The importance of our environment: a qualitative study of water and soil in Iznalloz (Granada, Spain)

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HIGHLIGHTS
environmental study, water and soil quality, soil fertility, uncontrolled dumping areas.

SUMMARY
Understanding and preserving our environment and spreading the information found about the richness of our cultural and natural background in Iznalloz (Granada, Spain) is essential for the development of our students. Therefore, by applying the scientific method and focusing our research on the surrounding fields through a water and soil quality analysis, we have obtained knowledge of how farming activities or even uncontrolled dumping of waste prove to be substantial in the modification of the quality of our environment. Thus, the presence of polluting elements in water like nitrates, phosphates or ammonia, can be attributed to a number of factors such as some farming routines. Olive trees, for instance, are located in fields with high cationic exchange capacity. High levels of microorganisms have been found to cause the high rate of fertility of these soils. On the other hand, the tests done on the wastelands which are too often used as uncontrolled dumping areas rather than farming fields show significant reductions in the amount of beneficiary parameters mentioned above. The whole educational community can benefit from the results and learning processes of this research in terms of a higher environmental awareness.

INTRODUCTION (AND OBJECTIVES)
The fundamental principles of the European environmental policies are conservation, protecting and improving the quality of the environment, protecting personal health, and finally, the prudent and rational use of natural resources. (Art. 130R of the Treaty of the European Union). At the national level, a large number of organisations have implemented the European Union norms, the most recent of these organisations being “La Dirección General de Calidad y Evaluación Ambiental y Medio Natural” (The Directorate General of Quality and Environmental Assessment and Natural Environment). This organisation was established in 2012 with the purpose of proposing, elaborating and programming national plans regarding pollution prevention and control, as well as pollution’s environmental impact. This includes pollution indicator systems and the evaluations to which natural spaces should be subjected (Art.4 point 1).
Among the different elements that form our environment, water quality and soil fertility levels have been protected since the initiation of these kinds of policies (1,2), which is due in part to the obvious relation not only with environmental quality, but also with human health itself (3,4). However, official reports, such as the one of 2006, have continuously shown that the water quality objective remains incomplete. Specifically, the water quality of various streams shows the presence of metals such as Se, Zn and Cr, as well as other toxic organic substances (5).

This same concern is evident when we analyze the situation of Andalusia, and while the 2012 reports of the “DMA (Directiva Marco del Agua)” [Water Framework Directive (WFD) network], under the Hydrographic Confederation of the Guadalquivir (6), identify degrees of improvement in the sections analyzed compared to that of 2007 (former ICA network). The number of runoff and oils that continue to appear have increased compared to the 2011 report. The most frequent impact was that the selected sections of river showed 66.3% residue present in the water. This impact becomes more serious in 10.9% of the sections, as in the areas near the river there are legal and illegal dumping areas.

The use of agricultural pesticides also contributes to pollution, and the presence of these pollutants in waters that return to natural sources compromise their later use, making the treatment of this wastewater a priority.

Soil quality is closely linked to water, especially when dealing with agricultural soils. Knowing their composition and treatment is crucial for improving its productivity and can correct possible contamination. According to Informe sobre Calidad y Evaluación Ambiental (2010) (7) of the Ministry of Agriculture, Nutrition and the Environment, the number of preliminary status reports of contaminated soils (IPS) received in the CCAA until 2009, amounted to 67,307, of which 11,130 correspond to Andalusia. Analysing soil pH level, the cation exchange capacity, and the degree of microbiological activity allow us to know not only the pollution index but the soil fertility.

The conservation of the environment is everyone's responsibility, but above that is the responsibility of solving problems that human activity generates. No policy related to the environment will succeed as long as society is not aware of the need to develop an environmental education that brings us back to a respect for nature. But for this we need to know what problems we are causing, which may have consequences for the environment and our own health and, of course, how we can prevent and solve such actions.

This conviction leads us to propose a research project that brings us to the environment of students themselves, as we are aware of the proximity of the students' school, therefore, the place in which they live must be the primary laboratory and object of analysis. This connection awakens more interest and enthusiasm among the students, helping them to learn about their immediate environment, but the learning process will make students become aware of the necessity to respect, care and dissemination of natural and cultural richness of the environment.

The quality and water use, its impact on the soil type and the use of it, influence and connection with the use of natural resources and the need to educate the implementation of the “three Rs” (recycle, reuse and reduce) allows students to not only learn from their environment, but translate that learning into an integrated and scientific project. Thus, the main objectives of this research project are to ascertain the quality of water and soil of Iznalloz (Granada, Spain) for possible contaminants and investigate their origin and understand the need to disseminate the results, showing the research as an essential form of
progress and improvement of our environment.

**MATERIALS AND METHODS**

The first step taken was to analyze and apply the scientific method, specifically, to understand the steps one must follow in any investigation for that work to be considered scientific. For that, we visited and analyzed the webpage http://www.sciencebuddies.org/science-fair-projects/project_question.shtml. Then, we focused on the web https://trello.com/, which permitted us to open a previously closed online communication channel by uploading and sharing information, as well as organizing the different steps necessary for the project.

All samples studied in this work were taken in different sites from Iznalloz (Granada, Spain). We proceeded to locate the illegal dump sites around the town; areas whose toxic substances could affect the water and soil quality of our town. Pictures were taken of the selected sites and data about possible toxic substances and its origin were gathered using an especial data collection chart (8). These areas would be selected for sampling water and soil for its further chemical and microbiological analysis.

**Preparation of water sampling program**

There were three aims:

1) quality control
2) characterization of specified parameters (pH, chromium, chlorine, copper, cyanide, iron, nitrate, phosphate, silica, sulphur)
3) identification of sources of contamination

To achieve these aims, the following materials were used:

For sampling:
- Latex Gloves
- Plastic containers with a minimum capacity of 300 ml with screw on lids, ensuring complete closure
- Adhesive labels to identify containers
- Pen
- Thermometers for taking water temperature

For the documentation phase:
- Pens
- Field Notebook
- Data collection quadrant
- Camera

Sampling was carried out in different types of sources: natural springs, rivers, public fountains and different potable water faucets:

In the surface sources (springs and rivers), samples were taken using latex gloves while holding the plastic containers in hand but away from mouths to avoid contamination. The bottles were immersed completely, filling and rinsing three times with water from the same source that we were going to sample. Once assured that the containers were not contaminated, we immersed them about 30 cm below the surface, sampling upstream to prevent an excess of floating material. In regard to choosing a sampling point sufficiently indicative of the quality and characteristics of the water, samples were taken neither too close to the shore nor far from the
spring. Plastic containers were completely filled, closed and labelled while keeping away from excessive light and heat. Water temperature was taken and then data was collected and put into the quadrant.

Sampling in wells without pumps was done by hand, using gloves and without touching the opening of the container. Once again, the plastic containers were rinsed with water from the same well. Touching the walls of the well was avoided, in order not to contaminate the sample. Samples were taken from the surface water of the well. In wells with pumps, the pump was turned on for one minute before taking the sample, which was collected using a hose whose opening was set one meter below the surface. The containers were closed and labelled, then the water temperature was taken and the data quadrant was filled.

Finally, when sampling of potable water taps we wash our hands to avoid contamination. Furthermore we cleaned the tap itself, for which the filter was unscrewed and the mouth of the faucet was cleaned disinfected with an alcohol wipe. The water was allowed to run for 2 minutes to ensure that there would not be any deposits from the pipes in the final samples. We took the plastic container, with care not to touch the opening, and we placed it under the tap and took the sample. The vessel was sealed and labelled, then the data quadrant was filled with the collected data.

All samples were kept away from heat and light until the laboratory analysis, which was undertaken no more than 96 hours after the moment in which the samples were taken. All the samples were labelled immediately, stating the sample number, the date, time, place, and the name of person who took the sample.

The labels went along with a quadrant in which the information about the sampling site was recorded, as well as on-site observations. Specifically, the recorded information was the name and place of the sample site, the time and date the sample was taken, the weather conditions in the moment of taking the sample, and the recent weather conditions, such as if it had rained strongly in prior hours. The colour, smell and clarity of the water were also recorded, or lack of clarity in cases in which the water was turbid or even muddy. Any other significant observations were also noted, such as the presence of rubbish or fish. Lastly, we photographed the site and the sampling process.

This water sampling method was performed at 11 different sites:

- Three were potable water taps in the high, medium and low level areas of the town, in order to analyse any possible changes in the quality or composition caused by the flow of water itself.
- The public fountain of the traffic circle of Iznalloz; a round fountain that serves to distribute traffic, and therefore could present pollution.
- Water spout located near the sports centre, near one of the areas with the presence of an illegal dump.
- The Well of Prado San Juan del Río; a private property well located in an area of olive groves. It was therefore interesting to investigate possible contamination by agricultural activity.
- The Periate Well; the same as the above well; it is located in an area of olive cultivation. We decided to test its level of pollution with the previous one.
- Ventorrillo River; located in an illegal dumping area.
- The Cañada Hermosa River; we wanted to test the water quality in relation to the Ventorrillo River.
- The Well in the Llano de la Valentina (a plain); a private well located in an area of olive cultivation.
- Fuentzuelas Natural Spring: This spring is located next to the main road of Iznalloz, and as such it is an area with continuous traffic. The population of Iznalloz has a custom of collecting and drinking water from the spring.

In the school laboratory, the chemical analysis of the different water samples proceeded, using the Labs-Aids Inc. Kit and protocol titled “Introducción cualitativa a la polución del agua” (Qualitative Introduction to Water Pollution). Our use of it was made possible by the University Rovira i Virgili de Tarragona (Ref. 19) through the scientific educational project APQUA.

**Preparation of Soil Sampling Program**

This preparation was carried out with three objectives:

1) To analyze the soil fertility and potential productivity, based on chemical and microbiological soil analyses.
2) To determine characterizing parameters (pH, cation exchange capacity, the need for adding lime (calcium carbonate) to the soil, optical 400x microscopic study of soil micro-organisms)
3) To identify the possible sources of pollution.

To do this, the following materials were used:

For taking samples:
- Latex gloves,
- Clean plastic bucket to collect the sample,
- Small spade or shovel to remove the soil,
- Plastic bags that have not contained fertilizer in order to save the labled samples.
- Adhesive labels to identify the containers.
- Pens.

For the documentation phase:
- Pens,
- Field notebook,
- Quadrant for data collection,
- Camera

As when performing the water analysis, different sites were chosen to sweep the widest possible space and make more accurate conclusions about the soil quality in the area. The selected points are located in areas of olive groves as well as meadows and landfills, and they were collected and located on a topographic map of the location. Care was taken so that the materials and tools used in sampling were clean and free of pollutants that would affect the sample taken.

The sampling procedure was as follows:
- Approximately 3 cm of the soil surface was scraped at each point in order to clean and remove residue of fresh organic matter, road dust and other artificial contaminants.

- A hole was dug in the shape of a "V" the width of a shovel and this earth was left on one side, while a second stroke of approximately 15 cm thickness was used for sampling. The edges were discarded by making a cut with a knife, and the rest was put in a bucket or large bag.

Upon carrying out not only a chemical analysis but also a microbiological one, it was necessary to take several samples from each sampling point, and reserve those designated for the
microbiological analysis for a week at room temperature with water until reaching its optimum moisture level without saturating, before proceeding to the analysis.

- Bags were identified with the identification label and closed securely. On the label of each of the samples, the Sample No. was recorded, along with the date, time, and the geographic coordinates at which the samples were taken, in order to later put the name of the farm or place of sampling and the name of the person who collected the sample on the topographic map.

- The labelling of the sample was supplemented with the quadrant in which the information about the site of sampling and in situ observations were recorded. Specifically the information recorded was: Name and location of the sampling site, date and time of sampling, geographic coordinates, depth of sampling, weather conditions at the time of taking the sample conditions and recent colour of the soil, the name of the person responsible for sampling and any other significant observations. Finally, we photographed the site and the sampling process and we located the site on the topographic map.

This sampling procedure was performed in six points:

- The olive grove next to the cemetery, to analyze the fertility of its soil.

- Valentina Olive Grove, compare their features and potential productivity with those of the grove above.

- The illegal dumping site named El Pilar, to determine the extent of pollution.

- The meadow by the cemetery, to characterize their parameters and potential soil productivity
- The Faragüit ravine and the ground in front of the school in order to compare the obtained data obtained after the microbiological analysis.

Once the samples we collected proceeded to chemically and microbiologically analyse soil samples in the laboratory of our secondary school using a kit and protocol from Lab-Aids inc. "Biology and chemistry of the soil," made possible by the Rovira i Virgili University of Tarragona (Ref. 32) through the APQUA educational science project.

RESULTS

Chemical Analysis of Water Samples

The results obtained after completing the chemical analysis of various parameters in water samples in our laboratory are shown in the ANNEX OF TABLES, Table 1 (Identification of Water Samples) and Table 3 (Water Samples Chemical Analysis Results). Discussion of the data obtained is as follows:

Ammonium nitrogen

Well ventilated surface waters usually contain little ammonia; Water from natural streams that are little polluted usually have no more than 0.10 mg NH\textsubscript{3}/L. Higher levels of ammonia are indicative of recent contamination. The main source of contamination of ammonia is sewage. In the waste water, the ammonia comes from the breakdown of the urea, CO(NH\textsubscript{2})\textsubscript{2}. Furthermore, it is known that rainwater, due to dissolution of nitrogen from the atmosphere, may have traces of this compound (9).
Our analysis of samples conducted show the following results for this parameter (Table 3):

There is a slight positive (a small change of coloration in the colorimetric test) in samples from the source of the roundabout of Iznalloz (sample 2) and the well of the Valentina Plain Olive Grove (sample 8). A possible explanation for these results would be the possible presence of agricultural wastes (animal excrement, garbage, fertilizers) in the case of water from the well located in the grove (10).

In the literature reviewed (11), we found that natural concentrations in groundwater and surface water of ammonia are usually less than 0.2 mg/L, but anaerobic groundwater may contain up to 3 mg/L and intensive farming can generate much higher concentrations in surface waters. The cement mortar used to coat pipes can also produce ammonia contamination. The latter reason could add small amounts of this compound to the water of the source analysed, which was taken at the roundabout near the secondary school.

**pH**

The origin of the pH in the water can be natural or artificial. As a natural cause, carbon dioxide is dissolved from the atmosphere, and, more fundamentally, can be found in the infiltration of the earth as a result of respiration of living organisms, as well as respiration and photosynthesis of aquatic organisms.

Organic acids, including humic acids, are also common in the waters, the latter owe their origin mainly to forest mulch, which is washed by water runoff.

Among others, calcium carbonate is one of the primary basic constituents found. This compound affects the pH of the water because it is able to react with dissolved carbon dioxide to form calcium bicarbonate, which is soluble, producing a buffer system.

Although the pH does not tend to directly affect the consumers, it is one of the most important operative parameters of water quality, and the optimal value is generally from 6.5 to 9.5 [According to data from the OMS (12)].

The colorimetric analysis of the samples placed the pH values in our samples between 7-9, as shown in Table 3.

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**Figure 1**

An example of the results of the colorimetric test in three water samples
Water has a natural pH of about 7, i.e., neutral. Living organisms require a level which is between 6 and 9.

As seen from our results (Table 3), in several samples the pH is alkaline. In water, the alkalinity is produced by the presence of a high concentration of carbon molecules in mineral suspension. Water with high alkalinity is said to be "hard." The mineral compound that is caused is calcium carbonate, from rock, such as limestone or dolomite leaching or ground calcite. This would explain the alkalinity of the water in the area, given the limestone geology of the study area according to the GEOLOGICAL MAP OF SPAIN-IZNALLOZ (Geomineral Technological Institute of Spain)(13).

**Chlorine**

The disinfecting action of chlorine in water derives from its high oxidizing power in the chemical structure of bacteria cells, destroying the normal biochemical processes of development. Environmental conditions that optimize the outcome of this disinfection are chlorine concentration, pH, temperature and contact time. The main characteristic of chlorine for use as a disinfectant is its continued presence in water as residual chlorine. The Spanish technical-health regulations determine that water intended for human consumption must have a minimum concentration of free or combined residual chlorine or other disinfectant as follow:

<table>
<thead>
<tr>
<th>pH</th>
<th>Minimum concentration of free residual chlorine (ppm, 10 minutes)</th>
<th>Minimum concentration of combined residual chlorine (ppm, 1 hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.2</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>8</td>
<td>0.4</td>
<td>1.5</td>
</tr>
<tr>
<td>9</td>
<td>0.8</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>0.8</td>
<td>--</td>
</tr>
</tbody>
</table>

Furthermore, chlorine not only acts as a disinfectant, but also reacts with other components present in the water, such as ammonia, iron, manganese and other substances that produce odours and flavours, improving water quality.

On the other hand, an excessive concentration of chlorine in water causes immediate rejection by the consumer. It is not harmful to health, but it gives a very strong and unpleasant taste to the water if its concentration exceeds 0.5 ppm (14).

The results in our sample (Table 3) suggest a positive for Chlorine in the sample from the water supply of the Iznalloz sports center. This being the only positive data in our analysis could be explained by the fact that the water of this sample is close to a chlorination point in the town, and the process could have taken place shortly before we took the sample.

**Chromium**

Hexavalent chromium (which rarely occurs in drinking water in its trivalent form) is carcinogenic, and it is necessary to determine and ensure that drinking water it is not contaminated with this metal (15). This metal is naturally in water, soil and rocks. It is also found in crops and as an element remaining in agricultural soils. In addition, there are trace levels of chromium in the environment, which come from industrial activity (16).

The presence of chromium in drinking supplies can be found as a result of industrial waste, especially from chromium salts used to prevent equipment corrosion, as chromates are added
to refrigeration water. Perhaps this could be explain the only positive sample in our analysis, tap water from the higher part of our town (Table 3) or it could be a false positive and we have to repeat the analysis after collecting a new sample at this point.

**Copper**

Copper is a metal of high interest when considering the quality of drinking water because it has a dual nature; it is an essential metal for humans and can, in both deficiency and excess, cause harmful health effects. The essential character of copper comes from its incorporation of a large number of proteins with catalytic and structural purposes. Its biochemical toxicity, when it exceeds the homeostatic control, comes from its effects on the structure and function of various biomolecules.

Copper is a widely used metal worldwide due to the following desirable qualities: durability, ductility, malleability, and electrical and thermal conductivity. Many of the materials used in distribution systems for drinking water faucets or pipes contain copper as the main component or as part of alloys.

The use of copper pipes in drinking water distribution varies widely around the world. The presence of copper in drinking water may be of natural or anthropic origin. The latter is as an affect of leaching/corrosion due to the physical and chemical characteristics of the water matrix that comes into contact with materials containing copper (17).

None of our samples proved to be positive in this parameter (table 3).

**Cyanide**

There may be presence of cyanide in some foods, particularly in some developing countries, and sometimes in drinking water, primarily as a result of industrial pollution.

In this case no cyanide was detected in any of the samples analysed (Table 3).

**Iron**

Iron is one of the most abundant metals in the earth’s crust. It is present in natural fresh water at concentrations of 0.5 to 50 mg/l. There may also be iron in water consumption due to the use of iron coagulants or the corrosion of cast iron or steel pipes during water distribution. No reference value for iron in drinking water is proposed [according to the WHO (12)]. In our analysis, all samples were negative for detection of iron in water (Table 3).

**Nitrates**

Figure 2 and Table 3 show the results obtained for this parameter.
The Results in approximate % of nitrate concentration are shown in Figure 3.

Nitrate is mainly used in inorganic fertilizers. The concentration of nitrate in groundwater and surface water is generally low, but can become high from the filtration of agricultural runoff or due to contamination by human or animal waste as a result of the oxidation of ammonia and similar sources. The area where the results are positive in this parameter are agricultural areas, which may explain the presence of nitrates.

The presence in most countries of nitrate concentrations in drinking water from surface water do not exceed 10 mg/L, although the levels of nitrate in well water often exceed 50 mg/L, (18), (19).
Phosphate

The only water sample that was found positive was the Valentina Well (Table 3). The origin of such presence can be very varied, but the most common reason is contamination by detergents for washing clothes or cleaning in general. The use of fertilizers, compost or pesticides that include phosphates may affect positively the detection of these compounds, this fact is due to the percolation effect of these products to natural aquifers (20). The Figure 4 shows the results of our analysis.

![Figure 4](image)

**Figure 4**
Results of the qualitative colorimetric study of phosphate in water samples

Figures 5 and 6 show the results obtained.

![Figure 5](image)

**Figure 5**
Results of the qualitative colorimetric study of Silica in water samples

We can explain the presence of silica as a consequence of erosion from rocks containing silica (clays). The eroded silica then becomes suspended particles in natural water sources, in colloidal or polymeric state, and as silica acids or silicate ions. These data are explained due to the Geology of the zone (13), where Sierra Harana is composed of clay mainly, dated from the Triassic period.

The silica content in natural water is usually between 1.0 and 30 mg/L, but it is not uncommon to find concentrations of 100 mg/L or even 1000 mg/L in some brackish water and high seas (21).
Figure 6. Results of the qualitative colorimetric study of Silica in water samples

Sulfur

The only positive result is found in the source at the Iznalloz Roundabout (Table 3). Hydrogen sulfide is a gas with an unpleasant odour characterised as a “rotten egg” and is detectable at very low concentrations (below 0.8 g/m³) in the air. It is formed by hydrolysis of the sulphides in water. However, the concentration of hydrogen sulfide in water consumption is usually low because the sulfides are oxidized rapidly in well oxygenated waters. Therefore, although no reference value is proposed, hydrogen sulfide should not be detectable in drinking water for taste or odour (12).

The Sulfur in the water samples may come from the following sources (22):
- Acid mine drainage
- Sewage: In some areas where the water is stagnant, all the oxygen has been used and, in its place is hydrogen sulfide. e.g. water from the bottom of stratified lakes and reservoirs.
- Other sources: the paper industry, petrochemical, tanneries and slaughterhouses.

Since the presence of sulfides in surface waters, and well-oxygenated water in general, is scarce, none of the above sources is responsible for the positive result of the roundabout sample. However, there are artificial sources of sulfur, as in the case of incomplete combustion (23). When combustion is performed with oxygen shortage, sulfur fossil fuel is converted into H₂S, and carbon into CO. The location of the roundabout is a constant passage of vehicles, which could be the reason why there is sulfur in the water from this source.

Chemical Analysis of Soil Samples

After conducting a chemical analysis of various parameters on soil sampling in our laboratory, the results obtained are shown in ANNEX TABLES, Table 2 (Identification of soil samples) and Table 4 (Chemical analysis results of soil samples). Discussion of the data obtained are as
follows:

**pH and need for addition of lime (calcium carbonate)**

In soil with pH lower than 7, the yield of most crops can increase if lime is added to the field. In our case, the pH of all soil samples is between 7-8, and therefore there is no need to add lime (Table 4) (Figure 7).

**Cation exchange capacity (C.E.C.)**

The cation exchange capacity is an important measure of fertility and productivity potential of soils. Organic matter has a high C.E.C., so therefore, soils with a high content of organic matter generally have a C.E.C. than that of soils with a low content of organic matter. Moreover, soil pH affects the C.E.C., as highly acidic soils retain a high percentage of hydrogen ions, whereas soils with a favourable pH of 6 to 8 (neutral) retain a high percentage of calcium ions. Soil texture (clay concentration) also affects the C.E.C. Thus, clay soils show high and desirable C.E.C. values. But again, the organic matter plays a vital role in soil texture (24), (25).

The diagram below (Figure 8) explains this concept in detail.

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Figure 7: Example colorimetric method to measure pH in soil (sample 2)

Figure 8: Schematic diagram of cation exchange in soils
The values obtained in our laboratory tests, are shown in Table 4 and Figure 9.

Soils with greater estimated C.E.C. correspond to the olive crop samples near the cemetery and on the Valentina Plain. Thus there is a correspondence in the study area between crops (olive trees in this case) and the highest estimated values of C.E.C. since soils with high C.E.C. typically have high clay and/or organic matter. These soils are considered more fertile as they can retain more nutrients. The soils analyzed with the scarcest estimate of C.E.C. correspond to areas of meadow and illegal dumps. (“El Pilar” dump site).

**Microbiological Analysis of Soil Samples**

In the soil samples analyzed (Figures 10a, 10b) possible diplococci, streptobacilli, fungi, plant roots and a large population of actinomycetes were found in some samples.
According to the literature review (26,27,28,29), the actinomycetes do not tolerate acidic pH, as its density is the inverse of the hydrogen ion concentration. Species of the genus *Streptomyces* do not proliferate at a pH lower that 5.9, and in acidic soil the ratio of actinomycetes is less than 1% of the total microbial population. Nevertheless, there are varieties resistant to acidity (27,28,29), which grow best in micro-environments with pH values ranging between 7 and 8, which corresponds to our observations.

Our observations have led us to conclude that the most active soil, from the microbiological point of view, corresponds to sample 4 (Valentina Olive Grove), where the frequency of possible streptobacilli, actinomycetes and fungi (optical microscope 400x) surpasses that of other samples. The soil with a lower presence of micro-organisms corresponds to sample 3 (“El Pilar” Dump Site), although it is in this sample in which microscopic nematodes were found (Figure 11).

**CONCLUSIONS**

This research, completed by the students of year 4 of E.S.O. (Secondary/High School Programme, bilingual section), has highlighted the importance of the scientific method as applied to environmental study of Iznalloz (Granada, Spain) and its surroundings. After the chemical analysis of water and soil samples and microbiological analysis of the latter, we have seen how agricultural or farming activities and uncontrolled discharges may affect the conditions of our environment.

Thus, the presence of ammonium nitrogen and phosphates in the Well of the olive grove in Valentina Plain and nitrate in water samples from streams and wells in areas adjacent to the town of Iznalloz confirm water contamination at these points given farming that occurs in them.

The richness of the silica in our waters (supply network in the city and surrounding wells and streams) is due to the presence of clays dating from the Triassic period as one of the geological components of the Sierra Harana Mountain. In this way we confirm the connection, from the chemical point of view, between geosphere and hydrosphere. The most fertile soils (with a high cation exchange capacity) are dedicated to cultivation, mainly in olive groves, while soils with fewer values for this parameter are areas left uncultivated (meadows and the “El Pilar” Dump Site).

The microbiological study in our soil samples has identified a wealth of actinomycetes, including micro-organisms, due to the pH measured in these samples (pH 7-8). The exception is found in the “El Pilar” Dump Site, where the incidence of micro-organisms was drastically reduced.
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REFERENCES


[2] Ley 22/2011, de 28 de julio, de Residuos y Suelos Contaminados. Insiste en la necesidad de mantener y proteger la calidad de los suelos así como en la definición y actuación frente a los suelos contaminados.


