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Inequality and ecosystem services: The value and social distribution of Niger delta wetland services

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Abstract

The Niger Delta wetlands are of international importance for their biodiversity, and support a large human population. The value and distribution of wetland ecosystem service benefits and costs across the three main stakeholder sectors (local community, government and corporate) were investigated. Results show that the net monetary value of the wetlands is $11,000 per delta household of which $9,000 was generated as cash income supporting household activities such as education and healthcare. The total annual value of provisioning services to local people is approximately $25 billion, about three times the value of oil production in the region. However, local communities also bear about 75% of the environmental costs of oil extraction, equivalent to about 19% of the oil industry profit. Local people, who experience considerable economic hardship and lack alternative income sources, receive little compensation from the oil sector. These results highlight the importance of understanding not only the benefits provided by Niger Delta wetlands, but also the distribution of the environmental costs associated with their use. We conclude that ecosystem service valuation studies should give greater attention to the social distribution of identified values. Such distributional analyses, rarely available, provide insight into how sustainable natural resource management policy and practice could be better aligned to social justice concerns.

Keywords: Ecosystem service value, benefits distribution, Niger Delta, environmental justice

1.0 Introduction

Natural ecosystems such as wetlands, forests and coral reefs provide valuable goods and services to people, and there is now strong interest in understanding these ecosystem services as a step towards sustainable natural resource use (Braat and de Groot 2012; McKenzie et al. 2014; Potschin and Haines-Young 2013). The value of ecosystem services globally was first estimated by Costanza et al. (1997), at around $33 trillion per year, after which interest in ecosystem service valuation has grown strongly. Ecosystem service valuation is the process of expressing a value for a particular environmental good or service in terms of something that can be quantified. Ecosystem service values can be expressed using sociological or ecological metrics, but are most are often expressed in monetary terms (Millennium Ecosystem Assessment 2003).

With new data, recent studies have greatly increased the estimated global value of ecosystem services, with values of $125 trillion per year or more (Costanza et al. 2014; de Groot et al. 2012). Recent studies have also proved useful for estimating the benefits and costs associated with resource use and land use change (Costanza et al. 2014), and valuation studies have extended beyond aggregate valuation of ecosystem services to consider questions of value distribution (Bullock et al. 2011; Muradian et al. 2010). That is, there is recognition that ecosystem service studies also need to consider the distribution of ecosystem service value, and gains and losses in that value, across stakeholders in order to adequately ascertain the real value of ecological services and natural capital to dependent groups. This is a mainstream issue of concern to ecosystem managers and policy makers alike, and recognises that, while the benefits derived from an ecosystem can be widely dispersed, costs associated with ecosystem use are often highly localized, and hence compensation may be needed.

How state and international capital have sought to exploit natural resources (Christmann 2004), and the social and environmental impact of these activities upon local people (Ludwig et al. 1993) have long been issues within the literature. Such concerns find common ground in the environmental justice movement, which in Western nations, has seen concerns expressed around disproportionate exposure to toxic risk of poor and coloured communities compared to white middle class communities (Cutter 1995) and, increasingly, with unequal access to the prerequisite environmental information and capacity to challenge environmental decisions (Fish 2011; Reed and George 2011). Such environmental justice concerns are in

practice evident worldwide with many communities experiencing environmental degradation from natural resource exploitation that has a profound impact on the ability to sustain their livelihoods (Kitula 2006; Scherr 2000). Managing the costs and benefits from resource use can be seen, therefore, as a key concern of researchers and policy makers.

These issues are particularly acute in Sub-Saharan Africa due to the scale of resource exploitation which is already large, and set to grow following discoveries of major energy and mineral reserves in Ghana, Kenya, Uganda, Tanzania and Mozambique (Vasquez 2013; McDonald 2012). However, local people, often uneducated and poor, find themselves having to deal with complex environmental issues for which they lack the skills, information, and capital to challenge the power interests developing the resources in their communities. The resulting unequal distributions of environmental ‘goods' and ‘bads' of resource exploitation often generate conflicts which threaten local, national and global security; such is the situation in the oil rich Niger Delta region of Nigeria (Ibeanu 2000; Omeje 2006; Agbola and Alabi 2003).

Interest is growing in ecosystem service valuation within African environments (Schuyt 2005), and indeed, in understanding their benefits distribution (Van Wilgen et al. 1998). However, a general lack of information on African ecosystem services means that land use change and resource development, with associated loss of ecosystem services, usually remains the more attractive option (Mmopelwa 2006). Provision of adequate context specific information is needed to address this problem. To this end, economic valuation provides an important supporting framework that can generate insight into links between ecosystem services and human welfare, evaluate development alternatives by quantifying the costs and benefits associated with resource use options, and inform adjustments to national income accounts to recognise ecosystem service value (Turner et al. 2003; Turpie et al. 1999).

There is a rich literature on the value of wetland ecosystem services; (see for example Odum (1978); Costanza et al. (1989); Mitsch and Gosselink (2000). Much of the early work on ecosystem services valuation focused on wetlands primarily to demonstrate their high value to a wider audience (Turpie et al. 2010), especially those in parts of the world where wetlands were viewed as wasteland with no economic value (Mmopelwa 2006). Schuyt (2005) argued specifically for economic valuation of African wetlands, not simply to demonstrate their

value, but with a view to ensuring that they received greater protection, and so were better able to sustain the livelihoods of poor households dependent upon them. However, given the scale of dependent populations, surprisingly little is known of the monetary value of African wetlands. Analyses have been conducted across Africa (see Emerton et al. (1999); Turpie et al. (2006); Turpie (2000); Adekola et al. (2012); Nabahungu and Visser (2011); Turpie et al. (1999)) but West Africa is not represented. The Niger Delta is the principal wetland in the region, and home to many millions of people, yet little is known of its ecosystem value (global studies of Costanza et al. (1997); de Groot et al. (2012) and Costana et al (2014) did not value the Niger Delta wetlands as the required information was not available) and nothing of how this value is distributed among its various stakeholders.

Comment [GM1]: What about Costanza et al 2014 - is there a ND specific value? If so prob need to compare to your value in section 5 discussion??, and also note they do not look at distribution

Comment [JUA2]: No ND specific values

Comment [GM3]: OK, have added the citation to support this

Therefore, this paper aims to: (i) assess the monetary value of the Niger Delta wetlands provisioning services, and their importance to the livelihoods of local communities; and (ii) assess the distribution of cost and benefits across key stakeholder groups, which we define as local communities, government and the corporate sector. Section 2 of the paper introduces the region and the development issues it faces; section 3 describes the methods used to determine aggregate wetland values in the region, and its distribution amongst the local community sector, government and corporations; section 4 presents the results, and section 5 further discussions.

2.0 The Niger Delta wetlands

2.1 Geography and people

The Niger Delta is located in southern Nigeria ($4^{o}2^{l}$ - $6^{o}2^{l}$ north, $5^{o}2^{l}$ east) in the lower reaches of the Niger/Benue River (Davies et al. 2009). When defined hydrologically, the Delta Region consists of Bayelsa, Delta and Rivers States (Figure 1) an area of about 20,000 km^2 (Uyigue and Agbo 2007; World Bank 1995). Defined administratively, politically, or in terms of development objectives, the Delta Region includes all the oil producing States and this nine states region covers 110,000 km^2 (Ighodaro 2005), and is home to 37 million people, 22% of Nigeria's population (National Population Commission 2006). The region is ethnically varied, typifying the diversity and plurality that gives Nigeria its socio-political strength. The Niger Delta is generally rural, but includes important towns such as Port Harcourt, Warri and Asaba. The population is predominantly animist, attaching cultural values to local fauna and flora (Anwana et al. 2010; Adekola 2011).

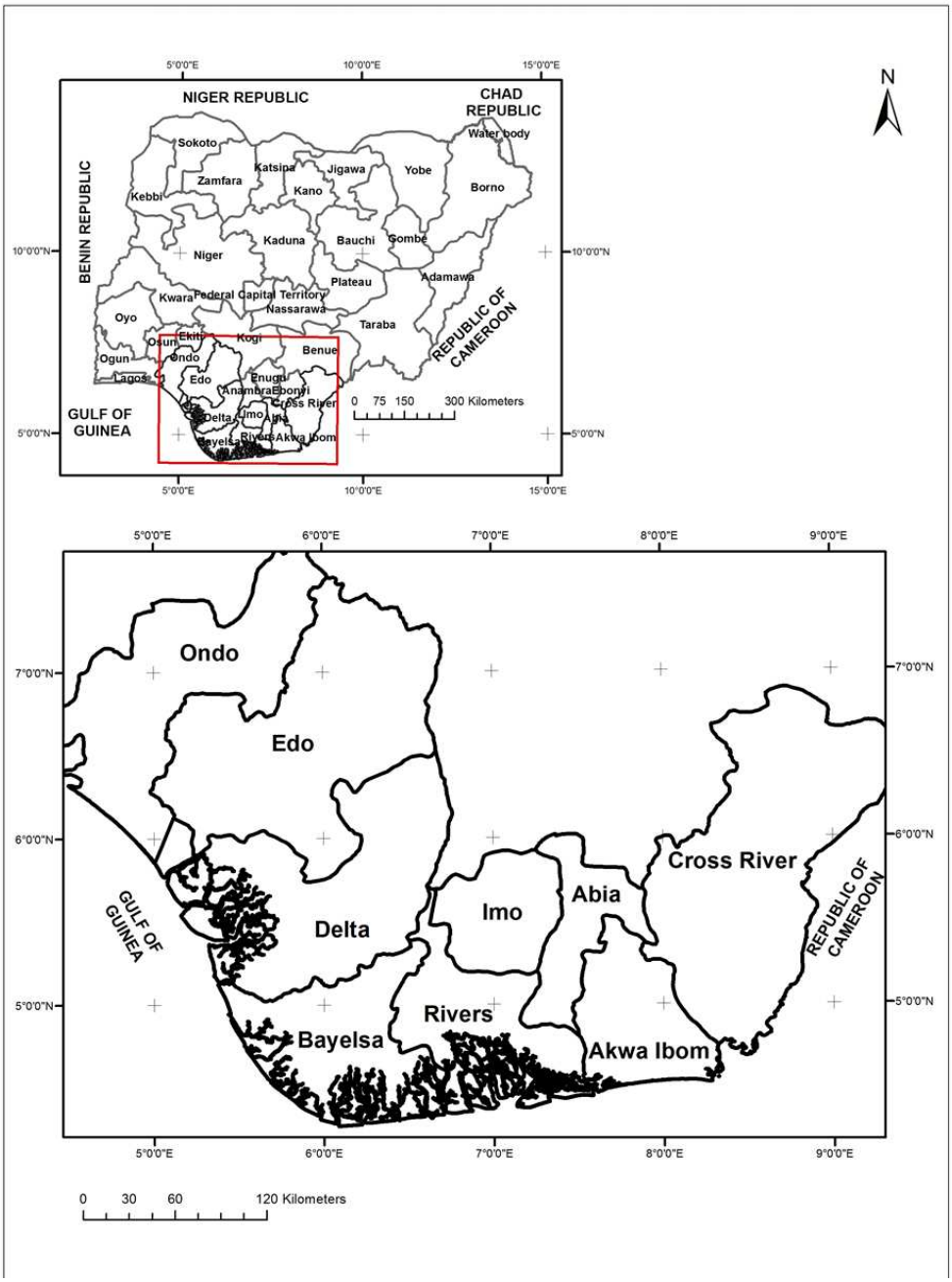

Figure 1. Nigeria, Showing the Niger Delta Region

2.2 The Niger Delta environment

Geologically, the Niger Delta is regarded as a modern delta (under 100 million years old in the Mesozoic era, Cretaceous period) (Galloway 1975; Okonny 2002). According to Short and Staeuble (1967) there are three depositional cycles in the Niger Delta. The first began with a marine incursion in the middle Cretaceous and was terminated by a mild folding phase in Santonian time. The second included the growth of a proto-Niger Delta during the late Cretaceous and ended in a major Paleocene marine transgression. The third cycle, from Eocene to Recent, marked the continuous growth of the main Niger Delta. The main geologic formations extending across the whole of the Niger Delta are the sandy Benin formation (including the Afam clay), an intervening unit of alternating sandstone and shale named the Agbada formation, and a lower shaly Akata formation (Short and Staeuble 1967). The accumulation of sedimentary deposits transported by the rivers Niger and Benue (World Bank 1995), which discharge water, sediment and other loads across southern Nigeria and beyond into the Gulf of Guinea, resulted in the formation of this complex and fragile delta with a rich biodiversity (Abam 2001). The Niger Delta is regarded as the third largest wetland in the world (Uluocha and Okeke 2004; Umoh 2008), and the largest river delta and mangrove ecosystem with the greatest extension of freshwater swamps in Africa (Ajonina et al. 2008; Dupont et al. 2000; Ogon 2006).

The Niger Delta forms an integrated mosaic of aquatic, semi-terrestrial (mangrove and freshwater swamps) and terrestrial habitats (Bisina 2006), which is highly diverse and supportive of numerous species of terrestrial and aquatic flora and fauna (Uyigue and Agbo 2007). The three major vegetation formations in the Niger Delta are brackish water swamps (comprising mangrove forest and coastal vegetation), fresh water swamp forests, and riparian forests (Nyananyo 1999; Nyananyo 2002). The brackish water swamps are dominated by white and red mangroves. Further inland from the coast into the fresh water swamp forests floating plants such as vossia cuspidata (hippo grass), nymphaea lotus, grasses and sedges begin to dominate. In the riparian forests no species can be said to be dominant, but, the region is home to some rare and endangered animal and plant species. Nyananyo (2006) identified 225 plant species in the Niger Delta, many of which are important as cultural, food, timber, medicine and industrial materials. The Delta has a rich flora and fauna, the richest biodiversity in Nigeria (Ebeku 2004), and is an area of international importance for its ecological riches which include several IUCN Red List species including endemic or near

endemic species (such as Kinixys homeana, Home's hinge-back tortoise) (Luiselli et al. 2006; Obot 2007). Blench and Dendo (2007) identified about 60 large mammals in the delta. Some of these, such as the African elephant (Loxodonta africana), chimpanzee (Pan troglodytes), Sclater's guenon, white-throated guenon, and crested genet (Genetta cristata) are endangered (Hilton-Taylor 2000).

2.3 Oil and social issues

The Niger Delta is the source of Nigeria's crude oil, which accounts for about 80% of national government revenue. Niger Delta oil is "sweet crude", less corrosive with lower sulphur content than the "sour crudes" from Latin America and the Middle East. The general rule of thumb is that, the "lighter" and "sweeter" the oil, the more valuable it is. However, despite the region's vast oil resources, regarded as the best quality crude oils in the world, the region remains poor, with high levels of unemployment (Agbogidi and Ofuoku 2006; Idemudia 2009). Unemployment and underemployment – at 8.8% and 26.2%, respectively – are higher in the Niger Delta than other regions of Nigeria (Ukiwo 2009). Only 27% of the Delta's population have potable water, 30% have electricity and one in three people is illiterate (Forest and Sousa 2006; Human Rights Watch 2005). This has been described as "a profound paradox of oil wealth and poverty" (Ali-Akpajiak and Pyke 2003).

People of the delta feel aggrieved that they have not benefited from the wealth of the region, resulting in conflict between local communities and developers over resource ownership and use, particularly those related to oil activities. The oil companies are seen by local residents to have failed to give back anything for what they have taken out, and to be complicit in human rights abuses carried out by government security forces deployed to protect their facilities. According to Human Rights Watch (1999), when protests occurred, the oil companies sought assistance from the government, whose military unleashed terror (indiscriminate killings and beatings, arbitrary detentions and extortions, rapes and destruction of properties) on the local population. Violence in the region was exacerbated following the return to democratic rule in May 1999. The conflicts are estimated to cost Nigeria $ 1 billion a year in oil revenue, as the Niger Delta insurgency has disrupted 60% of oil drilling (and output) by blasting pipelines and other oil installations (Forest and Sousa 2006). These are viewed as a response of the local people to the perceived injustice in the distribution of costs and benefits of oil exploration. They believe that other regions of the

country enjoy a disproportionate share of the economic benefits of oil development, while only the delta communities bear the environmental consequences (Agbola and Alabi 2003).

3.0 Data and methods

3.1 Data

To understand the distribution of costs/benefits across the three groups, data on the natural resources and services of the wetland is needed. While monetary information on government and corporate network benefits are available from secondary sources (websites, reports and budgets), little is known of the benefits, monetary or otherwise, that accrue to local communities from wetland services. Therefore, the main ecosystem services were identified, through literature review, personal experience of the region, informal interviews with local residents and an initial questionnaire survey. Then, with 2009/2010 as a baseline, the present use and non-use values of ecosystem services, provided by the Niger Delta wetlands to local residents, were estimated using questionnaire data. The household (people who live and eat together, and share the same kitchen and toilet facilities) was used as the unit of analysis for the survey, with the questionnaire administered to the head of each household. Households in the sample frame were chosen by first purposively selecting 12 settlements (in Bayelsa State) to cover the wide range of economic activities taking place in the wetlands. Then, a representative sample of households was randomly selected from each settlement based on their population. A total of 283 households in 12 communities of the Niger Delta region were visited for face-to-face interviews between July and November 2010.

The share of households indicating that they derive an ecosystem service from the wetlands gave an indication of its importance. The responses were then organized based on the categorization of ecosystem services into provisioning, regulating, cultural, and supporting services (Millennium Ecosystem Assessment 2003). To estimate the magnitude of each ecosystem's main provisioning services (use value) respondents were asked to quantify the amount harvested (used), whilst the average price was generated through group discussions and visits to local markets. Our valuation addresses only the provisioning services of the wetlands, and excludes all non-use values, so our aggregate values are conservative.

3.2 Monetary value estimation

The monetary value of the provisioning services was estimated and expressed as annual values using three indicators: the gross monetary value (GMV), net monetary value (NMV) and the cash income (CI). The procedure used is similar to those used in valuing the Ga-Mampa wetland in South Africa (Adekola et al. 2012). These indicators were estimated for each provisioning service on the basis of the 'expected' number of households participating in a specific production activity (EPHH), and the total annual quantity harvested (or produced) (TQH), to give the total quantity of each service collected by each participating household from the wetland. Quantities expressed by respondents in local units were converted to standard units, while monetary values were expressed by respondents in Nigerian Naira (N) and converted into US dollars ($) based on 2010 average exchange rate of N155.00 = $1. Thus:

$$EPHHa = \frac{m}{n} \times N \qquad \text{(Equation 1)}$$

where m is the number of households participating in a specific production activity in the sample (e.g. 179 for collection of bush mango, 132 cultivating Banana and 3 logging India Mahoganny), n is the total number of sampled households (n = 283), N the total number of households in the population (N = 2,172,842).

The total annual quantity harvested (or produced) (TQH) 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).

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

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

GMV captures the total monetary value of the service collected from the wetland. This indicator is appropriate for services that are used for subsistence. Gross monetary value (GMV) was computed as:

$$GMV_a = TQH_a \times P_a \quad \text{(Equation 3)}$$

where P is the average price per unit at which a product is sold.

NMV 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, and is calculated as:

$$NMV_a = GMV_a - CST_a \quad \text{(Equation 4)}$$

where CST is total costs of collection/production, excluding the cost of family labour. Family labour costs were excluded as the opportunity cost was considered minimal in a context of high unemployment and low earning skills. Costs were estimated based on monetary inputs (e.g. for seeds, tools and hired labour) to harvesting and use of each provisioning service of the wetland. Tools used for harvesting resources represent the main costs. The cost of tools such as canoes, hoes, cutlass and axes used for collecting wetland provisioning services was calculated using linear depreciation; costs of tools at the time of purchase are divided by average length of use suggested during interview and focus group discussions. This is based on the assumption that the capital goods will be available for a number of years and does not take into consideration spending to maintain tools or the number of other uses they might be put to.

Finally, the Cash Income (CI) is the monetary value of the quantity sold. CI 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, and is calculated as:

$$CI_a = QSD_a \times P_a \quad \text{(Equation 5)}$$

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

3.3 Estimating environmental costs

Next we calculated the environmental costs associated with natural resource based activities in the delta. Note that we do not use cost-benefit analysis in its formal sense, in order to support decision making over specific proposed activities. Rather, we seek to identify the benefits and costs associated with ecosystem use to better understand the distribution of benefits and costs across user groups, based on their main activities, and provide insight to support resource management.

To estimate the environmental costs of activities, we monetised the consequences of activities in a two-step process. First we quantified any environmental degradation. In this case we consider only the main impacts, such as change in soil productivity. Second, we monetised the consequences of those impacts using avoided, replacement and substitute cost methods (related methods that estimate monetary values based on the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services). Other costs, such as foregone benefits, and psychological and emotional costs, hospitalization and deaths are not included.

4.0 Results

4.1 Socio-demographic characteristics

Biographical data was collected for the sample of 283 respondents, 70% of which are male with an average age of 50 years. Overall, 31% of respondents had no formal education, 34% considered themselves unemployed, and the main occupation is farming (28%) followed by civil service (16%). About 30% of households have some income not derived directly from the wetlands, and the average monthly household income was ₦21,700 ($145). Given an average of six people per household this indicates that daily per capita income is below the commonly used poverty threshold of $1 per person per day (Anand and Sen 1997). This emphasizes the critical role that ecosystem services, particularly provisioning services, play in livelihoods.

Unsurprisingly, provisioning services emerged as the most important category of ecosystem service to local residents. The collection of materials such as snails, edible insects and food is the provisioning service from which all households derive a benefit. This is followed by fishing (cited by 89% of respondents), crop production (86%), hunting (57%) and logging

(9%). The wetland also provides important cultural services, including recreation (31%) and spiritual worship (26%). The importance of ecosystem regulation services was cited by 15% of respondents, while 6% felt they benefited from the wetlands supporting services. Although the term 'ecosystem services' as such was unfamiliar to the respondents, they recognized the concept, especially in the case of provisioning and cultural services. On the other hand, regulating and supporting services were poorly recognized. Provisioning and cultural services were cited by all education groups; however, 82% of those indicating regulating services and 65% of those indicating supporting services had at least a post-secondary/university degree. This suggests that knowledge of these non-use services is dependent on the respondents' level of education. Generally, all respondents were aware of the availability of the wetlands in their environment. They associated the wetlands with the presence of fish, forest, raffia palm, wild animals and water. Most households benefit from the multiple services provided by the wetland. For example, a household with farmland will also have household members who fish and collect materials from the wetlands. Next, the monetary value of these services is presented.

4.2 Monetary value of wetland provisioning services

4.2.1 Material collection

The collection of materials such as spices, wild food, insects, medicinal plants, and fire-wood is a service from which all households in the Niger Delta region derive a direct benefit. One respondent described the wetlands as a place where "you just go to and pick what you want". This is indicative of the diverse materials available in the wetlands that support the livelihoods of the local residents - over forty different types of materials are collected. Access to the wetlands to collect these materials is generally open to all, but there are some materials for which access is restricted, especially to non-natives (Nigerians not indigenous to the community). These people will be required to pay money before being permitted to collect materials. A non-native snail collector reported that the registration fee (whereby the community recognises the collector) is ₦4,500 ($30), with a monthly arrangement payment of ₦3,000 ($20), and an annual permit fee of ₦10,000 ($66).

Collection of some of these materials is seasonal, others can be found year round. Bush mango is widely collected between May and August; snails and crabs during the rainy season; while sand mining, palm weevil and art and craft materials can be found all year

round. Whilst most of these materials are available throughout the year, their periods of abundance are seasonal. For example, shrimp are abundant between June and September when households may collect up to a basket per day using basket traps. The collection of spices, medicinal plants, wild food and insects are female and children-dominated, while the collection of wood and material extraction is male dominated.

The monetary value of material collected is estimated at $4,266 per participating household. The gross monetary value generated by the 283 participating households is $1,207,245. Of this, 75% is in cash income, while the remainder is used for other purposes including subsistence use, gifts to neighbours and relatives, and for making other products. Given the diversity of materials collected, the economic cost and time spent on each activity differs widely. Some materials only require buckets and backyard collection, while others need specialized tools and labour. For most materials, the economic cost is associated with cutlass, buckets, baits or "poison", torchlight, canoes, paddles and bags. Taking cost into consideration, the net monetary value of material collection in the Niger Delta wetlands is estimated at $1,051,101 for the 283 households or $3,714 per participating household. The average time spent collecting materials is 5.5 hours per day per household. Sand mining is an exception, which most engaged in the activity report requires about 10 hours a day.

Materials collected from the wetlands have diverse uses. Spices are important in food preparation, and have medicinal value as cures for the common cold and hypertension. Wild foods are important sources of income and have subsistence household use. Bush mango, highly priced in the market, is a delicacy for most people in Nigeria. Bayelsa suya, roasted Palm weevil, is becoming a national delicacy craved by many visitors to the state, and has a high market price. Snails, also highly priced, are not eaten by all communities in the Delta, but all collect and sell them to traders who come from as far away as Lagos (the mantle cavity fluids also have medicinal value). Other marine and freshwater molluscs are important foods, and shells are used to reinforce concrete. Shrimps, rich in protein, minerals and vitamins, are used as condiments for soup and pottage. Palm wine and native gin collected from palm trees are important for medicinal and cultural activities. Craft materials are used to make baskets, fish traps, mats and brooms, used in the home or sold for cash.

The wetlands are also a major source of medicinal plants, many with diverse uses, such as Kolanut and Aziza. Informal interviews with three traditional doctors (in Odi, Zarama and Yenagoa) revealed that these practitioners see an average of four patients per day and charge ₦1,000-5,000 ($7-33) per consultation, most of which are midwifery and massage-related. This form of health care is predominant in places with no transport, such as in the interior where residents cannot readily visit town for western style treatment, and some respondents reported that nurses in hospitals recommend some native remedies. The traditional doctors indicated the main medicinal plants they collected from the wetland, and when checked against ethno-biological knowledge, a number of these plants were found to be used for similar cures in western medicine (Maduka and Okoye 2002; Odebunmi et al. 2010). This underscores the importance of traditional medicine in the overall health of the people who live in rural areas. However, to avoid double counting, since these materials are already valued as food or material collection, medicinal plants are not included in the monetary valuation.

4.2.2 Fishing

The Niger Delta has an estimated 196 species of fish across 105 genera and 46 families (Otobotekere and Sikoki 1999), distributed throughout the region from inland freshwaters to the saline coastal region. Of these over thirty are collected commercially, with fishing a critical part of the Niger Delta economy, and most fishing grounds, ponds and lakes under the ownership of a community, compound or family. Open access fishing can be carried out in open swamps and flooded areas around homesteads, but access to community or family owned ponds is restricted to the relevant members. Non-natives are required to seek permission from the compound, community or family head and often must pay a small fee. It is common practice for owners of fishing grounds to lease them to experienced non-native fishermen. About 4% of fishing households indicated that they depend on fishing grounds they lease.

Fishing takes place year round, but the catch is highest in the dry season when water levels are lowest, and harvesting requires less effort per unit catch. Most fishermen thus spend more time fishing in the dry season, and in the wet season engage in other activities. Excess catch is dried, smoked, roasted or fried to preserve it for sale or use during period of shortage. Common fishing methods includes the use of traps, hook and line, and drifting gill nets,

whilst use of spear or cutlass, cast net, lift net and fence is also widespread. It is men who are mostly engaged in commercial fishing (especially using cast and lift nets), while women collect fish for household subsistence, and are the principal fish processors and local traders, making sales with buyers who may come from as far away as Lagos. Generally, fishing is an activity engaged in by all, irrespective of age or gender. There are no formal fishing associations, but because commercial fishing is often more productive in groups, it is common for fishermen to work together and share the catch or proceeds.

The economic value of fishing in the Niger Delta wetlands was estimated at $4,139 per participating household. The total gross monetary value to the 251 participating households is estimated at $1,038,815. Of this, 80% was used to generate cash income, and the rest for household subsistence, gifts to neighbours and relatives, and in exchange for other services, such as labour. The economic cost incurred in fishing relates to the purchase of traps and nets, baskets, containers, cutlass, and canoes/paddles. About 15% of the gross value of fishing goes to offset these costs. This brings the net monetary value to the fishing households to $854,509 or $3,404 per participating household. On average, about 8 hours of household labour is spent daily on fishing. This includes time spent by fishermen commuting to and from their homestead, setting their gear and eventual landing.

Fish are the most abundant and readily available source of animal protein for consumption and income generation in the Niger Delta (Allison and Okadi 2009). As such, fishing is an important source of livelihood (household income) for many households in the region, as the economic activities of the whole population are either dependent on or related to it. The above valuation is based solely on the sale of freshly-caught fish, however, when fish is processed the net value can increase by up to 25%.

4.2.3 Crop Production

Cropping is significant for its contribution to subsistence and household income, exchange with neighbours and relatives, and production of some medicinal ingredients. Each cropping household has access to an average of three plots, of about 0.11 ha each, where the main crops grown are cassava, yam, cocoyam, maize, sugarcane, and varieties of vegetables (although over 60 crop types were identified for the delta wetlands). For most households, at

least one plot is located close to their homestead where food such as leafy vegetables, plantain and pepper are favoured, and tree crops, such as oranges may be grown. Most plots are inherited (72%) and the remainder leased, especially by non-native cropping households.

A typical cropping season begins with the clearing of farmland towards the end of the dry season, usually between November and February, and cultivation begins as the wet season starts, around March. The common cropping system is traditional bush fallowing, in which the farmer cultivates a plot, usually for about one to three years, and then abandons it temporarily (for three to ten years) to allow the soil to regain its fertility. However, rapid population growth and land shortage have drastically reduced the amount of arable land available to farmers, reducing fallow periods considerably and in most cases, continuous cultivation has emerged.

Intercropping of yam, cassava, maize, okra and pepper is widespread in the wetlands, but mono-cropping, where a single crop is cultivated year after year, is also practised. Agroforestry is also observed, with farmers integrating oil palm and rubber trees into their farmland. Farm labour is predominantly from the household, and there is widespread specialization and division along gender lines. Men undertake the more strenuous activities, such as land clearing and cultivating oil palm, rubber and yams, while women are mainly responsible for weeding, harvesting and cultivation of crops such as pepper and okra. There are no formal cropper associations but it is common for other croppers, friends and relatives to help each other when the need arises. In exchange, the benefiting household will reciprocate or give a part of the yield in appreciation.

Crop production in the wetlands was valued at $5,340 per participating household and $15,632 per ha in gross financial value. The total gross monetary value generated by the 242 cropping households was $1,292,228. Of this, about 51% is in cash income, with the remainder mainly used for household subsistence. The economic costs arise from acquisition of farm tools (hoe, cutlass, shovel, axe, spade, wheel barrow, knife, baskets and sacks), planting materials (seeds), and agrochemicals (fertilizer). Canoes and paddles are used for transportation. After costs are deducted, the net monetary value of crop production in the Niger Delta yields $4,825 per participating household or $14,596 per ha. We include the cost of any hired labour, but not that of household labour for which no money is paid. Cropping

households spend about 18 hours a day on farming, as land clearing, planting, irrigation, pest control, fertilizer application and harvesting.

4.2.4 Hunting

The Niger Delta wetlands harbours a distinct and diverse fauna, with some animals only recently known to science. There are about 24 common game animals, with access to hunting grounds governed by the same rules as material collection. Hunting is a year round activity, dominated by men, with market trading dominated by women. Fresh or live animals are more highly priced, and larger animals not sold on the day of catch may be cut and sold in pieces. Hunters using Dane guns are regulated through local associations, but small-scale trapping is unregulated. About 13% of hunting households have a professional hunter. Hunters are also imbued with traditional powers believed to protect them against wild animals.

Hunting in the wetlands has a gross monetary value of $546 per participating household and a total of $88,410 for all 162 participating households. Of the total gross financial value, 69% is cash income, and the remainder is mainly for household subsistence. Costs associated with hunting includes acquisition of Dane guns, traps, cutlass, torchlight's, spears, dogs and bags. After costs, the net value of hunting is $473 per participating household. An average of 4 hours per household per day is spent hunting. In addition to being a source of income, game is an important protein source for local residents, and also provides hides used in the production of local drums, while horns are used for fashioning trumpets.

4.2.5 Logging

Logging is the collection of wood for use as timber, and is distinct from fuel wood collection for energy (although sawdust is recovered for this purpose). Logged woods are used to provide construction materials, canoes and paddles, and artefacts such as traditional masks, and mortar and pestle. In addition to timber, logging may occur to obtain specialist products, such as tannin from the mangrove (used in ink manufacture) or those with medicinal value, such as the African oil bean. Most tree species are logged, except for economically valuable crop trees, such as the Bush mango.

Logging is a male-dominated year round activity, including the rainy season. As one respondent put it:

> "We log a lot during the wet season because during flood period, you can load (float) your logs or planks easily and free from restriction as in the dry period" (Logger in Amassoma community).

Logging is not regulated at the local level but there are associations of traders in sawn wood, who regulate their members and labourers who fell trees. Access to logging grounds is controlled by communities and families who own the land, and most forested lands are leased to loggers for a fee. Natives previously only served as labour to the loggers, but are increasingly aware of the economic value of timber. As one respondent put it:

> "Before now our people are not interested in wood, even if you tell the chief he will say is it just wood, allow them to take it, but now even the chiefs are selling the land and giving it out on lease" (Resident of Oporoma community).

Logging in the wetlands is the provisioning service least used by local residents, and has never been a widespread activity amongst natives. Only 26 households from our survey were involved in logging, of which 11 were non-native to the communities in which they operated. When natives do fell trees it is to build their own huts or canoes (which take 6-12 months to build), and the activity is small scale, but many non-resident individuals and companies log in the wetlands. Field observation and discussions confirmed that most loggers in the wetlands come from outside the delta region, and do not reside there. These were reported as often having military backing, and logging lands far from residential zones, without the landowners knowledge. One respondent described how his family had fallen victim to these external loggers:

> "I woke up in the morning only to hear that our family land has been destroyed by some people who came with the army (military officers)."

Our valuation of benefit from local logging is based solely on the value of the fresh log, but we note the value will increase after being sawn or used in canoe construction, so again, is conservative. Based on the assumption (derived from personal observation) that an average log has a length of 20-30 meters and a trunk diameter of 0.6-0.9 meters, the economic value of logging in the wetlands is estimated to be $6,045 per participating household. The total

gross monetary value for the 26 logging households is $157,175, of which 96% was used to generate cash income. The economic cost of logging relates to canoes used for transportation, axes, machetes, rope, machines, labour and fuel for boats. Considering these costs the net financial value of logging in the Niger Delta wetlands is $4,114 per participating household.

4.2.6 Aggregate value of provisioning services

Based on the valuation of each provisioning service, the aggregate monetary value of wetland provisioning services for the 283 households sampled was estimated at $3,783,928 for gross financial value, $3,256,837 for net monetary value, and $ 2,591,632 cash income (Table 1). Assuming the household sample is representative in terms of the composition of provisioning services harvested, the mean net monetary value of provisioning services is $11,508 per household per annum. Note that these estimates are based on yields from one section of the Niger Delta and different values may be derived for tribes elsewhere. For instance, farming is of greater importance in the drier landward part of the delta than the swampier zone characterized by extensive creeks. The valuation is also based on the price of 'raw goods' collected from the wetland, but in most cases, value is added as materials are used to make other products. For instance, cassava is used to make garri, fufu and starch, popular West African foods made from cassava tubers. Finally, some provisioning services have not been addressed including livestock grazing, a limited activity involving mainly small animals such as sheep, goats, pigs and rabbits, and water supply.

Table 1. Aggregate monetary value of the Niger Delta wetlands provisioning services in 2010

Activity	Surveyed households participating in activity (PH) [1]	GMV ($ / PH)	GMV ($) all survey sample[2]	NMV ($ / PH)	NMV ($) all survey sample[2]	CI ($ / PH)	Total CI ($) all survey sample[2]	Monetary value (Million $) Niger Delta [3]	GMV per ha Niger Delta [4]
Collecting	283	4,266	1,207,246	3,714	1,051,101	3,183	900,813	8,069	4,035
Fishing	251	4,139	1,038,815	3,404	854,509	3,291	826,045	6,560	3,280
Cropping	242	5,340	1,292,282	4,825	1,167,714	2,698	652,997	8,965	4,483
Hunting	162	546	88,410	473	76,552	376	60,938	588	294
Logging	26	6,045	157,175	4,114	106,961	5,802	150,839	821	411
Total			3,783,928		3,256,837		2,591,632	25,004	12,500
Mean per household			13,371		11,508		9,158		

Notes: 1. PH is households surveyed and participating in activity (283 households were surveyed), GMV is gross monetary value, NMV is net monetary value, and CI is cash income. 2. values determined for all sample, based on household values and households participating in activity; 3. Value determined for Niger delta, based on mean NMV per household, and 2,172,842 households in the Niger Delta; 4. Based on 20,000 km^2

4.3 Direct economic benefits of the wetlands to governmental networks

The Niger Delta environment has always played a crucial role in the Nigerian economy. During the colonial era, the region provided access for the import and export of essential commodities between Nigerians and the European traders. Until the 1960s, the Delta was globally renowned as the second largest producer of palm oil, after Malaysia, which obtained its first palm seedlings from the Delta (Initiative for Public Policy Analysis 2010). The importance of the Niger Delta to Nigeria became higher still after the discovery of oil and gas reserves, which make Nigeria the world's sixth largest exporter of crude oil. The importance of the Delta's oil has pushed agriculture, the traditional mainstay of the economy into the background. By 1970, petroleum exports accounted for 58% of the country's export value, rising in the 1980s to 97%, 94% in 1990, and 95% in 2001 (Akpabio and Akpan 2010). It is estimated that the Niger Delta currently accounts for over 80% of Nigeria's revenue (mainly from payments of royalties and taxes by oil companies) and over 90% of its total export value (Etekpe 2007; Frynas 2000). Based on an estimated total government revenue of ₦1.01 trillion ($6.73 billion) in 2010 (Federal Ministry of Finance 2011), with an assumed 80% generated from the Niger Delta, it is estimated that the annual revenue to the Nigerian government from the Niger Delta is $5.38 billion.

4.4 Direct economic benefit of the wetlands to corporate networks

The major corporate sector in the Niger Delta is the oil and gas industry. Benefits to corporate groups have steadily increased since 1958 when Shell-BP Petroleum Development Company of Nigeria Limited (SPDC), at the time the sole concessionaire, discovered crude oil in the Niger Delta. In 1958 when the first oil field came on stream production was 5,100 barrel per day (bpd). Today this is over 2.9 million bpd.

It has not been possible to acquire specific data on the profit of individual oil companies operations in Nigeria. However, it is suggested that about 57% of the annual oil profit is paid to the Nigerian government (this is the Nigerian government's revenue from the Niger Delta) while the oil companies take 43% (Okonjo-Iweala 2012). Therefore, profit accruing to the corporate network is estimated as $4.06 billion in 2010, based on the $5.38 billion government revenue from the Niger Delta in 2010.

4.5 Benefits distribution

It is generally suggested that benefits derived from the Niger Delta wetlands may not be distributed uniformly, increasing disparities within and across groups. Here, we consider how derived benefits are shared across local community, governmental and corporate networks.

4.5.1 Benefits accruing to local communities

The majority of provisioning benefits derived by local people accrue directly to them and are retained for subsistence and cash income, whilst indirectly, provisioning services support residents farther afield, beyond the Delta. Buyers of wetland products include traders from major Nigerian cities, such as Port Harcourt and Lagos. About 30% of total local cash income is from traders from outside the host state. Ecosystem services, particularly food production, timber, and fisheries, contribute significantly to local employment and national economic activity. However, government receives little from these benefits, as most locals pay hardly any taxes, and basic food items such as cassava, maize, rice, and fish, are VAT free (Ajakaiye 1999). A direct flow of local benefits to other sectors is, thus, negligible to non-existent.

4.5.2 Benefits accruing to government

It is widely argued that the benefits of oil exploration and production accrued to the government have not trickled down to local communities (Watts 2004; Oviasuyi and Uwadiae 2010). The major factor governing the sharing formula is derivation: the proportion of the nation's wealth given back to the source region. Successive governments (especially military governments) have unilaterally abrogated the derivation principle that existed before the discovery of oil in commercial quantities and imposed an authoritarian system. Before oil became an important source of revenue to the Nigerian government (pre-1960), derivation was 100%, meaning that host communities had almost total control of the benefits from the resources of their area. However, subsequently this changed to as little as 1.5%, after the volume of agricultural exports from the three main regions (groundnut from the Hausa-Fulani in the North, cocoa from the Yoruba in the South West, and palm oil from the Igbo in the South East) declined from a share of more than 80% at independence to less than 4%, while that of oil rose to 95% in the 1970s (Ikpeze et al. 2004). Other factors, such as population and land area in which these major regions had a competitive advantage, became the basis of revenue sharing. Derivation to host communities did increase in 1999, but only to 13%.

Concerning the allocation of overall government revenue to different regions over the years, benefits to the Niger Delta appear minimal. For instance, capital allocation to the region in the Third National Development Plan (1975-80) showed that while other regions had allocations of up to 38%, the Niger Delta region had the lowest allocation at just 6% (Akpabio and Akpan 2010). This is despite the majority of revenues originating from the region. The disparity is exacerbated by the fact that these monies, intended for infrastructure and social services, do not reach the people due to corruption (Obi 2010; Elebeke 2012). While the proportion of national revenue accruing to the Niger Delta states has increased since 1999, it is unclear how much reaches local communities because the process is not transparent or free of corrupt practices.

Based on the estimated total government revenue of $5.38 billion generated from the Delta in 2010, it is estimated that about 20% was directly allocated to the Niger Delta states (Federal Ministry of Finance 2011). There are no direct flows of benefits from the government to the corporate sector, but indirect contributions are made as the government contributes to a safe working environment for the oil industry, deploying its troops to the facilities. However, the oil companies also pay for some of these services (Brock 2012; Frynas 2001).

4.5.3 Benefits accruing to corporations

The corporate sector contributes to the Nigerian economy by generating revenues for the government, and paying taxes and royalties. In addition, corporations pay a statutory contribution of 3% of their annual budget to a regional developmental agency, the Niger Delta Development Commission (NDDC), whose mission is to develop the Niger Delta. The NDDC was established in 2000 with the aim of facilitating the rapid, even and sustainable development of the Niger Delta into a region that is economically prosperous, socially stable, ecologically regenerative and politically peaceful. In 2010, SPDC paid $161 million to the Niger Delta Development Commission.

Corporate actors also support community projects directly. In 2010 SPDC and Shell Nigeria Exploration and Production (SNEP) provided more than $22.85 million to local community projects (Shell International Petroleum Company 2011). This represents about 1.3% of corporate actors' profit. In addition, the corporate sector employs thousands of Nigerian employees and contractors, although it is argued that this generally favours people from the

three main regions who are employed in the top cadre, compared to the indigenes of the Niger Delta, employed in the lower cadre and as casual staff. Oil companies also assist local communities by funding projects implemented by non-governmental organizations.

Benefits from the corporate networks are widespread, with foreign nations benefiting from the oil products they import from the Niger Delta. The USA is the largest importer of Nigerian crude, receiving about 43% of the country's total oil exports, equivalent to about 10% of overall U.S. oil imports. Other destinations of Niger Delta crude include India, Brazil and Spain.

4.6 Costs associated with ecosystem service development

The ecosystem service benefits above are accompanied by costs, which may not be equitably shared among the different actors. Local communities, in particular, can lose out because they have less power in the decision-making processes (Adams and Hulme 2001).

4.6.1 Costs associated with local community activities

The main consequences of local community activities include changes in soil productivity and decline in forest cover (Adekola and Mitchell 2011). It has not been possible to estimate this cost because of a lack of reliable data. Most of the cost generated by the local community is borne by the local communities and government. Costs such as that of family labour or the value foregone when land is used for productivity management has not been included.

4.6.2 Costs associated with government activities

The government is generally responsible for dredging and the reclamation of wetlands, which result in increased incidences of flooding and erosion. This is carried out as part of oil and gas exploration to facilitate oil company activities.

4.6.3 Costs associated with corporate activities

The main costs of corporate network activities in the Delta relate largely to ecosystem service and biodiversity loss. The cumulative cost of environmental degradation due to oil extraction in Ogoniland alone is $1 billion (United Nations Environment Programme 2011), an average of $19 million a year since oil extraction began in 1958. Extrapolating from Ogoniland’s

1,000 km^2 to the 39,900 km^2 of the Niger Delta suggests an annual cost of $758 million. Of this, Niger Delta states spend about $187 million a year on remedial work (about 14% of their revenue). Thus local communities bear, on average, a cost of $571 million, which accounts for a large share of the cost of ecosystem degradation resulting from the activities of the corporate sector. Apart from biodiversity loss, corporate actors are responsible for burning farmland, polluting water and destroying crops. The implications of these changes are economic (less food; less money for food, medicine and children's education); emotional (inability to assist relatives and neighbours) and social (poor health and religious desecration). Locals indicated that government assistance is minimal, and they must cope by switching activities or relocating to a less affected area. However, the cost of this degradation is particularly serious for local communities as most households have little capacity to adapt to change.

Although no quantitative relationships have been established, costs also flow to other regions, both within and outside Nigeria. These costs exclude those resulting from oil and gas related conflicts, estimated at $4 billion yearly between 1996-2004, when 500 people died every month (Okolo and Etekpe 2010) and on which Royal Dutch Shell spent almost 40% of its $1 billion global security budget between 2007-2009 (Brock 2012).

5.0 Discussion

The importance of African wetlands to livelihoods is well recognised, as is the need for their sustainable management (Rebelo et al. 2010). Literature on the economic importance of West African wetlands, and how the benefits and costs resulting from their use are distributed is however weak. Results from this study of the Niger Delta wetlands, Africa's largest river delta and mangrove ecosystem (Dupont et al. 2000) emphasise the economic importance and livelihood contribution of the wetlands as well as the potential disparity in the distribution of environmental costs and benefits among stakeholders.

Our study underscores the importance of estimating the monetary value of wetland ecosystems and can be compared to values from similar studies of African wetlands (see Emerton et al. (1999); Seyam et al. (2001); Lannas and Turpie (2009); Turpie et al. (1999); Rebelo et al. (2010); Adekola et al. (2012)). Monetary values per unit area ($/ha/year) and per household ($/hh) in our study are generally higher than those reported in these studies (Table

2), which is likely due to the extent of the Niger Delta wetlands, and the level of dependence of the local community upon them compared to the other smaller wetlands. For instance only 13% of households use the Mfuleni wetlands and 65% in Letseng-la-Letsie (Lannas and Turpie 2009) compared with 100% of households in our study. Furthermore, the Niger Delta has one of the highest population densities in the world for an area of comparable size (Ericson et al. 2006; Balouga 2009) However, the total value of $12,500/ha/year from our study is consistent with global estimates for different types of wetlands (tidal marsh, mangroves, swamps and floodplains) which ranges from $13,786 - $193,843/ha/year (Costanza et al. 2014). Note that our study is for provisioning services only, so is necessarily conservative. We did not value provisioning service such as the water supply potentials of the Niger Delta wetlands because water does not generally have a market value in this society. Monetisation u~~U~~sing contingent valuation was an option but we decided against this approach due to its ~~considering the level of~~ complexity ~~of this method~~ (DeShazo and Fermo 2002) and the difficulty of incorporating scenario work ~~in combining it~~ into an already extensive ~~with~~ survey ~~work~~, which ~~will be~~ we judged too much for surveyors~~s~~ and respondents to handle in the time available. ~~It is f~~For similar reasons ~~; that~~ we have not valued the cultural, regulating and supporting ~~other categories of~~ ecosystem services. ~~i.e. cultural, regulating and supporting services.~~

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Table 2. Aggregate (gross) monetary value of ~~from studies that have valued~~ African wetland ecosystem services ~~in Africa~~[1]

~~Authors~~Study	~~Year of valuation Study Site~~Wetland and valuation year[2]	Size (ha)	GMV ($/ha/yr)	GMV ($/hh/yr)	% Cash Income	Cropping		Material Collection		Fishing		Hunting		Logging	
						GMV ($/ha/yr)	GMV ($/hh/yr)	GMV ($/ha/yr)	GMV ($/hh/yr)	GMV ($/ha/yr)	GMV ($/hh/yr)	GMV ($/ha/yr)	GMV ($/hh/yr)	GMV ($/ha/yr)	GMV ($/hh/yr)
Adekola et al (2012)	~~2006~~ Ga-Mampa Wetland, South Africa, 2006	100	1,206.7	306.4	16	494.5	126.3	650.4	165.3	2.7	0.8	4.0	0.9	53.8	1
Seyam et al (2001)	~~1990~~ Zambezi wetlands, Uganda, 1990	2,982,000	172.5			50.9		28.3		80.4					
Lannas and Turpie, (2009) ~~Lannas and Turpie, (2009)~~	~~2007~~ Letseng-la-Letsie, Lesotho, 2007	819	281.1	56.2	65							1.3			
	~~2007~~ Mfuleni, South Africa, 2007	310	2,255.1	92.0	71	33.2									
Turpie et al (1999) ~~Turpie et al (1999)~~ ~~Turpie et al (1999)~~ ~~Turpie et al (1999)~~	~~1999~~ Lower Shire Delta, Malawi and Mozambique, 1999	243,000	183.0	784.7	15	126.8	530.9	22.6	112.3	24.0	100.6	0.4	1.7		
	~~1999~~ Barotse, Zambia, 1999	550,000	37.4	743.6	17	8.1	161.9	2.4	57.1	16.1	320.3				
	~~1999~~ Chobe-Caprivi Wetlands, Namibia and Zambia, 1999	304,600	25.4	2,041.9	13	5.9	391.1	3.5	234.1	8.7	577.4	0.3	87.3		
	~~1999~~ Zambezi Delta, Mozambique, 1999	1,789,000	15.6	454.7	24	7.4	216.2	2.0	59.1	6.1	178.0	0.04	0.8		
Rebelo et al (2010) ~~Rebelo et al (2010)~~	~~2010~~ Kilombero Valley, Tanzania, 2010	13,520		516.0	66										
	~~2010~~ Bumbwisudi Valley Wetland, Tanzania, 2010	560			12										
Emerton et al (1999)	~~1993~~ Nakivubo Urban Wetland, Uganda, 1993	529	1,113.7	75.2		873.6	60.7	216.9	14.5	28.9	2.9				
~~Current~~ This study	~~2010~~ Niger Delta Wetlands, Nigeria, 2010	2,000,000	12,500.0	13,371.0	80	4,483.0	4,566.0	4,035.0	4,266.0	3,280.0	3,671.0	294.0	312.0	411.0	55

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Note: 1 Only studies using market price methods ~~is~~ are presented. ~~,~~ Values per ha is based on total ~~size of the~~ wetland area and value per household ($/hh/yr) i~~hh i~~s based on ~~entire~~ all households in the study area, and ~~on the~~ assumesption benefits are shared equally among all households. 2. Values converted to 2010 values using inflation rate from http://fxtop.com/

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The Niger Delta wetlands provide an array of provisioning, regulating, cultural and supporting services which are of global importance, but more importantly rural livelihoods (Adekola and Mitchell 2011). Like previous studies of African wetlands, we confirmed the high importance of provisioning ecosystem services in households. To local people, the wetlands are a "place where you go to and take whatever you want". That households use the wetland as source of goods and services which they would otherwise have to purchase in the market, and in the process are able save cash for other important household needs cannot be over emphasised. The wetlands contribute significantly to local livelihoods in terms of food security (subsistence) and direct cash income. Traditionally, the people of the Niger Delta are recognised as fishermen, with small cultivated plots. Although, not investigated directly, we found that all households in the study area depend on the wetland for daily food in one way or the other, and it was suggested that households could survive for a long period without buying food because they could easily collect it from the wetland. The importance of the wetland as a source of food is emphasised by the fact that half the gross value of cropping is used for subsistence purposes.

The large proportion of benefit generated as cash income further evidences the importance of ecosystem services in supporting rural households. About 75% of the gross monetary value of material collection was in cash income, with fishing, cropping, hunting and logging at 80%, 51%, 69% and 96% respectively (the lower value for cropping is because this is primarily for household subsistence food). The overall contribution of the wetland to cash income was high, some 80% of the $11,508 gross monetary value per household. Wetland use activities provide a significant supplement to other sources of earnings, and often generate the only regular cash income for households. These results are consistent with other studies (Lannas and Turpie 2009; Rebelo et al. 2010), but are considerably higher than that of some other African studies. For the Ga-Mampa wetland in South Africa 16% of the total value of the wetland was generated as cash income (Adekola et al. 2012); 17% in the Barotse wetland, Zambia, 13% in the Chobe-Caprivi wetlands, and 15% in Malawi's Lower Shire wetlands (Turpie et al. 1999). Our study shows that the cash generating potential of wetland ecosystem services could be much higher than previously thought. The high cash income is explained by the size of the Niger Delta wetlands which provide numerous commercial exploitation opportunities, coupled with easy market access with buyers from major Nigerian cities in the markets on daily basis. Unlike the Ga-Mampa wetland, a small wetland ($1km^2$) where gross

gain exceeds cash income, we found that cash income is most important for the Niger Delta wetlands. In Barotse, fisheries contribute 73% of cash income, in Ga-Mampa the highest contribution to cash income was from material collection accounting for about 73% of total cash income. This is similar to our study where material collection contribute the highest value to cash income.

Whilst others (Uyigue and Agbo 2007; Ezebuiro 2006) emphasise the role of fishing and farming in the delta, material collection is scarcely mentioned. However, we found that material collection is not only the most important activity in terms of the number of households supported (100%), but also in terms of the overall contribution to household cash income (35%).

Income from the sale of ecosystem services is an important contributor to other household needs such as children's schooling, modern healthcare, and purchasing household goods including cars and electronics. Rural households often have potential to combine multiple income streams to diversify their livelihoods (Barrett et al. 2001; Belcher et al. 2005) but we found that only 30% of households have income not derived directly from the wetlands, and that wetland income could be five times that generated from other sources. Wetland services also support small scale manufacturing activities (e.g. fish processing, canoe making, processing of local "gin"), and in fact most services are also used in the production of other goods, thereby increasing their income generating potential. This income from ecosystem services is very important, yet income from ecosystem services have been very poorly documented in national poverty alleviation and rural development strategies across Africa.

~~Although~~ ~~figures shown on~~ T~~t~~able 2 ~~will~~ suggest~~s~~ that of the activities engaged in, wetland cropping provides the highest return~~s~~. Note however that ~~in terms of~~per unit area and per household values are potentially ~~; this could be~~ misleading as the values have been compute~~ds~~ on the assumption that all of the ~~the entire~~ relevant wetland areas ~~is~~ are ~~used~~ exploited for each activity. ~~However, i~~In ~~reality~~ practice activities such as fishing are not thought to occur for all of the areas that might support fishing. ~~are only restricted to far less areas.~~ Further work is needed ~~however~~therefore, to understand the within region distribution of eco-service values~~importance of collected materials (and other services) according to~~, including by household factors such as size and age profile, as the a~~. A~~verage values

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presented can mask ~~the~~ important differences between ~~different~~ household socio-economic types.

The richness of the wetlands has attracted residents of other regions of Nigeria. Some studies (Niger 2012) suggest that the oil industry is responsible for the large scale migration into the Niger Delta, but we found evidence that benefits from wetland provisioning services could be an equally important factor, and points to the national importance of the wetlands provisioning services. Recognition that wetland services as important both locally and nationally should provide further impetus for government planners and natural resource managers to manage the wetlands in a more sustainable manner.

The oil revenue generated for the government from the delta is substantial, yet is only about a quarter of the value of the delta's provisioning services. The importance of the provisioning services is seen to be particularly high, when one further considers that only a small share of the benefits from oil revenues are returned to the delta itself. This is not to suggest that government should "chose between the environment or the economy", but rather that since ecosystems contribute significantly to well-being, they should be more explicitly recognised in development and economic planning. However, processes to integrate of ecosystem services into decision making are not evident, and institutions appear to lack the capacity to develop and implement them.

Environmental economic valuation is often crude, and inexact but its limitations are generally well recognised (Serafy 1998; Toman 1998). However, a common misconception is that valuing environmental goods and services is commensurate with their commodification and even privatization. However, in practice, not assigning a monetary value to the environment has often meant that it is considered to have no value, and is treated accordingly. Thus valuation of ecosystem services (in a transparent manner, recognizing uncertainties and limitations) can only support better decision making and more effective management. Our monetary estimates of ecosystem service value are based on data for Bayelsa State, but value will inevitably vary across the different eco-regions of the delta. We suspect Bayelsa state is relatively rich in wetland eco-services, so extrapolation to the entire Niger Delta may be result in an overestimate of total provisioning services, however, overall, our valuation of

ecosystem services is highly conservative, as some critical provisioning services are not addressed (e.g. water supply) and we limit our study solely to provisioning services. Our estimate of the value of provisioning eco-services to local people ($25 billion/yr) is therefore probably low, but is already three times the value of oil production. We also find that the distribution of benefits and costs associated with delta goods and services is highly unequal. In particular, local communities receive only modest benefits from oil development, but bear about 75% of the environmental costs of oil extraction whose impacts erode the value of the eco-services they rely upon. This benefits-costs distribution is a matter of great political debate in the region.

6.0 Conclusion

This paper has estimated the benefits from the Niger Delta wetlands, and how they accrue to the three principal stakeholder groups in the region – local communities, government and corporations. The environmental costs of each groups activity in the region has also been estimated. Available data only permits an estimate of the 'static' benefits and costs of wetland ecosystems use, and we do not know how values, or indeed net benefit distributions are changing over time. Substantial uncertainties remain even with static benefit-cost values, but we can conclude that our net benefit value is likely to be conservative as we only address provisioning services. The costs associated with exploiting the delta ecosystem services are poorly understood. Oil extraction activities which contribute to the government and corporate sector generate high cost (environmental damage valued at about 19% of oil industry profit), of which about 75% is borne by local people. Such disparities feature prominently in the discourse of resource management in the region, and indeed give rise to violent conflict.

Whilst the annual value of provisioning services to local people ($25 billion) is some three times the value of oil production, local communities must also bear most of the environmental costs of oil extraction with little oil industry benefits coming back to the delta. Continued oil exploitation in the wetlands comes at the expense of the livelihood of poor people living around and heavily dependent upon the wetlands. In contrast to other studies, we find that the Niger Delta people derive a very substantial part (80%) of their income (as goods and services and cash income) directly from the wetlands, and are much more

dependent upon the delta than wetland communities elsewhere in Africa. This underscore the need to develop managing institutions that recognise the value and significance of delta eco-services, and how value is socially distributed. Local people are poorly integrated into decision making processes and more participatory decision making by the government and corporate sector is a crucial step in developing more sustainable management of the Niger Delta wetlands. The wetlands are clearly a very important resource, and their value needs to be better recognised in national poverty alleviation and rural development strategies.

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