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Abstract

Is it possible to develop models that will not only provide consistent and elegant analytical framework for conceptualizing welfare change and sustainability of public policies and programmes formulated and implemented under a democratic setting, but evaluate the impact of such on the socio-economic welfare or wellbeing of the people living in project communities? Using the European Economic Community/Federal Government of Nigeria Katsina Afforestation Programme, which was conceived as a desertification control measure with the ultimate goal of improving the living condition of the people in the affected area through the provision of certain basic requirements, including fuel wood and poles, to reduce pressure on the remaining natural vegetation and reverse the trend of environmental degradation, this study attempts to measure its socio-economic impact as an example, this study employed the stylized models of Ravallion (1999) and Baker (2000), and Vouvoka and Xepapadeas (2008) to developed criteria for measuring intertemporal changes in social welfare conditions of the project communities within the period 1987-2006. The findings suggest that the project has not only gingered positive social welfare changes and sustainability in consumption and productive base in the short- and medium-term in the face of the existing threat of desertification, but promises to serve as good proximate yardstick for the evaluation of the effectiveness of environment-related public policy under a democratic dispensation, especially in the area of environmental degradation control.

Keywords: Democracy, Policy, Afforestation, Social-welfare, Sustainable Development

Introduction

Democracy, democratic governance and environmental degradation in a developing country like Nigeria are related through resource management, sustainable development and the instrumentality of public policy. Whereas democracy is considered to be the most advanced socio-political system yet invented by humankind that can help resolve age-long economic and societal ills that are sources of crises in the modern world, sustainable development under democracy is taken to mean development that meets the needs of the present generation of people without compromising the ability of future generations to meet their own needs (Afolabi, 2011; UNEP, 2011; Toman, 1992).

Indeed, the survival of democracy and its sustenance through the resilience of established democratic culture and institutions, are seen by many as a sine qua non for the survival and economic progress of most developed as well as emerging economies (Afolabi and Quadri, 2015). This is because democracy is mostly synonymous with broad popular consensus and social justice,
dedication to efficient service delivery of public good founded on an unequivocal faith that its presence promotes economic vitality which brings out the best of all and the creation of opportunities for jobs and prosperity in a global market place (Coppedge et al., 2015). Interestingly, this process can only be driven by an appropriate framework for the formulation, implementation and evaluation of sound public policy and programmes to resolve socio-political, economic and environmental problems, such as desertification.

The semi-arid or Sahel-Sudan zone of Nigeria has been experiencing environmental degradation (Majindadi and Adegbehin, 1991; Gadzama, 1995, Ayuba et al., 2002). Such degradation includes soil erosion, drought, soil nutrient depletion, deforestation, disappearance of useful species, and so on. In this particular region, the cumulative effects of the degradation has been desertification (Rasmussen et al., 2001). As a matter of fact, the concept of desertification is used to describe either signs of desiccation and the creeping of the Sahara desert into the Sahel (Bovill, 1921; Aubreville (1949) or the change of productive land into desert as a result of man’s activity in the tropical forest zone of Africa (Hermann and Hutchinson, 2005).

Desertification is the most serious environmental problem in ten semi-arid and arid states of Nigeria namely, Sokoto, Borno, Kano, Bauchi, Katsina, Jigawa, Kebbi, Gombe, Zamfara, and Yobe. In fact as at 1989, the landmass in these states that were prone to desert encroachment and desertification was estimated to be between 18 – 71 per cent (FGN, 1993). These states have a high carrying capacity and are home to about 43 million people or one-third of the country’s population (FGN, 2007). Their poverty rate ranges between 72 per cent and 82 per cent, which is above the national average (NBS, 2005).

These states support about 90 per cent of cattle population, two-thirds of goat and sheep, almost of all donkeys, camel and horses found in the country, exclusively of export crops such as cotton, groundnuts, gum Arabic, wheat and rice (FGN, 1993). Over 70 per cent of the people are heavily dependent on the environmental resources; from economic, social and ecological standpoints, while they try to cope with low technology, poor soil fertility and wind erosion (World Bank, 2003). The availability, use and management of existing resource stock in this zone are therefore important issues in economic efficiency, social welfare change, sustainable development and democracy.

Since public policy is the expression of a people’s will to translate its aspirations and wishes into concrete reality, the effectiveness of any policy executed under democratic dispensation, be it social, economic or environmental, can be adjudged as the success of that democratic system. It is therefore imperative, that to avoid a failing state in an emerging democracy like Nigeria, it safer to ensure that policy works both in form and in execution. To successfully do that will mean carrying out ex ante, in medias res and ex post cost/benefit analysis of public policy and programmes (Boardman et al., 1996). Therefore, policy, programmes and projects on environmental degradation control as part of the dividend of democracy are no exception.

The efficiency of development assistance and projects in general, and in particular on the impacts of desertification control on target communities have been questioned by many researchers (ICIHI, 1986), Grainger (1990) and Baker (2000).

Although, there is broad evidence on the benefits of such projects on the economic growth, investments in human capital as well as the provision of safety nets for the poor on macroeconomic scale, the questions that are often left unattended to include: 

a. Given specific projects or programmes in a given country, are the interventions/aids, producing the intended benefits and what are the overall impacts on the target population?

b. Would the projects or programmes have been better designed to achieve the intended outcomes?

c. Were resources allocated to these projects used efficiently to achieve the desired effects?

d. Are the benefits of the projects/programme or even the projects/programmes sustainable over the medium to long term periods?
These are the types of questions that can only be answered by an impact evaluation; being an approach that measures the outcomes of a project or programme intervention. The knowledge gained from impact evaluation studies will also provide critical input for appropriate design of future programmes and projects.

It is against this backdrop that evaluating the impacts of the first and major collaboration in the fight against desertification between Nigeria and the international community, the European Economic Community/Federal Government of Nigeria (EEC/FGN) Katsina intervention becomes an interesting research subject.

It is interesting to note the EEGN/FGN Katsina project was used as a pilot project to demonstrate how intervention can help, not only to curb desertification in the area, but provide social safety nets and improve conditions for agricultural production as well as promote self-sufficiency in the production of traditional domestic forestry produce, such as firewood, poles, fodder for livestock, medicine, and so on, among the rural people.

The broad objective of this study is to ascertain the efficiency of foreign aid on and appropriateness of afforestation programme as a strategy to fighting desertification in the arid and semi-arid zones of Nigeria. However, the specific objectives are to ascertain the extent of the impact of EEC/FGN Katsina project on the economic and social wellbeing of the people living in target communities in the aftermath of the project; and the sustainability of the welfare gain in the medium or long term.

Technically speaking, these objectives translate to developing an applicable and operational approach to measure changes that might have occurred as well as develop a framework for evaluating desertification control interventions; and in particular their impacts on socio-economic welfare conditions.

This study set out to test two mutually related hypotheses: (i) there were no net total social welfare gains among the target communities attributable to the execution of the EEC/FGN/ Katsina project; and (ii) if hypothesis (i) turned out to be true, there are no guarantee that net total social welfare gains would have been sustained over the study period.

**Methodology**

**Study Area**

The EEC/FGN/Katsina Afforestation Project was implemented between 1st January 1987 and 30th June 1993. The study area cover an area comprising nineteen northern local governments (LGs) of Katsina state which included Batsari, Bindawa, Batagarawa, Daura, Dutsin ma, Ingawa, Jibiya, Kaita, Kankiya, Katsina, Kurfi, Maiadua, Mani, Mashi, Musawa, Matazu, Rimi, Safana and Zango. This area covered approximately 16,000 square kilometers. Katsina State is located within the central northernmost part of Nigeria and between 7° 30’~ 19° 30’ E in longitude and 10° 30’ ~ 13° 45’ N in latitude.
The state lies north of Kaduna State and shares borders with Zamfara State in the east, Jigawa State in the northwest, Kano State in the southwest and the Republic of Niger in the north (Figure 1). The study area exhibits the typical features of an arid continental climate. Out of a total area of 24,192 km$^2$, 16,275 km$^2$ (or about 68 per cent) of the state is classified as prone to the threat of desertification (FRN, 1993). In 2006, the state had a population of 5,792,578 (FRN, 2007).

**Model Specification**

The currents in contemporary theoretical state of our subject matter of investigation provide the basis for our model construction. Two models were used in this study to examine changes in the social welfare conditions in the project communities, namely the Vouvoka and Xepapadeas (2008) model, and the Ravallion-Baker model. The Vouvoka and Xepapadeas (2008) model is a productive resource base approach. Here social welfare changes are related to value functions for the economy and accounting prices which follow certain feedback and open loop rules in a non-optimizing scenario (Umaru, 2009).

Borrowing from the felicity functional of Arrow et al. (2003):

$$V_t = \int_{t}^{\infty} e^{-\rho(\tau-t)} U(x(\tau), u(\tau)) d\tau, \quad \tau \geq t \quad \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

where $x = (x_1, \ldots, x_n)$ denotes a vector of state variables which can be interpreted as stocks of assets and $u = (u_1, \ldots, u_m)$ denotes a vector of control variables which can be interpreted as policy instruments. The function $U(x(\tau), u(\tau))$ was interpreted as the welfare of the generation living in the economy at time $\tau$, under appropriate assumption about the growth of the population, the following was obtained:

$$\dot{V}_t = p_K \dot{K} + p_N \dot{N} + p_A \geq 0 \quad \ldots \ldots \ldots \ldots \ldots \ldots (2)$$
Following Vouvoka and Xepapadeas (2008) and by dividing by \( Nk \) where \( k = \frac{K}{N} \), using the fact that
\[
\frac{d(K/N)}{dt} = \frac{K}{N} - \frac{K}{N}k
\]
and that the accounting price for capital in physical terms is related to the accounting price of capital per effective worker terms, equation (3) was derived:
\[
\hat{S}_i^A = \frac{p_{k_i}}{A_iN_i} + p_{k_i}n + \frac{1}{k_i}A_i + \frac{1}{k_i}p_{\pi_i} + D_i \quad \text{……..(3)}
\]
where \( \hat{S}_i^A \) was interpreted as the rate of return on produced capital measured in terms of social welfare; \( k, n, A_i \) being the parameters describing the structure of the economy. \( K \) was capital stock, \( N \) was labour input, \( \frac{A}{\hat{A}} = g \) was the rate of growth of labour augmenting technological change; \( L = AN \) was effective labour; \( D \) was the variable that captures the influence of policy intervention in the form of desertification control programme; \( p_{k_i}; p_{n_i}; p_{\lambda_i}; p_{\pi_i} \)
were the accounting prices for capital stock, effective labour, labour-augmented technical change and desertification control measure;
\( \hat{k}/k = \nu \) was the rate of growth of capital per worker; \( n \) was the rate of growth of domestic population and labour force; \( \tilde{n} = n + n + m \) was the growth of population and labour force at the constant rate plus the net migration rate (Sander, Abel and Riosmena, 2013).

The Ravallion-Baker Model was based on Ravallion (1999b) and Baker (2000), which suggests running a regression of years of living in the project community on a set of control variables as well as whether or not the household participated in the project promoted by the policy intervention. For the \( i^{th} \) household in the sample let:
\[
U(\hat{c}_i, \hat{D}_i) = S_{i1} = a + bP_{1i} + cX_i + \epsilon_i \quad \text{……..(4)}
\]
where \( P_{1i} = d + eZ_{1i} + v_{1i} \); and \( Z \) is several variables that include all the observed “proxies” used for programme targeting. There might have been some purely random error term that influences participation; these were proxies that might not be in the data, and also there might have been mistakes in selecting participants which would end up in the \( \nu \) term. This equation is linear, yet \( P \) can only take two possible values, 0 and 1. Predicted values between zero and one are acceptable, but a linear model cannot rule out the possibility of negative predicted values, or values over one. To take advantage of this property, most empirical studies in the past utilized either the Logit or Tobit models using the method of Maximum Likelihood (ML) instead OLS (Baker, 2000). Also, \( a, b \) and \( c \) were parameters; \( S_i \) represented project benefits, and \( X_i \) stood for control variables or household welfare attributes, \( \epsilon_i \) was a residual that included other project determinants and measurement error. \( P_i \) denotes project participation of the \( i^{th} \) household. This was taken to have the potential of assuming two possible values, namely \( P_i = 1 \) if the household participated in the project; and \( P_i = 0 \) if the household did not. If the \( i^{th} \) household did not participate, then its level of project benefit in time \( t \) would have been \( S_{0i} \), which stands for household \( i^{th} \)’s project benefits when \( P = 0 \). If the households did participate then its project benefits would have been \( S_{1i} \). Its gain for participating in the project would have been \( S_{1i} - S_{0i} \). The gain for the \( i^{th} \) household who participated \( (P = 1) \) would then have been:
\[
G_{1i} = S_{1it} - S_{0it} \quad | \quad P_i = 1 \quad \text{……..(5)}
\]
To know the average gain, we simply concentrated on the mean of all the \( G \)’s which gave the sample mean gain in project benefits among all those members of the project communities who participated in the project. So long as this mean were calculated well, it would provide an unbiased estimate of the true mean gain. The latter was taken to be the expected value of \( G_i \) and it was expressed as:
\[
G_{1i} = E(S_{1it} - S_{0it} \mid P_i = 1) \quad \text{……..(6)}
\]
This was another way of saying “mean”. However, it needed not be exactly equal to the mean calculated from the sample data, given that there would have been some sampling error. In the evaluation literature, \( E(S_{1it} - S_{0it} \mid P_i = 1) \) is sometimes called the “treatment effect” or the “average treatment effect on the treated.” In this case, the
policy intervention was considered the treatment (Ravallion, 1999b).

These models have some unique empirical qualities that need to be emphasized here. First, the model have the ability to analyze both theoretically and empirically the concept of the time derivative of a Ramsey-Koopmans social welfare functional (SWF) (that is, avoiding any decline in intergenerational social welfare, either from time $t$ forever onwards, or much less demandingly, just at time $t$ at a given time $t$) which provides a measure of the rate of change of the economy’s current social welfare, or a measure of genuine investment or genuine savings at this time. Second, by using the non-optimizing theoretical framework, these models show that when controls (or policy instruments) are chosen in an arbitrary way, which is independent of the stock of assets, the current CSW would depend not only on the growth of the assets and their corresponding accounting prices, but also on the arbitrary paths of the controls. Thus, their value function for the economy would depend both on current stocks and current flows. This suggests that the rate of change of SWF is not just the difference of the sums of current and previous CSW or genuine savings in specific assets, but that it may include changes in welfare brought about by policy intervention or instrument at their accounting prices. Third, they provide exact representation and closed form solutions for value functions and accounting prices. Four, they provide a means to develop an applicable and operational approach to measure current CSW, and a framework for the evaluation of development projects with respect to their impact on current social welfare conditions. Five, they have the ability to provide yardsticks for measuring, in quantitative terms, the magnitude of change in social welfare and sustainability of change in social welfare and productive base of the economy as a result of policy intervention, based on the yardsticks or decision rules provided for analysis, that is the prerequisite (necessary) condition for social welfare change as well as required (sufficient) conditions for sustainability.

Sources of Data and Estimation of Statistical Estimations

We used the stylized Vovouka-Xepapadeas and Ravallion-Baker models explained above to evaluate the impact of the EEC/FGN/Katsina Afforestation Programme by exploring the current social welfare conditions in the two dynamic time periods, namely, before 1987 – 1993, and 1993 – 2006. We first used the Vovouka-Xepapadeas model to evaluate changes in the current social welfare conditions in the two dynamic time periods in the project area. Secondly, we evaluated changes in social welfare conditions in the same area using the alternative approach, Ravallion-Baker model. Then lastly, we compared the relative changes from the two exercises to assess the overall relative impact of the programme on the target communities.

To apply the Vovouka-Xepapadeas model, estimates of the parameters was required to define the model’s value function. The method used was to estimate, using econometric procedures, parameters that correspond to structural relations and to assign plausible values to those parameters for which econometric estimations were not possible. The parameters needed to estimate measures in equation (3) are briefly explained in Table 1.

To compute the rate of growth of population and domestic labour force ($n$) in the study area, actual and projected population figures for the State by local government area from Nigeria’s National Population Commission as well as figures from cross-sectional data on members of household above the age of 10 who were directly or indirectly engaged in production were relied on. Because of the seasonal nature of labour migration in the area, it was assumed that the net migration effect on the economy ($m$) to be nil for the study area. It has been shown theoretically that the Solow growth model must assume Harrod-neutrality since it is the only form of technical progress consistent with a steady state solution (Burmeister and Dobell, 1970). This is quite appropriate for our purpose for two reasons. One, it has the advantage of being theoretically tractable $\dot{y} = \dot{y}_0 = f(K/L) = f(k)$. 

Umaru et al. / Ife Research Publications in Geography 13 (2015) 49 – 64 54
Table 1: Parameters used for estimation and their significance

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Rate of growth of domestic population and labour force</td>
</tr>
<tr>
<td>M</td>
<td>Net migration rate</td>
</tr>
<tr>
<td>V</td>
<td>The rate of growth of capital per worker</td>
</tr>
<tr>
<td>G</td>
<td>The rate of growth of labour augmenting technological change</td>
</tr>
<tr>
<td>A</td>
<td>Parameter of the production function reflecting the elasticity of capital input</td>
</tr>
<tr>
<td>S</td>
<td>Savings rate</td>
</tr>
<tr>
<td>Δ</td>
<td>Depreciation rate</td>
</tr>
<tr>
<td>$D_T$</td>
<td>Rate of growth of desertification</td>
</tr>
<tr>
<td>$z_D$</td>
<td>Potential reduction of gross earnings due to the desertification effects</td>
</tr>
</tbody>
</table>

Two, the model assumes long-run macroeconomic equilibrium, in the sense that Savings ($S = I = \dot{S}Y$), with a constant propensity to save (invest) $S = I = \dot{S}Y$ where $s$, the marginal propensity to save, is a constant fraction of current earnings (income or output). For empirical purpose, we assume $\delta$ (the constant rate of depreciation of the capital stock) to be zero, so that $\frac{\Delta K}{K} = sY - \delta K = \dot{S}Y - \delta sY$. This is because of the use of simple tools, implement and technology by farmers in the area (Dorosh and Sahn, 1993; CBN, 1998); even where heavier equipment (like tractors) is used, it is based on hire service. We also assumed the rate of exogenous technical change ($g$) in the study area to be zero because of the unchanging production technique of households over the years – the employment of hoe and cutlass. Agriculture is the basic economic activity in the area, and shifting cultivation, the main farming technique (Dorosh and Sahn, 1993; CBN, 1998). $a$, being the parameter of production function reflecting the elasticity of capital, was computed as

$$a = \frac{\ln \dot{y} - \ln (1 - z_D)}{\ln (1 - z_D)} \frac{\dot{y}}{k} = \left(1 - z_D\right)^a.$$

After the values of these parameters were determined, the next step was to estimate the respective accounting prices specified in the equation (3) of the stylized model, $p_{k_t}, p_{N_t}, p_{A_t}, p_{\pi_t}$, using data computed from the cross-sectional survey conducted on the sampled households in the project area. To provide value for the parameter $z_D$, which represents the potential reduction of income due to desertification, we adopted the mean average of the cost of environmental degradation of 7.7 per cent estimated for Nigeria by World Bank (2006) as proxy.

The values of parameters and accounting prices together with the values of the average changes in the variables, $A_t, N_t, k_t$, were then used to estimate $\dot{S}_t^F, \dot{S}_t^A$ for the two dynamic time periods. Table 2 shows comparisons and decision rules used to evaluate the overall impact of the programme based on the Vovouka-Xepapade as framework.

To estimate the equations under the the Vovouka-Xepapadeas model, secondary data were used to estimate some of the parameters for which econometric procedure could not be used. For those of them which econometric estimations could be undertaken, primary panel data computed from the cross-sectional survey in the Project area were employed. The fundamental data for this exercise were estimates of household income/gross earnings and capital, and labour measured in Naira and physical units respectively for the periods, pre-Programme; 1993; and 2006.
The average rate of these variables in physical units and in per capita terms during the sample dynamic time periods was computed. The basic structural relationship for the Project area was the aggregate production function, $D_T = \phi(f(k_T)AN)^{x(t-1)}$, since the estimates from the production function were used to determine elasticity of capital with respect to output, which were the parameter $a$, and the rate of labour augmenting technical change $g$.

Due to the characteristic low income level of households in the region of the country where the Project area was located, we assumed that the proportion of household income not committed to consumption was dedicated to production. Also for the estimation, the existence of a constant return to scale Cobb-Douglas long run aggregate production function for the Project area, defined over manmade capital and effective labour input was assumed. For the estimation, we assumed the existence of a constant return to scale Cobb-Douglas long run aggregate production function for the Project area, defined over manmade capital and effective labour input, which takes the form:

$$Y_t = BK^a (Ne^{g^t})^{1-a} \quad \ldots \ldots (7)$$

or in per worker terms:

$$y_t = Bk^a e^{qt}, q = g(1 - a)$$

The statistical model was expressed:

$$\ln y_t = \ln B + a \ln k_t + qt + \epsilon_t, t = 1,...,T^s \quad \ldots \ldots (8)$$

where $\epsilon_t$ is the usual error term. The production function (8) was interpreted as a long run equilibrium relationship that shifts in time as it is affected by technical change. Lastly, in determining the acceptable desertification limit for the model, we took and divided the national annual average of rate of desertification of 0.6 km (or 0.36 km$^2$) by Nigeria’s total land area of 923,768.64 km$^2$ to arrive at the value for $D_r$. We then used the value of $D_r$ to multiply by acreage under cultivation ($Pc$) by household in the project area to arrive at values of $D = F_s - [F_s (3.89 \times 10^{-7})]$ for the two dynamic time periods.

### Table 2: Comparisons and decision rule for social welfare change evaluation within the Vovouka-Xepapadeas framework

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Decision Rule</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>If $S_{t2} &gt; S_{t1} &gt; 0$</td>
<td>Programme has led to higher change in social welfare at time $t_2$ and $t_1$ relative to pre-programme period</td>
<td>Positive Social Welfare Changes and Sustainability were achieved by the Programme</td>
</tr>
<tr>
<td>If $S_{t2} &lt; S_{t1} &gt; 0$</td>
<td>Programme has led to higher change in social welfare during programme period (time $t_1$) relative to pre-programme period, but the welfare gains were not sustained</td>
<td>The Programme contributed to Social Welfare Changes but only limited to the Programme period (19987-1993) in the Project area. The Welfare gains were not sustainable</td>
</tr>
<tr>
<td>If $S_{t2} &gt; S_{t1} \leq 0$</td>
<td>Programme has led to higher change in social welfare at time $t_2$ than in time $t_1$ but had zero or negative welfare gain relative to pre-programme period</td>
<td>The Programme had added to zero or negative Social Welfare gain in the Project Area</td>
</tr>
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</tr>
</tbody>
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$\bar{U}$maru et al. / Ife Research Publications in Geography 13 (2015) 49 – 64
To evaluate the impact of the programme using the Ravallion-Baker model, $Z_{it}$ was defined in equation (4) as the summation effect of changes in household consumption level within and over dynamic time $t$, expressed as difference in the level of attributes such as $Z_{1t} = Y_{ih}$ = income/earnings of $i^{th}$ household; $Z_{2t} = E_{ih}$ = energy/fuel consumption of $i^{th}$ household; $Z_{3t} = F_{id}$ = food/farm yield of $i^{th}$ household; $Z_{4t} = H_{ih}$ = health status of $i^{th}$ household; $Z_{5t} = H_{sh}$ = housing/shelter for $i^{th}$ household; $Z_{6t} = C_{fs}$ = land under cultivation of $i^{th}$ household; $Z_{7t} = C_{fm}$ = domestic animal population of $i^{th}$ household; $Z_{8t} = C_{w}$ = water consumption of ith household; $Z_{9t} = F_{s}$ = family size of $i^{th}$ household; and $Z_{10t} = P_{i}$ = participation in desertification control programme, either through project activities or assistance, capacity building and training.

To collect data to evaluate the impact of EEC/FGN/Katsina Programme using the Ravallion-Baker model, an experimental design or randomization evaluation technique was adopted. The approach involved the use of reconnaissance visits to determine the sample size; then using a random sampling approach, structured questionnaire/interview was used to collect cross-sectional data on household characteristics and their perception on the extent to which the Project had influenced individual attributes of the households and on the overall welfare of the communities.

By and large, cross-sectional data collected from sampled households were used to estimate and compare Logit and Tobit versions of equation (4) using the Maximum Likelihood method (ML) for each dynamic time periods. Then the value of $b$ for each sub-sample (participating sample of households and non-participating sample of households) was used to compute the difference to determine the overall gain in welfare due to the Programme using the decision rule in Table 3.
Study Population and Sample

In this study, Katsina State with its 32 LGAs was taken to be the theoretical population; while 19 out of the present 32 LGAs namely, Katsina, Zango, Daura, Mai-Adua, Kaita, Jibiya, Batsari, Kurfi, Batagarawa, Rimi, Mani, Bindawa, Ingawa, Kankiya, Dutsin-Ma, Matazu, Safana, Musawa, Mashi and Dan-Musa were designated as the working population. Four hundred (400) households were randomly selected and covered in the sample.

A key assumption that was made is that the outcome of each individual attribute of the comparison group was uncorrelated with the error terms in the two groups as well as individual household characteristics in the treatment group.

The last part of Step I involved sorting of respondents into two categories, participating sample of households (treatment group) and non-participating sample (comparison group) of households; aggregation of data on household income, capital, consumption expenditures and physical units of labour.

Because Logit and Tobit models were specified for the study, conversion of multi-choice answers into binary form and coding data sets were undertaken. Probability values were then attached to each answer options which were later grouped and converted to binary codes of between 0 and 1. The converted data were then used to evaluate equation (4) using Maximum Likelihood method. Eviews version 3.0 and the Special Package for Social Sciences (SPSS) version 14.0 were used as statistical packages to process and analyze data in the study.

Results and Data Analysis
Vovouka-Xepapadeas model results

In the case of the Vovouka-Xepapadeas model, the average growth rates of capital, output and labour force as well as the parameter values used for computation are reported in Table 4. Using the above parameters, accounting prices were calculated, the results of which are presented in Table 6. Two sets of results were obtained. The first set presents estimated changes in social welfare under the no-programme scenario; while the second the actual welfare changes (that is, programme scenario).

The column \( pK_t \) refers to \( dV_t / dK_t \) which is the accounting price for capital. The prices of capital for the two sampled periods were positive. This is consistent with the a priori expectation. The second column \( pN_t \) represents \( dV_t / dN_t \) which is the accounting price of labour. The two prices of labour for the two sampled periods carry negative signs. This is to be expected, especially with the declining growth rate of the labour force in the project area.

\( pD_t \) is the accounting price of environmental damage associated with desertification. This price is negative as expected, since an increase in \( D_t \), that is a higher level of the limit in the rate of desertification, is expected to reduce the social welfare of communities in the project area, especially when \( zD \) remains constant.

Table 6 also shows the results of the estimated Vovouka-Xepapadeas social welfare changes [under no-programme \((\hat{S}^F_t)\) and programme \((\hat{S}^A_t)\) scenarios] from the EEC/FGN/ Katsina Afforestation Programme in the study area. The social welfare change under the no-programme scenario for the period, 1987-1993, was 0.009018 while that of 1993-2006 period was 0.006802. This represents an overall negative effect of 24.6 per cent (or 0.02216). However, due to the desertification control intervention, the communities in the project area experienced a modest increase in social welfare change of 15.74 per cent (or 0.0155) within the sampled period (1987-2006).
Table 5: The parameters used for computing accounting prices and social welfare change

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Parameter</th>
<th>$\tilde{n}$</th>
<th>$\nu$</th>
<th>$g$</th>
<th>$s$</th>
<th>$a$</th>
<th>$\sigma$</th>
<th>$\tilde{D}_t$</th>
<th>$z\tilde{D}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_1$ (1987-1993)</td>
<td>0.003</td>
<td>0.1865</td>
<td>0</td>
<td>0.1542</td>
<td>0.568</td>
<td>3</td>
<td>3.89E-07</td>
<td>0.077</td>
<td></td>
</tr>
<tr>
<td>$t_2$ (1993-2006)</td>
<td>0.002</td>
<td>0.3255</td>
<td>0</td>
<td>0.1988</td>
<td>0.649</td>
<td>3</td>
<td>3.89E-07</td>
<td>0.077</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Accounting prices and changes in social welfare for the EEC/FGN Katsina Afforestation Project area under programme and no-programme scenarios

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Accounting Prices</th>
<th>Changes in Social Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{\tilde{K}_t}$</td>
<td>$P_{N_t}$</td>
<td>$P_{\tilde{D}_t}$</td>
</tr>
<tr>
<td>$t_1$ (1987-1993)</td>
<td>0.0001204</td>
<td>-0.0000003003</td>
</tr>
<tr>
<td>$t_2$ (1993-2006)</td>
<td>0.0001209</td>
<td>-0.0000002608</td>
</tr>
<tr>
<td>Net Effect</td>
<td>-0.02216</td>
<td>+0.0155</td>
</tr>
</tbody>
</table>

It would seem that within the context of the Vovouka-Xepapades model framework, the welfare condition of the communities in the project area would have been worse had the programme not been implemented. It therefore might be claimed that for the examined sample period, the communities in the project area were characterized by positive changes in social welfare due largely to the EEC/FGN Katsina Afforestation Programme.

Ravallion-Baker model results

In the case of the Ravallion-Baker model, the functional forms which were specified in equation (3) and estimated using the estimation procedures of Binary, Logit and Censored Logistic (Tobit). Estimated changes in social welfare for the two...
models were computed and compared for the analysis on the best functional form.

In Table 7, the changes in social welfare, based on the specified functional forms of the Ravallion-Baker model, are reported. For the Logit model, the parameter that measures the probability value of programme impact \( p_i^* \) for the sampled period (1987-2006) shows an appreciable improvement. It rose by about 505 per cent (or a net effect of 0.107616). The coefficients for the two sub-periods were significant at 5 per cent level.

A similar trend was observed for the Tobit model. The value of the variable \( p_i^* \) for the second sub-period was higher than that of the first, leaving a net effect of about 180 per cent improvement for the entire period (1987-2006) or a positive net effect of 0.003504. For this model too, the coefficients of variable \( p \) for the sub-periods were significant at 5 per cent level.

Social welfare change and policy analysis

The necessary conditions for social welfare change: 
\[ S_{t_1} \geq S_{t_2} > 0 \text{ or } S_{t_1} \leq S_{t_2} < 0 \] implies positive change in social welfare over the sample period.

\[ S_{t_1} \geq S_{t_2} \leq 0 \text{ or } S_{t_1} \leq S_{t_2} \leq 0 \] implies negative or zero change in social welfare over the sample period.

Sufficient condition for both sustainability in positive social welfare change and sustainability in the productive base: 
\[ S_{t_1} \geq S_{t_2} > 0 \] implies sustained welfare change and sustainability in the productive base of the economy resulting from policy intervention.

Table 7: Estimates of changes in social welfare for the EEC/FGN Katsina Afforestation Project via the Ravallion-Baker Model

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Statistic</th>
<th>Changes in Social Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOGIT Model</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Std-Error</td>
<td>z-Statistic</td>
</tr>
<tr>
<td>( t_1 ) (1987-1993)</td>
<td>0.055171</td>
<td>0.386101</td>
</tr>
<tr>
<td>( t_2 ) (1993-2006)</td>
<td>0.075316</td>
<td>1.711688</td>
</tr>
<tr>
<td>Net Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOBIT Model</td>
<td></td>
</tr>
<tr>
<td>( t_1 ) (1987-1993)</td>
<td>0.068125</td>
<td>0.080038</td>
</tr>
<tr>
<td>( t_2 ) (1993-2006)</td>
<td>0.048038</td>
<td>0.040572</td>
</tr>
<tr>
<td>Net Effect</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Conclusions from the analysis of results based on the necessary and sufficient conditions for sustained welfare gains and sustainability in the productive-base arising from the EEC/FGN Katsina Afforestation Programme

<table>
<thead>
<tr>
<th>Effect</th>
<th>Vovouka-Xepapadeas Model</th>
<th>Ravallion-Baker Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOGIT</td>
<td>TOBIT</td>
</tr>
<tr>
<td>Gain in social welfare period ( t_1 ) (1987-1993)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Gain in social welfare period ( t_2 ) (1993-2006)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Necessary Condition</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Sufficient Condition</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Magnitude/significance of change</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note
✓ Positive/significant; ✗ Negative/insignificant; Positive \( = > 0 \); Negative \( = \leq 0 \); Significant \( = \geq 0.1 \); Insignificant \( = < 0.1 \)
Based on the sufficient and necessary conditions, the conclusions in Table 8 were arrived at. The implication of these findings is that within the context of our analysis and for the examined sample period, communities in the project area were characterized by positive changes in social welfare, which could be insinuated to mean an indication that the programme has promoted productive-base sustainability.

The only problem with the effect of the programme is the magnitude or significance of change with the passage of time. Among the three, only results from the experiment with Logit model indicated statistical significance in the magnitude of change over time. The implication of this is that the post-programme gains in social welfare might have been ‘vanishing’ with the passage of time within the sample period.

Discussion

The overall conclusion from the findings of the study is that given available evidence, the EEC/FGN Katsina Afforestation Programme was an appropriate strategy in the fight to control desertification in that particular arid zone of the country. A corollary to this is that afforestation is one of the possibilities and a workable solution to fighting desertification in the area. This may not come as a surprise because of the functions and the central role played by vegetation in the environment-economy linkages. As a matter of fact, after water, perhaps the most critical environment resource in the arid zone of Nigeria is vegetation cover of forests and related land cover types – woodland, shrublands, degraded forests and forest. These important terrestrial ecosystems serve as a series of vital environmental services, without which the functioning of the biosphere would be endangered.

Woodlands and forests regulate water regimes by intercepting rainfall and regulating their flow. Trees are also vital to the maintenance of soil quality, providing organic matter through leaf fall, limiting soil erosion through the binding effects of root systems and protecting soil from the direct impact of rainfall. Trees and forests play a part in modulating climates and are the lungs of the planet. But most importantly, trees and forest resources are also of major economic importance for the people of this region. They form the basis of a range of local industries and employment as well as economic sustenance for the people, through the provision of important domestic and commercial produce such as firewood, poles, fodder for livestock, saps and fruits for food and medicine. In the present circumstance where communities in the arid and semi-arid areas of northern Nigeria live and survive under the threat of desertification, improving the vegetation cover through massive reforestation/afforestation can safeguard and improve conditions for agricultural production in the endangered area, and promote self-sufficiency in the production and consumption of traditional domestic forestry produce among the rural people, thereby improving their economic and social wellbeing in a sustainable way, in addition to checking the advance of desertification unto the land area, farmlands and homesteads.

Summary and Conclusion

Foreign Aid and sustainable development as general definitions do not provide a systematic framework for empirical estimations, policy design and policy evaluation. This study is an attempt to make these definitions operational and capable of providing empirical estimates which are based on the structure of the economy, the nature of policy intervention and can be associated with concepts of current changes in social welfare and current productive base sustainability. Thus, important fundamentals such as the production function, household consumption and earnings, the rate of technical change, environmental damage from desertification and assets’ rate of growth, play a key role in the measurement of CSW areas where desertification control and natural resource sustainability programmes are implemented.

The models developed and tested in this research work are relevant to the democratic experience in Nigeria and its sustainability in two major ways. First, it directly relates to public policy formulation, implementation and evaluation of its effectiveness especially in a new political dispensation whose superiority and sustenance are adjudged by the
deliverance of economic and social dividends through improved living standards and economic prosperity. Second, such models cannot only be extended by including transition equations and human capital or by introducing certainty, and used to evaluate similar programmes or desertification control strategies in the semi-arid or arid zone.

On the whole, it can be said that the study integrated social welfare changes with sustainable development issues in one set of impact evaluation techniques to provide standard alternative models that can be used either singly or simultaneously to evaluate welfare outcomes of projects, interventions or public policy implemented in a democratic setting, especially in the area of environmental degradation control.

References


