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University Campus, Building D,
Ejido Emiliano Zapata Highway, Kilometer 8
Tuxtla Gutierrez, Chiapas; Mexico. Zip Code 29000

Phone: 01 (961) 214 07 00 • 01 (961) 165 55 89
E-mail: espacioimasd@gmail.com,
espacioimasd@unach.mx

www.espacioimasd.unach.mx

***“Equipped with his five senses,
man explores the universe around him
and calls the adventure, Science”.***

—Edwin Powell Hubble

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Academic Papers

XI National Chair of Chemistry CUMex 2016 «Dr. Mario Molina Henríquez»

Challenges of Environmental Chemistry for Sustainability

—

Raúl González Herrera
University of Sciences and Arts of Chiapas
ingeraul@yahoo.com

The concern for life on our planet is and must be a necessary condition not only of philosophical-ethical reflection but an educational, cultural, political and scientific task of the world's universities. Likewise, the scientific work from the exact sciences must establish a new epistemic and methodological orientation towards the problems of the environment, climate change and peoples different ways of cultural life.

In this sense, Environmental Chemistry, coming from the exact sciences, contributes to the work of innovation and generation of knowledge applied to technologies together with a social approach and the development of studies involving the complexity of the environment with water, soil, air and anthropogenic intervention in such a way that they constitute new lines of anthro-atmospheric or anthropic research.

For this reason, the Degree in Environmental Engineering linked to the Master of Science in Sustainable Development and Risk Management and the Doctorate in Science in Sustainable Development, both educational programs of the Faculty of Engineering of the University of Sciences and Arts of Chiapas, have developed the XI National Chemistry Chair of CUMex 2016 with the participation of several universities in the country.

Chemistry is present in every aspect of life on the planet. We find it in all the vital processes that we carry out, from the oxidation that comes from breathing, the appreciation of the colors of the sunset or rainbows, in the different substances like proteins and amino acids that run our body or the drugs we use; In the smell of flowers, in a perfume or in food, in the development of the clothes we wear or in the materials that help us build or contain our food.

Its study and development has brought unimaginable and unexpected advances. Nowadays data, information, images and videos can be sent at great distances and speed through the discovery of fiber optics and semiconductor materials. Parts of humans and animals have been synthesized in the form of prosthetics. Energy consumption has decreased with the development of LEDs in lighting. Likewise, more efficient fuels have been developed, biotechnology and molecular bioengineered drugs, better designed materials in the construction industry, the environment, aerospace technologies, etc.

We can state that the tendency and the approach of chemistry follows its order: from the study and synthesis of molecules, the formation of clusters, the obtaining of particles, the creation of multiphase systems, the design of unitary processes, the implementation of pilot plants to the integration of large industries- all contributing in small, medium and large scales in the development of product and process design.

A R T I C L E S

Reception: **May 14, 2016** | Acceptance: **July 30, 2016**

REMOVAL OF ORGANIC LOAD IN LEACHATES USING AGED REFUSE BIOFILTER

—

Lozano-Caballero Grecia[1], Bautista-Ramírez Jesús[1], Díaz-García Mayeli[1], Gutiérrez-Hernández Rubén F.[2], Martínez-Salinas Rebeca I.[1], Nájera-Aguilar Hugo A.[1*]

[1*] Environmental Engineering. Universidad de Ciencias y Artes de Chiapas. Ciudad Universitaria, Libramiento Norte Poniente S/N, Col. Lajas, Maciel, C.P. 29000, Tuxtla Gutiérrez, Chiapas, México; Tel: 52 (961)1256033. e-mail: hugo.najera@unicach.mx.
[2] Department of Chemical Engineering. Instituto Tecnológico de Tapachula. Tapachula, Chiapas.

— Abstract—

The final disposal sites poorly operated cause damages in the environment and generate public health problems; these sites are general conceived as environmental passives. In this study solid waste were extracted, which has more than 8 years of age. The materials were extracted from the closed landfill of the city of Tuxtla Gutierrez, Chiapas, Mexico. The wastes were characterized in terms of moisture, total and volatile solids; finding a high biological stability. The wastes were used as packing material in a semiaerobic biofilter to explore the biological potential in the treatment of leachates. During eight months of operation, the biofilter recorded removal efficiencies of COD between 60 and 90%, while removal efficiencies of color was 60% with hydraulic loads in the order of 10 to 11 L / m^3-d. These results demonstrate that these biofilters using aged refuse as packaging material can be used as an attractive alternative pretreatment for landfill leachate in Mexico.

Keywords

Aged refuse; leachate treatment; biofilter; COD

Deficiency in the management of municipal solid waste and leachate emanation forms a significant risk to soil, water and air quality (Prantl et al., 2006). Within the integral management of solid waste, the final disposal stage presents the greatest challenges to overcome. It is therefore important to know the composition and characteristics of the waste, not only in its generation stage (fresh), but also in its evolution over time after having been arranged, in order to lessen the problems caused in its final disposal, as well as determine their potential for being exploited.

Sanitary landfills have evolved from open pit dumps to highly technical landfills where emissions (liquid and gaseous) are potentially hazardous to the environment. There are numerous examples of negative impacts from leachate (Cossu et al., 2001). This has led to the generation of national and / or regional regulations and legislation aimed at protecting water bodies from contaminants from sanitary landfills or from solid waste at final disposal sites, as well as the search and implementation of new treatment processes for this liquid, and thus reduce the impacts to the environment.

1.1 Stabilized solid waste

As it has been recently reported, "old garbage" or stabilized waste has great capacity for cation exchange (0.068 mol / g), high porosity (37.25%) and is rich in microbial communities (1.40x10 6 CFU / g) which have adapted over the years to the high concentrations of pollutants (Zhao et al., 2002). Table 1 shows the characteristics of the stabilized waste based on a study by Li Zhao et al shown. (2009).

In the last decade, have been developed and evaluated biofilters "old junk" or stabilized waste for decontamination of leachate as in the case of Zhi-Yong et al. (2011), who developed a semi-anaerobic biofilter with stabilized residues.

Tabla 1. Characteristics of stabilized solid waste

Parámetros	Residuo estabilizado
Humedad (%)	31.84
Cenizas (%)	54.42
Materia combustible (%)	13.74
Materia biodegradable (%)	11.08
Materia orgánica (g/kg)	65.57
Nitrógeno Total (g/kg)	5.38
Nitrógeno amoniacal (mg/kg)	22.40

Source: Li *et al*. (2009).

1.2 Leachates

In sanitary landfills, once the solid waste has been buried it is necessary to minimize the impacts of this practice, since the water that has been in contact with the garbage collects a large amount of the substances that were originally inside the residue, remaining thereby highly contaminated. This water is called leachate, and is one of the most contaminated liquids known. If not collected properly and then treated, the leachate can in turn contaminate groundwater, surface water and soil. For this reason, landfills are waterproofed, drained properly and the leachate collected by these drains must be treated (Giraldo, 1997). The strong correlation between the age of a landfill and some features in the composition of leachates provides an important tool that helps in choosing treatment processes (Renou et al., 2008). Leachates are often classified by age in new, intermediate and old or mature, according to the age of the landfill that originated them. In general, the degree of biodegradability of leachate is inversely proportional to age, being more biodegradable when new and less degradable when mature (Fatima et al, 2012; Ramirez - Sosa et al, 2013..).

The problem lies in the fact that this liquid usually contains high concentrations of pollutants, the main groups being: dissolved organic matter, macro organic components (including nutrients), and organic xenobiotic components which if not correctly collected and treated can cause serious problems in the bodies of surface water and groundwater sources (Modin et al., 2011).

The following study carried out the characterization of a sample of waste disposed more than eight years ago in the closed area of the sanitary landfill of the city of Tuxtla Gutierrez. These residues were used as packing material in the construction of a biofilter, and its potential application for the treatment of leachates was evaluated, measuring the removal of organic load measured as COD and color.

2. METHODOLOGY

2.1 Characterization of stabilized material

With the help of a backhoe, a waste sample was obtained at three points in the closed area of the Tuxtla Gutierrez landfill (Figure 1), with a minimum age of eight years. Prior to taking the sample, a route was taken to select the sampling points, considering the areas where the oldest residues are housed.

Figure 1. Closed area of the sanitary landfill.

The residues were extracted to a minimum depth of 1 meter, in order not to compromise the quality of the sample.

The extracted residues were dried for 6 weeks by spraying the material onto tarps in thicknesses of 6 to 8 cm. To speed up the drying process, the material was moved weekly and the remains of larger materials were removed in order to facilitate the screening and cleaning of the material, removing cloth, glass, cardboard, stones, iron, plastics, etc. And in general bulky materials that could hinder the process.

To verify the stabilization of the residues, a weekly sample was taken, pH determined, volatile solids (VS), ash and humidity according to the techniques established in Mexican norms (Table 2). The analyses were performed once a week.

Table 2. Techniques and methods for each parameter.

Parámetro	Técnica o Método	Frecuencia
Humedad	NMX-AA-016-1984	1 vez / semana
pH	NMX-AA-008-SCFI-2011	1 vez / semana
SVT	NMX-AA-034-SCFI-2001	1 vez / semana
SF	NMX-AA-034-SCFI-2001	1 vez / semana

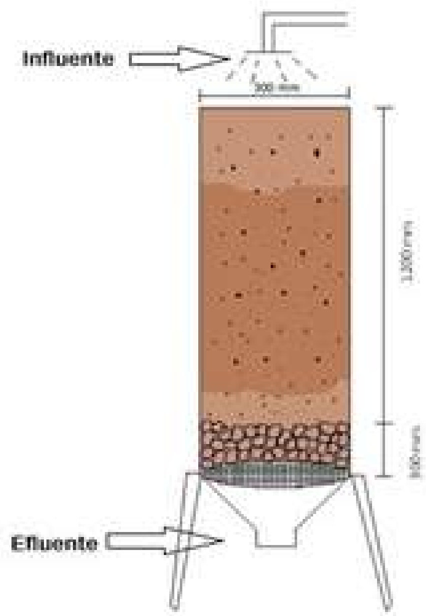
PH/ Hydrogen potential/ TVS: Total volatile solids / FS: Fixed solids.

Once dried, the residues were screened and separated according to the following particle sizes:> 40 mm, 16-40 mm and 2-15 mm.

2.2 Construction of the biofilter

A bioreactor was constructed with a PVC tube 30 cm in diameter and 1.5 m in height (Figure 2).

Figure 2. Dimensions of the bioreactor for the treatment of leachate.



In the bottom of the bioreactor a layer (about 30 cm) of support material (gravel), similar to that documented by Han et al was placed. (2011). The tube cap placed at the lower end was drilled to allow effluent to escape. In the upper and lower part of the support material, a mesh with a 2 mm opening was added to avoid excess trawling of the fine particles as these could obstruct the holes in the cover, making it difficult to remove the effluent. In the remaining volume of the tube there was added the filter bed (stabilized material). This finally resulted in a biofilter of 1.20 m in height.

For the load of the influent, a simulator vessel was used to favor the distribution of the leachate over the surface area and its descent through the filter bed, reducing the creation of dead zones and / or "short circuits".

2.3 Monitoring the operation of the biofilter

The influent and effluent were monitored in the COD and color parameters, with a frequency of once and twice a week, respectively. On the other hand, as reported in previous studies (Zhi-Yong et al., 2013), hydraulic loads in the range 10-11 L / m 3 -d settled, feeding for 1 hour twice a day . This activity was conducted six days a week. Monitoring of the biofilter was carried out over 8 months (35 weeks).

3. RESULTS AND DISCUSSION

3.1. Characterization of stabilized material and leachate in the influent

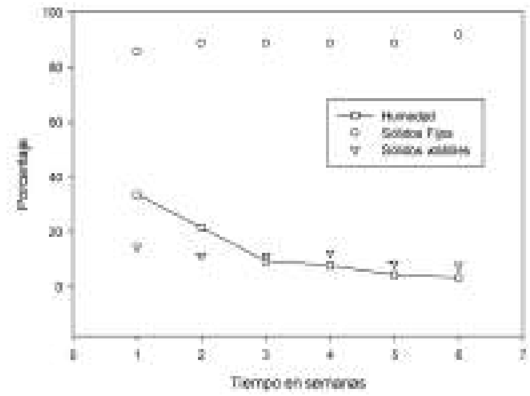
Solid residues showed a slight odor when extracted and laid, but during the first three days of the drying process at room temperature, the smell disappeared in its entirety without the presence of flies in the vicinity or leachate. These observations coincide with those reported by Zhao et al. (2007).

On the other hand, the initial moisture content (38%) observed in Figure 3 is similar to that reported by other authors (Han et al, 2013;. Chen et al, 2009;. Li et al, 2009;. Han et al, 2011;. Xiaoli and Youcai, 2006), and is considered an expected value as for being the material arranged in the subsoil, they are in contact with liquids (rainwater and re circulated leachate) that percolate through the different layers favoring the continuous generation of leachate. However, once removed and exposed to the natural drying process, in less than three weeks a rapid decrease in moisture content is observed, reaching almost constant behavior after this time.

As for the amount of FS and VS of the material, these materials practically did not change, because as expected these materials have reached their highest degree of degradation and as a consequence, the presence of organic matter is practically null which can be seen visually with the total absence of flies during the entire drying process, which may explain the almost constant behavior in their respective curves (Figure 3). In general terms, the material was observed to have few variations in its analyzed components.

For the characteristics that the evaluated waste presented, it can be said that it was physically and biologically stabilized, are rich in microbial populations (Zhao et al., 2002), and adapted to extreme and varied conditions.

Figure 3. Characterization of the extracted (stabilized) waste.



On the other hand, in order to know the different particle sizes in the dry basis (DB) residues, they were classified according to what is shown in Table 3. For the experiment, the bioreactor was packed with materials stabilized with a size of particle less than 40 mm.

Table 3. Classification by particle size in DB.

Tabla 3. Clasificación por tamaño de partícula en BS.

Tamaño de partícula (mm)	Cantidad	
	Kg	%
> 40	4.8	15.05
De 15 a 40	7.7	24.14
< 15	19.4	60.81
Total	31.9	100

From Table 3 it is observed that above 80% of them had a particle size below 40 mm, this fact is important because it allows to see that a high percentage of the stabilized materials once dry means it can be used in the construction of bioreactors. In laboratory level studies, authors like Zhao et al. (2002) have reported good results in the treatment of leachate using sizes of less than 20 mm particle, however, in more recent investigations and with scaled bioreactors at least at the pilot level (Li et al, 2009;. Xie et al ., 2010; Xie et al, 2012), the bioreactors were packed with stabilized waste of a larger particle size of the order of 40 mm, allowing better use of materials and reproducible results obtained at the laboratory level.

As for the characteristics of the influent shown in table 4, it is observed that they are typical of a type III or mature leachate, which is characterized by values of pH above neutrality, high alkalinity values and a low biodegradability index (<0.3) (Mendez et al . , 2004; Ntampou et al . , 2006 Ubaldo et al, 2014.).

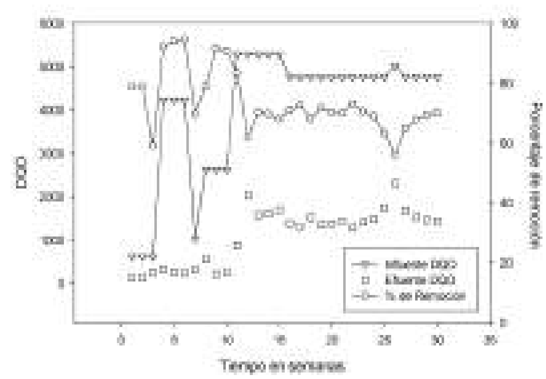
Table 4. Characterization of the influent.

Parámetro	Resultado
pH	8.0-8.4
DQO (mg/L)	4230 ± 630
Color (Pt-Co)	5 090 ± 820
Alcalinidad (mg/L)	1675
DBO_5 (mg/L)	800
DBO_5 / DQO	0.2

3.2. Process monitoring (biofilter)

Figure 4 shows the monitoring of the Biofilter over 35 weeks, observing the removal efficiency of organic matter (COD) in the leachate between 60 and 90% and reaching maximum removal (92%) after the week 6.

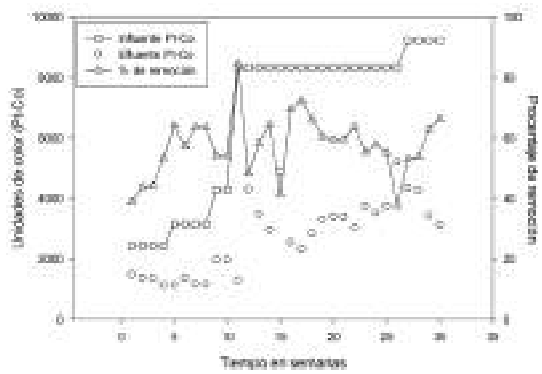
Figure 4. Results of COD removal.



From the graph (Figure 4) it is also observed that COD of the effluent ranges between 200 and 1600 mg / l, values that can be considered relatively fluctuating taking into account the variability in the influent (800-5000 mg / L). In general, the concentrations of both streams (influent and effluent) reflect stability of the bioreactor against important variations in the organic load supplied.

Another parameter used in the process as an indicator of the performance of the biofilter was color.

Figure 5. Color removal results.



From Figure 5 it is observed that during the first 12 weeks the color in the influent was predominantly black, with a value that ranged between 2400 and 4200 units of color (Pt-Co), with a slight odor, that after being admitted to the reactor it turned to a pale yellow color, similar to the color of the amber and without odor with units of color between the 1400 to the 1900 (Pt-Co). After these weeks the units of color in the influent were around 8,000 units of color, with an effluent quality between 2900 and 4800 units of color (Pt-Co), representing removals ranging from 40 to 75 %, with an average value of 60%. These variations may be due to non-ideal flow (Glynn and Heinke, 1999).

In practice, no reactor behaves as expected within ideal flows and for which deviations occur as a result of the pipeline. Short circuits can also occur because of the differences in the composition of the solid waste within the bioreactor, and finally another factor can be the appearance of stagnant zones. This type of alterations of the flow inside the reactor cause the average retention time to be smaller than the one calculated for its ideal operation, and with this certain particles present in the influent can circulate with greater speed, concentrating of greater way the color of the effluent. This also causes "dead volume" regimes to decrease the useful volume of the treatment system.

CONCLUSIONS

To date with eight months of monitoring, it has been possible to evaluate the COD removal of leachates from the Tuxtla Gutiérrez landfill, reaching removals between 60 and 90%. For the case of color, on average a 60% removal was achieved.

In general terms, given that these biofilters can be used as pretreatment units, the results obtained are acceptable in addition to taking into account that the materials that make up the biofilter come from the same waste, which provides a window of opportunity in the revaluation of urban solid waste disposed in landfills or any other disposal site. Finally, as far as our literature review was possible, these results represent the first of its kind in the national territory.

Thanks

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DESIGN AND CALIBRATION OF AN AUTOMATIC RAIN SIMULATOR

—

José Luis Carreras Nampulá[1], Carlos Manuel García Lara[2*],
Eduardo Espinosa Medinilla[2], Raúl González Herrera[2],
Pedro Vera Toledo[2], Rubén Alejandro Vázquez Sánchez[2]

[1] Master of Science in Sustainable Development and Risk Management. Faculty of Engineering, University of Sciences and Arts of Chiapas, Lib. Norte Poniente 1150, Tuxtla Gutiérrez, Chiapas. CP 29000, Mexico.
[2] Faculty of Engineering, University of Sciences and Arts of Chiapas, Lib. Norte Poniente 1150, Tuxtla Gutiérrez, Chiapas. CP 29000, Mexico. Email: carlos.garcia@unicach.mx

— Abstract—

In this work it was designed and built a rainfall simulator using low cost materials and easy to transport, which allowed control variables such as intensity, consistency and durability. a solenoid valve was controlled by a zero crossing detector, control board and a power stage. The results indicated that the behavior in the spatial distribution of rainfall was consistent with a value greater than 80%, intensity similar rain natural episodes with a kinetic energy greater than 27 J/mm m2, with flow control 97% precision.

Keywords

Simulated rain, droplet size, kinetic energy.

Water erosion is one of the main processes of soil degradation. Their study requires data collected over long periods (5 to 10 years). Rain simulators are research instruments designed to apply water in a manner similar to natural events. They are useful for obtaining erosion, infiltration, surface runoff and sediment transport data. This is due to the impact of rain drops as a function of kinetic energy (L. Wanga, 2014). The simulators allow to control the intensity of the applied rain, are efficient in terms of time and labor required and can be easily adapted for laboratory studies (A. Moussouni, 2014). The main characteristics of natural rainfall that must be obtained by rainfall simulators are (Sílvia CP Carvalho, 2014):

- Random distribution of raindrop size.
- Speed of impact similar to the terminal velocity of natural raindrops.
- Intensity of rain corresponding to natural conditions.
- Kinetic energy similar to that of natural rain.
- Uniform rain and random distribution of drops.

There are two types of rain simulators based on the mechanism of droplets, selected according to their availability, cost of construction and the experimental objective.

The drip method, where the initial velocity of the droplets is zero (Ibañez Asensio, Moreno Ramón, & Gisbert Blanquer, 2012), has a relatively low cost but the desired final velocity is achieved at drop heights of 12 m and in larger diameter droplets (Gopinath Kathiravelu, 2016).

The spray nozzle mechanism is one in which the water exits at an initial velocity different from zero because it is subjected to a determined initial pressure (Ibañez Asensio, Moreno Ramón, & Gisbert Blanquer, 2012). This simulator can provide rainfall of different intensity so that it is possible to simulate the characteristics of natural rainfall according to the study area (Meyer L.D., 1958) (Benito Rueda & Gomez-Ulla, 1986) , (Navas & Alberto, 1990), (Cerdá & Ibañez, 1997), (I. Abudi, 2012). The problem with this simulator is that very high intensities are required to obtain droplet sizes similar to those of natural rainfall, so they require mechanisms that allow them to be diminished while preserving the dimensions of the droplets. Rotary discs with a radial groove , a nozzle in a oscillating system , and oscillating motion sprinklers have been used in Mexico (Ognjen Gabric, 2014), (GB Paige, 2003)(Marelli, Mir, Arce, & Lattanzi, 1984) (Marelli, Arce, JM, & Masiero, & Lattanzi, 1984).

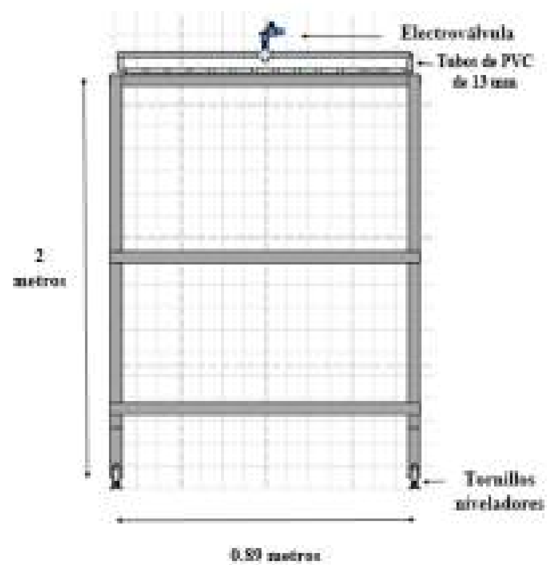
Another important feature is the size of the raindrop, as this will influence the intensity of the raindrop and the final kinetic energy. There are different techniques for its measurement using filter paper, relating the size of the stain on the paper to the size of the drop of water that caused it (Jau-Yau, Chih-Chiang, Tai-Fang, & Ming-Ming, 2008) , by means of photographs (Salvador, R; Bautista-Capetillo, C; Burguete, J; Zapata, N; Serreta, A; Playán, E, 2009), (Abudi, Carmi, & Berliner, 2012); the flour ball method (Parsakhoo, Lotfalian, Kavian, Hoseini, & Demir, 2012), and using spectropluviometers (Grismer, 2012), among others.

In this paper the characteristics and the operation of a rain simulator based on small holes made in PVC pipes are described.

Description of the simulator

A model of rain simulator, similar to the one developed by (Carreras Nampulá, García Lara, Espinoza Medinilla, González Herrera, & Medina Sansón, 2015) was designed and built with modifications in the structure and operation, taking into consideration the intensity and duration variables of precipitation (Figure 1).

Figure 1. *Structure of the rainfall simulator.*



For the management of the simulator, a zero-crossing detector and a power stage were built with an inexpensive Arduino UNO card with an easy integration with different systems and software, which allowed the generation from drops to a known flow rate using 12.3 mm PVC pipe in 0.8

m sections with holes approximately 0.8 mm in diameter spaced 2 cm apart, making a total of 481 holes (Figure 2 and 3).

Figure 2. Structure of the continuous sprinkler system.

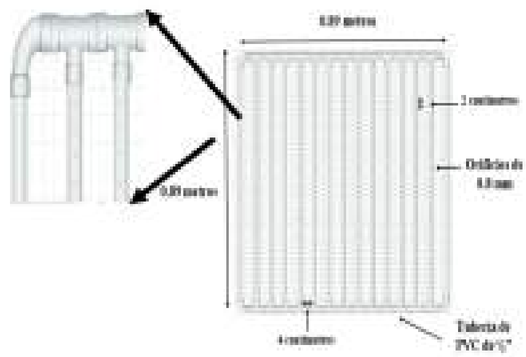
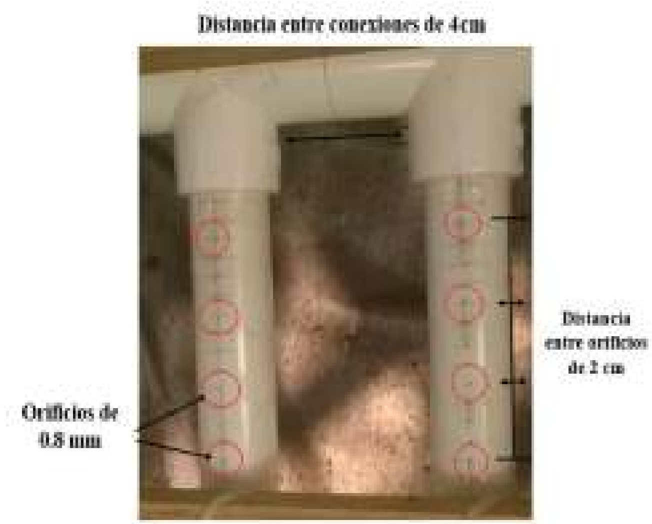


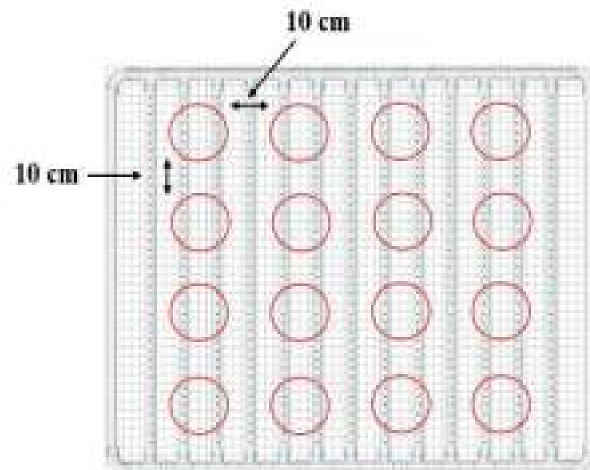
Figure 3. Dimension of the holes in the automatic system.



The flow and droplet formation was controlled using an electrovalve, which allowed it to be regulated with a maximum of 1.5 l / s, for working pressures from 20 Pa, at different intervals of time. The water supply was made using a 750 liter container and a piping system, which allowed the transport of water to the simulator. A wind shield was placed to avoid interference during the experiment.

Five trials were performed with three replicates, at 2 meters height for five different flow rates. The spatial distribution of the rain was evaluated by 16 1000 ml collectors, distributed in four rows at intervals of 10 cm between collectors and the same for each row (work area of the simulator), to determine the volume of water accumulated for 10 seconds (Figure 4). It should be noted that the number of repetitions was considered sufficient because the volume measured had a small standard deviation.

Figure 4. Spatial distribution of collecting vessels



Raindrop diameter

Due to the natural variation of raindrops, the diameter and volume were evaluated for reduced flow using a Sony brand, Cyber-shot DSC-W510 model camera with a resolution of 12.1 megapixels, 4x optical zoom and wide angle of 26 mm , which obtained images that were processed using the revolution solids technique for presentation and analysis. This method was performed by manipulating limits of sums of volumes of small sections or infinitesimal circular cuts of the revolving solid. A cylindrical layer method was used, considering the ends as spherical segments while the intermediate sections were evaluated as truncated spherical segments and the final volume was determined by:

$$V=\frac{\pi}{3}h\left(\frac{3}{4}s^2+h^2\right)+\frac{\pi}{6}\sum_{i=1}^{n-1}h\left(3a^2+3b^2+h^2\right)$$

Where h is the offset between segments, s is the diameter of each spherical segment, and while a and b are the diameters for each displacement of the spherical truncated segment.

Rainfall velocity was determined using the equation proposed by Gunn & Kinzer (1949), according to which the drops produced by the rain simulator have a terminal velocity:

$$v = 2.9379 \ln\left(D_g\right) + 4.393$$

With v, the speed (m / s) and Dg diameter in mm of the drop, the constant value of the second term should be considered as the initial velocity of the drop.

Distribución espacial de la lluvia

The kinetic energy of raindrops directly influences the separation of pollutants, particularly at the beginning of a rainfall episode (Vaze, 2003). The homogeneity of the raindrops is directly proportional to the spatial variability of rainfall intensity, and has a direct influence on the impact energy per unit area. Therefore a simulator must accurately reproduce the kinetic energy over an area of interest at a given intensity, as well as with a uniform spatial distribution. A number obtained in previous studies considered a Christiansen uniformity coefficient (CUC) of 80% or greater enough to consider rainfall patterns as realistic (Moazed, 2010). The CUC was determined by the expression:

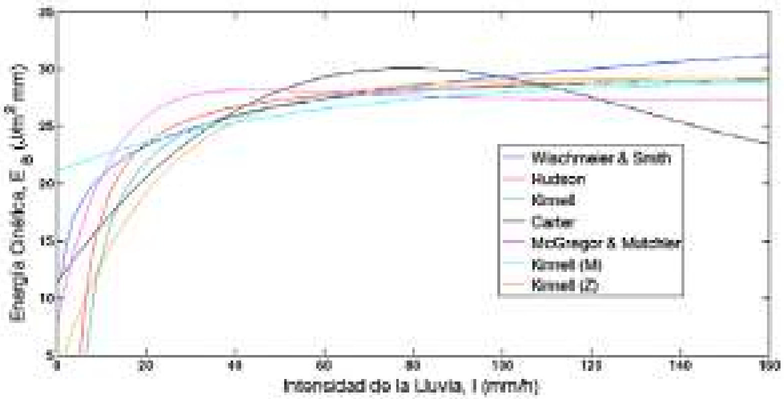
$$CUC\ (\%) = 100\left(1 - \frac{\sum x}{m\, n}\right)$$

Where m is the average value; n is the number of observations and x is the standard deviation of individual observations from the mean.

Kinetic energy

The kinetic energy of rainfall is a parameter that has been used to determine the erosion index defined in the Universal Soil Loss Equation (USLE), based on the drop size distribution. In figure 5, the different curves obtained from different mathematical expressions are presented according to the author or the area of study. (Wischmeier, 1958), (Laws, 1943), (Hudson, 1961), (Kinell, 1973) (Carter, Greer, & Braud, 1974).

Figure 5. Comparison of the relationship between kinetic energy and intensity established in different countries with different rain conditions.



In his investigations in 1973, Kinell determined that soil loss can be obtained from the total energy of the rain at intensities higher than the average acceptance rate of the soils. Because of this, it is important to obtain estimates of the relationship between the intensity and the kinetic energy of the rain by geographical areas (Rosewell, 1986). However, it is possible that the observed differences are due to the techniques used to measure raindrops. Therefore, the equation for the kinetic energy obtained by Kinell is expressed as:

$$Ec_K = e_{máx}\left[1 - a\,e^{-bI}\right]$$

Where $e_{máx}$, is the maximum kinetic energy for a given geographical area; a and b represent constants defined according to the study area.

Results

The size of the droplets generated at low pressure with a zero initial velocity, obtained a height of 5.54 mm and a diameter of 4.55 mm, and an average volume of 75.2 µ l was determined, which has a mass of 75.2 mg. With the above diameter and considering the initial velocity of the drop, it was determined that the average velocity of this drop was 4.447 m / s.

For the spatial distribution of the rain, 16 empty containers were used and were distributed on a symmetrical mesh located at ground level. The mesh sizes were 80 cm x 80 cm (6400 cm^2).

Figure 6. Intensity of the rain obtained at different electro valve control intervals .

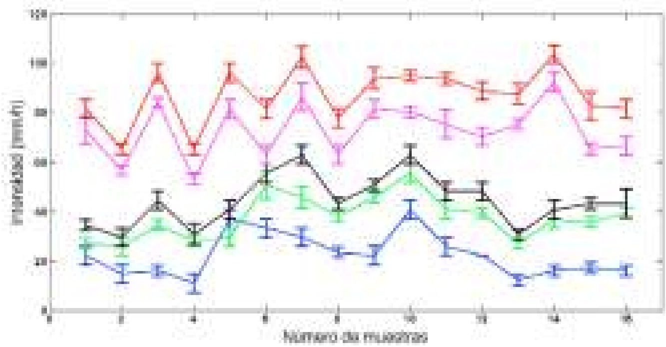
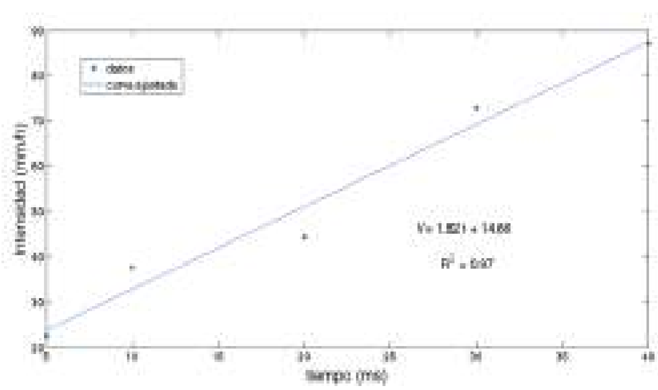


Figure 6 shows the intensity measurements performed in 10 seconds with 5 different control times on the solenoid valve (5, 10, 20, 30 and 40 ms). The CUC (%) was evaluated for each event, obtaining the following values : 69.52, 81.72, 82.46, 87.53 and 89.38, which represents a good degree of uniformity. This was achieved by modifying the structure, distributing the water pressure evenly and avoiding clearances in the pipe. However, a lower CUC was determined for the lower intensity, which was due to the minimum pressure used; on the other hand, by increasing it, good CUCs were determined for the other tests, which marks a clear relation between the pressure exerted and the CUC uniformity of the simulated rain. It is important to note that the variations present in the output intensity are also associated with imperfections in the holes that were made, residues by the perforation and the angle of the perforation in the pipe.

Figure 7. Averages of rain intensity obtained at different control intervals on the electrovalve with linear adjustment.

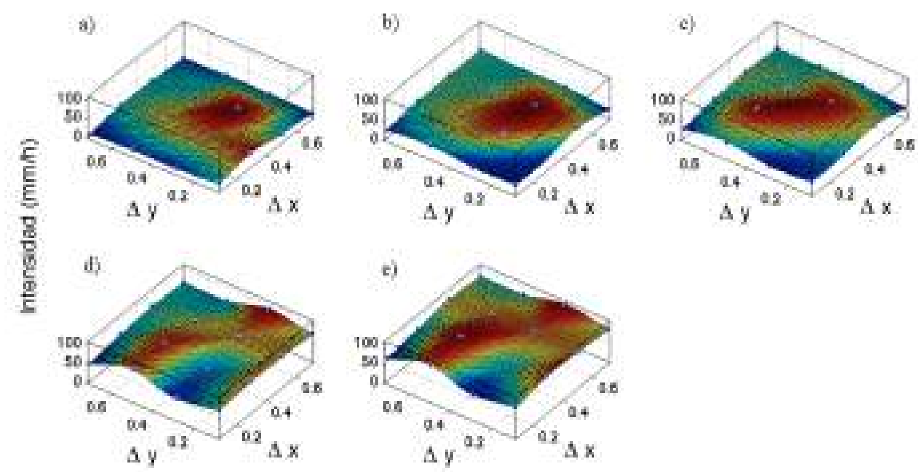


The kinetic energy (J / mm m 2) for each intensity of simulated rainfall as being 23.83, 25.13, 25.61, 27.09 and 27.59, using the Kinell model using the same coefficients calculated for Florida, due to the geographical proximity to Mexico. These values correspond to moderate to intense rainfall which is acceptable due to the search for factors that promote soil erosion.

For the development of the control of the solenoid valve, the average of the intensity was performed for each of the control times, obtaining the graph of Figure 7. This shows the linear equation that was obtained with a least square adjustment of 97% , which expresses the precision in controlling the intensity of the rain simulator in addition to the uniformity in the spatial distribution shown above.

In Figure 8, the homogeneity in the spatial distribution obtained for five different rain intensities is observed. The coefficient of uniformity obtained was 82.12% on average for the different opening times of the electrovalve, which is considered acceptable (Martínez-Mena, Abadía, & Castillo Sánchez, 2001). In spite of the mechanical adjustments made in the system, there is a tendency to focus the intensity in the central part of the impact area, so it is necessary to analyze changes in the design to minimize this effect.

Figure 8. Spatial distribution of rain intensity obtained at five different control intervals of the electrovalve a) 5 ms, b) 10 ms, c) 20 ms, d) 30 ms, and 40 ms.



Conclusions

The simulator which was built was low cost and modular, and presented at different opening times of the solenoid valve a coefficient of uniformity greater than 90%. For a pressure of 20 Pa, with a flow rate of 1.5 l / s and a height of 2 meters, droplet diameter of 4.5467 mm and a kinetic energy of 23.83 for a shower of low intensity was obtained , up to 27.59 J / mm m 2 which corresponds to a very intense rain. A a coefficient of uniformity of 82.12% was obtained, which is considered acceptable. From the simulation of rain was obtained a least squares adjustment of 97% which indicates a high repetitiveness of the system, achieving a simulated rainfall set compared to those presented in the natural events. A system was developed and evaluated that intends to study future soil erosion problems due to precipitation, simulating real conditions of a natural rainfall.

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REUSE OF "CASSOSTREA VIRGINICA" OYSTER SHELLS TO OBTAIN A MORTAR BINDER FROM THEIR MILLING AND CALCINATION

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Candelario Ramón de los Santos[1], Angélica Silvestre López Rodríguez[2],
Pio Sifuentes Gallardo[3], Miguel Ángel Hernández Rivera[4],
José Guadalupe Fabián Rivera Trejo[5], Laura Lorena Díaz Flores[6]

[1] calen89_teco@hotmail.com, [2] angiesilvestre625@yahoo.com,
[3] psifuentes1@yahoo.com.mx, [4] mahrivera1956@gmail.com,
[5] jgfabianrivera@gmail.com, [6] laura.diaz@ujat.mx
Universidad Juárez Autónoma de Tabasco. Av Universidad s/N Zona de la Cultura, Col Magisterial, CP 86040 Villahermosa Centro Tabasco México.

— Abstract—

Currently oyster shells "Crassostrea virginica" commercially exploited in Tabasco, represent a pollution problem. Because people after consuming the edible part of the scallop, discarded on the streets or in public places and even in landfills shells, causing bad aspect to the place, poor hygiene and spread of pests. Therefore, through this research it is to provide a solution to this problem of pollution and recycle this waste material for environmental purposes for construction. The shells were collected and selected in diffe-rent sizes and subjected to coarse grinding treatments with manual fracturing and dry grinding in a ball mill. Subsequently, these oyster shells were heat treated for calcining at 500, 700, 800, 900 and 1000°C. The powders obtained with the two treatments were separated with a vibrating table to perform the sieve analysis. Through analysis by X-ray diffraction (DRX), it was found that the powders are composed of CaO, CaOH and $CaCO_3$. By these results the feasibility of using this waste oyster shells as a material for mortar used in the construction is proposed.

Keywords

Reuse oyster shells; Crassostrea virginica; cement mortar, Calcite.

Currently oyster shells of "Cassostrea virginica", which are commercially exploited in Tabasco, represent a pollution problem since after consuming the edible part of the oyster, which is the abductor muscle, people dump them into the streets or in public places causing unpleasant scenes, poor hygiene and the spread of pests. This project intends to provide a solution to this pollution problem and recycle this waste to obtain an environmental material for the purposes of construction. In Tabasco like in many coastal states, the consumption of oysters is increasing because they have been considered a gourmet product because of their taste, palatability, appearance and secondarily by some myths about its alleged "aphrodisiac" powers. However, this does not pose any problem for Tabasco as it is one of the main oyster producers and has contributed a high percentage of production at the national level. With statistical data released by SAGARPA CONAPESCA in 2013 there was production of 15, 402 Tons / year, being second only to Veracruz, which produces 19,422 Tons / year (CONAPESCA, 2015).

In addition, its capture and production is the main activity for the settlers in the coastal lagoons of the state. The problem subsists in when you do not know what to do with the inedible part of this marine product. This problem affects restaurants and the civilian population and their government authorities, since tons of them are generated and only a quarter is used for the reproduction of the adductor mollusk. The above is not exclusive of the state, but at the national level as well in other coastal states such as Tamaulipas, Veracruz and Campeche which are also affected by this same problem.

The disposal of the shells in these places generates considerable inconveniences, mainly due to its insolubility in the water and its resistance to biodegradation. One of the problems that most concerns the communities is the growth of the mosquito carrying dengue within the oyster shells, since it has an irregular and asymmetrical shape. The outer face is rough and dark, contrasting with the interior, which represents a smooth surface in a concave shape that allows water to be retained in it.

It has been found that shells contain high amounts of calcium carbonate, calcium oxide and calcium hydroxide- compounds which, at present, are used for their functional properties to perform various processes that are beneficial to humans, covering such varied fields as food, medicine (Ronge Xing, Yukun Qin, Xiaohong Guan, Song Liu, Huahua Yu, Pengcheng Li, 2013), agriculture, cosmetics, wastewater treatment (Yao-Xing Liu, Tong Ou Yang (Yong Sik Ok, Sang-Eun Oh, Mahtab Ahmad, Seunghun Hyun Kwon-Rae Kim, Deok Hyun Moon, Sang Soo Lee, Dong-Xing Yuan, Xiao-Yun Wu, Kyoung Jae Lim, Weon-

Tai Jeon and Jae E. Yang, 2010) and soils contaminated with heavy metals, among others (Yao-Xing Liu, Tong Ou Yang, Dong-Xing Yuan, Xiao-Yun Wu, 2011). This mollusc has been used by man in his diet since prehistoric times, as revealed by the remains of their shells found in caves and shelters inhabited by primitive peoples or in shells that have been located by archaeologists in different areas of the coast and are very important in the dating of dates for this science. The shells were a material used by prehispanic cultures, as can be seen in the Teotihuacan Temple, where they appear carved in stone along with the symbolic serpent, or by the Maya who, in the absence of limestone, built and lined up large cities using shells in combination with other materials such as clay.

In recent years, the scientific publications, patents and websites of some countries or companies have been conducting studies and exposing advances in the production, characterization and applications of oyster shell components (Yang, Yong Sik Ok, Sang-Eun Oh , Mahtab Ahmad, Seunghun Hyun, Kwon-Rae Kim, Deok Hyun Moon, Sang Soo Lee, Kyoung Jae Lim Weon-Tai Jeon, Jae E., 2010) (Shih-Ching Wua, b, Hsueh-Chuan Hsua, b, Yu -Ning Wuc, Wen-Fu Hoc, 2011). It has been found that the materials that are the product of calcareous species can be considered as natural hybrid materials, since they are constituted by organic and inorganic compounds. An example of a natural hybrid material is bone, whose hardness and stiffness have not been found in any synthetic material.

The advantage of these porous materials is that by removing the organic components, the size and shape of the pores can be accurately controlled, making them fire resistant, impermeable in construction and for environmental uses such as absorbing contaminating gases (Kai-Wen Ma, Hsisheng Teng, 2010). They also form very complex and orderly structures with good mechanical and chemical properties, making these hybrids ideal for applications in the modern fields of Biotechnology, Computer Science and Nanotechnology (BIN). Nanotechnology continually requires self-assembling structures, because it is very difficult to assemble devices made up of a few molecules. One way to make good use of crustacean waste would be to obtain a material based on calcium carbonate, for use in the preparation of a powder consisting of nanoparticles of $CaCO_3$.

Materials and methods

Oyster shells were collected in places where they are disposed as waste, washed and all of the collected shells were rinsed with potable water to remove some of the dirt and were selected in size between 7 and 10 cm in length. With manual shredding, the size of the shells was decreased and divided into two groups of samples; Samples for grinding and samples for calcination. The first group of oyster shells was subjected to milling in a ball mill for 30 minutes. To the second group, heat treatment was applied in a muffle with air atmosphere at 500, 700, 800, 900 and 1000 ° C. Granulometric analysis was done on the powders obtained in the two treatments using meshes with aperture size of 0.42 mm to 0.074 mm, with a vibration time of 20 minutes. The crystal structure was determined by the X-ray diffraction analysis of all powders subjected to the various treatments.

Presentation and discussion of results
Granulometric analysis of the two treatments

Figure 1. (a) Shows the percentage of retention per mesh made at different calcination temperatures. (B) Shows the percentage of retention per mesh of the oyster shells subjected to mechanical treatment.

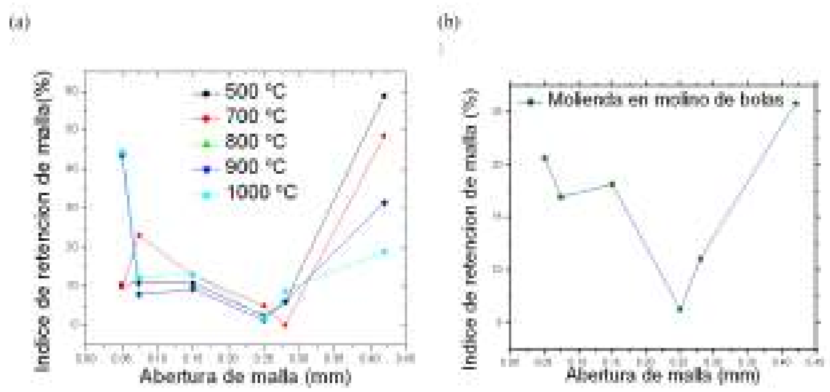


Figure 1 shows the granulometric analysis of the calcination (Figure 1a) and grinding treatments (Figure 1b) of the previously manually crushed oyster shells. Analyzing the graphs a and b of Figure 1, it is observed that with the heat treatment a greater decrease of the particle size is obtained as the calcination temperature increases, and a very fine powder with a particle size of about 74 μm is obtained. This treatment favors the use of oyster shells as a binder in the mortar used in the restoration process, as it has been reported that the historical mortar binders are composed of carbonates and silica of small sizes, which give it a hydraulic character and high strength (Elif U ğurlu Sagin, Böke Hasan, Nadir Aras, Şerife Yalçın, 2012).

Crystal analysis of the powders obtained

By means of the structural analysis, the crystalline structures present in each of the samples were analyzed and the diffractograms of Figures 2 and 3 were analyzed, which correspond to oyster shell powder with grinding treatment (Figure 2), and with thermal treatments (Figure 3). As you can see, all of the materials that were tested are highly crystalline and have a higher proportion of characteristic peaks of the rhombohedra type of $CaCO_3$, in the calcite phase with characteristic signals of 2θ = 29.34 °; 39.41; 43.16; 47,11° (according to PDF, No. 471743, JCPDS database).

Figure 2. Diffractogram of the oyster shell milled with ball mill.

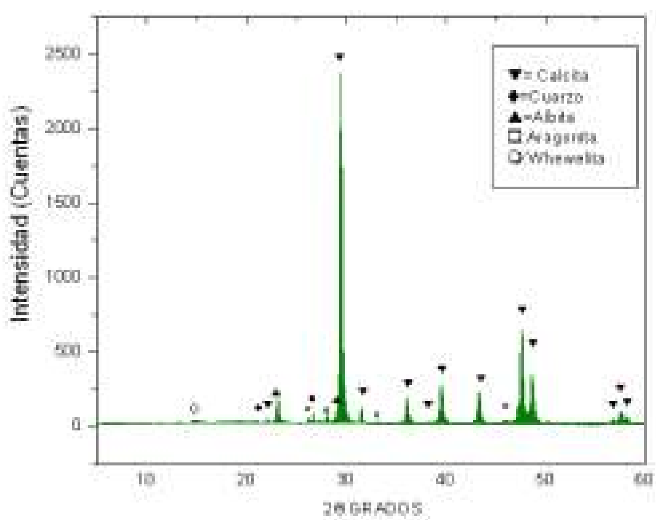
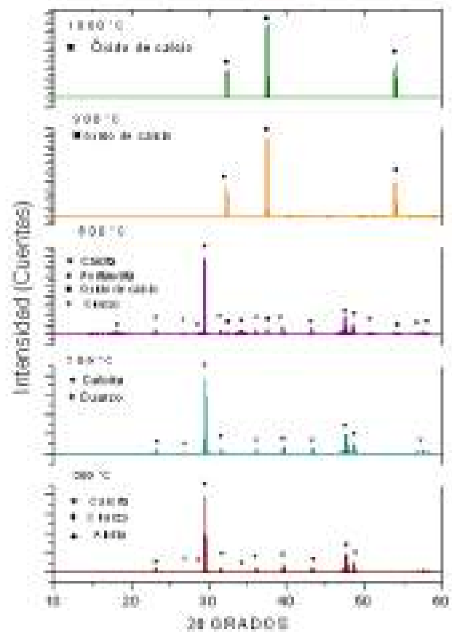


Figura 3. Difractograma de la concha de ostión tratada térmicamente.



In the case of powders from the untreated and manually ground oyster shells (Figure 2), it can be seen that in addition to calcium carbonate in the form of calcite (Shih-Ching Wu, Hsueh-Chuan Hsu, Yu- Ning Wu, Wen-Fu Ho, 2011), aragonite is also present which is another type of calcium carbonate but with a different crystalline structure (Zhuona Zhang, Yidong Xie, Xurong Xu, Haihua Pan, Ruikang Tang, 2012). When heat is applied to the aragonite that comes from mother-of-pearl (JE Parker, SP Thompson, AR Lennie, J. Potter and CC Tang, 2010) its crystal structure changes to calcite. This can be seen in the graph corresponding to the calcinated oyster shell at 500 ° C (Figure 3), in which the presence of aragonite is no longer detected and only calcite appears. In the case of the oyster shell powders which are heat treated from 500 ° C to 1000 ° C (Figure 3), it is observed that CaO or (quicklime) is obtained from 800 ° C. This is due to a decomposition reaction that occurs during the calcination process.

$$CaCO_{3(solido)} + Calor \rightarrow CaO_{(solido)} + CO_{2(gas)} \qquad Ecu. (1)$$

This reaction takes place above the decomposition temperature of the shell, that is to say at the temperature at which the Gibbs free energy standard of the reaction is zero. This results in a white or grayish white product (Kai-Wen Ma and Hsisheng Tengw, 2010). Such calcination reactions in an atmosphere of air lead to a mass loss of 45%.

On the other hand, when comparing the two types of treatments that were studied, it is concluded that with the mechanical treatment there are no favorable changes to obtain lime, which can be used as a mortar binder. Only the presence of calcite was detected, which is naturally present in oyster powder without any treatment and trace calcium oxalate monohydrate is detected as the mineral whewellite (Figure 2).

In the case of the thermally treated powder, the presence of aragonite can be found which upon the application of heat application changes its crystalline structure to calcite, as can be seen in the graph corresponding to the oyster shell calcinated at 500 ° C. The presence of aragonite is no longer detected and only calcite appears (Figure 3). The ideal temperature at which calcium oxide can be obtained as a material for use as a mortar binder is at 900 ° C, since the only thing that is achieved by calcinating the oyster shell at higher temperatures is the increase in alkalinity of the material.

CONCLUSIONS

The treatment that favors the use of the oyster shell as a mortar aggregate material for the restoration of old buildings is the heat treatment of the oyster shell at 900 ° C. At this temperature calcium oxide is obtained, which is a compound used in the construction industry. On the other hand, the shell which is calcinated at this temperature is easier to grind and has a particle size of 0.74 mm, which is able to adhere to the wet walls that are to be restored. The texture of the powder obtained with this heat treatment in this investigation is thinner and white, which favors the reflection of light, increasing the reflectance of visible light. It is for these characteristics that this material can be used as a mortar for the restoration of old buildings and archaeological sites, being the material used since ancient times and long before the discovery of Portland cement that is used today.

Thanks

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BIOREMEDIATION OF SOILS CONTAMINATED WITH AUTOMOTIVE OIL USED BY BIOPILE SYSTEM

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Héctor Guillermo Anza Cruz[1], Paula Deyanira Orantes Calleja[1],
Raúl González Herrera[1*], Alejandro Ruíz Marín[2],
Eduardo Espinoza Medinilla[3], Rebeca Isabel Martínez Salinas[3],
Carlos Manuel García Lara[1], Pedro Vera Toledo[1]

[1] School of Engineering, Environmental Engineering, UNICACH
[2] Biotechnology laboratory of the Autonomous University of Carmen, Campeche
[3] School of Engineering. Graduate school, UNICACH
[*] Corresponding author raul.gonzalez@unicach.mx

— Abstract—

In the investigation was made the bioremediation of contaminated soil with waste oils from automobile service by biopiles technique. The study was made taking four samples of soil, from the UMA "La Huella" of Pedro Méndez town in the municipality of Chiapa de Corzo, Chiapas, Mexico; being characterized in laboratories at the Universidad de Ciencias y Artes de Chiapas and El Colegio de la Frontera Sur, analyzing parameters such as moisture, organic matter, texture, pH, temperature, total nitrogen and available phosphorus. Four biopiles were built, developing three treatments with three replicates and a control, which were contaminated with oils used in different concentrations, 30,000 ppm to biopile witness, for the first treatment, 10,000 ppm, for second 30,000 ppm and 50,000 ppm third of HTP. The strains used were *Acinetobacter Sp, Stenotrophomona Sp and Sphingobacterium Sp*; each bacterium was inoculated at a concentration of 2.25 × 108 CFU for each of the treatments. Counts of viable microorganisms was performed the fifteenth day during the experiment. Treatments were monitored for three months on days 1, 15, 30, 60 and 90 in the biotechnology laboratory of the Universidad Autónoma del Carmen, Campeche. With this work considerable removal percentages of the fractions were achieved, in the aliphatic removal 93.7 to 87.1% was achieved and the aromatic hydrocarbon fraction, removals from 0 to 94.8 in 90 days of treatment with the application of bioremediation bacteria and identification of bacterial strains native soil, who managed to resist change in their environment.

Keywords

Bioremediation, automobile waste oils, biopiles technique, Acinetobacter Sp, Stenotrophomona Sp and Sphingobacterium Sp.

The inadequate management of hazardous waste has generated a global problem of contamination in soils, the air and water. Among the most severe contamination is that produced by the extraction and management of oil and its by-products. In Mexico, one of the countries with the highest oil production worldwide, there are a considerable number of sites impacted by these pollutants. In southeast Mexico there are sites with different levels of environmental impact by oil activity from over fifty years of activity (Randy et al . , 1999; Roldán and Iturbe, 2005).

The traditional physical-chemical methods for the remediation of contaminated sites have been: incineration, landfills, soil washing or some chemical treatment. These are costly and can produce different toxins that are able to stay on the ground, migrate into surface or groundwater, or are emitted to the atmosphere (Eweis et al . , 1998; cited by Volke and Velasco, 2002; Ifeanyichukwu, 2011) .

According to studies conducted in the United States and the United Kingdom, the bioremediation market for contaminated soil treatment has increased because costs can be reduced by 65-80% over physicochemical methods (Zechendorf, 1999; By Volke and Velasco, 2002). Acceptance of bioremediation as a viable strategy depends on its cost and efficiency on a contaminated matrix (Semple et al . , 2001; cited by Volke and Velasco, 2002).

In the United States, around 3.2 billion liters of used motor oil is recycled annually. In Mexico, their use and management are less adequate and has become a contamination factor (Ifeanyichukwu, 2011).

This study aims to bioremediate automotive oil contaminated soil by Acinetobacter Sp, Sphingobacterium Sp and Sp Stenotrophomona through a system of biocells, analyzing the physical-chemical soil characteristics and identifying the contribution of bioremediation bacteria during processing.

Background

The concept of bioremediation describes a variety of systems using live organisms to remove, degrade or transform toxic organic compounds into less toxic or safe metabolic products (Van Deuren et al., 1997). Biological processes involving enzymes as catalysts can alter organic molecules to produce changes in their structure and toxicological properties, resulting in the conversion of these compounds into inorganic products such as water, CO_2 or inorganic forms of N, P and S, cellular components and products of metabolic pathways (Alexander, 1994; cited by Volke and Velasco, 2002).

Used oils are composed of total petroleum hydrocarbons (TPH), polychlorinated biphenyls (PCBs), polycyclic aromatics (PAHs), metals and other pollutants that cause deterioration in the environment and human health, are toxic and poisonous, are substances that are difficult to degrade (Vasquez et al., 2010) and are hazardous waste NOM-052-SEMARNAT-2005. Motor oil is a lubricating agent and auxiliary fuel, refined and incorporated into asphalt. Many components of the oil are toxic and may be carcinogenic and endocrine disruptors. The aliphatic components are removed from the environment through natural attenuation; however, the recalcitrant fractions remain persistent. Polycyclic aromatic hydrocarbons (PAHs) are hazardous components of used motor oil (Ifeanyichukwu, 2011).

In California, in situ bioremediation in soils contaminated by diesel oil was done by indigenous microorganisms, nutrients, oxygen and inoculation of an enriched bacterial consortia extracted from the same soil mix soil. It allowed the identification of hydrocarbon degrading bacterial consortia identified by 16S-RNA gene sequencing, with Bacilluscereus, Bacillusphaerus, Bacillusfusiformis, Bacilluspumilis, Acinetobacterjunii, and Pseudomonas Sp (Volke and Velasco, 2002).

Perez et al. (2007) in Cuba studied biodegradation by isolated strains of soils contaminated with petroleum, by sequential enrichment using petroleum as a source of carbon and energy. They isolated bacterial strains, five Gram negative and four Gram positive, from the Bergey's Manual (1994). Pseudomonas aeruginosa was selected because of its higher growth with oil as a source of carbon and energy, degrading 57%.

In a study in Colombia, there was an evaluation of the native microbial consortia added to dewatering sludge biopiles from the primary treatment of domestic wastewater, sludge from car washings and sewage sludge from the industrial area of Bucaramanga. In these tests there were isolated, identified and preserved microbial strains degrading capacity of total petroleum hydrocarbons (TPH) like Pseudomonas spp., Pseudomonas aeruginosa, Acinetobacter spp, enterobacterial rcloacae, Citrobacter spp., Bacillusbrevis, Micrococcusspp and Nocardiaspp. It was inoculated at a concentration of 3x10 8 CFU / ml bacterial and fungal microorganisms as Aspergillus., Fusarium spp., Trichodermaspp., At a concentration of 1x106 spores / ml. Removal percentages were obtained up to 94% of HTP in 120 days and 84% in 40 days (Vasquez et al., 2010).

Garcia et al. (2012) in Venezuela, studied the biodegradation of a medium oil in two soils of different textures, with and without the addition of a structuring agent (litter). Soils that were tested were sandy (quartz and ilite), and sandy loam (quartz and kaolinite). Four treatments in triplicate in microcosms with an initial crude content of 5% (m / m) were evaluated and fertilizers were added to obtain the C / N = 60 and C / P = 800 ratios, and the piles were aired and the Humidity between 40 and 60% was maintained. The total hydrocarbon concentration was determined at 1, 15, 30, 45 and 90 days. The clay-sandy-clay texture favored the biodegradation process of the total hydrocarbons in the saturated components. The structuring agent influenced biodegradation.

Acuna et al. (2012), worked with humidity of 3, 10, 15 and 20% and temperatures of 5, 15, 28 and 37 ° C, and followed with hydrocarbon mineralization. To optimize the nutrient ratio, microcosms monitored for oxygen consumption and gas chromatography were designed. The results indicate that the mineralization was optimal for hydrocarbon humidity of 10 to 20% and temperatures of 25-37 ° C with production values of CO 2 from 3.000 to 4.500 mgCO2 kg-1. The optimum C: N: P ratio was 100: 1: 0.1 in which the highest oxygen consumption and removal of 83% of the total hydrocarbons were observed, with 78 and 89% removal of n- Alkanes and polyaromatic hydrocarbons.

Biochemical basis of bioremediation

It is based on oxide-reducing reactions that occur in the respiratory chain, or electron carrier of the cells. The chain is initiated by an organic substrate external to the cell that acts as an electron donor, where the metabolic activity of the cell degrades and consumes the substance. The acceptors used by microorganisms are oxygen, nitrates, iron (III), sulfates and carbon dioxide (Maroto and Rogel, 2013).

Biodegradability depends on factors such as:

Humidity (depends on soil texture and porosity).

Nitrogen is necessary for protein and cell wall synthesis and can be lost by the leaching of ammonium and nitrates and by soil denitrification. Phosphorus is useful for forming nucleic acids and ATP and is limited by low solubility and availability. The presence of minimal amounts of nitrogen and phosphorus allows the biodegradation at low speeds (Roldán and Iturbe, 2005).

Activity of microorganisms and oxygen supply. When the soil pores are occupied by water, oxygen is lower and anoxic conditions occur. For aerobic degradation it is necessary to have 10% of pores free (Roldán and Iturbe, 2005).

The pH affects microbial activity- the greater the diversity of microorganisms, the greater tolerance. The growth of most microorganisms is maximum at pH between 6 and 8 (Dibble and Bartha, 1979, cited by Torres and Zuluaga, 2009).

The temperature in mesophyllic conditions between 20 and 30 ° C allows bacteria to grow, decreasing at temperatures above 40 ° C and inhibiting below 0 ° C (Torres and Zuluaga, 2009).

Organic pollutants are a source of carbon that microorganisms require for biodegradation. When environmental conditions and colony forming units (CFUs) are not in adequate quantities, they are established through engineering processes. At high concentrations of contaminants, there is toxicity in microbial populations and nutrient insufficiency (Roldán and Iturbe, 2005).

Bioremediation technologies include:

- Bio stimulation: addition of oxygen and/ or nutrients to stimulate activity of autonomous microorganisms and biodegradation of contaminants (Van Deuren et al. , 1997; Manacorda and Pictures, 2005).
- Bio augmentation: addition of microorganisms to degrade contaminants (Riser and Roberts, 1998; Manacorda and Pictures, 2005).
- Bio styling: a mixture of volume and nutrient agents, is styled to favor aeration , mixing clean soil with contaminated soil (Van Deuren Et al. , 1997; cited by Volke and Velasco, 2002).
- Bio venting: stimulate biodegradation of a pollutant by a supply of air. Aeration promotes degradation by: volatilization, migration of the volatile phase of contaminants and biodegradation, stimulating bacterial activity (Maroto and Rogel, 2013; Manacorda and Pictures, 2005).
- Phytoremediation: using plants to remove, transfer, stabilize, concentrate and / or destroy contaminants in soils (Van Deuren Et al., 1997; cited by Volke and Velasco, 2002; Manacorda and Pictures, 2005).

Biopiles

Biopiling are ex situ bioremediation in unsaturated conditions, and reduces the concentration of petroleum contaminants from soil (Benavides et al., 2006). The choice of biopiles depends on climatic conditions and structure of volatile organic compounds in the soil. Biopiles are designed as closed systems to maintain temperature, avoid saturation of rainwater, and decrease evaporation of water and volatile organic compounds (Eweis et al., 1998, cited by Volke and Velasco, 2002).

Criteria for the design of biopiles:

- Extension of the contaminated soil (volume and site data) (Roldan and Iturbe, 2005).
- TPH in concentrations less than 50, 000 ppm and higher at 10, 000 ppm (Vasquez et al . , 2010; Roldan and Iturbe, 2005; Benavides et al., 2006).
- Heterotrophic bacteria in concentrations greater than 1 000 CFU / lg of dry soil (Roldan and Iturbe, 2005).
- PH between 6 and 9 (Roldan and Iturbe, 2005).
- Humidity content between 70 and 95% of field capacity.
- Low clay content and / or silt (Roldan and Iturbe, 2005).
- C, N, P and K about 100: 15: 1: 1 (Roldan and Iturbe, 2005).
- Toxic metals less than 2 500 mg / kg (Roldan and Iturbe, 2005).

According to the characteristics of the composting process, in the initial stage aeration is necessary due to an accelerated microbial activity. This increase in activity causes an increase in metabolic heat, producing temperatures in the thermophyllic range (50 to 60 ° C) (EPA, 1998, cited by Volke and Velasco, 2002).

Then the microbial activity decreases because the biodegradable components are consumed. At this stage the oxygen and temperature requirements decrease, so the compost requires less aeration. Once the cell cools and the temperature approaches the environment, the composting period is considered complete, including change of texture and odor. Depending on the amount of organic material mixed with soil, mass is reduced 40% (., Cited by Volke and Velasco, 2002 Eweis et al, 1998).

Optimum composting conditions depend on parameters in three categories: soil characteristics, climatic conditions and characteristics of pollutants. A key factor is the selection of additives, which leads to an increase in the rate of biodegradation of contaminants (Eweis et al . , 1998; cited by Volke and Velasco, 2002).

Regions with warm weather between 20 and 40 ° C are more efficient for bioremediation. The operating temperature of a biopile is between 30 and 40 ° C (mesophyllic stage) and depends mainly on the heat generated by the metabolic activity of the microorganisms in the compost and the climatic conditions of the place (Volke and Velasco, 2002).

Mexico is a region suitable for these technologies since 50.9% of the territory has climates with temperatures between 18 to 26 ° C. The average temperatures range from 25 to 28 ° C (maximum 41 ° C) in regions where most of the sites are contaminated by hydrocarbons (PEMEX, 2001) in coastal and low regions (Chiapas, Oaxaca, Tampico, Hidalgo, etc.) , Cited by Volke and Velasco, 2002).

Bioremediative Bacteria

Bioremediation accelerates biodegradable processes that naturally occur in contaminated ecosystems, where microbial communities are often dominated by adapted microorganisms capable of using toxic compounds from the contaminated location. Oil contaminated environments are often dominated by Gram negative bacteria (Perez et al . , 2007; Manacorda and Pictures, 2005) system.

If the contaminants are synthetic and new in the environment, the microorganisms do not have the capacity to degrade them, since the biodegradable genes have not evolved. Even if genes are present, the functional expression of genes is essential so that appropriate degrading enzymes can be produced (Daubaras and Chakrabarty, 1992).

MATERIALS AND METHODS

Soil characterization

EIn the laboratory of Environmental Engineering of UNICACH, the following parameters were evaluated: texture using sieves 4, 8, 10, 20, 50, 100 and 200 for a sample of 400 g of dry soil. The pH considered the NOM-021-SEMARNAT-2000, using a potentiometer. The field capacity was done by saturation and allowed to drain for twelve hours, and it was then weighed, kiln dried and weighed without moisture. The percentage of organic matter was obtained by weight difference.

Total nitrogen was calculated using the method of Micro Kjeldahl and available phosphorus with the Olsen method done by the Laboratory of Analysis of Soils and Plants in the Colegio de la Frontera Sur (ECOSUR), according to NOM-021-RECNAT-2000. Temperature was taken with a Taylor digital model 9842 thermometer.

Preparation of the inoculum

Samples of *Stenotrophomonas sp,Acinetobacter sp.* and *Sphingobacterium* strains were identified, which were isolated from soil contaminated with hydrocarbons in Tuxtla Gutierrez, Chiapas (93 ° 10'36.86''W 16 ° 45'43.92''N) identified by the Technological Institute of Tuxtla (Cisneros, 2011). Strains were maintained in 1.6 ml eppendorf tubes with LB medium and 30% glycerol at -20 ° C.

Bacteria were transferred to test tubes with approximately 3 ml of Luria broth and incubated at 37 ° C for 72 hours. Three sterile Petri dishes were seeded in three sterile boxes for each bacterium, and Agar Infusion culture medium was added and incubated at 37 ° C for 24 hours for identification.

The bacterial count was performed using the Machelle nephelometric scale prepared by the State Public Health Laboratory, for which threaded test tubes numbered 0.5 and 1 to 10 were organized. Each tube was filled with 1% anhydrous barium in aqueous solution and a cold solution of 1% sulfuric acid PA (V / V) in different concentrations according to the desired turbidity.

The bacteria were inoculated into petri dishes previously seeded in a test tube with 4 ml of 0.9% saline solution. The transfer was performed by taking bacteriological loop portions of inoculum and homogeneously mixing in test tubes to desired turbidity compared to the tube 0.5 of the scale, which represents a concentration of 1.5 x 108 CFU / ml.

Genetic analysis

Two genetic analyzes were performed- the first to corroborate the bacteria used and the second to know which bacteria were able to adapt. The extraction of deoxyribonucleic acid (DNA) was performed by cell lysis / phenol-chloroform-isoamyl alcohol method (Espinoza and García, 2003). Three inoculates were placed from a solid culture medium (heart brain infusion agar), for the first analysis and 10 for the second. To each tube added 360 µl of 0.5 M EDTA (pH 8.0); 19 µl of 10% SDS; 25 µl 0.1 M Tris HCl (pH 8.0) and 25 µl Proteinase K (10 mg / ml) was added. They were agitated for 20s and placed in a water bath of 12 to 18 hr at 55 ° C to dissolve tissue.

The samples were submitted to an RNAase treatment. They were removed from the water bath and allowed to cool to room temperature for 5 minutes. To each tube, 2.2 µl of RNAase at a concentration of 10 mg / ml was added and left in a water bath for one hour at 37 ° C. The tubes were removed and allowed to cool to room temperature for 5 minutes. 400 µl of ammonium acetate was added to each tube and vortexed for 20 s. The tubes were centrifuged for 5 minutes at 14,000 rpm.

The supernatant was removed and placed in tubes with 600 µl of alcohol at -20 ° C. Samples were centrifuged for 6 minutes at 14,000 rpm. The alcohol was removed from the tubes and 125 µl of 80% ethyl alcohol was added. They were allowed to stand for 1 to 2 minutes to rehydrate the DNA. The samples were centrifuged for four minutes at 14,000 rpm and the supernatant removed. The tubes were left uncovered for 30 minutes and 100 µl of sterile water was added to hydrate the DNA until the button disappeared.

DNA visualization

Visualization of the extracted DNA was performed by 1% (w / v) agarose gel electrophoresis. To prepare the gel 0.3 g of agarose was dissolved in 38 ml of 1X TAE buffer. 3 µl of 6X blue per sample was placed in a parafilm, and 5 µl of DNA was re suspended with a micropipette. The samples were then placed in the wells of the gel, the chamber was connected to a voltage of 120 volts, for one hour.

When the gel finished running, it was removed from the tray, then stained with fluorescent ethidium bromide (3.8-diamino-6-ethyl-5-phenylphenanthridium bromide, 10 mg / ml for 15 minutes, (Valadez and Kahl, 2000) which, when intercalating with DNA molecules, emits radiation by employing an transilluminator ultraviolet light, where the bands of total DNA are evidenced. DNA amplification was performed by the Polymerase Chain Reaction (PCR), a process consisting of synthesizing a DNA fragment with polymerase at elevated temperatures (Espinosa, 2007).

To prepare the polymerase chain reaction samples (PCR) the Green Master Mix kit was used, placing12 µl of master mix in tube for microcentrifuging, 10 µl of water for master mix, 1 of each primer and 1.5 µl of DNA , With a volume of 25.5 µl, they were placed in the TECHNE TC-3000 thermocycler, according to the following temperature conditions: a four-minute cycle at 94 ° C, followed by 32 cycles of 1 minute at 94 ° C, one minute At 53.5 ° C, one minute 30 seconds at 72 ° C and 7 minutes at 72 ° C.

Amplified DNA visualization was performed by 2% (w / v) agarose gel electrophoresis. For this, 0.6 g of agarose was dissolved in 38 ml of 1X TAE in an Erlenmeyer flask. The loading buffer was 2 µl of the amplified DNA and 1 µl of bromophenol blue and 1 µl of 100-base-pairs DNA ladder consisting of 11 fragments with exact increments of 100 base pairs from 100 to 1500 where the 500 bp band has a triple intensity compared to the other fragments. The gel bleeding schedule was 60 to 120 minutes at 120 volts. For visualization of the amplification the gel was stained with ethidium bromide and the image taken by the camera directly from the ultraviolet light transluminator. The photographs were edited with Picture Manager . The purification and sequencing of samples was performed by the MACROGEN company in Seoul, Korea with an Perkin Elmer ABIPRISM sequencer.

Preparation of biopiles

For the construction of the biocells, four samples of soil from 0.013m3 from the Management Unit and Conservation of Wildlife "La Huella" located in the ejido Pedro Mendez in the municipality of Chiapa de Corzo, Chiapas, Mexico were taken, At a latitude N of 495757 and longitude W of 1840501, with a height above the mean sea level of 420 m, which presents subhumid warm climate with summer rains (Awo) and average annual temperature of 26.3 ° C. The results of the soil characterization indicated that it has physio-chemical properties for bioremediation: pH between 6 and 8 units, low clay and / or silt content and high nutrient content, a temperature between 25 and 35 ° C is expected during the treatment (Roldán and Iturbe, 2005).

Four wooden crates, 35 cm long by 25 cm wide and 15 cm high, were constructed by calculating that the amount of soil would be adequate to carry out the analyzes during the process. The boxes were designed with slope of 2 to 3% to allow leakage of leachate (Roldan and Iturbe, 2005). They were lined with a plastic layer to avoid leachate absorption and allow it to run off.

In case leachates are generated, these would be collected in an impermeable base placed in the lower part.

Pollution and conditioning

5 kg of dry soil were weighed, then were contaminated by motor oil in three different concentrations of 10,000 to 50,000 ppm of TPH (Vasquez et al, 2010;. Roldán and Iturbe, 2005, Benavides et al . , 2006). The first treatment was contaminated with 10,000 ppm of TPH, the second with 30,000 ppm, the third with 50,000 ppm and the control biopile with 30,000 ppm. The quantities of oil were measured in a graduated cylinder. Finally, the soil was mixed with the oil.

The treatments were labeled: control biopile C1; Biopile with concentration of 10,000 ppm, C2; Concentration of 30,000 ppm, C3 and concentration of 50,000 ppm C4. The conditioning was performed biocell adding water until a humidity of 60 to 70% of field capacity (Vasquez et al., 2010), it was verified that the pH is between 6 and 8. found bacteria were inoculated to a concentration of 1.5 x 10 8 CFU / ml compared to the MacFarland scale 1.5 ml saline inoculated per bacterium (Roldan and Iturbe, 2005) were added inoculating a higher concentration of 1000 CFU / g of dry soil, the was aerated by half of manual mixes, the temperature was taken and the humidity was controlled by fist method every two days and humidity in the oven and pH every 15 days. It was covered with a plastic layer to avoid erosion and rainfall runoff.

Identification of removal levels

Three soil samples were taken from the bottom of each biopile, sectioning the box in three parts lengthwise, per box for each treatment and the control. The samples were placed in 120 ml plastic tubes with a screw cap and wide mouth filling them completely and finally freezing them to preserve them for analysis. Samples taken were oven dried at 60 ° C for 72 hours, the pellet was homogenized by stirring the three simple samples from the samples of each treatment and the control, thus having four samples to be analyzed for each sample, passed through a sieve of 0.5 µm.

To extract the hydrocarbons, a sub-sample of 20 g of sediment was weighed and the blank, for which sand was used, was weighed in an extraction thimble. 200 ml of methylene chloride was added to a 250 ml round bottom flask and boiling bodies were added. The soxhlet was then assembled and refluxed for 8 to 12 hours. The methylene chloride fraction was evaporated in a water bath using a rotary evaporator; hexane was added three times until the solvent was replaced without allowing the sample to dry. The sample was stored in the flasks to pass through column chromatography.

Column chromatography

For the preparation of the sample, glass chromatographic columns were packed with a Teflon key with glass wool stopper. 10 g of alumina and 20 g of partially deactivated silica gel were weighed into 50 ml beakers. 1 cm of partially deactivated sodium sulfate and dry alumina were added using funnel. 20 g of silica gel and sodium sulfate (1 cm) were added. 30 ml of methylene chloride was then poured through a funnel and keeping the key open, allowed to drain until the level was above sodium sulphate in order to add 1 cm of copper powder to contact with the chloride Methylene chloride.

When the solvent level was found on the surface of the copper powder, the sample was added along with three flushes with 0.5 ml hexane. The key was opened for the sample to enter and elution was initiated for fraction 1 aliphatic hydrocarbons with 100 ml of hexane and for fraction 2 aromatic hydrocarbons with 100 ml of hexane and 100 of methylene chloride mixed. The fractions were evaporated using rotary evaporator to a volume of 1 ml. The sample was transferred to a graduated tube, along with two 2 ml hexane rinses, and concentrated by flowing nitrogen to 2 ml. They were quantitatively transferred to 2 ml vials.

Fraction 1 of saturated aliphatic hydrocarbons was analyzed by gas chromatography using flame ionization detector. Fraction 2 of aromatic hydrocarbons and polychlorobiphenyl pesticides added prior to the injection of TCMX standards (100 µl to each sample) and O-terphenyl (5 µl to each sample) was analyzed by gas chromatography using flame ionization detector and capture de electrones para cada grupo.

Biopiles were monitored by Benavides et al. (2006) and Roldan and Iturbe (2005), five parameters: aeration, temperature, moisture content, carbon / nitrogen (C / N) ratio and pH. The viable cell count was carried out to determine the microbial activity and ensure that you condition were appropriate.

Viable cell count

The viable cell count was performed on the 15th day of treatment (Vasquez et al ., 2010), prepared according to Ruiz et al. (2013) a mineral medium were added with amounts compounds in distilled water: 0.15 g / L monobasic potassium phosphate (KH 2 PO 4); 1.156 g / L of ammonium (NH chloride 4 Cl); 0.02 g / L magnesium sulfate heptahydrate (MgSO 4 7H. 2 O); 0.04 g / L calcium chloride (CaCl 2); 0.07 g / L sodium chloride (NaCl); 1 ml / L of trace metal solution; 2 g / L peptone and 2 g / L dextrose. The compounds were added in 1 L of distilled water, the mixture was partitioned into eight 125 ml flasks each were sterilized same as in the autoclave. Each mixture was labeled in duplicate as C1, C2, C3 and C4, according to the labels of each treatment, and was added to the first four under sterile conditions, approximately 2 g of soil previously removed treatments the corresponding medium.

The inoculated medium was allowed mineral reposing for 24 h, so that bacteria will develop. After 24h the bacteria that grew on the medium were passed using a bacteriological loop to the remaining four flasks, growth steeping for 24 h. Over time the bacterial count by adding 1 .mu.l of medium inoculated on a slide using a micropipette it was performed. The slide was placed in an automated cell counter mark BIO-RAD (TC20).

The temperature was monitored every two days during the three months of treatment (Garcia et al., 2012). The schedule of temperature taking was not defined, sought to be held in the afternoons. The humidity was monitored with the cuff method every two days and lab every fortnight to keep humidity from 60 to 70% (Vasquez et al ., 2010). PH analysis were performed in the laboratory every fortnight. Manually it aired each treatment every two days to facilitate oxygen transfer (Garcia et al ., 2012).

Isolation of soil bacteria at end of treatment

Isolation of bacteria was held on 80 day of treatment to identify existing organisms at the end of the process. For this a gram of soil of each treatment was added to 5 ml of distilled water in test tubes labeled according to treatment and pre-sterilized. Subsequently the tubes were shaken on a vortex for 10 sec and left to stand for 30 minutes. dilutions were made by taking a 5 ml aliquot of the original mixture to be poured later in a test tube with 4.5 ml of distilled water, thus obtaining a 1/10 dilution, this step was repeated until achieving dilutions 1 / 10,000,000. dilutions 1 / 1,000 were taken; 1 / 100,000; 1 / 10,000,000 to add 5 ml of distilled water supernatant of each of the tubes and placed in Petri dishes with agar culture medium brain heart infusion. The inoculated media were incubated at 27 ° C for 24 hrs. Bacterial colonies were identified that were placed in Eppendorf tubes 1.5 ml for subsequent genetic analysis. Samples of the treatments were labeled with a total of 10 samples for analysis C1 (C101), C2 (C201, C202, C203), C3 (C301, C302, C303) and C4 (C401, C402, C403).

Results

According to the Unified System of Soil Classification (USCS), the soil belongs to soils of coarse particles located within the clean sands with wide range in intermediate sizes, being located in the SW group called well graded sands, sands with gravel, permeable in compacted states, excellent shear strength and negligible compressibility.

Soil pH is 7.6 units, to be in the range of 7.4 to 8.5 is considered a moderately alkaline soil pH. Moisture presenting half saturated soil is 30.67%. For every 3.5321 g 1.5629 g would be necessary to add water to achieve saturation. 75% of field capacity necessary to achieve good bioremediation amount to add for each 3.5321 g soil, 1.1721 g of water.

The organic matter was 7.45%, according to Mexican Official Standard NOM-021-RECNAT-2000, it is considered very high (greater than 6.0). The total nitrogen was 0.46%, according to Mexican Official Standard NOM-021-RECNAT-2000 and is considered a very high nitrogen content (greater than 0.26). A match available 19.5 mg / kg was obtained, according to Mexican Official Standard NOM-021-RECNAT-2000 content is high (greater than 11.1 mg / kg).

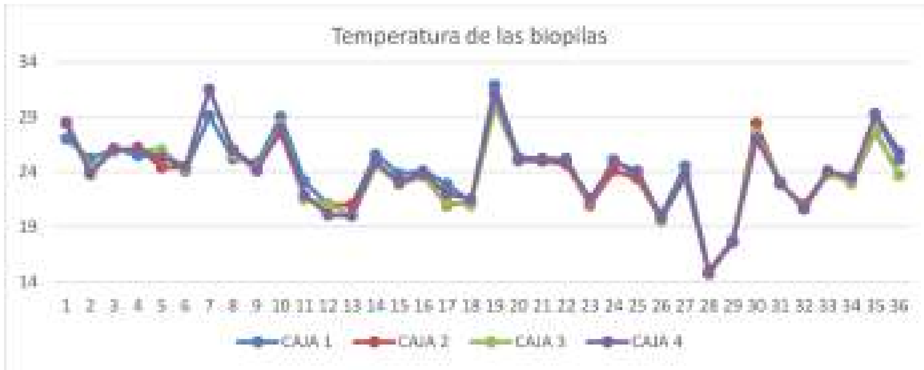
During monitoring, the biopiles moisture percentages were recorded every 15 days. The moisture content relative to field capacity is expressed in Table 1.

Table 1. Percentage of moisture during the bioremediation process.

Muestreos Tratamientos	H1	H2	H3	H4	H5	H6	H7
C1	63.06	51.45	73.39	80.99	89.63	74.50	88.52
C2	56.18	50.93	83.76	86.01	80.93	75.38	94.59
C3	64.43	42.06	87.35	84.02	88.52	75.51	86.86
C4	60.45	51.71	76.72	79.49	73.85	70.59	81.48

The humidity oscillated between 50 and 90%, and only in the second sampling where the humidity was low with an average of 49.04%, while the highest recorded was presented in the box 2 with 94.59%. On average, moisture percentage with respect to field capacity was 74.01% is (Figure 1).

Figure 1. Temperature monitoring of the treatment



Registration of pH is shown in Table 2.

Table 2. pH values obtained at each sampling during bioremediation.

Fechas de muestreos		Caja 1	Caja 2	Caja 3	Caja 4
M1	14/10/13	6.98	6.65	7.4	7.37
M2	20/11/13	7.01	7.08	7.08	7.2
M3	05/12/13	7.8	7.93	7.89	7.95
M4	18/12/13	7.84	7.71	7.9	7.88
M5	08/01/14	7.72	7.85	7.65	7.66
M6	17/01/14	7.39	7.42	7.58	7.61
M7	31/01/14	7.03	7.35	7.56	7.63

The bacteria counter showed that the amount of cells for biocell control (C1) was 5.98 x 105 cells / ml, treatment 1 (C2) 5.93 x 105 cells / ml, treatment 2 (C3) 2.29 x 105 cells / ml and treatment 3 (C4) 4.93 x 105 cells / ml. In Table 3 the initial and final concentrations of hydrocarbon fractions are shown.

Table 3. Initial and final hydrocarbon concentrations in the bioremediation process..

Tratamientos	Fracción aromática		Fracción alifática	
	Inicial ppm	Final ppm	Inicial ppm	Final ppm
C1	15387.2	35476.3	22221.8	1417.98

C2	9985.5	519.3	15471.9	1481
C3	21049.1	12885.2	17922.2	1997.85
C4	48092.3	8642	19135.2	2469

Similarly we can see the final percentage of removal of hydrocarbons obtained during treatment in aliphatic and aromatic fractions (Table 4).

Table 4. Percentages of removal in fractions of hydrocarbons in the bioremediation process..

Tratamientos	Fracción aromática	Fracción alifática
	% Remoción	% Remoción
C1	0	93.62
C2	94.8	90.43
C3	38.79	88.86
C4	82.04	87.1

The extraction and amplification of genomic DNA of 13 samples in total was achieved. Three are inoculated bacteria at baseline and 10 remaining bacteria were isolated at the end. Purification and sequencing of genomic DNA sequences of 13 with a total of 400 base pairs each was achieved.

Phylogenetic trees generated two were obtained by algorithm and nearest neighbor UPGMA respectively with the MEGA program. Within the algorithm UPGMA four clades called Group I, II, III and IV (Figures 2 and 3) are shown. The first group is composed of C302 unidentified C403 Burkholderiay C401 Mycobacterium . The second is made up of individuals initially inoculated, corresponding to OTEC 01, 02 and 03 called Acinetobacter Sp, Sphingobacterium Sp and Stenotrophomona Sp. The third group is made up of C203 Pseudomonas, C201, C301, C101 and C202 unidentified and finally the fourth group is composed of C303 Streptomyces and C402 Bacteroides. The tree generated by the nearest neighbor algorithm is composed of three clades called group I, II and III. The first group consists of C101, C202, C301, C201, C203, C303 and C404. The second group is composed of C302, C403 and C401 and the group III by OTEC 01, 02 and 03 as seen in Figure 2.

Figure 2. UPGMA algorithm Cladogram MEGA program via p-distance. The number on nodes corresponds to bootstrap support values with 100 repetitions.

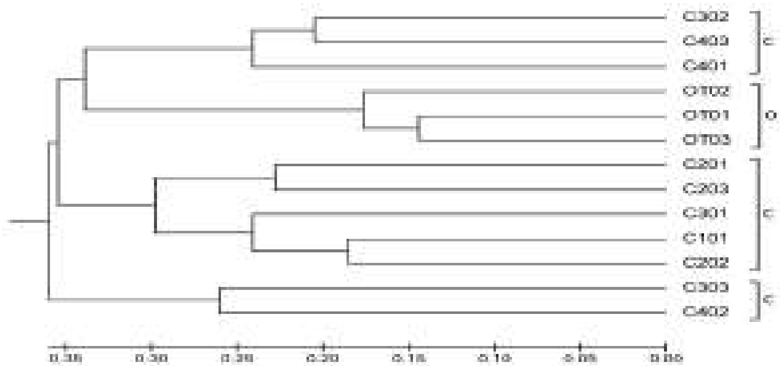
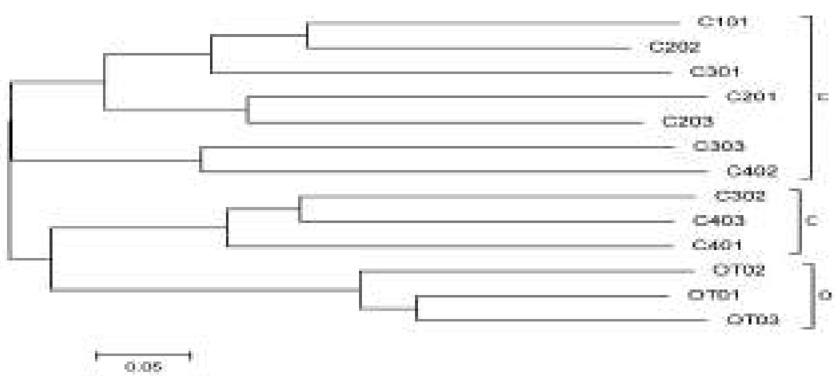


Figure 3. Cladograma of the nearest neighbor algorithm MEGA program via p-distance. The number of nodes corresponds to bootstrap support with 100 repetitions.



Discussion of Results

The soil from the UMA La Huella has a high sand content, SW group of SUCS, porous soil and has silts and clays and the presence of nutrients, which resulted: 7.45% carbon, 0.46% nitrogen and 19.5 mg / kg of phosphorus, with very high and the first two high phosphorus. It was not possible to know the bioavailability of nutrients in the soil, however, the results of hydrocarbon degradation assume that the microorganisms develop during treatment achieved in the environment, a process for which the presence is necessary nutrients bioavailable. Acuna et al . (2012) mention that the low concentration of bioavailable nutrients (nitrate, nitrite, ammonium and phosphate) is unfavorable for the bioremediation process that could be solved with biostimulation.

The sand prevailed in this soil, allowing oxygen to penetrate the pores thus achieving adequate oxygenation. Fine particles that were present favor the retention of water incorporated into the soil, conditions necessary for proper microbial growth (Acuña et al ., 2012). About Garcia et al . (2012) highlight that the availability and the microorganism hydrocarbon contact is key for bioremediation, soil SW group may be a viable option for the application of this technique. In addition to the above features, a neutral pH is essential for the proper development of the macro and micro in a treatment biopiles (Acuña et al ., 2012).

At the time that an oil spills in soils, as seen in the experiment, there results a series of processes that negatively impact the bacteria found to modify the environment that were acclimated, grow slowly or die (Manacorda and Cuadros, 2005) and some manage to adapt. Daubaras and Chakrabarty (1992) mention that if contaminants are synthetic and in a new environment, microorganisms have the ability to degrade pollutants as appropriate biodegradative genes could not have evolved even if the genes are present; the expression of functional genes is essential to produce appropriate degradation enzymes. The amount of oxygen decreases because the floor spaces are filled with hydrocarbon (Restrepo, 2002) and nutrients phosphorus and nitrogen that microorganisms used for development are generally limited in the middle by excess carbon generated in the oil spill (Tyagi et al ., 2011).

The bacteria used in treatments, Acinetobacter Sp , Sphingobacterium Sp and Stenotrophomona Sp , having been removed from a chronically oil contaminated soil, a place where substances such as lubricating oil are used, are considered suitable bacteria for the degradation of contaminants since they have been present at the affected site for a long period they managed to adapt to this and develop the system that allows them to degrade organic pollutants resulting from human activities (Ruiz et al., 2013). In this regard Manacorda and Cuadros (2005) highlight the importance of indigenous microorganisms, since they are the major decomposers in the ecosystem since this activity existed naturally in the environment prior to the disposition of xenobiotics (Benavides et al . , 2006; Martinez et al ., 2011).

After the spill, suitable ground conditions existed where aerobic bacteria could undertake their duties and reproduce at a faster rate and degrade the contaminant. The factors controlled during treatment were: humidity, temperature, pH and oxygen same as monitored throughout the process. Figure 4 shows the humidity recorded every two weeks during treatment.

Figure 4. Percentage of humidity recorded during treatment.

According to the results expressed we can see that the biopiles had the same moisture, although it was not constant during treatment. In Table 5 the moisture content expressed in relation to field capacity is presented. We can see that sometimes is raised up reaching 94.59%, corresponding to sampling in July of treatment 1 (C2). According Roldan and Iturbe (2005), excessive moisture is undesirable for bioremediation with biopiles, since the spaces in soil are filled by water causing a deficiency in aeration. Excess water leachate generation increases both hydrocarbon and nutrients. Due to the size and amount of soil, leaching was handled almost imperceptible in the biopiles.

Table 5. Percentage of humidity recorded in relation to field capacity..

Muestreos tratamientos	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
C1	63.06	51.45	73.39	80.99	89.63	74.50	88.52
C2	56.18	50.93	83.76	86.01	80.93	75.38	94.59
C3	64.43	42.06	87.35	84.02	88.52	75.51	86.86
C4	60.45	51.71	76.72	79.49	73.85	70.59	81.48

Optimal humidity ranges from 40 to 85% (Volke and Velasco, 2012), 70 to 95% of field capacity (Roldan and Iturbe, 2005); high humidities may be used in the process without generating problems for hydrocarbon degradation. At times the moisture was lower than that established in the experimental design (60 to 70%) during second sampling with 51.45%, the biopile control (C1); 50.93%, treatment 1 (C2); 42.06%, treatment 2 (C3) and 51.71%, treatment 3 (C4) and treatment one (C2) of the first sampling 56.18%. Moisture is needed for the transport of nutrients, metabolic processes and maintaining cell structure (Roldan and Iturbe, 2005). Garcia et al . (2012) adjusted the moisture value between 40 and 60% of field capacity, indicating that even with low moisture conditions were achieved registered acceleration of the degradation process. Figure 5 shows the behavior of temperature in the soil recorded every other day during treatment.

Figure 5. Temperatures recorded during treatment.

Temperatures varied over treatment with upper peaks at 30 ° C and less than 20 ° C. Biopiling had similar temperatures during the procedure, indicating that the experiment was properly controlled. Volke and Velasco (2012) mention the ideal temperature between 25 and 35 ° C. Acuna et al . (2012) highlight the importance of temperature for the growth of microorganisms.

Figure 6 shows the pH recorded every 15 days throughout the procedure. The pH according Roldan and Iturbe (2005) and Volke and Velasco (2012) must be in a range of 6 to 9 and 6 to 8, respectively, with optimal pH of 7. The results held in neutral range during treatment, which favored bioremediation (Acuña et al ., 2012).

Roldan and Iturbe (2005) propose lower levels of hydrocarbons to 50,000 ppm. Vasquez et al . (2010) removed 70 to 90% at different times with concentrations between 10,000 and 50,000 ppm. The concentrations used in this study (10,000, 30,000 and 50,000 ppm) and removal levels achieved 63.82% to 92.61% are similar to those reported in the literature. Table 6 shows the bacterial species isolated from soil at the end of treatment was observed.

Figure 6. pH registered bioremediation process.

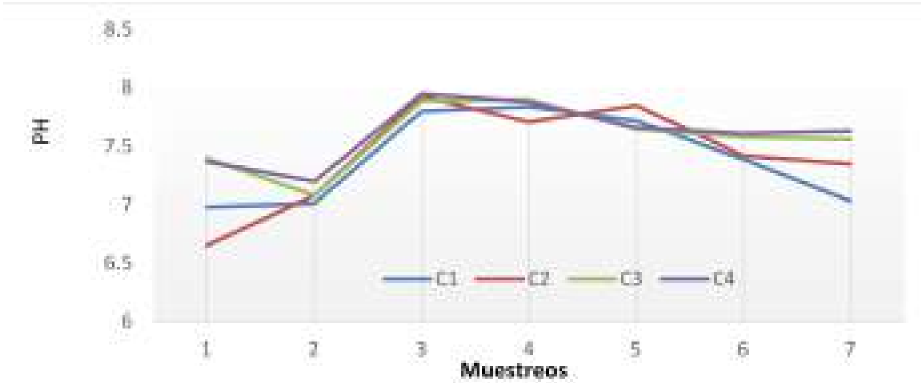


Table 6. Species isolated from contaminated soil at the end of treatment.

Biopila	Muestra	Bacteria o especie	Porcentaje Identificación	Plataforma	Observaciones
CI	C101	*No identificado*	--------	Todas	No se encontró ninguna especie de bacteria en la base de datos del genbank
C2	C201	*No identificado*	--------	Todas	No se encontró ninguna especie de bacteria en la base de datos del genbank
	C202	*No identificado*	--------	Todas	No se encontró ninguna especie de bacteria en la base de datos del genbank
	C203	*Pseudomonas*	33%	blast-blastx[1]	Productoras de biosurfactantes involucrados en la remoción de aceite
C3	C301	*No identificado*	--------	Todas	No se encontró ninguna especie de bacteria en la base de datos del genbank
	C302	*No identificado*	--------	Todas	No se encontró ninguna especie de bacteria en la base de datos del genbank
	C303	*Streptomyces*	41%	blast-blastx[1]	Se encuentran en suelos y en la vegetación descompuesta y produce numerosos antibióticos de uso clínico
C4	C401	*Mycobacterium*	84%	blast-blastx[1]	Degradan hidrocarburos aromáticos policíclicos en especial pyreno, benzo (a) pyreno es altamente cancerígeno
	C402	*Bacteroides*	37%	blast-blastx[1]	Son candidatos para el tratamiento de terrenos contaminados con HTP
	C403	*Burkholderia*	75%	blast-tblastx[2]	Es excelente degradadora de hidrocarburos aromáticos

1) Search protein using a nucleotide base.

2) Search nucleotide database using a translated nucleotide query.

Roldan and Iturbe (2005) propose lower levels of hydrocarbons to 50,000 ppm. Vasquez et al . (2010) removed 70 to 90% at different times with concentrations between 10,000 and 50,000 ppm. The concentrations used in this study (10,000, 30,000 and 50,000 ppm) and removal levels achieved 63.82% to 92.61% are similar to those reported in the literature. Table 6 shows the bacterial species isolated from soil at the end of treatment was observed.

One can see that the bacteria inoculated initially were not successfully isolated from the samples obtained, regarding this Tyagi et al . (2011) mention that the indigenous microorganisms are more likely to survive and develop when reintroduced into the site compared to the transitional or strains outside the habitat. After treatment, degrading bacterial hydrocarbon strains, which survived the newly polluted environment, were obtained. The released strains may have transferred catabolic plasmids to indigenous microorganisms, the same as the environment in which they are modulates for the recruitment and evolution of degradation genes pathway in bacteria (Cisneros, 2011; Daubaras and Chakrabarty, 1992), which explains their survival and appearance at the end of treatment. The average percentages of pollutant removal at 90 days for the biopile are expressed in Table 7.

Table 7. Percentage of final removal of total hydrocarbons per treatment

Tratamiento	Porcentajes de remoción (%)
C1	46.81
C2	92.61
C3	63.82
C4	84.56

The biopile that achieved the highest amount of removal was the one that had the lowest concentration of hydrocarbon at baseline (10,000 ppm), which influenced conditions for bacteria to succeed in degrading the contaminant. In this biopile the genus Pseudomonas was identified, a bacteria recognized for their bioremediation ability , being capable of degrading aromatic hydrocarbons: benzene, toluene, ethylbenzene, xylene, naphthalene and phenanthrene; it also produces extracellular biosurfactants. Treatment with the mean concentration (30,000 ppm), achieved a lower removal; the presence of identified as not degrading hydrocarbons bacterial species involves competition with the inoculated bacteria and may cause increase in the period prior to degradation of the compounds (Steffensen and Alexander, 1995; cited by and chefs, 2011) .

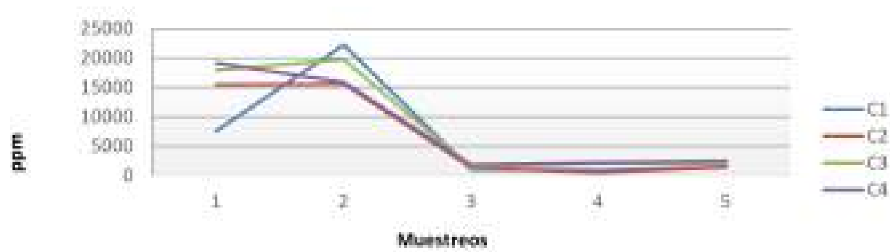
For treatments with higher pollutant concentrations (50,000 ppm), removals were achieved above average concentrations for treatment. In

Table 8, it is noted that apart from the inoculated bioremediation strains, there existed the presence of other bioremediation microorganisms such as of Mycobacterium , which is able to degrade PAHs especially pyrene, benzo (a) pyrene which is highly carcinogenic, Bacteroides genus candidate in treating contaminated with PAH and *Burkholderia* , excellent for degrading aromatic hydrocarbons (Benavides et al . , 2006; Tyagi et al ., 2011), that biopile presented more bacterial species for bioremediation, which explains the high removal percentage.

The control had the lowest biopile removal, which proves the importance of adding bacteria that are appropriate to a contaminated environment and have developed the ability to degrade the pollutants. Daubaras and Chakrabarty (1992) mention that to degrade synthetic and new compound in the environment, a microorganism must evolve genes encoding enzymes that have an affinity for the chemical, which is why it reduces or stops bacterial growth and the absence of microorganisms at the end of treatment.

In Figures 7 and 8 the reduction of hydrocarbons in the analyzed fractions is observed. In the case of biopiles control, the reduction is only observed for the aliphatic fraction (Ifeanyichukwu, 2011), it is common to find similar levels of degradation in both treatments as in biopiles controls. The PAHs, which are the most recalcitrant and dangerous engine oil fraction, are more difficult to degrade (Cerniglia, 1992) which explains a lower percentage of removal.

Figure 7. Concentration of aliphatic hydrocarbons during the bioremediation process.(Samples).



Removal percentages for the aliphatic fraction (Table 8), with stabilization of the pollutant were recorded in the environment on day 60. The aromatic hydrocarbons fraction had a different behavior to the aliphatic fraction (Table 8). A 30.56% increase for C1 was observed, indicating that the degradation process in biopile control was slow. During treatment there were observed in C3 and C4 high peaks around day 30, representing an increase in the concentration of hydrocarbons in this fraction which was also present in the control biopile on day 60 and the end of treatment. This is due to cleavage of molecules caused by the activity of the degrading bacteria, as Cerniglia (1992) explains, bacteria use enzymes to break down the hydrocarbon chains and thus be metabolized. On the other hand the same microorganism may have different degradation rates from different backgrounds to raw or chemical compositions in the same experimental conditions (Ortiz et al ., 2005).

Figure 8. Concentration of aromatic hydrocarbons oil during treatment.

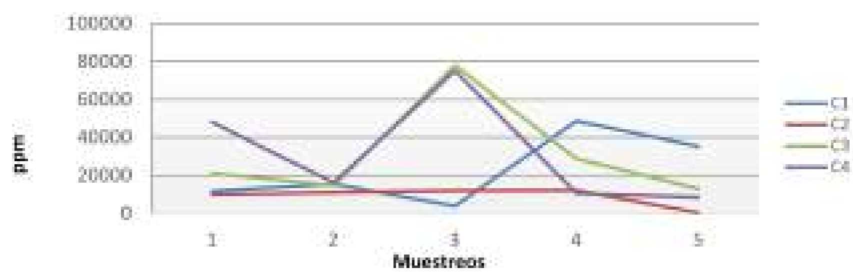


Table 8. Percentages oil removal during treatment.

Trata-miento	Día 1		Día 15		Día 30		Día 60		Día 90	
	Aromáti-cos	Alifáticos	Aromáti-cos	Alifáticos	Aromáti-cos	Alifáticos	Aromáti-cos	Alifáticos	Aromáti-cos	Alifáticos
C1	0.00	0.00	0.00	0.00	-73.93	-95.50	216.96	-95.79	130.56	-93.62
C2	0.00	0.00	10.85	0.74	-99.98	-91.43	-21.33	-97.14	-94.80	-90.43
C3	0.00	0.00	-30.08	9.97	270.64	-92.03	37.27	-88.16	-38.79	-88.85
C4	0.00	0.00	237.49	-17.04	56.26	-90.66	-77.89	-88.63	-82.03	-87.10

CONCLUSIONS

According to the physio-chemical parameters analyzed, the soil proved to be suitable for treatment with biopiles. In C1, for the aliphatic fraction there was a 93.7% removal, 90.4% for C2, for C3 88.8% and C4 87.1% was achieved. Regarding hydrocarbon removal, there were 0 for C1, 94.8 for C2, 38.8 for C3 and 82.0 for C4 in 90 days of treatment with application of bioremediation bacteria and identification of native bacterial strains able to resist change in their environment.

It was found that bioremediation can be used for treating oily residues characteristic of heavy hydrocarbons as well as reduced concentrations of hydrocarbons, aliphatic and aromatic fractions. The degradation of the aromatic fraction was notorious in the treatments that were inoculated with bacteria.

We recommend using native microorganisms and external bacteria to allow adaptation of native bacteria and achieve lower levels of hydrocarbons. Together native and external bacteria were able to use used motor oil as a source of carbon and energy.

With the results of this investigation, it is based that the presence of external and native bacteria, the addition of water and oxygenation, has positive effects in reducing concentrations of total hydrocarbons in soil contaminated by waste oil. As part of an initial characterization of the contaminant, it is important to determine the concentration of metals, since an amount above 2,500 ppm may be detrimental to the bioremediation process (Roldán and Iturbe, 2005).

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EVALUATION OF AN UPFLOW ANAEROBIC SLUDGE BLANKET BIOREACTOR FOR THE TREATMENT OF STILLAGE

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Abumalé, Cruz-Salomón[1], Rocío, Meza-Gordillo[2],
Arnulfo, Rosales-Quintero[3], Cristina, Ventura-Canseco[4],
Edna Iris, Ríos-Valdovinos[5]

[1] dr.abumale@gmail.com, [2] romego71@yahoo.com.mx,
[3] arnol122@gmail.com, [4] lcanseco66@hotmail.com,
[5] edna.riosv@gmail.com
[1, 5] Faculty of Engineering. University of Sciences and Arts of Chiapas.,
[2, 3, 4] Mexico National Technology / Tuxtla Gutierrez Institute of Technological.

— Abstract—

In this research the evaluation of a type bioreactor "upflow anaerobic sludge blanket" (UASB) of 4.4 L occurs during a period of 90 days, which was fed with wastewater (vinasse) of a fermented beverage company from Comitan, Chiapas. The removal efficiency of chemical oxygen demand (COD), stability with respect to reactor factor alpha (α) and hydrogen potential (pH) were mainly investigated. The COD removal efficiency of was 90 %. During the study, the α factor (0.28) and pH (7.1) remained stable in the system.

Keywords

Wastewater, Vinasse, UASB, COD.

Technology for anaerobic wastewater treatment has been applied in the treatment of wastewater from different industries such as: Distilleries, tanneries, textile, pulp and paper and food processing (Buzzini et al, 2002; Kasum et al . , 2002, Ramasamy et al . , 2004 Chavez et al, 2005). For this purpose, various configurations of reactors such as the contact anaerobic reactor (Nahale, 1991), fluidized bed reactor (IZA, 1991) anaerobic fixed film reactor (FFR) (Rao et al., 2005) and mantle up flow anaerobic sludge reactor, commonly known as UASB have been developed between the years 1976-1980 by Professor Gae Lettinga from Wageningen University in the Netherlands (Iñiguez-Covarrubias and Camacho-Lopez, 2011). The first UASB reactor was applied for the waste water treatment of a beet sugar refinery in the Netherlands (Lettinga, 1980). After the first pilot scale UASB reactor was successfully operated, many reactors of this type were used on a real scale to treat different types of industrial wastewater. This reactor is currently applied extensively because of their effectiveness in wastewater with a high organic load and for its economic advantages (Lettinga et al . , 1997; Buzzini et al . , 2002; Kusum et al . , 2002, Mahmoud et al. , 2003; Chavez et al, 2005)..

In the state of Chiapas, particularly in the region of the Comitan plateau, there can be found crops which include the *Agave americana L*. and *Agave salmiana Otto ex Salm-Dyck*, which are used for a typical alcoholic beverage (spirit) of the region called are Comiteco (Reynoso-Santos et al., 2012). Currently, the preparation process is carried out using traditional methods where 0.85 L of waste/L must is obtained from the distillation process, which is dumped into surface water or used as irrigation water causing eutrophication of surface water bodies and result in nitrate leaching to groundwater and reduced levels of dissolved oxygen (Vlyssides et al., 1997). In soil, it can be a threat to fertility due to an imbalance of nutrients or even harmful concentrations of nutrients (Kannabiran and Pragasam, 1993). For this reason the objective of this investigation was to evaluate a UASB bioreactor to treat stillage from the alcoholic distillation process of Comiteco.

METHODOLOGY

Obtaining the raw material

The stillage used was provided by the Company Balun Canan, SA de CV established in the city of Comitan, Chiapas, as a product of batch distillation, which were stored at 4 ° C until use.

Physicochemical analysis

The sediment solids (SS, mg / L) were determined according to the Mexican standard NMX-004 (2000). The total volatile solids (TVS, mg / L) and total dissolved solids (TDS, mg / L) were carried out following the Mexican standard NMX-034 (2001). The pH of the samples was determined using a HACH model SenSion 3 (influent and effluent) potentiometer, and the acidity was determined according to the norm NMX-036 (2001). The analysis of the chemical oxygen demand (COD, mg O2/L) was performed according to the Mexican standard NMX-030 (2001) using the technique of closed / spectrophotometric reflux (influent and effluent). The biochemical oxygen demand (BOD 5) was performed according to the Mexican standard NMX-028 (2001).

Description and preparation of the bioreactor

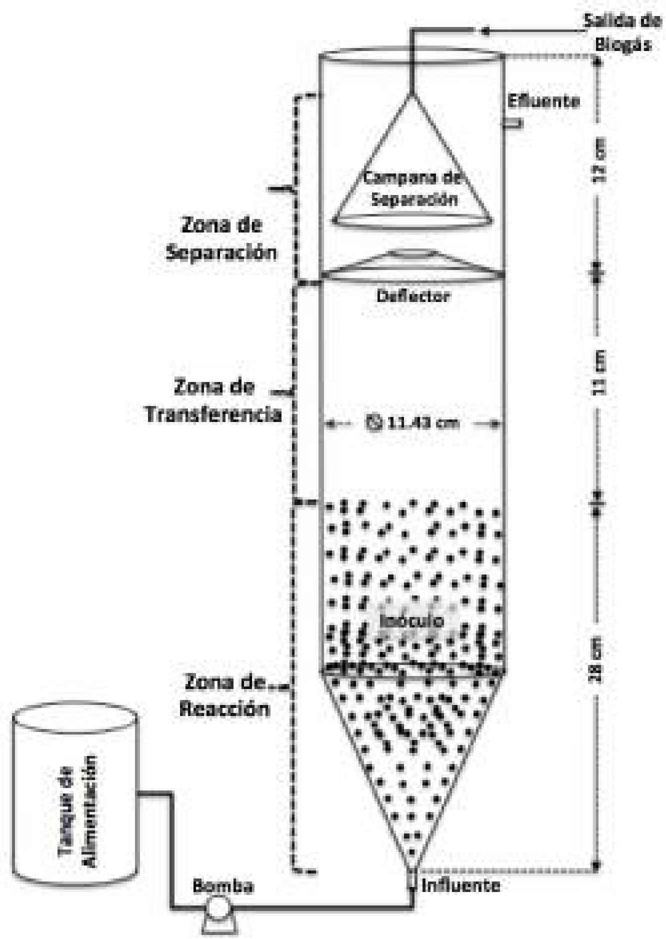
In Figure 1 you can see the design conditions of the bioreactor which was built in fiberglass with a volume of 4.4 L, with a cylindrical shape due to its hydrodynamic advantages and the least possibility of the formation of dead zones. The bioreactor was operated at a 24h hydraulic retention time (HRT) and inoculated with 2 L of anaerobic microbial complex (obtained from a bottled water treatment plant of a bottling plant), with a content of 2.5 gST / mL .

Bioreactor Monitoring

During the evaluation period of the bioreactor the COD was monitored. The control parameters were temperature, pH and alpha factor (α) which is obtained according to the following procedure (Speece, 1996): 10 mL of sample was taken and acidified with 0.1N HCl until a pH of 5.75 was recorded of the mL of HCl required (V1) . This volume corresponds to the bi-carbonic alkalinity. Subsequently, this sample was brought to pH 4.3 (V2). The alpha factor was calculated by the following equation:

$$\alpha = \frac{V_2}{V_1 + V_2}$$

Figura 1. Upflow anaerobic sludge blanket bioreactor.



Source: This investigation.

RESULTS AND DISCUSSION

The physicochemical characteristics of stillage (influent) in terms of COD, BOD5, TDS, TSS, TVS, and SS as well as temperature and pH are shown in Table 1.

Table 1. Physicochemical characterization of stillage.

Parámetro	Valores obtenidos
pH	3.9 ± 0.013
Acidez (mg CaCO3/L)	79.3 ± 4.9
DQO (mg O2/L)	120,221±18,447
DBO5 (mg O2/L)	102,180 ± 15,320
SS (mL/L)	100 ± 14.1
ST (mg/L)	71,691.42 ±186.6
SVT (mg/L)	62,890.47±172.6
SST(mg/L)	9,190 ± 95.8
SDT (mg/L)	62,501.42 ± 93

Source: This investigation

As seen in Table 1, the stillage had a pH below permissible range indicated by the NOM-001-ECOL-1996 (5-10 units), for this reason the stillage discharged into a body of surface water is considered to be a pollutant due to its low pH which can cause acidification (Lükewille et al., 1997). On the other hand, the concentration of organic matter measured as BOD5 and COD present in the stillage are 1000 times greater than the maximum extent permitted by NOM-001-ECOL-1996 (30-200 mg O 2 / L). This organic load is due to the presence of dissolved solids and reducing sugars, non - volatile compounds from the fermentation broth (alcohol), acetic acid, glycerol, melanoidins and phenolic and polyphenolic compounds (Capasso et al . , 1992; Sangave et al, 2007;. Robles-Gonzalez et al, 2010). For this reason it is vitally important to give treatment to these agro - industrial effluents, which by its level of biodegradability (0.85, obtained from the BOD5 / COD ratio) and organic matter, anaerobic biological treatment is feasible as it is carried out in the UASB reactors.

In Figure 2, the behavior of the bioreactor based on control parameters (pH and α) is observed during the 90 day evaluation. As can be observed, the pH in the bioreactor remained stable in the optimum range (6.8-7.4) for the methanogenic Archaea reported by Speece, (1996). On the other hand, the alpha factor is usually used to control the stability of the anaerobic process (Speece, 1996) and to measure the buffer capacity of the bioreactor. As we can see, the bioreactor operated properly due to its alpha index was found to be within the optimal operating range (0.2-0.4) reported by Rojas, (2004).

Figure 2. Control Parameters of the UASB

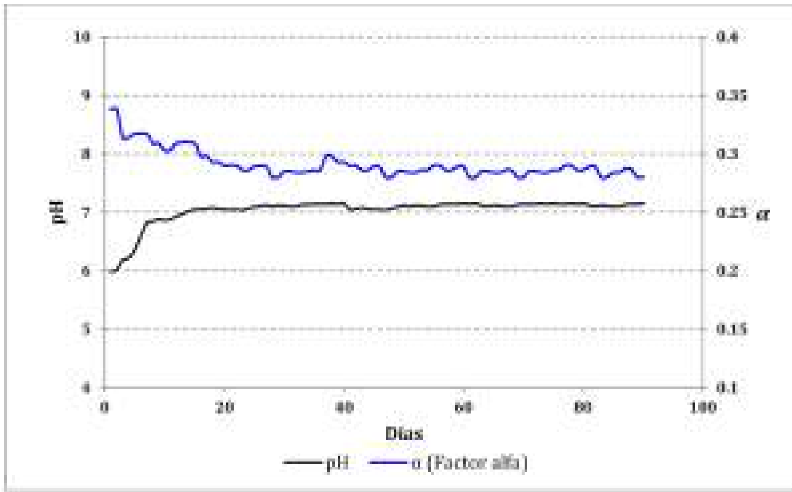
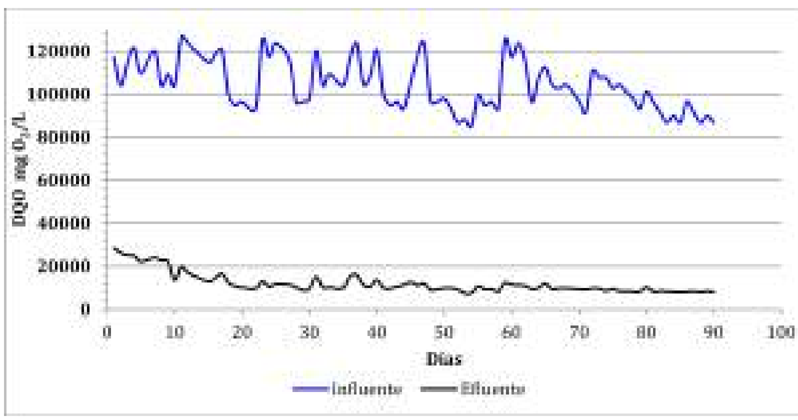
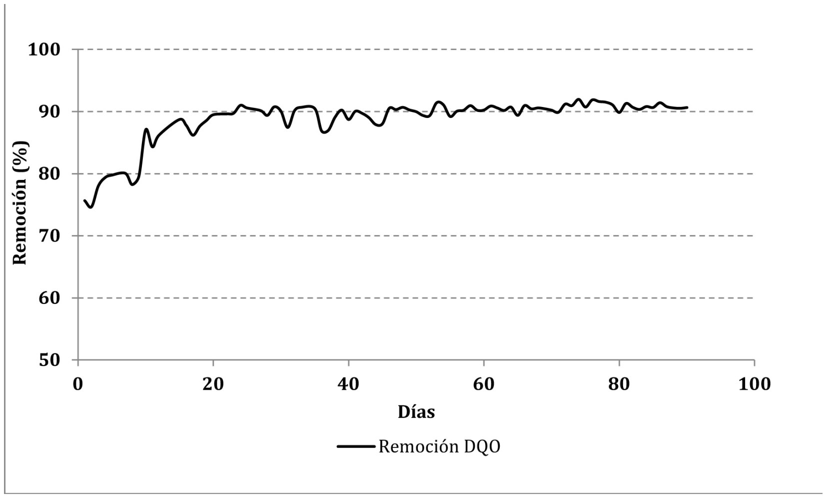


Figure 3. Evaluation of the UASB bioreactor.



Analysis of COD in **Figure 3 and Figure 4** shows the behavior of the UASB bioreactor during the evaluation period of 90 days, where one can observe that the bioreactor operated stably throughout the evaluation period, reaching a percentage of removal greater than 90%. However , even if the removal percentage was high, effluents were generated with a COD of 6500 mg O2/L, which still have large amounts of biodegradable organic matter which can be used as raw material of advanced oxidation processes, trickling filters , biodiscs or a second anaerobic treatment as reported by Robles-Gonzales et al. (2010).

Figure 4. Percent Removal..



CONCLUSIONS

According to the results of this study we concluded that an anaerobic biological treatment as provided by the up flow anaerobic sludge blanket reactor is an effective technology to carry out the treatment of stillage of the fermented drink produced in Comitan, Chiapas, because of its high performance measured in terms of COD removal with a percentage greater than 90%, reaching a profile similar to aerobic treatments. For this reason the use of such bioreactors is recommended due to the economic savings in energy costs compared to the operation of aeration is aerobic processes.

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MANAGEMENT OF NON-HAZARDOUS SOLID WASTE IN AN INSTITUTION OF HIGHER EDUCATION

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Pedro Vera Toledo [1], Hugo Alejandro Nájera Aguilar,
Carlos Manuel García Lara, Magnolia Solís López

[1] caachis1@hotmail.com, University of Science and Arts of Chiapas.

— Abstract—

In general, the higher education institutions gather many people, so they are considered as sources of high rate of solid waste generation, thus requiring for strategies and well-established protocols to ensure the proper management of solid waste to avoid the problems generated and the risks posed to both public health and the environment. In University City (CU), an institution of higher education in the city of Tuxtla Gutierrez, Chiapas, Mexico. A study was conducted to determine the solid waste management, which included the generation, collection, storage, equipment and infrastructure, in addition to the characterization, economic aspects and implementation of a tool to learn about environmental education focused to solid waste. The results show that 677,6 kg / day of solid waste is generated, with 0.143 kg/person-day, management has a cost of $7.00/kg and 10 fractions which potentially can be exploited at least four of them, hoping for a reduction of up to 63% of the generation were identified. Education becomes a necessity to achieve this reduction.

Keywords

Solid Waste, Institutions of Higher Education, Waste Management.

Solid waste management involves aspects ranging from its generation, management, treatment and final disposal in order to minimize the impact to the environment. Residues can be classified according to their physical state (solid, liquid and gaseous), their chemical characteristics (organic and inorganic), the degree of degradation in the environment (biodegradable and non-biodegradable), their physical characteristics (Inert and combustible), by the activity that originates it (municipal, industrial, mining, hospital, etc.) and by its type of management (dangerous, potentially dangerous, non-dangerous, special and dangerous biological infectious) (Buenrostro 2001) .

Problems generated by the inadequate management of solid waste have been widely doUCmented, putting the public health of the surrounding population at risk. This risk increases and is associated with the proximity of final disposal sites, low growth rate (Ocampo et al., 2008) and in other cases from asthma to cancer, which ends with the death of minoSW (Paschkes and Palermo, 2010).

On the other hand, some of the problems caused by the mismanagement, but especially the inadequate disposal, are: blockage of water UCrrents, deterioration of recreation sites, contamination of aquifeSW and bodies of surface water, salinization of soils, proliferation of noxious fauna and generation of bad odoSW (Cortinas, 2001). When garbage is burned, particles and all kinds of substances are emitted, including dioxins and chlorinated compounds with high toxicity (Cortinas, 2003), capable of causing a variety of negative effects in animals such as: weight loss and liver problems, impaired reproductive function, immune response and defects in the offspring (Olea et al . , 2002 Armengi et al, 2005)..

The proper management of solid waste represents a commitment for higher education institutions that have a greater commitment to social challenges, strengthening the social responsibility of univeSWity students and fostering a univeSWity committed to the society that surrounds it. At the global level, there have been studies foUCsed on solid waste management in institutions of higher education, such as that reported by Espinosa et al. (2003), at the UniveSWity of Granado, Spain, whose purpose was to know the environmental impact generated by the activities of its univeSWity centeSW and to define the strategies to be followed in environmental management. As a result, in 1998 it implemented a plan that includes the principles that constitute the institutional framework of the environmental management of this univeSWity. The doUCment highlights the importance of the joint participation of teacheSW, researcheSW, administrative staff and students.

In America, a study of solid waste composition conducted at Brown UniveSWity, in 1992, found that 45% of waste generated at this institution was recyclable. This univeSWity has had a recycling program since 1972 and in 2004 recycled 31% of its waste (Brown Programs, 2004). It should be considered that in the United States of America, it is mandatory for schools and univeSWities to have waste reduction and recycling programs.

Mexico has worked in several institutions of higher education. The Autonomous UniveSWity of the State of Morelos has established the UniveSWity Environmental Management Program, and the best known case is that integrates eleven institutions of higher education in an organization called the Mexican Consortium of UniveSWity Environmental Programs for Sustainable Development (COMPLEXUS), whose main objective is the collaboration and coordination of univeSWity environmental programs, committed to the incorporation of the environmental dimension in the substantive tasks of their institutions (Bravo, 2003).

For the state of Chiapas, there have been incipient efforts in relation to waste management, specifically in the UniveSWity of Science and Arts of Chiapas (UNICACH), the fiSWt with the creation of the UniveSWity Environmental Program and in the second, a study foUCsed on environmental education exclusive to the student population with respect to the generation of the solid waste that they did not deepen in subjects of handling. Since planning, the univeSWity has two instruments that observe this heading:

1) Policy of quality "that establishes the transveSWal incorporation of its commitment to sustainable development, quality and continuous improvement of its administrative processes and services; promotes the culture of pollution prevention and the preservation of the environment in the univeSWity community , and integrates the sum of professionalization aimed at increasing the compliance with the legal and regulatory framework".
2) The UniveSWity Environmental Program (UEP), which aims to "promote the incorporation of environmental action and sustainability within its substantive functions, research, teaching and extension, which are made in the various UNICACH educational programs, as well as promoting environmental awareness in the univeSWity community and in the state."

In order to reinforce the idea of knowing the state of the management of residues, this study was conducted at the main campus, "UniveSWity City" (UC) of the UNICACH, in the City of Tuxtla Gutiérrez, Chiapas, Mexico, with the purpose of having a solid waste management approach. A diagnosis of the generation, collection, management, equipment, infrastructure, characterization and finally the application of a survey on environmental education foUCsed on the knowledge and management of solid wastes was carried out.

MATERIALS AND METHODS

In order to know about the solid waste management within the facilities, a study was carried out in three stages.

FiSWt stage

Aimed at knowing the equipment, infrastructure and economic aspects of solid waste, an interview was conducted with the head of the Department of General Services of UC responsible for waste management to know the economic aspects in terms of expenses and day-to-day management. Solid waste peSWonnel assigned for that purpose were observed. In addition, a tour of the UC facilities was carried out to collect and compare information on the number and type of equipment and infrastructure such as containeSW, boats, general warehouse, etc.

Segunda Etapa

The generation and characterization of the solid residues inside UC for eight days was determined, taking as reference and adapting the Mexican technical standards such as those related to the method of quarantine (SECOFI, 1985a), the selection and quantification of byproducts (SECOFI , 1985b) and generation determination (SECOFI, 1985c).

The residues were collected in plastic bags, randomly taking 10% of the total accumulated in the day (Ruíz, 2012). In order to homogenize the sample, the residues were mixed and then divided into four equal parts, eliminating two opposing quarteSW and accepting the remaining two.

From one of the two accepted parts, the generation per peSWon per day was determined, weighing with a Nuevo Leon brand scale with a 500kg capacity , with a sensitivity of 10 g of the accumulated material and was divided among the number of people.

From the last part, the identified fractions were separated and classified, and later weighed separately. The percentage by weight of each of the by-products was calculated with the following expression:

Equation 1: $PC=(G1/G)*100$

Where:

PC = Percentage of component considered.
G1 = Weight of the by-product concerned, in kg..
G = Total weight of the sample, in kg.

Third stage

In order to know about the education and knowledge of solid waste management in UC, a descriptive type instrument was designed with semi-closed questions evaluated with the Licker scale. A pilot test was performed to verify its validity, using the Cronbach's alpha statistical test to 3% of the sample for reliability, which yielded 0.070, which was then applied to 20% of the population. The sample was stratified (Program, groups, careeSW and semesteSW), making a total of 945 individuals of which 856 were students, 80 teacheSW and 13 administrative staff.

RESULTS

Equipment and Infrastructure

For the storage of SW in buildings and facilities, there are 42 metal containers of 20 l capacity, fixed to the floor in pairs: one for the inorganic and another for the organic. Their distribution is shown in Table 1.

Table 1. Number of containers and distribution in UC

Facultades y/o escuelas	Contenedores (Orgánica)	Contenedores (Inorgánica)	Total por Facultad
Ing. Ambiental	3	3	6
Alimentos, Nutrición y Gastronomía	2	2	4
Energías Renovables	1	1	2
Centro de Lenguas	1	1	2
Ciencias de la Tierra	1	1	2
Biología-Laboratorios	1	1	2
Psicología	2	2	4
Facultad de Topografía e Hidrología	2	2	4
Odontología	1	1	2
Consultorios de Odontología y Nutrición	1	1	2

Biblioteca Central	3	3	6
Auditorio	3	3	6
Total			**42**

In addition to the equipment listed in Table 1, there are other containers of plastic material of approximately 15 l capacity, one in each classroom and generally in all spaces, such as offices, laboratories and cubicles. There are only 4 containers with an approximate capacity of 1m^3, where only PET (number 1), located in buildings of Surveying, Environmental Engineering, Biology and Earth Sciences is received.

In terms of infrastructure, it basically consists of a temporary warehouse for solid waste with dimensions of 9 x 9 m, roofing and fencing that prohibit the entrance of fauna but which in turn has sufficient ventilation, with a firm floor that prevents the infiltration of leachate to the subsoil, with access and circulation pathways. Residues from the different areas of UC are stored without further treatment for six days and collected every Wednesday by the city's cleaning service.

In signage there is a sign indicating that the waste must be deposited at the bottom of the warehouse. Finally, there are neither fire safety measures nor their corresponding signaling. No other activity is performed.

Economic analysis of solid waste management

Equipment and infrastructure costs were not included. Only two items were found where economic resources are invested. One is 40 cleaning workers whose activities include sweeping and collecting solid waste daily from containers, common areas and salons, with a nominal wage per worker of $ 3,800.00 / month.

Two: all the containers are supplied with a plastic bag that facilitates the handling of the material. For this item $ 2,300 / month are allocated.

With these costs, the total sum $ 5,143.33 / day and $ 7.00 / kg, handled in UC, not including collection, transportation and final disposal.

The revenues generated from the solid waste, by sale of the PET that is collected in containers is shown in Table 2.

Table 2. Monthly average of the sale of recovered PET from the UC.

PET en Kg	Ingreso en $	Ubicación	PET en Kg	Ingreso en $	Ubicación
33	66	Ing. Ambiental y Topografía	8.3	20.8	Biología y Ciencias de la Tierra

The average monthly income is $ 86.80, and this amount does not enter the University. The average decrease of solid waste specifically for the fraction of PET, is 41.30 kg / month equivalent to 1.37 kg / day and has not been included in the generation study, however, since there is no data for a comparison it becomes evident the need to develop specific economic indexes and thus have solid references for successful waste management (Acquatella, 2002).

Generation

To calculate the per capita generation a total population of 4,728 people including both full and part time teachers, administrative staff and service, undergraduate and graduate student population were considered.

The study was carried out for half a semester during the period of January-June 2015, when there is the largest influx of people in UC and therefore corresponds to a generation called typical maximum (Ruiz, 2012) taking the sample directly from the warehouse. With the weights of the samples we projected the total generation per day and the total average. The data are presented in Table 3.

Table 3. Solid waste generation per day in UC

Día	1	2	3	4	5	6	7	8	Promedio
Peso Total generado en kg.	634,42	585,08	715,5	809,81	240,05	809,92	805,67	730,6	677,6

Therefore, taking into account the total population and the total SW average, the generation corresponds to 0.143 kg / person-day, lower than the 0.33 kg / person-day reported by Ruiz (2012) in a study carried out in the Universidad Iberoamericana, but very close to the 0.132 kg / person-day reported by Cruz, et al. (S / F) in a study carried out for a school in CONALEP, in the state capital of Puebla.

Characterization

We identified 10 different fractions or components and their daily quantity, as well as the average of the 8 consecutive days, variance and standard deviation. These data are presented in Table 4.

Table 4. Composition of solid waste

Compo-nentes	Día								Prom.	Vari-anza	Des. Están.
	1	2	3	4	5	6	7	8			
Unicel	22,11	6,83	32,8	0	0,86	3,81	5,29	6,05	9,72	116,94	10,81
Plásticos	18,72	127,41	136,9	346,66	93,76	106,77	180,21	217,9	153,5	8380,27	91,54
Vidrio	30,19	141,12	11.1	53,66	2,01	259,48	82,75	56,96	89,45	6445,56	80,28
Cerámica	81,71	8,47	0	0	0	0	229,86	0	40,01	5847,59	76,47
Aluminio	8,33	7,22	13,8	20,47	0,83	14,78	6,67	4,98	9,64	34,59	5,88
Papel	35,73	29,4	75,4	44,48	3,87	85,01	114,93	56,39	55,65	1082,32	32,90
Cartón	6,74	95,39	73,1	19,77	57	133,59	4,37	29,89	52,48	1856,59	43,09
Madera	164,2	0	0	0	0	9,38	0	0	21,7	2910,42	53,95
Mezcla	188,5	61,72	0	188,51	30,72	34,42	0	89,36	74,15	5125,13	71,59
Orgánico	78,19	107,52	383,5	136,26	51	162,68	181,59	269,1	171,2	10402,36	101,99
Total:	634,42	585,08	715,5	809,81	240,05	809,92	805,67	730,6	677,6	32063,52	179,06

The variances reflect an enormous dispersion in the generation of both the totals and fractions that were identified, which would be reflected in the moment of making the proposals for containers and equipment oriented to its handling. The fractions that have economic potential in the local markets are: paper, cardboard, aluminum and plastics, of the latter is separated and a small part is sold. The percentages of each component with respect to the total are presented in Figure 1.

Figure 1. Percentage of the components of the SWU generated in UC

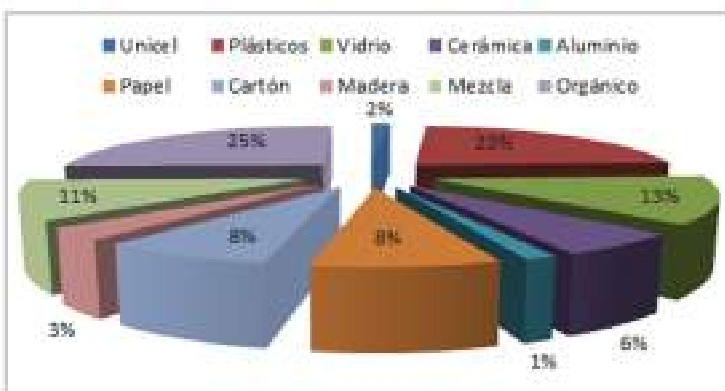

Figure 1 shows that the major component is organic matter with 23%, very close to 26 and 28% reported by Buenrostro (2010) and Goya-García (2001), respectively. The next major components were plastics with 23%, and glass with 13%; Paper and cardboard 8% for each one, close to what was reported in the study by Maldonado (2006). The components with the lowest percentages were residues such as aluminum (1%), Styrofoam

(1.5%) and wood (3%). With these data and according to university conditions, it is estimated that it can reach a decrease of about 67% (Maldonado, 2006) or up to 80%, as long as the residues are separated into their components (Armijo et al. , 2006).

The detected fractions invariably are mixed, which makes manual separation difficult, and reflects 11% of the mixed components found in the compositional study. In a study carried out by Hilerio (2005), it was reported that for that year, only in the Faculty of Biology of UNICACH a separation process was carried out. This reflected the low sensitization of the university population.

Environmental education

In the survey on environmental education, the following results were obtained: 39% say they know enough about solid waste and 33.9% say they know little; Only 5.9% have participated in training for the management of solid waste, while 35.6% know enough about organic and inorganic waste. 22.9% always separates solid waste by depositing it in containers while 9.3% never do it, 35.6% said they do not know the solid waste management plan of the Institution and only 11.8% know it. Finally, 85% of the respondents commented that if the University implemented courses for the solid waste management plan, they would participate.

The results reflect the need to continue environmental education activities, as reported by Hilerio (2005).

It has been recognized that environmental education is the most powerful tool to motivate new habits, attitudes and values in the population, as well as a trigger for social co-responsibility in solving environmental problems (SEMARNAT, 2005), which in the case of higher education institutions take on a larger dimension.

As an example of the importance of environmental education in schools, Barrientos (2010) reports that in a university in Costa Rica, education and improvements in organization and labeling increased the separation of fractions.

CONCLUSIONS

Making a comparison on the management of non-hazardous solid waste in UC of UNICACH with other universities, whether national or foreign, when data and working protocols are not available is difficult, considering that each educational institution has its own environmental management and are often different from each other.

The study yields a generation of 0.14 kg / person-day, the collection was done manually and there was no separation. Many areas of opportunity are presented and the characterization presents fractions that can easily be exploited, such as aluminum, organic matter, paper, paperboard and plastics. This means that it can potentially be reduced by up to 63%, but it is necessary to establish and operate a system that includes environmental education to ensure the separation of waste.

The sum of $ 5,143.33 / day and $ 7.00 / kg were appointed in UC of UNICACH, for the activities of sweeping, collection and storage of solid waste, without any amount for the recovery from PET, however, as there is no data for a comparison and it is necessary to develop specific economic indexes to have clear references on the management of solid waste.

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AEROBIC REACTOR WITH FIXED SUPPORT USING PET BOTTLES

—

María Yesenia Mendoza Burguete [1], José Alberto Rodríguez Morales [2]

[1] men_bur@hotmail.com • [2] josealberto970@hotmail.com
Faculty of Chemistry, Autonomous University of Querétaro, Campus Aeropuerto,
Santiago de Querétaro, Querétaro, CP 76010, Mexico

— Abstract—

The wastewater treatment is implemented worldwide using variety of systems to remove pollution because they are harmful to living beings. Therefore, the objective of this study was to construct and use a 90 liter rectangular biological reactor with aeration that contained PET (polyethylene terephthalate) plastic bottles. Inside the reactor the surface of these bottles were used as means for the production of a biofilm to be later used for treatment of domestic wastewater. During the experiment, influent and effluent water was monitored. In order to evaluate the quality of the mechanism, the removal of the Biochemical Demand of Oxygen (DBO_5) and Chemical Demand of Oxygen (DQO) were measured. The biochemical demand of oxygen was 97.7% and the chemical demand of oxygen was 97.6%. The average treatment time was 2.72 hours.

Keywords

Biofilm, domestic water treatment, polyethylene terephthalate.

Biofilm has been successfully used in water treatment for more than a century (Atkinson, 1975); however, the advantages of this type of process were of interest to a considerable number of researchers in the 80s, Not only in the field of wastewater treatment, but also in many other areas related to biotechnology (Adler, 1987, Yang et al., 2013). A large number of research projects are currently underway in biofilm reactors for the production of bioactive substances for plant and animal cell cultures, potable water production and wastewater treatment (Castro et al., 2016; McNaught And Wert, 2015, Hu et al., 2013, Vendramel et al., 2015, Gu et al., 2014).

A key advantage of biofilm processes is the positive influence of solid surfaces on bacteria. This activity was observed more than 50 years ago (ZoBell, 1943) and recently confirmed by other researchers (Bassin et al., 2012, Mohan et al., 2013, Dong et al., 2014; Park et al., 2010; Dvořák et al., 2014). There is considerable debate about the mechanism that induces greater activity of fixed biomass, (Rusten et al., 2006; Wang et al., 2006). Some authors (Zhan et al., 2006; Hibiya et al., 2004; Jorgensen et al., 2004; Yan et al., 2009) attribute this phenomenon to physiological modifications of bound cells. It has been shown that biomass processes with fixed support media are less affected than suspended sludge by changes in environmental conditions such as temperature, pH, nutrient concentrations, metabolic products and toxic substances (Tansel et al., 2006; Utgikar et al., 2002).

The activity of the biofilm is not proportional to the amount of biomass, but increases with the thickness of the biofilm to a certain level, known as the "active thickness" (Remoundaki et al., 2008). Above this level, nutrient diffusion becomes a limiting factor, differentiating an "active" biofilm from an "inactive" biofilm. Consequently, a stable, thin and active biofilm offers numerous advantages in water and wastewater treatment. In order to achieve this objective, it is important to develop methods for the activity of fixed biomass, an estimate that is not only simple and fast but also sensitive, accurate and representative.

In the present investigation the efficiency of an aerobic biological system using polyethylene terephthalate (PET) bottles as support medium to facilitate biofilm production for the treatment of domestic wastewater was analyzed and evaluated.

MATERIALS AND METHODS

Construction of the aerobic biological system and preparation of the support medium.

The rectangular glass reactor -50 cm wide, 61 cm long and 31 cm high- was constructed with PVC adaptations to facilitate aeration, feed and exit of the treated water as shown in Figure 1. The inside contains PET bottles (polyethylene terephthalate) geometrically ordered with small incisions in the walls of the support medium to allow the flow of water.

Figure 1. Aerobic reactor with PET bottles as medium of support.

Biomass acclimatization

50 liters of activated sludge from the wastewater treatment plant of the Universidad Autónoma de Querétaro, Campus Aeropuerto located on the Chichimequillas Highway, Ejido Bolaños, Querétaro, Qro. CP 76140, were emptied into the aerobic biological reactor. as shown in Figure 2 and fed with 40 liters of residual water from the Faculty of Languages and Literature and Gastronomy of the same university.

Figure 2. Inoculation of activated sludge to the aerobic reactor for biofilm production.

Biofilm Production

These 90 liters of activated sludge and wastewater were discharged into the reactor for inoculation, production and biomass fixation, and to begin the process of adhesion and biofilm formation which was obtained after three weeks. After this time several physicochemical studies were carried out at the entrance and exit of the system to determine the efficiency of the system, gradually increasing the concentration of pollutants from the waste water. The daily indicative analyzes showed a removal of between 70 and 85% in the first 25 days.

Physicochemical analysis

Every day for 30 days after biofilm was produced, 60 liters of treated water was obtained and 60 liters of residual water were administered. For the genetic strengthening of microorganisms, different wastewater conditions were fed, as shown in Table 1. In this table three analyses of different influent waters are observed and in turn were compared with the Official Mexican Standard NOM-003 -SEMARNAT-1997, which establishes the maximum permissible limits of contaminants for treated wastewater that are reused in public services.

Table 1. Results obtained from physicochemical analysis of the influent of aerobic biological system.

Determinación	Influentes			Max. Perm	Unidades
Demanda Química de Oxígeno	332	409.2	782	N.E.	mg/L
Demanda Bioquímica de Oxígeno	204	219.96	600	20	mg/L
Sólidos Suspendidos Totales	168	298	500	20	mg/L
Grasas y aceites	3	3.2	25	15	mg/L
Coliformes Fecales	23	≥2400000	≥2400000	240	NMP/100 mL
Huevos de Helmintos	Ausente	Ausente	Ausente	≤1	Organismos/L

Max. Perm. According to the NOM-003-SEMARNAT-97.
Results according to Chemical Services Center, No. Accreditation: AG-160-027 / 12
NS: Not specified.

RESULTS AND DISCUSSION

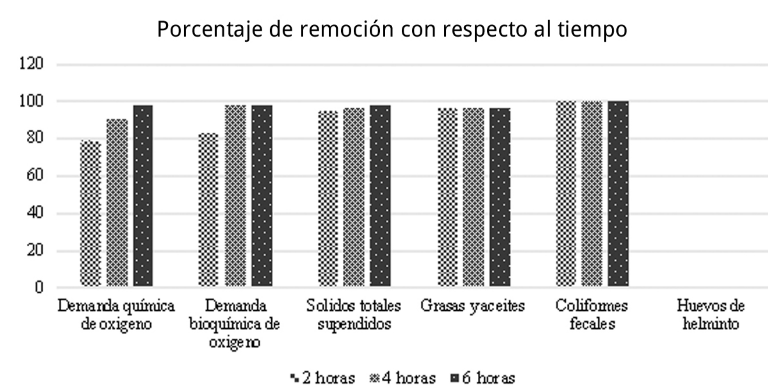
The subsurface support have proved to be highly efficient in removing COD and BOD in waste water (Osorio and Hontoria, 2001) and the results of this study prove it . This system can be adapted to plants built with little soil disposal (Bassin et al., 2012), and one can even increase the treated flow rate since a high solids concentration is maintained inside the reactor, and that for this study the contact area surface of the biofilm in the reactor was 5.74 m 2. One of the main problems of conventional treatment plants is the influence of flow and quality of the influent, and a solution is the implementation of aerobic biological biofilm reactors (Tóth & Szilágyi, 2013). Table 2 and Figure 3 show the results of the physico-chemical analysis of the residual water in which, after 4 hours of treatment, NOM-003-SEMARNAT-1997 was achieved. However, after 2 hours, it exceeded 80% of these pollutants.

Table 2. Results obtained from physicochemical analysis of influent and effluent at different times.

Determinación	0 horas	2 horas	4 horas	6 horas	Unidades
Demanda química de oxígeno	782	169.5	74	18	mg/L
Demanda Bioquímica de Oxígeno	600	101.37	15.83	14.66	mg/L
Sólidos suspen-didos totales	500	26	20	12	mg/L
Grasas y aceites	25	<1.0	<1.0	<1.0	mg/L
Coliformes fecales	≥2400000	<3	<3	<3	NMP/100 mL
Huevos del Helminto	0	0	0	0	Organisms/L

Max. Perm. According to the NOM-003-SEMARNAT-97.
Results according to Chemical Services Center, No. Accreditation: AG-160-027 / 12
NS: Not specified.

Figure 3. Analysis and comparison of percentage removal of some parameters at different times, (pH = 7.1 ± 1, T = between 23 and 25 o C).



The support material with PET plastic used in this study was successful for the development of microorganisms and fixation of biomass. In general, the biofilm is hard to fix (Battin et al., 2007; Mongenroth and Milferstedt, 2009), although there is scientific evidence on the adhesion of biofilm to polyethylene terephthalate in marine waters, where satisfactory results and experimentation were obtained as a means of support for other types of studies (Hayden et al, 2008;. Kishu et al . , 2009).

CONCLUSIONES

The aerobic biofilm system with polyethylene terephthalate bottle support medium is a simple system, easy to operate, and does not need large spaces for its construction. The microenvironment of the biofilm offers shelter to many species of microorganisms, promoting the use of a wide range of substrates, it supports variations in flow, among other advantages. Physicochemical results of this system compared to the maximum permissible limits established in the Mexican Official Standard NOM-003-SEMARNAT-1997 met in an average time of 2.75 hours with a percentage removal for COD: 88.86%, BOD 5: 92.69% , SST: 96.13%, Fats and oils: 96%, Fecal coliforms: 99.99%. From this it is concluded that the system is viable, economical and efficient for the treatment of domestic wastewater.

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CHARACTERIZATION OF GRAVITATIONAL PROCESSES IN DIFFERENT GEOLOGICAL ENVIRONMENTS OF CHIAPAS, MEXICO

—

Jorge Antonio Paz Tenorio[1], Raúl González Herrera[1],
Mario Gómez Ramírez [2], José Armando Velasco Herrera[1]

[1] University Science and Arts of Chiapas 1ra norte-poniente No 1460,
Tuxtla Gutiérrez. jorge.paz@unicach.mx.
[2] Universidad Veracruzana, Av. Xalapa, esq. Ávila Camacho s/n,
Xalapa Enríquez, Veracruz

— Abstract—

The gravitational processes (GP) are natural phenomena that generate forms of degradative relief in areas of material removal (for example, the erosion cirques), cumulative sometimes (such as slope deposits), so that change and shape the geographical environment.

In the absence of previous comprehensive studies, as well as a government planning it is common that these processes affecting human settlements, sometimes with loss of life, damage to infrastructure, roads and productive areas, among others.

There are different types of movement that vary in their geometry, speed and water content, likewise, these processes are becoming more frequent and vary their destructive effects. Therefore, today are designed methods of classification and study for these processes, for the year 2006, the National Center of disaster prevention employment a proposal that considers three types and nine subtypes of GP.

Therefore, this work focuses on the characterization of different sites where they occur GP, and are associated with geological environments in which they are located, such as igneous, sedimentary and metamorphic rocks, in different areas of the state of Chiapas.

External factors such as weathering and erosion, affect the type of rock different way, so it is important to know the classification according to their origin. For example, predominantly limestone chemical weathering, which fracturing, favors the rockfall. In deposits of landslides or slope flows are presented.

Large blocks of intrusive origin present a physical-spheroidal weathering, themselves that being discovered by erosion, high and roll the elevations reaching considerable distances.

The type of rock, together with other environmental and anthropic elements has a close relationship with the manifestation of the GP.

The use of basic and thematic mapping, and other online applications, provide information that should be complemented with field trips, in order to have greater certainty in the characterization of the site and generate mapping of threats, and infer the negative effects of these processes areas subject to similar conditions.

Keywords

Hazard, risk management, gravitational processes, vulnerability.

According to the United Nations International Strategy for Disaster Reduction (UNISDR, 2009), a threat is "a phenomenon, substance, human activity or hazardous condition that can cause death, injury or other health impacts, such as damage to property, loss of livelihood and services, social and economic disruption, or environmental damage. " Threats in general are a complex problem with multiple dimensions.

As for vulnerability, it is defined as "the characteristics and circumstances of a community, system or good that makes them susceptible to the harmful effects of a threat" (UNISDR, 2009). Wilchex-Chaux (1993) suggests that global vulnerability has nine dimensions: physical, economic, social, educational, political, institutional, cultural, environmental and ideological.

On the other hand, Risk Management is defined as "the approach and systematic practice of managing uncertainty to minimize potential losses and losses" (UNISDR, 2009).

Generally in a disaster scenario, these dimensions manifest themselves simultaneously to different degrees. The PG pose a threat which is understudied in the state of Chiapas, although there are one or two major events a year (Paz et al., 2011). Currently the focus remains on disasters. When they happen, there are no efficient contingency plans that support the population, despite having knowledge of previous events in the area. This, together with other socioeconomic variables, dangerously increases their vulnerability over time making risk management an absent or incipient task. For its study, one of the basic instruments is the integration of an inventory. This will allow us to know sites where they have occurred and will offer a historical reference for the case of recurrence.

Evictions or change of land use, with the consequent restrictions, have imposed radical measures that do not pay off for an efficient management of the risk. One cause is the lack of comprehensive inter- and multidisciplinary work, a situation in which institutionalized civil protection and academic work diverge, adding yet another element to this complex reality.

In this paper, eight cases are recorded on gravitational processes occurring in different geological environments in the north, center and south-central part of the state. It deals with the lithological aspect as one of the conditioners of these events, and rains and human activity as main detonators.

IMPORTANCE OF THE GEOLOGICAL NATURE OF THE TERRAIN

As Lugo et al state, (2005) "Sharpe (1938), Varnes (1958, 1978), and Mencl Záruba (1969), Crozier (1986) and Dikau et al. (1996), the influence of surface and groundwater, lithology, geological structure and relief are considered among the main factors of GP. For their part, Alcántara and Murillo (2008), propose a methodology to integrate an inventory of PG, where the geology of the site is the second important factor after hydrology.

Muñíz and Hernández (2012) place lithology as the first factor to consider in the methodology for PG zoning in Puerto Vallarta, Jalisco. In addition to the type of rock, the structural control by stratification planes, faults and diaclases are determinant in the behavior of these movements.

DETONATING FACTORS

Rains, along with earthquakes or volcanic eruptions, are considered as triggers of the gravitational processes (Mayorga, 2003; Alcantara et al, 2006) cited by Aristizabal, (2010). In the sites visited, rains are combined with cuts of slope for road construction or land leveling for housing construction.

BACKGROUND

From previous tours during eight years, sites of interest for the study of PGs were identified. These have been visited in different occasions from 2009 with groups of students as part of practices of the subject of geomorphology or for the elaboration of their thesis protocol. In May 2013, some of these sites were proposed in order to conduct a tour with INEGI geologists, in charge of designing a Susceptibility Model to Mass Movements. In July of the same year, as part of the Forensic Investigations of Disasters course the Center for Research in Risk Management and Climate Change of the UNICACH, presented the Fundamental Causes Methodology (IRD-FORIN, 2011) and fieldwork was carried out on the southern slope of Tuxtla Gutierrez.

METHODOLOGY

With the previous knowledge of 12 sites, 8 were chosen to be characterized in this investigation, which allow us to know the complex behavior of the PG in different geological environments and under different conditions of occupation.

The geology was obtained through the Series 1 Geological Information in digital format, elaborated by INEGI (1984), and complemented with the field observations. The software that was used was the digital desktop map view Ver. 5.1 (INEGI) and ArcMap ver 9.3 (ESRI). The geographic coordinates were recorded in the field with Garmin ETrex Vista browser, in degrees, minutes and seconds format. For estimation of road distances and other landmarks, we used Google Earth ver. 7.1.1.1888.

CASES

Eight cases were recorded in different geological conditions, mainly in the north, center and south-central of the state (Map 1), which highlight the importance of geology as one of the determining or conditioning factors. Most, because of their size, can only be represented in a timely manner in the conventional scales generated by INEGI 1:50 000, since they do not comply with the minimum mapping area (AMC) (Paz, 2012).

Map 1. Location of the cases that were studied

Photo 1. Autopista Ocozocoutla-Arriaga. Paz, 2013

Image 4 Case 1. Ocozocoutla-Arriaga motorway (190 D) (Photo 1).
Location: km 25 (16 ° 41'54.36 "N, 93 ° 32'32.56" W). (Photo 1).
The zone corresponds to the contact of two units: Tritic-Jurassic shale-sandstone and lower Cretaceous limestone-shale.

It is a slope made for the passage of the mentioned highway. At 25 m north, and 20 m above this level is the Pan-American Highway (190) Tuxtla Gutierrez-Tapanatepec, Oaxaca.

The cut caused cracks and unevenness in the latter, and detachment of material that invaded the lane for Arriaga-Ocozocoautla. These fragments were added, others carried by freight trucks, in order to stabilize the PG with the counterweight system. However, when making a schematic for movement, the ideal place for the counterweight to work is located on the other side of the highway (Paz, 2014).

Three years after the activation of the movement, it has not been adequately controlled. The corrective measures implemented are berms, blown concrete to avoid leakage, which presents cracks, and a geomembrane to facilitate the growth of vegetation.

Photo 2. Tuxtla Gutiérrez-San Cristóbal Highway. Paz, 2013

Picture 7 Case 2. Tuxtla Gutiérrez-San Cristobal Highway (190 D) (Photo 2).
Location: km 33 (16 ° 4'41.94 "N, 92 ° 46'25.51" W)
Upper Cretaceous limestones.

Translational slippage facilitated by the arrangement of strata. It was caused by the cut of slope, for the construction of the highway. The diaclases allowed several blocks of different sizes to slide, which invaded both lanes. As the material accumulated, it was removed. Soil cover, and therefore, vegetation cover has been lost, accelerating erosion processes.

Photo 3. Chicoasén-Copainalá Highway . Paz, 2013

Image 10 Case 3. Chicoasén-Copainalá Highway (102) (Photo 3).
Location: km 7.5 (16 ° 59'56.6 '' N, 93 ° 08'27.48 "W).
Paleocene sandstones that underlie some limestone blocks and conglomerates.

The cutting favors the detachment of intensely weathered material, behaving in the presence of abundant rainfall as a flow of debris. This causes the upper blocks to become destabilized and detached in a second moment due to difference in the lithology.

In the road cut, faults and evidence of old flows are observed. This road is obstructed annually, affecting the transit of people and goods. There is a record of a detached block that struck a vehicle (June, 2011).

Photo 4. Colonia 6th June. Paz, 2013

Image 13 Case 4. Colonia 6th June 3rd Section (Photo 4).
Location: south east of the city of Tuxtla Gutierrez (16 ° 43'38.44 "N, 93 ° 4'3.74" W).
Recent deposits (coluvions) on Eocene shale-sandstone.

Rotational sliding occurred on September 9, 2013, caused by different slopes for housing construction, detonated by soil saturation due to heavy rains in addition to leaks in drainage systems and potable water coupled with the burden of housing.

This aspect is addressed Lugo et al, (2005) by mentioning that "the buildings that are located in hazardous areas favor or accelerate the gravitational processes by deforestation, the weight of buildings, drainage, changing the profile of the slopes and the hydrological regime ".

Photo 5. Ladera sur de Tuxtla Gutiérrez. Paz, 2014

Picture 16 Case 5. Ladera sur Tuxtla Gutierrez, base of Cristo de Chiapas (Photo 5). Location: south of the city of Tuxtla Gutierrez (16 ° 43'13.55 "N, 93 ° 7'13.60" W). It is constituted by limestone-shales of the Oligocene. Here are the erosion fences (Paz et al. 2012), generating falls or landslides characterized by large angular blocks.

It is the base of an erosion fence of approximately 70 m in height. For the moment it is an uninhabited zone where the people of the peripheral colonies like Altos del sur and 7 de April go to stock up on water from a spring. At the top and scarcely 10 m from the edge there was built a monument known as Christ of Chiapas, which has a height of 62 m, of which there is not known to by any previous study and so it is exerting a weight on an area very susceptible to PG.

Photo 6. Volcán El Chichón. Paz, 2012

Picture 19 Case 6. El Chichón Volcano, Chapultenango (Photo 6).
Location: eastern slope of El Chichón volcano (17 ° 21'52.20 "N, 93 ° 12'32.60" W)

The lithology corresponds to an intermediate volcanic gap. Floods of soils or debris occur that originate on the slopes of a volcano, generally triggered by intense rains that erode volcanic deposits. Since they correspond to a volcanic structure, they are considered lahares, flows of volcanic materials transported by rainwater. As the arboreal vegetation is scarce, and in the presence of the intense sun that is felt at 9:00 a.m., hikers generally rest in the channels where the shadows of their margins reach up to 8 m in height. There exists the possibility of a slide.

For mapping slopes of this type, where runoffs are first order, Srthaler, 1968, quoted by Lugo et al, (2005), recommends the method of headwaters, monitoring retrogressive erosion.

Foto 7. Cafetal en Cabañas. Paz, 2013

Picture 22 Case 7. Location Cabañas, La Concordia (Photo 7).
Location: foothills of the Sierra Madre de Chiapas, municipality of La Concordia (15 ° 45'27.07''N, 92 ° 59'59.31''W)

The lithology corresponds to the metamorphic complex (Müllerried, 1957), called by INEGI (2015) as Chiapas Massif, consists mainly of granite and granodiorite of the Paleozoic. These are rollovers of large blocks are characterized by a spheroidal weathering, which generates rounded edges that facilitate their movement downhill. They are very dangerous when they come off the high parts as in this case.

The community cultivates coffee on the slopes of the mountains, as well as corn and beans in the lower parts.

Due to their topography, the mountains remain sparsely populated with scarce records of damage to mountain communities. However, many of these locations show rapid growth and constructions are moving towards dangerous areas (Lugo et al, 2005).

Foto 8. La Candelaria. Paz, 2013

Picture 25 Case 8. Location La Candelaria-Nueva Esperanza, La Concordia (photo 8)
Location: 12 km northwest of Jaltenango de la Paz (15 ° 58'08.99 N, 92 ° 47'6.59 "W)

Triassic-Jurassic limonite-sandstones predominate. This is a flow of debris, abundant large limestone blocks and conglomerate, which were dragged from the highlands during the passage of Hurricane Stan in October 2005.

This material is disordered and unstable, so it is susceptible to another removal process. With the next heavy rains, "streams can regain its base level and its own channel, if it has been modified" (Lugo et al, 2005).

CONCLUSIONS

The review of 6 cases in sedimentary and 2 in igneous environments is useful to know the behavior of the PG under different geological conditions, since they are conditioning factors it is convenient to consider them in the design of terrestrial routes, human settlements and areas destined to for agriculture in order to avoid as much as possible the rupture of the balance of the natural slope of the terrain, due to the slopes mainly.

Chiapas is a state with frequent seismicity and exposed to the clash of cyclones, so it should not be ruled out that in some areas, the three detonating factors: rainfall, earthquakes, or slope modification can act simultaneously thus complicating the emergency.

These registered events make clear the need to have an inventory of PG events and highlights the lack of previous studies, construction regulations and efficient technical specifications which would strengthen the work of risk management.

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A STUDY OF THE GRADUATES FROM THE MEDICAL SURGEON PROGRAM FROM THE SCHOOL OF HUMAN MEDICINE OF THE UNACH

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Salazar Gómez Carlos Patricio [1], Jiménez Pirrón Tomasa de los Angeles [2], Roblero Ochoa Sonia Rosa[3], Cuesy Ramírez María de los Angeles[4], Soltani Darani Ahmad [5], Rosa Martha Velasco Martínez[6]

[1] c_salazar03@msn.com, [2] angeles_pirron@hotmail.com, [3] sroblero1504@hotmail.com, [4] angelescuesy@yahoo.com.mx, [5] soltani@prodigy.net.mx, [6] oro_vel@hotmail.com

Professor, School of Human Medicine Dr. Manuel Velasco Suárez ,
University Autonomous of Chiapas

— Abstract—

This report shows the importance of how graduate studies can contribute in curriculum design based on student's perception who have finished the formal Study Plan and also their employers' opinion.

The objective of the follow- up graduate study (FUGS) is to incorporate its outcome into formal Career Plan of Medical School. It is a descriptive-transversal study. Two different types of questioners were developed. In the first one, educative model, operative programs, links with employees and hidden curriculum were included; the second one explored professional demand, general graduate data, reasons to stop working, professional performance, recommendation to improve professional profile. Both were accomplished by direct interviews to the graduate students and their immediate employee.

The results of the FUGS confirmed the advantages of the modular model, a basic and clinical formation identified with the environment and the nedd of a flexible curriculum, the reinforcement of competences related to the ability of a second language and management skills.

These results were included into the new curriculum proposal.

Keywords

Graduate study, curricular design, graduate opinion, professional profile.

The processes of globalization, of openness and the consequent search for integration of these factors are without a doubt proof of the current times, provoking and demanding transformations and profound social changes in all areas of social and productive life. The current job market demands that graduates have a different attitude, new ways of thinking, skills and different professional skills. (Rose, 2012).

Higher education institutions today face new challenges as economic, technological, social and cultural changes are constantly taking place. The most important in the case of studies of graduates is the social impact generated by professionals in the labor field. It is important that the institutions generate strategies to know the importance of their actions, while identifying new demands for training in each of their academic programs, all with the aim of responding with relevance to social needs.

The studies of graduates allow us to know the points of view of those who were students and detect the niches of opportunity of the academic program, in this case, the Medical Surgeon program. Special mention is also made of the link established and maintained with graduates, establishing open and cooperative communication. (Mendoza R. 2002)

The first educational institutions concerned with evaluating the relationship between school and the world of work through studies of graduates were located in the United States of America and in some European countries. These studies were characterized by predominance in operational trends and in their informative purposes to influence decision making. Since the 1970s, institutions located in the center of the country, such as the National Autonomous University of Mexico (UNAM), the Universidad Autónoma Metropolitana-Azcapotzalco (UAM), the National Polytechnic Institute (IPN) (ENEP), and others such as the Universidad Veracruzana (UV) and the Autonomous University of Nuevo León (UANL), initiate this type of evaluation in institutions of higher education (Barrón, 2003).

According to the last analysis of the state of knowledge about studies of graduates carried out in Mexico during the period 1992-2002, done by members of the Mexican Council of Educational Research (Barrón et al, 2003), the studies related to this subject were located in three well-defined sub-fields: 1) curricular evaluation, which describe the insertion and performance of the graduates in order to evaluate and get feedback for the educational programs in question, 2) relevance of the academic training received, which seeks to measure the correspondence of the profile of the graduate with the requirements of their professional practice and 3) labor insertion, to identify the incorporation and destination in the work area, as well as to know if the mechanisms of insertion in the professional market are traditional or novel. (Alonso, C. 2011)

In the twenty-first century, society and labor markets have become more demanding and it is obvious that the university-society relationship has become an important element to be included in the planning, and at the same time, in a strategy of an evaluation of higher education with two areas of interest:

- Internally, focused on analyzing the teaching process, the program objectives, contents and activities;
- Externally, the collection of information through two main sources, the follow - up study of graduates and analysis of the work situation..

In 2008, the Ministry of Public Education defined the concept of graduate follow up as "The follow-up studies of graduates do not refer only to the process of insertion of the graduates in the field of worik, nor are they only indicators of satisfaction of the graduate. They are also effective mechanisms to promote the institutional reflection on its aims and its values". (SEP, 2010).

The School of Human Medicine (SHM) Dr. Manuel Velasco Suárez of the Autonomous University of Chiapas, in its interest in achieving the training of quality physicians, has in the last years been in a constant search for teaching modalities that improve its curriculum.

To this end, in 1993 the modified version of the first curriculum was implemented, which in general terms did not replace the then Plan 74 (Facultad de Medicina Humana, 1974). Subsequently in 2013, a new flexible curriculum based on the development of competences which favors the mobility of students and teachers, reduces the transit time of students without undermining the profile that is intended to be achieved in the graduates and in which the experiences obtained from the studies of graduates were taken into account. (Cuesy, et al, 2010)

In 2003, the foundation was established to develop a system to follow-up on graduates of the Medical Surgeon's career at the SHM (Facultad de Medicina Humana, 1993 and 2013), following the basic scheme proposed by ANUIES (ANUIES, 2013) with the purpose of obtaining timely, relevant and reliable information to support decision making and academic planning, as well as assess the performance of graduates in the workplace.

The objectives of this program focus on two aspects: first, to know the opinion of the graduates, their degree of satisfaction with the educational process and systematically collect their suggestions to the curriculum, as well as to describe the socioeconomic characteristics of our graduates. (Trujillo, 2005)

Secondly, to know the coherence that exists between the profile of the graduate and the current training requirements in the professional practice and to have reliable information about the professional performance of the graduates and their relation with the successes and failures in their formation through the opinion of their employers.

GENERAL OBJECTIVE

Evaluate the Medical Surgeon educational program based on the opinion of the graduates and their employers.

SPECIFIC OBJECTIVES

- Evaluate the opinion of the employers with relation to the graduates
- Assess the degree of satisfaction of graduates and employers regarding the quality of structure of the medical surgeon program.

METHODOLOGY

For this study, two surveys were designed which include fundamental aspects which were evaluated, applied to a representative sample of 128 graduates of the class of 1993 and to their respective employers. These included the academic data of each of the graduates, the level of satisfaction and academic performance received by the School of Human Medicine Dr. Manuel Velasco Suárez, the professional performance they have had in the labor market, the professional development they have acquired after graduation, the socioeconomic factors during and after they have undergone the program of Medical Surgeon, and the proposals and suggestions that they consider important to achieve relevance in academic training and to maintain a better communication among the graduates and faculty.

The type of study was descriptive and transversal, the sample was constituted by 128 graduates of the Plan of Studies 1993 of the School of Human Medicine of the Autonomous University of Chiapas.

The surveys included closed questions and were applied through direct interview to the graduates and immediate bosses, through the personnel of a consultancy agency.

The Likert scale was used to measure respondents' attitude, level of conformity and knowledge, since it is useful to use it in situations that group response categories, which serve to assess the intensity of the respondent's feelings towards questioning.

The results were systematized in an Excel database and processed in the SPSS statistical package. In order to avoid bias in the interpretation of the data, the contracted agency for the application of the survey was the same that systematized the results and the group of teachers responsible for the project made the final interpretation of the results.

The questionnaires were organized to explore the following variables: 1) age, sex and marital status; 2) access to the labor market, first job and current employment: type of work, company regime, hours of work and salary; 3) quality of academic training: main academic limitations to find work, main causes of abandonment of work and suggestions of modification to the curriculum; 4) assessment of competences: skill that developed more in academic life and in professional practice.

RESULTS

The results obtained from the 128 opinion questionnaires applied are presented below. These correspond to the perception, evaluation and opinion of the graduates of the SHM of the generations 2003-2009, which are presented in a descriptive way and according to the order of the sections of the questionnaire of opinion used for the realization of the present study.

Data

The study included 128 graduates from the SHM of the generations 2003-2009, of which 55.5% were men and 44.5% were women. The ages of the graduates ranged between 24 and 40 years of age, with a mean of 32.59 years.

Regarding the marital status of the graduates, a little more than half of them are married or in a committed relationship, 39.4% remain single and 2.4% are divorced. The variables of gender, age and marital status are summarized in Table No. 1

Table 1. Sex, age, marital status.

Sexo		Edad	Estado Civil		
Femenino	Masculino		Soltero	Casado	Otro
44.5%	55.5%	Media 32.59 años	39.4%	58.2%	2.4%

Continuous training

The majority of the graduates attend actualization or professionalization events in the face-to-face modality, other forms are courses and / or workshops in the medical field, diplomas and master's degrees at school or online; Motivated by self-interest, some do it for labor issues (Table No. 2).

Table 2. Professional development.

Evento Académico	Realizó	No realizó	Motivo		Modalidad		Semi-presencial
			Personal	Laboral	Presencial	Distancia	
Cursos	90.6	9.4	69.1	30.9	94.2	5.8	0.0
Talleres	64.1	35.9	60.8	39.2	100.0	0.0	0.0
Seminarios	29.7	70.3	72.7	27.3	97.4	2.6	0.0
Diplomado	34.4	65.6	76.0	24.0	86.7	13.3	0.0
Especialidad	39.1	60.9	90.2	9.8	100.0	0.0	0.0
Maestría	12.5	87.5	86.7	13.3	82.3	11.8	5.9
Doctorado	1.6	98.4	100.0	0.0	100.0	0.0	0.0

It is important to note that a good percentage of graduates participate in refresher courses around 12 months after their graduation.

The events most attended by graduates are:

- • Assistance to state, national and international conferences on different health topics, public health, epidemiology and clinical specialties.
- Diploma course, courses and workshops on the aforementioned issues, in addition to aspects of health management.
- Attending courses, workshops and seminars on topics of formation for teaching and general culture of reading texts in English and intercultural health.
- Prep course for the National Examination of Medical Residences.

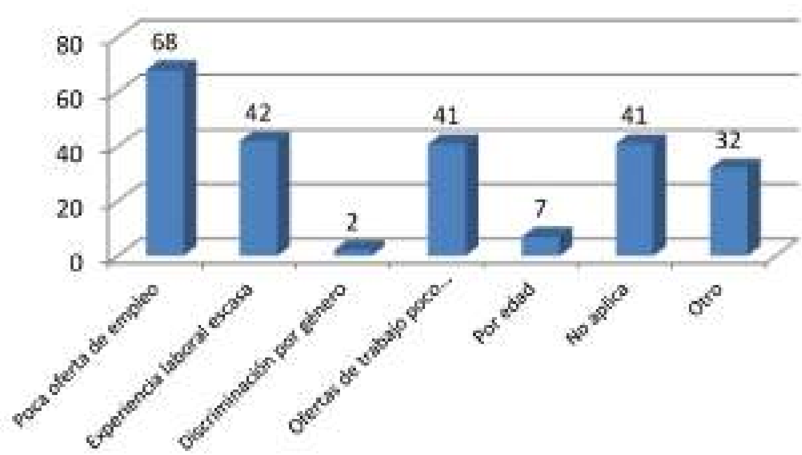
Work experience

79.7% of graduates had some opportunity to work at the end of social service. Of these, 41.2% worked in the same institution where they performed social service. It is pertinent to mention it was easier for women to obtain work when social service was completed and men had the opportunity to work in the same institution where they performed the social service.

Graduates obtain employment in less than three months after finishing their degree. This situation presents itself in a similar way in both men and women, the latter being the ones that most succeed.

Difficulties faced by graduates when they enter the market are: low work experience, age, gender, limited and unattractive job offer, as well as the time that takes the process to obtain the title and the professional certificate. In the particular case of women other factors are maternity and the distance of the location of the work in relation to the place where they reside.

Graph 1. Factors that influence the delay in obtaining employment.



The study showed that 9.4% accept jobs that do not correspond to the professional profile. Among the factors that are taken into account by employers who benefit from the acceptance of graduates in the labor market are: the prestige of the school, the social relevance of the Medical Surgeon program, previous experience and complying with the requirements imposed by institutions for admission.

The means most used by graduates who have been effective in finding their first job after completing undergraduate work are: the recommendation of a friend or relative; employment opportunities, and peer recommendations. 17.2% use combinations of the strategies mentioned above.

Career path

The graduates who participated in the study belong to the generations 2003 to 2009. This means that they between 4 and 10 years have passed since their departure, which allows them to obtain sufficient elements to inquire regarding the occupational trajectory

Employment rate

The employment rate is 90.6%. Of the graduates who are currently working, 54.3% are men and 45.7% are women.

Mobility in the labor market

79% consider that the position they currently play and their salary perception is better than that for the first time. The perception of labor mobility occurs through higher incomes and positions or positions of greater responsibility. The percentage of graduates who continue to occupy the same position or employment situation is very low.

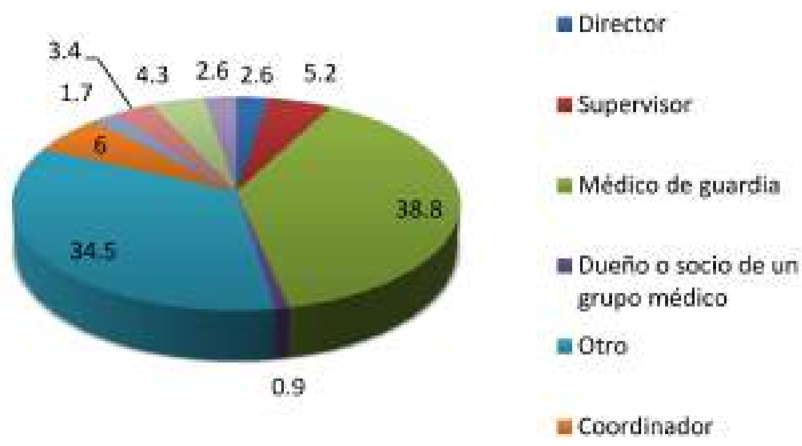
Regarding satisfaction with work performance, 73% of graduates stated that they were totally satisfied because they were able to respond to problems of social relevance, problems of medical practice, to apply the knowledge acquired in the career and the professional recognition that they achieved .

70% of the graduates are working in the clinical area. More men work in the administrative areas such as management, coordination or supervision than women, the area of teaching is the labor market is in least demand.

About 20% of the graduates work in more than one workspace. Of these, 74% work in two, 9% in three, the remaining percentage reaches up to four different areas of work. 52% are men and 48% are women.

Of the total number of graduates currently working, 14% do it exclusively in managerial positions (director, coordinator or supervisor), 2% are teachers, 42% hold positions of doctors on duty or medical assistants and 5% are owners or partners of a medical group and / or have their own practice.

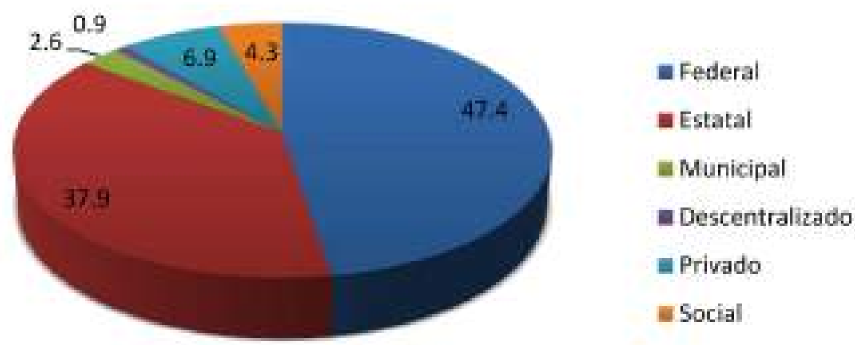
Graph 2. Current employment of graduates.



71% of the graduates are working in companies with more than 250 employees. Microenterprises are the sources of employment for graduates who are just beginning their work experience, however, as time goes by this situation is changing.

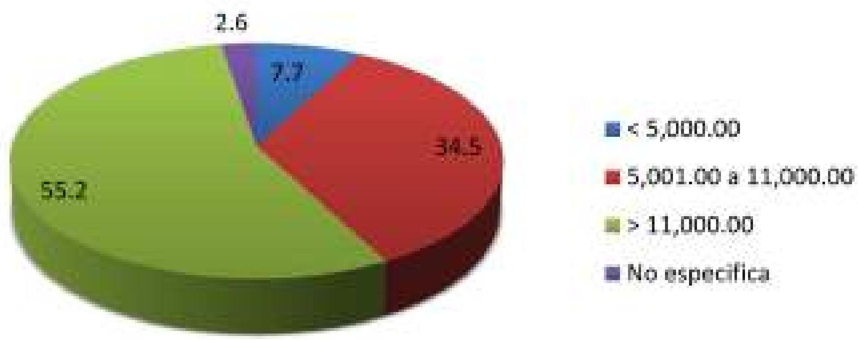
Graduates are usually employed within government institutions, particularly within the federal and state levels. The private sector does not represent an area of opportunity for them.

Graph 3. Legal status of the companies where graduates are employed.



In most cases the graduates receive a salary that goes from $ 9,001.00 monthly onwards, 7.8% receive low salary that goes from $ 1,500.00 to $5,000.00 monthly.

Graph 4. Monthly income of graduates.



62.1% of the graduates have between 1 and 5 years of employment, 19.8% over 5 years of experience and 17.2% have just joined and still have not completed a year.

78% of the graduates work within the health services. In addition, some provide their services in other institutions such as government, education and commerce.

Opinión de los egresados sobre la formación recibida

The opinion of the graduates on their training was evaluated from the relevance of the academic programs in congruence with the labor market. To this end, they were asked if the training received allows them to respond to the demands of the professional performance that they face in their daily work, a) the degree of exigency in the professional performance; B) the contents of the curriculum and c) the fulfillment of the graduate profile recorded in the syllabus, and the satisfaction in acquiring the knowledge and skills that they learned.

Degree of exigency in aspects of professional performance

79% of the graduates report that the aspects that are most in demand in their professional performance are::

- **Skills** for the application of knowledge, in their own skills in medicine, in decision making, how to devise solutions and in the process and utilization or handling of relevant and updated information, directing and coordinating teams, and oral or written communication.

- **Attitudes:** logical or analytical reasoning, disposition to work together, constantly keeping up to date, disposition in health risk management, punctuality / reliability, good presentation and taking responsibility.

Although in general, the graduates stated that decision making is the most demanded aspect and with a very high expectations, in contrast, the least required aspect is the ability of management / coordination and administration.

Suggestions for modifications to the curriculum

The graduates felt that in general the curriculum is pertinent and congruent with the demands of the labor market. However, they consider that it is necessary to approach contents and practices with greater amplitude, such as: the theoretical phase of the curriculum, laboratory practices, clinical practice, field practice and development of skills in research and medical informatics. Likewise, they believe that the contents on ethics, bioethics and deontology should be kept as they are in the curriculum.

13% expressed other aspects to consider within the curriculum, such as: the reduction of the duration of the degree, the evaluation of the pre-university course and giving more credits in the curriculum to aspects of emergency medicine, pharmacology and English.

EMPLOYERS' PERCEPTION OF SHM GRADUATES

This section aims to know how satisfied employers are with the professional performance of our graduates, through the following areas:

- Curriculum
- Administrative competence
- Leadership
- Social responsability

The organizations that were interviewed are satisfied with the performance of the graduates, with only three of the twelve indicators of the variables were found to be below 50%. In last place is use of a second language. An explanation for this is that in the curriculum that was evaluated, this subject is appears during only the first two modules.

The curricular area included the following aspects:

1. Role as a doctor
2. Search for pertinent and actualized information
3. Solution of medical problems
4. Disposition to learn
5. Verbal, oral, and graphic communication
6. Application of knowledge
7. Information process
8. General medical knowledge
9. Logical and analytical reasoning
10. Use of computer programs
11. Specialized knowledge
12. English

In relation to the specialized knowledge, this is an aspect that hinders the scope of the medical surgeon's curriculum, since it corresponds to the undergraduate level. This same situation invites us to reflect on the diversification of curriculums at the undergraduate level related to health to include them in the educational offer of the SHM.

Although the current curriculum includes two computer workshops in which students are trained in the handling of basic programs, it would appear to be insufficient and this will be an aspect to be considered in the future, both for the Medical Surgeon program and the new programs.

It is considered that the training for a second language and the management of information and communication technologies are important elements to consider in the new curricular design.

In terms of knowledge, skills, attitudes and values that are graduates are intended to develop from the curriculum, the qualification obtained by the employers was high. In more than half of the questions asked, over 60% were very or completely satisfied.

The Administrative Area was integrated with the following indicators:

1. Identification with the institution
2. Presentation
3. Public relations
4. Punctuality and formality
5. Administration

Only one of the five indicators of the variable was shown to be below 50%, which refers to administration. Although in the curriculum of the bachelor's degree the tenth module contemplates contents on administration, the result is not the one expected by the employers. The new paradigms faced by healthcare require new functions on the part of new professionals.

Perhaps this situation is due to the high medical content of the current program and the students' own perception of the functions of a doctor, or influenced by the concept that employers have about what the administrative process is. The truth is that graduates are facing new activities which could be the responsibility of another type of professional related to health.

Other administrative functions performed by the graduates were rated with a high degree of satisfaction on the part of their employers, particularly regarding the identification with their institution of employement.

The area of leadership consisted of the following points:

1. Creativity
2. Decision making
3. Teamwork
4. Coordination of a team
5. Leadership
6. Initiative

Only one of the six indicators of the variable was below 50%, related to the initiative. It is striking that graduates are well qualified in creativity and decision making. Both activities require initiative, so this finding is paradoxical.

The results on the other indicators were outstanding. Attention is drawn to teamwork and the coordination of a team, which is encouraged by the modular system. It can be deduced then that SHM graduates are efficient within their professional performance as leaders in their work areas and are perceived equally by their employers. For the School, this situation is an important indicator to continue with the modular proposal centered on the student with the development of competences in students and teachers as well as the structure of the new educational offer under the same principles.

Social Responsibility considered two aspects:

1. Risk management
2. Management of problems of social relevance

The two indicators considered in this variable are above 50%, this is an expected result because of the linking work developed in each module. Students, under the guidance of teachers, participate in health and environmental contingencies and health prevention, promotion and education programs that are developed throughout the career.

CONCLUSIONS

CONCLUSIONS

The intention of this investigation was to evaluate the graduate profile from the educational program of Medical Surgeon and to re-design the curriculum- a design that does not overlook the influence of biomedical research and its diagnostic and therapeutic advances, takes into account the views of graduates, employers and the participation of the cultural diversity of society, promotes the ethical and deontological principles and that favors the understanding of the social reality with its dynamic current reconfigurations.

Another of the desirable attributes of the curricular design is to adopt an educational approach that conceives the student as an active subject as the producer or constructor of their knowledge and which develops updated competencies at a pace similar to that produced by knowledge in their discipline.

Despite its detractors, the competency-based approach to education could be adopted in a context as unique as that of Chiapas, in its vast and rich diversity.

It is quite clear that the School of Human Medicine, which has existed for about 40 years, has gone through different stages and is located within the continuous improvement of quality. However, it is not possible to stop looking in the direction of the relevance of the educational program and understand the importance of involving the whole community and raise awareness of the need to train highly competent doctors.

From this perspective it is highly desirable that in the professional training of physicians in the School of Human Medicine Dr. Manuel Velasco Suárez (SHM-UNACH), the concept of the human being is recovered. In short, it is to recover the human essence in its entirety, relegating utilitarian perception that the capitalist development model has led, devaluing the *homo sapiens* as *homo aeconomicus*.

The curriculum, as presented, must promote human development with solid moral principles, capable of self-managing its disciplinary updating with broad ranges of performance in different scenarios: from the most rustic rural space with total absence of diagnostic and therapeutic technology to the more sophisticated high-specialty hospital. After all, society demands that medical professionals perform to the height of health problems.

Although we have accepted that there are favorable changes in the academic life of the school, in the historical evolution of the SHM-UNACH, we can not deny the persistence of certain attributes that act in a negative way in the training of medical students and in general, deteriorate the image of the institution, not counting the direct and indirect damages to the health of the people derived from malpractice.

Generally speaking from the views of employers, the graduate profile of this curriculum meets the expectations of the labor market. However, some aspects of dissatisfaction that need improvement are also identified. Diversification of the educational program is necessary in order to be relevant to the Millennium Development Goals and the epidemiological and demographic transitions.

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ACADEMIC PAPERS

CREATIVE TOURISM

Presentation at the Chiapas Tourism Conference 2015

—

Mtro. Sergio Molina Espinosa

smolinaespinosa@gmail.com
Center for Entrepreneurship and Innovation of Chile

TOURISMS

Tourism as a social phenomenon is expressed in different ways in reality. Therefore there is no single category of tourism, there is no unique way to build and operate it, but it is possible to conceive different strategies for its implementation which in turn end up configuring different forms of tourism. In other words, there are different models of tourism that, however, intellectual colonialism tries to hide. The idea of the existence of a single model of tourism, the industrial one, is often self-imposed in different circles of the countries of Latin America.

Just as there are different models of education, it is also necessary to recognize the existence of tourisms in the plural, which in turn implies the possibility of building and operating different models of tourism. This construction does not fall into chance, but is derived from the definition of deliberate public and private policies which seek a certain type of results: boost economic growth, promote capital gains, mobilize communities, distribute or concentrate economic profits, or exploit natural resources according to the private interest. Depending on how each of these priorities are categorized, ordered and valued, a particular tourism model will be available. The resulting tourism model will reflect a greater or lesser degree of democracy, citizen participation, and the value attributed to the local community and its resources.

By extension, some tourism models will have a greater capacity to promote economic and social development processes, while others, at the opposite extreme, will show less incidence and commitment to these processes favoring, for example, private profits and relegating local actors to secondary roles at best, or excluding them from the tourism project. There are tourism models that promote the exercise of the rights of citizenship, and others, such as the imitative industrial model, that isolate or limit political rights, specifically social participation in decision-making processes.

Therefore, the recognition of tourisms or of the different models of tourism is a central concept of the development of societies that resort to it to advance to more complex and advanced economic and social levels. All tourism models, regardless of their size, contain a political project, although it is remarked in dimensions that apparently do not link it with that reality. Every model of tourism implies a less or greater effort and cost for society and communities. The more traditional a community is with which modernized tourism is related, the greater the imbalances, and higher the costs that this community will have to assume. As long as a community has less participation in tourism decisions, the greater the costs it will have to absorb.

When talking about tourisms there emerges a deeper and differentiating knowledge of reality and intervention strategies to model and build it. In this context the different models of tourism are conditioned from the perspectives and forms of planning, to the tasks and operation of services, and the type of concrete links that it will have with the local societies and communities as well as the ways in which it incorporates, uses and rewards the human, natural and cultural resources it needs.

A first conclusion is that tourism, and more precisely each of its models, can be instrumented in order to obtain two basic categories of results:

- To effectively promote social and economic development. In this case tourism is implemented as a pathway to development and includes larger dimensions than the offer of merchandise or products. It is considered as a cognitive experience for residents, visitors and tourists;
- Or it can be built as a privileged business platform aimed at generating private benefits, without being mainly concerned with the effects that favors the welfare of the communities. In this case tourism is used as an end for itself, where what matters is the exploitation of resources within your reach and growth of its variables: number of hotel rooms, number of tourists received, investment, and spending by tourists for example.

Recognizing the existence of tourisms implies an extraordinary advance and a superior understanding in comparison with the concept or understanding of tourism in the singular, which insists on the idea that there is only one way of structuring tourism, regardless of the reality in which it is inserted or intended to be inserted. If the discourse is limited to the analysis and understanding of a single alternative to understand the existence of tourism, then again and again we will have to resort to the solutions offered by the tourist industry model, time and again we will have to identify responses in developed economies to bring them to our reality, again and again we will fall into imitation. This is how economic and social development becomes a mirage on the horizon.

When we talk about tourisms, we are starting to recognize the possibility of using different codes, paradigms and paths regarding the role of local communities, the forms of intervention of public and non-governmental institutions, the use of natural and cultural resources, the development of experiences for visitors and tourists, as well as the planning and definition of business strategies and service delivery.

Recognizing the existence of tourisms implies a sapiential expansion that goes beyond the responses of modernity and rationalism to meet the diverse and different, not only in relation to what tourism is or can become from technical and scientific platforms applied in all their dimensions, but also considering the concrete experience in which the communities in which it is to be inserted, or from which it will be built. This knowledge is very valuable and is often not approved.

On the contrary, when we understand the existence of tourism, and more specifically the tourism industry as a dominant and unique possibility, we are inevitably unaware that reality can manifest itself in different ways. Each community, each cultural system and each natural scenario has a development pattern that is its own, and therefore is articulated with its environment and deeply harmonious. Here is the first challenge of creative tourism: to understand the possibilities of its development from the reality and from the perception and management capacity of its actors. Recognizing this is fundamental to assume the human condition of individuals and their communities, and from this condition define expectations of development and growth, strategies, programs and projects.

However, the tourist industry is installed with the arrogance of its certainties and perspectives in the most dissimilar economic and social scenarios. In this way, it is the only option, the exclusive route and the solution that leads to economic and social development. This is how ministries, state secretariats and various agencies begin to imitate, rationalize and adopt beliefs, practices, uses and artifacts originating in developed countries, which set out guidelines on how tourism policy should be conducted, how a destination should be built on tourism, and also what tourists and local communities need.

This arrogance is often sufficiently accredited and even certified by international bodies such as the World Tourism Organization or universities, research centers and prestigious consultancies.

Creative tourism emerges as a response of its own, originating from a dialogue between local actors, between them and their environment, and with their strategic partners. This co-creative network leads to unforeseeable situations if we are located at a certain point of departure, but also attracts and appropriates the most important, the basic components that must integrate true development. It also values the experience and perception of communities, their talents and capacities, and their economic and social development needs. Creative tourism is the process and the result that a community that observes the challenges of its own development, which courageously identifies what it needs and discards what is a simple substitute. Creative tourism is the vehicle to circumvent the promises of the false development of industrial tourism.

An outline four basic types of tourism (to which is added creative tourism) that have been deployed with the development of societies included [2].

This explains why a tourism model represents the platform for the development and expansion of a more advanced or finished model. This sense of evolution gives tourism a dynamic behavior in time, which is expressed in increasingly complex and integrated processes of convergence and synthesis that originate in the great transformations of societies

Pretourism

This stage of the evolution of tourism is characterized by the fact that the provision of services and the levels of organization of companies and destinations are generally local. Inns and informal tourist guide services usually dominate traveler-oriented services. The first attempts of organization between companies to carry out promotional work can be found. The demand for services associated with tourism is limited to minority sectors of society. The state participates in marginal activities such as registration of entry and exit of foreign tourists, isolated promotional activities and certain training events.

Industrial tourism

Its boom began in the fifties of the twentieth century, propitiated by legal reforms that favored it such as the recognition of paid vacations and the increase of border facilities, which takes place in developed countries in the first instance. At this stage, tourism is massified and globalized by the emergence of vertically integrated companies and consortiums and by state intervention in planning, promotion, coordination, promotion and education. The main motivations of tourists are related to rest and fun. The sun and beach tourism is part of the main offer, especially in the Mediterranean Sea. From there it extends to other latitudes of the planet.

Post-industrial tourism

It represents a detachment of highly uniformed mass tourism. It is a tourism that takes up practices associated with nature and culture. It responds to changes in life in society, the expansion of environmentalism and sustainability as emerging values, but it is also based on associationism

2 Each of these touring models has been extensively treated by the author in his various works.

and the search for greater differentiation of offers. In fact, many of their offers are linked to the values and interests of local communities, which in this context acquire a greater relative role. The state supports it as part of an alternative to industrial tourism, since the latter continues to occupy a dominant position in public policies and marks the interests of business initiatives.

Post-Tourism

It is a tourism typical of postmodern culture, which installs and offers destinations created by man, characterized by a strong technological component. Unlike all the above mentioned tourism models, it does not maintain relations with the natural scenes and the local culture. Representative examples of post-tourism are the entertainment offerings in Las Vegas and the theme parks that converge to characterize the offer of cities like Orlando in the United States. In this model, the state plays a subsidiary role, since the planning of the enormous supply of equipment and infrastructure, and the promotion and development of markets rests with private corporations with strong capital support.

Creative tourism

It is a tourism based on creativity, innovation and the active participation of the organized community in networks constituted by local actors. Decisions linked to the tourism model are derived from the perceptions, knowledge and experiences of local stakeholders, their strategic partners and stakeholders.

Creative tourism responds to the new referents of postmodern culture, post rationalism and social constructivism, which converge towards the creation of highly differentiated realities. The participation of the state is important, but the local community is the main decision-making body in all matters concerning the strategies and scenarios for the future of tourism. Creative tourism is conceived as an instrument of economic and social development, not as an end in itself. Creative tourism is based on non-competitive processes, which nevertheless go beyond the models of competitiveness. Creative tourism is able to create differential conditions in the human, economic, social and political aspects.

Basic Concepts of Creativity and Innovation

Creating involves all dimensions of the person and human groups. It mobilizes and organizes rational, post rational and emotional intelligence, adjusts behaviors, reorders social bonds, gives new meaning to culture and enriches the ethical and moral perspectives of people and the group that assumes a commitment to transform their reality. Creating is an engine of significant experiences in various fields. In the case of tourism, creativity must break in to overturn the mirage of false development promoted by the tourism industry. Creating allows you to structure synergistic knowledge and drives original best practices, generates benefits and distributes them according to a concept that is more in line with what is meant by social justice. Creativity, in terms of creative tourism, generates social learning of value aimed at breaking the isolation that creates social marginalization. It should also be given to empower and to play with the different.

Creativity must manifest itself in everyday spaces, in the relations of exchange and in the growth of social and individual autonomy. That is why creativity leads to a new ethical dimension and is not restricted to the establishment of a different logic and values of production.

To be creative is to seek the divergent, the bifurcation along the way. It is to discover ways of thinking and doing things differently from the traditional. It is to insert or reintegrate with a new perspective. If the factual powers struggle to tackle the divergent and consolidate the paradigm of the tourism industry, creativity is affirmed in divergence to build a new structure of political, social, economic and personal relationships.

To innovate is also to renew what exists and give a new structure to the products and services which allows or facilitates new functions and builds new meanings, that facilitates the increase of productivity and promotes a dialoguing planning or that is in a position to generate new benefits to a particular group of users. In the field of tourism this renewal has to be done in accordance with the recognition of the realities linked to the tourist destinations, that is, according to the capacities and talents available in the local communities with the existing natural and cultural heritage and it is also congruent with institutional and entrepreneurial capacities without forgetting a fair and ethical return to local actors.

Each of these factors, and the relationships between them, should not be observed in a static way or stopped in time, but under a dynamic perspective; that is to say that they can be enhanced, improved and directed towards an entirely innovative project and therefore not subject to the tides of competition markets, fashions, prospects of political groups that eventually occupy power and business interests as always.

Creativity is a human talent that in markets of imitative competence is blocked, since the human capacities are focused in an effort of appropriation of what belongs to a competitor leader in the market. In this framework professional and personal skills are focused on discovering what can be useful, wherever it is, and not on what is the result of a process of creativity of its own.

To create is, then, is to develop a new vision of economic and social development in which actors, offers, roles and benefits will be inserted. Creating necessarily leads to a differentiation with respect to the conventional reality, or more specifically of the market reality generated by the paradigms of the tourist industrial competitiveness.

The markets for creative innovation are radically different from competitive industrial markets, and therefore the premises and rule that structure them are also of a different nature. Consequently, creative tourism is not an alternative to industrial tourism. It is a model in itself that responds to different valuesand that orders actors and resources in a qualitatively different, more complex and superior logic.

As we have pointed out throughout this text, any process of creative tourism development must consider factors or criteria that are valued as indispensable. Now we are going to focus on some of the specific challenges of processes that value creativity as the core of a development model. In the first instance, the creativity of the actors and their strategic partners must be managed - which does not mean that it has to be mediated - by instruments that promote deliberation, participation, autonomy and consensus. These instruments correspond to participatory planning techniques, as will be seen below.

Creative tourism is able to mobilize huge additional resources at relatively low costs, generating far-reaching transformations. However, initiatives to promote their installation and development need to recognize the existence of a set of opposing obstacles and interests that will emerge in the way of their configuration. But they also play in their favor the basic nature of any system in which they pretend to be inserted, which is synthesized in the following premises:

- All kinds of limitation or restriction are modifiable. This means that all structures, however reified they may seem, is subject to changes by actions arising from specific interventions;
- The restrictions posed by industrial tourism are systemic. In other words, they have to do with the set of variables of the activity and in addition with a series of interconnected forces operating from outside, from their environment. Therefore, change efforts must encompass both the focal system and the incident variables that press on from the environment.

Creativity and innovation require a systemic approach, such as the participation and interaction of a wide range of actors including the local community directly and indirectly related to it and with tourism. By extension, the stimulation of the development of this model requires the establishment of a network of actors and strategic partners, which far exceeds the sectoral limits and capacities of institutions and organizations attached to tourism.

The network operation offers great advantages to increase the incidence of tourism in the development processes of the host society. First, in most Latin American countries tourism is often undertaken as an activity with weak intersectoral links, so that this fact leads to a considerable waste of social capital widely distributed in the territory. On the other hand, the relative isolation of tourism in relation to other tasks hinders its renewal, producing with it a dangerous continuity in terms of policies and strategies.

The participation of universities and research centers as producers and distributors of knowledge can contribute significantly to creating differentiating decisions and capacities. In this way, they become facilitators of change in different spaces and areas. Without higher education and research centers it is not possible to strengthen innovation and creativity. In the context of imitative competitiveness, the role played by these institutions is secondary, and even commonly they are considered only as providers of human resources to meet the needs of routine work, especially in the private business sphere. In the model of imitative competitiveness, centers of higher education are practically marginalized since the production and dissemination of scientific and technological knowledge has a low added value. It is considered preferable and cheaper to copy, import knowledge and assimilate experiences that mobilize own resources to produce them.

Although the route of creativity and innovation requires time to develop its positive effects, and also to transmit and assimilate the skills required to operate them, it is no less true that once this process is completed tourism offers different attributes that enhance its insertion in markets.

Another important element of the creative innovative model is the added value derived from a transversal perspective and management that goes beyond the sectoral conception traditionally faced with the development of tourism. The alliance with other political, economic and social agents and their link with different interests facilitate the implementation of programs and projects with a wider impact on development. An example of this is the integration between the tourism and culture sectors: tourism derives patrimonial resources and contents, and culture benefits from attracting financial resources.

Principles of creative tourism

Creative tourism is based on seven basic principles that relate to each other, creating synergies or relationships and interactions that enhance them. These principles are manifested and present throughout the process that encompasses its conceptualization, development and operation. The principles are as follows:

- Abundance;
- Multidimensionality;
- Synchronicity;
- Collaboration;
- Ubiquity or non-locality;
- Reconnection ;
- Communication.

Let's see the basic concepts and meanings that integrate each of these principles below, without prejudice to its continuous revision and extension throughout the present work.

Abundance

Refers to all resources, capabilities and possibilities that exist and are available where they are needed. This principle is strengthened by creativity and associative work, which bring forth diverse and varied tangible and intangible resources.

Multidimensionality

Creative tourism encompasses all dimensions of human reality, therefore it is not limited to privileging economic dimensions but, in addition to it and at similar levels of importance, values and incorporates social, political and spiritual dimensions.

Synchronicity

The work oriented to the construction of creative tourism is based on the alignment and intelligent coordination of forces, capacities and resources. This creates the bases that allow and facilitate the emergence of new realities in accordance with individual and group aspirations.

Collaboration

It establishes that the network work of the local actors and their strategic partners projects the individual efforts to dimensions, results and scope not foreseen by the fragmented and individual action.

Ubiquity or non-locality

It ensures that resources to create a new reality, such as those which promotes the emergence of creative tourism and which is related to economic and social development, are available regardless of the conditions existing in a given initial state.

Reconnection

It emphasizes the importance of establishing and consolidating links with the local roots with the available resources and with the establishment of strategies that are devised and managed locally.

Communication

The effort of materialization of projects of creative tourism is based on intense processes of communication between the diverse actors, denominated the incumbents. They participate with their skills and visions in creative initiatives with effective impact on economic and social development at the local level.

Operationalization of the principles of creative tourism

Creative tourism is not only a model oriented to make efficient certain productive processes or the development of unique tourist offers in order to be put on the market. If this were so, it would be a fragmented model with its social environment, and unfinished from its very definition. Creative tourism comprises more complex and expanded dimensions, but it is not an unattainable and difficult model to operate by communities, public institutions, entrepreneurs and entrepreneurs, guilds and non-governmental organizations. It is an accessible tourism strategy, regardless of the condition of the community in which it is promoted.

The creative tourism model is conceived from a broad platform that includes the following concepts that need to be operative or managed:

- Take advantage of the local abundance, which means that all elements or resources to design a rupture and differential tourism model exist or can be created at a cost comparatively lower than whether imported or adopted from other economic and social realities. The local abundance of resources favors the generation of new realities, and in addition creates the conditions for relaunching the development process on stronger foundations.
- It allows the emergence of opportunities for large sections of population and thus extends welfare, which may be impossible with traditional econo - economic models based on scarcity. In this framework creative tourism, even before its installation, objects the realities and challenges local actors to make them aware of their opportunities.
- Creative tourism fights the forgetfulness and abandonment of itself, it joins others to care, pushes everyone to grow in the different domains of reality in which they operate. This tourism can only be built if it has been previously designed meeting spaces. Creative tourism carries a message for people and communities: that they matter, that people are important, there is interest in them.
- Abundance exists and is available to any community or social group, but must be administered and managed, have institutional public and social sector support, and also participation of entrepreneurship. Disparagement of local resources is a manifestation of the doctrine of scarcity. This reduction of value is inherent in the tourism industry, which tends to adhere to shortages of management, entrepreneurs and local authorities.
- Create and incorporate local knowledge in all areas to the extent possible. The knowledge and skills are widely disseminated in all social sectors and in a wide variety of urban conglomerates, regardless of its size or degree of development. When this dynamic explodes, there appear obvious cracks in the systems adopted from the outside, and in parallel start the fall of some obsolete structures entrenched in the local reality. The first major changes were noted in the value system of local society, as they reposition people, tradition, natural and cultural resources, forms of organization or ways of doing themselves, like the idea of progress and links between productive activities on nature and culture.
- It should give impetus aimed to build, strengthen and multiply local leaderships where necessary. This approach also implies the development of transverse leadership, like contemplating actions and decisions that are not isolated in the tourism sector.

- The creative tourism model is based on the design of an integrated social and productive system, which becomes the basis of a tourism network. Therefore value is added to the tourism sector, to whatever model, that is unable to produce on its own and for their own benefit, but players from other sectors can provide at low cost. Tourism built by traditional actors (the subsidiary state, employers who seek profits, mainly) is already an anachronism and incompetent, like every industrial tourism model. This model results in an effort that results in increased costs and lower profits in terms of economic and social development. The enlargement or number of actors favors the design or based on creative tourism processes, and promotes the abandonment of a tourism model which creates dependency, deepens imbalances, and facilitates privileged access to wealth and resources. If industrial tourism dismantles local forces, creative tourism creates convergences. If industrial tourism commoditizes offers and creates unique prospects, the de-commoditization of creative tourism opens spaces for variants and forks.
- Creative tourism requires greater efficiency of state institutions, which requires in addition to a new approach to priorities, responsibilities and capacity of officials, specialists and technicians. However, we must not forget that creative tourism projects emerge from the community and pass through state institutions for instrumentation.

Creative tourism model is positioned as a durable long-term productive activity, carried out on a controllable scale based on energy efficiency and respect for the natural environment using cultural resources as living and evolving systems. This is a synergistic model driven by different actors, directed by group decisions, incorporating as a relevant resource to human capital not only for their professional skills, but those who cherish traditional knowledge that can make significant contributions. This model opens the way for the innovators, for the creative. These people communicate and help create value.

In this sense tourism lies not in the availability of natural and cultural resources, but on creativity, information management, negotiation skills and management competencies of organizations and individuals to work collaboratively in orchestration of a business context.

Epistemological basis of creative tourism

From the perspective of evolution of processes, the tourism industry comes before the creative tourism model. The tourism industry was the dominant model for most of the twentieth century until the eighties, when new perspectives and solutions to implement within the currents of postmodernism and post called rationalism arose.

The tourism industry is inserted in the context of modernity and scientific rationalist thought, which claims that reality is objective, which is why it is well structured and is the same for everyone, for all societies and cultures. From this conclusion the model of the tourism industry moves from one environment to another, from highly developed areas to marginal territories, imposing its conceptual logic and practices. It is in this context that we find a sure path to development.

But under the post rationalism, tourism must be built as part of a new understanding of the human being, of reality and the relations between these with their environment. This emerging form of thought does not rule rationalism, but it is conceived as an instrument. It is no longer the beacon that guides the ideas and interventions of individuals and their reference groups. Thus, from the perspective of post rationalism, the tourism industry is positioned as a model or an understanding of what tourism is in a certain reality, but in no way does it amount to placing it as a single proposal and governing it to validate it being installed in other environments or realities. Tourism, then, acquires the structure and functions that the actors of a certain social reality attribute to it.

Consequently, from the horizon of post rationalism the tourism industry, pride of many governments and private investors and mirage for diverse communities, is a deciduous and relined demonstration which does not respond to the evolution of social and political systems and forms of thinking that have erupted since the eighties of the last century. Therefore, in this context, the tourism industry is unable to meet the challenges of development and improving the quality of life of the population.

However, modernism and its rationalist side have been commissioned to create a powerful myth about the ability of the tourism industry which is sufficient to combat underdevelopment and is able to overcome it.

Postmodernism and post rationalism criticize this belief or approach. So does the new empirical epistemology. Context began to expand our awareness of what we call reality. Reality ceases to be an objective entity and becomes co-dependent on our way of perceiving it, ordering it and understanding it . Therefore the assumption on which rests the tourism industry, in other words, a model that can promote development wherever it is installed, is false. So, the reality is not an entity that is given to the observer or that exists independently of him. The observer is no longer a neutral person, but the observer intervenes to co-build or build in collaboration with other observers. Hence participatory[3] creative tourism, which requires a state to assume a proactive leadership role and who is responsible and persistent but which also boosts the autonomy of communities. Creative tourism as a process of postmodernism establishes that observers act to build a reality, and identify the variables which are made and sort them .

The significance and construction of reality may contain subjective attributes from certain from experience, which is considered as entirely valid. Post rationalism knowledge, which is a representation of reality, has the following characteristics:

- It is emotional, which means that emotions have a very important role in the effort to build reality, categorize and create a hierarchy.
- It is sensorial; therefore it is also integrated with the concurrence of the senses.
- It is perceptual; validates perceptions of the actors or observers, but it isn't tested from the point of view of empiric rationalism.
- It is an engine, i.e., active and mobilizes actors in one given direction which in turn is selected by them.
- It is behavioral because it governs the conduct of the actors and their construction strategies or intervention in reality, according to previously identified shared objectives and consensus.

The reality that aims to transform requires, as we said, a process of ordering and a meaning that is given by observers and actors, not technocratic planners and centralizers like the rationalism that pervades the tourism industry model. In the process of development of creative tourism, tourism experts, planning and other subjects are mediators, as anyone who does not come from the community where it is manifested.

Post rationalism comprises constructivism as an epistemological pillar. In this sense, in constructivism the person or actors and partners, actively create their own reality. They do not allow their reality to be created by an external intervention as with the tourism industry model. In a more precise sense, there is no economic and social development if others are expected to build and transfer it.

Constructivism has two basic sources:

3 Al respecto, véase el artículo Hacia un turismo participativo, escrito por el autor en la revista Servicio, publicado en México, Distrito Federal, en 1980.

- Systems theory [4], which conceives tourism, in this case, as a whole, as an open system subject to dynamic probabilistic and modifiable trajectories. Therefore all tourism expresses inertia, entropy and uncertainty. But also all tourism with local roots can create emergent qualities and promote differentiation processes and development.
- Second Order Cybernetic, which deals with observant systems, i.e., the observer who observes his own observation in order to build a reality. This observation is found to be permanently articulated with homeostatic processes or correction of system deviations. For example, if tourism diverts to degrading behavior generated by tourists and it brings a negative impact on communities, the actors involved correct such deviations, so tourism is not beyond the objectives in terms of economic development or economic and social development.

It should be noted that there is a First Order Cybernetics, dealing with the observed systems. This perspective is, from the point of view of the community, consistent with the installation and monitoring of the tourism industry as an already given structure already built that can lead - at best – of only streamlining the observed system. It is the model of the tourism industry, but in no case is it able to transform it. This is the case of local communities or regions and countries who receive it. Here local interventions can not make it functional to the objectives of local development, for example.

In the best cases communities can only validate and legitimize it and this has happened frequently. While the mechanistic logic of the tourism industry is dysfunctional to change, with opposing barriers and various incentives to impede, creative tourism can not be explained without it and without the implementation of facilitator's processes. Creative tourism caters to the changes that society and communities need. While it means an advance and a model that aligns and is routed to resolve outstanding and emerging challenges, it is not without unintended consequences, uncertainties and delays.

There is an element or a central phase in dynamic systems, which is called catastrophe. This involves the disruption or radical change in the trajectory of a system.

4 In this regard, see text *"Un Nuevo Tiempo Libre"*, written by Sergio Molina, Roberto Boullón and Manuel Rodriguez Woog, whose first edition was published by Editorial Trillas in Mexico, Federal District, 1983.

In the context of post rationalism catastrophe is valued as an opportunity for change, and not necessarily as a negative event. For the tourism industry catastrophe is a negative event in any circumstance, because it means loss of stability, an irruption of disorder, a change in the rules of the game. All these events constitute a threat to the tourism industry. A catastrophe or interruption of the historical trajectory of a system provides opportunities to rebuild tourism in the context of the post rationalist and postmodernist conceptions. That is why creative tourism can be installed where industrial tourism has degraded and has even lost viability, or where it has proven its complete inability to promote development, firing and promoting social conflicts of various kinds. In this case tourism can be built on new foundations, regardless of its history and the problems created in a community.

But creative tourism is not based on a single model that can be replicated in different areas. While creativity forms a nonlocal power, creative tourism that works successfully in a locality may fail in another of similar characteristics.

Creative tourism sciences are not accurate. There are many platforms to support creative tourism in a community. Every community has the right to choose creative tourism; each community can choose the path that seems most appropriate to improve their living conditions. Each community has different skills, resources, and goals. Creative tourism is based on acts of freedom and autonomy, in full exercise of the rights of citizens.
Any tourism that does not meet these requirements will be a tourism that comes from outside to impose their objectives, operating rules and the role to be played by local actors and the community who become part of a broad sector: the "assimilated ", acceding to a model that is neither is nor will be a long-term convenience.

Poverty and marginalization create high barriers for the installation of creative tourism, however it can be overcome with the responsible participation of public institutions, non-governmental organizations and businessmen and entrepreneurs in addition to the whole community. These actors and partners must provide perspectives and tools to empower creative tourism projects. They should avoid preconceived solutions. Marginalization and poverty can not be used as an argument to displace the groups that are in these conditions. Creative tourism should be linked to the history of intra-community interactions with environmental resources and expectations of observers-actors. There can be no development without attachments between them, let alone, without involving them.

Traditional policies make up a high barrier to creative tourism. Overall politicians do have not the slightest idea about the tourism models and their impacts. Usually they rush to support the growth of the tourism industry, ignoring the ways in which it relates to society and specific communities. It is not that politicians are aware of tourism trends, because certainly will be referred to the trends in the tourism industry. Neither it can be difficult for traditional politicians to see that the tourism industry sees local communities as groups of "assimilated” peoples.

Politicians need to be shown new models such as creative tourism. We must educate them to act in ways that contribute to generating new objects in the field of infrastructure, equipment and organizational strategies and intervention. It may also help to generate new political, economic and social implications. Removing the barriers to development also implies leadership, perseverance, persuasion and courage of those who promote a different model. Traditional politicians often have a severe deficit of driving change.

Creative tourism does not place us as mere followers of trends in world tourism. This role of followers is the claim that stimulates the World Tourism Organization in Latin America. Creative tourism believes that identity is its substantial part of it, which varies from one community to another. To develop their identity each of the communities should launch and deploy their creativity, which is the synthesis of all the capabilities of its members and its strategic partners (public sector institutions, business, NGOs and consumers).

Creative tourism is disruptive in relation to tourism in the tourism industry. It is not a trend resulting from the development of industrial tourism, but can take advantage of many of the operating bases, such as those created by industry markets, and experience in terms of strategies and actions of promotion and marketing. There are, however, many architectures and meanings in these fields that need to be discarded.

Creative tourism opens the floodgates for communities to learn on their ways of being, understanding and acting in relation to development, progress and welfare. This is how their lives directly activate their aspirations and mobilize their skills and talents. If the tourism industry seeks to legitimize invariance, creative tourism represents the fact of diversity and seeks to grow and evolve based on other codes and paradigms. Creative tourism is anchored in who we are making visible everything that we need beyond the limits of a productive agenda. This is how it converges towards the "development model" that dictate their own patterns of community life on the ocean coast, in the rainforest, in the valleys and in the savannah in the Cordilleran mountainous or coastal or lacustrine spaces. In contrast, the tourism industry chooses known certainties coming from countries with advanced economies, imposing their certainties anywhere.

When communities and strategic partners connect with the fundamentals of creative tourism, there is a powerful tool to promote development. Only then creative tourism - like no other tourism model- can contribute to solving pressing social challenges and background. The power of creative tourism increases exponentially if used properly in the market as an instrument for the resolution of certain conflicts and challenges.

Creative tourism and socio constructivism

Economic and social development and creative tourism are not the result of a proposal issued by a group of investors or state institutions, but require the privileged participation of local communities from conception to evaluation of strategies, programs and projects.

Creative tourism is not built based on a collection of data or from the vision of a group of specialists, or even return expectations of investors. Creative tourism is a proposal that is not based solely on the rights of a community but of rights in general. The first of these rights has to do with learning to know reality itself, learn how to improve their own living conditions, how to participate in decision-making processes and how to achieve this.

Tourism conceived in this way is not just a business, as with the tourism industry, but first is a social necessity and a tool of true development. The business focus is important but not critical to achieving a sustainable improvement in the economic and social development. The most repeated fallacy in the legitimizing discourses of the tourism industry is based on its potential for development. This really can not come from outside, from other social contexts. In short it cannot originate in developed countries or those outside the economic conglomerates' host community. The most important social responsibility with tourism is to actively participate in its decisions and development.

The constructivism partner involves participation and social organization with the aim of improving the quality of life, well-being and development opportunities of a community.

It is based on the learning set of current and historical situation of the community and its members, knowledge and appropriation of forces and variables that affect the construction of the future scenario they want to achieve, and in learning strategies and options at its disposal, and measurement of results that are manifesting. Constructivisms partner contributes and supports the construction network of personal, economic and social reality that individuals and a community want to generate for themselves. In this effort there is no dependence on an external actor, although their input is needed in order to aim at achieving development goals that the community decides. Strategic partners or external actors are called to participate to generate local shared value.

The development of creative tourism can boost the elementary capability power of individuals and communities. Their project can start even when the community is disintegrated, frustrated, skeptical and depoliticized. But still any reality can be radically transformed if appropriate policies and strategies are used.

The constructivism partner can materialize any reality that the tourism industry in its authoritarianism, arrogance and supposed superiority has claimed or intends to bury or devalue for allegedly being impractical or inconvenient. That is, industry spokesmen - installed even in state institutions - often disqualify any reality other than the facts of the industry.

The constructivism partner believes that learning a reality must be essentially active, but also has an important space for collaboration, therefore besides active learning it is also collaborative, and you can get through to what we call the network of local actors and their strategic partners.

Knowledge of reality is given in the context of the individual's relationship with the environment, on the one hand, but it also formed with other individuals with which it is integrated, that is, on the designated network.

The social construction of reality to which it aspires does not refer to an exercise that takes place in working sessions, once or twice a week. On the contrary, that reality is being built every day, in line with a strategy at all points of the network in all areas of influence of the network of local actors.

The construction of creative tourism is done in certain social contexts, actors responding to specific features, which have been shaped by a history and relationships that also is their particular area. While creative tourism can be implemented in any reality or social sphere, it has no formulas that make a particular model and can be implemented in other realities. Each community or social group must build its own beacon to light the way they choose to go. If tourism is truly creative, then you can not be equal to or similar to that as seen in any other place on the planet.

From the point of view of economic and social development and creative tourism as its tool or strategy, constructivism partners act to create reality through a series of basic processes, among which we can highlight the following:

- Communication – intensive or multidirectional processes comprising ongoing exchanges of knowledge, concepts, priorities, differences, different experiences and skills among local actors. This communication allows building objectives-images and targeting future shared scenarios.
- Development of various complex skills in all local actors who will participate in various relevant ways to areas of creative tourism

projects. This participation may require conceptual, managerial or operational capabilities or planning, coordination and execution.

- Evaluation of abilities in order to ensure, firstly, that it is differentiating skills that will converge towards the construction of differentiated and creative tourism, and on the other, that people who engage special projects have the capabilities that these require, and that they are in a position to add value to initiatives that are promoted and which they will be directly involved.
- Permanent processes of evaluation of proposals and actions that are carried out. This allows the execution of adjustment actions in relation with the pursued objectives, or to properly assess tasks which may involve an opening toward broader goals.

Paradigm of the knowledge society

The society of knowledge is one of the paradigms that mainly define development strategies in different areas of human collectives of early twenty-first century. This paradigm has left behind the industrial society and also to call post-industrial society, which still faithfully follows the industrial tourism model and its later stage, post-industrial tourism. Both models are dominant in the international arena, and specifically in Latin America.

Public policies and business management follow their guidelines, and society in general receives the impacts of its structure and operation. Its features include:

- Sectorial perspective that defines their strategies and their evolution;
- The incremental emphasis, which therefore stresses the need for growth in some of its variables, such as the number of tourists and hotel rooms installed and their capacity; the incremental behavior questions the success of the model;
- Setting mainly economical goals and targets;
- Economical content of its programs and specific projects that devalue social and ecological variables or even economic variables;
- The instrumentation of cultural events, which are packaged and adapt to the taste and preference of tourists who tend to be of low sensitivity;
- The industrial production of products and services, aimed at meeting standardized and uniformed offers of the demands of mass tourism;
- The creation precarious, temporary and in many cases low productivity employment;

- High centralization of decisions, with little or no participation of communities, and even the interests of business groups with relatively less power.

The bases of industrial tourism model were generated just in industrial society, and therefore obey and respond to their principles and characteristics.

But the gradual installation of the paradigm of the knowledge society poses other challenges, perspectives and strategies shaping and operation of the tourism phenomenon. [5]

Among them it is possible to point out the following:

- Development based on knowledge, i.e. making this resource component important to touristic plans and projects;
- Linking universities and research centers with the tourism development. This requires the transfer of support and grant and stimulate in them a greater role;
- conceive a productive activity in a controllable scale, on the one hand, and form a structure of creative production on the real improving of the welfare of the population that relates to tourism;
- integration of tourism with other sectors of the economy: to the environment and culture, universities and research centers, as a set that comes together to add value to the planning or trade of tourism.
- to carry out a deep determination of natural and cultural resources at the local level, as a repositioning of its attributes and methods of use;
- strengthening and intervention or of state institutions so that their subsidiary character assumes leadership;
- It recognizes the growing importance of human capital;
- establishes the incorporation of an intensive use of new information and communication technologies;
- the importance of partnership working and networking, proactive approach, collaboration or ny the autonomy í a new job as strategies tur í stico on track to generate intangible assets and overcome structural constraints;

3 Some of these concepts and arguments have been developed by the author in his works Turismo y ecología (1981), Planificación integral del turismo (1987); Conceptualización del turismo (1987), Modernización de empresas turísticas: un enfoque para el logro de la calidad total (1991); Fundamentos del nuevo turismo (2007).

- support for new concepts and forms of organization within the company and in its relationship with other companies, institutions, non - governmental organizations and communities;
- the search, implementation and experimentation of forms and creative production strategies;
- boosting creativity and innovation as an engine for the valorization of new products, services and experiences, recognizing that they are the cornerstones of growth and development;
- the creation of quality jobs, that guarantee ethical income and support entrepreneurship;
- Community participation in the diagnostic processes, decision making, operation, instrumentation and evaluation of the development of tourism.

The development of creative tourism in the knowledge society does not depend on greater efficiency of institutions, companies and organizations in general, as it is not based on expansion of existing data on demand, supply and destinations of competition, or the generation of new data associated with the mode of production and industrial consumption. Creative tourism responds to an emerging generation of organizers and functional principles as a differentiated structure in relation to industry.

However, in the more consolidated and mature the model of industrial tourism in a country, the more difficult the adoption of the new paradigm and the shift towards a model of creative tourism. That is why the leadership of public institutions is essential, but if the state is in a subsidiary position and driving severe deficit, no doubt there will be comparatively more difficultly to move towards the inclusion of creative tourism in society. Meanwhile the large consortia of industrial tourism do not suit any transition process that involves transcending the models which are located in a dominant or privileged position.

Notwithstanding, creative tourism can act together with diminishing economic returns and generally, the accumulation of negative impacts on the social and environmental levels produced by the tourism industry. Undoubtedly the greatest value of creative tourism originates in its proposal, conceived in the singular, i.e., according to the specific reality of each community and who immediately benefit from it.

This context does not pursue that creative tourism grows or expands out of control, but primarily seeks to establish it's as a strategy to transcend into the development and welfare of the community. That is the core identity of creative tourism: coincide with reality, not with the representation of the reality of each community. This requires the exercise of state responsibilities and communities.

To achieve this overlap it is necessary to work to bring out the meanings of each reality derived from emotionality, sensuousness, beliefs, tradition, culture and customs, and rationality. This is how the creative tourism builds its structures and experiential order all in the context of the knowledge society.

In this process the leadership of schools and research centers is essential, for their participation in creative tourism means a contribution should go beyond its role of knowledge distributors of industrial tourism and assume a committed role to the generation of knowledge to enrich approaches and concrete solutions. The same should happen with other actors today are also mere distributors of experience in the industrial model: the public sector, investors, businessmen and entrepreneurs, consultants, international organizations and non-governmental organizations, among others.