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Challenges for Science and Technology in Environmental Preservation

Desafíos para la Ciencia y la Tecnología en la Preservación del Medio Ambiente

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ABSTRACT: These pages present an article that shows the imminent demand that our institutes model the scientific and technological commitments of future architects and engineers. In this, the social and economic roles of engineering works and the subordination of their debts to the environment are notified, which are the pillars of a sustainable tomorrow. It is our opinion that for this, the study of those social sciences that enhance these appreciations must be strengthened, as support for the pedagogue with the task of instructing the student in the comprehensive training that university education desires. The importance of the use of appropriate technology is reported here: a core component to be taken into account by present and future professionals at all times, in their mission of proposal, planning, design, execution and logistical scheme of any social project. Furthermore, the attributes that are revealed through the values of commitment are praised as complements, as a substantial share of the suitability of the protagonists of such tasks. In other words, through this document, ethical precepts are proposed to be followed by the manager of an engineering task to nourish a sensitive bond with the environment that surrounds us.
Keywords: Commitments, Scientists, Technology, Environment, Engineers.

RESUMEN: Se presenta aquí, un artículo que muestra la inminente exigencia de que se modelen, desde los institutos universitarios, los compromisos científicos y tecnológicos de los futuros arquitectos e ingenieros con el habitad. En el mismo se notifican los roles sociales y económicos de las obras ingenieriles, y la subordinación de sus adeudos para con el medio ambiente como cimientos de un mañana sostenible. Se sugiere el fortalecimiento del estudio de aquellas ciencias sociales que potencien estas apreciaciones, como apoyo para el pedagogo en su encargo de perfeccionar al estudiante en el adiestramiento integral a que aspira la enseñanza universitaria. Se divulga la trascendencia del uso de la tecnología adecuada: componente medular a tomar en cuenta por los presentes y futuros profesionales en todo momento, en su misión de propuesta, planificación, diseño, ejecución y esquema logístico de todo proyecto social. Además, se ponderan, como complementos, los atributos que se revelan a través de los valores de compromiso, como cuota substancial de la idoneidad de los protagonistas de tales faenas. Se proponen preceptos éticos a contraer por el gestor de una tarea de ingeniería para alimentar un sensible vínculo con el medio.
Palabras clave: Compromisos, científicos, tecnología, medio ambiente, ingenieros.

INTRODUCTION

The development of science and the use of technology have allowed humans to transform the environment: no one could doubt that both constitute two of the greatest achievements of the human species. The industrial revolutions that took place between the 18th and 19th centuries, and the Scientific and Technological Revolution of the second half of the 20th century, have radically transformed the living conditions and practical activity of human beings. These have also changed the way and manner of understanding the world, in all its richness and complexity, and the procedures for understanding ourselves, in the continuous process of interaction and growing transformation of all reality in which we are immersed.

In every field or sphere of human life, the multiple benefits that the development of science and technology has brought are evident (Saenz, 2004). The great achievements in communications, medicine, construction, economics, and education, to name just a few, are evident (Simeon-Negrin, 1997). These undoubtedly have an immediate and effective impact on a greater and better quality of life for a large portion of living beings on this planet. However, leading figures in the worlds of politics, science, education, philosophy, and other branches of knowledge have been warning about the real and potential dangers that the misuse of the achievements of science and technology brings and can bring to the environment (Saenz, 2004).

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A clear example of the relationship between science, technology, and environmental issues is the impact that the accelerated development of technoscience and the excessive and irrational exploitation of natural resources by transnational corporations from the most industrialized countries have on human living conditions. This has generated global crises: economic, political, social, ecological, and environmental. This excessive and illogical exploitation of natural resources and their use to satisfy material and spiritual needs; the unprecedented demands placed on the environment by rapid human population growth and technological development; are producing an increasingly accelerated decline in environmental quality and its capacity to sustain life.

Therefore, environmental protection has become a priority, a necessity of the first order to guarantee economic and social development, and, above all, for the health and survival of the human species throughout the planet. For this reason, there is a set of activities, mechanisms, actions, and instruments aimed at ensuring the rational management and use of natural resources through their conservation, improvement, and environmental monitoring, and the control of human activity in this sphere. This consists of applying the established environmental policy through a multidisciplinary approach, taking into account cultural heritage, accumulated national experience, and citizen participation.

In Cuba, the incorporation of environmental management into the production and service processes of companies that apply the Management and Administration system aims to prevent, reduce, and ultimately eliminate the negative impacts that these processes have on the environment, ensuring the protection and preservation of the natural resources on which the production of goods and services is based. Protecting the environment is an unavoidable social necessity for companies.

This paper aims to assess the challenges and prospects of using renewable energy and new technologies as a scientific proposal for environmental and resource preservation.

DEVELOPMENT OF THE TOPIC

Science, Technology, and the Environment

Science is a body of knowledge that changes our view of the real world. It is the investigative process that allows for the acquisition of new knowledge, which in turn offers greater possibilities for managing phenomena. Its practical and productive impacts characterize it as a productive force that fosters transformation and can be a source of wealth. It may or may not give rise to technology: a form of technology based on the existence of the aforementioned science, developing said technology, which, in general terms, can be defined as the application of the aforementioned science.

Kröber (1986) defined science as a system of concepts, propositions, theories, hypotheses, etc., which at the same time are a specific form of social activity directed towards the production, distribution and application of knowledge about the objective laws of nature and society. Furthermore, he sees that it presents itself to us as a social institution, as a system of scientific organizations, whose structure and development are closely linked to the economy, politics, cultural phenomena, with the needs and possibilities of a given society.

For his part, Pacey believes there are two definitions of technology: one narrow and one general. The first considers technology only in its technical aspect: knowledge, skills, tools, machines. The second also includes organizational aspects: economic and industrial activity, professional activity, users and consumers, and cultural aspects: goals, values, ethical and behavioral codes (Pacey, 1990). He also argues that among all these aspects, there are tensions and interrelationships that produce reciprocal changes and adjustments.

He suggests that the technological phenomenon be studied and managed as a whole, as a social practice, always highlighting the underlying cultural values. Technical solutions must always be considered in relation to organizational and cultural aspects. In other words, technical solutions are only one aspect of the problem; the organizational aspects and values involved in the processes of innovation and diffusion of information must also be considered.

Innovation and technology transfer. Moving beyond a strictly technical approach leads to a more precise definition of the role of experts and to accepting that, as a social process, as a social experiment that represents any technological change of a certain magnitude, it is essential to take into account public participation, the expectations, perceptions, and judgments of non-experts who will also participate in the technological process.

The environment is the surroundings that affect living beings and determine the vital scenarios of a place, group, or time. These are the physical, human, social, cultural, etc., realities or circumstances that surround people, animals, or things. It is the space in which the life of different organisms develops, fostering their interaction. It contains both living beings and nonliving elements, including those created by human hands. It supports life, as do all its components: air, water, atmosphere, rocks, plants, animals, etc.

Urbanization, intensive agriculture, industrial livestock farming, deforestation, and carbon dioxide (CO_2) emissions, among other actions, accelerate the loss of biodiversity due to global warming, desertification, and the pollution of oceans and rivers that are part of this environment.

Suffice it to recall the use of nuclear energy in the construction and detonation of the two atomic bombs that devastated the cities of Hiroshima and Nagasaki in 1945, causing a horrific trail of death and destruction whose effects still persist to this day, or the use of medical research by the Nazi regime on prisoners in the so-called concentration camps throughout World War II, to cite just two examples among many others.

On the other hand, the excessive and irrational exploitation of natural resources, primarily by large corporations and transnational corporations from the most developed capitalist countries, making effective use of technological advances and based on the philosophy of consumerism and the maximization of profit at all costs, regardless of any harm or damage to the environment, has caused a profound imbalance and deterioration of the multiple ecosystems and the global ecosystem of planet Earth, seriously threatening the very survival of the human species and the other species that inhabit it.

This requires the incorporation of cleaner and more efficient methods and technologies to improve the processes that cause harm.

Prospects for the Use of Renewable Energy and its Environmental Impact

Modern science and technology have opened up many new avenues. Solar energy, for example, is rapidly becoming one of the world's most important energy sources, and its use is expected to increase in the coming years. As a renewable energy source, the sun offers numerous advantages, from reducing carbon emissions to cost savings and reducing dependence on fossil fuels.

The use of solar energy has led to significant progress in this field in Cuba. Faced with rising oil prices and a likely critical shortage, the use of solar energy appears to have been emphasized, representing an intelligent response to energy problems. The Caribbean nation can greatly benefit from the high solar radiation it receives practically year-round, converting it into clean energy that will allow the national economy to break free from its dependence on hydrocarbons.

Cuba currently has 24,081 isolated solar panels installed in schools, polyclinics, homes in remote locations, and the family doctor's office, among other facilities. However, it continues its commitment to harnessing the solar radiation potential within the country, which is approximately five kilowatt hours (kWh) per square meter per day (CITMA-Cuba, 2021). The use of this energy must be intensified, in line with what is happening in the rest of the world. In Europe, for example, notable progress is being made in harnessing solar energy, among other facilities.

A recently discovered alphabet could give a new and perhaps unlimited impetus to civilization. This new alphabet has been unraveled from DNA: a complex organic compound found in all living cells and many viruses. Contemporary genetics works with genes to produce desirable results in medicine, agriculture, and countless other human activities. This could help humans reduce the negative effects of a change in rainfall patterns that produce more or less precipitation by creating plant varieties less susceptible to excess or deficiency of water.

But time doesn't seem to be available. There is literally a race against time. International cooperation, so severely undermined in recent years, does not foster hope for dynamic collaboration among all nations within a project aimed at combining knowledge, talent, equipment, experience, financial and human resources, geographic space, etc.

An example of the use of genetic science in human well-being is very close to home for Cubans. Since the early 1980s, Cuba has had a National Medical Genetics Program, the results of which have contributed to reducing the population incidence of genetically caused disabilities and increasing life expectancy. In 1964, the infant mortality rate due to congenital malformations was 4.5 per 1,000 live births; in 1980, it was 4.2 per 1,000; and at the end of 2014, it was 0.9 per 1,000 live births. In the last 35 years the value of this rate has been reduced by 78.6% with a sustained impact on the decrease in the country's infant mortality rate (Marcheco et al., 2017).

Green or clean technologies encompass techniques, processes, materials, and methods applicable to everyday life and various industries to positively change the quality of life while preserving and restoring the environment. Their main objectives can be summarized as sustainability, viability, innovation, and waste reduction: a complete cycle considering their application throughout the entire life cycle of a product or service. In this way, economic sectors can continue to perceive their economic benefits, consumers' budgets are not affected by increased costs, and a positive environmental impact is ensured. Among the main applications of green technologies are energy and fuel generation, waste and sewage treatment, and the incorporation of green areas in urban spaces.

In Cuba, specifically at the "Marta Abreu" University in Las Villas, an important initiative on the subject was launched in 2020. It proposes a set of concrete actions to be implemented in the curricula of various undergraduate programs and also in postgraduate training programs, where environmental education linked to the State's plan to combat climate change (Tarea Vida) and the use of renewable energy sources are encouraged. As a result of the integration between the Central University and other organizations, the Ministry of Energy and Mines (Minem) has built the first photovoltaic park on the premises of an educational institution.

Higher Education, located within the Faculty of Electrical Engineering, which, although directly contributing to the national electricity system, serves as a teaching unit for the training of future engineers in that field (Sánchez & Guerra, 2022).

Light energy can be directly converted into electricity using a device called a photovoltaic cell, solar cell, or PV cell. These have no moving parts and operate silently without polluting the environment. They are made of semiconductor materials such as silicon, the most common element in the Earth's crust. The silicon in PV cells is chemically treated to create positive and negative layers. An electric field similar to that of a battery is created between the two layers. When light shines on a photovoltaic cell, electricity is produced.

They come in a variety of sizes, but even the largest ones typically generate less than 3 watts. This isn't enough to power most household appliances. Consequently, to provide more energy, several cells are connected in hermetic packages called "photovoltaic modules" or "photovoltaic solar panels."

Until now, water heaters for showers and sinks are powered by gas or electricity. Thanks to green technologies, these can operate using energy collected by solar panels, mainly strategically placed on terraces and roofs. In all types of solar heaters, the heating system is powered by heat energy obtained from the sun, which is collected by the heater's structure and transferred to the water through recirculation, heat projection, and other methods. Currently, there are solar heaters with large capacities of more than 300 liters, with temperatures of over 190°C.

Their lower installation costs and low maintenance make the use of both photovoltaic and thermal systems common (IDEA, 2006). And it is that Cuba, Caribbean nation can greatly benefit from the high incidence of sunlight it receives practically all year round, converting it into clean energy that allows the national economy to free itself from its dependence on hydrocarbons. Furthermore, being a tropical country and due to its location receiving even radiation throughout the national territory, it is attractive to consider taking advantage of this renewable energy potential (Martinez, 2021).

Water filters can be used to convert the water we discard for consumption into potable water, allowing for the optimization of this vital resource for all living beings. They can be installed directly on faucets or in water supply pipes, ensuring that their use is easy, safe for health, and results in savings for consumers. Many external agents affect the properties of water, as well as its final odor and taste. For this reason, there is a growing trend toward using effective filtration systems in the home to ensure higher quality over the long term (Muela, 2023).

Bathroom fixtures require the most water, with 35 liters of every 100 used per home; showers use 30 of every 100; washing machines, 20 of every 100; and sinks, basins, and dishwashers (Mendiola, 2012; Gonzalez, 2019). It is now common to see designs that allow water to be delivered at a higher pressure and in smaller quantities, depending on the type of drainage. These allow for effective toilet flushing with improved water use. These water-saving devices are even designed for areas without drainage, where, by separating liquid waste from solid waste, both with simple treatment, they can then be used as fertilizer.

The treatment of urban solid waste is an urgent and evident issue in the face of the unavoidable problem of climate change. A significant portion of this waste, most of which is classified as polluting, consists of products discarded in homes that can be easily recycled because they are recoverable raw materials, such as paper, cardboard, glass, plastics, Tetra-Pak, etc. Separating waste by citizens themselves as a daily household activity will undoubtedly massively increase the possibilities of achieving urban-level selection of recoverable products for repurposing through industry. Thus, separating solid waste from homes offers industry better conditions for raw materials than separating them after mixing them in landfills (Jimenez, 2012).

In some countries, the separation of organic and non-organic waste is already mandatory to facilitate the recycling process. The country should make enormous efforts to engage in this type of initiative, which doesn't seem to require huge investments to implement, compared to the benefits it can bring.

The use of green roofs seeks to reforest the space used for the construction of buildings and urban properties, taking advantage of the area of their roofs, terraces, and/or rooftops for this purpose. The way to do this is by covering the surface, floor, or ground with grass, so we can take advantage of the oxygen, aesthetics, and quality of life that natural soil provides. This technology increases the value of a property, even more so if it is used additionally as a garden, with the planting of food products such as vegetables, greens, or herbs. However, despite this technology's benefits, it is only used in certain developed countries such as Switzerland, Germany, France, and Spain, and in some developing countries such as Colombia, Argentina, and Mexico, mainly due to the high cost of installation and maintenance (Lopez *et al*., 2020).

In Cuba, the Green Roofs project aims to produce vegetables, spices, and fruit trees on the rooftops of the Cuban capital and other cities. Sponsored by the Antonio Núñez Jiménez Foundation for Nature and Man and the Havana Bay State Working Group, the initiative is closely linked to urban agriculture (IPS-Cuba, 2023).

Worldwide, regardless of whether the energy source is solar or electric, buildings can integrate into the ecological and sustainable trend with the use of LED lights. These are already recognized for their brightness, capacity, and power, with lower energy consumption. They can reduce energy consumption by more than 80%, which represents benefits for the environment and for consumers, who will see savings on their bills.

In Cuba, the import and purchase of raw materials to produce this technology within the country has been secured. Imports are based on the characteristics of the Cuban electrical system and the tropical climate conditions, and based on these, raw materials with specific specifications are requested from the market to ensure the durability of the product. In addition, there is a lighting laboratory that guarantees most of the parameters established in the Cuban standard for the import and use of LED lighting in Cuba (Granma, 2023).

There are systems around the world that allow rainwater that falls on a roof to be collected, channeled, and stored for irrigation of green areas, cleaning, and sanitation. With a purification treatment, it can sometimes be used for human consumption. Rainwater is a resource that has not yet been fully utilized. This allows for cost savings on water bills, sustainable use of the natural resource, and a contribution to the environment.

Since the mid-20th century, innovative materials such as ferrocement, geomembranes, and polyethylene, among others, have been incorporated into this ancient technology. Furthermore, given social development, the use of this resource has diversified, destining it not only for domestic and agricultural consumption, but also for fish farming, car washing, firefighting, and more.

The largest of the Antilles has also focused on the use of these systems, providing several examples and promoting their use within the legal framework. However, the same water governing body recognizes that this is insufficient and necessary, given the downward trend in precipitation. Furthermore, there are elements presented that provide a broad overview of the status of these systems at the global and national levels, providing a highly useful document for consultation and implementation of these systems (Torres, 2019).

Osmosis is a physical-chemical phenomenon that occurs when two aqueous solutions of different concentrations come into contact through a semipermeable membrane. This membrane only allows the passage of water. Thus, water tends to pass through the membrane from lower to higher concentrations, equalizing the two. The pressure that causes this phenomenon to occur is osmotic pressure. In reverse osmosis equipment, the water transfer rate depends primarily on the concentration, the characteristics of the membrane, and the applied pressure (Marcheco et al., 2017).

The reverse osmosis method retains species as small as ionic or molecular sizes. Its most significant advantages include continuous operation, the small footprint, and its modular design. The quality of the feedwater determines scaling, fouling, and membrane degradation.

Scaling occurs when species form that exceed the saturation concentration. Some scaling also decreases the effectiveness of antiscalants and increases the rate of formation of additional deposits. Clogging can also occur due to the growth of microorganisms. Fortunately, membranes are resistant to bacterial attack. To prevent this type of clogging, chlorine is periodically added to some newer types of membranes.

Nanofiltration is another membrane filtration process operated under pressure in which low molecular weight solutes are retained, but the remaining solids pass, either completely or partially, through a filtration membrane. This provides a range of selectivity between ultrafiltration and reverse osmosis membranes, allowing simultaneous concentration and desalting of organic solutes. Its selectivity between molecules of similar size is the key to the success of the membrane separation process.

Nanofiltration systems according to Marcheco et al. (2017) are used for water softening, the targeted separation of heavy metals by jet processing for water reuse, and the reduction of salt content in light brackish water.

Ultrafiltration is another modern method used as pretreatment for reverse osmosis, seawater desalination, and low-cost drinking water production. It has advantages in pretreatment: good protection of reverse osmosis membranes; it requires no chemicals; chemical shock treatment for disinfection is economical; its design is compact, its operation is continuous, and it is easily automated (Marcheco et al., 2017).

Microfiltration membranes, on the other hand, have a membrane pore size that retains all bacteria and some viral contamination, even though viruses are smaller than the pores of the microfiltration membrane. This is because viruses can attach to bacteria. Microfiltration can be applied to water purification and as a water pretreatment for nanofiltration and reverse osmosis (Gonzalez, 2019).

CONCLUSIONS

Science and technology are two of humanity's greatest achievements, bringing countless benefits to multiple fields of human activity. However, their improper use can have negative consequences for the environment and, consequently, for people's health and the very survival of the human species. Given this situation, it is up to the family, schools, and society, but especially the university, to develop citizens and professionals with a high level of environmental awareness, committed to the comprehensive development of their territory, and rooted in the values of respect, selflessness, and solidarity.

A generalized and subjective abstraction that would express the considerations of this work is that the integration of the green technologies previously described and others, whether mentioned or not, considering the benefit-cost ratio, would allow us to meet the environmental needs demanded by this era.

Update the role those educational institutions, and especially the University, must play in shaping a new awareness that is respectful of the environment and proposes a new development model worldwide. This must be urgently needed as a new, mandatory pedagogical approach, both locally and globally.

Make use of the resources and potential of the environment, science, and technology, for the well-being and improvement of the quality of life of the vast majority of people, in a way that is respectful and conciliatory with the environment and does not jeopardize the well-being of future generations.

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