PROJECT IDEA NOTE: AFFORESTATION/RESTORATION OF RIPARIAN AREAS ALONG SANTA CRUZ RIVER, ARIZONA USA

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Winrock International

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Abstract

Riparian forests are crucial ecosystems linking the aquatic and the terrestrial environment. As a result, these riverine systems process large fluxes of energy, nutrients and life at various spatial and temporal scales. This project idea is for the revegetation of approximately 2,634 acres of riparian lands along the middle and lower reaches of the Santa Cruz River in the U.S. Five different properties were chosen for the implementation of this project. The revegetation project would generate a wide array of social and environmental benefits, such as: carbon sequestration, maintenance of water quality and quantity, fish and wildlife habitat enhancement, and aesthetics and human recreation improvement. In terms of sequestered carbon, the project would result in the uptake of as much as 150,000 tons of CO_2e from the atmosphere by 2050. Unfortunately, the implementation of this project was considered unfeasible in economic terms. Prices of the verifiable emission reductions (VER) would have to reach levels that are unlikely in the near future. For this project to break-even between costs and benefits (IRR = 0%) the price of the negotiated VER would have to reach US$ 67.00. Assuming a current estimate of US$ 7.00 it is unlikely this project can be implemented only using revenues from carbon sequestration.

Key words: Santa Cruz River, riparian forest, revegetation, carbon sequestration

Executive Summary

This project idea note is for a potential project for the revegetation of riparian areas along the Santa Cruz River in Arizona. The Santa Cruz River forms a bi-national ecosystem that has its headwaters in the United States, flows southward crossing into the Sonora desert in Northern Mexico and turns and reenters the U.S. just east of Nogales. This unique system supports tall and shaded forests in an arid climate, forming an oasis for vegetation, wildlife and people. Unfortunately, the riparian forests along the Santa Cruz have been historically mismanaged due to agricultural land expansion and are mostly inexistent from the borders of the river.

This project aims to analyze the viability of revegetating the riparian forests using the revenues generated from carbon credits as a result of the carbon sequestered by the established trees. The goal is to quantify the amount of carbon sequestered and potential revenues from credits in a regulatory market. As proposed, this project intends to revegetate a total of 2,634 hectares of land distributed over 5 different properties in the Southern portion (within the United States border) of the river.

The implementation of this project would generate the following direct social and environmental benefits to the local communities:

- Water quality maintenance;
- Storm water regulation and storage;
- Biodiversity maintenance and habitat enhancement;
- Sediment and nutrient retention;
- Improvement of human recreational activities; and
- Improvement of landscape aesthetics.

The establishment of this project would result in the sequestration of over 150,000 t CO_2e over its entire duration of 40 years. The uptake of carbon would be greater in the early growth stages of established vegetation and would slowly decrease over time. Costs of establishment however, as a result of the vast area to be revegetated, were estimated to be large, at the order of $4.7 million at the beginning of the project. Over time as plants uptake carbon and credits can be generated, this project would be able to balance costs with benefits.

To break-even between investments and revenues (internal rate of return – IRR ≥ 0%) in the 20 years subsequent its implementation the negotiated price of the Verified Emission Reductions (VERs or carbon credits) would have to be at the order of $67.00 per t CO_2e. This price is high because the project would have to operate for 5 years without crediting, as carbon sequestered would be dedicated to pay off emissions from removing existing vegetation during the project implementation process.

Due to the high cost of implementation, this project was considered not economically feasible. Current market prices for VERs of US$7.00 would have to rise to a level unlikely in today's or any near future market ($110.00) in order for the IRR of the project to reach over 5%. Therefore it was concluded that this project is not practical in economic terms if only using revenues generated from carbon offsets.

1.0 Introduction

1.1 Background and Overview

This project aims to reforest and restore native riparian forests along the Santa Cruz River in Southern Arizona. Riparian forests are unique systems because they connect the aquatic and terrestrial environments. Riparian forests of this river are degraded due to human presence. Yet, twenty-two threatened and endangered species make their home within the Santa Cruz basin, highlighting the importance of this green oasis in the arid landscape of the Southwestern United States.

Five (5) different areas within Pima and Santa Cruz counties accounting for a total of 2,634 acres are included in this afforestation/restoration project. The project will improve the integrity and functionality of the Santa Cruz River, ensuring a healthy stream system and maintaining the river's provision of societal goods and services, such as:

- Carbon sequestration;
- Water quality maintenance;
- Storm water regulation and storage;
- Biodiversity maintenance;
- Fish and wildlife habitat enhancement;
- Sediment and nutrient retention and soil integrity protection;
- Local microclimate regulation;
- Improvement of human recreational activities; and
- Improvement of landscape aesthetics.

1.2 Project Objectives

The main goal of this project is to restore the riparian forests along the Santa Cruz River in Southern Arizona reestablishing the functionality and integrity of this river system. By doing so, this project aims to promote carbon sequestration and the maintenance of other societal services provided by the river.

1.3 Report Organization

The "Project Idea Note" (PIN) is presented in section 2 describing potential type and size of an afforestation /reforestation project on riparian areas along Santa Cruz River in Arizona. This PIN is framed in the World Bank's BioCarbon Fund, PIN Template for Land Use, Land Use Change and Forestry (LULUCF) projects, available at: http://wbcarbonfinance.org/Router.cfm?Page=BioCF&FID=9708&ItemID=9708&ft=DocLib&ht=34&dtype=191&dl=0. More relevant information to the development of this project is also reported in section 3 "Additional Information".

2.0 Project Idea Note

Name of Project: Afforestation/restoration of riparian areas along the Santa Cruz River, Arizona USA

Date submitted: ***March 2010***

A. Project description, type, location and schedule

General description	
A.1 Project description and proposed activities	Afforestation/ restoration of ~ 2634 acre riparian area along Santa Cruz River, AZ. Project area will be planted with native trees and proper management will assure following vital function of riparian forest: • Carbon sequestration • Maintenance of water quality • Fish and wildlife habitat enhancement • Biodiversity maintenance • Flood and storm water storage • Sediment and nutrient retention
A.2 Technology to be employed (mention if REDD will be undertaken)	• Afforestation & restoration of riparian areas with native tree species
Project proponent submitting the PIN	
A.3 Name	**Winrock International**
A.4 Organizational category *(choose one or more)*	a. Government b. Government agency c. Municipality d. Private company e. **Non Governmental Organization**
A.5 Other function(s) of the project developer in the project *(choose one or more)*	a. Sponsor b. Operational Entity under the CDM c. Intermediary d. **Technical advisor**
A.6 Summary of relevant experience	Winrock International is a 501(c)3 non-profit organization that works with people in the United States and around the world to increase economic opportunity, build local institutional capacity, and sustain natural resources. Winrock has approximately 15 years' experience in the measurement, monitoring and verification (MMV) of forestry carbon projects in the US and internationally. Our peer-reviewed methods for carbon MMV are being used by a broad range of private sector, government and nongovernmental clients on over two million acres around the world. Winrock's carbon project services include project review and carbon benefit assessment, Kyoto Protocol – Clean Development Mechanism (CDM) and Joint Implementation (JI) project development and review, monitoring plan design and implementation, baseline establishment and leakage assessments, design of

	new CDM/JI project methodologies, customized workshops on CDM/JI project development, quality assurance and quality control protocols, spatial prediction of deforestation, workshops on baseline and monitoring plan design and implementation, field training in carbon estimation, aerial geo-referenced imagery for carbon monitoring and other applications, and remote sensing analysis. Winrock has assisted in the design of forestry carbon measurement and monitoring protocols for the USDOE 1605(b) program, the Voluntary Carbon Standard, California Climate Action Registry, Regional Greenhouse Gas Registry, World Bank BioCarbon Fund, UNDP, International Tropical Timber Organization, UNFCCC and others, and is an Authorized Verifier of forestry offset projects for the Chicago Climate Exchange. For publications related to carbon measurement, monitoring and verification, see http://www.winrock.org/ecosystems/publications.asp?BU=9086. Innovative carbon project design and implementation Over the last ten years, Winrock's portfolio has totaled more than $9 million to support carbon supply assessments, development of field carbon measurement methods, development of carbon sequestration and emissions avoidance projects (both terrestrial and clean energy), and transfer of knowledge and build capacity to local governments and organization in developing countries. Winrock has implemented carbon mitigation activities and projects with many partners and from several angles, including: Winrock has been the main carbon sequestration project development and project monitoring partner to the private sector in the U.S. Since the mid-1990s we have worked with more than 30 private companies who heard of us through our involvement in defining measurement criteria and best practices. Among the largest companies are AEP, Entergy and Cinergy/Duke Energy (power) and LaFarge (cement), all of whom have taken major steps to offset their carbon emissions. We have also worked with commercial forest operators in Asia, Africa and Latin America. In part as a result of our continuing efforts to reduce costs while improving measurement and monitoring technologies, Winrock has increasingly been asked by private companies to conduct official verifications for carbon offset registries.
A.7 Address	2121 Crystal Drive, Suite 500 Arlington, VA 22202
A.8 Contact person	Katherine Goslee
A.9 Telephone / fax	703-302-6500
A.10 E-mail and web address	carbonservices@winrock.org http://winrock.org/ecosystems
Project sponsor(s) financing the project *(List and provide the following information for all project sponsors)*	
A.11 Name	TBD
A.12 Organizational category *(choose one or more)*	a. Government b. Government agency c. Municipality d. Private company

	e. Non Governmental Organization TBD
A.13 Address *(include web address)*	TBD
A.14 Main activities	TBA.
A.15 Summary of the financials *(total assets, revenues, profit, etc.)*	This table displays a summary for a project lifetime of 20 years as suggested in C.7

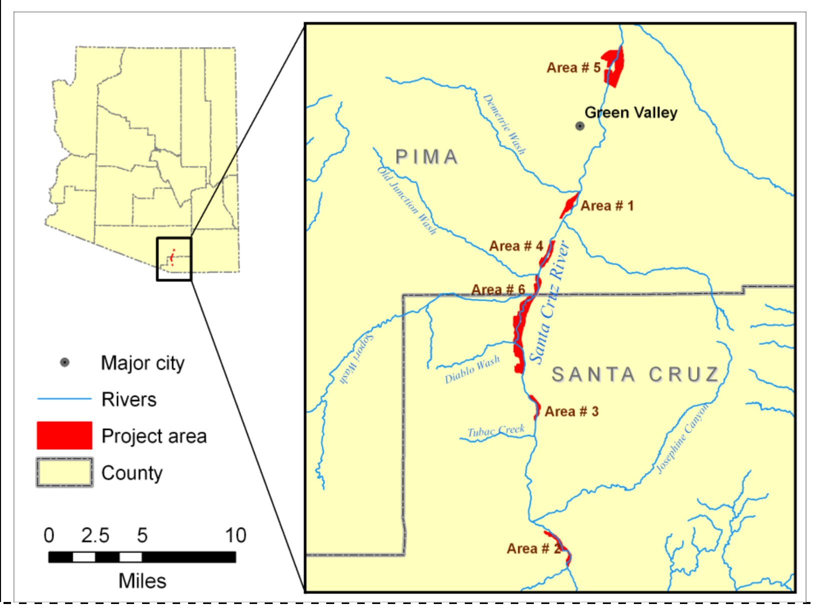
	2011	2012	…	2022	…	2030	2031
Investments	$4,741,200	$447,780	…	$0	…	$0	$0
Total Net Revenues	$0	$0	…	$417,745	…	$233,629	$216,008
(-) Total Costs	$0	$0	…	$25,000	…	$25,000	$25,000
Margin / (EBITDA)	$0	$0	…	$392,745	…	$208,629	$191,008
Net profit	$0	$0	…	$ 392,745	…	$208,629	$191,008
Free Cash Flow	**-$4,741,200**	**-$447,780**	**…**	**$392,745**	**…**	**$208,629**	**$191,008**

Type of project

A.16 Greenhouse gases targeted	CO_2
A.17 Type of activities	Sequestration
A.18 Field of activities (*Select code(s) of project category(ies) from the list*)	1a (forest) Afforestation of riparian areas with native tree species

Location of the project

A.19 Country	USA
A.20 Nearest city and map	Green Valley, AZ The six (6) project areas are located approximately within 20 miles from Green Valley, AZ



A.21 Precise location	(1) Lat: 31.795 Long -111.010 ; area = 179 acres (2) Lat: 31.530 Long:-111.018 ; area = 230 acres (3) Lat: 31.637 Long:-111.037 ; area = 116 acres (4) Lat: 31.754 Long:-111.032 ; area = 162 acres (5) Lat: 31.908 Long: -110.974 ; area = 835 acres (6) Lat: 31.709 Long: -111.052 ; area = 1,114 acres
Expected schedule	
A.22 Earliest project start date *(Year in which the project will be operational)*	March 2011
A.23 Estimate of time required before becoming operational after approval of the PIN	Time required for financial commitments: 12 months Time required for legal matters: 12 months Time required for negotiations: 12 months Time required for establishment: 12months
A.24 Year of the first expected CER / ERU / RMU / VER delivery	2012
A.25 Project lifetime *(Number of years)*	50 years
A.26 Current status or phase of the project	a. Identification and pre-selection phase b. Opportunity study finished c. Pre-feasibility study finished d. Feasibility study finished e. Negotiations phase f. Contracting phase

B. Expected environmental and social benefits

Environmental benefits	
B.1 Estimate of carbon sequestered or conserved *(in metric tonnes of CO_2 equivalent – t CO_2e. Please attach spreadsheet.)*	Up to and including 2020: 67,897 ±10,544 t CO_2e (mean ± 95% confidence interval) for 10years of expected sequestration Up to and including 2050: 150,010 ± 24,251 t CO_2e (mean ± 95% confidence interval) for 40 years of expected sequestration **Estimated carbon sequestration for riparian areas in Arizona was derived from field measurements along the Lower Colorado River presented in following table.**

Years	Expected Cumulative Sequestration	
	t CO_2e/acre	*95% CI*
0	0	*4.8*
1	2	*4.7*
2	5	*4.5*
3	7.9	*4.4*
4	11	*4.3*
5	14.2	*4.2*
6	17	*4.1*

7	20.3	*4.0*
8	23	*4.0*
9	25.8	*4.0*
10	28	*4.0*
11	30.6	*4.0*
12	33	*4.0*
13	34.9	*4.1*
14	37	*4.1*
15	38.6	*4.2*
16	40	*4.3*
17	41.9	*4.5*
18	43	*4.6*
19	44.6	*4.8*
20	46	*4.9*
21	47.0	*5.1*
22	48	*5.3*
23	49.0	*5.5*
24	50	*5.7*
25	50.7	*5.9*
26	51	*6.1*
27	52.1	*6.3*
28	53	*6.5*
29	53.3	*6.8*
30	54	*7.0*
31	54.4	*7.2*
32	55	*7.5*
33	55.3	*7.7*
34	56	*8.0*
35	56	*8.2*
36	56	*8.5*
37	56.6	*8.7*
38	57	*9.0*
39	57.2	*9.2*
40	57	*9.5*
41	57.6	*9.7*
42	58	*10.0*
43	58	*10.3*
44	58	*10.5*
45	58.3	*10.8*
46	58	*11.0*
47	58.6	*11.3*
48	59	*11.6*
49	58.8	*11.8*
50	59	*12.1*

B.2 Baseline scenario *(What would the future look like without the proposed project? What would the estimated total carbon sequestration / conservation be without the proposed project?)*	Without the project, land remains barren or non-forested composed mostly by grassland and shrubland with few sparse trees. Without the project, no significant changes are expected for total carbon sequestration/ conservation.
B.3 Existing vegetation and land use *(What is the current land cover*	The project area is covered predominantly with grassland and shrubland. The tree cover in the project area is less than 10% (Spatial combination of the project area with the 2001 NLCD map

and land use? Is the tree cover more or less than 30%?)	and Southwestern GAP 2001 vegetation map indicated that more than 90% of the project area is occupied with grassland and/or shrub and scrub land cover and vegetation classes).
B.4 Environmental benefits	• Maintenance of biodiversity by promoting plant and animal genetical fluxes between and within landscapes • Enhancement of plant, fish and wildlife habitat • Improvement and maintenance of water quality • Filtration and retention of upland and upstream sediments and associated nutrients • Regulation of water flow by reducing and storing flood water runoff • Regulation of local microclimate • Improvement of human recreational activities • Improvement of the aesthetics of the landscape

C. Finance

Project costs	
C.1 Preparation costs - gathering information on the area and writing PIN	US$ 0.1 million
C.2 Establishment costs - Planting	US$ 4.7 million
C.3 Other costs - Maintenance	US$ 0.4 million Year 1 US$ 0.3 million Year 2
C.4 Total project costs	US$ 5.5 million
C.5 Indicative CER / ERU / RMU / VER price *(subject to negotiation and financial due diligence)*	VERs price estimation: US$ 4.00 US$ 7.00 US$ 15.00
C.6 Emission Reductions Value *(= price per t CO_2e * number of tCO_2e)* Please discriminate VERs from REDD activities.	Price of VER per ton is based on Updegraff et al. (2004) estimations.
Until 2020	67,897 (±10,544) VERs at US$ 4.00 = US$ 271,588 ± 42,156 67,897 (±10,544) VERs at US$ 7.00 = US$ 475,279 ± 73,808 67,897 (±10,544) VERs at US$ 15.00 = US$ 1,018,455 ± 158,160
Until 2050	150,010 (± 24,251) VERs at US$ 4.00 = US$ 600,040 ± 97,004 150,010 (± 24,251) VERs at US$ 7.00 = US$ 1,050,070 ± 169,757 150,010 (± 24,251) VERs at US$ 15.00 = US$ 2,250,150 ± 363,765
C.7 Financial analysis *(If available for the proposed CDM / JI activity, provide the forecast financial internal rate of return (FIRR) for the project with and without the CER / ERU /*	FIRR without carbon: This project has no return without the benefits from carbon accounting. FIRR with carbon: In order for this project to achieve balance between all the costs and revenues, the price of the VER needs to be raised to US$ 67.00. In this case, IRR over 20 year would be

RMU / VER revenues.)	0.06%, since the first 5 years would not be crediting period as it would pay off emissions caused during establishment of the project.

3.0 Additional Information on Riparian Systems

Riparian ecosystems are the transitional zones characterizing the interface between terrestrial and aquatic environments. Considered ecotones, riparian areas are affected by continuous exchange of energy, nutrients, compounds, and organisms on the landscape at various temporal and spatial scales. These ecosystems are characterized by Naiman et al. (2005) to be among the most diverse, dynamic and complex natural systems. As a result, they encompass a great variety of environmental conditions, ecological patterns and processes, as well as animal and plant communities.

Most definitions of these systems agree upon the uniqueness of riparian forests and their capacity for promoting interactions between and within the landscape (Mitsch and Gosselink, 2000). The interactions across landscapes are defined by exchanges between the uplands and the aquatic ecosystems; whereas the interactions within landscapes are characterized by the exchanges within the different reaches of these aquatic systems. Due to their interconnectivity between and within the landscape, these forests process large fluxes of energy and nutrients, and support significant biotic diversity (Mitsch and Gosselink, 2000) at various scales. As a result of their importance within the landscape mosaic, these systems have been historically linked to society's welfare (Lockaby, 2009), dictating the quality of human life and often improving human wellbeing.

Geomorphologically, riparian forests are complex and dynamic fluvial landforms. The landscape complexity and diversity of these systems are the result of their primary shaping forces, described as the cut-and-fill process (Naiman et. al., 2005). This process depends basically on water mediated erosion in certain areas (cut) followed by transportation and subsequent deposition of this alluvial sediment on the lower reaches of the streams (fill). Therefore, we can infer that this portion of the landscape is continuously eroding in some places while aggrading in others. Generally, the resulting riparian ecosystems may occur as two main types of landforms: (i) narrow strips of streambank, or (ii) broad alluvial valleys. The type of landform which the riparian zone will assume is, however, dependent upon a wide array of factors, including surface and sub-surface geology, slope gradient, and hydrology.

According to Knox (1977), vegetation and forest cover in watersheds and along streams help decrease surface runoff and sediment yield, due to an increase in precipitation interception and soil infiltration capacity. Even though sediment may be considered to be in constant motion over long time scales, most riparian forested areas reveal net aggradation of sediment from two distinct sources: (i) runoff from adjacent lands and (ii) over-bank floods (Hupp, 2000). By trapping sediments, riparian forests also trap nutrients that are either carried by sheetflow or are attached to sediment particles (Hupp, 2000). As a consequence, most riverine forests are known for preserving and maintaining downstream integrity and water quality by retaining nutrients and sediments carried by surface runoff (Hupp, 2000; Cavalcanti and Lockaby, 2005; Jolley et al., 2009). In fact, this process has been identified as a natural function of riparian forests (Mitsch and Gosselink, 2000) and is often taken for granted (Lockaby, 2009).

3.1 Southern Arizona Riparian Forests

In the project area the riparian forest is constituted mostly of Fremont cottonwood (*Populus Fremontii*) and black willow (*Salix nigra*). These native riparian trees are part of nature's healing process for entrenched rivers and streams. The trees slow the flow, help build and hold soils in place, and provide a place for storage and slow release of water, which is an extremely important feature in the dry conditions of the state of Arizona. Riparian vegetation helps regulate flows by making the system "spongy" again. The Increased storage capacity in riparian zones makes available much of the water required for riparian growth.

According to Lomeli (2009, unpublished) earthquakes, climatic changes, historic overgrazing, fuel wood removal, beaver eradication, and altered fire regimes all contributed to river entrenchment between 1890 and 1908. Entrenchment changed many southwestern rivers around the same time period from surficial, sluggish cienega/marsh environments, to faster deeply incised rivers. As nature's response, rapid proliferation of cottonwood-willow riparian forests and increased river sinuosities immediately followed the entrenchment period.

Riparian vegetation increases roughness coefficients in channels and floodplains, slowing down flood flows, causing deposition of soils and debris that build and stabilize banks. Gradually, river beds and banks are stabilized, floodplains are built-up, and perennial river reaches are extended, resulting in a rise of base flow levels and water tables. Good watershed ground cover is essential to infiltrate precipitation and to prevent excessive runoff and erosion. In a floodplain, grasses and shrubs also help the healing process, but during higher flows each year, the larger trees provide better protection and faster aggradation (Lomeli, 2009, unpublished).

Riparian areas act as wildlife corridors between mountains, uplands, and the river by providing habitat continuity for species migrations. Small pools and near-surface water along these washes make excellent habitats. The vegetation provides cover, food, and nesting and roosting areas. Riparian corridors also provide habitat for many insects and reptiles, which in turn serve as a base for a complete food chain.

According to Lomeli (2009, unpublished) the challenge in the Upper Santa Cruz basin is not just one of balancing the water budget. Concentrated groundwater over-drafting between the mountain-front recharge zones and the river can cause loss of base flows in perennial stream reaches, and subsequent loss of riparian habitats. However, working together, impacts can be mitigated with appropriate water management, groundwater recharge, and watershed improvement projects.

4.0 Discussion of Project Feasibility

The VER price estimated in this PIN to break-even between the implementation costs and earned revenues is $67.00 (IRR=0.06%). This price is similar to the credits' costs estimated by Galik et al. (2009) ranging from $30 to $65.00 per ton of CO_2e which varied according to the protocol used (VCS, CCX, etc.). The VER estimated price was high because the project would have to operate for 5 years, out of the 20 years used in the analysis, without crediting, only paying off the emissions caused during the implementation by removing existent vegetation at site preparation for planting.

The feasibility of this project is critically influenced by the area where it is located. The implementation of this project is expensive because of Arizona's natural characteristics. Pearson et al. (2007) showed that 95% of the forests in the state of Arizona are within the six most northerly counties (Apache, Coconino, Gila, Mohave, Navajo and Yavapai). Pima and Santa Cruz counties, where this project takes place are situated in southern Arizona, where conditions for tree growth are poor.

According to the Western Regional Climate Center (WRCC) the state of Arizona has three main topographies that dictate the climate regime: (i) high plateau, (ii) mountainous, and (iii) desert. The proposed project takes place in the desert topographic area, which indicates low precipitation amounts; therefore, forest is not well sustained within this region if not along rivers and wetlands.

The lack of forested landscape in this region creates a lack of professionals who could provide forestry services; which drives the costs of implementation up. Thus, this aforestation/reforestation project becomes expensive in terms of price per area planted.

However, there are Federal incentives to develop such projects. The United States Environmental Protection Agency (US EPA) for instance, provides grants ranging from $5,000 to $20,000 through the Five-Star Restoration grant program.

Considering that the six different areas proposed in this PIN are spatially separated, little decrease in the total budget per acre would be possible due to issues of economies of scale. As a simple exercise to study the feasibility of this proposed project at a different scale, the smallest of the six proposed properties above (property 3 with 116 acres) was used, the cost of implementation proposed by Galik et al. (2009) was applied, and an assumption of an acquisition of a $10,000 US EPA grant was made. Still, the price of VER would need to be at the order of $61.00 for the project to break-even between costs and revenues in 20 years after project establishment. At this VER price, the financial rate of return (FIRR) calculated would be 0.04%. In terms of financial stand-point, the revegetation of riparian forests on all the properties along the Santa Cruz River proposed in this project would only be desirable (IRR>5%) if VER price was raised to $110.00 per t CO_2e.

Although the revegetation of the margins of the Santa Cruz River may generate innumerous environmental and social benefits, this project of revegetation of the riparian forests is ultimately unfeasible if dependent on the benefits produced by carbon offsets alone.

Current carbon credits prices cannot afford the implementation of this project. Furthermore, carbon prices will likely not rise to a level that allows favorable financial returns or even breaking even with costs.

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