

## Conserving womangroves: Assessing the impacts of improved cooking stoves on resource management in Langalanga Lagoon, Solomon Islands

Helen Maefasia Teioli<sup>1</sup>, Jan van der Ploeg<sup>1</sup>, Anne-Maree Schwarz<sup>2</sup>, Meshach Sukulu<sup>1</sup> and Hampus Eriksson<sup>1,2</sup>

### Abstract

Firewood harvesting is a major threat to mangrove ecosystems in Solomon Islands. Improved cooking stoves could reduce firewood use and thereby ease pressure on mangroves. We conducted a field-based experiment in Langalanga Lagoon to evaluate this theory of change. Our results suggest that the so-called 'kiko stove', an improved cooking stove that is widely promoted in Solomon Islands, is not more efficient than cooking on an open fire in terms of cooking time and wood consumption. Yet, women who use the kiko stoves perceive a number of benefits and think the stoves reduce mangrove degradation. Promoting kiko stoves can transform gender norms that inhibit community-based resource management, and thereby provide a starting point for the conservation and rehabilitation of mangroves.

Keywords: gender transformative approach, improved cooking stove, mangrove

### Introduction

Mangrove ecosystems have great economic and ecological value for coastal communities (McLeod and Salm 2006). In Solomon Islands, mangroves cover about 65,000 hectares (Warren-Rhodes et al. 2011). Mangroves are of critical importance for the food security of many coastal communities in the archipelago, directly through harvesting

marine invertebrates, and indirectly by sustaining coastal fisheries. Women especially make intensive use of mangrove forests, collecting a range of shells and crabs for food and to sell in local markets. The country's mangrove forests remain generally intact (Green et al. 2006). The main threats are land clearance for log ponds, timber harvesting and firewood gathering (Warren-Rhodes et al. 2011). In relatively densely populated areas such as the Langalanga Lagoon on Malaita (Figure 1) firewood gathering is an important driver of mangrove forest degradation (Goto 1996; MECM 2008; Albert and Schwarz 2013). Almost all rural households in the country rely on firewood as their main energy source for cooking (SINSO 2009; ADB 2015).

Since 2012 WorldFish has engaged with communities in Langalanga Lagoon to improve community-based resource management (Schwarz et al. 2013; van der Ploeg et al. 2016; Sukulu et al. 2016). People identify the ongoing degradation of mangroves as a major concern, and highlight the need for alternative energy sources (Albert and Schwarz 2013). Therefore, WorldFish facilitated a practical training on building improved cooking stoves in four communities in Langalanga Lagoon in 2015 in collaboration with Kastom Gaden Association (KGA; Figure 2). KGA is a Solomon Islands non-government organisation that is promoting the so-called 'kiko stove' (Kabu 2011a, b). The stove, made of clay and sand, wood ash and coconut husks, was designed by

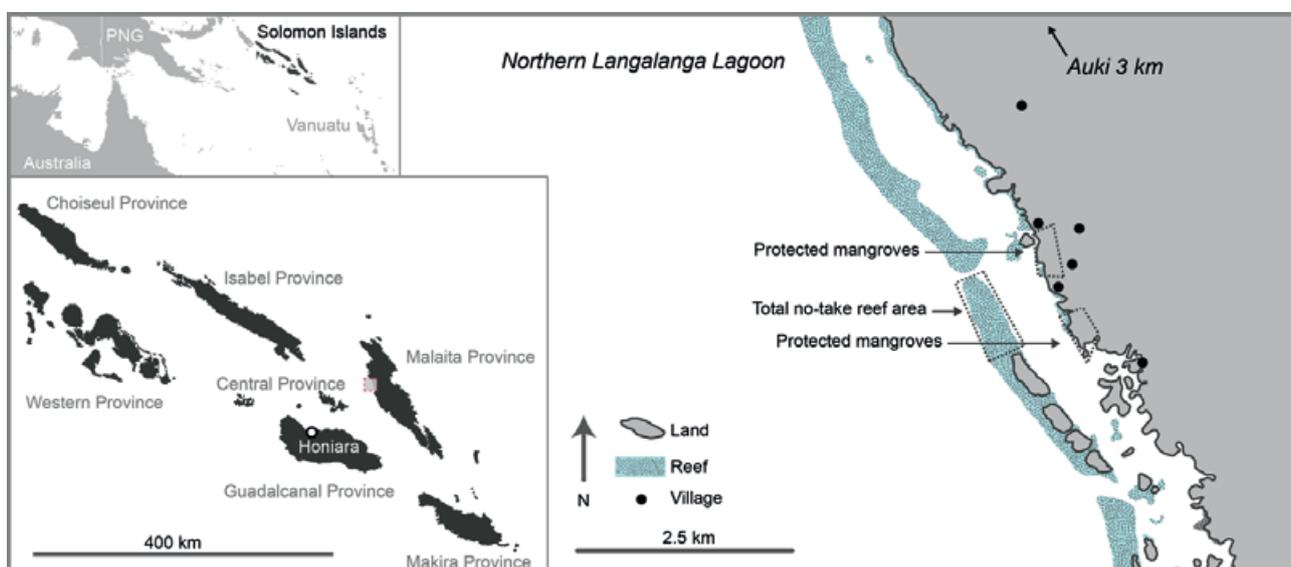


Figure 1. The Rarata locally managed marine area in Langalanga Lagoon.

<sup>1</sup> WorldFish, P. O. Box 438, Honiara, Solomon Islands.

<sup>2</sup> Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia.

a Japanese volunteer, Yukiko Kasuya; hence the name 'kiko stove' (R. Kabu pers. comm. 2017). The theory of change behind the training workshops was that the introduction of fuel-efficient stoves would reduce firewood collection and thereby reduce mangrove degradation in the lagoon (Sulu et al. 2015a: 17–18).

Improved cooking stoves are widely promoted in developing countries to address the 'global fuelwood crisis' (Manibog 1984: 199). In sub-Saharan Africa, where firewood and charcoal contribute over 90% of total energy demand, considerable resources are invested by national governments and NGOs to encourage households to use more efficient cooking stoves in order to reduce fuelwood demand and thereby counter deforestation (see for example Lasisi et al. 2015 on Nigeria; Malakini and Maganga 2011 on Malawi). Also in Asia and Latin America, improved cooking stoves are actively promoted to halt forest degradation (see for example Adiranzén 2013 on Peru; Granderson et al. 2009 on Guatemala; Hanbar and Karve 2002 on India).

The National Development Strategy 2016–2035, the strategic framework that guides all development policies and programmes of the Solomon Islands Government, aims to reduce the proportion of households for whom firewood is the primary source of energy for cooking from 97% to 80% by 2020, in order to prevent deforestation and restore degraded forests (SIG 2016). There is however very little information available on firewood use, cooking practices, or the views of people on alternative cooking methods. This paper explores the impact of improved cooking stoves in Langalanga Lagoon, and asks the question: does the kiko stove reduce the degradation of mangroves? In the next paragraph we describe the research methodology. We then summarise and discuss the results. We conclude that the causal links between kiko stoves, a decrease in firewood use, and reduced pressure on mangroves are tenuous. However, our experiences in Langalanga Lagoon suggest that the promotion of improved cooking stoves can contribute to mangrove rehabilitation: by recognising women as principal users of mangroves, highlighting women's domestic workload, and offering women an opportunity to learn new skills, the kiko stoves transformed gender norms that inhibit community-based resource management and provided a starting point for mangrove conservation.

## Methods

### Research area

The kiko stove training workshops were conducted from 2 to 10 November 2015 in four villages on Langalanga Lagoon: Radefasu, Oibola, Sita and Oneoneabu. The workshops were facilitated by two trainers from KGA with support from WorldFish and the community-based organisation OKRONUS (see Sukulu et al. 2016 for a detailed description of OKRONUS). Two hundred and twenty-six people attended these trainings: 137 women and 89 men. During the two-day workshops the participants constructed their own kiko stove: a total of 120 stoves were built. The total costs of the workshops amounted to SBD 14,614 (USD 1,850). This study concentrated on two villages: Radefasu and Oibola. Two ethnic groups inhabit the lagoon area: the bus pipol



**Figure 2.** (a) Collecting firewood in Langalanga Lagoon; (b) cutting firewood; (c) kiko stove; (d) kiko stove training workshop. Photos : Helen Maefasia Teioli

[bush people] from Kwara'ae and the solwata pipol [saltwater people] from Langalanga (Sulu et al. 2015b; Sukulu et al. 2016). Traditionally, the Kwara'ae inhabited the hills and the Langalanga lived on artificial islands constructed on the reefs and in the mangroves, but nowadays both groups reside in villages along the coastal road, such as Radefasu and Oibola. Women in the lagoon area depend heavily on the mangroves as a source of firewood, food and cash.

### Data collection

Data were collected using two different methods. First, we conducted face-to-face interviews with 30 women: 15 women who after the training started to use a kiko stove (the adopters) and 15 women who did not (the non-adopters). The interview focused on household livelihood strategies, cooking practices and wood consumption. We used Likert scales to assess the attitudes, views and perceptions of women on the kiko stove. Second, we conducted a field experiment in which we asked the adopters to boil one litre of water using a small kettle on a kiko stove, and the non-adopters on an open fire. We measured the initial water temperature with a thermometer and recorded the time it took to boil the water in minutes. The weight of the firewood was recorded (before and after cooking) using a digital scale.

All data were encoded into a Microsoft Excel spreadsheet. To compare the results of the field experiment we conducted an independent t-test using R software for statistical computing.

## Results

### Household size and literacy

Average household size in the two communities is six people (range 2–14). Fifty-seven per cent of the respondents said that their house accommodates five people or less. Fourteen per cent of the households are composed of more than 10 people. Seventy-three per cent of the respondents said that they could read and write. Twenty-seven per cent of the respondents did not attend school. Forty per cent of the respondents stopped going to school after finishing primary school (grade 6).

### Livelihoods

Gardening, fishing and livestock keeping (poultry and pigs) are key sources of income and food for the women in Radefasu and Oibola. All but one respondent cultivate their own gardens. Thirty-three per cent of the respondents fish on a regular basis. Twelve per cent are keeping pigs or chicken, mainly to earn cash for school fees. In Oibola most women earn cash by making shell jewellery. Only 13% of the respondents regularly travel to the market in Auki to sell products, such as shell jewellery, garden produce, home-baked buns or cooked fish. Only one woman had a regular income: she is a teacher.

### Firewood

Women use different mangrove species as firewood: dinale (*Lumnitzera littorea*) and kobleo (*Rhizophora stylosa*) are the most common. Other tree species include fata (*Vitex cofasus*), akwa (*Pometia pinnata*), kwa'u (*Bremna corimbosa*), dafa (*Terminalia brassii*) and ngali nut (*Canarium indicum*).

Coconut husk and sago palm stalks are also often used to make fire. Interestingly, most women (63%) collect firewood in the 'bush', i.e. secondary forests on the hills, and only 27% in the mangroves (Figure 3). The respondents in the two villages spend on average one hour per week collecting firewood. Typically, firewood gathering is seen as a women's job, but 27% of the respondents said that their husband helps with this task. In more than half of the cases firewood is collected by children (mainly girls). Twenty-six per cent of the respondents said that they have to ask permission from the landowners before they can collect firewood. Twenty per cent of the respondents regularly buy firewood from other people in the village. The type of firewood seems to affect the taste of the food: most women say that they prefer the taste of food prepared on mangrove firewood.

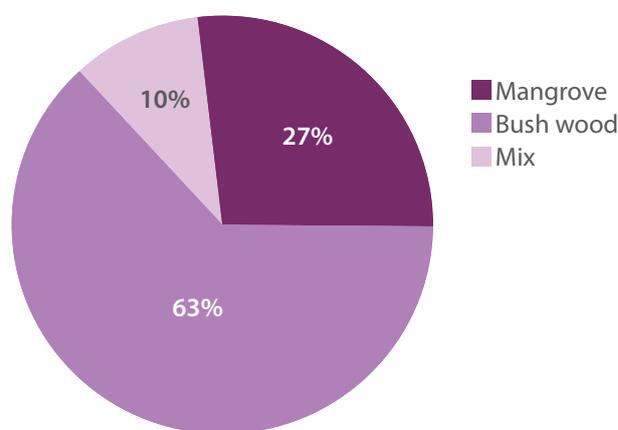


Figure 3. Source of firewood used by women in Radefasu and Oibola.

### Cooking

Women use a variety of cooking methods: open fire, hot stones, gas, charcoal and kerosene (Figure 4). All respondents say they cook on an open fire. Sixty per cent of the respondents also use the traditional Melanesian stone oven, motu, in which food is covered with hot stones and sealed with leaves. Most women regard the kiko stoves as a supplementary cooking method, not necessarily as a substitution for using an open fire. Women use an average of 5.26 pieces of split firewood, so-called 'sticks', per day (range 3–8). A stick is generally 50 cm long and 5 cm in diameter. Figure 4. Sources of energy for cooking used by women in Langalanga.

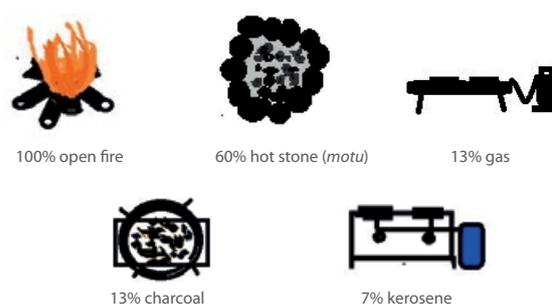


Figure 4. Sources of energy for cooking used by women in Langalanga.

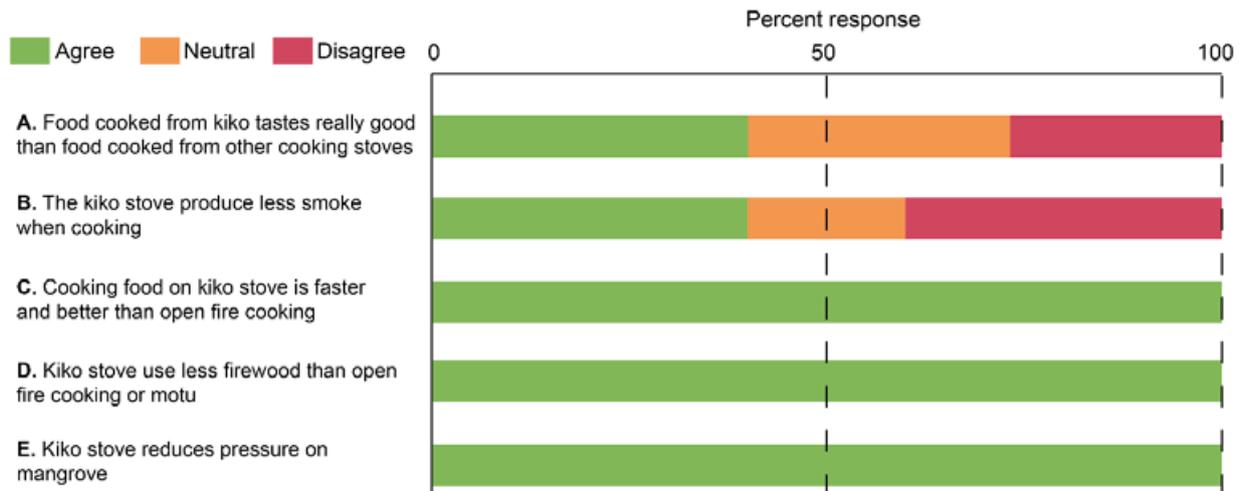


Figure 5. Women's perceptions of the kiko stove.

### The kiko stove

The women who adopted the kiko stove said that the stove reduces the burden to collect firewood ( $n = 15$ ). They also said that the stove reduces the time needed for cooking. Most of the women claimed that the stove enables them to cook more food using the same quantity of firewood (86.6%). Eighty per cent of the respondents said that the kiko stove improves the cleanliness of the cooking area, particularly because it produces less ash: "kiko no mekem mess" [a kiko stove doesn't make a mess]. We asked the respondents ( $n = 15$ ) if they agreed or disagreed with statements on: (1) the taste of food prepared on a kiko stove; (2) the amount of smoke produced by a kiko stove; (3) the efficiency of cooking on a kiko stove; (4) the amount of firewood needed; and (5) the impacts on mangroves (Figure 5). Opinions varied whether food prepared on a kiko stove tastes better than food prepared on other stoves: only 40% of the women agreed. The kiko stove seems particularly suitable for cooking rice: "kiko makes food taste really good. There is no smell. The rice dries up nicely." Only 40% of the women agreed with the statement that the kiko stoves produce less smoke. This is remarkable because an important additional reason to promote fuel-efficient stoves is to minimise indoor air pollution (WHO 2006; Clementh 2011). All women agreed with the statement that 'cooking food on kiko stove is faster and better than open fire cooking'. The women explained that the clay stove transfers heat slowly, enabling them to cook more than one pot: "the heat trapped in the kiko makes water boil faster". Similarly, all women agreed that the stove reduces the amount of firewood needed: "fo kiko iu no nidim staka faewud [for a kiko stove you don't need a lot of firewood]". "Kiko is easy: you don't have to cut firewood all the time" commented one woman from Radefasu. And all respondents agreed that the kiko stoves reduce pressure on mangroves.

### Cooking time and wood consumption

During the field experiments it took on average two minutes longer to boil the same amount of water on a kiko stove than on an open fire ( $t = 2.33$ ,  $df = 24.55$ ,  $p = 0.03$ ) (Figure 6).

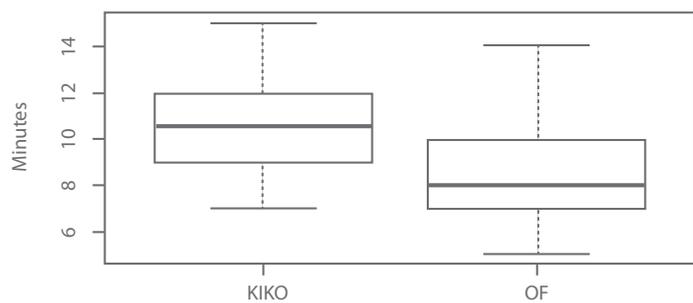


Figure 6. Time to boil one litre of water (kiko versus open fire,  $n = 30$ ).

Figure 7 shows that there was no significant difference between the amount of wood used by women to boil one litre of water on a kiko stove and on an open fire ( $t = -1.56$ ,  $df = 17.41$ ,  $p = 0.14$ ).

As women constructed their own stove there was considerable variation in the size and height of the stoves. It seems that kiko stoves that are higher use more firewood to boil the same amount of water than lower stoves ( $F(1, 12) = 5.13$ ,  $p = 0.04$ ). However, there was no significant relationship found between time to boil and height of kiko stove ( $F(1, 12) = 0.69$ ,  $p = 0.42$ ).

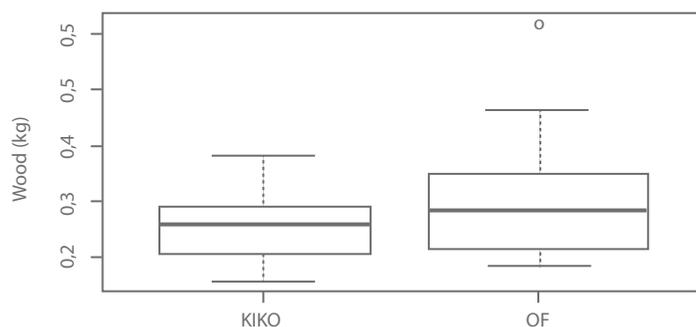


Figure 7. Wood (kg) needed to boil one litre of water (kiko stove versus open fire,  $n = 30$ ).

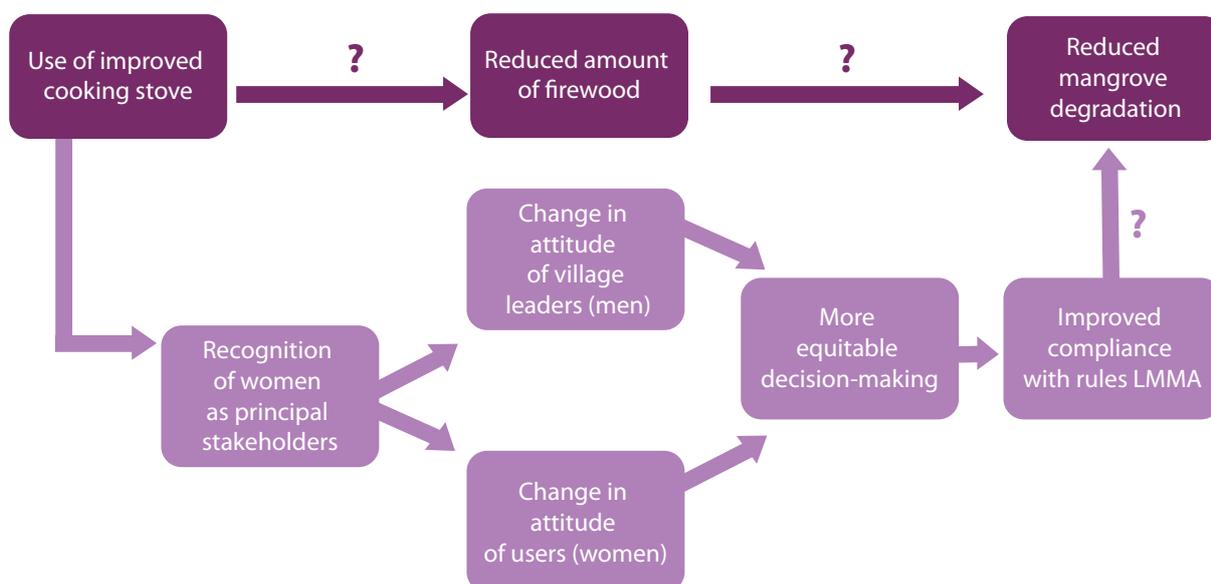
## Discussion: Conserving 'womangroves'

Women in Langalanga Lagoon, who after the training workshop started to cook on a kiko stove, say that they use less firewood and that this in turn leads to less pressure on mangroves. This seems to confirm the theory of change that the improved cooking stoves reduce the amount of firewood and thereby ease pressure on mangroves (Figure 8). However, we could not find evidence that cooking on a kiko stove is more efficient than cooking on an open fire. Clearly, the sample size of our field experiment is small, and the variation in height and width of the clay stoves could have influenced the measurements. But the proposition that a kiko stove reduces the amount of firewood used seems tenuous. Moreover, the insight that most women collect firewood in the bush and not in the mangroves further complicates the causal model linking improved cooking stoves to reduced mangrove degradation (Figure 8). Promoting kiko stoves therefore does not seem to be an effective strategy for mangrove conservation.

However, our experiences suggest that the kiko stoves did function as a catalyst for change in Langalanga Lagoon – but not in a way we anticipated. The kiko training workshops in the four villages underlined that mangroves are principally the domain of women. Whereas men fish on the reefs and at sea, women collect shells, crabs, mangrove propagules and firewood in the mangroves (SPC 2018; Kruijssen et al. 2013). In that sense, the word 'womangroves' perhaps better captures the gendered division of labour in the seascapes of Solomon Islands (Bosold 2012). Decisions about mangrove tenure and management are however typically made by men (Albert and Schwarz 2013). Externally supported initiatives often ignore and may unintentionally reinforce such power inequalities. For example, community consultations to discuss resource management often only involve men. Similarly, few women attend training workshops simply because the invitations are sent to 'community leaders' or 'heads of households', almost

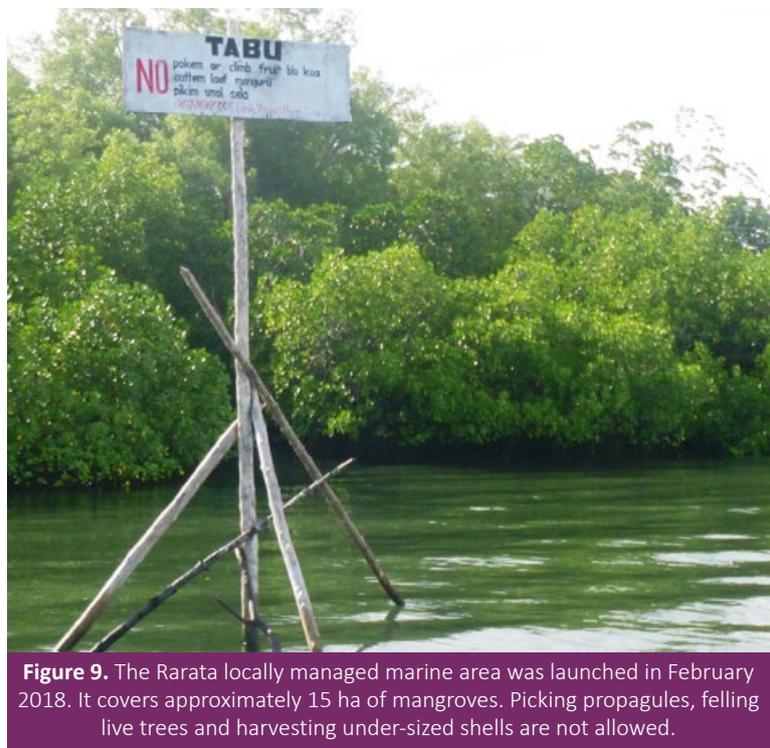
always men; or because the workshops are held in locations or at times when women cannot attend because of their household chores (Lawless et al. 2017). Clearly, this gender bias can undermine community-based resource management efforts, and may make the life of women harder (Schwarz et al. 2014; Blum and Herr 2017).

Our efforts to facilitate community-based resource management in Langalanga Lagoon were not an exception to this general pattern. OKRONUS, the community-based organisation that is spearheading efforts to conserve and rehabilitate mangroves in the lagoon, is led exclusively by men. Women attend meetings, but their participation is often cosmetic. In 2015 OKRONUS proposed a management plan for the mangrove areas around Radefasu, Oibola, Oneoneabu and Sita, which completely banned harvesting of firewood in the mangroves (Sukulu et al. 2016). The plan was met with scepticism during community consultations, and most women ignored the rule. The kiko stove changed this in two ways. First, the training workshops changed the attitudes of men. The OKRONUS leaders realised that women use and value mangroves in different ways, that mangrove management is primarily about and for women, and that without the support of women their plans to rehabilitate the mangroves were doomed to fail. They subsequently redesigned the management plan: the proposed locally managed marine area now covers a much smaller area and only bans the felling of live mangrove trees (Figure 9). Second, the workshops changed the attitudes of women. By specifically targeting women, recognising women's workloads and building the practical skills of women, the workshops generated much goodwill and support for the activities of OKRONUS among women. During the new round of consultations on the OKRONUS management plan in November 2017, many women in the four villages actively participated in the discussions about mangrove rehabilitation.



**Figure 8.** A theory of change logically links an activity to outcomes and impacts, usually in the form of a graphic model in which arrows posit causality. The kiko stove theory of change is shown in dark purple. An alternative pathway how improved cooking stoves could reduce mangrove degradation is highlighted in light purple.

As such, the kiko stove could reduce the degradation of mangroves in Langalanga, although in a more indirect way than was originally envisioned. Promoting improved cooking stoves can transform gender-biased decision-making processes that inhibit community-based resource management. Clearly, this is a small step in a much longer, non-linear journey (Cohen et al. 2014; Abernethy et al. 2014; Sukulu et al. 2016). It is unrealistic to expect that four training workshops will lead to significant changes in resource management in Langalanga Lagoon, nonetheless promoting a clay stove can be an effective first step to challenge deep-rooted ideas of men and women about how to conserve their womangroves.



**Figure 9.** The Rarata locally managed marine area was launched in February 2018. It covers approximately 15 ha of mangroves. Picking propagules, felling live trees and harvesting under-sized shells are not allowed.

## Acknowledgements

All authors planned the study together. Helen Teioli collected and analysed the data and wrote the manuscript. Johan van der Ploeg analysed the data and wrote the manuscript. Anne-Maree Schwarz initiated the mangrove work in Langalanga and reviewed the paper. Meshach Sukulu organised the training workshops and collected the data. Hampus Erikson analysed data, made the figures and reviewed the paper. The activities of WorldFish in Langalanga Lagoon were undertaken as part of the CGIAR Research Program on Fish Agri-Food Systems (FISH) and were funded by the ‘Strengthening community-based natural resource management to safeguard food security in Malaita Province’ project (ADB-SOL-7753) and the ‘Enhancing rural livelihoods while governing marine resources in Pacific Island countries’ project (SwedBio, a programme at Stockholm Resilience Centre).

## References

- Abernethy K.E., Bodin Ö., Olsson P., Hilly Z. and Schwarz A.M. 2014. Two steps forward, two steps back: the role of innovation in transforming towards community-based marine resource management in Solomon Islands. *Global Environmental Change* 28:309–321.
- ADB (Asian Development Bank) 2015. Solomon Islands country gender assessment. Mandaluyong: ADB.
- Adrianzén M.A. 2013. Improved cooking stoves and firewood consumption: Quasi-experimental evidence from the Northern Peruvian Andes. *Ecological Economics* 89:135–143.
- Albert J.A. and Schwarz A.M. 2013. Mangrove management in Solomon Islands: case studies from Malaita Province. Penang: WorldFish. 7 p.
- Blum J. and Herr D. 2017. Gender equity is key to mangrove restoration. [[www.iucn.org/fr/node/28839](http://www.iucn.org/fr/node/28839)]. Accessed on 26/06/18.
- Bosold A.L. 2012. Challenging the “man” in mangroves: the missing role of women in mangrove conservation. Gettysburg College Student Publication 14.
- Clementh. 2011. Kiko cooking stove and baking oven reduces kitchen smoke. Kastom Gaden Association. [[www.kastomgaden.org/2011/03/14/kiko-cooking-stove-baking-oven-reduces-kitchen-smoke/](http://www.kastomgaden.org/2011/03/14/kiko-cooking-stove-baking-oven-reduces-kitchen-smoke/)]
- Cohen P., Schwarz A.M., Boso D. and Hilly Z. 2014. Lessons from implementing, adapting and sustaining community-based adaptive marine resource management. Penang: WorldFish.
- Goto A. 1996. Lagoon life among the Langalanga, Malaita, Solomon Islands. *Senri Ethnological Studies* 42.
- Granderson J., Sandhu J.S., Vasquez D., Ramirez E. and Smith K.R. 2009. Fuel use and design analysis of improved woodburning cookstoves in the Guatemalan Highlands. *Biomass and Bioenergy* 33:306–315.
- Green A., Lokani P., Atu W., Ramohia P., Thomas P. and Almany J. (eds) 2006. Solomon Islands marine assessment. Honiara: TNC Pacific Island Countries Report No. 1/06.
- Hanbar R.D. and Karve P. 2002. National Programme on Improved Chulha (NPIC) of the Government of India: an overview. *Energy for Sustainable Development* 6(2):49–55.
- Kabu R. 2011a. KGA lead trainer continues training more women in kiko stove making. [[www.kastomgaden.org/2011/06/29/trainer-trained-woman-in-kiko-stove-making/](http://www.kastomgaden.org/2011/06/29/trainer-trained-woman-in-kiko-stove-making/)]
- Kabu R. 2011b. Kiko stove training at OISCA training center, Japan. [[www.kastomgaden.org/2011/07/20/kiko-stove-training-at-oisca-training-centre-japan/](http://www.kastomgaden.org/2011/07/20/kiko-stove-training-at-oisca-training-centre-japan/)]



- Kruijssen F., Albert J., Morgan M., Boso D., Siota F., Sibiti S. and Schwarz A.M. 2013. Livelihoods, markets, and gender roles in Solomon Islands: case studies from Western and Isabel Provinces. Penang: WorldFish. 13 p.
- Lasisi R., Alfred S.E. and Collinus S.I. 2015. Looking towards the forest: women's firewood consumption and environmental degradation in Bayelsa State Nigeria. *Advances in Social Sciences Research Journal* 2(10):224–249.
- Lawless S., Doyle K., Cohen P., Eriksson H., Schwarz A.M., Teioli H., Vavekaramui A., Wickham E., Masu R., Panda R. and McDougall C. 2017. Considering gender: Practical guidance for rural development initiatives in Solomon Islands. Penang: WorldFish. 23 p.
- Malakini M. and Maganga A. 2011. Does cooking technology matter? Fuelwood use and efficiency of different cooking technologies in Lilongwe District, Malawi. MPRA Paper No. 33866. [<https://mpra.ub.uni-muenchen.de/id/eprint/33866>]
- Manibog F.R. 1984. Improved cooking stoves in developing countries: problems and opportunities. *Annual Review Energy* 9:199–227.
- McLeod E. and Salm R.V. 2006. Managing mangroves for resilience to climate change. Gland: IUCN. 63 p.
- MECM (Ministry of Environment Conservation and Meteorology) 2008. Solomon Islands State of Environment Report 2008. Honiara: MECM.
- Schwarz A.M., Andrew N., Govan H., Harohau D. and Oeta J. 2013. Solomon Islands Malaita hub scoping report. CGIAR Research Program on Aquatic Agricultural Systems. Penang: WorldFish.
- Schwarz A., James R., Teioli H.M., Cohen P. and Morgan M. 2014. Engaging women and men in community-based resource management processes in Solomon Islands. Penang: WorldFish. 11 p.
- SIG (Solomon Islands Government) 2016. National Development Strategy 2016 to 2035: improving the social and economic livelihoods of all Solomon Islanders. Honiara: Ministry of Development Planning and Aid Coordination.
- SINSO (Solomon Islands National Statistics Office) 2009. 2009 Population and housing census. Honiara: Ministry of Finance and Treasury.
- SPC (Pacific Community) 2018. Gender analysis of the fisheries sector – Solomon Islands. Noumea, New Caledonia: Pacific Community. 65 p.
- Sukulu M., Orirana G., Oduagalo D., Waleilia B., Sulu R., Schwarz A.M., van der Ploeg J. and Eriksson H. 2016. 'Management over ownership': towards community-based natural resource management in Langalanga Lagoon, Solomon Islands. *SPC Traditional Marine Resource Management and Knowledge Information Bulletin* 37:13–21.
- Sulu R., Orirana G., Sukulu M. and Schwarz A.M. 2015a. Ecosystem approach to fisheries management (EAFM) in tropical fisheries; findings from a European Commission funded study in Langalanga Lagoon, Solomon Islands 2012–2014: a report prepared for national stakeholders. Honiara: WorldFish.
- Sulu R., Eriksson H., Schwarz A.M., Andrew N., Orirana G., Sukulu M., Oeta J., Harohau D., Sibiti S., Toritela A. and Beare D. 2015b. Livelihoods and fisheries governance in a contemporary Pacific Island setting. *PLOS One* 10(11):e0143516.
- van der Ploeg J. et al. 2016. Learning from the lagoon: Research in development in Solomon Islands. CGIAR Research Program on Aquatic Agricultural Systems. Penang: WorldFish. 43 p.
- Warren-Rhodes K. et al. 2011. Mangrove ecosystem services and the potential for carbon revenue programmes in Solomon Islands. *Environmental Conservation* 38(4):485–496.
- WHO (World Health Organization) 2006. Fuel for life: household energy and health. Geneva: WHO.

