

Sharing the Life of the Río San Pedro

*History, conservation, and
community stories*

For the Kingue Adventure School in Ecuador

Cuenca, Ecuador Project Center
March – May 2022

Authors:

Julian Robles

Marc Rosenthal

Luis Sandoval

Tarang Shah





WPI



KINGUE
adventure school

Sharing the Life of the Río San Pedro

History, conservation, and community stories for the Kingue Adventure School in Ecuador

An Interactive Qualifying Project Report
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements
for the Degree of Bachelor of Science

by:

Julian Robles
Marc Rosenthal
Luis Sandoval
Tarang Shah

Report Submitted To:

Project Advisors:

Prof. Courtney Kurlanska, Ph.D.

Prof. Melissa Belz, Ph.D.

Project Liaisons:

Joaquin Serrano, Kingue Adventure School

Jorge Anhalzer, Kingue Adventure School

This report represents the work of four WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see: <http://www.wpi.edu/Academics/Projects>

May 2, 2022

Abstract/Resumen

Despite a constitutional basis for protection, the Río San Pedro has become contaminated due to population growth, industrialization, and poor wastewater treatment; local policies have failed to properly protect the river. In association with the Kingue Adventure School, this project aimed to raise awareness to encourage community engagement and collaboration between stakeholders. In order to achieve this goal, we conducted interviews, archival research, and surveying. We found that the lack of river usability, visibility, and accessible information has affected the river's community role. We created an interactive map database, recommended conservation organizations make information more accessible, promote the river as a potential asset, and increase stakeholder collaboration.

A pesar de una base constitucional para la protección, el Río San Pedro se ha contaminado debido al crecimiento de la población, la industrialización y el tratamiento deficiente de las aguas residuales; las políticas locales no han logrado proteger adecuadamente el río. En asociación con la Escuela de Aventura Kingue, este proyecto tuvo como objetivo crear conciencia para animar la participación comunitaria y la colaboración entre partes interesadas. Para lograr este objetivo, realizamos entrevistas, investigación de archivo y encuestas. Descubrimos que la falta de usabilidad, visibilidad e información accesible del río ha afectado el papel del río entre la comunidad. Creamos una base de datos de mapas interactivos, recomendamos que las organizaciones de conservación hagan que la información sea más accesible, promover el río como un activo potencial y aumentar la colaboración de las partes interesadas.

Executive Summary

Overview

Rivers provide vital services to surrounding communities, including domestic, manufacturing, irrigation, hydropower, or recreational use (Tickner et. al., 2017). While rivers provide vital services to surrounding communities, they are often threatened by stressors such as urban growth, river misuse and poor wastewater management (Ticker et al 2017). In 2008, Ecuador adopted a new constitution declaring water a human right. This constitutional change has provided legal frameworks for environmental organizations, communities groups, and activists to protect rivers and their surrounding environment.

Río San Pedro

Over the past thirty years the Río San Pedro has become severely affected by pollution. Despite a constitutional basis for environmental protection and water protection movements in Ecuador (Ministerio del Ambiente, 2022), local planning and policies have failed to properly protect the river and address its current contamination issues, according to Daniela Rosero-Lopez, an environmental researcher. The population along the Río San Pedro has doubled over the past thirty years and industrial and agricultural practices have intensified (INEC 1990-2010; IGM,

2013). Regulations preventing dumping of both domestic and industrial waste have not been properly enforced, and a limited number of wastewater treatment facilities have failed to keep up with this growth. The resulting pollution of the Río San Pedro has caused citizens to have an overall negative or apathetic perception due to a lack of physical use and visibility of the river and its watershed. This, along with an overall lack of access to information of the Río San Pedro's watershed, brought about low levels of awareness of the river pollution, thus low community participation and engagement in restoration efforts. Recently however, there has been a revitalization of interest in the Río San Pedro due to conservation groups such as Rescate Río San Pedro. Our sponsor, The Kingue Adventure School, located along the banks of the Río San Pedro, is an outdoor environmental education school aiming to raise an environmental consciousness. The goal of this project was to inform and inspire community awareness, action, and education, addressing the pollution of the Río San Pedro in the Pichincha Province, Ecuador.

Objectives and Methods

To achieve this goal, the project pursued the following objectives:

1. **Determine** current pressures, issues, and water management structures for the Río San Pedro through archival research and interviews.
2. **Document** community attitudes and experiences with the Río San Pedro through interviews and story collection surveys.
3. **Determine** platforms to best make research and community stories of the Río San Pedro cohesively accessible through interviews and concept selection.

Findings

Through analyzing data collected via archival research, interviews, and story collection, we made the following findings regarding the pollution of the Río San Pedro, government policies, stakeholder collaboration, and community perception:

1. **Increased Population Growth and Development along the Rio San Pedro has worsened contamination:** A growing population and industrialization, paired with infrastructure that obstructs river flow, such as dams and culverts, contributes to an increase in domestic, urban, and agricultural contamination, as well as the buildup and concentration of contaminants where these infrastructures are located. A lack of wastewater treatment facilities, as well as ongoing struggles with the creation and implementation of environmental planning and protections allow the degradation of the Rio San Pedro to worsen with little to no

progress in cleaning and repairing the river and its watershed.

2. **Watershed Protections and Planning are Not Adequately Informed:** The Río San Pedro faces high levels of pollution and contamination due to poorly enforced governmental policy and planning. Federal governments have the ability to limit a river's watershed through the establishment of protected areas, but instead hand these protections over to local governments who are not set up to manage watersheds that span outside of their boundaries. Lower taxes along upstream areas of the Rio San Pedro have sparked rapid industrialization, while national and local budgets allocated to environmental work operate in a reactive manner, neglecting future conservation work which must be done.
3. **Local Communities have a Negative Perception of the Rio San Pedro:** There is an overall negative outlook of the river due to the pollution and an overall lack of physical and visual access to the river. This negative perspective has brought about a community-wide loss of connection to the river. Therefore, in order to restore a connection people's perspective needs to change. According to the sources gathered on this project, changing the negative outlook on the river can be done through encouraging communities to get outside and enjoy nature in parks surrounding the river, as well as get actively involved with awareness and community work events such as *Mingas*. A greater

awareness of the river's pollution is needed amongst community members, and thankfully a greater presence of activism and a progressive mindset has come about recently through growing conservation groups like RRSP and social media.

4. **Lack of Accessible Information about the Rio San Pedro:** There are limitations in access to information about the river, including areas where no research has been conducted or the research has not been published. Also, when information is made available, there is a common lack of knowledge about what exactly is available as well as where to find it. In addition, data may be accessible but in a format that is hard to comprehend, such as an academic paper or technical report. With these limitations in mind, methods for increasing accessibility can be determined through filling informational gaps which can be done through contacting involved stakeholders who may have this information, and work in collaboration to make up for the lack of accessibility.

Recommendations

The project team formulated the following recommendations for *El Colectivo Rescate Rio San Pedro* and partnered groups and associations to further river restoration efforts and create an environmental conscious among community members living near the Rio San Pedro:

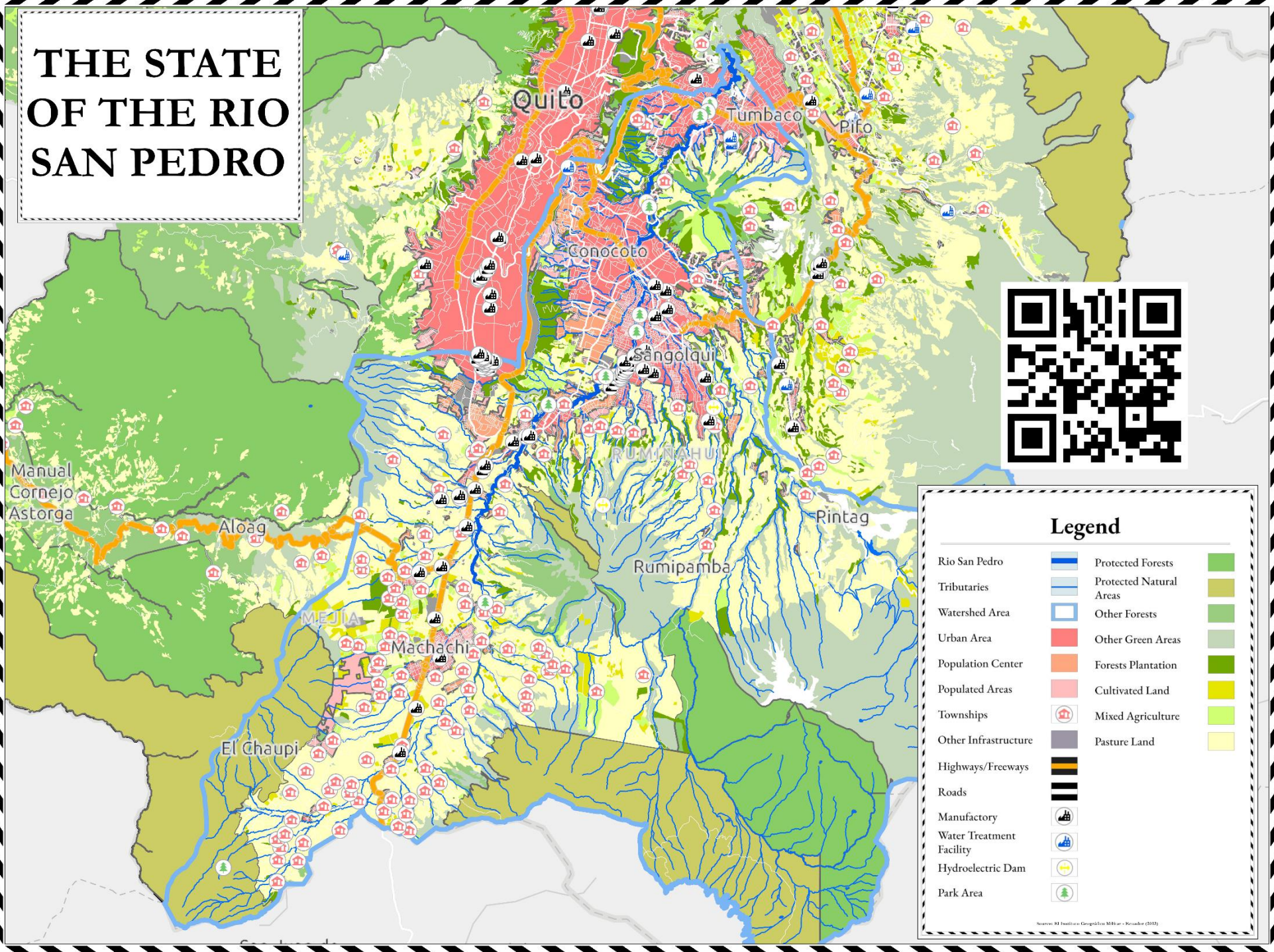
1. **Create a Repository of Information about the Rio San Pedro:** We found that information regarding the Rio San Pedro is hard to access and is dispersed among various stakeholders. To address the issue, we recommend developing a centralized repository of information that would allow activists, researchers, NGOs, governments, and private institutions to collaboratively share information, bridging gaps within their own knowledge and research. We developed an archival database detailing information about the Rio San Pedro, including previous river restoration efforts, zoning and land usage, as well as surrounding industries and their expansion.
2. **Easy Access Publications of Information for Surrounding Communities:** A major barrier for public participation in environmental advocacy and action is a lack of awareness about the issues the Río San Pedro faces and its potential effects on individuals and communities. To address this, we recommend that data be put into a format that is understandable to the public, with a focus on visual engagement. One visual format that can be used is a layered informational map that includes information such as the watershed area, location of potential pollutant sites, locations of nature reserves, and locations of other key landmarks. We developed interactive maps detailing some of this information about the Río San Pedro watershed (see Figure 1).

3. **Publicize the Rio San Pedro's Potential Strengths and Uses:** We recommend conservation organizations highlight the Río San Pedro as a valuable asset to the community prior to its severe contamination and create a future vision for a clean river. We believe this can be done by creating a platform for community members and leaders to share stories and personal experiences with the river. Additionally, community members can reconnect with the river through visiting nearby parks, other greenspaces, or participating in cleanups (*Mingas*).
4. **Increase Stakeholder Collaboration with Communities, Researchers, Governments, and Private Institutions:** Engagement and collaboration between multiple stakeholders has previously helped projects and initiatives towards environmental conservation. We recommend effective communication of information and research to communities, governments, and private institutions to inform all groups on what actions they can take to protect the river and their interests within it. Additionally, conservation groups should work to empower communities with the tools to effectively advocate for appropriate protections.

Conclusion

This project addressed ways in which to best spread awareness and education, bringing the Rio San Pedro back to life in the hearts and minds of surrounding community members. To spread awareness regarding this issue, and ultimately restore the Río San Pedro, the Kingue Adventure School has taken the initiative to increase education and awareness of this issue within surrounding communities. With the development of an interactive map, community members around the Rio San Pedro can not only become informed on the issue, but also further extend their knowledge as to the asset the Rio San Pedro once was to the community through their own personal stories.

THE STATE OF THE RIO SAN PEDRO



Legend

Rio San Pedro		Protected Forests	
Tributaries		Protected Natural Areas	
Watershed Area		Other Forests	
Urban Area		Other Green Areas	
Population Center		Forests Plantation	
Populated Areas		Cultivated Land	
Townships		Mixed Agriculture	
Other Infrastructure		Pasture Land	
Highways/Freeways			
Roads			
Manufactory			
Water Treatment Facility			
Hydroelectric Dam			
Park Area			

Source: IIG Instituto Geográfico del Ecuador - Ecuador (2015)

Resumen Ejecutivo

Visión General

Los ríos brindan servicios vitales a las comunidades circundantes, incluidos el uso doméstico, de fabricación, de riego, hidroeléctrico o recreativo (Tickner et. al., 2017). Mientras los ríos brindan servicios vitales a las comunidades circundantes, a menudo se ven amenazados por factores estresantes como el crecimiento urbano, el mal uso de los ríos y la mala gestión de las aguas residuales (Ticker et al 2017). En 2008, Ecuador adoptó una nueva constitución que declara el agua como un derecho humano. Este cambio constitucional ha proporcionado marcos legales para organizaciones ambientalistas, grupos comunitarios y activistas para proteger los ríos y su entorno circundante.

Río San Pedro

Durante los últimos treinta años, el Río San Pedro se ha visto gravemente afectado por la contaminación. A pesar de una base constitucional para la protección ambiental y los movimientos de protección del agua en Ecuador (Ministerio del Ambiente, 2022), la planificación y las políticas locales no han logrado proteger adecuadamente el río y abordar sus problemas de contaminación actuales, según Daniela Rosero-López, una investigadora ambiental. La población a lo largo del río San Pedro se ha

duplicado en los últimos treinta años y las prácticas industriales y agrícolas se han intensificado (INEC 1990-2010; IGM, 2013). Las reglamentaciones que impiden el vertido de desechos domésticos e industriales, así como un número limitado de instalaciones de tratamiento de aguas residuales, no han logrado mantenerse al día con este crecimiento. La contaminación del Río San Pedro ha provocado que los ciudadanos tengan una percepción general negativa o apática por la falta de uso físico y visibilidad del río y su cuenca. Esto, junto con una falta general de acceso a la información de la cuenca del Río San Pedro, provocó bajos niveles de conciencia sobre la contaminación del río, por lo tanto, una baja participación y compromiso de la comunidad en los esfuerzos de restauración. Recientemente, sin embargo, ha habido una revitalización del interés en el Río San Pedro debido a grupos conservacionistas como Rescate Río San Pedro. Nuestro patrocinador, The Kingue Adventure School, ubicada a orillas del río San Pedro, es una escuela de educación ambiental al aire libre que tiene como objetivo crear una conciencia ambiental. El objetivo de este proyecto fue informar e inspirar la conciencia, la acción y la educación de la comunidad, abordando la contaminación del río San Pedro en la provincia de Pichincha, Ecuador.

Objetivos y Métodos

Para lograr este objetivo, el proyecto persiguió los siguientes objetivos:

1. **Determinar** presiones actuales, problemas y estructuras de gestión del agua para el Río San Pedro a través de investigaciones de archivo y entrevistas.
2. **Documentar** las actitudes y experiencias de la comunidad con el Río San Pedro a través de entrevistas y encuestas de recopilación de historias.
3. **Determinar** plataformas para hacer que la investigación y las historias comunitarias del Río San Pedro sean accesibles de manera coherente a través de entrevistas y selección de conceptos.

Descubrimientos

Mediante el análisis de los datos recopilados a través de la investigación de archivos, las entrevistas y la recopilación de historias, hicimos los siguientes descubrimientos con respecto a la contaminación del Río San Pedro, las políticas gubernamentales, la colaboración de las partes interesadas y la percepción de la comunidad:

1. **Mayor crecimiento y desarrollo de la población a lo largo del Río San Pedro ha empeorado la contaminación:** Una población y una industrialización crecientes, junto con infraestructura que obstruye el flujo del río, como represas y alcantarillas, contribuye a un aumento de la contaminación doméstica, urbana y agrícola, así como la acumulación y concentración de contaminantes donde se ubican estas infraestructuras. La

falta de instalaciones de tratamiento de aguas residuales, así como las luchas en curso con la creación e implementación de la planificación y protección ambiental permiten que la degradación del Río San Pedro empeore con poco o ningún progreso en la limpieza y reparación del río y su cuenca.

2. **Las protecciones y la planificación de las cuencas hidrográficas no se informan adecuadamente:** El Río San Pedro enfrenta altos niveles de contaminación debido a políticas y planificación gubernamentales deficientes. Los gobiernos federales tienen la capacidad de limitar la cuenca hidrográfica de un río mediante el establecimiento de áreas protegidas, pero en lugar de eso, entregan estas protecciones a los gobiernos locales que no están preparados para administrar las cuencas hidrográficas que se extienden fuera de sus límites. Los impuestos más bajos a lo largo de las áreas aguas arriba del Río San Pedro han provocado una rápida industrialización, mientras que los presupuestos nacionales y locales asignados al trabajo ambiental operan de manera reactiva, descuidando el trabajo futuro de conservación que se debe realizar.
3. **Comunidades locales tienen una percepción negativa del Río San Pedro:** Existe una perspectiva negativa general del río debido a la contaminación y la falta de acceso físico y visual al río. Esta perspectiva negativa ha provocado una pérdida de conexión con el río en toda la comunidad. Por lo tanto, para restaurar una conexión, la perspectiva de las personas debe cambiar. Según las fuentes reunidas en este proyecto, se puede cambiar la perspectiva

negativa sobre el río, alentando a las comunidades a salir y disfrutar de la naturaleza en los parques que rodean el río, así como involucrarse activamente en eventos de concientización y trabajo comunitario como las mingas. Se necesita una mayor conciencia de la contaminación del río entre los miembros de la comunidad y, afortunadamente, recientemente se ha producido una mayor presencia de activismo y una mentalidad progresista a través de grupos de conservación en crecimiento como RRSP y las redes sociales.

4. **Falta de información accesible sobre el Río San Pedro:**

Existen limitaciones en el acceso a la información sobre el río, incluidas las áreas donde no se ha realizado ninguna investigación o la investigación no se ha publicado. Además, cuando la información está disponible, existe una falta común de conocimiento sobre qué está disponible exactamente y dónde encontrarlo. Además, los datos pueden ser accesibles pero en un formato difícil de comprender, como un trabajo académico o un informe técnico. Con estas limitaciones en mente, los métodos para aumentar la accesibilidad se pueden determinar llenando los vacíos de información, lo que se puede hacer contactando a las partes interesadas involucradas que pueden tener esta información y trabajar en colaboración para compensar la falta de accesibilidad.

Recomendaciones para el Colectivo Rescate Río San Pedro y Organizaciones Asociadas

El equipo formuló las siguientes recomendaciones para El Colectivo Rescate Río San Pedro y grupos y organizaciones asociados para promover los esfuerzos de restauración del río y crear una conciencia ambiental entre los miembros de la comunidad que viven cerca del Río San Pedro:

1. **Crear un repositorio de información sobre el Río San Pedro:** Descubrimos que la información sobre el Río San Pedro es de difícil acceso ya que está dispersa entre varias partes interesadas. Para abordar el problema, recomendamos desarrollar un depósito centralizado de información que permita a activistas, investigadores, ONGs, gobiernos e instituciones privadas compartir información de manera colaborativa, cerrando brechas dentro de su propio conocimiento e investigación. Desarrollamos una base de datos de archivos que detalla información sobre el Río San Pedro, incluyendo los esfuerzos anteriores de restauración del río, la zonificación y el uso de la tierra, así como las industrias circundantes y su expansión.
2. **Publicaciones de información de fácil acceso para las comunidades aledañas:** Una barrera importante para la participación pública en la defensa y acción ambiental es la falta de conocimiento sobre los problemas que enfrenta el Río San Pedro y sus efectos potenciales en las personas. Para abordar esto, recomendamos que los datos se coloquen en un formato que sea comprensible para el público, con un enfoque en el compromiso visual. Un

formato visual que se puede utilizar es un mapa informativo en capas que incluye información como el área de la cuenca hidrográfica, la ubicación de los sitios de posibles contaminantes, la ubicación de las reservas naturales y la ubicación de otros puntos de referencia clave. Desarrollamos mapas interactivos que detallan parte de esta información sobre la cuenca del río San Pedro (ver Figura 1).

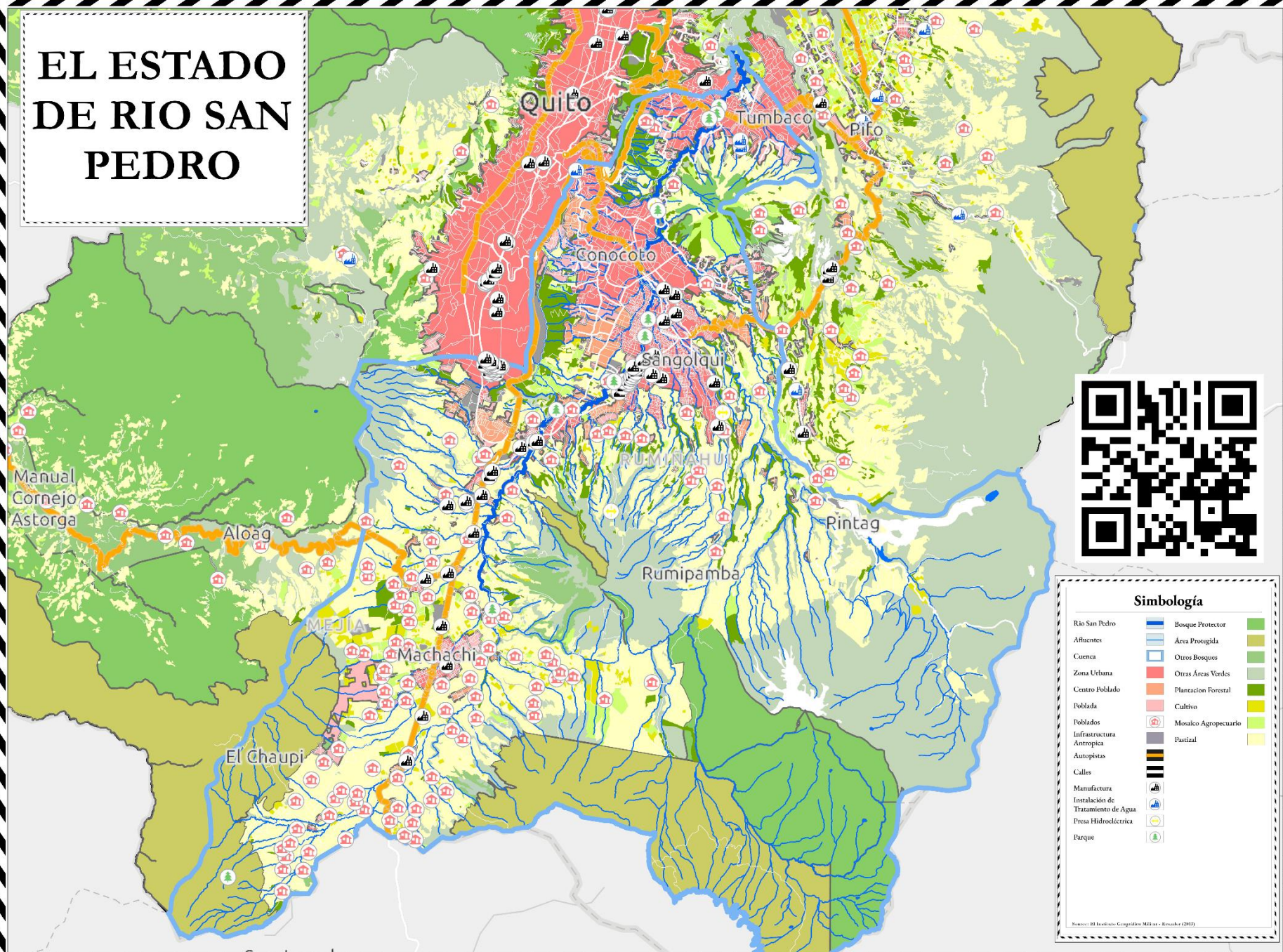
3. **Dar a conocer las fortalezas y los usos potenciales del Río San Pedro:** Recomendamos que las organizaciones de conservación destaquen el Río San Pedro como un activo valioso para la comunidad antes de su grave contaminación, y crear una visión futura para un río limpio. Creemos que esto se puede hacer mediante la creación de una plataforma para que los miembros y líderes de la comunidad compartan historias y experiencias personales que han tenido con el río. Además, los miembros de la comunidad pueden reconectarse con el río visitando parques cercanos, otros espacios verdes o participando en limpiezas (Mingas).
4. **Aumentar la colaboración de las partes interesadas con comunidades, investigadores, gobiernos e instituciones privadas:** El compromiso y la colaboración entre múltiples partes interesadas han ayudado previamente a proyectos e iniciativas hacia la conservación

del medio ambiente. Recomendamos la comunicación efectiva de información e investigación a las comunidades, gobiernos e instituciones privadas para informar a todos los grupos sobre qué acciones pueden tomar para proteger el río y sus intereses dentro de él. Además, los grupos de conservación deben trabajar para empoderar a las comunidades con las herramientas para abogar de manera efectiva por las protecciones adecuadas.

Conclusión

Este proyecto abordó formas de difundir mejor la conciencia y la educación, devolviendo el Río San Pedro a vida en los corazones y las mentes de los miembros de la comunidad. Para difundir la conciencia sobre este problema y, en última instancia, restaurar el Río San Pedro, la Escuela de Aventura Kingue ha tomado la iniciativa de aumentar la educación y la conciencia sobre este problema en las comunidades circundantes. Con el desarrollo de un mapa interactivo, los miembros de la comunidad alrededor del Río San Pedro no solo pueden informarse sobre el tema, sino también ampliar aún más su conocimiento sobre el activo que el Río San Pedro alguna vez fue para la comunidad a través de sus propias historias personales.

EL ESTADO DE RIO SAN PEDRO



Simbología

Río San Pedro		Bosque Protector	
Afluentes		Área Protegida	
Cuenca		Otros Bosques	
Zona Urbana		Otras Áreas Verdes	
Centro Poblado		Plantación Forestal	
Poblada		Cultivo	
Poblados		Mosaico Agropecuario	
Infraestructura		Pantanal	
Autopistas			
Calles			
Manufatura			
Instalación de Tratamiento de Agua			
Presas Hidroeléctricas			
Parque			

fuente: El Estado Geográfico Mejía - Rosador (2013)

Acknowledgements

We are extremely grateful to all the people and organizations that have helped us during our work in Ecuador. We would like to express our appreciation to the following who have made this project successful:

- Professor Courtney Kurlanska, our project advisor
- Professor Melissa Belz, our project advisor
- Gary Pollice, our project site director
- The Kingue Adventure School, our sponsor
- Joaquin Serrano, Director of the Kingue Adventure School
- Jorge Anhalzer, President of the Kingue Adventure School
- El Colectivo Rescate Río San Pedro (RRSP)
- Maribel Pasquel, Coordinator of Rescate Río San Pedro
- The University of Cuenca

Our eight weeks in Ecuador were a memorable experience and we would like to thank all the people above as well as the staff from Worcester Polytechnic Institute who made it possible. Their time and effort are greatly appreciated.



UNIVERSIDAD DE CUENCA

Table of Contents

ABSTRACT/RESUMEN.....	III
EXECUTIVE SUMMARY.....	IV
RESUMEN EJECUTIVO.....	IX
ACKNOWLEDGEMENTS.....	XIV
TABLE OF CONTENTS.....	XV
TABLE OF FIGURES.....	XVII
AUTHORSHIP.....	XVIII
INTRODUCTION.....	1
2. BACKGROUND.....	4
2.1 IMPORTANCE OF RIVERS.....	4
2.2 RIVER POLLUTION.....	4
2.2.1 <i>Causes and Impacts of River Pollution</i>	4
2.2.2 <i>River Pollution in Pichincha Province</i>	5
2.2.3 <i>Competing User Interests</i>	6
2.3 COMMUNITY ACTION IN CONSERVATION.....	7
2.3.2 <i>Water Protection Movements</i>	8
2.3.3 <i>Community Engagement</i>	9
2.4 RAISING ENVIRONMENTAL AWARENESS.....	9
2.4.1 <i>Environmental Education</i>	10
2.4.2 <i>Digital Storytelling and Mapping</i>	10
2.4.3 <i>Kingue Adventure School</i>	11
3. METHODS.....	12

3.1 INTERVIEWS.....	12
3.2 ARCHIVAL RESEARCH.....	13
3.3 STORY COLLECTION.....	14
3.4 CONCEPT SELECTION	14
4. FINDINGS.....	15
<i>4.0.1 Geography of Pichincha Province and the River.....</i>	<i>16</i>
4.1 URBAN GROWTH & RIVER DEGRADATION.....	17
4.2 POLICY & PLANNING ISSUES.....	19
4.3 COMMUNITY PERSPECTIVE & ENGAGEMENT	21
<i>4.3.1 Current Community Perspective & Engagement.....</i>	<i>21</i>
<i>4.3.2 Changing Community Perspective & Engagement.....</i>	<i>22</i>
4.4 ACCESSIBILITY TO INFORMATION ABOUT THE RÍO SAN PEDRO.....	23
4.5 LIMITATIONS OF FINDINGS	24
5. RECOMMENDATIONS AND CONCLUSIONS	25
5.1 MAPPING OF THE RÍO SAN PEDRO	25
5.2 RECOMMENDATIONS FOR CONSERVATION ORGANIZATIONS.....	27
5.3 FUTURE PROJECTS.....	29
5.4 CONCLUSION	30
REFERENCES.....	31
APPENDIX A: LIST OF INTERVIEWS	35
APPENDIX B: ENVIRONMENTAL RESEARCH AND MANAGEMENT QUESTIONS	36
APPENDIX C: COMMUNITY ATTITUDES AND EXPERIENCES QUESTIONS	38
APPENDIX D: STORY COLLECTION TEMPLATE (ENGLISH).....	40
APPENDIX E: STORY COLLECTION TEMPLATE (SPANISH)	42
APPENDIX F: PUGH CONCEPT SELECTION TEMPLATE.....	46
APPENDIX G: MAPS OF INFRASTRUCTURE	47

Table of Figures

FIGURE 1. THE RÍO SAN PEDRO AS IT FLOWS UNDER THE AV. ILALÓ IN CONOCOTO, QUITO.....	2
FIGURE 2. MAP OF POTENTIAL LOCATIONS OF CONTAMINATION ON THE RÍO SAN PEDRO DEVELOPED BY A TEAM AT WORCESTER POLYTECHNIC INSTITUTE FOR THE KINGUE ADVENTURE SCHOOL.....	3
FIGURE 3. COURSE OF THE RÍO SAN PEDRO-GUAYLLABAMBA-ESMERALDAS RIVER SYSTEM	5
FIGURE 4. MAP OF THE RÍO SAN PEDRO AND ITS WATERSHED WITHIN PICHINCHA PROVINCE, ECUADOR.....	16
FIGURE 5. MAP OF URBAN AREAS WITHIN AND AROUND THE RÍO SAN PEDRO WATERSHED.....	16
FIGURE 6. QUITO METROPOLITAN DISTRICT CURRENT JURISDICTIONAL BOUNDARIES AND GROWTH AREAS (1992)	17
FIGURE 7. MAP OF WASTEWATER TREATMENT FACILITIES WITHIN AND AROUND THE RÍO SAN PEDRO WATERSHED.....	18
FIGURE 8. MAP OF PROTECTED FORESTS AND NATURAL AREAS WITHIN AND AROUND THE RÍO SAN PEDRO WATERSHED.	19
FIGURE 9. MAP OF MANUFACTORIES WITHIN AND AROUND THE RÍO SAN PEDRO WATERSHED.	20
FIGURE 10. STATIC MAP OF THE RÍO SAN PEDRO, SHOWING THE WATERSHED AREA, URBAN AREAS, PROTECTED AREAS, WASTEWATER TREATMENT FACILITIES, HYDROELECTRIC DAMS, TOWNSHIPS, AND PARK AREAS.	25
FIGURE 11. USING QUERIES TO FIND MANUFACTURING INDUSTRY SITES NEAR MACHACHI, ECUADOR WITH THE INTERACTIVE MAP OF THE RÍO SAN PEDRO	26
FIGURE 12. INTERACTIVE MAP SHOWING THE LAND USES ON THE MAP AND IN THE PIE CHART NEAR THE RÍO SAN PEDRO BASED ON USER INPUT	27

Authorship

Section	Primary Author(s)	Primary Editor
Introduction	Luis Sandoval	Marc Rosenthal
2. Background		
2.1 Importance of Rivers	Marc Rosenthal	Luis Sandoval
2.2 River Pollution	Julian Robles Tarang Shah Marc Rosenthal	Tarang Shah
2.3 Community Action in Conservation	Tarang Shah	Luis Sandoval Julian Robles
2.4 Raising Environmental Awareness	Marc Rosenthal Luis Sandoval	Julian Robles
3. Methods		
3.1 Interviews	Marc Rosenthal	Luis Sandoval
3.2 Archival Research	Julian Robles	Marc Rosenthal
3.3 Story Collection	Marc Rosenthal	Tarang Shah
3.4 Concept Selection	Tarang Shah Luis Sandoval	Marc Rosenthal
4. Findings		
4.1 Urban & River Degradation	Marc Rosenthal	Julian Robles
4.2 Planning & Policy Issues	Luis Sandoval Tarang Shah	Marc Rosenthal
4.3 Community Perspective & Engagement	Julian Robles Marc Rosenthal	Luis Sandoval
4.4 Accessibility of Information	Marc Rosenthal	Luis Sandoval

4.5 Limitations of Findings	Julian Robles	Marc Rosenthal
5. Recommendations and Conclusions		
5.1 Mapping of the Río San Pedro	Marc Rosenthal Tarang Shah	All
5.2 Recommendations for Conservation Organizations	All	All
5.3 Future Projects	Luis Sandoval	Julian Robles
5.4 Conclusion	All	All
References	All	All
Appendices	All	All

Introduction

"Now the river, as you will see ... is the reflection of our society... it is a complex network of relationship with nature that ultimately manifests itself in the river."

-J. L. Chiriboga

Río San Pedro Environmentalist



Water resources, such as rivers and streams, are vital to surrounding communities, but are often one of the most threatened parts of the environment (Schreurs, 2018). Water from rivers and streams are resources that can be used for household use, manufacturing, irrigation, hydropower, or recreation (Tickner et. al., 2017). Rivers can be threatened due to increases in stressors such as urban growth, river misuse, and poor wastewater management. These all threaten the vitality of rivers and the services they provide. These stressors either cause or exacerbate the effects of pollution and contamination, which negatively impact the livelihood of surrounding communities (Tickner et. al., 2017).

Ecuador adopted a new constitution in 2008, which declared water as a human right. This constitutional change has provided legal frameworks for communities to protect rivers and their surrounding environment. Grassroots activism movements, movements in which people within a given community act as the basis for political or economic change, worked in collaboration with Non-Governmental Organizations (NGOs) and local authorities to bring about the constitutional change (Hoogesteger, 2016).

Ecuador, despite its new constitutional change, currently has multiple rivers experiencing high levels of pollution, contamination, and degradation, impacting the local environment and communities (Salazar, 2020). The Río San Pedro is one such polluted river located in the Pichincha province of Ecuador. The Río San Pedro begins at the Illiniza Sur Volcano and runs northwards through the communities surrounding Quito,

Figure 1.

The Río San Pedro as it flows under the Av. Ilaló in Conocoto, Quito



Source: (Google Street Maps, 2014)

Ecuador, and mixes with the Río Machangara, eventually reaching the Pacific (Voloshenko-Rossin, 2014). Due to high levels of contamination and pollution, the Río San Pedro has transformed from a place to swim to a smelly, garbage-filled urban river (J. Serrano, personal communication, February 2022; Anhalzer, n.d.). Quito and its surrounding urban areas are facing water-related challenges that will increase as the city expands, primarily poor wastewater treatment and long-term drinking water security, with potential for further pollution of the Río San Pedro (Schreurs, 2018). Increased stresses in urbanization and growth have caused challenges for this pollution and will continue to add stress to the river as infrastructure fails to keep up (Hoogesteger, 2016).

In the background chapter we discuss the importance of rivers, river pollution, community action within conservation, as well as raising environmental awareness. The methods chapter outlines our data collection through archival research and interviews with community members, conservation groups, and experts. To gather information about the features and history of the river, the group conducted archival research of government databases and interviews with researchers. To gather community stories, we distributed a survey to members of a community conservation group asking that they document their experiences with the river. In collaboration with the Kingue Adventure School, located on the riverbanks of the Río San Pedro, we produced digital resources that detail the features, history, and community stories of the Río San Pedro. Through this, we hope to bring the Río San Pedro back to life in the hearts of its surrounding community.

Figure 2.
Map of potential locations of contamination on the Río San Pedro developed by a team at Worcester Polytechnic Institute for the Kingue Adventure School



Source: (www.kingue-edu.org)

2. Background

2.1 Importance of Rivers

Rivers can provide various social and economic benefits to the communities that surround them. Bodies of water often are a critical part of a communities' cultural beliefs, values, and ways of life (Anderson, 2019). Social benefits provided to communities can range from religious associations, locations for natural recreation, real-world science education, or a sense of belonging to a specific place (Parker & Oates, 2016). These social benefits can provide a foundation for the community to come together and engage with each other. The interactions further benefit the lives of the community members (Tickner, 2017).

Economic benefits from rivers can be categorized into domestic, agricultural, industrial, energy, and transport. In the domestic economy, rivers can be a source of water for drinking, cleaning and cooking (Tickner et. al., 2017). For agricultural purposes, rivers are important for irrigation, while businesses and industries use river water for manufacturing and waste disposal (Parker & Oates, 2016). For energy, power can be harnessed from rivers through hydroelectric facilities to serve the energy needs of local communities or exported (Parker & Oates, 2016). If rivers are navigable, rivers can be used to transport people, materials, and

goods efficiently (Parker & Oates, 2016), economically benefiting communities.

These benefits, both social and economic, make rivers an essential asset to surrounding communities. However, utilizing these benefits often can lead to stresses on the river as resource usage increases - especially large-scale economic uses, potentially polluting rivers (Tickner et. al., 2017).

2.2 River Pollution

Since communities draw important values and services from local rivers, stresses to rivers and their surrounding environment can significantly affect surrounding communities. Urban development and river misuse apply stress to river systems and threaten the roles rivers play in the community (Selman, 2010).

2.2.1 Causes and Impacts of River Pollution

Though on different scales, domestic, agricultural and industrial activities utilize rivers to wash, dispose of waste, and as a source of freshwater (Igwe et. al., 2017). These uses cause sewage and chemical/biological waste to leak into local waterways (Coles et. al., 2012). Agricultural sources cause chemical fertilizers and soil

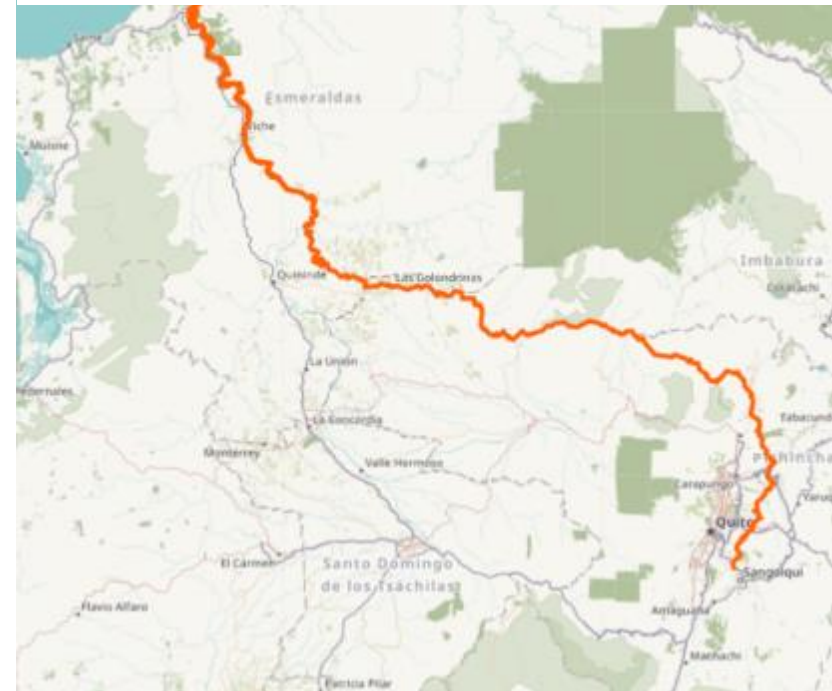
nutrients to drain into surrounding waterways through run-off (Igwe et. al., 2017). The drainage of nitrogen and phosphorus in pollutant runoff can cause eutrophication – algae blooms that consume oxygen in the river, creating dead zones where fish cannot live (Hilton, 2006). Eutrophication itself does not pose a significant direct threat to human health (Hilton, 2006), but can cause accumulation of biological and chemical pollutants within the body when polluted water is ingested directly or indirectly (WHO, 2004). Ingesting biological contaminants, specifically human and animal waste, can result in severe diseases from bacteria, viruses, and parasites, such as cholera, hepatitis, and diarrhea (Bedi et. al., 2015). Chemical contaminants which come from runoff or leach from natural and dumped trash can have long-term effects on human health – primarily carcinogenic (WHO, 2004, p.147). Plant life is also affected when pollutants leach into the soil (Moiseenko, 2010). Secondary impacts on the environment follow as other species that rely on affected aquatic and plant resources inherit the impacts (Moiseenko, 2010), decreasing populations and biodiversity in the ecosystem.

Contamination to rivers and other waterways, including the side effects that result from it, consequently, have a negative impact on local communities that live on them. Groups that utilize a river for fishing, cleaning, and travel can no longer do so when contamination and degradation exceed safe levels, adversely affecting community interaction, the local economy and ecotourism (Borgias, 2018). The same issues are currently being faced in the Pichincha Province along the Río San Pedro.

2.2.2 River Pollution in Pichincha Province

Quito and its surrounding urban areas are facing water-related challenges, primarily poor wastewater treatment and long-term drinking water security, which will increase as the city expands and its population grows (Schreurs, 2018). The Río San Pedro currently suffers from stresses due to increased discharge from urban growth, lack of protected natural areas, and expanding industries (Salazar, 2020). For example, as of 2010, the Río San

*Figure 3.
Course of the Río San Pedro-Guayllabamba-Esmeraldas River system*



Source: (www.openstreetmaps.org)

Pedro watershed carries the sewage of 2.3 million citizens of the Pichincha province into the Río San Pedro-Guayllabamba-Esmeraldas River system which eventually drains into the Pacific Ocean (Voloshenko-Rossin et. al., 2014). This, paired with the domestic, industrial, and agricultural impacts also prevalent in the Pichincha province, is significantly impacting the surrounding community in the same manner.

2.2.3 Competing User Interests

People can benefit from extractive services such as domestic sewer systems, manufacturing, agriculture, and hydroelectric power – either from the services themselves, or through economic gain (Tickner et. al., 2017; Borgias, 2018). For example, in Chile, a hydropower company and a mining company worked to build a hydropower dam and use the energy for mining, which benefited consumers and provided jobs to locals (Borgias, 2018). However, such services damage the surrounding ecosystem and reduce the natural services of rivers and livelihoods depending on those services (Tickner et. al., 2017).

Complicating interests further, the benefits and costs are rarely felt equally in society (Tickner et. al., 2017). Asymmetric power in governance often means that marginalized voices, which often rely more heavily on ecosystem services, are more affected by the damages of extractive services (Tickner et. al., 2017). Furthermore, the effects are not necessarily felt at all by those who

benefit (Tabios & David, 2002). Upstream pollution has a cumulative downstream impact, and polluters themselves might be distanced from the river (Sun & Sun, 2019). In this example from Chile, many local communities were outraged that not only was there no adequate environmental assessment, but the energy would not go to their communities. Essentially, they felt the brunt of the pollution with no benefit (Borgias, 2018).

Private landowners, businesses and water utilities often have large controlling stakes in the management of water resources and development of rivers (Borgias, 2018). These stakeholders are primarily focused on the benefits that can come from extractive services such as industry, agriculture, and hydropower (Tickner et. al., 2017). In contrast, other stakeholders use rivers as sources of drinking water, ecological services, or recreation – often residents and tourists (Borgias, 2018). However, the extent to which residents advocate against extractive services often depends on whether their employment is based in extractive or ecological services, or whether it may anger neighbors to advocate (Borgias, 2018).

Pollution can be seen as the result of favored user interests, where settlements, infrastructure and extractive industries are built without consideration of downstream ecosystem services and communities which rely on them. These conflicting user interests – often based on legitimate human needs and livelihoods – prevent conservation (Borgias, 2018).

However, development, industry and livelihoods need not be antagonistic to conservation: in Chicago, USA, waterfront

developments build new park and path areas with new developments, creating a vital community asset along an urban river and throughout the city (Daley, 2003). In addition, private donations also finance park areas (Daley, 2003), improving the city environment. This also benefits private businesses by improving property values, ecosystem services, employee satisfaction and public impressions (Corporate Watch, 2006; Riverfront Parks Now, 2020). Conflicting stakeholder needs prevent conservation action, implying that uniting stakeholders towards common goals and win-win scenarios is necessary for successful watershed management.

2.3 Community Action in Conservation

Centralized governmental planning tends to have goals and produce outcomes that do not necessarily address the needs of local communities. It divides stakeholders and sets up competing interests that impede conservation and community action, such as for the previously mentioned hydroelectric plant for mining in Brazil (Borgias, 2018). However, communities can act in partnership with various stakeholders to create their own vision for their watersheds through decentralized participatory planning.

2.3.1 Decentralized Participatory Planning

Decentralized participatory planning is a framework that places management power into the hands of residents, enabling

planning by and for community groups and residents (Harnecker et. al., 2019). Planning and management occur in partnership with other actors, such as federal and state governments, NGOs, businesses, and institutions. In contrast to top-down planning by a centralized government, residents take decision-making responsibility, initiate action, and create their own vision. Decentralized participatory planning is not about simply changing existing top-down structures but creating new powers and platforms within a community. Committees and agendas need to be defined and supported with the power to take action, and new agencies can give residents and community groups formal decision-making power (Abers, 2007).

Crucially, decentralized participatory planning unites a variety of stakeholders with diverse needs towards a sense of collective identity, increasing “recognition by a set of individuals that they belong to a group that is capable of acting collectively” (Abers, 2007, p.1454). This builds collaboration in the place of the conflict that can prevent conservation, as mentioned before. Setting this up and bringing stakeholders on board, however, can be a long and bureaucratic process, requiring persistent engagement by and with the community (Abers, 2007).

2.3.2 Water Protection Movements

Some successful water protection movements have set up decentralized participatory planning to organize social capital to gain power over community and watershed decisions. For example, the Manuelzão Project in Brazil started when the Federal University of Minas Gerais started having interns organize local committees to clean up the rivers local residents use for bathing and drinking. These committees united, "...local government agencies, civic organizations, businesses, and other local leaders to confront environmental problems" (Abers, 2007, p.1456). The project prioritized local solutions to water management, which, "...built a sense of common identity among hundreds of [affiliated] groups" (Abers, 2007, p.1456). Initial efforts succeeded, inspiring local people of the potential for collective action and built up decentralized participatory planning, and eventually taking small-scale action and building a collective identity are done concurrently, while building trust and collaboration in the place of conflict and disengagement.

Over time, these partnerships of small-scale actions can build up to larger local and national movements. One example is the WRF (Water Resources Forum) in Ecuador, which started in the 1990s as a collaboration of NGOs and the Ministry of Agriculture, Livestock, Aquaculture and Fisheries. The forum was conceived as an "open, democratic and plural space" for the, "...country to

analyze, debate and create proposals for water resources management" (Hoogesteger, 2016).

In 2007, Ecuadorian voters voted to draft a new constitution, and the WRF's massive social base with grassroots organizations was used to solicit input. The WRF presented and deliberated about different proposals for the constitution with its members across the country, held a public National Assembly, and publicly handed over their proposals, many of which were incorporated in the new constitution adopted in 2008. Water was recognized as a basic human right, water privatization was banned, it was stated that decision making would include social participation, and it was stated that water resources would be redistributed based on principles of social equity (Hoogesteger, 2016).

Such regulations and the government itself provide decentralized power by enabling watershed committees to have decision-making power and providing a basis for legal action (Abers, 2007). NGOs and multi-stakeholder groups can be critical components of community engagement but can only support and empower local social movements through financial, technical and professional support, while not creating local movements on their own (Abers, 2007; Hoogesteger, 2013). Grassroots community action begins and is led by just that – the community.

Essentially, successful watershed movements set up decentralized participatory planning with a foundation of grassroots organizations that network and grow around a common identity with successful small-scale actions, while having support

from external organizations and decision-making power through the government. The pressure and social capital that these social movements can provide when collected through broader collective organizations can pressure both corporations and the government to shift environmental policy and begin conservation actions (Borgias, 2018).

2.3.3 Community Engagement

Community engagement is the foundation of watershed movements that set up decentralized participatory planning – it gets local people active in the management of the community. It is, “...the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar situations to address issues affecting the wellbeing of those people” (McCloskey, 2018, p.3). The government and NGOs are often in positions to initiate engagement; as mentioned earlier, both the Manuelzão project and the WRF started with community engagement, with a university or NGOs working collaboratively with people concerned about water or watersheds and gradually networking to include more and more people (Abers, 2007; Hoogesteger, 2016).

According to Nurhayanti et. al. (2020), understanding community engagement on conservation and sustainability involves three main factors:

1. Awareness of the environmental issues and conservation efforts.
2. Attitudes, or a community member’s predisposition to ideas about conservation and their predisposition to conservation activities.
3. Action, including active participation in conservation, changing personal behaviors, or simply modifying the social mindset towards the environment.

Essentially, decentralized participatory planning is an evolution of the attitudes and actions of community engagement that forms long-term partnerships. Awareness, however, is the first step towards community conservation action.

2.4 Raising Environmental Awareness

When individuals engage with their environment through activism to create solutions for environmental issues, positive results for the environment and community are often observed (Dyball et. al. 2007). Creating active community engagement requires changes to the awareness and attitudes of individuals. Environmental education can be an effective tool to change awareness and attitudes, promoting community engagement and environmental action (Lynch, 2020).

2.4.1 Environmental Education

The traditional model for promoting community engagement in conservation is through environmental education – teaching about the environment and threats to it in order to change attitudes and promote action among communities. However, studies of environmental education efforts in Haiti show that addressing awareness of environmental issues alone is not sufficient. Apathetic attitudes and lack of action must be directly addressed, and environmental education is most effective as a form of community engagement itself (Lynch, 2020). To do this, Kathryn Lynch, who conducted an environmental education case study in Southern Ecuador, promotes an educational model that frames environmental challenges in a way that affects individuals' daily lives and provides them the tools to inspire change and develop solutions (2020). Similarly, Marianne Krasny, a professor in Civic Ecology at Cornell University, promotes a model that sees education as a method for eliciting intermediate outcomes – such as feeling connected to nature, which then can promote action (2020). From both of these models, environmental education is most effective when it teaches about environmental problems, effective solutions, stakeholders, and provides positive engagement with nature (Lynch, 2020; Krasny, 2020).

One method that can provide direct and positive engagement with nature is action-based learning, a form of education that focuses on developing knowledge as it can be applied

to the real world through participatory learning (Hart & Keen, 2007). This includes immersive engagement, where people experience the environment and develop connections with it through participating in conservation events (Hart & Keen, 2007). Another method is learning through questioning environmental issues and self-reflection of a person's relation to nature (Hart & Keen, 2007). This method can be done through both direct participation and encouraging deeper thinking on environmental issues using strong visual or artistic devices (Anderson, 2000).

2.4.2 Digital Storytelling and Mapping

One method for encouraging deeper learning and providing indirect engagement on environmental issues is storytelling (Gladwin, 2020). Storytelling can allow individuals to learn about environmental issues in a personalized context while imagining the historical past and the possible future. Storytelling in relation to environmental education can be used to begin conversations and develop narratives that shape how people behave and respond to relationships with others and our environment (Gladwin, 2020). By hearing about environmental issues through stories, people can have responses which are more effective in changing attitudes (Gladwin, 2020).

To bring storytelling-based environmental education to a wider audience, digital resources can be used to collect and organize stories and supporting information (Daskolia et. al, 2017). Digital

platforms allow for a narrative that frames individual stories together alongside other content in a manner that can best elicit community engagement (Daskolia et. al., 2017). Digital storytelling can also include linking and mapping as part of a digital library (Gladwin, 2020). Linking can connect individuals to external resources to further learn about the environment, conservation efforts, or any other relevant information.

A particular form of digital storytelling is mapping, which is frequently used as a visualization tool for various distributions of geographic data (Tulloch et. al., 2015). The first purpose of mapping is to identify information for use by scientists and researchers to identify areas in need for conservation or potential management actions (Tulloch et. al., 2015). The second purpose is to provide relevant information to the general public with geographic context, supplemental media, and user feedback (Curriero et. al., 2021). Such a format can allow the public to easily view the data, compare information, and contextualize the data (Curriero et. al., 2021).

2.4.3 Kingue Adventure School

The Kingue Adventure School is an outdoor environmental education school focused on promoting environmental stewardship. It places a great emphasis on environmental engagement through a unique, nature-inspired classroom curriculum focused on action-based learning and a “leave good

trace” principle. Located on the riverbanks of the Río San Pedro, the Kingue Adventure School experiences the effects of pollution firsthand and how its surrounding environment has been misused and mistreated. Previously, the Kingue Adventure School was able to successfully map the Río San Pedro and possible sites of contamination with the help of a group of students from Worcester Polytechnic Institute (WPI) in 2021. In collaboration with the Kingue Adventure School, our project sought to raise awareness on the Río San Pedro’s current polluted, damaged state and issues associated with it while highlighting the river’s potential to be an asset to the community. Through collecting and sharing the history, community stories, and current conservation efforts regarding the Río San Pedro, we assisted the Kingue Adventure School in their current conservation and activism efforts in hopes of creating an environmental consciousness of the Río San Pedro within surrounding communities.

3. Methods

The goal of this project was to inform and inspire community awareness, action, and education, addressing the pollution of the Río San Pedro in the Pichincha Province, Ecuador. To achieve this goal, we developed the following objectives:

1. Determine current pressures, issues, and water management structures for the Río San Pedro.
2. Document community attitudes and experiences with the Río San Pedro.
3. Determine platforms to best make research and community stories of the Río San Pedro cohesively accessible.

This chapter details methods utilized throughout the project, such as interviews, archival research, story collection, and concept selection, fulfilling the goal of the project and corresponding objectives.

3.1 Interviews

We conducted two sets of semi structured interviews with different populations that will be discussed below. Interviewees were selected using targeted sampling based on recommendations of our sponsor and independent research, as well as snowball sampling

based on recommendations from previous interviews. A list of interviewees can be found in Appendix A. We recorded interviews with permission for transcription. The interviews lasted approximately forty-five minutes to one hour. In cases when interviewees were appropriate for both interview topics, additional questions about their experiences were added on to the end of the first interview or follow-up interviews were scheduled. We conducted interviews in either Spanish or English based on the interviewee's fluency and preferences. We took written notes and audio recordings of these semi-structured interviews to be further analyzed, transcribing from Spanish to English if needed using online software.

To gain qualitative information on current pressures, issues, water management and environmental protection related to rivers in Ecuador, we conducted semi-structured interviews with five environmental researchers, four conservation leaders, one water management director, two government leaders and one business manager. While each set of interviews had standard guiding questions, we also designed specific interview questions based on investigations into the interviewee's research, work, or organization.

For interviewees who worked in environmental research, we requested information regarding relevant publications or data that could not be found through archival research. Interview questions in English and Spanish can be found in Appendix B.

We conducted qualitative analysis looking for common themes and different perspectives along several areas of interest that begun developed over the course of interviewing:

1. Urban and Industrial growth in communities surrounding rivers.
2. Issues and damages that rivers face.
3. Current and future governmental policies and plans.
4. Current areas of or for multi-stakeholder collaboration between governments, communities, conservation organizations, and companies.
5. Trends and current state of community and government participation of the issues and damages rivers face.

To gain qualitative information on community attitudes and experiences with the Río San Pedro, we conducted semi-structured interviews with conservation leaders and key community members (Berg, 2007). Standard guiding questions for these interviews (see Appendix C) began with discussing conservation work the interviewee has done, then their personal experiences with the Río San Pedro, and finally how they see public opinion about the Río San Pedro. We conducted qualitative analysis looking for common themes and different perspectives on experiences with the

Río San Pedro, and how pollution has changed experiences with or outlooks on the Río San Pedro.

3.2 Archival Research

Archival research completed through research in online government databases, libraries, or other repositories made available to the project was done in order to determine current pressures, issues, and key features related to the Río San Pedro (Jones, 2010).

We investigated the following topics:

1. Industries and expansion of Quito and other urban areas in Pichincha province
2. Land cover, use and zoning in the Río San Pedro watershed
3. River and water management in Quito and Cuenca
4. Local ordinances in Quito and Cuenca
5. Ecuadorian court rulings on river and water protection
6. Effects of the hydroelectric dam along the Río San Pedro and other Ecuadorian rivers

For data that was not easily publicly accessible, we contacted institutions with data such as FONAG (Fondo para la protección del Agua), Instituto Geográfico Militar Ecuador, and Biosphere Institute for additional information and assistance in obtaining data. Data was collected in multiple formats, including images files, shapefiles (GIS) and databases, often with PDF metadata and was analyzed either qualitatively or quantitatively to discover how themes related to the river have changed over the time period of

1950-2020. These maps were utilized, in part, to populate the map data we created. A catalog of acquired maps and documents can be found in Appendix G.

3.3 Story Collection

A media collection survey was used to obtain information about community member's personal experiences with the river and how pollution has affected their relationship with the river through stories (Berg, 2007). A story collection survey was developed using ArcGIS Survey123, where we collected the age of respondents, a story about their personal experience with the river and how pollution has affected it, and the approximate locations of places mentioned in the story. Details on the story collection survey format can be found in Appendix D and Appendix E in English and Spanish. Age and location were collected to allow for the analysis of the differences and similarities of stories across different age brackets and locations along the river. To ensure accessibility of the survey, we selected software that was optimized for both computers and mobile, and stories were accepted in video, audio, and written formats. Participants were given email and WhatsApp information to submit responses in case they were not able to complete the survey. A total of ten stories were collected, we used qualitative analysis to look for common themes and different perspectives on experiences with the Río San Pedro, and how pollution has changed experiences with or outlooks on the Río San Pedro.

3.4 Concept Selection

The Kingue Adventure School desires a platform to view and share information publicly about the Río San Pedro. Pugh concept selection, a quantitative decision-making matrix, was used to evaluate different platforms to visualize an interactive map (Cudney & Agustiady, 2016). Through semi-structured interviews with our sponsor, defined criteria were generated and weighted by importance on a scale from 1 - 5, where 1 was deemed least important while 5 was deemed most important. The platforms for sharing information publicly were evaluated based on:

1. Accessibility
2. Aesthetics
3. Ability to be modified by Kingue staff
4. Ease of Design
5. Upkeep of Online Platform
6. Usability

The types of information to include on the platform were evaluated based on:

1. Technical Relevance
2. Relevance to Public
3. Relevance to Sponsor/Rescate Río San Pedro
4. Integration

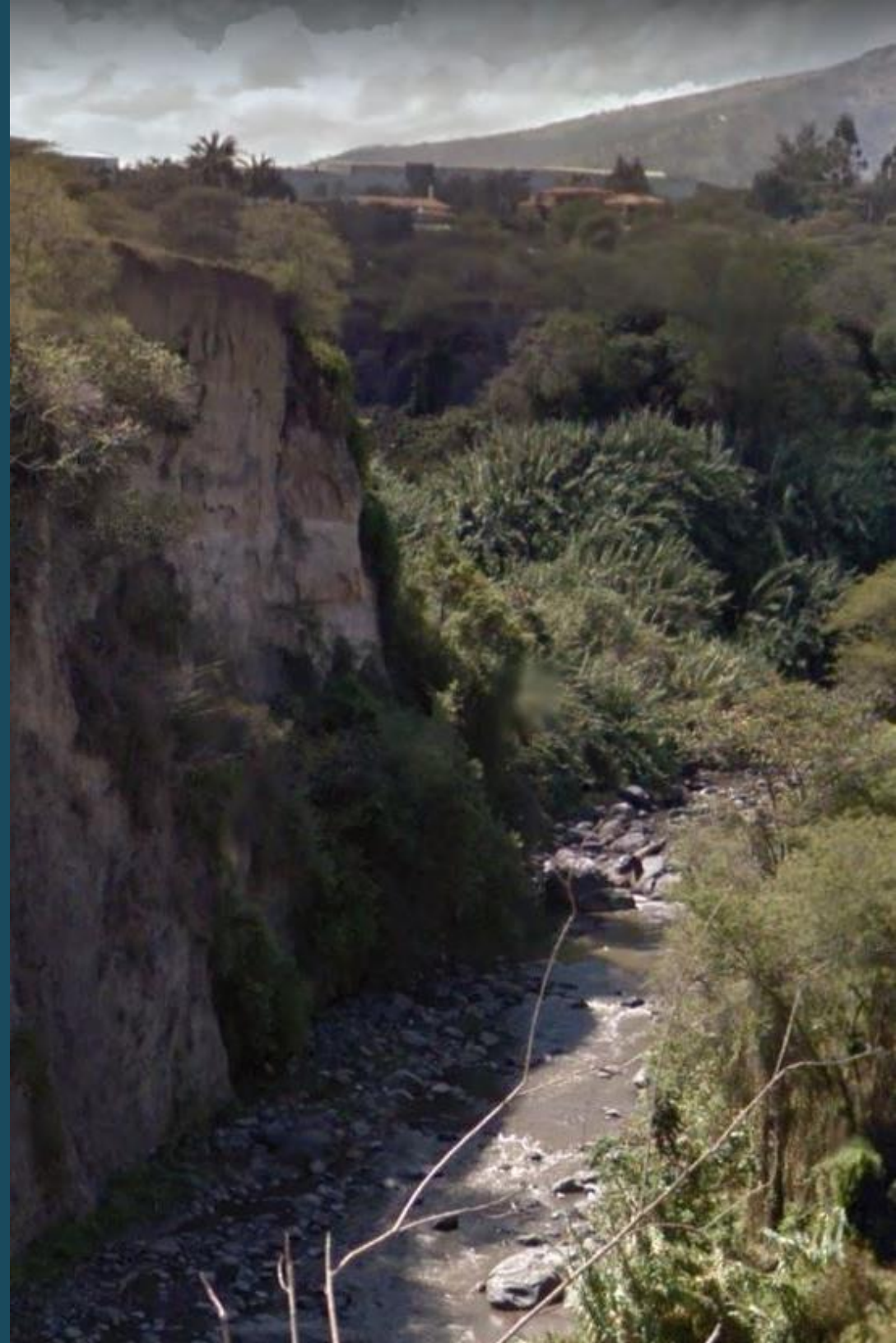
Platforms and types of information were scored with either a -1, 0, or 1 by the team based on how well each platform or type of information fit a given criteria. These scores were summed using the

4. Findings

“Here where I live there are many children and I ask them where they think the river goes. And very few know that it goes to the sea. It's not like the river doesn't occupy the two hundred meters that they see and nothing else, it doesn't exist, it has no end or beginning. We all lack a lot of education.”

– J. J. Anbalzer

Río San Pedro Community Member



This chapter presents the findings from interviews and archival research, organized by common themes we observed during data collection. We discuss the findings surrounding the pollution of the Río San Pedro, government policies, stakeholder collaboration, and community perception.

4.0.1 Geography of Pichincha Province and the River

The Río San Pedro and its watershed stretches across three cantons: Mejía, Rumañhui, and the Quito Metropolitan District

Figure 5.

Map of the Río San Pedro and its watershed within Pichincha Province, Ecuador

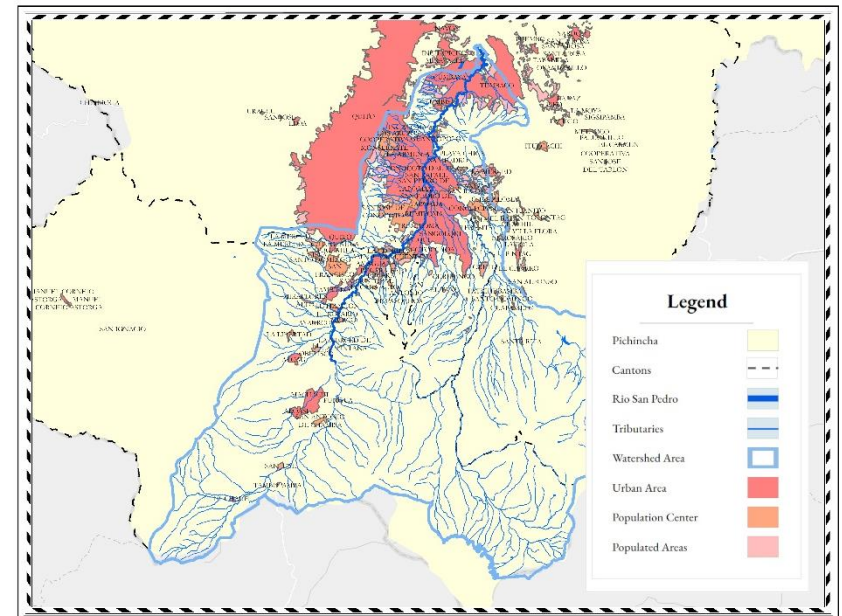


Source: (IGM, 2013)

(DMQ) within the Pichincha Province, Ecuador, located in the north of the country (Figure 4). While the Río San Pedro's watershed is tangential to the main urban center of Quito, there are many smaller urban centers that sit alongside the Río San Pedro or within its watershed (Figure 5).

Figure 4.

Map of urban areas within and around the Río San Pedro watershed.



Source: (IGM, 2013)

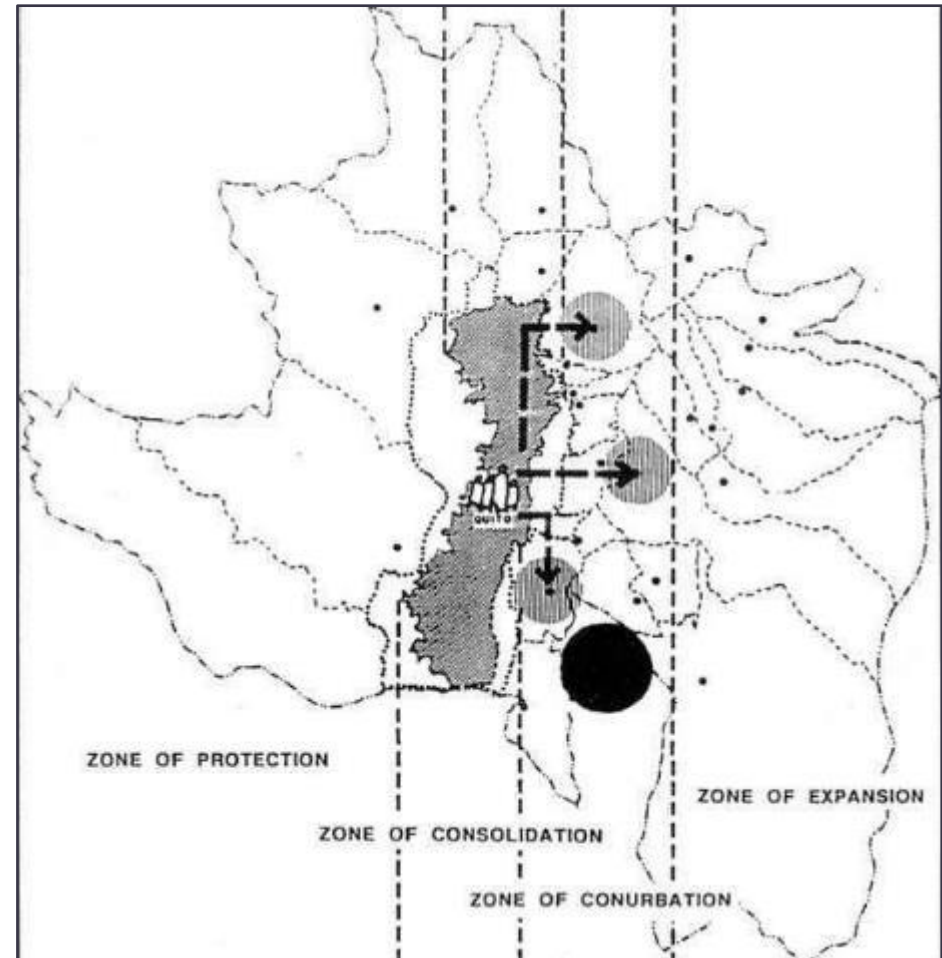
4.1 Urban Growth & River Degradation

According to Ecuador's National Institute of Statistics and Censuses (INEC, 1990; INEC, 2010) the population of the parishes that the Río San Pedro and its tributaries run through, doubled between 1990 and 2010. Excluding the Quito metropolitan district, population in the urban parishes outside of Quito increased from 192,530 to 395,523. While the population growth seen in the past half century is expected to slow down in the coming decade, estimations from INEC indicates that growth that occurs is expected to be proportionally concentrated in the urban centers that are developing on the outskirts of Quito and in the more rural cantons of Mejía and Rumañhui. This information is consistent with a diagram from the Quito Metropolitan Government, found in a UN Report on Quito, highlighting that co-urbanization, the nodal development of smaller urban centers, and expansion were focused on the east of the city, directly into the Río San Pedro and its watershed (Murray, 1997).

In interviewing three environmental researchers, all of them agreed that the growth of urban population puts significant strain on the environment and public services such as transportation services, drinking water, garbage, and wastewater processing. One hydrological researcher that we interviewed highlighted that co-urbanization can make the extension of public services in order to accommodate the growing populations. According to Fernando Palacios, the environmental director of the Tumbaco zone, the

growth is made more difficult by it being focused in environmentally precarious areas such as the slopes of mountains or ravines. This claim is supported by a report from the Department of

Figure 6.
Quito Metropolitan District Current Jurisdictional Boundaries and Growth Areas (1992)



Source: (Murray, 1997)

Development, Environment, and Territory, which raises concerns with the effect of informal settlements on the environment and the ability to provide public services (Salazar & Cuvi, 2016).

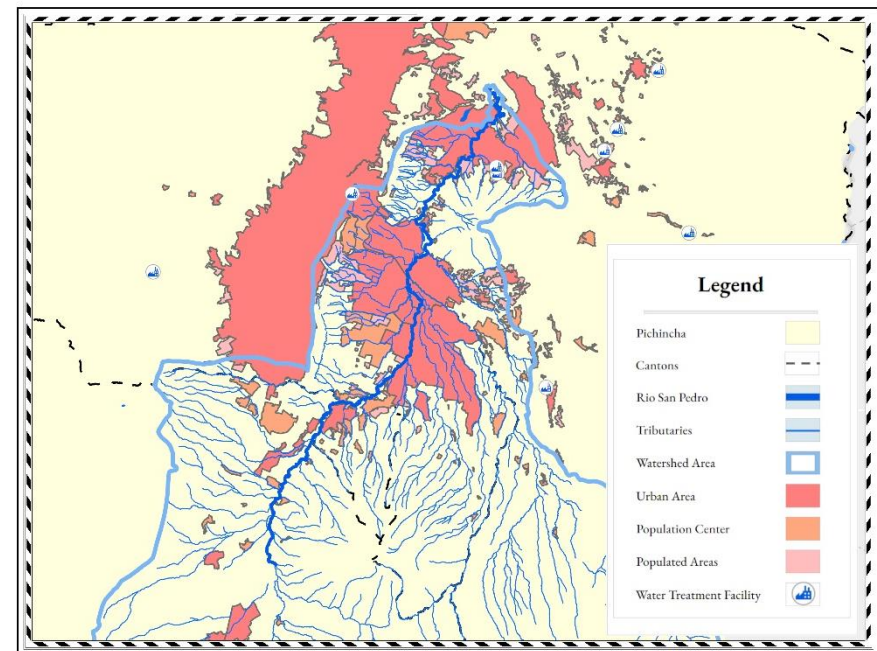
The outlying parishes of Quito and the other communities along the Río San Pedro face a lack of appropriate wastewater treatment, or any wastewater treatment at all. From interviewing two local historians and other community members, wastewater along the Río San Pedro includes domestic waste, agricultural runoff, and waste generated from various industries. In the parishes surrounding Quito there are ten wastewater treatment facilities, three of which fall within the Río San Pedro watershed (Figure 7). Daniela Rosero-López, a professor and environmental researcher in ecohydrology, and Natalia Alvarado-Arias, a Ph.D. candidate in Sustainability and Urban Regeneration, emphasized that much of the wastewater generated in the outlying parishes of Quito and in Mejía and Rumañhui goes directly into the river without treatment. In fact, upstream in the cantons of Mejía and Rumañhui there is a complete lack of treatment facilities (Appendix G). The inadequacies of wastewater treatment are supported by Hazen & Sawyer, the water management company that was selected to update Quito’s sewage systems (Hazen & Sawyer, 2022).

Infrastructure, such as damming and culverting, that alters the flow of the river, exacerbates pollution on the Río San Pedro. According to Rosero-López, the lower water levels caused by hydroelectric dams along the river – particularly the Central Hidroeléctrica Guangopolo, both disrupts ecosystems and

concentrate pollutants both in the water and riverbeds, making areas directly downstream from these dams, “...almost dead”. According to a local historian, diversion of rivers for manufacturing also occurs on the Río San Pedro, which similarly reduces water flow and water level in the remaining portion of the river. Another disruption of the river, which Natalia Alvarado discussed is culverting, the channeling and sometimes covering of a waterway, often done in urban waterways, which disrupts the natural flow and surrounding ecosystem of the rivers.

Figure 7.

Map of wastewater treatment facilities within and around the Río San Pedro watershed.



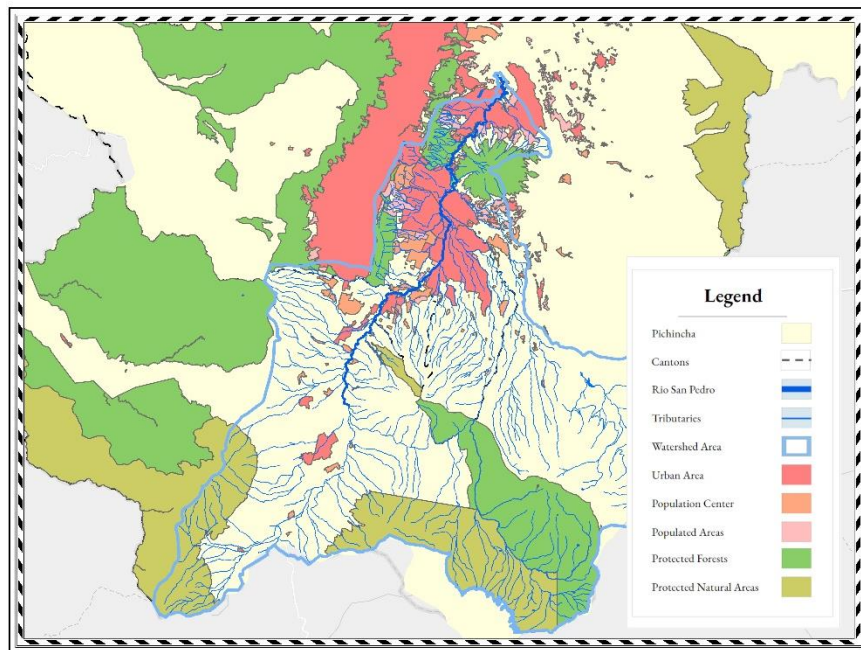
Source: (IGM, 2013)

4.2 Policy & Planning Issues

Within Ecuador, the national government can establish protected watershed areas, parks, and forests (Ministerio del Ambiente, 2022). However, Daniela Rosero-López states that these national protections do not apply to the urban and rural areas along the Río San Pedro, a fact confirmed by maps of nationally protected areas which do not cover the majority of the river (Figure 8).

Figure 8.

Map of protected forests and natural areas within and around the Río San Pedro watershed.

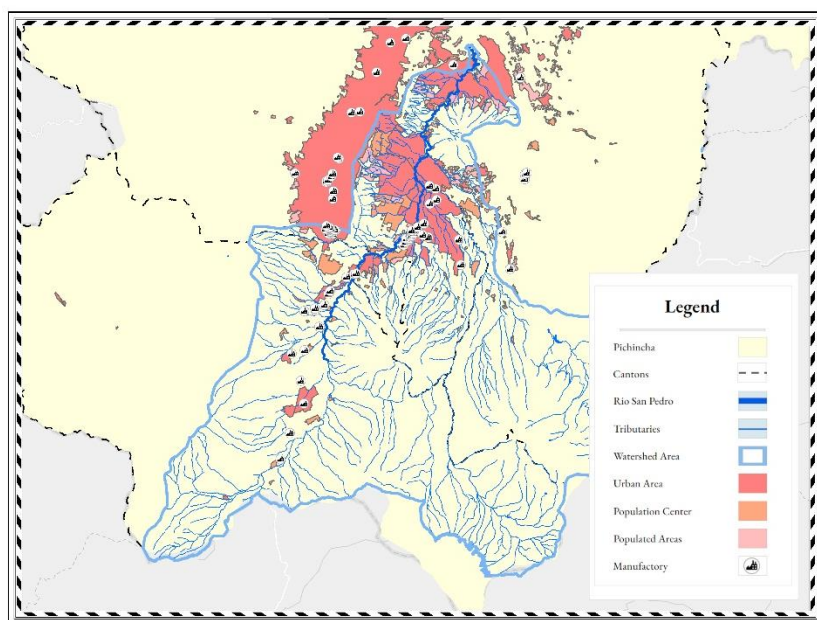


Source: (IGM, 2013)

Instead, she says protections devolve to local governments which are not set up to manage watersheds that span beyond their boundaries. For example, the Quito metropolitan plan primarily focuses on the city, ignoring the impacts that come from upstream or tangential pollution (Metropolitan Institute of Urban Planning, 2018). Professor Andres Alvarado Martínez, a professor at the University of Cuenca, seconds that a centralized water treatment plant, such as in Quito, cannot adequately serve further away rural areas.

Rosero-López adds that lower taxes have sparked rapid industrialization along the upstream rural areas of the Río San Pedro, such as Rumañhui. Rosero-López details that the Río San Pedro used to have little to no industrial sites, but a large increase of commercial and manufacturing sites along this portion of the river over the past 50 years can be observed in Figure 9. Rosero-López mentions how there is, “...little to no regulation of the manufacturing industry, yielding higher levels of water contamination and pollution,” further damaging the Río San Pedro downstream. Professor Patricio Chambers, the executive director of the Guayllabamba Waterkeeper Association, along with Rosero-López, discuss how despite certain stakeholders, such as businesses, economically benefit, those most impacted by this lack of regulations are community members living in rural areas near the Río San Pedro.

Figure 9.
Map of manufactories within and around the Río San Pedro watershed.



Source: (IGM, 2013)

Additionally, specifically within Quito, Patricio Chambers explains that national and local government budgets delegated to environmental work tend to operate in a reactive manner, allocating funds to immediate necessities. Rosero-López elaborates that work regarding the implementation of a sewage treatment plan along the Río San Pedro is underway by municipalities surrounding the river, “but the problem is that when municipalities start this it’s almost ten years removed, so [these plans] really are obsolete.” Since reactive plans struggle to maintain relevancy as river conditions continue to deteriorate, Chambers explains that governmental

budgets allocated to environmental work must be, “working in a proactive manner, providing future environmental protection.” Rosero-López and environmentalist Jose Luis Chiriboga add that future planning encompassing the entire watershed with a comprehensive vision is needed.

Rolando Celleri, a professor at the University of Cuenca, explains that FONAPA, the watershed management organization for the Río Paute in Cuenca, has found success in working with institutions, private owners, municipalities and citizens, bringing them together on integrated, proactive plans focused on a singular vision. Celleri states that bringing stakeholders together is essential because “private companies need a strong connection to the local government, so the government knows what to do in terms of conservation.” Eduardo Toral-Contreras, the technical secretary of FONAPA, elaborates that FONAPA receives public and private funding and uses it to incentivize private property owners to commit to conserving certain areas in exchange for incentives. FONAPA also continuously works with NGOs, municipalities and citizens to pass municipal ordinances to protect areas for conservation across the watershed. Essentially, Toral-Contreras explains that FONAPA protects the watershed by forming partnerships with stakeholders and using them to take action that they cannot do themselves.

4.3 Community Perspective & Engagement

Based on interviews and stories from seven community members who grew up along the river, at least thirty to fifty years ago the Río San Pedro was used for various economic and social benefits and was viewed as a vital aspect of the community. Many community members who grew up or lived along the Río San Pedro used to frequently use the river or one of its tributaries for various social activities when the river was clean. The three community members that were interviewed all recalled a time that locals used the river water for cooking and cleaning as well as various recreational activities. One member, Jorge Juan Anhalzer, who has been a resident for over 50 years recalls being able to play water sports, swim, and spend time relaxing with family along the banks of the river. Additionally, we discovered that the Río San Pedro has significance to communities as a whole. According to Antonio Morales, a historian and long-time local to the river, indigenous communities have long had traditions and celebrations that were directly tied to the water of the Río San Pedro. Morales emphasizes that the Río San Pedro always had a strong religious divinity among surrounding indigenous communities but due to contamination, pollution, and alterations to the river, indigenous traditions and celebrations along the river hardly occur. Maria Barragan, a long-time resident and member of the *el Colectivo Rescate Río San Pedro* (RRSP), states that communities also used the Río San Pedro for commerce and travel, while farmers would use river water to give to

their animals or crops, and fishermen would rely on the river to feed their families.

4.3.1 Current Community Perspective & Engagement

Eight community members and conservation leaders interviewed agree that the river was once a vital asset but is now polluted. Anhalzer explains that the river, when clean, used to be a staple in the lives of local community members, abundant with fisherman huts and a booming fishing industry, children playing in the water, and families picnicking along the banks. However, Maribel Pasquel, the leader of the RRSP, describes how she first visited the river a year ago when she visited with her family, and was overwhelmed by sadness from images of garbage flooding riverbanks were paired with an awful odor, prompting her to learn more about the Río San Pedro. Another community member wrote that, "... [the river] is very polluted just by smell, and of course when you see it you see garbage and a cloudy tone in it." Overall, there is a predominantly negative outlook on the Río San Pedro in its current condition.

According to Natalia Alvarado-Arias, one major cause for the current lack of awareness about the river among surrounding communities is that, "...the river...goes unnoticed. Many people don't...pay attention to it and this is a problem because it means that there is no awareness about its recovery, [or] about [its] condition." Alvarado-Arias, Anhalzer, and Rosero-López all explained how the

river is hidden in ravines created by large mountains making it out of sight to most people, which when combined with many people not choosing to be around the river, contributes to the low levels of awareness about the Río San Pedro.

The negative perspective held by local community members has brought about a loss of connection to the river throughout the community according to eight of the community members, leaders, and environmental researchers interviewed. Alvarado-Arias states that today, “...people have forgotten the value the river has to its surrounding community after seeing the poor state it is in.” With the state it is in now, people do not go near it aside from dumping trash. From the contamination and invisibility, Anhalzer states that the surrounding community has, “...suffered a kind of divorce with nature,” through which locals have forgotten the importance the river and the environment around has within their lives.

4.3.2 Changing Community Perspective & Engagement

Despite the river’s current state, the Río San Pedro still has the ability to be an asset to the community through the natural space it provides. According to Natalia Alvarado-Arias and Maribel Pasquel, while the river itself is currently unusable and there is significant amounts of trash along the banks in areas, there are several parks and green spaces along the length of the river, primarily clustered in the urban centers along the river (IGM, 2013). According to Pasquel, these parks and green areas can still be utilized

by the communities as areas for recreation and to enjoy nature within their communities. *Mingas*, a traditional form of community work in the Andes, have been organized by the communities around the Río San Pedro to clean up the river and parks around it. Chambers adds that these *Mingas* bring the community together through shared experiences and the music, art, and traditions that can all accompany a cleanup.

According to two interviewed environmental researchers and community leaders/members, the local community needs to be made more aware of the full extent of the damage occurring to the river. Pablo Palacios, president of Arcandina Foundation, an environmental education organization in Quito, explains that it is often when community members become fully aware of the problems with the Río San Pedro being and begin to work to fix them, there can be a hope that the river is restored. In two of the stories we collected, community members described visiting Parque Los Algarrobos which is adjacent to the river and seeing the potential of the park and the river, which inspired them to lead conservation efforts for the Río San Pedro. Joaquín Serrano, director of the Kingue Adventure School, and Daniela Rosero-López add that when the public is put face to face with the problems of the river either by being presented research, seeing the river firsthand, or hearing it through the news, they can start to learn. Maribel Pasquel also details that this education can foster a more progressive perspective in communities that embraces the positive potential of the river and a desire to clean it.

More community members along the Río San Pedro recently began holding this progressive perspective, as Pablo Palacios describes, leading them to want to engage with the river and its conservation. The increased desire to engage with the river has led to the organization of conservation groups such as *Colectivo del Rescate Río San Pedro* (RRSP), which serves as a platform for connecting community members, and existing conservation efforts. As a part of RRSP and other conservation groups, the community utilizes social media such as WhatsApp, Facebook and TikTok to share research, news about the river, and to organize *Mingas* to clean up the Río San Pedro. As Rolando Celleri puts it, community awareness of issues also goes beyond community action because public support can pressure governments and companies to make changes in favor of conservation and environmental protections.

4.4 Accessibility to Information about the Río San Pedro

Environmental researchers and two leaders of conservation organizations which have a focus on environmental education agree that it is difficult to access research, data, and information about the Río San Pedro. A lot of information simply does not exist for the public either because the research has not been done, such as in the case of levels of chemical contamination in the Río San Pedro, or as Fernando Palacios discussed, the resources simply have not been published.

Lack of knowledge about what information is available and where to find it also limits accessibility to information. Ten out of thirteen environmental researchers, conservation leaders, and government officials that we interviewed asked for or expressed a desire for research that was not publicly available but may be available by asking other researchers or officials. At the same time, they all offered to share the information or research they had at their disposal. A concern expressed by conservation leaders and experienced firsthand through research on this project was that information that is managed by state institutions on the national, provincial, and local levels often is not published publicly or is done so in a disjointed manner.

Additionally, according to Daniela Rosero-López, the information may be published but only in academic papers or technical reports, which may be difficult for non-experts, such as government officials, companies, and the public to fully understand. To Rosero-López, “...the problem basically is that we have a lot of information, but nobody that has the power to make decisions has analyzed it,” contributing to the lack of effective policy making. Rolando Celleri compares the issue of lack of analysis to the way it affects companies and the public’s ability to support conservation, being that if they do not understand what to support, they will not support it. To both, and a sentiment supported by other conservation leaders interviewed, is that information needs to be simplified and coalesced into understandable formats to be made available to different stakeholders by researchers.

4.5 Limitations of Findings

This project was conducted virtually from the WPI project site in Cuenca, Ecuador, creating challenges for reaching locations and contacts of interest in Pichincha, Ecuador. This aspect limited the number of community members we were able to interview and forced targeted and snowball sampling methods. The majority of the individuals interviewed were associated with an environmental activist group, activists, or environmental researchers. Interviewees were potentially biased in their advocacy for increased environmental protection and their views on community perspectives on the river.

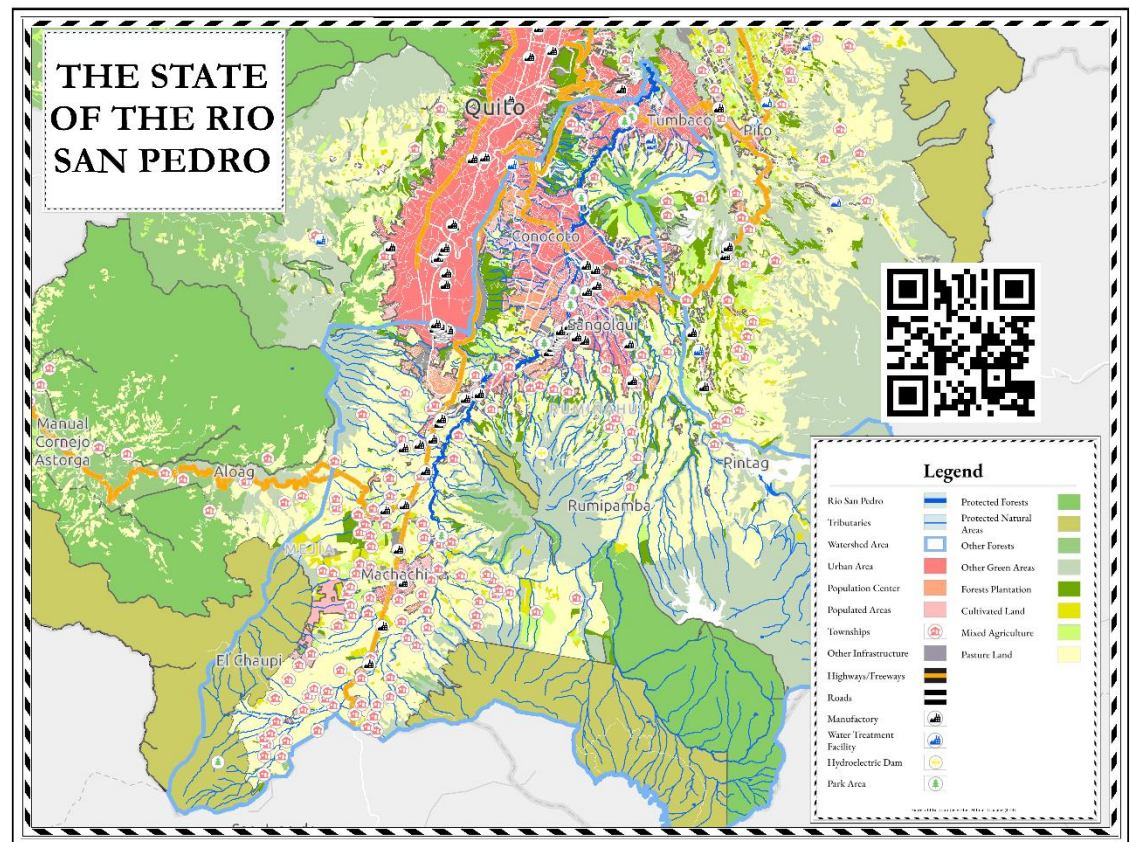
5. Recommendations and Conclusions

5.1 Mapping of the Río San Pedro

To teach the public about the issues that the Río San Pedro watershed faces and to share community stories using principles of digital storytelling, we created a static and a digitally interactive ArcGIS map for the Kingue Adventure school. The purpose of the map is to provide conservation organizations with a tool for promoting awareness of the Río San Pedro.

The static map highlights the key locations along the river as an easy visual to teach the public about the scope of threats to the Río San Pedro and its watershed, as well as to highlight areas of successful protection, parks, and images of the river along its course (Figure 10). Urban areas and townships were included to highlight that the population of the area is primarily concentrated along the Río San Pedro or closely within its watershed. Locations of manufacturing sites were included to highlight the concentration of industry along the Río San Pedro, and to imply that the utilization of the river by industry can have an impact on the river. Park areas,

Figure 10.
Static map of the Río San Pedro, showing the watershed area, urban areas, protected areas, wastewater treatment facilities, hydroelectric dams, townships, and park areas.

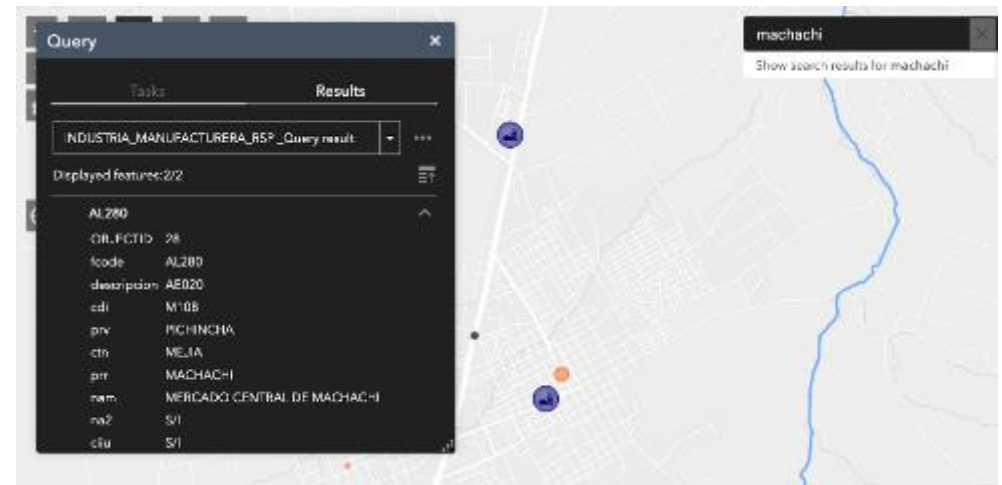
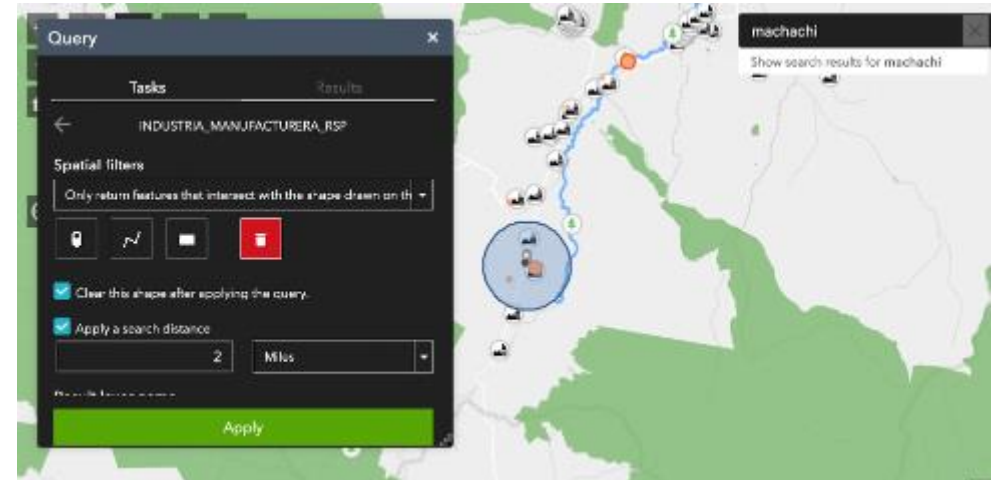


Source: (IGM, 2013)

protected forests, and protected natural areas were included to highlight where nature, especially along the river, could be enjoyed, as well as to note the absence of parks and protected areas through significant parts of its course. Several images were also included on this static map to show park areas, show how the river quality deteriorates as it moves downstream, and to highlight a hydroelectric dam which has a significant impact on the river.

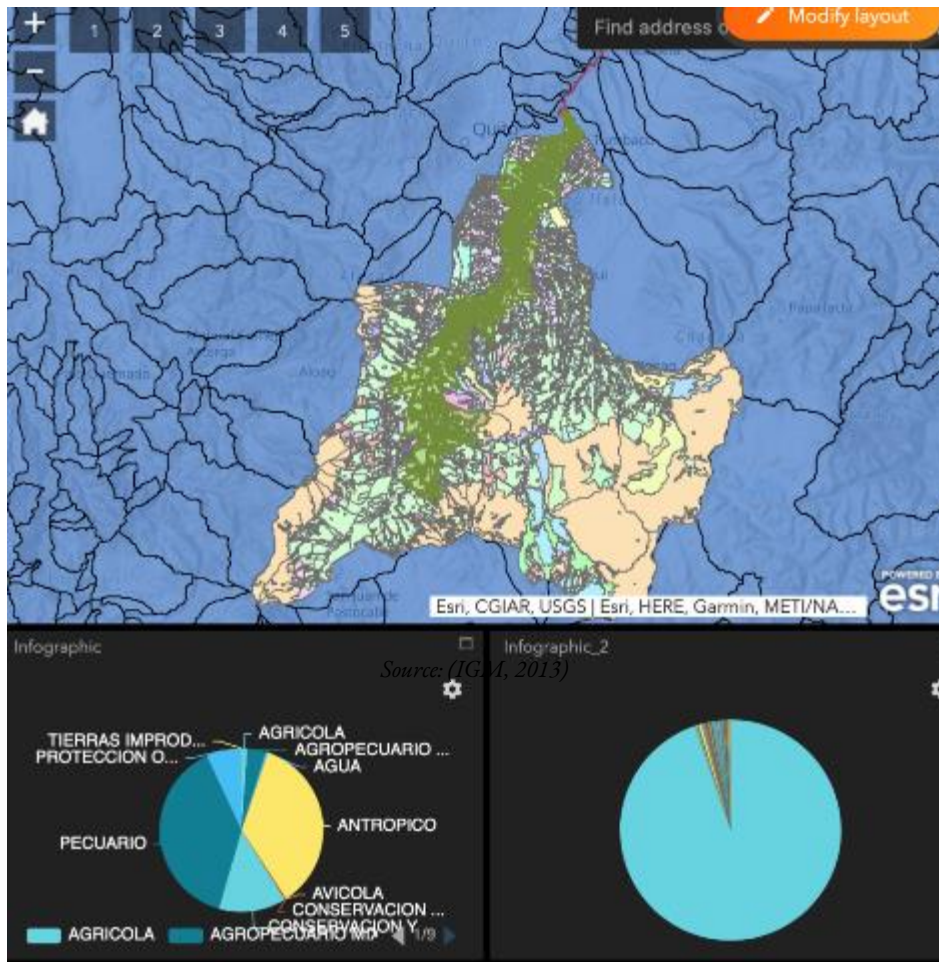
The interactive map contains multiple layers about Río San Pedro, which users can explore. Aside from scrolling and zooming, they can type in their address or click on the map to get information about land use, zoning, population density, protected areas, the course of the river, tributaries, and other information (Figure 11). Additionally, users can find the number and percentage of industrial areas, wastewater treatment facilities and land use within a specified distance nearby, around the river or within certain watersheds or administrative boundaries (Figure 12). The interactive map also contains points which give an interactive tour of the river and the communities around it, including stories from residents.

Figure 11.
Using queries to find manufacturing industry sites near Machachi, Ecuador with the interactive map of the Río San Pedro



Source: (IGM, 2013)

Figure 12.
Interactive map showing the land uses on the map and in the pie chart near the Río San Pedro
based on user input



Source: (IGM, 2013)

5.2 Recommendations for Conservation Organizations

We recommend that *El Colectivo Rescate Río San Pedro* (RRSP) and associated groups create a repository detailing environmental research, data, statistics, policies, and conservation efforts related to the Río San Pedro to assist conservation projects, future research, and environmental policy creation. We have found that detailed information about the river is dispersed across various websites, databases, and archives. From our interviews and archival research, we found that it would be useful for environmental education projects and data analysis for policy making to have easier access to a broader base of data. A central repository of data could be created to collect and organize raw data, published papers and technical reviews, and relevant government and corporate ordinances and policies. This repository could then be shared between conservation organizations, researchers, and others interested to provide access to the information, or to be added upon. This would enable easy access of information for conservation organizations, researchers, and decision-makers to not only support action, but also make informed decisions based on concrete data, research, and information regarding the issues.

We recommend that *El Colectivo Rescate Río San Pedro* (RRSP) and associated groups publicize valuable information about the Río San Pedro and the issues it faces to increase environmental awareness among surrounding communities. From interviews with conservation leaders and environmental researchers we have found that a major barrier for public participation in environmental advocacy and action is a lack of awareness about the issues the Río San Pedro faces, and its potential effects on individuals. To address this barrier, relevant research and statistics should be translated into a format that is understandable to the public – ideally with a focus on visually understandable information. We created one such format: a digitally interactive ArcGIS map for the Kingue Adventure School. The map data should be shareable on social media and on the Kingue Adventure School’s website, with links to access to detailed information such as the watershed area, location of potential pollutant sites, locations of nature reserves, and locations of other key landmarks. Additionally, we suggest that the information should be presented in different formats and in distinct levels of complexity to suit different subgroups of the public such as activists, the general public, and children to allow for appropriate education across a broader range of the community.

We recommend that *El Colectivo Rescate Río San Pedro* (RRSP) and associated groups highlight the potential benefits the Río San Pedro could have by publicizing the river’s uses and sharing community stories to increase environmental awareness and improve environmental attitudes. We have found that when community members can see a path towards a clean river, they are inspired to participate in environmental action. We were able to learn about how the Río San Pedro was once an asset and can be an asset to the community once restored. This inspiration could be publicized by providing a platform to share stories from people who lived along the river when it was once a community asset, and those who have experienced its negative effects due to pollution and contamination. These stories can highlight potential benefits of the river, recalling back to when it was once a community asset. By providing a platform for these stories to be shared, the Río San Pedro’s potential strengths can inspire a broader range of communities to take environmental action. Additionally, future plans for the river, such as the locations and plans for urban parks, walking trails, and conservation efforts could be made public in a visual manner to make the Río San Pedro’s path forward understandable by the public.

In order to address the issue of reconnecting community members with the river, one method we also suggest is that organizations and community leaders encourage members to visit the river, especially in urban green spaces, parks, or paths along the river. Visiting the river creates a firsthand experience, which can

raise the community's awareness of the issue and inspiring action. Through our interviews, we found that *Mingas* have shown to be effective events that draw people to the river, so broadening publicity of events such as *Mingas*, and park spaces in general could have a positive impact on community engagement. Conservation organizations should continue holding events and encourage stakeholders and the surrounding community to visit the river.

We recommend that *El Colectivo Rescate Río San Pedro* (RRSP) and associated groups increase collaboration with communities, researchers, governments, and private institutions. Tackling a broad problem like river pollution needs diverse stakeholders to work together. Stakeholders can help one another as they each cover a different facet of the issue. Collaboration between research institutions, NGOs, governments, and corporations is necessary to conduct effective, detailed, and well-funded research. Effective communication of information and research to communities, governments, and private institutions is necessary to inform all groups on what actions they can take to protect the river and their interests within it. Education of private companies is especially crucial because laws protecting rivers can be difficult to enact and enforce, meaning self-regulation by companies could be more effective. Our interviewees, particularly the environmental researchers, have highlighted that public pressure on companies and governments is necessary and effective to push them towards conservation. Thus, conservation groups should work to

empower communities with the tools to effectively advocate for appropriate protections. The Kingue Adventure School and RRSP can also expand collaboration with government and private institutions and build up to collective action across multiple municipalities encompassing the entire watershed.

5.3 Future Projects

Future teams could conduct further investigation into various informational gaps encountered throughout the project as outlined within our recommendations. These topics include investigation into community attitudes and awareness, local and national watershed policies, and the feasibility of setting up collaboration with private stakeholders. Our group detailed the current condition, history, and community perspective(s) of the Río San Pedro through an interactive map (made using ArcGIS) while also creating an archival research database of the Río San Pedro to be used by the Kingue Adventure School and future partners and collaborators; however, further development of the map and database can be done.

Throughout the course of the project, we found that accessing various topics of information proved difficult due to the nature of the project. In order to effectively detail the state of the Río San Pedro, further research and investigation must be completed. Such endeavors include a number of things. One example of this would be to interview citizens who have or currently

live near the river, and investigate community attitudes and awareness of the river. Future groups could also perform watershed studies of the Río San Pedro, accurately depicting the high levels of pollution observed throughout the river. Additionally, groups can investigate government policies, collaborate with private entities, and set up a vision for the Río San Pedro's watershed.

We hope work done throughout the project supports RRSP's goal of a clean river in five years. By analyzing and sharing information about the Río San Pedro that can be used to inform community members, as well as by activists to fight for a clean river, we hope that our project increases awareness in both the activist group and the general public, supporting future action and building public support towards RRSP's goals.

5.4 Conclusion

Witnessing the effects of pollution affecting the Río San Pedro, our sponsor, the Kingue Adventure School created an environmental collective focused on saving the river and restoring it to pristine condition (Serrano, 2022). The Kingue Adventure School asked our team to assist in the development of an interactive map and archival research database. By interviewing conservation experts as well as government and business representatives, collecting stories from local residents, and performing archival research on governmental and environmental databases, we gathered information to share in a database for activists and an

interactive map for the public, which can be displayed on Kingue Adventure School's website. Through these deliverables based on our research, our group was able to execute the project goal of detailing and sharing the life of the Río San Pedro.

References

- Abers, R. N. (2007). Organizing for Governance: Building Collaboration in Brazilian River Basins. *World Development*, 35(8), 1450–1463. <https://doi.org/10.1016/j.worlddev.2007.04.008>
- Anderson, E. P., Jackson, S., Tharme, R. E., Douglas, M., Flotemersch, J. E., Zwarteveen, M., Lokgariwar, C., Montoya, M., Wali, A., Tipa, G. T., Jardine, T. D., Olden, J. D., Cheng, L., Conallin, J., Cosens, B., Dickens, C., Garrick, D., Groenfeldt, D., Kabogo, J., ... Arthington, A. H. (2019). Understanding rivers and their social relations: A critical step to advance environmental water management. *WIREs Water*, 6(6). <https://doi.org/10.1002/wat2.1381>
- Anderson, H. (2000). A River Runs through It: Art Education and a River Environment. *Art Education*, 53(6), 13–18. <https://www.jstor.org/stable/3193878>
- Anhalzer, J. (n.d.). Kingue Adventure School - Ecuador. Retrieved February 14, 2022, from <https://www.kingue-edu.org/>
- Bedi, J. K., Ghuman, R. S., & Bhullar, A. S. (2015). Health and Economic Impact of Unsafe Drinking Water: A Study of Ludhiana. *Economic and Political Weekly*, 50(2), 23–26. <http://www.jstor.org/stable/24481298>
- Berg, B. L. (2007). Dramaturgy and Interviewing, Types of Interviews, Guideline Development. In *Qualitative research methods for the Social Sciences* (pp. 106–122). essay, Pearson/Allyn & Bacon.
- Borgias, S. (2018). “Subsidizing the State:” The political ecology and legal geography of social movements in Chilean water governance. *Geoforum*, 95, 87–101.
- Coles, J. F., McMahon, G., Bell, A. H., Brown, L. R., Fitzpatrick, F. A., Scudder Eikenberry, B. C., Woodside, M. D., Cuffney, T. F., Bryant, W. L., Cappiella, K., Fraley-McNeal, L., & Stack, W. P. (2012). Effects of urban development on stream ecosystems in nine metropolitan study areas across the United States. *Circular*. <https://doi.org/10.3133/cir1373>
- Corporate Watch (2006). What’s Wrong with Corporate Social Responsibility? A Corporate Watch Report. *Corporate Watch*. <https://corporatewatch.org/wp-content/uploads/2017/09/CSRreport.pdf>.
- Curriero, F. C., Wychgram, C., Rebman, A. W., Corrigan, A. E., Kvit, A., Shields, T., & Aucott, J. N. (2021). The Lyme and Tickborne Disease Dashboard: A map-based resource to promote public health awareness and research collaboration. *PLoS ONE*, 16(12).

- Daley, R. M. (2003). Revitalizing Chicago Through Parks and Public Spaces [Place Views]. *Places*, 15(3), 26-29.
<https://escholarship.org/uc/item/8rd7b2xv>
- Daskolia, M., Dettori, G., & Lejano, R. P. (2017). Digital Urban Storytelling. In A. Russ & M. E. Krasny, *Urban Environmental Education Review* (1st ed., p. 330). Cornell University Press. <http://www.jstor.org/stable/10.7591/j.ctt1qv5qhq>
- Dyball, R., Brown, V. A., & Keen, M. (2007). Towards sustainability: five strands of social learning. In A. E. J. Wals (Ed.), *Social Learning towards a Sustainable World* (2nd ed., pp. 181–194). Wageningen Academic Publishers.
- Gladwin, D. (2020). Digital storytelling going viral: using narrative empathy to promote environmental action. *Media Practice and Education*, 21, 275–288. <https://doi.org/10.1080/25741136.2020.1832827>
- Harnecker, M., Bartolomé José, & Fuentes, F. (2019). Chapter I. What We Mean by Decentralized Participatory Planning. In *Planning from below: A decentralized participatory planning proposal* (pp. 20–25). essay, Monthly Review Press.
- Hart, P., & Keen, M. (2007). Social learning as action inquiry: exploring education for sustainable societies. In A. E. J. Wals (Ed.), *Social Learning towards a Sustainable World* (2nd ed., pp. 313–329). Wageningen Academic Publishers.
- Hazen & Sawyer. (2022). Integrated Water and Sewer Master Plan for Quito, Ecuador.
- INEC. (2021). PROYECCIONES A NIVEL CANTONAL POR SEXO Y GRUPOS DE EDAD. <https://sni.gob.ec/proyecciones-y-estudios-demograficos>
- INEC. (2017). PROYECCIONES REFERENCIALES DE POBLACIÓN A NIVEL CANTONAL 2010-2030. <https://sni.gob.ec/proyecciones-y-estudios-demograficos>
- INEC. (1990-2010). Base de Datos – Censo de Población y Vivienda. [Base de Datos – Censo de Población y Vivienda | \(ecuadorencifras.gob.ec\)](https://ecuadorencifras.gob.ec)
- Instituto Geográfico Militar (IGM). (2013). Mapas de Mejía, Rumiñahui, y Quito.
- Hilton, J., O'Hare, M., Bowes, M. J., & Jones, J. I. (2006). How green is my river? A new paradigm of eutrophication in Rivers. *Science of The Total Environment*, 365(1-3), 66–83. <https://doi.org/10.1016/j.scitotenv.2006.02.055>
- Hoogesteger, J. (2013). *Movements against the current Scale and social capital in peasants' struggles for water in the Ecuadorian Highlands* [Wageningen University]. <https://edepot.wur.nl/266201>
- Hoogesteger, J. (2016). NGOs and the Democratization of Ecuadorian Water Governance: Insights from the multi-Stakeholder Platform el Foro de los Recursos Hídricos. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, 27(1), 166–186. <https://doi.org/10.1007/s11266-015-9559-1>

- Igwe, P. U., Chukwudi, C. C., Ifenatuorah, F. C., Fagbeja, I. F., Okeke, C. A. (2017). A Review of Environmental Effects of Surface Water Pollution. *International Journal of Advanced Engineering Research and Science (IJAERS)*, 4(12), 128-137. <https://ijaers.com/detail/a-review-of-environmental-effects-of-surface-water-pollution/>
- Jones, C. (2010). Archival data: Advantages and disadvantages for research in psychology. *Social and Personality Psychology Compass*, 4(11), 1008–1017.
- Lynch, K. A. (2001). *Environmental Engagement and Conservation in Southern Ecuador: Constructing an Engaged Political Ecology Approach* [Ph.D. Dissertation, University of Florida]. <https://ufdc.ufl.edu/UFE0000331/00001/pdf/0>
- McCloskey, D. J. (2018, December 6). *Community Engagement: Definitions and Organizing Concepts from the Literature*. Agency for Toxic Substances and Disease Registry. https://www.atsdr.cdc.gov/communityengagement/pce_what.html
- Metropolitan Institute of Urban Planning INPU - MDMQ. (2018). *Visión de Quito 2040 y su Nuevo Modelo de Ciudad* (1st ed.). Municipality of the Metropolitan District of Quito.
- Ministerio del Ambiente (MAE), Agua y Transición Ecológica. (2022). *Conoce el Sistema Nacional de Áreas Protegidas -SNAP*. <https://www.ambiente.gob.ec/areas-prtegidas/>
- Moiseenko, T. I. (2010, May 20). Effect of toxic pollution on fish populations and mechanism of maintaining population size. *Russian Journal of Ecology* (41), 237-243.
- Murray, S. (1997). Urban and peri-urban forestry in Quito, Ecuador: A case study. Food and Agriculture Organization of the United Nations, Forestry Dept.
- Nurhayati, A., Aisah, I., & Suprianta, A. K. (2020). Community-Based Environmental Education in Coastal Regions and its Role in the Conservation of Fisheries Resources in Indonesia. *International Journal of Conservation Science*, 11(4), 1103–1114.
- Parker, H., & Oates, N. (2016, February). *How do healthy rivers benefit society?: A review of the evidence*. Retrieved March 3, 2022.
- Riverfront Parks Now. (2020). *Economic Impact of Riverfront Parks*. Riverfront Parks Now. <https://www.riverfrontparksnow.org/wp-content/uploads/2020/07/Economic-Impact-of-Riverfront-Parks.pdf>
- Salazar, E., Henríquez, C., Sliuzas, R., & Qüense, J. (2020). Evaluating Spatial Scenarios for Sustainable Development in Quito, Ecuador. *ISPRS International Journal of Geo-Information*, 9(3), 141. <https://doi.org/10.3390/ijgi9030141>
- SEPA. (2015). *SEPA Position Statement to support the implementation of the Water Environment (Controlled Activities) (Scotland) (Position Statement and Supporting Guidance WAT-PS-06-02)*. https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf
- Schreurs, E., Koop, S., & van Leeuwen, K. (2018). Application of the City Blueprint Approach to assess the challenges of water management and governance in Quito (Ecuador). *Environment, Development and Sustainability*, 20(2), 509–525. <https://doi.org/10.1007/s10668-017-9916-x>

- Selman, P., Carter, C., Lawrence, A., & Morgan, C. (2010, September 15). Reconnecting with a recovering river through imaginative engagement. *Ecology and Society*. Retrieved February 3, 2022, from <http://www.ecologyandsociety.org/vol15/iss3/art18/>
- Serrano, J. (2022, February 7). Proyecto del Rio San Pedro D22. personal.
- Sun, P., Hou, D., & Sun, H. (2019). Responsibility and sharing the cost of cleaning a polluted river. *Mathematical Methods of Operations Research*, 89, 143–156. <https://doi.org/10.1007/s00186-019-00658-w>
- Tabios, G. Q., & David, C. (2002). The cases of Angat, Laguna, Batangas and Cebu City: Competing uses of water. *Development Research News*, XX(8), 1–6.
- Tickner, D., Parker, H., Moncrieff, C. R., Oates, N. E., Ludi, E., & Acreman, M. (2017). Managing rivers for multiple benefits—a coherent approach to research, policy, and planning. *Frontiers in Environmental Science*, 5. <https://doi.org/10.3389/fenvs.2017.00004>
- Tulloch, V. J. D., Tulloch, A. I. T., Visconti, P., Halpern, B. S., Watson, J. E. M., Evans, M. C.,
- Voloshenko-Rossin, A., Gasser, G., Cohen, K., Gun, J., Cumbal-Flores, L., Parra-Morales, W., Sarabia, F., Ojeda, F., Lev, O. (2015). Emerging pollutants in the Esmeraldas watershed in Ecuador: discharge and attenuation of emerging organic pollutants along the San Pedro-Guayllabamba-Esmeraldas rivers. *Environmental Science: Processes & Impacts*, 17, 41-53.
- World Health Organization. (2004). *Guidelines for Drinking-water Quality* (3rd ed.).

Appendix A: List of Interviews

Interviewee	Interview Date	Title
Andres Alvarado	April 1, 2022	PhD in Applied Biological Sciences, University of Ghent, Belgium
Antonio Morales	April 18, 2022	Historian, Mejia Canton
Daniela Rosero-Lopez	March 17, 2022	PhD in Ecohydrology, Cornell University
Eduardo Toral-Contreras	April 6, 2022	Technical Secretary of FONAPA
Fernando Palacios	April 19, 2022	Environmental Director of Tumbaco
Jorge Juan Anhalzer	April 18, 2022	Community Member
Jose Luis Chiriboga	March 28, 2022	Environmentalist
Maria Barragan	March 30, 2022	Community Member
Natalia Alvarado	March 29, 2022	Ph.D candidate in Sustainability and Urban Regeneration, Universidad Politécnica de Madrid
Pablo Palacios	March 18, 2022	President of Funación Arcandina
Patricio Chambers	March 30, 2022	Guayllabamba Waterkeeper
Rolando Celleri	March 17, 2022	PhD in Hydrology, Catholic University of Leuven, Belgium
Shuber Aguirre	April 19, 2022	Chicken Processing Plant Manager - Uyumbicho
Ximena Palomeque	April 6, 2022	PhD in Forestry Sciences, Technical University of Munich

Appendix B: Environmental Research and Management Questions

Grand Tour Question:

1. Can you tell me about how water resources are managed and protected in your municipality/province? Are there any notable strengths or weaknesses?

¿Puede contarme cómo se gestionan y protegen los recursos hídricos en su municipio/provincia? ¿Alguna fortaleza o debilidad notable?

Guiding Questions:

2. What are the protections given by the national government to your city's rivers?
¿Cuáles son las protecciones dadas por el gobierno nacional en relación con los ríos de su ciudad?
3. What are the protections given by the local governments to your city's rivers?
¿Cuáles son las protecciones dadas por los gobiernos locales relacionadas con los ríos de su ciudad?
4. What have been the impacts of these protections?
¿Cuáles han sido los impactos de estas protecciones?
5. Are there any gaps in these protections either in writing or in practice?
¿Hay alguna laguna en estas protecciones, ya sea por escrito o en la práctica?
6. Are there any planned protections that you are aware of?
¿Hay alguna protección planificada que conozca?
7. How are conservation areas or protected rivers determined?
¿Cómo se determinan las áreas de conservación o los ríos protegidos?
8. Can you talk to me about current and planned treatment facilities or other major construction (such as hydroelectrics) on the river and how it has impacted the surrounding community and the river itself?
¿Puede hablarme sobre las instalaciones de tratamiento actuales y planificadas u otra construcción importante (como las hidroeléctricas) en el río?

9. Are there potential/new/existing important plans and/or regulations that we should know about? Do regulations support the plans, and are they enforced?

¿Existen planes y/o regulaciones importantes potenciales/nuevos/existentes que debemos conocer? ¿Las regulaciones respaldan los planes y se aplican?

10. Do you know of any other resources that could prove to be beneficial for gathering information/data on the Río San Pedro history?

¿Conoce otros recursos que podrían resultar beneficiosos para recopilar información/datos sobre la historia del río?

Appendix C: Community Attitudes and Experiences Questions

Grand Tour Question:

1. Would you be willing to talk about your personal stories regarding the San Pedro River?
¿Podría contarnos sus historias personales sobre el río San Pedro?

Guiding Questions:

2. How do you interact with the river in your daily life?
¿Cómo interactúas con el río en tu vida diaria?
3. How was the river previously used before it was contaminated? How did you personally utilise it?
¿Cómo se usaba el río antes de que se contaminara? ¿Cómo lo utilizaste personalmente?
4. How has the river changed from when you were young to today?
¿Cómo ha cambiado el río desde que eras joven hasta hoy?
5. How would you rate (1-5) the severity of the changes exhibited by the Río San Pedro over the last 5 - 30 years?
¿Cómo calificaría la gravedad de los cambios exhibidos por el Río San Pedro en los últimos 5 a 30 años?
6. How has this change impacted your daily livelihood? How has this impacted the communities daily livelihood as well?
¿Cómo ha impactado este cambio en su sustento diario? ¿Cómo ha impactado este cambio en el sustento diario de la comunidad también?
7. Why did the river change? What changed around the river?
¿Por qué cambió el río? ¿Qué cambió alrededor del río?
8. Do you have a special memory of using the river and what lies around it?
¿Tiene un recuerdo especial de usar el río y lo que está alrededor del río?
9. How has the river emotionally changed in the hearts of people over generations?
¿Cómo ha cambiado emocionalmente el río en los corazones de las personas durante generaciones?
10. How has the community's relationship and attitudes changed?

¿Cómo han cambiado la relación y las actitudes de la comunidad?

11. Do you know of any other resources or people that could prove to be beneficial to talk to for gathering information on the Río San Pedro's impact on the community and its members?

¿Conoce algún otro recurso o persona que pueda resultar beneficioso para hablar con ellos para recopilar información sobre el impacto del Río San Pedro en la comunidad y sus miembros?

Appendix D: Story Collection Template (English)

We are a group of four students from the United States working with the Kingue Adventure School and we are collecting information and stories along the San Pedro River. For more information about this project, please visit: [here](#). Submissions will be used for research on community perspectives of the river and published publicly on kingue-edu.org with your consent. First name, age will be collected for research but will not be shared. If you do not feel comfortable with any question, please skip. If you have any difficulties with the form, you can contact us via email or WhatsApp (gr-kingued22@wpi.edu or +593 96 377 7587)

Please share with your family and friends if they have stories!

Name?

Email or WhatsApp (optional)

Years

Under 18 years old

18 to 25 years old

26 to 40 years

41 to 65 years

Over 65 years old

Share with us a story, or multiple stories about the San Pedro River, telling us about your personal experiences with the river.

Upload a video or audio recording of your story

(Upload file)

If you cannot record, please author your story about the San Pedro River here

Where did this story happen?

Anything else you'd like to share?

Consent Question:

Submissions will be used for research on community views of the river and published publicly on a digital map on kingue-edu.org with your consent. First name, age, and contact information are collected for research but will not be published. For more information about this click: [here](#). Please indicate below if you agree with these conditions:

I agree for my video/audio/writing to be publish publicly

I agree for my video/audio/writing to be used for research but not made public

I do not agree to the use of my story

Appendix E: Story Collection Template (Spanish)

Somos un grupo de cuatro estudiantes de los Estados Unidos trabajando con Kingue Escuela de Aventura y estamos recopilando información e historias a lo largo del río San Pedro. Para obtener más información sobre este proyecto, visite: [aquí](#). Los envíos se utilizarán para investigar las perspectivas de la comunidad sobre el río y se publicarán públicamente en [kingue-edu.org](#) con su consentimiento. El nombre y la edad se recopilaron para fines de investigación, pero no se compartirán. Si no se siente cómodo con alguna pregunta, salte. Si tiene alguna dificultad con el formulario, puede contactarnos por correo electrónico o WhatsApp (gr-kingued22@wpi.edu o +593 96 377 7587)

¡Comparta con su familia y amigos si tienen historias!

¿Nombre?

Correo electrónico o WhatsApp (opcional)

Años

Menores de 18 Años de Edad

18 a 25 años

26 a 40 años

41 a 65 años

Mayores de 65 años

Comparta con nosotros una historia o varias historias sobre el río San Pedro, contándonos sus experiencias personales con el río.

Sube un video o una grabación de audio de tu historia:

(Subir archivo)

Si no puede grabar, por favor escriba su historia sobre el río San Pedro aquí:

¿Dónde sucedió esta historia?

¿Algo más que quieras compartir?

Pregunta de consentimiento:

Los envíos se utilizarán para investigar las opiniones de la comunidad sobre el río y se publicarán públicamente en un mapa digital en kingue-edu.org con su consentimiento. El nombre, la edad y la información de contacto se recopilan para fines de investigación, pero no se publicarán. Para más información acerca de esto, haz click aquí. Indique a continuación si está de acuerdo con estas condiciones:

Acepto que mi video/audio/escritura se publique públicamente

Acepto que mi video/audio/escritura se use para investigación, pero no se haga público

No estoy de acuerdo con el uso de mi historia.

[Informed Consent/Additional Information \(Spanish\):](#)

¡Muchas gracias por su interés en nuestra encuesta!

Somos un grupo de cuatro estudiantes del Instituto Politécnico de Worcester en los Estados Unidos trabajando con Kingue Escuela de Aventura en Tambillo. Estamos recopilando información e historias a lo largo del río San Pedro.

El propósito de nuestro proyecto es informar e inspirar la conciencia, acción, y educación de la comunidad acerca de la contaminación del río San Pedro, mediante la recopilación y publicación digital de información e historias sobre el río San Pedro.

El propósito de esta encuesta es recopilar historias que tenga sobre el río, ya sean personales o comunitarias, para comprender cómo era el río antes de que se contaminara severamente y cómo ha cambiado.

Las envíos pueden ser de video, audio, o escritas. Los envíos se utilizarán para la investigación sobre las perspectivas comunitarias del río y se publicarán públicamente en un mapa digital en kingue-edu.org con su consentimiento. El nombre y la edad se recopilarán para la investigación, pero no se publicarán ni compartirán. Si no se siente cómodo con alguna pregunta, por favor saltar la. Si se utiliza para investigación, se puede incluir en nuestro informe una transcripción anónima de la entrevista. Si no desea que su envío se publique públicamente y solo se use para investigación, indíquelo en la encuesta.

Su participación en esta investigación es voluntaria, si en algún momento se siente incómodo tiene derecho a revocar este formulario de consentimiento y su envío. Si tiene preguntas sobre la investigación, comuníquese con los investigadores del equipo lo antes posible. (grkingued22@wpi.edu o +593 96 377 7587)

Agradecemos su participación y ayuda en nuestro esfuerzo. Esperamos que nuestro trabajo pueda ayudar en la restauración del río San Pedro.

Appendix G: Maps of Infrastructure

All maps within this appendix were downloaded from Instituto Geográfico Militar (IGM) – Ecuador and are not products of our team.

