# STATED PREFERENCE METHOD IN ENVIRONMENTAL VALUATION: THEORETICAL AND METHODOLOGICAL FRAMEWORK OF THE DISCRETE CHOICE EXPERIMENT

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## Abstract
The management of forest has been confirmed to be best achieved when the fringe communities are allowed to participate in such management plans. However, enlisting people's interest in forest management is largely based on their perception of substantial benefits in exchange. These benefits also known as values are not always marketable or tangible goods and determining such preferences are achieved through the non-valuation methods. Non-market valuation methods can be broadly classified into two categories- Revealed and Stated preference methods. While the revealed preference (RP) method makes use of individuals' behaviour in actual market to infer the value of an environmental good or service, the stated preference method (SP) involves the use of surveys or interviews to ask people directly how much they are willing to give to have a specified environmental quality improvement over a given period. This paper reviews the theoretical and methodological issues in the use of the discrete choice experiment – a stated preference method of valuation. The discrete choice experiment allows for variation in the levels of attributes in a management plan. This study recommends the use of the discrete choice experiment in the determination of values and benefits that can attract the forest communities in the cultivation, preservation and management of forest particularly in the Sudano Sahelian region of Nigeria.

**Keywords:** Forest, Indirect Valuation, Stated preference, Discrete choice experiment, Management.

## Introduction
The Sahel is characteristically noted for dryness. The Sudano Sahelian is one of the three agro-climatic zones that make up the Sahel. The zone roughly covers the Sudano-Sahelian, Sudanese and Sudano-Guinean region, with a shrub and tree savannah vegetation and a single rainy season which brings between 500 and 1 200 mm of rainfall per year. The other two are the pastoral region with less than 200 mm of rainfall and a precarious agricultural region with dry savannah type of natural vegetation having a rainfall of 400 mm in a year. However the Sudano Sahelian region is the only of three that has wooded area. This wooded area is fast depleting mainly due to human activities

(Flandez, 1995). Attempt by the countries involved and international economic assistance agencies through reforestation, dam construction, well sinking and promotion of agroforestry have not yielded the desired result due to technical issues that relates to inappropriateness of exotic species for the areas, the lack of agricultural development infrastructure and training for the farmers. The other factor that is most pronounced is the rejection of these activities by rural people. These experiences, which included failures, problems and a few successes, confirmed the need to: manage the natural forests, enlist people's participation and involvement in land management and foster multi-use production forestry. Enlisting people's interest in forest management is largely based on their perception of substantial benefits in exchange. These benefits also known as values are not always marketable or tangible goods and determining such preferences are achieved through the non-valuation methods to allow for their integration into management plans.

An environmental resource such as the forest has the *use or instrumental value* as well as the *non-use (or passive use) or intrinsic value* (Barbier et al 1997). Use values, which are most commonly known, refer to the capacity of a good or service to satisfy our needs or preferences. Use values can be further divided into direct value and indirect use value. According to Olarewaju (2011), the use-values can further be divided into three, viz., direct value which entails directly making use of a facility such as harvesting a resource for food or income purpose, indirect value accrues from the natural functioning of ecosystem such as storm protection provided by forest, and option value in which a resource is valued in terms of its potentials for future contribution. Non-use value also can be divided into two. These are the existence value which derives from the knowledge of the existence of the resource and the appreciation of its intrinsic value especially as a source of aesthetic pleasure due to moral, altruistic or other reasons which are clearly different from current or future use. The bequest value hinges on individuals contribution to the continuity of a resource so as to ensure that his or her future generations will be able to use it. Preferences attached to use values can be readily measured by market prices where market exist while the non-use ones are problematic either because these goods simply do not exist yet, or because they are public goods, for which exclusion is not possible (Alpizar, *et al*, 2001). Values for such are therefore achieved through the non-market valuation methods.

Non-market valuation methods can be broadly classified into two categories- Revealed and Stated preference methods. The Revealed preference (RP) method makes use of individuals' behaviour in actual to infer the value of an environmental good or service. The value of a resource is estimated from actual payments made for other goods or services associated with them. For example, the value of a game reserve (forest) is inferred by the cost tourists incur in getting to the place. This method is also referred to as indirect or surrogate market method. Examples of RP approaches include Travel Cost

Method (TCM), Hedonic Pricing Method (HPM), Cost (or Expenditure) Method. The chief advantage of this type of valuation method is that payment has actually been made for the said goods or services that the non-market resource is being bundled along with. Major disadvantages associated with these approaches are that valuation is conditioned on current and previous levels of the non-market good and the impossibility of measuring non-use values e.g. altruistic or bequest values. These limitations have led to the increased interest in the stated preference method. The Stated Preference Method (SP) involves the use of surveys or interviews to ask people directly how much they are willing to give to have a specified environmental quality improvement over a given period. Stated preference method is used to value environmental resource by directly asking for respondent's value for such resource through survey techniques, hence the alternative name of 'direct approach'. Stated Preference models include contingent valuation method (CVM), conjoint analysis, and discrete choice experiment. This paper reviews the theoretical and methodological issues in the use of the discrete choice experiment.

The Contingent Valuation method is the most popular method of valuing environmental resources or the desired change in a resource, it is however associated with strengths and weaknesses. The strengths of Contingent Valuation are its basis in economic utility theory and ability to produce reliable estimates for both the use and non-use values and consequently its successful use in a variety of situations. Its major weakness is the difficulty in validating non- use value estimates. The method is also greatly limited in that it cannot be employed in situations where different values (WTP) associated with different levels of improvement is required. This limitation is circumvented by the discrete choice experiment (DCE).

The DCE is a method based on the idea that any alternative or good can be described in terms of attributes or characteristics and levels these can take. Therefore in a DCE, respondents are presented with a series of choice sets comprising of at least two alternatives and are asked to choose which alternative they prefer. An alternative is a combination of several alternatives where each attribute is assigned a value usually called level. These alternatives are described in a questionnaire format that details the attributes considered, the change in quantity and quality levels that may occur, alongside with the payment the respondents would incur as a result of the choice (Farrerasa and Mavsarb, 2012). Relative to the contingent valuation method (CVM), the DCE is more advantageous as it is easier to estimate the value of different attributes that makes up a good, provides the opportunity to identify marginal values of attributes that may be difficult to identify using revealed preference data because of co-linearity or lack of variation, DCE model also allows for inclusion of socioeconomic variables which can be used in the measurement of benefit transfer, it also avoids some biases of the Contingent valuation (CV) such as "yea-saying" (i.e. *warm glow effect* or *compliance bias*), protest

ids, strategic behaviour and ethical protesting problem (Ready, Buzby and Hu 1996; Brown et al. 1995), since respondents are not forced to make a choice but allowed to esort to the status quo. There are thus repeated opportunities for them to express their nvironmental preferences within a CE design. Adamowicz *et al.* (1998) has speculated hat DCE may be a good way around the embedding problem encountered in CVM since ests of scope are essentially built in to the CE. The repeated sampling approach of CE allows for internal consistency tests such that models can be fitted on sub-sets of the data.

## Methodology

The DCE in its simplest design is a set of alternatives[1] which describes a bundle of different attributes and cost. The cost is systemically varied in such a way that the changes in probability of choosing an alternative as its cost changes can be estimated. As earlier mentioned other matching variables apart from cost can be used. The single binary and multinomial choice design is achievable in DCE as in CV. In the single binary choice design the respondent is saddled with the responsibility of making tradeoff between different levels of attribute inherent in just two alternatives while in the multinomial design, he is to do same in a situation with three or more alternatives. The successful conduct of credible DCE just like CV involves some steps that are integrating with feedback. As in CV all biases therein are also applicable here if the following steps involved with the design of DCE are not carefully undertaken. They are: definition of attributes and levels as well as experimental design. Others which are important in all surveys are questionnaire development and choice of sample and sampling strategy (Alpizar *et al* 2001). It is pertinent that the research instrument that is the questionnaire be carefully designed to capture the objective(s) of the study in the simplest way possible so that respondents will find it un-ambiguous to answer. Also sampling procedure must be scientific and representative of the population of interest so as to allow extrapolation of the findings from the sample on the larger population.

Correct identification alongside presentation of attributes with levels and experimental design are the two most important and critical elements of a DCE study (Carson and Louviere, 2010). The DCE design is done in a way that will facilitate the estimation of the marginal value of changing attributes. Therefore a proper definition of different attributes, the associated levels as well as the cost implication of such is very essential. The contextual local understanding of this is very paramount. Thus focus group discussions that will allow for harvest of credible minimum and maximum attribute levels, interaction effect between the attributes as well as the affordable minimum and maximum cost are paramount before defining the attributes and their levels. Also when

[1] Alternatives are different choice sets which are different with respect to the levels of attributes. Attribute refers to the desirable quality of the good in question while the levels depict the degree or amount of the different attribute that are inherent in each choice set.

needed, inter disciplinary understanding of associated effect in this combination should be sorted so as to allow for credibility and reality in design. Other sources of information useful here are past studies, secondary data and evidences regarding impact of a phenomenon (Bridges *et al,* 2008).

Experimental design is the process of systematically manipulating the attribute (factor) levels to create the alternatives. Experimental design is concerned with how to create the choice sets in an efficient way, i.e. combine attribute levels into alternatives and choice sets (Alpizar *et al*, 2001). A factorial design is obtained when more than one attribute is varied simultaneously in a way that all possible combinations of the attribute levels are presented. The design must be done in such a way that will allow for the estimation of model parameters with the highest precision possible. In other words, the experimental design affects model forms as well as its statistical efficiency. Orthogonality[2], balance and efficiency are important properties to watch out for in an experimental design (Bridges, 2008).

Factorial designs are of two main types, namely; (1) Full factorial design. This is a complete set of all possible combinations of the attribute levels that characterize the different alternatives. In real life situation, a full factorial design is not plausible this is because it is too large and not tractable in a choice experiment. (2) Fractional factorial design; like the name suggest, a fractional factorial design does not contain all the possible combinations of the attribute levels. Fractional factorial designs are orthogonal profiles constructed from a subset of the full factorial. These designs guarantee that all attribute main effects are independently estimable and they allow for the independent estimation of some attribute interactions if such interactions were previously defined (Bridges, 2008). The most common fraction used in applications is based on the principle of orthogonality (zero correlation between attributes). This is known as orthogonal main effects plan –OMEP (Carson and Louviere, 2010). Other principles that allows for good statistical efficiency in linear probabilistic models are level balance[3] and minimal overlap.[4]

The non-linear probabilistic models have an additional requirement of utility balance[5] for their fractional factorial design (Alpizar, *et al,* 2001). This last property is difficult to satisfy because it requires prior knowledge about the true distribution of the parameters.

[2] A design is orthogonal if all attribute columns are statistically independent of each (uncorrelated). It is balanced when each level of an attribute is presented the same number of times across the choice set while an orthogonal design and balanced design is efficient same number of times across the choice set while an orthogonal design and balanced design is efficient.

[3] Level balance requires that the levels of each attribute occur with equal frequency in the design.

[4] A design has minimal overlap when an attribute level does not repeat itself in a choice set.

[5] Utility balance requires that the utility of each alternative within a choice set is equal.

These methods of factorial designs are usually referred to as more efficient in that they allow for higher precision in model estimates. These methods after meeting the orthogonality condition move on to check the statistical efficiency of the design. The most widely used measure is called the *D-error*, which takes the determinant of the AVC matrix. Other measures exist, such as the *A*-error, which takes the trace (sum of the diagonal elements) of the AVC matrix, however, in contrast to the *D*-error, the *A*-error is sensitive to scaling of the parameters and attributes. Apart from complexity associated with the design of these methods it is no clear whether the improvement in statistical efficiency outweighs the trouble involved in their designs.

There are five major elicitation formats that can be used in DCE (Carson and Louviere, 2010). These formats give rise to the different variant of DCE that are found in literature. The techniques are: (1) Binary choice format. This technique follows exactly the same procedure of the close ended dichotomous choice in CV. Therefore, all the variant of the dichotomous choice as observed in CV holds here too. (2) Multinomial choice format; the only difference between this and the binary choice format are in terms of the number of attributes presented to the respondents. While the binary choice has two alternative choices in a set, the multinomial format has three or more alternatives. (3) Complete Ranking Exercise; this requires the respondents to completely rank all the alternatives presented to them. There are two major issues with this format: (i) respondent task difficulty grows as the number of alternatives in a choice set (k) increases; and if the IIA property is violated, the effective number of parameters that must be estimated can become large because one needs to condition on other alternatives and (ii) the implied Single Binary Choice can have different variances. (4) Best-Worst choice as the name implies, requires the respondent to pick their best and worst choice in all the alternatives presented to them. The method is less burdensome than the complete ranking exercise. (5) Alternative sub setting: under this format, respondents are asked to divide the alternatives into two or more groups based on the criteria related to the preferences.

**Empirical Application of Discrete Choice Experiment**

The discrete choice experiment was used to investigate farmers' preferences for various property-rights attributes of a forest land contract (Qin et al, 2007). In the study, the need to decentralize the management of Chinese forestry led to the investigation of forest management attributes that would enlist farmer's maximum participation. The five attributes that were included in the survey are annual payment, tenure length, risk of termination of a contract, harvest quota, and first right to renew a contract. The payment was designed as an annual payment for a forestland contract. The annual payment had five levels of 30, 60, 75, 90,120 Yuan[6]. The tenure length was a multiple of 25 years leading to three levels of 25, 50, and 75 years. The risk of termination of a contract was

[6] US$ 1 = Yuan 7.42 at the time of the survey.

another attribute used to assess how much farmers value a reduction in the risk of premature termination of a contract. Two attribute levels are given: 5-percent probability that the contract will be prematurely terminated, and zero probability that the contract will be prematurely terminated. Harvest quota is a forestry policy imposed by the central government. It requires that a farmer apply for a quota in order to gain the right to harvest timber. Timber harvesting without a quota is defined as illegal logging. Farmers might have to reapply for a quota the following year if they did not obtain one the first year. To assess the impact of quota policy on forest farmers, a policy attribute that described the rules and procedures of how the quota policy will be implemented was included. It was constructed by varying how long the farmers would have to wait for a quota in case their application was rejected the first year. In this scenario, there was only a 50-percent chance that they would get a quota the first year. Levels one, two, and four years of waiting for the quota if an applicant did not get the quota the first year were used. The first right to renew the contract provides the farmer the opportunity of getting the same plot in the future and thereby preserve the huge investment that might have been made on the forest land. The two levels of the attribute used were: there is a first right to renew the contract, and there is not a first right to renew the contract.

The relative importance of these policy attributes were revealed by the mean willingness to pay of the attributes. Overall, the results showed that forest farmers valued the current tenure security and future tenure security as the most important attributes as farmers are willing to pay more for a 50-year contract than for a 25-year contract. They prefer that the contract be not prone to termination either in the present or future. Owing to the high uncertainty created in the forest sector by historical policies. In addition, farmers are concerned with harvest regulations. The farmers have a clear and strong preference for a contract that includes an extended waiting time for a quota of only one year.

**Conclusion**

The need to develop and manage wooded area in the Sudano Sahelian region necessitated the involvement of the people who often are farmers. It is however increasingly evident that enlisting people's participation and involvement in forest management is largely based on their perception of substantial benefits in exchange. These benefits are best determined in the discrete choice experiment which allows for variation in the levels of attributes in a management plan. It is against this backdrop that this study concludes that the needed attributes that will elicit maximum participation of people in sustainable management plans for the forest in the nation can be achieved through the implementation of the outcomes of a discrete choice experiment. It is to this end that this study recommends the use of the discrete choice experiment in the determination of values and benefits that can attract the forest communities in the cultivation preservation and management of forest particularly in the Sudano Sahelian region of Nigeria.

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