Are Developmental Interventions Helpful in Coping against Climatic Aberrations? Evidences from Drought Prone region in India

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Abstract

Variations in environmental conditions and the occurrence of climatic aberrations and extreme events (like droughts, deficient rainfall spells and floods) pose a threat to economic growth of the households in the vulnerable regions of the developing countries like India. They also act as an impediment to the intervention programmes (like poverty reduction programmes) undertaken for reducing the vulnerability of households. The vulnerability in these hot spots is further under stress due to the limited capacities of households to cope with the impacts. The western districts of the state of Odisha are one of the poorest districts of the country and traditionally vulnerable to droughts and deficient rainfall spells. Government led developmental interventions have been undertaken in the districts with an aim to reduce poverty of rural households. In view of this the objective of the present paper is to analyze the impact of these developmental interventions on the coping capacity of the households to deal with the drought impacts. Based on the primary household level data collected from 800 households based on a stratified random sampling and econometric analysis using a difference in difference (DID) and Instrumental Variable (IV) estimation the findings suggest that: (i) Interventions have increased the income of beneficiary households compared to non-beneficiaries, (ii) More coping mechanisms are adopted by beneficiaries to deal with drought impacts and (iii) other govt. led interventions like employment guarantee and provision for housing have also contributed in generating additional coping capacity at household level.

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1. Introduction

Risks arising out of climatic aberrations and extremes (like droughts, deficient rainfall spells cyclones and floods) disrupt the livelihoods of people. They also pose a threat to economic growth of the households living in the vulnerable regions of developing countries like India. The rural population in these countries are susceptible to a greater extent due to their high dependence on climate sensitive sectors like agriculture for their living and climatic aberrations and extremes are the primary sources of risk to agriculture and in turn to the livelihoods of people. In recent years, vulnerability of rural households living in disaster prone regions of India has increased mainly due to the climate change related factors like higher intensity of floods (IPCC, 2012; NATCOM 2004). It is also observed that the damages due to the incidence of these events have increased and could also rise in future due to climate change, especially for the developing countries (Mirza, 2003; Bouwer et al., 2007; Botzen and van den Bergh, 2009; IPCC, 2012). Further, Mirza (2003) also highlights that the direct losses due to natural disasters was US$ 35 billion per annum for the developing countries during 1990's, around eight times higher in comparison to 1960's. Specifically, in the context of India, Padmanabhan (2012) finds that the total economic damage due to extreme events was US$ 480.64 billion during 1980-2010 (an average of US$ 15.51 billion per annum).

Although the risks faced by households due to climatic aberrations and extremes are covariate, the impacts vary across households based on their ability and capacity to cope with these shocks which is idiosyncratic. For instance, it may result in immediate reduction in income and consumption for some households increases in poverty and food insecurity for other groups and longer-term impacts on some others. Continuous exposure to risk also proves detrimental to the ability of the households to cope with the impacts (coping / adaptive capacity) over a longer term and simultaneously also has a negative effect on the standard of living. Similarly, if the households are able to successfully cope with the impacts of disaster events, then there is a possibility for the households to reduce their level of poverty and raise the level of their income and consumption. In this context Dercon (2002) observes that risks faced by the households are crucial in determining the level of assets and endowments maintained by them. Therefore, the state of vulnerability faced by a household is determined by both from their past and current levels of entitlements which define the resilience of the household to respond to any disaster impact.

Reduction in poverty levels, diversification of livelihood options, schemes enhancing the primary and secondary sources of income and are important mechanisms to build the resilience of the households and improving entitlements which also enhance the capacity of the households to cope with the impacts of climatic aberrations and extremes. On account of this various developmental interventions (like poverty reduction programmes, natural resource management schemes, livelihood diversification programmes etc.) are undertaken in developing countries from time to time for the upliftment of the vulnerable households. These programmes are sometimes directly led and run by the national, state and local governments and sometimes also run in partnership with and multilateral donor agencies. In view of the above discussion, the pertinent questions to ask are: (i) how helpful are the

developmental interventions in reducing the poverty of people, (ii) are these programmes helpful in securing the livelihoods of the poor and reducing vulnerability to climatic aberrations and extremes and (iii) whether these interventions have directly or indirectly helped households in building resilience in climate sensitive hotspots to cope with extreme events like droughts and rainfall gaps.

In view of this the present study attempts to empirically examine (i) the impact of developmental interventions aimed at income enhancement and poverty reduction on the treatment and (ii) do these interventions also contribute in building the resilience of the targeted population to deal with climatic aberrations and extremes like droughts and deficient rainfall spells. The study is with reference to a rural region in state of Odisha in India (Bolangir district in western Odisha). The state of Odisha is one of the poorest states in India and is prone to multiple disasters. Especially the western districts are one of the poorest of the country and traditionally vulnerable to droughts and deficient rainfall spells. Government led interventions have been taken up in these districts from time to time intending to reduce poverty of the households and drought vulnerability. The Western Odisha Rural Livelihoods Programme (WORLP) is one such intervention which aimed at providing income enhancement options and provision of irrigation facilities from cropping through creation of micro watersheds.

2. Background and Study Area

The Odisha Watershed Development Mission (OWDM) is the nodal agency for implementing watershed programmes and projects in the state of Odisha. The DFID-funded WORLP was one of the programmes implemented across four most disadvantaged of the state: (i) Bolangir, (ii) Bargarh, (iii) Nuapada and (iv) Kalahandi. The project was run through a partnership between the Government of Odisha (GoO) and the UK's Department for International Development (DFID). The cost of the project was INR 230 crores[1] (GBP 32.75 million). It was designed to cover 1,180 villages in 677 watersheds in these four districts, where human development indicators are very low and comparable to sub-Saharan Africa. It was designed on a new concept called "Watershed Plus" approach, a term coined during design which referred to the additional focus on people's livelihoods which was thereby introduced in the project. The ultimate goal of the project was to reduce poverty in rain-fed areas of western Orissa, through more effective ways of promoting sustainable rural livelihoods. The project started in the year 2000 in the two districts: Bolangir (covering 14 blocks[2]) and Nuapada (covering 5 blocks) and in January 2004 expanded to other districts of Bargarh and Kalahandi. Out of the project outlay of INR 230 crores, INR 140 crores was available as financial aid for implementing the Watershed and Watershed Plus activities. and INR 90 Crores was available under a Technical Cooperation fund for technical support, capacity building, monitoring and evaluation, project management etc. Theoretically, investment made by WORLP in a micro watershed of 500 Ha was INR 47.5 lakhs. The cost norm of INR 6000 per hectare was followed in implementing the watershed activities, while INR 3500 per hectare was provided for the livelihood component. At the state level, OWDM was the Nodal Agency responsible for planning, implementing and monitoring of the project. At the district level, the Project Director, Watersheds was responsible for project

[1] 10 lakhs equal 1 million and 1 crore equals 10 million.
[2] Block is an administrative division within a district.

implementation while the Project Implementing Agency (PIA) facilitated the implementation of the project at the watershed level. In each block, one PIA was responsible for managing and implementing ten micro watersheds project.

As described in the preceding section the present study is with reference to Bolangir district in western Odisha which is one of the four districts where the WORLP programme was undertaken. The programme was first started in this district during 2000-01 and later expanded to the other three districts. The district lies between 20 9' and 21 11' North latitude and 82 4' and 83 9' East longitude and is situated in the valley of rivers *Ang* and *Tel*, which are having tributaries like *Lanth, Sonegarh* and *Suktel*. It is surrounded by Bargarh, Baudh and Sonepur districts on north, Boudh and Phulbani districts in east, Kalahandi in south and Nuapara in west respectively. The HDI value for the district is 0.546 and it ranks 21st among the districts in Odisha. The district ranks 15th in Infrastructure Development Index and 16th in Gender Development Index (Economic Survey, GoO, 2010).

The average rainfall in Bolangir from 1950-91 was around 1230 mm and was close to the Odisha average of 1339 mm and also stood at a much higher level than the all India average. However during the period 1986-2003 the rainfall pattern was highly erratic with a CV of 12.6 percent with evidences of the long term normal rainfall gradually declining. The average annual rainfall for Bolangir from 1901-50 was 1443.5 mm, which declined to 1230 mm for the period 1951-91 and this further declined to 1206.7 mm for the period 1986-2003. As a result of declining trends of annual rainfall with high degree of variability, frequency of drought was successively rising and probability of occurrence of drought in Bolangir is around 56.35 (1986-2003) with huge variation in the probability of occurrence of droughts in different blocks of the district (Swain and Swain, 2011). It is also one of the poorest regions of the state and it is observed that limited diversification of the agriculture and low penetration in the non-farm sector further aggravated the vulnerability to climatic aberrations and extremes. The WORLP intervention area in western Odisha is classified as an area where the mean temperatures are rising, and where the vulnerability profile places it among the highest risk areas in the country (Satyanarayana et al. 2009). The spatial patterns of linear trends in temperature in India from 1901 to 2000 shows that these areas lie within an area that is warming and the following climatic risks have been identified (Satyanarayana et al. 2009): (i) high variability of rainfall, leaving people with two peak periods of food stress, (ii) droughts and dry spells every two years, with a major drought every five to six years and (iii) flash floods during the rainy season.

3. Study Design and Methodology

For the present study four blocks the district were chosen: (i) Agalpur, (ii) Bongamunda, (iii) Gudvela and (iv) Patnagarh. The map of the study area and the blocks are shown in figure 1. In all these blocks the intervention under WORLP were carried out during the initial phase of the project. The block Agalpur is geographically located on the northern part of the district while Bongamunda is located on the southern part. Similarly Gudvela and Patnagarh are located in the eastern and western part of Bolangir.

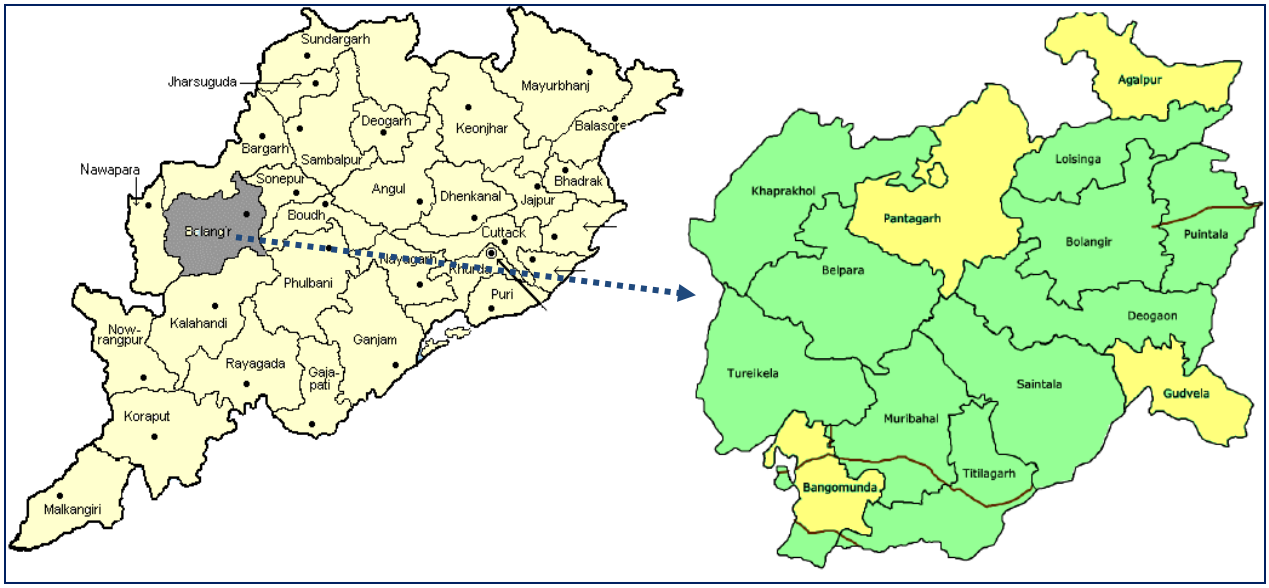

Figure 1: Map of the study area in Bolangir District, Odisha

The study uses data derived from secondary sources as well as collected through primary household surveys. The secondary sources of data are published reports of Odisha Watershed Development Mission, Govt. of Odisha, and other research reports (both published and unpublished) of governmental and non governmental agencies.

The present study adopts a two stage stratified random sample design. The first stage of stratification is done for choosing sampling blocks for the survey. This was done on the basis of performance of watersheds in these blocks under the WORLP programme. Accordingly blocks were categorized to the ones where: (i) better performance of watersheds was recorded under WORLP and (ii) where performance of watersheds was not so good. The second stage of stratification is for selecting villages from these blocks and also for identifying the counterfactual. The complete list of villages falling under these four blocks was drawn from the Census of India. Villages were categorized into the ones that lie (i) inside the command area of watersheds and (ii) the ones that lie outside the command area. The villages that lie inside the command area of watersheds are the ones that have benefited from the intervention and hence termed as WORLP beneficiaries (also referred to as treatment villages). Similarly, the villages falling outside the command area have no direct benefits from the WORLP interventions and are termed as non-beneficiaries of WORLP (also referred to as control villages) and treated as the counterfactual. Sample villages for conducting the household surveys were identified from the ones satisfying the above criteria and checked for the availability of baseline data for households which were collected by the respective PIAs before the start of WORLP programme.

As described in the introduction the objectives of the present study are to: (i) examine the impact of the WORLP programme on the income of the households and (ii) find whether the interventions also facilitated in generating additional adaptive capacity of the households to cope with extreme events. The first objective is analyzed by first adopting a DID estimation and then combining DID with Propensity Score Matching. The second objective is examined by using Instrumental Variable 2SLS approach. The double difference (DID) is also

commonly known as difference in difference method and is popular in non experimental evaluations and is described in equation 1.

$$DID = \mathrm{E}(Y_1^T - Y_0^T | T = 1) - \left(Y_1^C - Y_0^C | T = 0\right) = 0 \quad (1)$$

In equation 1, $T_1 = 1$ denotes treatment or the presence of the program at t = 1, whereas $T_1 = 0$ denotes untreated areas. The DD estimator allows for unobserved heterogeneity (the unobserved difference in mean counterfactual outcomes between treated and untreated units) that may lead to selection bias. For example, one may want to account for factors unobserved by the researcher, such as differences in innate ability or personality across treated and control subjects or the effects of non-random program placement at the policy-making level. DD assumes this unobserved heterogeneity is time invariant, so the bias cancels out through differencing. In other words, the outcome changes for nonparticipants reveal the counterfactual outcome changes as shown in equation 1.

The operationalization of DID in the present study was achieved by using the model described in equation 2. Instead of a comparison between years, program and non-program villages are compared, and instead of a comparison between participants and nonparticipants, target and non-target groups are compared (Pattanayak, 2009; Khandekar et.al. 2010).

$$Y_i = \alpha + \beta T_i + \gamma X_i + \epsilon_i \quad (2)$$

In equation 2, the outcome variable measures the changes in income of a household to the income at baseline, T_i is the treatment dummy (i.e. beneficiary or non-beneficiary of WORLP) and X is a vector of household specific characteristics. DID method estimates the difference in the outcome during the post intervention period between a treatment group and comparison group relative to the outcomes observed during a pre intervention baseline survey. In the present case by using this method program and non program villages are compared, and instead of a comparison between participants and non participants, target (beneficiaries) and non target groups (non beneficiaries) are compared. Further this is combined with Propensity Score Matching (PSM) technique, with the idea being to match each beneficiary with an identical non beneficiary and then measure the average difference in the outcome variable between them.

For examining the second objective of the study the adaptive capacity of households is defines as a function of the exposure and resilience of the households.

Adaptation / Coping = ƒ [Exposure, Resilience] (3)

The exposure part in equation 3 is covariate in nature as household residing in proximity face the severity of disaster event on a similar scale. The four study blocks in the present case lie within a district and hence are not likely to face extreme event on varying scale. What varies for the household is the resilience part which is idiosyncratic. The disaster management literature stresses that characteristics of a household are essential determinants of adaptive capacity. These characteristics include the capacity to anticipate, cope with, resist, and recover from the impact of a natural disaster. Additionally, the asset-

based approach links vulnerability and adaptation to asset ownership which is again linked to the level of income, poverty and entitlements of the households. With this background it should be highlighted that the WORLP project was not designed with any climate change objectives in mind. Nonetheless, the nature of poverty reduction (income enhancement) and the benefits of increasingly sustainable and diversified livelihoods (ground water recharge and assistance for creating water resources) are such that the project could have contributed to people's ability to cope with climatic aberrations or extremes or in other words enhance adaptive capacity by building their resilience.

A two step regression approach (2SLS) with instrumental variable (IV) method was undertaken to study the second objectives of the study. It measures the impact of the program when treatment has not been randomly assigned is by using the instrumental variable (IV) method. The IV estimation regards the treatment variable as endogenous. The idea is to find an observable exogenous variable or variables (instruments) that influence the participation variable but do not influence the outcome of the program if participating. Thus, one would want at least one instrument that is not in the covariates and that satisfies the preceding requirements. IV estimation is a two-step process. First, the treatment variable is run against all covariates, including the instruments. Then, the predicted value of the treatment, instead of the actual value is used in the second stage (Khandekar et.al., 2010). In the first equation the outcome variable is the current income of the households and the explanatory variables consist of a matrix consisting of WORLP specific variables, dummies representing the other different interventions operational in the study region and other variables capturing household specific characteristics. The following equations shows the relationship

$$Y_i = \beta_1 Z_i + \alpha_1 X_i + \lambda_1 u_i + \varepsilon_i \quad (4)$$

where Y_i represents the income of the households, Z_i represents WORLP specific variables, X_i represents the vector of household specific characteristics and u_i represents the other programme interventions. In the second step an instrument variable is used in the analysis which is correlated with the outcome variable of the first stage but not correlated with the outcome variable of the second stage. The outcome variable in the second stage is the number of adaptation options (A_i) employed by the households to hedge against the climatic aberrations and extremes and the independent variables are again a matrix consisting of the household specific characteristics (X_i) and various other programme interventions captured by (u_i). The specification for the equation is given below:

$$A_i = \beta_2 \hat{Y}_i + \alpha_2 X_i + \lambda_2 u_i + \varepsilon_{2i} \quad (5)$$

The instrument chosen in the present case is the income of the households at the baseline or the income of the household before the start of the WORLP. This instrument will be correlated to the variable current income but there is no reason to believe that this will be correlated to outcome variable in the second stage i.e. number of adaption options used by the household.

4. Data and Variables

The baseline data was collected from the PIAs for the WORLP beneficiaries and from the BPL census of Govt. of Odisha for the non beneficiaries. The baseline data had household level unique identifiers due to which it was possible to track down the same household and administer the survey instrument for primary data collection. The information detailed the block name, gram panchayat and village name with the name of the head of the household. The data also had information about the head of the household, age and gender details of the head along with occupation, farm type and the annual income of the household. It also described a well-being category for the household. This was classified into four classes: (i) very poor, (ii) poor, (iii) manageable and (iv) well off. The categorization of households amongst these categories was arrived in the respective villages based on village level meeting and participatory resource appraisal exercises initiated by the respective PIAs before the start of WORLP interventions. Data on similar indicators was also available from the BPL census undertaken by Govt. of Odisha and was used in the present study for collating the baseline information for the non beneficiaries.

The primary data collection was undertaken in the villages where the baseline data for households was available. Households from the baseline were drawn randomly and surveyed based on their availability to participate in the survey. In total 800 households were surveyed out of which 600 households are WORLP beneficiaries and 200 households are non-beneficiaries from the WORLP interventions. It was also observed during the exploratory visits and the pilot survey that the head of the household is the one who takes all decisions for the family and other members in the household follow his decisions. Therefore, the survey instrument was administered to the head of the household, so that she/he can recall the activities of the family and also answer about the selection of coping mechanisms by the household.

A number of variables were used in order to study the objectives of the present study. These variables were constructed both from the secondary sources and the household surveys. The study used proxies to capture the coping practices of the households to deal with climatic aberrations and extremes. Socioeconomic characteristics of the households were captured through variables like households living below the poverty line, human development factors like caste, age, education, housing, health, etc. Livelihood aspects were measured through proxies such as agricultural yields, cropping pattern, income and consumption, sources of income, assets, migration, and availability of food and water resources. Table 1 lists the variables used in the analysis for the study and describe the method to constructing the variable and the descriptive statistics.

Table 1: Definitions of the variables and the descriptive statistics

Variable Name	Definition of the Variable	Mean	S.D.
WORL	Programme Treatment Dummy (Equals 1 if the household resides in the Treatment Village, 0 otherwise)	0.752	0.431
PERF	Programme Performance Dummy (Equals 1 if the WORLP performance was good, else 0)	0.492	0.50
CROS	Interactive Dummy of Treatment and Performance	0.369	0.483

MEM	Number of Members in the Household	5.252	2.731
AGE	Age of the Head of the Household	51.314	12.084
EDU	Number of years of Education of the Head of the Household	3.173	3.331
TECHED	Technical Education (Dummy equals 1 if the Head has technical education else 0)	0.043	0.203
BPL	Below Poverty Line (Dummy equals 1 if household belongs to the Below Poverty Line Classification else 0)	0.824	0.381
EGA	MGNREGA Participation (Dummy equals 1 if the household has participated, else 0)	0.669	0.471
IAY	Housing Benefit (Dummy equals 1 if the household has benefited from govt. housing schemes, else 0)	0.176	0.381
AAY	Public Distribution System (Dummy equals 1 if the household has benefited from govt. food security schemes, else 0)	0.137	0.344
LAND	Land in Acres of the Household	1.455	1.520
LVSTK	Number of Livestock owned by the household	3.095	5.061
SHG	Social Networks (Dummy equals 1 if the household has membership in Self Help Groups, else 0)	0.345	0.475
LBASEY	Baseline Income of the household in natural logs	9.098	0.664
BVP	Household Status at Baseline (Dummy equals 1 if the household belonged to the Very Poor Group, else 0)	0.204	0.403
BPR	Household Status at Baseline (Dummy equals 1 if the household belonged to the Poor Group, else 0)	0.412	0.492
BMG	Household Status at Baseline (Dummy equals 1 if the household belonged to the Manageable Group, else 0)	0.311	0.463
LCUTRY	Total Income of the household in the previous year in natural logs	10.536	0.467
LCUPY	Total Primary Income of the household in the previous year in natural logs	10.392	0.533
LCUSY	Total Secondary Income of the household in the previous year in natural logs	9.098	0.651
NMIG	Number of migrants present in the household during the previous year	0.395	0.763
LVTCP	Value of Total Crop Production in natural logs	10.097	0.612
LTIC	Total Input Cost for cultivation in natural logs	9.112	0.653
LIRRGC	Irrigations Charges in natural logs	6.585	0.757
LLABC	Labour Cost in natural logs	8.101	0.825
COPN	Number of coping mechanisms adopted by the household to cope with disaster impacts	1.195	0.783
Note: (i) Number of Observations (N) in Treatment = 574 and Control = 189, except for LCUSY where Treatment N = 404 and Control N = 119;(ii) For Farming / Cropping related Variables N in Treatment = 388 and Control = 126			

In total we use 28 variables in the analysis. The information from the baseline consists of is used to create four variables. The income of the household during the baseline is represented by the variable BASEY. Three dummies are created for depicting the well-being status of the households observed during the baseline; BVP if the household belonged to the very poor category during baseline, BPR if it was classified as poor in the baseline and BMG if the household belonged to the manageable class. Current income of the households is measured through three variables: (i) CUTRY depicts the current income of the household in constant prices; (ii) CUPY measures the current primary income of the household and (iii) CUSY which shows the current secondary income of the household. Household specific characteristics are reflected in the variables AGE, EDU, TECHED, BPL etc. Crop production

details are measured using VTCP, TIC, IRRGC and LABC. Land ownership is measured by the variable LAND and LVSTK measures the number of livestock owned by the household. Membership in social networks is depicted by the dummy SHG and it shows whether a household if affiliated with any self help group in their village. Coping with climatic aberrations and extremes is captured by the variable COPN which measures the number of non-farming coping mechanisms that the household adopted to deal with the previous drought spell. Table 3 shows the descriptive statistics of the variables used in the analysis.

Along with WORLP other developmental interventions of the govt. are also ongoing in the study area like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Indira Awas Yojana (IAY), Rajiv Awas Yojana (RAY), Biju Awas Yojana (BAY), Mo Kudia scheme, State Rural Livelihoods Mission (SRLM) / Mission Shakti. The MGNREGA is an act that provides livelihood security to the households in the rural India supplying at least hundred days guaranteed wage employment to every household which is depicted in the present case by the variable EGA. Similarly the IAY / RAY / BAY / Mo Kudia scheme aim at providing affordable dwelling structures to the households on a mutually contributory basis and captured through the variable IAY. The AAY is a food security scheme of the govt. which is carried out through the Public Distribution System (PDS). Here the households are entitled to specific quota of food items per month which includes cereals like paddy and wheat along with sugar, kerosene and cooking oil. The variables WORL, PERF and CROS are dummies for capturing the beneficiaries of the WORLP and the performance of water sheds in the programme.

5. Results and Discussion

5.1 The Impact of WORLP on Income of Households

There was no significant difference between the income of the control and the treatment groups at the baseline (before the implementation of WORLP programme in the study area). The primary income during last year stands at INR 38,000 for the WORLP beneficiaries and for the control it stands at INR 34,000. Similarly the average secondary income was INR 7,800 during last year for the beneficiaries while that for control it stands at INR 6,000 respectively. The differences are also statistically significant across these two groups. Similar is also the case with total income for the treatment and control. We control for other household level covariates and try to find whether the total income of the households is statistically significantly different across the treatment and control households and also estimate the impact after matching the households. Table 2 shows the results obtained from the estimations.

Table 2: Estimation Results for impact on Total Income of the Households

Variables	DID	DID with PSM and Replacement	DID with PSM and Replacement
LBASEY	0.213***	0.341***	0.262***
	(0.063)	(0.032)	(0.063)
WORL	0.078**	0.053*	0.081*
	(0.041)	(0. 029)	(0.049)
PERF	0.029	-0.062**	-0.025

	(0.052)	(0.030)	(0.054)
CROS	0. 011	0.125***	0.112
	(0.062)	(0.045)	(0.076)
MEM	0.056***	0.041***	0.044***
	(0.005)	(0.004)	(0.007)
BVP	0.240**	0.430***	0.265**
	(0.105)	(0.072)	(0.115)
BPR	0.061	0.169***	0.011
	(0.077)	(0.057)	(0.091)
BMG	0.015	0.021	-0.063
	(0.057)	(0.047)	(0.075)
AGE	-0.002	-0.003***	-0.003*
	(0.001)	(0.001)	(0.001)
EDU	0.001	-0.001	0.005
	(0.004)	(0.003)	(0.006)
EGA	0.108***	0.025	0.079*
	(0.031)	(0.025)	(0.042)
IAY	0.052	0.129***	0.040
	(0.033)	(0.027)	(0.059)
AAY	0.1*	0.228***	0.169*
	(0.044)	(0.031)	(0.105)
LAND	0.111***	0.119***	0.119***
	(0.009)	(0.007)	(0.013)
Constant	8.001***	6.345***	7.706***
	(0.611)	(0.318)	(0.612)
N	763	1096	336
F	29.74***	49.46***	14.65***
R-Square	0.425	0.474	0.453
Difference in ATT	-	0.061	0.129
t value of ATT	-	1.06	2.68
Dependent Variable	LCUTRY	LCUTRY	LCUTRY

Note: *** indicates significance at 1%; ** indicates significance at 5% and * indicates significance at 10% respectively; Robust Standard Errors (S.E.) are denoted in parentheses

The results depicted in table 2 suggest that there is a statistically significant difference between the total income of the treatment and control groups. On an average the total income of the beneficiaries is approximately 5%-7% higher than the non-beneficiaries. Similarly around 24% of the households who were in the very poor category during the baseline have moved out of this group. Also LAND is significantly related to the increases in the current income of the households. Having one acre of more land can mean an increase of around 10% in current income of the households. Similarly households participating in MGNREGA programme have 10% more current income than the non participating ones. Households with higher income during the baseline have moved still higher. The average increase in income is in the range of 20-30%. Other govt. programmes like the IAY and AAY turn up significant across different estimations with positive sign implying that these programmes are also significantly contributing to the rise in the income of households.

The observed increase in income has been mainly due to the following reasons: (i) diversification in agricultural practices, (ii) increase in agricultural production and (ii)

decreased expenditure on inputs for agriculture. It is also observed that regions where the performance of the WORLP has not been so good have reported a decline in their value of production for all crops. The decline has been on a scale of approximately 25 – 60 percent. The input cost of cultivation has come down in the range of 60-90 percent in regions where the performance of WORLP has been good. The major impact of the WORLP has been on the cost of irrigation. The beneficiaries of the programme have 35-40 percent lesser cost of irrigation than compared to the non beneficiaries. Compared to the control households the cost of labour for the WORLP beneficiaries has reduced in the range of 20-50 percent with notable decrease in labour cost in the regions where the performance of watersheds has been good.

5.2 Impact of Climatic Aberrations and Adaptation Practices

The incidence of drought and rainfall gaps is reported in study area during both the cropping seasons. The direct impact of droughts and rainfall gaps is the resultant crop loss due to unavailability of water in the growing periods. Adaptation and coping mechanisms describe actions taken to cope with changing climate conditions, for example changes in the cropping system to suit the climatic aberrations, soil texture and structure. They also refer to the specific efforts undertaken at micro and meso level to address the risk of such extremes and aberrations. At a household level the following nonfarm level adaptation / coping options are identified that are in use in the study area to cope against climatic aberrations and extremes: (i) Selling of Livestock, (ii) Selling of Household Assets, (iii) Use of Loans and Credit, (iv) Selling of Land, (v) Use of Govt. Relief, (vi) Interest free transfers from Friend and Relatives, (vii) Use of Past Savings, (viii) Migartion and (ix) Insurance. Out of these the most preferred means of coping are: interest free transfers from friend and relatives (38%) and use of loans and credit (31%) which is followed by options like selling of livestock (18%) and depending on govt. relief (19%) during present times. These options are not mutually exclusive and households choose to employ any measure or a combination of measures. Table 3 presents the results obtained from the estimation.

Table 3: Estimation Results for impact on Adaptation Mechanisms of the Households

Variables	**IV Estimation 2SLS**	**First Stage OLS**
WORL	-0.183* (0.097)	0.071* (0.042)
PERF	-0.108 (0.107)	0.025 (0.051)
CROS	0.343*** (0.124)	-0.018 (0.063)
MEM	-0.015 (0.015)	0.056*** (0.005)
AGE	-0.006 (0.018)	0.036*** (0.009)
EDU	-0.001 (0.021)	-0.001 (0.01)
AGE SQ	-0.0006 (0.0001)	-0.0003*** (0.00009)
EDU SQ	-0.001 (0.002)	0.00007 (0.001)
TECHED	-0.092 (0.111)	0.131** (0.056)
BPL	0.045 (0.071)	-0.019 (0.034)
EGA	0.298*** (0.061)	0.094*** (0.031)
IAY	0.242*** (0.08)	0.036 (0.034)
AAY	0.105 (0.104)	0.101** (0.044)
LAND	0.102*** (0.028)	0.107*** (0.009)

SHG	0.107** (0.056)	-0.012 (0.027)
LBASEY	-	0.206*** (0.062)
BVP	-	0.241** (0.104)
BPR	-	0.075 (0.076)
BMG	-	0.019 (0.056)
LCUTRY	0.129 (0.182)	-
Constant	-0.601	7.138***
	(1.705)	(0.646)
N	763	763
F	9.27***	23.29***
Centered R^2	0.151	0.443
Uncentered R^2	0.745	0.998
IV Estimation Test Statistics		
Kleibergen-Paap LM statistic	25.991***	-
IV Redundancy LM Test	20.875***	
Cragg-Donald Wald F statistic	16.583	-
Kleibergen-Paap Wald F statistic	4.289	-
Endogeneity Test Sargan-Hansen C statistics (p-value)	0.0 (0.988)	-
Hansen J for Orthogononality (p-value)	3.283 (0.193)	-
Hansen J statistic Over identification (p-value)	3.379 (0.336)	-
Summary of First Stage Regressions		
F test of excluded instruments	-	4.29***
Angrist-Pischke F test	-	4.29***
AP Chi-Square (Under id)	-	17.62***
Anderson-Rubin Wald test (p-value)	-	0.97 (0.422)
Stock-Wright LM S statistic (p-value)	-	3.93 (0.416)
Instrumented	LCUTRY	-
Excluded Instruments	LBASEY, BVP, BPR, BMG	-
Dependent Variable	COPN	LCUTRY

Note: Robust Standard Errors are reported in parentheses; *** implies significance at 1% level, ** implies significance at 5% level and * implies significance at 10% level respectively

The results suggest that instrument is exogenous as Sargan-Hansen C statistics for checking the endogeneity of the instrument turns out insignificant and hence the null hypothesis that the instrument is exogeneous is accepted. Further the Kleibergen-Paap LM statistic is statistically significant indicating that the model is identified. Similarly the test statistics from the first stage are all significant different from zero, with a p=value of 0.0000. Similarly a F statistic over 10 is required to suggest instruments are sufficiently strong because if the instruments are weak, 2SLS gives standard errors which are too small and Limited Information Maximum Likelihood (LIML) estimates is thought to be a better approach if instruments are weak. Since the F value in the present case turns out to 38.21 we find the 2SLS method to be appropriate.

From the IV estimation results we find that the variable CROS to be positive and statistically significant we can say that households who were WORLP beneficiaries and where the performance of the programme has been good adopt for adaptation options. Similarly more

adaptation mechanisms are available for households: (i) having membership in social networks, (ii) possessing livestock, (iii) having higher land ownership and (iv) benefitting from other govt. programs like MGNREGA, IAY and AAY. The variable LCUTRY although has a positive sign, turns out to be statistically insignificant. Therefore it can be concluded that firstly, WORLP has definitely had a positive impact on the adaptive capacity of households (in terms of having access to more adaptation / coping options) but only in regions where the performance of the programme has been good and secondly other govt. interventions have also enhanced the adaptive / coping capacity of the households.

6. Summary and Conclusion

Variations in environmental conditions and the occurrence of climatic aberrations and extreme events (like droughts, deficient rainfall spells and floods) pose a threat to economic growth of the households in the vulnerable regions of the developing countries like India. They also act as an impediment to the intervention programmes (like poverty reduction programmes) undertaken for reducing the vulnerability of households. The vulnerability in these hot spots is further under stress due to the limited capacities of households to cope with the impacts. The state of Odisha is one of the poorest states in India and is prone to multiple disasters and the western districts in particular are one of the poorest districts of the country and traditionally vulnerable to droughts and deficient rainfall spells. The Western Odisha Rural Livelihoods Project (WORLP) is implemented by the Government of Odisha, funded by DFID, U.K. The objective of this programme was on development of watershed through financial assistance to households for creating watershed structures. The key research question for this study was firstly, to examine whether WORLP has led to any income enhancement at household level and second whether this has also resulted in building additional adaptive capacity at household level to cope against climatic aberrations and extremes. Based on the analysis it is found that: (i) interventions have increased the income of beneficiary households compared to non-beneficiaries, (ii) more coping mechanisms are adopted by beneficiaries to deal with drought impacts and (iii) other govt. led interventions like employment guarantee and provision for housing have also contributed in generating additional coping capacity at household level.

During the last fifty years India has been following a pattern of balanced approach to achieve long term growth. Five year plans have however focused largely on increasing economic growth, reduction in poverty and inequality. This burdened portfolio of development programmes faces the challenges of adaptation to issues arising out of climate change (for example the changing patterns of rainfall or the increased frequency of climate related natural disasters etc.). Although in this direction various policies are put in place (like income generation schemes, provision for housing, disaster mitigation, and stress reduction on livelihoods through diversifications etc. and indeed are helpful in reducing the impacts of climatic aberrations like droughts. However these policies need to be amalgamated with adaptation and disaster risk reduction policies to deal with the impact of climatic aberrations, the incidence of which are projected to increase due to climate change.

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