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**V DETERMINATION OF AVERAGE ANNUAL RAINFALL IN THE AGUABLANCA STREAM WATERSHED USING GIS AND IDW METHOD.**

**V DETERMINACIÓN DE LA PRECIPITACIÓN MEDIA ANUAL EN LA CUENCA DEL ARROYO AGUABLANCA MEDIANTE SIG Y EL MÉTODO IDW.**

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## ABSTRACT.

In this investigation is analyzed the average annual rainfall of the hydrographic basin of the Aguablanca stream through the data provided by the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) ranging from 1976 to 2016, because there aren't pluviometric stations relatively close, the methodology is used IDW with the intention of interpolation results and have a calculation close to reality. It's concluded the average annual precipitation of this river is 1327.9 mm/year, a normal value for a river basin in a tropical zone, also calculating the amount of water volume, it's possible to calculate the amount of evapotranspired water, parameters that vary according to temperature and type of vegetation.

**KEY WORDS:** Mean precipitation, watershed, stream, IDW.

## RESUMEN

En esta investigación se analiza la precipitación media anual de la cuenca hidrográfica de la quebrada Aguablanca a través de los datos suministrados por el Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) que van desde 1976 hasta 2016, debido a que no existen estaciones pluviométricas relativamente cercanas, se utiliza la metodología IDW con la intención de interpolar los resultados y tener un cálculo cercano a la realidad. Se concluye que la precipitación media anual de este río es de 1327,9 mm/año, un valor normal para una cuenca hidrográfica en una zona tropical, además calculando la cantidad de volumen de agua, es posible calcular la cantidad de agua evapotranspirada, parámetros que varían según la temperatura y el tipo de vegetación.

**PALABRAS CLAVE:** Precipitación media, cuenca, arroyo, IDW.

## INTRODUCTION

Precipitation is one of the most important parameters of the hydrological cycle, which, in turn, is one of the main sources of crop supplies, human consumption and necessary for the conservation of wildlife [3] Due to this importance, it is essential to collect all the necessary information to be able to establish hydrological models that allow a more precise understanding of the behavior of the water cycle in any study area.

A hydrological model is a set of historical data that serves to predict long-term changes in hydrological flows, where some of its uses are for: Watershed management, operation of reservoirs, water supplies, planning and design of hydraulic structures, among others [13]. Water resources are scarce and essential in all types of ecosystems [11] in such a way that the spatial distribution and temporal variability of precipitation, control the growth of vegetation and the massive transport of hydrological resources on the land surface [4]. It is for this reason that the influence of precipitation is significant in hydrology, in the environment, since it has a direct effect on types of vegetation and in turn on wildlife. Thus, obtaining accurate and reliable rainfall data becomes a crucial need to be able to make applications for the purpose of this study topic [5].

The way to measure rainfall is mainly through the use of pluviometric stations, which are well known for their installation and easy operation, in addition to the low costs that they require. When there is a considerable amount of stations, the measurements are characterized by consistent and precise measurements, where the results are used to describe the characteristics and regimes of these precipitations [7].

Climate change is one of the aspects that most concern the scientific community, since human activities, such as the burning of fossil fuels and changes in land use, generate an environmental impact that increases atmospheric concentrations of greenhouse gases. This change translates into large-scale climate patterns and these are the ones that end up affecting meteorological variations [2].

Part of this problem has manifested itself over time with the economic development of society [9], since it is directly related to the exploitation of water resources, which leads to significant changes in aquatic ecosystems. Thus, the over-exploitation of this resource leads directly to consequences such as the disappearance of the causes, excessive erosion that affects the workability of soils [6], pollution of rivers and finally the deterioration of ecosystems [10]. Therefore, foreseeing this type of consequences can be achieved with an adequate management of water resources, which will also serve for disaster prevention, which must have an environmental policy with a water quality model that allows a correct handling and delivery of these resources to nature [8] [12] [14] [15].

This type of prevention has already been taken by different European countries, one of them, Switzerland, where approximately more than 3 decades ago, extensive and costly measures have been invested in mitigating the environmental impact to this natural resource [1]. Therefore, in this work we will calculate the average annual precipitation for the Aguablanca stream located in the municipality of Bochalema, Norte de Santander, Colombia, in order to subsequently carry out more detailed studies that will allow the management of these resources in an efficient, administrative manner and with the least environmental impact, contributing to the development and economy of the region in a sustainable manner.

## **MATERIALS AND METHODS.**

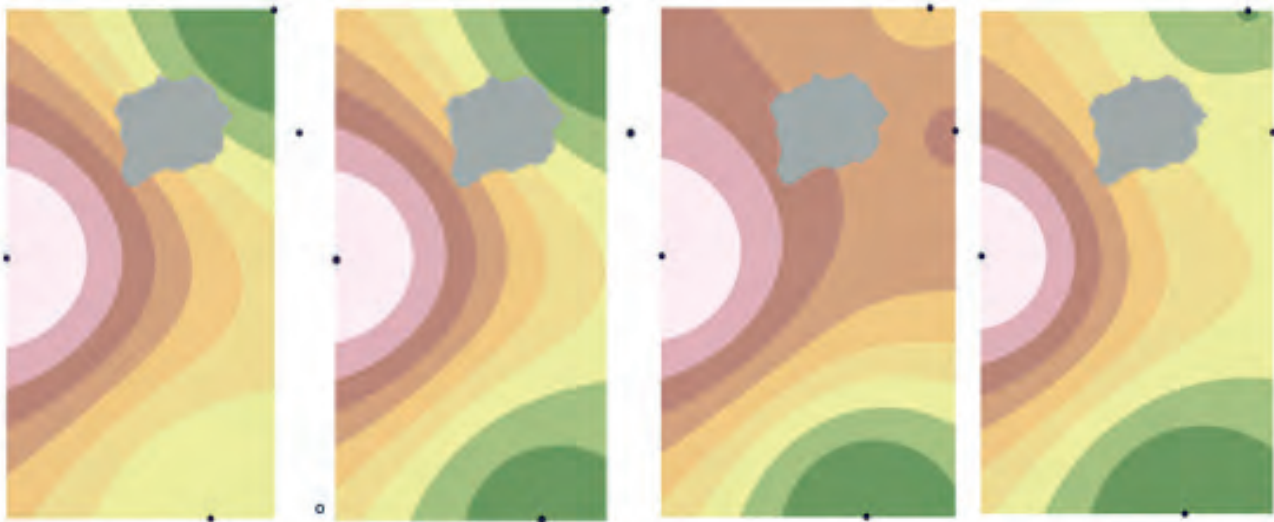
To calculate the average precipitation, first, the watershed of the stream of study was delimited, which is the Aguablanca stream, located in the municipality of Bochalema, in the department of Norte de Santander, in the city of Cúcuta.



**Figure 1.** Hydrographic basin of the Aguablanca stream.

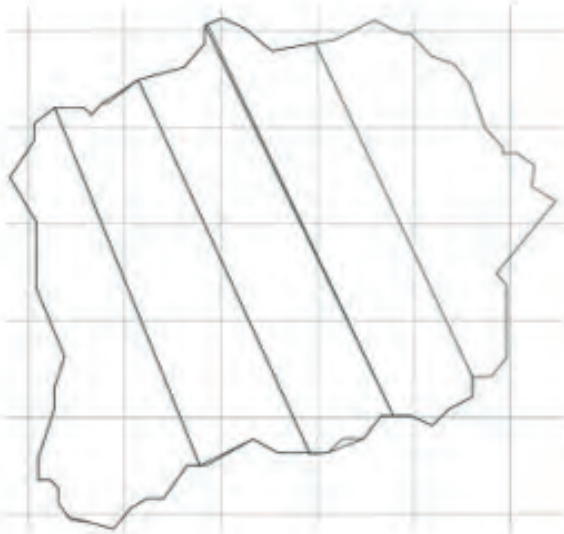
Subsequently, data from 4 nearby rain gauges that had a large historical record of rainfall were used. These data were provided by IDEAM and geographically referenced in the ArcGIS software. The 4 rain gauges are, to the north LA DONJUANA 2, to the east LOS MANZANARES, west CUCUTILLA, and to the south ALSA DE PAMPLONITA.





**Figure 4.** Rainfall for the years 1973, 1991, 2010 and 2016, respectively.

Later, for the calculation of the average precipitation, a CAD drawing is used as a reference, where each segment occupies 20% of the total area.



**Figure 5.** CAD of the basin



**Figure 6.** Basin with precipitation.

For example in the above figures an approximate of 10%, 20%, 25%, 25% and 20% can be determined for the stripes that overlap the figure. In this way it is calculated with the values of each precipitation and its percentage, obtaining an average precipitation of the basin with the following table.

**Table 2.** Average precipitation for the years 1973-1979 only with data from rain gauges 1,2 and 3.

PREC. PROM	YEAR	P1	%	P2	%	P3	%	P4	%	P5	%
1256.25	1973	1421	15%	1284	55%	1123	30%				
1260.4	1974	1455	30%	1239	50%	1022	20%				
1893.5	1975	1963	50%	1824	50%						
1393	1976	1576	10%	1454	30%	1332	60%				
973.2	1977	1118	20%	1115	20%	912	40%	809	20%		
1375.8	1978	1595	10%	1458	20%	1321	70%				
916.6	1979	1362	20%	1139	20%	917	20%	694	20%	471	20%

**Table 3.** Average precipitation for the years 1980-1990 only with data from rain gauges 1,2 and 3.

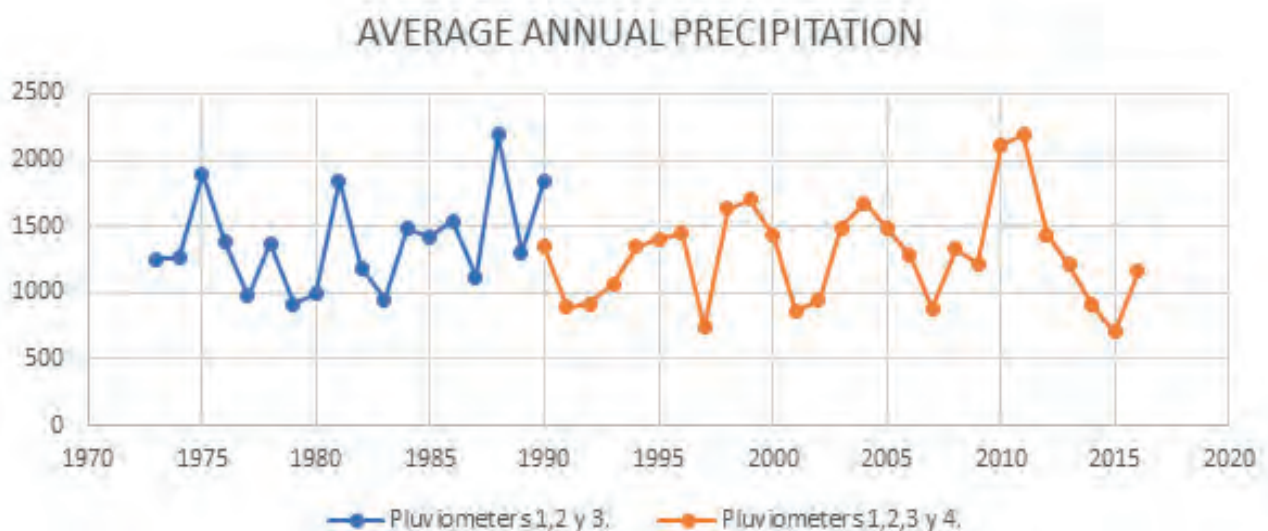
PREC. PROM	YEAR	P1	%	P2	%	P3	%	P4	%	P5	%
994.6	1980	1174	20%	1084	20%	995	20%	905	20%	815	20%
1847.9	1981	1943	30%	1824	60%	1706	10%				
1185.8	1982	1467	20%	1327	20%	1186	20%	1045	20%	904	20%
949.8	1983	1115	20%	1032	20%	950	20%	867	20%	785	20%
1483.8	1984	1572	10%	1474	90%						
1425.1	1985	1540	10%	1463	30%	1387	60%				
1539.7	1986	1747	10%	1678	20%	1489	60%	1360	10%		
1120	1987	1280	20%	1200	20%	1120	20%	1040	20%	960	20%
2195.2	1988	2179	90%	2341	10%						
1306.5	1989	1422	10%	1317	70%	1212	20%				
1837.55	1990	1983	5%	1862	70%	1740	25%				

**Table 4.** Average precipitation for the years 1990-2016 only with data from rain gauges 1,2, 3 and 4.

PREC. PROM	YEAR	P1	%	P2	%	P3	%	P4	%	P5	%
1358	1990	1606	5%	1451	45%	1296	35%	1141	15%		
890.7	1991	1098	3%	998	17%	898	50%	797	30%		
916.85	1992	1001	15%	917	70%	832	15%				
1065	1993	1287	5%	1176	20%	1065	45%	954	30%		
1351	1994	1472	10%	1351	80%	1230	10%				
1402.4	1995	1543	15%	1421	55%	1298	30%				

1445.05	1996	1630	15%	1493	35%	1356	50%		
740.95	1997	803	5%	744	85%	684	10%		
1630.9	1998	1767	10%	1631	80%	1494	10%		
1699.8	1999	1806	15%	1688	80%	1570	5%		
1431	2000	1459	65%	1379	35%				
864.5	2001	965	5%	898	40%	831	55%		
941.55	2002	1046	15%	969	35%	891	50%		
1490.95	2003	1692	5%	1553	45%	1415	50%		
1675.75	2004	1777	50%	1621	35%	1466	15%		
1490.95	2005	1692	5%	1553	45%	1415	50%		
1281.45	2006	1556	5%	1373	45%	1190	45%	1006	5%
887.25	2007	1235	5%	1065	20%	896	40%	726	35%
1329.4	2008	1672	10%	1482	30%	1291	30%	1101	30%
1218.85	2009	1370	5%	1254	60%	1137	35%		
2112.2	2010	2192	40%	2059	60%	60			
2188.6	2011	2362	35%	2158	45%	1954	20%		
1437.3	2012	1540	10%	1461	50%	1382	40%		
1211.9	2013	1229	10%	1138	10%	1219	80%		
905.2	2014	970	5%	916	70%	862	25%		
702.3	2015	838	10%	779	20%	720	20%	661	30%
1161.8	2016	1271	20%	1180	40%	1089	40%	602	20%

Therefore, with the calculated data, precipitation can be plotted over the years studied.



**Figure 7.** Annual precipitations of the Aguablanca Stream Basin.

In this way, the following table is obtained with the relevant data for each year and its precipitation value.

**Table 5.** Average multiannual precipitation of the Aguablanca stream basin.

PREC. PROM	YEAR	PREC. PROM	YEAR
1256.25	1973	1402.4	1995
1260.4	1974	1445.05	1996
1893.5	1975	740.95	1997
1393	1976	1630.9	1998
973.2	1977	1699.8	1999
1375.8	1978	1431	2000
916.6	1979	864.5	2001
994.6	1980	941.55	2002
1847.9	1981	1490.95	2003
1185.8	1982	1675.75	2004
949.8	1983	1490.95	2005
1483.8	1984	1281.45	2006
1425.1	1985	887.25	2007
1539.7	1986	1329.4	2008
1120	1987	1218.85	2009
2195.2	1988	2112.2	2010
1306.5	1989	2188.6	2011
1837.55	1990	1437.3	2012
890.7	1991	1211.9	2013
916.85	1992	905.2	2014
1065	1993	702.3	2015
1351	1994	1161.8	2016

An arithmetic average is then taken, which is simply the sum of all rainfall divided by the total number of years.

$$\sum_{1973}^{2016} P_{\text{anual}} = 58428.3 \text{ mm} \quad (1)$$

$$P_{\text{prom}} = \frac{58428.3 \text{ mm}}{44 \text{ años}} = 1327.9 \frac{\text{mm}}{\text{año}} \quad (2)$$

#### 4. CONCLUSIONS

The average annual precipitation of this river basin was successfully calculated using the IDW model executed by the ArcGIS software, which gives a result of 1327.9 mm/year, a normal value for a river basin in a tropical zone.

Calculating the amount of water volume, it is also possible to calculate the amount of evapotranspired water, which are parameters that vary according to temperature and type of

vegetation.

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