Debate on the conflicting values for wetland ecosystem services in East Africa: A case study of forest resource users from Lake Naivasha Region

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1. Ecosystem Services

Ecosystem services (hence ES) are functions of ecosystems which can be of direct or indirect benefit to human life and well-being, which can be utilised to provide a livelihood for humans, or those which make human life 'worth living' (UK NEA [online], 2009). This benefit can be expressed in a monetary value, and there has been much debate on the merits of both ES valuation itself, and the methods of ES valuation (Sagoff, 2008). The Millennium Ecosystem Assessment (2005; FIND) identified that ES can be subdivided into four categories: provisioning, regulating, cultural, and supporting, with this final category consisting of systems which sustain the previous three.

2. Forest Ecosystem Services around Lake Naivasha, Kenya

Forests ES have been routinely and abundantly identified (Krieger *et al.*, 2001; Nasi *et al*., 2002; Stiebert *et al*., 2012; UNEP [online] 2012; Grieg-gran *et al*., 2015), and are summarised in Tab. 2.1. As Tab. 2.1 is a general list, all of these ES could potentially be relevant to Lake Naivasha (UNEP [online], 2012). However, several studies have evaluated the economic benefits of forested areas in Kenya and Africa, which may be relevant to the Naivasha region; ES have been recognised as the area's primary resources (Everard & Harper, 2002). Attempts will also be made to provide economic valuations of these ES at relevant scales; if exact valuations cannot be found, then inferred benefits will be mooted.

2.1. Provisioning ES in Kenyan and African Forests

Timber production alone accounts for 1.3% of Kenya's annual GDP and provides 18,100 people with direct employment, allowing their income to benefit the wider economy (Stiebert *et al*., 2012). Though this is not solely due to the Naivasha region, it is clearly a significant economic benefit, as is the estimate that forest products as a whole contribute 7.8bn KSh annually to the economy, and support 5% of the manufacturing industry (Stiebert *et al*., 2012). Similarly, fuelwood is the most common source of energy in Africa as a whole, according to a report which included Kenya as a case study (FIND). Though not directly relevant to Naivasha, Kipkore *et al*. (2014) found that the medicinal ES provided by a forest in Marakwet District, Kenya were of significant benefit for the local population, as was the indirect productive benefit of reducing the lost working capacity of the population.

2.2. Regulating ES in Kenyan and African Forests

The Kenyan economy is vulnerable to it supply of fresh water for industrial, domestic and tourist use: any interruption to the supply of water to these sources of income would have large ramifications to the economy, and Montane Forests provide 75% of Kenya's renewable freshwater (UNEP [online], 2012). Deforestation (for timber) in 2010 generated an estimated 1.3bn Kenyan Shillings (KSh) in revenue; the loss of regulating ES, and the resulting need to substitute these ES *or* the impacts of these ES losses on other services and industries was estimated to cost 5.8bn KSh per year (UNEP [online], 2012). Approx-imately half (2.363bn KSh) of this loss was due to reduced water availability for agriculture, a sector of the Kenyan economy which provides 30% of employment (UNEP [online], 2012), but loss of hydroelectricity generating capacity cost the Kenyan economy 12mn KSh/yr due to reduced industrial capacity. The increased runoff caused by deforestation caused nutrient-loading and sedimentation of downstream water supplies, increasing the cost of water treatment by 192mn KSh/yr, and reduced the fish catch, costing 86mn KSh/yr for the economy and doubtless causing food security concerns. The loss of forests increased malaria prevalence, which through lost working days and medicinal/healthcare cost the Kenyan economy 395mn KSh/yr. Finally, the report conclud-ed that the reduction in carbon storage from deforestation cost 341mn KSh/yr, and the loss itself has both national and international implications: not only will it affect the nation's potential income from carbon-trading schemes, not only will it ensure that time and resourc-es will have to be spent in Kenya to replace the lost carbon storage, not only may it affect the nation's global standing and generate potential shocks for the national economy, but the unmitigated climate change could have untold economic costs for Kenya. This is not only a Kenyan issue: African forests now a source of carbon emissions (Grieg-gran *et al*., 2015).

2.3. Cultural ES in Kenyan and African Forests

The tourism industry itself vital for the Kenyan economy: through spending by tourists, the Kenyan government, and tourist-industry employees, tourism contributed 463bn KSh to the Kenyan economy in 2014 (WTTC [online], 2014). Not all of this tourism is generated by the aesthetic quality of forests, but their importance to the tourism industry has been recognised by the nation's Climate Change Action Plan (Stiebert *et al*., 2012).

2.4. Supporting ES in Kenyan and African Forests

Biodiversity is occasionally recognised as a supporting ES in its own right, and it is therefore important to ensure that use of forests does not compromise its biodiversity. This report is from the perspective of stakeholders who intend to plant woodland either as an expansion of or replacement for current forests in the Naivasha region, and it has been recognised that such woodland can be similarly, though not as, diverse as the prior ecosystem (Chazdon, 2008; Thompson, 2010).

3. Matrix and variety of ES and ecosystems

It should be stressed that the favouring of any one ES above others, or attempting to manage as ecosystem to that effect has been recognised as detrimental to the ecosystem as a whole and to the provision of other ES (Bennett, 2009). Therefore, any management plan for the purpose of harnessing ES provision must account for as wide a variety of ES as feasible. Similarly, it has been recognised that the diversity of an ecosystem is positively correlated with its provision of regulating ES (Raudsepp-Hearne *et al*., 2010) and co-benefits of ES (Locatelli *et al*., 2014), which relates to the prior point about planted forests.

4. Challenges for the Lake Naivasha Region

4.1. Water Loss and Lake Shrinkage

Lake Naivasha is shrinking (Mekonnen *et al*., 2013), with current water abstraction for local industry, homes and tourists estimated to cause an annual loss of ten million cubic metres of water from the lake. This water loss has caused the lake area to be reduced by 12%, and the area of papyrus wetland (itself a vital source of regulatory ES, notably in the filtration of waste water (Bateganya *et al*., 2015) and sediment (Morrison, 2013), for carbon sequestration (Saunders *et al*., 2007), and as a site of tremendous scientific interest recognised by RAMSAR (Owino & Ryan, 2007)) by 37%, over a period during which the output from floricultural industry in the area increased by 102% (Onywere, 2012), indicating a high correlation of the two (Awange *et al*., 2013). It is for this reason that the floricultural industry has been blamed for declining water levels and has been described as unsustainable (Louckes, 2010). Forests could be used to ensure a steadier and more consistent flow of water into the lake system, either in isolation or by returning land that has been converted for floricultural purposes (Agustina, 2008) to its original forested state. Forests may also induce greater rainfall through increased evapotranspiration, thereby perhaps reducing the need for irrigation via lake abstraction (Hesslerová & Pokorný, 2010).

4.2. Water Pollution

[In addition to soil erosion (Mergeay *et al*., 2004)], high volumes of fertilisers, pesticides and effluents produced by the Naivasha floricultural industry have been blamed for the large rise in Pb, Cd and Cu levels observed in the waters of Lake Naivasha (Mutia *et al*., 2012; Njogu, 2014). These pollutants are not regarded as dangerous to humans, but have nonetheless been found in high concentrations in fish tissues and do affect the wider ecosystem of the lake (Oloo, 2010; Njogu, 2014), evidenced by the decline of the African Fish Eagle (Gudka, 2012). Again, the conversion of floricultural land to forestry could alleviate this issue, either by reducing the amount of pollution potential or by the regulating ES of water filtration and flow consistency. This improved water flow and reduced land pressure may also allow the recovery of papyrus wetlands around Lake Naivasha (Becht & Harper, 2002; Morrison & Harper, 2009), further improving the capacity of ES to alleviate water pollution.

4.3. Unsustainable dominant industry

For all its negative aspects, not just regarding to ES and ecosystems but also poor working practices, low wages, and the increased population pressure it generates (Louckes, 2010), floriculture *is* the dominant industry of the Naivasha region (Harper *et al*., 2011)[and has been a positive (Moosbrugger, 2007) for the region]. It provides direct employment to 30,000 locals, and the local economy has benefitted from the infrastructure spending gener-ated by hosting 70% of the nation's floricultural industry (Otiang'a-Owiti & Oswe, 2007). The dominance of such an unsustainable industry (Louckes, 2010) is an issue for policymakers, not least for the case of these stakeholders; it may be possible for some currently employed in floriculture to find employment in the more sustainable forestry sector, but given that forestry only employs 18,100 across all of Kenya, forestry alone is an unsuitable substitute.

5. Potential Changes in Lake Naivasha Region

5.1. Improved Forestry Management

The current management of forestry in Kenya as a whole is not sustainable (Schlit, 2010), and nor is it in the Naivasha region (Schlit, 2010); if it were, then current levels of deforestation would not cost significantly more in lost ES provision than is gained by revenue of timber products (UNEP [online], 2012). Current levels of timber, non-timber forestry products, and even the potential for carbon-trading have all been regarded as problematic (Schlit, 2010) in sustainability terms, though there is hope yet. Community Forest Management can be used to promote sustainable extraction of resources from forestry while maintaining ES benefits; it has been observed that when people are given the opportunity to garner income from forests, they plant more forests (Corbridge and Kumar, 2003). However, such schemes have been established regarding the abstraction of water from Lake Naivasha, which simply put local stakeholders in competition to extract water (Isyaku *et al.*, 2011). A more collaborative and authoritative management structure will be needed to ensure the success of CFM, as will better education of local stakeholders as to the benefits of the system and sustainability in general (Everard & Harper, 2002; Harper *et al*., 2011) [and may even draw on private sector investment (Nmirembe & Bernard, 2013)].

5.2. Improved Irrigation

Smallholders in the Naivasha region currently operate at a 31% efficiency of water use in their irrigation systems (Njiraini & Guthiga, 2013), which contributes significantly to declining water levels and pressures on the surrounding ecosystem and ES. Improving the efficiency of these systems will undoubtedly lead to reduced monetary and ES impact costs.

5.3. Economic Development

Bijleveld (2010) identified that many local stakeholders are interested and willing to participate in REDD+ schemes in the Naivasha area, but lack the necessary resources to do so. It is therefore imperative that any scheme to harness the benefits of forest ES must generate some form of economic development in the area, perhaps through Payment for ES schemes, which are known to have succeeded in the Naivasha area (Nyongesa 2011).

6. Summary

Forest ES can be used to provide both monetary and currently non-market benefits to local populations, as well at a national and international scale. In the case of Lake Naivasha, these benefits may be used to restore the damage that previous development has wrought on the ecosystem and provide a source of economic development, though management practices will need to be reviewed and modified in order to facilitate this.

Tables and Figures

Table 2.1: Table of Ecosystem Services (ES) derived from forests as identified by Krieger *et al*. (2001), Nasi *et al*. (2002), Stiebert *et al*. (2012), UNEP [online] (2012), and Grieg-gran *et al*. (2015), divided into the four categories identified in the Millennium Ecosystem Assessment (2005). This is intended to be a general list of forest ES, applicable to the majority of forest ecosystems.

Overall ES type	Forest ES
Provisioning	• Timber and fuelwood • Food, game, and fishing • Livestock fodder • Pharmaceutical and medicinal
Regulating	• Water quality and quantity (consistency) • Air quality • Habitats for pest-controlling, seed-dispersing and pollinating species • Flood defence • Rain generation • Carbon sequestration and climate change mitigation
Cultural	• Aesthetic quality • Heritage • Habitats for endangered species • Tourism
Supporting	• Soil formation and stabilisation • Nutrient cycling • Preservation of biodiversity

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