Rio Soco Dam Site Analysis

Dominican Republic

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Dr. E. James Nelson:

The following report is a comprehensive study of two proposed dam locations along the Soco River in the El Seibo region of the Dominican Republic. The report provides hydrologic studies and models that analyze each dam's location and watershed. At the end of the report a summary and recommendations are given as to the best possible site for a dam.

This report also included the help and efforts of the students at INTEC and the engineers at INDRHI. Without their help this report would not have been possible. The report uses several different methods where the best possible option is chosen for each case.

The finished report will allow the engineers at INDRHI to make informed decisions for the El Seibo region as they choose where the best location for a dam will be. Each location has various positives and negatives which are laid out in the report. The engineers will now have helpful information about the proposed dams and can choose a site that will best benefit the people of the Dominican Republic.

Respectfully,

Ryan Egbert

Christian Kesler

Jacob Nielsen

Executive Summary

This report is a study and comparison between two possible dam sites within the Soco River Watershed. The two most optimal locations were identified by the Instituto Nacional de Recursos Hidráulicos (INDRHI) of the Dominican Republic. These sites were Paso del Medio and El Seibo. A map of the area is shown in Figure 1 below.

FIGURE 1: MAP OF EASTERN DOMINICAN REPUBLIC WITH PROPOSED DAM SITES

A hydrologic analysis was made of the two sites. A return period, curve number, and probable maximum precipitation (PMP) was calculated for each location. Then storage capacity and flow duration curves were made for El Paso del Medio and El Seibo. The return periods and

PMP values were similar between the two sites; however, the curve number varied due to little agricultural land use above El Seibo. The storage capacity and flow duration curves generated showed that El Seibo, although having less flow, was capable of having more storage at almost 400,000,000 m^3 when the dam is full. Although El Seibo has the potential for a taller dam, the larger flow at Paso del Medio results in greater hydroelectric potential at this downriver site. The hydrologic models for the two locations were created in WMS. A HEC-HMS model was made to simulate return period rainfall events and a GSSHA model was used to simulate dam break.

A comparison between these two models showed that the dam near the city of El Seibo was a better choice for the dam site because of the hydroelectric power that could be generated, the storage capacity of the dam, and the benefit of the water for domestic use. The dam at Paso del Medio was also a great site and had the ability to provide water for many crops and generate more power; however, the storage capacity was much smaller, and there was not a large city close to the dam site.

Introduction

The Soco River flows through the eastern part of the Dominican Republic. This part of the country is widely covered by farmland. The feasibility of installing a dam along the Soco River was considered in two different locations. A dam located in this region would largely benefit the irrigation of this farmland. A hydraulic analysis was performed to determine the hydroelectric capacity at each site. This information in connection with storage capacity will be used to determine the most beneficial dam site.

Problem Description

The Dominican Republic government is looking for areas on the eastern side of the country where they can build a reliable earth dam structure. For this report INDRHI asked that BYU students, with the help of a few INTEC students, study and analyze a few potential sites along the Soco River. Israel Acosta, the INDRHI engineer overseeing this study on these locations, said they are looking for a site that could fill some of the following needs: water supply (domestic and irrigation), hydroelectric power generation, and flood control. He asked for a hydrologic comparison of two sites, Paso del Medio and El Seibo, using graphs and models in order to find which location would be most ideal for a future earth dam structure.

Description of Sites

For this project, two sites were looked at as possible dam locations. The first site is called Paso del Medio which is located where two rivers come together. The other location is near the city of El Seibo, located further upstream from Paso del Medio, and is in a more mountainous region.

Paso del Medio

At this location, also known as the confluence, the Soco and Anama Rivers join to form a larger Soco river. Just after the rivers unite is where the proposed dam site is, as seen in Figure 2. There is a great location for a dam about 100 m after the rivers meet where there is a strip of bed rock about 5 m wide that can be seen straight across the river. This would make a strong foundation for the dam if it were built here. This area is located in the middle of sugarcane fields and small farms and is also about 5 km away from the nearest major road. It is located about 15 km from any largely populated cities.

Figure 2: Paso del Medio Proposed Dam Site

This region is sparsely populated by the local farmers. It is mostly flat except for right at the point of the potential dam site where there is an elevation difference on either side of roughly 40 meters. The reservoir for this dam would extend back up the two rivers that meet at this location and would reach high up the channel and the flood plains based on the flatness of the land. The main outcomes of this dam site would be to provide hydroelectric power, domestic use, and irrigation for crops.

El Seibo

The dam location in El Seibo is located in a more mountainous region than the location at Paso del Medio, as seen in Figure 3. On the slopes of where the dam would be located the land rises to well above 100 meters on either side. While a dam of this magnitude would likely not be built, it does offer the possibility of a larger dam. This site has the option of creating a great amount of hydroelectric power. This larger dam would also provide a lot of water storage which could be helpful for crop use and people in the area.

Figure 3: Upstream of the El Seibo Proposed Dam Site

While this dam has many benefits, there are a few negatives. There are a good number of people living in this valley that would have to relocate because of the dam. Also, it would take more work to get the water out of the reservoir and to the people or crops because of its location up the mountains, but it would be easy to run the water through pipes, gravity fed, downhill to where the people and crops are.

Hydrologic Analysis

Return Periods

The return period of a storm is a significant factor when planning for a dam. The size, occurrence, and reliability of the precipitation data can help a dam prepare for a huge storm by controlling the outlet and spillways of the dam before the storm comes so that the dam does not overflow. This preparation can make it safe upstream and downstream for the residents of the area from floods. Listed below are the return periods and charts in years for a given precipitation amount. There were two different ways that the return period and associated precipitation was found. The first method was using the given precipitation data for the area and using an extension of the curve to find the future values for larger storms. The second option was found by using a book with maps and precipitation data published by INDRHI.

In the figures below are shown graphs of the time in years versus the occurrence of an amount of precipitation in millimeters. Using the graphs general direction, a trend line was inserted using a logarithmic line to find an equation. The equation, which uses a log function, can find the return period of a storm in millimeters of precipitation by plugging in the amount of years desired. Shown below each graph there is a table with the return period and the precipitation that would come with that storm in a given 24 hour period.

Figure 4 uses precipitation data from the years of 1975-1980 to find the return periods, while Figure 5 uses the years of 1968-1986 for the El Seibo area. The two data sets for the years give almost identical results as seen in Table 1 and Table 2. The precipitation for each return period only differs by a millimeter or two for each time period.

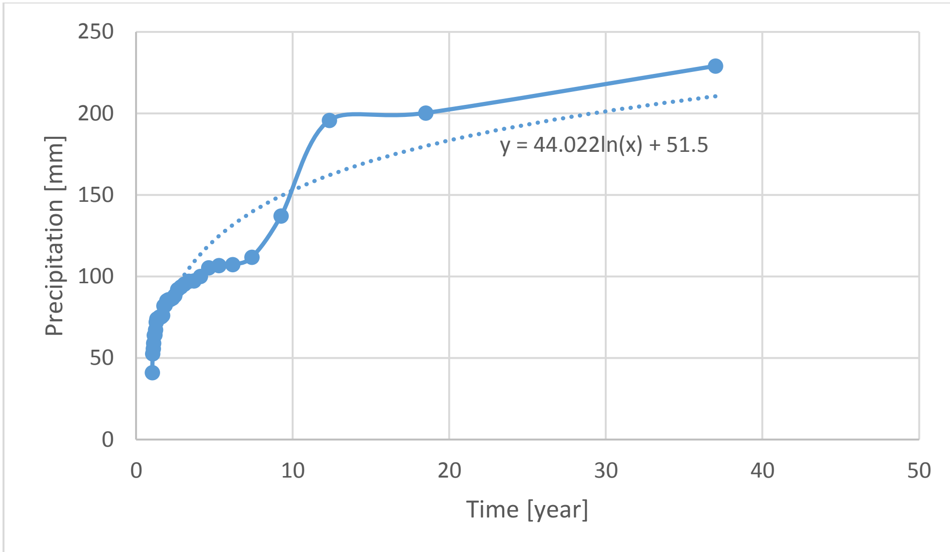

Figure 4: Return Period of Storms in El Seibo using data from 1945-1980

Table 1: Return Period of Storms in El Seibo using data from 1945-1980

Return Period	Precipitation
[year]	[mm]
10	152.9
25	193.2
50	223.7
100	254.2

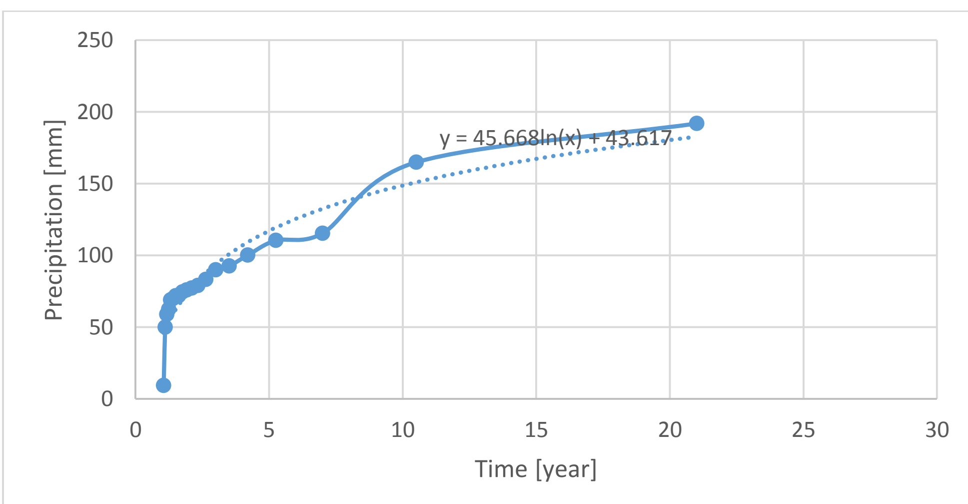

Figure 5: Return Period of Storms in El Seibo using data from 1968-1986

Table 2: Return Period of Storms in El Seibo using data from 1968-1986

Return Period	Precipitation
[year]	[mm]
10	148.8
25	190.6
50	222.3
100	253.9

In Figure 6 and Table 3 below are the return periods at Paso del Medio using data from 1972-2010. The resulting precipitation for this area is higher than in El Seibo. This is likely due to the fact that Paso del Medio is located much closer to the ocean and that the rain will be dumped here first rather than further inland.

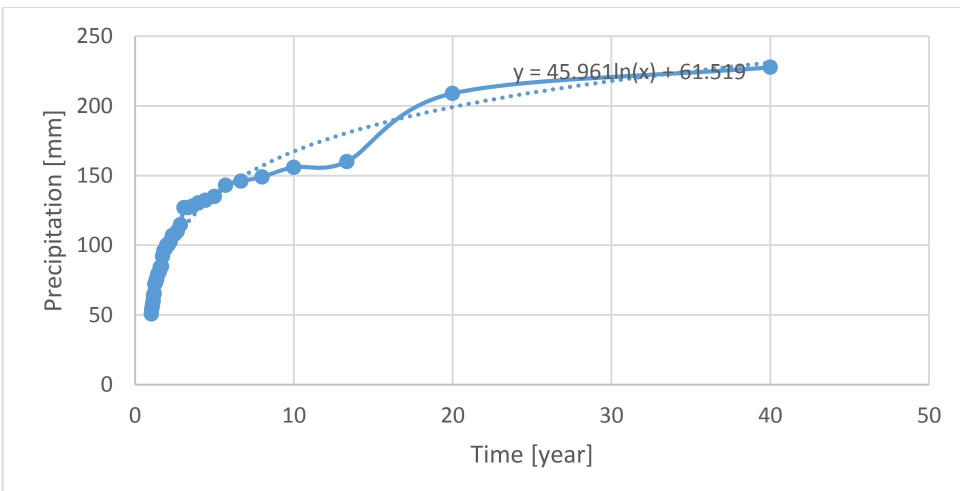

Figure 6: Return Period of Storms at Paso del Medio using data from 1972-2010

Table 3: Return Period of Storms at Paso del Medio using data from 1972-2010

Return Period	Precipitation
[year]	[mm]
10	167.3
25	209.5
50	241.3
100	273.2

Using the book from INDRHI also gave valuable information on the amount of precipitation of the return periods. The data was said to be mostly accurate except for the 100 year storm, so the 100 year storm data was not included in Table 4 below. The data is given in a single table for Paso del Medio and El Seibo. The maps show contour lines for the precipitation so a good guess was used when the location needed was in the middle of two contour lines. The maps used to find these values can be found in the appendix.

Table 4: Return Period of Storms using Book published by INDRHI

	Paso del Medio	**El Seibo**
Return Period	Precipitation	Precipitation
[year]	[mm]	[mm]
10	156	150
25	190	185
50	210	223
100	N/A	N/A

The values from the book from INDRHI are nearly identical to the values that were found using the precipitation data for the area in El Seibo. In the area for Paso del Medio the 10 and 25 year return period are a good amount smaller using the book. However, the 50 year return period for the amount of precipitation is extremely smaller than the value in Table 3. The value from Table 3, using the actual precipitation data, came out to 241 mm while the INDRHI book came out with only 210 mm. The two methods for the 50 year return period have a difference of 31 mm. The people at INDRHI warned that the return period values when getting over the 50 year mark could be slightly inaccurate. It would most likely be better to use the return period values calculated using precipitation data in the first method for Paso del Medio. While for El Seibo either method could be used because the values are so close when compared to one another.

Curve Number

The curve number is important when calculating the flow in a watershed when flow data is not available, which was used in the flow duration curve calculations in a separate section below. The curve number depends on the type of soil that is in the area, as shown in Figure 7, as well as the land use in the area. INDRHI provided land use and soil type data that made it possible to calculate an appropriate curve number for each dam's watershed. From the soil map shown in Figure 7 it can be seen that the watershed for Paso del Medio is mostly soil type A with a small portion of soil type C near the top edge of the watershed. While at the dam site at El Seibo the soil type is almost all type C. Shown in Table 5 are curve numbers that were found using averages of the soil type and land use. The curve number at Paso del Medio is 71 while at El Seibo the curve number is 62.

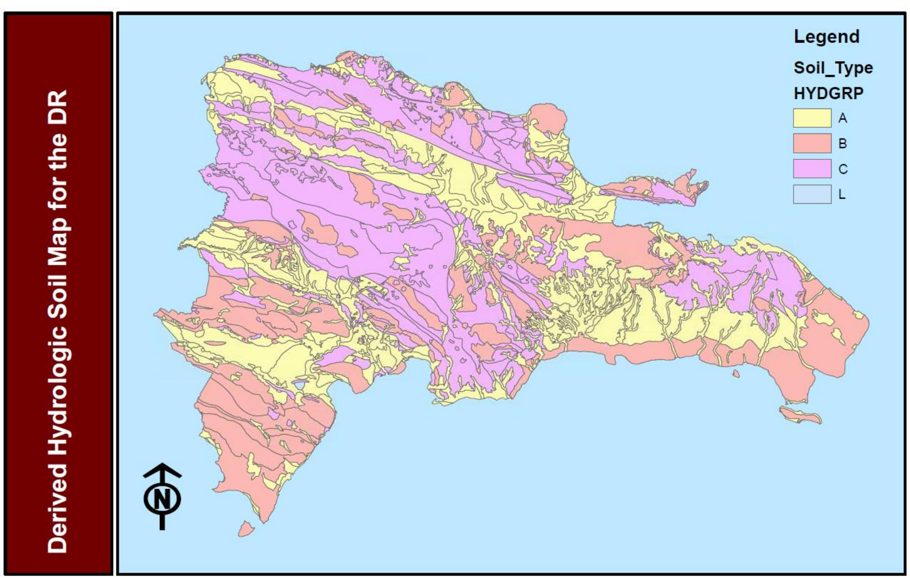

Figure 7: Soil Map for the Dominican Republic

Table 5: Curve Numbers for Paso del Medio and El Seibo

	Paso del Medio	El Seibo
Curve Number	71	62

Probable Maximum Precipitation

The probably maximum precipitation (PMP) is theoretically defined as the greatest depth of rainfall for a given duration that is physically or meteorologically possible over a station or a geographic location at a certain time of the year (Hansen et al, 1982, OMM, 1986). When this value is found it can be inputted into hydrologic models to simulate floods, dam breaks, etc. For this report, the Hershfield Method was used to find the PMP. This method takes the average and the standard deviation of the annual maximums for a series of years. The equation in Figure 8 show how the PMP is calculated. Shown in Table 6 below are the PMPs for each location.

$$PMP = \text{Average Maximum} + 15 * \text{Standard Deviation}$$

Figure 8: Hershfield Equation Used to Find the Probable Maximum Precipitation (PMP)

Table 6: Probable Maximum Precipitation for Paso del Medio and El Seibo

	Paso del Medio	El Seibo
PMP [mm]	707	684

Storage Capacity Curves

Storage Capacity Curves were calculated as a way of comparing the amount of storage that each reservoir was capable of holding. The graphs show the volume of water that each could can hold as the height of the dam rises. The elevation shown on the y-axis of the graphs is the height above sea level. The x-axis represents the total storage in cubic meters. In Figure 9 below the storage capacity curve at Paso del Medio is represented. The bottom of the dam is located at approximately 14 meters above sea level. With the dam full at a DEM elevation of 41 meters the total volume of storage is over 110,000,000 cubic meters.

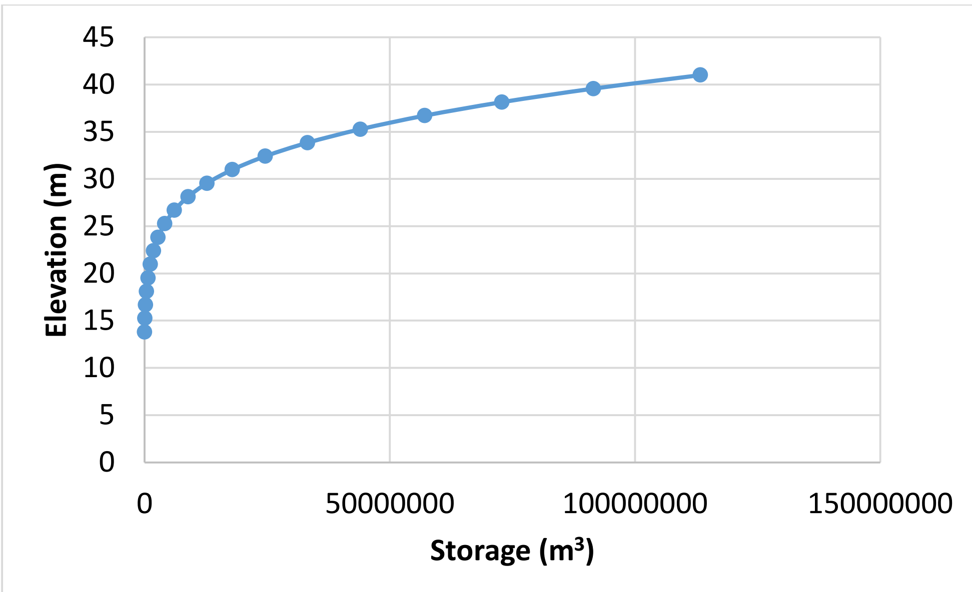

Figure 9: Storage Capacity Curve at Paso del Medio

Figure 10 shows the storage capacity curve at El Seibo. The bottom of the dam is at 109 meters in elevation, while the top of the dam DEM elevation is 158 meters. When the dam is full to 158 meters the total volume of storage is over 370,000,000 cubic meters. This shows that a dam at El Seibo would potentially hold over three times as much water as one built at Paso del Medio. This can be seen in the storage capacity curve comparison graph in Figure 11. This graph shows that El Seibo has much more storage capacity than Paso del Medio.

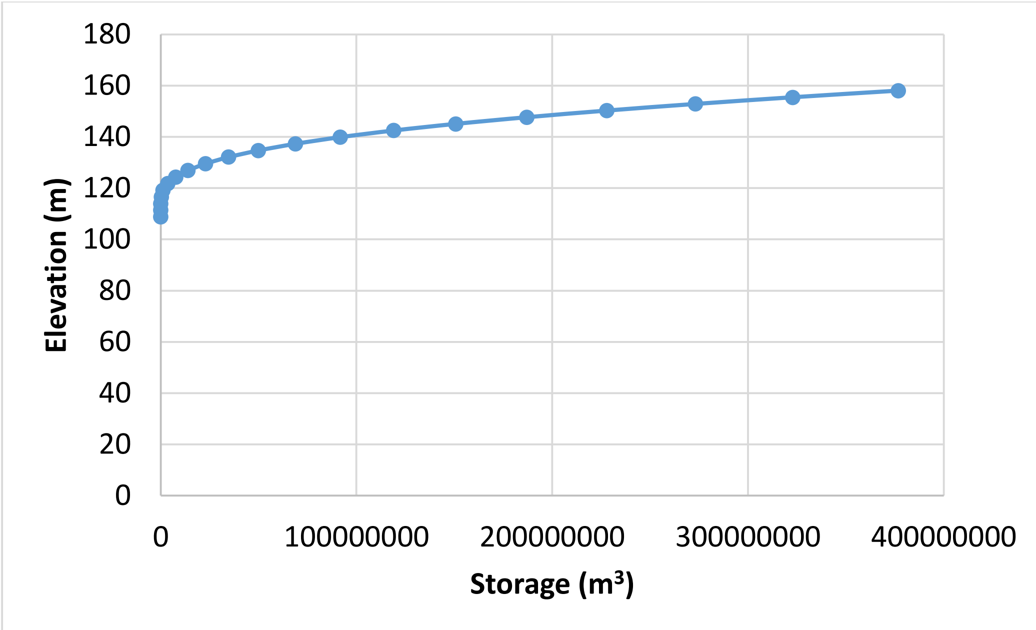

Figure 10: Storage Capacity Curve at El Seibo

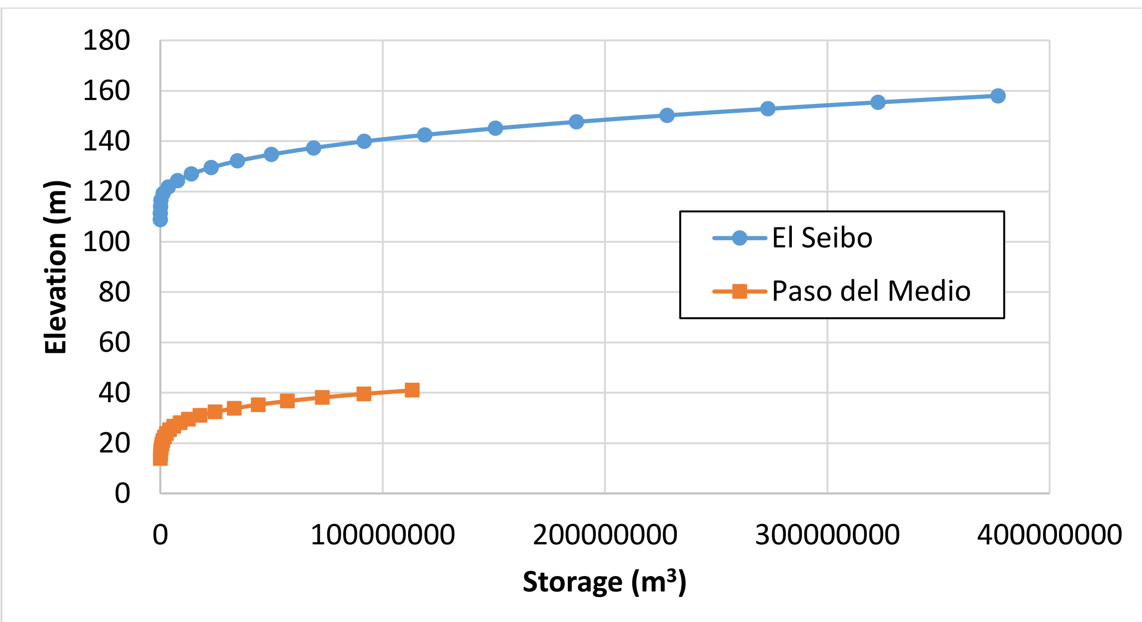

Figure 11: Comparison of Storage Capacity Curves

Flow Duration Curves

Two options were looked at when determining the flow at the two dam site locations. The first method used the actual streamflow data to find the average flow. While the second method assumed there was no flow data to find the values.

In Figure 12 and Figure 13 below the flow records provided by INDRHI gave reliable data to what the actual flow is in the rivers. In the graphs, the flow is graphed on the y-axis with the percent chance of that flow being on the x-axis. When analyzing the ability of a dam to generate power the most common flow will be used in the models. Further down in the report under the Hydrologic Models section the flow data will be used to analyze the capability of the dams. Figure 12 shows that the flow at Paso del Medio is much higher on average than in Figure 13 at El Seibo. The Q50 for Paso del Medio is equal to 3.12 cms while at El Seibo the Q50 is only at 0.89 cms. This is to be expected because Paso del Medio is much further downstream and it is also where two rivers combine.

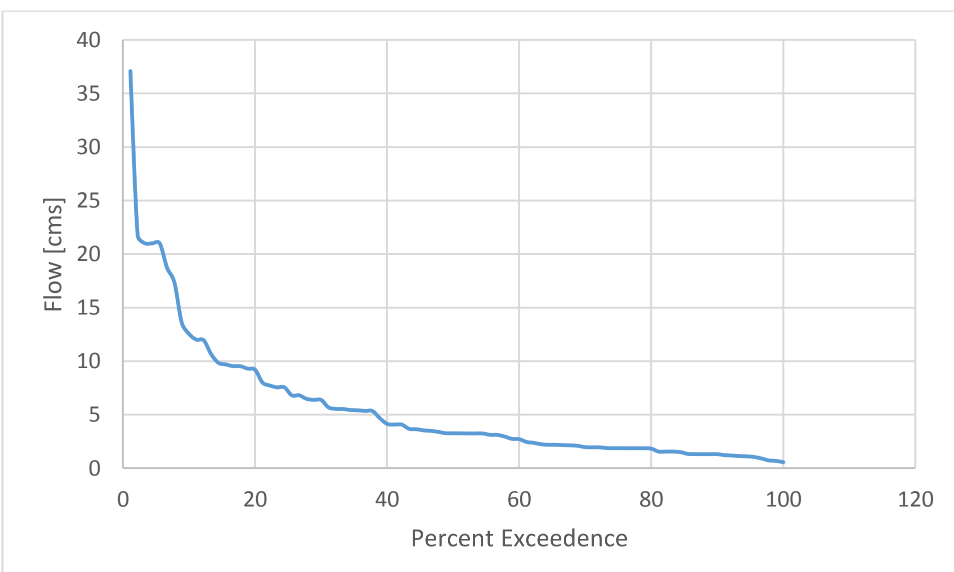

Figure 12: Flow Duration Curve at Paso del Medio Using Real Flow Values

Table 7: Specific Flow Values at Paso del Medio Using Real Flow Values

	Flow
	[cms]
Q85	1.50
Q50	3.27
Q30	5.53

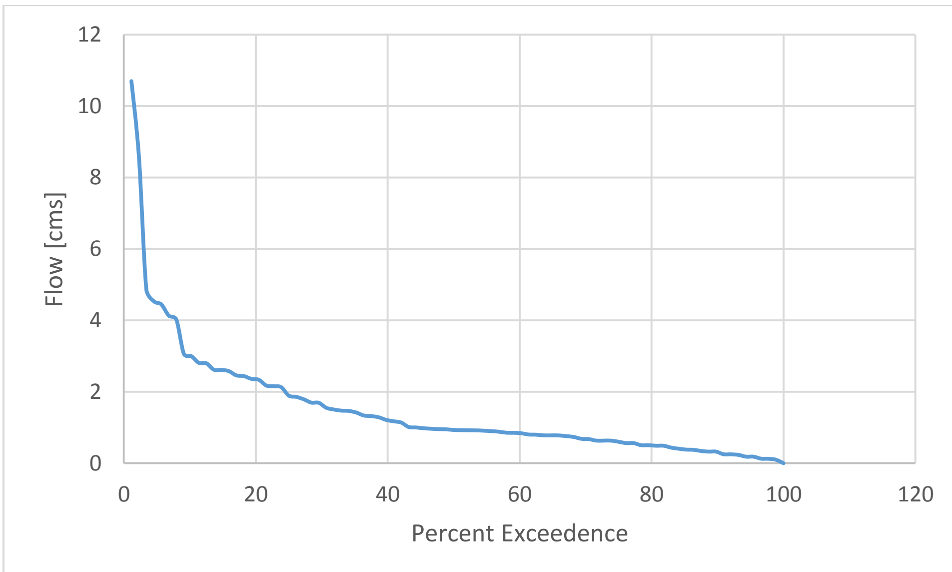

Figure 13: Flow Duration Curve in El Seibo Using Real Flow Values

Table 8: Specific Flow Values in El Seibo Using Real Flow Values

	Flow [cms]
Q85	0.38
Q50	0.93
Q30	1.47

The other option used a series of empirical equations to find the flow in the rivers. The equations use the area of the watershed, precipitation, curve number, and slope. The specific equations are shown below in Figure 14.

$$Q_{99} = 7.683 * 10^2 * A^{0.729} * P^{0.916} * CN^{-3.826} * S^{0.380}$$

$$Q_{95} = 2.785 * 10^4 * A^{0.695} * P^{0.362} * CN^{-3.553} * S^{0.473}$$

$$Q_{90} = 1.168 * 10^4 * A^{0.640} * P^{0.292} * CN^{-3.118} * S^{0.435}$$

$$Q_{85} = 1.088 * 10^4 * A^{0.636} * P^{0.295} * CN^{-3.071} * S^{0.430}$$

$$Q_{80} = 1.376 * 10^4 * A^{0.643} * P^{0.319} * CN^{-3.150} * S^{0.435}$$

$$Q_{75} = 2.065 * 10^4 * A^{0.659} * P^{0.358} * CN^{-3.312} * S^{0.444}$$

$$Q_{70} = 2.452 * 10^4 * A^{0.673} * P^{0.397} * CN^{-3.413} * S^{0.450}$$

$$Q_{60} = 2.836 * 10^4 * A^{0.699} * P^{0.484} * CN^{-3.584} * S^{0.464}$$

$$Q_{50} = Q_{mean} = 4.070 * 10^4 * A^{0.713} * P^{0.551} * CN^{-3.758} * S^{0.472}$$

$$Q_{40} = 2.734 * 10^4 * A^{0.666} * P^{0.681} * CN^{-3.789} * S^{0.432}$$

$$Q_{30} = 8.512 * 10^4 * A^{0.717} * P^{0.611} * CN^{-3.954} * S^{0.461}$$

$$Q_{20} = 3.221 * 10^5 * A^{0.740} * P^{0.603} * CN^{-4.218} * S^{0.484}$$

Figure 14: Equations Used to Find Flow Assuming No Known Flow

Shown below in Figure 15 and Figure 16 are the flow duration curves for the two locations. It can be seen from the graphs and in Table 9 and Table 10 that the flow using this method gives a much higher flow than what was actually observed. It is likely that the flows found by this method are highly unrealistic average flows for the actual river. When analyzing the dams using the hydrologic models the flows from the first method, using the actual flow data, will be used.

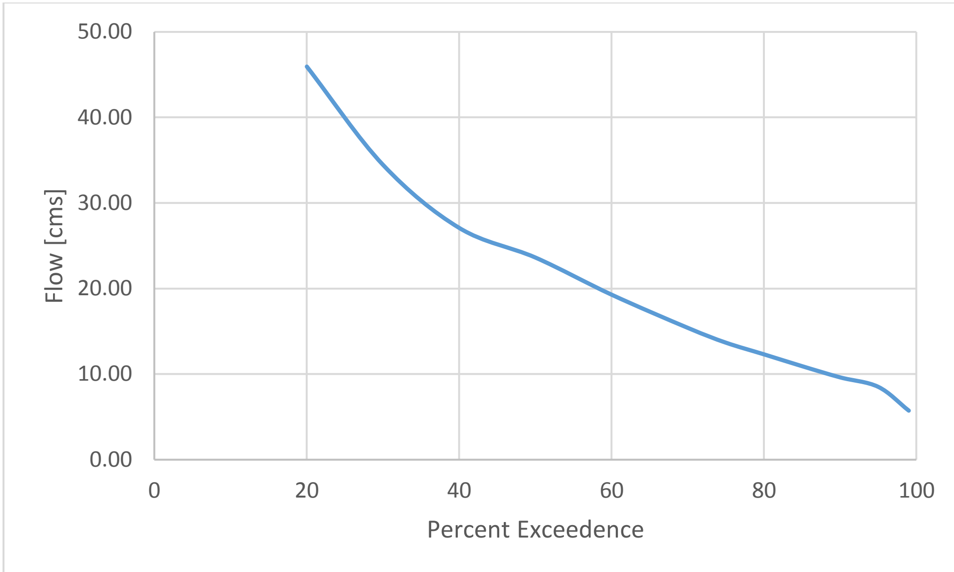

Figure 15: Flow Duration Curve at Paso del Medio Assuming No Known Flow

Table 9: Specific Flow Values at Paso del Medio Assuming No Known Flow

	Flow [cms]
Q85	10.94
Q50	23.63
Q30	34.46

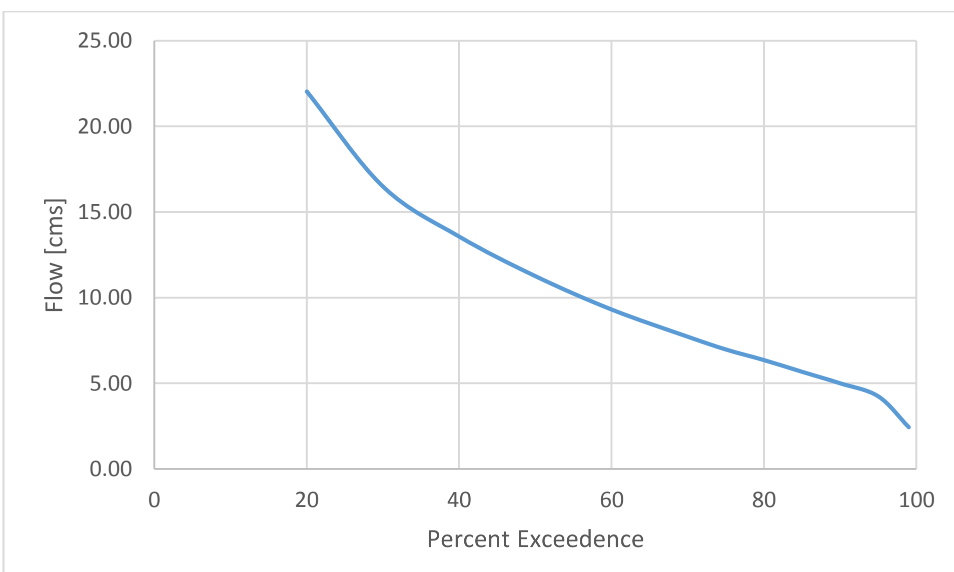

Figure 16: Flow Duration Curve in El Seibo Assuming No Known Flow

Table 10: Specific Flow Values in El Seibo Assuming No Known Flow

	Flow [cms]
Q85	5.67
Q50	11.25
Q30	16.48

Electric Power Development Capacity

The electric power development capacity was generated using the Q85 values calculated in the previous section. The following equation was used in calculating power.

$$P = \gamma HQ(efficiency)$$

P = Power, kilowatts (kg*m^2/sec^2)

γ = 9.80 kN/m^3 (specific weight of water)

efficiency = 85%

Paso del Medio:

H = 27 m

Q_{85} = 1.5 cms (real flow value from Table 7: Specific Flow Values at Paso del Medio Using Real Flow Values)

P = 337 kW

Q_{85} = 10.94 cms (no known flow value from Table 9Table 7: Specific Flow Values at Paso del Medio Using Real Flow Values)

P = 2,461 kW

El Seibo:

H = 49 m

Q_{85} = .38 cms (real flow value from Table 8)

P = 155 kW

Q_{85} = 5.67 cms (no known flow value from Table 10)

P = 2,314 kW

These calculations show that in most cases due to the larger flow at Paso del Medio, it will be able to generate more power. However, because the height is so much greater at El Seibo it is able to generate a large amount of power for even though the flow there is much less in comparison with Paso del Medio. The large difference in the values calculated for power shows that the flow is going to be crucial in power generation potential. Choosing Q85 gives conservative values but shows what can be consistently generated. The difference between power calculated using real flow values versus unknown flow values is roughly a factor of ten. This reflects the unknown flow values being roughly ten times the values of real flow.

Hydrologic Models

Introduction to the Models

All of the models were set up using the program WMS. Within the WMS interface a HEC-HMS and GSSHA model were set-up. The GSSHA model was only used to simulate the dam break analysis. The HEC-HMS model was used to simulate each return period rainfall event in both Paso del Medio and El Seibo. The discharge hydrographs at each site were compared to display the effects a dam would have on the attenuation of the runoff without a dam installed.

HEC-HMS Parameters

Each storm event was modeled using a 24-hour SCS type 3 precipitation event. This SCS storm curve was selected because the Dominican Republic is nearest the type 3 region in Figure 17.

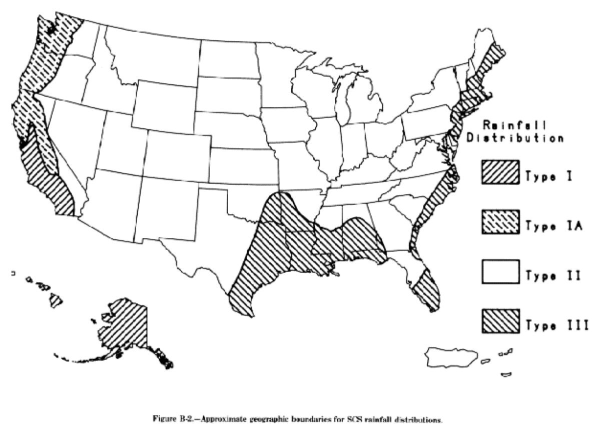

Figure 17: SCS rainfall distribution types

The loss method applied to the HEC-HMS model was the SCS Curve Number. These numbers identified in Table 5 are used to quantify the volume of runoff that is lost to infiltration. A high curve number is associated with soil that is less porous. This leads to less infiltration and a greater volume of runoff. Curve numbers range from 30 to 100. The Clark method was selected as the transformation method to move the runoff through the watershed. The Kirpich Method for overland flow on bare earth was used to calculate the time of concentration and storage coefficient. The time of concentration and storage coefficient for Paso del Medio was respectively coefficient. The time of concentration and storage coefficient for Paso del Medio was respectively 9.8 and 15.99 hours. The time of concentration and storage coefficient for El Seibo was respectively 3.6 and 5.89 hours. The time of concentration refers to the time it takes water to flow across the entire watershed from the farthest point to the outlet. A large time of concentration means the runoff travels across the ground longer. This increases the amount of runoff that can infiltrate the ground which increases losses and decreases discharge at the outlet.

The model at Paso del Medio was set up assuming the top of the dam is at an elevation of 41 meters. This makes the dam approximately 26 meters tall. A low-level outlet, with a 1 meter diameter, was placed 2 meters above the bottom of the dam. When acting as a weir, the low-level has a weir coefficient of 1.838. When acting as an orifice, the coefficient is 0.6. The spillway was modeled 20 meters above the bottom of the dam. The length of the spillway was 10 meters, with a weir coefficient of 1.711. Figure 18 shows what the reservoir at Paso del Medio would look like with the given parameters.

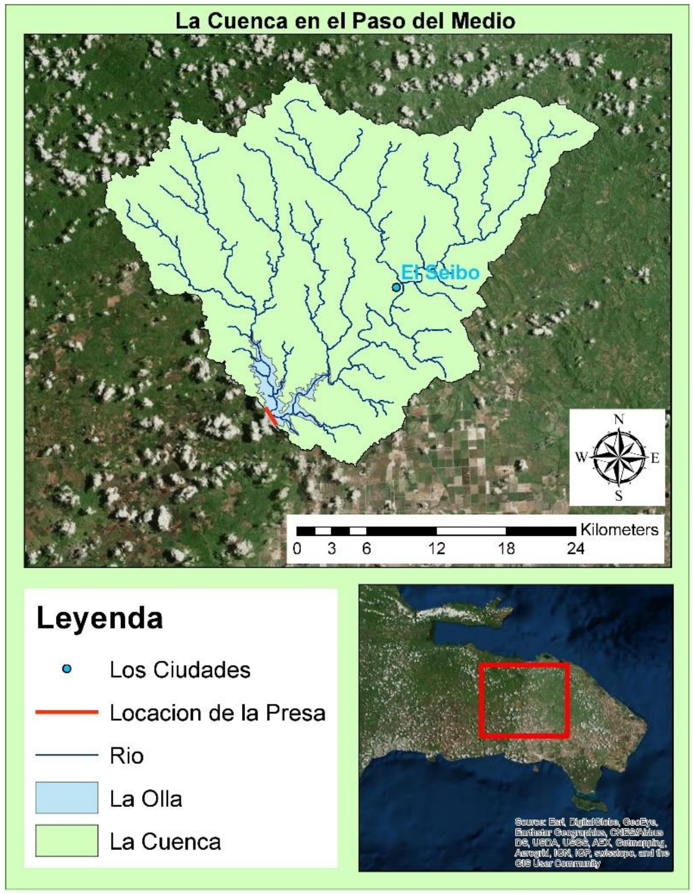

Figure 18: Reservoir at Paso del Medio

The model at El Seibo was set up assuming the top of the dam is at an elevation of 158 meters. This makes the dam approximately 50 meters tall. A low-level outlet, with a 1 meter diameter, was placed 2 meters above the bottom of the dam. When acting as a weir, the low-level has a weir coefficient of 1.838. When acting as an orifice, the coefficient is 0.6. The spillway was modeled 35 meters above the bottom of the dam. The length of the spillway was 15 meters, with a weir coefficient of 1.711. Figure 19 shows what the reservoir at El Seibo would look like with the given parameters.

Figure 19: Reservoir at El Seibo

HMS Models

The first site modeled was Paso del Medio. Figure 20 shows the outflow through the dam's low-level outlet and spillway at each return period. The PMP was not modeled because the volume of water was too great that the dam was overtopped and failed. The volume of water either stored in the reservoir or discharged downstream is equal to the depth of the storm multiplied by the watershed area minus the losses from the curve number. Because the watershed at Paso del Medio is much larger than El Seibo, the volume of runoff is much greater. The reservoir fills up much faster because of the large volume of runoff. This is why the outflow in Figure 20 is high, even at the 10 year storm. Simulations with the reservoir partially full were not executed because if the reservoir did not perform well to control flooding when it was empty then it would likely not perform well to control flooding when it is partially full.

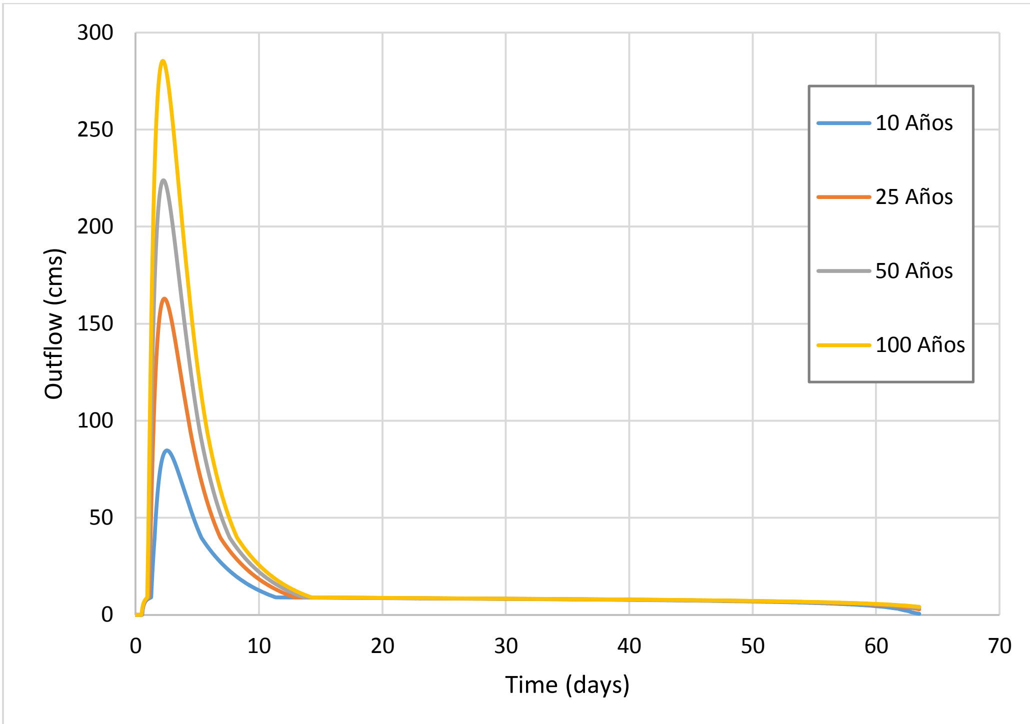

Figure 20: Outflow Hydrographs at Paso del Medio with Reservoir Empty

El Seibo was a much smaller watershed, so the volume of runoff was much less. However, due to the terrain in this area, the storage capacity of this dam was much greater than Paso del Medio. With the reservoir empty, all of the return periods, even up to the PMP, were stored in the reservoir. Figure 21 shows that the reservoir never reaches the spillway at any of the storms. All of the water is discharged through the low-level outlet.

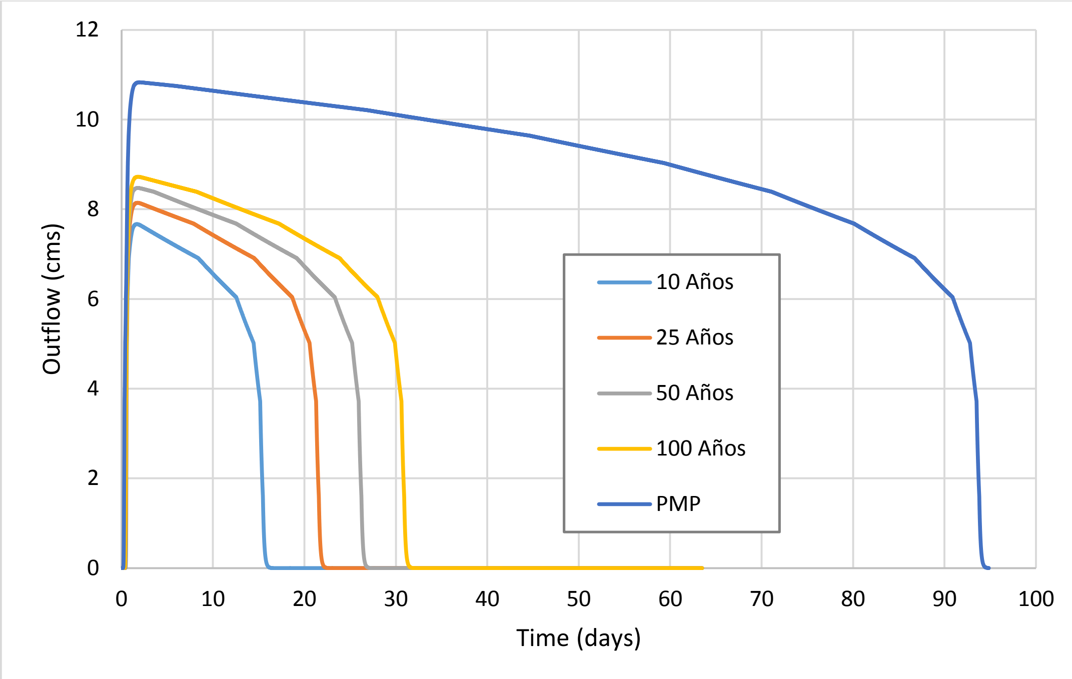

Figure 21: Outflow Hydrographs at El Seibo with Reservoir Empty

Practically, the reservoir will likely have water in it when storms occur, so a simulation was run with the reservoir at El Seibo half full. In order for the reservoir to be half full, the water level is above the level of the spillway. This is why Figure 22 shows the discharge starting high and then dropping. Once the flood wave from each storm reaches the reservoir the hydrograph peaks. Water is discharged over the spillway for about the first five days and then when the water level has dropped below the spillway and only flows out of the low-level outlet.

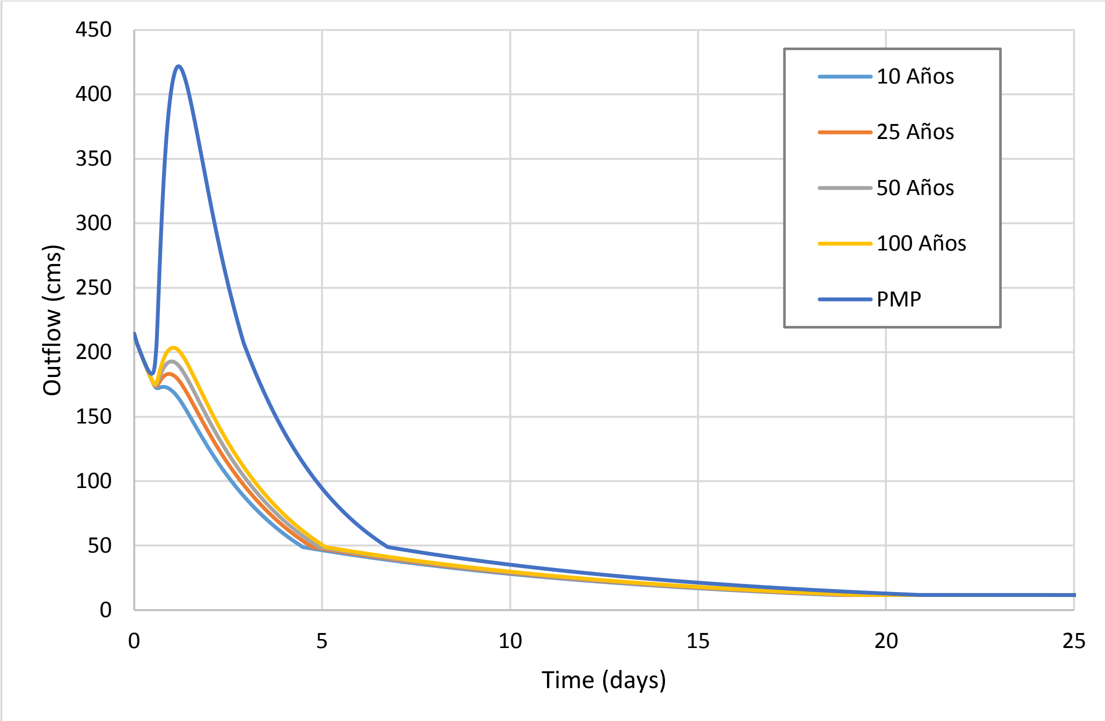

Figure 22: Outflow Hydrographs at El Seibo with Reservoir Half Full

The placement of a dam can greatly reduce the peak runoff of a flood event if the dam was not installed. As was mentioned earlier, when the reservoir at El Seibo was empty the entire flood wave from the PMP was stored in the reservoir. To better show a more likely comparison, the outflow hydrograph of the PMP with the reservoir half full was compared to a hydrograph of the PMP with no dam in place. Figure 23 shows a great reduction in the magnitude of the peak without a dam compared to when a dam is in place. With the dam installed the peak also occurs slightly later than without the dam. This delay could allow people more time to evacuate.

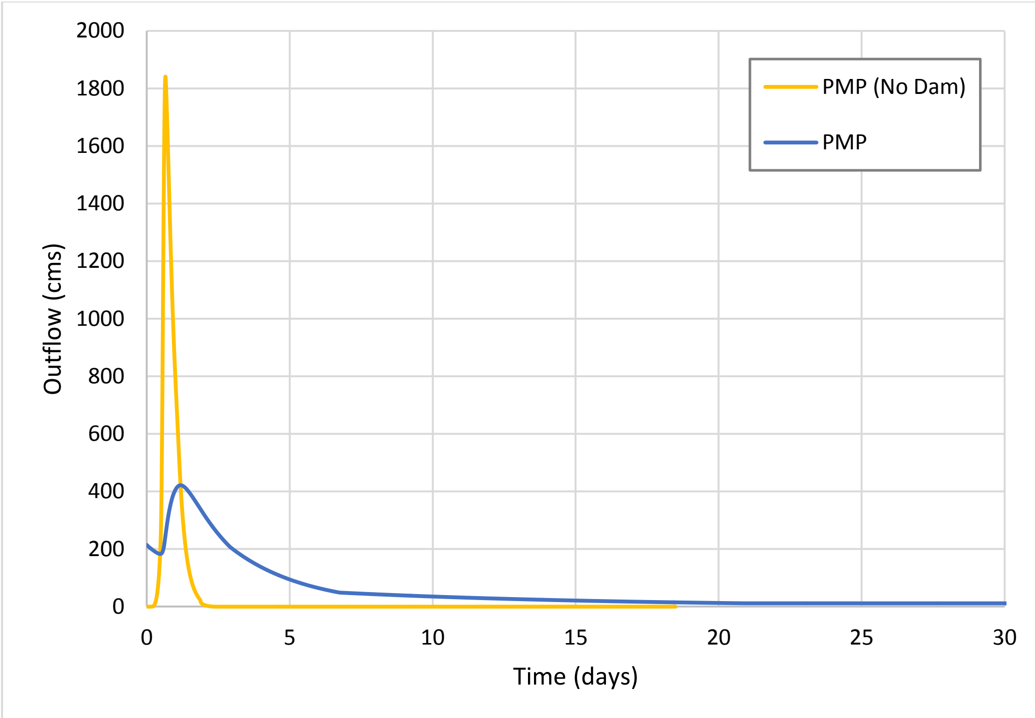

Figure 23: Comparison of El Seibo With and Without Dam

All of the HEC-HMS models depict the reservoir draining until it is empty. However, it is more likely that water is let out of the reservoir to attenuate the peak of the flood wave. Then the spillways and low-level outlet would probably be closed to maintain the storage of the reservoir for irrigation and power generation.

Dam Break Analysis

An important part of analyzing the effects of installing a dam include understanding how the dam could affect the downstream population if the dam were to fail. This type of analysis cannot be performed in HEC-HMS so a GSSHA model was used. The GSSHA model was set up using a grid size of 75 meters. The dam break analysis was only performed at El Seibo because this dam could store approximately four times the volume of water as the Paso del Medio site. The flood wave propagated from El Seibo would also pass through Paso del Medio. It was determined that an analysis at El Seibo would be sufficient to get an idea of the magnitude of the potential flooding from El Seibo to the outlet at the Atlantic Ocean. The GSSHA model simulated the sudden release of a 50 meter wall of water over a two hour period of time at the El Seibo dam site. The city El Seibo is just downstream of the dam El Seibo. Due to the proximity of this city to the dam site, the greatest flooding impacts would occur in El Seibo. Figure 24 and Figure 25 show what the city of El Seibo would look like before and after the dam breaks.

Figure 24: City of El Seibo before dam breaks

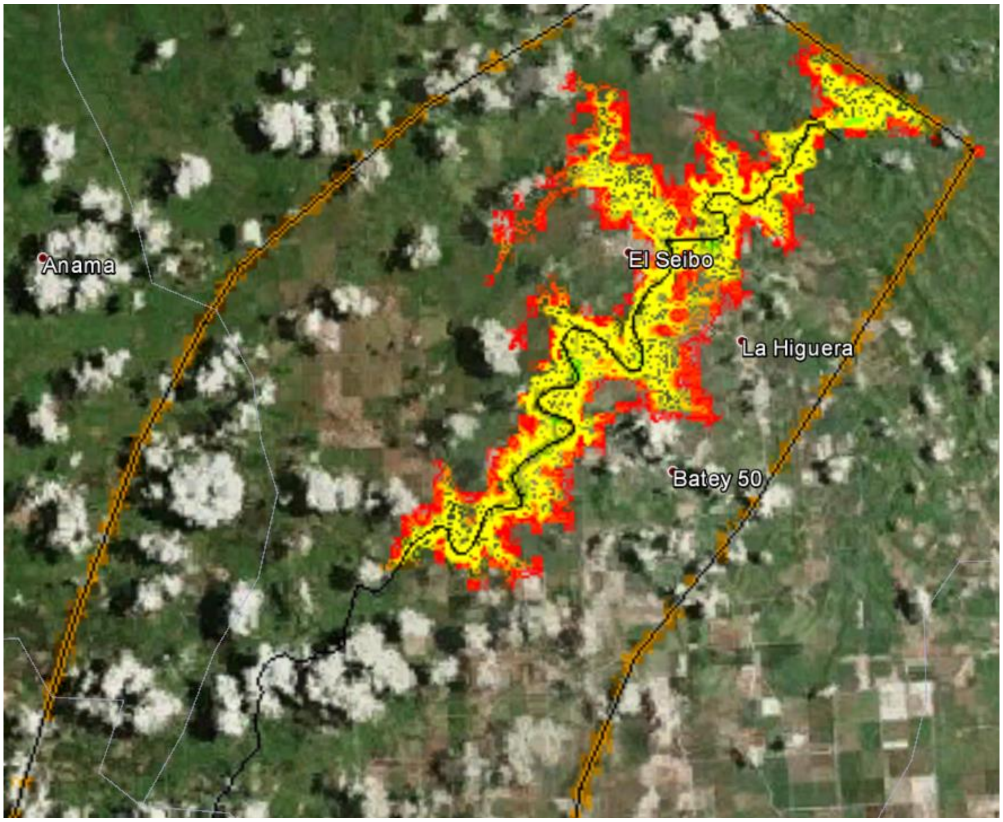

Figure 25: City of El Seibo after dam breaks

Additional images of the dam break analysis are included in the Appendix. This GSSHA model only gives a rough estimate of what the flood wave would look like. Higher resolution DEM data and a smaller GSSHA grid would provide a better view of what the flood wave would look like. However, in either case, the GSSHA model is conservative because this simulation released the entire volume of the reservoir in only two hours. It is very difficult to accurately simulate a dam break because most dam failures happen gradually.

Environment Assessment

Current Conditions

The Soco River currently flows unimpeded from the north above El Seibo to the south passing through Ramon Santana before entering the ocean. The area receives lots of precipitation each year especially during the rainy season that lasts from approximately June to November (U.S. News Travel). The river carries large amounts of sediment downstream each year (Santiago and Padós). The river is also known to exhibit high levels of eutrophication. This means that in some areas the introduction of inorganic materials, such as nitrogen and phosphorous from natural erosion and human activity, is causing large amount of growth of algae and other aquatic plants, which overcrowd the river and decrease biodiversity (Dominican Republic Encyclopedia Dictionary of the Environment). The occurrence of this is most likely the result of heavy agriculture involving fertilizers that occurs in the watershed especially between the towns of El Seibo and Ramon Santana.

Sedimentation

The creation of a dam along this river will have direct impacts on the passing of sediment, as taught by Dr. Rollin Hotchkiss of BYU. Currently a large amount of sediment is being moved down the Soco River unimpeded each year. The creation of a dam will block that passage of sediment. The consequences of impeding sedimentation include, but are not limited to, scouring beneath the dam, a decrease in storage volume, a decrease or total loss of hydroelectric power generation, a decrease in flood control potential, and shortening the lifespan of the dam.

These problems can be very expensive in the future. By taking the preparation now to build a dam that allows for sediment transport, a large amount of money can be saved in the future as well as an increased lifespan of the dam. It may cost a little more money up front but it can be worth it throughout the overall lifespan of the dam. This is an issue that will need to be discussed as further plans are made.

Comparison of the Locations

After running the numbers and the models, it is now possible to determine which dam would be better to place along the Soco River. Several of the important aspects of the dam analysis are storage capacity, the effect on the surrounding people, and the power that could be generated.

Paso del Medio

The flow at this dam site is very strong which would allow hydroelectric power to be generated constantly. The height of the dam is also fairly high and would also be beneficial in creating lots of power. The storage capacity at this area, however, is not very great because the land here is so flat. The volume of water that could be stored here is just over 100,000,000 m^3, when compared to El Seibo, it is very small. The water here could very easily be used to irrigate the many sugarcane plants and other crops in the area.

El Seibo

This location has the possibility of having a very high dam. The height of the dam and water stored would be extremely useful in generating immense amounts of power for this region.

The flow in this area is not very strong so it would take a long time to fill the dam, but once it is full the dam would be of great use in generating power. The volume of water that could be stored here with a full dam almost reaches 400,000,000 m^3, which is a huge upgrade from the dam at Paso del Medio. The water stored at this location also would benefit famers as well as the people who live in El Seibo.

Conclusion

The dam near El Seibo appears to be a better site because it has a much larger storage capacity. This site is also in a more mountainous region, which increases the ability to generate hydropower. The ability to store and safely pass the PMP is an additional benefit that the El Seibo site provides. A dam in either Paso del Medio or El Seibo would greatly aid the irrigation of farmland in this region. An increase in farmland production could help the economy in the Dominican Republic, which could be a source to help pay the expenses to build a dam. Sedimentation has the potential to severely damage the functionality of a dam. Further studies should be carried out to determine sediment loads of the Soco River.

References

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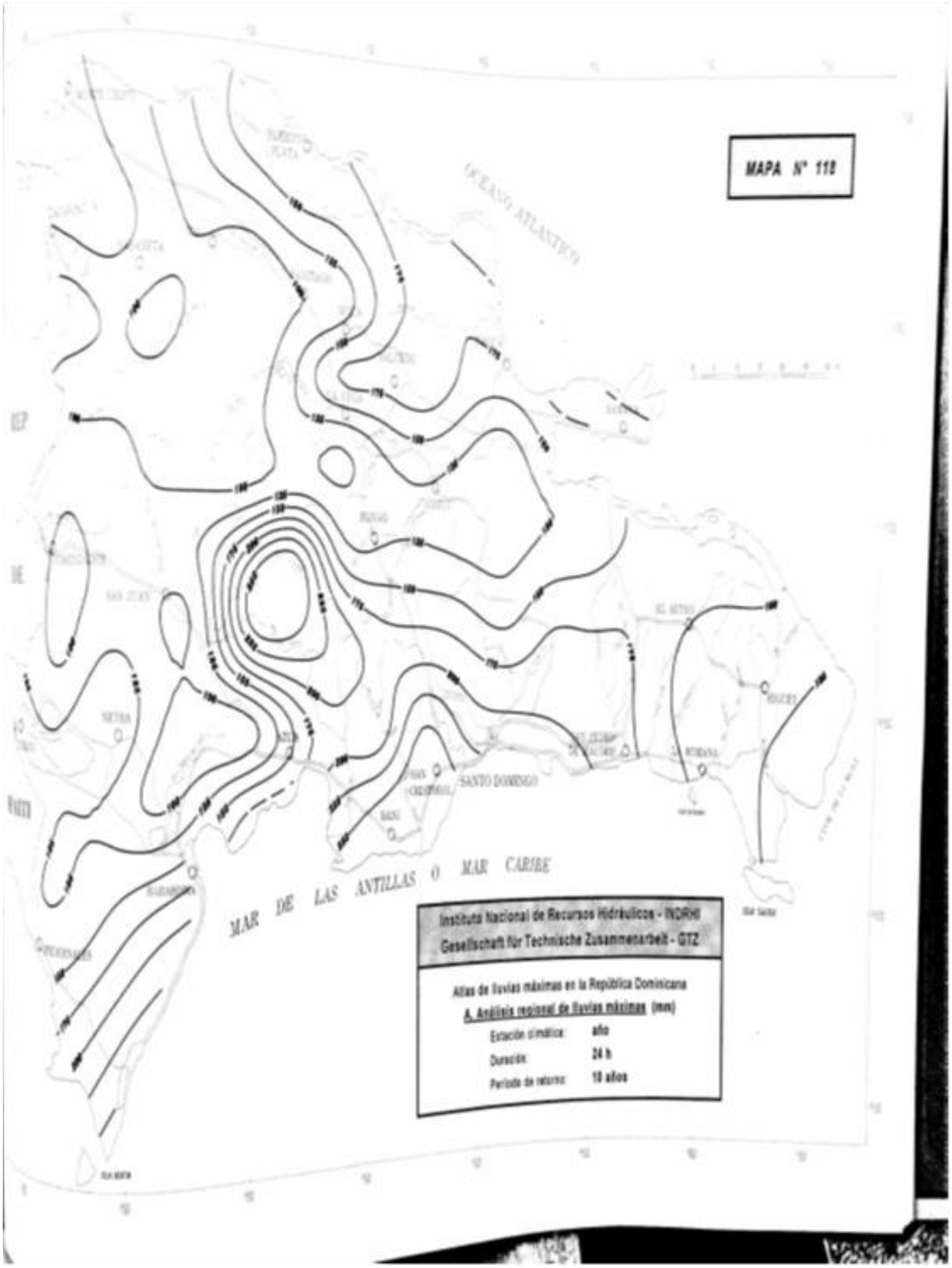
"Eutrophication." Dominican Republic Encyclopedic Dictionary of the Environment. Web. 11 Apr. 2015. <http://www.diccionariomedioambiente.org/DiccionarioMedioAmbiente_en/en/definicionVer.asp?id=382>.

Santiago, Linares R., and Padrós M. Piñol. "La Sedimentación Deltaica Actual En El Embalse De Cellers." Sociedad Española De Geomorfología (1996): 457-67. Web. <http://ruc.udc.es/bitstream/2183/6217/1/CA-21-35.pdf>.

Appendix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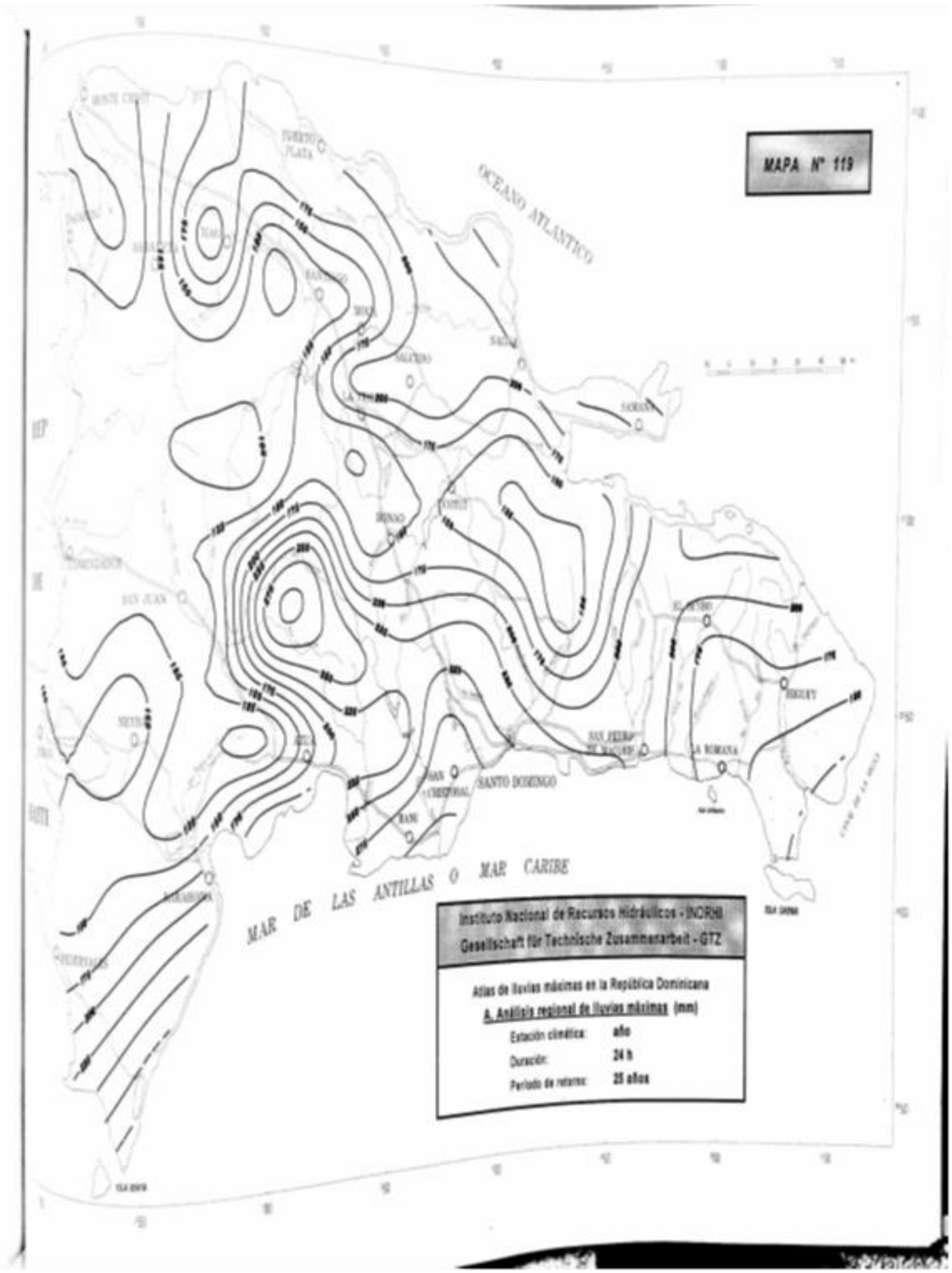
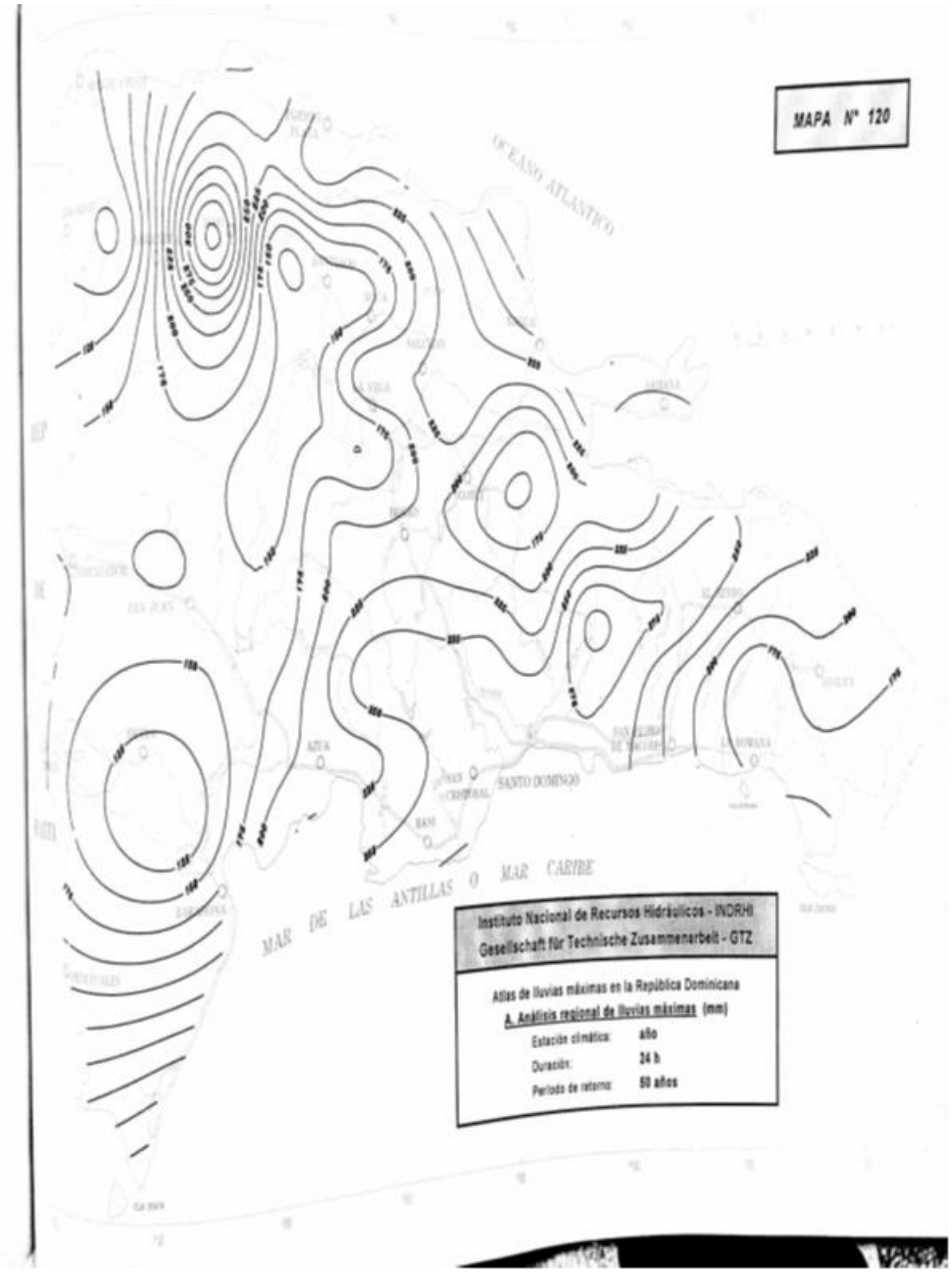
OCEANO ATLANTICO
SANTO DOMINGO
MAR DE LAS ANTILLAS O MAR CARIBE
Instituto Nacional de Recursos Hidráulicos - INDRHI
Gesellschaft für Technische Zusammenarbeit - GTZ
Atlas de lluvias máximas en la República Dominicana
A. Análisis regional de lluvias máximas (mm)
Estación climática: año
Duración: 24 h
Período de retorno: 10 años


MAPA N° 119
OCEANO ATLANTICO
MAR DE LAS ANTILLAS O MAR CARIBE
PUERTO PLATA
SANTIAGO
SANTO DOMINGO
SAN JUAN
LA ROMANA
HIGUEY
BARAHONA
Instituto Nacional de Recursos Hidráulicos - INDRHI
Gesellschaft für Technische Zusammenarbeit - GTZ
Atlas de lluvias máximas en la República Dominicana
A. Análisis regional de lluvias máximas (mm)
Estación climática: año
Duración: 24 h
Período de retorno: 25 años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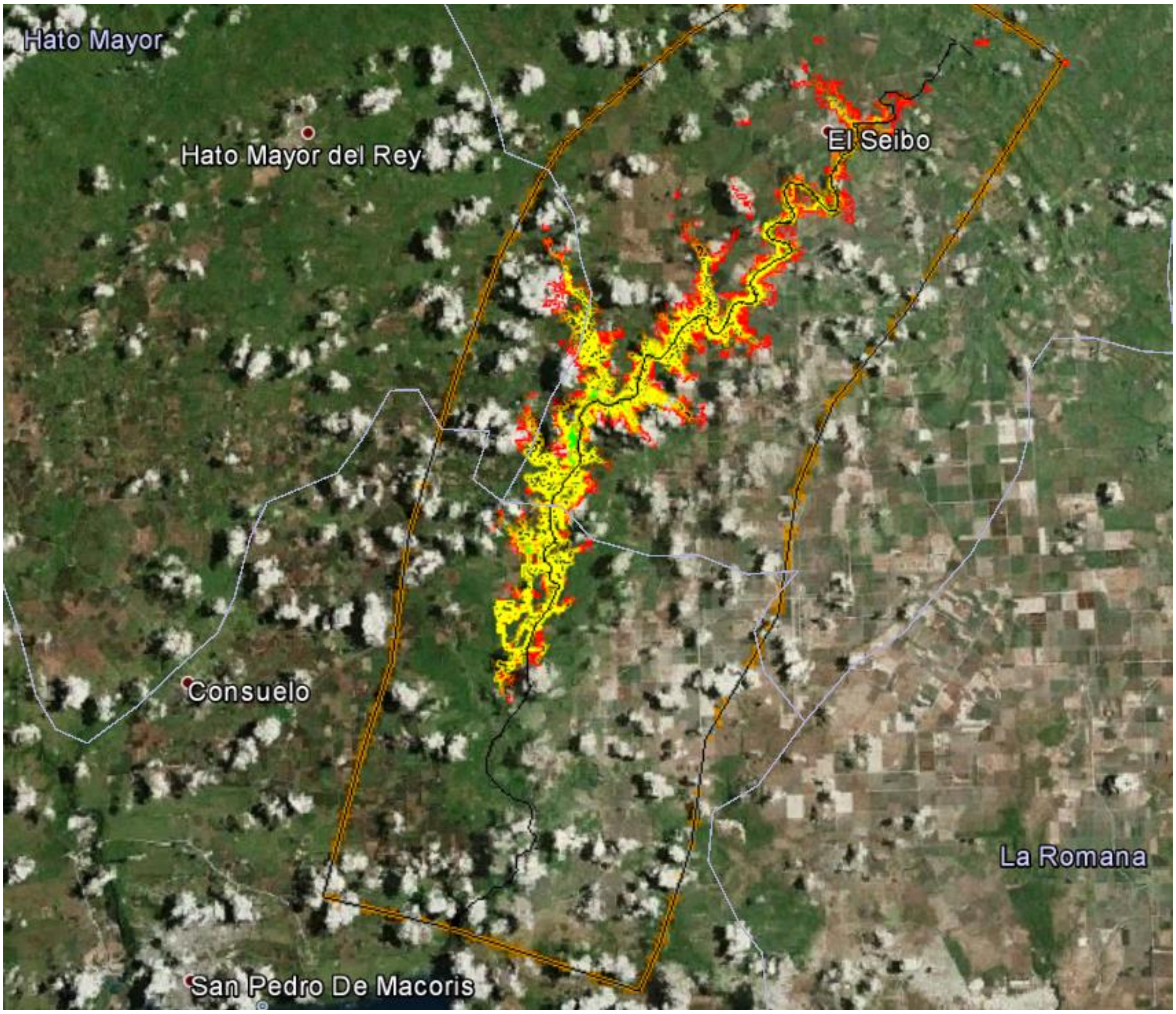
MAR DE LAS ANTILLAS O MAR CARIBE
SANTO DOMINGO
Instituto Nacional de Recursos Hidráulicos - INDRHI
Gesellschaft für Technische Zusammenarbeit - GTZ
Atlas de lluvias máximas en la República Dominicana
A. Análisis regional de lluvias máximas (mm)
Estación climática: año
Duración: 24 h
Período de retorno: 50 años


Hato Mayor
Hato Mayor del Rey
El Seibo
Consuelo
La Romana
San Pedro De Macoris