A BRIEF REFERENCE ABOUT FRESH AND SALT WATER WORLDWIDE AND IN CUBA

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Abstract: -

Though many water testing have been produced worldwide and in Cuba, there are not yet deep studies of how fresh and salt water behave and how they can be compared according to some chemical parameters. This kind of study is very useful to characterize the quality of water in some regions of Cuba where human activity is frequently present. This paper becomes a starting point of a series of water testing that will be carried out after analyzing the situation of water quality and the implication this water has to human health and socioeconomic activity. The objective of this work is to reveal the potentials, weaknesses about fresh and salt water worldwide and specifically in Cuba. To meet this goal, the authors have confirmed their criteria through a practical experiment based on 5 indicators: Dissolved Oxygen, water temperature, pH, Phosphates and Nitrates. This comparison has been the base for determining which are the main causes that have provoked water disruption in some lakes, rivers, dams and several beaches. In this research several University students have participated, whose activity and reflection have been part of their outdoor formation and the permanent link between school and community

Keywords: *Water testing, Salt-fresh water, water quality indicators.*

INTRODUCTION

Some historical information on science about the relationship between fresh and salt water worldwide

Some have been the scientific worries about the relationship between fresh and salt water, most of them started from the vision of their meeting near the beach where generally rivers and some other freshwater bodies mix and become one. The focus beyond analyzing the isolated properties of each sort of water it has been trying to make understand what makes from salt water a facilitator of fresh water to come into the sea. Cooper, (1959) dedicated his work to unveil such a discovery. Through his paper he took his theory from the flow pattern of the water near the beach; he described how the ground water was conducted to the sea through an interface. In this experiment he stated that the pressure of the static salt water, owing to its greater density was able to get counterbalance and drive the fresh water seaward. It is clear that he didn´t cover specifically the features of both kinds of water but in a certain way he motivated the need to follow-up research.

We might say that one of the earliest comparisons of the two kinds of water, at least ever registered in scientific journals was that of Monahan, Zietlow, (1969). This reference traced the difference between the formation of bubble in fresh water and in the sea. According to this postulate, whitecap lifetimes were greater on the oceans than on the lakes. For this aim they measured and verified that there were bubbles with radii below 500 μ for sea and parallel to this research, he confirmed that in saltwater whitecaps simulation lasted 3,85 seconds otherwise in fresh water it lasted just 2.54 seconds. It is obvious that chemical components in salt water permitted such a potential, but certainly it was not the focus to find out which was the reason for this behavior. Many years later, Reilly, Goodman, (1985) tried to achieve an attempt of reviewing the history of the relationship between the salt water and the fresh water but seen from a mathematical description. In this study, density was one of the components of comparison, however the hydrodynamic dispersion was the main target that made possible a quantitative analysis between salt water and fresh water in this paper.Lugo, et al., (1988) get an approximation to the study of these two water differences, nevertheless the contextualization of this water in wetlands and the forested environments was so deep and complex that hardly reached space to understand the real and standard peculiarities of this waters out of this field. In other words, the salt water and fresh water were tested both according to the implication of the characteristic biota of wetlands, the incidence of forestry ecosystem in quality of water as such. It was very resourceful research but undoubtedly it pointed out to a more specific data considering the context. Lee, Bell, (1999) touched the relationship of these two waters not from the characteristics of the two waters as such but from the impact of saltwater animals that invaded freshwater environment. The effect of the presence of these species denoted the difference in the process of adaptability and nourishment of these animals in the new water scenario, taking into consideration the properties in the ecosystem of these two kinds of waters.Leung, et al., (2001), perhaps has followed the previous research in a very representative manner, because if the center of the attention was focused in invading animals, this one is centered in the level of salt water toxicity in fresh water.

These authors claim the necessity of using empirical data to represent the results of ecotoxicity tests, this paper adjusted to some realities of estuarine and coastal environments, gave some figures, though not sufficient to customize the intrinsic proprieties of each kind of waterBarlow, P. M. (2003) got very close to comparison between the two waters, and he made it through the content of salt in each kind of water. According to his position, all kind of water have a certain quantity of salt; fresh water should have less than 1,000 mg/L; waters with a total dissolved-solids concentration greater than 1,000 mg/L are considered to be saltwater (or saline).

But according to this author there is a saltier water, and it is the brackish water, having a total dissolved-solids concentration of 1,000 to 35,000 mg/L. The average concentrations of the major dissolved constituents of seawater are found in some chemical elements such as: chloride, sodium, sulfate, and magnesium.Santoro, A. E. (2010). Inserted a new element in the interaction between fresh and salt water and this is mainly located approximate to estuaries. His element was linked to microbial influence in the process of salinization. He explained in details how this process evolves, these microbes were supposed to transform the environment through to the nitrogen cycle, which was significant to the coastal surface. There have been many other authors who have contributed to the experiment of this interaction of fresh water-salt water but from different perspectives: Burns, Meigburg, (2015) made it through nonlinear simulations; Mazzei, Gaiser, (2018) made it through diatoms as tools for inferring ecotone boundaries; Lyu, Zhu (2019) made it through a tidal flat reclamation on saltwater intrusion and freshwater; Luo, et al., (2020) made it through a Carbon mineralization in tidal freshwater; Ronczka, et al., (2020) made an attempt to monitor the quality of these two kinds of waters but they just got to test their interfaces; Zhu, et al., (2020) investigated high salinity in a tropical freshwater-saltwater ecosystem; Servais, et al., (2021) linked Saltwater with the presence of Phosphorus to analyze the biogeochemical processes in freshwater and brackish wetland. As well as it can be seen this interaction was mostly described in the context of interaction with other elements or environment. However, Bonamico, et al., (2021) started to open a focus to their chemical difference in the interaction of these two waters in a coastal aquifer. And so on we could find more works related to the relationship of these waters, but as it be noticed there are not many papers referring to their quality water testing in specific.

A brief reference about the monitoring of Fresh-Salt Water in Cuba

It is possible that this topic has been very well treated and experimented through the passing of the years in Cuba. This is a fact because Cuba is a tropical island whose geography is full of intersections between the rivers and the plenty diversity

of sea all over the coasts, Besides, Cuba is well known for his high level of education and the use of sciences. However, it can be said that there are not many of these works registered or published in scientific journals. Among the few of themis relevant in the scientific literature: González et al., (1996) who established the study of the relation between fresh and salt water through the study of rock. Another sample was that of González, (2018) who presented a methodology to recover a wetland taking into account the characteristics of the influence of fresh water in contrast to the salinization.

Valladares et al, (2020) in their research measured temperature, pH, water turbidity, and dissolved oxygen in some lakes, rivers, and beaches. They found in the work that the dissolved oxygen was low, turbidity was high in all of the lakes and the pH was low for the rest of the diagnosed water bodies. Given that these conditions indicate impairment, they transmitted the information to the authorities about the recreational facilities, these water bodies belonged to.In these contemporary years Larrea et.,al (2022) has given a strong push to the history of water monitoring in Cuba, because through testing the water of Almendares river (fresh water), they have boarded remarkable aspects for the quality water testing.

Almendares is a wide river that flows through the capital of Cuba, La Habana and for 15 years this research have delivered crucial results that have helped to understand much better the role of this river in this urban ecosystem. Some of the figures that have been reference in this paper: temperature (25-30º C), Conductivity (600-6300 µS.cm-1), pH (6,5-9,6), dissolved oxygen (0,2-5,3 mg.L-1).Maybe there are many other papers related to this topic of describing and comparing results of water testing on salt water-fresh water; however, the purpose of this section is not making and exhaustive review but just mentioning some representative works to explain the evolution and characteristics of this field of sciences. The objective of this work is to reveal the potentials, weaknesses about fresh and salt water worldwide and specifically in Cuba in such a way that it becomes a starting point for a series of water testing.

Material and Methods

Documents Review: To get a consensus about an average of opinion about the quality of water in fresh and salt water, the authors consulted some publications whose target is related to the comparison of fresh-salt waters or in case of shortage of literature in this topic, the authors took into account the results of research about fresh water and salt water in an isolated way.
The references that were consulted according to the topics were the following:
-Comparison between fresh water and Salt water (worldwide): Alley, (2007) Hong, et al., (2018); Essaid, (1986); Caraco, et al., (1990); Rahman, Hamidah, (2020); Ochsenkühn, et al., (2021)
-Monitoring of fresh water: Rossetti., et al. (2020); Mosley, (2015); Maybeck, et al., (1990)
-Monitoring of salt water: Gasser, (1993); Anderson, Phillips, (2016); Ward, (2020);
-Monitoring of fresh-salt water in Cuba: Valladares et al, (2020); Larrea, (2022)

Criteria considered in the review:
- indicators taken into account
- Positions of the consulted authors regarding its criteria on FW and SW
- coincidences and differences based on a comparison between Cuban waters and the ones consulted worldwide.
-Aspects through the water testing that affect the ecological environment

Measuring Water Quality through water testing kit

This kit involves some instruments that support the information compiled through the previous documentary review.

1. YSI Pro Multiparameter meter: This instrument was used to measure Dissolved oxygen in Water and also water temperature.
2. Hanna Instruments nitrate meter: This colorimeter is a tool to indicate Nitrates in water.
3. Hanna Instruments Phosphate meter: This colorimeter is a tool to indicate Phosphate in water.
4. pH probe: This tool was used to test pH in water.

Implication of University Students:

In this experiment, 10 students from the Faculty of Physical Culture, University Pinar del Río, Cuba have been selected and encouraged to undergo this research.These students are member of a Science Fan club at the school, following the target of a better integration of academic and crossed disciplined formation. They were motivated by his coordinating professor to use the water testing kit in order to monitor the water of two local water resources linked to their professional link of physical recreation: a spring and a beach.

Selected Area to be tested:

For this goal, the authors selected two water bodies at random that represent salt water and fresh water from Cuba. The fresh water was taken from a Spring called *La Yuquilla*, 56 kms away (North) from the capital of Pinar del Río, (the westernmost province of Cuba) Located exactly between Sumidero and *Las Minas de Matahambre to*wn. (latitude:22.7439, Longitude: -83.3025) The salt water was taken from Boca de Galafre beach, located southwest 45 kms away from Pinar del Río, the capital city of the province. (Latitude:22.1666667, Longitude: -83.9).

Results and Discussion

Through this chart, it can be seen some meaningful information about fresh-salt water according to authors already mentioned in the previous section of this paper.

Chart 1. References about the study of waters according to the cited authors

References about fresh water (FW) and Salt water (SW) worldwide	
Alley, (2007)	This author classifies water use no matter if it is fresh or salt into the following group: . Public water supplies • Propagation of fish and wildlife • Irrigation • Recreational purposes • Navigation
Hong, et al (2018)	Studied the difference between the two waters through the zooplankton; these are species very abundant in the both waters, they were significantly distinguishable between the inner and outer regions; cladocerans were the most dominant species in freshwater and cyclopoida were predominantly found in saltwater.
Essaid, (1986)	A quasi-three-dimensional finite difference model which simulates coupled, fresh water and salt water flow, separated by a sharp interface revealed that the magnitude and duration of the departure of aquifer is function of the ease with which flow can be induced in the salt water region.
Caraco, et al., (1990)	The difference in Phosphorus cycling is large enough to have an influence on the difference in phytoplankton nutrient limitation between fresh- and salt-water systems.
Rahman, Hamidah, (2020);	Turbidity was the strongest predictor of bacteria density in freshwater and saltwater ponds. It had strong negative influences on bacteria density in freshwater ponds whereas, it had the results of this study support and emphasized the importance of developing appropriate programs for the monitoring and conservation of various freshwater and saltwater ponds.
Ochsenkühn, et al., (2021)	Freshwater bacterial communities commonly have higher diversity than marine water because of the wide variety of terrestrial fauna, flora and geography. For both FW and SW characteristic communities mainly consist of Proteobacteria, Bacteriodetes and Actinobacteria, but they are low in numbers of Firmicutes, which are generally found in high abundance in freshwater.
Monitoring of fresh water	
Rossetti., et al. (2020)	The results showed a decrease in the chemical water quality especially, in springs south of the Po river, evidenced by high nitrate levels. Most of the monitored springs showed a relevant decrease in dissolved reactive silica, probably related to recent transformations of either agricultural practices or crop typology. Ostracods were mostly represented by common and tolerant species, and communities were characterized by

	low alpha diversity and high species turnover. Water temperature and mineralization level were the most influential variables in structuring the ostracod communities. The authors stressed the need to implement conservation and restoration measures for these threatened ecosystems.
Mosley, (2015)	Severe droughts are predicted to increase in many regions of the world due to climate change. There is a need to better understand the effects of droughts on freshwater quality to prevent and/or manage adverse impacts. Over the last 10–20 years there has been an increasing amount of observational studies on the water quality effects of drought in freshwater systems, mostly in North America, Europe, and Australia. This review highlighted that a complex variety of water quality responses can occur.
Maybeck, et al., (1990)	This study investigated the main areas of scientific and environmental interest. Most chapters, such as that on nitrates, presented a statement of the issue covered, looking at natural cycles and comparative data on naturally occurring levels of nitrates in freshwater. It happened fairly before going on to examine sources of additional input, and the effect of increased levels on the water body itself and on human health.
Monitoring of salt water	
Gasser, (1993)	Results showed that the slough produced extreme DO fluctuations during the summer with anaerobic conditions occurring routinely in the morning due to excessive algal growth. The lake had more muted cycles but violated the 5.0 mg/l RWQCB (Regional Water Quality Control Board) DO standard frequently during the summer. Managing water levels in the slough apparently has little effect on DO, but a 12:00-24:00 h pumping schedule delivers significantly more oxygen to the lake than the alternative 7:00-19:00 h schedule.
Anderson, Phillips, (2016)	This chapter summarizes laboratory methods for assessing toxicity of marine and estuarine receiving waters, with an emphasis on standardized procedures used for regulatory purposes.
Ward, (2020)	
Monitoring of fresh-salt water in Cuba	
Valladares et al, (2020)	Presented the difference in results between FW and SW in a series of water testing through the westernmost province of Cuba. In this case most of indicators (DO, turbidity, temperature and PH) were altered due to the use of mismanagement of fertilizer and Agricultural activity.
Larrea, (2022)	In this work there is a presentation of Water testing in *Almendares* River and the impact of salinization and urban pollution. This testing followed a wide array of indicators and traced a huge plan to restore a significant part of the river.

Just to confirm by the way of experiment, some potentials, and weaknesses of these two kinds of water it was carried out a water testing in two water bodies, according to the description of the section above. As follows it will be shown a chart about the results of testing and subsequently there will come up a brief discussion about the findings.

Chart 2. Results of Water testing

Indicators	FW (Spring)	SW (Beach)
pH	6.90	7.10
DO	2.85mg/l	6.38 mg/l
%S	39.2 %	83.1 %
WT	32.5 °C	28.8°C

PHP	0.00 ppm	0.77 ppm
NT	1.55 ppm NO2	3.6 ppm NO2

Legend: DO: Dissolved Oxygen. %S: Percent of Saturation, WT: Water temperature, PHP: Phosphates, NT: Nitrates.

According to this comparison It is in the beach where life is more consistent, due to the neutral value of PH of the beach; though the difference is very slight, this criterion is stronger if we analyze the content of DO. Scientifically there are evidence that confirm that there is more probable existence of life whenever there is more oxygen in water (lovelock, 1975; Glasser, et al., 2020) or when the water reaches a high levels of saturation (Armstrong, 1980; Kurkin, et al.; 2021).It seems that in both cases, life in the ecosystem is at risk, because according to some authors, the over warming condition of the planet is a process that is affecting seriously all species and comes gradually growing (Meybeck, et al., 1990; Karlson, et al.,2020).

It is objectively evident than in this sample of salt water there is more content of phosphates and nitrates, enough quantity to point out that the ecosystem is richer in biodiversity; much more in the SW source that in the FW body. (Zhang, et al., 2020; Fatima et al.,2021) Nevertheless, this comparison is only based on the analysis of two water bodies at random. Probably much more information would be more meaningful if the samples were multiple and selected in many other resources. Anyway, this study has served as a reflex of how water is behaving towards life conservation on Earth and as a starting point to carry out more water testing to discover some deeper evidences.Through this work the University students have participated in the explanation of the water kit usage and in the processing of information while testing the water. This part of the research has been an educational drive that makes this experiment more sustainable and socially more remarkable.

Conclusion

This paper has served to supply a summarized information of Fresh and Salt water according to some important authors in this matter and also there is a practical experiment that confirms some potentials, weaknesses and threatening that both kinds of water have.There is an amount of information that supports the permanent relation existing between FW and SW through the cycles of life. At all extent, it has served as a material to start a water testing for carrying out a deeper study in this field and facilitating a more sustainable life in the water environment.

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