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# *Hidden harvest* or hidden revenue—A local resource use in a remote region of Southeast Sulawesi, Indonesia

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In the 5-7 million years we spent as hunter-gatherers, our knowledge base evolved with the ecosystems within which it existed and has further developed as a result of historical continuity of local resource dependence. Knowing which wild animals and plants are palatable and have nutritious content has long been a survival strategy for the rural poor, indigenous peoples and tribal communities, particularly those living in harsh environmental conditions. This information is essential to supplementing diets when harvests fail due to insect blights, disease or adverse weather conditions, hence wild nutritional resources are often termed the *hidden harvest*. Earlier ethnobotanical and ethnozoological surveys were studied to assess the relationship between wealth and use of local resources in a remote region of Indonesia. Poorer households were found to use local resources to generate income than wealthier households, who are more likely to use local species for consumption and rely on other sources of income. It also found that individuals or communities with higher income levels are less likely to support traditional ecosystem practices. The shift in resource collection incentives (from subsistence to income) as a result is likely to threaten ecosystems, management practices and the human populations that will have to rely on them in the future. Therefore, it may be essential to externally-manage systems of resource management in the future as economic development encroaches on traditional communities. These findings also have implications for the future of less wealthy communities in resource-rich regions. Both wild and human populations inhabiting an ecosystem come under threat when economic development and market pressures force the local view of natural resources to shift from one of hidden harvest opportunities to hidden revenue.

**Keywords:** Hidden harvest, Hidden revenue, Local ecological knowledge, Indonesia, Traditional food, Economics, Resource management, Traditional management practices

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In the 5-7 million years we spent as hunter-gatherers, our knowledge base evolved with the ecosystems within which it existed[1]. It has further developed as a result of historical continuity of resource dependence and closeness of relations between a society and its environment[2,3]. This knowledge base has previously been termed traditional, indigenous and local ecological knowledge or ecoliteracy; ecology being the study of the natural systems around us and literacy being the intellectual frameworks that support this knowledge[2,9]. In this study, the term Local Ecological Knowledge (LEK), reflecting its place-based nature rooted in the history, geography and culture of a site without being static, outdated and retrogressive has been used[10]. LEK evolves through one generation's detailed experiences being orally transferred to the next. The following generation combine this knowledge with their own observations in the field. Consequently, a stockpile of experiences and observations based on close daily interactions is formed[2,3,11]. Therefore, a key feature of LEK is its non-static ever-evolving nature. LEK is a situated practice that goes unwritten and, instead, is transferred through narratives, such as stories and songs, and personal experience via observation and practical implememnation[12]. LEK content ranges from best practices for harvesting natural resources and classification of local species and their uses, to understanding resource occurrence, distribution and the environmental interactions affecting this. Specific knowledge base composition of a society will depend upon what is important to a society's cultural beliefs, to its survival and to that of its homelands[3,13]. Knowledge content can be highly heterogeneous, both

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spatially and temporally, especially in highly stratified societies where differential access to learning resources exists[2,14,15].

Knowing which wild animals and plants are found locally, are palatable and have nutritious content has long been a survival strategy for the rural poor, indigenous peoples and tribal communities, particularly those living in harsh environmental conditions. This information is essential to supplementing diets when harvests fail due to diseases or adverse weather conditions[1]. In such cases, wild foods collected can either be used to supplement local staples previously harvested or on their own to ensure food intake and nutritional requirements are met during periods of adverse environmental conditions. Hence, wild nutritional resources that can be used for consumption purposes are often termed the hidden harvest[1]. Knowledge of *hidden harvest* species, how to collect, preserve and prepare them, has been essential to ancestral generations' survival during harsh conditions through to the present day and still is key to many indigenous and rural poor communities today[1,2,16]. In addition to supplementing human diets, the *hidden harvest* of a region can also be used by traditional communities to feed livestock and meet the nutritional requirements of certain human conditions, such as pregnant women, ill people and even young babies being weaned[17]. Therefore, traditional food knowledge comprises of far more than just knowing which species are palatable. Knowledge of nutritional components of species are often understood, species collection sites known, withdrawal methods, preservation techniques and procedures for preparation and cooking the species are also shared. However, this in-depth knowledge and skill comprehending every aspect of food preparation is currently under threat, particularly where market purchases are replacing *hidden harvest* collection, and convenience foods are replacing home preparation[18,19].

Aboriginal cultures gave birth to generation after generation of excellent naturalists, or else they perished[20]. However, this knowledge is only sustained today in economically deprived communities who rely heavily upon their local ecosystems on a daily basis. Here, LEK acts to not only sustain the local population through meeting their food and economic needs, but also to meet local cultural, spiritual and social needs[21]. Human populations in these regions have little choice but to learn sustainable methods of managing and harvesting local resources without depleting them, based on their ancestors' detailed knowledge combined with their own observations[22]. As a consequence of such management techniques, traditional farmers have bred and developed a variety of crops estimated to be worth US$15 billion to the global seed industry today, and if protected, could play a significant role in developing sustainable food productions systems in the future[19]. 25% of the world's plant and animal species are expected to become extinct by 2050, many of which hold *hidden harvest* opportunities and thus have the potential to provide food security to remote regions in the future[23]. Of the 6500 domestic animal breeds that exist globally, most of which originate from traditional communities, a third of these are currently threatened with extinction[1]. Consequently, genetic diversity is declining, threatening the wild relatives of today's staple crops and global food security[24]. Therefore, the more knowledge and genetic diversity humanity can conserve, the more likely we are to find sustainable solutions to global problems where other solutions fail[13].

Through sustainable food production, medical care and income generation via the manufacture of traditional products, LEK may aid the alleviation of poverty and food insecurity in the future[23,25]. However, with population pressures rising and the possibility of external exploitation of knowledge bases and ecosystems, LEK and the security it provides are likely to become threatened. As subsistence lifestyles shift in the light of economic development and expectations rise, LEK is more likely to be replaced by modern knowledge of industry, economy and profit. Previous studies into the effect of economic development on LEK have revealed an inverse relationship between wealth and use of local edible plants[14,26]. Thus, a common assumption throughout the literature is that local species are primarily used as food by families with high levels of resource dependence caused by low-income levels[6]. Here, wild resources provide food security and often constitute the bulk dietary intake since market-purchased foods are financially inaccessible[18]. Therefore, local species knowledge is thought to be commonly focused on food uses in communities where economic-deprivation is high and purchasing power low. This inter-community variation is typical of the heterogeneous nature of LEK[14,15]. Wealthier families have access to new, often


Fig.1 Map showing the location of the Wakatobi Marine National Park, Indonesia

imported, food products, and therefore become less reliant on local resources and forget a great deal of the knowledge they once held on local *hidden harvest* opportunities[14].

However past studies, on the whole, have been limited in sample size, qualitative in nature and culturally isolated, focusing primarily on indigenous groups relatively isolated from impending marketisation and economic pressures[27-30]. Those that have looked at knowledge levels in relation to relative community wealth have not yet done so by a comprehensive assessment of income and valuating individual wealth, and instead used local facilities and degree of urbanisation as indicative of level of economic development[6, 31]. This study quantifiably tests the relationship between actual wealth and local species uses with a large sample from two different ethnic groups living in a remote region of Indonesia. Like many traditional societies today, economic market pressures have already landed in the region and commodofication of local resources is putting pressure on traditional systems of management and the ecosystems they support[18, 19,31]. Therefore, this study aims to provide a rigorous approach to assessing the impact of market economies upon indigenous peoples use of natural resources and determine which groups will suffer if one day these natural resource systems are no longer accessible. This is an area previously neglected despite its increasing relevance to developing communities worldwide[32].

## Methodology

Semi-structured interviews were carried out in 6 villages on the island of Kaledupa situated within the Wakatobi Marine National Park (WMNP), Indonesia. The WMNP is situated in the southeast peninsula province of Sulawesi that incorporates a large number of islands and lies between 3-6$^o$ latitude and 120$^o$ 45'-124$^o$ 06' longitude[33]. The remoteness of this archipelago region has resulted in high diversity and endemism both on land and in the surrounding waters. This region is situated on the theoretical division, termed the Wallace Line that demarcates the transvergence from Australian flora and fauna to that of Asia, thus it is considered of immense importance in terms of biogeography and evolutionary biology[34]. At the centre of this biodiverse Wallacea region is the Tukan Besi archipelago, designated a protected area in 1996 (Fig. 1). The 13,900 sq km of the WMNP incorporate all of the islands, atolls and reef systems of the archipelago and constitutes the second largest Marine National Park in Indonesia[35,36].

The study site on the island of Kaledupa was selected as it was accessible and segregated into smaller subpopulations (villages/sub-villages) for sampling, local terrestrial resources and marine resources encircling Kaledupa were accessible as common property, local resources are currently under increasing threat from expanding market forces, locals sustain differing levels of resource dependence, different cultural groups co-exist, and work could be supported by a local organisation. This work was carried out with the support of Operation Wallacea, a UK-based conservation and research organisation, who had pre-existing relations of trust with local communities in the region and good knowledge of local traditions and cultural taboos essential to carrying out such research. Interviews were conducted between July and September 2005. Villages representative of traditional resource-dependent communities under emerging assimilation pressures were selected. Two ethnic groups, *Kaledupan* agriculturalists and the nomadic maritime tribe of the region, the *Bajo* are represented in this region. The *Kaledupans* live sedentary lifestyles on the land and, today, often pursue alternative occupations and seasonal work for Operation Wallacea where available[36]. The formerly nomadic *Bajo*, today, live in stilt houses over the sea, but remain somewhat disconnected from the land and Kaledupan way of life. They still retain many cultural beliefs and social practices of their ancestors based on the sea and its inhabitants[34,36,38]. As a result of limited development, both economically and socially, the Bajo are on the whole more income-deprived and locally-resource dependent than Kaledupan communities.

Traditional systems of management in this area had remained largely unaltered for generations with many livelihoods continuing to be subsistence-based despite increasing economic development[39]. However local commoditisation of resources and access to modern fishing technologies is slowly creating a departure from these systems towards a more exploitative, economically driven way of life[40]. Other recent introductions include market co-operatives, schools and western health clinics[41,42]. Traditional foods of this region are primarily marine-based, particularly for the once nomadic *Bajo*, with all of their protein historically derived from their daily fish catch. However, with the introduction of rice, maize and even sweet potatoes, diets have been gradually shifting. This is particularly the case for families on higher incomes and, thus, with greater purchasing power, enabling them to buy both preferred local foods and imported goods from local markets. Therefore, families with increased household income have experienced a shift from a traditional subsistence diet to a more varied, higher energy diet, similar to that in industrialised regions. Low-income families however have not experienced such a transition. Lacking local purchasing power they still rely heavily on traditional local diets of marine products, particularly fish, sometimes mixed with small portions of traditional foods such as cassava.

In this study, quantitative ethnobotanical and ethnozoological interviews (employing species flashcards) were used to identify local species uses, primarily food and economic uses[43,44]. Previous studies have focused exclusively on ethnobotanical surveys, making this study unique by exploring communities' knowledge of plants and animals, both terrestrial and marine. Species flashcards comprised of a selection of images of local wild plant, animal, bird and marine species. A number of scientists familiar with the ecology of Kaledupa were consulted to formulate a list of 72 common species in total, including plants like cashew (*Anacardium occidentale* Linn.) and coconut (*Cocos nucifera* Linn.) used for income generation in the region and animals like green turtle (*Chelonia midas* Linn.) and butterflyfish (*Chaetodontidae*) used in religious ceremonies and as food respectively. All species lists were verified by a selection of local experts recommended by Operation Wallacea staff on site. Respondents were asked to identify the species shown to them. Upon positive recognition the respondent was then asked if they used the species in their daily lives and if so, what they used it for. Likert-scale questions were used to assess support for local traditional practices[45]. Respondents were given a series of statements and asked if they strongly agree (*sangat setuju*), agree (*setuju*), are indifferent (*ragu*), disagree (*tidak setuju*), or strongly disagree (*sangat tidak setuju*). Based on the responses given, each respondent was scored between 1 and 5 for their support of local traditional practices (1 being the least supportive and 5 being the most). Local translators were used during interviews.

At the study site, individual income was highly seasonal and, thus, hard to define even by respondents themselves. Therefore, using a point scoring system wealth was ranked[46]. This method was used to assess and compare individual wealth levels, or intra-community wealth, with the wealthiest scoring the highest wealth rank and the least wealthy scoring the lowest. To assess inter-community wealth, data from in-depth economic surveys were used that summarized mean primary household income by village[47]. Previous ecoliteracy studies have focused on identifying experts. Few have taken the widely utilised community knowledge and practices of laypersons into account despite their known contribution to local resource management practices[3]. Limited sample sizes are another shortcoming of many earlier studies[27,29]. In this study, large sample sizes ensured that all voices were heard (including women and children) using stratified cluster sampling as the basis for respondent selection. Cluster sampling was used to select a sample of villages and then stratified sampling within the chosen villages, ensuring all subpopulations were represented at equal proportions. Thus designated quota sizes were pre-determined and statistically viable[48].

To identify individual respondents haphazard sampling methods were used[3,15,49]. This involves collating a list of potential participants from interviewees, and then randomly contacting a selection of names from the list. In total 192 interviews were conducted, 96 from 3 *Bajo* communities and 96 from 3 *Kaledupan*. SPSS 12.0 package was used for database construction and for the handling, analysis and manipulation of data[50]. Non-parametric statistical tests were used to provide a more conservative result when analysing non-normally distributed data. Mann Whitney-U was used to test for a difference in the number of species used for food and income between the economically

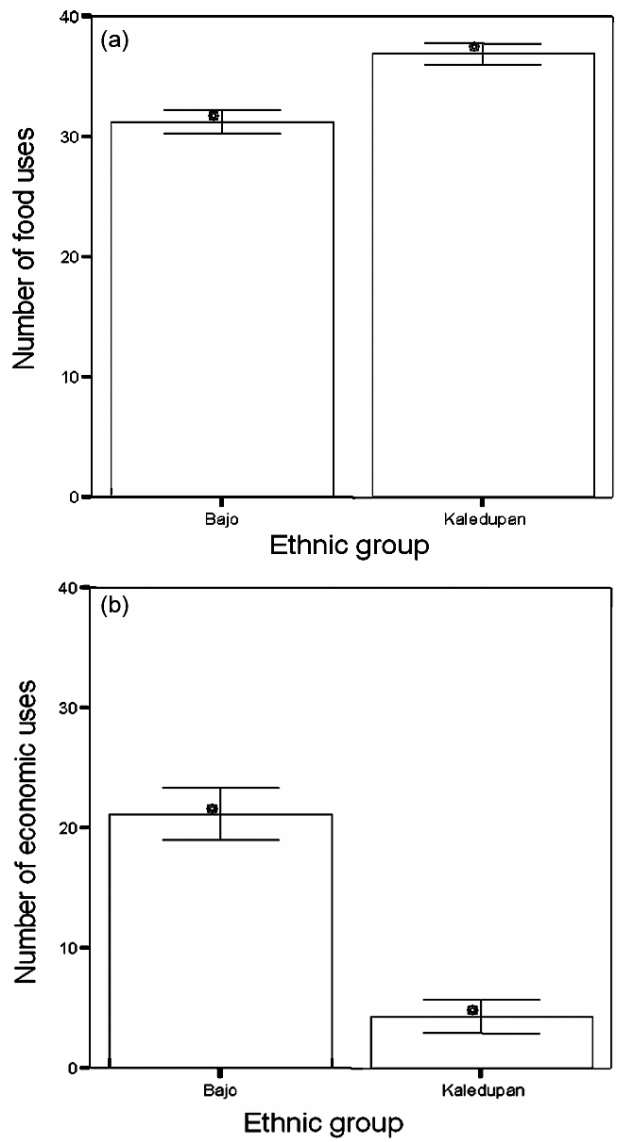


Fig. 2 a & b Comparing local food and economic species uses between 2 ethnic groups (mean +2SE).

deprived *Bajo* and the more developed *Kaledupans*. Spearman's rank was used to test for an association between intra- and inter-community wealth and exploitation of local species for food and for income. Finally, Spearman's rank was used to test if wealth (both intra- and inter-community) was correlated with local support for traditional practices.

**Results and discussion**

The results showed that the *Bajo* employed significantly less species for food uses than the *Kaledupans* (6 less uses) ($U=1761.500$, $p<0.001$, $n=192$), but more species for economic uses (16 more uses) than *Kaledupan* communities ($U=764.500$, $p<0.001$, $n=192$) (Fig.2) Both ethnic groups revealed more in-depth knowledge of local consumption uses than economic uses, particularly the *Kaledupans*. Standard error bars indicate that there is more variation in local economic species knowledge than in food knowledge. These results indicate that the more developed, less resource dependent *Kaledupans* are more likely to use local species for food than the less wealthy *Bajo*, whereas the less developed Bajo are more likely to use local species for income than the more wealthy *Kaledupans*.

The results looking at intra-community wealth (material wealth ranking) revealed a direct relationship between individual wealth and food uses listed ($Rs=0.190$, $p<0.01$, $n=192$) and an inverse relationship between wealth and economic uses ($Rs=-0.254$, $p<0.001$, $n=192$) (Fig.3). Although the relationships between changing wealth and knowledge of food and economic uses do not indicate a rapid knowledge transition with change in material wealth, they do show a distinct gradual change that is nevertheless highly significant. Error bars indicate particularly high variation around the mean in the highest wealth ranks (ranks 10 and 11). This is most likely due to low sample sizes within these groups since wealth was sparse in this region and consumer goods rare. This shows that as individual wealth increases, local species are used less for income and more for consumption purposes. However, the less wealthy resource dependent individuals are more likely to exploit local species for income rather than for food.

Inter-community wealth data (mean village primary household income) also revealed a direct relationship between mean village income and food uses listed ($Rs=0.254$, $p<0.001$, $n=192$) and an inverse relationship between village income and economic uses ($Rs=-0.408$, $p<0.001$, $n=192$) (Fig. 4). Both relationships revealed were highly significant, however a stronger relationship was found to exist between economic use knowledge and household income than food use knowledge and income. Both figures reveal an outlier community. This was the *Bajo* community of Sampela who claimed to have unexpectedly high levels of income. This may stem from a number of villagers carrying out seasonal work for Operation Wallacea in recent years combined with the difficulties encountered in collating economic data through socio-economic surveys where income is seasonably variable. However, the results clearly

indicate that as mean household income of a village increases, local species are used less for income by local villagers and more for consumption. However, the lower income, resource dependent communities are more likely to exploit local plants and animals for income rather than for food.

When testing for an association between intra-community wealth and local support for traditional practices, a significant inverse relationship was revealed ($Rs=-0.299$, $p<0.001$, $n=192$). The same inverse relationship between wealth and support for traditional practices was revealed when testing for an association with inter-community income levels ($Rs=-0.379$, $p<0.001$, $n=192$). Both were highly significant and revealed quite a strong relationship between departure from tradition and increased wealth. Again standard error bars indicate variation around the mean, as expected when collating income data through socio-economic methods in seasonally changeable economic environments. Therefore, in this region increases in wealth, both individually and on the level of community, are correlated with a decline in support for local traditional practices (Fig. 5).

In this region of Indonesia, this study showed that both individual and community wealth play a huge part in local species use. Members of the less wealthy ethnic group, the *Bajo*, are more likely to use local species for income than the more wealthy *Kaledupans*. However, the *Kaledupans* are more likely to consume local species than the economically deprived *Bajo*. This result could be a consequence of any number of social or cultural differences between the two groups, however further testing revealed that economic differences are the most likely explanation. The wealthiest individuals within a community were found to be the most likely to consume a species than less wealthy individuals, whereas poorer community members are more likely to sell local species for income purposes than wealthier individuals. The results also found a similar relationship between inter-community differences in wealth and inter-community differences in local resource use. That is poorer communities are more likely to use local resources to generate income than residents from wealthier communities, who are more likely to use local species for consumption and rely on other sources of income.

The results are contrary to the findings of most previous studies[14,26]. These generally show an inverse relationship between food uses of local species and income level, the rationale behind this being that the least wealthy within a community are the most resource dependent. Therefore, they are unable to trade in local markets and depend upon local wild foods to supplement dietary intake, particularly when bad weather conditions, disease or insect blights affect-harvested yields[18]. However, this study revealed that quite the opposite is the case in this remote region of Indonesia under increasing development pressure. In this region, local resources have recently developed monetary value, local knowledge has been questioned and local practices influenced. Such introductions include market co-operatives, formal schools and modern health clinics[39]. This is indicative of the situation that more and more traditional communities find themselves in today, where isolation has been penetrated by globalisation. The pattern observed between wealth level and local species uses can be explained in these remote regions by the primary economic resource of the rural poor and indigenous peoples being natural resources. A similar study revealed that common property resources in India contributed significantly to household income of the rural poor but not wealthier households[51]. Therefore, once monetary influence has entered a region, the only way for economically deprived groups to compete in these markets are through generating their own income. In the case of the remote rural poor and indigenous, this means collecting and selling local natural resources of monetary value to both wealthy locals and outsiders, in this case for food.

Therefore, instead of consuming the tasty catch, such as certain genus of sea cucumbers (*Bohadschia*) or tuna (*Thunnus albacares*), poor *Bajo* families more often than not sell the highest quality catch to wealthy *Kaledupans* and outsider boats for income[52]. Outsider boats may come from other islands within the region (such as Wanci Wanci) or even as far as the Philippines or Japan to purchase species for use in the live food trade[39]. Therefore, low-income *Bajo* families are left with the less tasty, low-variety portion of the daily catch for family meals, for instance sea urchin (*Diadema*) or triggerfish species (*Balistapus undulatus*). Lacking the purchasing power to trade in local markets limits low-income *Bajo* families to a less varied, less palatable and low energy diet compared to their high-income *Kaledupan* neighbors. The least wealthy households rely on a greater variety of local species for income today rather than for

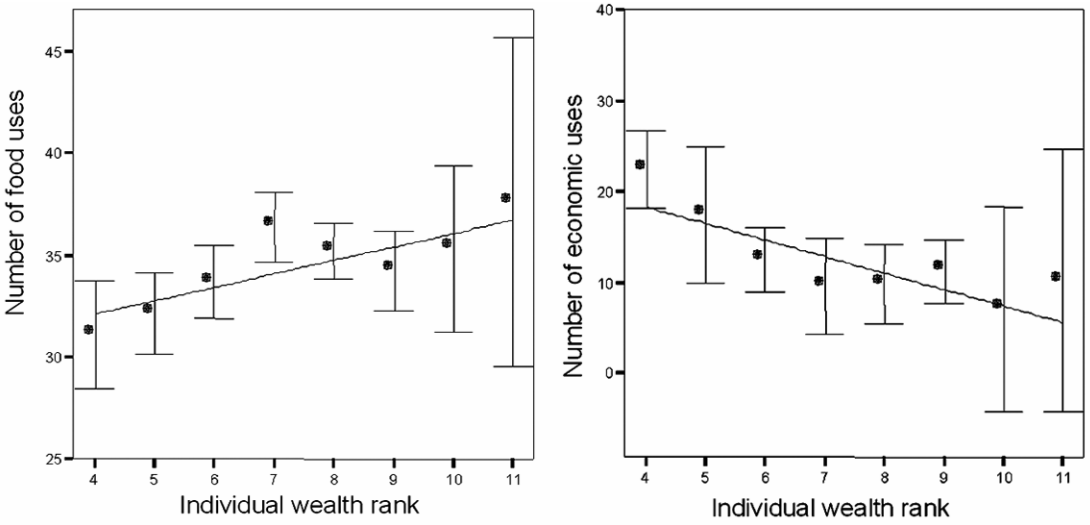


Fig. 3a & b Comparing the relationship between individual wealth rank and number of food and economic uses for local species

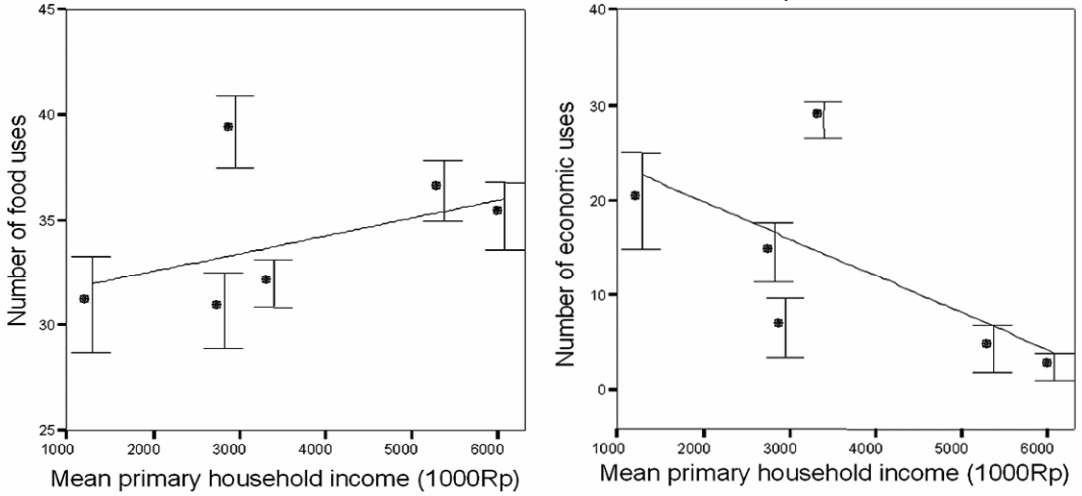


Fig. 4a & b Comparing the relationship between village income level and number of food and economic uses for local species.

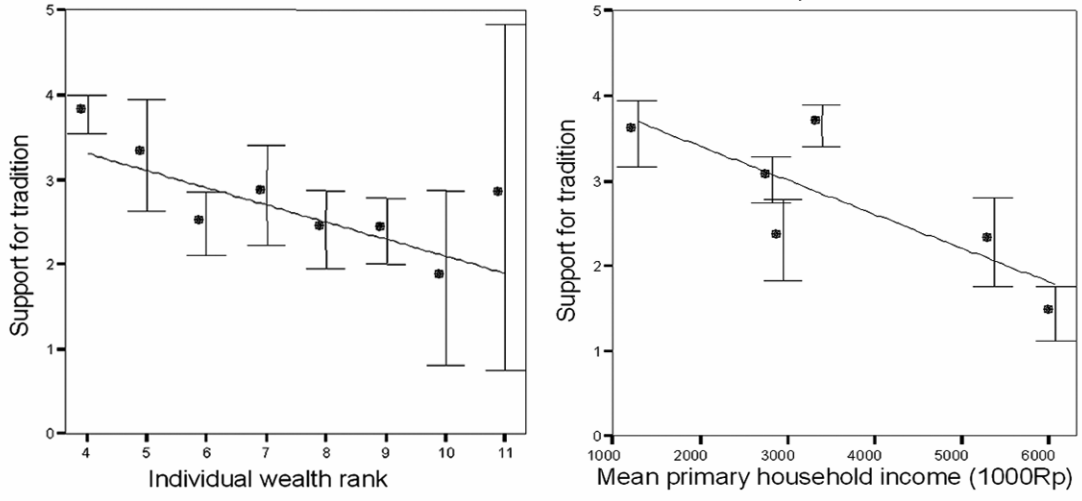


Fig. 5a & b Comparing the relationship between local support for traditional practices and wealth by (a) individual wealth rank, and (b) by village income level.

consumption, as they most likely did in the past before external market forces emerged. One reason for this is to access new modern facilities locally and to purchase staples (such as rice from the local market) [41,42]. As a result, a shift in local knowledge has probably occurred. Poor *Bajo* families no longer consume the diversity of species that their grandparents consumed and therefore, are likely to have forgotten detailed knowledge on how to prepare them and the full variety of palatable species in the area. However, this knowledge is likely being replaced with new information more useful in the light of modern economic development, for instance, knowledge of which species can be sold for the best price and who to.

Wealthier families on the other hand can afford to purchase and consume a greater variety of local foods to supplement their diet. Their income is generated from other sources[36.] Therefore, they do not have to depend on local natural resources for income and can afford to purchase the more tasty palatable species collected by poor fisher families. Consequently, they use a greater variety of species in meals and a great deal less for economic gain, relying primarily on other forms of income. Therefore, in this region where market forces now persist, wild plants and animals no longer fill the role they once did to economically deprived groups as the *hidden harvest*. Instead, they have become the primary source of *hidden revenue* for poor households, as the only product available of any monetary value to them. This creates a shift in incentive for resource collection and management, from long-term subsistence to maximization of profits and income opportunities. The desire to maximise income and exploit local markets and modern facilities means the removal of larger yields[53]. Increased resource withdrawal combined with locals no longer having the stake in the environment that they once had when it was the only available resource to feed their children and grandchildren in the future, means that the incentive for sustainable management and controlled resource withdrawal is lost.

Hence, where market values have recently been placed on local resources, the view of local ecosystems shifts. Ecosystem perception changes from that of the key resource available to support future generations, to a disposable resource necessary to maximise economic income in the here and now. This perception can lead to overexploitation, a scenario unlikely in long-term subsistence-based communities[54,55]. For instance, the sustainability of giant clam (*Tridachnidae*) stocks is highly dependent upon local knowledge with sedentary populations developing site-specific requirements, and yet community management of these stocks more often than not fails. Researchers assert this failure to the high market prices of giant clam overwhelming traditional social norms and economic incentives controlling opportunism, a situation unlikely to arise where subsistence is still the key motivation behind resource collection[56]. Therefore, the long-awaited intrusion from state and market pressures has the capacity to generate despoiling communities from the image of ecological primitives in harmonious balance with their ecosystems[55]. Although, this image may be somewhat thwarted by idealism, the shift as a result of external forces is certainly not.

## Conclusion

Although, local knowledge has long been valued for its contributions to traditional management used in the collection, withdrawal and sustainment of species from ecosystems worldwide, altered incentives for collection combined with this in-depth knowledge could act in reverse to deplete local ecosystems and the species they support[2,22,55]. The results of this study found both intra- and inter-community wealth increases to be correlated with a decline in local support for traditional practices. Therefore, individuals or communities with higher income levels are less likely to support traditional ecosystem practices. Instead, new incentives for resource collection (economic rather than subsistence driven) are emerging and combining with reduced support for traditional management practices and in-depth local knowledge of where and how to maximise local resource collection to cause the collapse of local ecosystems that have sustained human populations in the region for generations.

With modern patterns of economic development inevitably spreading to even the most remote communities in the future, the knowledge bases of these communities are going to change. This is likely to happen as economically deprived groups try to contend with the rest of society by abandoning traditional uses of local wild plants and animals and selling them for monetary gain as the only economic resource available to them. The resulting shift in resource collection incentives and management practices is likely to threaten ecosystems,

management practices and the human populations that will have to rely on them in the future. This implies that external monitoring of resource management practices, their sustainability and impact on ecosystems, is likely to become essential in the future as economic development encroaches upon more traditional communities, altering resource collection incentives from subsistence-based to income-based. In addition, the results of this study have implications for the future of less wealthy communities in resource-rich regions. If access to natural resources is ever reduced or removed in the future, for instance through ecosystem degradation or management regulations limiting extracted yields, in addition to ensuring that alternative food sources are available, state authorities must ensure that alternative income streams are found for these communities in order for them to have any role in today's market economies, particularly in the light of future economic development. Therefore, both wild and human populations inhabiting an ecosystem come under threat when economic development and market pressures force the local view of natural resources to shift from one of *hidden harvest* opportunities to *hidden revenue.*

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