Geographical appraisal about Dependency on Natural Resources and Sustainable Resource Management with special reference to Bankura District

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Abstract

The paper attempts to provide a comprehensive study on the dependency on natural resources of the district of Bankura and provides a guideline to achieve sustainability so far as dependency on natural resources is concerned. It focuses mainly on two natural resources: forestry and drinking water on which people in our study area are heavily dependent. The paper starts with a discussion on few aspects of irrigation and forestry in our study area and after that it considers a profile of our study area, based on field survey, to discuss the socio-economic features of the people residing in that area. The paper also considers some methodological issues in terms of dynamic optimisation model, absolute convergence and contingent valuation method the results of which have strong implications from the point of view of policy analysis in our study area.

Key Words: *Dependency, Sustainability, Dynamic Optimisation, Convergence, Contingent Valuation, Willingness to Pay.*

1. Introduction

The world's drylands are fragile ecosystems due to harsh climatic conditions and growing human pressures. Yet, they constitute some of the world's largest land reserves and provide a wide range of goods and services which are fundamental to the livelihoods of millions of people. The semi-arid and arid regions are situated in the tropical and sub-tropical parts of the world and they account for almost 30% of the world's total area and around 20% of the total population. According to the World Atlas of Desertification (UNEP, 1992), drylands have a ratio of average annual precipitation (P) to potential evapotranspiration (PET) of less than 0.65. In fact, according to the report of Food and Agricultural Organisation (FAO) in 1993, drylands are categorised into hyper arid, arid, semi-arid and dry sub-humid zones not only on the basis of P/PET ratio but also on the basis of rainfall (in mm.). Thus, when P/PET ratio is less than 0.05 and rainfall is less than 200 mm, the dryland is referred to as Hyper-arid. Again, when P/PET ratio lies between 0.05 to 0.20 with rainfall less than 200 mm. in winter and 400 mm. in summer, it is considered as arid zone. The next categorisation is Semi-arid zone for which P/PET ratio lies between 0.20 and 0.50 with rainfall less than 200-500 mm. in winter and less than 400-600 mm. in summer. Finally, when P/PET ratio lies between 0.50 and 0.65 with rainfall less than 500-700 mm. in winter and less than 600-800 mm. in summer, it is referred to as Dry sub-humid zone. On the basis of FAO statistics, the percentage share of arid and semi-arid categories combined together are the highest among the total dryland areas of the world.

In India, arid and semi-arid zones are characterised by low to medium mean annual rainfall coupled with high coefficient of variability, large amplitude of fluctuations of temperature, strong wind regions and high potential evaporation. The average annual rainfall of these regions varies between 150 mm and 500 mm along with a

coefficient of variation as high as 60% to 70%. The distribution of rainfall is also very erratic.[1] In India out of the total geographical area, almost one-sixth area with 12% of the population belongs to drought prone areas. At present 74 districts, covering 13 states of the country have been identified as drought prone.

The dryland areas of West Bengal comprise of districts like Purulia, Bankura, West Midnapore and a part of Birbhum as per the State Plan of West Bengal, based on the document "State Agriculture Plan for West Bengal"[2]. Part of Bankura district comes under "red laterite soil region" in West Bengal and here crop productivity is limited. FAO's classification for categories of dryland areas is based on P/PET ratio and on rainfall (in mm). The State Plan of West Bengal has considered FAO's classification. Additionally, the plan has classified agro-climatic region based on soil contents. Bankura district can be termed as semi-arid for the nature of its soil and parts of it showing features of aridity.

The dryland area of Bankura is also a part of the 'Jangal Mahal' area with the feature that people residing in this region are poor and are heavily dependent on natural resources. The two major natural resources on which people of this area are highly dependent are forestry and drinking water. Though they extract these resources for their livelihood, they have the knowledge base to sustain these resources for future. Hence, they maintain a balance between sustainable resource management and extraction of resources in the context of their dependency on natural resources. So, a study of the economic behaviour of the people residing in the Bankura becomes essential. However, such a study requires having a quick analysis of the literature that exists in this line.

Though there are quite a substantial number of works on dryland areas in India, here we mention only a few works that are relevant for our present study. One can refer to the works of Gautam and Rao (2007), Ram and Davari (2010), Bhattacharya and Gupta (2010), Saha and Usha (1992), Bouma and Scott (2006) etc. Gautam and Rao (2007) have shown, in detail, about history of rainfed agriculture in India, starting from pre-independence period. They have also discussed about the magnitude of problems of rainfed agriculture, delineating of rainfed farming. Ram and Davari (2010) have considered rain water and soil as the two most important natural resources of dryland resources. They have emphasised on management practices that maximize the usefulness of limited rainwater by imposing relevant conservation measures and land uses matching with the water availability period in India. Bhattacharya and Gupta (2010) have shown the impact of integrated watershed projects in India. They have shown the impact of completed watershed projects on the livelihood of rural population who are associated with the projects. People of arid regions are forced to migrate to the urban areas to avoid the manifold problems of such areas, especially the problem of water. The authors, in their work, have addressed this reality and have recommended the amount of income that a watershed project should generate to avoid the migration. Saha and Usha (1992) have made a study about the role of rural women of drylands in decision-making processes of various socio-economic activities. In decision making, especially, in agriculture, livestock and socio-religious matters, women were consulted by the heads of households. By and large, little differences in decision-making processes between different groups established homogeneous character of the population. Bouma and Scott (2006) have made an assessment of the impact of large-scale investments in soil and water conservation on dryland crop yields in three semi-arid watersheds in India. Investments in soil and water conservation are supposed to contribute to dryland crop yield improvement by rehabilitating the productive capacity of the land. On the basis of farmers' interviews, group meetings and field visits, they have explored the main constraints for dryland crop yield improvement. There are only a few works related to the dependency on natural resources in dryland areas of West Bengal.

The motivation behind the present study generates from the fact that most of the people living in the dryland areas are poor and are heavily dependent on natural resources of the area so that a study on sustainable resource management and extraction of resources is very much relevant. For example, most of the people in the area are aware about harvest of timber and non-timber forest products (NTFP) but they are also aware about the fact that forests are to be protected and conserved for their own sustainable livelihood. Our study area is featured with underdevelopment, poverty and starvation, dependence on natural resources for livelihood, lack of alternative job opportunities and last but not the least frequent political disturbance.[3] So a comprehensive study of the area will help us to suggest appropriate policy to uplift the conditions of the people residing in the region. There is lack of such comprehensive study in the literature and the present paper attempts to fill the lacuna. The present paper deals with a comprehensive study that deals with a collection of issues on dependency on natural resources by the people in the Bankura of West Bengal.

The paper is organised in the following manner. Section 2 deals with a brief outline of the agriculture and forest related infrastructural scenarios in the district of Bankura. A brief profile of the surveyed regions is analyzed in

section 3. Some methodological issues to capture dependency on natural resources are explained briefly in Section 4. Finally, the conclusions are derived in Section 5.

2. Agriculture and Forest Related Scenarios

Bankura In order to understand the agricultural scenario of Bankura, we start with some facts and figures related to the irrigation situation in the district of our study, given the fact that there is scarcity of water in our study area. Condition of Bankura is reflected through Table 1.

Table 1: Irrigation of Land from Different Sources in Bankura (in Thousand Hectares) from 1998-99 to 2012-13

Year	*Govt. canal*	*Tank*	*HDTW*	*MDTW*	*LDTW*	*STW*	*RLI*	*ODW*	*Others*	*Total*
1998-99	187.00	44.70	1.79	1.22	14.10	94.06	5.32	4.60	16.81	369.60
1999-2000	205.20	44.60	1.51	1.41	16.20	93.65	5.40	6.10	17.93	392.00
2000-01	151.00	39.50	1.51	1.56	17.40	93.06	5.83	4.30	18.62	332.78
2001-02	183.60	36.20	1.52	1.68	20.30	87.69	5.94	5.20	9.97	352.10
2002-03	152.73	40.46	1.53	1.84	18.96	98.10	3.81	5.86	8.84	332.13
2003-04	109.02	26.74	1.02	1.36	7.49	44.25	4.18	2.66	5.96	202.68
2004-05	109.89	32.35	0.50	1.45	0.68	47.98	7.28	2.17	6.32	208.62
2005-06	176.29	33.11	0.47	1.46	0.70	47.43	5.38	2.52	6.20	273.55
2006-07	180.35	33.47	0.53	1.49	1.35	45.91	5.08	2.49	6.28	276.94
2007-08	195.93	32.76	0.76	2.50	1.14	48.71	9.67	3.36	6.21	301.04
2008-09	180.60	35.18	0.95	2.50	1.14	55.32	11.57	3.58	6.68	297.52
2009-10	152.04	35.02	0.95	2.50	1.14	56.45	10.30	3.43	5.20	267.03
2010-11	26.36	19.29	1.03	2.54	1.16	50.80	6.24	2.01	5.77	115.20
2011-12	183.21	27.80	0.80	2.94	1.42	54.49	8.88	2.42	6.33	288.29
2012-13	153.32	29.19	0.80	2.94	1.42	53.18	19.04	2.37	6.59	268.85

Source: Bureau of Applied Economics and Statistics, Government of West Bengal[4].

Keeping aside the extreme drought of 2010-11, this district has performed fairly well regarding irrigation, although there were few years of poor performance in between good seasons. But this is far below than the desired level. Let us check the numbers of sources of irrigation in table 2.

Table 2: Irrigation of Land from Different Sources in Bankura (in Numbers)

Year	*Tank*	*HDTW*	*MDTW*	*LDTW*	*STW*	*RLI*	*ODW*	*Others*
1998-99	22328	41	76	118	130	197	1479	6859
1999-00	22438	42	77	147	153	224	1479	3702
2000-01	21351	42	75	171	148	232	1479	751
2001-02	21391	41	85	164	151	232	1479	912
2002-03	21392	38	102	1065[5]	25930[6]	236	7379[7]	969

2003-04	20716	38	104	173	27445	281	6765	791
2004-05	20952	38	104	173	27754	353	7049	1065
2005-06	20957	38	104	173	27785	354	7084	1179
2006-07	20977	38	104	173	27798	355	7106	1190
2007-08	21006	38	125	190	28700	386	7257	1191
2008-09	21006	38	125	190	28870	434	7257	1195
2009-10	21011	38	125	190	28890	436	7272	1191
2010-11	21293	41	127	194	29634	438	6089	1676
2011-12	21343	32	147	237	29700	438	6101	1681
2012-13	21409	32	147	237	29887	473	6119	1736

Source: Bureau of Applied Economics and Statistics, Government of West Bengal.

In the above table 2, we can see that the number of sources of irrigation has varied over the years but the number of tanks has gone down consistently, but, that of other sources have fluctuated year by year, showing ups and downs.

Table 3: Forest Area, Forest Produce, Revenue and Expenditure from Foresrty in Bankura from (2003-04 to 2012-13)

Item	*Unit*	*03-04*	*04-05*	*05-06*	*06-07*	*07-08*	*08-09*	*09-10*	*10-11*	*11-12*	*12-13*
Reserved Forest	Hectare	8004	3889	3889	3889	4449	4449	4449	4572	4572	4572
Protected Forest	,,	131119	131199	131199	131199	132002	132002	132002	136230	136230	136230
Unclasse-d State Forest	,,	9054	7756	7756	7756	2713	2713	2713	2238	2238	2238
Khas Forest	,,	-	-	-	-	-	-	-	-	-	-
Vested Waste Land	,,	-	-	-	-	-	-	-	-	-	-
Forest owned by Corporates	,,	-	-	-	-	-	-	-	-	-	-
Forest owned by Individuals	,,	-	-	-	-	-	-	-	-	-	-
Total	,,	**148177**	**142844**	**142844**	**142844**	**139164**	**139164**	**139164**	**143040**	**143040**	**143040**
Forest produce	Thousand cubic meters										
Timber	,,	4.89	6.287	5.546	5.56	5.011	5.38	4918.41	546.63	840.44	765.51
Non-timber	,,	51.723	46.760	44.686	21.684	6.965	13.99	8945.43	950.23	3597.23	2532.54
Revenue earned	Thousand Rs	15032	14378	30823	30619	59207	68491	148972	170799	181725	210569
Expenditure	,,	70318	60958	105286	142740	203087	182203	543342	631482	487296	158652

Source: Bureau of Applied Economics and Statistics, Government of West Bengal

Next, we shall look into the forestry-oriented conditions. This district has good figures regarding the forest area, its produce and revenue generation. This is shown in table 3.

From the above Table 3 it is apparent that expenditure is much higher than revenue earned. So, here forestry runs in subsidies. Also, the production of non-timber is very high compared to that of timber. There is absence of private bodies in forest-owner category. So, from these figures it is appearing that there is scope for developing forests in these areas and the government has been doing that by providing subsidies.

3. Brief Profile of Surveyed Areas of Drylands

We have surveyed 300 households in Bankura district. We have categorised the respondents in different income groups. We have classified the entire income range in different groups like ₹ 0-2500, ₹ 2501-5000, ₹ 5001- 10000, ₹ 10001-20000 and more than 20000 then, frequencies of people falling in each group with their percentages shown in the Table 4.

Table 4: Different Income Groups of Respondents with Frequency and Percentage

Districts	***Bankura***	
Income Groups (Rs.)	***Frequency***	***Percentage***
0-2500	50	16.66%
2501-5000	150	50%
5001-10000	78	26%
10001-20000	12	4%
More than 20000	10	3.33%

Socio-economic condition of the surveyed area is shown in table 5. During our survey, we have observed most of the area is poverty- stricken. As per our survey report the share of BPL is very high than that of APL. It is quite expected for our surveyed backward areas. Regarding religion, we have found the presence of Hindus and Muslims only. Existence of any other religion has been rarely observed. But, as far as 'caste' is concerned, we have found the presence of people of all types of castes.

The condition of education is very pessimistic, as we have observed around 57% of the respondents (or, any family member of that respondent) have not completed elementary education. We have focused on the availability of drinking water facilities for the households of our surveyed area. We can see that none of the households have the facility of drinking water in their houses. It is apparent from the table that the problem of drinking water is an important issue in the drylands of West Bengal.

Table 5: Division and Socio-Economic Conditions of Households of sample survey

District	***Village***	***No. of Households Used for sample survey***		***Nature of Dryland***	
	Susunia	225		Hilly	
	Sewlibona	75		Hilly	
	Total No. of Families Surveyed	No. of APL families		No. of BPL families	
Bankura					
	300	123		177	
		Families "With In house Drinking Water" Facility		Families "Without Drinking Water" Facility	
		0		300	
		No. of respondents Taking water from tube wells		No. of respondents Taking water from ponds/ watersheds/waterfalls	
		210		90	
		No. of Families Using Fuelwood	No. of Families Using Fuelwood and Gas	No. of Families Using Gas	
		212	79	9	
		No. of General Category Respondents	No. of SC Category Respondents	No. of ST Category Respondents	No. of OBC Category Respondents
		95	53	108	44

		No. of illiterates	No. of people studied between class 1 to 7	No. of people completed elementary education (passed class 8)	No. of people studied after elementary education (class 9 to 12)	No. of Graduates and/ or Master degree holders
		56	114	62	56	12

Source: Primary Survey.

Next, if we consider the term 'forest dependency', we find that almost all the people of our study area are forest dependent. Almost all the households use non-timber forest products for their cooking purpose. Even if few of them use 'gas' as the main source of fuel, they also use firewood as an alternative source of fuel but in lesser quantities than those who cannot use gas. So, we have classified the households in three segments- those who use only fuelwood, those who use both fuelwood and gas and those who use only gas. People are heavily forest dependent in the dryland areas of West Bengal. Even during field-survey we have seen that people residing 5-10 miles away from the exact forest, also come to the forest for collecting fuelwood. In our surveyed area, it is very difficult to distinguish who are forest-dependent and who are not. One important thing that needs to be mentioned is that people of these areas are dependent on forest throughout the year. They go to forest throughout the year; maximum households go for 10 to 20 days per month. Very few households, those who are not so much dependent on forest, go for 5 to 7 days per month. They collect fuelwood and few other things like sal leaves, honey, kendu leaves, etc., both for consumption as well as for selling in the market during poor financial condition of the family. Forest products collected mainly for selling in the market – such phenomenon is also observed in West Midnapore. People mainly collect those forest products that are being permitted to collect by the Joint Forest Management Committees (JFMC) and Forest Protection Committees (FPC). To a large extent, they collect these products for consumption purpose. So, the collection of fuel wood out of all types of non-timber forest products (NTFPs) is very high because the committees allow them to collect those products only. More than 95% of the respondents are dependent on forest products for getting their fuels.

Land is generally considered as an indicator for economic wealth of a family. In our survey areas we have seen only 185 families out of 300 possess their own land but the average amount of land holding is very poor. The lowest amount of land held by a family is 1 bigha or 0.1338 hectare or 0.3306 acre8 and the highest is 6.235 acre.

4. Some Methodological issues to Capture Dependency on Natural Resources

There are various ways on the basis of which one capture dependency on natural resources in the dryland areas. We shall briefly discuss two ways it can be captured. The first one is the dynamic optimisation technique which can be used to analyse such dependency through sensitivity analysis, the second one is the use of absolute Beta Convergence, which is used for checking the nature of growth of income from forestry in this district and the last one is the use of contingent valuation method to value the natural resources on which the stakeholders are dependent. This valuation exercise has strong implications for sustainable livelihood and hence on sustainable resource management. We shall first explain the dynamic version in a descriptive manner and after that we shall provide some elements of applicability of contingent valuation method (CVM) for forestry and drinking water.

4.1 Application of Dynamic Optimisation Technique to Analyse Dependency on Natural Resources

The dynamic model that has been considered is an extension of the work of Gupta (2006). In this paper we just want to present the outline of the model without going to the equational specification. The actual model is shown in the paper by Chatterjee and Gupta (2018).[9] The present model is different from the model of Gupta (2006) in a wide extent. Gupta (2006) has considered the interlinkage between mangrove (forestry) and shrimp (fishery), whereas the present model focuses on the forestry sector only with harvest of timber and NTFP. The purpose is to examine whether (i) a change in the proportion of timber harvest obtained as NTFP or (ii) a change in the intrinsic rate of growth of forest stock or (iii) a change in the discount rate measuring the opportunity cost of forestry gives us some counter- intuitive results. The base values for sensitivity analysis are obtained through calibration (field survey and secondary sources). The structure of the model can be explained in terms of the following points:

- Objective: To maximize welfare from extraction of timber and non-timber forest product (NTFP)
- Constraint: Net growth of forest stock.
- Enforcement: Harvest of timber is mainly under government's control and a part of non-timber as well.
- Property rights: Well defined property rights and are managed through the joint forest management (JFM) system.
- Operation: Given the fact that the foresters are price-takers, welfare maximisation of the foresters (through the JFM system) is in the form of maximisation of profit.
- Study Area: Bankura.
- Analysis: Done through Sensitivity Analysis after calibrating for the base values.

The main result of the study, which is contrary to the conventional wisdom, is that for Bankura, an increase in the proportion of timber harvest obtained as NTFP reduces the level of welfare in the study area. Apart from this we find that a reduction in the intrinsic growth rate of forest stock reduces the level of timber cutting and also reduces the availability of NTFP. These two results show the awareness of the forest-fringe people regarding the sustainable use of forest. Finally, we have shown that a change in the discount rate causes insignificant changes in the major study variables, emphasising dependency as well as sustainability of forests.

4.2 Application of Convergence for Checking the Growth of Income from Natural Resources

Now, we would like to focus on a different issue which has also some dynamic flavour. Economic growth and convergence are one of the most discussed fields in economics, as the long-run growth determines the welfare of countries. The word 'convergence' has been used by different economists in different contexts. For example, Baumol (1986) has pointed out that the phenomenon of convergence has an unambiguous meaning which can be interpreted in terms of faster economic growth of late comers to industrialisation so that in the long run they move towards convergence of per-capita product. The phenomenon of convergence has found a life in modern growth economics. A natural starting point for a theoretical discussion of economic growth is the neoclassical growth model developed by Solow (1956) and Swan (1956).

Thus, all economies, over time, may converge in terms of income per head. In economic growth literature the term 'convergence' can be interpreted in two ways. The first kind, also known as 'sigma-convergence', refers to a reduction in the dispersion of levels of income across economies. 'Beta-convergence' on the other hand, occurs when poor economies grow faster than rich ones. Economists say that there is 'conditional beta- convergence' when economies experience 'beta-convergence' but conditional on other variables being held constant.

It is said that 'unconditional beta-convergence' or 'absolute beta- convergence' exists when the growth rate of an economy declines as it approaches its steady state. Thus, when the dispersion of real per capita income across a group of economies falls over time, there is β-convergence. When the partial correlation between growth in income over time and its initial level is negative, there is β-convergence.[13] Broadly speaking, unconditional convergence occurs when the income gap between two countries decreases irrespective of these countries' "characteristics" (e.g., institutions, policies, technology or even investments). Conditional convergence occurs when the economic gap between two countries that are similar in observable characteristics is becoming narrower over time. Convergence can be considered not only by comparing between countries but also by comparing between regions within a country.

From the point of view of methodology, we have used simple diagrammatic and econometric technique of Least Square method for our analysis of convergence by using various statistical tools.

Our econometric equation, for testing Beta convergence, is of the following

$$\text{form } g_{it} = \alpha + \beta Y_{it-1} + u_{it} \qquad (1)$$

Equation (1) is used for testing Simple or absolute β convergence. Here, 'g' is the average growth rate of Y, which is our concerned variable (such as income from forest). Here, 'i' refers region or area and 't' refers to time period. From equation 1, Y stands for income from forestry.

For the sake of removing the heterogeneity from the data set, we have converted the actual values of the variables in their log-values. A negative value of β would mean convergence, given that is significant according to statistical tests, where as a positive value means divergence and u_{it} has mean zero, finite variance, $\boldsymbol{\alpha}^2_u$, and is independent over t and i.

We have used a panel data set for Bankura for the time period 2002- 2012; including the variables Gross district domestic product, growth rate of district domestic product, Net district domestic product from forestry and per capita income. All variables are in constant price. By using net district domestic product from forest, we have computed the growth of income from forest sector.[11] Our analysis has shown that there is absolute Beta convergence in the growth of income forest sector. So, growth rate of income from forestry depicts a falling tendency. Here, NDDP refers to Net District Domestic Product. The finding of Bankura district is described by the following diagram. (Fig. 1).

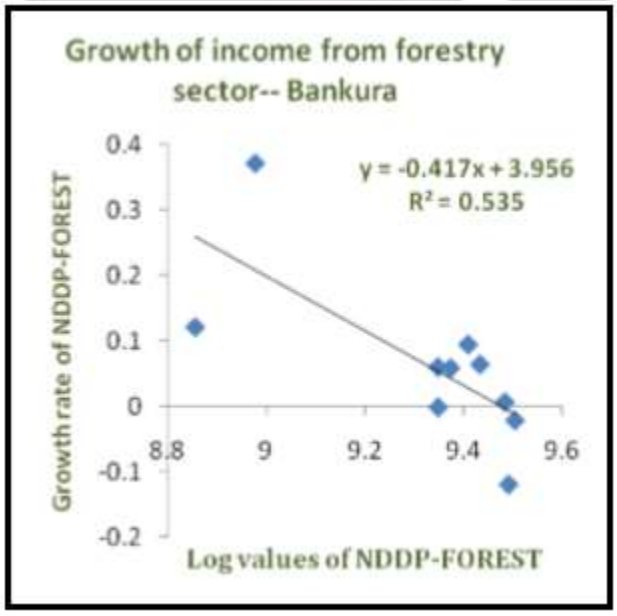

Fig. 1: Absolute β convergence in Bankura 2002-2012.

We have seen absolute Beta convergence, regarding income from forest sector in the study area. One can say that the existence of absolute Beta convergence, in Bankura is quite significant from the point of view of forest management.

4.3 Application of Contingent Valuation Method (CVM) for Valuation of Natural Resources

Economic value of the environment is specified in the background of three important features of environmental goods which are namely, (i) irreversibility, (ii) uncertainty and (iii) uniqueness. We can classify total economic value into two categories: (i) user value (ii) non-user value.

Valuation can simply be defined "as an attempt to put monetary values or to environmental goods and services or natural resources". It is a key exercise in economic analysis and its results provide important information about values of environmental goods and services. This information can be used to influence decisions about wise use and

conservation of forests and other ecosystems. The basic aim of valuation is to determine people's preferences by gauging how much they are willing to pay (WTP) for given benefits or certain environmental attributes e.g. keep a forest ecosystem intact. In other words, valuation also tries to gauge how much worse off they would consider themselves to be as a result of changes in the state of the environment such as degradation of a forest.

In the dryland areas of developing countries the conservation of environment should get more priority because in the presence of very few alternative income opportunities, people of such areas rely very heavily on environmental goods, especially on forests, for their livelihoods. Valuation of water is also another important aspect that has been neglected as far as drylands are concerned. Lack of ground water availability and recurrence of droughts hinder agricultural activities. For the same reason, scarcity of drinking water makes living more difficult for the people of drylands.

For the valuation of forest-dependency as well as problem of drinking water, we have used Contingent Valuation Method (CVM). For this purpose, we have conducted household surveys without which it is impossible to conduct CVM. In our work, single bounded dichotomous choice has been considered in closed ended referendum. Here one particular bid is shown to each respondent and the responses are in the form of either "yes" or "no", that is, whether he is going to accept the bid or not. Accordingly, few statistical tests have been done to derive average willingness to pay.[12]

Contingent valuation surveys were first proposed in theory by Ciriacy- Wantrup (1947) as a method for eliciting market valuation of a non-market good. The first practical application of the technique was performed in 1963 when Davis used surveys to estimate the value hunters and tourists placed on a particular wilderness area. He compared the survey results to an estimation of value based on travel costs and found good correlation with his results. This type of Contingent Valuation (CV) exercise has several drawbacks. In response to criticisms of contingent valuation surveys, a panel of high-profile economists (chaired by Nobel Prize laureates Kenneth Arrow and Robert Solow) was convened under the auspices of the National Oceanic and Atmospheric Administration (NOAA) in 1990. The NOAA panel was set up in the early 1990s in the US, to review the CVM. A concrete background for the panel was the controversy surrounding the so-called Exxon Valdez incident, with a large oil spill off the Alaska coast, in 1989. In that case, WTP data obtained from CVM studies were brought to court. These studies were contested, and the entire CVM seriously questioned.

The NOAA panel tried to remedy this problem, by providing guidelines for use of the CVM, in particular as court evidence. It issued a report in 1993, which has been widely cited and followed. The guiding principle behind these recommendations was that the survey operator has a high burden of proof to satisfy before the results can be seen as meaningful. Surveys meeting these criteria are very expensive to operate and to ameliorate the expense of conducting surveys the panel recommended a set of reference surveys which future surveys could be compared to and calibrated against. The NOAA panel also felt, in general, that conservative estimates of value were to be preferred and one important consequence of this decision is that they recommended contingent valuation surveys measure willingness to pay to protect the good rather than willingness to accept compensation for the loss of the resource.

As a result, current contingent valuation methodology corrects for these shortcomings, and current empirical testing indicates that such bias and inconsistency has been successfully addressed. In the application of CVM, obtaining of bids is the most important section of the study. At this stage field survey is conducted, generally. A face-to-face interview by well-trained interviewers is needed for effective data collection. Individuals are asked to state their maximum willingness to pay (WTP) or minimum willingness to accept (WTA) for a proposed change in the environmental quality. To quantity the precise amount fruitfully, a number of alternative strategies are applied which are:

(a) Closed ended referendum (b) Open ended referendum

Average WTP calculation for a closed ended referendum is different from that of an open-ended bid. In case of open-ended bid, since exact information about max WTP is available, the average is calculated by using either arithmetic mean or median. Since the lower bids are more likely than higher bids for environmental goods (for free-riding problem), thus median WTP < mean WTP. But in case of dichotomous choice type closed ended bidding, it is recognised that though the consumer knows his preference completely, it is not totally observable to the researchers.

Hence, a Random Utility Model (RUM) is chosen to represent the choice decision where the probability of a "yes" response to a bid can be derived by applying logit estimation technique.

The purpose of using CVM is very clear. Natural resources perform several economic functions on which price cannot be assigned. Even if there are announced property rights related to ownership of the resource, the rights cannot be properly assigned to the owners. Use of CVM helps to resolve these issues. In our study we want to value forest resources and drinking water in the dryland areas of West Bengal. In our study for selection of villages we have followed stratified sampling and for selection of households we have followed partly stratified and partly random sampling. The number of respondents interviewed in the two villages, taken together from Bankura, is 300 and it has seen that the response rate is 100% which is high.

For the above kind of analysis, it is important to determine the bid first and then to determine how these bids are to be shown to the respondents. The bids that we have considered are ₹ 2, ₹ 5, ₹ 8, ₹ 10, ₹ 15 and ₹ 25 (in terms of per month) to conserve and sustainably use forestry. The same bids are offered for having "in house facility of drinking water supply".16 Here the bids are determined after discussing with the local people through pilot surveys which gave us an idea of the maximum and minimum amounts that we should put forward to the respondents as bid amounts. The next step is to identify the "valid" responses out of 200 respondents. For this we have followed a strategy in the final survey. We have categorised the respondents in three bid groups, namely, low, medium and high. We have applied single-bound dichotomous choice CV method. The low bid group implies bids of ₹ 2 and ₹ 5 per month for having and also to conserve drinking water. For medium bid group the bid amounts are ₹ 8 and ₹ 10 per month. For high bid group the bid amounts are ₹ 15 and ₹ 25 per month. 14 Our present survey reflects that 95 respondents out of 300 respondents are not willing to accept the bids and thus we will consider 205 respondents as "willing" respondents and 95 respondents as "non-willing" for our further analysis. Here 95 "non-willing" participants are considered as "protest bidders" for the conservation of forestry and for water. We have considered a logit analysis to estimate Willingness to Pay (WTP) for both conservation of forests and drinking water under closed ended referendum. We have also estimated WTP for both conservation of forests and drinking water under open ended referendum.

In case of forestry under close-ended referendum we have found the mean WTP to be ₹ 13.25 per month whereas it is ₹ 6.75 per month for the open-ended referendum. We can find an average of the two mean WTPs and name it as 'true WTP, in our model. The 'true WTP' turns out to be ₹ 10 per month. One can say that for the sake of their own livelihood in the long run because of the presence of very few alternative income opportunities, people of Bankura, despite being poverty-stricken, are willing to pay this minimal amount. This amount though appears to be low, is reasonable given the fact that most of the stakeholders in our study area either lives below the poverty line or belongs to the lower income groups.

In case of drinking water under closed-ended referendum we have found the mean WTP to be ₹ 12.80 per month whereas it is ₹ 10.20 per month for the open-ended referendum. The 'true WTP' turns out to be ₹ 11.50 per month. One can say that for the sake of their own development and to get rid of the problem of drinking water, people of Bankura can bear to pay this amount. This amount once again though appears to be low, is reasonable given the fact that most of the stakeholders in our study area mostly poor. Their WTP for conservation cum sustainable use of forestry and drinking water has important policy implications from the point of development of Bankura. Government should give special emphasis on these issues for developing this area.

The methodology that we have discussed here provides a guideline to the researchers and the policy makers to conduct serious study to understand dependency on natural resources in other parts of the World and also to link it with sustainable resource management.

5. Conclusions

Here, we have made an attempt to integrate the major issues related to dependency on natural resources and their implications on sustainability issues in the Bankura district of West Bengal. This comprehensive study is not actually a survey of existing works rather it provides an analysis of facts and figures along with a guideline regarding the methodologies that can be followed to study the nature of dependency on natural resources. Our study shows that people in the Bankura of West Bengal depend heavily on forestry and suffer from the lack of drinking

water, owing to the poor irrigational-agricultural conditions and dryness of the weather. Then we have described few aspects of socio-economic conditions of the district, as we have observed from our field survey. In terms of a dynamic model, we have shown that, contrary to the conventional wisdom, how in Bankura (part of dryland areas of the state) an increase in the proportion of timber harvest obtained as NTFP reduces the level of welfare in the region. In terms of our dynamic model, we have shown the importance of forestry and hence its conservation (can be interpreted as sustainability of forestry) from the point of view of the people residing in the area. Then, we have shown how the growth of income from forestry in this district has been falling over the years, which an issue of concern for the government and raises the question of conservation-cum-sustainable use of this important natural resource. Lastly, we have shown that how the people of Bankura think about conservation of forestry and drinking water and also the use of these two resources through Contingent Valuation Technique. Thus, we have captured the overall natural resource scenario of Bankura of West Bengal and also, we have emphasized on people's perception in their (natural resources) protection and sustainable use. Our study suggests some values for the conservation of resources in terms of their WTP. These figures are really useful for policy analysis to achieve sustainable resource management of natural resources in our study area.

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