

Development Renewal Model of a Region Considering the Local Seismic Risk in Argentina



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SUMMARY:

This paper presents the case of Jáchal, one of the political and administrative units in northern San Juan, Argentina, in an oasis of territory, unique spaces of life, rich in resources, but are marginal in the development models that have shape the land and the national infrastructure.

The National Policy Development and Zoning, defined for the San Juan restructuring:

a) The Bi-Oceanic Corridor Porto Alegre-Coquimbo; b) Mining; c) The agribusiness; d) Tourism

It considers regional history and the current process of globalization, which means substantial changes in socio-territorial activities, land use and human settlements, especially in the departments of central and north of the province.

What would be the exposure of these future scenarios to the local seismic hazard of northern provincial administrative units?

Methodologically working with the local seismic history and earthquake risk management at municipal level.

The historical earthquake -pre instrumental considered is the so called Argentine Earthquake of October 27, 1894 with estimated magnitude Mw 7.5.

Keywords: Local development Seismic risk management , Strategic Plan Argentina 2016

1. INTRODUCTION

As a component of the relationship development-environment-society, seismic activity affects all human activities, the quality of life of residents and the availability of environmental resources for their survival.

In Argentina began to introduce risk management tools such as seismic zoning since 1982 with the study of Seismic Microzonation of Tulum Valley in San Juan.

This study was strategic after destructive earthquakes of 1944 and 1977 for the fragile territorial relationship of the oasis of Tulum-Ullun-Zonda, located in the most seismic Argentina and accumulated most of the resources-financial, human, cultural-of the province.

The continuity of the development model that helped to remain circumscribed to this territory was not extended to the other oasis with human settlement.

The incentive for the sustainable development of other areas and activities to balance the national and provincial development proposed in the Strategic Plan Argentina 2016 brings up the northern province of San Juan, organized politically for the followings departments: Jachal, Iglesia and Valle Fertil.

The municipal level is seen as best placed to integrate the exceptional everyday and unpredictable seismic activity, developing plans, coordinating public awareness raising networks to respond to seismic risk

This work could be considered a preliminary study for recognizing the need to expand and update the study of Seismic Microzonation of Tulum Valley to the whole provincial territory, adapting to local and provincial decision about land use.

We present the case of the Jachal Department for having this, the second major urban settlement outside the Oasis Tulum-Ullun-Zonda, San José de Jachal and projection on this urban center are the latest trends in mineral development, tourism and basically, the Bi-Oceanic Corridor Porto Alegre-Coquimbo.

In order to assure a diagnosis oriented seismic risk management at the municipal level, methodologically worked with historical, statistical, seismological, geological and geotechnical data, but also include environmental perception and social representation of both development and seismic risk of the people of Jachal as an expression of local awareness on the issue which results in the effectiveness of management.

The earthquake considered is the " Argentine Earthquake" October 27, 1894-, occurred outside instrumental period, due to this was studied under the premises of a historical earthquake where it is essential obtain many documents, primary sources preferably and in view of current knowledge perform their interpretation.

2. NATURAL ENVIRONMENT

One of the environmental characteristics of Jáchal may have undesirable effects on society and its development is its seismicity, a characteristic that is expressed in the earthquake of magnitude 4.7 Mw approximately the October 27, 1894, Argentine-called earthquake with its epicenter in this zone.

The Quaternary formations of interest only from the point of view of earthquake resistance, cover a significant portion of the study area and are expressed in the following Table Stratigraphic (Table 1).

Table 1. Stratigraphic Table Jáchal (part 1)

Era	Períod	Geological Units	Lithology	Environment	Thickness in mts.	Diastrofism
	Quaternary	Alluvial Deposits Formation	Sand-gravelsilt Sandstone-silt-clay		14	
		Pachimoco Formation	Conglomerates		10	
		Niquivil Formation	Conglomerates		15	
		Iglesia Formation			50	
		Tudcum	Conglomerates		20-30	

Table 1. Stratigraphic Table Jáchal (part 2)

Cenozoic	Terciary	Ancient Alluvial fans– Formation Rodeo	Conglomerates ConglomeratesSandstone-Tuffs	Continental Volcanic	500	Andico
		Formation Corral	Conglomerates-Sandstones		800	
		Formation La Pareja: -Member Rio Paloma -Member Mogna Member Los Morados	Conglomerates Sandstones-shale Fanglomerados		1500	

2.1. Water Table Jáchal Basin-Niquivil

The depth of the groundwater in the area can be estimated through groundwater studies conducted by the Ministry of Water Resources of the Province of San Juan (SRH).

The water table is at a depth ranging between 6 and 64 m, depending on the distance to this Jáchal river.

According to studies conducted geophysical SRH has been shown that the sedimentary basin can be up to 600 m thick, consisting mainly of gravel and sand deposited by the river only Jáchal. Similar thickness but with smaller distribution was found to Niquivil basin.

The recharge is primarily by infiltration that occurs in unlined irrigation canals. This type of recharge is added the occasional floods, rains and streams input from the pocket of Jáchal side.

According to the evidence, is estimated to be very likely to occur large amplifications of ground motions produced by earthquakes in the area where the city is built of Jáchal.

It is also observed due to the formation of soil and ground water levels, a high potential for liquefaction of soil in north-west (Pachimoco training), although this phenomenon may also occur in rural areas.

3. ARGENTINE EARTHQUAKE

It is called "Earthquake Argentino", is located in the non-instrumental period in history happened on seismic Argentina Saturday, October 27, 1894: at 16 hours, 25 centered in the northern province of San Juan.

All reports agree to define it as very strong, wavelike character and long lasting. This earthquake was characterized by large ground disturbances even in areas far from the epicenter. As side effects occurred liquefaction with ground cracking, sand volcanoes and outflow in the jets of up to 2 meters high in water-saturated soils without cohesion. In the mountainous regions were numerous landslides and rock falls.

Caused alarm in much of Argentina, perceived to varying degrees in Chile, southern Brazil and Peru (figure 1).

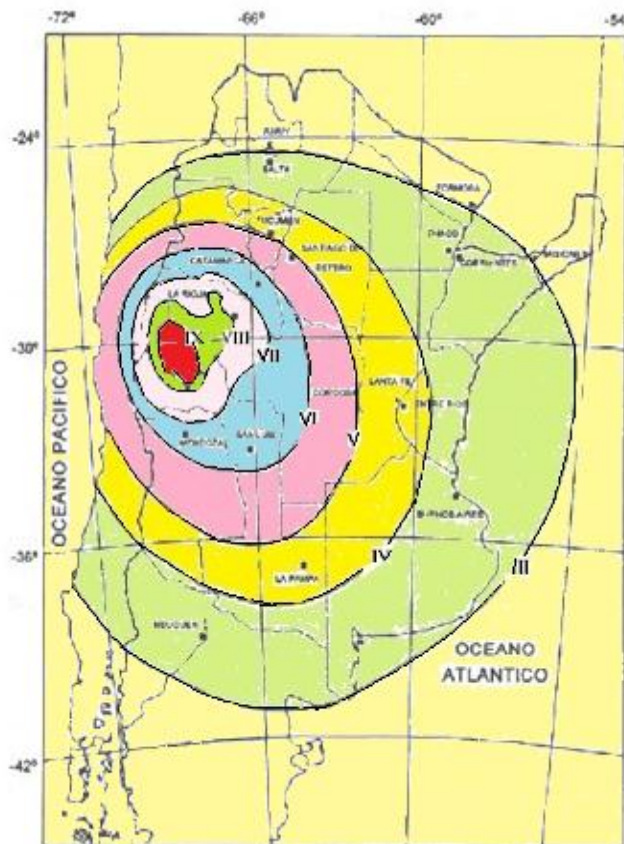


Figure 1. Earthquake isoseismal Argentino -27 October 1894

In the Department of Jáchal, the effects of this event were recorded in numerous reports of damage-official newspaper, as it is the epicentral area but without details due to the lack of instruments to record the event.

Among the reports was selected for its documentary value for this job, the government's deputy and Chairman of the Committee on Aid to the Department Mr. Jacinto Diaz provincial government minister, Juan Echegaray -7 December 1894 -.

This is based on a survey of the area affected by neighborhood committees. It was made three days after the main event, the department divided into 8 districts which are interpreted in this work using the Modified Mercalli Scale and is expressed in Table 2 and in Figure 2.

Table 2. Compatibilización Neighborhood Report -1984 with Modified Mercalli Scale

<p>First District San José de Jáchal</p>	<p>Deaths: 1 Injured: blunt</p> <p>Damages Collapsed buildings: 19 and the cementery (mausoleum) Buildings (homes) damaged; 246 Buildings (homes)collapsed: 100 Buildings with important damage: schools, govemment Office, Church, Hospital</p>	<p>Intensity MM IX</p>
<p>Second District Cruz de Piedra San Roque</p>	<p>Damage Buildings (homes) damaged; 103 Buildings (homes) collapsed: 36 and 1public building In South and rising parts have produced large openings in the surface of which has emanated large amount of water, gray color, a bitter taste and, noting that these cracks have sprouted sands vary in color.</p>	<p>MM IX With liquefaction</p>
<p>Third Fourth District Otra Banda, Fical, Pampa Vieja And part of Chañar</p>	<p>Damage Collapsed buildings: 14 in Fical Buildings (homes) damaged, 1835 fall under ledges and cracks Buildings (homes) collapsed: Majority Fical</p>	<p>MM VII</p>
<p>Fifth Sixth District San Isidro Villa Mercedes</p>	<p>Damage All buildings have been damages</p> <p>Villa Mercedes Collapsed buildings. Buildings at great cost Severely damaged buildings: the temple</p> <p>On the main street of the Chañar there has been an opening whose width varies from 2 to 5 meters, covering a distance of twelve this blocks or so.</p>	<p>MM VIII</p>
<p>Seventh District Huaco Cienaguita</p>	<p>Deaths: 1 Injured: blunt: several</p> <p>Damage Collapsed buildings: 17 houses in Huaco. Most in Cienaguita Buildings (homes) collapsed: Majority Huaco Everywhere there have been major cracks and pits of water that have sprung up to one meter in height.</p>	<p>MM IX with liquefaction</p>
<p>Eighth District Mogna Tucunuco Niquivil</p>	<p>Killed: 9 in Mogna</p> <p>Large openings to the extent of land have been buried in her bosom more cattle, land big boards are down to their level to eighty centimeters. The large farm has been in excess Tucunuco, buildings, mill, destroyed.</p>	<p>MM IX With liquefaction</p>

Table 3. Assignment of intensity to the Department-San Juan Jachal obtained from the Catalogue of Earthquakes for South America CERESIS 1985 Vol 2

Locality	Intensity	Dist. Hipocentral	Epicentral Dist.
Jachal	VII	53	43
Mogna	IX	36	20
Pampa Vieja	IX	53	44
Pampa del Chañar	VIII	87	82
Niquivil	IX	49	39
Villa Mercedes	IX	?	?
Las Flores	IX	85	80
Huaco	IX	50	41
Cienaguita	IX		

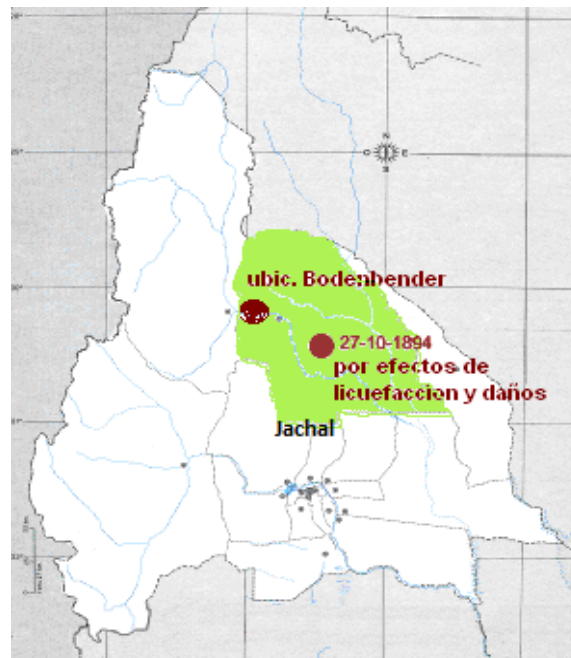


Figure 2. Epicenter of the earthquake of 27 October 1894

Bodenbender Report: Unique Scientific Report survey of damage and estimated epicenter 1895 Academy of Sciences National University of Cordoba Argentina

Data for effects of liquefaction and damage: Authors of this paper

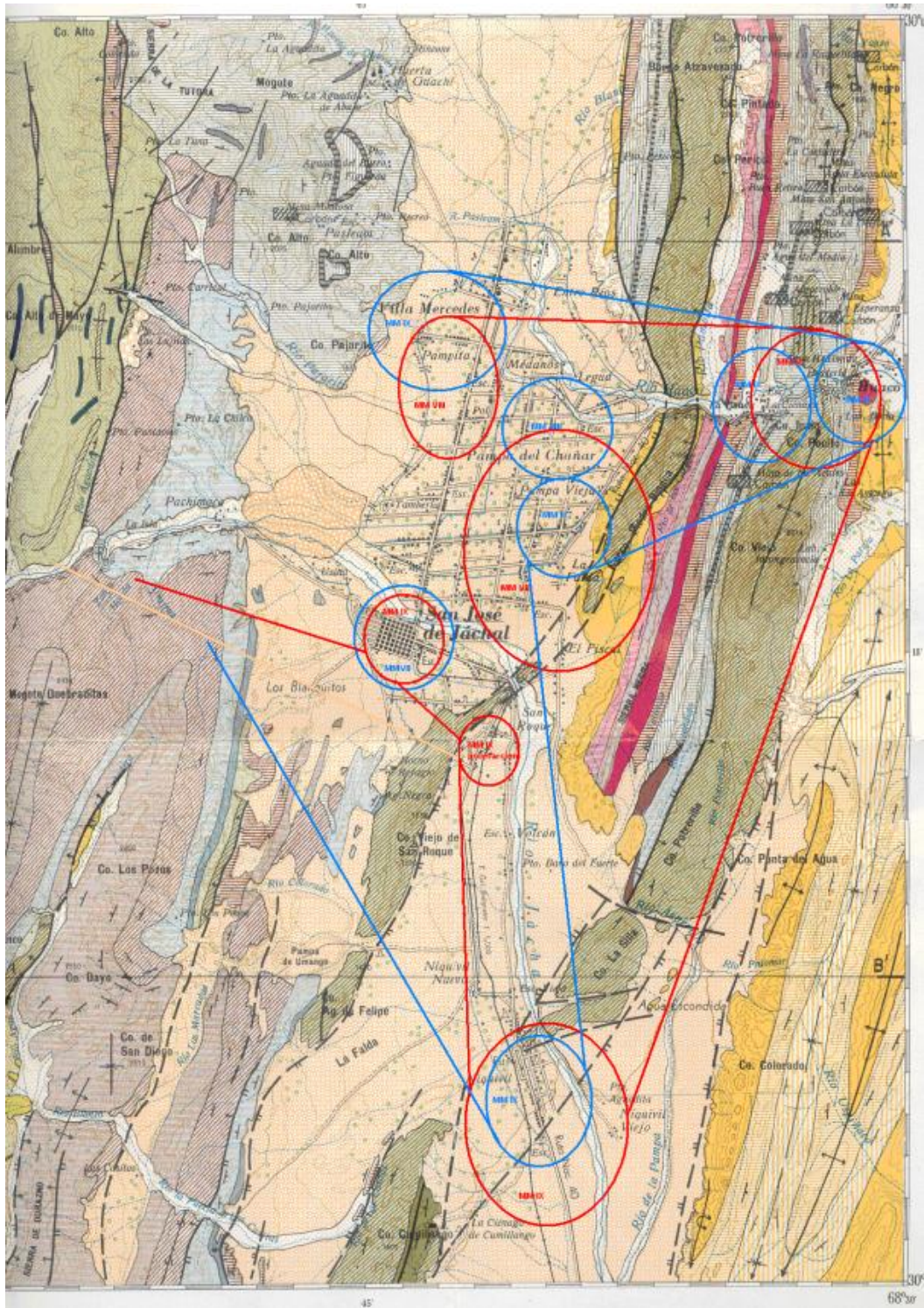


Figure 3. Geological map and Isocistas Earthquake of 1894 in Jachal

Neighbors report – Jacinto Diaz

Earthquake Catalog Report for Latin America CERESIS

Analysis of these data together to delineate a microzonation of damage to the north of the province in this earthquake, showing pockets of lower intensity surrounded by an isoseismal indicating areas of higher intensity Concluding that the geological formation gives a thorough orientation areas with higher risk of damage from seismic effects in the Valley of Jachal

4. STAGE: NODE FUNCTIONAL: CITY OF SAN JOSE DEPARTAMENTAL HEAD CITY OF JACHAL

The city is located at the intersection of National Road No. 40 and National Route No. 150-provincial portion of the future Corridor Porto Alegre-Coquimbo.

The city of San José de Jáchal, currently has around 10,299 inhabitants, 49% of the population of the department, the remaining 51% are rural, located in small towns: Villa Mercedes, Huaco, Niquivil, Huerta de Huachi, the Cienega, Pampa Old, Great China, Entre Rios, San Jose barycentric.

On the foundational trace around the square checkerboard, rise institutional buildings such as municipal, cultural and Popular Library D. F. Sarmiento, the religious and cultural center and the ancient Church of San José de Jáchal.

The space constructed in the central area of the city are mostly adobe houses developed around a central courtyard and orchards and vineyards that share the block with institutional buildings, services and trade.

The existing infrastructure and its quality are developed in Table 4, and the institutional density of this city in Table 4.

Table 4. Institutional density

Service	Scale	Users	Quality			Comments
			B	R	M	
Household Water	Osse-	80%				Poor Service Distribution Plant
Irrigation Network	sectorial	30%				Old Sectors is irrigated between plots in the center of the block
Public Trees	around the central square					Low
Sewage	particular	100%				No urban network. There are many collapsed septic
Storm Drains	municipal					Old, without maintenance, insufficient
Urban Cleaning	municipal					Daily. Insufficient depending on the season. No equipment for urban emergency
Household Electricity	departamental	70%				Central Salto de la Loma (30km.) brownouts. Frequent power cuts in summer
Public Lighting Network	departamental	90%				Network old and incomplete
Gas	particular	100%				High cost
Tele communications	Local-provincial					Local radio stations. TV satellite service
Phone	Nacional	30%				Insuficientecapacidad insuficiente
Cell Phone	Nacional	50%				Alternativa al alcance de toda la población limitada por los alcances de cada empresa
Internet	Global					Sufficient local public access

Analyzed the vulnerability of the built public space, open space networks and services, considering that the municipal government has a project to declare Provincial Heritage city.

From this analysis emerges a medium vulnerability rating values between low, medium, high, especially in the central area consolidated.

Analyzed the vulnerability of the private space of the central city area, was obtained for the scale above the value of medium vulnerability

4.1. Seismic risk perception population of Jachal

To estimate the motivation Jachal population would include in the Municipal Management Seismic Risk interviews (Table 5.) were conducted with key informants and residents of San José de Jachal as well as in surrounding settlements on the following questions:

Have you heard about the earthquake of 1894 and the damage that occurred in Jachal?

Do you think that the risk of earthquakes can cause significant damage Jachal?

Synthesis in relation to the second question it synthesizes the repeated phrase "in Jachal not tremble."

Table 5. Outcome of questionnaire to Jachal population

Social actor	Have you heard about the earthquake of 1894?		Is there Jachal Seismic Risk?
	Yes%	No%	
Government Official Provincial	50	50	No
City government officials	30	70	No
Academic	70	30	50% No
Population Jachal	20	80	No

5. CONCLUSIONS

Currently Jáchal San Jose, has 10,299 inhabitants, 49% of the population of the department, the remaining 51% are rural, located in small towns: Villa Mercedes, Huaco, Niquivil, Huerta de Huachi, the Cienega, Pampa Old Great China, Entre Rios, San Jose barycentric.

The damage to the productive structure of Oasis Jáchal, agricultural base of the economy department, would compromise the quality of life for its inhabitants and even their permanence and that levels would lead to even more precarious the current level of subsistence.

The low incidence that agricultural production has on the economy of the province would not favor raising funds for reconstruction.

The city of San José de JachaL are highly vulnerable to seismic risk in particular in the central area for its urban setting, the quality and age of its buildings. This can be very committed to the policy of preserving the built heritage as tourism resource base that seeks to promote the municipal government. It also shows disorder, disruption and inefficiency in land use and road network due to the location of

new residential and commercial and service activities.

The story is again offering the city the parallelism with the city of San Juan that was in the days of Spanish colonization, which is needed to give the city the tools to meet the new demands that Argentina presents the Strategic Plan 2016 integrating seismic risk they are exposed.

Having technical tools of land use, seismic microzonation, land use and policies that provide greater decisional security not only a strategic city of the province, also the national and then implemented the Bi-Oceanic Corridor Project, international.

Have been identified short-term needs such as:

Further define areas of architectural heritage as it met the condition for the entire founding the city center would be prevented from responding to other lines of action.

Increase open space for recreation and possible evacuation before a destructive earthquake, using land that meet under safe conditions.

The urban road network hierarchy

Designing filters between the city with the RN150 and RN40 to facilitate their duties.

Deepening the research geological and seismological that allow a deeper understanding of seismic hazard in the region to allocate land uses to enforce environmental sustainability and territorial competitiveness.

The present city of San Juan claimed an earthquake such as 1944 to find a new setting, San Jose has a similar opportunity without suffering the pain of the tragedy.

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