# Ecosystem Service Assessment and Cost-Benefit Analysis of Ecosystem Based Adaptation Options for Wotho Atoll, Republic of the Marshall Islands

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## Introduction

This report describes the results of two economic analyses for Wotho Atoll, Republic of the Marshall Islands: 1. An ecosystem service assessment, which measures the importance of ecosystem services to the livelihoods and welfare of the islanders. It quantifies the economic value of ecosystem services and assesses the level of dependence on them as a proportion of total income; 2. A Cost-Benefit Analysis (CBA) of two climate change adaption options and potential combinations to evaluate the net economic benefits of these investments to the Marshall Islands.

## Site description

Wotho Atoll is a small, hot and dry atoll in the Ralik chain of the Republic of the Marshall Islands. Wotho is comprised of three large and fifteen small islets around a large lagoon, and the largest island houses the community of Wotho. The islanders practice agroforestry and catch fish for subsistence purposes, and there is some trade of copra and handicrafts. Imported goods supplement the resource harvesting and islanders have salaried positions with the government, such as local council and teaching at the school. The atoll has experienced climate change effects, most notably a drought in 2013/2014 that required government assistance to manage, and Typhoon Gay in 1992 that leveled all households (MICS, 2016).

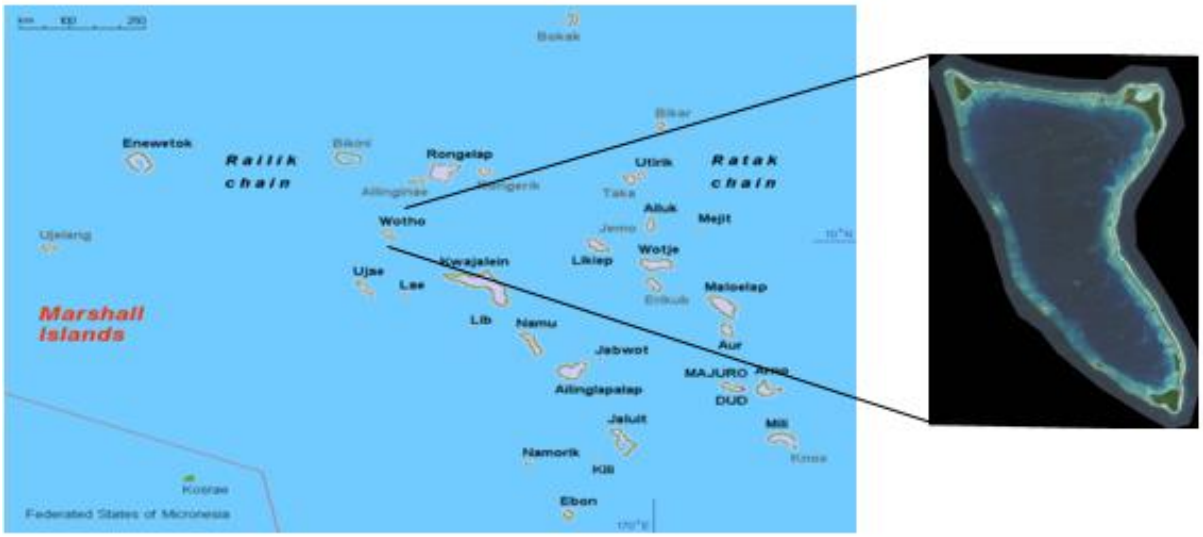


Figure 1. Map of the Republic of the Marshall Islands and Wotho Atoll

## Household survey

To gather data for use in the ecosystem service assessment and Cost-Benefit Analysis-benefit analysis, a socio-economic survey was administered to the community of Wotho. The survey was comprised of 22 questions in both English and Marshallese and designed to take around 20 minutes. The survey asked questions on demographics, income, resource use and dependency, environmental threats and asked for opinions on specific adaptation options. The questions used were taken from surveys administered in other BMUB case study sites and the Reimaanlook socio-economic survey applied earlier in Wotho to maintain consistency and comparability with previously gathered data.

Wotho was visited on January 19th by Martin Romain of Marshall Islands Conservation Society (MICS), who trained a local enumerator and explained the survey to the community. The enumerator surveyed 19 households over three days with an average survey time of 51.4 minutes. The surveys were then sent back to Majuro and phone appointments were held to fill in missing or incomplete responses.

Based on the survey data, the island is home to 109 people, 48, or 44%, of which are children in 19 households. Of the surveyed population, 89% were male and 11% were female and the average age of the respondent was 44. The population distribution is shown in Figure 2. The survey was intended as a census, and so one person from every household was interviewed. The household list included a few residences where people had moved or were off-island, and these were skipped.

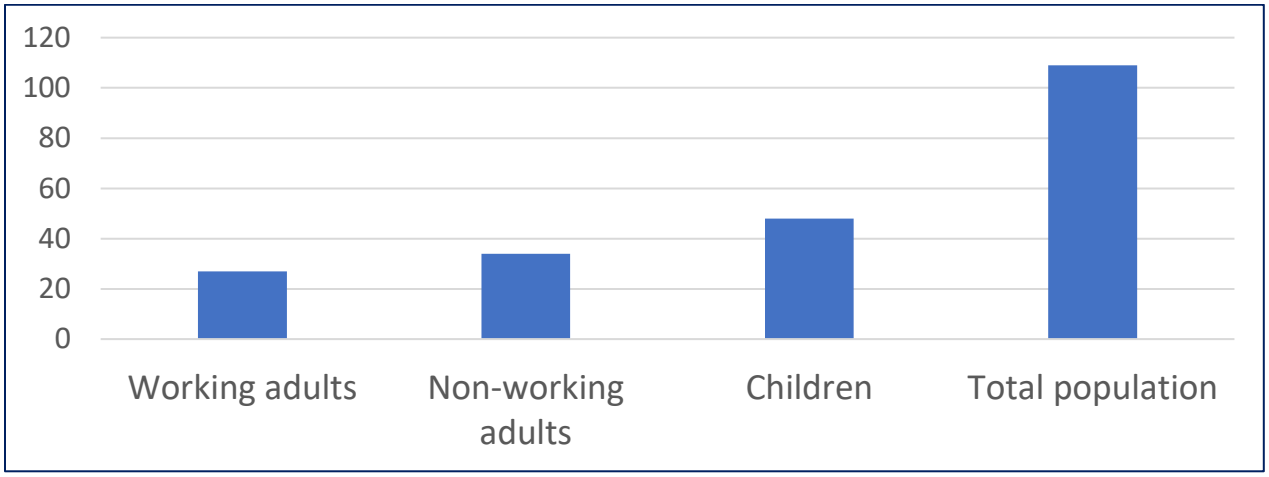


Figure 2: Population distribution

The average monthly income recorded was $341 with 58% of households choosing the options '$249 or less'. The primary sources of income were selling copra (95%), handicrafts (53%) or salaried income (68%). Of the salaried income, positions recorded there were 3 teachers, 4 involved in the local government/council, 2 church officials and three maintenance workers. Figure 3 shows the income distribution.

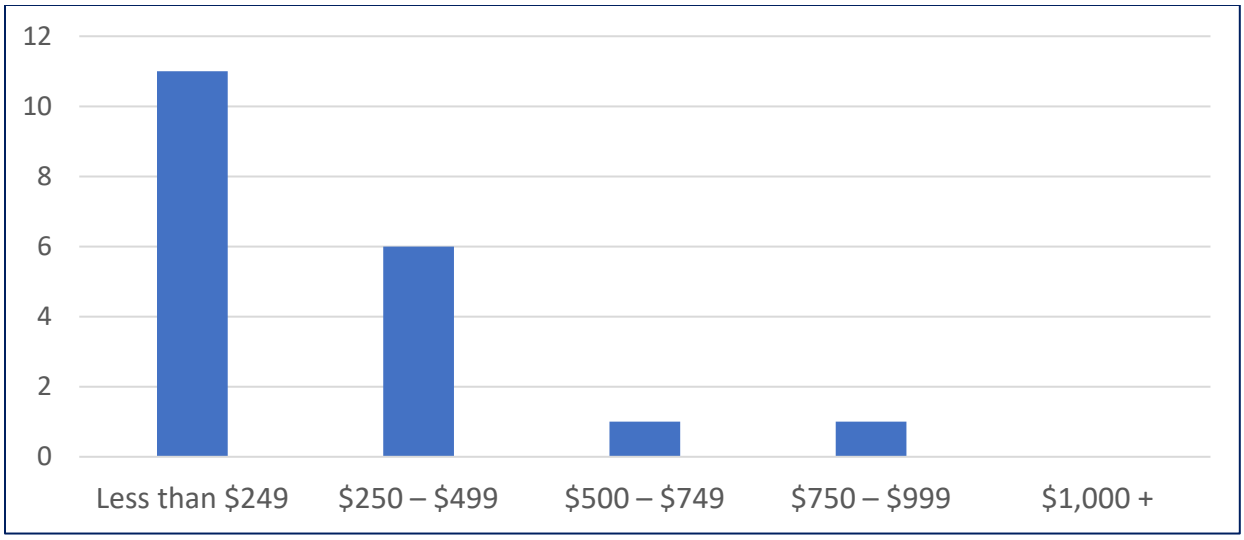

Figure 3: Income distribution

## Ecosystem Service Assessment

### Ecosystem services

The concept of ecosystem services defines the natural world in terms of the goods and services provided to human populations. This conceptualization is a useful way to analyze, communicate, quantify and even monetarily value the environment (de Groot et al., 2002). Ecosystem services are grouped into four categories; provisioning, regulating, cultural and supporting. These categories differ in function, but all are necessary for human life and well-being. Provisioning services involve resources that are harvested, such as food, water and raw materials. Regulating services maintain habitable ecosystems for humans, animals and plants, including soil, air and water regulation. Cultural services encompass benefits from education, recreation, spirituality or aesthetic value from the environment. Finally, supporting services are the underlying services necessary for life such as soil formation, genetic diversity, biodiversity and habitat (MA, 2005). Table 1 gives an overview of the ecosystems and ecosystem services in Wotho atoll. Even on such a small island, the environment provides many benefits both terrestrial and marine, and many of these ecosystems are highly coupled. The ecosystem services were identified by interviews with local experts and consultation of reports and literature.

Table 1: Ecosystem services on Wotho Atoll

| Ecosystem | Category | Services |
|---|---|---|
| **Forest & agroforest** | Provisioning | Food, raw materials, medicinal resources |
| | Supporting | Genetic diversity, habitat for species |
| | Cultural | Spiritual, education, recreation |
| | Regulating | Local climate, carbon sequestration, soil erosion & soil fertility, pollination, coastal protection, water regulation |
| **Coastal zone** | Provisioning | Raw materials |
| | Supporting | Genetic diversity, habitat for species |
| | Regulating | Soil erosion, coastal protection, water regulation |
| **Lagoon** | Provisioning | Food, raw materials |
| | Supporting | Genetic diversity, habitat for species |
| | Cultural | Spiritual, education, recreation |
| | Regulating | Coastal protection, water regulation |
| **Coral reef** | Provisioning | Food, raw materials |
| | Supporting | Genetic diversity, habitat for species |
| | Cultural | Spiritual, education, recreation |
| | Regulating | Carbon sequestration, coastal protection, water regulation |
| **Open ocean** | Provisioning | Food |
| | Supporting | Genetic diversity, habitat for species |
| | Cultural | Spiritual, education, recreation |

After identifying ecosystem services, these services can be economically valued. The value that natural systems provide to humans are often not considered in monetary terms. Fish and wood may be harvested without any cost, and clean air and water may be consumed without any consideration of the value. By pricing these services, it can be made clear to policy makers and communities the degree of benefits provided by the environment, and this information can be used to make more effective and well-informed decisions (Holland, 2014). Valuing ecosystem services is done in a number of ways, depending on the service. Some services, most commonly provisioning services, are traded on traditional markets and can be quantified using market prices (Everard & Waters, 2013). For example, the value of fish harvested as food can be calculated using the market price of fish. However, most services are not directly valued and so indirect techniques must be used. In this report, direct valuation is used in order to quantify the economic value of provisioning services on Wotho atoll, while regulating, cultural and supporting services are discussed qualitatively.

## Provisioning services

The household survey in Wotho asked respondents to describe their income and resource harvest and use patterns. This information was analyzed and the average monthly income and resource use is shown in Table 2. The income reported is dependent on natural resources (copra and handicrafts) and provisioning services provide much of the subsistence needs for the households on Wotho. Table 2 shows the average monthly quantities of income categories and resource harvests, alongside the average monthly value.

Table 2: Average income and provisioning services, quantities and values

| | | Average monthly amount per household | Average monthly value per household (US$) |
|---|---|---|---|
| **Income** | *Total income* | ---------- | 341.32 |
| | Copra | 3.22 bags | 193.16 |
| | Handicrafts | 1.84 handicrafts | 9.22 |
| | Salary | ---------- | 139.10 |
| **Provisioning services** | Open ocean fish | 24.4 fish | 121.45 |
| | Reef fish | 200 fish | 249.55 |
| | Breadfruit | 24.5 fruit | 36.81 |
| | Pandanus | 3.5 fruit | 35 |
| | Water – well | 232.11 gallons | ---------- |
| | Water – rainwater catchment | 262.89 gallons | 394.34 |
| | Water – reverse osmosis | 146.84 gallons | ---------- |
| | *Total provisioning services* | ---------- | 837.15 |

As a proportion of total household income, the value of provisioning services accounts for 88% of income and salaried employment accounts for the remaining 12% (see Figure 4). The population of Wotho is significantly dependent on provisioning services for its livelihood.

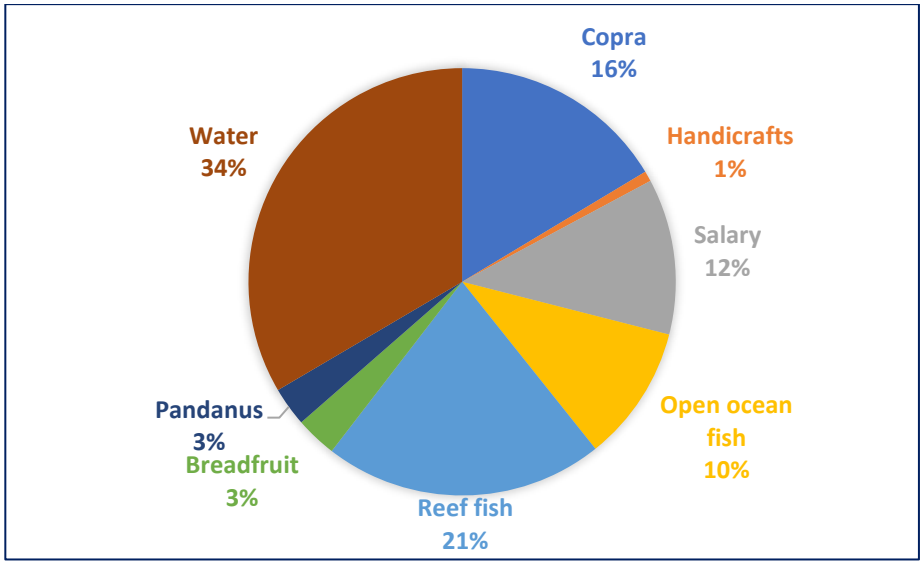


Figure 4: Relative contribution of provisioning services to household income

It should be noted that many resources do not have a monetary value on Wotho atoll; most harvested goods are not bought and sold (besides copra and handicrafts). Most food harvested is consumed by the household, shared or traded amongst neighbours. Attaching a monetary value to these resources shows the hidden values of the environment on Wotho. If the provisioning services on the island were compromised, this could be devastating as the islanders

are reliant on these services for food, water and income. Since income from other sources (e.g. salaried employment) is limited, it is not possible for households to rely on monetary income to replace environmental services. In 2016 during a poor harvest year, the island relied on government drought relief supplies to compensate for limited breadfruit and islanders have expressed worry that current agroforestry is insufficient to keep the island population fed (MICS, 2016).

## Other ecosystem services

Beyond provisioning services, regulating, cultural and supporting services play important roles in the livelihoods of Wotho islanders. Though harder to valuate economically, these critical services are highlighted in Table 3. Evidence for these services come from the socio-economic surveys, key informant interviews and literature.

Table 3: Regulating, cultural and supporting services on Wotho Atoll

| | Ecosystem service | Evidence | Source(s) |
|---|---|---|---|
| **Regulating services** | Coastal protection | 79% of households have experienced effects of flooding. Islanders recall numerous flood events, most notably Typhoon Gay in 1992. Pandanus are planted for coastal erosion protection | Household survey, key informant interviews. Quataert et al. (2015), MICS (2016). |
| | Water regulation | 95% of households have experienced effects of drought. Wells tapping into groundwater are a source of household water usage accounting for 29% of daily water use. | Household survey, key informant interviews. Elevitich, Ragone & Cole (2014). |
| | Climate regulation | Agroforestry is practiced on the atoll islets. | Household survey, key informant interviews. Elevitich, Ragone & Cole (2014). |
| **Cultural services** | Spiritual / cultural | Traditional foods, legends and rituals are linked to environmental resources. | Household survey, key informant interviews. Petrosian-Husa (2004), Williamson & Stone (2001). |
| **Supporting services** | Soil formation/ primary production | Coral atolls have little topsoil, maintaining soil is critical for plant matter, animals and humans to survive. | Key informant interviews. Elevitich, Ragone & Cole (2014). |

Regulating services are vital for Wotho, as the atoll relies on coastal ecosystems for protection from storms and king tides. Almost 80% of households experienced damage from flooding, and the sandy coastline is at risk from erosion. Some households have used palm fronds or vegetation as a buffer for sand erosion. The fringing coral reef and lagoon play a role as marine buffers to wave events and high tides. Small islands and atolls have limited water resources, and 95% of the islanders reported negative impacts from drought. After a severe drought in 2013/2014, the

government assisted in increasing the rainwater storage capacity and introducing a reverse osmosis treatment system. These measures suggest the freshwater regulation and storage on the island is insufficient to meet the needs of the current population. Small scale climate regulation occurs as trees and dense canopy cools the ground and air. Protecting the marine, coastal and terrestrial environment can help bolster these regulating services and improve the resilience of Wotho.

Cultural services are reliant upon the environment as many legends, rituals and daily activities involve nature. Pandanus leaves are dried and then woven into handicrafts.

The supporting service most relevant to Wotho Atoll is soil formation and primary production. Atolls are formed on coral substrate, and the production and retention of organic matter and soil is a key prerequisite to life and livelihoods on the island (Baker et al. 2011). Other important supporting services include nutrient and water cycling and photosynthesis.

## Cost-Benefit Analysis of adaptation options

### Cost-Benefit Analysis methodology

Cost-Benefit Analysis (CBA) is the most commonly used economic assessment method for evaluating and comparing investments, projects and policies. In appraisals of potential public investments CBA is used as a method in which the societal costs and benefits of alternative options are expressed and compared in monetary terms. CBA provides an indication of how much a prospective project or investment contributes to social welfare by calculating the extent to which the benefits of the project exceed the costs – essentially society's 'profit' from a project.

The main steps in performing a CBA are presented in Figure 5. These steps are described below:

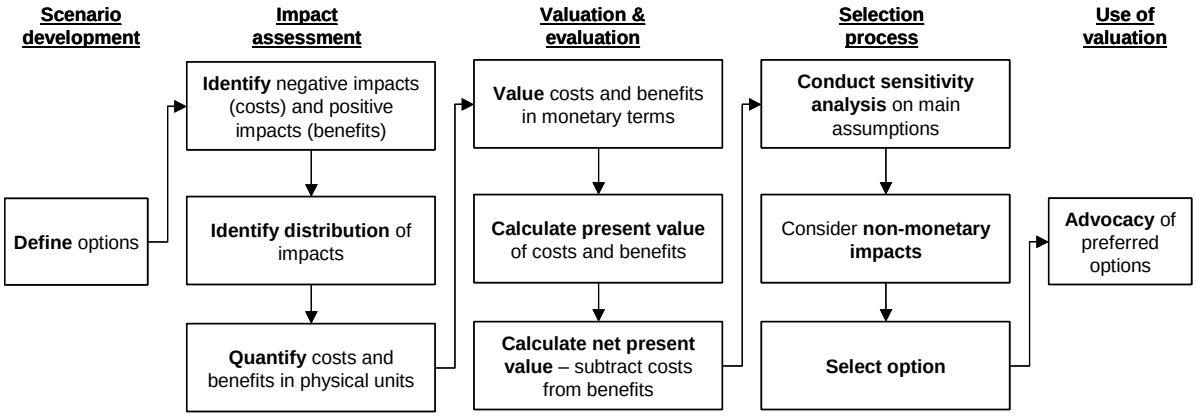


Figure 5: Methodological steps in cost-benefit analysis (source: Brander and van Beukering, 2015)

The first step in a CBA is to identify the alternative options or alternatives to be considered. The process of identifying climate change adaptation options for Wotho is described in the next section.

The impact assessment in a CBA starts with the identification of the complete set of negative impacts (costs) and positive impacts (benefits) related to the intervention options under consideration. This includes costs and benefits accruing to all affected groups and individuals (not just those involved in the project development) and costs and benefits that are incurred in the future. The final step in the impact assessment phase is to quantify each cost and benefit in relevant physical units for each year in which it occurs. The methods used for assessing costs and benefits for the climate change adaptation options for Wotho are outlined in Appendix 1.

To conduct a CBA, all of the quantified positive and negative effects need to be expressed in monetary units. In cases where costs and benefits are not directly observable in monetary terms in well-functioning markets (as is the case for many ecosystem services), estimates can be generated using non-market valuation methods or value transfer. After estimating annual values, the time-series of costs and benefits are converted to present values (PV), which involves discounting and summing values that occur in future years.

The economic performance of each alternative option can be calculated using two different statistics:

1. The net present value (NPV) of each option is calculated by subtracting the present value costs from present value benefits. A positive NPV indicates that implementing a project will improve social welfare. The NPVs of alternative investments can be compared in order to identify the most beneficial project;

2. The benefit cost ratio (BCR) is the ratio of discounted total benefits and costs, and shows the extent to which project benefits exceed costs. A BCR greater than 1 indicates that the benefits of a project exceed the costs.

## Climate change adaptation options for Wotho

Community consultations carried out by the Marshall Islands Conservation Society (MICS) as part of the Local Early Adaptation Planning (LEAP) process identified two adaptation options for Wotho: 1. Sustainable fish market; and 2. Marine protected area (MPA). The two options are proposed with the intention to improve resilience by offering a new income source, while protecting the natural resources with sustainable regulations and protections. A fish market feasibility study was conducted by Mark Stege of MICS and a technical Kabin Meto fishery status and health report by Andrew Jarett and Dr. Peter Houk of the University of Guam, but steps towards implementation have not been taken. Also a costing of MPA establishing and maintenance across the Marshall Islands has been done by Mark Stege and Scott Walsh as part of the Micronesia Challenge Sustainable Finance Plan.

The fish market has been proposed to be established in Ebeye to provide an alternative means of income for Wotho fisherman, and the proposition necessitates a new shipping and transportation route from Kabin Meto islands (Wotho, Lae and Ujae) to Ebeye. This would increase adaptive capacity and improve access to social networks available on Ebeye and among Kabin Meto atolls. Ebeye is the second most populated island in the Marshall Islands and is close

to the American military base on Kwajalein. Ebeye is an under exploited market for fish, making it a suitable destination for a fish transport and sale scheme (Stege, 2018). Presently, trading boats to Wotho only come once every three months and are not equipped to transport fish, which must be kept frozen. Although waters of Wotho have yet to be used for commercial fishing, other neighboring atolls have experienced commercial fishing conducted by the Kwajalein Atoll Fish Market Center (Stege, 2018). However, establishing a fish market would require substantial setup costs to buy the necessary equipment and technical expertise to ensure proper management and establish proper regulations (i.e. fish size limits).

The marine protected area is suggested as an addition to the fish regulations and as a way to permanently protect part of Wotho's marine resources, which would be especially critical if commercial fishing begins. The proposed marine protected area would increase a traditional fishing closure area (called mo). A fishery health analysis has suggested four zones for the Wotho lagoon, including a commercial fishing zone, an expansion of the mo, retention of the current mo and a subsistence only fishing zone, shown in Image 1 (Jarett & Houk, 2018).

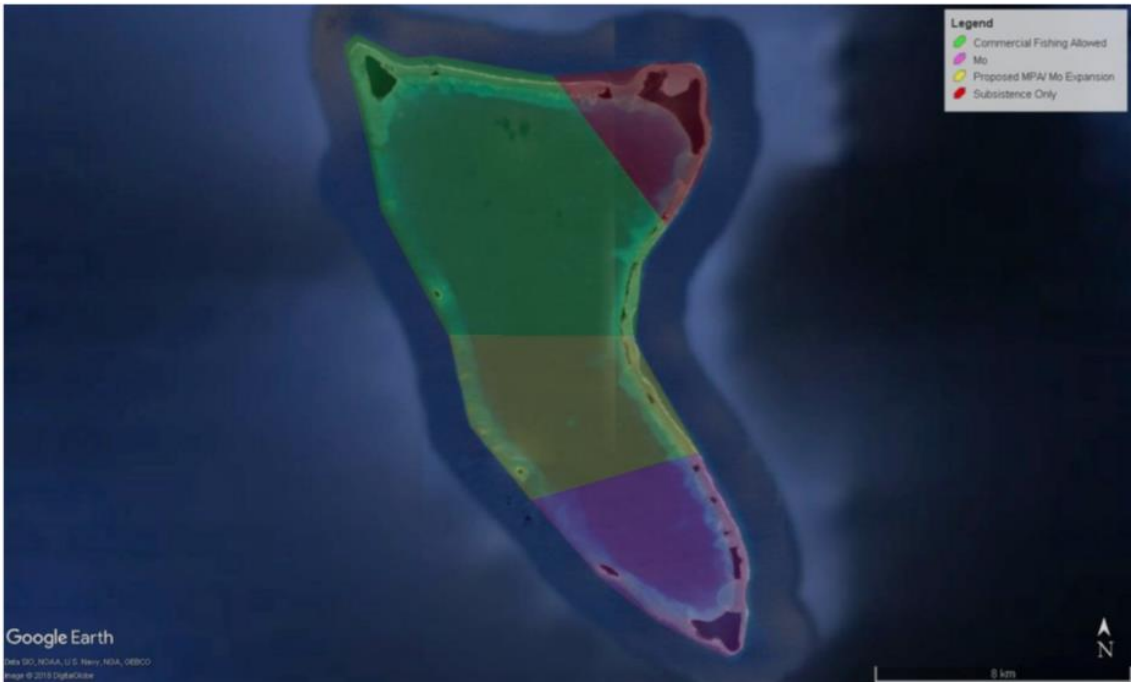


Image 1: Proposed marine protected area (MPA) zones for Wotho Atoll. Source: Jarett & Houk, 2018

## Cost-Benefit Analysis results

The results of the CBA for the two adaptation options are summarised in Table 4 and represented in Figures 6-7

Table 4. Cost-Benefit Analysis of climate change adaptation options

| | **Fish market** | | **Marine protected area** | |
|---|---|---|---|---|
| Description | Commercial fishing program, including shipment of catch to Ebeye | | Expanded protected area to cover 52.03 km2 of Wotho lagoon | |
| Time horizon | 2018-2050 | | 2018-2050 | |
| Costs (US$) | Set up<br>Operation | -48,450<br>-81,300 | Set up<br>Operation | -122,788<br>-396,929 |
| Total costs (US$) | | -129,750 | | -519,716 |
| Benefits (US$) | Fish catch | 129,572 | Fish catch | 10,845 |
| Total benefits (US$) | | 129,572 | | -396,929 |
| NPV (US$) | | -179 | | -508,871 |
| Benefit-Cost Ratio | | 1.0 | | 0.2 |
| Co-benefits not included in CBA | Education; enhanced connectivity via more frequent boat trips; ability to sell more copra and handicrafts; connection to social networks | | Coastal protection; biodiversity; genetic diversity; carbon sequestration; education; primary production | |
| Key messages | • Fish market produces similar costs and benefits in this analysis, however some benefits are not calculated.<br>• Costs are detailed and specific for the fish market, including large initial purchases for boats and equipment.<br>• Benefits beyond fish catch income are not shown – considering the benefits of increased connectivity could raise the benefits substantially.<br>• The costs are mostly capital investment and maintenance costs, which could be subsidized by the government, which would mean benefits are concentrated for islanders | | • Marine protected areas are costly to set up and enforce, and the benefits in Wotho for improved fishery health are minimal.<br>• Economic benefits of fish spillover from MPAs is small, but conservation has many other benefits that are not easily monetized.<br>• The proposed MPA is not bordering the village, however the healthy reef would still contribute to stability and protection.<br>• The value of an MPA would increase if tourism were promoted to the biodiverse reef. | |

Figures 6 show the costs, benefits and net present values of the fish market adaptation option, and Figure 7 depicts the marine protected area. Both figures show the high costs of the adaptation options, while the fish market supports higher benefits.


Figure 6: Fish market total costs, benefits and net present value (US$; 5% discount rate)

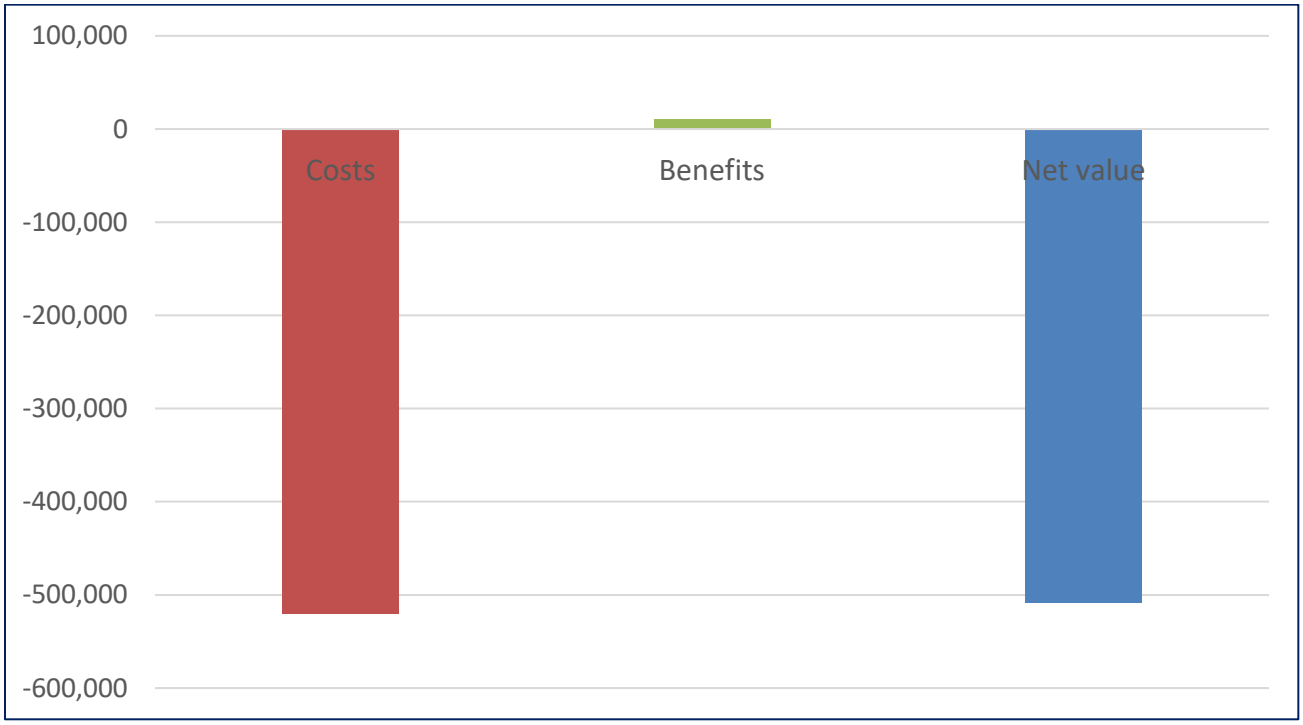


Figure 7: Marine protected are total costs, benefits and net present value (US$; 5% discount rate)

Figure 8 compares the costs and benefits of the fish market and MPA adaptation options. The MPA has fewer costs than the fish market, but also produces far fewer benefits, generating a negative net value. The comparison shows that the options vary in scale of costs and benefits, though neither are found to have a significantly positive net present value.

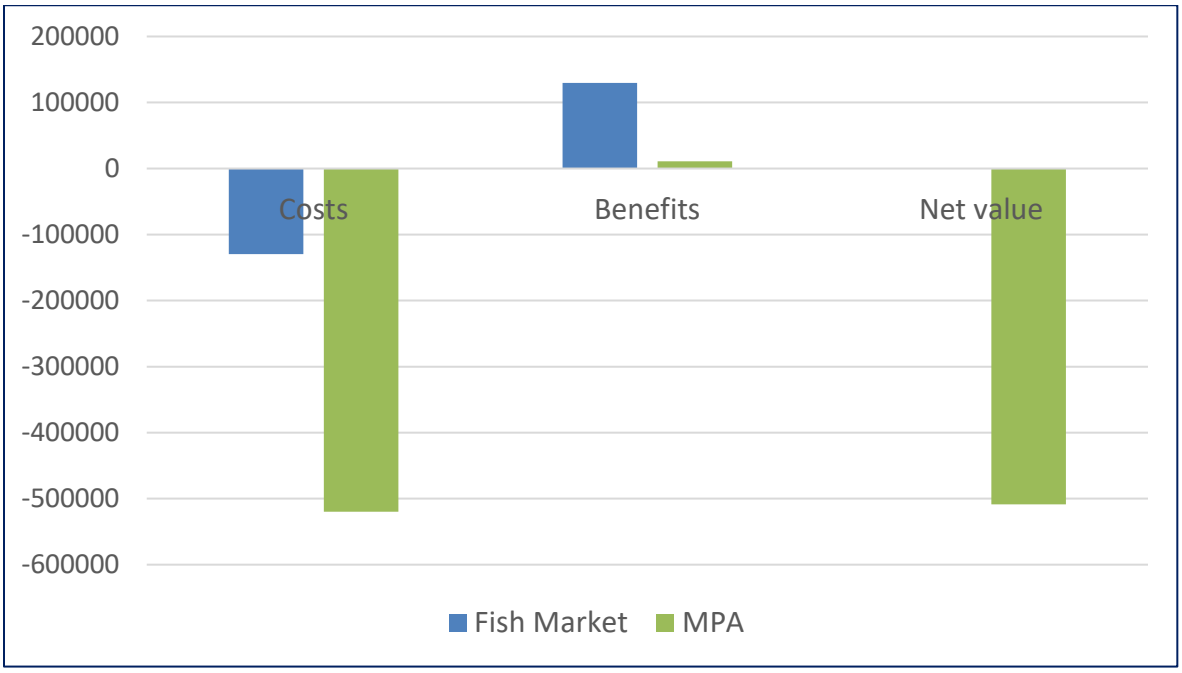


Figure 8: Comparison of costs, benefits and net present values for climate change adaptation options (US$; 5% discount rate)

Although the Cost-Benefit Analysis can be used as a comparison tool and as a decision support tool, there are some effects not captured by the analysis. Cost-Benefit Analysis translates effects into monetary values, but not all impacts can be easily quantified in monetary terms. Distribution issues, for example, are not shown in the figures above. Considering the fish market, the costs are mainly for buying boats and commissioning boat trips to deliver fish to Ebeye. These costs require capital investment that would have to be supported by the government or other organizations. The benefits would then mostly be received by the fishermen, who would gain a new source of income. Deciding who participates in fishing with these newly purchased boats could be an issue. The CBA calculations were done for four boats each with four fishermen, however the household survey suggests there are 61 adults on Wotho. If only 16 people could fish at any given time, there would have to be policies or systems to support fair distribution of resources. Community cooperation is required to ensure benefits are shared, and there is a risk of unfair distribution of costs and benefits. The increased connectivity due to more frequent boat trips to Wotho would benefit the entire island. This connection is difficult to value, but the community has already stressed a desire to be better connected to resources and support systems on other islands (MICS, 2016).

The marine protected area, on the other hand, applies to the whole island and the costs are more uniformly distributed. For the marine protected area, the time horizon is key as the benefits expected (improved fish catches beyond the MPA boundaries) are not anticipated to be noticeable for at least 10 years. Beyond distributional issues, the analysis shows that engaging in conservation management is costly and may not produce immediate or obvious economic benefits. However this CBA is limited in scope to fishery health and spillover benefits, which does not capture the full scale of benefits provided by marine protected areas such as biodiversity, genetic diversity, coastal protection and more.

The two adaptation options suggested for Wotho present a unique opportunity for combination, as they both seek to manage and utilize the marine resources in a sustainable way. Figure 9 shows the combinations available with these two adaptation options, with two possible aggregations. The orange bars represent a synergistic combination, whereas resources and knowledge are shared by the MPA and fish market managers and participants. For example, the boats required for the fish market could be used as MPA monitoring vessels when fishing is not occurring, and visits by external organizations could be consolidated to save money. The purple bars depict a scenario where the fish market and MPA are occurring at the same time, but separately. Between the pure MPA, combined MPA and fish market, and concurrent MPA and fish market, the combination scenario is the most preferred. This analysis suggests, that if the MPA is pursued as a conservation goal, the addition of the fish market could be a way to reduce costs or increase benefits for the community.

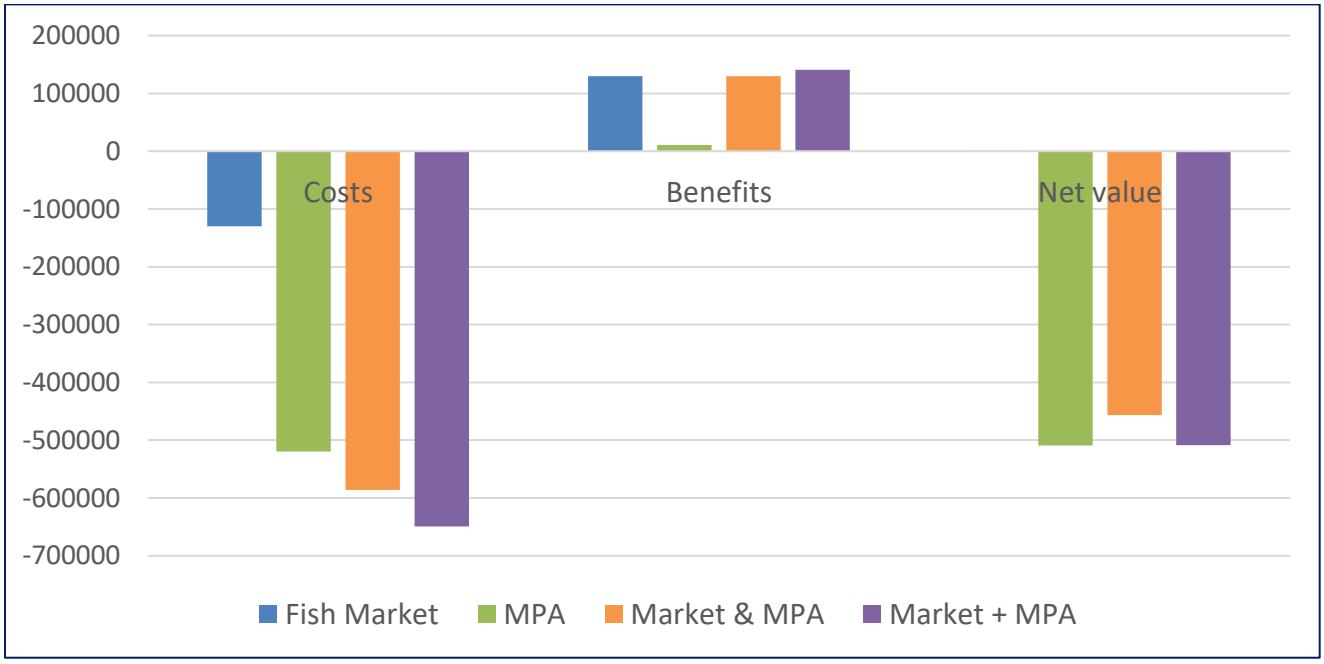


Figure 9: Comparison of costs, benefits and net present values for climate change adaptation options (US$; 5% discount rate)

A discount rate of 5% was used to compute present values of the costs and benefits summarized above. The process of "discounting" future impacts is used to represent society's preference for the timing of costs and benefits. A higher discount rate places a greater importance or weight on present and near future impacts relative to impacts that occur further in the future. Social discount rates can be very low, potentially even zero, to reflect the value of ecosystem services or other benefits for future generations. Private or individual discount rates can be high, reflecting impatience and potentially high returns on alternative investments (Salcone, Brander & Seidl, 2016). In order to examine the influence of the choice of discount rate on the results of the Cost-Benefit Analysis, we conduct a sensitivity analysis using a lower rate (3%) and a higher rate (10%). Figure 10 shows the net present values for the two adaptation options when a 3%, 5% and 10% discount rate is applied.

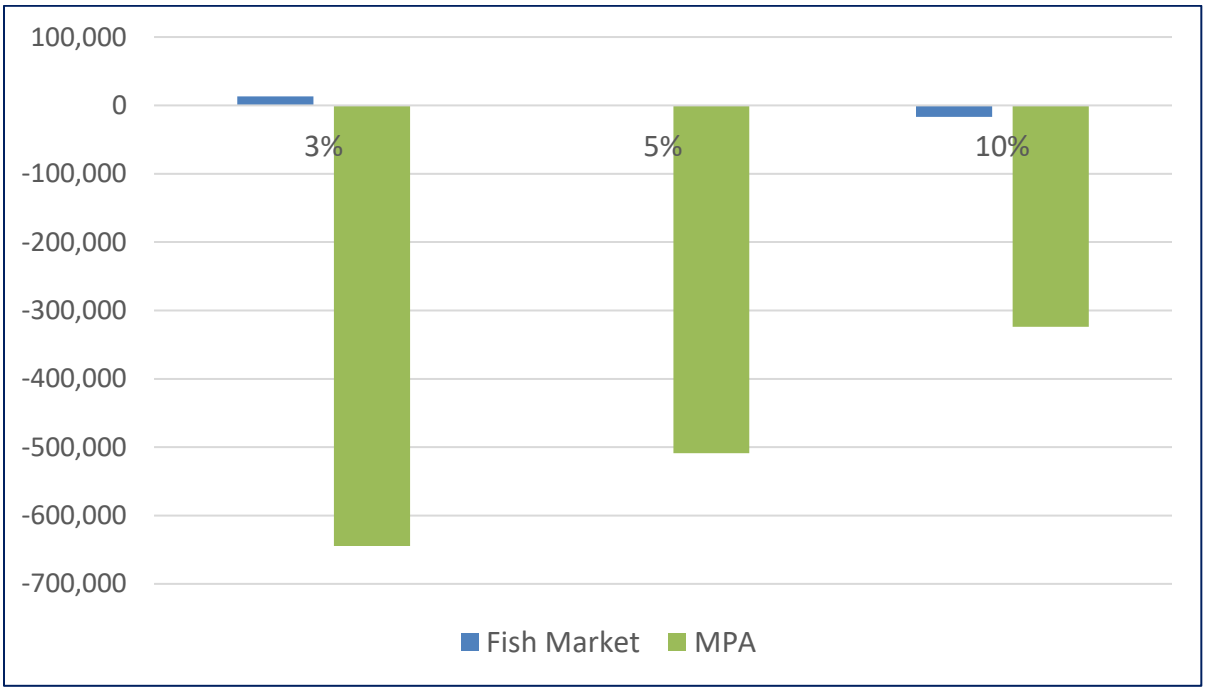


Figure 10: Comparison of net present values for climate change adaptation options (US$; varying discount rates)

When considering a low discount rate of 3%, the net present value for the fish market increases as the future benefits are given more weight. The MPA sees a lower net present value since the future operation and management costs are given more weight, which increases the costs. When adopting a higher rate of 10%, the net present value drops for the fish market, due to the high setup costs. The MPA option, on the other hand, improves due to reduced weighting on future management.

## Conclusions and recommendations

The Wotho atoll community is reliant on ecosystem services for their resource use and income. After applying an ecosystem service assessment to the atoll, it was found that over 88% of the monthly income and resource value were attributed to the natural environment. This assessment is useful as it demonstrates the dependencies and importance of natural systems to wellbeing. If the environment would be degraded or harmed, the island community would be negatively affected by a reduction in income and resources. These negative effects could be gradually caused by unsustainable use or climate change effects, or occur suddenly after a damaging event such as an oil spill or typhoon. The results of the ecosystem service assessment advocates for sustainable use and protection of Wotho's environment. The community and government should choose policies and projects that support the natural ecosystem, such as replanting of vegetation, sustainable fishing practices and preservation of coastal shrubs and seagrasses.

The Cost-Benefit Analysis applied in this report compared two proposed adaptation options for the Wotho community. Neither of these adaptation options have been implemented, however community focus groups and discussions, as well as scoping reports, have been prepared for both. The fish market initiative was found to have a benefit-cost ratio of approximately 1, suggesting the costs and benefits would be similar. However when considering the added benefits that are not easily quantifiable, such as improved access to markets, social networks and support, the market becomes more economically attractive. On the other hand, the marine protected area proposal is found to have a very low net present value. This is partially due to the difficulty of valuing biodiversity and other indirect benefits of the MPA, and high establishment and management costs. The MPA costs are prohibitively high, due to a comprehensive plan including monitoring, staff salaries and yearly visits by external organizations. Since the community is small and close knit, an alternative MPA plan may be better suited, and less costly, for the atoll.

The natural environment of Wotho contributes to the livelihoods of the approximate 100 people who live on the island. These islanders have high dependence on their natural ecosystems, which should be sustainably managed to preserve their resources and improve their resilience. Two adaptation options were suggested for the atoll, which aim to provide additional income sources and also conserve the critical marine environment. The fish market adaptation option is found to be economically viable, while the MPA proposal has a negative net present value. However, if these adaptation options are combined, along with measures to reduce the high costs of MPA management, perhaps a synergistic adaptation plan can be designed for the atoll. If efforts to increase food security and adaptive capacity through investments in fishing can be paired with conservation and sustainable management, the marine ecosystem of Wotho can better serve the community. If any adaptation option is implemented, monitoring of the actual costs and benefits will help improve the accuracy of the analysis, and serve as a case study for replication on other atolls in the Marshall Islands or other Pacific islands.

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Appendix 1. Methods for assessing costs and benefits

| Adaptation option | Costs | Benefits |
|---|---|---|
| Fish market | Fish market costs include the investment costs for the three extra boats needed to supplement the single boat already on Wotho. The operation costs include the material costs for fishing (fuel, maintenance), opportunity cost for the fishermen and the transport costs for the fish. The transport includes boat crew, fuel and ice. There is also a cost function of unregulated fishing, represented by a yearly decrease in fish value. | The fish market benefits include the increased income from the sale of fish to the Ebeye fish market. The benefits are calculated for four fishing boats with four fisherman each. It was suggested that the transport to Ebeye would occur four times a year. |
| Marine protected area | The costs for the MPA include establishment costs such as planning, salaries for facilitators, airfares and per diems. Workshop and meeting costs, fuel and boat hire, printing of and translation of materials. Additional purchases include a monitoring boat, snorkeling gear, uniforms, radio equipment and building a meeting house. The operation and monitoring costs include conservation officer salaries, ongoing external support and maintenance of equipment. Yearly visits by facilitators are also included in costs, accounting for airfare, per diem and workshop materials. | The benefits for the marine protected area are focused on the increase in fish catch supported by the protected marine areas. This effect is included but only occurs after 10 years, which is the estimated time needed for spillover effects to be recorded. |