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Novotel Hotel, Nadi

COST BENEFIT ANALYSIS OF CLIMATE CHANGE ADAPTATION INTERVENTIONS - CASE STUDIES IN KIRIBATI AND SOLOMON ISLANDS

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ABSTRACT

This paper aims to shed light on the role of economics in deciding what constitutes an appropriate climate change adaptation project. The economic methodology used is cost benefit analysis (CBA) and the basics of CBA are reviewed alongside a short discussion on where CBA fits in a policymaker's toolbox. Two case studies are presented to demonstrate how CBA has been used to inform decision making processes associated with the SPC/USAID food security project.

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1.0 Background

1.1 The Project

The SPC/USAID project 'Vegetation, Land Cover Mapping and Improving Food Security for Building Resilience to a Changing Climate in Pacific Island Communities', supports Pacific Island Countries in their efforts to adapt to the impacts of climate change on long term food security. Part of the project involves updating national vegetation and land cover maps for Fiji, Kiribati and Solomon Islands. The other part aims to work with local communities across the Pacific to implement appropriate adaptation methods. While scientists and geographers have been engaged to deliver the former, economists have helped inform the latter.

1.2 Using Economics to Assess Food Security Adaptation Projects

The SPC/USAID project is promoting the use of cost benefit analysis (CBA) to discern the value of investing in public projects. Private businesses usually make decisions based exclusively on whether an investment will result in a financial profit. In contrast, governments make investments in order to improve the wellbeing of society in general. A well conducted CBA will indicate the potential to which a project could improve wellbeing in a community and even informed how it might be designed. It takes into account the financial implications of a proposed public project, but also values the wider impacts (the costs and benefits).

It is likely that for each food security problem the SPC/USAID project adresses, a number of possible solutions could be considered. The questions then become, what specific project should governments and/or their donors fund and what factors will determine their success? Through careful assessment of the impacts of each proposed option, CBA can be used to select and design the adaptation project most beneficial to society. Such information provides a guide for governments/donors to make informed and defendable investment decisions.

2.0 Cost Benefit Analysis Methodology

Economists from SPC's Geoscience Division were asked to deliver preliminary CBAs of two proposed adaptation projects; one involving the renovation and extension of a livestock breeding facility in Kiribati, and the other of community biogas digesters in the Solomon Islands. In both cases, the analysis was conducted before the decision to invest in a specific project had been finalised. This section provides a brief explanation of the steps involved in completing an ex-ante CBA.[1] Please see Buncle et al. (2013) for a more detailed guide to CBA, at all stages of the project cycle.

2.1 Basic Steps of Cost Benefit Analysis

An ideal CBA enables decision makers to see what difference a proposed project would make to the well-being of society. [2] This involves comparing the costs and benefits of doing nothing with those expected if the proposed project were to be invested in. This is often called 'with and without' analysis and the difference between the 'without' and 'with' project scenarios may be represented visually as in figure 1.

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1 Although the methodology adopted in ex-ante and ex-post CBA changes little, the results of an ex-ante CBA are only projections by definition. This implies CBA is probably best used at all parts of the project life cycle; both before the project is implemented to inform its design, and after it has been operational to monitor and evaluate its achievements.

2 Of course, the complexities of the vast majority of issues mean that a perfect CBA is almost always impossible and we have to make do with educated estimations.

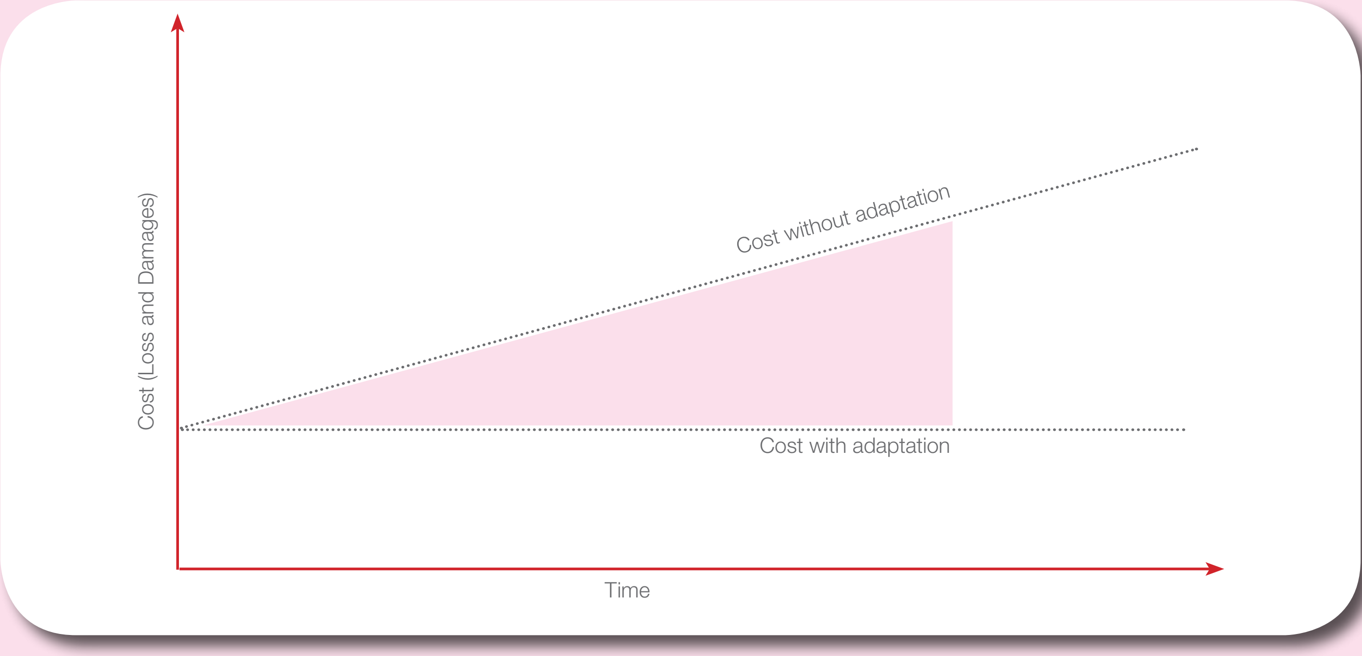

Figure 1. Dynamic change and 'with' and 'without' analysis.

To make a comparison between the 'with' and 'without' scenarios possible, the expected impacts are monetized (assigned dollar values). For certain costs/benefits, assigning a monetary value is simple; the costs of constructing a new pig shed can be discovered by adding the costs of the materials to the cost of labour required to assemble them. For other impacts, monetary valuation is far more difficult; the impact of building a new pig shed on the local ecosystems, for example. There are a number of methods used to monetize costs and benefits, including those that do not have a market price or are not readily available. Using market prices requires little effort and fewer resources than more complex approaches such as commissioning surveys to ascertain peoples' willingness to pay for non-market impacts (contingent valuation).

For projects that are designed to last many years, most of the benefits will occur in the future while the bulk of the costs will be faced today. For example, the costs of constructing a seawall will need to be paid by those that are currently under threat from coastal inundation, while the benefits of the protection will accrue from now into the future. To consider whether the future benefits of an investment are worth costs faced today, all future values must be brought into present day terms. A project's future impacts can be converted to their 'present value' (PV) through a simple calculation known as 'discounting'. This places all present and future impacts on the same footing and allows them to be aggregated correctly. The PV of the aggregated benefits 'net' of the PV of the aggregated costs may then be calculated.

By its very nature, ex-ante CBA relies on assumptions used to make projections of activities that are yet to be implemented. These assumptions are the source of uncertainty that should be explored through a process known as 'sensitivity analysis'. If the CBA results remain robust to plausible fluctuations in the assumptions used, the analyst may estimate a project's 'net present value' (NPV) with reasonable confidence. Distributional issues such as who in society will be impacted most must also be carefully considered. The results of this entire process may then be used to make informative recommendations to policymakers. Figure 2 depicts the key steps in the CBA process in one diagram.

Figure 2. Key steps of the CBA process

1. Determine the objective of the cost–benefit analysis
Clarify the questions the analysis seeks to answer. What decision does it seek to inform?

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2. Identify the costs and benefits
Clarify the potential impact of the activity and the type of costs and benefits it would generate

↓

3. Value the costs and benefits
Express (as far as possible) the value of benefits and costs in monetary terms. Which of these can be valued and how?

↓

4. Aggregate the costs and benefits
Sum costs and benefits over time

↓

5. Perform sensitivity analysis
Assess the importance of major uncertainties associated with the analysis and activity

↓

6. Consider distributional impacts
Consider who will incur the costs and benefits and what impact this might have on the activity

↓

7. Prepare recommendations
Summarise how to proceed from here. Which option should be chosen and why?

2.2 Key Outputs from CBA

CBA yields a number of technical outputs that must be understood before its results can be interpreted correctly. The first output to be generated by most CBAs is called the net present value (NPV). The NPV is a statistic that describes the difference between the present value of a projects benefits and the present value of its costs. If an option's benefits outweigh its costs, the calculated NPV will be greater than zero. A NPV lower than zero implies its costs outweigh its benefits. Choosing between an option with a positive NPV and an option with a negative NPV is therefore easy; policymakers would always choose the option beneficial to society. When a number of options yield positive NPVs, they should be ranked according to their NPV and the project with the highest value would usually be chosen. This implies its benefits outweigh its costs to a greater extent than the projects with lower, but still positive, NPVs. In general, the option which offers the highest NPV is considered to provide the greatest improvement in wellbeing[3].

Most CB analysts choose to report a further statistic called the benefit-cost ratio (BCR). The BCR is related to, but distinctly different from the NPV. Like the NPV, the BCR uses the present value of a project's benefits and the present value of its costs. By dividing the former by the latter, the ratio of benefits to costs is calculated. The BCR indicates the benefits expected for each dollar invested, implying that a project with a BCR greater than one is beneficial. However, unlike the NPV, the BCR gives no indication of the magnitude of the net benefits. It is therefore possible for two projects with vastly different estimates of benefits and costs to have identical BCRs. For this reason, the BCR is often seen as a complementary statistic to, rather than a substitute for, the NPV.

2.3 How does CBA contribute to the decision making process?

In an ex-ante CBA, the recommendations offered will often help design the project in such a way to provide the greatest net benefit to society. It is important to highlight the areas where uncertainties remain and how this might affect the recommendations. The discussion above suggests that from an economic perspective, the project with the highest quantified NPV should be recommended. However, one major advantage of using a CBA framework is that it highlights many impacts that are too difficult to quantify. In most cases, the most suitable project will have a combination of high NPV and a number of supposedly valuable but unquantified benefits.

In the Pacific, voting and reaching a consensus are common ways to make decisions (Lal and Holland 2010). Such systems offer advantages but are also imperfect. Voting is subject to political arguments that may not necessarily consider the wellbeing of society in general. Waiting for a consensus is often prohibitively time consuming, especially when many people are involved. CBA on the other hand forces decision makers to consider the impact of the proposed options on society in general. The process also generates much information surrounding the distribution of impacts across the community. This enables projects to be designed in such a way that ensures the expected benefits materialise fairly, making a consensus easier to reach.

CBA may therefore be seen as one tool among many that can be employed to guide decisions. The results of a well conducted CBA can be used to inform voting and consensus processes. Policymakers are then better able to make more balanced decisions, based on transparent and defensible recommendations.

3 It is possible to imagine a project being shelved despite having the highest NPV if it entails politically infeasible distributional impacts.

3.0 Case Studies

The purpose of this section is to provide a brief background of the adaptation projects analysed and a high level view of the results of the CBAs conducted. To this end, the full technical details and many of the quantitative aspects have been excluded. The full analyses can be found via the virtual library of the SPC's Geoscience Division (http://www.sopac.org/virtual-library).

3.1 Economic Dimensions of the Tanaea Livestock Facility of the Government of Kiribati (Rios Wilks 2013)

3.1.1 Background

Under the SPC/USAID project, the Government of Kiribati has been examining options to increase food security through its chicken and pig breeding centre in Tanaea, Tarawa. Presently in a state of disrepair, the facility is only able to rear a minimal number of piglets and focusses mainly on chicken production. A preliminary economic analysis of renovating the breeding centre and extending its pig production operations was conducted.

3.1.3 Methodology

The analysis was conducted using a cost-benefit framework, where the financial implications of continuing current chicken operations were compared to either; 1) shutting down pig production altogether, or 2) increasing production of pig stock at the facility. The total revenue expected from the sale of the centre's produce was compared to the expected running costs. The analysis accounted for a 40-year time period with future impacts discounted at a rate of 10%. It should be noted that no wider economic impacts (e.g. increased food security) are quantified.

The Government of Kiribati is expected to be responsible for running the facility and the costs of renovating and/or extending the facility are to be met by donors. To inform potential donors, the analysis provides an estimation of the lifetime economic returns to renovating the facility.

3.1.4 Possible technical issues

One of the likely barriers to the success of the livestock facility is insufficient water supply. To reduce the risk of water shortages, water containers with a total capacity of 30,000 litres could be installed alongside the newly constructed barns. If the facility were to run at full potential, 1,220 litres of water – far more than could be collected from rainfall - would be required each day. To meet the shortfall, water from the Kiribati main supply would continue to be delivered to the facility but this arrangement could be adversely affected during droughts. At times during the dry season, there has been no supply for months on end. With climate change, droughts in the region are expected to occur with less frequency, yet it is clear that water remains the greatest risk.

3.1.5 Assumptions and uncertainties

The analysis was conducted under 'best case scenario' assumptions. There was assumed to be sufficient demand to meet the total supply of eggs, chicks and pigs produced at the facility. It was also assumed that production at the facility is unaffected by adverse events such as extreme weather or livestock disease epidemics. Appropriate waste management technologies were assumed to already be in place, ensuring environmental costs are at a minimum. Finally, a number of costs are assumed not to change significantly from those currently faced; medication/vaccination of livestock, labour requirements and facility power demand.

3.1.6 Results

Both with and without pig production, the expected net income of the facility was expected to be positive. If only chicken production were pursued the Government of Kiribati could expect a higher return; expected revenues would exceed expected running costs yielding a revenue-cost ratio of 1.53. This implies that the Government of Kiribai would receive AUD 1.52 for every AUD 1.00 spent.

The CBA found that, compared with stopping pig production altogether, increasing pig production would reduce the facility's discounted lifetime net income by around AUD 140,000. Despite this, the expected revenues generated remain higher than the costs, resulting in a revenue-cost ratio of 1.32. The high costs of pig production are such that, if it were pursued in isolation, around 34 cents in every dollar invested would be lost.

When the costs of renovating the facility were included, the results remained consistent. The revenue-cost ratio of regenerating and running the facility with chickens and pigs was estimated to be 1.27. Similarly, regenerating and running the facility with chickens yields a higher revenue-cost ratio: 1.50. Pig production in isolation yields a revenue-cost ratio of 0.58 when renovation costs are included; implying donor funds invested in this manner would lead to losses.

3.1.7 What if?

It was assumed throughout the analysis that the facility continues to produce chickens as it is at present and there would be no adverse events such as extreme weather or livestock epidemics that affect chicken production. If either of these assumptions failed, producing pigs could lead to costs over and above the revenue received from the sale of chickens. It was not possible to calculate potential losses due to a specific event, but if, for example, production of chicken-based produce were to decrease by approximately 25 per cent, the facility would incur overall losses and would require funding from elsewhere to maintain operations.

3.1.8 Conclusions and recommendations

The analysis was scrutinized by the Government of Kiribati which has stated a clear desire to increase pig production at the breeding centre and has requested support from the SPC/USAID and GIZ climate change projects to do so. The results of the CBA suggested that pig production presents a financially feasible opportunity only when pursued in conjunction with chicken production. For every dollar spent on running the facility, the Government of Kiribati can expect to receive $1.32 in revenue from the sale of chickens, eggs and pigs.

If the Government of Kiribati prefers to maximise the revenue created by the facility, it might consider shutting down pig production altogether and focus entirely on chicken production. The analysis suggested that the facility would generate $0.21 in extra revenue per dollar invested if it were to pursue this strategy. However, the analysis was only concerned with the financial feasibility of the proposed options and the benefit of increased food security from the production of pig stock, for example, is not included. Further study into the wider economic impacts of pig production is required before the Government of Kiribati and its development partners can make a truly informed decision.

3.2 Preliminary Cost Benefit Analysis of a Biogas Digester – Case Study in the Solomon Islands (Rios Wilks 2014)

3.2.1 Introduction

The Choiseul Integrated Climate Change Adaptation Programme (CHICCHAP) aims to reduce the vulnerability of the Lauru people of the Solomon Islands to natural hazards, food insecurity and climate change threats. To support this, the Solomon Islands Government has proposed encouraging the adoption of swine manure digesters in villages across Choiseul Province. The idea is that treated swine manure could be used to fertilise crops while also providing biogas as an alternative to kerosene and reducing harmful pig sewerage run off. Drawing on an already existing demonstration digester in Honiara, a preliminary CBA examined the economic dimensions of digesters in Choiseul.

3.2.2 Key messages

The analysis observed that little real monitoring and evaluation of digesters has occurred or been documented in the Pacific. Drawing on what little data was available, the analysis suggested that losses might be expected in every year the digester of a specific size is in operation. In fact, to breakeven the digester would require more manure than is plausibly available. On the other hand, because little monitoring and evaluation of digesters in the region has been reported, the effect of digestate on agricultural yields is unknown and therefore not quantified. Similarly, the potential health benefits of spreading safer fertiliser are unquantified due to there being no data. This means that the value of digesters is underestimated. If these additional benefits are positive, the benefit-cost ratio would increase from the value presently calculated: 0.74.

Considering the need for better monitoring and evaluation when contemplating bio-digesters in the future, the analysis provides a template for quantifying digesters' impacts in Choiseul. The 'data collection plan' details information which must be collected in order to monitor and evaluate the outcomes of the project effectively and provide a more thorough economic assessment of the demonstration digester. If enacted, the plan would assist the Solomon Islands Government in making an informed decision on whether to pursue the policy throughout the province.

3.2.3 Methodology

The wellbeing of the community without the digester was compared to the potential wellbeing of the community with the digester. The costs and benefits were totalled in each year, converted to their present day value using a discount rate of 10% and aggregated in order to determine the final contribution of the digester to the community. Constrained by data limitations, the analysis provided only preliminary estimates of the effect of a demonstration digester.

3.2.4 Possible technical issues

The Taiwan Technical Mission already runs one 15-swine digester at their Honiara site. The specifications for this facility were used as the basis for the economic analysis. At the facility, each adult pig produces 3kg manure/day for a 5m3 digesting tank which produces enough gas to power a single hob cooking burner for one hour each day. The slurry mixture spends approximately 2 weeks in the digester before being removed as effluent, stored for a few months and then used to fertilise crops.

Given the limited suppliers of tanks in Honiara and the few personnel able to assist in setting it up, the CHICCHAP digester was assumed to be identical to that used by the TTM. However, it is unlikely that sufficient manure will be collected from villages, most of which do not own 15 swine. Less manure means weaker gas pressure, increasing the length of time required before a burner can be powered effectively and reducing the digester's potential benefits.

3.2.5 Assumptions and uncertainties

A total of 15kg of manure from five swine was assumed to be fed to the digester every day so it runs efficiently all year round. Collecting the manure, filling and maintaining the digester was expected to require one hour of labour per day at a rate of SBD 7.69 per hour. All of the methane produced in the digester was assumed to be burnt by cooking hobs which run 100% efficiently. Following previous studies, the benefit of carbon emission reduction was quantified using a monetary value of USD 5.90 per tonne. All quantified impacts were expected to remain constant over time and are discounted at a rate of 10%.

The cost of rearing the pigs from which the manure is collected was not included in the analysis, only the presently quantifiable benefits and costs of the digester demonstration project are. The analysis yielded an underestimation of the overall impact of the digester.

3.2.6 Results

The quantified benefits were biogas use and the resultant emissions reductions. Combined, these totalled SBD 2,212 in the first year and SBD 2,613 for all future years the digester is operational. The costs quantified were those of construction and the labour required to keep the digester running. These were higher than the quantified benefits both in year 1 when they totalled SBD 10,845 and in all future years when they total SBD 2,807.

Aggregated over a 50 year period, the calculated benefit-cost ratio equalled 0.74; for each SBD invested, only 74 cents might be expected in return. Without sufficient values for the benefits associated with digestate, the project would not be expected to breakeven. In fact, given the costs and benefits quantified in the analysis, the digester would have to be supplied with 20 to 30 kgs of manure per day to breakeven. This is well above what is plausible.

3.2.7 What if?

When swine manure is in abundance the CBA suggested that the digester would generate multiple benefits. However, pigs are in short supply at the study site and the digester is presently unlikely to be properly supplied with swine manure. Without access to the optimal volume of manure, the communities that choose to accept bio-digesters would therefore be unlikely to reap the full potential benefits of their use. The analysis suggested that a digester with requirements identical to the TTM's facility in Honiara, would require 30 kgs of manure from ten swine to breakeven over a five year lifespan. Without having a sufficient value for fertiliser benefits, a digester using 15kg manure per day would not be expected to breakeven, and losses would be expected to increase with every year the digester is running.

3.2.8 Conclusions and recommendations

The construction of a demonstration facility provides the Solomon Islands government with a good opportunity to assess the impact of introducing community bio-digesters to villages throughout Choiseul Province. The preliminary analysis recommends a number of measures that would provide a solid foundation from which to confidently estimate the value of community digesters. Considering the lack of empirical data, governments and donors should appraise bio-digester projects in the Pacific. The lessons from this activity are likely to support improved policy in the region in general, not just Choiseul Province.

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