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VERNACULAR ARCHITECTURE IN THE CUYO REGION (ARGENTINA)

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Key words: vernacular architecture, desert environment, high seismicity, buildings materials and technologies.

Abstract

As it is widely known/universally accepted, the concept of vernacular architecture implies the consideration of certain building terms, such as:

- a) Building practices are related to popular wisdom, which is transmitted through tradition, with scarcely or no professional intervention during each construction stage.
- b) Native materials and technologies that fit the local bioclimatic features are used to construct these buildings.
- c) These types of building practices are mainly related to rural areas, where the modernization of construction technology has not arrived.

Within the Cuyo Region (Argentina), some other conditions related to the physical environment have been added to these particular architecture features: Dry weather and high seismicity characterize the vernacular type of construction.

This article summarizes the outcome of a series of systematic studies: Historical, cataloguing and surveillance, and restoration studies, which our team has been carrying out over several years on these kinds of buildings. Vernacular construction, due to its authenticity and originality, represents a valuable part of the architectural patrimony of the region, but it is also the most vulnerable, since it is at high risk of being lost.

Our aim, through this article is to offer a brief description of the most significant architectural types, providing examples of buildings, which are still preserved, within a frame of analysis of the social-historical and technological situations in which these buildings were erected. The objective of this work is to understand the serial development of certain building traditions, which may be construed –within the historical process- as medium and long lasting phenomena, and to establish a relationship between building techniques in the Cuyo region (Western Argentina) and a wider scope, which is vernacular architecture from the Southern Cone of Latin America.

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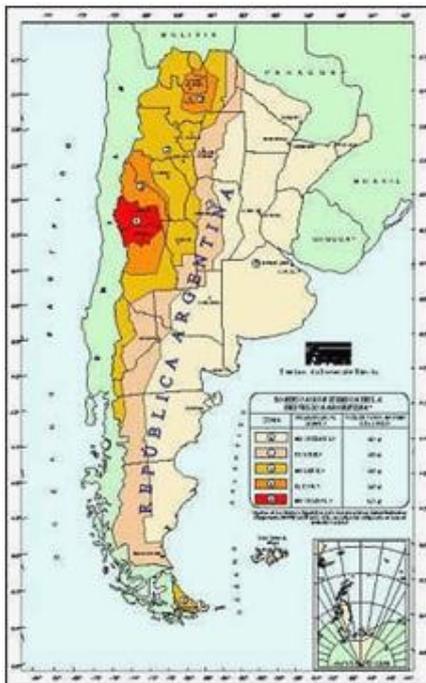
1. The Cuyo region, an irrigated oasis

The Cuyo region², with Mendoza as the main city, has characteristics of its own that bestow the region a particular identity within the Argentine territory. Since the foundation by Spaniards in the middle of the 16th century, Mendoza's development has been strongly conditioned by two factors inherent to the natural physical background: a) the aridity in a desert environment and b) the high seismicity of the region.

Human settlements have been linked, since pre-Spanish times, to the presence of water. The regional economy, based on agriculture and the distribution of the population are highly dependent on artificial irrigation. This has determined the conformation of "irrigated oasis" ecosystems, using and systematizing hydric nets fed by rivers. In the case of Mendoza, these oases occupy a minimum part (4 per cent) of the province's surface where 97 per cent of the population is concentrated.

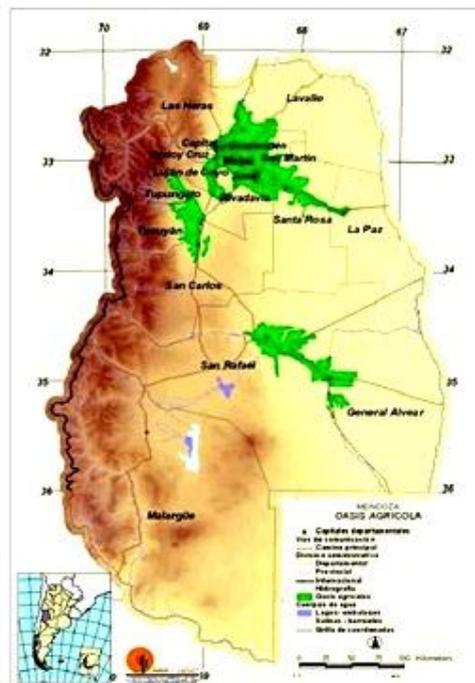
The region of Cuyo (particularly the cities of Mendoza and San Juan) is in a high seismic region, with violent earthquakes recorded along its history. The hazard zone coincides with the arid and semiarid diagonal of the country, where both cities are in the most dangerous zone (see figures 1, 2).

Figure 1. Seismic map of Argentina



Source: INPRES – Argentina.

Figure 2. Map of irrigated oasis



Source: Gobierno de la Provincia de Mendoza.

² When we talk about the Cuyo region, we first refer to the historical "Province of Cuyo", formed by the current Mendoza, San Juan and San Luis provinces. However, the geographical region we refer to -located at the intersection of two variables: dry weather and high seismicity- also includes La Rioja, Catamarca, and a portion of Córdoba provinces. Likewise, there is cultural region that has to do with traditional technologies and systems, which bind the architectural production from the West of Argentina with that from Chile and the Andean cultures.

These two conditioning factors have affected the architectonic production since the early years to the middle of the 20th century when the traditional solutions gave way to the effects of modernization and technology.

Vernacular architecture adapted adequately to the environment in these bioclimatic aspects as well as in the use of regional materials. Due to their scale and dimensions, the settlements did not destabilize the natural ecosystems until the end of the 19th century.

In the case of Mendoza, this hispanic city, which was founded in 1561 on an indigenous Huarpe agricultural settlement, had systematized the use of water coming from a branch of the Mendoza River. The rigid orthogonal trace was conditioned from the beginning and through its consequent evolution to the irrigation net.

Water constitutes a structural element in the oasis' organization. The evolution of the city proves a strong subjection to a primary net, organized in the pre-Hispanic times from the use and systematization of the natural watercourses in relation to the topography and the slopes. This hydric matrix conditioned the location of this Spanish city and the structural plotting of the territory: the streets, the roads, the urban and rural cadastre, and the location of buildings and cultivated areas in the flat plains (Ponte, 2007)

In the Cuyo region the empiric management of traditional materials and technologies, resulted in homogeneous knitting in the city and in its agricultural periphery.

The buildings were very low, one-storey with thick adobe or adobón (or tapia) walls, reed and mud roofs over poles or wood tie beams. Descriptions by travelers in the middle of the 19th century coincide in their praising of its gardens and orchards, and also in the flatness and sparseness of the buildings, where only churches outstood. The agricultural activity, together with an intensive use of the soil, determined a territory organization where differences between rural or urban, faded. This means that the city had quite a rural appearance due to the low density, the presence of many orchards, vineyards and cultivations, and the surrounding agricultural land, organized by the irrigation net, had buildings as good as those of the city.

The vernacular architecture has been generally characterized by two factors: one, the prevailing development of unbaked mud architecture, and low buildings. The available materials of an arid environment were mud, reeds, found by rivers and lagoons and very scarce wood.

The lack of wood heavily influenced the building traditions up to the 19th century. In particular, this lack made it impossible to install brick kilns that used wood as fuel. Instead, adobe was used for curious roofing such as the mud domes, with or without the supporting framework.

The consolidation of the agricultural oasis, the availability of wood from the crops (fruit and olive trees) and the introduction of some foreign species that rapidly spread like the poplar tree (*populus alba*, *populus nigra*, *populus canadensis*) gave way to important modifications in 19th century architecture. Buildings became progressively lighter and modulated. Columns and breast summers appeared in traditional galleries (semi-open spaces as extension of inhabited locals), instead of the solid pillars with arcades of previous years. Dome covers and the roofs with a marked pitch disappeared (Guaycochea, 1978).

The earthquake of 1861, which was very destructive, notably affected the architectonic production of the region. Popular knowledge was then reformulated - new and ingenious solutions were sought after, where the technical knowledge of "specialists" and the building techniques of other seismic regions (Central Valley of Chile and Peru) were the reference from where information came or with whom a continuous cultural contact was maintained.

After the "great earthquake" the buildings were still made with mud systems as they were considered more elastic, needed cheaper resources and it was technology at everyone's reach. Technological innovations were the adding of resistant wood structures, using "adobe", and "quincha" (wall of reeds and unbaked mud) in the closing or interior walls. Works produced since then cover a wide range of variants where mud systems, light "quinchas", and wooden frameworks were combined.

Even though buildings were still low and one-storey, these technological modifications affected the spatial form. Floor plans as well as façades tend to symmetry and to modulate openings and columns. These modifications were fed by a new cultural tradition from the Italian and French immigrants who had been arriving in the region in large numbers since 1880. Vernacular technology and forms are presently maintained in the architecture of rural or urban periphery zones - especially in domestic architecture - where the building replacement has been slower.

2. The criollo tradition

The Cuyo region was inhabited by Huarpe tribes when the Spaniards arrived. The aborigines, who were farmers and very docile, accepted the Spaniards' domination as they had formerly accepted the Incas. Their dwellings consisted of one room, probably with a circular or oval shape, built with the local vegetation, and sometimes covered with mud. In other cases when facing the effects of the conquest and the "encomiendas" system³, the Huarpes adapted refuges in areas neighboring the Spanish domain as underground rooms (tunnels in the sand) in the lagoon zone in the northeast Mendoza. The Inca presence is manifested in roads, ceremonial sites in the high mountains and in the "tambos".⁴ The Huarpes learned "adobe" technology from the Incas.

The "criollo" cultural tradition has its foundation in the Spanish dominion (middle of the 16th century) and has developed it over three centuries (the Criollo is the Spaniard offspring born in America). The Hispanic influence prevails in the cultural process that incorporates the Huarpe builder's tradition on the management of the region resources, within a situation of isolation. The architecture is a Mediterranean type, low, single level using a system and technology based on mud (adobe or rammed earth = tapia).

In the urban zones, the buildings have few openings and are closed to the outside; life develops in the inside around patios and orchards, with a special microclimate created by vegetation and water in contrast with the environment. It is possible to identify the Arab tradition in the network of irrigation ditches used to water patios and gardens. The floor plans are a combination of a single row of rooms with undifferentiated use, and open galleries defined by masonry pillars and

³ *Encomienda*: Forced labor system applied to the aborigines.

⁴ *Tambo*: local administrative centers or post houses of the Inca road, with pirca walls (pirca: a) stone settled with mud or plants mortar, or other ingredients such as animal manure; b) dry stone wall.

arches or wood columns. The colonial' architecture does not manifest an aesthetic intention but a strong subjection to conditions such as the climate, the environment and available resources.

2.1 Houses

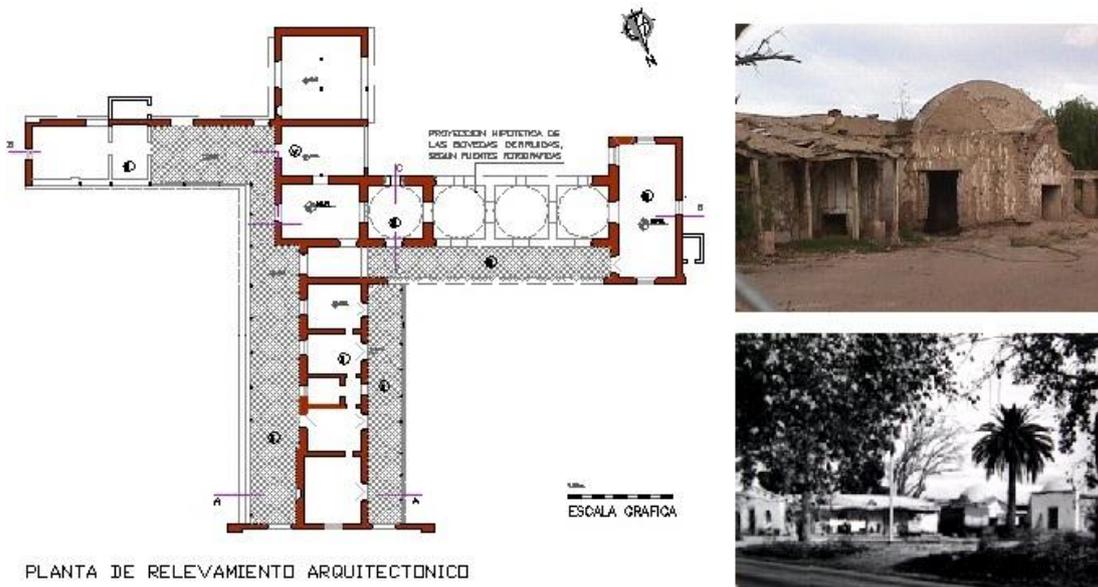
The agricultural and semi-rural character of the cities (Mendoza and San Juan) means that there is scarcely any difference between urban and rural houses. The floor plans are L, U or T (inverted) shaped, and they spring from the line - above the rooms, which are almost identical and of undifferentiated use. The attached galleries have a freer disposition in the rural areas (double gallery, frontal gallery) than in the city, where these elements appear introverted.

Open and semi-open spaces such as patios, orchards, and galleries have a central role in everyday life.

Examples of these types of buildings are (in figures 3, 4, 5) (Cirvini, Armani, Gómez, 1998):

- *Casa Molina (Maipú-Mendoza)*. Floor plan is T shaped, with four domes covering one of the branches. There are two galleries, with a principal masonry arch, and a back gallery with wood pillars. Domes were a widespread solution that can currently be seen in a typical bread oven.

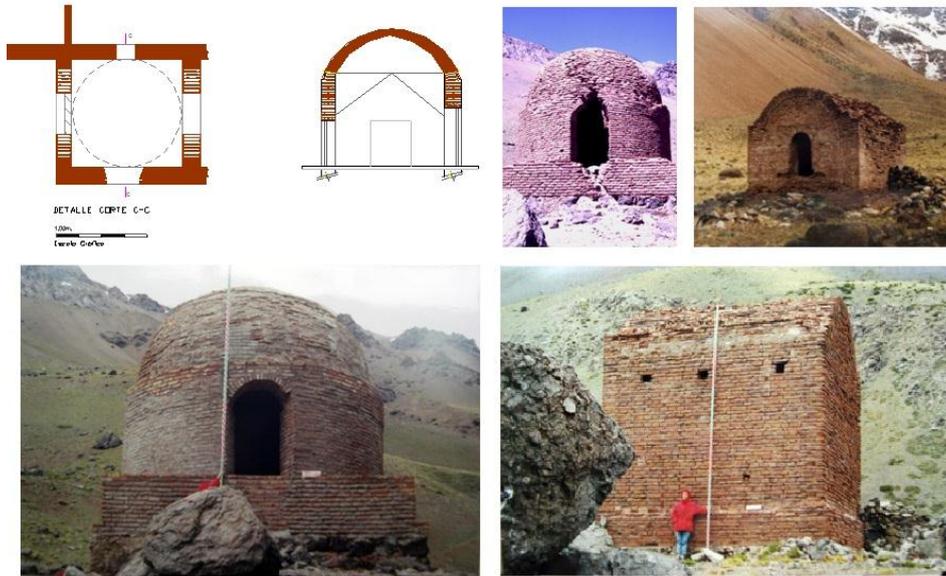
Figure 3. **Casa Molina (Maipú - Mendoza)**



Source: Plan Floor, Photos (by author).

- *Casuchas de la cordillera (Cordillera de los Andes)*. Shelters, temporary dwellings for travelers crossing the Andes (built at end of the 18th century). There are three still left out of eight. They were built with baked brick, settled with lime mortar. The floor plans are square or circular with roofs as domes to avoid snow accumulation.

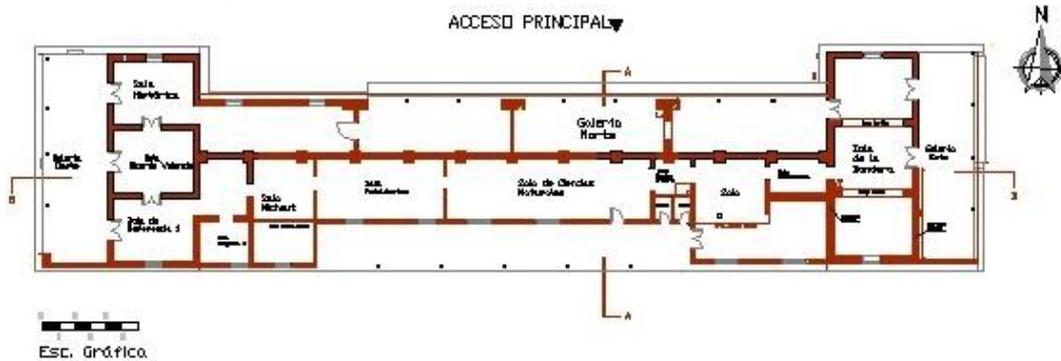
Figure 4. Casuchas de la Cordillera



Source: Plan Floor, Photos (by author).

- *Casa de las Bóvedas (San Martín: Mendoza)*: It was built over the older existing one, destroyed in the 1861 earthquake. The central body has a double gallery terminating at both ends with two blocks covered with great domes, with ellipse-shaped bases.

Figure 5. Casa de las Bóvedas (San Martín - Mendoza)



Source: Plan Floor, Photos (by author).

2.2 Chapels

Chapels are built in rural locations, for religious worship, sometimes of the missionary type. They are generally part of a group of houses, bell tower, and cemetery. The floor plans are narrow and deep, and there is always a closed area used as an oratory, and an open area (galleries or atria) for catechism or mass celebration for a large Indian or peasant population.

Examples of these types of buildings are in figures 6, 7, 8, 9

Capilla del Rosario de las Lagunas (Lavalle - Mendoza): Built at the end of the 18th century and rebuilt with the same characteristics after the 1861 earthquake. It is a traditional chapel of the aboriginal population of the ancient *Lagunas de Guanacache*. This chapel was built with adobe walls, has only one nave, very narrow and deep. It has two choirs and a balcony with eaves, from where mass can be celebrated in the open-air atrium. Since the 20th century, the change in ecological conditions of the lagoon oasis determined that these territories, converted into deserts, were only suitable for breeding goats. The chapel is currently the gathering point of the scattered population of this vast region, and at same time represents a testimony and a symbol of a cultural group that refuses to disappear.

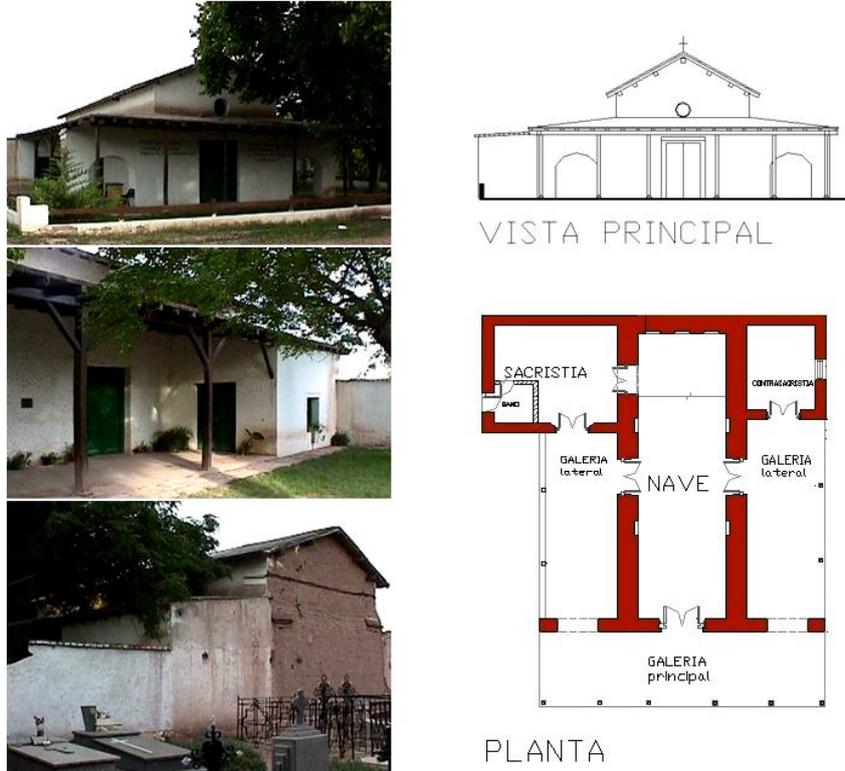
Figure 6. **Capilla del Rosario de las Lagunas (Lavalle – Mendoza)**



Source: Plan Floor, Photos (by author).

Capilla del Rosario de las Barrancas (Maipú – Mendoza): The Chapel is located in a valley, which used to be a great *Huarpe* settlement in pre-Hispanic times, and ever since the 19th Century, this area has been devoted to grape growing and the wine industry.

Figure 7. Capilla del Rosario de las Barrancas (Maipú - Mendoza)



Source: Plan Floor, Photos (by author).

This chapel, dedicated to the *Virgen del Rosario*, resembles the style of the missionary times and shows the attributes of popular colonial religious architecture from non-Argentinean territory. The local Cemetery can be found to the east of the Chapel.

The building has only one narrow nave, with a vestry and a counter-vestry at the head of the nave and galleries surrounding the other three sides. The origin of the style of this chapel lies in its front wall, which is wider than the body of the building. It shows a central gate and two minor arches to each side of it, crowning the galleries, as if the chapel had three galleries. Not only does this wall support the solid ceiling, which covers the corridor and borders the three sides of the building, but also contributes to the symmetry of the design, creating a greater resistance to seismic activity.

The walls are made with adobe bricks and the gable roof is built with wood, cane, and clay. The Chapel can be entered through the front gallery, which acts as an atrium, allowing access to the narrow nave through a gate. The missionary style is still preserved and, as in colonial times, the galleries are used as classrooms where local children take catechesis lessons.

Capilla de Alto Salvador (San Martín: Mendoza): Built in the middle of the 19th century. The group is formed by a closed chapel (oratory) for the private worship of the landlord family, an open chapel (gallery) used to celebrate mass for the peasants and catechism; a house (now museum) and a bell-tower/mangrullo⁵. The group is an accurate insertion in the surrounding

⁵ *Mangrullo*: pole lookout used to watch for Indian raids.

agricultural landscape. Dedicated to the Saviour, the altar has three wooden carved images, of Hispano-colonial facture.

Figures 8 and 9. **Capilla Alto Salvador (San Martín – Mendoza)**



Source: Photos (by author).

2.3 Mills

Rural buildings of an agro-industrial type, testimony the cereal stage of the regional economy, before the development of the wine industry. The mills are placed by water-courses as they used hydraulic energy to grind the grain. While in Mendoza only isolated exponents are preserved, a whole group of mills has been preserved in the Northwest of San Juan (Iglesias and Jáchal districts).

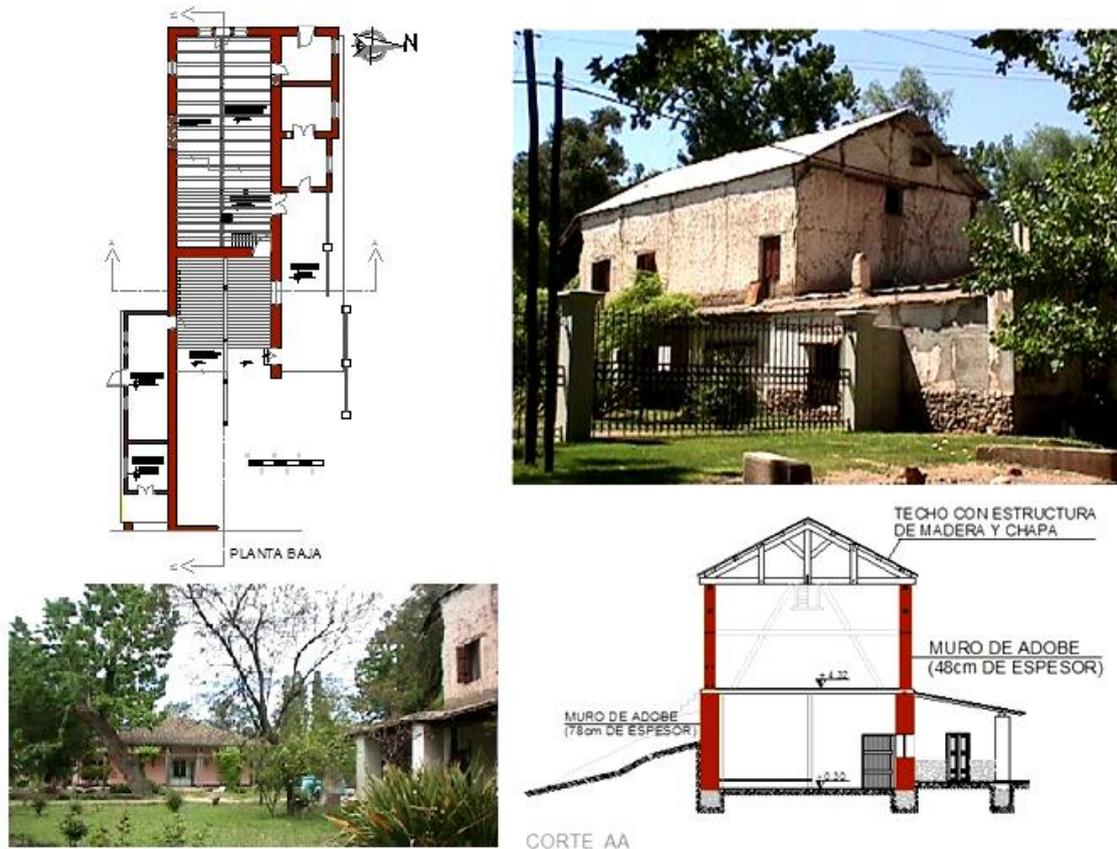
Example of this type buildings are:

Molino de Malargüe (Malargüe-Mendoza): Is a flour mill that together with a house constituted the buildings of "La Ortegüina", cattle-ranch, in southern Mendoza. The building has two differentiated bodies: a lengthy storehouse with a wooden double – sloping roof, following the milling room, higher and with hip roof. It is built with reddish adobe, colors' given by the zones soil tonality.

Molino de La Banderita (Guaymallén-Mendoza): This estate, which dates back to the middle of the 19th Century, was composed of the owner's house, the mill building, housing for the employees, the chapel, and space for the crops (see figure 10).

The mill building is located to the front of the land, on the current Las Cañas Street, which was an old road bordered by an irrigation ditch dating back to colonial times. The building features a mixed construction system, with walls made of adobe bricks of varied sizes, which are wider on the ground floor and narrower on the top floor and are reinforced with horizontal embedded battens in order to support the ceiling truss and the wooden beams of the mezzanine.

Figure 10. Molino La Banderita (Guaymallén- Mendoza)



Source: Plan Floor, Photos (by author).

The construction system used allowed the building to remain standing despite the seismic activity, even during the 1861 earthquake.

The main structure of the mill is a rectangular floor, 23 x 9 x 11 m, developed in two top floors and a basement connected with the water course which allowed the mill to turn.

Regarding the operation, three areas can be distinguished: the basement, located to the southern area of the building where the energy generation system used to be; the barn, located on the ground floor; and the grinding room, located in the mezzanine next to the machinery.

3. Transformation of the "criollo" tradition

From the middle of the 19th century, modifications began in the Criollo tradition in relation to spatial forms as well as to technologies. Modifications answered to two concurrent motives: the process of cultural modernization and the arrival of the European immigrants.

In Mendoza, the 1861 earthquake greatly accelerated changes as it meant an abrupt rupture with the past and allowed for an almost total renovation in architectural production.

Immigration had two different stages in relation to building. A small group began its arrival in the middle of the 19th century and increased after the earthquake. This first immigration wave introduced important technological innovations such as the use of baked brick and wooden resistant structures.

Immigrant contingents - particularly Italians - began arriving after 1880 continuing in a massive and sustained manner until 1914.

Although most of them were dedicated to agriculture, many had trades connected with buildings and brought knowledge and books: handbooks, treatises, and guidebooks from their country. The cultural predominance of the Italians is evident in the rural and urban houses organized on regularity and symmetry, and they typify outlines that have been endlessly repeated for decades (Cirvini, 1989).

The Italian presence is noticeable in the modulation of facades and metrics, in the classic proportions of wineries, the use of baked brick, and the numerous ornamental and decorative elements. In contrast, the French presence is less important than the Italian, but is evident in the adding of certain combined technologies of wooden structures, frameworks and mud closings.

3.1 Building types

- URBAN HOUSES

The "row house" resulted from a process of synthesis between a *Criollo* tradition of houses, patios, orchards, with galleries and the cultural contribution of Italian immigration that adapted to the new conditions in narrower urban lots and with a more rigorous spatial array.

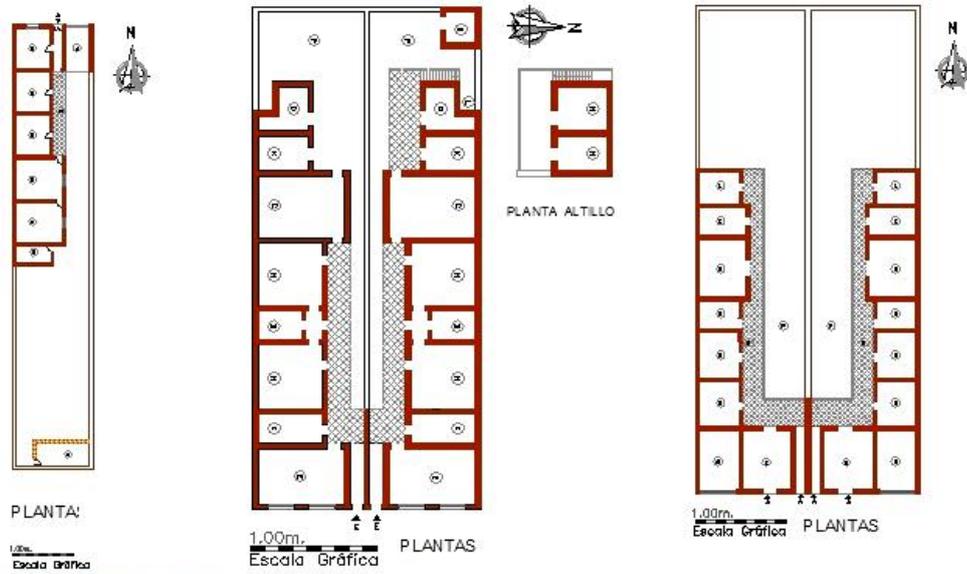
This type of house became very popular in the urban zones of cities and small villages or rural settlements.

The type is very versatile and adapts to different situations. If the land plot is narrow, the patio is rectangular, if it is wide the patio is square as in earlier years, but keeps a strict symmetry and modulation. The galleries are always on the inside, while the 20th century, ones are closed with glass screens (or glass doors).

The typical immigrant house is structured in three functional sectors: the front with the social or business area; another in a row with an affixed gallery that constitutes the main sector of the house and contains the bedrooms and dining room; and a back sector towards the rear with kitchen and bathroom.

This kind of house, which became very popular, had the advantage that it could grow while the family's needs increased, with rooms being added to the main row. The family itself usually built houses to enlarge them (see figure 11).

Figure 11. Urban Houses of Immigrant. Mendoza



Source: Plan Floor, Photos Montevideo Street, Mendoza, (by author).

- RURAL HOUSES

The "contract" system for the exploitation of the grapevine becomes general with massive immigration. In this system, the owner gives his farm, or part of it, to a person who will work it, and pay the owner a percentage based on the production (see figure 12).

Figure 12. Rural house with galleries and typical contractor house



Source: Photos (by author).

The typical housing of the contractor (where Italians prevailed) invaded the farms of the agricultural periphery. The outline of the floor plan is a double-row rectangle with an open hall over the longer side. The rooms form an inverted “U” that can have an affixed gallery at the rear. The hall is roofed, has two pillars that mark the entrance, and communicates to all rooms. The kitchen can be placed in one of the lateral rooms, while the bathroom is always a latrine outside the house. (Cirvini “et al”, 2009)

- WINERIES

The most typical and representative industrial buildings of the region, the wineries are essentially for storing wine, and were always built at soil level, even though since 1885 buildings of industrial scale started to have cellars with one or more levels. A cool environment was achieved by having very wide buildings, with thick walls to ensure insulation, and with few openings -generally a door and a few skylights- to keep them dark.

The outside of the older wineries was similar to those of mills (for example: Bodega Panquehua, Las Heras, Mendoza). The floor plan is rectangular, narrow, and deep, with a wooden roof frame. The external form is very austere without any modulation and treatment (see figure 13).

Figure 13. Wineries of 19th Century



Source: Photos (by author).

The wineries from the end of the 19th century, of Italian influence, are the same simple prismatic buildings, but have notably varied proportions, modulation, and the façade treatment. The use of baked brick of Italian tradition, and the appearance of numerous ornamental and decorative elements from the classic repertory: pilasters, cornices, arcs, etc. manifest a clear aesthetic intention. This tradition was widely spread over half of the 20th century.

4. Vernacular technologies of the region (walls construction)

Three types of earth building technology used in the area characterized: tapiales o adobón (rammed earth), adobe (unburned mud brick) and quincha (wattle covered with mud). In most cases, being used individually but also combined.

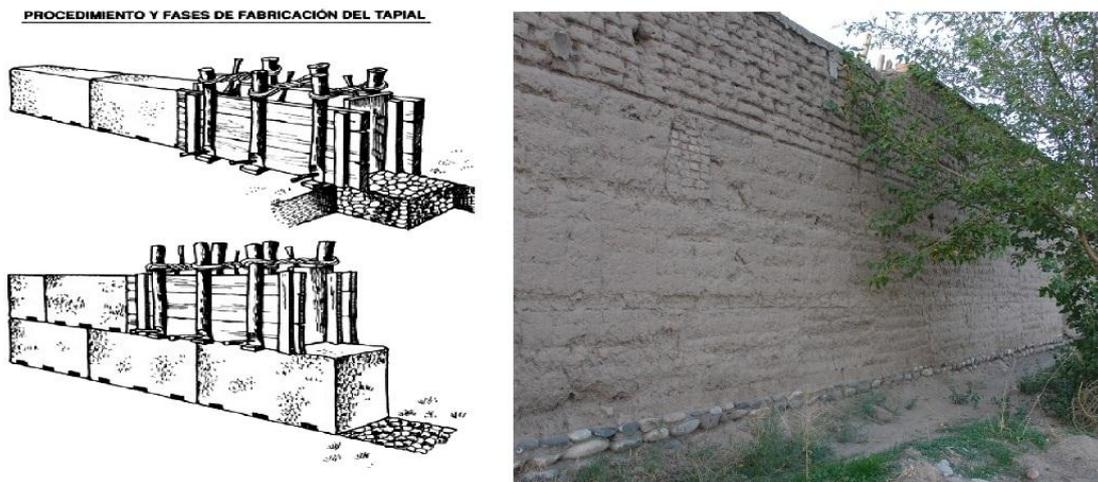
4.1 *Tapia o adobón (rammed earth)*

This ancient technology of the Cuyo region was used during the colonial period (17th and 18th centuries), the same techniques were also used in Spain, but without the quality and variations seen in the peninsula. (Jiménez Delgado, Cañas Guerrero, 2006)

The method used in the region was to dig fields cultivated without the first vegetable layer (10 cm upper) and break them down into fragments preferably no larger than 50-75 mm. The soil type was silt-clay sandy, with up to 5% gravel (<20mm). Next, incorporate water by adding successive irrigations and mixing thoroughly until the result is a dark-brown soil color with a "smell of damp earth". The tenor moisture required (approximately 10%) corresponds to 85% test Proctor. Then a slight wetness in the soil is left to "rest" to the next day to achieve homogeneity of the moisture before ramming. (Alva, Avrami, 2000)

The rammed earth formwork ("tapiales") must be strong and stiff and able to withstand the pressure of the earth during compaction. The traditional formwork comprises three to six timber shutters made out of softwood planks 1" thick with three to five crossbars also in wood. Final dimensions vary due to wood availability (scarce resource in the Cuyo region), typically 0.50m/0.80m high per 1.00m/1.50m length. A couple of "tapiales" located parallel to each other separated with timber as long as the thickness of the wall and linked up through "tientos" (ties of wet and twisted cow skin).

Both frameworks are erected at defined perimeters of the building (foundations) and layers ("tongadas") 0.10m to 0.20m in height of moist soil are placed fully covered into the form manual and is then manually compacted by one or two workers with a wooden rammer. Thus, the soils mechanical compression displaces air, reduces volume and increases the compactness and resistance of the mass (see figure 14).

Figure 14. **Tapia: Technology and building**

Source: (RODRÍGUEZ, 2005)

Tapial en Luján, Mendoza. Photo (by author)

The walls rise in “hiladas” (layers) overlap half tapia, like a brick wall around the building (skipping sections and returning to them later). After a few days another tapia will be complete, allowing time for the retraction and reduction of the thickness of the joints. The walls varies between 0.5m and 1.00m in thickness, and typically sit in beds of coarse gravel, cobbles or crushed stone directly supported on the ground, occasionally with a manure layer. If the building requires windows or doors, wooden jambs and lintel are put into the formwork beforehand and then soil is compacted to close openings. However, this wall was used typically in property boundaries or yards and therefore ended with a gravel, fire clay tile or straw layer to protect pluvial erosion.

This technology demonstrates, like all constructions of crude earth, a high vulnerability to water capillary rise which grows worse with poor foundations. Thus, a few years after the walls were built, degradation in the vadose zone (between 0.20m to 1.00m on base wall) was seen. The loose mass weakens the strength which causes a very dangerous situation in high seismic regions. However, a few buildings that used this constructive practice can still be seen today in Casa Solanilla, Luján, Mendoza.

4.2 Adobe (unburned mud brick)

Typically, since Spanish times until the beginning of the 20th century, building technology was adobe. Gradually it was displaced by brick and concrete structural technology.

The manufacturing of adobe has been used in agricultural land (silt-clay medium sandy, SM-SC, 14 to 21% clay content). Soil and water mixed by a treadmill and powered by horses to produce mud. The animal slop becomes moisture and homogeneous material, manure was added to improve plastic property clay due to chemical-colloidal fermentation. After one or two days knead add different cereals straw (e.g. wheat, barley). Resulting material was “rot” to complete plasticity state. Adding straw (one per two or three soil volume) has two functions: reducing retraction, cracking while drying process and improving tensile strength adobe.

Then the mud was hand-moulded in wet and sandy wooden moulds called “adobera” to obtain both blocks at the same time. The next day the bricks are stored in an area called “secadero” (dryer) so the water can evaporate. To prevent shrinkage occurring too quickly, exposure to wind and direct sun must be reduced. Drying out will take approximately two weeks. The bricks dimensions have wide variations (38/50cm length, 9/11cm height, 20/25cm width)⁶, which gives a material which is very easy to handle and very flexible in its use. The sizes have been reducing over time (Jiménez Delgado, Cañas Guerrero, 2007).

The first attempts to standardize adobes sizes were the initiative of the Town Councils “Cabildos”. In Cuyo 1789 Marqués de Sobre Monte were established measures of materials: adobes, bricks, fire clay tile, weights, flooring also guild regulated. In the Spanish colonial period each town council regulated standard adobe sizes, formworks and tile molds. Typically dimensions were ½ vara, ¼ vara, 1/8 vara (w x l x h) (Greve, 1938).

Typically, adobe had the most prominent position as a construction material for all building types in the region. The adobe walls were found in a bed of stone (coarse gravel, crushed stone, and latter cobbles) laid in lime mortar. The height of the foundations was 50 to 70 cm and the upper ground was raised by a plinth of the same material to protect pluvial erosion. Adobe walls were raised up by row, and were staggered so the vertical joints where two bricks meet one another did not line up. Wide final walls depend on the type of bricklaying: until the end of the XIX century header bonds were used, later Flemish bonds, and finally Stretcher bonds.

Earthen buildings allowed wooden structural members between bonds to be used, “keys” (wood reinforcement at the corners) and wooden bond beams. Jambas and lintels in openings in the walls were also used, such as doors and windows⁷. Versatile brickworks, adobe arches, pier, ornaments, vault (barrel, fan, dome) were enabled. Typically, ending walls with a wooden Vierendeel truss (like a ladder) received structure roof made in dirt mud layer and giant cane (*Arundo donax*) supported wooden beams roof. At the end of the 19th century the roofs were finished in sheets of iron and at the beginning of the 20th concrete lintel had been introduced and continued around the building perimeter. (Cirvini, 1989b)

Plaster was made with a thin layer of mud and straw (double used in adobes), and was usually used with a binder like manure, lime or animal blood to get better adhesion and plasticity. Since the 20th century cementitious plaster has been used (see figure 15).

⁶ Data by S. Cirvini and M.G. Armani at “Survey houses adobe typologies in Mendoza” Project (1999- 2001) Conicet-Argentina (unpublished).

⁷ To build these types of walls a particular adobe brick was used with a U-shaped groove made into the end of the pieces. Wooden columns (called “pie derecho”) or angle supports (called “pie de gallo”) were fitted into these notches. This building system was used widely in the post earthquake period of 1861. (Cirvini, 2- 1989)

Figure 15. Adobe: Technology and building



Source: Making adobes

School building (Luján, Mendoza) Photos (by author)

4.3 Quincha (Wattle and daub)

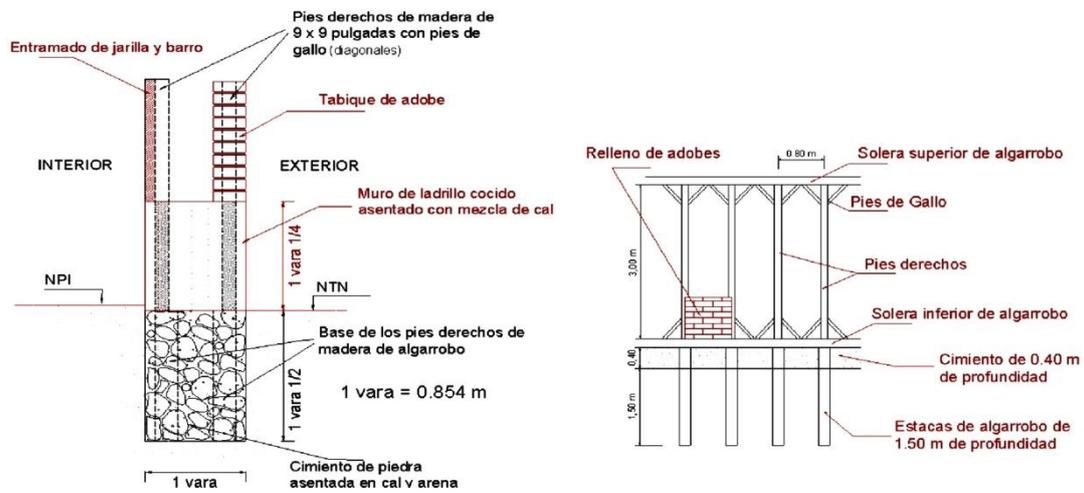
Wattle and daub typology (like “bahareque”) was also used in Latin America before the colonial period. (Guerrero Baca, 2007) The technique was widely used in Chile and Peru (neighboring countries) regularly or habitually, but in Mendoza it was used only after the 1861 earthquake, building systems which respond better to earthquakes were being looked for.

In fact, this technique allows for ductile structures and buildings lighter than the adobe and tapia construction, which is a much better answer to the seismic problem. However, “quincha” presents the problem of constant maintenance to prevent its degradation. Therefore, in the Cuyo region there are only a few examples of quincha buildings.

Basically, wattle and daub typology consists of wooden a structural frame with columns directly in the ground and diagonal timber struts to prevent lateral actions. Over this frame “tientos” thin cane/branches (“jarilla”: Creosote Busch: *Larrea divaricata*) were bound to form an interwoven fence filled in with mud on and between laths.

The walls could be single or double and finished with one to three mud and straw handed plaster. To get better finishes, the binder was made of manure, limestone or animal blood (see figure 16).

Figure 16. Building systems in post-earthquake period



Source: Graphics by author

In the province of Mendoza, wattle and daub typology was used for frame double walls. But while this solution was efficient for maintaining thermal comfort for the occupants, it also presented some problems such as moisture, rodents, and insects. (Cirvini, Gómez, 2005) A variant of this technique was to have houses with two floors, with the first level made of adobe or combined with adobe or rammed earth at ground-level (0.90/2.10m height). Towers, belfries and belvederes were also made (see figure 17).

Figure 17: Quincha: Technology and building



Rural house in Lavalle Mendoza

Gonzalez's House (Panquehua, Las Heras, Mendoza)

Source: Photos (by author).

In the post-earthquake period, between 1863 and 1867, all public work used wattle and daub or adobe combined typology, but at the beginning of the 20th century it was substituted due to early damage. However, there are some “quincha” buildings of that time that are still in good condition. For example, Gonzalez's House (Panquehua, Las Heras, Mendoza) is a construction

in "jarilla" - daub typology with a wooden base at ground-level and double walls. Its regular module, compact and symmetric, with relatively little weight and building quality was used in order to respond well to earthquakes and the ravages of time.

5. Conclusions

In the region, the building technologies of crude earth have created real long-lasting traditions, whose origins are traceable to pre-Hispanic times. These technologies developed into varied forms until almost disappearing, due to the influence of modernization.

Earthquakes have worked as catalysts of technological innovations in the region. After the destructive 1861 earthquake this search for better buildings solutions was aided and enhanced by the foreigners presence, as they were carriers of different knowledge, that combined with the local available resources resulted in novel solutions.

The Italians had masons who were outstanding in the use of fired brick for walls, arches and domes; the French had notable carpenters who introduced elaborate wooden structures combined with the ancient Spanish and Indian "*quincha*" technology. In a rural zone very close to Mendoza city (Corralitos - Guaymallén) a group of French immigrants developed a particular building tradition. The zone presents problems for "*adobe*" buildings over foundations because of the presence of a very superficial phreatic layer that generates moisture and destroys the adobe. The system used by the French is a wooden framework laid over deeply buried piles of the same material. The walls are built over this structure with a wood and reed framework, filled with tufa (that abounds in the area) and mud plastering. The wooden shingles, straight and diagonal, reflect the structure of the "*pan de bois*" of Norman architecture.

From the late 16th Century until the mid 19th Century, the Criollo tradition developed, based on Hispanic architecture and technology. The most common technological methods were adobe and tapia (rammed earth).

The 19th Century brought along significant changes in different fields of the local lifestyle. The socio-cultural process became greatly dynamic and left its footprint in the architecture of that period. On the one hand, the use of adobe gets spread and wood became much more available in this expanding oasis than in previous years. On the other hand, the commercial activity brought to the area materials, staff, and people from other cultures. This situation was prosperous for many changes, regarding not only construction methods but also cultural guidelines related to the everyday life and the way of living, which represents the preface of the big transformations of the modern age by the late 19th Century.

The big 1861 earthquake was considered a landmark, a turning point for the life of the city and its citizens. The breaking of its physical integrity contributed to the blurring of the past and created the concept of a founding reconstruction.

This was a period where land architecture displayed a wide range of construction systems, with great technological and typological value. Then the 20th Century modernization imposed, in a gradual but relentless way, the use of new materials, such as steel and the innovative

reinforced concrete, setting the traditional construction systems aside, especially the use of crude earth.

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