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A BRIEF REVIEW ABOUT INDICATORS TO TEST THE QUALITY OF WATER IN CUBAN SPRINGS

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Abstract

This present study sets as an objective: to establish a brief review about some of the indicators that have been used in the world and specifically in Cuba to evaluate the quality of water in Springs. The author makes a logical transference of environmental components worldwide and nationwide to propose a group or integrated parameters that can be considered in Cuba according to the potentials and the specification of this Caribbean island. Springs in Cuba are characterized by being rich in mineral components because of the Mountain precedence of springs. Most of the water contamination has been related to the influence of Sugar Industry, misuse of Mining and a progressive advance of Salinization due to the impact of Climate Changes. Some of the springs contain ingredients very beneficial to health. In this paper there is a historical tendency to evaluate the situation of springs based only in physical, chemical and biological parameters. However, due to the anthropological incidence of Springs in its environmental deterioration, there is a necessary and strong claim of the socio environmental indicator. There comes up a balance of the most environmental parameter historically used and the necessity of empowering these parameters.

Keywords: *Springs, Environmental parameters, Cuban springs*

INTRODUCTION

Brief description of Cuban geology focused on karst and springs

Cuba is a tropical country located in the Caribbean Sea, water bodies are enriched by the rains which are more frequent from May to November and less perceived for December to April. In the wet months there are seldom prevalence of hurricanes and tropical storms. It is in these seasons (end of Spring, Summer and Autumn) when aquifers conduct more water to springs, rivers, lakes and dams and occasionally floods and strong winds affect directly the ecology of the waters. According to Govea, at al (2010) the coming of waters generated by allochthones, which are non karst, territories, influence significantly in water that is present in karst, these waters move the same on the surface or underground. That´s why there is an evident dependence between the quality of water and the discharge from karst springs or rivers. Many caves are also transformed by the existence of water, and very often might turn into flooded, mainly when they are situated next to mountains or mogote foothills. This Karst characteristic has been part of the indicator to test the quality of some water bodies in Cuba, above all in the westernmost region, but not mostly considered in the rest of the territories, that´s why it has been in chase some other indicators which could be standard for the country, mainly in the environmental field.

A basic reference about the ecology of Cuban Springs

According to a guide for the evaluation on the situation of surface and subway water situation (Callejas et al., 2021), there has been identified a group of chemical agents that generally pollute the quality of water, in a general scope they are associated to As, Cd, Pb, Hg, NH4+, Cl-, SO4 nitrates and phosphates, Synthetic and artificial substances: trichloroethylene, tetrachloroethylene. There are also presence of parameters indicative of salinization or other intrusions, such as: conductivity or Cl-, SO4.

However, it is very objective to estimate the premise that without having a global perception of the ecosystem where the water involved, it would be impossible to have a scientific data of water testing. The establishment of the system of relationships of a territory and, within it, the role of the groundwater regime, is basic for a correct determination of the effects, in Environmental Impact Assessments, of groundwater abstractions. As an example, it is worth mentioning, for these studies, the possibility of the origin and permanence of natural discharges on the surface of the ground and wetlands. There must be a register of the biological and chemical environment. It will make sure, whenever appropriate, the degree of rarity of the fauna; the possibility of alternative habitats; the biological cycles and dependence on the uses of the area. The same can be established for their relationship with the base flow of some other watercourses. (Bascones, 1997 p. 276).

After following this premise, there have been observed some papers that show the behavior of some ecological components which affect directly to the situation of springs, among these items are found:

-presence of animals that come from zoos or farms, leaving a large amount of feces on the ground that can reach the catchment due to structural defects such as cracks.

-prevalence of weeds near the spring (tall grass, bushes, brambles, hawthorns, etc.) They posed a risk in itself as the decomposition of the organic matter (plant debris). It can leach through the soil, altering parameters such as oxidability, turbidity, ammonium, nitrites or nitrates.

-Abundant thick vegetation which provides the reproduction of birds and rodents whose nest or establishment of burrows give rise to a possible

contamination by the filtration of their excreta.

-Confluence of urban supplies with the proximity of sewage or wastewater

of sewage crossings or organic matter deposits (farmyards, manure dumps, etc.)

-extensive or intensive cultivation of farming areas. In this case, springs collect the seepage water from rainwater or irrigation, which can

from rainwater or irrigation, it also brings about contamination pollution from organic substances (slurry, manure) or from chemical substances (fertilizers, pesticides, pesticides, etc.) Rodriguez et al. (2003),

Aspects that might influence the environmental indicators for Springs in Cuba, its relationship with, Sugar production and Mining

In some regions, of all the anthropogenic activities that affect the environment, it is mining that has the greatest impact on surface waters. Mining has the greatest polluting effect on surface and groundwater, followed by agriculture.

The mining industry generates a large number of environmental problems, including, most notably, the contamination of groundwater by acidic water drainage.

Groundwater pollution comes from acid mine drainage, leachate and the dumping of mining waste rich in heavy metals. Generally, the accumulation of these generally accumulates on the surface of the ground in tailings dumps, dams that cause a change in the surface of the ground, leading to a variation of the local hydrogeological conditions.

The water from the waste facilitated the raising water table and consequently it recharges flow conditions, the development of a large number of processes and chemical reactions of the various pollutants, modifying the geo-geological equilibrium. The geochemical equilibrium can give rise to industrial process linked to oxidation, reduction, speciation, complexation, dissolution, precipitation, adsorption, desorption, flocculation and colloid digestion.

The Holguín region, located in the northeast of the island of Cuba, has been characterized by an important mining industry that has been exploiting the great mineral resources of the lateritic crust developed on the rocks of the ophiolitic complex of Cuba. Among them stand out Ni, Co and Cr deposits, considered one of the largest reserves in the world.

The exploitation of the mineral mass, with an average content between 1 and 2 % of nickel, is carried out by the following methods of nickel, it has been mined by open-pit mining since 1943, in the municipality of Mayari (Nicaro) and since 1963 in the municipality of Moa (Nicaro). (Romero-López, Suárez-Alvarez, 1993)

To exploit these precious minerals, it has been necessary the employment of aquifers which have been very useful for the required extraction, filtering and cleaning.

To evaluate water quality, chemical analyses were carried out during a sampling campaign in October and November 1996. The total number of water samples analyzed was 46, of which 32 were groundwater samples. In this research 10 were surface water samples, 2 were waste water samples and 2 were interstitial water samples; they were discharged from the waste by the factory to dump landfill. The determination in the laboratory consisted of a complete analysis, turbidity and Ni complete analysis, turbidity and Ni, Mn, Cr and Fe.

The pH values for the various groundwater and the surface water samples range from 6.7 to 8.2; conductivity range was between 6.7 and 8.2, and conductivity between 200 and 7300 S/cm and hardness pointed out between 1.7 and 103 meq/l; these have been the highest values in the wells near the dam. (Rodríguez, Candela, 1998 p. 305).

The contamination of groundwater and surface water by industrial sugar waste is one of the most serious environmental problems affecting water resources in Cuba and, in general, in those areas linked to industrial sugar cane production (Molerio, Gutierrez, 1999; Genorguiev, 1980; Gutiérrez Dorticós, 1982; Piñera & Molerio, 1982; Rodríguez, 2009; León, Parise, 2009, Ingaramo, et al, 2009)

Concerning Sugar production and water quality in Cuba, it is very important to clarify that Cuba has been considered a high potential in this field, due to the tropical climate, the clayish prevalence of soil, and the regular characteristics of plains in most territories. (Dyer, 1956)

In the first stage of Sugar production in Cuba under the Spanish metropolis, it was very noticeable the deforestation of the Colonial empire in the search of timber for steam machines to transport and process the Sugar cane. This deforestation affected directly the ecosystem of the forests, the frequency of rain rate and subsequently the reduction of underground water availability. (Monzote, 2008)

Some years later, the mismanagement of industrial fertilizers, irrational deforestation to multiply the export market to big countries, first the United States and later, to the Soviet Union and Socialist countries, generated a marked pollution of waters driven from soil to the rivers and lakes. (Rodríguez-Castellón, 2003). In this scenario of the 1970s and 1080s in Cuba there also came up a significant biodiversity loss, groundwater contamination, erosion, soil salinization and compaction (Wright, 2006).

By the arriving at the so-called special period, Cuba stopped receiving raw materials from the socialist European framework and it brought away the fall of Sugar production, and through this fact, the country had to use organic fertilizer by making use of the local innovation and precarious traditions of the farmers. (García-Álvarez and Nova González, 2014; Riera and Swinnen, 2016). It is the true that the method was less aggressive to the environment but helplessly the levels of production did not cover the emergent needs of the ever-growing population. During the first harvest under AZCUBA (a new Cuban sugar institution) in 2011/2012, the area targeted to sugar decreased to 361,300 ha, which was 65.2% below the area dedicated to sugar cane during the 2001/2002 harvest (ONEI, 2017).

Some other outstanding information that could constitute the Environmental indicators to evaluate the quality of waters in Springs

It is a very basic that the water bodies which can be seen superficially are sometimes the sources more outstanding to our consideration. However, it is an absolute truth that underground waters are essential to life in the planet since they are the main sources of rivers, springs, lakes and wetlands. They are also very effective in terms of keeping away from pollutants and salt water influence on land. (Morell, 2008; Sahuquillo, 2009). On one hand, there are cases in which the local geography of some countries help them to keep way from salinization of springs due to the Climate changes incidence. On the other hand, some countries suffer the inclusion of threatening of salinization because the level of the sea rises and as the availability of wetlands are seriously affected (as a natural protection), it is s fact that they lose fertile lands near the coasts and the aquifers are getting gradually more polluted.

Custodio and Llamas (1983, p.15) define a spring as a water body from surface whose origin comes from subway cracks. This source can be permanent or intermittent. In some way It is related to atmospheric element since the rain water seeps into the ground that will emerge by a process of filtering cycle in a distinctive place of lower altitude; also in igneous variant (Thermal waters).

For Rodríguez et al. (2003, p. 424), springs are underground waters which comes up to the surface, due to the orography of the field, they can emerge on slopes or plains, when the streams find impermeable layers in the soils through which they flow. These definitions focus on conceptualizing the springs from the hydrological point of view, but unfortunately they do not address the link created between the inhabitants and these sources, and it is precisely here where the progressive deterioration of the springs underlies, tinged by the agricultural management and the impression of the ecological footprint in their context.

In the world, research has been carried out on the environmental situation of springs that recognize the incidence of the hydrological, biological and chemical elements, but not the anthropological ones, as in the case of the study on the springs belonging to the Po River in Europe.

"The lowland springs of the Po river plain can be regarded as important sentinels of environmental changes because the monitoring of their hydrological, hydrochemical and biological conditions provides useful information on the present status and trends of an area subjected to multiple interacting pressures." (Rossetti, et al., 2020 p. 17)

As samples of environmental indicators which have been used in some other papers are included: water temperature (temp., °C), insolation (insolati, %), water pH (pH), conductivity (cond.,mS/cm), total hardness (hardness, mg CaCO3/L), oxygen content (O2, mg/L), ferric ions (Fe3C, mg/L), phosphates (PO3, mg/L), ammonia nitrogen (NH4, mg/L), nitrate nitrogen (NO3, mg/L), concentration of solids (mg/L),BOD5 (O2,mg/L),

mineral sediment contribution (mineral, %), organic sediment contribution (organic, %), mean sediment grain size (M, mm), sediment sorting (W, mm), and density of aquatic vegetation (plants, on a scale from 0 to 5, where 0 indicates the complete absence of plants and 5 means total overgrowth). Szlauer-Łukaszewska et al. (2021)

The water found in nature is not pure, through its passage through the soil it is loaded with minerals that will give it its peculiar characteristics, but it can also pick up organic matter, gases or microorganisms. Traditionally, people associate spring water with good quality, trusting that the natural purification process, as it filters through different phreatic layers, will eliminate undesirable substances (Rodríguez et al., 2003).

As a curiosity about springs It is always expected that people usually look for water when they think of springs, nevertheless in 1998 there was an expedition in Cuba, under the leadership of Dr. Manuel A. Iturralde-Vinent, accompanied by agents from the American Museum of Natural History (AMNH), New York. In this trip an important new type of palaeontological site for the Caribbean was discovered and excavated a fossil-bearing natural tar spring located near the city of Mart, in the Matanzas province of Cuba. (ITURRALDE-VINENT, 1999)

However, it is undeniable that most of the Cuban Spring waters are healthy, drinkable and famous worldwide by its incomparable properties. As examples of these springs are found: Manantiales de Santiago de Cuba, Manantial "El Templado", Manantiales "Ciego Montero", Manantiales de la isla de la Juventud, Manantial "La Cotorra", Manantial "Mayabeque" and as a bathing resort for healing purposes, nowhere else could be a better destination than the thermal waters of "San Diego de los Baños." (Zerquera, Prendes, 1993)

After analyzing the results of this brief review on the consulted materials, the author of this paper has decided to balance the importance of the environmental indicators already exposed in the existing scientific literature. (See figure 1) This consulted references are selected into 6 water bodies are already cited in this paper.

For the analysis of the 5 indicators it was determine which have been the more common kinds of indicators used in the texts consulted: they were the hydrological parameter (HP), the biological parameter (BP), the chemical parameter (CP), the physical parameter (PP)and the socio environmental parameter (SEP).

As it can be viewed in this work, the HP is determined by following the proper characteristic of the waters itself, The BP is considered, taking into account the presence of the biodiversity in its natural field, The CP is conceived, based on the chemical constituents of the waters, the CP, taking into consideration the physical characteristic of the water body, its position and all the physical nature of the fluent body and finally the SEP is understood as the integration of the natural and social factors, the incidence of human settlement and its managements.

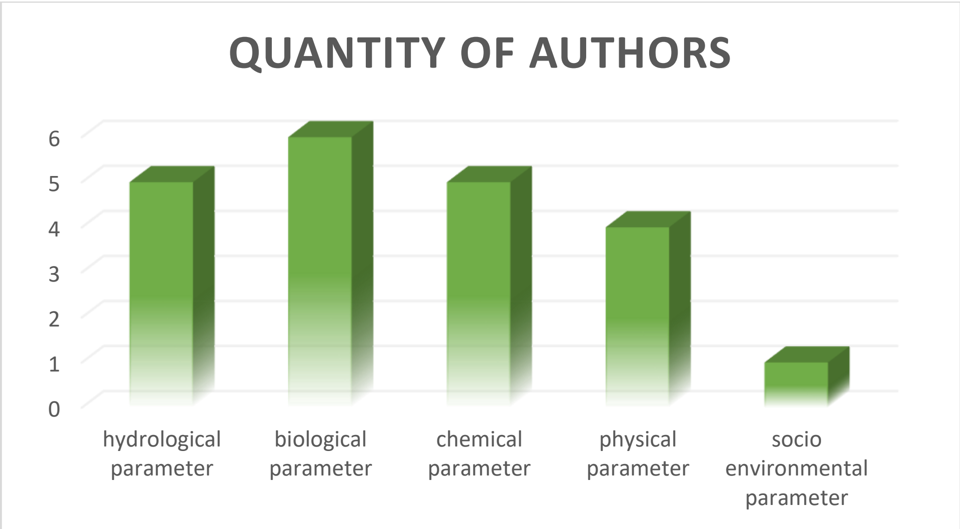

Figure 1. Balance among the quantity of authors who have used the mentioned parameters

Note: The socio environmental indicator is that one whose focus is the direct and direct relationship between Mankind´s activity and the development of Springs and its ecology.

As a concluding interpretation of the graphic it can be said that: Originally, it has been biological metrics to evaluate freshwater, but now due to the strong incidence of anthropogenic component on environment it is necessary to consider the overall effect of human activity on earth.

About socio environmental indicators in Cuban springs it can be said that despite they haven't been largely used by authors in the scientific literature, this foundation has served to make understand that empowering the evaluation of this field, it is clear that the total validation is more integrated.

So, it is interpreted that most of authors have focused more in BP, HP, and CP than any other. Otherwise the socio environmental is less considered. It is probable that in the history of water treatment humanity hasn't t recognized strongly the role and the implication we have to preserve and improve the quality of water, that´s to say the quality of our lives.

Conclusions

This work has met the goal of establishing a brief review about some of the environmental indicators that have been used in the world and specifically in Cuba to evaluate the quality of water in Springs.

In this review it was found the importance of springs for the cycle of water in nature and all the process for life in the planet.

Through the chronology there is a representation of the first environmental parameter used to evaluate the quality of waters, also specifically attending to the characteristics of Cuba. In a brief summary it was also presented the historical and existing relation between the pollution of aquifers and sugar production. There also come up a balance of the most important parameters mentioned in the consulted literature and the necessity of empowering the socio environmental power on behalf of the stainability of Springs in the Cuba and in the world.

In this paper there is a proposal on environmental integrated parameters to evaluate the impact of springs and clarifies the sub parameters of the socio environmental indicator.

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