Engineers Without Borders Erosion Control Projects
Communities of Malingua Pamba, Tunguiche, and Guantugloma
Cotopaxi Province, Ecuador

Ecuador Group, Denver Professional Chapter

June 2017 Monitoring Update with Photolog

Background: Prior to intensive land use, the mountainous areas of the indigenous Kwicha Andean communities of Malingua Pamba and QuintaTunguiche, Cotopaxi Province, Ecuador, were vegetated with dense cloud forest which held the soils in place, augmented water supplies and provided firewood, building materials, and food products. Construction of roads and water supply systems as well as increased farming of steep slopes have resulted in many areas of soil erosion as well as occasional slope failures.

The Projects: The goal of the Erosion Control Team has been to empower the Community to implement and replicate low-cost and sustainable methods of erosion control based on locally-available materials. Erosion control work jointly conducted by the communities and EWB in 2012 and 2013 included:

- Native tree and shrub plantings to increase biodiversity
- Seeding of kikuyo, a naturalized African grass
- Planting of native sigsig grass hedges to promote water infiltration
- Installation of erosion control mats, both local and US-made
- Installation of live post and wicker grade control
- Construction of plunge pools, toe walls, rock vanes
- Construction of a discharge water spreader at a pressure break tank.

The projects were the start of a major community erosion control effort, resulting in planting of 7000 trees and shrubs, according to community leader Paulino Sacatoro. The community over-plants sites to allow for attrition. Sites 16 and 96 need follow-up maintenance, and much revegetation work remains to be done.

Conclusion: Overall, the project has resulted in benefit for the communities although much work remains. Soil stability has greatly increased at most sites due to survival of sufficient cover by native tree and shrub plantings and installation of erosion mats which have allowed establishment of volunteer native species as well as due to construction of live stake and boulder structures. No further road closures due to landslides have occurred. Problems remain where roadside drainage is poor, livestock grazing continues, or the site surface is bedrock.

Map of erosion control sites is attached to this document.

Photolog of Erosion Control Sites

Photographs by Laura Backus unless otherwise credited

Site 9, Malingua Yacu, GPS coordinates -0.823090, -78.852570

Culvert inlet

Erosion Problem	Project Activities	Vegetation planting survival	Stability of culvert and road	New erosion features	Road closures due to erosion
Heavy rains of 2011 caused landslide on slopes above stream. Debris and a large boulder washed into culvert inlet. High flows over-toped inlet and road.	Native tree and shrub plug planting along 10 m of stream banks above the culvert. Removal of all material clogging inlet.	Very low due to grazing.	Structure and banks are stable Culvert remains open, flows are not over-topping the road. Functionality: 100%	None	None

July 2012, pre-project. Note debris and large boulder from a landslide are clogging culvert inlet and forcing flows over the road.

June 2017, 4 years following removal of boulder and debris. Water continues to flow freely through culvert; flows have not over-topped road.

Site 9, Malingua Yacu Culvert Outlet

Erosion Problem	Project Activities	Vegetation	Structures	Stability of road and culvert	New erosion features	Road closures due to erosion
Storm flows at the pipe outfall eroding the base of the road fill slope.	installation of boulder plunge pool at culvert outlet to dissipate energy of storm flows.	Excellent growth of volunteer chilca is stabilizing slope.	Boulder plunge pool effective, allowing chilca growth.	Functionality: 75-100%	None	None

October 2012 view to north, pre-project. Note right side of wing wall is missing. Albert Kettner photo

October 2012, view to north, post-project. Note boulder plunge pool constructed to protect roadside from further erosion. Albert Kettner photo

June 2017, view to north, 5 years post-project. Note that construction of the boulder plunge pool allowed stabilization of road slope and culvert outlet, thus allowing excellent growth of volunteers chilca which further stabilizes the infrastructure.

Site 16 Tingo Water Spreader, GPS coordinates -0.827350, -78.8704

Erosion Problem	Project Activities	Stability of irrigation tank	New erosion features
Gulleying from leaking pipe overflow pipe was threatening stability of irrigation system pressure break tank.	Installation of perforated PVC pipe to spread out tank overflows.	Improved	None

July 2012, pre-implementation. Note pipe outlet from Tanque Tingo overflow pipe leakage is causing gulley erosion.

October 2013, 1 year post-implementation of perforated PVC pipe to spread out overflows from tank. Note village has fenced out animals.

June 2017, view to north of Tanque Tingo and gulley from north gulley, about 60 m distance. Note development of shrubby vegetation in gulley below Tanque Tingo.

Site 16 North Gulley, GPS coordinates -0.827900, -78.870360

Erosion Problem	Project Activities	Vegetation planting survival	Stability of pipeline	New erosion features
Gulleying caused by leaking irrigation pipe, then by pipe breakage	October 2012 - planting native trees and shrubs, installation of erosion matting	All plants washed out by pipe breakage. Pipe repaired in 2013; natural revegetation taking place	Irrigation pipeline and reconstructed trail appear stable.	Not known. Recommend replanting erosion gulley

October 2012 post project. Note woody plantings in gulley below supported irrigation pipe.

June 2017, 5 years post-implementation. Note that trail along irrigation pipeline has been reconstructed and woody vegetation is developing above gulley.

October 2013 view across top of gully, 1 year post-implementation. Slump occurred when the pipe burst 2 days before photo. All plantings appear to have washed out. Albert Kettner photo

Site 16, South Gully (wicker weir #8), GPS coordinates -0.828000, -78.870450

Erosion Problem	Project Activities	Vegetation planting survival	Stability of pipeline and gulley	New erosion features
Gulleying caused by Irrigation pipe leakage .	Installation of live post and wicker grade control: lechero poles, sigsig grass hedges plus mats with woody plantings.	Low, but sufficient to greatly reduce erosion and promote volunteer species. Wicker weirs are effectively holding sediment.	Functionality: 50-75%	Gulleying evident, pipeline at top of gulley is undercut.

October 2013, pre-implementation, view up gully. Note sparse vegetation in gulley and unstable soils. Jen Walsh photo.

March 2015, 1.5 years post-implementation. Note that wicker weir has held in place, vegetation cover increased. Same overhanging pine branch as 2013 photos.

October 2013, view down gulley of construction of living wicker weirs.

June 2017, 3.5 years post-implementation. Note both new gulleying from possible pipe problems / heavy rains and survival of stabilizing vegetation.

Site 18, Cachiyacu, Cut Slope GPS coordinates -0.820540, -78.82770

Erosion Problem	Project Activities	Vegetation planting survival	Slope stability	New erosion features	Road closures due to erosion
Unstable volcanic subsoils slumping during heavy rains causing road closures.	Native tree and shrub plantings, sigsig grass hedges on contour.	Low, but sufficient to greatly reduce erosion and promote volunteer species. Grass hedges effective.	Functionality: 75-100%	None	None

July 2012, pre-project. Note deep rilling, sparse vegetation following 2011 slumping and road closures.

October 2012, post construction.

June 2017, 4.5 years post-project. Note greatly decreased rilling and increased vegetation cover by plantings and volunteer native species and invasive eucalyptus.

Site 20 Facha Chimbusig (-0.81904, -78.8709)
Cut Slope

Erosion Problem	Project Activities	Structures	Vegetation planting survival	Slope stability	New erosion features	Road closures due to erosion
Slumping during heavy rains causing road closures	Installation of erosion mats, woody plantings, grass hedges, tree pole plantings to block animal access. Construction of boulder toe wall.	Boulder retaining wall effectively held soils in place while plant roots developed.	Low, but sufficient to greatly reduce erosion and promote volunteer species. Grass hedges grew well.	Functionality: 75-100%	None	None

October 2012 Pre-project. Note almost barren slope. Slump debris at toe along roadway.

October 2012 Project Construction. Note children helping to sew local erosion mats, installation of donated map.

June 2017, 5 years post-construction. Note very good growth of native acacia trees, sigsig grass hedge, good vegetation cover. Retaining wall remains in place, stabilized by volunteer plantings inbetween boulders.

Site 20 Facha Chimbusig, slope below road

Erosion Problem	Project Activities	Vegetation planting survival	Structures	Slope Stability	New erosion features	Road closures due to erosion
Steep, unstable slope below road. Sand bags are shoring up area of water draining from road and cut slope.	Installation of erosion mats with native woody plantings, grass hedges along contours. Construction of boulder step pools in sandbag area.	Low, but sufficient survivorship to stabilize slope. Grass hedges grew well. Some eucalyptus invasion.	Step pools effective in stabilizing slope while plant roots developed.	Functionality: 75-100%	None	None

July 2011, assessment trip, view to NE. Note active erosion and placement of sand bags below the road, white road culvert on left. Will Mahoney photo

October 2012, Project Construction, view to SW. Erosion mats and sigsig hedges in center; boulder step pools at lower left.

June 2017, 4.5 years post-implementation, view to NE. White road culvert shown in 2011 photo is at left. Note very good growth of trees, much increased vegetation cover contributing to increased soil stability, some volunteer invasive eucalyptus. Enma Sacatoro photo

Site 32 Carretera a Pucará (coordinates -0.822800, -78.851680), Big Cut slope

Erosion Problem	Project Activities	Vegetation planting survival	Slope stability	New erosion features	Road closures due to erosion
Slumping road cut causing road closures	Installation of erosion mats with woody plantings, grass hedges along contours.	Low for woody plantings, but sufficient to greatly reduce erosion and promote volunteer species. Grass hedges are vigorous, not palatable to sheep.	Functionality: 75-100%	None	None

October 2013, project implementation. Sewing local erosion mats into one wide mat.

October 2013, project implementation. Note Installation of erosion mat, sigsig grass for contour hedges staged at bottom of slope, sheep along road.

June 2017, 3.5 years post-implementation. Note development of shrubby plantings and volunteer plants, good growth of sigsig grass hedges.

Site 96 Alcantarizado de Malingua, GPS coordinates -0.822480, -78.865660, Channel Below Culvert Outlet

Erosion Problem	Project Activities	Vegetation planting survival	New erosion features	Road closures due to erosion
Culver storm water discharge threatening adjacent house	Installed woody plantings and erosion mats along slopes of channel below culvert outlet. Placed log and boulders at toe of side slopes to stabilize soils during plant establishment.	Low, but sufficient survivorship to stabilize sides of channel, especially with Invasion of Scotch broom.	Upper channel is stable, as well as sides of lower channel. Grading of slope and removal of soil above culvert inlet have changed drainage pattern. Culvert is nearly filled with sediment. Functionality: 75-100%	None Owner of house is building 2nd house adjacent to channel.

October 2012, pre-project, view across drainage below culvert.
Note active erosion of drainage bank adjacent to house. A Kettner photo

October 2012, project implementation.

June 2017, 4.5 years post-implementation. Note vigorous vegetation growth, especially of non-native Scotch broom, has stabilized channel sides, house is intact.

Site 96 Alcantarizado de Malingua, Lower Drainage Channel

Erosion Problem	Project Activities	Vegetation planting survival	Structures	Channel stability	New erosion features
Downcutting from culvert storm water discharge	Installed woody plantings along banks. Constructed cross-vanes, boulder plunge pools, infiltration trench at channel terminus.	Low, but sufficient survivorship to stabilize sides of channel.	Plunge pools intact, very effective. Very little remains of cross-vanes except for largest structure at low end of channel. Fate of cross-vanes is unclear.	Functionality: 75-100% above cross-vane, 50-75% below cross-vane. Changed conditions due to slope cutting above culvert.	Sides of lower channel are stable. In-channel downcutting below remaining cross-vane. Natural gulley below the channel could be at risk during very high flows.

July 2012, pre-project, view up drainage. Note actively eroding channel walls and extensive sand deposition.

March 2015, 2.5 years post-implementation. Note increased plant growth, probably due to cessation of grazing and possibly reduction of scouring flows.

October 2012, post-implementation. Note 3 of the 4 cross-vanes in lower channel, 2 step pools above in upper channel. Matt Barbian photo

June 2017, 4.5 years post-implementation. Note good shrub growth at channel sides, downcutting in potato field occurring below remaining cross-vane.

Selection of Community-Initiated Projects

Watershed of Rumi Checka Potable Water Source Springs

To protect their potable water source with its organic black soil, the community of Guantugloma has purchased the watershed and installed fencing and native plants grown in their own nursery started in 2013. They plan to complete the fencing to keep out sheep and continue to plant native species to protect the soil and provide a source of edible berries.

July 2012, view up watershed prior to potable water project undertaken with EWB.

June 2017, Note removal of most yaugal in upper watershed to limit their water use, natural revegetation taken place in uppermost watershed, grazing sheep which were chased out.

March 2015, Note yaugal plantings along foreground fence and upper watershed.

June 2017. Estalin Toaquiza planting native chilca shrubs to protect watershed soils.

Elvia Ante's Plantings at Malingua Pamba Hostel

October 2013, Elvia Ante and husband Paulino Sacatoro participate in planting the eroding cut slope adjacent to their hostel.

June 2017, Chilca and acacia negra plantings have grown well, increasing slope stability.

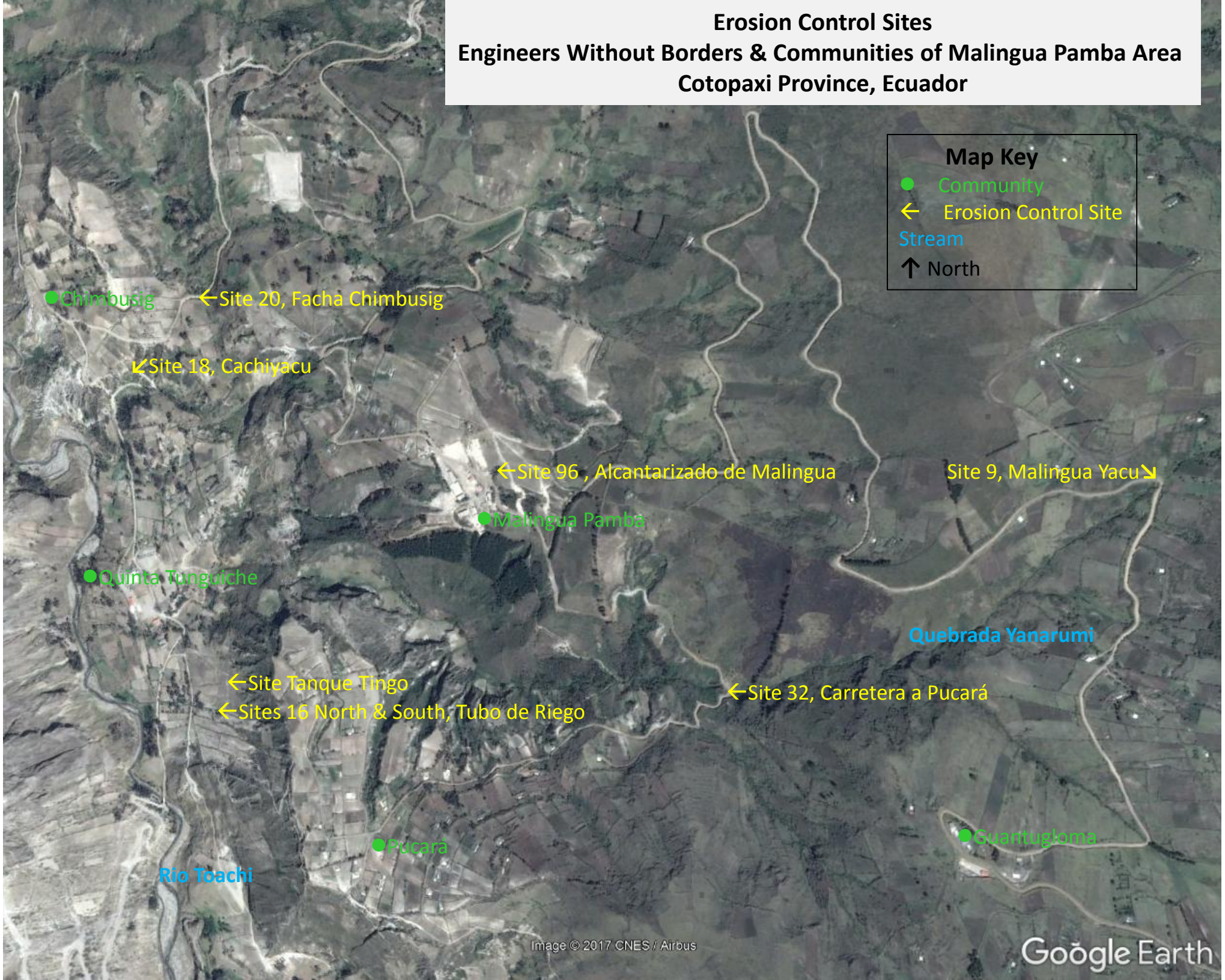
Ignacio Sacatoro's planting project along road to Pucará

October 2013. Sr. Sacatoro's students at the Malingua Pamba high school planted native trees and shrubs to stabilize the edge of the road.

June 2016, Enma Sacatoro's planting project on new fill slope

June 2016, Malingua Pamba high school students plant native woody species to stabilize a new slope constructed of fill material.

June 2017, low planting survivorship, but grasses are beginning to stabilize slope.


Erosion Control Sites
Engineers Without Borders & Communities of Malingua Pamba Area
Cotopaxi Province, Ecuador
Map Key
Community
Erosion Control Site
Stream
North
Chimbusig
←Site 20, Facha Chimbusig
↙Site 18, Cachiyacu
←Site 96 , Alcantarizado de Malingua
Site 9, Malingua Yacu↘
Malingua Pamba
Quinta Tunguiche
Quebrada Yanarumi
←Site Tanque Tingo
←Sites 16 North & South, Tubo de Riego
←Site 32, Carretera a Pucará
Pucará
Guantugloma
Rio Toachi
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