Environment Conservation Journal 18(1&2) 189-195, 2017
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed

Analyzing economic viability of implementing Redd+ in India: Cost benefit approach

Bibhu Prasad Sahoo and Karman Kaur ✉

Received:10.12.2016 **Revised: 11.02.20147** **Accepted: 18.04.2017**

Abstract

The paper seeks to find the economic viability of implementing REDD+, a voluntary market mechanism which involves incentivizing developing countries to stop deforestation and forest degradation in exchange of payment by the developed countries, to achieve their greenhouse gas concentration targets. The net revenues to the farmers from undertaking the REDD+ program and from the next best uses of forest land i.e. using the land for Rice plantation is calculated. It was found that REDD+ comes out to be the most profitable option for the farmers of Andhra Pradesh. The effect of uncertainty was also taken into account by doing a sensitivity analysis of the results. The fact that REDD+ still came out to be highly profitable ensures that the model is efficient and robust even in case of uncertainty.

Keywords: REDD+, Andhra Pradesh, sensitivity analysis, rice plantation, opportunity costs

Introduction

Global warming is a global issue. It is the increase of Earth's average surface temperature due to effect of greenhouse gases, such as carbon dioxide emissions from burning fossil fuels or from deforestation, which trap heat inside the Earth atmosphere. Over the last 2 centuries, the concentration of CO2 in the atmosphere has increased by more than 25% since the 18th century (Neftel et al 1985). Trees are 50% Carbon, and ability of the trees to capture carbon from the atmosphere is called Carbon Sequestration. So, forests play a very important role in Carbon Sequestration. The more forests we have, the more carbon we can capture, and the more carbon we capture, the fewer greenhouse gases we contribute to the atmosphere. Due to the growing levels of global warming in the atmosphere, a lot of efforts have been made in order to include the forestry sector so as to reduce the GHG concentrations into the atmosphere. This sector can contribute significantly to reduce global CO_2 emissions through deforestation, and can also provide opportunities to lessen the levels of CO_2 in the atmosphere by sequestering it in soils and vegetation as well as in wood products. In this way the forestry sector can play a critical role in stabilizing global CO_2 concentrations (IPCC 2007).

Author's Address
SGTB Khalsa College, University of Delhi
E-mail:karmanbright@gmail.com

Creating a market for such solutions is of prime importance in this regard. The forest sector can play a key role in filling the gap between the mitigation pledges by the developed countries and the cumulative mitigation necessary to achieve the global 2°C stabilization target.Market based solutions in case of environmental problems involve creating a market for using the environment and making the beneficiary pay for it. A number of ways can be used by the government in order to set a price on the use of environment, e.g. setting a tax on pollution emitted by firms, selling pollution permits to firms at a set price and creating an emissions trading market. Voluntary markets also act as an alternative enabling businesses, governments, NGOs, and individuals to reduce their emissions by purchasing credits that are created in the voluntary market. These markets are not legalized by the legislation and are undertaken voluntarily to meet their emission targets and make money. Although it is smaller than the compliance market, it is said to have great potential in reducing the greenhouse gases (Wunder 2005). Forestry projects are very popular in the voluntary carbon market largely due to their tangible nature and characteristics like ecosystem services, conservation, and biodiversity and community benefits (Harris 2007).One such example is REDD+. Adopted by the United Nations Framework Convention on Climate Change

(UNFCCC) at Bali in December, REDD is a United Nations collaborative initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) in developing countries. It involves creating an incentive to reduce carbon emissions by avoiding deforestation and land degradation. It is an international system of Payment for Ecosystem Services (PES). PES can be defined as voluntary and conditional transaction between at least one buyer and one seller for a well-defined environmental service (Wunder 2005). It has the potential to implement effective and cost efficient instrument for implementing REDD+ on ground. The economics behind this is that the economic value of the carbon REDD+ saves has to exceed the total cost of providing the environmental service – i.e., the opportunity costs, and the protection and transaction costs of conservation. If this condition is not met, service providers will become worse off and thus not participate. A lot of researchers have studied the impact of PES and have shown mixed results.

Table 1: Area under Forest and deforested area in Andhra Pradesh

Area revised(sq. kms)			Area (sq. kms)	Change in area(sq.kms)		
2003	2005	2007	2009	2003-05	2005-07	2007-09
44,412	45,231	46,670	46,389	819	1439	-281

In this paper attempts is made to calculate the benefit from implementing REDD+ and from the next best alternative, that is, rice cultivation on the deforested land. Several studies have been done regarding implementation of REDD+ across different countries. Here some significant studies done in this field are discussed. Potvin et al (2008) examined two types of proposed REDD mechanisms: market- or fund based for addressing developing countries' concerns, using Panama as a case study. . It was assumed that Panama would reduce deforestation on an area of 5,000 ha per year, an assumption deemed realistic by government officials. In Panama, the protection of 5,000 ha of forest land corresponds to an annual reduction in emissions of 3,320,000 tCO2e with a break-even opportunity cost of US$3,678,594. The additional costs of protection, transaction and administration would augment the overall cost by 25%. It stated that in a fully fungible market, REDD credits are likely to be relatively cheap.

Plum et al (2012) in their paper 'Challenges of Opportunity cost analysis in planning REDD+: A Honduran case study of social and cultural values associated with Indigenous forest uses' have assessed the opportunity cost associated with an indigenous community's forest uses in Hondura's Rio Platano Biosphere reserve. Total economic value of all agricultural products was calculated by multiplying production in each crop type by its respective market price which was then summed and divided by total hectares planted to get an estimate of the annual return per hectare. The results showed that the opportunity cost for slowing deforestation from agriculture ranges from 2-7$/tCO2 and even less for other forest uses. Since these are within the range of voluntary carbon market prices, it provided an economic justification for development of the REDD+ project.

According to report by Ministry of Environment, Forests and Climate Change New Delhi December 2014, some of the components of REDD+ that may be difficult to implement in India are: (a) Remote sensing maps for multiple time periods for each of the REDD+ activities for a given project location at a scale which would enable project development. (b) Land use change matrix for the IPCC land categories such as forest land, cropland, grassland, wetland, settlements and other lands. (c) Emission factor for different IPCC land categories and sub-categories subjected to transition or land use change (d) Drivers of deforestation, forest degradation and other plus components. REDD+ is still a developing subject in India in terms of technology, methodology and financial options, and, therefore, all aspects of REDD+ require research. However, there is a need to identify research areas of REDD+. Institutions need to be identified in different parts of the country for undertaking research on various aspects related to REDD+ such as identification of potential locations for REDD+ implementation, setting up of national forest reference level, sub-national/project level reference level and reference emission level, generating data for developing project proposals for REDD.

Objective

The objective of the study is to analyze the benefits from protecting the forest (a case for implementation of REDD+) and compare with the costs of protecting it, that is, opportunity costs from rice plantation.

Data sources

To calculate the net revenue of farmers from Rice cultivation and Forest conservation, secondary data on Rice and Forest Biomass was used. The data on Rice yield, prices and costs of harvesting was obtained for the period 1987-2009 from the Directorate of Economics and Statistics, Ministry of agriculture and Commission for Agricultural costs and Prices (CACP) reports. Data on Forest Biomass was obtained from the Forest Survey of India Reports. Since the data on Forest Biomass was published only for the years 1982, 1992, 2002 and 2011, so Cardinal Spline Interpolation was used to complete the dataset for the period 1987-2009. This method of interpolation uses lower degree polynomials in each of the intervals and then chooses the polynomial pieces such that they fit smoothly together, and thus incur a smaller error than linear interpolation, to get a smoother interpolant (Joseph et al 2003). It also avoids the problem of Runge's phenomenon, which occurs when interpolating between equidistant points with high degree polynomials. Linear interpolation also leads to loss of high frequencies, which makes it perform poorly as compared to other cases (Thevenaz et al 2000).

Material and Methods

For this study, a Cost Benefit Analysis (CBA) is carried out to compare the costs and benefits of implementing REDD+ and then to decide upon whether such a program is beneficial for the farmers of AP. It is the most common method of economic project and policy appraisal. It is a decision tool which judges projects according to a comparison between their costs (disadvantages) and benefits (advantages). If a project shows a net benefit, it can be approved, and different projects can be ranked according to the size of their net benefit.

[Benefits - Costs] > 0 (Bann 1997)

(Eqn. 1)

Here, Costs will be captured by calculating the net revenues from alternative land uses i.e. Rice cultivation which represent the opportunity costs of conserving forests, and benefits will be captured by calculating the net revenues that the farmers will receive by conserving forests and selling carbon credits in the carbon market.

In this paper we calculate the total Economic value of land used for agriculture as:

Total Economic value = Efficiency Price * Maximum sustainable yield – Harvest Cost

(Eqn.2)

To calculate the revenue from conserving forests, price per ton CO2 i.e. the price of a carbon credit will be multiplied by the Carbon content of forest:

Total Revenue = Price/tCo2 * Forest Carbon

(Eqn.3)

Where, Forest Carbon = 0.5*Forest Biomass (Houghton 2005).Values for these variables will be forecasted for the next 10 years i.e. up to 2022. This is because REDD+ in Andhra Pradesh has still not been implemented and will take around 5-10 years to be implemented. For the purpose of forecasting, an Autoregressive Integrated Moving Average (ARIMA) model popularized by Box and Jenkins is used for the study.

Results and Discussion

Yield of Rice is the total production of rice during the year, and is measured in Kg/hectare. The price of rice is the price at which the commodity is disposed off by the farmer to the trader during the marketing period, measured in Rs./quintal. It was then converted into Rs./Kg.The cost of harvesting rice is the total costs/expenses incurred on material inputs, labor, and bullock and machine labor by the farmer, measured in Rs./ha. All the variables show a rising trend over the years. Forest Biomass was converted to Forest Carbon by multiplying by 0.5 which represents the Carbon content of forest biomass (Houghton 2005, IPCC 2006, MacDicken 1997), i.e. 50% of the total forest biomass is forest carbon.

Figure 1: Below shows the 4 different ways of interpolating data. The yellow dotted line shows the Cardinal Spline Interpolation used for the study.

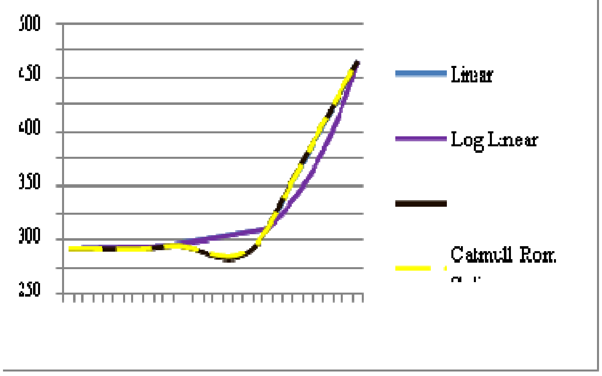


Table 2: Data summary statistics

Variable	Mean	Min.	Max.
RiceYield(Kg/ha)	2555	1859	3247
RicePrice(Rs./Qtl)	390.3	84.7	800
RiceCost of Harvesting(Rs./ha)	10683.5	2014	29001
Forest Biomass (t/ha)	148.3	69.96	429.87

Based on the Augmented Dickey Fuller test, the series was made stationary at first difference. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were then plotted to get the significant lag values. The ACF had significant lag value at level 1 and the PACF had significant lag value at levels 1 and 2. This gave us our tentative models as (1,1,1) and (2,1,1).The AIC and SBC tests were then conducted to reach our final model. Results of the tests can be seen as:

Table 3: AIC SBC Value of Rice Yield

Value	(1,1,1)	(2,1,1)
AIC	12.94	12.87
SBC	13.08	13.01

Since the AIC and SBC values came out to be minimum at (2,1,1). The final ARIMA came out to be (2,1,1). The final forecasted value of Rice Yield in 2022 came out to be 3556.9Kg/hectare.

Rice Prices

Based on the Augmented Dickey Fuller test, the series was made stationary at first difference. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were then plotted to get the significant lag values. The ACF had significant lag value at level 1 and the PACF also had significant lag value at level 1. This gave us our final ARIMA models as (1,1,1).The AIC and SBC values of the model came out to be:

Table 4: AIC SBC Value of Rice Price

Value	*(1,1,1)*
AIC	*9.73*
SBC	*9.59*

The final forecasted value of Rice Prices in 2022 came out to be Rs.1099/Quintal. It was then converted into Kg to get the price as Rs.22.89/Kg

Cost of planting rice

Based on the Augmented Dickey Fuller test, the series was made stationary at first difference. The Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were then plotted to get the significant lag values. The ACF had significant lag value at level 1 and the PACF also had significant lag value at level 1. This gave us our model as (1,1,1).The AIC and SBC values of the model came out to be

Table 5: AIC SBC Value of Cost of Rice

Value	(1,1,1)
AIC	17.05
SBC	16.91

AIC and SBC tests found out that the MA term was insignificant to the series, this gave us our final ARIMA model as (1,1,0). The final forecasted value of Cost of planting Rice in 2022 came out to be Rs.41306.15/Kg.

Forest biomass:

Based on the Augmented Dickey Fuller test, the series was made stationary at first difference. The

Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) were then plotted to get the significant lag values. The ACF had significant lag value at levels 1, 2, 3, 4 and 5 and the PACF had significant lag value at levels 1 and 2. This gave us our tentative models are (1,1,1) (1,1,2) (1,1,3) (1,1,4) (1,1,5) (2,1,1) (2,1,2) (2,1,3) (2,1,4) and (2,1,5).The AIC and SBC tests were then conducted to reach our final model. Results of the tests can be seen as:

Table 6: AIC SBC Value of Forest Biomass

Value	(1,1)	(1,2)	(1,3)	(1,4)	(1,5)	(2,1)	(2,2)	(2,3)	(2,4)	(2,5)
AIC	4.57	4.99	5.21	5.37	5.24	5.44	6.09	6.44	6.67	6.51
SBC	4.72	5.14	5.35	5.51	5.38	5.58	6.23	6.58	6.82	6.65

Since the AIC and SBC value came out to be minimum at (1,1,1). The final ARIMA model came out to be (1,1,1). The final forecasted value of Forest Biomass in 2022 came out to be 838590 tonnes/hectare.As per Houghton 2005, MacDicken 1997, the carbon content of forest biomass is 50% i.e. forest biomass is made up of 50% carbon. So, we multiplied the forest biomass with 0.5 to get Forest Carbon as 419295 tonnes/hectare.As per the methodology explained in the Methodology section, revenues from the 2 land use options: Rice plantation and Conserving forests were calculated. The price of a REDD+ carbon credit is the price per ton CO2 sold in the voluntary carbon market. These prices are decided up on trading on the voluntary exchange boards. At the time of writing of the report, price of a carbon credit ranged from \$3-9 (Ghosh 2011). So, a price of \$3 was used to calculate the revenues from conserving forests.

The revenues from the land use options can be summarized as:

Table 7: Revenues from land use options

Forecasted Revenue from Rice Plantation in 2022	Forecasted Revenue From Protecting Forests
Rs. 40146.86/ha	Rs.69183675/ha

So, as it can be seen, the revenue from conserving forests comes out to be Rs. 69183675 which is way too high as compared to other land use options i.e. Rice plantation implementing REDD+ will be a profitable option for Andhra Pradesh.

SENSITIVITY ANALYSIS:

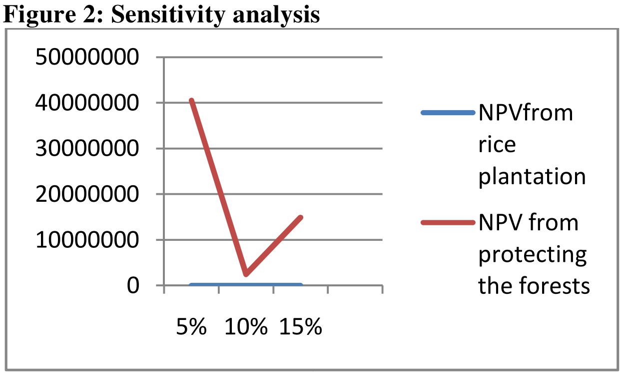
Since the forecasting has been done for the future 10 years, the effect of uncertainty is taken into account using the parameter of discount rate and calculating the NPV.Sensitivity analysis is used to determine how sensitive a model is to changes in the value of the parameters of the model and helps to build confidence in the model by studying the uncertainties associated with it.So, a sensitivity analysis using 3 discount rates: 5%, 10% and 15% was done to check for robustness of the results.

The results of sensitivity analysis can be seen as:

Table 8: NPV of the revenues from land use options

Discount rate	NPV of revenue from rice plantation	NPV of revenue from protecting forests
5%	Rs. 22428/ha	Rs. 40458289/ha
10%	Rs.12826/ha	Rs. 24274973/ha
15%	Rs. 7504/ha	Rs. 14878209/ha

Figure 2: Sensitivity analysis



Sensitivity Analysis shows that the results are robust to a change in discount rate. Thus, the effect of uncertainty does not affect our analysis. So, it be said that implementing REDD+ will be the most profitable option for Andhra Pradesh

Conclusion

Purpose of this paper was to check for the economic viability of implementing REDD+ in Andhra Pradesh. Different land use options i.e. Agriculture in the form of Rice plantation, and Conserving forests were assessed. Net revenues from conserving forests came out to be the highest as compared to the net revenues from the other land use options. The results were also checked for efficiency and robustness by carrying out a sensitivity analysis using three different discount rates. Thus, it was found that Andhra Pradesh serves to be a good site for implementing REDD+ in the future 10 years.Although many countries have shown that REDD+ tends to alienate the farmers from their own lands and that is why there is a lot of resistance from farmers with respect to implementing this scheme, the solution to this problem lies in the fact that since farmers are not well aware of the working of REDD+ and are kept outside the boundary of project designing, it develops a fear of losing their lands among the farmers. Thus the need of the hour is that farmers should be made aware of the program through campaigns and proper training and should be done to show them how farmers from other countries have benefitted from such programs.Although India has traditionally been characterized a low forest low deforestation (LFLD) country, analysis done by Ravindranathan et al (20012) suggests that there is significant deforestation and forest degradation occurring in India. Consequently, there is large potential for REDD+ activities in the country. India is partially ready for implementing the emerging REDD+ components and mechanism, despite robust, stable and predictable forest policies, programmes and institutions. Benefit-sharing mechanisms need to be put in place for REDD+ to be successful.The REDD+ initiative will help local Indian communities as it clearly safeguards their rights. India is committed to the fact that monetary benefits from REDD+ will flow to local, forest dependent, forest-dwelling and tribal communities. This is ensured for three reasons; first, in the Indian context. (Sarkar,2010). REDD+ is intended to be an additional co-benefit to the goods and services already accruing to and being enjoyed by the local communities, and therefore, it comes as a bonus without compromising on the existing benefits. Second, the Indian Government additionally ensures that REDD+ will not adversely impact the traditional and legal rights of the local communities over forests, but on the other hand, will ensure more monetary benefits flowing to them. Third, REDD+ recognizes and respects national legislations relating to safeguards for the rights of indigenous peoples and local communities, and aims to promote their participation in implementation and monitoring of the endeavour.

Acknowledgement:

Author are thankful to SGTB Khalsa College, University of Delhi for cooperating during the research

Abbreviations:

- NVP- net present value
- ARIMA- autoregressive integrated moving averages
- ADF- augmented dickey fuller test
- AP- Andhra Pradesh

References

Bann,C.1997 *The Economic Valuation of Tropical Forest Land Use Options* : A Manual for Researchers, International Development Research Centre, Ottawa

Ghosh,S.2011, REDD+ in India, and India's first REDD+ project: a Critical Examination, ***Mausam***Vol. 3.Issue 1, 32-49

Harris,Kim S. and Raymond M. Leuthold, 2007, Alternative forecasting techniques: a casestudy for livestock prices, North Central ***Journal of Agricultural Economics,*** 40-50.

Houghton,R.A., 2005, Above ground forest biomass and the global carbon balance, ***Global Change Biology*** II, no. 6, 945-958.

IPCC2007,The Fourth Assessment Report.Geneva,Switzerland: ***Intergovernmental Climate Change. Details*** availablea thttp://www.ipcc.ch/pdf/assessment-report/ar4/syr/ ar4_ syr. pdf

Joseph,B.,Ziv,Georg Gerber,Itamar Simon,David K.Gifford and Tommi S. Jaakkola., 2003, Comparing the continuous representation of time-series expression profiles to identify differentially expressed genes, ***Proceedings of the National Academy of Sciences,*** no. 18, 10146-10151

Macdicken,Kenneth G., 1997, Project specific monitoring and verification:state of heart and challenges, ***Mitigation and Adaptation Strategies for Global Change*** 2,no.2-3,191-202.

Ministry of environment, forest and climate change report , 2014, available athttp://www.envfor.nic.in/sites /default/files/press-releases/Reference% 20Document %20For%20REDD+%20in%20India.pdf

Neftel,A.,E.Moor,H.Oeschger,andB.Stauffer.1985, Evidence from polarice cores for the increase in atmospheric CO_2 in the past two centuries, ***Nature***315, 45-47.

Plum,SpencerT.,Erik A.Nielsen,andYeon-SuKim, 2012. *Challenges of Opportunity Cost Analysis in Planning REDD+:A Honduran Case Study of Social and Cultural Values* Associated with IndigenousForest Uses, Forests3, no. 2, 244-264

Potvin,Catherine,Bruno Guay,and Lucio Pedroni, 2008, Is reducing emissions from deforestation financially feasible?A Panamanian casestudy, ***Climate Policy*** 8,no.1, 23-40.

Ravindranath,N.H.,Rajiv Kumar Chaturvedi and Indu K. Murthy, 2012, Deforestation and forest degradation in India, ***Current Science***,no. 8, 216-222.

Sarkar J. 2010, REDD, REDD+ and India, ***Current science,***Vol.101 No. 3

Thévenaz, Philippe, Thierry Blu and MichaelUnser, 2000, Interpolation revisited [medicalimagesapplication],Medical Imaging,IEEE Transactions, no. 7, 739-758

Wunder, S., 2005,*Payments for Environmental Services*: Some Nuts andBolts, CIFO Roccasional paper No. 42.CIFOR, Jakarta,Indonesia