ENS 236
Restoration Ecology

Restoring The Big River

A proposed restoration plan for Sapangdaku River in Toledo City
that has been threatened by Climate Change, Sand & Gravel Quarrying and Urbanization

Presented by:
Mark A. Cabanlit & Rhee S. Telen

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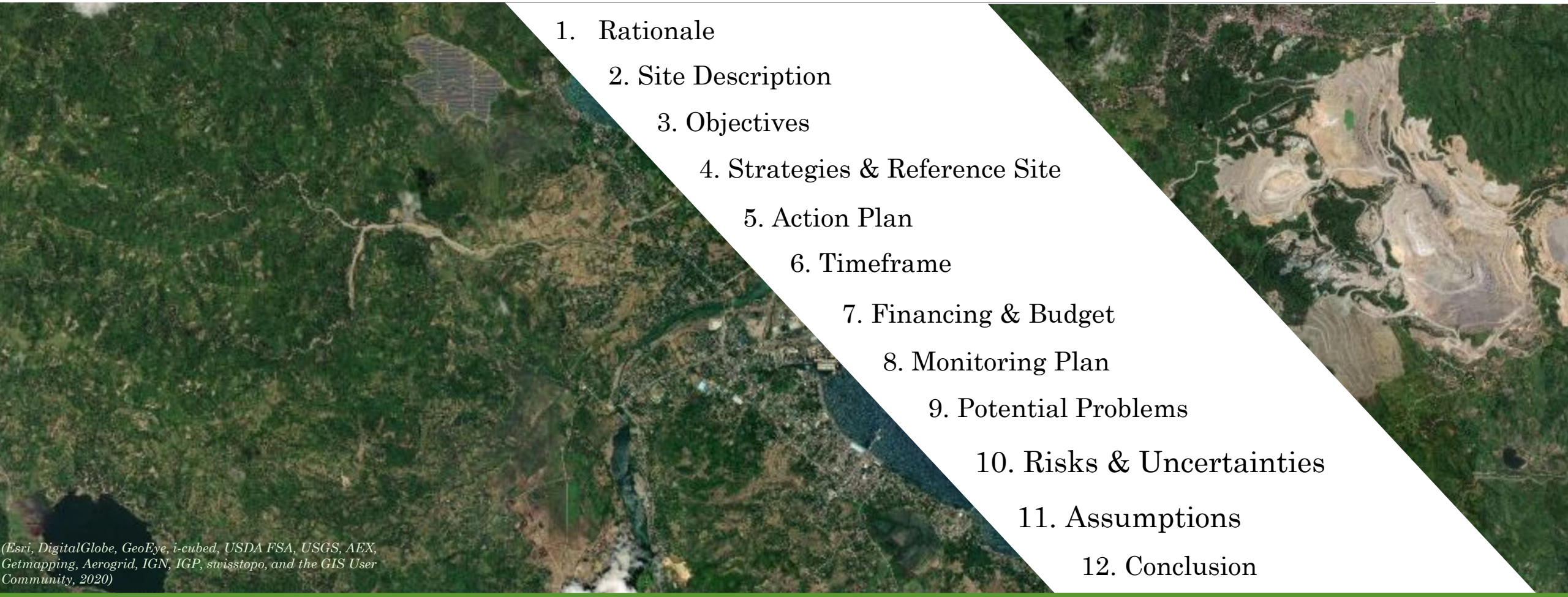
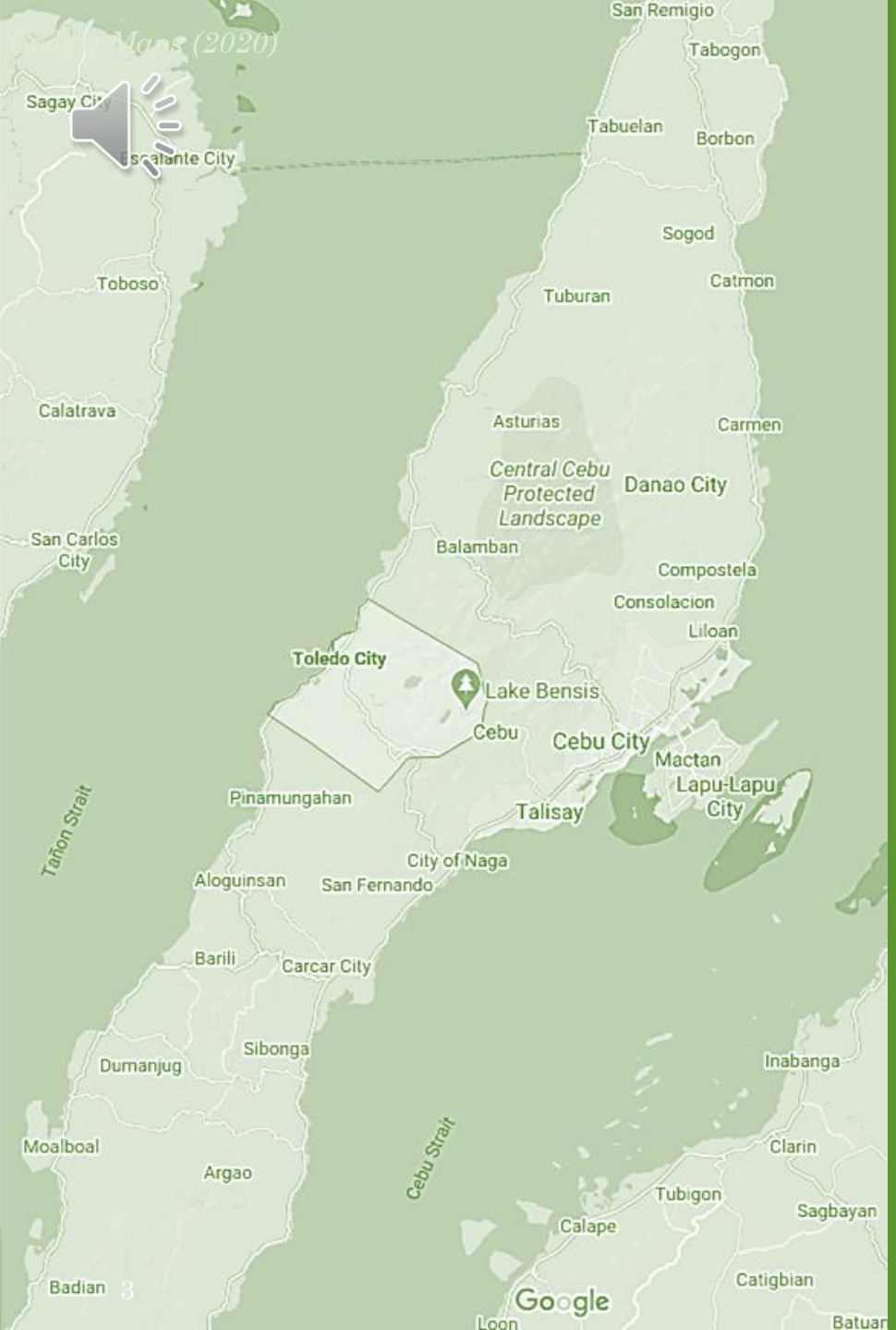


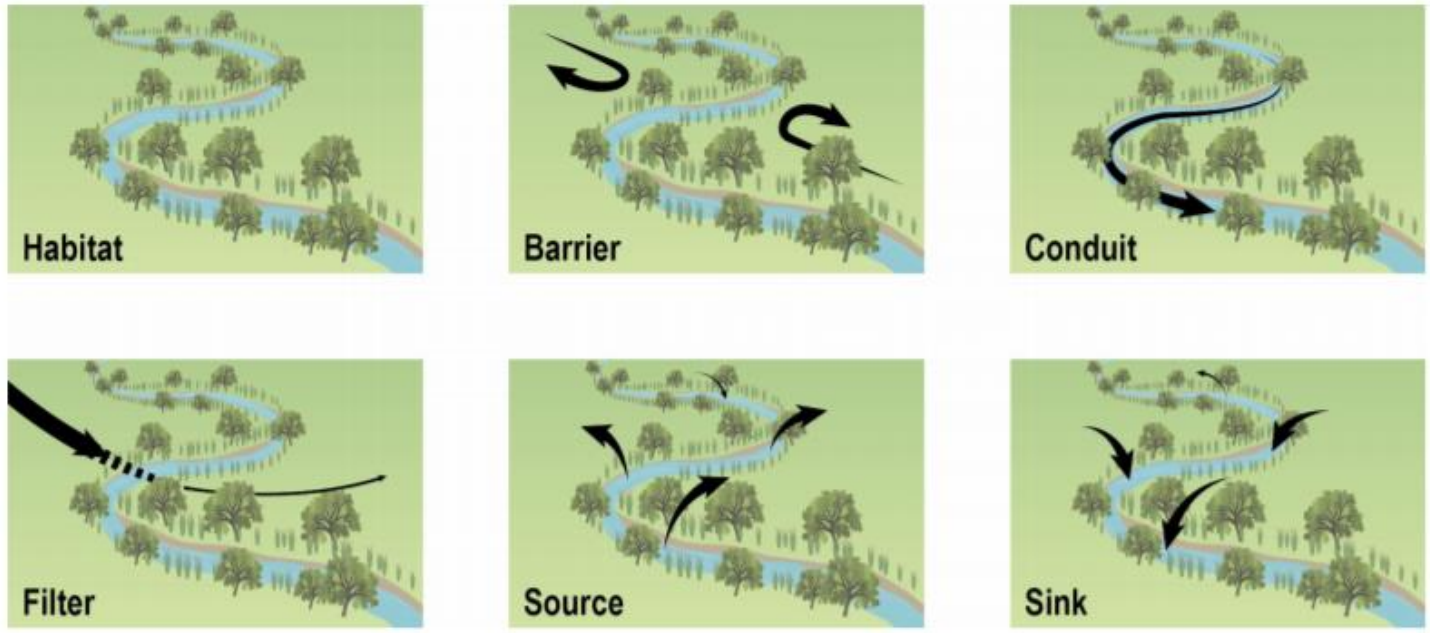
(Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, 2020)



Rationale

Toledo City is the only city in Cebu Province that is situated on the Western seaboard facing Negros Oriental, while the remaining cities are in the East (Danao, Mandaue, Lapu Lapu, Cebu, Talisay, Naga and Carcar, and on the North and Easter side (Bogo).

Toledo City produces:Copper, gold, silver, red burning clay, marble, cement raw materials, bentonite, limestone, marbleized limestone, sand, gravel, coconuts and buri, pandan leaves, nito stalks, rice stalks, buri palms, seedlings, etc.



Source: Adapted from FISRWG, 1998

(World Wide Fund for Nature (WWF), General Institute of Water Resources and Hydropower Planning and Design (GIWP), & UNESCO, 2016)

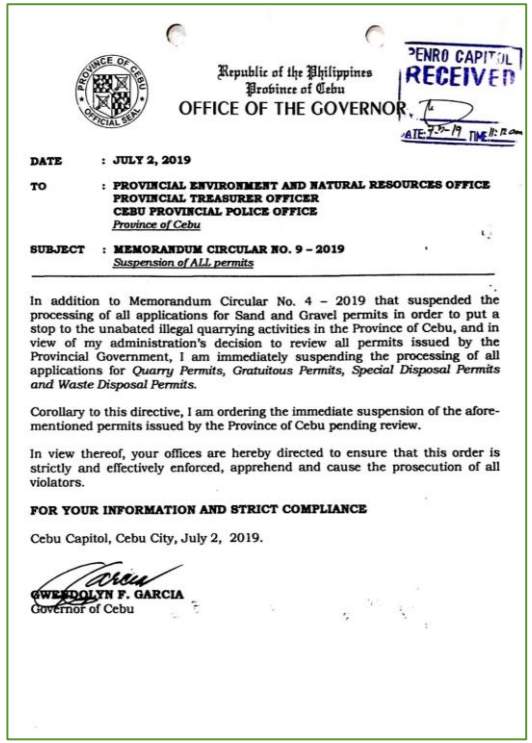
Why Restore?

River restoration is the re-establishment of natural physical processes, feature and physical habitats of a river system.

River ecosystems perform a number of critical ecosystem functions.

These functions can rely on any and all of the various parts that make up a river ecosystem.

Why Restore Now?



Republic of the Philippines
Province of Cebu
OFFICE OF THE GOVERNOR

PENRO CAPITOL RECEIVED
DATE 7-5-19 TIME 11:12 am

DATE : JULY 2, 2019

TO : PROVINCIAL ENVIRONMENT AND NATURAL RESOURCES OFFICE
PROVINCIAL TREASURER OFFICER
CEBU PROVINCIAL POLICE OFFICE
Province of Cebu

SUBJECT : MEMORANDUM CIRCULAR NO. 9 – 2019
Suspension of ALL permits

In addition to Memorandum Circular No. 4 – 2019 that suspended the processing of all applications for Sand and Gravel permits in order to put a stop to the unabated illegal quarrying activities in the Province of Cebu, and in view of my administration's decision to review all permits issued by the Provincial Government, I am immediately suspending the processing of all applications for *Quarry Permits, Gratuitous Permits, Special Disposal Permits and Waste Disposal Permits.*

Corollary to this directive, I am ordering the immediate suspension of the aforementioned permits issued by the Province of Cebu pending review.

In view thereof, your offices are hereby directed to ensure that this order is strictly and effectively enforced, apprehend and cause the prosecution of all violators.

FOR YOUR INFORMATION AND STRICT COMPLIANCE

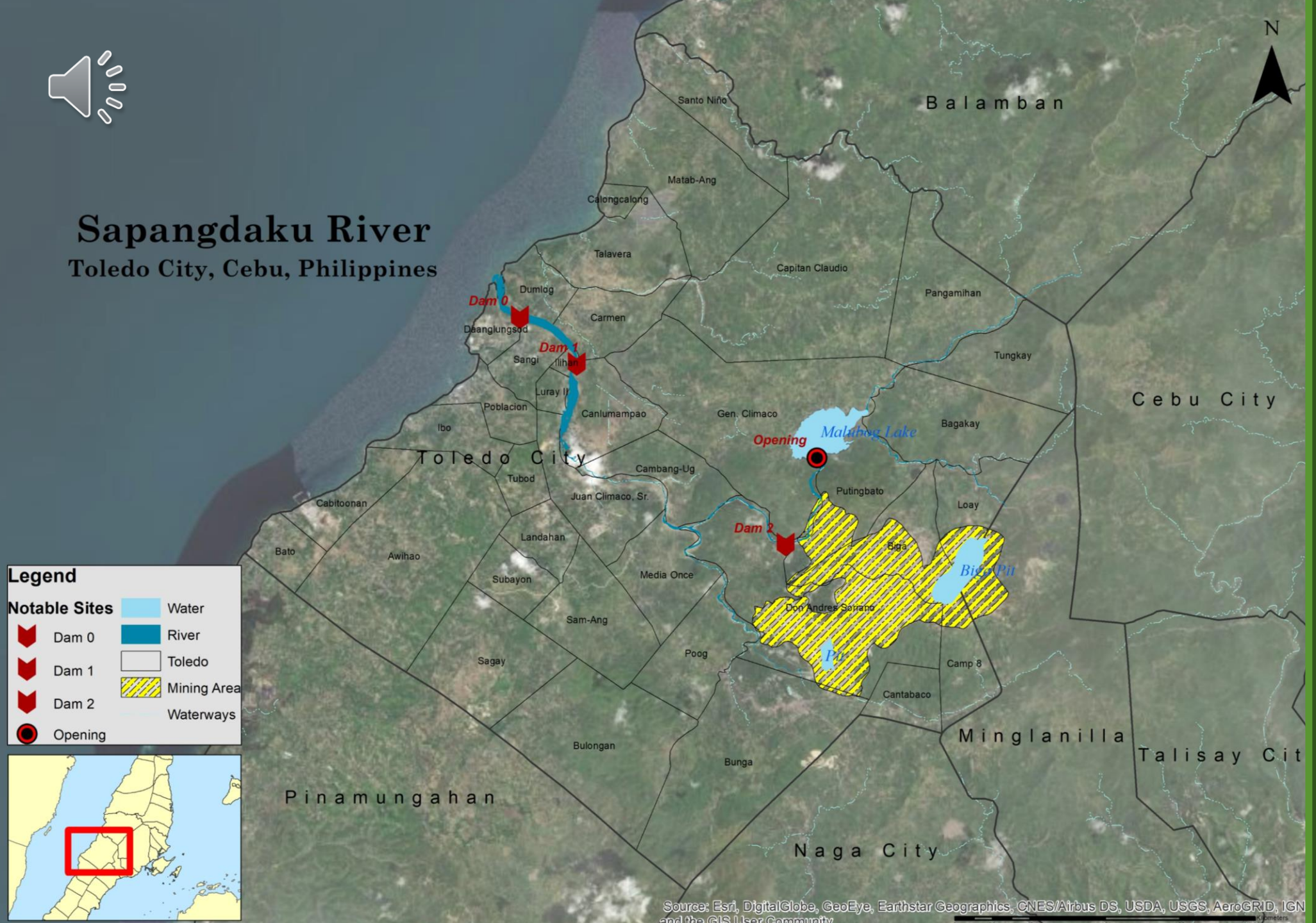
Cebu Capitol, Cebu City, July 2, 2019.

GWENDOLYN F. GARCIA
Governor of Cebu

A ban on sand and gravel quarrying has been implemented in the province of Cebu as of July last year through the issuance of Memorandum Circular 4 and 9 S 2019.

The reason for the implementation of the ban may not be entirely of ecological reason but rather of political and financial gains.

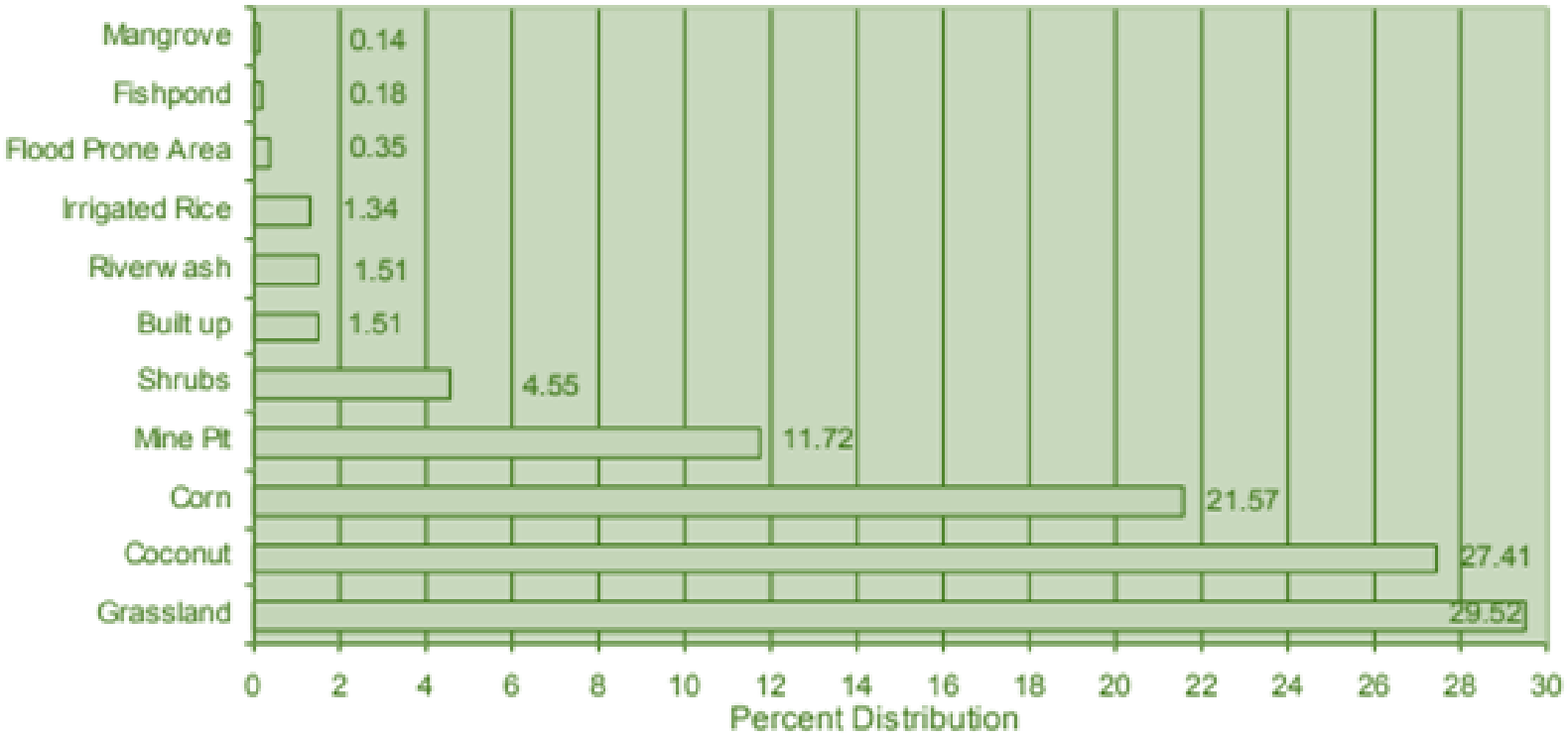
However, due to the climate crisis that the planet is experiencing, we must act now before it's too late.



Site

The river cuts across at least 7 Barangays of the city. Within these barangays, there were around 7 Sand and Quarry extraction site within the river systems.

At least 2 gabion dams were also constructed to prevent siltation to reach the marine waters.



Land Use

Population is highest in the coastal barangays where most of the barangays are located. About one fourth of the total population is located in the six mining host barangays. The five upland barangays have the least population.

Approximately 80 % of the total land area of Toledo City is classified as alienable and disposable (A&D) lands and the remaining 20%, timberland.

Environmental Science for Social Change, 2008

Toledo City

Toledo City has a total land area of 17,400 hectares subdivided into 38 barangays, classified into five groups based on their geographical location in relation to Atlas mining impact.

Host mining communities	Sapangdaku River headwater communities	Downstream Sapangdaku River communities	Coastal barangays	Other communities
Don Andres Soriano (DAS) Biga Cantabaco Loay Malubog (Gen. Climaco)	Bunga Campo 8 Pangamihan Poog Tungkay	Cambang-ug Canlumampao Carmen Ilihan Juan Climaco Sr. Media Once Puting Bato Sangi Landahan	Bato Cabitoonan Calongcalong Daanglungsod Dumlog Ibo Luray II Maingit (Santo Nino) Matab-ang Poblacion Sam-ang Talavera	Awihao Bulongan Capitan Claudio Landahan Sagay Sam-ang Subayon Tubod

Environmental Science for Social Change, 2008

Barangay	Population
Dumlog	5288
Daanlungsod	2933
Sangi	4201
Carmen	3858
Canlumampao	4170
Ilihan	3206
Magdugo	6279
Total	**29935**

Threats

Save Hinulawan River, 2018

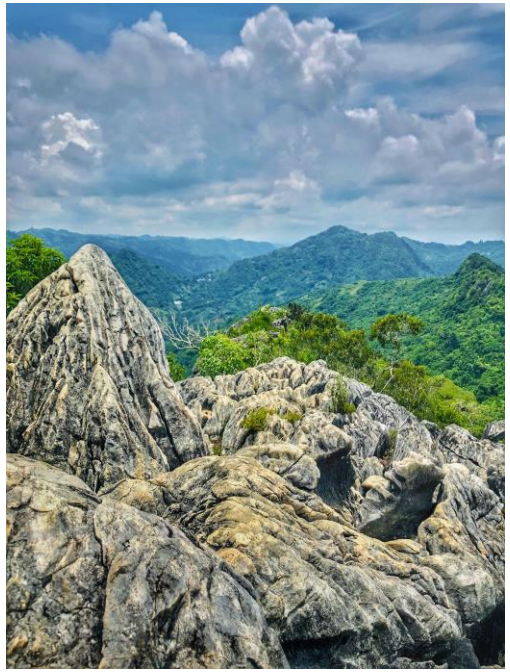
Extraction of Sand and Gravel, Removal of vegetation, creation of Pavements, roadways due to heavy equipment crossing within riparian zones, creating fragmentation.

Contamination of water and sediments; severe erosion and mass wasting processes in unstable landforms (pits, stockpiles, waste dumps);

Sediments coming from pits undergoing severe erosion that are washed into the creeks and rivers do not only worsen siltation in streams. These are also contaminated, thus re-contaminating the streams and when carried downstream, transport pollutants offsite.

Environmental Science for Social Change, 2008

Importance



Connects 2 Protected landscapes

In the ridge, Hinulawan river's tributary stream and creeks are connected to the Central Cebu Protected landscape. CCPL is one of the few protected landscapes in the Province which aims to conserve and preserve Native flora and fauna species at risk to extinction

Downstream, Hinulawan River is connected to Tanon Strait which is declared as a Protected Seascape since 1998. This is the largest marine protected area in the Philippines, home of 14 species of whales and dolphins which live within this special place.

History


Photo by Falco Negenman on Unsplash

Based on an interview with Architect Ahmed Lebumfacil, the administrator of the Save Hinulawan River Group:

- Years back, they can still catch danggit upstream.
- The mouth of the river was teeming with wild ducks
- A lot of these plants were still present: Nauclea orientalis and Pithecellobium dulce

The recent floods occured in Sapangdako river were on December 2015 (Typhoon Seniang) and December 2017 (Typhoon Nona). These said inundation incident caused to displace thousands of families living in beside the said river system, damages to residential and agricultural areas.


Photo by ThisisEngineering RAEng on Unsplash

Goals

Ecological Goal (Phase I)

To reestablish :

- Natural physical processes such as variation of flow and sediment movement.
- Features such as sediment sizes and river shape
- Physical habitats of a river system including submerged, bank and floodplain areas.

Holistic Goal (All Phases)

To promote wellness for the citizens of Toledo City living within the river by restoring their river and its ecological functions and to develop environmental consciousness leading towards a community-managed and sustainable river protection effort.

Objectives (Phase I-V)

I
- To facilitate the redirection the water stream to its proper flow, allowing occasional rise of water as a natural disturbance in the flood plain without causing further damage to the communities nearby.

II
- To analyze the feasibility of the structures and measures implemented in Phase I and check the flow from a control site without any current intervention as compared to the one test site in Phase I. If the results are optimal then proceed with replicating Phase I.

III
- To analyze and model the flow of the river now that the physical modifications have been made and to check and improve water quality .

IV
- To reintroduce historical species on the site such as *Nauclea orientalis, Pithecellobium dulce* & *Siganus canaliculatus* and to plant and reforest nearby forests to have stronger banks to prevent landslides.

V
- To employ sustainability in the restoration through institutionalization, educational partnerships, and to provide sustainable ecotoursim opportunities.


Photo by Charlein Cracia on Unsplash


Photo by Egor Myznik on Unsplash

General Strategies

& the Reference Site

Due to the extent of the damaged caused by sand and gravel extraction, construction of structures and other urban developments, the whole restoration project is subdivided into 5 different phases of action.

Each phase contains specific spatial and temporal set of objectives encompassing the river's physical, geological, chemical attributes as well as its biotic factors expected to be done in a span of 10 years.

But for this specific restoration, the restorers will only deal with the 1st phase (the physical attributes) which is scheduled to be completed in the next 3 years (2021-2024).

Reference Site

The restorers used the upland portion of the rivers (Ilag and Hinulawan tributary rivers) as the reference site.

Also, researches of other rivers in Cebu, such as the Badian river were also used to compare the status of the Hinulawan River as one of our measurement of success.

Badian River holds population of threatened endemic species including the endemic and restricted-rage, namely; Cebu Frill-wing, Black Shama, Cebu Hawk-owl, and Tube-nosed Fruit Bat. In 2016 the wildlife observed in the river can be classified into fifteen (15) groups of wildlife. A notable number of species came from Class Aves (26 species), Order Lepideptera (17 species), Class Gastropoda (16 species) and Order Odonata (10 species).

Phase I

River Restoration Measure	Active Restoration	Passive Restoration	Responsible Entity	Output	Outcome
Catchment management	Earthworks to create natural levees Massive plantation of different native plant and tree species to protect the river banks Selective construction of concrete flood control infrastructures to the densely populated areas near riverside	Revise and Improve Development plans of the City Government (CLUP, FLUP DRRM) Strict imposition of the Provincial Memorandum to stop all forms of sand and gravel quarrying in the Rivers Constant implementation of Monitoring and evaluation including all stakeholders and community members	City Government, Barangay officials, residents, CSOs NGOs, Business Contractors formerly extracted sand and Gravel in the area	Number of Bamboos and Native Trees are planted within riverbanks of site 1 Length of river banks upheaved and strengthened	Reduction of soil erosion cases in the riverbanks of site 1 Elimination of all forms of sand and gravel quarrying in the pilot site
Flow modification	Delineate zones of the river (Stream, River Bank, Riparian zone etc.) Installation of water level measuring measurement (Indigenous/Manual and High-Tech specialized sensors) Conduct conservative dredging to specific sites of the river basin			Fully delineated river zones in Site 1 Length of riverbed dredged Number of water monitoring devices installed	Reduction of flooding cases in nearby settlements and agricultural area Increased capacity of the Community to prepare and respond to any inundation incidences

Action Plan

River Restoration Measure	Active Restoration (to 7 other extraction sites)	Passive Restoration	Responsible Entity	Output	Outcome
Catchment management	Earthworks to create natural levees Massive plantation of different native plant and tree species to protect the river banks Selective construction of concrete flood control infrastructures to the densely populated areas near riverside	Modify the restoration activities based on the learnings from Phase I	City Government, Barangay officials, residents, CSOs NGOs, Business Contractors formerly extracted sand and Gravel in the area	Number of Bamboos and Native Trees are planted within riverbanks of other 7 sites Length of river banks upheaved and strengthened	Reduction of soil erosion cases in the riverbanks to other 7 sites Elimination of all forms of sand and gravel quarrying in the pilot site
Flow modification	Delineate zones of the river (Stream, River Bank, Riparian zone etc.) Installation of water level measuring measurement (Indigenous/Manual and High-Tech specialized sensors) Conduct conservative dredging to specific sites of the river basin			Fully delineated river zones in the other 7 sites Length of riverbed dredged Number of water monitoring devices installed	Reduction of flooding cases in nearby settlements and agricultural area Increased capacity of the Community to prepare and respond to any inundation incidences

Phase II (Replication)

Restoration Measure	Purpose	Active Restoration	Passive Restoration	Responsible Entity	Output	Outcome
Water Quality Management	Protect and improve water quality, including chemical composition, temperature, colifom count and presence of other particulates	Community drainage, sewerage and septage management Upland wetland restoration entrapment and collection of solid waste and regular monitoring for the presence of hazardous materials	Strict implementaion of the Watercode Adopt and localize water management policies from National Government and International Organizations	City Government, Barangay officials, residents, CSOs NGOs, Business Contractors formerly extracted sand and Gravel in the area	Percentage of communities with proper drainage and septage systems No of wetlands developed upstream	Water Quality Test Passed in several water quality assessments Absence of Solid waste and other particulates in the water

Phase III (Water Quality)

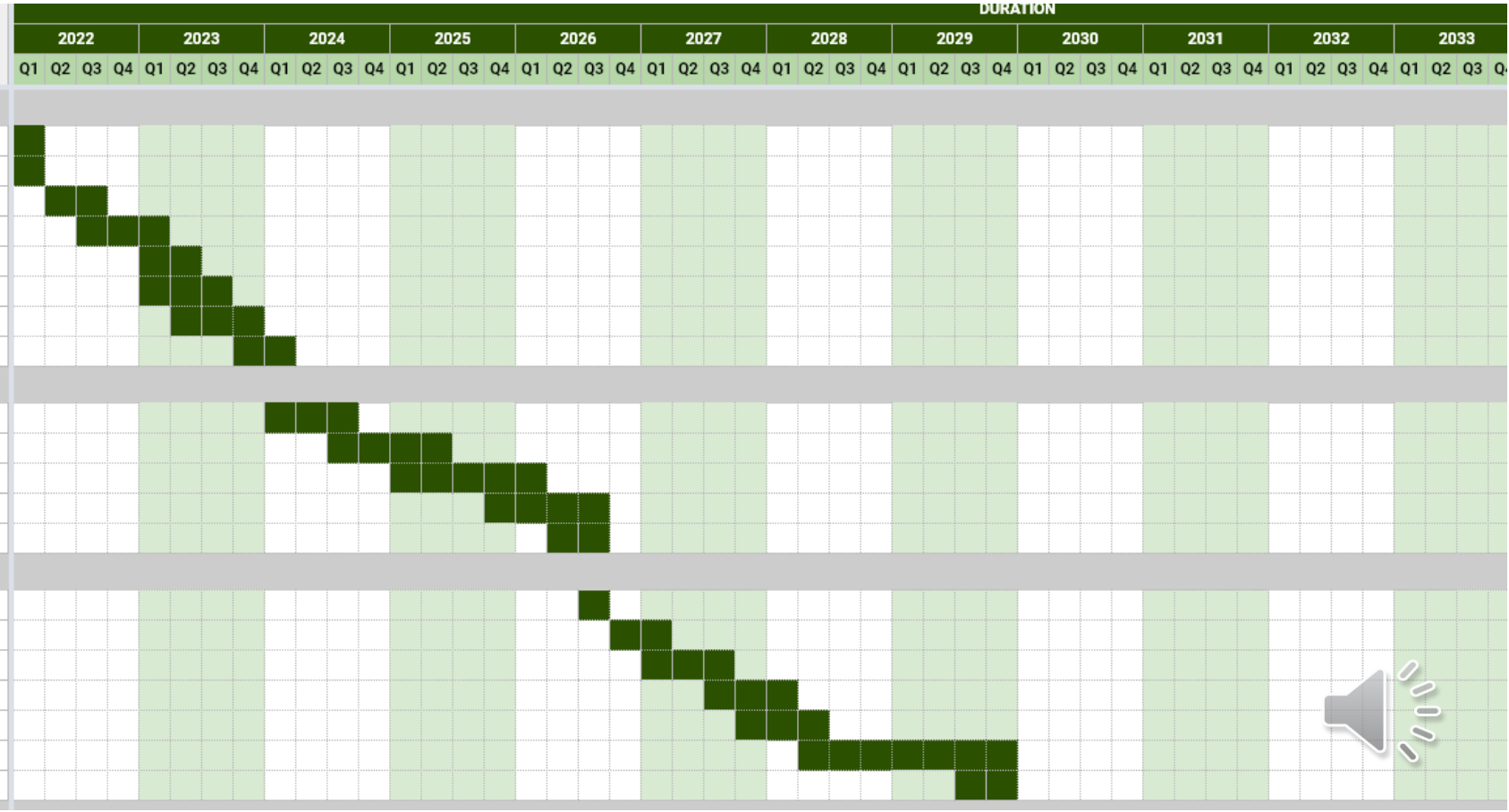
River Restoration Measure	Purpose	Active Restoration	Passive Restoration	Responsible Entity	Output	Outcome
Phase IV (Biodiversity - Reintroduction of Species) 2024 Onwards						
Reintroduction of Flora and Fauna species	To reactivate the ecosystem function services provided by the river though species protection and management	Reintroduction of species such as danggit, wild ducks as well as the native flora such as Nauclea orientalis (Bangkal) and Pithecellobium dulce (Camachile) that were previously thriving in the river.	Management and control of species growth Establishment of Protected zones and No dwelling zones	City Government, Barangay officials, residents, CSOs NGOs	No of flora and fauna species reintroduced in the entire stretch of the river system	Increased species biodiversity and mean density presence of other terrestrial species benefiting from the river ecosystem

Phase IV (Biodiversity)

River Restoration Measure	Purpose	Active Restoration	Passive Restoration	Responsible Entity	Output	Outcome
Phase V (Socio-Cultural - Sustainability, Education and Eco-Tourism) 2024 Onwards						
Sustainability, Education and Recreation	To ensure the sustainability of the project to the active engagement of community stakeholders as well as to become as a reference for other river restoration initiatives	Restocking of species And Redredging of riverbed Removal of concrete infrastructures if bioengineering initiaives took off efficiently	Constant monitoring and evaluation for regular assessment and adaptive management	City Government, Barangay officials, Community leaders and residents	Inventory of species present in the river system Levels of pollution, erosion and other river related incidences Maintained and accessible data of the entire river health, its features and processes	Increased number of researchers, tourists and excortions in the river Sustained Ecosystem funtion and stabilized structure without human intervention

Phase V (Sustainability)

TASK	TASK TITLE	DURATION (Q)
PHASE 1	**Physical Intervention**	
1.1	Meeting with Local Governemnt Unit	1
1.2	Meeting with DENR	1
1.3	Disccusion and Forum with the Community	2
1.4	Survey and Inspection of Site	3
1.5	Analysis and Removal of Physical Barries to River Flow	2
1.6	Earthworks, & Flood Control Structure	3
1.7	Delineation of River	3
1.8	Reevaluation of Plan	2
PHASE 2	**Replication of Physical Intervention**	
2.1	Analysis and Comparison of Phase 1 Test Site	3
2.2	Analysis and Removal of Physical Barries to River Flow	4
2.3	Earthworks, & Flood Control Structure	5
2.4	Delineation of River	4
2.5	Reevaluation of Plan	2
PHASE 3	**Water Flow & Water Quality**	
3.1	Water Sample Collection	1
3.2	Water Sample Analysis	2
3.3	Drainage Sewerage & Septage Management	3
3.4	Upland Wetland Restoration	3
3.5	Entrapment and Collection of Solid Waste	3
3.6	Monitoring	7
3.7	Reevaluation of Plan	2



Timeline

The plan is expected to run for 15 years with a reevaluation of goals, approach and targets for each phase in order to reassess if the project needs to adapt.

Phase	Duration
I	2 years
II	2 years and 9 months
III	3 years and 6 months
IV	6 years and 6 months
V	2 years and 3 months
Total	**15 years**

Financing & Budget

Phase I

River Restoration Measure	Activities	Costs	Source	Sub-total
Catchment management	Rental of Heavy Equipment and Manpower	Free (Exploiters Pay)	Private Contractors Companies	P 1,000,000.00
	Purchase of Seedlings	P 100,000.00	Government NGA	
	Management of Nursery	P 100,000.00	Government CLGU	
	Logistical needs during Planting activity	P 50,000.00	CSOs, NGOs	
	Labor and Materials for Flood Protection infrastructure	P 750,000	Government (Equipment shouldered by contractors, sand and gravel from dredging)	
	Honorarium for Monitoring Personnel	Free (Brgy Tanods)	Barangay LGU	
Flow modification	Hiring of GIS Specialist	Free	Government CLGU	P 250,000.00
	Rental of Heavy Equipment and Manpower	Free (Exploiters Pay)	Private Contractors Companies	
	Purchase of Water Level Measurement devices (Manual and Computerized)	P 200,000.00	CSOs, NGOs	
	Logistical needs for community coordination, Meetings etc.	P 50,000.00	CSOs, NGOs	
TOTAL COST (Phase I)				P 1,250,000.00

Element Of River Ecosystem	River Restoration Measure	Activities	Costs	Source	Sub-total
Replication	Catchment and Flow Modification	As stated in the action Plan. Subject to change depending on the result of the assessment in phase I	P 3,000,000.00	Stakeholders	P 3,000,000.00
Water Quality	Water Quality Management		P 1,000,000.00	Stakeholders	P 1,000,000.00
Biodiversity	Instream Species Management		P 1,000,000.00	Stakeholders	P 1,000,000.00
Socio-Cultural	Sustainability, Eco-Tourism		P 500,000.00	Stakeholders	P 500,000.00
				TOTAL (PHASE II-V)	P 5,500,000.00

Phase II-V 2024 Onwards

Local : Local Development Fund, Intelligence Fund, Local DRRM Fund

National Fund: Congressional Funds, People's Survival Fund,

NGOs, iNGOs CSOs, Private and Business present in the Locality working for Environmental Protection

Green Climate Fund, Soil and Water Conservation Foundation, Justice Peace Integrity of Creations Ramon Aboitiz Foundation, Quarry Operators' Free Services (Polluters and Exploiters Pay)

MONITORING TYPE	SCOPE	DETAILS	FREQUENCY	RESPONSIBLE ENTITY
Baseline	Current River status before restoration	Define and characterize the physical, ecological and sociological conditions of the entire river stretch This will include the historical accounts of the river attributes as a basis for comparison	Before Restoration commences	Restoration Team, City Environment and Natural Resources Office
Activity	Activities projected in the Action Plan for Phase I as per scheduled	Check each restoration activity if done properly following the stipulated timeline (Delineation, Dredging, Planting, Installation of Equipments etc.) Activities can be altered, changed or impeded anytime or as deemed necessary based on the conducted assessment and monitoring	**Monthly** Monthly reports should be submitted to the Technical Working group for Process Assessment	Restoration Team, Hired contractors
Financial	Expenses and Cost-Effectiveness	Monitor the expenses incurred in each activities done Locate and Assess which specific activity expenses can be realligned, Increase or Decrease the expenses according to the current situation and needs Identify new partners and stakeholders who could provide free services in relation to the activities to be done for the restoration Prepare a cost-benefit analysis of the overall expenses incurred for the entire duration of the restoration (Phase-1) and serve it as a basis for the next phases of the restoration	Monthly (For Expenses) Quarterly (For resource Mobilization) Post Restoration Phase-1/Year 3 (for Cost-Benefit Analysis)	Restoration Team's Technical Working Group, Partner CSOs, NGOs, City Government

Monitoring

To facilitate the redirection the water stream to its proper flow, allowing occasional rise of water as a natural disturbance in the floodplain without causing further damage to the communities nearby.

Monitoring Type	Scope	Details	Frequency	Responsible Entity
Impact	Assessment of the Expected output and outcome	Monitor the Geo-Physical factors of the river system compared to the previous contemporary status Check the parameters such as length of riverbed dredged, length of riverbanks altered, Number of plants species planted and grown Monitor the possible negative impacts created by the earth movemeths in the coastal areas (nearby delta, esturane ecosystem, coral reef within the municipality) Monitor the Socio-Economic impacts of the ongoing river restoration (Has the restoration affected the livelihood of the residents? Has the restoration impeded their domestic uses of the river, were there property enrcrouchment and other disturbances created due to the Restoration?)	Quarterly Quarterly reports should be submitted to the Technical Working group for assessment and planning Post Restoration Phase-1/Year 3 Report will include the overall assessment of the project's output based on the project's Goals and Objectives	Restoration Team's Technical Working Group, Partner CSOs, NGOs, City Government
Surveillance	Other Factors affecting Restoration	Monitor other external events that are happening in the upstream and other River tributaries Monitor the possible resumption of Illegal quarrying activities may it be manual labor or small scale companies Monitor weather conditions as well Socio-Political dimensions that could hamper the implementation of the restoration efforts	Constant/Regular from beginning to end Surveillance reports could be included in the overall monthly reports	Restoration Team's Technical Working Group, Partner CSOs, NGOs, City Government, Barangay Officials and Community Residents

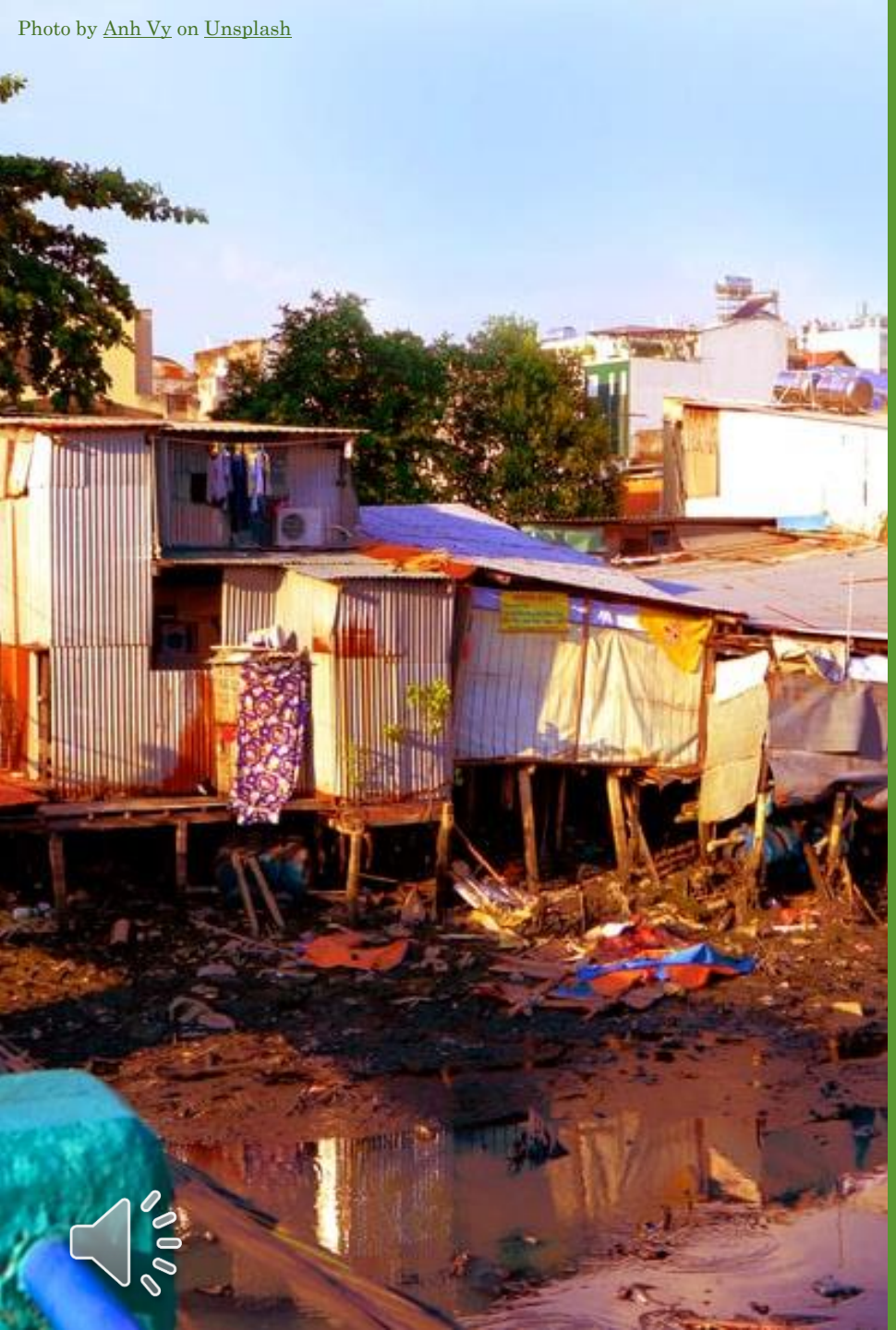


Photo by Anh Vy on Unsplash

Potential Problems

- There are a few potential problems that may arise with the restoration plan however, the plan is divided into five phases with allotted timeframe for a reevaluation of the plan so that people involved can adapt and modify the plan if necessary. However here are a few potential problems that may arise:
  - Relocation of residents near the river if necessary.
  - Extreme unreported contamination from previous mining activities
  - Removal of sand & gravel quarrying ban after term
  - ExcessiveFlooding

Risks and Uncertainties

- There are always going to be risks and uncertainties in doing restoration.
  - Cost might be too much
  - Duration might be too long but there are studies that are even longer like the 79 years study about men by Harvard that has been well funded, we believe that this one is a much noble cause since it involves the lives of not just men but the whole ecosystem.
  - Effects of climate change such as the rising of the sea level
  - Change in policies or unfavorable action from elected officials.


Photo by Tony Lam Hoang on Unsplash

Assumptions & Dependencies

- That the proposed budget will be approved
- The proposal does not take into account the possible externalities caused by copper mining.
  - The mill tailings are deposited to the Biga Pit Tailings Storage Facility (TSF), which continues to prove as a strong, safe, and secure facility for the mine. Overflow of excess water due to build-up of tailings mass is being channeled through a decant tower which passes through a series of sedimentation ponds before flowing into a combination of subterranean and above-ground pipelines discharging towards Hinulawan River and ultimately into the Sigpit Creek.
  - The water discharge permit was issued by the Department of Environment and Natural Resources in 2012. The water at Biga Pit has a PH level of 7.5 to 8 with fish species like tilapia thriving within. There are no reported storage leaks or containment breach at the Biga Pit TSF .

Conclusion

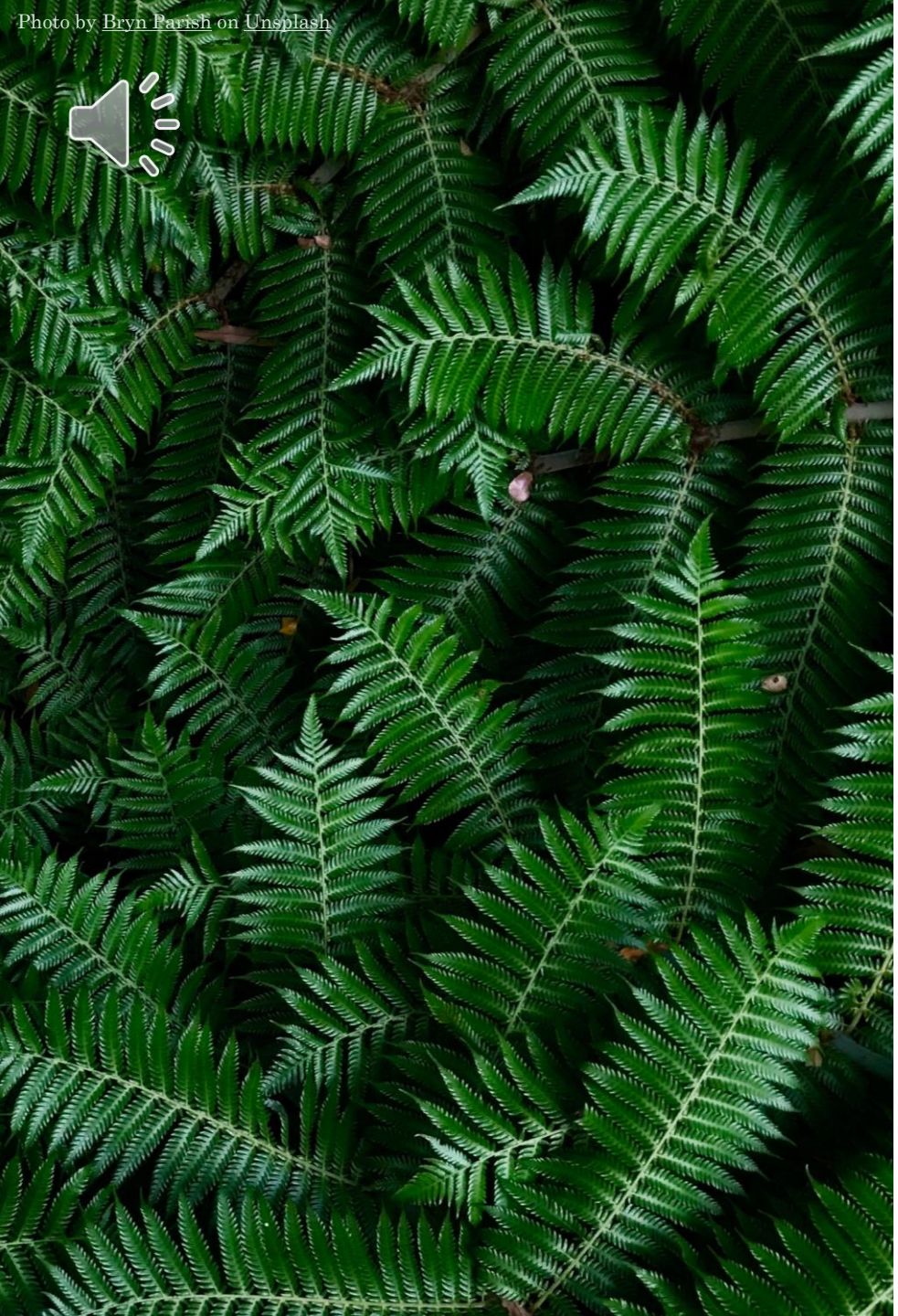
Sapangdako of Toledo city is considered one of the major river system in the Province of Cebu. With its length, Sapangdako plays a very important role in the maintenance of biodiversity as well as in providing different services to the communities surrounding it.

Despite the fact that the said river connects 2 Biggest protected areas in the country (CCPL and TSPS), rampant, excessive and ubiquitous exploitation has been done in the entire stretch of the river which started couple of decades ago.

With the Implementation of Memo Circulars 4 and 9 of 2019 of the Cebu Provincial Government - Stopping all sand and gravel extraction in the entire Province plus the suspension of all extraction permits, it is considered timely that all stakeholders to take action to protect and restore the previous pristine status of the river - home of danggit, wild ducks, and several endemic trees and other species native in Cebu and the Philippines.

As Sapangdako river stretches around 9.36KM paired with intense degradation due to the over and illegal extracion of Sand and Gravel, the Restoration Program is then divided into 5 Phases encompassing the aspects of Geophysical, Water Quality, Biodiversity and Sustainability, each with specific Goals, objective and specific activities to be done. Restoration Team will take the program step by step following the proposed phases. Each Phase is specially designed to undergo a full assessment and monitoring which will become the basis of the implementation of Phases II to V.

WIth the support of all stakeholders, considering all the risks and assumptions in the implementation of the program, this restoration effort will serve as the learning hub for a holistic, sustainable and long term initiative for the protection and management of river systems.



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