Constructing a contingent valuation database for climate adaptation cost-benefit purposes

1. Introduction

As the realized and projected impacts of climate change mount, it becomes imperative to undertake ever greater levels of climate adaptation investment and integrate new practices into economic, social, and cultural activities across the globe. Well-designed adaptations are good investments, both from a financial/business perspective and for their environmental, social, and health benefits and protections.

However, with finite public resources, there is mounting need to tap the much greater levels of available private finance, but frequently great challenges in building the business case for private investment, One key to developing a suitable approach is to ensure that the resources allocated to adaptation are efficiently contributing to reducing vulnerabilities induced by climate change, which requires articulating as comprehensively as possible the many benefits and corresponding value of climate adaptation.

The Higher Ground Foundation (HGF) has developed and validated a mechanism for comparing adaptation projects through the form of a single metric that quantifies vulnerability reduction. This instrument is known as the climate Vulnerability Reduction Credit (VRC™). There are numerous benefits associated with the creation of this metric including the ease at which projects can be prioritized, the revenue that can be gained from pricing different levels of vulnerability reduction, justified and transparent decision-making for investment, the need to optimize project quality, and the creation of incentives for sustainable projects.

A VRC represents avoided impact cost. Impact cost factors may be financial or incorporate non-financial costs using standard approaches to undertaking cost-benefit analysis. However, for the purposes of calculating VRCs, only the vulnerability owing to climate change may be counted. Therefore, avoided impact costs calculations consider the total avoided impact costs a project is estimated to realise, but must avoid not counting the impact costs not related to climate change. Many of the real impacts of climate change cannot be measured using market pricing approaches, and require alternative approaches to incorporate their values into the avoided impact analysis. Since there are several cost-benefit tools available to estimate the non-monetized factors, it would be beneficial to have an accessible database consisting of such studies.

Contingent valuation (CV) is a subset in the realm of determining the aforementioned avoided impact costs. For nonmarket goods, CV is the only method that is able to incorporate the existence or passive use component of the economic value into the valuation process. Passive-use is when consumers can get utility from a good without physically using it. The general approach is to collect survey information about agents' preferences in the context of a constructed market situation. Due to the recurring need of policymakers for economic valuation of nonmarket goods, work on contingent valuation now typically comprises the largest single group of papers at major environmental economics conferences and in several of the leading journals in the field (Carson & Hanemann, 2005).

Since contingent valuation is not a single method but rather a general approach consisting of several techniques, the applications and context in which they are applied vary depending on the study. A notable aspect of CV surveys is carefully describing the nonmarket or public good in great detail, before obtaining valuation estimates. This emphasis on establishing a clear scenario enables the respondent to provide a contextual response.

In order to apply these studies to HGF's VRC process, HGF have successfully archived several CV studies based on different categories that can be used to monetize factors associated with climate change adaptation. These studies were also organized into an Excel file that includes a short summary of the papers, along with the key conclusions that can be draw from them. In this manner, the data and methods found can be incorporated into avoided impact cost estimation. Although several issues still exist with CV approaches such as applicability of passive-use, effect of scope and quantity, protest-zeros and relevant biases, this project serves as a stepping stone for HGF to build upon.

2. Purposes and process for VRCs

2.1 How do VRCs work?

A VRC represents avoided impact cost, normalized with an income equalization factor. Downscaled climate projections are used to estimate increased impact costs with climate change, and projects are then assessed for how they decrease these costs. In addition, projects wishing to be awarded VRCs must meet certain social and other criteria (Schultz & Adler, 2017). The VRC is a credit for work done to avoid damages or losses owing to climate change. There are three fundamental assumptions in VRC analysis that, if accepted, validate their value in measuring vulnerability reduction:

1. Economic conditions are a valid measure of human wellbeing and can proxy for adaptive capacity,
2. Economic impacts can often be quantified, and,
3. Impacts can be equalized for poorer communities.

Essentially, a Vulnerability Reduction Credit represents €50 of avoided impact cost. It consists of:

- The Avoided Impact Cost (AIC), and;
- An Income Equalization Factor (IEF).

Dividing the product of the AIC and the IEF by €50 gives the number of credits a project earns:

$$\#\,VRCs = (AIC \times IEF) \div €50$$

2.2 How do VRC projects work?

In generating VRCs, a project employs a cascading chain of results projection, as shown in Fig.1 (Schultz & Adler, 2017)

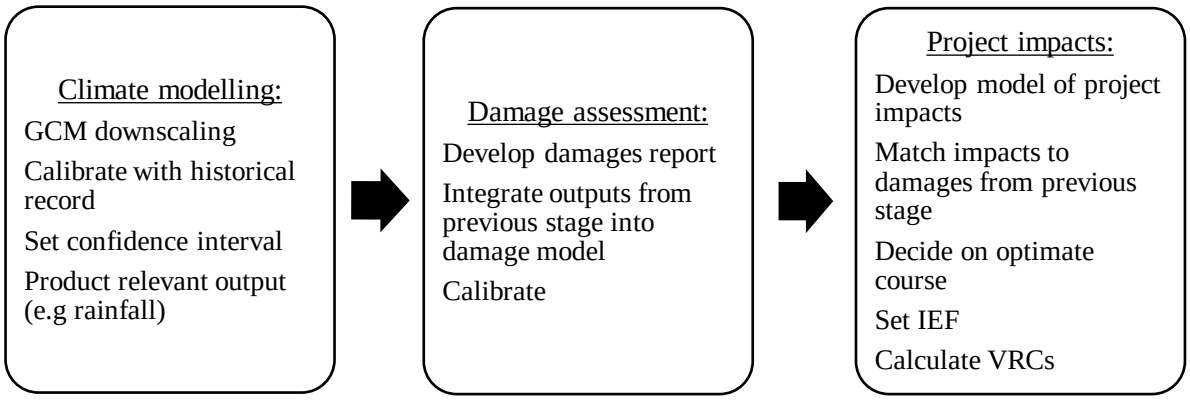

Fig. 1: VRC project flow (Schultz & Adler, 2017)

Following climate modelling, the estimation of impacts is required. The avoided impact costs of the project are first estimated for the scenario without climate change. Then, the avoided impact costs of the scenario with climate change are calculated in order to determine the difference. Without valuations of high confidence, calculation of avoided impact costs would be inaccurate, potentially affecting the VRC calculation.

In order to be as comprehensive as possible, the calculation of VRCs must abide by the VRC Standard Framework, developed by HGF and validated by a panel of outside experts that outlines the requirements and permitted approaches to VRC quantification. Since many costs of climate change impacts are non-market, the VRC Standard Framework permits non-market priced items to offer a more holistic means of quantifying adaptation results. Specifically, the framework emphasizes on Page 32 that "Impact cost factors may be financial or incorporate non-financial costs using standard approaches to undertaking cost-benefit analysis."

3. Contingent Valuation and its Validity

Placing an economic value on nonmarket goods and services is mainly conducted in two main ways: revealed preference (RP) and stated preference (SP) methods. Stated preference (SP) methods refer to survey-based methods that use constructed or hypothetical markets to elicit preferences for specified policy changes (Atkinson & Mourato, 2008). On the other hand, RP methods look at "surrogate markets," that is, analyse or infer preferences for nonmarket goods as implied by past behaviour in an associated market.

Contingent valuation (CV) is the most well-known and widely used SP method. CV relies upon a carefully constructed questionnaire, designed to describe a hypothetical market where the nonmarket good (such as protection of an ecosystem) is traded. The CV survey aims to construct different scenarios based on future possibilities, whereby respondents are asked to state their preferences concerning these scenarios. The economic value is then derived from the choices observed in this hypothetical market (Carson, 2000). The simplest question format of a CV survey is centered around binary choice. The two alternatives are the status quo policy and an alternative policy that costs more than the status quo. The respondent is told that the government will increase costs if the alternative policy is adopted. In order to make an informed decision to 'favor' or 'not favor' this alternative policy, the respondent must be apprised of how and what the alternative policy entails, as well as its precise cost (Carson, 2000).

The notable economic parameters that researchers use once cost numbers are assigned to respondents are willingness to pay (WTP) for the good and minimum willingness to accept (WTA). This is conducted by first forming a parametric functional distribution from which statistics such as the mean/median WTP can be determined. Since CV is firmly rooted to the economic value of individual choice, this method can be used to estimate all benefits - both use and nonuse (Atkinson & Mourato, 2008). Both WTP and WTA are useful measures but should be applied depending on the type of information required. WTP is appropriate when an agent wants to acquire a good, whereas minimum WTA is appropriate when an agent is voluntarily being asked to give up a good (Carson, 2000).

The applicability of CV is a subject of debate among economists. One of the key issues is whether or not passive-use or existence values should even be included in economic analysis. Unlike marketed goods, contingent valuation assumes that consumers can get utility from a good without physically using it. These uses are known as passive-uses. Another debatable subject is the economic criteria that CV results must meet to be deemed valid and of suitable quality. Due to the wide range of CV studies conducted providing both good and bad results, specific criteria have been developed to examine the quality of a particular study. Firstly, it is crucial to recognize that many goods have both direct-use and passive-use values. However, some people argue that passive-use values are irrelevant to decision making while others believe that passive-use values can be reliably measured (Carson, 2000). There has also been a concern regarding the fact that WTP estimates from CV studies increase in a plausible manner with the quantity or scope of the good being provided. Critics argue that the lack of sensitivity to scope occurs because respondents receive moral satisfaction from the act of paying for the good independent of the characteristics of the actual environmental good.

Nonetheless, CV is the one of the only forms of valuation that enables comparison of valuations of provision in the past with provision in the present. The validity of CV has also improved due to the increased potential of CV to create scenario experiments that avoid many of the economic modelling problems that are common to most observational data (Carson & Hanemann, 2005).

4. Creating a database

4.1 Modifying an existing bibliography

In an attempt to find cost-benefit tools of specific applicability for climate adaptation, HGF noticed that the vast majority of cost-benefit studies were not directly applicable to calculating avoided impact costs. VRC quantification requires studies that can serve as a tool for understanding the economic impact cost of nonmarket goods; however, CV studies explicitly for adaptation are limited. Nonetheless, a large number of CV studies are appropriate for adaptation for a number of reasons. Firstly, the flexibility that CV offers in terms of the various approaches that may be used provides different confidence intervals. Secondly, CV can be applied to explore different sectors that are vulnerable to climate change. Lastly, CV scenario experiments can be tailored to focus on specific groups of people, thus providing a more precise valuation of nonmarket good estimation.

The lack of publications directly linking cost-benefit analysis to climate change adaptation inferred that results from contingent valuation publications needed to be adapted and analyzed further in order to be the basis for analysis of avoided impact costs. Critically, however HGF

identified an existing bibliography of contingent valuation studies by Dr. Richard T. Carson entitled: 'Contingent Valuation: A Comprehensive Bibliography and History' published in 2011. This compilation of sources includes 7,500 CV studies and papers from over 130 countries. This bibliography was relevant due to its sole focus on valuing nonmarket goods and services.

Although this bibliography by Dr. Carson consisted of contingent valuation studies, a majority of the included studies were not relevant to determining avoided impact costs for the purpose of climate change adaptation. One of the main limitations of this complication for HGF's purposes was its presentational structure. The list is arranged alphabetically rather than being categorized under different headings (e.g. health, water quality, etc.). As a result, HGF aimed to modify this list into one that is categorized and specifically focuses on studies that are relevant to assessing avoided impact costs of climate adaptation projects.

When sorting the bibliography into categories, the goal was to split the valuation studies into convenient categories for policymakers and for project developers. HGF intern Theeranai Charaschanya reviewed the entire compilation of studies and organized the list in several different categories for contingent valuation. Furthermore, several studies that were irrelevant in regard to climate change adaptation were removed for this list. The final organized list comprised of over 650 studies and papers, sorted into five major categories of Environment, Health, Coastal, Protected Areas/Cultural Sites/Historical Sites and Value of Statistical Life (VSL). Since the 'Environment' and 'Health' comprised of a range of studies, these two major categories were further split into smaller sub-categories.

Following the reorganization of Dr. Carson's original bibliography into a smaller, categorized list, HGF went on to archive publications that were accessible. As a result, HGF now has access to approximately one-third of the studies provided in this modified list, with just over 230 publications. In order to present the key information contained in this modified list of studies, HGF has created an Excel database that arranges the archived publications into the sub-categories. To make the database useful, the Excel sheets also consist of a brief summary of each study, along with a paragraph summarizing the key conclusions or potential applications for avoided impact cost purposes. This makes the database user-friendly and expandable.

Explanation of the categories and sub-categories

As mentioned above, the five major categories are Environment, Health, Coastal, Protected Areas/Cultural Sites/Historical Sites and Value of Statistical Life (VSL). This section summarizes the sub-categories that exist within two of these major categories – Environment and Health; and also explains the other major categories.

In terms of the **'Environment'** category, the sub-categories include Biodiversity, Ecosystems, Farming, Fisheries, Forests, General, Recreation, Riparian, Waste Management, Water Services/Quality and Wetlands.

> **Biodiversity:** Refers to studies that focus on the valuation of habitats as well as the valuation of species preservation.
>
> **Ecosystems:** Refers to studies that valuating both ecosystem services and environmental quality.

Farming: Consists of studies that focus on farm animal welfare, and how much people value the importance of welfare policies.

Fisheries: Consists of studies that focus on the valuation of recreational fishing associated with different fisheries in a variety of areas.

Forests: Consists of studies that emphasizes valuation of preservation, recreation and tourist-potential of rainforests.

General: Refers to studies or textbooks that emphasize the economic interpretation environmental valuation through providing several methods for analyzing goods that are nonmarketable.

Recreation: Focuses on WTP estimates focused on specifically isolating welfare benefits.

Riparian: Consists of studies that determine the WTP of households near riparian areas to preserve the riparian habitat.

Waste Management: Focuses on the economic aspects of household's opinion on waste management

Water Services/Quality: Consists of studies that focus on household valuation of receiving water services and studies that focus on household valuation of water quality

Wetlands: Focuses on the potential for economic valuation of wetlands and how such valuation studies should be conducted

In terms of **'Health'** category, the sub-categories include Air Pollution, Drinking Water and General.

- **Air Pollution:** Consists of studies that aim to estimate of the cost of air pollution damage on human health
- **Drinking Water:** Consists of studies that aim at valuation of drinking water by evaluating its effect on human health
- **General:** Refers to studies or textbooks that focus on health economics, specifically valuation that elicits an individual's monetary valuations of health programs or health states.

In terms of the **'Coastal'** category, the focus is on public perception of coastal services and cost-benefit analysis of coastal protection. However, there is also one study on flood risk management that has been included. In terms of the **'Protected Areas/Cultural Sites/Historical Sites'** category, the studies primarily consist of contingent valuations that place a value on the preservation and conservation of built cultural heritage sites in various different locations around the globe. Lastly, in terms of the **'Value of Statistical Life (VSL)'** category, the studies have estimate the value of a statistical life depending on the country applying the valuation method.

4.1.1 Sample extract from Database

A sample extract from the draft database is shown in Figure 2 below.

Title of work (CLICK TO ACCESS)	Author(s) and Year of Publication	Brief Summary	Key conclusions / HGF Application
Using Stated Preferences Methods to Evaluate the Impact of Water on Health: The Case of Metropolitan Cairo	Abou-Ali, Hala, 2003	This paper analysis the impact of better water quality on health improvements using two stated preference methods: choice experiments and the contingent valuation method. These methods were administered to a random sample of 1500 households living in metropolitan Cairo, Egypt. The results indicate that households living in Metropolitan Cairo have a positive but rather small willingness to pay for reducing health risks owing to water quality.	No considerable difference is found between the estimated values of the changes in health risk derived from both methods. However, it still could be concluded that the household living in Metropolitan Cairo have a positive WTP for reducing health risks owing to water quality. This WTP is around 1% of mean income for a decrease in the short run health effect due to poor quality water by 25% and a reduction to 2% of the probability of contracting water born diseases in the long run. The one percent of mean income results in very little value due to the fact that Egypt is a rather poor country.

Fig. 2: Extract from HGF Contingent Valuation Database

As shown in Figure 2, the database is organized into four columns. The first two columns provide the title of the work, along with the author(s) and year of publication. The user may click on the title of the work to access the archived file. The third column provides a brief summary of the study, while the four column highlights the key conclusions from the study that can be incorporated into climate adaptation analysis.

4.2 Observations from CV studies

From analysis of the studies, most publications tend to construct WTP equations in terms of several variables based on the survey answers. These include factors such as income, usage, knowledge-based questions and other relevant financial information. Such equations are usually justified in terms of the coefficient values and signs (positive or negative) that support the evaluation of WTP. However, if the study does not provide a clear indication as to how the survey results have been transformed into the relevant elements of the equation, the WTP responses should for practical purposes be deemed random and inconclusive.

It was observed that several studies also touch upon the issue of bias that may exist within survey inputs to CV. Strategic bias occurs when individuals try to influence the outcome of the survey results by not stating their true preferences. This occurs when respondents believe that a specific response will influence the price they will have to pay, thus causing them to overstate or understate their true preferences. Hypothetical bias is a result of the contention that WTP amounts are not actually paid, causing individuals to lack incentives to reveal their true preferences.

It is also interesting to notice the role of potential outliers in results from CV surveys. For example, some individuals may declare a zero willingness to pay (protest zeros), when they are actually in favour of the proposed project. Protest zeros occur when a respondent who has a positive WTP for a good gives a response of 'zero' to a question that requests a WTP value. This may occur due to the respondent's rejection of the legitimacy of the scenario presented in the survey. On the other hand, extremely high values can also affect the distribution on the upper end. Since the calculation of the mean WTP is taking an average, a slight 'extreme' on either tail of a WTP distribution may significantly affect the mean WTP value. These small spikes in the distribution can be controlled by providing constraints in the survey – such as income constraints and distinguishing between protest zeros and "true" zeros. In this manner, studies involving these judgemental decisions show a stronger initiative to attain accurate valuation.

A major question that often arises is which format should be used to elicit information of the preferences of the respondents. There are three basic type of questions that are usually used in CV surveys: Open-ended questions, closed-ended questions and iterative bidding. Open-ended questions are where an individual is asked to state a WTP or WTA associated with a specific level of the hypothetical good. When opting for an open-ended or a continuous response questionnaire, there can be a problem due to the distorted variation that may occur. The respondents may also round their values to the nearest whole number rather than giving more precise answers, or even be unable to formulate a numerical answer - requiring well-defined preferences for the good to be made. Iterative-bidding questions start from a pre-set price and ask for incremental changes. An inherent weakness of this technique is the fact that the initial bid can influence the respondent's final bid. Close-ended questions involve splitting the sample into equal parts and assigning random prices for each group where all individuals face the same scenario. As a result, these quantitative responses provide much less information about respondents' actual values than is utilized.

Another key question that needs to be addressed is whether the average population's responses will yield more accurate valuations than responses from experts in the field. Surveying experts will ensure that the responses are from people who technically understand the alternative scenarios presented in a survey, rather than from people who are unaware of such scenarios. This is crucial because CV estimates are instrumental in providing costs for climate change adaptation. Therefore, strictly using preferences of experts may be an option to consider.

5. Methodological challenges and issues

Contingent valuation is based on what people say they would do, rather than what people will actually do if faced with the scenario. This could either viewed as its greatest strength due to its ability to produce economic estimates, or as its greatest weakness due to its inaccuracy of trusting people's words.

When developing CV surveys, the survey design and administration could also affect the results. Studies that provide a copy of the questionnaire in the appendix enable the user to analyse the quality of the study and visualise what a respondent was facing. One of the most pressing challenges of CV surveys is the cost that is required to conduct quality information gathering while maintaining a high degree of reliability. However, a combination of telephone and mail surveys can be a feasible solution to this problem – recruit a random sample of individuals through phone call, mail them the visual aids, then ask the questions through the phone. Comparing the results of CV surveys to results of other value elicitation methods will also help confirm the validity of studies.

Despite the range of the data that CV studies provide, some issues still remain. In the environmental studies specifically, a key concern was how much information to provide about the scenario within the CV survey, as well as the payment method. The two main methods for binary discrete choice in environmental studies are through constructing an interval for the value, or from asking the respondent about different but related goods. Both methods, however, are heavily dependent on the question context and have room for strategic bias. The most pressing concern lies in the impact of various techniques on the reliability of the CV study.

Such analysis would enable the user to implement several different studies and compare the techniques in a consistent matter.

All in all, CV provides a clear indication of what the public thinks and knows about certain elements of nonmarket goods while providing a detailed procedure as to how the data is obtained. With a well-designed survey and a large enough sample, the confidence intervals of such studies will enable HGF to use the data in the avoided impact cost estimation process when calculation VRCs.

6. Conclusion

In summary, HGF has created a contingent valuation database aimed at assessing avoided impact costs for climate adaptation projects. This database has been categorized into five major categories, two of which include sub-categories, in order to make the distinction between sectors more apparent.

The CV database provides a brief summary of each study, along with key conclusions derived from the study that can be applied when considering avoided impact costs. One of the main issues with the database is the publication date of the sources present. Many of the studies are from the 1990s, suggesting that some of their approaches may be outdated or less accurate than modern approaches. Another concern is that the database is not organized in terms of geographic location, a format which may eventually be more useful when considering the applicability to adaptation projects. There is also some overlap in regard to the specific category of a study. A solution to this issue would be to include the same study in different categories.

The application of CV survey results to VRC calculation may be a challenge due to the variation in how the conclusions of the studies are presented. Some studies merely present key trends associated with certain survey data, while others present concrete WTP values. The specific WTP values are sometimes restricted to follow certain assumptions that may not be in line with the assumptions listed in VRC calculations. Although the results of CV studies may not directly contribute to the quantification of a specific adaptation measure, the specific CV survey format and questions can be replicated when attempting to collect new WTP data.

To advance upon the existing database, its structure can be extended to include explicit details of WTP and associated confidence. It may also be useful to extend this database to include revealed preferences studies. As more CV studies are published, the existing database should be extended to include new findings that potentially encompass improved approaches.

Further consideration of how CV may be deployed to quantify avoided impact costs for VRC analysis may develop as sectoral/project type methodologies are created and approved by The Higher Ground Foundation. Furthermore, creation of a guide for use of CV in VRC analysis could be helpful.

The Higher Ground Foundation invites sectoral experts in climate adaptation projects, economists and others with expertise in contingent valuation, and the broader community engaged in supporting and implementing climate adaptation projects, programs and policies to offer their insights and engage with us as we work to improve the capacities for applying VRCs for a broader set of adaptation interventions, and counting more holistically the benefits of these interventions.

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References

Atkinson, G. & Mourato, S. (2008) Environmental Cost-Benefit Analysis. *Annual Review of Environment and Resources.* 33 (1), 317-344. Available from: https://doi.org/10.1146/annurev.environ.33.020107.112927.

Carson, R. T. (2000) Contingent Valuation: A User's Guide. *Environmental Science & Technology.* 34 (8), 1413-1418. Available from: https://doi.org/10.1021/es990728j.

Carson, R. T. & Hanemann, W (2005), 'Chapter 17 Contingent Valuation', *Handbook of Environmental Economics*, vol. 2, pp. 821-936. Available from: https://doi.org/10.1016/S1574-0099(05)02017-6

Schultz, K. & Adler, L. (2017) Addressing Climate Change Impacts in the Sahel Using Vulnerability Reduction Credits. In: Tiepolo, M., Pezzoli, A. & Tarchiani, V. (eds.). *Renewing Local Planning to Face Climate Change in the Tropics.* [e-book] Cham, Springer International Publishing. pp. 343-363. Available from: https://doi.org/10.1007/978-3-319-59096-7_17.

To find out more

The Higher Ground Foundation (*HGF*) is the voluntary joint effort with a mission to develop and manage the climate vulnerability reduction credit (VRC™), a universal standard metric for the results of climate adaptation, in order to encourage more effective global climate resilience.

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