DISASTER RISK WITHIN THE FEDERAL PRISON SETTING

GOOD INFORMATION FOR A BETTER MANAGEMENT
NATIONAL DIRECTION
ARGENTINE FEDERAL PRISON SERVICE
ENVIRONMENT SUSTAINABILITY AND
DISASTER RISK MANAGEMENT SERVICE
INTRODUCTION

The spirit behind this publication is to set the basis of the Federal Prison Service regarding Disaster Risk Management (DRM), bearing in mind that this is an innovative and transforming approach since it is the first time that prisons are linked to sustainability. In this sense, its incorporation is seen as a strategic guideline that strengthens, fortifies and consolidates the policy to recuperate rights, quality standards, efficacy and efficiency within the prison system administration as an integral part of society. Risk is seen by the State from an undeniable and indisputable ethical position whereby doing the right thing has not the same meaning as looking the other way.

This implies thinking about what type of community we desire, want and can outline situated in time and space. Since some time ago, some approaches regarding gender, human, economic, political, educational, and social rights were incorporated; at present we are aware that our institution is in an objective position to start the DRM incorporation process.

To talk about Risk Disaster Management within the Argentine federal prisons is to put on agenda our interest on central aspects of our system, such as on the one hand penitentiary infrastructure and on the other hand the incorporation of the integrated prison system to the ideas of prevention, mitigation and resilience.

Regarding the connection between Risk Management and prison infrastructure it is necessary to investigate the appropriateness and the corrective risk action strategies together with the incorporation of parameters, guidelines and minimum standards necessary to reduce vulnerability and risk within the future prison infrastructure planning.

Risk is a concept that we build daily through actions and omissions and that we can also correct and reduce through the incorporation of the said approach within all the actions of our system. Risk management must be present within the planning stage of all critical and basic infrastructure works as an essential priority and, at the same time, it must be borne in mind that our task is to look out for the recovery of all the persons deprived of their liberty. In this sense, care and protection are regarded as human rights, as a legal and administrative mandate and –above all– as an unwavering ethical principle. For this reason, the incorporation of these principles requires the commitment and participation of every member of our institution.

This is why within these first steps we are taking regarding prevention, the core idea is based on strengthening our resilience as a system.

As it was previously said, in order to adhere to a suitable and worthy space in a sustainable environment within the federal prison facilities, this National Directorate has fostered programs that promote a friendly context through actions that contribute to prevention and reduction of emergency situations. These programs, that until now had been oblivious to our system were boosted with the creation of the Environment Sustainability and Disaster Risk Management Service, its objective is to maximize the performance of institutional resources, to train all officials—regardless of rank and position—and to enforce the current regulations.

DRM has grown in the last decades as a response to strictly fiscal emergentism which operated on the consequences and looked the other way when facing the causes. The magnitude of the catastrophes that took place over the last decades due to climatic change—as a result of the global mistreatment of the environment on behalf of key countries and an extractive productive model of concentration—set the whole world under alert. The impact levels are not necessarily related to the characteristics of the phenomenon but to the development of everyday life. Today, climate change has a great impact on every aspect of society and clearly the prison service is a part of it.

DRM is a multidiscipline in constant evolution that is usually defined from different perspectives but it always refers to the “systematic process for the use of administrative guidelines, organizations, dexterities, and operative capacities in order to implement policies and strengthen coping capacities in order to reduce the unfavourable impact of natural hazards and the chances of a disaster taking place”.

It is clear that in order to a disaster to happen hazards and vulnerabilities must work synergistically since they mutually retrofit and define each other. A hazard is understood as a phenomenon, a substance, a human activity or a dangerous condition that can cause death or injuries as well as property damages, loss of livelihoods and services, social and economic inconveniences or environmental damages. Vulnerability seen as a concept that leaves generalization aside—usually wrongly associated to poverty—refers to the circumstances of a community that make it susceptible to suffer the detrimental effects of hazards. A hurricane at the sea is not seen as a catastrophe as well as an earthquake in the desert. That is to say there is no vulnerability without hazards or hazards without vulnerability. As we have seen, they both complement each other and generate a vicious cycle that will only be interrupted by the strategic action of the State.

Having said so, we reach to the conclusion that the Federal Prison Service cannot stay aloof from this
specialization; that it is impossible to turn this topic sideways when dealing with the influence a penitentiary facility has on the environment and that from now on, every project and every action that involve intramural life will have to measure its present and future impact.

However, we can ask ourselves the following unanswered questions: Which was the position taken by our prison service and which is the position needed to face natural and technological hazards? Are we conscious of our vulnerabilities? What is our risk level? How can we reduce the level of exposure when dealing with a disaster? Inmates should become part of the prevention system? And in this case, which position should they take on?

Risk management is eminently local. That is to say, the volcanic Patagonia is not the same as the littoral which is permanently being threatened by recurring floods. It is totally different to talk about a federal penitentiary complex that binds four thousand people together-between staff and inmates- than to talk about a penal colony located in a deserted area. The same happens to a prison that has been built decades ago in a barren plain and nowadays is situated inside the city.

We should bear in mind that penitentiary units must be considered as equally or more vulnerable than schools and hospitals and –at the same time- that the risks and vulnerabilities of a community are replicated within each penitentiary facility. In other words: gender issues, mothers with children, education, groups exposed to dangers, illnesses, etc.

All that is left is to set out classification and distribution issues that arise during evacuations and in what way the above mentioned objective criteria can be insufficient when applied to inmates or to the guard’s ratio during these occasions.

RDM seeks to reduce risk, mitigate its consequences, prepare the response, rehabilitate and rebuild without replicating vulnerability. The Federal Prison Service manages facilities around the four cardinal points. The vastness and complexity of the territory force us to pay attention to unavoidable factors: a proven dynamic climate; seismic and volcanic history; floods from multicausal origins; mass movement phenomena; wildfires; dams with large settlements located downstream; and technological hubs in inhabited areas.

An indispensable requisite for a good system management is to understand this idea and its multiple aspects and above all it is important to put the emphasis on risk management. This means that in order to manage the potential risks within the facilities, a comprehensive diagnosis of each unit has to be done first.

To accept this responsibility and incorporate this approach, reassigns and situates our jurisdiction as central in facing the challenge of putting forward this complex initiative; this is a challenge we lead daily in a responsible and indefatigable way with the incentive of knowing that we are contributing to the consolidation of a national and regional sustainable and feasible development.

This handbook has been divided taking into consideration the different hazards, it also has a special section on climatic change and a section dedicated to disaster history divided by regions. This handbook allows completing the general outlook on the risks that the current, under construction and future federal penitentiary facilities might have to face.
A seism or earthquake is the vibration of the different layers of the Earth product of the liberation of energy when a block of the Earth’s crust breaks or frictions. Most of the earthquakes are followed by aftershocks, some are even as strong as the earthquake itself. Many deaths and serious injuries can arise as a consequence of said aftershocks.

Argentina is affected by the convergence of the Nazca plate (that conforms the bottom of the Pacific Ocean) with the South American plate. This contact zone lies along the shores of Peru and Chile and it is considered the longest in the world.1

The Nazca plate moves towards the East and it submerges beneath the South American one which moves towards the West this is done by a mechanism called subduction. Both plates move in a relative speed of 11 cm/year.

Due to the big compression efforts generated between the plates’ contact by the subduction mechanism, earthquakes can take place within a considerable distance from the point of contact. These earthquakes are generally associated with active geological fault lines. In our country, the most representative cases are the earthquakes occurred in Salta (1962, 1844 and 1948), San Juan (1894, 1944 and 1977) and Mendoza (1782, 1861 and 1985).

Most of the seismic activity in Argentina is concentrated in the central-East and Norwest regions, it is within these regions that the Federal Prison Service manages seven facilities (one in Mendoza, three in Salta, two in Jujuy and one in Santiago del Estero) and there is another under construction in Mendoza.

Only between August 2011 and January 2012, more than four thousand seisms took place in the country.

Even though the NOA (Argentine Nor-West Spanish acronym) has born many destructive earthquakes in the last 400 years, as the affected areas were not densely populated, the problem was not given the importance it really has, since, according to the National Institute of Seismic Prevention, it is an area of high level of potential seismic danger.

The earthquake of August, 25th, 1948 with epicentre in the Eastern area of the province of Salta, was the most important of the region due to the damages caused in that province and in Jujuy, even though the number of victims was small.

On March, 20th, 1861 a series of seismic events took place which affected the provinces of San Juan and Mendoza. It was graded as one of world’s most catastrophic earthquake of the XIX century; the movement totally destroyed the city of Mendoza and killed one third of its population. Furthermore, the seism of January, 15th, 1944 that destroyed San Juan and caused 10 thousand fatal victims represents the biggest natural disaster of the Argentine history.

The Argentine south –below 35˚ latitude- has suffered, many times, the consequences of big Chilean earthquakes that caused minor damages to the bordering populations. The quantity of seisms with epicentres in the Argentine territory is small.

The movements are classified according to its depth. The more superficial its location, the more dangerous it becomes. The biggest quantity of seisms with focal points of less than 70 km of depth are found in San Juan and Mendoza, this area includes their capital cities.

Intensity and magnitude are the scales use to classify a seism according to its size.

Intensity is related to the effects caused by an earthquake. It depends on the conditions of the terrain, the vulnerability of constructions and the epicentre’s distance. The scale has a subjective nature and varies in accordance with the severity of the produced vibrations and the caused damages in a determined place.

It considers the damages caused to buildings, the effects on the terrain and on objects and people. The most used scale in the Western hemisphere is the Modified Mercalli (MM), it is a close scale and it contains twelve degrees expressed in Roman numbers (from I to XII).

Furthermore, magnitude is an instrumental measure related to the elastic energy released by the seism and spread as waves within the interior and surface of the Earth. It is independent from the hypocentre and the observation site, and it results in a unique value product of the mathematical analysis of seismograms. There are different scales to measure magnitude but the most popular one is the Richter scale. This scale is an open one, with no superior or inferior limits; its figures are expressed in decimal numbers.

Earthquake engineering gives special importance to accelerations since they are a fundamental parameter for the study of the effects of seisms in constructions.
The seismic danger involves the probability of a determined amplitude of ground movement within a fixed period of time. It depends on the level of seismicity of the area.

The seismic zoning maps show areas with different levels of seismic dangers. The seismic zoning map of the 103 INPRES-CIRSOC Regulations identifies five seismic areas.

The Cuyo area which includes the capital cities of San Juan and Mendoza, is the most earthquake prone area in Argentina.

The following chart shows the history of important seisms with epicentres in/or that affected provinces where there are federal penitentiary facilities.²

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Earthquake description</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>September, 13th, 1692, SALTA.</td>
<td>It destroyed the Esteco village, it caused building collapses and fissures in the Lerma Valley. 11 deaths were reported and the aftershocks were felt during several days. Its intensity was of IX degrees in the Mercalli scale.</td>
<td>-25,400</td>
<td>-64,800</td>
<td></td>
</tr>
<tr>
<td>May, 22nd, 1782, MENDOZA.</td>
<td>First serious documented seism in the province; it was called the Santa Rita earthquake. It destroyed and fissure constructions. It reached an intensity of VII Mercalli degrees.</td>
<td>-33,000</td>
<td>-69,200</td>
<td></td>
</tr>
<tr>
<td>July, 4th, 1817, SANTIAGO DEL ESTERO.</td>
<td>Large amount of damages were reported in the north of the City of Santiago where building collapsed and the ground fissured. The aftershocks lasted for almost a week. An intensity of VIII Mercalli degrees was estimated.</td>
<td>-28,000</td>
<td>-64,500</td>
<td></td>
</tr>
<tr>
<td>October, 18th, 1844, SALTA.</td>
<td>It affected the City of Salta where serious damages and destruction of houses were reported; it was also very strongly felt in the City of Juluy. The aftershocks were felt for 10 consecutive days. The intensity was of VII Mercalli degrees.</td>
<td>-24,800</td>
<td>-64,700</td>
<td></td>
</tr>
<tr>
<td>March, 20th, 1861, MENDOZA.</td>
<td>The most destructive earthquake in percentage terms in the Argentine history took place. It destroyed the City of Mendoza and nearby areas and it caused 6 thousand deaths over an 18 thousand population. Its intensity was of IX Mercalli degrees.</td>
<td>-32,900</td>
<td>-68,900</td>
<td></td>
</tr>
</tbody>
</table>

Earthquake description

**January, 14th, 1863, JUJUY.**
A movement of exceptional intensity and duration took place in the City of San Salvador de Jujuy. It seriously damaged constructions, particularly the Cathedral and Town Council. Its intensity was of VIII Mercalli degrees.

**October, 9th, 1871, SALTA.**
An important earthquake affected Oran and the Argentine north. It shattered buildings to pieces and caused many fatal victims. Its intensity was of VIII Mercalli degrees.

**July, 6th, 1874, SALTA.**
Oran was affected once again. The 1871 memories generated a big exodus to the cities of Jujuy and Salta. The following constructions were damaged: Town Council, hospitals, schools and all the houses in the village. Its intensity was of VII Mercalli degrees.

**August, 19th, 1880. MENDOZA.**
It happened at 1:30 in the morning and it caused great alarm among the citizens who went out into the streets. It affected the City of Mendoza and caused the walls and ledges to collapse. There was a fatal victim in Tunuyan. Its intensity was of VI Mercalli degrees.

**September, 23rd, 1887. SALTA.**
Destructive seism in the bordering area between Bolivia and Argentina. It affected the areas of Tarija and Yacuiba in Bolivia and Salvador Mazza and Campo Duran in the north of Salta. The Seismologic Service of Bolivia estimated an intensity of IX Mercalli degrees.

**June, 5th, 1888, BUENOS AIRES**
It affected all the settlements near the coast of the River Plate, especially the City of Buenos Aires and Montevideo. It caused small damages since its epicentre was located in the river. Its intensity was of VI Mercalli degrees.

**October, 27th, 1894, SAN JUAN.**
The biggest magnitude earthquake in the Argentine history, it affected the North-western area of San Juan and caused damages and fatal victims in that province and in the province of La Rioja. It caused smaller damages in the provinces of Catamarca, Córdoba, San Luis and Mendoza. Its maximum intensity was of IX Mercalli degrees.
Earthquake description | Latitude | Longitude
--- | --- | ---
March, 23rd, 1899, SALTA. | -22,100 | -63,800
It destroyed the settlement of Yacuiba (Bolivia) and the city that is known today as Salvador Mazza in Salta. People fled to Campo Duran. Its intensity was of VIII Mercalli degrees.

April, 12th, 1899, LA RIOJA. | -28,650 | -68,400
It left the area of Jagüe in ruins and caused serious damages in Vinchina. It caused the death of eleven people and several were injured. It was felt in La Rioja, Catamarca, San Juan, Córdoba, Tucumán and Santiago del Estero. Its maximum intensity was of VIII Mercalli degrees.

August, 12th, 1903, MENDOZA. | -32,100 | -69,100
It shook the outskirts of Mendoza, particularly the Las Heras area where it affected the villages of Us pallata, Punta de Vacas and Puente del Inca. There were three fatal victims and serious damages in the buildings of the city. Its intensity was of VII Mercalli degrees.

December 17th, 1920, MENDOZA | -32,700 | -68,400
It destroyed Costa de Araujo and nearby vicinities within a 50 km radius. The estimated number of deaths was of 250 and there was a large number of injured. Crevices arose on the terrain and water emerged from within, in same places swamps were formed. Its intensity was of VIII Mercalli degrees.

May, 30th, 1929, MENDOZA. | -35,000 | -68,000
It destroyed the constructions in Colonia Las Malvinas and Villa Atuel, San Rafael area. It caused the death of thirty nine people and there were numerous people injured. It was felt up to the Northern area of San Juan, the East area of Buenos Aires, Neuquén and the Southern area of Río Negro. Its intensity was of VIII Mercalli degrees.

December, 24th, 1930, SALTA. | -24,700 | -66,300
The most important damages were caused in La Poma where houses collapsed and fissured. Thirty one people were reported dead and there were seventy people injured. It was felt in the entire North-western region, A VIII Mercalli degrees intensity was estimated.

June, 11th, 1934, CORDOBA. | -33,500 | -64,500
It affected the Sampacho area, in the south of the province where 90% of the constructions were damaged. It was felt in the south of Córdoba, west of Santa Fe, north of La Pampa and south of San Luis. A VIII Mercalli degrees intensity was estimated.

January, 15th, 1944, SAN JUAN. | -31,400 | -68,400
It destroyed the province of San Juan and nearby vicinities. It caused about 10 thousand deaths over a 90 thousand population. It also caused damages in the North of Mendoza. The maximum intensity of the earthquake was of IX degrees in the Mercalli scale.

Descripción del terremoto | Latitud | Longitud
--- | --- | ---
December, 17th, 1949, TIERRA DEL FUEGO. | -54,000 | -68,770
The most important earthquake of the Argentine south took place. Its epicentre was on the west of the Tierra del Fuego Island and it affected the settlements of the island and the southern area of the province of Santa Cruz. Its intensity was of VIII Mercalli degrees.

May, 15th, 1959, SALTA. | -23,180 | -64,650
The most affected areas were Orán and San Martín. It was in the San Andrés village 60 km to the west of Orán where it caused the biggest damages; it destroyed houses and caused the sliding of hillslides. Its intensity was estimated in VII Mercalli degrees.

October, 15th, 1968, CHACO. | -26,870 | -60,880
The most affected areas were Corzuela and Campo Largo where fissures in the brick walls appeared together with plaster falls. It was also felt in Avia Teral, Roque Sáenz Peña and Las Breñas. It was also felt but with less intensity in Quitilipi, Machagai and La Tigra. Its intensity was of VI Mercalli degrees.

November, 19th, 1973, JUJUY. | -24,578 | -64,588
It was the longest and most violent event; it caused panic and injured people. The biggest damages were recorded in the area between Santa Clara, Arroyo Colorado, Apolinar Saravia and Las Lajitas. It was felt from Paraguay to San Antonio de los Cobres and from Tartagal to Tucumán. A VII Mercalli degrees intensity was estimated.

August, 17th, 1974, SALTA. | -23,000 | -64,000
It was a short duration seism that affected the settlement of Orán where important material damages were recorded; several buildings became uninhabitable. It was strongly felt in Tabacal, Pichanal and Embarcación. Its intensity was of VII Mercalli degrees.

November, 23rd, 1977, SAN JUAN. | -31,041 | -67,764
It destroyed the constructions of the Caucete area. It lasted for more than one minute in its destructive phase. It caused the death of sixty five people and three hundred were seriously injured. It also affected the areas of 25 de Mayo, Sarmiento, Pocito and the north of Mendoza where more than 50% of the adobe constructions were destroyed. Its maximum intensity was of IX Mercalli degrees. It had strong aftershocks on December, 6th of that same year and on January, 17th, 1978.

Damage in San Juan (INPRES).

Postcards of the Caucete earthquake (INPRES).
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</tr>
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<tbody>
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<td>January, 26th, 1985, MENDOZA.</td>
<td>-33.120</td>
<td>-68.820</td>
</tr>
<tr>
<td>December, 16th, 1993, JUJUY.</td>
<td>-23.567</td>
<td>-65.016</td>
</tr>
<tr>
<td>June, 17th, 1997, SANTIAGO DEL ESTERO.</td>
<td>-27.744</td>
<td>-64.753</td>
</tr>
<tr>
<td>October, 6th, 2011, JUJUY.</td>
<td>-24.248</td>
<td>-64.352</td>
</tr>
</tbody>
</table>

**HAZARDS WITHIN THE COUNTRY**

**Volcanism**

In the Andes Mountain Range there are several active volcanos. Only in the shared section with Chile there are 117 and strictly on Argentine territory there are thirty seven, situated, according to the National Geographical Institute, in the provinces of Jujuy, Salta, Catamarca, Mendoza, Neuquén, Río Negro, Chubut and Santa Cruz.

With the exception of the province of Catamarca, in all other above mentioned provinces there is presence of the Federal Prison Service.

In the last two centuries the eruptions of the following volcanos have affected different areas of our country with varied intensity: Quizapu-Descabezado (Chile 1932), Llonquimay (Chile 1988/89), Peteroa (Argentina-Chile, 1991), Hudson (Chile, 1991), Láskar (1992), Chaitén (2008), Puyehue-Caulle Range (2011) and Calbuco (Chile, 2015), among others.

The vast majority of the world’s volcanos are found on the oceans’ ridges. In general, as these are low-lying areas, they are covered by the oceans (only small portions of land emerge such as Iceland in the North Atlantic).

The other area of the Earth that presents active volcanism is constituted by the subduction zones, areas of the Earth’s crust where the plates that make up the bottom of the oceans sink within the mantle, generally beneath the continental plates as it happens in the Andes. As these areas are normally found within the continents, volcanos are more visible. Besides, in general, they are more explosive.

An eruption is the result of the discharge of magma and gases from the internal volcanic vent. The most common consequences of eruptions are lava flows, pyroclastic flows, volcanic ash rain and gas emissions, among others.

As the geologist from the Buenos Aires University Corina Risso explains in her work “Volcanic Risk in Argentina”, an eruption is a natural process impossible to prevent. “The volcano will erupt whenever it wants and however it wants, no matter how thorough investigations have been and how much money has been invested on prevention”.

Of all volcanic dangers, volcanic ashes are the ones that cover the largest surface and affect the biggest number of people and material assets in Argentina, as it has been proven during the last years.

Volcanic ash rain is caused by explosive eruptions product of the unexpected expansion of gas or by hot magma entering into contact with superficial or subterranean water and thus transforming this water into vapour. The thinner particles can be swept away by the wind, very far away from the crater (they can travel thousand of kilometres before they settle out).

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3. There are several criteria to classify an active volcano. The National Geographical Institute considers a volcano active to those that have had eruptions within the last 10 thousand years.


In our field, Esquel’s Unit 14 (Chubut) has had to face the consequences of volcanic activity. This was one of the causes for a series of dialogue roundtables with municipal and provincial institutions in order to create protocols for joint work for cases of emergencies and disasters. In the last Calbuco episode of the year 2015, the visibility and traffic of Neuquén were affected thus obliging to enhance safe-keeping in Unit 9– Regional Prison of the South.

Man—says Corina Risso—can mitigate some effects, can evacuate thousands of people, can create barriers but the eruption will take place and its outcome may or may not be devastating depending on the type of eruption of that particular volcano and the type of human settlement situated around that volcano. A volcano erupting in the Puna will not pose the same risk as one in which mountain slopes live thousands of people, even though the eruptions of the first might be much more explosive than the ones of the second.

This is why it is important to be prepared. The penitentiary setting due to its particular characteristics, demands planning and organization.

**Volcanic Ash Rain impact**

We must highlight that the thin material discharged by big eruptions (such as the one of the Krakatoa volcano, Indonesia, in 1883) can travel round the world many times suspended on the atmosphere and it can cause important effects on the world’s climate due to the reduction by reflection of visible solar radiation.

The effects of ash rain vary according to the volume of the discharged material, the duration of the eruption and the climatic conditions of the area where the volcano is situated and of its surrounding region.

From the medical point of view, ashes can cause important diseases even though they present low rates of mortality for humans: acute respiratory problems such as nasal irritation and secretion, sore throat and irritation, irritation of the respiratory tracts in people with asthma and bronchitis; ophthalmological symptoms such as conjunctivitis and corneal abrasion; skin irritation such as dermatitis and allergies.

Besides, they cause fog which reduces visibility, increasing the risk of vehicle accidents. Ashes can accumulate on roofs and cause buildings to collapse. They can pollute water for human consumption and cause digestive diseases.

Ashes can cause the water supply to stop by blocking the water intake filters of superficial water springs that provide water to different settlements.

Ashes can expose urban areas to catastrophic floods by creating water barriers and/or reducing the course flow by totally or partially occluding them. This risk is potentiate in areas where rivers collect water product of ice melting (such as the cases of Los Antiguos, Santa Cruz after the Hudson eruption and Villa La Angostura, Neuquén, after the eruption of the Puyehue-Caulle Range volcanic complex – CVPCC (Spanish acronym)–).

The eruptions of ash clouds generate strong magnetic fields thus resulting in the falling of lightings and interruption of telephone communications due to micro waves. (Hudson volcano eruption, Chile, 1991).

From the productive point of view, thick material deposited in areas near the volcano can cover lands dedicated to agricultural and livestock use thus resulting in the destruction of crops and pastures and making soils unusable.

If the ashes’ temperature is high enough it can start fires, especially forest fires within areas of coniferous woods.

It can increase sheep’s weight up to thirty per cent thus exhausting cattle that has to move with all that overweight, this together with the reduction of fodder and water contribute to deaths among livestock (such is the case of the eruptions of the Hudson, Chaitén and Caulle Range volcanos).

In strong wind areas, ashes (angular particles) destroy vegetation and pastures thus resulting in

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Ash Impact of the Puyehue-Caulle Range volcanic complex on the Comahue lakes (CONICET).
the loss of livestock due to fodder defects (Hudson; Chaitén; Caulle Range).

The ingestion of pastures covered in ashes can cause livestock deaths by intoxication, digestive conditions and teeth erosion.

Ash rains can also cause high bee mortality since they can eliminate more than 70% of the individuals that form the hive (Eruption of Hudson, 1991; Chaitén 2008 and CVPCC, 2011).

Ash fall will also have direct and indirect effects on vegetation productivity.

It also causes infrastructure and transport damages: it collapses roofs, blocks combustion engines air filters and obstruct wheels.

It seriously affect s air traffic (that among other wrongs must face abrasion and can also cause airscrew engines to stop). The eruption of the Caulle Range Complex in 2011 caused the cancellation of thousands of domestic and international flights and also affected the normal functioning of airports as far as in New Zealand.

HAZARDS WITHIN THE COUNTRY

Mass movement phenomena

This is the name given to slow or quick mobilization processes of a determined volume of soil or Stone or both, in different proportions and caused by a series of factors. The types of mass movements include: falls, topples, landslides (rotational and translational movements) and flows (avalanches, earthflow, mudflow, creep).

These are descendant movements as they are controlled by gravity. They usually take place in high energy regions with significant soil slopes typical of foothills and plateaus areas.

Large areas of the Argentine territory have these characteristics.

The provinces that share the Sierras Pampeanas (Pampas Range), the Precordillera and the Andes Mountain Range are prone to these type of phenomena.

We can point out the determining factors and the trigger factors for these processes as the following:

• Internal features of potentially movable material.
• Geomorphic settings and surrounding geosystems.
• Independent external factors commonly known as trigger mechanisms: excessive rain; earthquakes or volcanic eruptions; man intervention: settlements in alluvial soils and mountain slopes, deforestation of slopes, hills or mountains; inadequate sowing on mountain slopes, among others.

History allows us to verify the consequences of these sudden phenomena. We must highlight the cases that took place in provinces with current presence of penitentiary facilities.

On February, 12th, 1995, in the El Infiernillo area, near Comodoro Rivadavia small fissures in the pavement of national route 3 turned into big cracks of 3 metres depth. The Chenque Hill collapsed causing the falling down of buildings and the communications between the city’s centre and its northern neighbourhoods were blocked.

As this section of national route 3 disappeared the central-southern area of the Patagonia became isolated from the rest of the country. The government declared the state of emergency and the municipal authorities launched a strategic plan to return to normal the situation of the main city of the province of Chubut.

Afterwards a new road was constructed over the original one and it is the one currently in used in spite of the potential risks.

Tartagal in Salta suffered mudflows in 2006 and 2009 and similar events happened in Vespucio-Mosconi in Salta in 2000 (one fatal victim) and in 1984 (nine fatal victims); and in Palmasola in Jujuy in 2001 in which ten people died and almost two dozen disappeared. The concurrence of soft rocks, heavy rains and nearby settlements triggers a potentially lethal situation.

All the Argentinian north has historic evidences of these phenomena given its particular geological and meteorological conditions.

These events have been repeating themselves over thousands of years and will continue happening. It can be forecasted where they will take place (space) but not when they will take place (time).

HAZARDS WITHIN THE COUNTRY
Hydro-meteorological phenomena

Floods and Droughts

Argentina has regularly borne extreme phenomena of flooding and droughts in different regions of the country, these phenomena has increased its periodicity and has intensified in the last decades.\(^{11}\)

The region of the Del Plata Basin endures big extraordinary floods in terms of volume, time, flooded areas and losses.

The floods of the years 1982/83, 1992 and 1997/98 were product of the extraordinary increase in the flows of the rivers Paraná, Paraguay and Uruguay due to the El Niño phenomenon\(^{12}\) and affected seven provinces of the Littoral-Mesopotamia region: Buenos Aires, Corrientes, Chaco, Entre Ríos, Formosa, Misiones and Santa Fe.

From the year 1970, these events increased their frequency with an average of one every four years thus generating important losses in infrastructure, farming, private assets and economic activity.

Besides the floods caused by the increase of big river flows, we can also find mudflows caused by torrential rains with bulk solid material movement (Western Precordillera region in the North-east, ravines in the Comahue region), by quick fusion of snow in the Andean foothills or by strong storms in urban areas.

Meanwhile, the cold phase of the El Niño-Southern Oscillation, called La Niña causes lack of precipitations in medium latitudes thus affecting rain-fed agriculture. The impact of ENSO cold events in Argentina is as follows:

- Rain reduction within the central region.
- Warmer summers.
- Winters with higher medium temperatures above the normal season’s temperatures.
- Increase of precipitations in the North-west.
- Rain reduction in Mesopotamia and in the Littoral.

The extraordinary heavy rain episodes in areas of the Pampas plain (North-west of the Buenos Aires province, South of Córdoba and Santa Fe) and the Chaco flatland (Eastern area of the provinces of Chaco and Formosa, South of Chaco and North of Santa Fe) cause waterlogging due to drainage limitations and are worsen because of bad soil management and deficient rural roads.

We must add up urban settlements within the territory that have been established without taking into consideration its potentialities and restrictions thus being settle down near riverbeds or waterways.

In the last decades, these settlements – commonly associated to the property value of the land – have been drastically affected by floods and aggravated by buildings that impede the normal runoff of water. In general, there is little and unarticulated urban development and control.\(^{13}\)

The AMBA region is a clear example of this; this region holds many penitentiary complexes which house a great number of the system’s inmates.

Only regarding precipitations, we must say that the historic annual totals nearly reached 1,000 mm, with a positive hydric balance of +150 mm. The rains of the last decades have caused a slip to the west of the 1,000 isohyet and today the region lies within the 1,100 mm isohyet.

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12. The global climatic phenomenon El Niño-Southern Oscillation involves big water areas of the Equatorial Pacific Ocean and the atmosphere above this region. It consists of the translation of a mass of warm water from the West that forms a big positive anomaly in the temperature of the sea’s surface within an extension of million square kilometres. (2012 Country Document).
Even though there are no well-defined diseases outbreaks recorded as an immediate consequence of floods, the deterioration of basic sanitary conditions of the community is only to be expected.

Floods can cause an unexpected number of victims, injuries or diseases outbreaks together with increase of psychological disorders risks.

In the cases where people have to be relocated, if this is done under overcrowding conditions and little hygiene, some medical conditions may arise such as acute diarrhoea, acute respiratory failure, malaria, dengue and leptospirosis, among others.

When a flood occurs there is mortality risk because of getting a respiratory or diarrheal disease or because of the high probability of getting electrocuted or drowning.

### Tornados

A tornado is a violent whirlwind that is formed in the base of a storm cloud and spreads downwards till it touches the ground generating damages of different intensities.

Generally the diameter of a tornado is smaller than 1,000 metres and the wind’s velocity can reach 500 km/h. Usually, its maximum speed cannot be measured with conventional instruments therefore it is estimated from the damages caused.

The terms tornado and waterspout identify the same meteorological phenomenon, but the first takes place over the earth and the second over the sea.

Tornados in Argentina tend to be low scale and usually just cause the falling of branches and trees. Less frequent we can see roofs falling off and vehicles being moved.

The biggest amount of tornados is recorded during November and March, while a low percentage takes place during the winter. Tornados have been detected all over the country except for the central and southern Patagonia area.

They occur up to 40° latitude south, most of all in the so called Tornado Corridor in the provinces of Entre Ríos, Córdoba, Santa Fe, La Pampa, the City of Buenos Aires and Greater Buenos Aires area.

The Fujita scale represents tornado intensity:

<table>
<thead>
<tr>
<th>Category</th>
<th>Wind Speed (km/h)</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0</td>
<td>65 to 115</td>
<td>Breaks branches and damages signs and antennas</td>
</tr>
<tr>
<td>F1</td>
<td>116 to 180</td>
<td>It separates roofs covers, moves vehicles and knocks over motorhomes.</td>
</tr>
<tr>
<td>F2</td>
<td>181 to 250</td>
<td>It blows away roofs, knocks over vehicles and breaks big trees.</td>
</tr>
<tr>
<td>F3</td>
<td>251 to 330</td>
<td>It destroys houses, elevates vehicles and throws them some distance away. It uproots trees.</td>
</tr>
<tr>
<td>F4</td>
<td>331 to 420</td>
<td>It creates big size projectiles. It removes tree barks from standing trees.</td>
</tr>
<tr>
<td>F5</td>
<td>421 or more</td>
<td>It seriously damages reinforced concrete structures.</td>
</tr>
</tbody>
</table>

Mortality associated to these types of phenomena is rare in Argentina. Generally, deaths are caused by the squashing of blunt objects.

The Meteorological Service highlights some episodes that took place in the Argentine history. One of them in the year 1928 destroyed the facilities of the Pilar Observatory in the province of Córdoba.

The following tornado events are remembered from the last three decades:

- San Justo Tornado, Santa Fe (January, 10th, 1973)
- Morteros Tornado, Córdoba (October, 28th, 1978)
- Centre and South-West of the Buenos Aires province (between April, 3rd and 4th, 1993)
- Buenos Aires province (December, 26th, 2000)
- Buenos Aires province (between January, 9th and 10th, 2001)

The phenomena of the years 1993, 2000 and 2001 caused numerous damages to overhead power lines.

- Tornado in the Ramallo area, Buenos Aires province (January, 30th, 2004).

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2012 Tornados

Between 7:30 and 9:30 pm on April, 4th, 2012, some severe meteorological phenomena affected various regions of Greater Buenos Aires and also fifteen neighbourhoods of the City of Buenos Aires.

An inspection was conducted between April, 10th and 26th, 2012 in order to determine the type and intensity of the meteorological phenomena. The study gave as a result the trajectory and impact area of tornados. The general damages occurred within an area of 40 km wide that spreads out to the shore from a western limit that unites Luján, Marcos Paz, Glew and La Plata. The most severe damages took place over four almost parallel stripes oriented from West to East facing towards the shores of the River Plate.

The damages caused to houses, manufacturing facilities, vehicles, buildings and trees corresponded to a F1 and F2 intensity in the Fujita scale, the maximum speed of winds was estimated in between 140 and 220 km/h.

Thunderstorms

It’s main feature is the presence of lightning; thunderstorms are generally accompanied by rain and strong winds, but they can do without these last two items. As it is impossible to forecast where lightning will strike it increases risks for man and material assets. It is during summer that the biggest amount of lightning strikes is recorded.

The Puna region registers the biggest amount of thunderstorms, anyhow this type of storms can occur in all the regions of the country.

People who are struck by lightning receive a very powerful electrical discharge that can cause serious burns or even death. Most of the deaths and injuries occurred during the summer months when people are outside in the afternoons or nights.

Snowstorms and Frosts

Winter storms are the result of very cold weather; they frequently deliver snow very intensively thus endangering human and animal life.

Winter storms entail ice, snow, low temperatures and very often dangerous conditions for driving.

Snowstorms are solid precipitations in the form of snowflakes while frosts entail low temperatures below 0° Celsius.

Winter storms mostly affect the Patagonia area.
The affected areas within this region are the provinces of Neuquén, Rio Negro, Chubut, Santa Cruz, Tierra del Fuego, Antarctica and South Atlantic Islands.

Snow and frosts can cause respiratory diseases or even death due to hypothermia. Snowstorms can produce a very cold environment that can freeze the surface of the human body and increase its blood pressure thus demanding a greater effort from the heart. This cooling effect also reduces resistance to infections such as a simple cold or diseases such as influenza. The storm can freeze uncovered parts of the body in thirty or sixty seconds, this usually happens when temperatures descend below 30° and -55° C. Hypothermia can cause death.

Also, gas heaters wrongly used and poor air circulation can result in carbon dioxide intoxication.

Zonda wind

It is a hot and dry wind that blows in the Western area of Argentina, leeward to the Andes Mountain Range, between 38° latitude South and the South of Bolivia. It belongs to the group of winds that descend from the crest of the mountain to the valley or grassland. It receives different names according to the areas where it blows: Chinook in the United States and Canada; Föhn in the European Alps; Canterbury Northwestern in New Zealand; Berg wind in South Africa; Zonda in Argentina.

17. Regional Meteorology Program IANIGLA-CONICET.
The Zonda generally appears in March and stays until October. It is produced by the ascent and later orographical descent of a prefrontal mass of air that on top of the mountain range is cold and heats up on its way down.

It is a less frequent phenomenon on the grasslands and in this area the occurrence of extreme or severe events is unlikely to happen. The greatest number of cases takes place between May and November. In populated areas, it causes damages that vary according to the intensity of the gusts: roofs blown away, falling of high tension wires and trees; interruption of telephone and electrical services.

The Zonda favours fires; it is harmful to agriculture due to the wind force and its extreme dryness and high temperature and it can accelerate the blooming of fruit trees at the end of the winter leaving them exposed to future frost and its potential risk.

Zonda categories

<table>
<thead>
<tr>
<th>GUSTS (km/h)</th>
<th>Zonda</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gust ≤ 65</td>
<td>Z1 (Zonda One)</td>
<td>Moderated</td>
</tr>
<tr>
<td>65</td>
<td>Z2 (Zonda Two)</td>
<td>Severe</td>
</tr>
<tr>
<td>90</td>
<td>Z3 (Zonda Three)</td>
<td>Extreme</td>
</tr>
<tr>
<td>Gust &gt; 120</td>
<td>Z4 (Zonda Four)</td>
<td>Catastrophic</td>
</tr>
</tbody>
</table>

Heat Waves

The World Health Organization (WHO) defines a heat wave as a long period of time excessively hot (compared to local weather in specific places) accompanied by high humidity.

In Argentina we consider a heat wave a period of maximum and minimum temperatures that surpass certain values –changeable according to the regions– over three consecutive days and in a simultaneous way.

Heat waves take place, mainly in the Central North-East area of Argentina, since in the rest of the country minimum temperatures are not high enough.

The alert system for Heat Waves and Health of the area on Meteorology and Health of National Meteorological Service, works to forecast extreme weather situations and its possible effects on people’s health. They are classified in 4 levels:

Green: Minimum State of vigilance during the summer. No risk for population’s health.

Yellow: They can be dangerous, especially for risk groups: babies and small children, elderly people above sixty five years of age or people with chronic diseases –high blood pressure, obesity and diabetes- It is declared when the threshold of the city’s maximum and minimum temperatures is crossed.

Orange: They can be very dangerous, especially for risk groups. It is declared when a wave continues through time and increases overheat.

Red: Exceptional cases. It can not only affect risk groups but also healthy people.

The consequences of these phenomena over health can be more or less serious according to the general State of the person, the type of alert and the preventive measures.
taken: heatstroke or sunstroke; body dehydration; weakness or lack of strength; fatigue; headaches; lack of appetite; insomnia; rapid pulse; cramps; muscle pains; exhaustion; excessive perspiration; faintness; syncope; low blood pressure, etc.

Heat waves can aggravate or strengthen the outbreak of a variety of diseases and its impact on health. For instance, they can cause a myocardium infarct and especially diarrhoeic conditions. Diarrhoea is the second cause of infant mortality in the whole world (mainly by dehydration). This is why it is very important to be alert, particularly with regard to children.

Heat waves can also be dangerous for adults and for people with chronic respiratory or heart diseases –high blood pressure, obesity and/or diabetes-

Between February and April 2015, more than 41 thousand hectares were devastated by a fire in the North West of Chubut this force the government to declare the state of emergency since this was catalogued as the worst forest fire in the Argentine history. The flames reached as far as some kilometres away from Unit 14 of Esquel but did not cause any inconveniency as it was confirmed on the field.

Among the effects of fires, the National Ministry of Health highlights skin burns which can be very serious. Also, smoke can affect airways and caused asphyxiation and eyes can become irritated since the released gases are generally toxic.

Fire ashes can irritate the skin and also the nose and throat. Moreover, toxic smoke can worsen lungs and heart chronic diseases.

Besides, the water sources can become polluted because of ashes and fire residue. Roads and routes can be blocked by the fire or by authorities in order to stop the expansion of the fire and to protect the population. Smoke can reduce visibility and cause car accidents. Houses can be totally or partially destroyed.

If fire expands, it can devastate vegetation, crop fields and can also kill livestock thus giving way to food scarcity especially in locally-supplied economies.

Health services can collapse since the treatment for burns can require a lengthy hospitalization, specific cares and supplies within adequate facilities (Burn Centres).

We should make a distinction between climate change and climate variability

Variability refers to fluctuations of climate components (temperature, precipitations, etc.) within the limits accepted as normal and during fixed periods of time (weeks, months or years).

We understand the concept of climate change as a significant variation of climate components when compared within a long period of time (decades or more); for example: medium temperature of the fifties compared to the one of the nineties.

Even though climate is affected by natural causes (such as the earth axis tilt) it can also be affected by man-made factors such as the increase of greenhouse gases in the atmosphere.

The greenhouse gases such as carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4) are linked to activities related to the production of energy, transport, soil usage, industries and waste management, among others. The build-up of these gases in the atmosphere increases the natural effect called *Greenhouse effect*.

Experts highlight the following items as the main consequences of climate change in the world:

- Alteration of the oceans’ flow.
- Increase or reduction of precipitations (according to geographical areas)
- Increase in the sea level.
- Glaciers retreat.
- Increase of extreme climatic events
- Increase of heat and cold waves
- Increase of migratory flows (because of catastrophes’ emergencies and labour)
- Increase of health issues and of number of illnesses

In Argentina, the annual range of precipitations has suffered sustained changes over time with different intensities in different periods of the year. Also, there have been significant changes in extreme precipitation events such as very strong rains in a short period of time and long periods of droughts.²¹

In April 2015 specialists summoned by the Urban and Sustainable Development Secretariat presented the Third National Communication on Climate Change.²² The report was elaborated by a team of fourteen local experts and it represents a unique material.

From the analysis of the climate between 1960 and 2010 the experts draw to the conclusion that in the northern half of the country the medium temperature rose half a degree, a smaller rise than the one recorded in the continental regions of the country.

As a counterpart, the rise in temperature in some regions of Patagonia surpassed one degree. In relation to this, the report affirms that the warming of the Andean region could have been the result of the retreat of the existent glaciers of the region.

In most parts of the country there was a reduction in the number of days with frosts, this being a potentially beneficial factor for agriculture.

Furthermore, heat waves increased considerably in the north and east of the country. “These events (one of the most severe expression of this kind of event took place in December, 2013), evidence the need for active adaptation policies on behalf of the local, provincial, and national government and also of society as a whole. Particularly, -the report stated that- it would be important to improve and strengthen the current systems of alert, prevention and response”.

A similar scenario is expected for the rest of the XXI century. Medium temperatures will increase in the whole country with a higher tendency towards the end of the century taking into consideration a

²¹ Ibidem.
²² In 1994 Argentina ratified the United Nation Framework Convention on Climate Change (UNFCCC) by Law 24,295 thus assuming a series of obligations. Some of those obligations are: to inform about the national inventories of greenhouse gases, implement national programs concerning measures to mitigate and facilitate the appropriate adaptation to climate change and inform about any other relevant information to achieve the Convention’s objective. All is summarised in the national communication as it was established by articles 4 and 12 of the UNFCCC. This Third National Communication will inform the Convention the situation of our country on the subject.
scenario with higher emissions of greenhouse gases. And the occurrence of extreme temperatures will be more frequent.

In the future decades, the increase will be of half a degree in the whole country thus giving rise to an acceleration of the climate warming of the last 50 years.

The projected increase is bigger in the North than in the South, with a maximum figure in the Northeast of 3.5°C which extends to the South to higher warming places and also reaches the centre of the Patagonia.

In the case of rains, the study of the last fifty years shows that they have increased in the whole territory but with a bigger emphasis in the East where there are areas that present more than 200 mm thus giving way to the expansion of the agriculture frontier to the West.

The specialists also indicate that extreme precipitations became more frequent in a bigger part of the country.

In regard to the Western and Northern part of the country, in the last five decades there was a switch to a longer period of dry winter. This could mean problems in the availability of water for the different settlements, more favourable areas for uncontrolled forest and pasture fires as well as stressing conditions for farming activities.

Beyond these extreme phenomena, the changes in the average precipitations of the whole country will not be relevant: changes could circle between an increase of 10% and a reduction of 10%.

Nevertheless, a reduction on the availability of irrigation water in the Cuyo region is expected, and this will jeopardize the viticulture and fruit production activities of the region.

HAZARDS WITHIN THE COUNTRY

Hazardous Waste issues

An accident or chemical emergency is a dangerous situation product of the release of one or several health and environmental threatening substances.

This category includes, among others, fires, explosions, toxic/poisoning release of substances and gas leaks that can cause different types of injuries, illnesses, disabilities or even death. There can be low or long term damages.

Generally, these incidents can by triggered by natural causes (such as earthquakes, tsunamis, volcano’s eruptions) or technological causes. The second ones are easier to prevent since they are the product of the intervention, carelessness or negligence of man.

Within the Argentine territory there are different chemical risks. The higher risk hazard is given by fixed installations and by the transport of hazardous substances. The prone regions are Patagonia, the Central region and the Buenos Aires’ metropolitan area.

In the case of fixed installations, the greater risk lies on petrochemical hubs located in urban and suburban areas and also in the ports.

Main threatened areas:

- Dock Sud, City of Buenos Aires, Avellaneda, Lanús and Quilmes: 3,349,730 inhabitants.
- Bahía Blanca – Ingeniero White. Urban conglomerate of Bahía Blanca made up of the neighbourhoods of Villa Harding Green and Villa Stella Maris; together with the localities of Ingeniero White, Grünbein, Villa Espora and Villa Bordeau. Making a total of 300,000 inhabitants.
- Zárate – Campana: 205,930 inhabitants.
- Greater La Plata (La Plata, Berisso and Ensenada). 793,365 inhabitants.
- Greater Rosario. Departments of Rosario and San Lorenzo, making a total of 1,161,188 inhabitants.
- Luján de Cuyo: 110,000 inhabitants.
- The petrochemical Hub of Neuquén: Plaza Huincul. It forms an urban conglomerate together with Cutral Có, which has more than 40,000 inhabitants.

In what the transport of hazardous substances is concerned, the most affected routes are: the national and provincial routes that traverse Buenos Aires, Entre Ríos, Córdoba, Santiago del Estero, Corrientes, Misiones, Formosa, Río Negro, San Luis, Catamarca, San Juan and Mendoza.

The worst incident in the country regarding the transport of hazardous substances took place in the access to the Buenos Aires port, in the River Plate on May, 11th, 1972. The British freezer vessel Royston Grange was carrying a cargo of 7113 tons and was

23. “Health in Emergencies and Disasters”, National Health Ministry
heading to the London port with its refrigerated cargo of meat and butter and also with passengers when it collided with the Liberian tanker Tien Chee that was travelling from Bahía Blanca to Buenos Aires with 20,000 tons of crude oil.

The incident happened in the Punta del Indio Canal at 5:20 a.m. due to a thick fog and a bad manoeuvre that caused the British vessel to crash onto the Liberian one which spelt oil on the engines of the vessel and these caught fire immediately.

The explosion of the ammonia refrigerator tanks and a non-declared white phosphorous cargo with final destination Brazil together with the burning oil caused the death of ten passengers and sixty three crew members (including the Argentine harbourmaster). The British vessel burned for almost 48 hours and the heat of the fire was so strong that it melted the on board glasses and bronzes.

The fact that none of the victims tried to escape and were found inside their cabins indicates that the deaths were caused by the inhalation of high concentrated doses of ammonia.

Eight members of the Liberian Crew (most of them Chinese) died during the abandon ship drill; but the harbourmaster and other thirty eight members of the crew were rescued by the Argentine Naval Prefecture.

The incidents that arose between Argentina and Uruguay during the rescue operations lead to the signing of the River Plate Treaty and its Maritime Front on November, 19th, 1973 in Montevideo.25

Environmental and Sanitary consequences

Chemical incidents cause different health conditions depending on the risk level and the type and duration of exposure and previous health status of people.

The effects on the organism can be immediate or delayed: carcinogenic, dermatological, immunological, liver conditions, neurological, lung or teratogenic (agents that can cause or increase the chances of congenital malformations).

If the exposure, expansion and type of substance are toxic and strong enough (plus the time of exposure and the previous health status of the person) and if medical assistance is not received immediately, the consequences can be fatal.

If the toxic spillage affects the water directly it turns unsuited for consumption, hygiene, watering and also it does not allow home-made purification processes.

Roads and accesses can also be affected.

Should there be an explosion it can result in the destruction of buildings and infrastructure.

If houses and buildings are affected, people should be evacuated and these places decontaminated taking into consideration the kind of chemicals involved.

The atmospheric conditions are determinant for the level of impact. A chemical emergency related to the expansion and concentration of gases and volatiles particles can severely affect the air we breathe and all our surroundings. Wind, rain, high temperatures and humidity are potentially aggravating factors. Humidity and high temperatures can increase damages since they favour chemical concentrations and act as reagents.

Fresh, canned and bottled food can be polluted. This alteration turns food and beverages into toxic and not suitable for human consumption. In the same way, a chemical incident can affect agriculture and farming.

Also, hospitals and health centres together with their access roads could be located within toxic areas; if this were the case they will not be able to provide their service normally nor receive patients for a long period of time.

Dams are barriers set on rivers that impede the flow of water and stores it inside the reservoirs; they can also be used to alter the course of the river. The main conditions a dam should meet are impermeability and resistance; impermeability for the water not to go through and resistance for the water thrust.

Most common types of dams:26

- Embankment Dams: big embankments made of stones, gravel, sand, slime and clay which are compacted till they reach an adequate consistency in order to provide impermeability and the necessary strength to resist water thrust.

- Gravity Dam: it is concrete dam that resists the force of water acting on it by its own weight. Stability

is the product of the widening of its base.

- **Buttress Dam**: A concrete dam. The buttresses are structures that resist the water thrust. Impermeability is the result of a concrete slab membrane hold by the buttresses.

- **Arch Dams**: These dams are arched dams of simple and double curvatures. These concrete dams seize the “arch effect” to concentrate water thrust in its foundation (support base) and in its abutments (lateral support). The span needed for the dam is narrow therefore they are built using lesser amount of construction material but they require high resistance bedrock in its foundation and abutments.

In Argentina there are nearly 130 dams according to the survey conducted by the Dams Security Regulating Organization (ORSEP Spanish acronym). These constructions have different owners: the Nation, the provinces and private owners and they fulfill different purposes; many of them have settlements located downstream that are exposed to hazards such as the operation of extraordinary flows or a catastrophic failure.

The ORSEP is the enforcement authority in 31 national multipurpose constructions that were given under concession in the nineties. Most of them belong to the provinces and a small percentage is private. There are also two big binational hydroelectric power stations: Salto Grande (Argentina-Uruguay) and Yacyretá (Argentina-Paraguay).

The dams constitute critical infrastructure. Its blockage or destruction has a big impact on health, security, citizens’ wellbeing, in the functioning of governmental institutions and of public administration. It catastrophic potential is undeniable.

**Some of the dams in our country are rather old.**

The alert/emergency scenario concerning dams is typified according to its hydric origin (ordinary overflows or extraordinary floods that can affect public security) or construction origin (partial or total collapse or disqualification of evacuation authorities).

We understand incidents as hazards of natural origin (hydric and seismic) or human-induced origins (structural, bad handling, sabotage, terrorism).

### Settlements at risk

Provided below there is a list of urban settlements located downstream, or near dams which present a high risk level because of failures in the dam’s operation or accidents (population information was provided by the 2001 National Census).

**Cities of Neuquén and Cipolletti**

Urban conglomerate of 290,000 inhabitants threatened by failures of operation or accidents or accidents that can occur in El Chocón (30 years old) which reservoir’s holds 20,000 hm³ of water. The dam is located over the Limay river, 80 km upstream of the city of Neuquén and 100 metres above the level of the mentioned city; 30 km away-downstream- the Arroyito dam is located and between this dam and the urban nucleus there are two small cities Senillosa and Plottier (that both add up 30,000 inhabitants)

By the Negro river (which is formed by the confluence of the Limay river and Neuquén between the cities of Neuquén and Cipolletti), downstream from Cipolletti the following cities and localities are in danger: General Fernández Oro, Allen, Contramirante M. Guerrico, J. J. Gómez, General Roca, Padre A. Stefanelli, Cervantes, Mainqué, Ingeniero Huergo, Godoy, Villa Regina, Ingeniero O. Krause, Chichinales, Valle Azul, Chelforó, Chimpay, Coronel Belisle, Darwin, Choelé Choelé, Luis Beltrán, Lamasquè, Pomona, General Conesa, Guardia Mitre and Viedma, in all they add up 210,000 inhabitants.

Risk can also arise from failures in the operation of the Hydroelectrical Complex Cerro Colorado (more than 30 years) which takes advantage of the flow of the Neuquén river; or by the occurrence of a natural extraordinary disaster such as the maximum probable flow increase²⁸, which its peak flow, estimated by successive revisions, surpasses the capacity of the discharge organs of the system.

Downstream we find the dam Ingeniero Rodolfo Ballester (75 years old), head of the important irrigation system of Alto Valle and home of the localities of Añelo, San Patricio del Chañar, Villa Manzano, Barra del Medio, Vista Alegre Norte, Vista Alegre Sur, Contralmirante Cordero, Ferri, and the cities of Centenario and Cinco Saltos. If a flood wave will occur within the Neuquén river, it will impact on the above mentioned settlements except for the

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²⁶  According to the “Geohydrological Glossary” written by Ramón Ortiz Aguirre, it is the “Maximum estimated increase in the flow that results from a combination of critical weather and hydrological conditions, considered physically possible and that can be present in a given flow of water within a recurrence period.”
cities of Senillosa and Plottier.

Greater Córdoba
It has a stable population of 1,400,000 inhabitants. It presents high risk due to the operation failures, incidents or accidents that might occur in the San Roque dam (60 years of service) placed over the Primero river, 25 km upstream of the city of Córdoba. This river traverses the city.

Greater Tucumán
The greater Tucumán (740,000 inhabitants) and the cities of Termas de Río Hondo and Santiago del Estero (350,000 inhabitants); add up to a population or little more than 1,000,000 inhabitants that can be reached by incidents in the El Cadillal dam (37 years old). As a result of a chain effect a flood wave from El Cadillal or the Escaba dam, will impact on the Río Hondo dam (35 years old).

The El Cadillal dam is located over the Sali River and it holds 275 hm$^3$ of water, and it will impact first on the city of San Miguel de Tucumán which is 20 km away from the dam and afterwards it will impact on the Río Hondo dam which holds 1,740 hm$^3$ and it is located 80 km downstream the city of Tucumán.

The Río Hondo dam is located upstream of the locality of Termas de Río Hondo. The Sali river is later called Dulce and any flood wave generated within the dam will have direct impact on the city of Santiago del Estero.

City of San Juan
The Quebrada de Ullum dam, is located over the San Juan River and it has a reservoir of 440 hm$^3$, it is constructed 19 km upstream of the city of San Juan, with a population of nearly 420,000 inhabitants.

City of San Fernando del Valle de Catamarca
The city of San Fernando del Valle de Catamarca has nearly 170,000 inhabitants and 29 km away, upstream we find the Las Pirquitas dam. It is 71 metres tall and it holds 75 hm$^3$.

City of La Rioja
The Los Sauces dam is located in the valley of the Los Sauces river, 18 km away from the city of La Rioja. This construction has 64 metres high and a reservoir capacity of 26 hm$^3$ due to its age and lack of maintenance it jeopardizes a settlement of nearly 140,000 inhabitants.

Inferior Valley of the Chubut river
Within the inferior valley of the Chubut river, 80 km away from the cities of 28 de julio, Dolavon and Gaiman (7,000 inhabitants) the Florentino Ameghino dam is located, it is a construction of 113 metres high and it holds an important volume of water (2,050 hm$^3$)

In the river’s course towards the sea, we find the cities of Trelew and Rawson (110,000 inhabitants), both cities present a potential risk given the volume of water stored 150 metres above them.

City of San Rafael
In 2002 a level 1 emergency was declared in Los Reyunos dam over the Diamante river because of the anomalous behaviour of the structure which was detected by one of the auscultation instruments. It is an embankment dam of 131 metres high that stores 260 hm$^3$.

The city of San Rafael has a population of 100,000 inhabitants and is located downstream a number of dams located over the Atuel and Diamante rivers: El Nihuil, Valle Grande, El Tigre and Agua del Toro.

Greater Mendoza
This case of moderated risk was selected due to the dificulties of the torrents generated by extreme summer storms in areas of steep slopes. In this place they are mitigated by the dams located over the rivers Papagayos, Frias and Maure which store rain water. The constructions are located to the West of the city of Mendoza that has a 850,000 population.

HAZARDS WITHIN THE COUNTRY
Epidemics, outbreaks and pandemics

Among the phenomena associated to epidemics, outbreaks and pandemics in Argentina, the diseases with greater potential risk are: cholera, dengue, chikunguña fever and influenza.

Cholera
It is an infectious disease produced by the vibrio cholerae bacteria that once inside the body can cause diarrhoea. In the most serious cases, if the quick loss of bodily fluids is not treated on time it can lead to dehydration, prostration and death.\textsuperscript{29}

In some cases, it occurs in mild form but it is calculated than one every twenty infected persons can suffer from the severe form that is characterized by the following symptoms:

- Frequent diarrhoeas which are liquid at first of normal colour and later turn to a rice water like colour. Bowel movements can be colourless and

\textsuperscript{28}. National Health Ministry, Special edition “Health in Emergencies and Disasters”.

\textsuperscript{29}. National Health Ministry, Special edition “Health in Emergencies and Disasters”
painless.

- Quick dehydration, dry tongue and intense thirst, rapid pulse, cold sweat.
- Relatively painful muscle cramps and/or numbness of legs due to lack of potassium.

It is important for someone who is experiencing these symptoms to receive medical attention since dehydration can take place in a few hours. The deadliness average range for non-treated cases usually gets to 30%-50% but can decrease to 1% if the proper treatment is applied in time and due form.

**Even though our country has not registered cholera cases since 1999, there is risk of the introduction of this disease by travellers coming from endemic countries.** The outbreak can start in any region depending on the exposure of the population to sewage water or untreated water or contaminated food by the bacteria.

**Dengue**

Is a viral disease transmitted by the bite of the mosquito *Aedes aegypti*. When this mosquito feeds on the blood of a person that is ill with dengue it stings others and transmits the disease to them.

The contagion is only produced by the bite of the infected mosquitoes, never from person to person, nor through objects nor breast milk. Nevertheless, even though it is not very common pregnant women can transmit this disease to their babies.

After an incubation period of 5 to 7 days, clinical symptoms might appear but most of the infected persons will present no symptoms.

Symptomatic infections can vary from mild forms that only present a clinical picture with fever (2 to 7 days) and other cases were fever is associated to a general malaise, headaches, pain behind the eyes, muscle pain and joint pain.

Some dengue cases can turn to its severe form in which there are haemorrhagic manifestations that can lead to the dengue shock syndrome.

**Dengue in Argentina is epidemic,** and the cases usually happen during high temperature months (November to May), and it is strongly linked to outbreaks in neighbouring countries. It affects the Norwest and Noroest region, Central and Metropolitan area of Buenos Aires and Cuyo.

**Chikunguña Fever**

It is a viral disease that is recently circulating through the region of the Americas; it is transmitted to humans by the same mosquito that transmits the dengue fever. It is characterized by high fever and joint pain.

**Till now, the only cases that appeared in our country were imported cases from other countries of the region, but the vector is present in most of the country except for the Patagonia region.**

The chicunguña symptoms generally appear 3 to 7 days after the infected mosquito has bitten the person; these symptoms are fever (higher than 38°), strong joint pain and joint inflammation, generally of hands and feet. It can also present headaches, muscular pain and rashes.

Even though most of the patients recuperate in a week, some people might have joint pains during a longer period.

**Influenza**

**Influenza** is an aerial transmitted disease caused by the RNA virus of the Ortomixoviridae family, which affects all the regions of the country.

There are three types known; A, B and C. The A virus has two subtypes that are currently circulating among humans (H1N1 and H3N2). For influenza viruses B and C there are no described subtypes and they only infect people.

Its high contagiousness during epidemic seasons causes high incidence rates (from 10 to 20% of the population) and can elevate to 50% in closed settings.

Its main complication is pneumonia in elderly people, 5 year old children and patients with chronic diseases (heart, lungs, and kidneys, metabolic diseases) or immunosuppressed patients.

Higher mortality rates are expected in age groups that include children and young adults and they can reach 35%. For adults and elderly people the rate circles around 10 and 15%.

During pandemics these rates can get higher, such are the cases of years 1918 and 1919 where the rate surpassed 40% within the general population. 10% rate of influenza cases cause problems within the
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community; 25% collapse community and health services; 50% rates cause a disaster.

As it has been concluded from the observations done during pandemic and interpandemic periods, pregnant women represent a risk factor as they can have serious complications or even die because of influenza, particularly during the second and third trimester of the pregnancy.

**DISASTERS BY REGION**

The data base for disasters in Argentina (developed by the Centre for Social and Environmental Studies) has 17,833 records of disasters that cover the period 1970-2007. At least 26 different types of disasters were registered.

In general terms, recurrent risks are the ones that have caused more accumulated damages during the last decades. Yet, seisms constitute an exception as mudflows in the Cuyo area; especially seisms show a relatively low recurrence within the period under analyses but the level of destruction is considerable. The first comparative look on the regions shows an uneven distribution of disaster around the territory. Taking into consideration the different kind of risks present in Argentina: three regions concentrated 73.5% of the disaster records between 1970 and 2007: Central, AMBA and NOA.

However, if we only consider flood risk which is the one with greater recurrence and accumulated potential damages on a national scale, four regions have concentrated 92% of the disasters of the last 38 years. In descendant order of records we find: Central, NEA, AMBA and NOA.

According to the weighted data, between 1970 and 2007, the Central region and AMBA concentrated the biggest percentage of human lives’ loss due to disasters (63.6% between the two regions) which is also consistent with a greater concentration of inhabitants in both regions.

In terms of displaced people, the biggest percentage corresponded to the Central region (40.1%), followed by NEA (26%) and AMBA (21.4%). However, the substantial difference in population between the NEA and the Central region results in a relatively higher impact in the first region.

Regarding the destruction of houses, the data was distributed evenly between the Central region, AMBA, NEA and Cuyo with lower percentages in NOA and Patagonia.

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30. It is taken into consideration the regionalization proposed by the National Institute of Statistics and Census (INDEC Spanish acronym) in 1980. NEA (Spanish acronym for Nor- eastern region) it includes the provinces of Formosa, Chaco, Misiones and Corrientes; NOA (Spanish acronym for Nor-western region) it includes Jujuy, Salta, Tucumán, Catamarca, La Rioja and Santiago del Estero; CUYO region: it includes San Luis, San Juan and Mendoza; CEN- TRE it includes Buenos Aires (except for the Metropolitan area of Buenos Aires), Santa Fe, Córdoba and La Pampa; AMBA (Spanish acronym for metropolis area of Buenos Aires) it comprehends the Autonomous City of Buenos Aires and the 24 localities that surround it; PATAGONIA region it includes Neuquén, Rio Negro, Chubut, Santa Cruz, Tierra del Fuego, Argentine Antarctica.


32. The information on this section belongs to the Country Document: Disaster Risk in Argentina (Argentine Red Cross and Centre, 2009)
Taking into consideration the number of damaged homes we see that the Central region concentrated almost 52% of the total, follow by far by NEA (15.4%) and afterwards Cuyo (12.9%). AMBA and Patagonia accumulated the lowest percentages: 5.9 and 6.1% respectively.

As far as relative floods impacts are concerned, the NEA region is the one most clearly affected, with a greater number of people who had to be displaced considering the total population; this region is followed by the Central region.

The Central region is the one with the biggest proportion injured/sick per floods if we consider the regional population.

NEA has the biggest number of destroyed houses due to floods, in regard to an approximate value of the regional population.

This last region, followed by the Central region, is the region with a higher proportion of homes affected by floods over an approximate value of the population.