

The history of human impact environmental sciences essay



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Conclusion 14. References Introduction On the 25th of April 1998 in

Aznalcollar, Spain, the Los Frailes tailings dam, ruptured. It contained tailings from the mining of arsenic, silver, cadmium, copper, zinc and lead. The Los Frailes mine had a mining rate of approximately 4 million tonnes per year.

The ruptured dam released about 5-7 million cubic meters of toxic tailings sludge and contaminated wastewater into Agrio River, which is a tributary to

Guadamar River. The cause of the incident The actual cause of the Los Frailes tailings dam failure is still to this day exactly 100% clear as the final report has yet to be published and released. The authorities blamed the

Swedish-Canadian operator of the mine, Boliden Ltd, and Boliden Ltd claimed instantaneously after this terrible incident occurred that they were not at

fault. Immediately after the accident happened it was suspected that a foundation failure occurred in the separation dam that's located between

two parts of the impoundments, e. g. the soil underneath the base of the Los Frailes dam lost its mechanical strength. The separation dam is positioned

among the basins, which are filled with tailings from pyroclastic rock and pyritic rock and the foundation failure of this lead to the breaking of the main

dam. The Swedish-Canadian operator of the mine, Boliden Ltd, has assured the authorities and the people of Aznalcollar that there was no possible way of foreseeing the foundation failure. There have been many different reports

and opinions given as to why the dam failure occurred. The company Boliden Ltd stated at the start, that the cause of the dam rupturing was a landslide,

which resulted in the movement of a part of the wall. However, the

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authorities stated that the dam was not of adequate construction and also that any signs of a probable break were ignored by the company in charge. Three independent investigations were carried out into the cause of the dam failure. One investigation was commissioned by Boliden Ltd and carried out by EPTISA, another was commissioned by the regional authorities and carried out by CEDEX and the 3rd investigation was commissioned by the judge who was in charge of leading the legal proceedings of the accident and was carried out by the University of Barcelona. From the findings of the three investigations it was agreed that the cause of the dam failure was from the formation of sliding surfaces in the marl beneath the foundation. The foundation failure occurred because of the chemical attack of the impounded acidic pyritic sludge on the marl. Marl contains calcium carbonate and clay. The attack of acid on the marl decomposed the calcium carbonate present, which resulted in the deterioration of the mechanical stability of the soil. Fig 1: The breaking of the dam: A large part of soil, which was located underneath the dam, moved towards Río Agrío (approx. 1 metre). The front part of the moving soil was approx. 20 metres wide and positioned where the junction of the two impoundments. This caused the dam to crack and break suddenly causing the wall to collapse move forward along the separation dam, between the two impoundments. Approximately 5 million cubic metres of toxic tailings sludge and contaminated wastewater seeped through the opening. The bed of Agrío River increased by roughly 3 metres and changed its course. Fig 2: Detailed diagram showing before the displacement had occurred and after the displacement had occurred. The Los Frailes dam is approximately 25 meters in height and lies on 4 meters of alluvium, which is situated under 70 meters of blue marl. By the overstressing of the blue marl,

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it resulted in the dam, alluvium and the marl to slide. This sliding caused the pyrite tailings to liquefy, which then resulted in increasing the loading on the dam while the foundation resistance was decreased. These various processes were the result of the 60 meters of horizontal displacement of the Los Frailes dam. Various other factors were ruled out as being contributing factors to the failure of the dam, e. g.: blasting, earthquakes etc. Fig 3: Actual photograph of the Los Frailes tailings dam failure showing a total of approximately 60 meters of displacement. In the beginning of November 1998, Boliden sent a report to the judge who was in charge of the case. In the report it stated that a new displacement (3 millimetres) of the dam had taken place since the spill. The Government confronted the public, as there was an increased risk of a new spill. Mid-November 1998, the Environmental Protection Department warned that there was still a higher amount of tailings than what was lost when the dam ruptured in April, and if it rains and the dam fills with the rainwater then it would apply even more pressure to the walls of the dam. In February 1999, Boliden Ltd finally admitted for the first time that the tailings dam was not properly designed. They directed the blame entirely on the contractor (Dragados y Construcciones) and the two engineering firms used by them. Environmental Impact

A mine that is situated on the Agrio River that joins the Guadiamar (a major tributary of Guadalquivir River) used sulphuric acid as a way of removing metals from floated pyrite (up to 2 million metric tonnes per year¹) and this is stored in a tailing pond confined by a dam. Following the rupture of a part of the dam in the Los Frailes lead-zinc mining residual tank at Aznalcóllar near Seville, Spain there was a release of harmful substances in the forms of sludge and contaminated wastewater from the tailing pond. It was approximated that 5-

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7 million cubic meters of the acidic and toxic metal contents were released over 5 days while authorities tried to get the situation under control². The total amount of area affected was 4. 634 hectares and from this, 2. 703 hectares was contaminated with sludge and 1. 931 hectares was contaminated with acidic water. It was the wastewater that contaminated the Guadiamar River with heavy metals such as lead, zinc, cadmium and copper³. In high doses they have an extremely harmful effect on humans, animals and the environment but damage can also occur in minuscule amounts and stay in the environment for years to come. Following the rupture of the dam, the sludge and toxic water progressed into the Guadiamar River. As is flooded it moved into agricultural land and went into the edges of the Doñana National Park. This Park is actually situated nearly 45km away from the river and en route it covered cropland and pasture land. The Coto Doñana Park and the National Park is situated in the Guadalquivir region and is part of the World Heritage site. These marshes are known as the largest and most ecologically important wetlands in South West Spain and all of Europe⁴. 132, 000 hector of the Doñana is protected by international law. This is especially important for most migratory birds as it supports nearly half a million waterfowl and waders every year in the winter. In addition to this, these marshes are vital for supporting settlements of breeding birds like egrets, stilts, storks, herons and avocets⁵. These sites are these birds homes in which they build nests and feed but the damage of the wetlands prevents this and therefore endangering the species that do reside here. The aftermath of the toxic wastewater spill had an extreme effect on the aquatic biota as the lowering of the water's pH instantly killed the majority. In the first initial hours of the spill, the oxygen would not dissolve in <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

the water and a large quantity of solids in suspension, which lead to various sub aqueous organisms being starved of oxygen and killing them. In the days after the disaster, it was estimated that 30 tonnes of dead fish and 170kg of dead crabs were collected. It took a month for the river to recover from the spill and this led to a major decrease in the fish and aqueous organism supply in the river leading to a decrease in the food supply for the species that feed on fish and also a high chance of contamination due to the fish consumption. This disaster had a major negative impact on the organisms that were in the sediment and also those that were feeding on the sediment. As this land was contaminated by heavy metals from a mine and the concentrations were very high, this killed most organisms that were in the soil and the sediment. The change in pH value, due to the acidic water, taking the pH from a basic 8.5 to an acidic 4.5 had an impact by killing most of the wildlife in its path. The surrounding areas of the spill that had as little as 2 centimetres of contaminated water compared to the two metres that covered the area of the rupture were equally affected. Also as the soil is ruined then this contamination can rise up the food chain leading to a higher death rate and the death of organisms that were not even in the geographical area to be affected. The effects on the bird population was quite extreme as these wetlands and its surrounding area, including the National and Natural Parks, was incredibly significant for the wildlife of Doñana. It took 5 days before the damage was under control but the damage was already done within a couple of hours. A week after the incident, it was seen that black kites were scavenging for food in agricultural fields that were contaminated and that white storks were feeding on 'entremuros'

(canalisation walls) that were contaminated with the acid water. In the <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

national park alone it was found that 200 birds were found dead with a lot of sick birds turning up over a number of weeks. The different death rates may have been due to that those who were directly rummaging in the contaminated water soil and those ingesting the sediment were affected instantly as the metal concentrations in the soil were so high, where as acute toxification affected birds that scavenged prey after the drop in pH would not have been subjected to such a high level of metal. The toxic effect happened over time. The short term effects that this had on the bird population was that those directly involved were killed almost instantly of over a few hours and the upset of the natural breeding process of the species of bird. The long term effects that this episode had on the bird population of the Doñana region were that it resulted in a loss in the natural breeding and feeding routine of a variety of birds for a temporary period. This incident also effect the migratory bird population as the flooding of the marshes of the National Park is quite important to them as they either pass through or winter in the area and this provides food for them. As the slice gates were closed along with the Brazo De Torre for an extended period past the winter months to stop any further contamination, as rainfall increases in the winter months then this autumn rainfall can't carry any contaminated sediment to further a field and destroy anymore of the important ecological wetlands. As a result of this there was a difference in the distribution of the migratory birds in the Doñana and this lead to a food scarce due to the 'drying out' of the marshes. At a reduction of 20% of rainfall that winter, the bird population had to seek food elsewhere and this in turn increased their chance of getting contaminated. The fact that most of aquatic biota was killed because of the lower pH levels also affects the scarcity of food. Major victims of this were

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the white storks and the black kites as their habitat was near the sludge contaminated area. During the time of the incident these species had already in breeding season so it would have been difficult to relocate and to source other food sources. The only species that had not been affected were those who were tolerant to metal. A longer term threat to the bird population would be the accumulation of metal through the food chain. This can be said for species that prey but also through directly consuming sediment while feeding⁶ i. e. Waterfowl and waders as they feed in the area that was contaminated with the sludge in the North of the park. The absorption and the toxic effect that such metals, that had contaminated the soil, rely on such factors as the nutritional composition of the diet of the specie but also the chemical form in which the metal is available in. For example lead as when it is in metallic state it is not as easily absorbed or toxic as to when it is in an organic form^{7, 8}. There is also the factor of susceptibility to consider as birds of the same species may feed on large amount of metal containing sediment while feeding where others may not be subject to the same amount of metal contamination. It is not only the sediment that was contaminated but the feed itself. The Typha rhizomes are an important food source in the Guadalquivir marches⁹ for specie such as the purple gallinules and are known to be high metal accumulators. Many of these migratory birds will present the toxic effects of metal during times of stress i. e. breeding and food shortage and will carry these with them to other areas in which they breed. This exposes bird species in which never had been to the Doñana region. It is not only birds but the farming surrounding the land and fishing also suffered from these disasters which lead to a huge financial loss to the region. The surrounding of the contaminated water leaked out onto <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

agricultural land. This ruined surrounding cotton and other crop fields leading to distress to local farmers. The contaminated water instantly destroyed the crops and they were not allowed to grow or harvest any crops from the affected area. This led to huge financial loss for the region. It was some time before they were allowed to harvest or grow crops on the affected land for consumption to make sure that the levels of heavy metals were at a normal level as a small amount is naturally present in the environment and the soil. It was vital that this disaster was repaired as soon as possible as it put protected species at risk in the most important ecological wetlands in Europe. The high levels of heavy metals caused the pH to drop to an acidic level of 4.5. This acidic state led to the solubilisation of the metals arsenic, lead and zinc which was lethal to aqueous species, invertebrates and on other levels of the food chain such as protected bird species. It destroyed natural habitats, farmland and surrounding areas. Human Impact Aznalcollar, a town in the region of Andalusia, is located in the south west of Spain. The region of Andalusia is the second largest region of Spain, and it is the country's highest populated region. Andalusia is known to be an economically poor region with the majority of growth in its industry and service sectors. The region can be divided into two major sub regions; in the north, the Sierra Morena Mountains can be found and below this in the south is the valley of the Guadalquivir. This valley is home to the region's most fertile land, which is found along the banks of the river Guadalquivir and its tributaries. One of these tributaries is the river Guadiamar which flows through the town of Aznalcollar. The flow of the Guadiamar River is very seasonal; however it still sustains agricultural activity throughout the area.

Approximately 45% of the Andalusia region is responsible for agriculture.
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Agriculture is mainly located around the fertile banks of the regions Rivers such as the river Guadiamar. The main agriculture in this area is made up dry land farming of cereals such as barley and oats. Other cereals grown in the area were use irrigation. These cereals include maize, cotton, olives and rice. Only 17 percent of Spain's cultivated land is irrigated, proving that this region is of great importance to Spain's primary sector. Taking the type of crop into account, this land could also allow for the harvest of two successive crops in the same year proving its benefits to the area. Other primary sectors in the region include: fishing and mining which are all located around the Guadiamar River. The Guadiamar River is a valuable source to the population of Aznalcollar, providing a source of food, materials and employment. Fish is the main source of protein in the Spanish diet and it is commonly found in traditional Spanish dishes. Fishing not only provides a source of food to the area but also employment due to its demands. Mining still holds a great level of importance to the Andalusia region. The region is responsible for producing half of Spain's mining product by value. The product comes from different provinces of the region including Seville, where various metals are extracted from the mine at Aznalcollar. The Los Frailes mine at Aznalcollar produces around 125000 tons of zinc and 2. 9 million ounces of led per year. This mine offers a great source of employment and income to the area from raw materials which are exported. Tourism is also a major beneficial source to the tertiary sector of the region. The coast of Andalusia offers a very obvious source of tourism however The Donana National Park located along the bank of the Guadiamar River, is thought to be a Mecca for bird watchers. The national Park covers 543km²(337. 41 mi²) of which 135 km² (83. 89 mi²) is a protected area. It is made up of marsh,

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shallow streams and sand dunes. In 1963 the park was established as a nature reserve when the World Wildlife Fund joined with the Spanish government and purchased a section of marshes to protect it. Donana National Park is one of Europe most important wetland reserves and a major site for migrating birds. The park itself is internationally recognized for its great ecological wealth and has become a key center in the world of tourism. It has become very popular due to its enormous variety of bird species, permanent residents, winter visitors from north and central Europe or summer visitors from Africa, such as its numerous types of geese and colourful colonies of flamingo. The park is also home to one of the world's largest colonies of Spanish imperial eagles. As a whole, the park offers three distinct types of ecosystems: the marismas, the Mediterranean scrublands and the coastal mobile dunes with their beaches. The park attracts a vast amount of tourists annually, which in turn benefit the economy of the area. The park is also used by pilgrims taking part in the Romeria de El Rocio. This event alone can attract up to one million pilgrims each year. It is visible from the information above that the area surrounding the Guadiamar River is extremely dependent on its surroundings natural sources. The town of Aznalcollar is reliant on the following; agriculture, fishing, mining and tourism. However in April 1998 when the dam of the mining residual tank of a pyrite mine in the locality ruptured, releasing sludge and contaminated waste water. The wastewater entered the Agrio River and the Guadiamar River. Both these rivers had low water levels due to a spring drought. In turn the rivers flooded nearby - cultivated fields and threatened to flood the Donana National Park further downstream. This had an enormous affects on the population of Aznalcollar. Initially families living near the river were

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physically threatened. They had to flee their homes immediately, not only due to rising flood levels, but the fact that the water had been polluted with toxic heavy metals. These families lost vast amounts of their belongings in the flood and the polluted water threatened their health. Fortunately there were no initial fatalities, just a small number of people injured. However it was not recorded but these families were at the greatest risk of contracting terminal disease from the toxic water. PUT IN WHAT AOIFE

SAID[http://fuentesdeciencia.files.wordpress.com/2010/10/hungria-aznalcollar.jpg? w= 480&h= 268](http://fuentesdeciencia.files.wordpress.com/2010/10/hungria-aznalcollar.jpg?w=480&h=268)Initial affects to the area surrounding the Guadiamar River. The cultivated lands along the banks of the River Guadiamar were also destroyed. As the toxic waste water entered the river the level rose and flooded the cultivated land along the river banks. Not only were the crops damaged by the polluted water but by the residual mud. Any of the crops that had little water damage still could not be harvest due to fears of toxic contamination, so all harvest had to be destroyed. This occurrence lead to a great economic loss, believed to estimate at \$10million. Not only is this a very large sum of money for a poor region, but it was spread mainly among 2, 000 small farmers who had a great dependence on agriculture. This in turn also increased the price of rice, cotton and olives (main crops grown) in the area as they had to be bought and transported from other areas. However not only were harvest effected in 1998, due to the pollution of soils, crops could not be grown for a least another five years, until analysis had deemed the land safe for cultivation. This caused great loss for the farming community in the area as they had to abandon farming for this period and find another source of employment. Pasture farmers were also affected in a similar way. When the area flooded rapidly farmers had to <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

abandon their farms, without any time to bring their animals to higher ground. These animals either drowned from high flood levels or were poisoned from drinking the contaminated water. When farmers could return to the area, their herds had been killed and no vegetation would grow for years after due to level of pollution in the soil. These farmers also had to seek different forms of employment, which deemed very difficult in this poor region. Fishing in the area was a great source of income for the community as there was a great demand. However once the contaminated wastewater entered the river all fish stocks were killed by the toxins. Fears also remained within the community years after the incident of how clean the river really was and were it safe to consume fish from the river. images. jpg

Mining was another great source of income for Aznalcollar, as a poor region it depended greatly on its natural resources. However when the incident occurred at the Los Frailes Mine, the mine was closed down instantly due to further risk of contamination to the area. This impacted the area greatly as the mine employed 500 people and an estimated 1800 people indirectly. The employment of the area had a great dependency on the mine. Once the mine closed there were more that 2000 people in the area left unemployed. Also the material extracted from the mine when sold brought a source of income to the area, which was lost due to the closure of the mine. As visible from above, the Donana National Park is Aznalcollar main source of tourism and bring in a great source income to the area. The park was not directly affected by the incident however it was under threat from the toxic flood water entering the site. The sand and dirt dikes which were constructed to control the flow of the contaminated water prevented the park from begin affected. However the surrounding areas were covered in a thick toxic

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sludge. This area was then covered with dead fish, frogs, crabs etc which had been killed by the contaminated water in the river and were then washed up in this area of sludge. Although the park was not directly affected, the birds in the park were attracted to these poisoned animals on the sludge. When the bird consumed these poisoned creatures they were poisoned themselves. The number of birds in the park decreased dramatically. Also these birds spread disease from these dead creatures to other creatures inside the park, creating a continuous negative affect within the park. The national parks main water source was cut off as it was sourced from the contaminated river - Guadiamar. This also created difficulty in the running to the park as a new water supply had to be sourced immediately. The park was closed for a short occasion; so that staff could help assist in the cleanup operation outside the park and so that a new water supply could be sourced. When the park did reopen there was a report in a drop of numbers of tourist visiting the park. The local association for tourism ACETA reported that in 1998 about 40 percent of reservations for tourist visits were cancelled, within the national park which calculated to a loss of approximately €480, 000. This was possibly due to health fears in the areas. One of the most prominent human impacts from the disaster was its affect on human health. Short term health problems resulted in a small number of minor casualties recorded. However the long term health effects were most feared. The toxins found in the water consisted of heavy metals such as lead, zinc, arsenic, cyanide and other heavy metals from the mines reservoir. The fear was that these toxic metals could be consumed by humans through drinking water. Even after the area was cleaned, trace elements of these metals could still remain in water pipes etc. Also the soil which may also contain trace elements of these toxins could

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transfer the toxins from the soil into crops and contaminate the food chain. The fear behind long term human health effects is the high risks of cancer and neurological disease which can be caused by these toxins. The final human impact caused by the catastrophe at Aznalcollar was the large scale cost involved. It is estimated that overall cost for the Boliden Company came to € 89 million, these were figures given out by the Boliden. This figure included the cost of cleaning up the northern sector of the Guadiamar - €27 million, the acquisition of the harvest of 1998 - € 11 million, the operations of decommissioning of the tailings lagoon - € 41 million and the loss due to the stop of the mining activity in 1998. The regional government of Andalusia provided € 145 million for the disaster remediation. This budget was mainly used for cleaning up operations, the acquisition of the polluted land - € 48 million and restoration - € 90 million. The Ministry for Environment provided a budget of € 136. 7 million. € 13 million was used in the removal of the tailings; € 15 million was used for the treatment of toxic water accumulation in the marshlands. The Ministry for Environment has also approved to provide € 93. 7 million for a hydria regeneration plan for Donana National Park and the Guadiamar riverbed. The overall cost of the whole devastation amounted to € 377. 7 million, which impacted humans as this was mainly funded by tax payer's money. Active IngredientsInterventionsEmergency measures put in place in order to minimize the social, economic and environmental impact of the Aznalcollar spill. An emergency operation had to be put in place in order to minimize the damage caused by the spill. The Spanish Authorities, the Regional Government of Andalusia and also Boliden Ltd (Apirsa) were involved in the clean up. On the 1st of May 1998, the different administrations created a Mixed Commission of Coordination. The <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

1st task that was carried out was the immediate removal of the tailings, which were found at the old part of the mine. Removing the tailings was spread out over two operations, in 1998 and 1999. Approximately 99% of the tailings were recovered as a result. According to the Regional Government of Andalusia, the collection of nearly all the tailings means that around 7000 million litres of soil and tailings have been recovered. Also in 1999, Boliden Ltd was granted the licensing of stabilization works for the dam as it was found that there was a significant movement after the initial spill (17 centimetres) and was a cause for major concern. Another campaign was then undertaken by the Mixed Commission of Coordination, which involved treating the soil. The soil was treated using a chemical procedure, which would result in immobilizing the various heavy metals that remained in the soil. The construction of the Entremuros dike caused the retention of 2 billion litres of acid water. In order to allow the Guadalquivir River Basin Authority to purify the dammed waters, a water treatment plant was constructed beside the Entremuros dike. After the purification process, it would then discharge the purified water to the estuary of Guadalquivir. Another drastic measure was put in place in order to control the environmental quality in the surface waters, the air, the subterranean waters, the estuary, and also a sanitary control program of the people living in the surrounding area who were affected by the Aznalcollar spill. The entire process was established in a series of published laws, decrees and also orders between May 5th 1998 and 1999. Also in May 1998, the Council of Ministers of the Regional Government of Andalusia had approved the various actions that were necessary for carrying out a project of regeneration and adaptation for public use. This was called the Guadiamar Green Corridor. The Guadiamar Green Corridor project <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

was developed in 1999. The reason it was developed was to restore the Guadiamar basin and its surrounding ecosystems. The plan of action of the project was described in the Guadiamar Green Corridor Strategy, which was supported by the International Seminary on Ecological Corridors in March 1999. The Guadiamar Green Corridor project is also revealed in the results of an investigation program, which is known as PICOVER. PICOVER was developed between the years of 1998 and 2002. The Regional Government of Andalusia published the conclusions found as a result of this program. The estimated total amount of the PICOVER was € 5. 8 million. It was divided down into 2 different stages. The 1st stage was developed between 1998 and 2001. The effects of the Aznalcollar spill were studied (on organisms and ecosystems) and the necessary guidelines for the restoration were set out. The 2nd stage was developed between the years of 2002 and 2003. The objective of the 2nd stage was to control the factors that were most affected by the spill, which were soil and water. Attention was also given to the species that were considered to be the most important bio indicators e. g. plants, fish, etc. The Green Corridors objectives and the plan of action: To decontaminate the water, soil and also organisms of the riverbed. Also the decontamination of the flooded plains and the marsh that was damaged by the acid water and tailings. Water: The Green Corridor has a technical office, which had set up stations. These stations were put in place to control the surface water (17 stations). From all 17 stations, only one of them has had an increased value (El Guijo). A study that was carried out by the Guadalquivir River Basin Authority back in 2003 concluded that the El Guijo station, which was situated in the Guadiamar River, had continued to present an increased level of zinc, cadmium and copper metals. The El Guijo station, <https://assignbuster.com/the-history-of-human-impact-environmental-sciences-essay/>

out of the 17 stations, is one of the closest to the Los Frailes mine. It is 2.5 km beneath water. All of the remaining 16 stations are within the legal limits and fit for human consumption. The Guadalquivir estuary was tested after the spill and it showed an increase in the level of contamination. This problem solved itself after a few short months as the contamination level returned to what it was before the spill occurred.

Soil: Since the Aznalcollar spill, the process of decontaminating the soil had been successfully carried out for the most part. The monitoring of the soil to ensure the contamination level remains low has continually been followed up, especially focusing on the main affected area (the Aznalcollar mine and the bridge of Doblas). The reason this area was the main affected area was because of its closeness to the disastrous lagoon. This resulted in high levels of zinc, arsenic and lead contamination. Since 2002, the majority of soil areas that were affected were cleaned. The cleaning process eliminated central points of contamination but in some particular stains of the land, minute residual contamination still remains.

Fauna: One of the main populations affected were fish and amphibians. Since the Aznalcollar spill, the riverbed has been decolonized with fish and amphibians and they have survived without any problems. In 2004, it was detected that 6 different species of fish had laid eggs. It was the 1st year since the spill that different species of fish laying eggs was detected.

Flora: The contamination of metals in plants has decreased with time. 2.5 million Plants have been planted in order to restore the affected area. The majority were planted between the Entremuros marsh and the Los Frailes mine. The Entremuros area was restored by replanting in small plots. This method allowed the ecosystem to improve naturally. To restore the functioning of the terrestrial and aquatic ecosystems which were damaged

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or ruined by the spill. The large amount of area that was affected, from the mine to the entrance to the Entremuros swamp, has now been restored. The aim is to create a fluvial ecological corridor. The gravel extractions or the agricultural occupation has caused the Guadiamar riverbed to suffer extreme transformations. When the riverbed was being restored it was thought that it was more critical to recover the processes for fluvial dynamics, which had been modified, rather than recreate the original morphology of the river. In 2004, it had been noted that the natural dynamic of the river, particularly the flood plains, had been recuperated. Also, non-indigenous vegetation had been removed as instructed. Since the spill, there used to be many gravel exploitations found on the bed of the river of the Guadiamar, between the upper and middle branches. These were reformed serving two purposes. One use is environmental recuperation and the other is for the use of the public.

Entremuros marshes: The main reasoning behind the activities was to ensure the riverbed was recuperated by the removal of the impacts that hindered the natural functioning. The results have shown to be considerably good. The fauna and flora have quickly colonized the area. To promote a model for the management of the various uses of the region so that ecological heterogeneity could be promoted in order to reinstate the different species and natural processes among the mountain range and the coast. Positive results were found on the movement of land animals through the Corridor, in the middle course of the Guadiamar River. There are many communities that began to become established in the Corridor, such as the eagle, rabbit, and the lynx. As a result it has aided the purpose of the ecological corridor of the Guadiamar River. The Corridor has needed to be attached through the northern part as this restored the river basin of the Guadiamar River and the

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mining region in its upper course. The restoration continues to be followed up, even today, as it ensures its function as a fluvial ecological corridor and the future tendencies of the river. To improve and promote the quality of life of the many people living in the area through the strategies of development fitting with the conservation of the functions of their natural systems. Public use: The Green Corridor is now recognized as a tourist destination. It has trails that can be used for walking, biking and horse riding. A variety of infrastructures have been constructed including recreational areas, a botanical garden, visitor centres, etc. There has been sign posts put up of the area, and also the roads. There have also been guides produced on the infrastructures and programs in the Green Corridor (for public use). Other uses: In the Green Corridor there are many kind of acts prohibited which include hunting, fishing, and raising livestock. Also, on the grounds of the old mine an environmental services site has been constructed. Relations with the surrounding population: Many environmental educational activities were developed in order to educate the population, but mostly for schoolchildren. A lot of the people living in the surrounding area were not aware of the many activities in the Green Corridor and its ideas. To make it clear to the population, it was necessary to cover the wildlife values, historical, landscape etc of the Green Corridor. To contribute to the conversion of the Network of Protected Natural Areas of Andalusia as an arrangement of areas, which are connected by ecological corridors and which fluvial ones stand out the most. The Green Corridor had to be declared as a ' Protected landscape' in order to comply with this objective. The Green Corridor does not reach up to the north of Aznalcollar therefore it is not connected as an ecological corridor with the coast and mountain range. To operate as a model of

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integrated planning of a Mediterranean basin with could be extrapolated to other regions. The WWF has recognized that the Guadiamar Green Corridor operates as a model of basin restoration. The office for the Mediterranean selected one of its projects to be a model of management and restoration of Mediterranean wetlands. The WWF gave the ' lessons learned' of the Guadiamar to Romania to help them after the mine accident of Baia Mare.

Lessons Learnt