Radiofrequency Temperature Control System for Fish Capture

Walter Vásquez-Cubas[1], Marvin Zarate-Cuzco[2], Michael Cabanillas-Carbonell[3]
Facultad de Ingeniería, Universidad Privada del Norte
Lima, Perú

José Luis Herrera Salazar[4]
Facultad de Ingeniería y Negocios
Universidad Norbert Wiener, Lima, Perú

Oswaldo Casazola-Cruz[5]
Facultad de Ingeniería Industrial y de Sistemas
Universidad Nacional del Callao, Callao, Perú

***Abstract*—Artisanal fishing is one of the activities with the greatest economic impact worldwide. In the present research, the radiofrequency temperature monitoring system for fish catches was aimed to determine the influence on the satisfaction of fish catches. The dimensions included were time delay and direct cost; on the other hand, in the monitoring system were usability and reliability. It was shown that the use of the radiofrequency temperature monitoring system decreased the direct cost incurred, reduced the time required to locate hot spots, increased satisfaction and confidence in the system by 95%.**

***Keywords*—Temperature monitoring system; satisfaction; radiofrequency; fish capture**

I. Introduction

Artisanal fishing activity plays an important role in food, profit and work occupations in the world. The fishermen who are independent as well as those organized in associations, take the activity as a daily life and use it for their consumption, using small boats and artisanal skills [1]–[3]. In this regard, the current pandemic has hit fisheries hard, especially in the early 2020 [4], which has been evolving favorably, achieving a recovery in recent months [5], but greater attention still needs to be paid to artisanal fishing. From the economic point of view, it produces benefits that symbolize a significant percentage of GDP, basically in developing countries with coastal environments. About 82.1 million jobs in the world are in this activity [6].

Artisanal fishing is currently known as the activity carried out by natural or legal persons operating personally in small boats. In Peru it is known as small-scale fishing. According to the Encuesta Nacional de Hogares (ENAHO) [7], 0.6% of the economically active population belongs to the artisanal fishing activity with 91,937 jobs at the national level, characterized by a high presence in the maritime and continental areas. There are programs for Peruvian artisanal fisheries that are often too expensive and not suitable for multiple ports, and incentives for fishermen to keep logbook reports are very low [8].

The association of artisanal fishermen of Huanchaco was founded on June 3, 1986, and is currently made up of 30 artisanal fishermen whose main work is catching and selling fish. They enter the sea an average of one kilometer out to sea, sailing for hours without having a specific point or place to throw their fishing nets to catch more fish. The “caballito de totora”, oars and fishing nets are the instruments they use for their work; when the tide is high or rough (as they colloquially call the sea waters when the waves are larger than average) they do not enter.

Few fishermen know from empirical knowledge how to determine if the area where they are going for their fishing activity is favorable, because there are fish that tend to be in favorable biophysical environments located in areas where the sea temperature is pleasant for their habitat [9], [10]. But since knowledge is minimal, not all associates have the experience to know which points or places have a high or low temperature index. This generates a problem in terms of loss of time and the direct cost of rowing from one point to another without having at least some help to make a correct decision at the moment of deciding on a favorable capture point. To achieve an adequate catch of fish, it is necessary to apply certain technologies that help the optimal performance [11], both fishing nets and electronic devices should be taken into account to help the rapid location of fish and data collection for better decision making, helping to reduce the unit cost.

II. Related Work

The following studies were considered as background for the radiofrequency wireless temperature monitoring system and fish catch satisfaction:

In the research [12], the objective was to collaborate in the exploration of warming signals, ocean acidification and its impact on marine and coastal ecosystems in the Colombian territory. To achieve this, they analyzed data from different coastal, estuarine and oceanic stations in the period 1993-2011 by Invemar. They showed a long-term average sea temperature increase trend, in the Caribbean at 0.23 °C per decade and in the Pacific Ocean at 0.18 °C per decade. They concluded that continuous changes in sea temperature continue to affect Colombian marine ecosystems.

In [13], the objective of the research was to raise fishermen's awareness of the need to fish correctly without harming the environment. They used the Nahed and Tirado Methodology and semi-structured surveys. The results showed that 30% of the fishermen interviewed spent 5 hours, 25%

spent 4 hours, 25% spent 6 hours, 10% spent 3 hours, 5% spent 8 hours and 5% indicated that it depended on the tide. They concluded that all groups are in favor of better control of their work.

The research is significant in terms of taking the temperature of the sea to show warm spots, which will stimulate people to make the decision to look for the best place to carry out their artisanal fishing activity, generating direct and indirect income to him or his family and by reducing the time the fisherman can perform other activities that will help him to have other economic income.

The research has a positive environmental impact, as it provides the measurement of sea temperature, which will help to make decisions on whether to carry out a possible targeted closure.

III. Methodology

The type of study was pre-experimental; the sample consisted of 30 artisanal fishermen. Data collection was by means of questionnaires.

A. Population

For this research, a total of 30 artisanal fishermen have been considered as a sample, taking into account all the members of the association of artisanal fishermen of Huanchaco, Trujillo.

B. Data Collection

1) Technique: The survey technique was used to obtain the indicators of delay time to locate hot zones, delay time to detect hot zones and direct cost.

2) Data analysis: SPSS was used for quantitative data analysis. It is a powerful tool for data processing and statistical analysis [14].

3) Procedure: The following steps were taken to collect data before using the RF wireless monitoring system:

a) Observation: A meeting was held with the fishermen at accessible times so as not to interfere with their work, and each fisherman took an average of 5 minutes per person to complete the questionnaire. The questionnaire consisted of a total of 7 questions related to fishing activities, where the grade range was A - D, where "A" is excellent and "D" is very deficient.

b) Sorting: The information was then sorted by means of dynamic tables in Excel.

C. Monitoring System Simulation

A complete circuit of the monitoring system was made in Proteus, software that we used mainly to test (simulate) our measurement node, which consists of a microcontroller (ATMega328P) [15], DS18B20 temperature sensor that communicates digitally with the terminals Vcc, GND and the Data pin [16], GSM module SIM800F which was connected to the TX and RX pins [17], for transmission and reception, capacitor and quartz crystal.

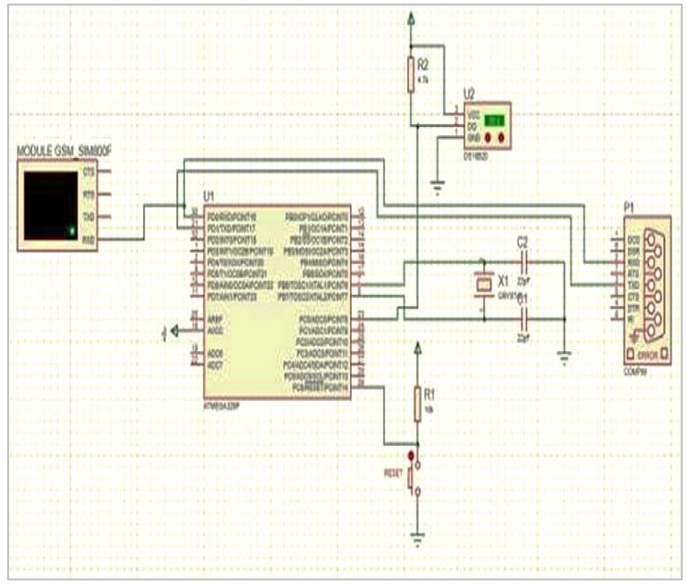

Fig. 1. Complete System Circuit in Proteus.

Fig. 1 shows the terminal where the AT commands appear, executing one after the other to send the temperature obtained by the temperature sensor, this data is sent in JSON format.

D. Development of the Mobile Application

The Mobile-D methodology was used, which has a mixture of many techniques and best practices to aid in the development of mobile applications [18], consisting of five phases: exploration, initialization, production, stabilization and testing.

1) Exploration and Initialization Phase:

Analysis of initial requirements.

- Display a mapping of warm zones.
- Display Temperature.
- List the possible fishes in the area.

2) Production: Implementation of the functionality to list the buoys and identification of zones by temperature through the heat gradient, then the implementation of the functionality to show the possible fish that may appear in the previously identified zones.

3) Stabilization: A refactoring of the functionality of listing (buoys and idenified zones) and displaying possible fish that may appear in the color zones established by their temperature.

4) Tests: An evaluation of the wireless monitoring system with radiofrequency is carried out, performing the heat map visualization test with internet connection, fish visualization, in an interval of 6 days to later give way to the analysis of the results obtained by means of the post-test examination.

a) Listing of buoys: The data from the database are correctly displayed, making the list of buoys, shown in Fig. 2.

Fig. 2. Buoy Listing Interface.

b) Heat map: The heat map of the correctly selected buoy is displayed, showing the buoy in the sea with colors with respect to the thermometer, shown in Fig. 3.

c) Display possible fish: Possible fish that are close to the selected buoy are correctly displayed next to the temperature map, as shown in Fig. 3.

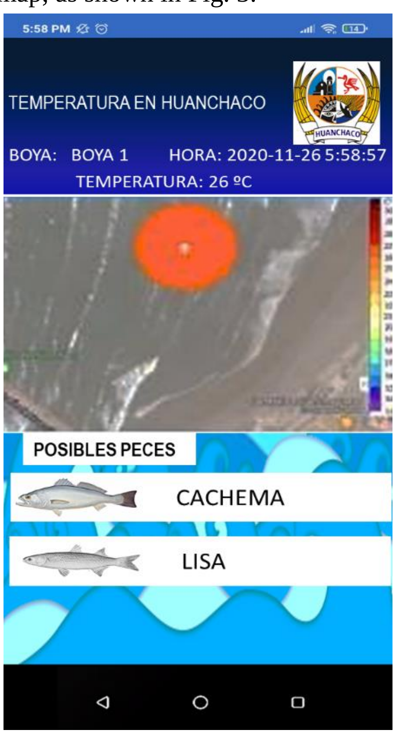

Fig. 3. Heat Map Interface and Fish Listing.

d) Temperature history: The average daily temperature of the selected buoy for the week is correctly displayed (Fig. 4)

Fig. 4. Week Average Temperature.

IV. Result

The graphs are shown based on the average result, obtained from the Pre and Post implementation tests of the radio frequency temperature monitoring system on fish catch satisfaction for the artisanal fishermen's association, shown in the statistical graph in Fig. 5.

The descriptive results of the general comparison of satisfaction with fish catch. In the pre-test a value of 58% was obtained, while in the post-test it was 83% as can be seen in Fig. 6; this indicates a great difference before and after the implementation of the system.

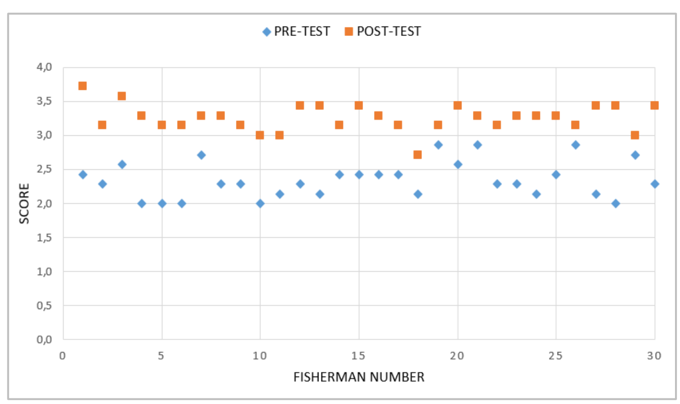

Fig. 5. Overall Comparison of the Pre-Test and Post-Test Satisfaction Results of the Artisanal Fishermen Questionnaire.

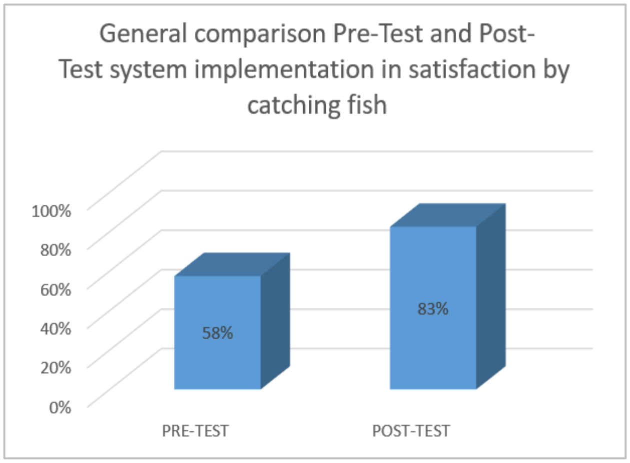

Fig. 6. General Comparison Pre-Test and Post-Test Implementation of the Temperature Monitoring System with Radiofrequency in the Satisfaction of Catching Fish.

Additionally, an in-depth analysis of the results was performed by means of Wilcoxon's W test [18]. Nonparametric statistical methods are useful when there are directional differences.

A. Result based on Satisfaction

When the tests were conducted, the following data shown in Fig. 7 were collected, being the results obtained in the Pre and Post Test based on satisfaction after the implementation of the RF monitoring system according to the score obtained in certain numbers of fishermen.

Subsequently, the Wilcoxon W statistic was used for the study and comparison of related samples to find the level of confidence in the satisfaction with fish capture.

The summary processed in SPSS is shown in Table I.

As can be seen, the Wilcoxon W statistic was -4.7200 and the p value (asymptotic sig. (bilateral)) is 0.000 (less than 0.05), so the null hypothesis is rejected and it is concluded that there is sufficient evidence to affirm that the proposed monitoring system improves fish catch satisfaction with a confidence level of 95%.

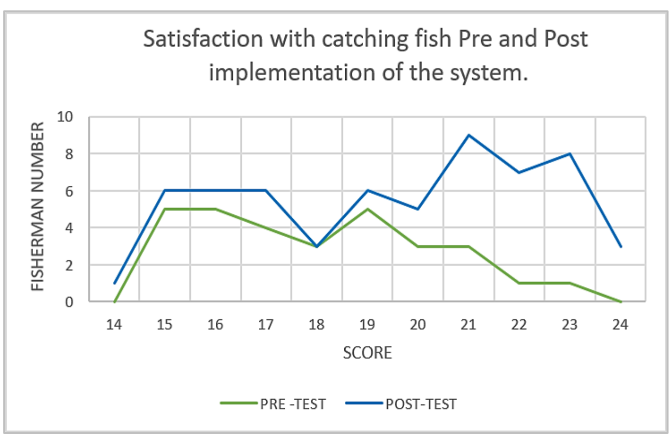

Fig. 7. Pre vs. Post about Satisfaction with Catching Fish.

TABLE I. WILCOXON W TEST (CALCULATED IN SPSS) - SATISFACTION

Ranges				
		N	**Average range**	**Sum of range**
Total POST – Total PRE	Negative ranges	0^a	,00	,00
	Positive range	29^b	15,00	435,00
	Ties	1^c		
	Total	30		
a. Total POST < Total PRE				
b. Total POST >Total PRE				
c. Total POST = Total PRE				
Test Statistics[a]				
		Total POST – Total PRE		
Z		-4,720[b]		
Asymptotic sig. (bilateral)		,000		
a. Wilcoxon signed-rank test.				
a. It is based on negative ranges.				

B. Results based on Delay Time

When the tests were conducted, the following data shown in Fig. 8 were collected, being the results obtained in the Pre and Post Implementation Test of the radiofrequency monitoring system according to the score obtained in certain amounts of fishermen, based on the location of hot zones for catching fish.

Wilcoxon's W statistic was used for the study and comparison of related samples to find the time delay for the location of hot spots.

Subsequently, the Wilcoxon W statistic was used for the study and comparison of related samples to find the delay time for the location of hot zones.

The summary processed in SPSS is shown in Table II.

As can be seen, the Wilcoxon W statistic was -4.683 and the p value (asymptotic sig. (bilateral)) is 0.000 (less than 0.05), so the null hypothesis is rejected and it is concluded that there is sufficient evidence to affirm that the use of the proposed monitoring system had a positive influence on the time delay for fish catching for the fishermen's association, with a confidence level of 95%.

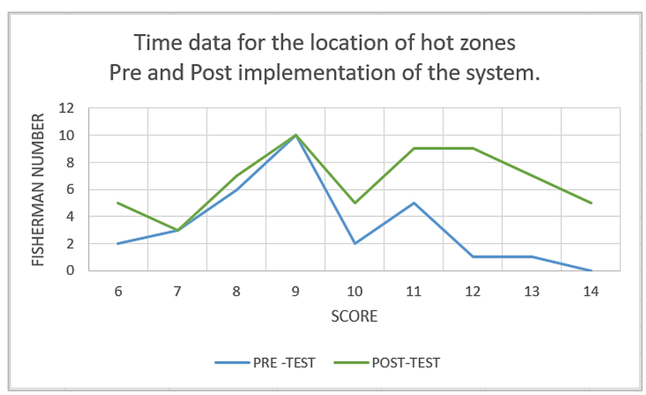

Fig. 8. Pre vs. Post about the Time Data for the Location of Hot Zones.

TABLE II. WILCOXON W TEST (CALCULATED IN SPSS) - TIME FOR THE LOCATION OF HOT SPOTS

Ranges				
		N	**Average range**	**Sum of range**
Total POST – Total PRE	Negative ranges	1^a	2,00	2,00
	Positive range	28^b	15,46	433,00
	Ties	1^c		
	Total	30		
a. Total 1 POST < Total 1 PRE				
b. Total 1 POST >Total 1 PRE				
c. Total 1 POST = Total 1 PRE				
Test Statistics[a]				
		Total POST – Total PRE		
Z		-4,683[b]		
Asymptotic sig. (bilateral)		,000		
a. Wilcoxon signed-rank test.				
a. It is based on negative ranges.				

C. Results based on Direct Cost

When the tests were conducted, the following data shown in Fig. 9 were collected, being the results obtained in the Pre and Post Implementation Test of the radio frequency monitoring system according to the score obtained in certain quantities of fishermen, based on the direct cost incurred by the fish catch for the fishermen's association.

Subsequently, the Wilcoxon W statistic was used for the study and comparison of related samples to find the direct cost.

The summary processed in SPSS is shown in Table III.

As can be seen, the Wilcoxon W statistic was -3.987 and the p value (asymptotic sig. (bilateral)) is 0.000 (less than 0.05), so the null hypothesis is rejected and it is concluded that there is sufficient evidence to affirm that the proposed monitoring system improves the average direct cost incurred by the fishermen of the fishermen's association, with a confidence level of 95%.

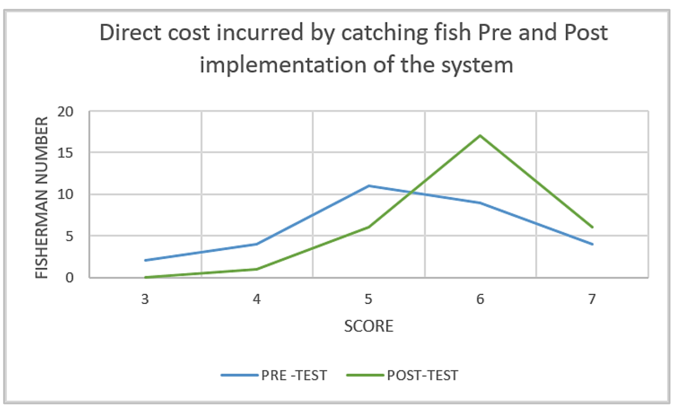

Fig. 9. Pre vs. Post about the Direct Cost Incurred by Catching Fish.

TABLE III. WILCOXON W TEST (CALCULATED IN SPSS) - DIRECT COST

Ranges				
		N	**Average range**	**Sum of range**
Total POST – Total PRE	Negative ranges	0^a	,00	,00
	Positive range	19^b	10,00	190,00
	Ties	11^c		
	Total	30		
a. Total 2 POST < Total 2 PRE				
b. Total 2 POST >Total 2 PRE				
c. Total 2 POST = Total 2 PRE				
Test Statistics[a]				
		Total POST – Total PRE		
Z		-3,987[b]		
Asymptotic sig. (bilateral)		,000		
a. Wilcoxon signed-rank test.				
a. It is based on negative ranges.				

V. DISCUSSION AND CONCLUSION

The influence of the temperature monitoring system with radiofrequency in the satisfaction of catching for the Huanchaco artisanal fishermen's association according to the established index is reflected favorably according to Fig. 5.

The results obtained from the pre- and post-implementation tests of the radiofrequency temperature monitoring system on fish catch satisfaction for the Huanchaco artisanal fishermen's association (Fig. 6 to 9) were relevant for the development of this research.

The use of the temperature monitoring system with radiofrequency in the satisfaction of catching fish had a positive influence.

In Fig. 7, it can be seen that 29 fishermen out of a total sample of 30 are in the positive range, which shows that the use of a radiofrequency temperature monitoring system positively influences fish catch satisfaction.

It was demonstrated that the use of temperature monitoring system with radiofrequency in the satisfaction of catching fish. The result (Fig. 8) shows that 28 fishermen out of a total sample of 30 are in the positive range of the Wilcoxon test, thus demonstrating that the use of a radiofrequency temperature monitoring system has a positive effect on the delay time for the location of hot zones.

It was demonstrated that the use of the temperature monitoring system with radiofrequency decreased the direct cost incurred. The result (Fig. 9) shows that 19 fishermen out of a total sample of 30 are in the positive range of the Wilcoxon test, thus demonstrating that the use of a radiofrequency temperature monitoring system reduced the direct cost incurred by the fishermen's association.

The analysis of the results showed that the use of the radiofrequency temperature monitoring system reduced the time required to locate hot zones for 28 fishermen, reduced the direct cost for 19 fishermen, and increased satisfaction and confidence in the system by 95%.

The research has allowed the integration of radiofrequency that so far has tried to address the problems of artisanal fishermen in their work. The conclusions of this research allow the decision making of the artisanal fisherman for his fish catching process.

VI. Recommendation

In a research project as interesting as this one, it is desirable to improve it; therefore, it is recommended to future students or researchers who are interested in our research project, the implementation of more interactive interfaces to help the user, as well as to accelerate the data collection process. It is important to take into account that more studies related to the improvement of the work in artisanal fishing should be carried out, since there are many problems that afflict this small sector.

References

[1] N. J. Bennett, "Marine Social Science for the Peopled Seas," Coast. Manag., vol. 47, no. 2, pp. 244–252, 2019, doi: 10.1080/08920753.2019.1564958.

[2] Presidencia de la República del Perú, "Presidente Vizcarra: Estamos fortaleciendo la pesca artesanal porque contribuye a la alimentación saludable de los peruanos," Plataforma digital única del Estado Peruano, Lima, Peru, 2019. Available: https://www.gob.pe/institucion/presidencia/noticias/45205-presidente-vizcarra-estamos-fortaleciendo-la-pesca-artesanal-porque-contribuye-a-la-alimentacion-saludable-de-los-peruanos.

[3] M. J. Mendoza, J. Guerra, N. Layedra, J. Morales, and P. Romero, "Red Inalámbrica de Sensores Inteligentes con Nodos Robotizados para la Supervisión del Ecosistema y Contaminación del Agua en Lagos y Lagunas," Rev. Publicando - Ciencias Soc., vol. 3, no. 2, pp. 120–136, May, 2018. Available: https://revistapublicando.org/revista/index.php/crv/article/view/1252/pdf_965.

[4] J. Sueiro and G. Torres, "Las exportaciones pesqueras en tiempos de pandemia," OCEANA Protegiendo los océanos del mundo., 2020. https://peru.oceana.org/es/blog/las-exportaciones-pesqueras-en-tiempos-de-pandemia-0.

[5] J. Sueiro and G. Torres, "La recuperación de las exportaciones pesqueras," OCEANA Protegiendo los océanos del mundo., 2020. https://peru.oceana.org/es/blog/la-recuperacion-de-las-exportaciones-pesqueras (accessed Jul. 01, 2021).

[6] Food and Agriculture Organization of the United Nations (FAO), "World Fisheries and Aquaculture the State of Sustainability in Action," 2020, doi: 10.4060/ca9229en.

[7] Ministerio de la Producción - Produce, "Anuario Estadístico Pesquero Y Acuícola," Lima, Peru, 2018. Available: https://ogeiee.produce.gob.pe/index.php/en/shortcode/oee-documentos-publicaciones/publicaciones-anuales/item/901-anuario-estadistico-pesquero-y-acuicola-2018.

[8] L. Ayala, M. Ortiz, and S. Gelcich, "Exploring the role of fishers knowledge in assessing marine megafauna bycatch: insights from the Peruvian longline artisanal fishery," Anim. Conserv., vol. 22, no. 3, pp. 251–261, 2019, doi: 10.1111/acv.12460.

[9] A. Rodríguez-Roa, B. Arce-Barboza, F. Boshell-Villamarin, and N. Barreto-Triana, "Effect of climate variability on collaria scenica (Hemiptera: Miridae) on the bogota plateau," Agron. Colomb., vol. 37, no. 1, pp. 37–51, Jan. 2019, doi: 10.15446/agron.colomb.v37n1.75954.

[10] J. Valencia, T. Baumgartner, and D. Reginaldo, "Effects of ocean climate on life cycles and distribution of small pelagic fishes in the California Current System off Baja California," Scielo, pp. 315–348, 2015, doi: 10.7773/cm.v41i4.2571.

[11] FAO, "Fisheries & Aquaculture - Tecnología de la captura de peces," División de Pesca, 2021. http://www.fao.org/fishery/technology/capture/es (accessed Jul. 01, 2021).

[12] P. J. Rojas-Higuera and J. D. Pabón-Caicedo, "Sobre el calentamiento y la acidificación del océano mundial y su posible expresión en el medio marino costero colombiano," Rev. la Acad. Colomb. Ciencias Exactas, Físicas y Nat., vol. 39, no. 51, p. 201, 2015, doi: 10.18257/raccefyn.135.

[13] E. F. Cortez, D. I. Mata, and D. O. Molina Rosales, "Percepción y calidad de agua en comunidades rurales del área natural protegida La Encrucijada, Chiapas, México.," Rev. Int. Contam. Ambie, vol. 35, no. 2, pp. 317–334, 2019, doi: 10.20937/RICA.2019.35.02.05.

[14] J. L. Rivadeneira, A. I. De La Hoz, and M. V. Barrera, "Análisis general del spss y su utilidad en la estadística," vol. 2, no. 4, pp. 17–25, Jan. 15, 2020. Available: https://revista.estudioidea.org/ojs/index.php/eidea/article/view/19.

[15] Atmel, "ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash DATASHEET," 2015.

[16] AG Electrónica, "DS18B20 CABLE: Sensor de temperatura DS18B20," 2017. Accessed: Jul. 01, 2021. Available: http://agelectronica.com/AG/.

[17] SIM COM A company of SIM Tech, "SIM800 Series_AT Command Document Title: SIM800 Series AT Command Manual," 2015.

[18] J. Gomez and D. Hernandez, "Mobile D (programacion dispositivos moviles)," Universidad del Quindío, 2016. https://es.slideshare.net/pipehernandez1020/mobile-d-programacion-dispositivos-moviles (accessed Jul. 01, 2021).