# Cost–benefit analysis of the emergency 'grab bag' programme

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*Another successful rescue of three fishers at sea occurred on 4 March 2018 in Tuvalu after they activated the personal locator beacon (PLB) from their emergency 'grab bag', which has been promoted by the Pacific Community (SPC)[4] and supplied by the Tuvalu government. There have now been at least four known successful rescues of vessel crews since the grab bags were distributed in Tuvalu in 2015. This article presents the findings of a cost–benefit analysis of the grab bag programme. It demonstrates that the grab bag programme has excellent value for money and leads to significant cost savings and social benefits. The results call for an expansion of the programme throughout the country and Pacific Islands region more broadly to ensure fisher safety in a cost-effective manner.*

## Introduction

Coastal resources are an important source of the Pacific region's nutrition, food security, culture, employment, and recreational activities (SPC 2017a). In Tuvalu, 74% of households engage in reef fishing and the estimated annual coastal fisheries production is over 1400 tonnes, which is worth AUD 2.3 million (Gillett 2016). Small vessels[5] are not only used extensively by people of the Pacific Islands countries and territories (PICTs) for commercial and subsistence fishing, but also commonly used for inter-island transportation and recreational diving (Gillett 2016). Given the intensity of their activity in the region, most maritime incidents[6] are associated with small-scale fishers (SSFs) and small vessels (Danielsson et al. 2010; Gillett 2003). For example, a collation of records obtained from the civil registry, health departments, news reports and police reports of incidents at sea within the last 10 years in Fiji and Kiribati showed that at least 58 incidents occurred in Fiji and 28 incidents in Kiribati[7]. The collated data showed at least 58 deaths, 54 missing and 129 people rescued at sea in Fiji, and at least 80 deaths, 97 missing and 41 people rescued at sea in Kiribati during this period. In Tuvalu, five incidents were reported to the Fisheries Department and seven deaths at sea were captured in the civil registry and health records within the last five years. However, incidents remain poorly recorded in PICTs and many more incidents are probably unreported, particularly those associated with SSFs and small vessels.

Local fishers are typically exposed to numerous risk factors for incidents at sea including bad weather, engine failure, fires, improper vessel construction, overloading, prolonged trips, and limited safety equipment or training.[8] In Tuvalu, the high dependence on single outboard skiffs and widely dispersed islands compound these challenges. In addition, overfishing alongside a range of environmental and ecological stressors has forced SSFs to switch their effort from harvesting reef and coastal species to the more abundant oceanic resources, especially where they can be found relatively close to shore (Adams 2012). This increases the safety risks as the fishers are not visible from land and are often out of mobile signal range. The low-lying topography in Tuvalu is particularly important in this regard.

Measures that improve sea safety[9] are crucial as most PICTs have limited resources to conduct extensive search and rescue (SAR) operations and rely on foreign assistance (SPC 2013). Gillet (2003) estimates the actual cost for SAR activities by PICTs may be between USD 0.75 million to USD 1 million (2003 prices). The New Zealand Government expenditure for SAR for the 2016–2017 year included NZD 2.639 million by the New Zealand Defence Force and NZD 6.624 million by the Rescue Coordination Centre New Zealand, which both conduct SARs in PICTs (New Zealand Search and Rescue Council 2017).

To improve sea safety, the emergency grab bag programme has been implemented throughout the region. The use of grab bags has been spearheaded by SPC since the mid-1990s to ensure SSFs have essential equipment in a compact bag to signal for help and ensure survival in the case of an

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[4] See http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon_17_safety_grab_bag.pdf
[5] In this article, small vessels refer to locally based boats of up to eight metres in length. Small-scale vessels are defined as <7 metres in Tuvalu.
[6] 'Incident' refers to any occurrence on board a vessel, involving a vessel, or associated with the activities of a vessel at sea, which 1) causes death or injury to any person, or, 2) whereby the vessel is lost or presumed to be lost at sea (adapted from Danielsson, Kuyateh, Ravikumar, Westerberg and Yadava, 2010; International Maritime Organisation, 2008). 'Incident' is preferred over 'accident'.
[7] Research findings of Carah Figueroa's internship project.
[8] See SPC Sea Safety Information Bulletins: http://coastfish.spc.int/en/publications/bulletins/sea-safety
[9] 'Sea safety' refers to the preparations and activities associated with safely returning a vessel to its home village, island or port at the conclusion of a trip without outside assistance (FAO 2004).

emergency. Table 1 and Figure 1 lists the contents of the SPC emergency grab bag[10]. Safety gear provision is an integral part of a holistic approach to sea safety that encompasses standards for vessels, trained personnel, incident reporting systems, and safety objectives in fisheries management.

The grab bag programme was introduced in Tuvalu in 2015 by SPC, which prompted the Tuvalu Fisheries Department (TFD), along with other funding partners, to procure and distribute more bags to fishers. Besides the provision of bags, the programme also provides training to fishers on

Table 1. Contents of an SPC emergency grab bag for motorised small vessels (numbering also relates to Figure 1).

| Safety item | Description |
|---|---|
| 1 Floating emergency grab bag | Water-proof bag used to store all of the above items; it should of a size large enough to store additional items such as tinned food, water bottles, a knife, some light fishing tackle and a few basic tools |
| 2 Manual inflatable lifejackets | Very light-weight and compact personal flotation device that may be inflated by either activating a self-contained $CO_2$ cartridge or by exhaling through a blow tube |
| 3 Sea rescue streamer | Signalling-device used at night or in foggy conditions to attract the attention of nearby boats as well as aeroplanes |
| 4 Whistle | Signalling-device used at night or in foggy conditions to attract the attention of nearby boats |
| 5 Mirror | Signalling-device used during day-time to attract the attention of nearby boats, as well as aeroplanes and people on the coast |
| 6 Rescue laser flare | Long-range, AAA battery-operated laser device used at night to attract the attention of nearby boats as well as aeroplanes; the rescue laser flare favourably replaces flares or parachute rockets, although the later may still be required under national sea safety regulations |
| 7 Personal locator beacon (PLB) with built-in global positioning system (GPS) [7] | When activated the PLB transmits a signal with the beacon's ID and vessel position to the nearest rescue coordination centre (RCC) |
| 8 Strobe light | AAA battery-operated, waterproof, flashing light that is visible for a long distance at night and lasts longer than flares and parachute rockets |
| 9 Batteries | AAA-size dry cell batteries used in portable electronic devices such as the hand-held GPS, VHF radio, the strobe light and rescue laser flare |
| 10 Hand-held VHF radio (waterproof) | Multi-channel, two-way radio (can transmit and receive) that enables boat-to-boat and boat-to-land communication; the operating range is 5–10 nautical miles in open water and distress signals should be sent on channel 16 (international calling frequency for distress messages) |
| 11 Map compass | A device used to determine geographical direction and consisting of an horizontally mounted magnetic needle that is free to pivot until aligned with the Earth's magnetic field |
| 12 Emergency blankets | Very low-weight, low bulk first-aid blanket made of heat-reflective plastic sheeting; it reduces the heat loss in a person's body and because of its large metallic surface, it can be used as an improvised signalling device by drifters if the sun is shining or as a locator-beacon by searchers |
| 13 Mobile phone | Useful communication tool in areas with adequate mobile phone coverage; does not allow boat-to-boat communication with unidentified/unknown boats and, from a legal point of view, does not replace the VHF radio |
| 14 Hand-held GPS | Navigation device that uses the GPS and relies on a network of satellites to give the user's a geographical position; it increases the safety of boat operators who are navigating at night or with poor visibility and, in a distress situation, the exact geographical position of the vessel is known and can be given to the rescue team using the VHF radio or mobile phone |
| 15 Medical kit | Box or bag containing medical supplies and tools to give emergency medical treatment to a sick or injured person on board |
| 16 Sea anchor or drogue | Device, usually made of canvas, deployed upwind of the vessel to keep the vessel heading into the wind and to slow its drift; unlike a conventional bottom anchor, the sea anchor can be deployed whatever the depth of water |

[10] See more about the grab bag in the recent leaflet here: http://www.spc.int/DigitalLibrary/Doc/FAME/Brochures/Anon_17_safety_grab_bag.pdf


Figure 1. The safety grab bag and its contents (images: Jipé Le-Bars, SPC).

how to use and maintain the grab bag contents. Since its introduction, grab bags have played a role in at least four known successful rescues of small vessels. Given the notable success of the grab bag programme in Tuvalu, this article outlines a cost–benefit analysis (CBA) of the grab bag programme, which was undertaken for this country, in order to highlight the benefits arising from the positive commitment that Tuvalu has shown, and to provide a case for greater investment by the governments of other PICTs. By doing so, the CBA also provides supporting evidence for greater awareness and prioritisation of the safety of SSFs and small vessel operators across the Pacific Islands region.

## Methods

A CBA framework was used to assess whether investment in the grab bag programme was justified based on the expected changes in direct financial and social costs and benefits resulting from increased sea safety. This CBA evaluated scenarios where an incident occurred and: 1) no grab bag was on-board resulting in death; 2) no grab bag was used and the fishers sustained injuries requiring treatment; and, 3) a grab bag was used resulting in an efficient rescue and minimal injury. These scenarios were established based on the following assumptions:

- 168 grab bags were distributed by the end of 2017, covering 44% of the fishing vessels in Tuvalu. Each vessel carries two to three fishers, all of whom are trained in the correct use and maintenance of the bag and its contents (James et al. 2018).
- The grab bag is expected to last five years (the length of the PLB warranty)[11].
- There were two rescues within a one-year period that involved four people in total in which a grab bag was used; therefore, it is expected that 10 rescues will to be linked to the use of a grab bag within five years (Poulasi 2017).

[11] The battery in the personal locator beacon is expected to last a minimum of six years


Figure 2. Tuvalu Pacific Patrol boat, *Te Mataili* (image: Tuvalu Fisheries Department).

Figure 3. New Zealand Air Force P-3K2 Orion Aircraft (image: NZDF and Maritime New Zealand).

- Both Tuvalu's patrol boat (*Te Mataili*) (Figure 2) and New Zealand Air Force patrol aircraft (Orion) (Figure 3) are mobilised when an incident occurs at sea where the distressed occupants of the vessel have no grab bag and thus no PLB is available. SAR activities are also performed by local community members, local police, and other foreign countries (e.g. by Australia or the United States of America); due to uncertainty these costs are not included in the CBA.

- Should a PLB from a grab bag be used, it is assumed the Orion does not need to be mobilised and only the local patrol teams are recruited and diverted from their current patrol duties.

- The search time for locating a vessel without a grab bag is estimated to be up to 20 hours longer than the search time for a vessel that has a grab bag (PLB activated), based on available media releases from relevant agencies (New Zealand Defence Public Affairs 2013, 2015; Poulasi 2017).

A CBA lists, quantifies, and monetises all potential costs, as far as possible, that will be incurred and all expected benefits in order to determine whether the benefits outweigh the costs invested for the programme. In this CBA, the costs and benefits were evaluated from a regional perspective. The grab bag programme costs cover the contents of bags, training, and radio awareness programme. The direct costs of the programme have borne by donor funding sources.[12] Costs data were obtained from TFD and SPC personnel or estimated from secondary sources (Asian Development Bank 2016; Kelleher 2002; Sharpe 1996; Tuvalu Fisheries Department 2017).

The benefits of the programme comprise the saved costs resulting from reduced SAR operations costs and reduced loss of life, as well as fewer serious injuries, including financial costs for treatment and health impact costs. SAR operation costs – including fuel, medical/hospital costs for treating injuries including drowning/near-drowning injury, burns or striking/crushing injuries – were estimated using

[12] The SPC and FFA's Development of Tuna Fisheries in the Pacific Project (DevFish2), the United Nations Development Programme's National Adaptation Programme of Action II project (NAPA II), and the New Zealand Aid Programme.

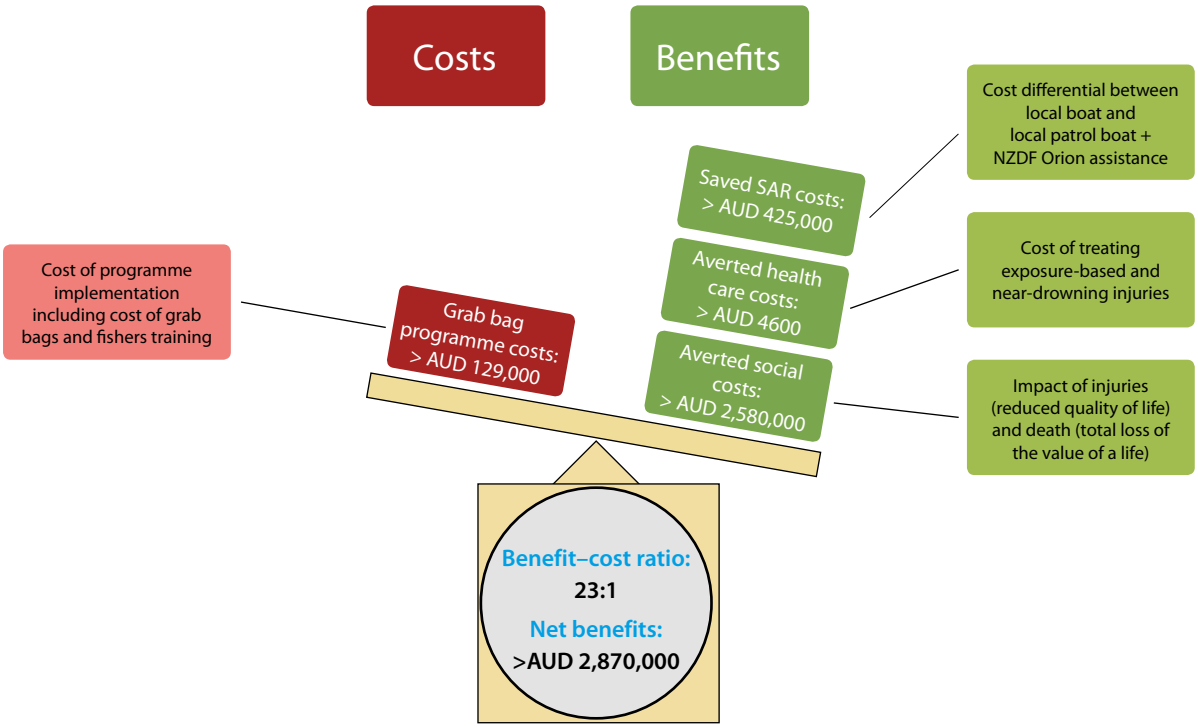


Figure 4. Cost–benefit analysis of one-year implementation of the grab bag programme in Tuvalu.

the available information from relevant agencies[13]. Other potential costs incurred such as vessel damage and costs of incident investigation, were not directly included in the model due to limited data availability. To measure the social costs, the value of a statistical life (VSL) measure was used. In the absence of Tuvalu-based studies, the VSL was calculated using an Australian meta-study and by transferring the values to the Tuvaluan context using GDP per capita purchasing power parity comparison as recommended by the World Bank (Access Economics 2008). Using this technique, the total VSL is calculated at over AUD 15,000 per year (assuming optimal health). Injuries have a disability weighting, which reduces this value for each year or part year that the injury is suffered. Future health impact costs were discounted at standard rates in order to estimate their present value. Other anticipated benefits such as the earnings and harvest of the fishers and vessel users, which are assumed to reflect the economic value of their productivity to society, were not directly included in the model.

The total programme benefits, net present value, and the benefit–cost ratio (BCR) were calculated. The total programme benefits equate to the sum of all the saved costs from injuries, loss of life and SAR costs. The net present value is the difference between the total programme benefits and direct programme costs. The BCR equates to the total programme benefits divided by the direct programme costs and represents the return per AUD 1 that is invested in the programme. A BCR of >1 means that the benefits outweigh the costs. The impacts of the programme were assessed over a one-year period of programme implementation.

## Results

Figure 4 details the estimates of the total costs, total benefits and social costs and social benefits of the grab bag programme. The total costs of the programme amount to over AUD 129,300 per year. The costs of SAR operations were estimated to be over AUD 9000 during the rescue where a grab bag is used (assuming only the local patrol boat is mobilised), versus over AUD 430,000 during the SAR of a fisher missing at sea without a grab bag (assuming New Zealand air force assistance is also recruited). Without a grab bag, the direct financial costs of treating injury incurred during the incident amount to over AUD 4600. The social costs of injury are over AUD 19,000. The social impact of total loss of VSL is valued at over AUD 2.14 million.

[13] German Agency for International Cooperation 2016; Toafa 2016; http://www.airforce.mil.nz/about-us/what-we-do/aircraft/orion.htm

The results of the CBA show that the grab bag programme is significantly cost-beneficial. A BCR of 23.20 means every AUD 1 society pays yields AUD 23.20 of benefits. The present value of the total monetised benefits of over AUD 2.87 million demonstrates the amount saved by society due to the grab bag programme in one year. Within a five-year timeframe, this equates to an undiscounted average amount of over AUD 14.36 million. If earnings and harvest of the fishers and vessel users were included in the model, the BCR would be expected to be higher than 23.20.

The model only included the estimated costs of treating a few injury types that are commonly sustained during incidents at sea. These costs are valuated only for the directly affected individual; the impact of the incidents on family members of the affected individual including loss of household income have not been valued. If the costs of other injuries and the costs to victims' families were included, this would increase the value of the programme benefits. The key assumptions have been sensitivity tested and the results are robust to this testing.

## Discussion

The CBA demonstrates that the grab bag programme has a positive social impact. This study benefited from having actual cost data on the programme as well as incident data. The CBA highlights a capital investment of the programme with potential benefits accruing in the following years, as longs as the battery in the PLB is replaced every five to six years. The current programme only covers 44% of the vessels in Tuvalu; hence, much greater benefits are foreseeable for distributing the bags to all small vessels in Tuvalu in terms of reducing the costs per bag.

The Tuvalu Fisheries Department is seeking a grab bag memorandum of understanding between fisheries, local government and fishers associations on every island. They hope to establish a land-based VHF station on each island to receive and rapidly respond to distress signals from fishers who are at risk at sea (Tuvalu Fisheries Department 2017).

Although the estimated programme costs and benefits were specific to Tuvalu, the findings are highly relevant to all other PICTs, where the number of active SSFs is high and for which sea incidents are a well-known concern. Scaling the programme to a regional level by providing grab bags to every local fisher or fishing community may be a worthwhile investment for donors, particularly from countries involved in SARs across the region, and governments for improved sea safety in PICTs.

Investment in the grab bag programme would promote the interests and vision of key search and rescue organisations in the Pacific Islands region. For example, the Pacific Search and Rescue (PACSAR) Steering Committee's[13] mission is, by 2021, for:

> the SAR capability of each PICT in the Pacific region, and of the region as a collective, has measurably improved in line with international standards and our success measures [for responsible SAR governance, efficient SAR coordination, effective SAR operational response, and SAR prevention] in order to respond to distress. (Pacific Search and Rescue Steering Committee 2016)

Similarly, the New Zealand Search and Rescue Council seeks:

> an informed, responsible, adequately equipped and appropriately skilled public who are able to either avoid distress situations or survive them should they occur... We will collaborate with, inform, and contribute to partner organisations and when required, enable, coordinate or lead public focussed SAR preventative strategies and actions in order to reduce the number and/or the severity of SAR incidents within the NZSAR region. (New Zealand Search and Rescue Council 2017).

## Conclusion and recommendations

The grab bag programme in Tuvalu, which comprises both distribution of the bags and training on the proper use and maintenance of the grab bag equipment, is highly cost-beneficial to society. The CBA found that AUD 1 invested in the programme can be reasonably expected to yield over AUD 20 of benefits, reflecting current net benefits for society of over AUD 2.87 million, and an undiscounted annual average amount of over AUD 14.36 million, in addition to saved household costs and improved productivity.

With an assessment of the resources available and the cost distribution, scaling up the grab bag programme in Tuvalu and in the Pacific Islands region should be considered by all other relevant stakeholders. The value of programme benefits, nationally and regionally, is crucial for the strengthening of small vessel safety together with complementary initiatives, which include the following: standard incident reporting procedures; small vessel safety regulations; vessel crew training; boat building standards; education for school children; awareness-raising for fishers, their families, and local community members; and, above all, the raising of political will to address small vessel safety in a holistic manner.

[13] The Pacific Search and Rescue (PACSAR) Steering Committee is a group of search and rescue agencies from Australia, Fiji, France, New Zealand, and the United States of America that manage major search and rescue regions (SARs) of the central and south Pacific regions.

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