Juan Diaz River Restoration, with Marea Verde

Alex Guerra, Alexander Boucher Jr, Sophie Chretien, and Kristen Soden

A Brief History of Environmental Issues in Panama

Rapid Industrialization
During the 60s, Panama entered a period of substantial industrial expansion - the most the country has ever seen - which has characterized Panama throughout the modern era.

Global Introduction of Plastic Products
Materials like PVC, PET and others were first introduced to the global market, revolutionizing the manufacturing industry

Panama Adopts Plastics

Sometimes between the 1970s and 1980s, Panama began importing and exporting plastic products,.

Plastic Accumulation First Discovered in Ocean

Charles Moore first discovered the massive plastic deposits in the ocean

General of the Environment Created

Law 41 of July, 1998 established standards of environmental protection, civic responsibilities, and legal capacities. It has since undergone four reforms.

Mirei Endara Works as Ministry of the Environment
Ms. Endara, with whom we've worked closely, worked as the ministry of the environment during this 2 year period right after the general's status was elevated.

"Zero Trash Policy" and a Law Regulating Plastic Processing Ratified
Two laws which dealt with certain aspects of plastics and pollution ratified from 2018 to now. Plastic bags were also banned in 2019; the scale of the ban continues to increase.

Our Sponsor: Marea Verde

- Marea Verde is a non-profit environmental organization in Panama which seeks to raise awareness for environmental issues and promote green lifestyles
- They perform research, host community events, and work with local/international universities to analyze the region and develop intervention strategies

The Project

Our project can be separated into four main stages:

- Social Research/Data Collection
  - We will help Marea Verde to customize a survey for the Juan Diaz district from which we can derive statistical relationships between pollution and the answers provided by the citizens. We will collect ground and satellite images provided by Marea Verde through the Environmental General.
- Data Analysis
  - Upon collecting the previously mentioned data, we will analyze it by deriving relationships between factors identified in the surveys and using the mapping software, arcGIS, to create topographical representations of image data.
- Compiling Results/Creating Deliverables
  - Prepare the data in a presentable for so that it can be used by Marea Verde
- Intervention Plans
  - Propose a course of action for Marea Verde going forward.

Stage 1: Data Collection

Survey Collection

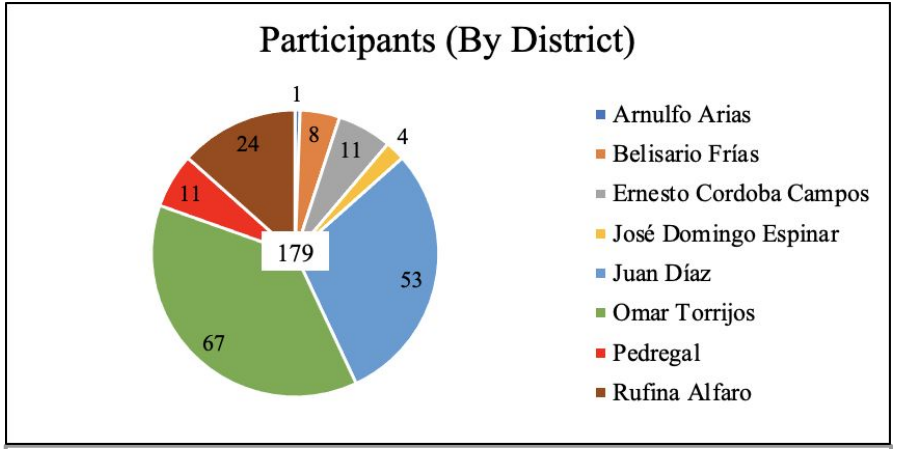
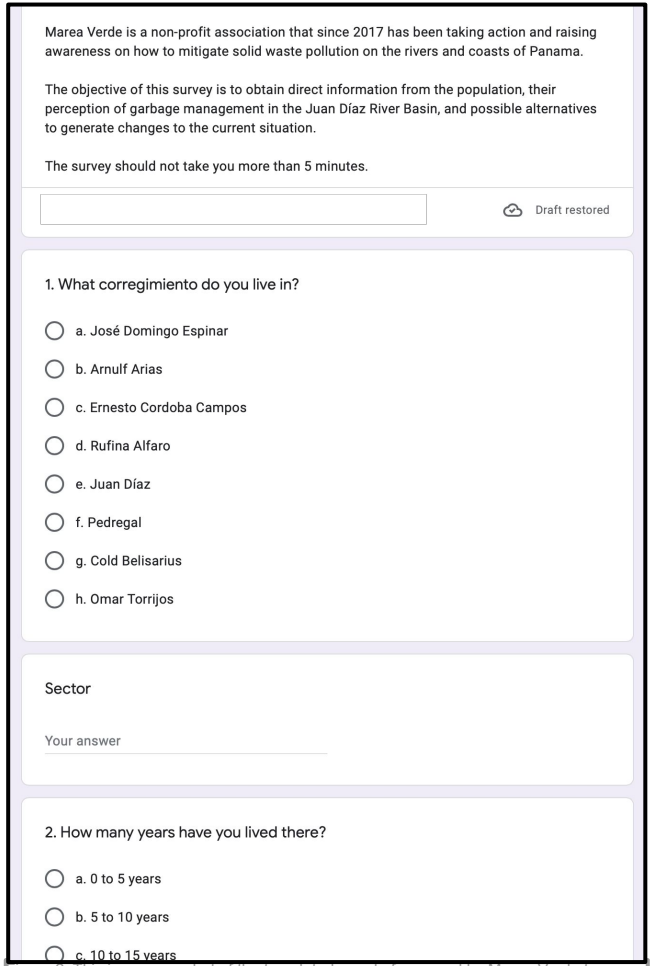


Figure 1: This is a pie-chart representing the total amount of surveyed participants and the districts they reside in.

Key Information Collected from Surveys:

- Residential History
- Waste Production Tendencies
- Garbage/Recycling Collection Processes
- General River Knowledge/Habits
- Willingness to participate in Environmental Studies relating to River Pollution



Marea Verde is a non-profit association that since 2017 has been taking action and raising awareness on how to mitigate solid waste pollution on the rivers and coasts of Panama.

The objective of this survey is to obtain direct information from the population, their perception of garbage management in the Juan Díaz River Basin, and possible alternatives to generate changes to the current situation.

The survey should not take you more than 5 minutes.

Draft restored

1. What corregimiento do you live in?

- a. José Domingo Espinar
- b. Arnulf Arias
- c. Ernesto Cordoba Campos
- d. Rufina Alfaro
- e. Juan Díaz
- f. Pedregal
- g. Cold Belisarius
- h. Omar Torrijos

Sector

Your answer

2. How many years have you lived there?

- a. 0 to 5 years
- b. 5 to 10 years
- c. 10 to 15 years

Figure 2: This is a screenshot of the translated google form used by Marea Verde to distribute the Survey used in this project to residents of the Juan Diaz Watershed Districts.

Satellite Images

Figure 3: This is an image of the Juan Diaz district uploaded into ArcMap with the the JDR outlined in blue and the boundaries outlined in green.

- Obtained from Ministry of Environment and Earth Explorer
- Overview and ground-level images of Juan Diaz communities
- Both Recent and Older Images for Comparison and Community Development observations

Figure 4: Satellite image of the Juan Diaz district with the river outlined in blue.

Stage 2: Analysis

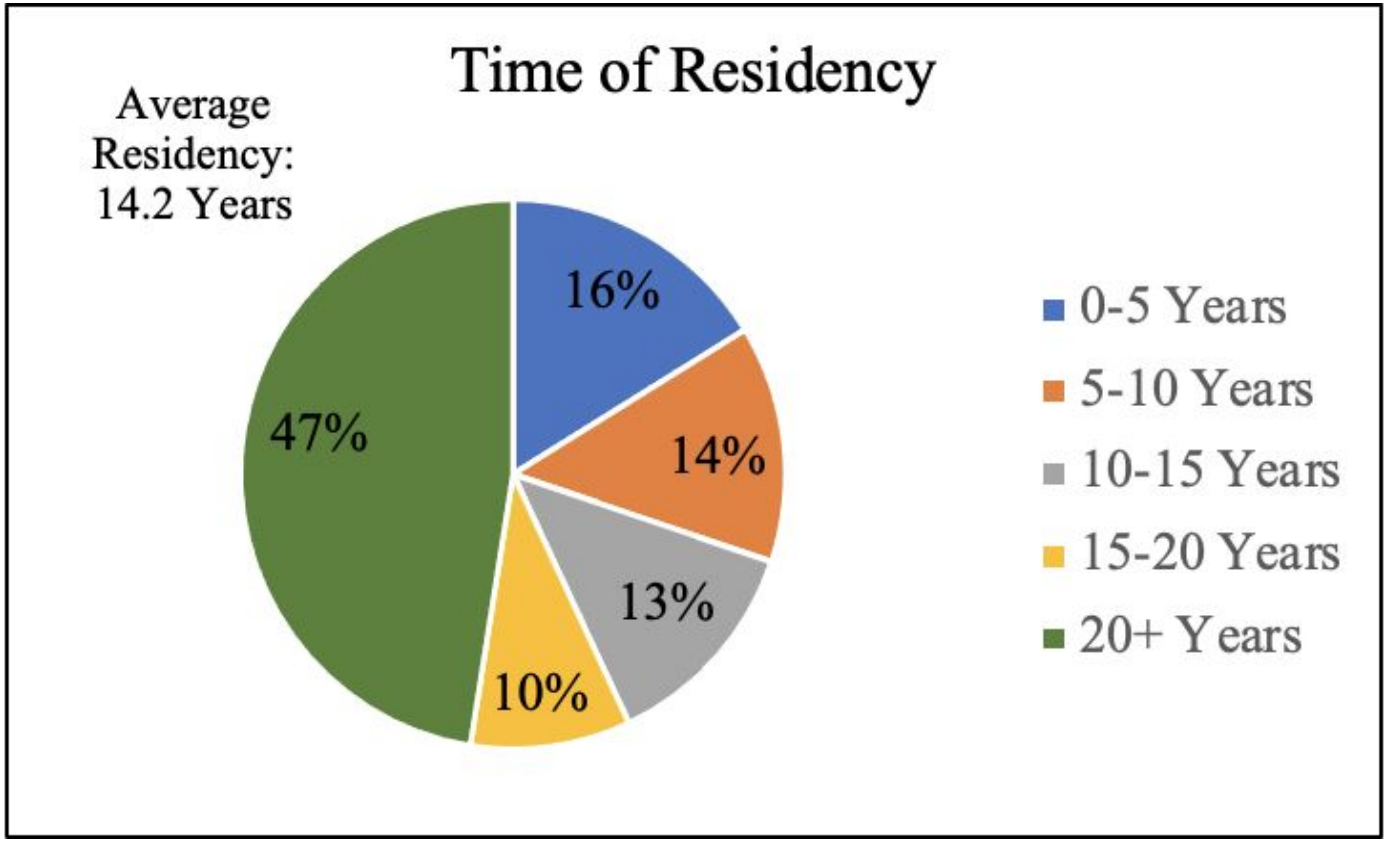
Survey Analysis

- Translating/Compiling results into most comprehensible form
- Creating visuals to perceive communal trends
- Drawing conclusions

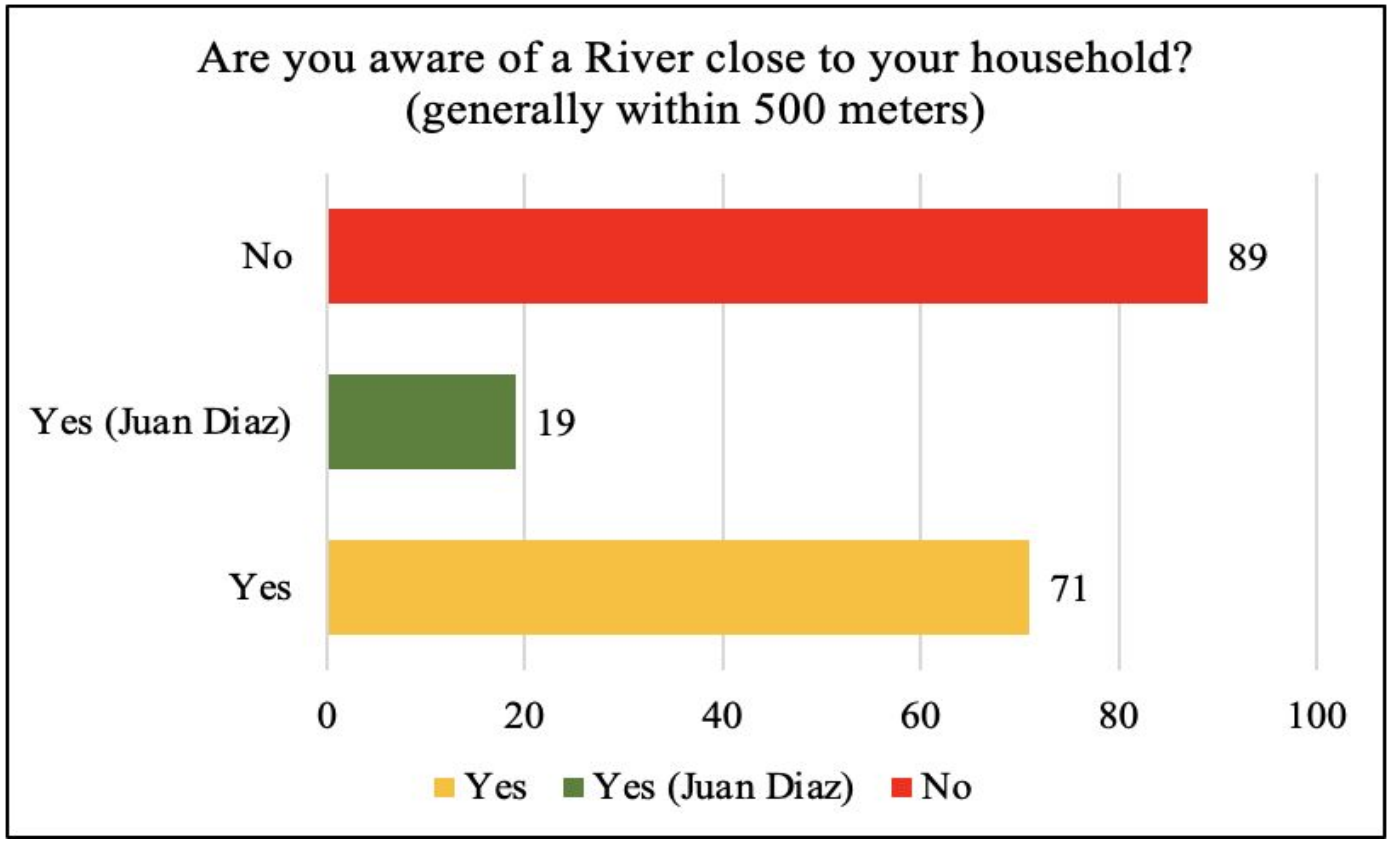
	A	B	C	D	E	F	G	H
1	Timestamp	1. ¿En qué corregimiento viv	Sector	2. ¿Cuántos años ha vivido a	3. ¿Qué tipo de productos co	4. ¿En su mayoría, su familia	5. ¿Dónde lleva la basura qu	6. ¿Ud. considera que
2	10/3/2021 21:20:20	e. Juan Díaz	Santamaria	a. 0 a 5 años	b. Productos de supermercac	b. Usamos utensilios desech	b. La llevamos a un punto cei	c. No es un problema
3	10/3/2021 16:27:46	e. Juan Díaz	Santa Maria	b. 5 a 10 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
4	10/1/2021 17:00:13	h. Omar Torrijos		b. 5 a 10 años	a. Productos de mercado loc	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	a. Tremendo problema
5	10/1/2021 16:59:14	h. Omar Torrijos	Amelia Denis de Icaza, San	a. 0 a 5 años	b. Productos de supermercac	b. Usamos utensilios desech	a. La recogen frente a la casa	b. Es un problema mer
6	10/1/2021 16:57:21	h. Omar Torrijos	Santa Elena #2	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	a. Tremendo problema
7	10/1/2021 16:56:32	h. Omar Torrijos	2 etapa Santa Librada		b. Productos de supermercado (con envoltorios de plástico, papel, etc)			
8	10/1/2021 16:54:23	h. Omar Torrijos		e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	a. Tremendo problema
9	10/1/2021 16:53:12	h. Omar Torrijos		d. 15 a 20 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
10	10/1/2021 16:51:06	h. Omar Torrijos	H. Libardo	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
11	10/1/2021 16:49:20	h. Omar Torrijos	Sector #2	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	a. Tremendo problema
12	10/1/2021 16:48:36	h. Omar Torrijos	La Rosita	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
13	10/1/2021 16:47:36	h. Omar Torrijos	Ernesto Córdoba	e. 20 a más años	a. Productos de mercado loc	b. Usamos utensilios desech	a. La recogen frente a la casa	b. Es un problema mer
14	10/1/2021 16:46:18	h. Omar Torrijos	Carter 4	e. 20 a más años	b. Productos de supermercac	b. Usamos utensilios desech	b. La llevamos a un punto cei	c. No es un problema
15	10/1/2021 0:22:09	e. Juan Díaz	Santa María	b. 5 a 10 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
16	9/30/2021 14:44:27	g. Belisario Frías	Torrijos carter	c. 10 a 15 años	a. Productos de mercado loc	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	a. Tremendo problema
17	9/30/2021 12:09:56	e. Juan Díaz	Santa Maria	b. 5 a 10 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
18	9/30/2021 12:06:24	e. Juan Díaz	Santa Maria	a. 0 a 5 años	b. Productos de supermercac	b. Usamos utensilios desech	b. La llevamos a un punto cei	c. No es un problema
19	9/30/2021 11:43:23	e. Juan Díaz		a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	c. No es un problema
20	9/30/2021 9:44:12	e. Juan Díaz	Santa Maria	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	b. Es un problema mer
21	9/29/2021 22:15:55	e. Juan Díaz	Costa del este	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	a. Tremendo problema
22	9/29/2021 21:10:16	c. Ernesto Cordoba Campos	Villa zaita	e. 20 a más años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	b. Es un problema mer
23	9/29/2021 20:55:34	c. Ernesto Cordoba Campos	villas del Rocio	b. 5 a 10 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	a. Tremendo problema
24	9/29/2021 18:32:13	e. Juan Díaz	Santa Maria	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
25	9/29/2021 18:24:54	e. Juan Díaz	santamaría	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
26	9/29/2021 18:24:00	e. Juan Díaz	Santa maria	b. 5 a 10 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	a. Tremendo problema
27	9/29/2021 18:19:56	e. Juan Díaz	Santa maria	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	a. La recogen frente a la casa	c. No es un problema
28	9/29/2021 18:14:05	e. Juan Díaz	Santa Maria	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	b. Es un problema mer
29	9/29/2021 18:04:03	e. Juan Díaz	Santa marina	a. 0 a 5 años	b. Productos de supermercac	a. Usamos utensilios reutiliza	b. La llevamos a un punto cei	b. Es un problema mer

	A	B
1	**District**	**Number of Responses**
2	Arnulfo Arias	1
3	Belisario Frías	8
4	Ernesto Cordoba Campos	11
5	José Domingo Espinar	4
6	Juan Díaz	53
7	Omar Torrijos	67
8	Pedregal	11
9	Rufina Alfaro	24
10	Total	179
11		
12	**How Long Have You Lived In**	**Number of Responses**
13	0-5 Years	29
14	5-10 Years	25
15	10-15 Years	23
16	15-20 Years	17
17	20+ Years	85
18	Total	179
19		
20	**Kinds of Products they use in**	**Number of Responses**
21	Supermarket Products (plastic v	166
22	Local Market (Non-Packaged fo	13
23	Total	179
24		
25		
26	**Reusable Utensils**	**Number of Responses**
27	Yes	159
28	No	20
29	Total	179

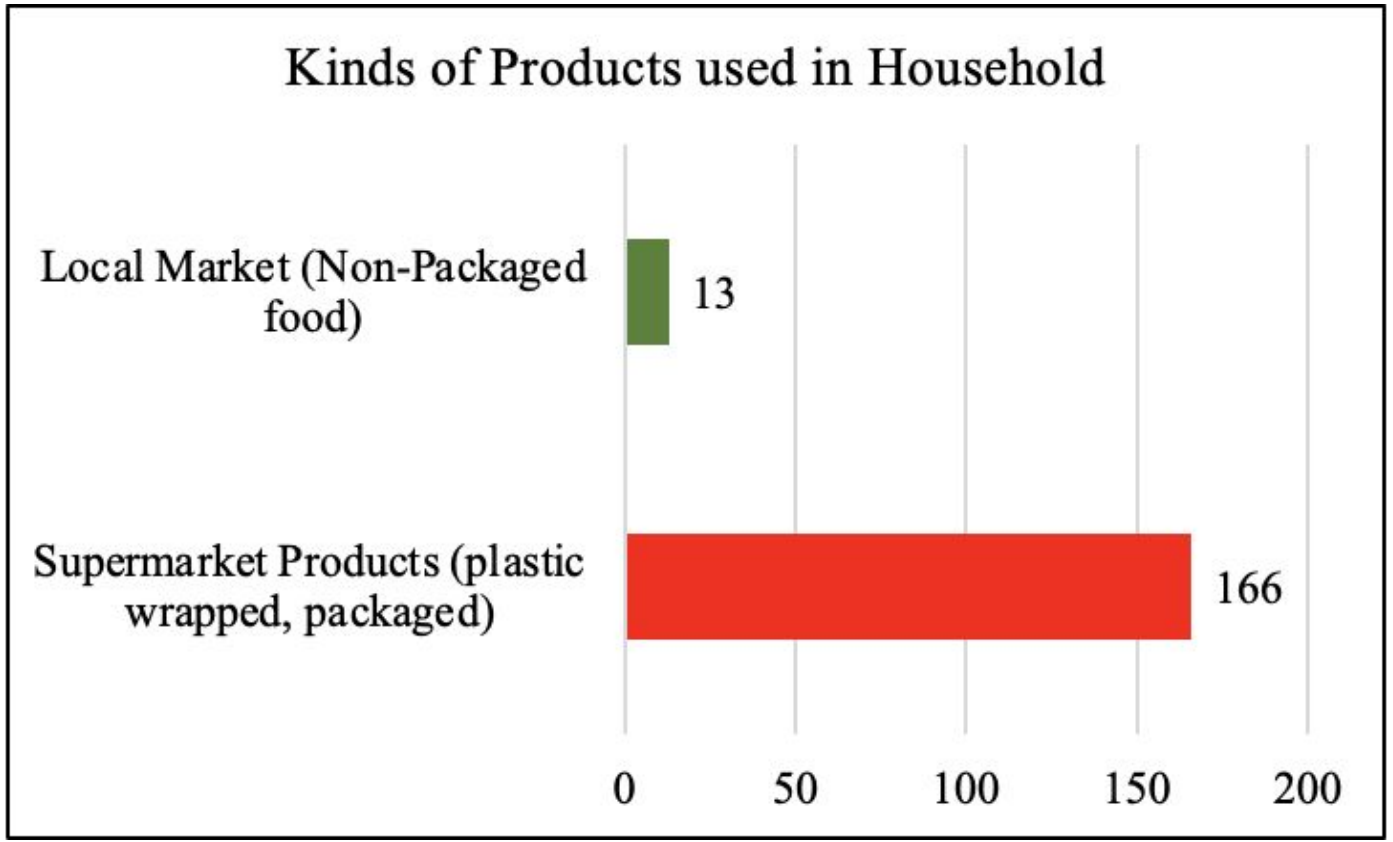
Survey Analysis (Residential History)



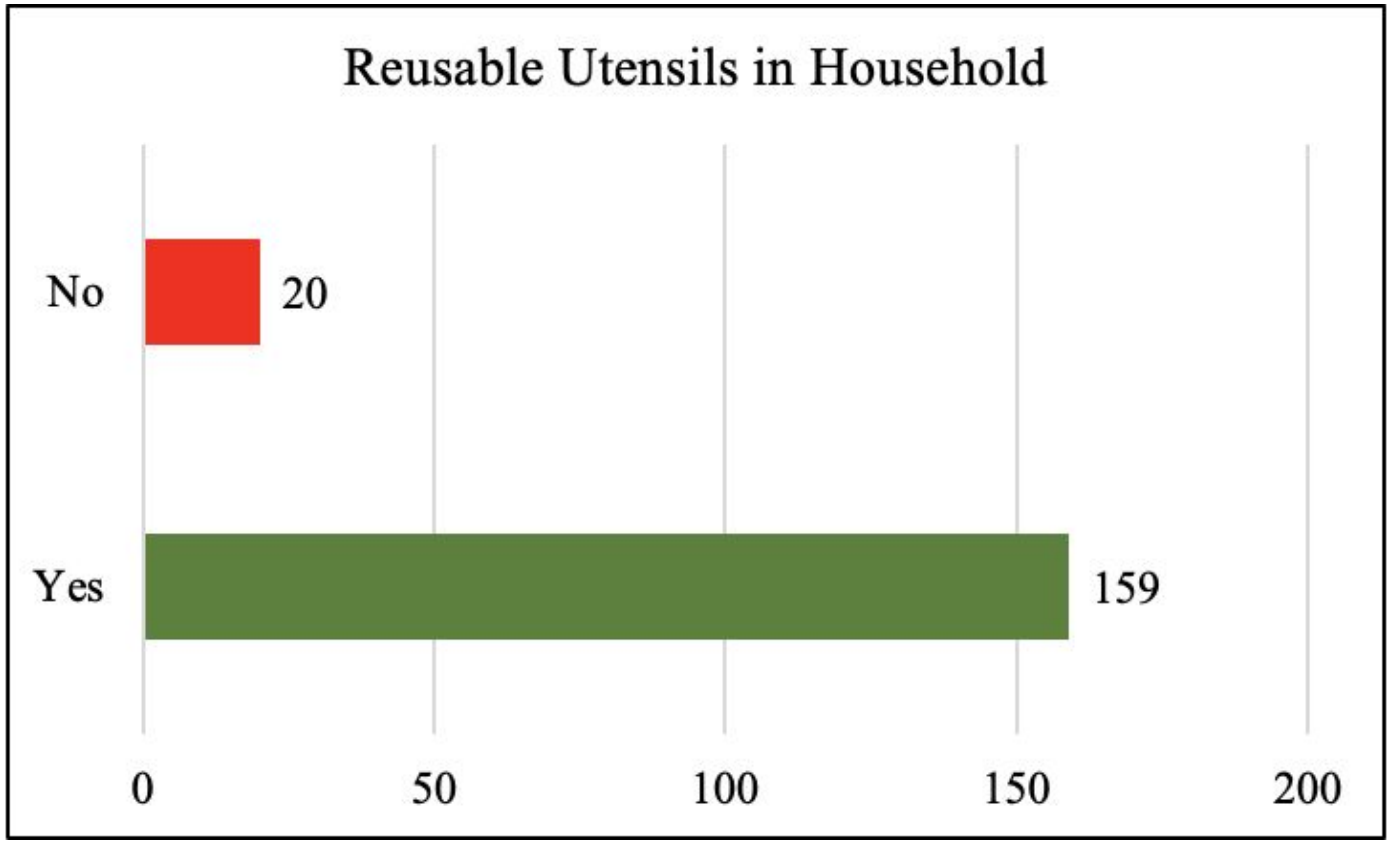
Survey Analysis (Residential History)



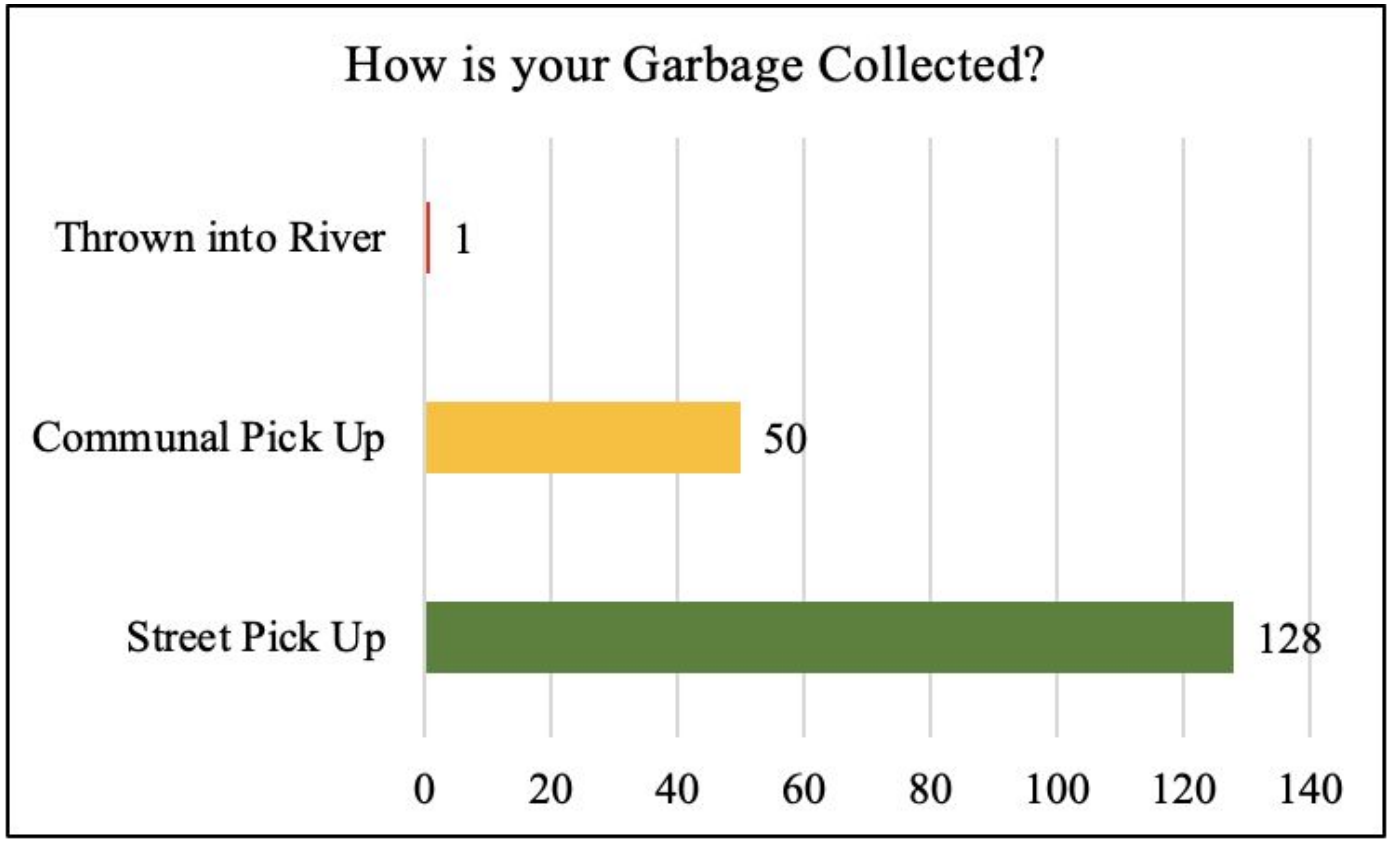
Survey Analysis (Waste Production Tendencies)



Survey Analysis (Waste Production Tendencies)



Survey Analysis (Garbage/Recycling Collection Processes)



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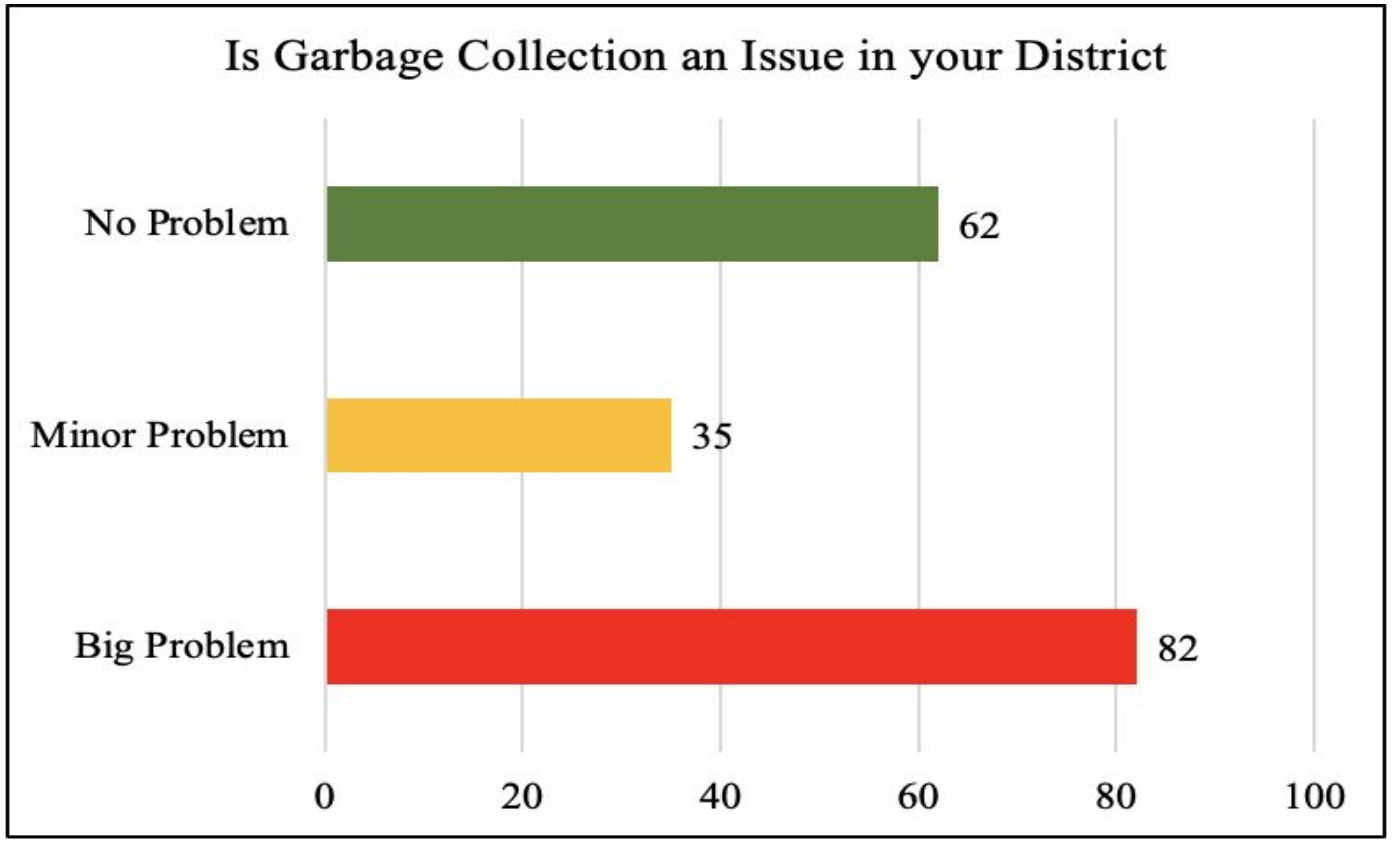

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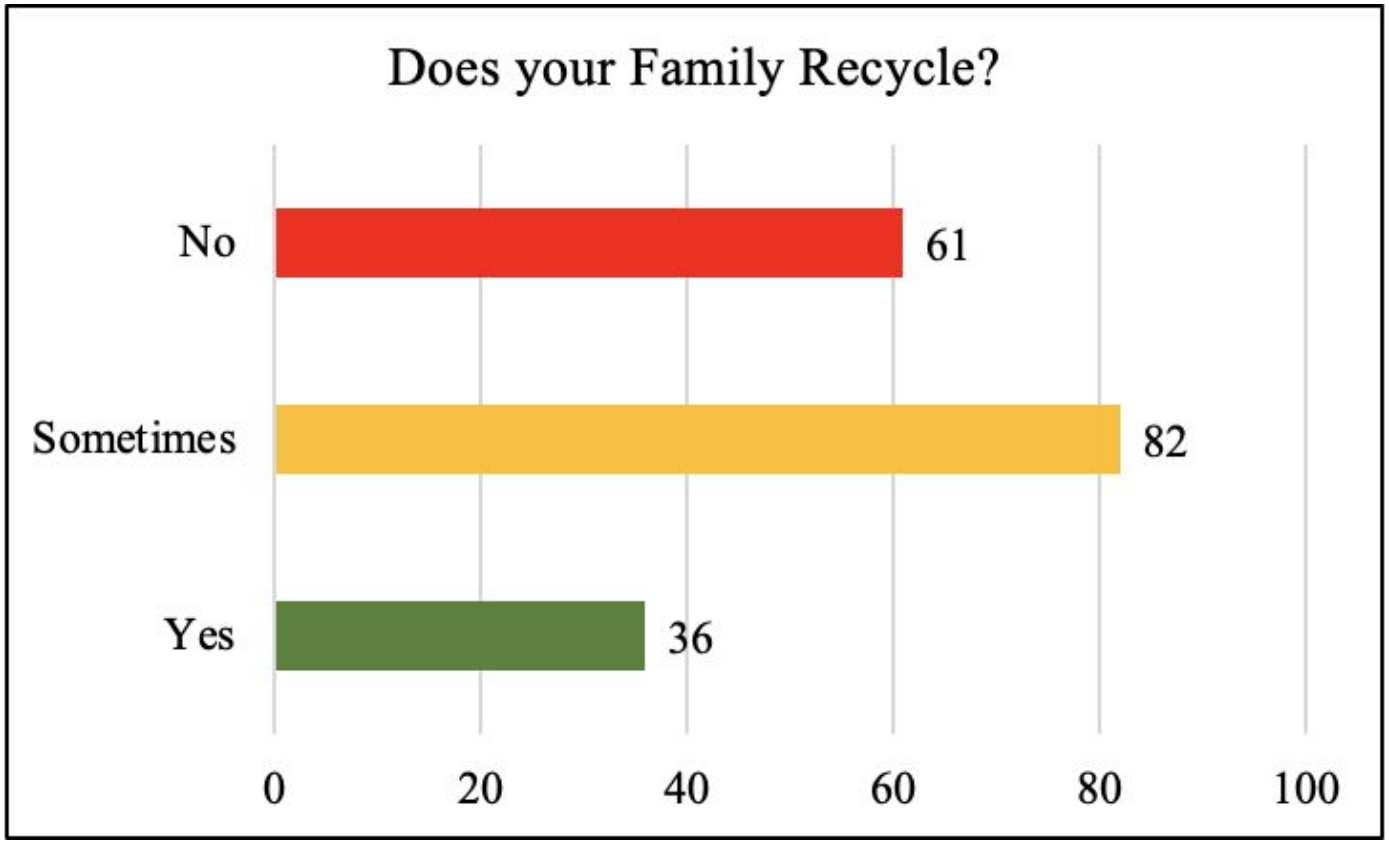
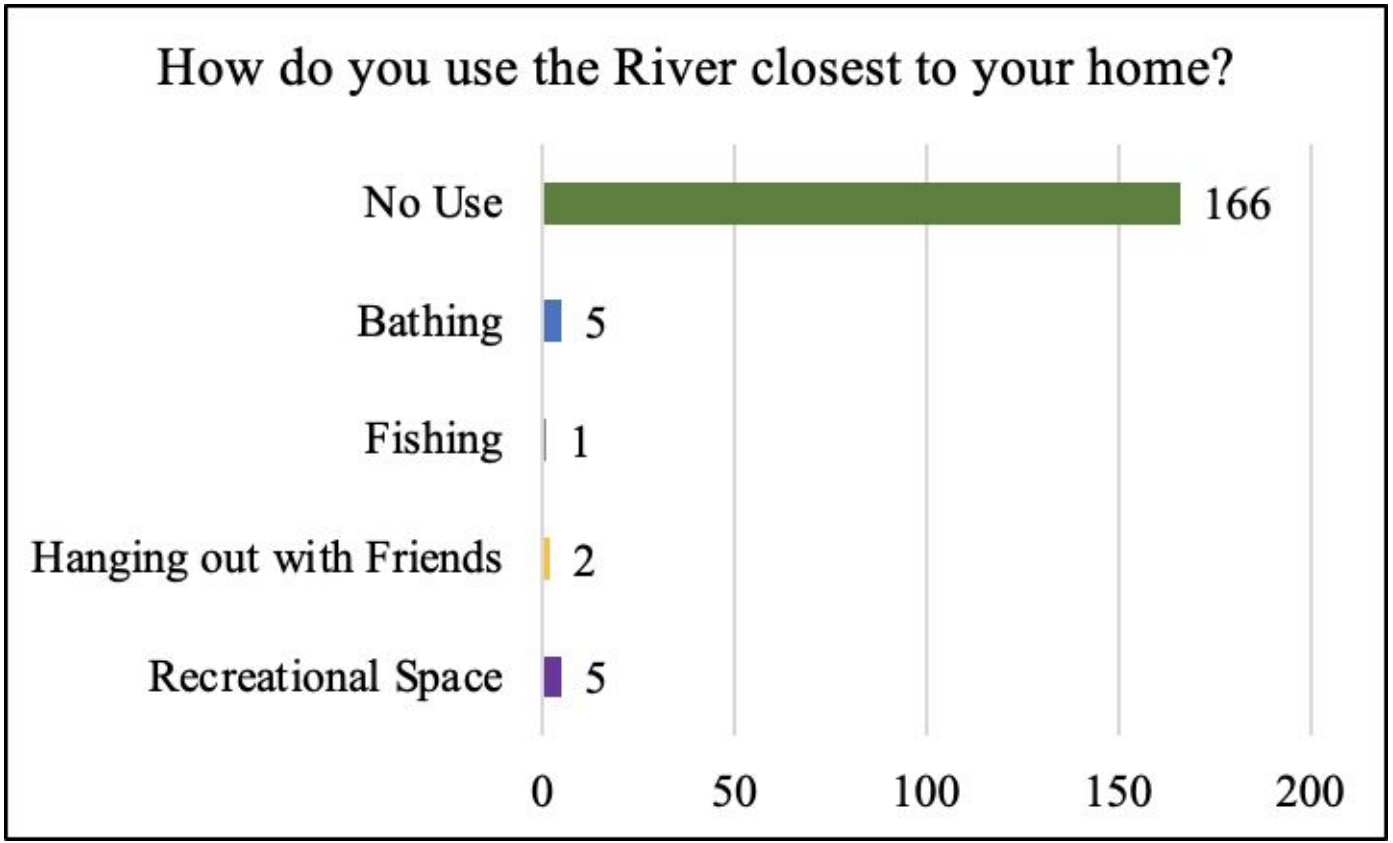
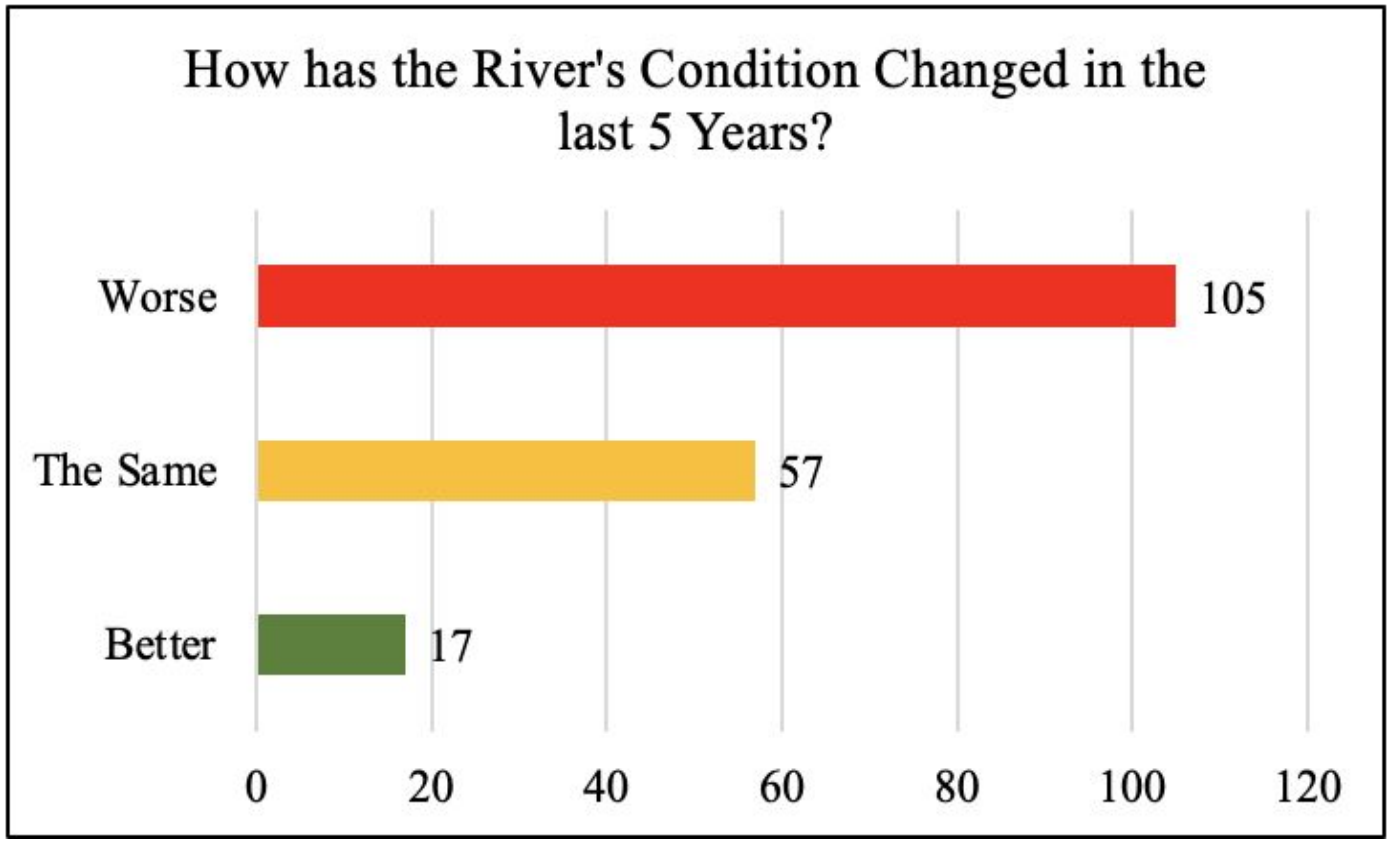


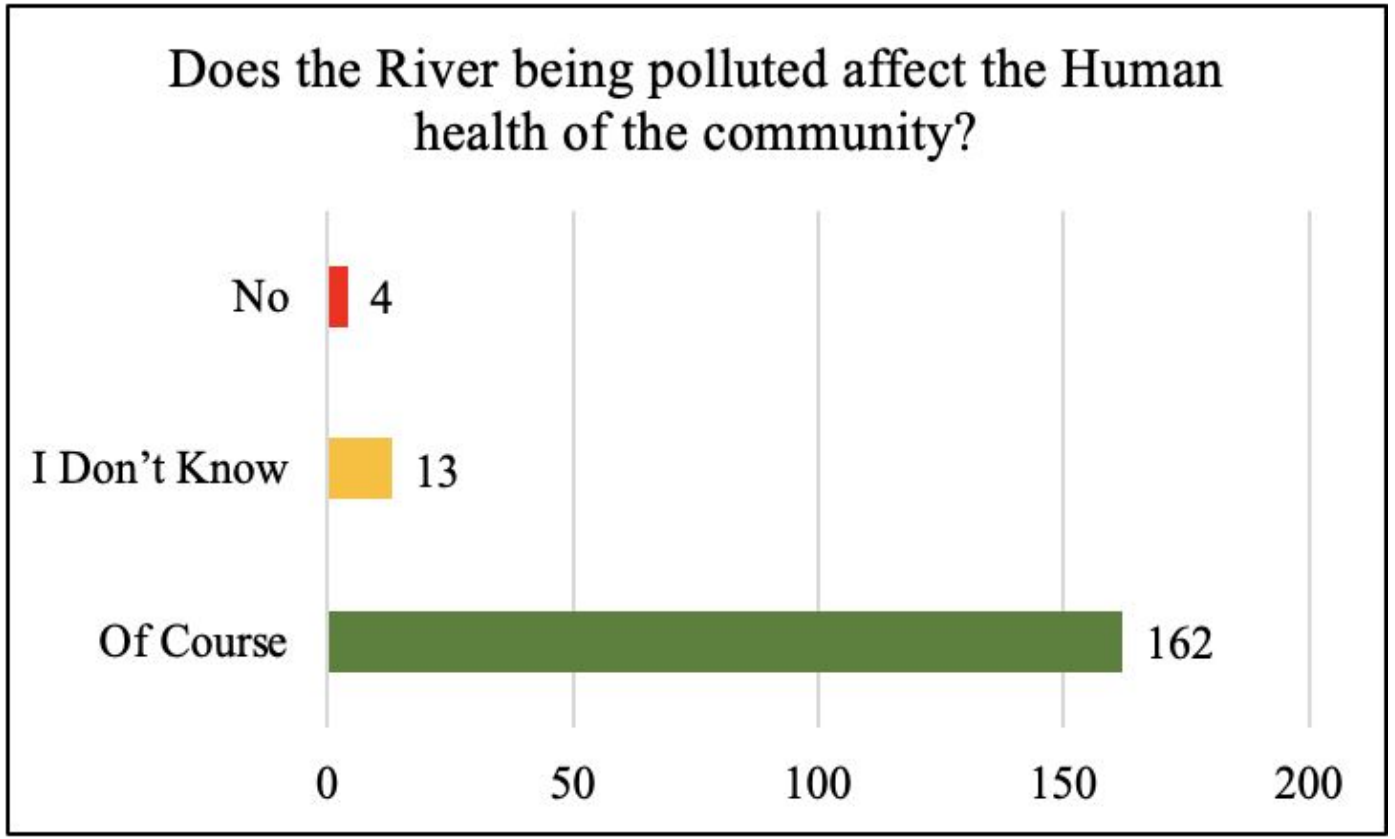
Survey Analysis (General River Knowledge/Habits)



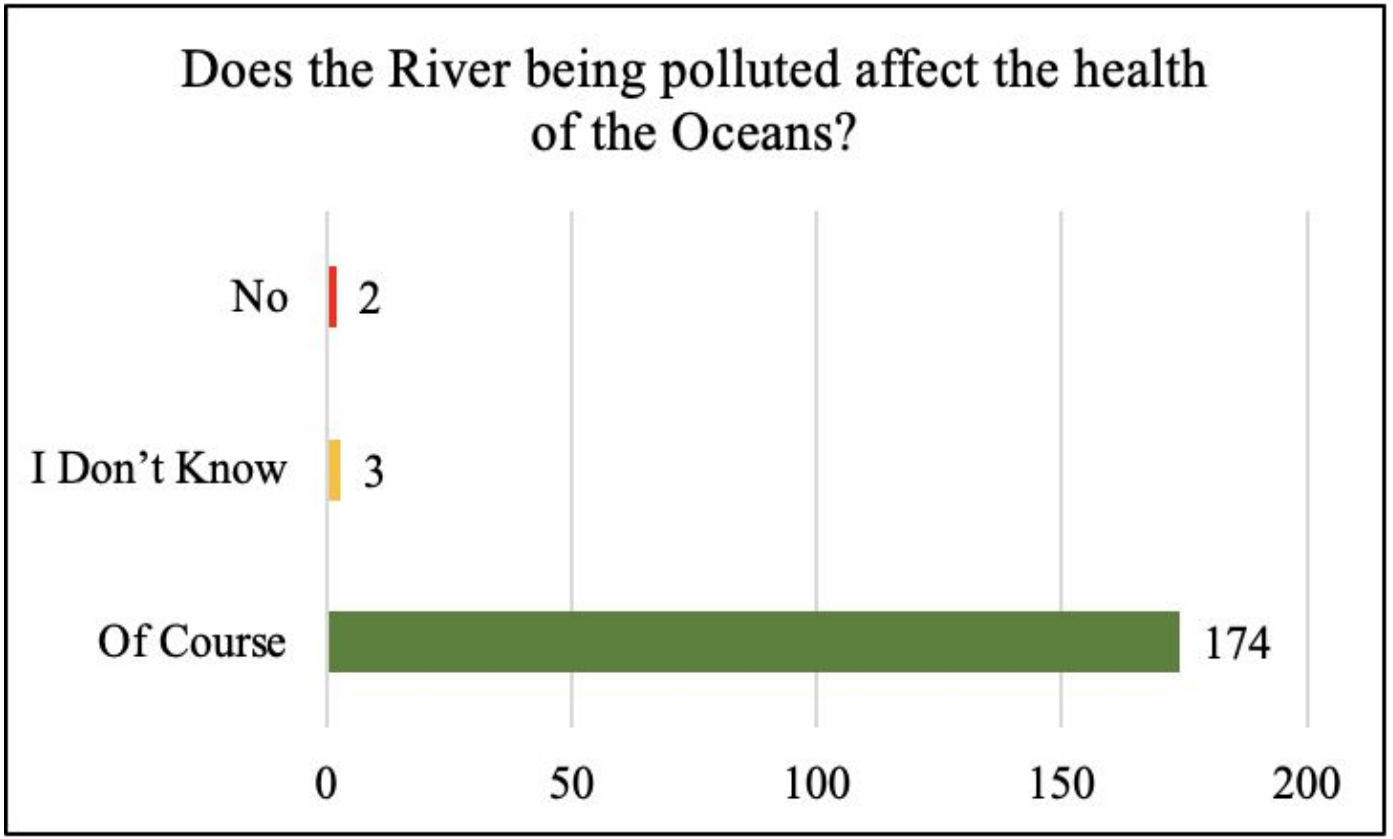
Survey Analysis (General River Knowledge/Habits)



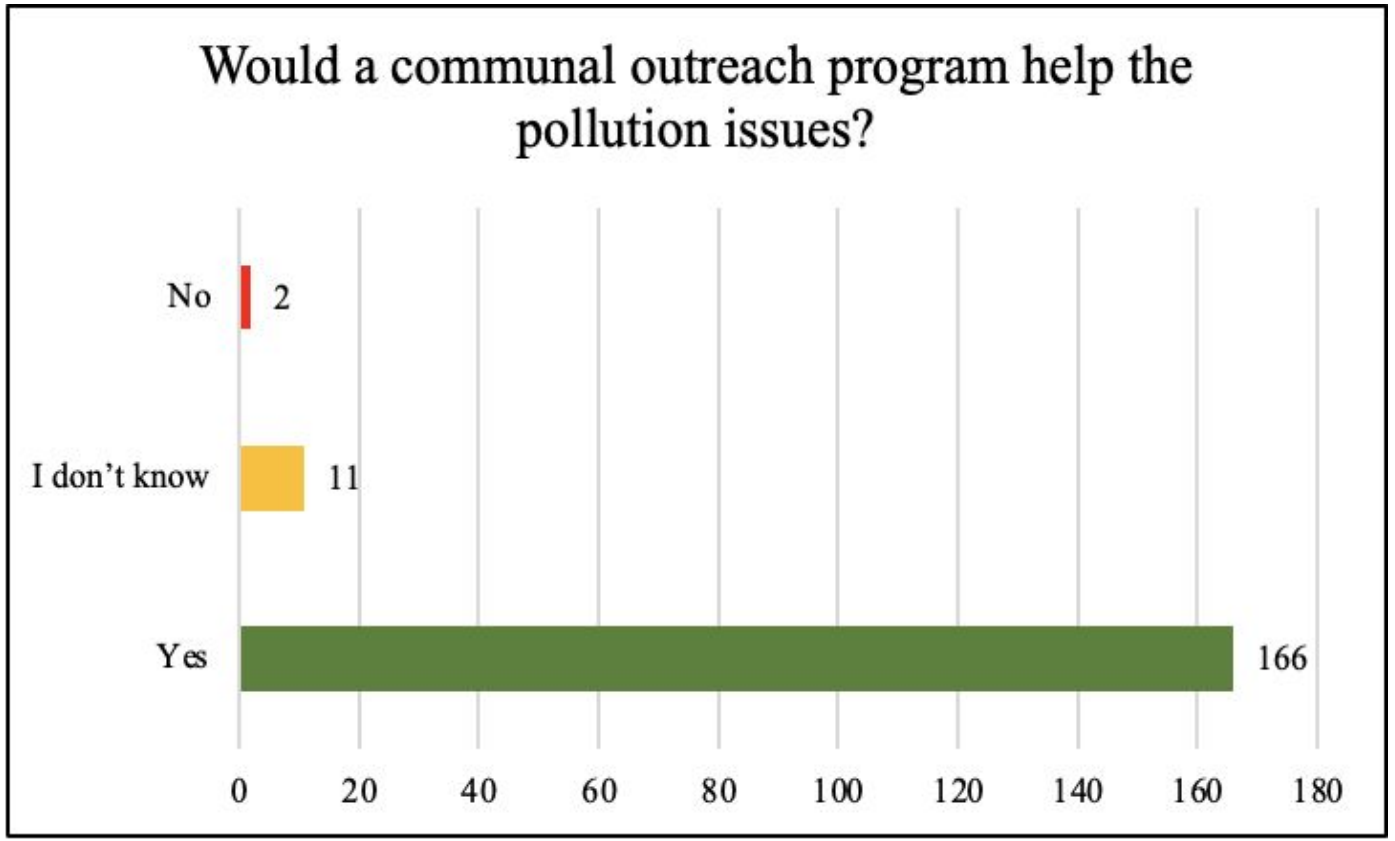
Survey Analysis (General River Knowledge/Habits)



Survey Analysis (General River Knowledge/Habits)



Survey Analysis (Future Pollution Studies/Programs)



ArcGIS

- Visual analysis of the watershed area
- Informal settlement comparisons
  - Past and present satellite images
- Outline of district and river

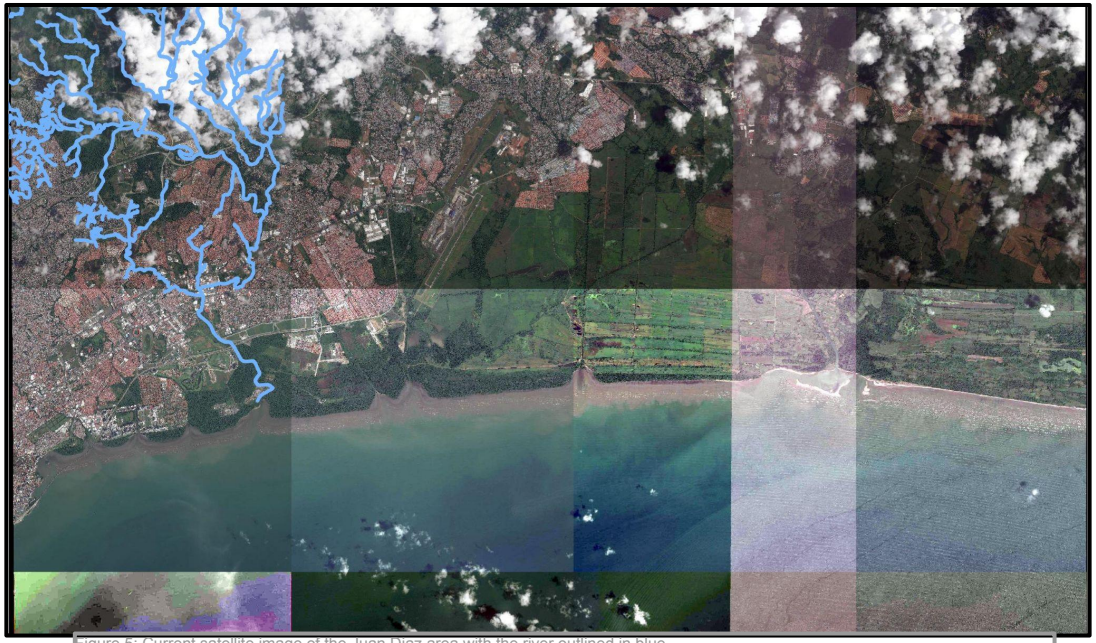
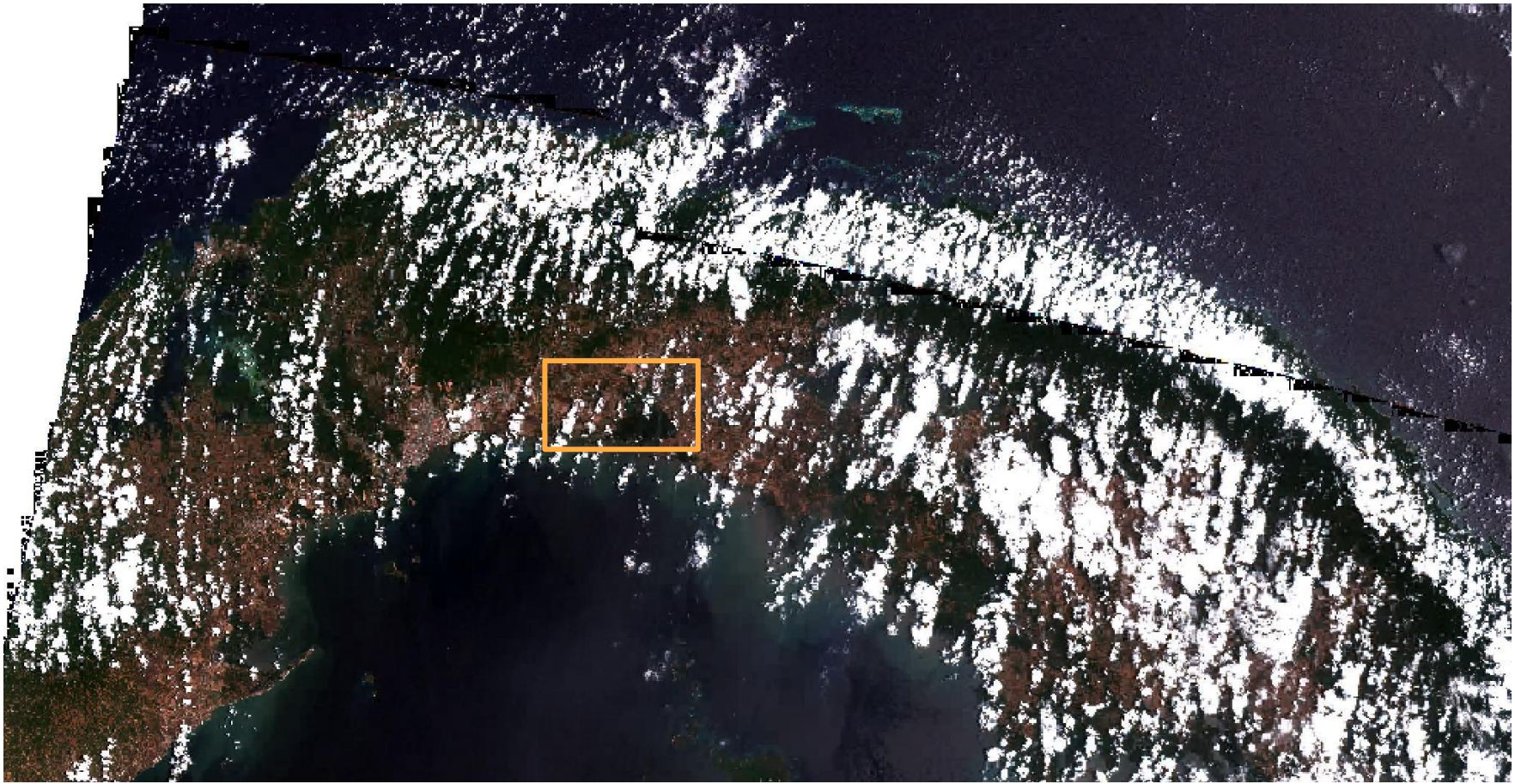
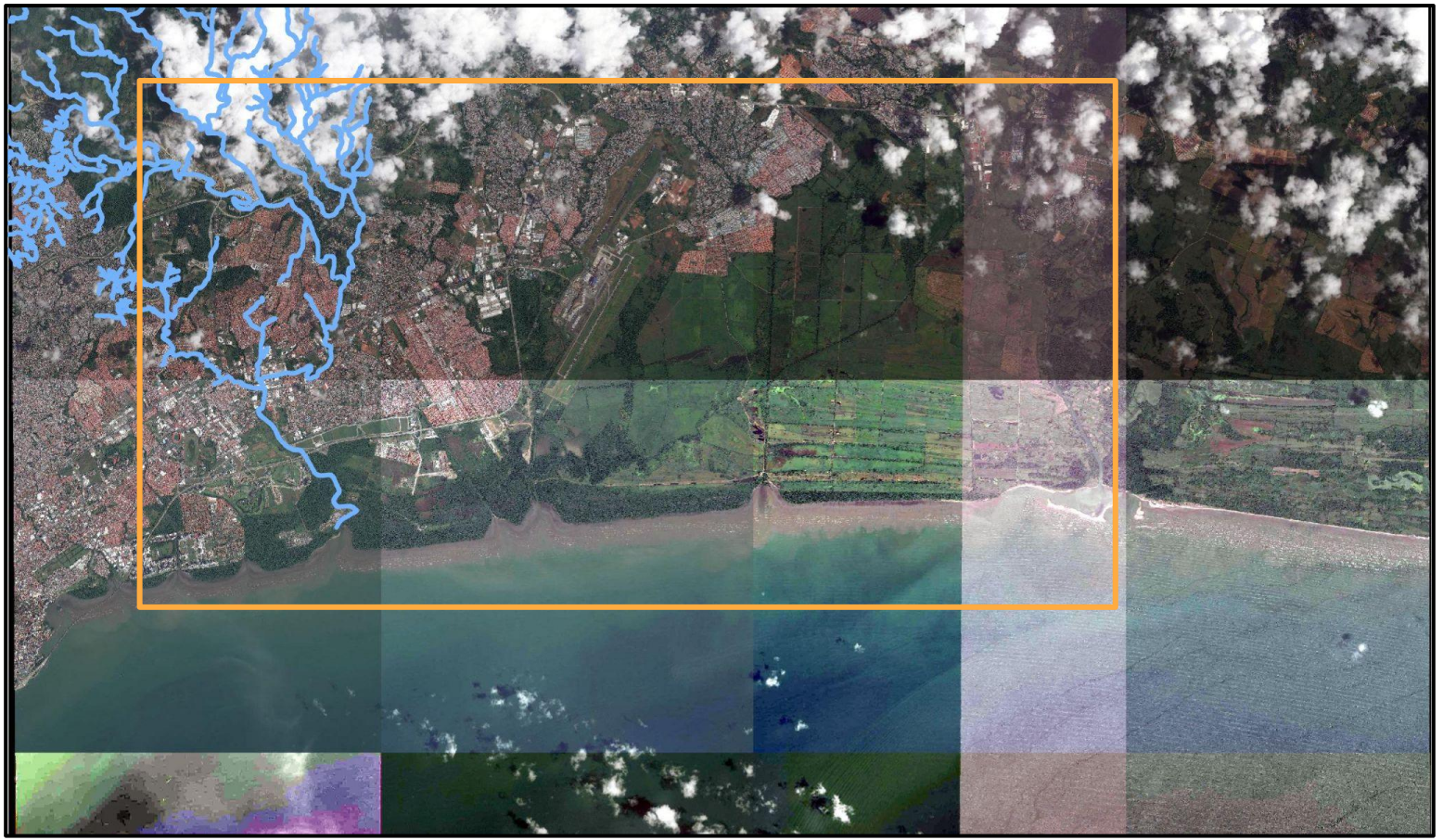


Figure 5: Current satellite image of the Juan Diaz area with the river outlined in blue



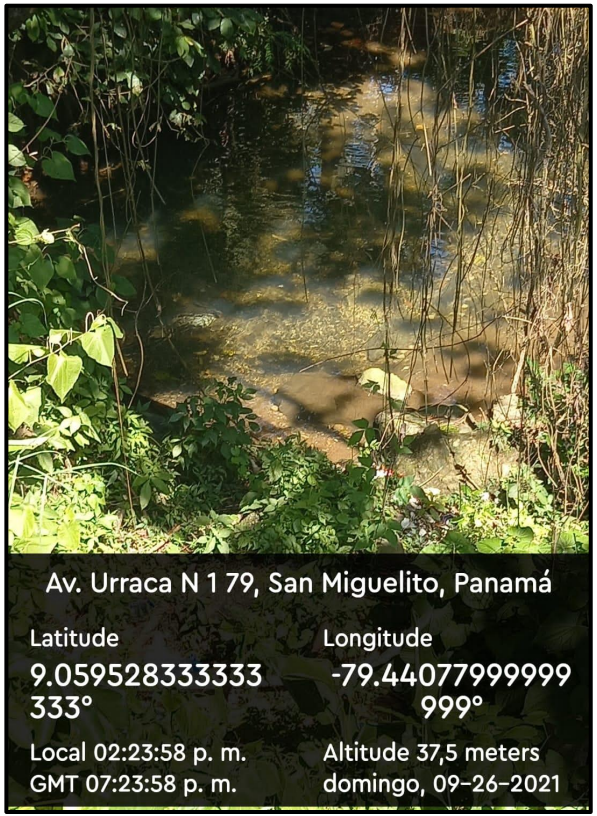


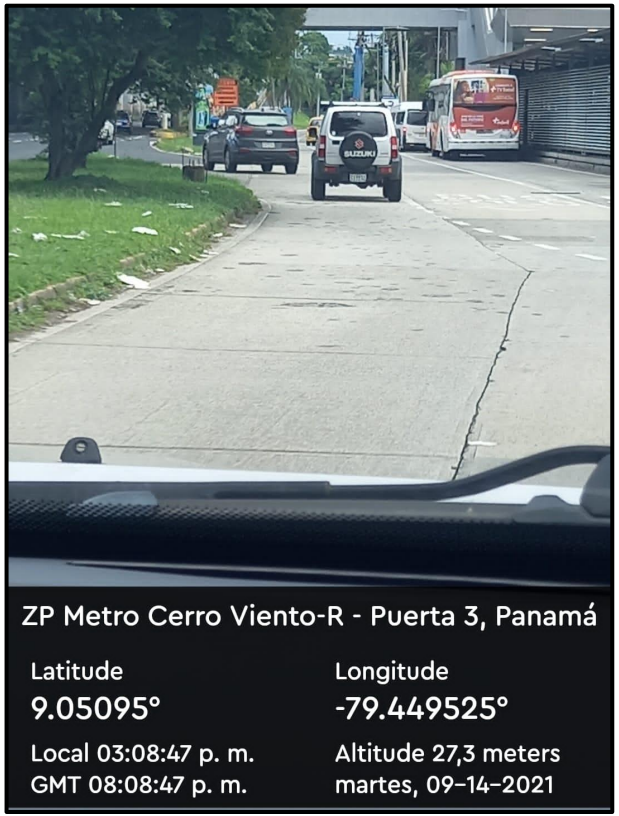
Community/District Photo Analysis

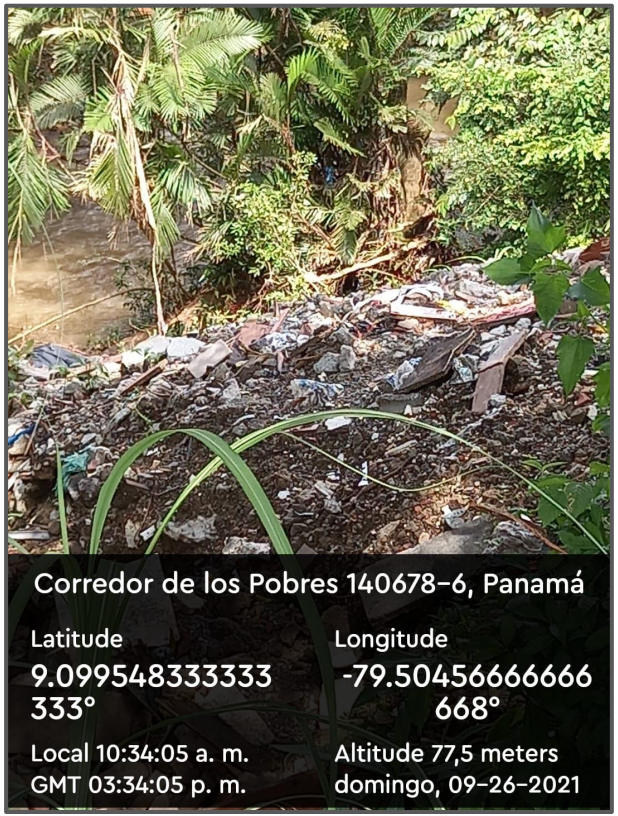
- Photo Analysis Process
  - Received images of watershed (along with their latitude and longitude)
  - Add pictures to map on Google Earth
  - Analyze and create conclusions based on pictures and location

All images photographed by Yasmina Rojas

Step 1: Receiving the images





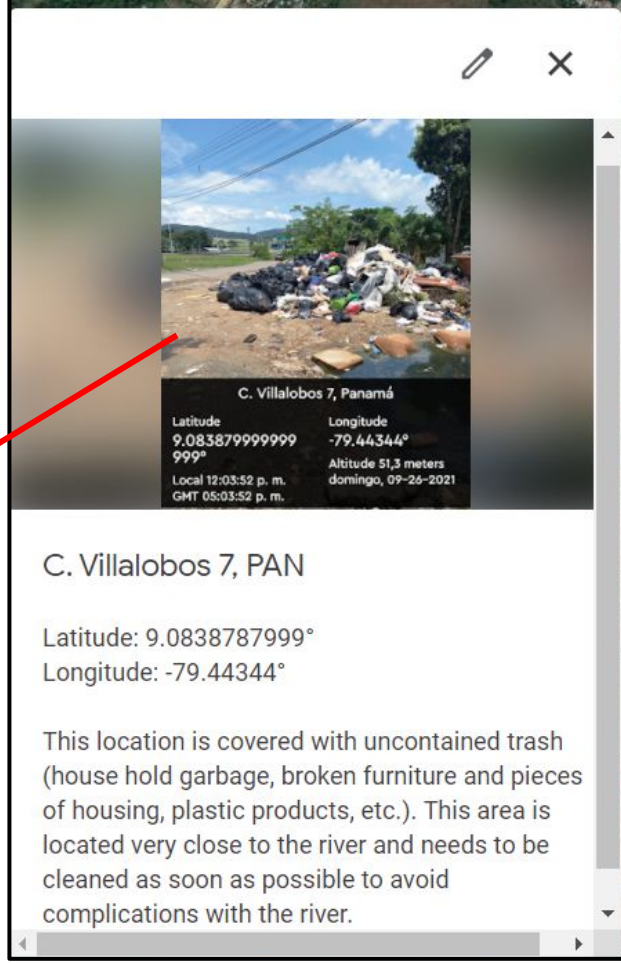


Step 2: Add Images to Google Earth

Step 3: Photo Analysis; Write up

Create a write up for each location

- How much trash is present?
- What kind of trash is present?
- Where is this location in relation to the river?

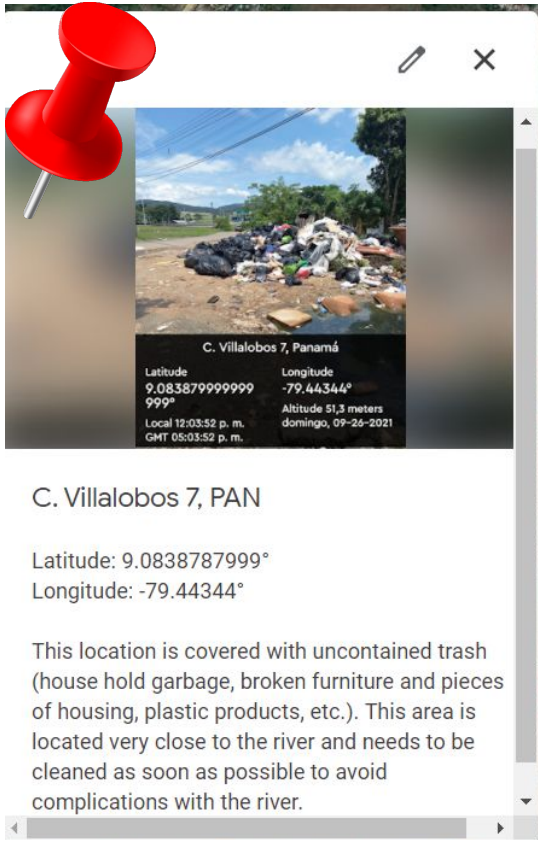


Step 3: Creating Analyses; Pin Color Coding System

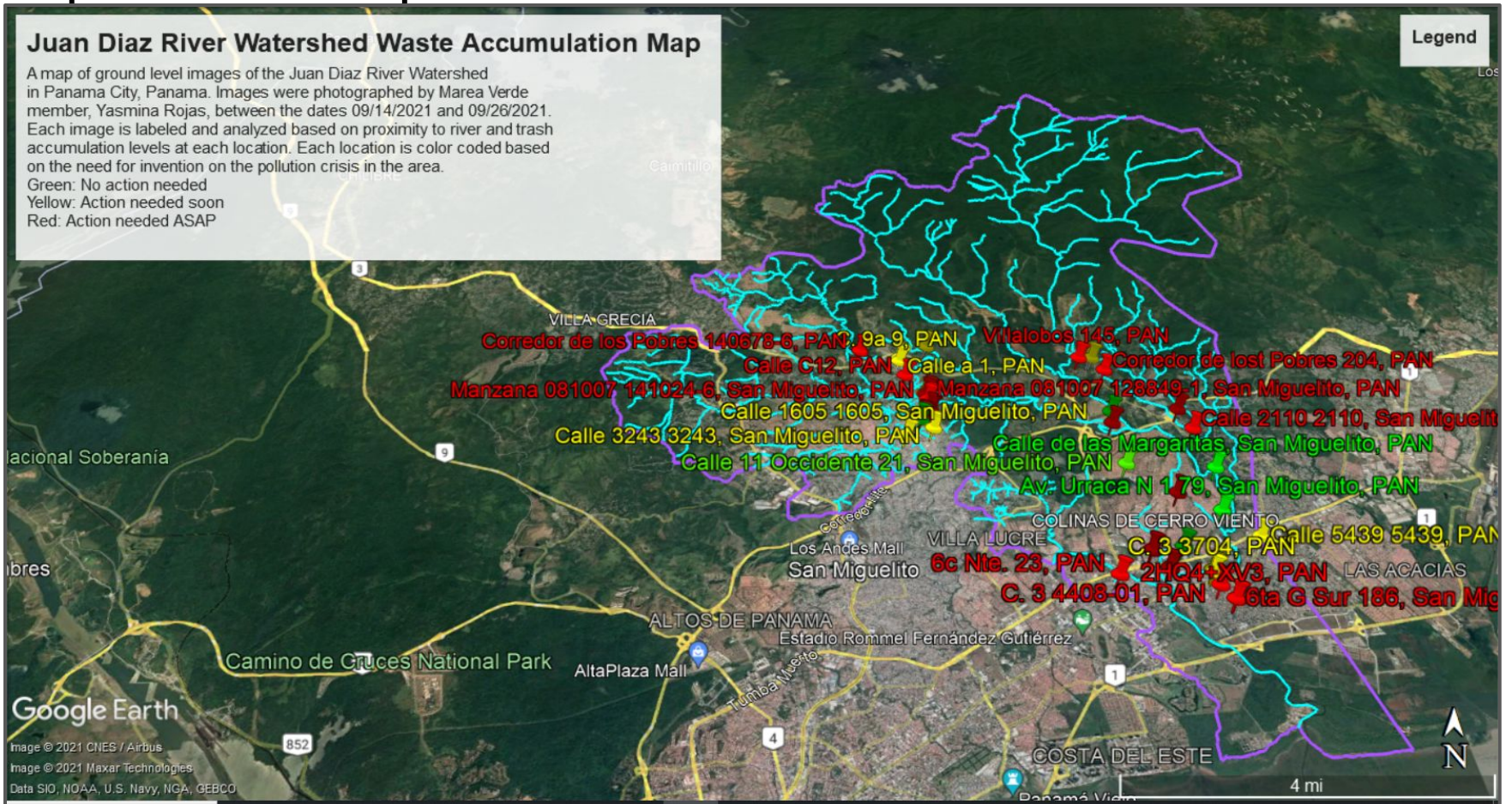
- Green: No trash present or minimal amount of trash that's well managed and far from river. Does NOT need action

- Yellow: Large amount of well contained trash 500+ m from river or a small amount of semi contained trash between 100-300m of the river. Needs action soon.

- Red: Trash in river/river bed or lots of trash build up within 100 meters of river. Needs action ASAP



Step 4: Final Map



Stage 3: Conclusions

Survey Conclusions

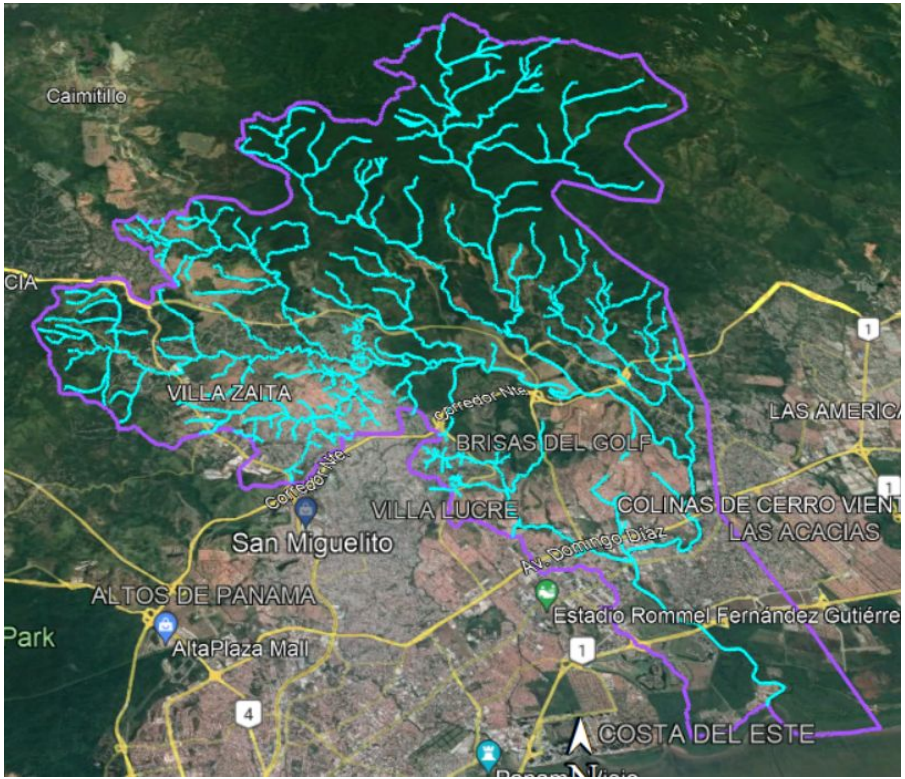
Pros

- Residential History
  - All districts surveyed
  - Long average residency
- Waste Production Tendencies
  - 88% of households use reusable or recyclable utensils/supplies
- Garbage/Recycling Collection
  - 72% of respondents claim to have street pick-up
  - All but one have some kind of trash collection process
  - Seems to be general knowledge of recycling
- River Knowledge/Habits
  - Surveyed Watershed inhabitants' do not regularly use the river
  - Insight into personal historical knowledge of the river

Cons

- Residential History
  - Uneven distribution of households surveyed from each district
- Waste Production Tendencies
  - 93% of households are consuming commercially packaged items regularly
- Garbage/Recycling Collection
  - ⅔ of respondents have either minor or major issues in their districts
  - Infrastructure is not there to support full scale recycling or garbage removal
- River Knowledge/Habits
  - 5 Year decline of most identified rivers' condition

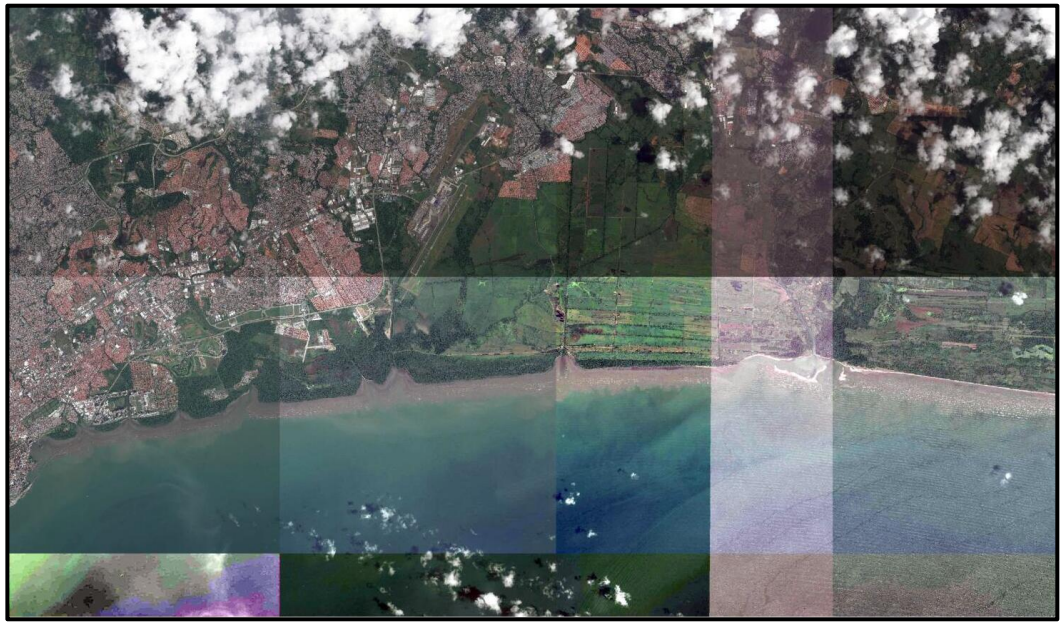
Community Ground-Level Photos Conclusions



- Zone Break down
  - 6 Green Zone
  - 13 Yellow Zone
  - 28 Red Zone
- Green Zones do not need attention
- Yellow Zones need to be cleaned up and need a more organized trash collection system
- In Red zones, the action needed is physical trash pick up regularly

ArcGIS Conclusions

- Population changes
  - Difficult to tell if there was increased settlement
  - Easier to determine that the area has not lost significant population
- Paired with survey results and ground images
  - Can conclude pollution in the JD watershed is an issue
  - Negligible changes to the quantity of residents
  - River/watershed pollution will persist



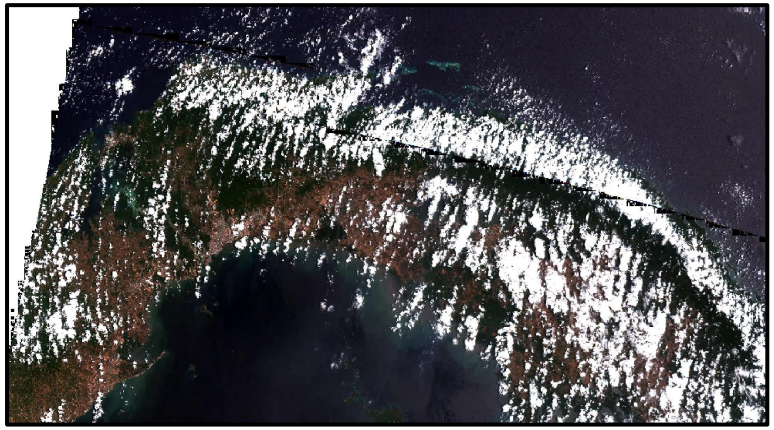
Overall Conclusions

- Pollution in JDR Watershed has likely been rapidly worsening over the past 5-10 years
  - River condition getting worse or staying the same
  - Photos of, and issues with, uncollected trash
  - Last 5 years of community development was not the beginning of the environmental pollution issue

- Government assistance is likely the next step to mitigate the pollution in the watershed
  - People using commercially packaged and available products
    - Not enough solid waste collection infrastructure to support
    - Households take normal urbanized community approach to reusing utensils
  - Most information pointing towards residents not having means of disposing their solid waste

Limitations

- Survey analysis
  - Data availability
  - Individual household location
  - Statistical analysis
- ArcGIS
  - Data availability
  - Quality of older images
    - Cannot compare changes over time
  - Population estimates
- Communal Photo Capturing
  - Collection of pictures from similar locations
  - Dispersion of pictures



	A	B
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27	Yes	159
28	No	20
29	Total	179

Stage 4: Intervention Plans

Future Directions

- Compiled Survey Data
  - Statistical analysis when collection is complete
- Google Maps/ArcGIS
  - Pinpointing garbage accumulation sites
- Pollution mitigation intervention scale
  - More communal exploration
  - Identify communal garbage reception sites
  - Create a list based on need of rectifying action
- Provide information to proper environmental sectors of the Panamanian Government
  - Use intervention scale to begin strengthening garbage collection infrastructure in “red zone” areas

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Questions?