Who are the poor? Measuring wealth inequality to aid understanding of socioeconomic contexts for conservation: a case-study from the Solomon Islands

Tammy E. Davies[1,2,*], Nathalie Pettorelli[2], Will Cresswell[1], Ioan R.A. Fazey[3]

[1] University of St Andrews, North Street, St Andrews, Fife, KY16 9AL, UK

[2] Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY, UK

[3] School of Environment and the Centre for Environmental Change and Human Resilience, University of Dundee, Perth Road, Dundee, DD1 4HN, UK

* ted6@st-andrews.ac.uk

Keywords: Poverty; Participatory; Monitoring, Solomon Islands; Melanesia; Conservation

Word count: 6730

Summary: 195

References: 83

Summary

Understanding the local socioeconomic context is important for the design of appropriate conservation initiatives and associated monitoring strategies, especially in areas with high degrees of inequality, to ensure conservation interventions do not inadvertently further disadvantage vulnerable people. Typical assessments of wealth inequality in remote rural areas are constrained by limited engagement with a cash economy, complex family and tribal ties, and an absence of basic infrastructure. With this paper we present a simple participatory approach to measure wealth inequality that does not predefine indicators, such as income or assets, but allows the local people choose the most appropriate indicators. We demonstrate our approach using a case study from the Solomon Islands. We found poor households in Kahua were characterised by fewer members, less members of working age, and less male members than wealthier households. The poor also owned fewer of the locally defined indicators of wealth that were collectively correlated with limited land tenure, and consequently conservation or development initiatives that are tied to land in Kahua will be less likely to assist the poorest. Our approach could improve the effectiveness of community-based conservation through facilitating opportunities to explore local poverty and routes for alleviation.

Introduction

Conservation interventions aimed at improving the sustainability of natural resource use take place within a complex and dynamic ecological, economic, and social landscape (Dawson *et al.* 2010; Rissman 2011). Understanding these complexities is important for the design of successful conservation interventions, especially in areas with high degrees of inequality, to ensure conservation interventions do not inadvertently further disadvantage vulnerable people (Lawlor *et al.* 2010). In response to the failure of 'fortress' conservation efforts that often had

substantial negative impacts on local people, many conservation projects now aim to work with local communities (community-based conservation) and include social objectives, such as poverty reduction, as part of their aims (Hutton *et al.* 2005). However, too frequently community-based conservation initiatives are implemented without fully understanding the local socioeconomic context (Homewood 2013). This ignores the heterogeneity of stakeholders and important factors, such as gender, ethnicity, religion, livelihoods, and reliance on biodiversity, that affect how people are able to respond and interact with conservation initiatives (Agrawal & Redford 2006). Failing to recognise these differences risks unequal distribution of costs and benefits from the intervention, with powerful elites capturing the majority of benefits, and the poor becoming further marginalised (Iversen *et al.* 2006; Saito-Jenson *et al.* 2010). This not only violates the ethical responsibility of conservation to do no harm (Homewood 2013), but is also likely to generate conflict between practitioners and communities, undermine support for conservation and ultimately compromise the long-term success of the intervention (Sommerville *et al.* 2010). Understanding the local socioeconomic context can help mitigate the unequal distribution of costs and benefits from conservation by informing the design of appropriate conservation initiatives and associated monitoring strategies (Barrett *et al.* 2011; Homewood 2013).

Given the unequal, and often highly-skewed distribution of resources and access to their benefits in developing countries, it is evident that researchers must analyse conservation benefits to the poor separately from the rest (or whole) of society (Daw *et al.* 2011), which requires wealth inequality to be measured so the poor can be identified. Thus far, the majority of conservation-based studies looking at poverty have used income as a measure of household poverty (Cavendish 1999; Ambrose-Oji 2003; Fisher 2004; Yemiru *et al.* 2010), mainly because income information is often readily available (Perry 2002). While monetary approaches can be useful, they do not provide a multi-dimensional picture of poverty that is

necessary to develop targeted conservation and development strategies. Poverty is understood to be a multi-dimensional concept, incorporating elements of political disempowerment, a lack of access to critical investments such as education, and economic exclusion, rather than just low levels of wealth (Sen 1993; Chambers 1995; Gönner *et al.* 2007; McGregor & Sumner 2010; Alkire & Foster 2011). In addition, income data have limitations in both accuracy and measurement, particularly in the context of developing countries where community-conservation projects are based, due to temporal fluctuations in income, inaccuracy in recollection, and sensitivity of certain types of income (e.g. illegal extraction). Income may not provide the best indicator of wealth inequality, particularly for short-term studies (see Nielsen *et al.*, 2012) often required in community-conservation efforts. Income data also fail to reflect the full amount of resources available to a household, including productive assets (e.g. livestock) and financial assets (e.g. savings), which can be used as insurance against income shortfalls (Brandolini *et al.* 2010; Nielsen *et al.* 2012).

Broader definitions and consequently measurements of poverty, such as asset wealth, are widely used in development economics (Carter & May 2001). (Filmer & Pritchett 2001) Filmer and Pritchett (2001) developed an approach to asset wealth measurement in the absence of expenditure data that used an aggregate index based on durable assets owned by households to rank households. Assets provide a better picture of long term wealth because they accumulate over time, last longer and contribute to the productive capacity of a household through its resource stock (Moser & Felton 2009). Asset based poverty classifications better predict future income and expenditure than income and consumption measures (Liverpool-Tasie & Winter-Nelson 2011) and are the most important determinant of households choice of livelihood strategy (Ellis & Freeman 2004; Babulo *et al.* 2009; Nielsen *et al.* 2012). In addition, development studies that have examined the empirical relationship between initial inequality and subsequent growth have found a stronger effect of

land and human capital inequality, than of income inequality, suggesting that asset inequality matters more (Birdsall & Londoño 1997; Rodríguez-Pose & Tselios 2010). Asset measures of wealth inequality may thus better inform conservation strategies than income or consumption inequality.

Typically, an asset measures approach uses presence/absence data on ownership of assets that capture living standards (e.g. radio, television, telephone, bike, motorbike, refrigerator and car; Alkire & Santos 2010) and infrastructure and housing characteristics (e.g. source of water, sanitation facility; Vyas & Kumaranayake 2006), which may form an index of socioeconomic status (or Material Style of Wealth) (Cinner 2009). Measurement is often limited to assets that are in some way measureable, with more intangible assets (e.g. social capital, access, and power) often ignored. Intangible assets are difficult to quantify because they are linked to the context, and to other complementary assets through which the intangible asset is deployed (Kaplan & Norton 2001; Hulme & McKay 2005). The asset approach usually involves an external assessor determining the kinds of assets to be assessed (Rakodi 2002). This external approach can be less informative for conservation studies, particularly where standard asset lists (e.g. radio, TV, fridge and bicycle) are inappropriate (i.e. all households lack basic assets).

Assessments of poverty can either be participatory or non-participatory. Participatory approaches are reflexive, flexible and iterative, and therefore better able than external approaches to facilitate exploring local knowledge and perceptions and encourage learning and empowerment at local levels (Chambers 1992; Cornwall & Jewkes 1995). Participatory approaches to poverty assessments are becoming more widely used in the conservation and development arenas, including methods such as wealth ranking that involves categorising households or individuals (Chambers 1994; Laderchi *et al.* 2003). However, people's own assessment of their condition may be biased as a result of limited information and social

116 conditioning (Laderchi *et al.* 2003), or exaggerated in hope of receiving tangible benefits
117 (Krishna 2009). In addition, despite the measures being nominally participatory, the level of
118 participation is usually only extended to a few key stakeholders (McGee & Brock 2001;
119 Naughton-Treves 2012).

120 Across many remote rural areas there are constraints to the use of typical assessments
121 of wealth inequality, such as limited engagement with a cash economy, strong social
122 networks and complex family and tribal ties, and absence of basic infrastructure and
123 development. To gather appropriate and valid data, an approach that goes beyond monetary,
124 presence/absence of standard assets, and key informant approaches is required. With this
125 paper we aim to present a simple participatory approach to measure wealth inequality that
126 does not pre-define the indicators to be used, but enables local people to identity them. This
127 ensures a flexible and inclusive method, providing a perspective on poverty that is sensitive
128 to local contexts, while simultaneously remaining straightforward and replicable for remote,
129 rural community-conservation projects. We demonstrate our approach using a remote and
130 data-deficient region of the Solomon Islands where there is no prior information on poverty.
131 Our specific objectives were to: (1) identify locally appropriate indicators of wealth, (2)
132 assess whether these indicators are able to represent variation in wealth within communities,
133 (3) compare the indicators with annual monetary income and expenditure, and (4) determine
134 the key predictors of poverty.
135
136 **Methods**
137 **Study area**
138 The Solomon Islands are an archipelago in the South West Pacific (Fig. 1) that contains one
139 of the last remaining tracts of coastal tropical rainforest (Bayliss-Smith *et al.* 2003) and is
140 part of the East Melanesian Islands biodiversity hotspot (Myers *et al.* 2000). These islands are

undergoing rapid environmental and social change, with an economy heavily based on extractive industries, coupled with one of the highest population growth rates in the world (2.6% per annum; UNICEF 2011).

This study was conducted in the Kahua region (Wards 12 and 13; $162^{0}0-162^{0}15$E, $10^{0}25-10^{0}40$S) of Makira Island (formally San Cristobal). Makira is the fourth largest island of the archipelago with an area of 3191 km^2 and consists of a narrow coastal plain with steep forested central ridges with altitudes up to 1200 m (Allen *et al.* 2006). There is limited infrastructure, with no roads and only a limited number of high-frequency radios for communication. Transport to the provincial capital of Kirakira (access to main market and hospital) is either by foot or fibreglass boats with small outboard motors. Lack of market access is a major constraint on economic development (Allen *et al.* 2006).

The Kahua region has approximately 4500 inhabitants across 42 communities, mostly located on the coast. The main livelihood strategy is subsistence agricultural production, supplemented by fishing and exploitation of a wide range of species. Kahua is experiencing rapid social and environmental change through an increasing population, desire for monetary prosperity, a loss of social cohesion (Fazey *et al.* 2011) and a loss of traditional methods of natural resource use and management (Ministry of Environment Conservation and Meteorology 2008). Changes in primary productivity suggest significant ecological change at a landscape scale (Garonna *et al.* 2009) and at the local level, the availability of forest and marine resources may be declining with reports of falling crop yields and increasing incidence of pests and diseases (Bourke *et al.* 2006; Fazey *et al.* 2011).

The market economy was introduced to the Solomon Islands far later than in other developing countries (Furusawa & Ohtsuka 2006). Interaction with the cash economy in Kahua is limited, but increasing, mainly through the payment of school fees, transport and imported foods. Households engage in a range of income generating activities including the

sale of agricultural produce, handicrafts and livestock (chickens and pigs), and the production of cash crops (copra and cocoa). Participation in these income-generating activities requires access to land, which is predominantly customary-owned across Melanesia, with tenure established through genealogy (Fazey *et al.* 2011). The Solomon Islands have a traditionally male dominated society, and men continue to dominate all sectors of society from political posts to village chiefs (Fazey *et al.* 2011; Mataki 2011) and consequently there are major gender inequalities. Men also dominate most income generating activities and tend to have a lower commitment (than women) to spending on the health and education of their children (Gibson 2000; McMurray *et al.* 2008; Macintyre 2009). Cultural traditions remain strong, and as with other Pacific Island economies there is an emphasis on redistributive activities, with most households involved in tribe-specific networks that give and reciprocate goods and services, termed the 'wantok system' (Gibson 2006).

Data collection

Our research approach was broadly exploratory and inductive, with a combination of focus groups, discussions and a widely scaled household survey. It aimed to facilitate exploration of local knowledge and perceptions using deliberative methods that in Kahua are more closely aligned to social deliberative ways in which people communicate (Fazey *et al.* 2010; Kenter *et al.* 2011). Data were mostly collected by five local villagers, trained as facilitators and closely supervised by T. Davies; these local facilitators were essential for maintaining trust between researchers and communities, engaging with local communities, and translating information. Data collection methods were simplified to account for the facilitators' low levels of education and limited ability to simultaneously translate and record information, while also designed to capitalise on their local cultural and social expertise and knowledge (Fazey *et al.* 2011).

Focus groups were conducted in six villages, with one coastal and one inland village sampled from each of the eastern, central and western localities. All village inhabitants were invited to participate. A total of 12 focus groups were conducted, which included a total of 109 participants, with an average of 9 per group. Focus groups lasted on average c.3 hours; all were conducted in local language (Kahuan), and separately for men and women to manage gender-based power relationships. Due to low levels of literacy, informed consent was sought verbally from all participants at the start of the focus group. After an ice-breaker exercise, participants were asked to identify different wealth groups within their community. All groups identified three different categories: poor, average and wealthy. In groups, participants were then asked to identify items or characteristics that changed across these categories (indicators of wealth). Groups were asked to choose an item close to hand, such as leaves, to represent their chosen indicators which were then brought together for discussion. How these indicators changed across the wealth categories was then discussed. The total list of indicators from all focus groups was presented and discussed at a workshop, with 30 participants from across Kahua, where in groups of three, participants were given five stones and asked to rank the indicators they considered the best. This led to a shortlist of five asset indicators.

A household survey was used to collect information on ownership of the top five asset indicators at the household level. A household was defined as people living together and sharing meals. The household survey was piloted in April 2011, refined and then conducted across 74 households from three communities in February 2012 and July 2012. All households were surveyed in each of the three communities. The head of the household was interviewed, or if unavailable another adult from the household was interviewed. Basic information on household social structure including composition and levels of education was collected, and in January and July households were also asked to recall major sources of

income and expenditure in the last 6 months. The latter data combined for a crude annual figure, focussed on major cash expenditures such as school fees and transport. Where there were differences in the information collected (e.g. household members, age) between January and July, the average value was used for analysis.

Analyses

All data were analysed with R v2.15.1 (R Core Team 2013). Local indicators of wealth were identified as household ownership of number of pigs, chickens, coconut trees, cocoa trees and gardens. A Principal Component Analysis (PCA) was applied to household data on ownership of these locally defined indicators of wealth; the indicators are all continuous variables well suited to PCA. The factor scores from the first principal component (the vector that provides the most information about the variables) were used as the socioeconomic status index (wealth score) for each household. The higher the wealth score, the higher the implied wealth of the household. Differences in wealth score between villages were determined using an ANOVA.

To explore the variation in household demographics, a PCA was also applied to the household social structure data (number of household members, number of household members <18 years, age of household head, education of household head and dependency ratio (number of dependents [0-14 or >65 years] to the working-age population [15-64]) as a first step to determine the factors explaining most of the variation within the data. We did not consider the first axis of the household social structure PCA as a factor explaining the variation of the first axis of the household asset PCA, as we aimed to assess how each component of the household asset dataset related to wealth inequality between households. To identify the main characteristics of the poor, the constructed household wealth score was then included as a continuous independent variable in a general linear model to explore the

relationship between the wealth score and the household social structure: number of household members, age of household head, education of household head, gender of household head, proportion of males in the household and the dependency ratio. All possible combinations of main effects, followed by combinations of interactions were explored and then compared using Akaike's information criterion (AIC) values, which were compared among all possible combinations of explanatory variables. AIC is an evidence factor that is corrected for model complexity. Weighting AICs can be used to assess the best approximation to reality (model truth) by approximating Kullback-Leiber information loss to see how changing the model affects the fit (Bradshaw & Brook 2010), with a small value representing a better fit of the model to the data. To avoid model selection uncertainty where there were rival models, weighted averages of parameter estimates were calculated following Burnham & Anderson (2002). (Burnham & Anderson 2002). General linear models were used to compare the wealth score with income and expenditure, with the strength of the correlation assessed using Spearman rank correlation and R-squared values.

Results

Data was collected from 74 households across three communities (Table 1). Respondents had a mean age of 47.5 (±15.0) years, with an average of 5.6 (±2.4) years of education. Households had an average of 5 members (±2.1), with a mean of 2.4 (±1.6) children (those under 18 years).

Focus group discussions indicated that wealthier households owned more of the locally defined indicators, which was corroborated with analysis of asset ownership (Table 2). PCA of these assets generated three components that together explained 71.4% of the variation (Table 3). The first component was composed of chickens with the greatest positive loading, followed by number of pigs, number of cocoa trees and number of coconut trees;

these factors explained 36% of the variation in the data. The second component, with positive loading from number of coconut trees and strong negative weighting of garden number and garden size explained 20% of the variation, indicating less variation in gardens across the different wealth categories. The third component, explained 15% of the variation had a positive loading from number of gardens and number of cocoa trees and a high negative loading from garden size and number of coconut trees.

Based on the factor scores from the first principal component wealth scores for households ranged from -2.07 (poorest) to 5.40 (wealthiest) (mean = 0.00 ±1.5). Villages did not differ in wealth scores (ANOVA $F=1.4$, $df=2$, $p=0.25$) and therefore all analyses refer to grouped data.

A PCA of household social structure data generated three components that together explained 79 % of the variation (Table 4). The first component consisted of negative loading from number of household members, number under 18 years and the dependency ratio; the first component of this PCA explained 41% of the variation in the data. The second component had a positive loading from education of household head and negative loading from age of household head; the second component of this PCA explained 22% of the variation in the data. The third component had a strong negative loading from the proportion of males in the household; the third component of this PCA explained 16% of the variation in the data.

AIC model weights revealed the household social structure data, modelled as main effects, which best explained the variation in wealth scores were number of household members, age dependency ratio and proportion of males. A higher number of household members, lower age dependency ratio and higher proportion of males were associated with a higher wealth score. Based on Akaike weights, there was a rival model composed of number

of household members and age dependency ratio. To avoid model selection uncertainty, weighted averages of parameter estimates were calculated (Table 5).

There were positive correlations between wealth scores and monetary income ($p = 0.006$, $R^2 = 0.11$), the strongest being between wealth scores and monetary expenditure ($p < 0.0001$, $R^2 = 0.24$, Fig.2).

Discussion

Our participatory asset measurement method avoided typical constraints to assessments of wealth inequality in remote rural areas, such as limited interaction with the cash economy, in addition to avoiding biases associated with external approaches. Our approach provided key insights into characteristics of poor households where there was no prior information on poverty in a culturally sensitive manner that enabled participants to express their views on which indicators were important. Household asset wealth was particularly well correlated with household expenditure, which tends to be a better metric than income because households can smooth their expenditure during a temporary low-income period by borrowing or using savings (Perry 2002). As we only collected a crude measure of household expenditure, more detailed data would be expected to improve the strength of this correlation. However, our participatory approach to asset measurement goes beyond monetary metrics by providing better characterisations of the poor, which in turn provides further insights for the design and implementation of appropriate conservation projects and poverty reduction policies.

The poor in Kahua owned less of the locally defined indicators of wealth, particularly chickens, pigs, coconuts and cocoa trees. Little is known about rural poverty in Melanesia; however these assets reflect traditional Melanesian symbols of power. For example, pig ownership and pig killing traditionally conveyed status, wealth, and informal power in

315 Melanesia (Miles 1997) and pigs are still culturally important in the region, remaining
316 currency for major transactions (Glasse 1959; Miles 1998), including compensation payments
317 and bride price that are commonly applied across the Solomon Islands. Food produce has
318 long been used as a display of power, prestige and competition in Melanesia (Roscoe 2000),
319 with the group with the largest number and size of pigs, food crops and cooked food
320 commanding the most respect (Nanau 2011).

321 Analysis of ownership of these assets also provided insights into the household
322 characteristics of the poor, whose households had fewer members, a higher age dependency
323 ratio and a lower proportion of males. In fact the poorest households contained no male
324 members (i.e. older female living with young female child); other studies have also found
325 female-headed households to be over-represented among the poor (e.g. Buvinić & Gupta
326 1997; Biewen 2006; Medeiros & Costa 2006). Our participatory research approach enabled
327 additional information to be elicited that would have been difficult to achieve otherwise.
328 Focus group discussions revealed that people felt the poor's social position could be
329 improved through hard work and a recurring theme was that the poor were lazy. For example,
330 they might have access to land, but did not necessarily put in the effort to cultivate it, and
331 therefore depended on exploiting the wantok system. Views that the poor are lazy are
332 common (e.g. Lockwood 2002). However, although the poor may appear lazy, they may in
333 fact be marginalised in some way, which means that they are unable to capitalise upon
334 opportunities. For example they may have low personal empowerment (e.g. low confidence
335 or social skills), or may not conform to social norms or abide by the same values as the rest of
336 society (Applebaum 2003). In addition, the poor may not have access to land, for example if
337 they are immigrants from other areas or families of men who have married into the region.

338 These results may help planning of appropriate community-based conservation and
339 development initiatives to benefit the poorest. The locally defined indicators of wealth are

collectively correlated with land tenure. Thus, a higher wealth score can be seen to equate to ownership of, or access to more land and consequently conservation and development initiatives that are linked to land will naturally favour uptake by the wealthy, whereas the poor may be unable to invest or allocate land for such schemes (Corbera *et al.* 2007; Börner *et al.* 2010). Yet, current development activities in Kahua are focussed on the promotion of cash crops, activities which are unlikely to benefit poor households that have less land and are thus less likely to directly participate in these initiatives. In addition, monetization of resources can increase gender inequalities, adversely impacting women, which is of concern for poor alleviation efforts in Kahua where poor female-headed households could become further marginalised. The commodification of natural resources (e.g. through the introduction of cash crops) has shifted the Melanesian relationship with land from cultural to economic, and this shift is eroding social cohesion, with property rights currently a major source of conflict across Melanesia (Bonnemaison 1984; Foale & Manele 2004; Fazey *et al.* 2011). Given the assets and characteristics of poor households in Kahua, cash payments for conservation (e.g. payments for ecosystem services) are unlikely to be an appropriate conservation strategy there, because they could increase community conflicts, ultimately undermining conservation activities. Strategies that focus on small-scale resource management, balancing food security and conservation, such as agroforestry and locally managed marine areas are likely to be more appropriate for the social context in Kahua. Understanding the local socioeconomic context could help develop an appropriate enabling environment with interventions to improve people's capabilities and conditions, such as empowerment programmes and land reform (see McGregor & Sumner 2010).

Community conservation projects are often constrained by time and resources, with a limited portion of these available for monitoring activities (Gardner 2010). Our asset-based approach within a participatory framework is well suited approach to community-based

conservation projects in areas with low levels of literacy and resources because it can collect valid and reliable data in an easily replicable manner. The participatory approach also provides an excellent starting point for discussing inequalities, and providing insights into how they can be alleviated or managed (Moser & Felton 2009). Findings from this approach can then be used to assist decision making on how best to target the poor and also as an input to other research problems, such as the relationship between wealth and observed behaviours, for example use of destructive fishing gear (Cinner 2009), uptake of conservation initiatives (Brandolini *et al.* 2010) and livelihoods (Reardon & Vosti 1995). For those community-based conservation projects that also aim to reduce poverty, longitudinal asset data can be used to monitor and determine transitions out of poverty. Although we used asset measures to provide an initial assessment of wealth inequality, this approach can also be employed in community-conservation projects before and after an intervention as part of monitoring activities to record longitudinal asset data or 'asset dynamics', which can help elucidate transitions out of poverty (Carter & Barrett 2006; Adjei *et al.* 2009). An approach for assessing household strategies for poverty alleviation has been pioneered by Krishna (Krishna & Shrader 1999; Krishna 2009).

Although our approach goes further than basic income measures of wealth inequality commonly used in community-conservation projects, but is still restricted to material dimensions of poverty. Our approach was unable to distinguish between important capabilities, for example those who do not have access to land, and those who have access to land but choose not to cultivate it. Less tangible dimensions of poverty, such as social capital and power, were also not reflected in our assessment. Our approach is not a panacea and further research is required into advancing poverty measurement that is better able to capture both tangible and intangible aspects of deprivations. However, it did provide insights into how poverty is viewed in the region, which appears to be based heavily on traditional

hierarchies and symbols of power (pigs), and therefore the locally identified wealth assets may also be a proxy for power; although the extent to which these assets reflect power should be further explored. Social capital is the most commonly cited intangible asset (Moser & Felton 2009), yet kin and friendship networks are often the most important relationships that households mobilize to reduce vulnerability (Bacon 2005). The wantok system is an important informal institution in Melanesia for social cohesion and its contribution to balancing wealth inequality, and its ability to function as a support network, should be further explored using approaches that go beyond asset measures (Krishna & Shrader 1999).

Acknowledgments:

We are grateful to the villagers of Toroa, Huni, Katoro, Pa'a, Nama, Borowe, Naopaworo. Taratarena and Narame, and particularly thank research assistants: James Ta'ata, Freda Wagoa, Romano Tarohania, Nellie Haga, Betty Haga, Mevis Kamera, Eddie Maka, Bassie Wa'apa, Mandy Haga, and the Kahua Association for guidance and support. Thanks are also extended to the Ministry of Education and provincial authorities of Makira-Ulawa Province for supporting this research. TD was supported by a Natural Environment Research Council studentship (DTG: AGS6-NERC10). Additional funding for fieldwork was provided by Chester Zoo and Rufford Small Grants (11022-1). We thank two anonymous reviewers for their insightful comments that improved the manuscript.

409 ## References

410 Adjei, J., Arun, T. & Hossain, F. (2009) Asset building and poverty reduction in Ghana: the case of
411 microfinance. *Savings and Development* **33**(3): 265-291.
412 Agrawal, A. & Redford, K. (2006) Poverty, development, and biodiversity conservation: Shooting in
413 the dark? In: *Working paper no. 26*, p. 56. Wildlife Conservation Society.
414 Alkire, S. & Foster, J. (2011) Understandings and misunderstandings of multidimensional poverty
415 measurement. *Journal of Economic Inequality* **9**(2): 289-314.
416 Alkire, S. & Santos, M. E. (2010) Acute Multidimensional Poverty: A New Index for Developing
417 Countries. In: *OPHI working paper No. 38*, p. 139. Oxford, UK: Oxford Poverty & Human
418 Development Initiative.
419 Allen, M. G., Bourke, R. M., Evans, B. R., Iramu, E., Maemouri, R. K., Mullen, B. F., Pollard, A. A.,
420 Wairiu, M., Watoto, C. & Zotalis, S. (2006) Solomon Islands Smallholder Agriculture Study: Volume 4
421 Provincial Reports. In: Canberra, Austraila: AusAID.
422 Ambrose-Oji, B. (2003) The contribution of NTFPs to the livelihoods of the'forest poor': evidence
423 from the tropical forest zone of south-west Cameroon. *International Forestry Review* **5**(2): 106-117.
424 Applebaum, L. D. (2003) The influence of perceived deservingness on policy decisions regarding aid
425 to the poor. *Political Psychology* **22**(3): 419-442.
426 Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J. & Mathijs, E. (2009) The economic
427 contribution of forest resource use to rural livelihoods in Tigray, Northern Ethiopia. *Forest Policy and*
428 *Economics* **11**(2): 109-117.
429 Bacon, C. (2005) Confronting the coffee crisis: can fair trade, organic, and specialty coffees reduce
430 small-scale farmer vulnerability in northern Nicaragua? *World Development* **33**(3): 497-511.
431 Barrett, C. B., Travis, A. J. & Dasgupta, P. (2011) On biodiversity conservation and poverty traps.
432 *Proceedings of the National Academy of Sciences* **108**(34): 13907-13912.
433 Bayliss-Smith, T., Hviding, E. & Whitmore, T. (2003) Rainforest composition and histories of human
434 disturbance in Solomon Islands. *AMBIO: A Journal of the Human Environment* **32**(5): 346-352.
435 Biewen, M. (2006) Who are the chronic poor? An econometric analysis of chronic poverty in
436 Germany. *Research on Economic Inequality* **13**: 31-62.
437 Birdsall, N. & Londoño, J. L. (1997) Asset inequality matters: an assessment of the World Bank's
438 approach to poverty reduction. *The American Economic Review* **87**(2): 32-37.
439 Bonnemaison, J. (1984) Social and cultural aspects of land tenure. In: *Land tenure in Vanuatu*, ed. P.
440 Lamour, pp. 1-7. Suva, Fiji: University of the South Pacific.
441 Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Tito, M. R., Pereira, L. & Nascimento, N. (2010) Direct
442 conservation payments in the Brazilian Amazon: Scope and equity implications. *Ecological Economics*
443 **69**(6): 1272-1282.
444 Bourke, R., McGregor, A., Allen, M., Evans, B., Mullen, B., Pollard, A., Wairiu, M. & Zotalis, S. (2006)
445 Solomon Islands Smallholder Agriculture Study: Vol 1. Main findings and recommendations. In:
446 Canberra: Australian Government and AusAID.
447 Bradshaw, C. J. A. & Brook, B. W. (2010) The conservation biologist's toolbox–principles for the
448 design and analysis of conservation studies. In: *Conservation Biology for All*, eds. N. S. Sodhi & P. R.
449 Ehrlich, pp. 313-334. Oxford University Press.
450 Brandolini, A., Magri, S. & Smeeding, T. M. (2010) Asset-based measurement of poverty. *Journal of*
451 *Policy Analysis and Management* **29**(2): 267-284.
452 Burnham, K. P. & Anderson, D. R. (2002) *Model selection and multi-model inference: a practical*
453 *information-theoretic approach*. Springer.
454 Buvinić, M. & Gupta, G. R. (1997) Female-headed households and female-maintained families: are
455 they worth targeting to reduce poverty in developing countries? *Economic development and cultural*
456 *change* **45**(2): 259-280.
457 Carter, M. R. & Barrett, C. B. (2006) The economics of poverty traps and persistent poverty: An asset-
458 based approach. *The Journal of Development Studies* **42**(2): 178-199.

Carter, M. R. & May, J. (2001) One kind of freedom: Poverty dynamics in post-apartheid South Africa. *World Development* **29**(12): 1987-2006.
Cavendish, W. (1999) *Poverty, inequality and environmental resources: quantitative analysis of rural households*. Centre for the Study of African Economies, Institute of Economics and Statistics, University of Oxford.
Chambers, R. (1992) Rural apprasial: rapid, relaxed and participatory. In: *Discussion Paper 311*, Brighton: Institute of Development Studies.
Chambers, R. (1994) The origins and practice of participatory rural appraisal. *World Development* **22**(7): 953-969.
Chambers, R. (1995) Poverty and livelihoods: whose reality counts? *Environment and Urbanization* **7**(1): 173-204.
Cinner, J. (2009) Poverty and the use of destructive fishing gear near east African marine protected areas. *Environmental Conservation* **36**(4): 321-326.
Corbera, E., Kosoy, N. & Martínez Tuna, M. (2007) Equity implications of marketing ecosystem services in protected areas and rural communities: Case studies from Meso-America. *Global Environmental Change* **17**(3–4): 365-380.
Cornwall, A. & Jewkes, R. (1995) What is participatory research? *Social science & medicine* **41**(12): 1667-1676.
Daw, T., Brown, K., Rosendo, S. & Pomeroy, R. (2011) Applying the ecosystem services concept to poverty alleviation: the need to disaggregate human well-being. *Environmental Conservation* **38**(04): 370-379.
Dawson, T. P., Rounsevell, M. D., Kluvánková-Oravská, T., Chobotová, V. & Stirling, A. (2010) Dynamic properties of complex adaptive ecosystems: implications for the sustainability of service provision. *Biodiversity and Conservation* **19**(10): 2843-2853.
Ellis, F. & Freeman, H. A. (2004) Rural livelihoods and poverty reduction strategies in four African countries. *Journal of development studies* **40**(4): 1-30.
Fazey, I., Kesby, M., Evely, A., Latham, I., Wagatora, D., Hagasua, J.-E., Reed, M. S. & Christie, M. (2010) A three-tiered approach to participatory vulnerability assessment in the Solomon Islands. *Global Environmental Change* **20**(4): 713-728.
Fazey, I., Pettorelli, N., Kenter, J., Wagatora, D. & Schuett, D. (2011) Maladaptive trajectories of change in Makira, Solomon Islands. *Global Environmental Change* **21**(4): 1275-1289.
Filmer, D. & Pritchett, L. H. (2001) Estimating Wealth Effects Without Expenditure Data - Or Tears: An Application To Educational Enrollments In States Of India. *Demography* **38**(1): 115-132.
Fisher, M. (2004) Household welfare and forest dependence in Southern Malawi. *Environment and Development Economics* **9**(2): 135-154.
Foale, S. & Manele, B. (2004) Social and political barriers to the use of marine protected areas for conservation and fishery management in Melanesia. *Asia Pacific Viewpoint* **45**(3): 373-386.
Furusawa, T. & Ohtsuka, R. (2006) Inter-household variations in subsistence strategies within a rural society of Roviana, Solomon Islands: An analysis of agricultural production and cash income in relation to socio-demographic factors. *Tropics* **15**(1): 29-37.
Gardner, T. (2010) *Monitoring forest biodiversity: improving conservation through ecologically-responsible management*. London, UK: Earthscan.
Garonna, I., Fazey, I., Brown, M. E. & Pettorelli, N. (2009) Rapid primary productivity changes in one of the last coastal rainforests: the case of Kahua, Solomon Islands. *Environmental Conservation* **36**(3): 253-260.
Gibson, J. (2000) Who's not in school? Economic barriers to universal primary education in Papua New Guinea. *Pacific Economic Bulletin* **15**(2): 46-58.
Gibson, J. (2006) *Are there holes in the safety net?: Remittances and inter-household transfers in Pacific Island economies*. Institute of Policy Studies.
Glasse, R. M. (1959) Melanesia: Social Anthropology.: Revenge and Redress among the Huli: 1 A Preliminary Account. *Mankind* **5**(7): 273-289.

Gönner, C., Haug, M., Cahyat, A., Wollenberg, E., de Jong, W., Limberg, G., Cronkleton, P., Moeliono, M. & Becker, M. (2007) Capturing nested spheres of poverty: a model for multidimensional poverty analysis and monitoring. In: *CIFOR Occasional Paper No. 46*, Jakarta, Indonesia: Center for International Forestry Research (CIFOR).
Homewood, K. (2013) Monitoring and evaluating the socio-economic impacts of conservation projects on local communities. In: *Biodiversity monitoring and conservation: bridging the gaps between global commitment and local action*, eds. B. Collen, N. Pettorelli, J. Baillie & S. Durant, pp. 265-290. Cambridge: Wiley-Blackwell.
Hulme, D. & McKay, A. (2005) *Identifying and measuring chronic poverty: Beyond monetary measures*. Indian Institute of Public Administration.
Hutton, J., Adams, W. M. & Murombedzi, J. C. (2005) Back to the barriers? Changing narratives in biodiversity conservation. *Forum for Development Studies* **32**: 341-370.
Iversen, V., Chhetry, B., Francis, P., Gurung, M., Kafle, G., Pain, A. & Seeley, J. (2006) High value forests, hidden economies and elite capture: Evidence from forest user groups in Nepal's Terai. *Ecological Economics* **58**(1): 93-107.
Kaplan, R. S. & Norton, D. P. (2001) Transforming the balanced scorecard from performance measurement to strategic management: Part I. *Accounting horizons* **15**(1): 87-104.
Kenter, J. O., Hyde, T., Christie, M. & Fazey, I. (2011) The importance of deliberation in valuing ecosystem services in developing countries—Evidence from the Solomon Islands. *Global Environmental Change* **21**(2): 505-521.
Krishna, A. (2009) Subjective assessments, participatory methods, and poverty dynamics: the stages of progress method. In: *Poverty Dynamics: Interdisciplinary Perspectives: Interdisciplinary Perspectives*, eds. T. Addison, D. Hulme & R. Kanbur, pp. 183-201. Oxford, UK: Oxford University Press.
Krishna, A. & Shrader, E. (1999) Social capital assessment tool. *Social Capital Initiative Working Paper* **22**.
Laderchi, C. R., Saith, R. & Stewart, F. (2003) Does it matter that we do not agree on the definition of poverty? A comparison of four approaches. *Oxford Development Studies* **31**(3): 243-274.
Lawlor, K., Weinthal, E. & Olander, L. (2010) Institutions and policies to protect rural livelihoods in REDD+ regimes. *Global Environmental Politics* **10**(4): 1-11.
Liverpool-Tasie, L. S. O. & Winter-Nelson, A. (2011) Asset versus consumption poverty and poverty dynamics in rural Ethiopia. *Agricultural Economics* **42**(2): 221-233.
Lockwood, V. S. (2002) Poverty in paradise: Development and relative income poverty in rural Tahitian society. *Human organization* **61**(3): 210-225.
Macintyre, M. (2009) Police and thieves, gunmen and drunks: Problems with men and problems with society in Papua New Guinea. *The Australian Journal of Anthropology* **19**(2): 179-193.
Mataki, M. (2011) Solomon Islands National Assessment Report Rio + 20. In: Honiara: Solomon Islands Government.
McGee, R. & Brock, K. (2001) *From poverty assessment to policy change: processes, actors and data*. Institute of Development Studies Brighton.
McGregor, A. & Sumner, A. (2010) Beyond Business as Usual: What Might 3-D Wellbeing Contribute to MDG Momentum? *IDS Bulletin* **41**(1): 104-112.
McMurray, C., Foale, S., Roberts, P., Breen, B. & Cann-Evans, S. (2008) People's survey 2008. In: p. 134. Canberra, Australia: AusAID.
Medeiros, M. & Costa, J. (2006) *Poverty among women in Latin America: Feminization or over-representation?* : United Nations Development Programme. International Poverty Centre.
Miles, W. F. (1997) Pigs, Politics and Social Change in Vanuatu. *Society and Animals* **5**(2): 155-167.
Miles, W. F. (1998) Tenure, Promotion, & Pig-Killing. *Change: The Magazine of Higher Learning* **30**(5): 30-33.

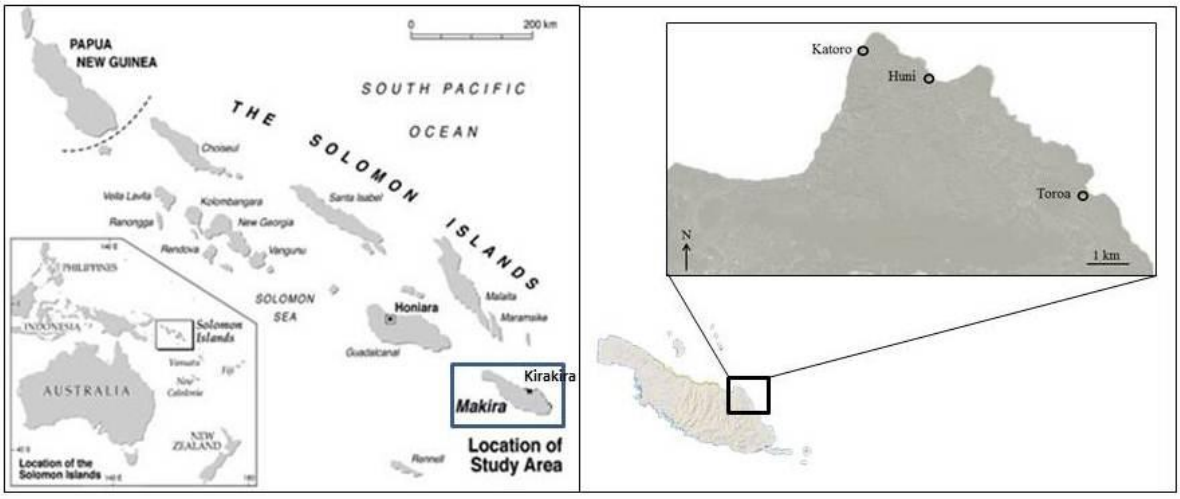
559 Ministry of Environment Conservation and Meteorology. (2008) Solomon Islands State of
560 Environment Report In: Honiara, Solomon Islands: Ministry of Environment Conservation and
561 Meteorology.
562 Moser, C. & Felton, A. (2009) The construction of an asset index. In: *Poverty Dynamics:*
563 *Interdisciplinary Perspectives*, eds. T. Addison, D. Hulme & R. Kanbur, pp. 102-127. Oxford, UK:
564 Oxford University Press.
565 Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. & Kent, J. (2000) Biodiversity
566 hotspots for conservation priorities. *Nature* **403**(6772): 853-858.
567 Nanau, G. (2011) The Wantok System as a Socio-economic and Political Network in Melanesia. *The*
568 *Journal of Multicultural Society* **2**(1): 31-55.
569 Naughton-Treves, L. (2012) Participatory Zoning to Balance Conservation and Development in
570 Protected Areas. In: *Integrating Ecology and Poverty Reduction*, eds. J. C. Ingram, F. DeClerck & C.
571 Rumbaitis del Rio, pp. 235-251. New York: Springer.
572 Nielsen, M. R., Pouliot, M. & Kim Bakkegaard, R. (2012) Combining income and assets measures to
573 include the transitory nature of poverty in assessments of forest dependence: Evidence from the
574 Democratic Republic of Congo. *Ecological Economics* **78**: 37-46.
575 Perry, B. (2002) The mismatch between income measures and direct outcome measures of poverty.
576 *Social Policy Journal of New Zealand* **19**: 101-127.
577 R Core Team. (2013) R: A language and environment for statistical computing. In: Vienna, Austria: R
578 Foundation for Statistical Computing.
579 Rakodi, C. (2002) A livelihoods approach: conceptual issues and definitions. *Urban livelihoods: A*
580 *people-centred approach to reducing poverty*: 3-22.
581 Reardon, T. & Vosti, S. A. (1995) Links between rural poverty and the environment in developing
582 countries: asset categories and investment poverty. *World Development* **23**(9): 1495-1506.
583 Rissman, A. R. (2011) Evaluating Conservation Effectiveness and Adaptation in Dynamic Landscapes.
584 *Law & Contemp. Probs.* **74**: 145.
585 Rodríguez-Pose, A. & Tselios, V. (2010) Inequalities in income and education and regional economic
586 growth in western Europe. *The annals of regional science* **44**(2): 349-375.
587 Roscoe, P. (2000) New Guinea leadership as ethnographic analogy: A critical review. *Journal of*
588 *Archaeological Method and Theory* **7**(2): 79-126.
589 Saito-Jenson, M., Nathan, I. & Treue, T. (2010) Beyond elite capture? Community-based natural
590 resource management and power in Mohammed Nagar village, Andhra Pradesh, India.
591 *Environmental Conservation* **37**(3): 327-335.
592 Sen, A. (1993) Capability and Well-being. In: *The quality of life*, eds. M. Nussbaum & A. Sen, pp. 30-
593 53. Oxford University Press.
594 Sommerville, M., Jones, J. P. G., Rahajaharison, M. & Milner-Gulland, E. J. (2010) The role of fairness
595 and benefit distribution in community-based Payment for Environmental Services interventions: A
596 case study from Menabe, Madagascar. *Ecological Economics* **69**(6): 1262-1271.
597 UNICEF. (2011) Children in the Solomon Islands 2011: an atlas of social indicators. In: Suva, Fiji:
598 United Nations Children's Fund.
599 Vyas, S. & Kumaranayake, L. (2006) Constructing socio-economic status indices: how to use principal
600 components analysis. *Health Policy and Planning* **21**(6): 459.
601 Yemiru, T., Roos, A., Campbell, B. & Bohlin, F. (2010) Forest incomes and poverty alleviation under
602 participatory forest management in the Bale Highlands, Southern Ethiopia. *International Forestry*
603 *Review* **12**(1): 66-77.

604

605

606 **Figure legends:**

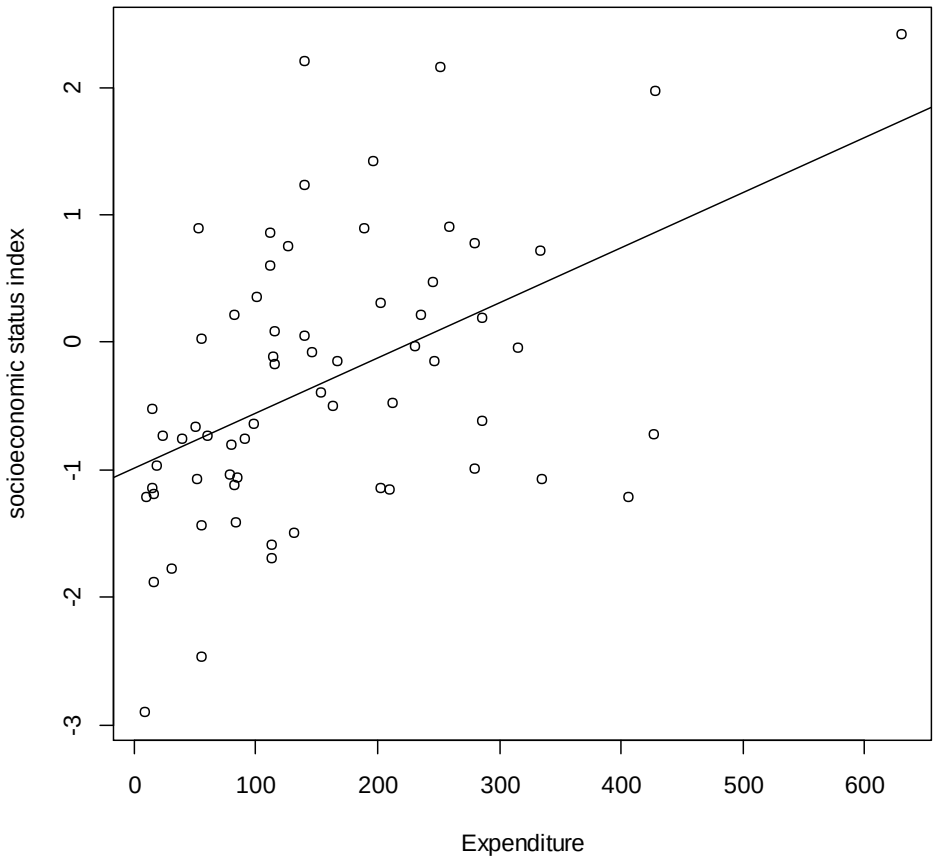
607 Figure 1. Location of Kahua region of Makira, Solomon Islands



608

609

610 Figure 2. Plot of wealth score against annual monetary expenditure



611