock. By means of terracing and other types of support infrastructures for agricultural activity, settlement grew most sharply in the second half of the 19th century and the first half of the 20th century. The total amount of cultivated land peaked in the 1950s, even though local demography had already begun to fall off in the first decades of the century.

Meeting Domestic Needs and Water Consumption

Water consumption is a primary necessity of those inhabiting the town centre, satiating the thirst of people and animals as well as responding to cooking and food preparation needs, and those related to domestic cleaning, clothes washing and other necessities. In order to meet such demands, a variety of family strategies were developed. This led to a diversity of infrastructure solutions, including shared ponds, fountains and wells around the town,

as well as private cisterns and other highly varied solutions depending on each residence.

Historically, domestic water supply for the inhabitants of Torrebesses had two key reference points: the large constructed pond in the upper part of the village, and the smaller one in the lower part. Compared with other sources of water supply, the water from the ponds was clearly preferable as it was of superior quality, and only water coming from other masonry reservoirs, which were also filled with rainwater, was more highly appreciated. However, these reservoirs were usually found farther away and were for more exclusive use. Residents were clearly more habituated to consuming water from the ponds, in spite of the

fact that its colour or taste was not always optimal.

When water availability in the ponds fell, it was necessary to recur to other supply sources. For reasons of its proximity and for the abundance of water found there, the natural spring fountain at the valley floor, at the confluence of Vall Major and the Siscars River, was the preferred place. The well of the town was just beside this fountain; as it was much deeper than the spring, it was possible to access reserves from below the river bed in times of greater drought.

When it came to water for drinking or cooking, if there was not enough in the ponds or if the water found in them was discoloured, the townspeople preferred the water from the two



■ Filling jugs at the pond above the town from the access stairs still conserved.
MUNICIPAL ARCHIVE OF TORREBESSES

fountains in the municipality to the water from the spring fountain or the wells at the valley floor. However, the trip to the fountains took considerably longer and water flow was weak, so that there would typically be a long wait to fill up with water. In dry conditions it was even more common to go to the fountain—no evidence exists suggesting it ever dried up—and it was not unusual to even go at night.

For the houses in the town and for any kind of covered construction, the most autonomous way of ensuring water availability was to take advantage of rainwater falling on the roof. The implantation of such self-sufficient supply systems was relatively easy and gave better results in free-standing buildings, unlike with the townhouse-style homes characteristic of Torrebesses and other towns in the interior. It is likely for this reason, and also due to the relative abundance of available resources near the town centre (as already observed) that the presence of homemade water capitation systems using cisterns has not been particularly significant in Torrebesses.

Hydraulic Heritage in Present-day Development of Dry Lands

In general terms, the inventory of rural heritage in the municipality of Torrebesses, along with the study of a diversity of territorial variables, together paint a picture where agricultural production on larger farms has expanded and human presence has decreased, symptomatic of the shift in agricultural activity since the 1960s. Local agroclimatic conditions have not been adapted to the models of industrial agricultural transformation, as seen in agricultural areas where production is more intensive; nor have there been local initiatives to open up specific lines of development adapted to the zone. As a consequence, agricultural activity in the present consists fundamentally of intensive livestock exploitation, almost entirely unrelated to the local agrarian base. Agricultural land is being lost, while, in general, areas of uncultivated terrains or forested areas are expanding.

The previously-explained process of change also explains how nowadays a good part of the rich agricultural

heritage built up until the 1960s has remained intact, as a result of a type of agrarian activity and culture grounded in Mediterranean dry land conditions, with the intensive use of manual labour, mostly family-sized production units and a strong component of family self-consumption.

The needs giving meaning to the full set of heritage in the area, constituted as an agrarian society based on family farms and the intensive use of manual labour, have been transformed or have disappeared, while the new approach taking hold is adapted to the demands of these changing times. In this sense, the possible use of heritage features should be placed in the context of the diversity of functions required of agricultural areas, as an addition to more classic productive activities, which themselves are undergoing change. As for the different types of infrastructures and features of interest, a full range of specific functional possibilities can be indicated (see accompanying table).

- Smaller garden plots and their dividing walls have great agronomical interest, and their preservation

Table 2

Number of water storage features and maximum volume of reserves as calculated in cubic metres, according to types; 2010 inventory.

	FEATURES BUILT BEFORE 1950					FEATURES BUILT IN 1950 AND AFTER				
	FEATURES	(m ³) MINIMUM	(m ³) MAXIMUM	(m ³) AVERAGE	TOTAL	FEATURES	(m ³) MINIMUM	(m ³) MAXIMUM	(m ³) AVERAGE	TOTAL
Pond	36	3	4887	484	17434	6	24	5600	2631	15788
Stone pit	20	0	8	1	28	2	1	5	3	5
Masonry reservoir	45	2	23	9	393	8	1	8	5	38
Cistern	5	4	18	11	55	4	2	16	9	36
Basin	6	2	56	21	128	1	1	1	1	1
Deposit	1	32	32	32	32	5	12	4624	1121	5604
Mill Ponds	4	0	420	105	420					
TOTAL	117				18490	26				21472

SOURCE: elaborated by the author from the inventory of construction in the municipality. The cisterns found inside buildings in the municipal limits are not included. It could seem insignificant in the present that in 1950 all forms of water storage, excluding cisterns in the town itself and the wells themselves, came to a total capacity of under 20,000 m³, just a tenth of the total amount of water stored in just one of the large ponds made using modern construction techniques along the Segarra-Garrigues Canal. However, historical water reserve capacity ensured reserves of some 20 m³ per person per year in times of maximum population. This quantity is significantly lower than current water consumption averages, though it was large enough and adequately adapted to local needs in the period circa 1900 (see accompanying table).



■ Sisters at the public washing basins at the end of the Vall Major, 1960s. Until 1965 the running water network was not connected to individual homes, so that at Torrebesses washing was done in public basins, while in certain cases it was also done in private basins. MUNICIPAL ARCHIVE OF TORREBESSES

should be viable from a productive perspective, particularly in areas that are not too steep and where mechanization would be feasible. A productive option should possibly be considered that would enhance their surplus value.

- Still today the wells have agricultural interest. However, even though there is no need for such a large quantity of them, their possible recuperation would be linked to the regeneration of the water cycle and the revival of the reserves below the river bed,

along with shared management of the aquifer.

- Reservoirs, ponds and other features related to domestic consumption in the rural environment have lost their original purpose, making it necessary to seek out more recreational or touristic alternatives. To the degree that some kind of habitat or temporary occupation is sustained, this would make it more viable to give these infrastructures some sort of function. In any case, agricultural activities, hunting, horseback riding or other leisure activities should not lead to the creation of new hydric facilities, but rather should benefit from the use of existing ones whenever possible.
- Environmental functions or those favouring the landscape correspond to a great diversity of features, although they are especially interesting for those that have been historically used for drinking water for animals, or those standing out and clearly visible in the agrarian landscape. This would be the case with ponds, and with the irrigation canals and other complementary features at the valley floor.

Due to changes in material culture over the past 50 years, historical water heritage features have generally fallen into disuse. This lack of use brings with it a lack of maintenance and gradual deterioration, affecting some facilities more than others. The purposes they were originally built for have lost interest, and, on the other hand, the materials and construction techniques are not well-adapted to new uses. Without functional recuperation able to reactivate existing heritage, as has previously been observed, the proposal would be to highlight the need to at least preserve those features of greatest interest or especially at risk of deterioration, or those already damaged or in poor condition. ■



■ A mother and her daughter on their way to fetch water at the Clin Clan fountain, with jugs carried in the side baskets, called *esgrael·ls*. MUNICIPAL ARCHIVE OF TORREBESSES

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