Cloud Forest Blue Energy Mechanism

ANNEXES
August 2017

ANNEX A: PAYMENTS FOR ECOSYSTEM SERVICES AND PAY-FOR-SUCCESS FINANCING

Cloud Forest Blue Energy Mechanism brings together Payments for Ecosystem Services (PES) and pay-for-success financing. This annex provides an overview of these two concepts.

Payments for Ecosystem Services

The OECD defines PES as follows: "agreements whereby a user or beneficiary of an ecosystem service provides payments to individuals or communities whose management decisions influence the provision of ecosystems. More specifically, PES are defined as 'a voluntary, conditional agreement between at least one 'seller' and one 'buyer' over a well-defined environmental service – or a land use presumed to produce that service'" (OECD, 2010).

Pay-for-success financing

Pay-for-success is an approach to contracting that ties payment for service delivery to the achievement of measurable *outcomes* (Pay for success, 2017). In a pay-for-success model, the entity paying for outcomes – the hydropower operator in the case of the Mechanism – agrees to make payments only if, and when, services delivered achieve a pre-agreed result. Pay-for-success contracts are usually accompanied by financing agreements that provide upfront capital to support service delivery throughout the project period (Ibid).

Pay-for-success financing has been used extensively for the provision of social services, particularly in the area of 'social impact bonds'. At present, there are 15 pay-for-success financing projects that are either active or finished in the United States, with a further 62 in development (Pay for Success, 2017).

With the issuance of the DC Water Environmental Impact Bond, discussed in a separate Annex, interest in using pay-for-success financing to deliver environmental services is growing.[1]

[1] See for example http://seatuva.org/pfslab/blog/2017/6/21/3znvgjh1fnb3sjf072v04uqhua9n61

ANNEX B: LESSONS LEARNED FROM COMPARABLE PAY-FOR-SUCCESS INSTRUMENTS FOR GREEN INFRASTRUCTURE

The sample of products from which we can draw lessons is small: only one product (the DC Water Environmental Impact Bond) has been issued, with another product near-market (the Forest Resilience Bond). This small sample of comparative instruments reflects Cloud Forest Blue Energy Mechanism's innovative nature.

Performance-based payments are a source of risk for investors

Performance-based payments are variable: this introduces uncertainty into the revenues received by a service provider, which translates to the risk that investors might not receive the returns they expect. From the DC Water example and the Forest Resilience Bond we can see that the value of performance-based payments represents a relatively low proportion of the total value of the investment product (shown in Table below). This reflects the balancing act of distributing risk between service provider and beneficiary.

Table 1: Comparable performance-based PES financial products

Initiative	% of investor repayments performance based	Performance measured	Performance measurement technique
DC Water Environmental Impact Bond	13.2%[2]	Reduction in storm water runoff as a result of green infrastructure	• Pre-construction monitoring data are used to create a model that predicts runoff based on rainfall. • Three performance outcome ranges are established: underperformance, performance as expected and over performance. • A one-time monitoring exercise is conducted post-construction to compare predicted run-off with actual run-off and establish the performance outcome.
Forest Resilience Bond	3 - 4%	Increased water quantity as a result of reduced water evaporation	• Forest coverage – a close proxy for water evapotranspiration – is used as to measure the additional water provided to utilities through forestry activities. • Coverage is measured before and after implementation.

Investor risk from performance-based payments comes in two forms: the risk of unpredictable revenue streams and uncertainty around the measurement and attribution of performance.

Products should be structured to deliver more stable revenue streams

Both of the products examined have a high proportion of fixed revenue streams. This provides investors with greater certainty over their returns and reduces the risks that they face. On top of this,

[2] The DC Water EIB has a face value of $25 million and a ±$3.3 million performance-based payment

it ensures that the beneficiary has 'skin in the game' – a regular fee ensures that projects have buy-in at a senior level and incentivizes the beneficiary to ensure project success. The key lesson for Cloud Forest Blue Energy Mechanism is that the composition of its revenue streams should balance between fixed and performance-based.

Performance measurement and attribution are risks that must be addressed
Uncertainty around performance measurement is a key issue for the Mechanism. Techniques that measure performance must quantify the benefits delivered to the beneficiary to an acceptable level of accuracy. When dealing with natural phenomenon like reservoir sedimentation, complex and robust techniques *that are accepted by both service provider and beneficiary* are necessary to determine performance.

These measurement techniques must be developed and can introduce costs. For example, in the case of the DC Water Environmental Impact Bond a year's data collection was conducted to enable modelling activities that compare storm runoff before and after project implementation.

Performance-based payments are the key innovation of the Mechanism: quantification of the benefits delivered to the hydropower plant is at the core of the success of the instrument.

The key lesson to draw from these comparable instruments is that where the metrics and measurement techniques are not in place, resources must be applied to develop and refine them. Advanced modelling techniques that compare a (modelled) baseline scenario (in which reforestation does not occur) with the empirical data gathered after reforestation will be necessary to assess the performance of Cloud Forest Blue Energy Mechanism. For the Mechanism, these techniques will need to be refined and tested in an initial project, financed with concessional capital. Table below outlines the key pay-for-success components of the Mechanism, the performance element measured and the measurement technique.

Table 2: CFBEM pay-for-success components

Initiative	% of investor repayments performance based	Performance measured	Performance measurement technique
Cloud Forest Blue Energy Mechanism	33.1%[3]	i. Reduction in sediment inflows ii. Increase in water quantity ii. Water flow reliability	i. Existing and historic sedimentation in reservoir is measured using bathymetry and sediment concentration sampling. Data are used to model (baseline) sedimentation, without the Mechanism. This baseline is compared with 'real time' data to assess performance ii. Increase in net water inflows / outflows is compared with a modelled baseline iii. Dam volume throughout the year, compared to modelled baseline.

In this case, the Mechanism would have a much greater pay-for-success component than the two comparable instruments – over twice the proportion of the DC Water Environmental Impact Bond.

[3] The DC Water EIB has a face value of $25 million and a ±$3.3 million performance-based payment

ANNEX C: CASHFLOW MODEL - ASSUMPTIONS AND SOURCES

Table 1: Assumptions and sources used in modelling

Assumption	Value	Source	Comments
Cost of equity	6%	Assumption	Assumed to be an impact investor
Catchment size	50,000 ha	Saenz 2013	A catchment is an area where water is collected by the natural landscape. For Calima, this is the area that collects water that flows into the reservoir. Catchment sizes vary considerably across hydropower plants.
Area of cloud forest in catchment	27,000 ha	Saenz 2013	A proportion of the catchment area is covered in cloud forest. This will vary across hydropower plant catchments. Without monitoring and maintenance, these forests might be degraded and deliver lower ecosystem benefits to the hydropower operator. We assume the operator pays CFBEM to maintain this area of cloud forest, thus securing a level of ecosystem benefits.
Area of cloud forest 'hotspots'	9,000 ha	Saenz 2013	This is the area of degraded cloud forest that is reforested in the Mechanism. Hotspots are areas that deliver particularly high ecosystem benefits and thus a higher return on investment from reforestation.
Cost of reforestation	$750 / ha	WRI 2016, *The economic case for landscape reforestation in Latin America, pg. 25*	We define reforestation costs as the direct costs of planting (including inputs such as labor, equipment and trees), transaction costs and the cost of identifying and securing land. The literature and conversations with experts indicate a wide range of reforestation cost – from $375/ha to $2,700/ha in WRI 2016, *including maintenance*. Industry experts estimate costs of $600/ha to $1,500/ha[4]. Costs depend upon whether reforestation is 'active' – using labor to reforest or 'passive' – managing natural restoration processes. Costs will depend upon conditions at the actual site.
Cost of forest maintenance	$2 / ha / yr	Based upon WRI 2015, *The economic costs and benefits of securing community forest tenure: evidence from brazil and Guatemala*	We define maintenance costs as the direct costs of protecting the forest, monitoring and enforcement activities, transaction costs, any recurring investments in activities to support local communities and any equipment required for maintenance. The literature is less forthcoming on maintenance costs. In WRI 2015, annual costs are $1.57/ha in Brazil and $16.85/ha in Guatemala
Administrative costs (for SPV staff)	$74,400 / yr	Assumption	We assume that the Special Purpose Vehicle requires one manager, one assistant and one accountant to oversee implementation and monitoring activities throughout the project
Equipment costs (total)	$20,000	Assumption	The cost of equipment that is required for any activities separate to reforestation, forest maintenance and sediment monitoring (the cost of these latter activities includes necessary equipment). For example, this category could include

[4] Email correspondence with The Nature Conservancy, 2017

			the cost of IT equipment for the Special Purpose Vehicle, such as laptops, printers, etc. This is a placeholder – the cost will need to be determined at feasibility study stage
Years of upfront opex lump sum	5 years	Assumption	We have assumed that equity investors will provide capital to cover operating costs in the first 5 years of operation.
Sediment monitoring costs	$31,250 / yr	Expert interviews and additional assumptions	This is the cost of conducting annual sediment monitoring. We assume that monitoring begins in year 1, with one bathymetric survey per year (at $25,000), for project lifetime. We assume a 25% additional cost for modelling the results of bathymetric surveys into modelling (to identify the benefit delivered by the Mechanism).
Fixed payment / ha from HPP to SPV	$20 / ha / yr	Assumption – pending data on HPP environmental spend	A fee paid by the Hydropower Plant to Special Purpose Vehicle to maintain forest in the plant conservation area (many operators must pay an annual fee for these services already)
Year at which benefits of lowered sedimentation begin	Year 5	Saenz 2013, *The role of cloud forests on energy security* and expert interviews	Drops in sediment yield can be achieved within five years of when a degraded site has been restored
Benefit share between HPP and SPV	50%	Assumption	This refers to share allocation of the benefits the ecosystem services provide. The share allocated to the special purpose vehicle will enter as revenue to the special purpose vehicle.
Cost of physical damage to plant from sediment	4% of annual O&M costs	Statkraft 2016, State of the art sedimentation management practices, presented by Siri Stokseth at IHA World Congress 2017.	Median value across 8 Statkraft dams used
Calima dam capacity	132 MW		
Operating costs	$44,972 / MW / yr	Climate Investment Funds, *Investment grant for the financing and risk transfer program for Geothermal power – economic analysis annex*[5], pg. 7	Based on costs of hydropower O&M as reported by UPME.
Trap efficiency	90%	Lewis et al 2013, *Calculating sediment trapping efficiencies for reservoirs in tropical settings: a case study from the Budekin falls dam, Australia*[6], *pg.* 1	We have no Calima-specific data for trap efficiency and as such rely on data from other dams. Trap efficiency is defined as the proportion of sediment flowing into a reservoir that remains in the reservoir. We take the figure for large particles. The World Bank handbook, *Extending the life of reservoirs: sustainable sediment management for dams and run-of-river hydropower*, provides a case study of a dam in Pakistan with a trap efficiency of 95%
Production loss from sedimentation	26.2% of annual O&M costs	Statkraft 2016	Median value across 6 Statkraft dams used
Sediment released during production shutdown	20%	Assumption	As a percentage of total annual inflows. No hard data available for this value: this should be treated as a placeholder.

[5] Available at https://www.climateinvestmentfunds.org/sites/default/files/meeting-documents/economic_analysis_annex_-_co-g1007_-_modified.pdf

[6] Available at https://research.jcu.edu.au/tropwater/resources/Lewis%20et%20al%20%202013%20dam%20trapping.pdf

Cost of sediment extraction	$3 / m^3	World Bank 2016, Extending the life of reservoirs	Expert interviews and literature review suggest a range of $2/m^3 to $5/m^3
Cost to dispose extracted sediment	$12 / m^3	REFORM river restoration wiki, an EU funded project which provides guidance and tools for hydromorphological assessment and physical restoration of rivers and streams in Europe[7]	The major cost share of dredging is not excavation, but dewatering and deposition of 'surplus' sediment. It is hard to find data for this value. We assume disposal makes up 80% of overall cost. Interviews with Royal IHC, sediment disposal experts, suggested costs of at least $7/m^3, noting that disposal can be very expensive. (Royal IHC offer solutions that can process sediment into usable construction materials)
Net sediment yield from forest	57,200 m^3 / yr	Conservation International modelling	Conservation International used the WaterWorld model to assess the sediment yield into the Calima reservoir from forests in the Calima catchment area
Reduction in sediment inflows from full reforestation of cloud forest	96%	Conservation International modelling	Conservation International used the WaterWorld model to assess the impact of full reforestation of cloud forests in the Calima Catchment area on sediment inflows into the reservoir. This reduction assumes that 90% of the degraded forest is restored, giving a yield of 2,435m^3 / yr
Reduction in sediment yield achieved by reforesting cloud forest hotspots	32%	Conservation International modelling, calculations	We assume that the extent of restoration is linearly proportional to the reduction in sediment. That is, if 100% of the degraded forest were restored, 100% of potential sediment reductions would be realized. In the model, we assume that 9,000 ha are restored, which is 33% of the total degraded forest in the catchment. As such, we assume that 33% of the potential reduction (96%) is realized. So the resultant sediment yield is 33% * 96% = 32% of baseline sediment yield.
Loan tenor	10 years	Assumption	Considered an acceptable tenor for private investors
Payments begin in	Year 1	Assumption	
Cost of debt	6%	Assumption	
Debt Profile	Constant payments	Assumption	For transparency, we assume that constant debt payments are made. Debt could also be profiled, with higher payments due once pay-for-success revenues are received.
Leverage	36%`	Calculated	Debt is secured against fixed payments less annual operating costs.
Corporate income tax	0%	Assumption	Income tax will depend upon project structure, left at zero
Revenues from increased water flow / water regulation	$0 / yr		Left at zero to be conservative and in absence of robust data

[7] Available at http://wiki.reformrivers.eu/index.php/Manage_dams_for_sediment_flow

ANNEX D: SENSITIVITY ANALYSIS

Table 2: Sensitivity of NPV, IRR, payback and total cost to key variables.

Variable	Range	NPV ($)			IRR (%)			Payback (Yrs.)			Total cost ($)		
Area reforested	4500 - 13500 ha	2,042,994	-	-1,645,423	14.7%	-	4.0%	9.0	-	14.5	4,391,250	-	11,141,250
Cost of reforestation	375 - 1125 $/ha	3,573,786	-	-3,176,214	19.3%	-	1.9%	6.5	-	17.1	4,391,250	-	11,141,250
Area maintained	10000 - 50000 ha	1,920,461	-	3,502,773	8.4%	-	15.7%	10.3	-	10.0	7,596,250	-	7,996,250
Cost of maintenance	2 - 50 $/ha	198,786	-	-15,687,009	6.4%	-	-100%	12.7	-	n/a	7,766,250	-	14,246,250
Fixed payments?	No / Yes	-5,994,972	-	1,747,225	-4.8%	-	9.4%	n/a	-	11.2	7,766,250	-	7,766,250
Maintenance payment per ha	10 - 50 $/ha	-2,898,093	-	9,489,422	1.0%	-	-100%	18.2	-	n/a	7,766,250	-	7,766,250
Leverage	0% - 78 %	198,786	-	198,786	6.3%	-	6.4%	11.3	-	12.7	7,766,250	-	7,766,250
Sediment decrease (after year 5)	48% - 100 %	-1,574,402	-	334,901	2.7%	-	6.6%	16.2	-	12.5	7,766,250	-	7,766,250
Cost of sediment	25 - 50 $/m3	-1,023,205	-	752,655	4.0%	-	7.3%	14.8	-	11.9	7,766,250	-	7,766,250
Discount rate	6% - 10 %	198,786	-	-1,535,264	6.4%	-	6.4%	12.7	-	12.7	7,766,250	-	7,766,250
Amount of sediment	28600 - 85800 m3	-184,800	-	582,371	5.7%	-	7.0%	13.2	-	12.1	7,766,250	-	7,766,250

ANNEX E: CFBEM RISKS

Table 3: Risks and mitigating actions for CFBEM

Risk	Description	Mitigation
Performance (and allocation risk)	The benefit which will be tied to sediment yield will be complex to tie to intervention area. In addition, there is a risk that the activities will simply not provide improvement in sedimentation and/or increased water flow and regularity.	Sedimentation monitoring and methodologies will be agreed with the hydropower plant during research & development The potential effectiveness of implementations will be gauged in Stage 1.
Market/Financing Risk	The innovativeness and unpredictability of the contract could deter investors	The Mechanism can incorporate a fixed payment portion to revenue stream from which loans can be acquired
Counterparty	HPP default.	Only credit worthy hydropower operators will be approached and contracts will be properly structured to assure win-win.
Construction Risk	Implementation might not bring desired outcomes.	Financing enhancements can be studied once potential cashflows are more fully understood.
Regulatory	Regulatory changes may create project risks	The Special Purpose Vehicle structure allows liabilities to be born at project level.
Lifecycle	The entity might cease to be viable as a going concern and may threaten operations	The Special Purpose Vehicle structure allows for takeover of control by a competent management that can possibly renegotiate liabilities and maintain programme activities.

ANNEX F: CFBEM BRINGS TOGETHER THREE PRACTICES IN THE HYDROPOWER, ENVIRONMENTAL AND SOCIAL SERVCES SECTORS

Hydropower

The World Bank Group (World Bank) engages in hydropower and water supply projects of all sizes and types and is raising awareness that careful planning is needed to ensure resilience against the uncertainties of climate change and disaster risk. The World Bank leads many initiatives in this area, such as the development of the reservoir conservation (RESCON) approach. Most recently the World Bank published the guide "Extending the Life of Reservoirs" to serve as a compliment to the upgraded RESCON model and provide guidance on adopting sustainable sedimentation management practices. In particular, the book highlights three sustainable sediment management alternatives (1) Reduction of sediment yield from upstream; (2) Routing sediments; and (3) Removal and/or redistribution of sediment deposits. Cloud Forest Blue Energy Mechanism activities would overlap with reduction of sediment yield from upstream.

Environment

The OECD report: “Paying for Biodiversity: Enhancing the cost effectiveness of payment for ecosystem services” highlights twelve key criteria that should be addressed in the development of a PES programme to enhance environmental and cost effectiveness. Cloud Forest Blue Energy Mechanism aims to incorporate these criteria, which are:

1. Remove perverse incentives
2. Clearly define property rights
3. Clearly define PES goals and objectives
4. Develop a robust monitoring and reporting framework
5. Identify buyers and ensure sufficient long term sources of financing
6. Identify sellers and target ecosystem service benefit
7. Establish baselines and target payments to ecosystem services that are at risk of loss or to enhance their provision
8. Differentiate payment based on opportunity cost of ecosystem service provision
9. Consider bundling or layering multiple ecosystem services
10. Address leakage
11. Ensure permanence
12. Deliver performance based payments and ensure adequate enforcement.

Social Services

The first pay-for-success instrument (also known as a social impact bond) was launched by “Social Finance” in 2010 to tackle a reduction in reoffending in Peterborough, Cambridge, UK (Social Finance, 2016). As of early 2017, over a dozen projects have launched, one project has completed and there are more than 50 projects in development (Pay for success, 2017). These instruments attract private finance to finance social programs for which government agencies (or others) pay back, based on the achievement of measurable benefits or outcomes. Cloud Forest Blue Energy Mechanism uses this payment Mechanism to scale up investment in year 0 and have the Hydropower Co as a reliable payment counterparty that investors will find enticing.

ANNEX G: SEDIMENTATION MONITORING

As author Gregory Morris describes in “Extending the Life of Reservoirs”, “*sustainable sedimentation management seeks to maintain long term reservoir capacity, retarding the rate of storage loss and eventually bringing sediment inflow and discharge into balance while maximizing usable storage capacity, hydropower production and or other benefits*” (World Bank, 2016). The development of a sedimentation program will follow the following basic steps:

1. Monitor and document existing or historical conditions
2. Develop design and operational strategy
3. Monitor effectiveness and adjust management practices.

Mechanism scoping (within Research & development, Stage 1) will incorporate step 1 above in order to be able to perform a feasibility study of the instrument on the chosen watershed. This data will then inform the design of the pay-for-success contract. It is noted that these activities and data produced can then form part the first step of a hydropower plant’s sustainable sedimentation program.

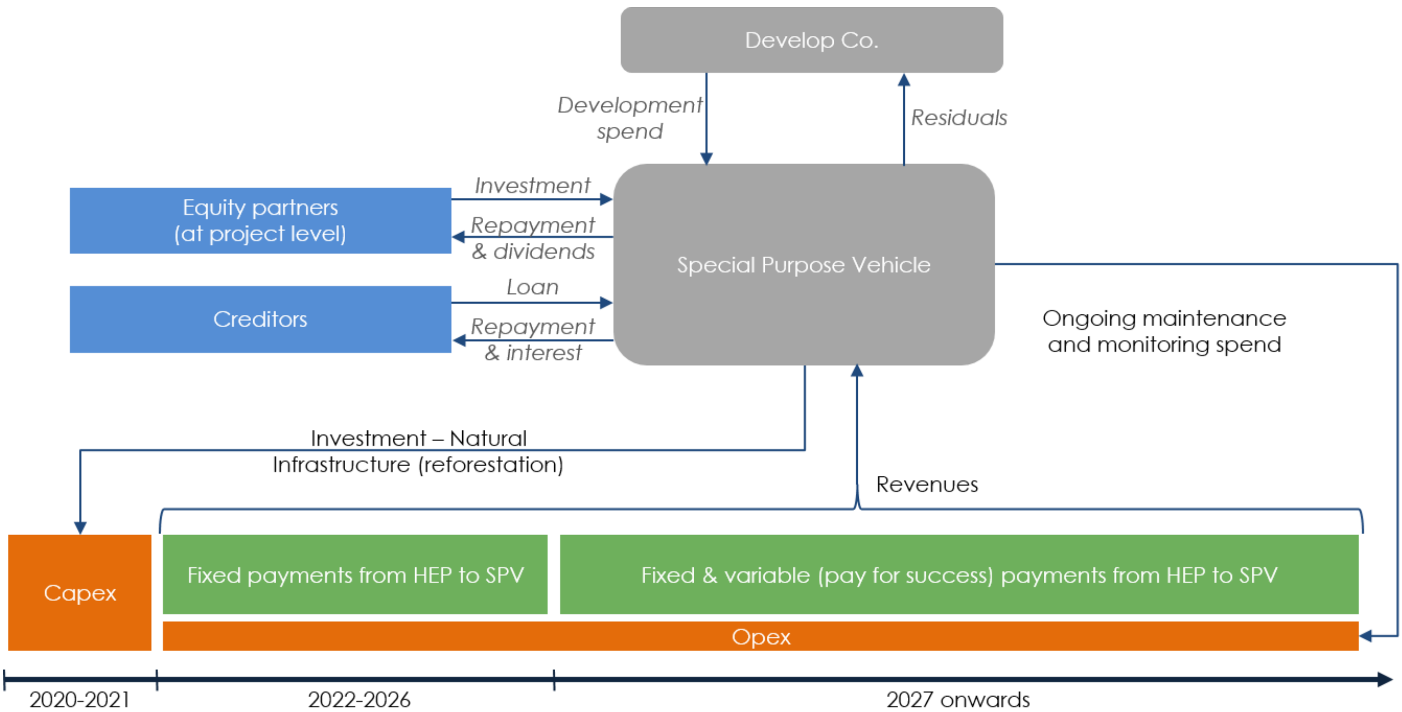
Examples of key metrics and measures (from flows into the reservoirs and within the reservoir) that can be potentially used in monitoring are listed below. We note that Morris states that collection of samples over large range of flows (rather than large number of samples) is the key to obtaining representative data.

1. Suspended load
2. Suspended sediment concentration
3. Sedimentation rate
4. Rate of sediment deposition
5. Bed material load
6. Sediment Bulk density
7. Sediment grain size distribution
8. Water discharge

ANNEX H: FINANCIAL FLOWS

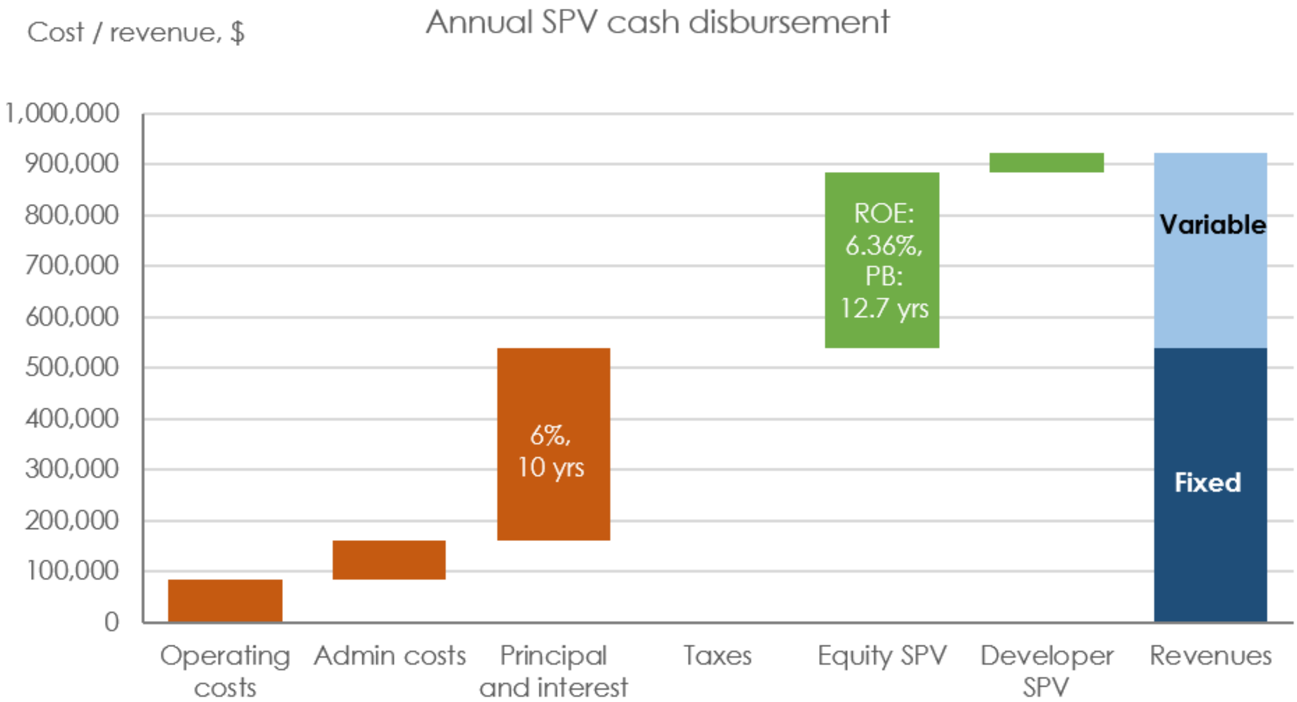
A typical project will follow the financial flow as observed in Figure 1. Our illustrative modelling assumes that the Hydropower Plant would pay a mix of fixed (for maintenance) and variable (pay-for-success on sediment reduction). In the scenario, the project could support a 10-year fixed amortization loan with no grace period at 6%. We believe the interest rate could be achieved as the loan would be granted based on the maintenance payment agreement with the Hydropower Plant. This would peg loan risk to the Plant's credit rating. The equity distributions would depend on overall performance of the pay-for-success contracts. In our modelling, we have estimated that IRR can be up to 6% and payback be achieved by year 13.

Figure 1: financial flows in Cloud Forest Blue Energy Mechanism



The graphic below goes into further detail as to the pecking order of how revenues are used in the expenses and distributions of funds.

Figure 2: Illustrative annual Special Purpose Vehicle cash disbursement



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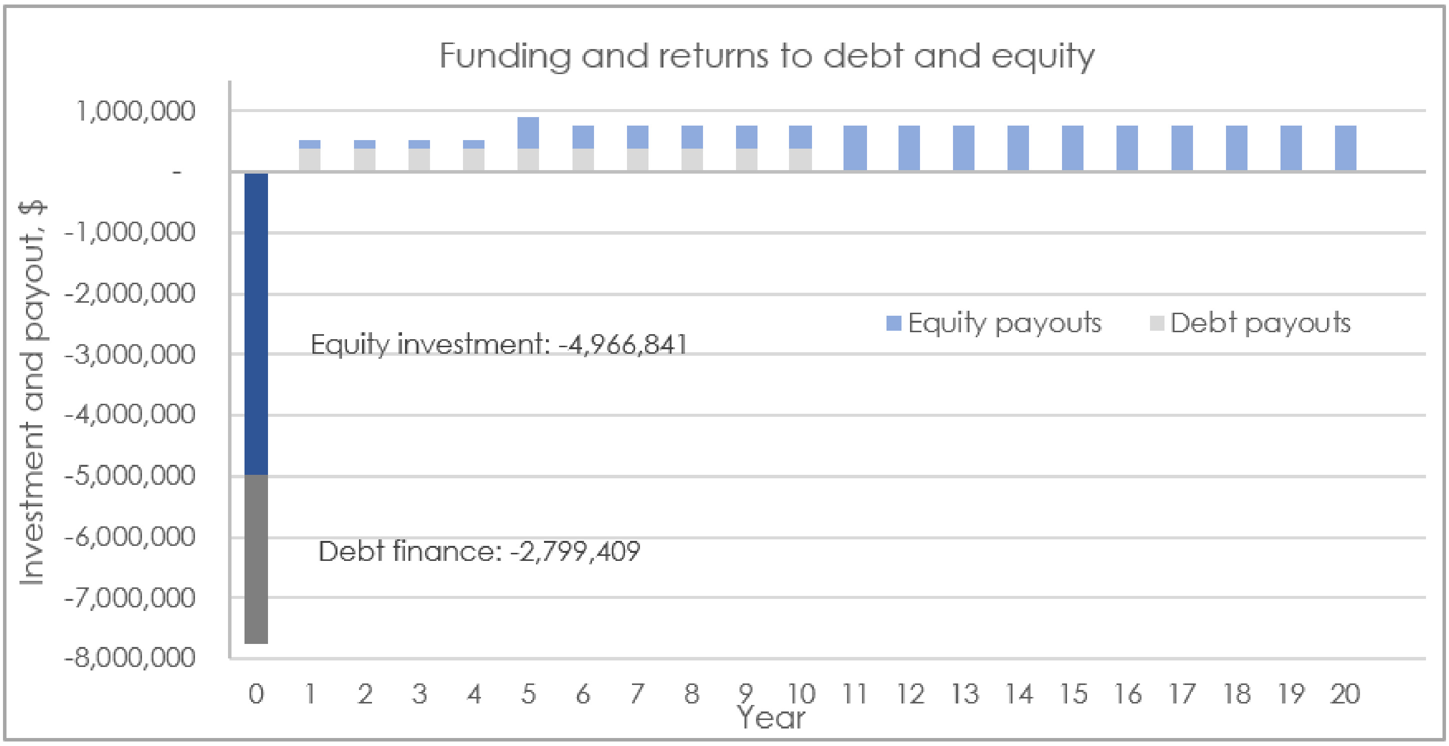
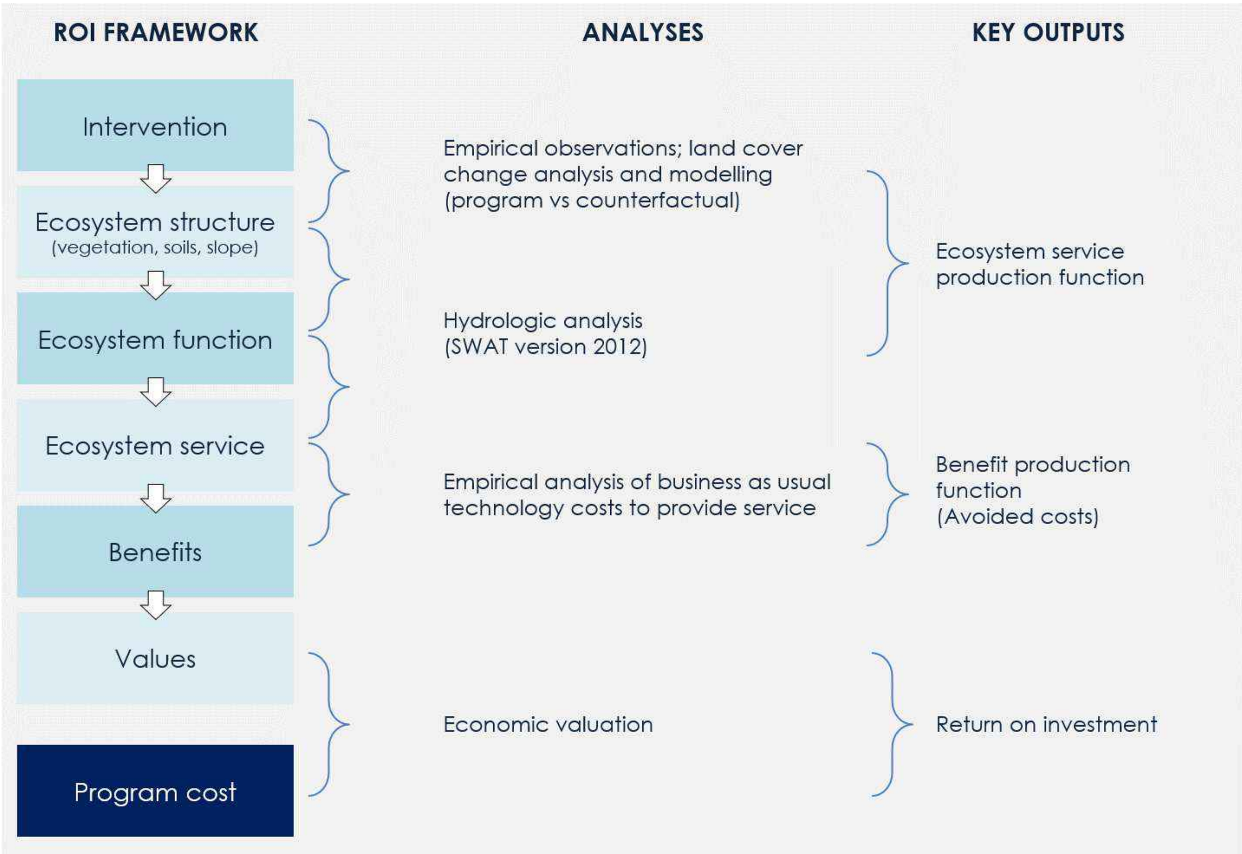


ANNEX I: ROI ASSESMENTS

The Nature Conservancy has developed an analytical framework that allows an economic assessment of watershed conservation and restoration thus permitting those interested in evaluating the business case of investing in natural infrastructure for their own geography.

The framework follows the following steps, analysis generating the respective outputs as shown in the figure below.

Figure 3: The Nature Conservancy Return on Investment analytical framework. Source: TNC 2017, *Beyond the Source*



OUTREACH AND EXPERT INTERVIEWS

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