Contribution of provisioning services of the Ga-Mampa wetland, South Africa to local livelihoods

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Abstract
This paper describes an assessment of the contribution of provisioning services provided by the Ga-Mampa wetland (1km^2) to the livelihoods of local stakeholders, including monetary values for some services. The study used a combination of data collection approaches including a questionnaire survey, focus group discussions, key informant interviews, field observation and measurements, and collection of market prices. The results show that the contribution of the wetland to the livelihoods of local community is an estimated annual $228 per household, which represents about 15% of the average 2006 household income of $1,584/y. Crop production contributed the highest gross value, while sedge collection yielded the highest cash income. Overall, an annual gross value of $900/ha is provided through provisioning services in the Ga-Mampa wetland. In addition, it was found that wetland services are essential for household subsistence and providing resources for gift giving to neighbours and relatives. Due to the lack of alternative income sources, the declining income from sedge and reed harvesting caused by continued degradation of the wetland poses considerable economic hardship. Integrated assessment of all ecosystem services and identification of involved stakeholders is needed to develop sustainable management strategies that deal with the environmental and socio-economic changes in the area..

Keywords
Wetland ecosystem, provisioning services, livelihood, market valuation, South Africa

1. Introduction

Wetlands have provided valuable resources and refuge for human populations since the beginning of human life on earth (Ramsar Convention Bureau 2000). They perform many ecological functions, such as regulation of biogeochemical cycles, provision of habitat for life cycles of plants and animals, which in turn provide many goods and services (hereafter called ecosystem services) (De Groot et al. 2002). Ecosystem services are the benefits derived from nature that are important for human well-being (MEA 2005). Many studies have shown that wetlands in Africa support the livelihoods of rural and often poor households (Adams 1993, Turpie et al. 1999, Mwakaje 2009). However, in spite of their importance in sustaining livelihoods, many African wetlands are threatened by human activities (Schuyt 2005) such as conversion to agricultural lands and urbanisation, which are responsible for the loss of about half of global wetlands in the twentieth century (Rijsberman and Silva 2006, Bruland, Hanchey and Richardson 2003, Wood and van Halsema 2008). It is becoming increasingly clear that corresponding changes in wetland ecosystems undermine not only their ecological integrity but also alter the supply of wetland services resulting in significant consequences for human wellbeing (McMichael 1993, Millennium Ecosystem Assessment 2005, Schuyt 2005).

The lack of readily available data and information on the values of wetlands is identified as a major reason why their conversion and ‘development’ have been, and still are, viewed as a generally more attractive option than conservation and sustainable use, especially in developing countries (Balmford et al. 2002, Mmopelwa 2006). In the African continent, there are few studies that explicitly estimate the economic values of wetlands (Schuyt 2005). Even where such studies are available, it is often for large wetlands or focused only on a single ecosystem service (see Eaton and Sarch, (1997); Emerton et al., (1999); Lannas and Turpie, (2009); Mmopelwa, (2006); Schuyt, (1999); Schuyt, (2005); Turpie, (2000); Turpie et al., (1999)). The economic value of smaller wetlands (i.e. smaller than 5km^2) has been little studied, possibly because they are considered insignificant. However, in Africa, small wetlands are extensively used for subsistence agriculture and are often more important to national development than the large ones (Taylor, Howard and Begg 1995, Macfarlane and Teixeria-Leite 2009). They are also important for the maintenance of biodiversity (McCulloch, Aebischer and Irvine 2003, Gbogbo 2007). This underscores the need for more and better information on the values of small wetlands.

Benefit transfer (applying economic value estimates from one location to a similar site in another location) (Plummer 2009) is often suggested as an alternate method to value ecosystem services. However, the variation in values from existing studies suggests that it is not realistic transferring values from one wetland to another. For instance, in the study of four wetland sites in the Zambezi Basin, Turpie et al (1999) estimated that annual net financial income per household from livestock production ranges from US$31 in the Lower Shire to US$120 and US$422 in the Barotse and Caprivi wetlands, respectively. In the same study, cropping yields net financial incomes per household of between US$89 in Barotse to US$295 in the Lower Shire. In essence, the value of each wetland ought be considered as unique to it.

This paper is an addition to the scarce literature on economic value and contribution of small African wetlands to livelihoods. The aim is to describe the monetary value of the provisioning services derived from the Ga-Mampa wetland and their contribution to the livelihoods of local stakeholders. Provisioning services are the tangible goods or products obtained from ecosystems such as food, freshwater, timber and fibre. We discuss two pertinent questions, (i) what is the monetary value of provisioning services derived from the Ga-Mampa wetland? (ii) will households value gross financial gain from the wetland over the wetlands contribution to cash income?

2. Methods

2.1. Study area

The Ga-Mampa valley is a rural area located in the Mafefe tribal area of the Lepelle-Nkumpi Local Municipality of the Republic of South Africa. The Ga-Mampa valley covers an area of about $5km^2$ of which approximately $1km^2$ is the Ga-Mampa wetland of the Mohlapitsi River, a tributary of the Olifants River (Troy et al. 2007). The Mohlapitsi makes a significant contribution of up to 16% of the Olifants River flow during the dry season (McCartney 2006). Thus, it was initially hypothesized by stakeholders outside the local community, that the hydrological regime of the Ga-Mampa wetland might be important to the Olifants River (Troy et al. 2007).

The Ga-Mampa valley has a semi-arid climate with seasonal rainfall that largely occurs from October to April with mean annual rainfall of 630 mm. May to September are dry months. The area is rugged and mountainous with an average altitude of 1305 metres. In the wetland, altitude ranges from 536-755 meters. The surrounding area of the Ga-Mampa valley is covered by bushes which were established as a nature reserve in the 1960s. Reeds (*Phragmites mauritianus*) and sedges (*Cyperus latifolis and Cyperus sexangularis*) are abundant plant species occurring in the wetland (Kotze 2005).

Based on the fieldwork done for this study, the population of the valley was estimated at 2,758 inhabitants in 394 households in November 2006. The average household size is seven persons, and average monthly income in 2006 was $132/household ($1,584/household/year), the majority of which comes from pension and welfare grants[1]. There are few employment opportunities in the valley and the people resort mainly to farming (65% of respondents) as their main occupation. Of the household heads, 30% have no formal education and another 30% have less than five years of formal education. There are two main villages in the valley: Ga-Mampa and Mantlhane, of which Ga-Mampa is the largest.Both villages have a headman *(Induna*, traditional head of the people*)*, who is responsible for allocation of communal land and gives authorization for harvesting natural resources within the wetland. The people of Ga-Mampa have also formed a development forum - Ga-Mampa Community Development Forum (GCDF), responsible for formulating programmes for the development of the area and liaise with the local municipality.

[1] Elderly citizens are paid $137 per month while $29 is paid to children under 14 years

Three small-scale irrigation schemes built in the mid 1940's have contributed to a large part of the local food production. After the withdrawal of government support in the mid-nineties, and floods in 1995 and 2000, the irrigation infrastructure has deteriorated, thereby rendering a large part of the schemes obsolete. After the collapse of irrigation schemes and drought following the floods, farmers have resorted to the wetland for agriculture because of its wetness and rich soils. As a consequence, half of the wetland area was converted to agricultural land between 1996 and 2004 (Troy et al. 2007).

The Ga-Mampa wetland provisioning services include the use for crop cultivation, livestock grazing (forage and water), reed collection (building material), sedge collection (art and craft material), fishing, hunting, fuel-wood collection, wild edible plant collection, medicinal plant collection and collection of water for drinking, washing and bathing. Wetland cultivation is popular because of the limited availability of arable land in the area which was aggravated by the damage done to the irrigation schemes. Wild edible plants (mostly leafy greens), used by the local population to diversify their diet, are collected from the wetland because it provides high quality edible plants all year round, unlike the surrounding area. The wetland is also the only location where reeds and sedges, used for building and crafting activities, are available. Use of other services is usually combined with these main activities. For example, collection of bathing water is mostly associated with cropping activities in the wetland.

2.2. Conceptual framework and research methods

This study adopts an Integrated Ecosystem Assessment Framework first developed by De Groot et al., (2002) and improved by De Groot et al., (2010) to disentangle the interactions between ecosystems and human wellbeing. This framework was used to identify and measure the contribution of wetland provisioning services to livelihood of local communities. The two important steps of analysis guiding this study are: *ecosystem function analysis* and *economic valuation* of the associated services (Figure 1).

Insert Figure 1 about here

Ecosystem function analysis is the process by which a wide range of key elements of complex ecological structures and processes are translated into a limited number of functions, which in turn determine the services an ecosystem provides (De Groot 2006).

This study adopts the typology and nomenclature of ecosystem services proposed by the Millennium Ecosystem Assessment, which classifies them into provisioning, supporting, regulating and cultural services (Millennium Ecosystem Assessment 2005). Once the services derived from the ecosystem are identified (top part of Figure 1), the next stage of the assessment is to determine the value to human society (economic valuation – bottom part of Figure 1).

Humans attach value to ecosystems because they satisfy material and non-material needs. Economic valuation attempts to assign quantitative values to market and non-market services provided by environmental resources (Barbier, Acreman and Knowler 1997). Part of the economic value can be expressed in monetary terms to make the outcome comparable to other sources of income for local population. The main approaches to attach monetary value to ecosystem services are direct and indirect market valuation, non-market valuation and benefit transfer. In this study we only used market valuation which is based on collecting information on the quantities of the ecosystem services harvested, their market prices and cost implications. This is done by quantifying the amount of an ecosystem service derived from an ecosystem and then relating this (multiply) to the local market value (or value of a substitute) of the service. Having identified the ecosystem services to be valued, and the valuation methods to be used, the next step is to collect relevant data on the quantity of services used, costs of using the service and market price.

2.3. Data collection

Data were collected using a combination of approaches that include questionnaire survey, focus group discussions, key informant interviews, field observation and measurements and collection of market prices. Identification of the main provisioning ecosystem services derived from the Ga-Mampa wetland was based on existing literature on the wetland i.e. Darradi, (2005) and Tinguery, (2006) complemented with information collected during the first focus group discussion and field observations. In total 66 households were interviewed directly (face-to-face) between August 2006 and November 2006 using a structured questionnaire. The sample (N=66) was divided into two sub-samples: 33 wetland farmers (households cultivating one or more plots in the wetland) were randomly selected among the 99 wetland farmers identified by the headmen of the two villages. From the rest of the population; and 33 households were selected randomly. The proportion of wetland farmers selected for the interview is higher because they are the main users of the wetland and available time did not permit a survey of a corresponding proportion from the rest of the population. The questionnaire was structured into three sections: the first section captured demographic and socio-economic characteristics of respondents; the second dealt with general information about access and use of the wetland; and the third section asked detailed information on each provisioning service under study (quantity of service harvested, costs and price). Additional questions were asked to wetland farmers on their crop production. Most of the questions covered respondent's activities in the last year (September 2005-October 2006). The questionnaires were administered to head of households and when possible done in the presence of other household members.

These interviews were complemented by group discussions, interviews with key informants and direct field observation and measurement. A first focus group discussion was held at the beginning of the study to provide some background information, identify the main uses and users of wetland resources and establish the list of wetland farmers. A second focus group discussion was conducted after completion of the household survey, to verify and complement information collected during the survey, for example on price variability, durability of tools and methods used in wetland services collection or cropping, and use of household labour. During the second focus group discussion, participants were asked to collectively rank wetland services in terms of their value for the community, using the so-called pebble distribution method, which is a participatory rural appraisal tool used to document the perception of respondents on selected issues (Sheil et al. 2003). To understand the perceived livelihood value of the wetland by local people, participants were asked to discuss and divide twenty-five tiny stones among wetland ecosystem services based on their perceived importance. Several key informants were also interviewed: the headman of Mantlhane (who provided information on access to the wetland and number of households in his domain); the chairman and secretary of the Ga-Mampa Community Development Forum (who gave general information on cultural and historical background); agricultural extension officer (on activities in the wetland and crop yield); the ward councillor (on future potential of the wetland for tourism); a farmer who could speak English (cropping activities, sale and use); and the wife of one of the traditional healers (on use of wetland plants for medicinal purpose). Traditional measurement units used by local people (eg. "bambas" for land area) had to be translated into standard units, and travel time between homesteads and the wetland were estimated through direct field observation and measurements.

In cases where market prices could not be ascertained through the household survey, group discussions or informant interviews, a visit to the local market in Ga-Mampa and the neighbouring community at Mafefe provided further information about market prices. When a product was not marketed in Ga-Mampa, the price of the closest marketed substitute was used. For example, hunted animals are not sold; hence we used the price of chicken suggested as the closest substitute during the focus group discussion. Finally, in the spirit of *giving back* to the community (Walker 2007), a feedback workshop was organized for the local stakeholders to communicate the preliminary results of the study. The questions and comment sessions proved to be an important avenue for gaining more insight into stakeholder perceptions on the services.

2.4. Data analysis

The values of the Ga-Mampa wetland provisioning services were estimated and expressed as annual values using three economic indicators. The Gross Financial Value (GFV - economic worth of total quantity harvested), the Net Financial Value (NFV - the total subsistence plus cash value to households net of input costs but not household labour costs) and Cash Income (CI – economic worth of quantity sold). GFV captures the total monetary value of the service. This indicator is appropriate for services that are used for subsistence. On the other hand, NFV is an acceptable indicator of the potential market values that could be received, if the ecosystem service would be sold on markets, and if the costs of collection involve the direct financial costs made. In other words, it gives a good indication of the profit made. Cash income is an appropriate indicator for the actual cash generated from the sale of ecosystem services. This indicator measures cash generated from sale of ecosystem services and used for other household livelihood activities.

Quantities expressed by respondents in local units were converted to standard units, while monetary values were expressed by respondents in South African Rand (R), and were then converted into United States Dollars ($) based on an average exchange rate between September 2005 and September 2006 at R6.46 = $1.

The ‘expected’ number of households participating in a specific production activity (EPHH) (e.g maize cropping, sugar cane cropping sedge collection) and total annual quantity harvested (or produced) (TQH) were used to compute for GFV and NFV as follows:

$$EPHH_a = \frac{m}{n} \times N \qquad \textit{(Equation 1)}$$

where *m* is the number of households participating in the activity in the sample, *n* the total number of sampled households (n=66) and N the total number of households in the population (N=394).

TQH (i.e. for production activity a) was computed from the average annual quantity collected per sample household, multiplied by the ‘expected’ number of households participating in that specific production activity (EPHH).

$$TQH_a = \frac{\sum_{i=1}^{m} HC_{ia}}{n} \times EPHH_a \qquad \textit{(Equation 2)}$$

where HC_{ia} is the quantity of product a collected by household *i*.

Gross financial value was computed as follows:

$$GFV_a = TQH_a \times P_a \qquad \textit{(Equation 3)}$$

where P is the average price per unit at which a product is sold in Ga-Mampa (September 2005 – October 2006).

Net financial value was computed as follows:

$$NFV_a = GFV_a - CST_a \qquad \textit{(Equation 4)}$$

where CST is total costs of collection/production, excluding cost of family labour and travel. The cost of family labour was not taken into account as the opportunity cost was considered minimal in a context of high unemployment and low earning skills. Costs were estimated based on monetary inputs (such as cost of seeds, tools and hired labour) going into the harvesting and use of each provisioning service of the wetland. Tools used for harvesting resources represent the main source of cost. The cost of tools such as hoes, cutlass and axes used for collecting wetland provisioning services was calculated using straight line depreciation. Costs of implements at time of purchase were corrected for inflation using rates from (Statistics South Africa 2006), and then further divided by average length of use suggested during focus group discussions, and number of uses (for implement used in multiple activities as indicated by households during the survey). By using GFV and NFV as indicators we are able to assess the level of financial investment needed to derive benefits from the Ga-Mampa wetland.

Finally, the Cash Income (*CI*) is the monetary value of quantity sold:

$CI_a = QSD_a \times P_a$ (Equation 5)

where *QSD* is the total quantity of product sold. It was estimated using the same method as for *TQH*. CI is different from GFV in that it is an indication of the total local market value of the quantity sold out of the total harvest.

3. Results

3.1. Use and value of wetland provisioning services

This section presents the results on the value of each of the provisioning ecosystem services derived from the Ga-Mampa wetland. We have presented the value of each ecosystem services separately to make their individual contributions to livelihood clear. However, it is important to note that in reality services are interlinked and a change in the wetland will impact not one, but multiple ecosystem services because the ability to provide one group of services depends on the proper functioning of the others (Millennium Ecosystem Assessment 2005)

Because of the high uncertainty associated with information obtained on grazing, water collection and medicinal plant, these services are not included in the financial and economic results presented, however some information about these services is still provided. Households seldom collect forage from the wetland, are not aware if their livestock graze in the wetlands neither is information on time spent by livestock grazing the wetland reliable. Likewise, the secrecy surrounding collection of medicinal plants from the wetland meant that necessary information on types, quantity collected and location were not disclosed during the interviews.

3.1.1 Cropping

About 25% (99) of households in Ga-Mampa valley have permission to access and use the wetland for cropping purposes. As the wetland falls under communal land, permission to access it for cultivation is usually given by the headmen. Presently, there are no more available plots and even if there are, no more authorisation is being given due to advocacy by a non-governmental organization on wetland conservation (Mondi Wetlands Project) which argued about the negative impacts of wetland clearance on the catchment hydrology. Of the $1km^2$ wetland, about 0.66 km^2 or 66% is currently under cultivation. Wetland cropping plots ranged from 0.25ha to 1.5ha, the average plot-size in the wetland is about 0.7 ha per wetland farming household. Our analysis showed that plot size does not vary a lot across household. The greatest upsurge in wetland farming was after 2000, this was when about 80% of wetland farmers acquired their plot. This coincides with the period of the second flood that destroyed the irrigation scheme. To maintain the integrity of the wetland, croppers are to rely on natural fertility of the wetland, because the Ga-Mampa Community Development Forum discourages the use of fertilizers and pesticides. However, the secretary of the forum does not exclude that some farmers may be disobeying this rule, but maintained they will be punished if caught.

The main crops[2] cultivated in the wetland during the wet season (October–April) are maize *(mabele),* which is the staple food, often intercropped with vegetables *(morogo)* and groundnut *(dimake).* Coriander (*mospo*) and beans are popular dry season crops. Sugar-cane *(moba)* and banana are the most common permanent crops in the wetland, but in limited quantity. Other crops cultivated in the wetland include spinach, cabbage, tomatoes, onions, pumpkins and beet-root. While maize cultivation remains high, cultivation of coriander is decreasing because of rapid decline in its market price.

Of the 99 households with a wetland farm plot, 90 cultivated their plots during the 2005/06 cropping season. Lack of money and ill health are the reasons given for not cropping. Data for individual crops is presented in Table 1. The total value of all crop production was estimated at an annual gross value of $36,798 (Table 1). The main costs associated with cropping come from purchase of seeds, hiring of tractors and donkeys and transportation of yields. If this is factored in, the NFV from cropping is $25,687. About 92% of this is generated from wet season crops – maize (83%) and vegetables (9%). Total cash income from cropping is $3783. Only 57% of this is generated during the wet season, indicative that dry season crops are more marketed. Up to 86% of dry season crops – groundnut, coriander and beans are sold for household income (Table 1). In all, cropping contribute 27% of the total cash income of the Ga-Mampa wetland provisioning services. On the other hand most of the wet season crops – maize and vegetables are used for household consumption.

Insert Table 1 about here

The Ga-Mampa wetland supplies a large proportion of food consumed by the people. More than 20% of the total yield of each crop is consumed directly for household subsistence. The proportion of wetland products self-consumed is even higher (over 80%) for maize (main staple meal in Ga-Mampa valley) and vegetables (source of nutrient diversification). Pap made from maize is the most common meal of the locals, eaten almost every day by each household in the Ga-Mampa valley. Considering the generally low level of cash income per household, most families cannot afford buying milled maize from the market. Thus, the Ga-Mampa wetland plays an important role in the food security of the local population. It is deduced that an average household requires approximately a bag (95kg) of maize per month. The total annual maize requirement for the 394 households would then amount to around 449 tons. With total maize production from the wetland estimated at 110 tons per annum (Table 1), maize produced from the wetland therefore represents almost 25% of the subsistence needs in the valley. Some part of the maize are kept to be used as farm seed for the next cropping season, while another part is given in exchange for farm labour. Cultivating vegetables (cabbage and spinach) in the wetland is also important to household food supply. Over 80% of cultivated vegetables are used directly for household consumption, serving the same purpose as wild edible plants collected from the wetland. The wetland further contributes to food security by enabling all year-round access to crop production and aid diet diversification by allowing the cultivation of crops, such as bananas or sugar cane that cannot be found in dryer areas of the valley.

[2] Pedi names used by local people are indicated in brackets

An average cropping household spends about 942 hourson cropping annually[3] to generate $409. Therefore, the value of time spent on cropping was estimated at R3/h ($0.4) which is less than the average hourly wage in Ga-Mampa valley (R8, $1.24).

3.1.2 Wild edible plant collection

Wild edible plants are the most widely used provisioning ecosystem service provided by the Ga-Mampa wetland. Collection takes place all year round with highest collection intensity between November and March. Some households collect an excess of these plants in the wet season and sun-dry them for use in the dry season when available quantity in the wetland is reduced. Collection is done by hand into small farm seed buckets. There are about 24 different types of edible plant collected in the wetland. *Morogo* is the generic name for wild edible plants and the most common are *Moshwe, Leshashe, Mshigi, Morotse and Bolotse*, all these are leafy plants comparable to spinach.

All households in the valley have collected wild edible plants from the wetland prior to the 2005/2006 session, but about 95% of households collected edible plants from the wetland during the 2005/2006 session. This is the service in which most households (376) participate. The total quantity of wild edible plant collected from the wetland is estimated at 15,273kg. At an average price of R13 ($2.01) per kg, annual gross value of wild edible plants from the Ga-Mampa wetland is $30,735 (Table 2). The cost of using this service is associated to the farm seed bucket used for collection and is regarded as negligible; therefore, NFV of wild edible plant is estimated equal to GFV.

About 3% of collected wild edible plants are sold to generate household income. In all, an annual cash income of $861 representing about 6% of total cash income from the wetland is generated from wild edible plant collection. 86% of harvested edible plants are used for direct household consumption. Wild edible plants are used to diversify meals as most household may not have enough money to buy meat. Thus, local people consider edible plants from the Ga-Mampa wetland as quite important. Therefore, besides direct nutritional contributions the diversity of wild edible herbs is a source of variety, spice and taste in local meals (Dovie et al. 2007). The remaining 11% of wild edible plants is used to meet social responsibilities through gift giving to elderly neighbours and relatives.

It takes 91 hours of household labour to collect the average value of $84 per participating household. The value of time spent on edible plant collection is thus worth about R6 ($0.9) per hour.

3.1.3 Reed collection

Reeds together with sedges are the most sought after fiber resource provided by the Ga-Mampa wetland. The period to collect reeds (usually between June and July) is sanctioned

[3] Based on farmers average time spent on major farm activities such as land preparation, sowing, weeding, fertility management, pest control, disease control, harvesting, transportation of harvested produce and post harvesting activities. Most of the labour used for these activities comes from household labour.

by the headmen. It is an offence to collect reeds without the headmen's permission when they have not yet declared time for reed collection.

About 96% of households have collected reeds from the wetland in the past, but only 21% collected reeds from the Ga-Mampa wetland in 2005/2006 session. Most households desired to collect this resource but indicated that they could not find any, probably a sign of declining service. The annual reed harvest is estimated at 2526 bundles (a bundle is about 60cm in diameter and could weigh between 5kg and 10kg). At an average price of R20 ($3.10) per bundle of reed, the gross financial value accruing from reed collecting from the Ga-Mampa wetland is estimated as $7,820. Taking the cost of tools (cutlass) used in reed collection into consideration; it contributes a NFV of $7,795.

18.8% of harvested reeds are sold for cash. In total reeds contribute $1467 (10.6%) of the total cash income from the Ga-Mampa wetland provisioning services. About 72% of collected reeds were used directly by households for roofing their own houses. Field observation revealed that about half of buildings in Ga-Mampa are roofed with reeds believed to have come from the wetland. This is an indication of the wetlands support of basic material for good life through the provision of shelter. The remaining proportion of collected reeds is used as gifts. This is mostly given to neighbours as a sign of social bond, to relatives and to elderly ones who cannot go into the wetland.

Each participating household spent an average 41 hours collecting average quantity worth $93. This translates to R14.6 ($2.3) per hour spent on reed collection.

Insert Table 2 about here

3.1.4 Sedge collection

Sedge *(Cyperus latifolis* and *Cyperus sexangularis)* is another sought-after service harvested from the Ga-Mampa wetland. Sedge collection is regulated by headmen in the same way as reeds.

The wetland has been a source of sedge to about 94% of households in the past, but only 23% of households collected sedges from the wetland during the 2005/2006 survey. All interviewed households reported their desire and efforts to collect sedges during this period; however, they could not find any. An estimated 756 bundles of sedges was harvested from the wetland during this period (2005/2006). Sedges are used for making different art and craft items such as baskets and mats (*legoga).* In calculating the economic value of sedge we took note of the quantity sold as 'raw material' (in bundles) and the value added from the portion used in making art and craft material.

Of the total quantity harvested, 75% (567 bundles) was used in making mats and the remaining 25% (189 bundles) was sold as 'raw material', mainly to households within Ga-Mampa. It can be assumed that they were also used for making mats, however because this was not investigated during the field work, this was not considered in the calculation. On average, 0.75 bundles of sedge are required to make one mat, meaning in total, about 756 mats were made. Of this total, 77% were sold to customers from Ga-Mampa, Kappa and

Mafefe. The remaining was used as gift and for personal use. Combining the worth of the quantity sold directly in bundles (189) at R20 ($3.10) per bundle, with the number of mats made (756) at a standard price of R80 ($12.38) leads to an average annual Gross Financial Value derived from sedge harvesting from the Ga-Mampa wetland, estimated at $9,947 (Table 2). The cost involved in the use of sedge from the wetland is due to (i) cutlass used for harvesting (ii) thread and needle used in making mats (iii) cost of building a locally made knitting machine, and (iv) cost of transportation to and from market. Taking these monetary costs into consideration, the average annual Net Financial Value was estimated as $7,918. Cash income derived from sales of bundles of sedges and mats amounts to $7,785 (Table 2). As such, sedge contributes the highest proportion of 56% to the total cash income derived from the Ga-Mampa wetland. Unlike, other services no part of harvested sedge is used in gift giving.

It takes about 20 hours of household labour to collect an average quantity of sedge (8.4 bundles). In addition, it requires about 7.2 hours making one mat. The total time spent on average benefit of $111 is 80 hours. Therefore, the value of time spent in this activity is then estimated at R8.9 ($1.4) per hour.

3.1.5 Fuel-wood

Fuel-wood collection in the wetland is very limited and occurs only in the dry season. This is due to limited availability of woody plants and their wetness. While about 40% of households have collected fuel-wood from the wetland in the past, only 1.5% of Ga-Mampa valley households collected fuel-wood from the wetland in the 2005/06 survey. All of these reside in the Manthlane – settlement closest to the wetland. Wood from the surrounding mountains and other parts of the Ga-Mampa valley is the main source of fuel-wood to all households. Fuel-wood is collected in bundles, which could measure up to 70cm in diameter and about 200cm long with an approximate weight of 10-15kg.

An estimated annual harvest of 1,296 bundles of fuel-wood is reportedly collected from the Ga-Mampa wetland (Table 2). The standard price for fuel-wood in Ga-Mampa valley is R20 ($3.10) per bundle. Thus, GFV for fuel-wood is estimated as $4,012. The only cost involved in fuel-wood harvesting is the cost of the axe. NFV is therefore estimated as $4,003 (Table 2). All collected fuel-wood is used directly by households as a source of cooking energy and energy to keep warm. No part of the fuel-wood is sold or used for gift.

An average of 108 hours is spent per participating household collecting fuel-wood in the wetland. Relating this to the average $669 per participating household means that R40 ($6.2) is gained for every hour spent on this service. Of all services, fuel-wood generates the highest monetary value per time spent.

3.1.6 Hunting

An estimated 1.5% of households hunted in the wetland during the 2005/06 survey, but about 40% hunted game in the wetland in the past. Rabbit was the most common animal mentioned to be collected from the wetland. Hunting in the wetlands seems to be a spontaneous activity and not a deliberate action as it is mostly associated with cropping.

Game is not commonly sold in Ga-Mampa valley; hence it was not possible to get its market price. Participating households and members of focus group discussion suggest chicken as the closest substitute for game. It is believed that an average game of about 3kg is worth about R31.5 ($4.80). A total of 60 animals (mostly rabbits) were hunted in the wetland. Annual GFV of hunting in the Ga-Mampa wetland was therefore estimated at $288. Game was collected using dogs to hunt them down, cost was thus considered insignificant as such GFV=NFV. All the hunted animals from the wetland were used for household consumption. On average, 10 hours a year is spent hunting per participating household, this equates to a benefit of R31.5 ($4.9) per hour spent hunting.

3.1.7 Fishing

In this study the Mohlapitsi River was not considered as part of the wetland, hence fishing activities going on in the river were not regarded as wetland activities although the wetland will likely provide a nursery-service. 4.5% of households collected fish from the wetland in 2005/06 survey while 30% suggested they have fished in the wetland in the past. Only households with cropping plots in the wetland reported fishing from the wetland. It was not possible during this study to determine the different species of fish available in the wetland.
An average sized fish of about 100g weight is worth R2.25 ($0.35). In total, 708 average sized fish were caught from the Ga-Mampa wetland annually. This gives an annual gross financial value of $247. Cost is associated with buying hooks and thread giving an annual NFV of $221 (Table 2). All fishes collected were used for household consumption.

3.1.8 Water collection for domestic use

Wetland water is mainly used for washing, bathing and drinking. Other uses of wetland water are for drinking water for domestic animals and building purpose. Because of their close proximity to the wetlands, only households from Manthlane sub-village deliberately go to the wetland to collect water. For households in other settlements, water collection in the wetland is associated with other activities, such as cropping or edible plant collection. In all the villages, the main sources of water for domestic uses are the numerous springs and streams located at the bottom of the mountains, and closer to the settlements than the wetland.

It is estimated that about 1,288 m^3 water is drawn annually from the wetland. This represents about 418 m^3 for bathing; 186 m^3 for washing; 583 m^3 for drinking; and 101 m^3 for other purposes. Valuing the monetary benefit from water collection in Ga-Mampa valley presents two main difficulties; (i) generally, in South Africa, there is no market price for water in this kind of rural areas with very low level of water services (Lefebvre et al. 2005) and (ii) substitutes are available to wetland water and these alternatives (because of its location and geology, there are a number of springs and rivers closer to the settlement from where most households collect their daily water requirement) require even less travel time. Thus, the economic value of water is not included in the economic analysis in this study[4]. On the basis of a daily consumption ranging from 29 litres (the consumption from the municipal

[4] If we use the value of bulk water supplied to municipalities received from Department of Water Affairs and Forestry in Tzaneen (closest settlement to Ga-Mampa where price exists) at R3.44 per kl, domestic water use drawn from Ga-Mampa wetland will yield a gross value of $686.

network estimated by the Department of Water Affairs and Forestry (2003) and 50 litres per person (suggested by (Gleick 1996) as a minimal water requirement) only between 2.6% to 4.5% of the total water requirement of the inhabitants of Ga-Mampa valley is collected from the wetland.

3.1.9 Livestock grazing

It is estimated that approximately 70% of households in Ga-Mampa valley own at least one type of livestock (cows, donkeys and goats). However, only an estimated 38% of all households in Ga-Mampa valley could ascertain that their livestock does depend on the wetland for forage. Generally, data on grazing benefits from the wetland (number of animals, period of grazing, contribution of the wetland to total grazing needs) was difficult to acquire because people usually leave their livestock roaming unsupervised. Using a rough extrapolation based on field observations, 84 Donkeys, 618 cows and 1115 goats are grazing in the Ga-Mampa wetland. Using an estimated average intake per animal per day (Animal Unit Day) of 5kg of dry matter for cattle, 1kg for goats and 3kg for donkeys (Taddese 2003), grazing in the wetland contributes a gross value of up to $75,000 annually. This value[5] is over three-quarters of the value of all other wetland services. However, because of lack of adequate data and high uncertainty, the economic value of livestock grazing is not included in the total economic value.

Livestock is consumed (and sometimes sold) during festivities or celebrations. The animals are an important source of milk, eggs and meat manure is used on farms and as substitute to cement for plastering floors; and as a means of transportation and draught power.

3.1.10 Medicinal plant collection

Not much is known about the use of the Ga-Mampa wetland plants for medicinal purpose. This is due to "secrecy" in the community about its use. Information gathered reveals that three main medicinal plants are collected from the wetland: *Mupurogu*, *Mutusa*, *Masheo Mabe.* Unfortunately it was not possible to determine the scientific name of these plants during the field survey. *Mupurogu,* is claimed by one of the users to be able to "prevent any type of disease, no matter how bad it could be". *Mutusa* and *Masheo Mabe* are used together with other plants collected from elsewhere (mountain) as local male fertility drug. Because of the secrecy surrounding its use, it was not possible to estimate the economic value of medicinal plants in this study. Several authors have emphasised the importance of such medicinal plants to the health care of rural people particularly in remote parts of the developing world (Levingston and Zamora 1983).

3.2. Aggregated economic value of the main provisioning services

Based on the calculation of the economic value of each individual provisioning service of Ga-Mampa wetland, the aggregate economic value of provisioning services provided by Ga-Mampa wetland was estimated at about $90,000 for gross financial value; $83,000 for net financial value and $14,000 for cash income (Table 2). Based on this estimation, cropping contribute the highest value of about 40% of the total gross and net financial values of the

[5] This excludes the estimated value of water taken by animals from the wetland. This was estimated to be 5,041 kl giving a gross value of $2,684.

Ga-Mampa wetland while sedge collection account for the highest cash income, generating 56% of total cash income.

To address the question whether locals would value gross financial gain over cash income from wetland resources, during the second focus group discussion respondents ranked the value of wetland services, using a pebble distribution method. The weights assigned by respondents were then used as the "perceived" livelihood value (how locals value the importance of a wetland service) of the wetland by local people. Comparing the weight of empirically estimated economic values of each wetland service with the weight of the perceived livelihood value put on them by respondents (Figure 2) shows that, except for cropping, the relative importance of services perceived by people is closer to their relative weight in gross financial terms than in cash income ones. This suggest that people generally integrate in their valuation the part of services self-consumed by households and that GFV is an appropriate indicator of value of ecosystem services to local people. This result is supported by a correlation analysis using SPSS (Statistical Package for the Social Sciences) that showed that correlation between weight assigned by household and weight of GFV is significant with a Pearson correlation of 0.857. However, the closeness of the perceived weight of cropping and its CI will suggest that for cropping, cash income will be a better indictor. However, this comparison should be made with great caution, as the metric used in both cases is not the same and the composition of the focus group, even if it reflects the general diversity of wetland users is not statistically representative of the population, contrary to the sample. GFV is used as against NFV because the cost of production in Ga-Mampa is negligible i.e. less than 8% of total gross value is associated to cost and most of the cost (72%) is from cropping. Respondents during focus group discussions also suggest that for most services they do not regard the cost as relevant.

Insert Figure 2 about here

In all, about $900 can be generated from every hectare of the wetland. However, it is difficult to assume that all hectares of the wetland have an equivalent value for example, in terms of comparing fishing with cropping. On the other hand, if we are to consider benefits based on time inputs, fuel-wood will yield the best benefit at the value of time spent collecting fuel-wood at $6.2/hour. This value exceeds average hourly wage in Ga-Mampa valley (1.24). The hourly wage for reeds ($2.3/hour), sedge ($1.38/hour), and hunting ($4.9/hour) exceed the average hourly wage in Ga-Mampa valley, but that for cropping ($0.4/hour) and collecting edible plants ($0.93/hour) is less than the average hourly wage in Ga-Mampa valley. Putting these figures in context with figure 2 gives an indication that households do not value household labour time spent on wetland activities. For example, cropping which gives low benefit per time spent but generates a high proportion of gross value is ranked higher than fuel-wood.

If benefits are divided only among participating households, households collecting fuel-wood has the highest benefit of $669 per annum while fishing yield the least value of $14 per annum. In the next section, we analyse our result based on the premise that benefits from the wetland can be distributed among all households in the valley.

3.3. Distribution of benefits among households

The fact that all households used the wetland for at least one service during the 2005/06 cropping season and all ranked the wetland as either important or extremely important to their livelihoods underscore its importance in Ga-Mampa. If we assume that all benefits will accrue equally to all households in Ga-Mampa, then each household receives $228 in gross value of which $35 is in cash income. If compared with the average annual household income of $1584, cash income from the wetland makes up only 2.2% of household income, but considering that households value GFV more than cash income, the wetland contributes up to 15% of the average annual household income.

In practice there were considerable differences between households. The household with the highest estimated annual gross benefit of $2625 used the wetland for all services except for fishing and hunting. On the other hand, the household with the least gross benefit of $17 used the wetland only for wild edible plant collection. This suggests a high variation in value of benefit between households. Therefore, an analysis of differences in benefits derived from wetland provisioning services across households was conducted using SPSS (Table 3). For the purpose of this analysis, provisioning services have been grouped into three categories: cropping; material collection (sedge, reed and edible plant collection) and others (fishing, hunting and fuel-wood collection). We observe that age of household head has a significant effect on cash income from material collection. Households with a head aged over 70 derive more cash income than households with a younger household head. This might be due to the possibility that the older generation posses the old skill in mat making (which is a major source of cash income) and probably, the younger are not interested in this activity anymore. Similarly, material collection benefit (CI, NFV, GFV) is significantly impacted by household size: households sized between 11 and 15 tend to get more benefit than households with other size, probably due to their higher manpower. As expected, differences in wetland benefits from cropping can be explained by the occupation of the household head: the households who see themselves as farmers get more benefits from cropping than others. Ownership of wetland cropping plot has a significant effect only on overall cash income, but not on the overall gross value and net value. There was no significant variation in benefit based on gender and education level of the head of household and household income.

Insert Table 3 about here

We sought respondent's (participating households) perception on the status of each service. Figure 3 is based on data of respondent's recall of past activities when they cast their mind back to the last five years and compare the availability of services then and now. Except for cropping, most respondents believe that all services are declining in the wetland. Respondents blamed poor rainfall and the clearing of reeds and sedges and digging of drainage ditches by farmers to convert natural wetland into agricultural land for the changes in wetland ecosystem services. This has caused the shrinking of the natural wetland thus reducing the availability of most wetland services. Considering the importance of these services to the well-being of the locals as enumerated above, these changes can have a strong impact on their livelihoods since some do not have alternatives.

Insert Figure 3 about here

For fishing, fuel-wood and game, there may be direct substitutes like collecting wild edible plants in other locations or even planting in the garden, travel further distance into the surrounding area to collect fuel-wood, fishing in the river and hunting games in the surrounding. Finding substitute/alternatives to sedge and reeds is more challenging. 93% of sedge collecting households do not have a substitute/alternative for it. Those who collect sedge to make mats for household use suggested the use of wooden beds as a substitute, but they do not have the financial means. Likewise, use of roofing zinc was suggested as substitute for reeds. Although it appears that preferences of some households are changing for modern materials such as zinc, most households cannot afford this. All those generating cash income from reed and sedge do not have an alternative should this resource disappear. If considered in terms of existence of alternatives, the foregoing will suggest that households may be able to adjust (economically) to decline in wetland services more easily in the case of services used for subsistence, than for those generating household income. But, only 15% of the wetland value generates cash, 85% is used for household subsistence. This is an indication that the Ga-Mampa wetland maybe more important for subsistence rather than for cash income. Besides, households value cropping and edible plant collection (used mainly for subsistence) ahead of sedge and reed (used mainly for income generation) and more households depend on the wetland for subsistence than for income generation. However, it is clear that decline in sedge and reed translates into a reduction in cash income source. This makes it imperative to find alternative sources of income.

For some services (such as fuel-wood, water collection, and edible plants) households are able to find alternatives to the wetland services lost. However, they expressed regret at having to travel extra distance to collect fuel-wood, or having to do with lower quality edible plants. For these households the economic implication of wetland loss was rather minimal. However, for wetland services used for income generation and for which there are no alternatives (sedge and reed), households experienced economic hardships since they do not have alternative source(s) of income. This lack of alternative income generating activities seem to stem from the limited agricultural lands in the community; low educational skills in the community[6] which limit opportunities for off-farm employment and lack of capital to embark on any meaningful enterprise. This further highlights the economic safety net role played by the Ga-Mampa wetland. Because of the limited irrigable area due to the poor state of irrigation infrastructure, alternatives to cropping in the wetland are limited. In the absence of the wetland, the chances of struggling for the remaining marginal lands may be higher.

4. Discussion

4.1. Comparison with literature

Our study underscores the importance of wetlands to people's livelihoods in Africa and compares well with the results from other studies on African wetlands, for example

[6] Over 60% of respondents have less than 5 years of education. This might be a consequence from the long apartheid regime which did not provide the black population adequate access to education

Emerton et al., (1999) on the Nakivubo Urban wetland, Uganda (529 ha) and Turpie et al., (1999) who studies the Barotse wetland in Zambia (550km^2), the Lower Shire wetland in Malawi (162km^2) and the Zambezi Basin in, Zambia (1275km^2). To make their values comparable, they were converted to 2006 values using an annual inflation rate of 3%.
When per hectare value estimates are compared, the services of the Ga-Mampa wetland yield high values relative to other studies. For example, the gross value of cropping per hectare in Ga-Mampa is $368 while it was $196 in Nakivobo Urban Wetland in Uganda (Emerton et al 1999); $165 in Barotse, Zambia and $66 in Chope Caprivi, Namibia (Turpie et al 1999).

In Ga-Mampa valley, the total contribution of the main provisioning services provided by the wetland per household is estimated at $228 in GFV and $35 in CI. When values per household from Ga-Mampa wetland are compared with a similarly small wetland such as the Nakivubo urban wetland (529ha), the Ga-Mampa community derives higher gross benefits due to the population density per wetland area (0.25ha/household in Ga-Mampa against about 0.02ha/household in Nakivubo). Interestingly, we found no relationship between wealth (household income) and gross annual direct benefit from the wetland. This is consistent with findings in literature suggesting that wealth does not significantly influence the use of resources in terms of proportion of households or the average number of resources used per household (Shackleton and Shackleton 2006, Paumgarten and Shackleton 2009).

Furthermore, it was found that households place more value on gross financial gain over cash income, indicating that the subsistence value of ecosystem services from the wetland is important. This is consistent with studies which suggest that communities using wetlands for subsistence constitute a significant proportion of the population in Africa (Silvius et al. 2000; Lannas and Turpie 2000). Similarly, households do not count their time spent for the use (mainly harvesting time) of ecosystem services, which supports studies that do not account for household labour in estimating the value of ecosystems.

4.2. Uncertainties in valuation

Our study was limited to direct market valuation of provisioning services which can only capture use values of wetland services. It is likely that the inclusion of other techniques (for example contingent valuation) to elicit cultural values attached to some provisioning services will lead to different results and probably indicate even higher livelihood values.

Economic valuation approach has its critics, who point to the fact that not everything can or should be valued in monetary terms and that economic valuation studies are by nature fraught with uncertainties which can result in value estimates that are crude and inexact (Toman 1998, Serafy 1998). Nevertheless, economic valuation is useful because “failure to quantify ecosystem values in commensurate terms with opportunity costs often results in an implicit value of zero being placed on ecosystem services” (Loomis et al. 2000). In practice, therefore, it may be better to reach an agreement based on imperfect value estimates rather than continuing theoretical disputes over the “real” value of ecosystem services (Hermans et al. 2006).

In order to calculate market values, we had to make several assumptions regarding quantities and prices of the provisioning services included in this study. The average quantity of resources collected per time period (e.g. average weekly collection) was used to calculate the total quantity harvested (TQH) within a year. For services such as wild edible plants whose period of collection is seasonal, this assumption may generate some uncertainty, either over- or under-estimating the yearly average. The same holds for the prices of some products which are dynamic and vary over the year. For the sake of simplicity, average values have been used in the calculations.

In conducting any valuation study (for naturally produced services as well as man-made), such assumptions are unavoidable and highlights the fact that all prices (and economic values) are time and context dependent leading to a high level of uncertainty to the value estimates. Approaches to dealing with such uncertainties have been discussed in literature (Korsgaarda and Schoub 2010, Bingham et al. 1995) and to reduce uncertainty, we found the use of the so-called triangulation method (Punch 2005) very useful to offset some of the limitations by providing complementary and supplementary information. For example, some values given by households were cross checked with the extension officer and the secretary of the Ga-Mampa Community Development Forum.

Another potential source of uncertainty is the risk of double counting of benefits. There are three potential sources of double counting relevant to this study. First, is double counting the value of services. The risk is highest in studies valuing services that correspond to two different service categories (Ojea, Martin-Ortega and Chiabai 2010, Boyd and Banzhaf 2007), e.g. valuing water quality (regulating service) and water quantity (provisioning service). Since the Ga-Mampa study only looked at provisioning services the potential of double counting for this reason is minimal (Ojea et al. 2010). Second: double counting due to the use of GFV, NFV and CI. It should be noted that the values calculated for GFV and NFV *includes* CI values. If the value for CI is counted as additional, this would result in double counting of values. Therefore, CI should be treated as that part of the GFV that is sold for household income. The third potential source of double counting arises from services with added value, such as sedge used for mat making. To avoid double counting we estimated monetary values based on the end product. For instance, the portion of sedge used or sold directly by households in bundles is valued based on the price of each bundle, while the portion of sedges used for making mats is valued based on the price of mat.

4.3. Data collection constraints

Time was a major limiting factor in this research, especially for data collection. There was only about six months for the entire study, of which less than three months was spent on actual field data collection. A research with field work covering a longer period, allowing for monitoring of household wetland use, will no doubt allow collecting more data and provide better estimates. We believe, longer field study with adequate time to observe livestock grazing activity, would have greatly enhanced the reliability of the monetary value of this service. Likewise, time was needed to build adequate rapport with users who are secretive with their uses. The little success achieved on medicinal plant collection was in the late stage of the field study when this level of rapport was just building.

Interviews were often long, on average about 1.5 hours, taking a toll on respondents. This was not always a problem because respondents were informed more than a week before they were scheduled to be interviewed, and for some respondents interviews were split into two sessions. The fact that the researcher collected field data personally was very helpful, as it allowed for more probing questions not originally foreseen in the questionnaire. The iterative nature of the study left some flexibility and was essential in positively modifying the study as it progressed to take new information into account. This is important to a successful valuation study. These facts are in line with suggestions for an integrated wetland research framework suggested by (Turner et al. 2000).

In spite of some of the limitations mentioned above, this study shows that it is possible to collect data on the economic value of ecosystem services of reasonable quality in a relatively limited amount of time (approximately 6 months), even in a data-poor environment. It is important for the quality of data to combine different data collection techniques and to closely monitor the administration of the household survey. One of the original aspects of this study is that it applies to a small wetland, unlike most studies in Southern Africa, which generally focussed on larger wetlands (for example, see Turpie et al., (1999)). It shows that smaller wetlands are also important to sustaining the livelihoods of the local stakeholders.

5. Conclusions and recommendations

The aim of this study was to analyse the livelihood importance of African wetland ecosystems, especially of small wetlands (< 5 km2) which have been little studied. This study collected original field data which provided valuable information, showing that the direct use value of the main provisioning services of the Ga-Mampa wetland (1 km^2) contributes at least $90,000 per year (2006 values) to the livelihoods of communities in Ga-Mampa valley. This translates into a total wetland provisioning service value of at least $900/ha/year since this study only looked at a limited number of provisioning services and excluded all other regulating, habitat and cultural services.

This study showed that the Ga-Mampa wetland contributes significantly to the livelihoods of the local stakeholders as a source of income, subsistence needs (food, raw materials) and for the sustenance of social and cultural responsibilities through gift giving to neighbours and relatives. The contribution of the wetland to the livelihoods of the local community (394 households) was estimated at an annual gross financial value of $228 per household of which only $35 was cash income.

Unfortunately, the wetland-size has decreased recently due to agricultural encroachment which, if left unchecked, will deplete the livelihood contributions of the wetland. The present lack of alternative income generating activities will lead to much hardship if the wetland is further degraded. We therefore recommend that integrated assessment of all ecosystem services, and identification of involved stakeholders is needed to develop sustainable management strategies that deal with the environmental and socio-economic changes in the area.

Based on our observations, options available for managing the wetlands may include the repair of the irrigation scheme and an analysis of other ecosystem services (regulating, supporting and cultural, including recreational benefits) can help to involve other local and downstream stakeholders in developing sustainable management strategies for the Ga-Mampa wetland. Also the development of educational materials aimed at showing the importance of the wetland is important.

Information generated from this study was integrated into the overall Challenge Program Water and Food research project in the Limpopo basin. In particular, it contributed to the dynamic model developed to analyse trade-offs among Ga-Mampa wetland services and support decision-making about its management (Morardet et al. 2010). A better understanding of the bio-physical functioning of the wetland and the running of the above-mentioned dynamic model will help to draw conclusions regarding the sustainability of present wetland use levels.

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Table 1: Monetary values of the main crops cultivated in Ga-Mampa wetland 2005/2006

Crops	Total number of participating households (EPHH) (1)	Total harvested (TQH) (2)	Average quantity harvested per participating household (3)	Unit	Total area (ha)	Yield per ha	% sold	Unit price in Rands (US$) (P) (4)	Gross financial value (GFV) (US$) (5)	Net financial value (NFV) (US$) (6)	Cash income (CI) (US$) (7)	GFV/ EPHH (US$)	GFV/Yield per ha (US$/ha)
Maize	90	110010	1222	kg	56.3	1960	5	1.79 (0.28)	30483	25687	1524	339	541
Vegetable (*)	57	1584	28	kg	*		0	13.33 (2.06)	3269	3181	0 (**)	57	
Ground-nut	8	1704	213	kg	2.2	774.5	88	2.69 (0.42)	710	660	624	89	323
Sugar cane	6	750	125	Stick(s)	0.4	1875	72	1.00 (0.15)	116	74	84	19	290
Banana	3	150	50	Bunche(s)	0.4	375	60	12.50 (1.93)	290	235	174	97	725
Coriander	3	2880	960	kg	1.9	1516	67	2.69 (0.42)	1199	1150	804	400	631
Beans	3	840	280	kg	2.3	365	86	4.69 (0.73)	610	444	524	203	265
Beetroot	3	450	150	kg			40	1.75 (0.27)	122	79	49	41	
Total crops									36798	31510	3783		
Average per EPHH									409	350	42		
Average per all household (N=394)									93	80	10		

(*) Intercropped with maize

(**) None of the planted vegetable was sold, however, standard price of vegetable in Ga-Mampa valley is R13.33/kg.

(1) estimated from proportion of participating households in the sample and total household number in the population.

(2) computed from average quantity harvested per participating household and total number of participating households

(3) estimated from surveyed households

(4) Unit prices were estimated from household survey and observation in local markets. Rands prices were converted to US$ using an exchange rate of R6.46 for US$1 (Statistics South Africa).

(5) Gross financial value is the economic worth of total quantity harvested.

(6) Net financial value is GFV less cost of harvesting. Here GFV and NFV are almost equal because most uses often require little or no cost to households.

(7) Cash income is the economic worth of quantity sold.

Table 2: Monetary values of the main provisioning services of the Ga-Mampa wetland 2005/2006 (for details on cropping -see Table 1)

Material harvested	Total number of participating households (EPHH) (1)	Total harvested or produced (TQH) (2)	Average quantity collected per participating household	Unit	% sold	Price per unit in Rands (P) (US$) (4)	Gross financial value (GFV) (US$) (5)	Net financial value (NFV) (US$) (6)	Cash income (CI) (US$) (7)	GFV/ EPHH (US$)	GFV/Yield per ha (US$/ha) (8)	GFV/ per hour (US$/h)
Wild Edible plants (Morogo)	376	15273	41	kg	3	13.0 (2.01)	30735	30735	861	82	307	0.9
Building material (reeds)	84	2526	30	bundle	19	20.0(3.10)	7820	7795	1470	93	78	2.3
	90	756	8	bundle	25	20.0 (3.10)	585	-	595			
		756		mats	77	80.0 (12.38)	9362	7918	7190			
Art and craft material (sedge)							9947	7918	7785	111	99	1.4
Fuel wood	6	1296	216	bundle	0	20.0 (3.10)	4012	4003	0	669	40	6.2
Hunting	6	60	10	piece	0	31.5 (4.80)	288	288	0	48	3	4.8
Fishing	18	708	39	piece	0	2.25 (0.35)	247	221	0	14	2	
Total natural resources							53049	50960	10116			
Per household (N = 394)							135	129	26			
Total cropping							36798	31510	3783	409	368	0.4
Total wetland service							89847	82470	13899		898	
Total per household (N = 394)							228	209	35			

(1) estimated from proportion of participating households in the sample and total household number in the population.

(2) computed from average quantity harvested per participating household and total number of participating households

(3) estimated from surveyed households

(4) Unit prices were estimated from household survey and observation in local markets. Rands prices were converted to US$ using an exchange rate of R6.46 for US$1 (Statistics South Africa)

(5) Gross financial value is the economic worth of total quantity harvested.

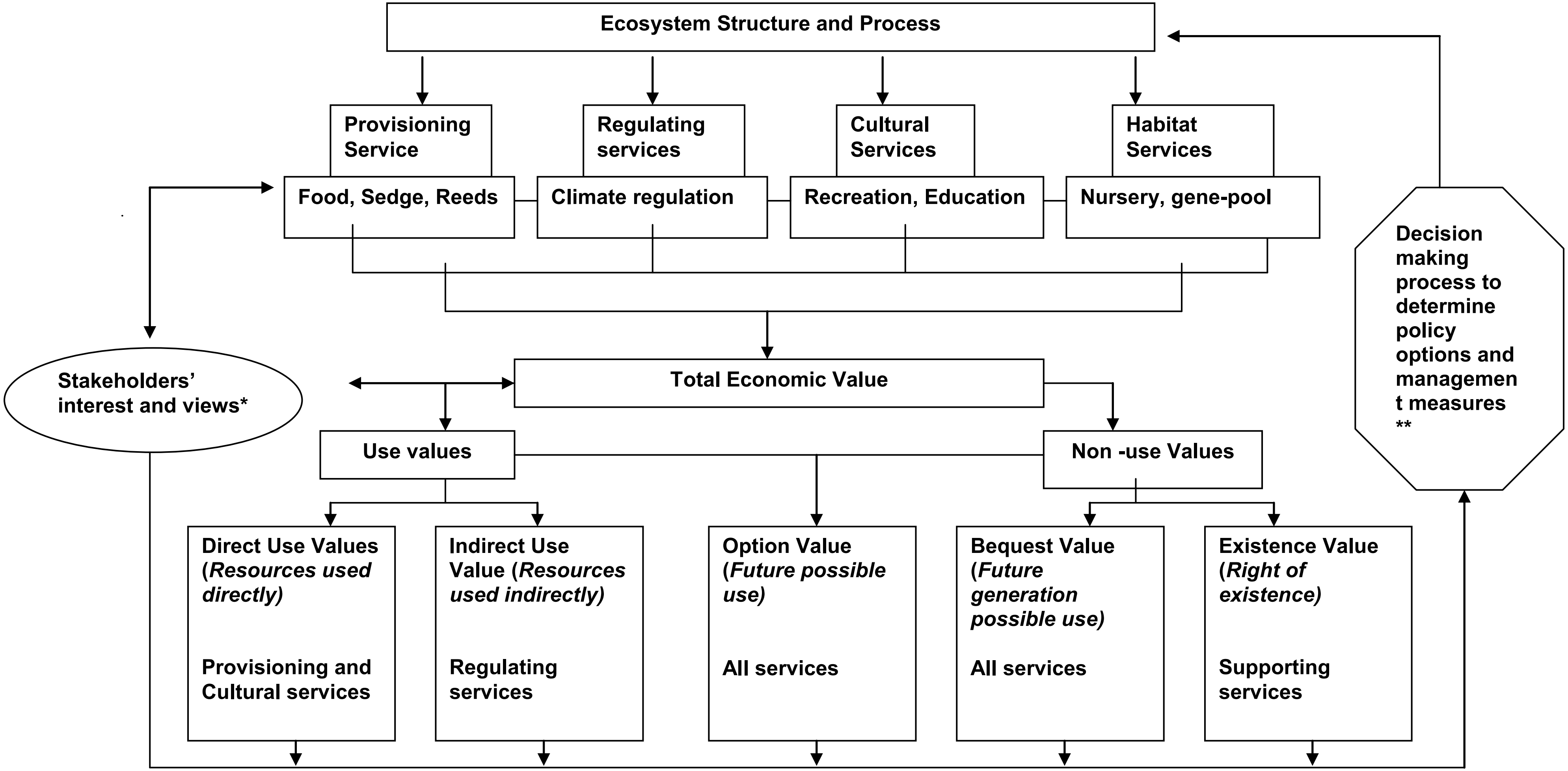
(6) Net financial value is GFV less cost of harvesting. Here GFV and NFV are almost equal because most uses often require little or no cost to households.

(7) Cash income is the economic worth of quantity sold.

(8) Based on total wetland area

Table 3: Differences in benefits derived from ecosystem services across different household variables, Ga-Mampa community

Variable	Coefficient								
	GFV	NFV	CI	Material collection GFV	Material collection NFV	Material collection CI	Cropping GFV	Cropping NFV	Cropping CI
Income	0.934	0.891	0.427						
Household size	0.317	0.278	0.163	0.042*	0.039*	0.033*			
Age of household head	0.102	0.123	0.460			0.032*			
Year of education of head of household	0.763	0.818	0.596						
Occupation	0.632	0.715	0.056				0.000*	0.000*	0.006*
Ownership of wetland cropping plot	0.208	0.235	0.037*				0.000*	0.000*	0.000*
Gender of household head	0.981	0.971	0.197						
	Note: * = p < 0.05								



*Stakeholders interest and views should be considered in most steps of the assessment.
** Tools such as cost benefit analysis, trade-off analysis and multi-criteria analysis are used in support of the decision making process.

Figure 1: Framework for integrated assessment and valuation of ecosystem services (Adapted from De Groot et al. 2002)

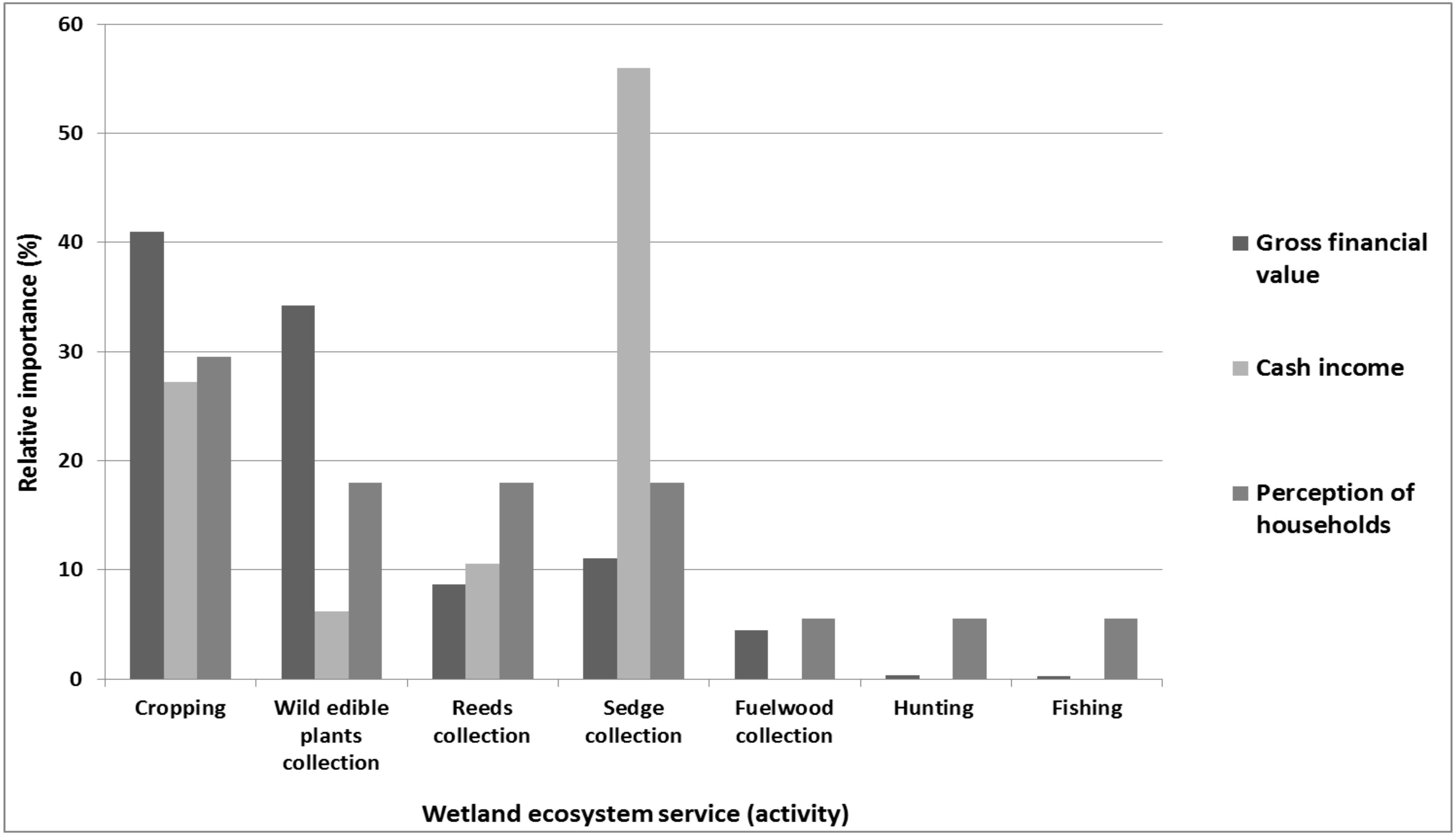


Figure 2: **Relative importance of economic value of wetland services (GFV and CIC in percentage of total wetland economic value) compared with their relative value as perceived by stakeholders (from field survey 2006)**

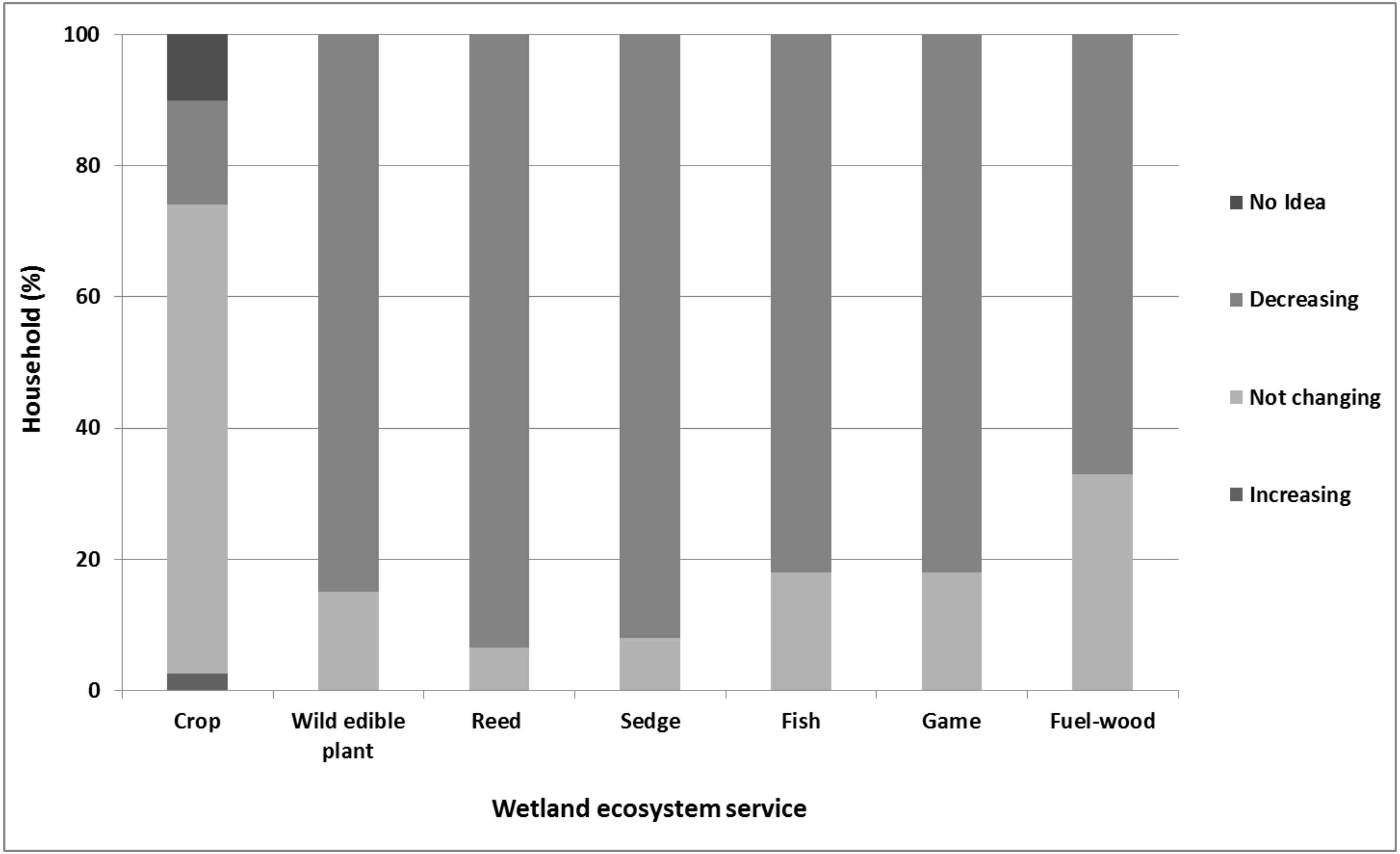


Figure 3: Household perception of the availability of wetland services based on whether there were more or less compared to the last 5 years prior to the study.