Physicists have designed a device for automobiles to make it possible with a high degree of reliability to determine what occurs in a traffic accident and thus facilitate judicial proceedings. A black box, but for automobiles.
Microorganisms Clean the Air around the Bogotá River

A system that uses microorganisms to degrade sulfur, which is the main environmental pollutant in the zones around the Bogotá River, is reducing concentrations of hydrogen sulfide gas, which is highly corrosive and damaging to the health of the inhabitants.

Researchers from the International Center for Physics (CIF) gather microbiological samples from the substrate to evaluate their efficiency in the biofiltration system that has been installed at the company on the banks of the Bogotá River.

H2S irritates the eyes, dries out the nasal mucus and leads to colds, frequent symptoms among those who must put up with this odor on a daily basis. If the concentration in the air exceeds 300 ppm, it can even cause dizziness and fainting. That is why professor Guardiola says that hydrogen sulfide must not be underestimated. "If concentrations go beyond 500 ppm, it can be imperceptible to the nose while generating brain damage."

The biofilter for the pilot project carried out by the CIF was installed at a company located between San Antonio de Tequendama and Mesitas de Colegio (Cundinamarca), whose emissions affect four villages with a population of around 1,500 inhabitants. In this area, H2S concentration tends to rise between 3:00 and 5:00 a.m.

Another characteristic of this gas is its highly corrosive action. According to the CIF researcher, "even when concentrations are low, iron or any other element alloyed with it is destroyed. In many cases, industries seek the benefits from the biofilters not only to reduce toxicities emitted into the environment but also to lower maintenance costs for their equipment, which tends to suffer deterioration from the H2S. Among local farmers, the corrosion damages roofs and fences."

Protective measures

The system created by the CIF makes it possible to measure the environment in real time and monitor it through a webpage in order to calculate the entry and exit of the gas. This part of the system was not easy to achieve.

"It implied designing a mechanism that would constantly measure the quantity of gas entering and leaving the filter, and that would be sufficiently robust to not corrode due to aggressive conditions from the medium and high H2S concentrations," recalls José Enrique García.

In accordance with the estimated time frames, the biofilter should last a bit longer than a year, but has actually now been in operation for nearly two years. Despite the rugged conditions, the measurement mechanisms remain intact, which shows the success of the system as a whole.

Currently, researchers at the CIF are designing a new biofilter for another company, also near the Bogotá River. "We need to adjust it to the characteristics of the particular company, because there are differences between a paper producer or an electric power plant and a meat processor. Each biofilter is a world in itself due to the type of distribution that it applies to the gas. Also, the H2S never appears on its own but is always accompanied by another type of gas, depending on the particular kind of industrial process. We even have to take into account the biological material used to nourish the microorganisms," concludes Professor Martha Guardiola.
An “Oil Boom”? For how long?

With an average production of 900,000 barrels per day, the country’s current oil reserves would be exhausted in around four years. Rather than engaging in useless debate about a bonanza, analysis must focus, for example, on the ability to find 180 million barrels per year of new exploitable reserves in order to maintain the production levels that have been achieved.

Collateral costs

It is also important to point out certain costs generated by oil activity. In the environmental field, despite technological improvements and greater resources aimed at forestalling such effects, hydrocarbon production continues to cause damages, particularly to bodies of water, agricultural zones, roads, etc.

In this context, sustainability appears more difficult to achieve. If the use of these considerable resources cannot be effectively and efficiently channelled, one of the best opportunities that the country has had in the last 100 years to surmount the problem of poverty and all of its nefarious consequences will have been lost.

In conclusion, more exploration, more education and training, a broader vision of external markets on the part of national oil service companies, zero corruption in the use of royalties, better projects and greater planning in the use of resources are absolutely necessary premises to be able to effectively speak of an oil bonanza, in the sense of Colombia having better living conditions for its population and better conditions for the well-being of future generations. Anything else is simply a semantic debate.

Benefits

It is evident that oil production now brings significant economic benefits in terms of foreign exchange, royalties, tax receipts and, to a lesser extent, increased employment; thus the importance of working to maintain this increase, as much as possible, for a longer period. Additionally, Colombia is seeing an unusual appearance of small and medium-sized companies –able to compete with the large international companies–, dedicated to providing services ranging from basic geology, seismic, analysis of prospectives, electricity generation, drilling, the taking of measurements and logs, etc., which are the ones that best reflect technological transference and the direct added value stemming from oil activity.

Decreased production due to a falloff in reserves can lead to the shutdown of these firms, unless they are prepared to export their services, which is feasible given the high quality of national human resources. This is a fundamental task to guarantee sustainability of the sector. The same applies to the training of technicians and professionals in the universities and specialized institutes.
90% Precision in Detecting Breast Cancer

As opposed to current methods that are 65% effective, a new system created by engineers at the National University makes it possible to detect breast cancer with nearly 90% precision.

With greater precision than in conventional methods for detecting cancerous masses, biomedical engineers at the Universidad Nacional (National University) launched their Support System for Breast Cancer Diagnosis, a disease that affects 7,000 Colombian women each year (according to the 2010 National Survey on Demography and Health / Encuesta Nacional de Demografía y Salud 2010) and which can be cured as long as it is discovered in time.

This system, as explained by biomedical engineer Fabián Narváez, “can detect masses in 80.3% of cases and determine the classification of pathology or severity, in other words, whether it is benign or malignant, with 85.3% precision.”

He clarifies that the system is based on single projection mammography and Health / Encuesta Nacional de Demografía y Salud 2010 and which can be cured as long as it is discovered in time.

With those mammographs, radiologists can see each breast and compare them. “The idea is to compare the images and make an inspection. The supposition is that, given their nature, there must be symmetry and a similar distribution of tissues”, according to Narváez.

With this approach, the experts seek zones that have been affected or show indications of masses. That is the idea behind the system implemented by the UN: superimposing the images to compare the images and make an inspection. The supposition is that, given their nature, there must be symmetry and a similar distribution of tissues”, according to Narváez.

The new method was created under the Bi–rads Protocol, use by radiologists to identify and compare mammographic masses. According to the biomedical engineer, depending on the form and size of the mass, it is possible to determine whether it is benign or malignant and suggest timely treatment.

"This leads us to analyze the general functioning of the systems. There are currently various platforms called CADS, or Computer–Assisted Diagnosis, which serve as automatic tools to detect or segment regions of interest. They are guides to enable radiologists to easily identify if there is an abnormality in the breasts”. The problem with the CADS is that, because they use mathematical algorithms, there is the risk that detection will not be exact. “Depending on the volume of cases, a bias can be created which leads to various errors”, according to Narváez.

This happens because information is used from one single projection, whereas the support platform makes it possible to superimpose two images at the same time. Also, the CADS system does not make annotations, because it merely locates the region where the mass can be found. “Our system shows the characteristics of the masses, their size, form and location. This is something completely new, stresses Fabián Narváez.

According to studies carried out by the Telemedicine Group at the National University (Grupo de Telemedicina de la UN), CADS have 85% sensitivity in detecting microcalcifications, but only 65% in detecting masses, a relatively low percentage which means that these tools are not widely accepted in real clinical scenarios.

“In addition to describing the region in radiological terms, the objective is to suggest a diagnosis, although ultimately it is the radiologist who makes that decision”, according to the engineer.

This is how it works

The two projections that have been made are used, one from above and one in profile. They are then superimposed, and the mass is analyzed based on the observations.

The process is used to obtain an image of crisis levels, which is then used to make one description of the form and another of the texture to determine whether or not the mass is malignant. Its contours are determined compared to Narváez.

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Orthopedic Surgeries in the Technological Vanguard

X-rays and other advanced imaging technologies provide specialists with the most accurate possible information on the part of the skeleton to be surgically treated. Now, a three-dimensional computer modeling tool and a prototype adapted to each patient will make it possible to carry out such surgeries with greater precision and in less time.

Elizabeth Vera Martínez, Universidad Nacional de Colombia

Skeletal deformations can produce pain and affect a person’s physical performance. Diagnostic imaging such as X-rays, computerized axial tomography and magnetic resonance allow orthopedists to identify and locate the precise areas of these alterations, helping them to plan the needed surgical correction (osteotomy).

The osteotomy consists in cutting the bones to modify their form and orientation, as explained by specialist Carlos García Sarmiento, an orthopedist at the Universidad Nacional de Colombia (National University of Colombia), who points out that in this manner the deformation is repaired in order to relieve pain and improve the patient’s affected parts.

Skeletal imperfections can be congenital (at birth) or acquired, due to fractures, degenerative processes such as aging and excessive weight.

The Biomechanical Research Group at the Mechanical and Mechatronical Engineering Department, led by Professor Carlos Julio Cortés Rodríguez, with participation by engineers Mauricio Cuervo, Óscar Rodríguez and Indy Araque, is developing an innovative physical prototype for surgical planning, which focuses on the affected part of the patient's body through computerized three-dimensional modeling.

This technology is an important medical tool that offers greater orientation, safety and precision during a surgical intervention, according to specialist García.

Pelvic region

During the first years of life, the pelvis is made up of the ilium bones (large and flat) and the ischium bones (round and curved), which help to support the body's weight when seated; and the pubis (which joins together the two sides of the pelvis). These are slightly separated and, as the person grows, become joined together to form what in adults is referred to as the coxa and which, along with the sacrum, make up the pelvic region.

The pelvis is therefore a ring-like structure that, if fractured in a certain place or if its segments are separated, produces a fracture or luxation in another place.

The hip is made up of two bone structures, one known as the acetabulum (a spherical cavity in the pelvis) and the other as the femoral head (a massive sphere at the end of the femur). Its joint makes possible the movement of the inferior members, the forward movement of the human body and enables the body to support its own weight. Improper fit between these two parts results in pain and limping.

Until now, using imaging technologies, physicians have been able to see the location of fractures or other deformations, but the work of the Biomechanical Group goes further.

“This tool incorporated by the engineers at the National University is innovative in our field because it enables surgeons to have a physical prototype similar to the bony structure prior to surgery. Thus, we are able to approach the area that must be cut or modified with greater precision”, says the orthopedist.

Rapid prototyping

Based on three-dimensional modeling software, a customized database is created called Dataset, into which all of the patient’s data and pathology is introduced, explains Professor Cortés Rodríguez.

The idea is that this program, once the complete and precise information is received, creates a physical impression of the particular osteal system.

The model reproduces the texture and tissues of the pelvis in a nearly real form, thus making it possible to have a three-dimensional geometric recognition of the bone.

The diagnostic images create the part of the bone to be remodeled in 3D, and, using a rapid prototype, the final piece is made.

At that point in the process, the specialist can use the computer to observe the condition of the bone in all its angles (three-dimensional form). With this technology, the information is exported through a special format, called STL (program), which is used to physically create the required prototype.

The model is generated through additive production by layers (rapid prototyping), similar to a “three-dimensional impression”, that creates the specific part of the human body using polymeric material with textures and colors similar to the real tissues. For orthopedist García Sarmiento, the product of this impression, in other words, the bony structure copied from the patient, facilitates manipulating and becoming familiar with the situation before the surgery.

“The additive manufacturing technique by layers is able to clearly reproduce the details, with geometries that would be impossible to imitate using conventional processes”, according to Professor Cortés Rodríguez.

Advantages

Using the physical sample of the osteal structure or of the region of interest, which contains a representation of the bony tissue from each of the patient’s scanned axial cuts, a specialist can guide his approach and see the exact morphology that he will have to deal with. He can thus shorten the duration of the operation while improving the probability of a successful surgery.

“The solid three-dimensional models make it possible for these surgeries to be constantly improved, because diagnostic imaging by itself frequently does not facilitate the characterization of a deformation”, says this specialist at the National University, who successfully tested the technique last year on a child with hip dysplasia. This congenital anomaly occurs because the acetabulum and the head of the femur are not correctly joined, thus producing pain and skeletal alteration.

“The technique has shown itself to be very valuable in complex surgeries, insofar as simple interventions such as luxations of the bones of the fingers, hands or feet are sufficiently well managed through imaging”, said Professor Carlos García.
Parkin and Pink, Genes that Signal the Appearance of Parkinson’s

Hernán Sáenz, DND/Unimedios

Parkinson’s is a disease that occurs when the neurons that produce dopamine are slowly destroyed. Without this important neurotransmitter hormone, brain cells cannot appropriately send messages, leading to loss of muscular function, which worsens over time.

Between 5% and 10% of cases are hereditary; the rest occur sporadically. There is speculation that constant contact with herbicides, pesticides or similar products could cause this disorder. In Colombia, some 75,000 people suffer from it and a large percentage of those diagnosed are above the age of 65.

Why are 90% to 95% of reported cases sporadic? What genes are involved? Gonzalo Arboleda, coordinator of the Cellular Death Group at the Genetic Institute of the Universidad Nacional de Colombia, is working to decipher this enigma.

We are particularly interested in two genes associated with Parkinson’s, Parkin and Pink1, which undergo mutations in the inherited form and have the particularity of leading to the disease in people under the age of 20, he says.

The main pathological characteristic is damage to the dopaminergic neurons that constitute the so-called black substance, located in the nucleus of a part of the brain known as the mesencephalon. These cells to a great extent control body movements.

The accumulation of a protein within these neurons known as Lewy Bodies has been detected, whose manifestation begins in the mesencephalon and which, later on, affects other areas of this vital organ such as the limbic and cortical zones.

The cause of this degenerative disease remains a mystery. Colombian scientists are following the clue of two genes that are involved in inherited cases. The goal is to find answers involving sporadic cases, which represent nearly 95% of those diagnosed.

With the passage of time problems of movement and cognitive type symptoms such as memory loss appear. The UN neurologist affirms that in very advanced stages the genes show peculiar clinical characteristics. “Brains with these mutations do not have Lewy Bodies, but do show degeneration of the black substance, in other words, destruction of the dopaminergic neurons”.

It is known that there is a mutation of these two genes that gives rise to the disease and that the death of these neurons occurs in the inherited types, but the genetic cause in the sporadic cases is unknown.

“We have cultivated mouse neurons; it is an interesting model because they are dopaminergic that express very particular markers that have their prolongation and potentials for action, which is why we want to find out why they die,” according to Arboleda.

In the Genetics Laboratory at the Universidad Nacional they remove the Parkin and Pink1 genes in order to observe what happens with the neuron. “We have found that these two genes are involved in the dynamic and natural protection of the mitochondria, the organelle of the cell that provides much of its energy.”

“If the cell lacks the ability to ensure that the mitochondria are in a certain place, it will not have sufficient energy to carry out its tasks. At the same time, if the organelle fails to degrade when it must do so, this leads to chaos that can cause premature cell death and reach damaging levels. That is what interests us: to see how neurons survive when the gene is extracted and how these processes can or cannot regulate the genes,” explains María José Contreras, a doctoral student in biomedical sciences and member of the research team.

They have also investigated what happens if, instead of taking them out, more are applied. “We have found a toxin of environmental origin that has been associated with one type of Parkinson’s. It is a lipid called ceramide; we have observed that if the gene is overexpressed, the neurons are more resistant to the toxin and do not die”, says Arboleda.

If the genes mutate they lose their function; that is why, thinking about a possible therapy for Parkinson’s, the ideal would be to increase the function of those genes given that they protect the neuron and mitochondria.

Contreras clarifies that all human beings have the Parkin and Pink1 genes, the difference being that people with hereditary Parkinson’s have the mutation, which prevents them from fulfilling this function correctly and generates the disease.

It is not known what happens in the sporadic cases. Studies have shown that exposure to herbicides and similar substances are risk factors; in general, animal models use these substances in the experiments.

“We are working with rats that are injected with the toxins and a model is generated in which the problem appears; it is a practice which is just now getting underway at the UN. There are also transgenic models, in other words, with mutations in some of these genes that also generate motor problems, but these experiments are carried out with Drosophila flies.”

Although the experts recognize that we are far from achieving a cure for Parkinson’s, this research helps to decipher the mysteries of this complicated disease step-by-step.

At the Genetics Laboratory of the UN experiments are carried out with animals and show how the disease affects the motor system of certain rats.
A Virtual Technique Will Make It Possible to Predict Genetic Diseases

Using knowledge of the genome to anticipate diseases that a person will suffer is close to being a reality. A technique developed by researchers at the University of Wisconsin—Madison and the Universidad Nacional de Colombia, based on tiny structures known as nanochannels, is helping to decipher the genetic code with greater detail and speed.

Gimena Ruiz Pérez, Unaludis

What if a medical consultation could tell you that in 10 years time you will suffer from cancer, Parkinson’s, arthritis or other afflictions, but that treatment to prevent the onset of the disease could begin now? Surprising isn’t it? Researchers from the University of Wisconsin–Madison in the United States and from the Universidad Nacional de Colombia in Medellín are working jointly to achieve this important scientific advance.

Over the course of several decades, professor David C. Schwartz developed an optical map in microchannels (set of “tubes” or “tanks” created on a microscopic scale using lithography methods, 1 million times smaller than microchannels), which makes it possible to completely sequence and extract the human genome in high-resolution.

This technique is based on the organized presentation of DNA molecules that are then analyzed using visual tools such as the optical microscope.

Predictions in a short time

Although the procedure was created years ago, the complete analysis of a genome – from its preparation until its interpretation – takes months. That is why, based on this first advance, professors at both institutions developed a methodology to optimize and reduce the time for the procedure to just hours, through the use of nanochannels (1 billion times smaller than microchannels).

“This is the only method that currently exists in the world to analyze the genome at a resolution of various nucleotides (the basic unit of DNA). There are latest generation techniques that create sequences, but none have the quality, simplicity and low cost of optical nanomapping. This means that in a few years we will be able to have a clinical tool that will enable us to compare good and bad genes to predict whether a person will suffer from diabetes or if their offspring will have malformations”, says Juan Pablo Hernández Ortiz, a professor at the Mining Faculty at the UN in Medellín.

“In optical nanomapping we mark the DNA at various points and then pass it through a nanochannel, where we stretch it and read it optically as though it were a barcode. This reading enables us to extract the genome”, he reports.

Thus, using a computational model (developed at the UN), a digital experiment is carried out into which all of the physical elements of the process are incorporated.

The researchers have performed experiments with sequences and genomes of animals and humans using the procedure. According to professor Hernández, “in the physical experiment, the virtual simulation process is replicated. A DNA solution is taken, in other words, from a chromosome, it is separated and the DNA molecules are extracted. They are then placed in a saline medium and enzymes are added that adhere to determined parts of the molecules, creating a fluorescent point. Using a syringe, this substance is then injected into a microchannel, and in an electrical field, the molecules are forced to pass through the nanochannels. By combining this information, the genetic code is extracted one by one.”

State-of-the-art in medicine

He affirms that perfecting this technique would make it possible to advance in other hitherto unexplored fields. “There are diseases whose origins have not been determined and it is not known how to prevent them. They are aberrations of our genetic code that could be clarified through this procedure.”

For professor David C. Schwartz, “the project is discovering ways of obtaining data from this so-called ‘individual genetic profile’, fostering medical advances through the development of new computer programs and machines that rapidly and economically read the biological information of each individual”.

“When medical science is able to gain access to this technique, complications from these illnesses will decrease. In the economic sphere, people will spend less on medications, more will be known about conditions such as cancer and diabetes and many new diseases will be preventable”, reconstructive plastic surgeon Claudia Mora acknowledges from her perspective.

Catalina López Correa, vice president for Scientific Affairs at Genome Quebec, stresses the way in which microfluids technology and nanotechnology applied to the study of DNA and genomics in general (DNA, RNA, study of proteins) is accelerating and facilitating research such as optical mapping. “Its impact on the development and validation of new genetic tests and the way of diagnosing and treating diseases such as cancer and other cardiometabolic conditions is huge”.

“Seeing and reading the complete book of life”. That is how professor Hernández views the process that can be carried out using this technology: “DNA is simply a language of four letters that tells us all of the functions of living things. Using the high-resolution genome, we will also be able to study the way to create vaccines and treatments. In this way, a field of research will also open up for other disciplines such as pharmaceuticals and bioengineering”.

The project entitled “Study of DNA in Nanochannels for High-resolution Genome Studies (Estudio de ADN en nano-conexores para estudios de genomas de alta resolución)” is financed by the National Institute of Health (NIH) and the National Science Foundation (NSF) of the USA through the Nanoscope and Engineering Center (NSEC) of the University of Wisconsin–Madison.
The crisis that Colombia has gone through over the past five years because of the rainy seasons has resulted in the destruction of millions of crops and numerous victims in much of the national territory. Experts agree that one of the gravest errors has been the lack of prevention and follow-up on the country’s main river flows.

According to the Institute of Hydrology, Meteorology and Environmental Studies (Instituto de Hidrología, Meteorología y Estudios Ambientales – Ideam), the institution responsible for monitoring the behavior of water levels in the rivers, along with some of the Regional Autonomous Corporations (Corporaciones Autónomas Regionales – CAR) in Colombia, there are around 800 hydrological stations distributed around the main hydrographic river flows such as the Magdalena, Cauca and Amazon, measuring and recording their levels directly or indirectly. However, even with this information they have not been able to accurately predict floods.

Thus, researchers at the Universidad Nacional de Colombia (National University of Colombia) in Palmira and from the IRD in France (Institut de Recherche pour le Développement) have been working for the last five years on the development and application of a hydrological monitoring network based upon information obtained from space. The goal is to efficiently and precisely measure the levels of Colombia’s main rivers and observe their behavior over time.

One of these systems is already operating in the Orinoco basin. It was created by Professor Juan Gabriel León, who holds a doctorate in Earth and Environmental Sciences, along with Astrid Lili Puertas, an Environmental Engineering student. With data from the Envisat satellite, the researchers obtain information to determine the amount of water flowing through the rivers.

Without the need to install physical measurement stations on the rivers which must be physically observed on a daily basis, as performed by the Ideam, the experts in 2002 and 2008 were able to identify around 600 remote virtual stations or monitoring points in Colombia detected by satellite. Around 208 are located in the country’s main river basins (see graphic 1).

Incomplete official information

“A virtual station is defined as any intersection that occurs between the sweep of a satellite and a body of water that it identifies, based upon which it is possible to obtain information on variations in water levels over a given period of time”, according to student Astrid Puertas.

The data on the Orinoco river were organized by the researchers using the so-called Alitico database (alitometry for Colombia), which they supplemented with hydrological data obtained from the Ideam. In this initiative, Professor León found that the Ideam furnished reports from only 20 of the 64 stations corresponding to this important basin, with incomplete reporting for some periods.

If the authorities responsible for disaster prevention and the scientists consult this information, they will definitely be working based on incomplete records, which generates many uncertainties, that may be the reason why it is so difficult in this country to precisely predict the overflowing of the large rivers that cause flooding”, affirms the professor.

Using the Envisat satellite, the researchers at the National University identified 120 virtual stations in the Orinoco River basin (the world’s third most abundant), obtaining precise information on variations in the water levels in 2002 and 2008. By comparing the records of one of these virtual stations with those of a physical station installed in the field by the Ideam, whose geographical positions are exactly the same, a similarity is observed in their series, thus leading to the conclusion that the information obtained from space is accurate and reliable (see graphic 2).

Astrid Lili Puertas affirms that “this research is very important, not only because it provides supplementary data to those of the Ideam, but because it makes it possible to have a monitoring station anywhere in the country, regardless of the existing social or demographic conditions that would normally affect traveling to it. Meanwhile, it may be possible for scientists to gather key information on the Orinoco basins.”

Useful for generating early warnings

In addition to identifying virtual points from which to carry out satellite monitoring of the water levels in the basins, the researchers were able to estimate flows, in other words, to analyze the amount of water flowing through the rivers, which could make it possible to know beforehand at what specific level there could be an overflow.

“We make these assessments by applying a hydrological model, which could provide us, for example, with information on the limits of flooding,” says León.

However, the researchers clarify that it is the relevant entities that must be responsible for the prevention of natural disasters, and that this type of reports is reliable for feeding their early warning models.

Professor León concludes that “the control bodies must be called upon to work together with academia to develop high-impact projects, which are the basis for working to improve their modeling methodologies and prevention plans”.

Using data obtained in space, researchers measured river levels in the Orinoco basin and the approximate amount of water contained in its main river flows. They were thus able to develop a hydrological monitoring network that governmental institutions would be able to use to predict flooding and avoid possible catastrophes.
After an air accident, part of the work of first responders is to find the aircraft’s black box where the flight parameters and conversations of the crew during an emergency are recorded. The compilation of those data makes it possible to reconstruct what happened before the accident and to determine its causes.

Inspired by this idea, Plinio Teherán, Professor of Physics at the Universidad Nacional de Colombia (National University of Colombia), created an apparatus based on the same principle, but to establish what has happened before, during and after a traffic accident. It is called the Testigo Digital Automotor (Digital Automotive Witness) (TDA) and, in contrast to the black box on an aircraft, it does not record conversations but merely records the dynamics of the movement of a vehicle as it travels.

The professor has been working for the last 15 years as a consultant for the Attorney General’s Office to try to clarify the facts in vehicular collisions, and has observed that the mathematical patterns used for this purpose obtain reliable results in very few cases. “We carry out this work without being paid, at the request of the judicial institutions. It requires a lot of time and a sufficiently high technological level in order to obtain better and timely data”, adds Teherán.

That is why, along with two Physics and Engineering students, he built the TDA, as it is called, to reliably save the information, so that the trajectory, in other words the way in which an automobile moves, can be reconstructed.

The apparatus consists of accelerometers, memories and circuits, and is able to measure when an automobile backs up, turns to the right or left, goes over a bridge or reduces speed, etc. Because it is digital, its data is then processed in a computer, where an educator then creates an animated version of the vehicle’s last movements.

Increased accidents

According to statistics kept by the Road Prevention Fund (Fondo de Prevención Vial), there are around 5,000 deaths each year in Colombia due to traffic accidents. “In 2000 there was a peak of 7,000 highway deaths. As a result of campaigns to promote the use of seat belts, the figure fell to 4,200, but motorcycle accidents have once again led to an increase”, comments Teherán.

Injuries due to traffic accidents have reached 50,000 per year. Data on how many of these people after being hospitalized is not yet available because death certificates always give a different cause of death, such as cardio-respiratory failure.

The Colombian Insurers’ Federation (Federación de Aseguradores Colombianos – Fasecolda) in 2010 recorded around 250,000 accidents involving vehicle damage but without injuries, and in the great majority of such cases the guilty party is never determined. “It appears that drivers do not care if they break the law because they feel sure that they will never be prosecuted. Given that lack of concern, along with the inability of the system to prosecute the responsible parties, it is only natural that there is an increase in the number of accidents”, explains the physicist.

That is why the idea is to convert the TDA into a forensic tool, so that responsibility can be determined and cases can be promptly and fairly resolved. This system is actually an improved version of Wii, which uses accelerometers. “When the racket moves, the computer records it because the accelerometer indicates the angle that is activating the device. The accelerometers in the game consoles are of lesser quality than the ones we use, because Wii is not able to deal with an increase in velocity on the order of 300 g (gravities), which is what happens when an automobile collides with a truck”, according to Yamid Núñez, a Masters student in Physics at the UN and a member of the project.

The TDA, whose size is similar to that of a cellular phone, has been subjected to processes of acceleration and tested in different parts of vehicles and even motor-cycles, where it has been shown to record every movement. The apparatus is installed near the gearshift lever underneath the radio, a zone rarely affected by the deformation following a serious collision. At the same time, the device would be enclosed in a steel box that only a competent authority would be permitted to open in order to recover the information. The apparatus would be capable of recording as many as 10,000 pieces of data per second, which is enough to reconstruct what happens during a collision. The necessary information, with certain algorithms, is permanently recorded in an inviolable memory.

“We are working to provide the apparatus with a sufficient degree of invulnerability, so that the data could not be altered mechanically, electrically, or by hackers”, says Teherán.

One of the big advantages of this device in the court system is that it would make it possible to resolve cases in less time. Currently, with the new accusatory criminal system, two years or more can pass between the time an accident occurs and when formal charges are brought. The TDA provides virtual animation of the accident in five minutes and would therefore substantially reduce the timeframe for trial.

In addition to being convinced of the valuable contribution of the TDA in clarifying what has happened during a traffic accident, Teherán and his students are sure that, if each driver were to have one of these apparatus installed in their vehicle, they would think twice before committing imprudent acts. They therefore look to the possibility that someday pedestrians would carry a similar but smaller device on their belts to be able to completely clarify any accident that they could suffer.

“We designed and presented the proposal, and now we are working to get it accepted”, concluded the physicist from the Universidad Nacional.
Electronic waste, a mine for precious materials

Agencia de Noticias UDI

Junked computers, cell phones or TVs could be a gold, silver or copper mine, according to UN students, through a chemical process called hydrolysis.

Although there are companies devoted to the extraction of precious materials on an industrial scale, seven Mining College students have come up with a novel model. Unlike more traditional procedures, this one uses hydrolysis to extract these elements from disposable computer electronic boards.

The method consists of separating magnetic particles and polymers through a chemical process, while searching for elements such as gold, silver or copper. These are obtained by leaching or extracting them from liquid components such as sulphuric acid.

Carlos Mario Suárez, a Mechanical Engineering student, explains that the procedure is known as hydrolysis where "liquids like sulphuric acid and cyanide extract metals, without leaving residues which neither affect the environment nor consume a lot of energy". It is not performed from smelting as this could harm the environment.

Tomasa del Carmen Pavón, an Industrial Engineer states that the interest to do the project is due to the fact that in "Colombia electronic waste management is something new; we know that these components have toxic and chemical residues that may be harmful to people".

It's been estimated that the country produces more than nine thousand tons a year of electronic computer waste. The Gestión de Residuos de Aparatos Eléctricos y Electrónicos (RAEE) in Colombia projects 0.5 kg per person for 2013. Therefore, students of the UN have devised this optimization strategy for materials which are generally disposed of, as a recycling mindset hasn't yet developed in Colombia.

According to the tests realized by the students, for each 100 grams of electronic boards up to 0.2 grams of gold, 0.1 of silver, 20 of copper, 2 of zinc and 7 of aluminium can be extracted. Additionally, this method may be applied to electronic boards of other electronic appliances such as washing machines, TV's, cell phones and laptops.

This innovative method was proposed during the Academic Open House put on by the Mining College. The creators of this innovation are confident that in the future this strategy can be implemented on a full scale.

Creating biodegradable polystyrene from mushroom waste

Agencia de Noticias UDI

A group of students from Universidad Nacional in Medellín is utilizing the waste from abandoned edible mushroom heaps and turning it into biodegradable polystyrene for commercial use.

Researchers have discovered that waste utilized in commercial mushroom farming, such as sawdust, grass, plantain leaves, coffee waste, amongst others are compacted after being mixed with mycelium, the reproductive colonies of fungi. Furthermore it has an assembly quality that enables the creation of an element similar to polystyrene.

The process consists of collecting the waste or units left over after mushroom harvesting and then building "a standard block providing a uniform size (1 to 2 kilos): this is performed using a manual hydraulic press in order to minimize energy expense, emissions and water consumption", according to Laura Soto, a student of Industrial Engineering in the Mining College.

After the material is produced, another machine is used to form the packing material used for glasses, candles, wine bottles and other similar products. The process is completed with a baking and evaporation procedure, which helps to eliminate the moisture and finalize the production of the polystyrene.

To manufacture the "artificial" polystyrene, byproducts from mushroom farming, such as sulphuric acid, are utilized by the students, for each 100 kilograms of electronic boards up to 0.2 grams of gold, 0.1 of silver, 20 of copper, 2 of zinc and 7 of aluminium can be extracted. Additionally, this method may be applied to electronic boards of other electronic appliances such as washing machines, TV's, cell phones and laptops.

This innovative method was proposed during the Academic Open House put on by the Mining College. The creators of this innovation are confident that in the future this strategy can be implemented on a full scale.

Example of mushroom waste after conversion to "Icoplan".
**Machine would dry yucca leaves for nutritional purposes**

Agencia de Noticias UN

A thermodynamic design, developed by Mining College researchers, dehydrates yucca leaves for animal or human consumption. 

Víctor Hugo Borda, a researcher of the Applied Thermodynamic and Alternative Energy Group (TA-YEA, for its Spanish acronym) of UN, developed a thermo-photo-voltaic system for drying yucca leaves. This project was articulated as an academic secretary of the Faculty of Agronomy of the University of Antioquia, and the industrial processing of the Nariño potato producing peasants (Nariño being the pilot Colombian province for the tests) went from being poor man’s criolla, in other words, from a popular Colombian grill setting (fritanguería) to international gourmet kitchen. Exports of criolla, that unlike white mashed potatoes, will have organoleptic elements as well as better taste and texture properties, in addition to high zinc and betacarotene contents”, he says. The third proposed line are frozen foods. According to the researcher, “potatoes are pre-cooked and then quick-frozen with a thermal shock system. This type of freezing method maintains most of the color and taste features that make papa criolla so special, as well as its flour-like texture”.

Colombia is the first producer and exporter of papa criolla in the world. Annually, between 8,000 and 10,000 hectares of this potato are planted, generating a harvest of more than 1,000 tons. Although the research only proposed the genetic process and not yet implemented it, the project is expected to increase the potato’s water resistance and resilience against diseases such as ‘potato blight’ (Phytophthora infestans) and the ‘yellowing vein’ virus, a disease linked to climate change and global warming”.

**“Papa criolla” will now be canned and naturally preserved**

Agencia de Noticias UN

Work performed by UN, in conjunction with potato growers, has come up with a genetic improvement of the potato so that it can be canned and naturally preserved, while still maintaining its primary characteristics.

Speaking with this news agency, Luis Ernesto Rodríguez, the academic secretary of the Faculty of Agronomy of the Universidad Nacional de Colombia, explained that this project was multi-disciplinary and had two distinct goals: a genetic improvement of the potato, and the industrial processing heated by Professor Angel Herrera, Director of the Instituto de Ciencia y Tecnología de Alimentos (ICTA) of UN.

This genetic exercise extends all the way to industrial production. It has been performed completely at ICTA and has several plans of action, one of them being the making of canned or glass pickled potatoes (papa criolla). The potatoes are cooked and bottled in a salt and vinegar solution. The benefit is that they have between 3 and 4 years of shelf life and still preserve their flavor, odor and texture characteristics. Furthermore, they can be exported to remote markets such as China and the rest of the Far East”, he adds.

“Starches are another planned product line for this inter-disciplinary project with this resistant vegetable. We are also going to market mashed papa criolla, that unlike white mashed potatoes, will have organoleptic elements as well as better taste and texture properties, in addition to high zinc and betacarotene contents”, stated Víctor Hugo Borda.

Another great feature of this machine is that renewable and solar energy is used in order to enable areas without electricity to use this kind of alternative procedure. The machine has a thermosolar system, composed of several Fresnel lenses, focusing solar energy towards a thermal plate with photovoltaic panels. The focused heat is used to increase the air temperature inside the drying chamber, where the yucca leaves are deposited.

Preliminary drying tests have been performed in laboratory operating units with 3 kilos of leaves brought from the Centro Internacional de Agricultura Tropical (CIAT) in Palmira. This center has the specific material and special varieties in their crops for the tests performed with UN hybrid photovoltaic equipment which is used for drying other materials.

Although the research only utilizes the thermodynamic model in order to analyze the behavior of the material in an industrial setting, countries in Africa and China have been known to test this nutritional strategy using raw materials such as the yucca leaf.

This strategy could be used in the Colombian Department of La Guajira or the Mutatá region in the Department of Antioquia.

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**The genetic process**

The Professor indicated that the Genetic Improvement Program of the Faculty of Agronomy began in 2008, improving the variety of the papa criolla by means of scientific work. “It all started with the idea of achieving a more robust product which would be resistant to the diseases that affect potato crops, such as ‘potato blight’ (Phytophthora infestans) and the ‘yellowing vein’ virus, a disease linked to climate change and global warming”.

“As the production area temperature grows, so will the population of the white fly that transmits the disease. Almost all of the potato production areas (not only papa criolla, but all varieties) are already infected. First, we gathered disease resistance plants and introduced in the latter virus-clean white flies to feed on the leaves. Later, the infected flies were introduced to the genetically modified white potato plants. Afterwards we analyzed the data to determine which modified plants had genetic resistance to the disease”, he concluded.

*Andean yellow potato/creole potato*
Erosion Alert at Colombian Beaches

Over the last year, Bocagrande, in Cartagena, has lost 50 meters of its coastline due to problems stemming from erosion and rising tides (mares de leva). Palmeras, in the Gorgona National Natural Park, is going through a similar situation. The infrastructure, tourism and a unique species of turtle found only there are seriously threatened. Experts point to the need to take action in the affected zones and to recover the coasts.

Giovanni Clavijo Figueroa, University of Cartagena

While the country tries to recover from one of its most extreme series of floods in recent years due to the winter rainy season, some of the coastal zones of Colombia are threatened by climate variability in this region of the continent, according to a study carried out by the research group on Oceanography and Coastal Engineering (Oceánicos) at the Universidad Nacional de Colombia, the Research Center for Environmental Management and Development (Centro de Investigación para el Manejo Ambiental y el Desarrollo – Cimad) and the Universidad de Cantabria (Spain).

The experts point to the need to take action in areas affected by erosion in Bocagrande, Cartagena, to protect the tourism industry, and to recover Playa Palmeras on the island of Gorgona, to conserve a unique species of turtle found nowhere else in the world, the Golfo (Lepidochelys olivacea).

The objective of the Oceánicos group is to analyze the natural dynamics of the Colombian coastal zones (which have not been widely researched until now), generate knowledge and provide solutions for their problems. And at the same time, to call the national government’s attention to the need to organize the beaches into natural ecosystems that are constantly affected by changes.

Monitoring the beach

Bocagrande has a vital tourism sector, but it has been affected by climate processes such as rising tides (mares de leva) – which are increasingly intense, tail ends of hurricanes and coastal erosion, among other phenomena. Over the last 20 years they have changed the natural dynamic of the sea and waves, making them very unstable.

To understand the problem in this context, it is important to note that this is a matter of coastal erosion: the beaches have a certain width (area) for bathers next to the sandy sediment. The continuity of this process generates a loss of beach area so that the waves end up striking the cliffs, buildings and roads. In Cartagena this process is endangering the sustainability of its infrastructure and the well-being of its population.

At the same time, the rising tides (mar de levá) are a phenomenon that affects the Colombian Caribbean and comprises all of the extreme events that generate flooding on the coast. For example, the sea level may rise due to winds and pressure fronts (meteorological tides). In addition, the waves that reach the beaches can be intensified by cold fronts and/or hurricanes, which make the level of flooding on the coast higher than normal and overwhelm the embankments of the roads, seafronts and buildings.

In Bocagrande there are hotels and homes near the beach that are in danger of being flooded, according to professor and researcher Andrés Osorio, from the Oceánicos group at the Mining Faculty of the Universidad Nacional in Medellín.

"To counteract the risk, the government must implement a plan to organize the coasts along with a permanent monitoring program, as well as coastal infrastructure in certain cases, and in others strategies for relocating the population that lives in the most vulnerable zones."

To measure the erosion, the Universidad Nacional has developed a system that is unique in Latin America to monitor the beaches in real-time. "Using digital cameras, we constantly take photographs which we send over the Internet to an operational center where the erosion of the beaches is analyzed and identified along with the way in which sediments accumulate in certain stretches. This also enables us to measure the currents and quantity of the waves", says the UN researcher.

50 meters less of beach

The monitoring carried out by the researchers a year and a half ago at Bocagrande made it possible for them to see how the beach has lost 50 meters, due to the extreme climatological fluctuations and severe tidal events that occurred during the hurricane season between January and December of 2010.

Osorio warns that “the rising sea level and climate variability associated with the El Niño and La Niña phenomena are a reality that the country has just gone through, and what occurred on the rivers, although it has been more critical, is also happening on the coasts, which are at great risk and threatened; it is just that we have not perceived this”.

Osorio says that tourism, which is one of the main locomotives for Cartagena’s economy, could be significantly reduced because of these threats. "If the beach is eroded, travelers will not have a place to soak up the sun. In response to such destruction, they will surely avoid returning".

However, their study proposes short, medium and long-term solutions, beginning with an understanding of the coastal dynamic. "If we monitor the beaches, we..."
will have average data and reliable information to enable us to estimate the time of year in which, for example, a hurricane could come through along with its possible impact on the coasts. This would make it possible to take preventive measures”, concludes Andrés Osorio.

The project, financed by the Spanish International Development Agency (Agencia Española de Cooperación Internacional para el Desarrollo - Aecid), has made it possible to address this research problem using state-of-the-art technology.

**The Golfinas is losing its nest**

Playa Palmieras, in the Gorgona National Natural Park, has an area that is approximately 1200 meters long and some 20 meters wide on average at low tide conditions. It is therefore a really short and small beach where the sea turtles of the *Lepidochelys olivacea* species, commonly known as the Golfinas, come from the Gulf of Mexico to lay their eggs.

For more than 40 years, the island was a maximum-security prison, and numerous coconut palm trees were planted on its beach, thus giving rise to its name. These plants grew without any control, occupying ever more space along the sandy edge and colonizing the places available for the turtles to build their nests. Currently, the space available for them to naturally lay their eggs is minimal.

The impact on their nests has been huge because it means they are exposed to the sea, and when the water level rises above what is normal, the nests get washed by the waves, as observed by Diego Amorocho, PhD and executive director of the Cimad. “Between August and December of 2010 we recorded around 28 nests, and in the year-to-date between 80% and 90% have been lost”.

The situation is increasingly critical for this species, which is in danger of extinction, even though Palmieras is one of the few beaches that does not have direct anthropogenic impacts, in other words, there is no pressure on the turtles and their eggs from a human population.

During the 2010 reproductive season, the researchers relocated the nests on a kind of platform to facilitate better incubation, attempting to isolate them from the impact of the tides and the action of the waves. This, however, proved insufficient. “The successful hatching rate was only 34%, compared to previous years when it ranged between 78% and 86%. In other words, 86 baby turtles would emerge from the nest”, according to the director of the Cimad, who has closely followed the behavior of these animals.

**Nesting process**

Of the seven species of sea turtles that exist in the world, the Golfinas is the smallest, measuring between 60 and 70 centimeters and weighing around 45 kilos. They arrive on the Pacific coast of Colombia between July and November to lay their eggs in a 60 cm deep nest that the female digs. There she deposits an average of 100 eggs, which take between 45 and 50 days to complete their incubation period. When the young emerge, they go to the edge of the beach and then begin to walk to the sea; 30 or 40 years later, if they are lucky enough to survive to adulthood, the females return to lay their eggs on the same beach where they were born.

For Amorocho, “this place has a very dynamic oceanographic and climatological process, and what is happening can affect the sandy border available for the turtles to nest. The worst thing is that the growth and colonization by the coconut palms towards the sea is taking away this species’ space for egg laying”.

That is the finding of the Oceánicos group from the UN that he leads, which last year began a project to evaluate the impact on the Golfinas of the palm and beach erosion and accretion processes. This knowledge will enable them to propose alternatives for conservation of this species.

With the approval of the National Parks Unit, an attempt will be made to selectively modify the area where the vegetable species are planted. The idea is to enlarge the space available for the turtles’ normal reproduction towards the land in order to protect the existence of this species on the Colombian Pacific coast, which has a crucial role in the ecosystem.

“The sea turtles are indispensable for maintaining the balance of the marine ecosystems and play an important role as elements for the flow of nutrients between the land and maritime environments. The baby turtles have an ecological function on land because they serve as food for other species that prey upon them, such as crabs, marine birds and small mammals. In this way, the stability of the trophic chain in the beach ecosystem is maintained”, asserts Diego Amorocho.

In addition to the Oceánicos group from the UN and the Fundación Cimad, the National Parks Unit also takes part in the Playa Palmieras research project, with support from the Fund for Environmental Action and Children (Fondo para la Acción Ambiental y la Niñez) as well as Conservación Internacional.
A New Bee Species with an Unusually Long Tongue

Found in the Department of Nariño, near the Ecuadorian border, captivating because of its bright colors, but above all because of its enormous tongue, which is twice as long as its body, the world’s longest until now.

Scientists estimate that there are around 20,000 species of bees in the world, and approximately 5,000 are found in the Neotropical, in other words, in Latin America, according to Carlos Sarmiento Monroy, an entomologist at the Institute for Natural Sciences of the Universidad Nacional (National University).

The complete inventories carried out by the Bee Research Laboratory of the National University (Laboratorio de Investigaciones en Abejas de la UN –Labun), led by Professor Guiomar Nates, contain information on the five families of these insects present in Colombia (Colletidae, Andrenidae, Halictidae, Megachilidae and Apidae), around 60% of the genera and nearly 25% of the species.

Euglossa natesi n. sp. is one of the orchid bees, so named because of its pollinating action and special relationship with these flowers. According to Rudolfo Ospina, professor at the Biology Department of the UN and who first described this new variety, “the males are attracted by certain species and not only look for honey and pollen but also aromatic substances”.

With long tongues

All of the bees of the genus Euglossa, which in Germany are known as Jewel Bees because of their bright blue, green, brass and gold colors, have very long tongues. This organ can be even longer than their bodies, but even so the tongue of the Euglossa natesi, named in honor of Professor Guiomar Nates for her contribution to the study of bees, is unusually large.

“This insect is different, because it has the longest tongue found until now, which is more than twice the length of its body”, says Professor Ospina. He added that this characteristic enables it to gain access to sources of nectar that other bees cannot reach while at the same time pollinating other plants besides orchids.

Euglossa natesi looks for oleaginous substances that it can use to attract a mate. It impregnates its feet with aromatic oils that it stores in its rear tibia, and using a kind of spray in its middle feet, deploys fragrances that it uses to compete and seduce the females. Every male has its own combination of aromas.

The orchid bees are abundant in the rainforests of the lower altitudes of the Neotropical region, “although the possibility that some species also live in dry and open habitats cannot be ruled out”, says Ospina.

There is still disagreement among scientists regarding the subgenus E. natesi, because on the one hand its morphology is similar to that of Glossurella, such as the absence of hoods on the sternum, while on the other hand it resembles Glossura, in the form of the posterior tibia, the length of the tongue, the size of the body and the tuft of hair that the males have at the tip of their genitals. This contradiction makes them unique among the members of these two subgenera.

Endemic

This new bee was found in 2005 in the Río Ñambi Private Natural Reserve in the Department of Nariño, in the municipality of Barbacoas, by student Víctor Solarte, of the Labun, along with Alejandro Parra and Santiago Ramírez, who are carrying out their postdoctoral studies abroad. To trap them in the forest, they used bait that imitated the aromas of the orchids.

The species has a limited distribution and is endemic to the biogeographical region of the Chocó, “which demonstrates the potential biodiversity of this region”, says the professor.

The foothills of Nariño where this new species lives is one of the world’s rainiest places, and due to its highly sloped terrain and its vegetation, the bee communities frequently move between relatively close by areas.

This “exchange” of species among neighboring ecosystems is known as “beta diversity or differentiation of the diversity between areas”, and complements the concept of alpha diversity, which is based simply on the number of species and their local abundance.

In this regard, the foothills of the Pacific and particularly the Nambi
region demonstrate a high level of beta diversity compared to other regions, “as shown by the results obtained with the orchid bee community”, according to the expert.

He adds that these insects tend to exploit two types of flowers: those that are available throughout the year and, depending on the season, those from plants with defined flowering periods. For example, some species flower during one month a year, whereas others flower during as many as 10 months.

This strategy of exploiting resources, along with the mobility of the bee communities along the altitudinal gradient (progressive transformation in the vegetation, soil and fauna of a slope) “shows that the forests of the biogeographical Chocó, far from being homogenous, are systems that effectively respond to environmental variations”, says Professor Osipina. “Therefore, they must be understood in their variability in order to implement effective measures for protection or recovery of one of the planet’s most diverse areas.”

The Labun, recognized in the scientific world for its bee collection, has the privilege of conserving the holotype, in other words, the only example that serves as a point of reference for the description and comparison of new species. However, some examples of this species (paratypes) have been sent to other collections.

Threatened Bird is Saved

The pava caucana, an endemic bird of Colombia classified as being in danger of extinction, is recovering its survival possibilities in the Yotoco Natural Reserve (in the Department of Valle del Cauca). The good condition of this forest has made it possible to conserve 100 members of this species.

In 2004 researchers from the Universidad del Valle found that in order to locate a group of pava caucana they had to walk through 5.3 km of dense forest to find an average of 1.4 individuals. In contrast, the researchers from the UN in Palmira, sampling as many as 92 km, have discovered that this year in order to find a group of these birds they needed to walk approximately 2.3 km, a lower indicator in terms of distance.

According to zootechnician Carlos Jaramillo, director of the reserve, this increase in the frequency of sightings shows that the pava caucana has not been extinguished in the Valle del Cauca and that the Yotoco Reserve is artfully working to acquire knowledge about it and for its conservation, as it is cataloged as being in imminent danger of extinction.

Experts committed to conservation of the pava caucana have carried out studies and monitoring to identify its role in the ecosystem and determine if the population is increasing or decreasing over time. A study undertaken in 2006 by biologist Gustavo Kattan for the Fundación Ecodependia and the Instituto Humboldt, in the Otún Quimbaya Fauna and Flora sanctuary in the Department of Risaralda (where the greatest number of these birds are found), showed that they eat 91 species of plants with large quantities of seeds that they disperse intact through their fecal material.

“This shows that the pava can be an effective disseminator in transporting and depositing seeds through the forest, because thanks to its flexibility in the use of different habitats, including secondary forests and tree plantations, it helps to regenerate them”, says the researcher.

This potential functionality pava caucana in the ecosystem led a group of students from the UN (National University) in Palmira, coordinated by researchers from the WCS and with support from the Fondo Mohamed Bin Zayed, to walk through the rainforest of the Yotoco Reserve for a year to monitor the status of these bird populations.

“Because it is a bird that is unique to Colombia and is found in very few places, we need to constantly watch over its populations to determine if they have increased or decreased, and to identify if they are in good condition”, affirms Catalina Gutiérrez, a scientist with the WCS.

Not much is known about the elusive Penelope perspicax, commonly known as the pava caucana or pava de monte. This galliform bird, which belongs to the Cracidae family, found in the geographical valley of the Cauca River, is on the list of endangered species, according to the International Union for Conservation of Nature (IUCN), partly due to loss and fragmentation of its habitat as well as hunting.

Researchers from the Universidad Nacional de Colombia in Palmira (National University of Colombia) and the Wildlife Conservation Society (WCS) are tracking it through a meticulous monitoring program in the 559 hectares of the Yotoco National Forestry Reserve (owned by the UN), where one of the last populations, consisting of approximately 100 individuals, is conserved.

Seed dispersal potential

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Bacterial infections are afflicting and killing the most popular decorative fish in the country, according to an epidemiological study that examined 4,000 of these animals and more than 100 species found in the departments of Vichada, Guainía, Putumayo, Amazonas and Meta and in export warehouses in Bogotá.

After clinical, histopathological, stereological and molecular biological analysis of the individuals, it was found that the main cause of mortality and disease are bacterial infections, mainly those caused by *Aeromonas hydrophilia*. These bacteria affect a large number of highly sought after fish such as the ‘cuchas’, ‘cardenales’, ‘escalares’, ‘sapuraras’ and ‘estrigas’, “The infections are associated with overcrowding, excessive handling of the fish and sudden alterations of water quality, mainly levels of oxygen, temperature and ammonium”, said the veterinarian from the UN.

Diseases were also identified that caused serious problems in particular species, such as brachial parasitic stemming from *Piscinoodinium* in ‘cuchillos’, gastrointestinal coccidiosis in ‘estrigas’ and skin infections compatible with *Favobacteriosis* in ‘monedas’.

In this regard, Penagos affirms that “it involves alterations that tend to strike particular families or species and need to be handled differently from the moment of capture”.

In a number of species, infections were also found due to mycobacteria (tuberculosis). In addition to the difficulty in controlling those diseases, the bacteria can cause skin infections among humans, which is why special handling is required at the storage sites.

The study creates a basis for improving the quality of health of aquarium fish exported from Colombia, and makes it possible to affirm that the country currently does not have diseases that lead to restrictions or health vetoes from the World Trade Organization. A book with the results will be published, under the title *Mapa epidemiológico de las enfermedades de los peces ornamentales en Colombia* (Epidemiological Map of Diseases of Decorative Fish in Colombia), along with two booklets on public health handling.

The research was financed by the Ministry of Agriculture and Rural Development, in partnership with the Universidad Nacional de Colombia, the Universidad de los Andes, ICF Caribfish and Coop-esca.
In 2005, a farmer in Villa de Leyva, who lived on a hillside in La Carolina, found what, at first glance, seemed to be two common ordinary rocks. His curiosity made him doubt this, however, and so despite their considerable weight, he took them to the Colombian Geobiology Foundation (Fundación Colombiana de Geobiología) in a rural area of the municipality, where experts confirmed his suspicions: those two objects found in the open air were actually fossils.

But there is nothing unusual about discovering prehistoric remains in Villa de Leyva, particularly when they come from marine reptiles, because numerous such findings have been recorded in that municipality. However, these nearly round remains were different because they proved to be femoral heads from a dinosaur.

The event became the first appearance of signs of a discovery in the region, and the third such discovery in Colombia. Six years later, research confirms that the fossils are indeed from a land animal, and that its morphological characteristics correspond to those of a dinosaur.

“The fossilized bones found in previous years in Villa de Leyva allow us to make comparisons. The femur from a marine animal is smaller, flattened and with a rounder volume. Bones from this recently-studied finding are different and may correspond to a sauropod”, according to María Páramo, professor of paleontology at the Universidad Nacional de Colombia and at the Foundation.

Although species are defined by such characteristics as the cranial and vertebral, it is difficult to conclude with precision the species to which these remains belong. Nonetheless, professor Páramo alludes to a particular characteristic of the sauropods: “They have a kind of lateral protruberance on the femur that could help us to approximate the identity of this individual. The size of this thigh bone shows that the animal could have a length between 12 and 18 meters”.

The pieces were found on the surface on top rocks that are approximately 125,000,000 years old. Based on this data, on the form of preservation and on the geological characteristics of the region, it appears that the sauropod lived during the Cretaceous era between 125 and 110 million years ago.

The geologist explains that the fossils came to be there through a process of natural mechanical transport. After the muscles and organs decompose, the bones are dragged along by water currents, nearby waves, rising tides or rivers and thus fossilize in a place other than where the animal had actually died.

On the beaches of Villa de Leyva

During part of the Cretaceous era (between 145 and 65 million meters ago), half of Colombia’s territory was covered by the ocean, which is why marine species from that period are relatively easy to find there: plesiosaurs, ichthyosaurs and marine turtles dating from between 130 and 125 million years.

In Villa de Leyva, a number of geologists have associated the discovery of so many marine reptiles with its past proximity to the coast, while others have cited the rocks that were deposited in deeper sites away from the shores. “The fact that these dinosaur remains have been found here associated with those sediments is an additional indicator that the coast could not have been far away, because these animals were supremely continental”, adds Páramo.

Another important aspect in the research is that the pieces found in this northwestern corner of the South American continent are of great scientific interest because they were discovered in an intermediate point between the large quantity of dinosaurs found in southern Argentina and Chile and those of North America and Europe. Thus, the few fossils that have been reported are of strategic importance in clarifying the relationships between the creatures from the two hemispheres.

For the first time, the remains of a dinosaur have been found in Villa de Leyva. In this municipality in Boyacá, known for its marine species fossils, scientists from the Universidad Nacional identified a sauropod approximately 125,000,000 years old. The finding of this land animal refutes the hypothesis that this region was far from the seacoast 145 million years ago.

Maria Páramo has been studying this femoral head for six years to determine the dinosaur species to which it belongs.

Dinosaurs from the coast and from the Department of Tolima

While María Páramo and student David García continue to put together the jigsaw puzzle in search of further details on the dinosaur, it is known that in Colombia remains have been found from two other land-based giants.

The first was discovered during excavation carried out by the Tropical Oil Company in 1945. According to the book entitled Paleontological notes, by Langston and Durham, vertebrae from the side plate of the thorax belonging to a sauropod dinosaur was found in the municipality of La Paz, Magdalena.

The piece is at the Paleontology Museum of the University of California at Berkeley, and what is unusual is that, for a sauropod, the bone is of modest size: the centrum (center of the vertebrae in the form of a drum) is 180 mm long, 165 mm high and 154 mm wide. This specimen is important because it had hitherto been found more to the north of South America.

The remains of the second dinosaur were found at Ortega, Tolima, in 1949. They consist of three isolated teeth from theropods, according to research carried out by Spanish geologist Martín Escurra.

The continental sediments from the Cretaceous epoch as well as a bit before during the previous Jurassic epoch make it difficult to find additional dinosaurs in Colombia, because the fossils do not easily rise to the surface. “They are not found exposed to the surface but rather at depths, which is why there are not many such solid materials available for study”, according to Professor Páramo.

Compared to the paleontology being carried out in Argentina or Chile, Colombia does not yet have much to contribute. ‘The advantage however is that we can learn from them’, she concludes.
The Mortiño, a promising fruit for the country's health and economy

A fruit with properties that help to prevent cardiovascular diseases, diabetes, arthritis, Alzheimer and Parkinson's is set to become an important export product. Mortiño, as it is popularly known, is being intensively studied while at the same time used to produce jams, sauces and even wines.

Gimena Ruiz Pérez, Universidad Nacional de Colombia

The mortiño, or Andean blueberry, Vaccinium montezumae, is popularly known, is being intensively studied while at the same time used to produce jams, sauces and even wines. Mortiño has been found to contain pigments known as anthocyanins, which act as antioxidants (substances that protect cells) in organisms.

That is why researchers at the Food Science Laboratory at the Universidad Nacional de Colombia (National University of Colombia) in Medellín, in Association with experts from Argentina, have focused on this fruit and are studying its chemical and biochemical characterization, antioxidant properties and agriculure potential, with a view towards promoting its production and consumption.

Professor Benjamín Rojano, the coordinator of the laboratory, reports that this curious fruit is found in the northern Andes, in certain zones of Venezuela and Ecuador and in the departments of Santander, Boyacá, Cundinamarca, Nariño, Cauca and Antioquia in Colombia.

Although the mortiño grows wild and the first adaptations of the plant in vitro are just beginning to be made, Colombia has a great potential to produce it. Therefore, and taking into consideration that berries (the family to which the mortiño belongs) are sought-after at the international level, above all in Europe and the United States, Colombia over the long term could become a large-scale exporter of the fruit.

One of the laboratory studies seeks to establish the conditions for greater production of antioxidants in different states of the plant, and to create a productive chain. "We are monitoring different zones of the Departments of Antioquia, Boyacá and Santander to find the terrains where the best fruits that can better conserve their nutracetical characteristics (natural substances with therapeutic action) can be produced", says Professor Rojano.

By analyzing different clones, the researchers have found differences in the expression of certain secondary metabolites (anthocyanines) and identified that the mortiños from the municipalities of El Retiro and Santa Rosa de Osos, and from the Township of Santa Elena, in Antioquia, have the greatest benefits.

With respect to climate change and its effects on flowering and fruiting, Clara Medina, PhD in Agricultural Sciences from the UN and a researcher at Corpoica, through her research study entitled Populational and Ecophysiological Variability of the Mortiño, a Species with Productive and Agro-export Potential in the High-Andean Tropic (Variabilidad poblacional y ecológico del mortiño, especie con potencial productivo y agroexportador en el trópico altandino), observed the behavior of the fruit in its natural habitat and under different light intensities.

"The main findings show that during times of constant rain, productivity decreases, whereas in shade the plant has a better response. Meanwhile, its growth can be controlled through pruning", affirms Medina.

Using a certification project for the species, it was found that in the Department of Antioquia the fruit survived in damp zones, whereas in Boyacá and Cundinamarca it is found in cold dry zones.

According to this expert in agricultural sciences, 'planting seeds of this species has made it possible for us to determine variables, for example that the entire growth process of the plant can take as long as four years'.

Yasmin Lopera, a master’s student in Food Science and Technolgy at the UN in Medellín, evaluated the antioxidant activity and cardio-protective effect of this fruit, but in wines. Her work was carried out in association with professors at the Universidad Nacional de La Plata (Argentina) and was based on the fact that consumption of this beverage in that country has increased by 55% over the last five years, while epidebmological studies have found that some wines act as antioxidants. She wanted to prove this herself.

Lopera now has a standardized beverage under conditions and parameters suitable for fermentation. She says that it is feasible to produce a quality wine that would be attractive and appetizing to consumers.

What is this unexplored fruit like?

The andino plant can be from 1.5 to 7 meters high. It grows wild in altitudes between 2200 and 3400 meters above sea level. Its fruit is round, approximately 1.2 cm in diameter, green when growing, dark red (with a black or violet appearance) when mature and has a tart flavor.

During its cultivation, the mortiño is subjected to a domestication process, in other words, it is transplanted to a terrain that has been prepared with better solar lighting conditions, good slopes and acid soils. After transplanting, it can take 3 to 4 years to reach an optimum level of production.
The country hopes to incorporate 3.6 billion new barrels during this decade. This implies drilling some 90 exploratory wells each year as well as more than US$4 billion in foreign investment.

Record production and good international prices are the ingredients of the so-called oil boom that has accounted for 40% of Colombia’s exports. However, large discoveries of crude have yet to be confirmed and the estimated 2,058,000 barrels of reserves are being exhausted.

Oil production in Colombia has reached record levels. The country is producing around 927,000 barrels per day, the highest figure since 1999, when 780,000 barrels per day were produced. And expectations are even higher: the Ministry of Mines and Energy estimates that production will soon exceed 1 million, and for 2014 will have reached 1,150,000.

An oil bonanza. International crude prices have also been favorable. As never before, the price of a barrel has hit record highs and is currently around US$90. Price and production are the elements that many have referred to as an oil “bonanza.”

Since 2007 there has been a significant acceleration in national production, which has gone from 531,000 barrels per day in that year to 785,000 in 2010. This wildly optimistic panorama however is not complete. The experts warn that the country’s reserves are being exhausted and if no new fields are discovered within 10 years, crude will have to be imported.

Germán Corredor, director of the Colombian Energy Observatory (Observatorio Colombiano de Energía), points out that in the country’s oil history only four or five large fields have ever been found, such as Caño Limón and Cusiana. “In the last 20 years we have not heard of a single large-scale discovery. Fortunately small fields have been found, which have kept the reserves stable, but there has been no significant increase in them, although production has been greatly expanded.”

Reserves until when?

As of December 2010, domestic oil reserves had reached 2,058 billion barrels, and according to official projections, self-sufficiency will be maintained until 2020. Without a significant increase, growing production and improved technology for extraction in the mature fields, in a few years the country will be unable to supply itself.

In this context, is it possible to speak of an oil bonanza? For how long will the country be self-sufficient in fuels?

Alejandro Martínez, president of the Colombian Petroleum Association (Asociación Colombiana del Petróleo –ACP), in an interview with the UN Periodico in late 2010, explained the reasons for the favorable oil situation. “What has happened is that there has been an increase in the level of recovery in small fields, which had previously been discovered, based on large-scale investments in the use of state-of-the-art technology. This has been due to several factors: oil policy, increased investments in old fields and a substantial rise in the price of oil, which traditionaly had been between 17 and 18 dollars.”

In this industry, the multinational companies are quite optimistic. Private investment has grown ostensibly and according to ACP estimates, around 3.6 billion barrels of oil could be found. “3.6 billion barrels are expected to be incorporated during this decade. This implies the drilling of 90 exploratory wells each year and more than 4 billion dollars of annual foreign investment over the next decade; these levels, along with the figures on exploitation and new reserves that starting in 2012 would mean a daily production of more than one million barrels per day for 10 years, are excellent news for the country”, according to Martínez.

To find these resources, Eco-petrol – whose production accounts for 61% of the country’s total – has begun intense exploratory efforts. The company is leading projects in an area of around 17 million hectares, compared to 2002 when only 9 million had been explored. For the multinationals, the trend is the same: to explore. In Colombia, the private sector has a 56% share in investments in projects aimed at finding oil. The challenge is to discover new fields that would make it possible to maintain the growing trend in production.

Prudence regarding the figures

Carlos Rodado Noriega, Minister of Mines and Energy, expresses moderate optimism and prefers to avoid words such as “boom” or “bonanza”. For him, the surge in hydrocarbons is evident; this in turn has been reflected in increased revenues in the sector. “We must be aware that, when projections are made about prices and quantities, we need to include uncertainty factors. We have to be a bit prudent”.

A large part of this favorable situation stems from the production of heavy crude, which until a few years ago was little appreciated. Heavy crude is different from light crude because its yield in gasoline is lower; it is denser and more viscous, which increases the costs of extraction, transport and refining.

The Rubiales and Castilla fields, in the Llanos Orientales (Eastern Plains), have become one of the country’s most important heavy crude reserves. Over the last five years their production has risen considerably, and firms such as Pacific Rubiales Company, with a presence in the Rubiales field, report a production of approximately 200,000 barrels per day.

Why has heavy crude become so important? Professor Sergio Lopera, from the Mining Faculty at the Universidad Nacional (National University) in Medellin, explains that “the price of a barrel of oil in the markets makes the extraction of this type of crude very attractive. Extracting Castilla crude costs 7 or 8 dollars per barrel, which in the context of prices of 9 dollars per barrel is not profitable, but when prices rise as they have in recent years, Castilla crude can easily be sold for more than 50 dollars.”

Without large-scale new findings and with exploration projects currently underway at top speed, the most immediate challenge is to develop technology to reduce uncertainty during the exploration phase.

“Colombia is a country with oil but it is not an oil country, and under that premise we must work to find reserves in very complex structures. Geologically, we could say that in 70% of the country there is great potential to find hydrocarbons”, affirms Edgar Rodríguez, professor of Petroleum Geology at the Universidad Nacional de Colombia.

Academics and economists point out the importance of developing new talents, investing in knowledge and leveraging large-scale infrastructure projects. Science and technology are keywords in transforming raw materials exporting country into a nation with a strengthened petrochemicals industry that would be able to compete in international markets. Hopefully the favorable situation in the field of hydrocarbons will make it possible to see its benefits even in scarcity!
Cocoa:
From Chocolate to Fuel

Biogas and syngas can be made using cocoa wastes, an under-used product in Colombia that ends up being a significant environmental contaminant. The researchers’ main idea was to avoid such a harmful process. They therefore took the waste, dried it and placed it in ovens specially built at the mechanical workshops of the University, with the aim of warming the material to release the gas. The procedure produced two types of fuels: syngas, obtained from carbon-rich substances, and biogas, the product of the different biodegradation reactions of the organic material, through the action of microorganisms and other factors in the absence of air.

The benefits
These substances are renewable, because they are naturally and continuously produced, as long as human beings contribute to this effect. They are ecologically supportive because the atmospheric carbon dioxide emissions produced during the combustion process are the same ones that the plant absorbed during its growth through photosynthesis. They are more economical in comparison with other fuels, and the creation of biomass can be increased without affecting the environment. For example, compared to the production of petroleum derivatives, there is around a 40% savings.
Bovine viral diarrhea is an infectious disease that occurs during pregnancy and causes problems such as miscarriages or simply preventing pregnancy by causing the cows to go back into heat, thus decreasing the reproduction rate.

Its impact in the cattle–ranching sector can be seen in low meat and milk production rates. "It is estimated that reproductive diseases such as this virus (which is highly prevalent) cause annual losses of 44 billion pesos in this country," according to professor Jairo Jaime, coordinator of the research group in Microbiology and Epidemiology of the Veterinary and Zootechnics faculty at the Universidad Nacional de Colombia (National University of Colombia).

The disease reached Colombia in 1975, with a batch of calves imported from the Netherlands, whose clinical manifestations of the illness were subsequently confirmed by that country's government. In the 1990s, the research group at the UN, led by professors Víctor Vera and Gloria Ramírez, for the first time determined the presence of antibodies against the virus in the blood streams of certain bovines.

There are three genotypes of bovine viral diarrhea and each one has variants called strains, which may or may not be cytopathic (meaning that they involve drastic alterations in the molecules). They are categorized as such due to their ability to damage or destroy cells in vitro, and the severity of the disease depends on the type of strain involved. The genotype classified as type I is the most widespread in Colombia and the one that causes the most reproductive problems. Genotypes II and III have less frequency and have not yet been detected in this country.

The agent that causes viral diarrhea is an RNA (ribonucleic acid) virus with a great capacity to transform itself in nature. It has been classified within the family of Flaviviridae viruses (generally transmitted by mosquitoes), which includes other animal viruses such as classical swine fever, hog cholera, and a number of others such as the ones that cause or hog cholera.

Traditionally they have been classified under two types: dead viruses and live viruses. The veterinarian affirms that the dead viruses do not multiply within the host, provide poor immunity and need to be applied more than once, which is why they are not optimum for use in production species.

The live virus vaccines, also known as attenuated, generate good immunity with just one dose, but are also problematic: "If the attenuation of the virus (reduction of its virulence) has not been stable, it could find a complementary virus and reverse its pathogenic capacity to the point where it could cause the illness", says the coordinator of the research group at the UN.

The adeno-virus

Beginning in 2007, the veterinarians were able to isolate the bovine diarrhea virus to study it in detail. "We analyzed its genome and isolated a gene from the protein called E2, which is responsible for the immunogenic response. We worked on two versions of that protein and have inserted them into a type V human adenovirus (the adeno viruses are families of viruses that affect animals as well as humans). Subsequently, we evaluate its capacity for expression in cellular cultures (test tubes) and purify the virus with better activity, to then produce them on a large scale and test them on live animals (in mice)," according to Diana Susana Vargas, who developed this proposal for her master’s thesis, under the direction of professor Jaime.

According to the researchers, the result was a recombinant virus, in other words, created from two different genetic materials. When used as a vaccine for bovines, it leads to a situation in which, while the viral diarrhea protein is expressed, the animals' immune system produces antibodies that protect it from the pathogenic virus responsible for the disease.

From the test tubes, the adenovirus will be tested for its effectiveness in mice, using experimental models that will make it possible to also analyze the vaccine from the point of view of toxicity, protective doses and immunity, both of a cellular type as well as in the production of antibodies.

In this way, the Microbiology and Epidemiology group adapts technologies to conditions in the Colombian environment and enters into advanced research fields. According to Professor Jaime, "it involves a practical contribution to prevent a disease that has a great impact in the livestock sector". Currently, this generic therapy is used to treat cancer in humans and is progressively being implemented to develop vaccines. "It is possible that in the near future traditional pharmacological treatments would be replaced by corrections at the genetic or molecular level such as this one", concludes the researcher at the National University.
A Technology for Saving Energy in Ethanol Production

A new system will make it possible to manufacture ethanol using 35% less energy than is currently the case. In addition to reducing environmental impact, this technology doubles productivity in industrial biofuels processes.

In search of a solution to these problems, the Giant group designed a fermentation process using membrane technology (tubular filters), that makes it possible to capture and selectively remove the ethanol while retaining the flow of untransformed sugars, water, salts and organic material.

To reach their goal, the members of the Giant group made membranes that remove five times more ethanol than the commercially available ones, thereby decreasing the investment of capital in the process.

Researcher Miguel Ángel Gómez García explains that "economic studies show that one of the problems facing industrial implementation of membrane technology in this country is the cost of the filters. The ones that we make locally are more economical and have a removal velocity and selectivity regarding the ethanol that makes them attractive for this type of process."

In this way, the new system for obtaining ethanol begins with a concentrated sugar solution that, thanks to the presence of the yeast, is transformed into ethanol, which is then simultaneously removed by the membranes along with a water fraction.

The mixture that has been removed is obtained with a 50% concentration of ethanol during the fermentation stage, whereas in the conventional process this concentration is just 7%. There is therefore a 35% savings in energy consumption during the purification process.

This occurs because the membranes, in contrast to other distillation processes, make it possible to achieve high energy efficiencies that considerably reduce consumption. "The amount of membrane that must be used in this new fermentation system is approximately 1/5 as much as in the conventional system, thus reducing operation- and capital costs. For example, to produce 100,000 liters per day requires approximately 35,000 m² of the commercial membranes, whereas using those developed at the UN, only 7,000 m² are needed" affirms the professor and director of the project at the UN in Manizales, Javier Fontalvo Alzate.

In addition to being a continuous fermentation process (with no time lapses in its manufacture), it provides greater control over the manufacturing of the alcohol. The scale of the size of the fermentation equipment is smaller, so that it is easier to transport. The process makes it possible to produce four times more ethanol with less energy, which is reflected in 2.5 times more alcohol. Also, because less water is removed during distillation, there is a corresponding decrease in the volume of vinasse, another environmentally favorable aspect.

The filters have a useful life of approximately 4 years, and their wear does not imply changing them but rather making adjustments to the process.

While the savings in production costs are significant, both because of the characteristics of the membranes as well as the savings in energy consumption and low environmental impact of the process, the cost of implementation for a company interested in the system is also attractive.

Angela María Betancurt Jaramillo,
Universidad Nacional de Colombia

Innovation

Gasoíle comes from fossils extracted from the earth which, when burned, create atmospheric emissions and generate pollution.

Ethanol comes from crops whose emissions are absorbed and reused by the soil, generating less environmental impact.

The new system reduces water consumption and vinasse production, chemicals that have an impact on the environment during ethanol fermentation.
Incinerators, industries, heating systems and vehicles are some of the sources of pollution that constantly emit gases into the atmosphere such as carbon monoxide, sulfur dioxide or lead, which are substances that affect people’s health as well as the environment.

According to the World Health Organization (WHO), 2 million people die each year due to air pollution, above all in the large cities, which causes heart disease, asthma and lung cancer.

The effects of soot

Soot is a combination of very small particles composed of impure black-colored carbon, which are generated by burning wood, coal and mainly diesel engines used in public transport buses, trains, ships and even construction equipment.

Precisely because of its microscopic size, soot has the ability to be easily introduced into organisms, and its atmospheric concentration contributes towards global warming.

The problem of pollution caused by diesel engines stems from incomplete combustion due to insufficient oxygen to enable the fuel to completely burn, producing soot or coal dust.

Once the particles are created through this process, the soot, which is mainly made up of carbon, has two destinations: part of it is released into the atmosphere through exhaust gases while the rest remains inside the engine, causing internal damage.

An optimum reduction

To contribute towards reducing the coal dust produced by those engines, implemented in this country since 1983, the Chemical, Catalytic and Biotechnological Processes research group at the National University (Universidad Nacional) in Manizales, and the MCMA group at the Universidad de Alicante (Spain) are working on a project aimed at degrading the compound using chemical elements.

The first step taken by the chemists at both institutions was to select the (solid) catalysts to facilitate degradation of the soot. These elements are important because they help to make the chemical reactions more rapid and selective, as they have the ability to affect only the compounds of interest, and their use can be prolonged for a number of cycles for the same operation.

In this case, the chosen solids are birnessite or pyrolusite type manganese oxides – the most important within the manganese –, which are characterized by their low environmental impact because they are analogous to minerals found in natural deposits in various regions of the country.

These oxides are inexpensive, as opposed to titanium or palladium, which are usually used, and have greater structural versatility. Also, their properties can be extensively modified as needed.

"The increase in contaminating emissions from diverse sources makes it necessary to develop new and more efficient, economical and environmentally friendly materials. Manganese oxides fulfill these requirements while also making it possible to generate changes in their states of oxidation, chemical composition, structure, surface and morphology, which significantly affect the metallic oxide making it easy to work with", according to Oscar Hernán Giraldo Osorio, a professor at the National University in Manizales.

Calcination, washing and recalcination

The manganese oxides that are to be adapted in the exhaust pipes of the engine are exposed during a first stage to a three-step method consisting of calcination, washing and recalcination. The process lasts for a total of 48 hours and begins by heating the potassium permanganate to 400°C; it is then removed to wash away the impurities formed during this stage and reintroduced into the oven, this time at a temperature of 60°C, to be finally recalcinated at 600°C.

Giraldo Osorio explains that "this process of synthesis was determined based on previous studies. However, it produced better results for modulating the properties for its specific application as a catalyst for burning soot".

The oxides are adhered to a supporting structure created using a material called alumina, which facilitates impregnation and application of the product in the automotive filter, through which the exhaust gases pass into the atmosphere.

In contact

After being impregnated into the filter, the oxides begin their work: to retain the soot and begin its process of degradation, made possible by the temperature of the solid when it comes into contact with the contaminant, and which is different from that of the vehicle itself.

Although use of the diesel engine is economical, its incomplete combustion produces soot, which is a toxin that is emitted directly into the environment.

The diesel engine, used throughout the world because it is economical and consumes less fuel, involves incomplete combustion that generates soot, which is one of the most influential contaminants in global warming. Engineers have invented a system that reduces its atmospheric emissions.
New Technique to Identify Birdsongs

The coffee-growing region in Colombia is home to nearly 10% of the world’s birds, a wealth that has yet to be explored. Engineers from the UN in Manizales have come up with a procedure to identify species found in a particular area by their songs, facilitating classification and recognition.

Making an inventory of the birds in an ecosystem is no easy task; generally, it is done through visual inspection in the field that involves arduous workdays of travel and observation and also requires auditory training.

Sergio Tobón Ocampo, president of the National Network of Bird Observers of Colombia, says that the best hours of the day for observation and study are dawn and dusk. Specialized long-range binoculars are needed along with lenses able to capture the smallest details of the birds.

In countries such as Puerto Rico, where conservation and protection of birds is regulated by the Wildlife Law of 1976, a computer program is being implemented to facilitate the recognition of species.

Inspired by the Automated Remote Biodiversity Monitoring Network (Arhinom), a network for monitoring of biodiversity, the Signal Processing and Recognition Group (Grupo de Procesamiento y Reconocimiento de Señales) at the Universidad Nacional de Colombia in Manizales developed an acoustic characterization study to produce software that is adapted to local conditions.

“Based on Arhinom—which was created at the Universidad de Puerto Rico—and in collaboration with professionals in the fields of computer science, electronics, biology and ecology, we wanted to implement new automatic recognition techniques as representations of dissimilarities, which was the method used in this case”, according to research coordinator Mauricio Orozco Alzate.

**Digital identification**

The system operates through birdsong characterization. Traditional techniques analyze various acoustic signal measurements or particularities of the sounds—such as wave frequency and duration, among others—whereas the UN study classifies the signals using methods based on dissimilarities.

This is a recent procedure in the theory of automatic or pattern recognition, which consists in directly comparing two elements without measuring their particular properties.

It is similar to the way human beings reason, when for example, they distinguish a particular person through general characteristics such as the face or voice; in other words, based on a complete pattern that we already have in mind, without stopping to determine if their skin is white or dark, without discriminating the color of their eyes or hair, or if the timbre of their voice is high or low.

“The methodology works because the program is trained to recognize the birdsongs from a database so that it is able to predict what animal it is. Very good performance is obtained, but enlarging the database of sounds is the key to increasing the precision”, according to José Francisco Ruiz Muñoz, who is developing the technique as his master’s thesis in industrial automation—engineering.

Application of this method is the starting point for consolidation of a larger scale process in automatic monitoring of diverse specimens.

According to the engineer, the procedure would be adapted to a natural environment by placing microphones in strategic sites; the sounds captured are sent over the Internet to a computer that has previously been fed the systemized songs, which then makes the identification; in this way, the researchers do not need to travel and temporary coverage is achieved over a larger space, in that the recording and analysis is permanent, with the added advantage that it can be carried out in a number of places simultaneously.

**Effectiveness**

The tests were performed using 538 birdsongs, corresponding to 11 species from the Río Blanco Reserve in Manizales. The researchers then processed information, extracted the portions of the audio track containing the required segments, marked the samples with the label corresponding to the bird to which the sound pertained, and inserted this information into the system.

The material analyzed on the UN computers resulted in 97.87% certainty in the species identified. "This figure shows the good performance of the process, because it only erred with two species whose sounds are very similar", says Ruiz Muñoz.

Applications of this process include studying volcanic seismic signals, although this is not the core function but rather another way of proving its performance. Professor Orozco Alzate has been doing this since 2006 in collaboration with the Vulcanological and Seismological Observatory (Observatorio Vulcanológico y Sismológico) of Manizales.

José Francisco Ruiz’s masters project can be implemented in this field because the nature of acoustic and seismic signals is similar: both waves are elastic with the difference that audio signals are propagated through air while vibrations are propagated through the earth.

In this manner, their experiments contribute towards the objective of the primary research, aimed at improving the identification of seismic signals and the delivery of already classified data to geologists, according to its typology.

In Colombia, where there are an estimated 2,000 species of birds—a huge resource in terms of biodiversity—this new technology would have a number of uses, ranging from classification of species in determined ecosystems to the identification of new specimens as yet unknown in our territory.