www.qjoest.com

QUANTUM JOURNAL OF ENGINEERING, SCIENCE AND TECHNOLOGY

eISSN: 2716-6341

Dr Paran Gani - Chief Editor
chief@qjoest.com

QUANTUM ACADEMIC PUBLISHER
3, Seri Sutera A/1, Taman Seri Botani,
31350 Ipoh, Perak,
Malaysia.
admin@qjoest.com

Current Issue : **Vol. 2 No. 3 (2021)**
2021-06-01

Table of contents

Indexing : Malaysian Citation Index (MyCite), Google Scholar

http://qjoest.com/index.php/qjoest

Current Issue : Vol. 2 No. 3 (2021) : QJOEST *Published* : 2021-06-01

Editorial Team

About the Journal

Quantum Journal of Engineering, Science and Technology (QJOEST) is an online electronic publication, double-blind peer reviewed and open-access journal. Researchers from all countries are invited to publish engineering, computer sciences, architecture and design, agricultural sciences, biological sciences, chemistry, physics, earth sciences, environmental science, life sciences, mathematics and statistics, sport sciences, or multidisciplinary science research of international interest on its pages.

Budapest Open Access Initiative :

This journal provides instant access to its content on the principle that free availability of research journals to the public contributes to the global exchange of knowledge.

Frequency : 4 issue per year; March, June, September and December

Language: English

Level of publication : International

The Journal publishes theoretical papers as well as application-oriented contributions and practical case studies. There is no bias with regard to taxon or geographical area. The journal is published in yearly volumes of four (4) (but at least two (2) issues in one year) issues. The journal will have a limited number of printed copies (mainly for libraries), articles and their appendices (if any) will be available on our website for free download.

Editorial Desk

We glad to announce that the Quantum Journal of Engineering, Science and Technology (QJOEST) were developed with the aim to assist researchers to grow at all levels - research scholars, scientists, professors, post-docs, students, who are seeking publishing opportunities for their research work. The journals aim to a broad ranging open access journal, fast and efficient online submission, rapid publication with high visibility, expert peer-reviewed research that will serve to create a innovative information to the human dimension to disseminate in the society and has an international repute.

We are Registered. Only reputed Indexed cite in **QJOEST**. The journal is equally interested in Engineering, Computer Sciences, Architecture and Design, Agricultural Sciences, Biological Sciences, Chemistry, Physics, Earth Sciences, Environmental Science, Life Sciences, Mathematics and Statistics, as well as Sport Sciences.

The editors of our journal have long-standing and distinguished careers in their respective fields. The editorial board members and external reviewers of our journal are committed in providing unbiased, rapid evaluations of the submitted manuscripts to shorten the duration between the submission and final publication. Therefore, the authors will certainly have a pleasant and intellectual experience working with our editors and reviewers. Finally, positive opinion from my perspective on the need of open platforms worldwide for sharing global thoughts. So, I invite your kind self to look into this matter seriously.

Aims and Scope

Quantum Journal of Engineering, Science and Technology (QJOEST) publishes research in several areas of engineering, computer sciences, architecture and design, agricultural sciences, biological sciences, chemistry, physics, earth sciences, environmental science, life sciences, mathematics and statistics, as well as sport sciences.

Engineering : chemical and bioprocess, civil and building, computer, electronical and electronic, industrial, mechanical and manufacturing, biomedical, control engineering and robotics, energy and power, micro and nanotechnology, environmental, etc.

Computer Science : artificial intelligence, computer networks and communications. computer vision and pattern recognition, computer graphics and multimedia, software system, data management and data mining, theory and algorithms, mobile computing for e-commerce, cryptography and foundation of computer security, quality of services and communication protocol, hybrin computational, emerging areas, etc.

Architecture and Design : architectutal landscape design, design management and design coordination, facilities management, urban and regional planning and studies, building design and construction, quantity surveys, real estates studies and management, philosophy of architecture, architectural design and practices, etc.

Agricultural Sciences : crop and vegetable sciences, physiology and morphology, fruit science and viticulture, aquaculture, zootechnics, soil management, horticulture, poultry science, dairy science, entomology, fish and fisheries, phytomedicine, agricultural engineering, veterinary, virology, viticulture, weed biology, food technology and biochemistry, agricultural economics, etc.

Biological Sciences : cell biology, developmental biology, structural biology, microbiology, molecular biology and genetics, biochemistry, biotechnology, biodiversity, entomology, toxicology, ecology, freshwater biology, marine biology, genetics and epidemiology, environmental biology, plant biology, ethno-medicines and bioinformatics, etc.

Chemistry : organic and inorganic, forensic, pure and applied chemistry, neurochemistry, marine chemistry, geochemitsry, electrochemistry, clinical chemistry, analytical chemistry, agricultural and food chemistry, organometallic chemistry, histochemistry and cytochemistry, cereal chemistry, cellular biochemistry, etc.

Physics: atomic physic, molecular and optical physics, solid state physics, applied and metal physics, condensed matter, energy, phtonics, nuclear and particles physics, etc.

Earth Sciences : geology, petrology, dynamics of the lithosphere, mineralogy and hydrocarbons, ore deposit geology, tectonics and volcanology, paleontology, stratigraphy, global dynamics of physicochemical cycles, sedimentology,evolution of life, geochemistry, geophysics, surface processes, etc.

Environmental Science : atmospheric environment, aquatic environment, biomonitoring and biomarkers, emerging contaminants, environmental analysis and methods, environmental biology, environmental chemistry, environmental catalysis and nanomaterials, environmental health and toxicology, environmental microbiology, environmental nanotechnology, environmental remediation and management, terrestrial environment, etc.

Life Sciences : biology, genetics, biological anthropology, botany, medical sciences, veterinary sciences, biochemical genetics, biometry, clinical genetics, cytogenetics, genetic epidemiology, genetic testing, evolution and population genetics, immunogenetics and molecular genetics, etc.

Mathematics and Statistics: mathematical and numerical analysis, algebra, geometry, topology, mathematical physics, discrete mathematics, operations research, mathematical programming, mathematical logic, mathematical control, dynamical systems, decision sciences, probability theory, statistical mechanics, applied statistics, mathematical finance, actuarial science & risk management, applied econometrics,

bioinformatics, applications to the modeling of complex phenomena arising in physics, chemistry, biology, social, economics and behavioral sciences, etc.

Sport Sciences : Sport and exercise physiology, excecise and brain health, physical education, sport and exercise biomechemistry and nutrion, biomechanics and motor behavious, physical activity epidemiology, public health promotion, sport and exercise medicine, injury prevention and clinical rehabilitation, traditional chines sports exercise and health, etc.

Publication Ethics & Malpractice State

Quantum Journal of Engineering, Science and Technology (QJOEST) is double-blind peer-reviewed online international journal. The PEMS larifies ethical behaviour of all parties involved in the act of publishing an article in this journal, including the Editor, the Reviewers, the Authors and the publisher (Quantum Academic Publisher). This statement prepared based on COPE's Best Practice Guidelines by Elsevier for Journal Editors.

The publication of an article in QJOEST is an essential building block in the development of a coherent and respected network of knowledge. It is a direct reflection of the quality of the work of the authors and the institutions that support them. Peer-reviewed articles support and embody the scientific method. It is therefore important to agree upon standards of expected ethical behavior for all parties involved in the act of publishing: the author, the journal editor, the peer reviewer, the publisher and the society.

Quantum Academic Publisher as the publisher of QJOEST takes its duties of guardianship over all stages of publishing extremely seriously and we recognize our ethical and other responsibilities. We are committed to ensuring that advertising, reprint or other commercial revenue has no impact or influence on editorial decisions. In addition, QJOEST Editorial Board will assist in communications with other journals and/or publishers where this is useful and necessary.

Duties of Editor

Fair play

Editor of QJOEST evaluates submitted manuscripts exclusively on the basis of their academic merit (quality, originality, research validity, clarity) as well as its relevancy to the journal's aim and scope, regardless of the authors' race, gender, sexual orientation, ethnic origin, citizenship, religious belief, political philosophy or institutional affiliation.

Editorial independence

Decisions to edit and publish are not determined by the policies of governments or any other agencies outside of the journal itself. Editor has full authority over the entire editorial content of the journal and the timing of publication of that content.

Confidentiality

The editor and any editorial staff must not disclose any information about a submitted manuscript to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher, as appropriate.

Disclosure and conflicts of interest

Unpublished materials disclosed in a submitted manuscript must not be used in an editor's own research without the express written consent of the author. Privileged information or ideas obtained by editors as a result of handling the manuscript will be kept confidential and not used for their personal advantage.

Publication decisions

The editors ensure that all submitted manuscripts being considered for publication undergo peer-review by at least two reviewers who are expert in the field. The Editor is responsible for deciding which of the articles submitted to the journal should be published. The validation and quality of the work in question and its importance to researchers and readers must always drive such decisions. The editors may be guided by the policies of the journal's editorial board and constrained by such legal requirements as shall then be in force regarding libel, copyright infringement and plagiarism.

Duties of Reviewers

Contribution to Editorial Decisions

Peer review assists the editor in making editorial decisions and through the editorial communications with the author also assist the author in improving the paper and revised it based on the given comments .

Reviewers are welcome to recommend a particular course of action, but they should bear in mind that the other reviewers of a particular paper may have different technical expertise and/or views, and the Journal's editors may have to make a decision based on conflicting advice. The most useful reports, therefore, provide the editors with the information on which decision should be based. Setting out the arguments for and against publication is often more helpful to the editors than a direct recommendation one way or the other.

Promptness

Abstract of the submitted papers' must be send to the selected Reviewers while inviting them to Review. This is to inform the Reviewers on the area of the research and the content of the submitted paper. Reviewers should be prompt with their reviews. Any selected Reviewer who feels unqualified to review the research reported in a manuscript or knows that its prompt review will be impossible should notify the editor and excuse himself/herself from the review process. The initial given time to the Reviewers for their ***review is 3 to 4 weeks***. This can be extended based on the Reviewers' requirement due to Editor's decision.

Confidentiality

QJOEST follows a double-blind peer-review process, whereby authors do not know reviewers and vice versa. Peer review is fundamental to the scientific publication process and the dissemination of sound science.

The manuscript must be send to the Reviewers in anonymous status (without name or any sign of the Author's identity). Any manuscripts received for review must be treated as confidential documents. They must not be shown to or discussed with others except as authorized by the editor. The submitted manuscript is a privileged communication; reviewers must treat it as confidential. It should not be retained or copied. Also, reviewers must not share the manuscript with any colleagues without the explicit permission of the Executive Editor.

Standards of Objectivity

Reviews should be conducted objectively. Personal criticism of the author is inappropriate. Referees should express their views clearly with supporting arguments. Reviewers will be asked to fill in the QJOEST ***Evaluation Form*** to give their complete comments on the paper for its originality, quality, and research validity. Moreover, reviewers required stating in their review report using "Manuscript Evaluation Form" if the article fulfils the criteria below which are based on QJOEST archiving policy on Review criteria:

i)Theoretical/Conceptual Soundness: The article should make reference to previous research or theories in the reported study. The theory, if any, behind the research should be logically applied and thoroughly justified. It should correctly interpret and appropriately synthesize relevant prior research. And finally, are the hypotheses, if any, derived from the theory to be tested, clearly stated, and are they actually tested.

ii) Methodological Soundness: Qualitative or quantitative empirical studies reported on should have a systematic and coherent method of study. The article should include a clear account of the study's project background, objectives, subjects, methodology (methods should be the most recent, if not, the relevancy/ appropriateness should be questioned), data analysis, and conclusions. The reviewer should comment accurately and constructively upon the quality of the author's interpretation of the data, including acknowledgment of its limitations. Are the appropriate analytical techniques applied to the data collected, and the results correctly interpreted? Are the conclusions and/or implications correctly derived from the research findings?

iii) Contribution: Does the article advance knowledge in/of the discipline? Are the findings and their implications noteworthy? Is the paper of interest to many people in the field or at least one segment of it (e.g., academics, practitioners, public policy makers, consumers etc.)? The article should also discuss the implications of the reported project, and/or report on any conclusions or products which may be of relevance to future research, development or practice.

iv) Communication: The article should be of an acceptable quality in terms of linguistic accuracy, clarity and coherence. Is the article clearly written and the major points easily grasped? Is the article laid out in a logical format? Data presentation/ tabulation: Any irrelevant tables/ figures should be checked. The reviewer should comment on major strengths and weaknesses of the manuscript as a written communication, independent of the design, methodology, results, and interpretation of the study.

Apart from above criteria , reviewers are also requested to complete rating section of the Manuscript Evaluation Form by selecting appropriate rate in terms of ; Clarity of formal structure, Suitability of title to

the contents, Abstract sufficiently informative, Originality/Novelty, Methodology sufficiently described, Methodology appropriate to study, Results / Conclusions supported by data analysis, Clarity in the presentation of findings, Scientific soundness, Bibliography adequate and relevant.
Moreover, reviewers are asked for their detailed comments to the Author. The reviewer's comments should be constructive, professional and be sufficiently specific in order to help the author improve the article when revising it for publication or re-submission to QJOEST journal (in the event that it is rejected by QJOEST). If reviewers suspect misconduct, they should notify the Editor in confidence, and should not share their concerns with other parties unless officially notified by the journal that they may do so. Reviewers also give their recommendation on decision to the manuscript's publication to the Editor.

Review Quality

QJOEST selects its reviewers as experts in the scientific topics addressed in the articles they review. They provide written assessment of the strengths and weaknesses of written research with the aims to improve the reporting of research and identifying the most appropriate and highest quality material for the journal. Individuals who do not have such expertise will not be selected as reviewers.
Ratings of review quality and other performance characteristics is periodically assessed by the Executive Editor to assure optimal journal performance. These ratings also contribute to decisions on reappointment to the QJOEST Editorial Board and to ongoing review requests. Individual performance data on Reviewers are available to the Editors but otherwise kept confidential. Reviews are expected to be professional, honest, courteous, prompt, and constructive.

Publication Ethics & Acknowledgement of Sources

Plagiarism is scientific misconduct and is an unacceptable violation of publication ethics. It should be dealt with promptly. The journal's editors and reviewers are the primary means of detecting plagiarism in manuscripts submitted to QJOEST. Reviewers should identify relevant published work that has not been cited by the authors. Any statement that an observation, derivation, or argument had been previously reported should be accompanied by the relevant citation. If reviewers suspect misconduct, they should notify the Editor in confidence, and should not share their concerns with other parties unless officially notified by the journal that they may do so.

Disclosure and Conflict of Interest

Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage. Reviewers should not consider manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors, companies, or institutions connected to the papers.

Duties of Authors

Reporting standards

Authors of original research should present an accurate account of the work performed as well as the objective/s discussion of its significance. Underlying data should be represented accurately in the paper. A paper should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behaviour and are unacceptable.

Authorship of the Paper

Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the reported study. All those who have made significant contributions should be listed as co-authors. Where there are others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors. The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper, and that all co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Originality and plagiarism

Authors should ensure that they have written and submit only entirely original works, and if they have used the work and/or words of others, that this has been appropriately cited. Publications that have been influential in determining the nature of the work reported in the manuscript should also be cited. Plagiarism takes many forms, from "passing off" another's paper as the author's own, to copying or paraphrasing substantial parts of another's paper (without attribution), to claiming results from research conducted by others. Plagiarism in all its forms constitutes unethical publishing behaviour and is unacceptable. The

accepted **similarity** of the submitted articles for publication consideration in QJOEST is **less than 10%**. The corresponding Authors should clearly confirm and acknowledge the originality of their submitted manuscript in the cover letter to the Editor while they are submitting a paper.

Data Access and Retention

If necessary, authors will be asked to provide the raw data in connection with a paper for editorial review, and should be prepared to provide public access to such data. Also, if practicable, and should in any event be prepared to retain such data for a reasonable time after publication.

Peer review

Authors are obliged to participate in the peer review process and cooperate fully by responding promptly to editors' requests for raw data, clarifications, and proof of ethics approval, patient consents and copyright permissions. In the case of a first decision of "revisions necessary", authors should respond to the reviewers' comments systematically, point by point, and in a timely manner, revising and re-submitting their manuscript to the journal by the deadline given.

Multiple, Redundant or Concurrent Publication

An author should not in general publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behaviour and is unacceptable. Authors must clearly acknowledge in the cover letter that the paper was not published before and is not under revision for any journal's publication.

Acknowledgement of Sources

Proper acknowledgment of the work of others must always be given through the *Cover Letter*. Authors should cite publications that have been influential in determining the nature of the reported work.

Disclosure and Conflicts of Interest

All authors should acknowledge in their manuscript any financial or other substantive conflict of interest that might be construed to influence the results or interpretation of their manuscript. All sources of financial support for the project should be disclosed.

Fundamental errors in published works

When an author discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the journal editor and cooperate with the editor to retract or correct the paper.

Duties of Publisher

Handling of unethical publishing behaviour

In case of alleged or proven scientific misconduct, fraudulent publication or plagiarism, the publisher, in close collaboration with the editors, will take all appropriate measures to clarify the situation and to amend the article in question. This includes the prompt publication of an erratum, clarification or, in the most severe case, the retraction of the affected work. The publisher, together with the editors, shall take reasonable steps to identify and prevent the publication of papers where research misconduct has occurred, and under no circumstances encourage such misconduct or knowingly allow such misconduct to take place.

Access to journal content

The publisher is committed to the permanent availability and preservation of scholarly research and ensures accessibility by partnering with organizations and maintaining our own digital archive. *Quantum Academic Publisher* is committed to the permanent availability and preservation of scholarly research and to ensure accessibility by converting and upgrading digital file formats to comply with new technology standards

Submission Preparation Checklist and Author Guidelines

1- Submission Preparation

As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

- The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor).
- The submission file is in OpenOffice, Microsoft Word, or RTF document file format.
- Where available, URLs for the references have been provided.
- The text is single-spaced; uses a 12-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
- The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.
- The author(s) agree with the Open Access Policy, as well as Article Processing Charge (APC).

2- Author Guidelines

Please observe the following points in preparing manuscripts. Papers not conforming closely to these instructions may be returned to their authors for appropriate revision or may be delayed in the review process.

Readability: Manuscripts should be written in clear, concise and grammatically correct English (British or American English throughout). The editors can not undertake wholesale revisions of poorly written papers. Every paper must be free of unnecessary jargon and clearly readable by any specialist of applied ecology or environmental research. The abstract should be written in an explanatory style that will be comprehensible also to readers who are not experts in the subject matter.

General format: The complete paper has to be written preferably in Rich Text Format or in a MS-Word 2003 compatible file, with a maximum of 30 pages including text, figures and tables. Page size: A4, margins: 3 cm on each side, line spacing: single, font type: Times New Roman. Please leave headers and footers unchanged, since it should be filled by the editors.

The order of the material should be as follows: Title, Author(s), Abstract, Keywords, Main text (Introduction, Review of literature, Definitions (if any), Materials and methods, Results, Discussion), Acknowledgements (if any), References, Appendix (if any). This structure of the main text is not obligatory, but the paper must be logically presented. Footnotes should be avoided. The main text must be written with font size 12, justify, first indent 0.5 cm. Within each main section, two levels of subheadings are available and the titles must be with bold, bold and italic, italic respectively.

The manuscript should contain tho whole text, figures, tables and explanations according to the followings (we suggest using the sample of Microsoft Words file):

Title: Should be brief and informative. The title should reflect the most important aspects of the article, in a preferably concise form of not more than 100 characters and spaces. Font size 14, capital letters, center alignment. Style: Title of Paper

By-line: Names (size 11, small capital, Style: Names of Authors) of the authors. No inclusion of scientific titles is necessary. In case of two or more authors, place their names in the same row, separate them with a hyphen (not with a comma) and please indicate the corresponding author with * in superscript. Authors from different institutions must be labelled with numbers in superscript after the names. Addresses of the authors, phone and fax number and e-mail should be also given (size 11, italic, Style: Addresses of Authors).

Abstract: Required for all manuscripts in which the problem, the principal results and conclusions are summarised. The abstract must be self-explanatory, preferably typed in one paragraph and limited to max. 200 words. It should not contain formulas, references or abbreviations. Size 10, only the word Abstract. bold, justify. (Style: Text of Abstract). The Acknowledgements (if any) should also be written in this format.

Keywords: Keywords should not exceed five, not including items appearing in the title. The keywords should be supplied indicating the scope of the paper. Size 10, italic, justify, only the word Keywords must be bold.

Introduction: The introduction must clearly state the problem, the reason for doing the work, the hypotheses or theoretical predictions under consideration and the essential background. It should not contain equations or mathematical notation. Section numbering and headings begin here.

Review of Literature: A brief survey of the relevant literature, so that a non-specialist reader could understand the significance of the presented results.
Materials and Methods: Provide sufficient details to permit repetition of the experimental work. The technical description of methods should be given when such methods are new.
Results: Results should be presented concisely. Only in exceptional cases will it be permissible to present the same set of results in both table and figure. The results section should not be used for discussion.
Discussion: Point out the significance of the results, and place the results in the context of other work and theoretical background.
Conclusion: Conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. Authors are strongly encouraged not to call out multiple figures or tables in the conclusion - these should be referenced in the body of the paper.
Acknowledgements: (if any) These should be placed in a separate paragraph at the end of the text, immediately before the list of references. It may include funding information too. Font size 10, the word Acknowledgements. is bold. Use Style: Text of Abstract.
References: In the text references should be cited in American Psychological Association (APA) style (Author, year). Alternatively, the author's surname may be integrated into the text, followed by the year of publication in parentheses. Cite only essential resources, avoid citing unpublished material. References to papers "in press" must mean that the article has been accepted for publication.
At the end of the paper list references alphabetically by the last name of the first author. Compulsory, list only those references that are cited in the text and prepare this list as an automatically numbered list.
The list should contain names and initials of all of the authors.
[1] Abdullah, J. (2012): City competitiveness and urban sprawl: their implications to socioeconomic and cultural life in Malaysian cities. – Procedia-Social and Behavioral Sciences 50: 20-29.
[2] Barnes, K. B., Morgan III, J. M., Roberge, M. C., Lowe, S. (2001): Sprawl Development. Its Patterns, Consequences and Measurement. A white paper. – Towson University, Maryland.
[3] Behera, D. M., Borate, S. N., Panda, S. N., Behera, P. R., Roy, P. S. (2012): Modelling and analyzing the watershed dynamics using Cellular Automata (CA)–Markov model–A geo-information based approach. – Journal of Earth System Science 121(4): 1011-1024.
[4] Podani, J. (1994): Multivariate Data Analysis in Ecology and Systematics. – SPB Publishing, The Hague.
[5] Thompson, J.N. (1984): Insect Diversity and the Trophic Structure of Communities. – In: Huffaker, C. B. (ed.) Ecological Entomology, Wiley-Interscience, New York.
[6] Tothmeresz, B. (1995): Comparison of different methods for diversity ordering. – Journal of Vegetation Science 6: 283–290.
Tables: Tables should be self-explanatory. They should be mentioned in the text, numbered consecutively (e.g. Table 1) and accompanied by title at the top (size 11, italic). For the title of Tables use: ***Table 1***. Table Titles; which style also contains the serial number of the given table (since it is a listing), so consecutive numbers of tables will be generated automatically. Or else, you need to number them manually.
Figures: All photographs, graphs and diagrams should be numbered consecutively (e.g. Figure 1) in the order in which they are referred in the text. Caption must appear below the figure (size 11, italic) and should be sufficiently detailed to enable to understand apart from the text. The style: ***Figure 1***. Figure Titles; should be used, which also contains the serial number of the given figure (since it is a listing), so consecutive numbers of figures will be generated automatically. Or else, you need to number them manually.
Explanation of lettering and symbols should be given also in the caption and only exceptionally in the figures. Figures should be of good quality and preferably in black and white. (Color figures will appear in the downloadable files, but all papers will be printed in black and white.
Figures should be designed to fit to the text area and must be embedded. In addition authors are requested to submit each figure also as an image file in one of the following formats: pcx, bmp, tif, wmf, jpg or eps.

STATISTICAL APPLICATION OF THE CONTINGENT EVALUATION FOR CONSERVATION OF AGRICULTURAL SOILS IN BENIN

DOSSA, A. B. K.[1*] – KOMBIENOU, P. D.[1]

[1] *Benin Center for Scientific Research and Innovation (CBRSI), University of Abomey-Calavi (UAC), Cotonou, Benin.*

**Corresponding author*
e-mail: dossa.alfred[at]yahoo.fr

(Received 06th March 2021; accepted 05th May 2021)

Abstract. Land degradation is an environmental problem that constitutes a serious threat and endangers food production and rural livelihoods. Thus, where water and wind erosion, reinforced by human activities, can have negative impacts on soils, there are methods to restore or maintain soil fertility in a context of financial constraints. (Dossa, 2016). The contingent evaluation method is the mathematical tool used to model the willingness to pay (CAP: WTP) of farm households to invest financially in soil conservation techniques in the commune of Kérou in the north-west and on the ADJA Plateau in the south-east of Benin. Its formalisation made it possible to calculate the average CAP E (CAP) on a sample by the following formula: $E(CAP)=m(\alpha/\sigma)/(\beta/\sigma)$. Thus, in estimating the average CAP using the probit model, the tobit model (Tobin, 1958) is tested by the two-step method of Heckman (1979) to control for selection bias in the sample of 385 farm households in Kérou and 267 on the ADJA Plateau. The results of the econometric regression give an average CAP of 1,260.92 FCFA/month/hectare for the adoption of SCTs (soil conservation techniques) in Kérou and 1,557 FCFA/month/hectare on the ADJA Plateau.
Keywords: *contingent evaluation, agricultural soil conservation, selection, probit*

Introduction

The mathematical application of models of monetary valuation of the environment is one form of response that the social sciences provide to the environmental problems with which society is increasingly confronted. These methods help to fill the gaps related to market and public policy failures. They also make it possible to penalize actions that result in negative externalities on the environment. In addition, the evaluation methods of natural assets include: the Displacement Cost Method (DCM), the Hedonistic Price Method (HPM) qualified as indirect methods and the Contingent Method of Evaluation (CME), qualified as a direct method. The "soil" being the main object of the "land", it is immediately considered as an asset or natural heritage. According to this nature, its value will therefore be estimated by the willingness to pay (WTP), based on the Contingent Evaluation Method (CEM). It uses, on the basis of surveys, the reconstitution of a contingent market to encourage households to reveal the value they place on their quality of life or natural resources, their improvement or the damage that has been caused to them.

Contingent evaluation seeks to bring out perfectly determined values buried within them (the individuals surveyed). The choice of MEC for financing agricultural soil conservation techniques is based on its frequency of use (70% compared to other economic evaluation methods), the credibility of its users (Reveret et al., 2008) and above all its scientific recognition through the report of the National Oceanic and Atmospheric Administration (NOAA) panel (Arrow et al., 1993). Its implementation is

based on surveys of a representative sample of the population concerned, during which respondents are presented with different scenarios to estimate the monetary value they place on agricultural land. The contingent evaluation method is the mathematical tool used to model the willingness to pay (WTP) of farm households to invest financially in soil conservation techniques in the commune of Kérou in the north-west of Benin and on the ADJA Plateau in the south-east of Benin.

Materials and Methods

Methods for determining WTP in term of price and consumer surplus

Individual preferences are revealed in the market and are expressed in terms of willingness to pay (CAP) and willingness to receive (CAR). Willingness to pay can be represented as follows (Eq. 1);

CAP = expense (Price) + consumer surplus (Eq. 1)

Within the framework of the survey in Kérou and on the ADJA Plateau, the agricultural household's willingness to pay (WTP) would be the expenditure it would be willing to make for the adoption of soil conservation techniques (SCT), and in return obtain an improvement in the quality (fertility) of its soil in order to increase the yields of its agricultural production. Author has (Eq. 2);

CAP = expense (SCT) + soil fertility (Eq. 2)

On the one hand, merchant goods represented by X = (X1, X2, X3,…, Xn), and on the other hand, a certain quality of the environment Z0 representing non-merchant goods. The utility function is written as follows: U = U(X, Z0) under the constraint of revenue Y and price P = p (P1, P2, ...Pn) of merchant goods and services. Consumers maximise their utility level by choosing a certain level of consumption, given their income and market price constraints. The level of environmental quality is exogenous to choice. Its programme is therefore written;

Max (U(X, Z0)) s/c Y = PX; Z0 being fixed (Eq. 3)

A formal presentation leads us to consider an indirect utility function (we substitute the demand function in the direct utility function);

U(X (P, Y, Z) Z) = V (P, Y, Z) (Eq. 4)

where, X means all the consumer goods; P means their price; Y means the revenue; and Z means the condition of the agricultural soils in the environment, related to the quality of the environment with *Zl > Z0 > Z'1*.

The four (4) cases of consumer surplus measurement previously presented will thus be found (Voltaire, 2011). Suppose an improvement in the quality of the environment leading to an improvement in the conservation of household agricultural soils. The compensatory variation of an individual who pays for an improvement in environmental quality can be specified as follows;

$$V(P, Y - CAP, Zl) = V(P, Y, Z0) \quad \text{(Eq. 5)}$$

In this case, the willingness to pay represents the offsetting variation in the surplus. How much does a household that is indifferent to an improvement in environmental quality receive for giving up its environmentally destructive occupation.

$$V(P, Y + CAR, Z0) = V(P, Y, Zl) \quad \text{(Eq. 6)}$$

In this case, the consent to receive represents the equivalent change in surplus. Assuming a degradation of the quality of the environment, what compensation makes the household indifferent to this degradation?

$$V(P, Y + CAR, Z'1) = V(P, Y, Z0) \quad \text{(Eq. 7)}$$

In this case, the consent to receive represents the offsetting variation of the surplus. Assuming a potential deterioration in the quality of the environment, how much is a household willing to pay to avoid this deterioration?

$$V(P, Y - CAP, Z'1) = V(P, Y, Z0) \quad \text{(Eq. 8)}$$

In this case, the willingness to pay represents the equivalent change in the surplus. The following table summarizes the definition of consents based on the state of nature (*Table 1*).

Table 1. *Definition of CAP and CAR based on different surplus.*

Nature of willingness	Improvement	Deterioration
Willingness to pay (CAP)	Offsetting surplus	Equivalent surplus
Willingness to receive (CAR)	Equivalent surplus	Offsetting surplus

Source: Dossa (2016).

The study model

The generalised Tobit model (Tobin, 1958) the structure of which is very similar to that of the selection model popularised by Heckman (1979) is used to model average WTP. This model is preferable to Maximum Likelihood Method (MMV) modelling in order to control the problem of sample selection bias that often arises because individuals self-select through their decisions to adopt soil conservation techniques (SCTs). It consists in assuming a sequential behaviour with two (2) stages.

Results and Discussion

Estimation of the CAP (WTP)

The estimation of WTP is an econometric model that falls within the domain of qualitative variables, more precisely sample selection models in contingent evaluation (Garcia et al., 2009). A two-stage sequential behaviour is assumed. In the first stage the individual decides whether or not to pay for soil conservation techniques (SCTs). This decision can be represented by a dichotomous qualitative model based on a certain criterion $Y_1^*{}_i$.

If $y^*_{1,i} > 0$, the individual i decides to pay
If $y^*_{1,i} \leq 0$, the individual i decides not to pay

(Eq. 9)

In a second step, the individual decides how much he or she is going to spend on the SCT, after deciding to pay. We then have a censored data model since, if we note y2,i the actual payment of household i, this is defined by ∀i = 1, 2,..,N:

$$y_{2,i} = \begin{cases} y^*_{2,i} \; if \; y^*_{1,i} > 0 \\ 0 \; if \; y^*_{1,i} \leq 0 \end{cases}$$

(Eq. 10)

This formulation generalises the simple Tobit model to the extent that the simple Tobit model is found by putting $y^*_{1,i} = y^*_{2,i}$. The advantage of this modelling is that it makes it possible, in particular, to show the more or less strong correlation that may exist between the two decisions (Tobin, 1958): willingness to pay (WTP) and amount of willingness to pay (MCAP). We do have a generalised Tobit model, since only the sign of the variable $y^*_{1,i}$ represented by the dichotomous variable $y^*_{1,i} = I\,(y^*_{1,i} > 0)$ is decisive.

Mathematical formalisation of the model

The model can be formalised as follows for each agricultural household i;

(1) *Selection equation*: Participates in the soil quality improvement programme.
Let Z be the qualitative variable, such that Z = 1 if household i participates in the programme and 0 otherwise;

$$\boldsymbol{Z = w_i\beta_i + \mu_i} \qquad \text{(Eq. 11)}$$

μ_i, follows a normal law N[E (μ_i), V (μ_i)] = N[0,1].

(2) *Substantial equation*: Estimate of the announced willingness to pay (CAP) (observable only if Z = 1);

$$\boldsymbol{Y = x_i\alpha_i + \varepsilon_i} \qquad \text{(Eq. 12)}$$

$\boldsymbol{\varepsilon_i}$ follows a normal law N[E (ε_i), V (ε_i)] = N[0,1].

w_i and x_i are observable socio-economic variables. Assuming a normal distribution N (0, 1), the error terms of the two equations (selection and substantial) are therefore absolutely continuous and admit f(x) as density, such that;

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2} \quad \text{where, avec } x = \mu_i, \varepsilon_i. \qquad \text{(Eq. 13)}$$

This kind of model is normally estimated by the Maximum Likelihood Method (MMV). However, as convergence is sometimes difficult, the two-step estimator of

Heckman (1979) is sometimes preferred. The selection equation is first estimated by a Probit model, then a Least Ordinary Square (LOS) regression is used to obtain the coefficients of the second equation. The selection equation is based on the work of Mäler (1974). By considering the primal programme of a respondent that maximizes his or her utility function U for a given price vector P and income level Y. His programme is written as follows;

Max U(X, Q), sous contrainte de *: PX = Y* (Eq. 14)

This program admits a solution which is an indirect utility function defined by;

$u_{ij} = u_i (p, y_j, q^i, m_j)$ (Eq. 15)

Let j be a given surveyed household, and i = 1 corresponding to the quality of the environment after soil conservation and i = 0 to the status quo (the current situation). P, the price vector, the income of j is denoted yj; mj represents a vector of the individual characteristics (gender, age, income,...), and q the quality of the environment which depends on the quality of the agricultural soils. For an improvement in the quality of the environment between situations 0 and 1 corresponding to an improvement in soil quality from q0 to q1 (with q1 > q0), there will be an improvement in agricultural production yields due to an improvement in soil fertility. The farmer's utility increases from u0 to u1. Author have;

$u_{1j} = u_1 (p, y_j, q^1, m_j)$ (Eq. 16)

The measure of household welfare due to a change in soil quality is the compensatory surplus (SC = Ω). Let;

$\Omega = u_{1j} - u_{0j} = u_1 (p, y_j, q^1, m_j) - u_0 (p, y_j, q^0, m_j)$ (Eq. 17)

In order to have better soil quality (q1) to avoid land degradation and declining fertility, the household would be willing to participate financially in the programme by reducing its consumption of private goods in favour of environmental goods (agricultural soil quality). The WTP equation of an agricultural household j to be estimated is therefore;

$CAP_j (q^1 - q^0) = f (m_j, u_o, q^1 - q^0) + \mu_j$ (Eq. 18)

With μj the random component of preferences unknown to the surveyed farm household. Since the random component of preferences is unknown, one can only make probabilistic assumptions about 'yes' and 'no' responses. Let Yj be the answer to these questions: Yj = 1 corresponds to the answer 'yes', i.e. agrees to contribute financially to the programme. The probability of answering yes is therefore;

$Pr (Y_j = 1) = Pr (u_1 (y_j - CAP_j, m_j q^1, \mu_{1j}) \geq u_0 (y_j - CAP_j, m_j q^0, \mu_{0j}))$ (Eq. 19)

In this linear random utility model, the utility function is in an additively separable form. It thus breaks down into a linear deterministic part (vi) and a stochastic part (μ_{ij}).

$$u_j (y_j, m_j\mu_{ij}) = v_j (y_j, m_j) + \mu_{ij}\,;\ \ avec\ v_j (y_j, m_j) = m_j\alpha + y_j\beta \quad \text{(Eq. 20)}$$

So author have;

$$Pr (Y_j = 1) = Pr (v_1 (y_j - CAP_j, m_j, \mu_{1j}) \geq v_0 (y_j, m_j, \mu_{0j}))$$
$$= Pr (v_1 (y_j - CAP_j, m_j, \mu_{1j}) - v_0 (y_j, m_j, \mu_{0j}) \geq 0) \quad \text{(Eq. 21)}$$

The indirect utility function is specified as the sum of a deterministic and a random component. The difference between the two random components can be identified in a single error term such as;

$$\mu_j = \mu_{1j} - \mu_{0j} \quad \text{(Eq. 22)}$$

In the deterministic part of the indirect utility function author have;

$$v_{1j} - v_{0j} = m_j (\alpha_1 - \alpha_0) + (y_j - CAP_j)\,\beta_1 - y_j\beta_0 \quad \text{(Eq. 23)}$$

It is assumed that the marginal utility of income is constant between the two states. As a result $\beta_1 = \beta_0 = \beta$, and noting that $\alpha = \alpha_1 - \alpha_0$, The probability of answering "yes" is then given by the following equation;

$$Pr (Yj = 1) = Pr (m_j \alpha - CAP_j \beta + \mu_j) > 0 \quad \text{(Eq. 24)}$$

It is assumed that the random terms μij are independent and identically distributed according to the same law, with zero expectation. Two laws are possible for μj: the normal law and the logistic law. When the reduced centred normal law is used, we speak of the ***Probit*** model and when the logistic law is used, we speak of the ***Logit*** model (Maddala, 1983). The Probit model is the one for which F is the distribution function of the reduced centred normal law;

$$F (w) = \Phi (w) = \int_{-\infty}^{w} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}}\, dt \quad \text{(Eq. 25)}$$

The result is;

$$P (Y = 1) = \int_{-\infty}^{X\beta} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}}\, dt = \Phi (X\beta) \quad \text{(Eq. 26)}$$

The Logit model is the one for which F is the distribution function of the logistic law;

$$F (w) = L (W) = \frac{e^w}{1 + e^w} = \frac{1}{1 + e^{-w}} \quad \text{(Eq. 27)}$$

The result is;

$$P\,(Y = 1) = \frac{1}{1+ exp(-X\beta)} = L\,(x\beta) \qquad \text{(Eq. 28)}$$

L (distribution function of the logistic law) and Φ (distribution function of the reduced centred normal law) are both symmetrical with respect to 0, and between 0 and 1 (which is perfectly suitable for representing a probability). The logistic distribution function L has an average of 0 and a variance $\pi^2/3$. It is therefore natural to compare to Φ(w), a distribution function of N (0,1), the function L1(w) where;

$$L_1(w) = \frac{1}{1+ exp(-\pi w/\sqrt{3})} \qquad \text{(Eq. 29)}$$

In most cases, one can choose one or the other model indifferently, as these laws are close to each other. The Logit model has the advantage of greater numerical simplicity. The Probit model, on the other hand, is closer to the usual Least Ordinary Squares (LOS) regression model. However, the choice between the two models for the residuals of the latent regression is truly arbitrary. However, this choice generally leads to different estimators of the parameters. Which model to choose?

The two models can be tested to decide between them. Testing the logit against the probit, is like testing α = 1 against α = 0. To do this, a score test is used which has the advantage: (1) of not requiring the general model to be estimated (the model is estimated under the null hypothesis only), (2) of having a standard distribution despite the fact that the test is done at the border of the domain (since $0 \leq \alpha \leq 1$). There is therefore very little difference between the estimated parameters (β ̂) under the two models. Marpsat and Trognon (1992) have shown that the estimators obtained with the Logit model are $\pi/\sqrt{3}$ times larger than those obtained by the Probit model; i.e. β ̂logit ≈ 1,8β ̂probit. As for Amemiya (1981), he proposes as a first approximation to use the relationship β ̂logit ≈ 1,6β probit between logit and probit estimates. In practice, the results of the two methods are similar, and both methods are indifferently chosen except for very large samples. If μ*j* follows a normal law ***N (0, σ*** ^{2}***)***, Θ*j = μj/σ follzs a reduced centred law.* Then author have;

$$Pr\,(Yj = 1) = Pr\,(\mu j < m_j\alpha - CAP_j\beta)$$
$$= Pr\,(\Theta j < m_j \frac{\alpha}{\sigma} - CAP_j \frac{\beta}{\sigma})$$
$$= \phi\,(m_j \frac{\alpha}{\sigma} - CAP_j \frac{\beta}{\sigma}) \qquad \text{(Eq. 30)}$$

If μ*j* follows a logistic law with null average and variance $\frac{\pi^2 \sigma_L{}^2}{3}$, the probability that j answers « yes » is;

$$Pr\,(Yj = 1) = \frac{1}{1+exp[-\left(m_j \frac{\alpha}{\sigma_,} - CAP_j \frac{\beta}{\sigma_,}\right)]} \qquad \text{(Eq. 31)}$$

In order to calculate the willingness to pay (CAP) for a random utility model, it is theoretically defined as a sum of money that leaves the respondent indifferent between the status quo and the proposed situation. CAP is thus defined as;

$$m_j \alpha_1 + (y_j - CAP_j)\,\beta + \mu_{1j} = m_j \alpha_0 + y_j\beta + \mu_{0j} \qquad \text{(Eq. 32)}$$

and the CAP of household j is therefore;

$$CAP_j = m_j \frac{\alpha}{\beta} + \frac{\mu j}{\beta} \qquad \text{(Eq. 33)}$$

To calculate the average CAP E (CAP) on the sample, the formula is as follows;

$$E(CAP) = \bar{m} \frac{(\alpha/\sigma)}{(\beta/\sigma)} \qquad \text{(Eq. 34)}$$

With $\bar{m}$, the vector of averages of individual household characteristics. The coefficient of the variables in the matrix *m* corresponds to the estimate α/σ and the coefficient associated with the proposed amount corresponds to an estimate of β/σ (In fact, logit or probit models provide an estimate of –β/σ). The analysis of the distribution of CAP, theoretically shows that it is between 0 and the income of the respondent. How then can we ensure that this is the case in practice? In other words, how can the willingness to pay be 'limited'? Haab and McConnell (2002) propose a model that correctly limits CAP. This model is written as follows;

$$CAPj = G\,(mj\gamma + \mu j)\,y_j, \text{ où } 0 \le G\,(mj\gamma + \mu j) \le 1 \text{ et } G\,(mj\gamma + \mu j) \ge 0 \qquad \text{(Eq. 35)}$$

Function G expresses willingness to pay as a fraction of income. The most widely used version of this model is;

$$CAPj = \frac{y_j}{1+exp(-m_j\gamma - \mu_j)} \qquad \text{(Eq. 36)}$$

Suppose that the error term follows a normal law, then the model becomes;

$$Pr\,(Yj = 1) = \emptyset\left(\frac{m_j\gamma + Log\frac{y_j - CAP_j}{CAP_j}}{\sigma}\right) \qquad \text{(Eq. 37)}$$

On the other hand, if the term error follows a logistic law, then the model is written;

$$Pr\,(Yj = 1) = \frac{1}{1+exp\left(-\frac{m_j\gamma + Log\frac{y_j - CAP_j}{CAP_j}}{\sigma}\right)} \qquad \text{(Eq. 38)}$$

With the vector of the terms "amount/income": $Log\frac{y_j - CAP_j}{CAP_j}$. The coefficient of the variables in the matrix *m* corresponds to the estimateϒ/σ and the coefficient associated with the variable "amount/income" corresponds to an estimate of 1/σ.

Determinants of the CAP in Kerou and on the ADJA Plateau

Table 2 presents the econometric results of Heckman's estimate. In Kérou, the model estimates the inverse of the Mills ratio whose significance shows that the substantial equation is not independent of the selection equation, i.e. the decision to reveal the amount to be paid is not made independently of the decision to be available to contribute financially to the agricultural soil quality improvement programme. Furthermore, the results in *Table 2* indicate that the inverse of the Mills ratio is not significant. There is therefore no selection bias, and this makes it possible to state that the Heckman model is better suited to this work in Kérou, unlike on the ADJA Plateau.

Table 2. *The determinants of CAP in the study setting.*

Variables	Department of ATACORA: Commune of KEROU				ADJA Plateau (APLAHOUE, DJAKOTOMEY, DOGBO, LALO, KLOUKANMEY, TOVIKLIN)			
	Obs.	Coef.	Z	p>|Z|	Obs.	Coef.	Z	p>|Z|
1st step: Selection equation (Willingness to pay – CAP)								
TM	385	0,008***	5,50	0,000	267	0,2282***	6,56	0,000
INCOME	385	0,03238	0,38	0,702	267	-5,56e-***	-2,61	0,009
NONAG	385	0,16645**	2,04	0,041	267	1,6898***	5,42	0,000
ACCMAR	385	0,2186***	3,59	0,000	267	-0,265778	-0,70	0,483
AGE	385	0,1440***	3,66	0,000	267	-0,009655	-0,95	0,343
EDUC	385	0,0577921	1,20	0,229	267	0,68987**	2,55	0,011
2nd step: Substantial equation (Amount of the willingness to pay – MCAP)								
TM	385	-115,0***	-10,89	0,000	267	0,020**	2,18	0,029
INCOME	385	0,0032***	4,24	0,000	267	-0,6839*	-1,65	0,099
AGE	385	-552,5***	-4,67	0,000	267	0,000***	4,71	0,000
EDUC	385	11,32648	0,80	0,425	267	-0,981***	-2,78	0,005
*Mills_*	385	-119,8337	-0,76	0,451	267	0,404***	4,58	0,000

Source: Based on Probit and MCO regressions in STATA, 2021.

Determinants of the CAP amounts in kerou and on the ADJA Plateu

Table 3 was used to calculate the willingness to pay amounts in the study setting. The results of the econometric regression give an average CAP of 1260.92 FCFA/month/hectare for the adoption of SCTs in Kérou and 1557 FCFA/month/hectare on the ADJA Plateau. It should be noted that these results depend on the influence of agricultural production systems on land use, fertility and agro-biodiversity in Kerou, as demonstrated in Kombiénou (2016).

Table 3. *Calculation of the amounts of CAP in the study setting.*

	Department of ATACORA: Commune of KEROU	ADJA Plateau (APLAHOUE, DJAKOTOMEY, DOGBO, LALO, KLOUKANMEY, TOVIKLIN)
Total area sowed	69 144 hectares	201 739 hectares
Average CAP/ month /hectare	1260,92 FCFA	1557 FCFA
Average annual CAP /hectare	15 131,04 FCFA	18 684 FCFA
Total annual CAP	1 046 220 630 FCFA/an	3 769 291 476 FCFA/an

Heckman (1979) two (2) step model for modelling CAP by MEC shows that the substantial equation ($Y = xi\alpha i + \varepsilon i$) is not independent of the selection equation ($Z = wi\beta i + \mu i$). In other words, the decision to reveal the amount to be paid is not made independently of the decision to be available to contribute financially to the agricultural

soil quality improvement programme in the commune of Kérou and the ADJA Plateau. The average CAP E (CAP) on the sample was calculated by the following formula;

$$E(CAP) = \overline{m}\frac{(\alpha/\sigma)}{(\beta/\sigma)} \quad \text{(Eq. 39)}$$

Thus, by estimating the average CAP using the **probit** model, the **tobit** model (Tobin, 1958) is tested by the two-step method of Heckman (1979) to control the selection bias in the sample of 385 farm households in Kérou and 267 on the ADJA Plateau. The results of the econometric regression give an average CAP of 1260.92 FCFA/month/hectare for the adoption of SCTs in Kérou and 1557 FCFA/month/hectare on the ADJA Plateau.

Conclusion

MEC's modelling of CAP has multiple benefits for a country's socio-economic and environmental development. It enables decision-makers in environmental economics to take decisions to improve the environment and living conditions of populations. In Benin, for example, the contingent evaluation method (MEC) was used to analyse the determinants of rural households' consent to pre-finance their primary health care in Sèmè-Podji (Yaya et al., 2013). Avocè (2012) used it to determine the health costs of air pollution in the city of Cotonou. It was used to assess the financing of household waste management in Cotonou (Gbinlo, 2010). It was also used to reveal the CAP of the price per cubic metre (m3) of gravels by operators in the district of Dévé in the commune of Dogbo (Dato, 2010). It was also used to reveal consumers' willingness to pay (CAP) for healthy vegetables in urban and peri-urban areas in Cotonou and Porto-Novo (Amadou, 2008). The contingent evaluation method was used to capture the willingness to pay (CAP) of farmers in Atacora department to conserve the soil both financially and through labour (Alinsato, 2006).

Acknowledgement

The authors thank the households surveyed (the heads of households) during the data collection phase for their attentive ears that they lent to the questions asked to them. He also thanked the local elected representatives of the various municipalities of the departments of Couffo (Plateau ADJA) and Atacora, for granting him their availability. Finally, the Departmental Directorates of Agriculture, Livestock and Fisheries (DDAEP) of Couffo and Atacora for the provision of quantitative data.

Conflict of interest

The authors of this paper confirm that there is no conflict of interest. They have fully contributed to its development and drafting.

REFERENCES

[1] Alinsato, A.S. (2006): Analysis of the determinants of willingness to pay for soil conservation. – Faculty of Economics and Management, University of Abomey-Calavi 25p.
[2] Amadou, I. (2008): Consent to pay consumers for healthy vegetables in urban and peri-urban areas: the case of southern Benin. – University of Abomey Calavi 85p.
[3] Amemiya, T. (1981): Qualitative Response Models: A Survey. – Journal of Economic Literature 19 (4): 481-536.
[4] Arrow, K., Solow, R., Portney, P.R., Radner, R., Schuman, H., (1993): Report of the NOAA panel on contingent valuation. – Federal Register 58(10): 4602- 4614
[5] Avocè, V.F. (2012): Health costs of air pollution in the city of Cotonou in Benin. – University of Abomey-Calavi 245p.
[6] Dato, P. Z. (2010): Policies for the sustainable management of non-renewable natural resources in Benin: the case of gravel exploitation in the municipality of Dogbo. – University of Abomey-Calavi 21p.
[7] Dossa, A. (2016): Assessment and financing of environmental expenditures: case of willingness to pay for the conservation of agricultural soils in Kérou, Benin. – University of Abomey-Calavi 303p.
[8] Garcia, S., Harou, P., Montagné, C., Stenger, A. (2009): Models for sample selection bias in contingent valuation: Application to forest biodiversity. – Journal of Forest Economics 15(1-2): 59-78.
[9] Gbinlo, R. E. (2010): Organization and financing of household waste management in the cities of Sub-Saharan Africa: Case of the city of Cotonou in Benin. – University of Orleans 237p.
[10] Haab, T.C., McConnell, K.E. (2003): Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation (New Horizons in Environmental Economics series). – Edward Elgar Pub 352p.
[11] Heckman, J. (1979): Sample Selection Bias as a Specification Error. – Econometrica 47(1): 153- 162.
[12] Kombiénou, P.D. (2016): Influence of agricultural production systems on land use, soil fertility and agro-biodiversity in mountainous areas in the department of Atacora in Benin. – University of Abomey-Calavi 283p.
[13] Maddala, G.S. (1983): Limited dependent and qualitative variables in econometrics. – Cambridge University Press 401p.
[14] Mäler, K.G. (1974): Environmental Economics: A Theoretical Inquiry. – John Hopkins University Press 267p.
[15] Marpsat, M., Trognon, A. (1992): Overview of the Logit model. – Journées de Méthodologie Statistique 32p.
[16] Reveret, J.P., Charron, I., St-Arnaud, R.M. (2008): Reflections on methods for estimating the economic value of wildlife habitat loss. – AGECO Group for the Ministry of Natural Resources and Wildlife, Department of Socio-Economic Development, Partnerships and Education, Quebec 54p.
[17] Tobin, J. (1958): Estimation of Relationships for Limited Dependent Variables. – Econometrica 26(1): 24-36.
[18] Voltaire, L. (2011): Contingent valuation method and economic valuation of a nature reserve project in the Gulf of Morbihan (France). – University of Western Brittany 281p.
[19] Yaya, S., Nouatin, G.S., Singbo, S.J. (2013): Community pre-financing: the willingness to pay of households for primary health care in the commune of Sèmè-Podji. – Department of Ouémé, Benin 7p.