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Mainstreaming biodiversity accounting: potential implications for a developing economy

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Abstract

Purpose – The paper seeks to respond to calls by Jones for more studies exploring the possibility of operationalising accounting for biodiversity.

Design/methodology/approach – Archival data are used to produce a natural inventory report for the Sundarbans, the world's largest mangrove forest declared as a World Heritage site by UNESCO in 2007.

Findings – The study extends prior research on biodiversity accounting by exploring the applicability of Jones' natural inventory model in the context of Bangladesh. The results indicate that application of Jones' natural inventory model is feasible in the context of developing countries such as Bangladesh. It is also recognised that the socio-economic and political environment prevailing in developing economies may lead to the emergence of important stakeholder groups including local civil society bodies, international donor agencies and foreign governments. Biodiversity accounting may provide a legitimate basis for the government in allaying concerns regarding environmental stewardship and assist in negotiations with powerful stakeholder groups on important issues such as financial assistance after natural disasters and claims to the global climate change fund.

Originality/value – This is one of the early attempts to operationalise biodiversity accounting in the context of a developing economy.

Keywords Biodiversity accounting, Climate change, Developing economy, Environmental disclosures, Sustainable development, Bangladesh, Developing countries, Economic development

Paper type Research paper

1. Introduction

As Jones (2003) notes, although environmental accounting and reporting has a secured place in the accounting literature, there is a paucity of studies attempting to operationalise it. Rather, most researchers have concentrated on identifying the levels of environmental disclosures (for example, Roberts, 1991; Hackston and Milne, 1996; Deegan and Gordon, 1996, Cho and Patten, 2007) and/or attempting to explain managerial motivations for such disclosure practices from a number of theoretical perspectives (O'Donovan, 2002; Laine, 2009; Jones, 2010). In recent years, however, there have been some efforts to mainstream environmental accounting into the reporting process. However, such efforts have been largely confined in developed economies[1]. From a stewardship perspective, it can be argued that developing countries can perhaps benefit more from attempting to operationalise environmental

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accounting, as these countries tend to be more vulnerable to the effects of the global climate change and subsequent degradation of natural assets. However, despite this, to date, efforts to operationalise environmental accounting in the context of developing economies have been few and far between. The paper aims to explore this gap in the environmental accounting literature.

Building on the work of Jones (1996, 2003), this paper attempts to operationalise biodiversity accounting in the context of Bangladesh. Although Bangladesh is one of the poorest economies in the world, due to its geographic location, the country is rich in biodiversity. A significant number of Bangladesh's rural poor is completely dependent on natural resources for their livelihood, leading to extensive degradation of natural assets and deforestation (USAID, 2006). Environmental stewardship is important for the Bangladesh government, as it is sometimes accused by different civil society groups for their failure to protect natural assets. This is largely due to the presence of widespread corruption in the public sector and negligence of duty by administrators and law-enforcing agencies. Also, Bangladesh's vulnerability to natural disasters is well-documented. In addition to significant human casualties and economic losses, such natural disasters have considerable impact on the biodiversity of the country. Bangladesh is also one of the most vulnerable countries exposed to the threats of global climate change. It is projected that a one metre rise in the sea levels will inundate 17 per cent of Bangladesh's total land area by the year 2050 (IPCC, 2007). Sea level rises will significantly affect the biodiversity of the Sundarbans- the world's largest mangrove forest and also the natural habitat of many endangered species in the world. Bangladesh's susceptibility to natural disasters and climate change effects, together with the country's fragile economic condition and poor record in combating corruption has led to the emergence of an important group of environmental stakeholders. This group comprises of influential members of the local civil society, international development agencies such as the World Bank, and other foreign governments who regularly provide development assistance to Bangladesh. Bangladesh also has a strong claim on the global climate change fund, promised by developed nations as a means of assisting the developing countries in coping with the effects of climate change. However, access to such resources will depend on its capability in ensuring transparency and accountability in the manner such climate financing is managed. In addition to biodiversity losses from natural disasters and sea level rises, regional issues such as barrages built in neighbouring India affect the biodiversity of Bangladesh on a regular basis. The country's economic vulnerability, as well as absence of information relating to inventory of natural assets puts Bangladesh in a relatively weaker position in negotiations relating to such issues. This provides the context for this study.

The objective of this study is to consider how biodiversity accounting can assist poor nations such as Bangladesh in responding to stakeholder demands for greater environmental stewardship and accountability. The paper also explores the possibility of using biodiversity accounting to produce an inventory of natural assets for Bangladesh that can be used as an objective, legitimate basis for communication with the international community. Using Jones' natural inventory model (Jones, 1996) to produce a natural inventory report for the Sundarbans, the study provides evidence of the possible application of the model in the context of a developing economy. Although, the application of Jones' model for the purpose of this paper is constrained by the availability of data regarding natural assets in Bangladesh, the study indicates that

given an updated record of the natural inventory, it is possible to use the Jones' model to produce a natural inventory for the Bangladesh government. An objective statement of natural inventory can address some concerns regarding environmental stewardship, and may help prevent further degradation and misuse of natural resources. Such an inventory may enable quicker assessment of biodiversity losses after any natural disaster. Also, data regarding inventory of natural assets can be used for calculation of loss of natural assets from the global climate change, and can form a reasonable basis for Bangladesh's claim on the global climate change fund. Incorporation of inventory of natural assets will put the Bangladesh government in a stronger negotiating position as such a statement could be used as an acceptable basis in support of Bangladesh's objections regarding any projects in neighbouring countries that might significantly affect the biodiversity of Bangladesh.

The paper makes a number of contributions to the accounting literature. This is the first attempt to operationalise biodiversity accounting in the context of a developing economy. Previous environmental accounting research in the context of developing countries have mostly concentrated on identifying the levels of environmental disclosures (for example, Ahmad and Sulaiman (2004), in the context of Malaysia; Imam (1999), in the context of Bangladesh). Of late, a few papers (for example, Elijido-Ten *et al.*, 2010; Belal and Owen, 2007; Rahaman *et al.*, 2004; Islam and Deegan, 2008) have applied different theoretical perspectives to investigate the motivations for managers in developing economies to provide social and environmental disclosures. However, research attempting to operationalise environmental accounting in the context of developing countries has been uncommon. By applying Jones' model to produce an inventory of the Sundarbans, this study provides evidence that biodiversity accounting can be operationalised in developing countries such as Bangladesh. The study also recognises that due to the socio-economic and political environment prevailing in developing economies, civil society groups, international development agencies, and foreign governments emerge as powerful stakeholder groups who ask for greater environmental stewardship and accountability from the government. It is argued that using biodiversity accounting in the accounts produced by government agencies may provide a legitimate means of responding to the requirements of such powerful stakeholder groups for the government. Thus, the study also recognises the importance of operationalising biodiversity accounting in the public sector.

The remainder of this paper is organised as follows. Following a brief review of theoretical perspectives and empirical approaches to biodiversity accounting, the institutional context is presented. A subsequent section then discusses the institutional context. The Sundarbans is introduced as a case, and Jones' natural inventory model is applied in an attempt to produce a natural inventory model for the Sundarbans. This is followed by some reflective comments and possible implications for mainstreaming biodiversity accounting in the context of Bangladesh. The conclusion section then reiterates the objectives of this research, and the principal findings.

2. Accounting for biodiversity: theoretical perspectives and empirical approaches

Prior research in environmental accounting has predominantly concentrated on studying social and environmental disclosures. This has included proposing rationale for environmental disclosures (Gray and Bebbington, 1993; Gray *et al.*, 1993),

quantifying the level of such disclosures (Harte and Owen, 1991; Roberts, 1991; Hackston and Milne, 1996; Deegan and Gordon, 1996) more recently Magness (2006); Cho and Patten (2007), and capturing the managerial motivations for making such disclosure (Deegan and Rankin, 1999; O'Donovan, 2002; Cho and Patten, 2007; Grabsch *et al.*, 2010; Laine, 2009). Gray *et al.* (1995) provide a review of alternative theoretical approaches used in the social and environmental accounting disclosure literature, and identify stakeholder theory, legitimacy theory, and political economy theory as the major theoretical approaches used to examine environmental accounting disclosures. The stakeholder theory suggests that a firm's environmental disclosure practices are shaped by three factors, namely, stakeholder power, firm posture, and profitability (see Ullman, 1985; Roberts, 1991; and in a developing economy context, Elijido-Ten *et al.*, 2010). The legitimacy theory has been applied widely in the environmental accounting literature to explain managerial motivations for environmental disclosure (for example, see Deegan, 2002; O'Dwyer, 2002). It is argued that positive environmental disclosures can help repair, or restore an organisation's legitimacy (Milne and Patten, 2002; Mobus, 2005). Jones (2010), discussing the principal theoretical approaches to environmental accounting, mentions that an organisation's attempts to promote "greener" environment and working conditions may also help it gain legitimacy. Apart from these two dominant approaches, Gray *et al.* (1996) offer insights from political economy theory to help understand an organisation's social and environmental activities, claiming that for a meaningful analysis of the economic activities of an organisation, the socio-political environment within which the firm operates must be considered.

Jones (2003) proposes a theoretical approach explaining the need for operationalising environmental accounting. The paper uses environmental stewardship as the major theoretical premise in an attempt to operationalise biodiversity accounting. Environmental stewardship has been defined "as the comprehensive understanding and effective management of critical environmental risks and opportunities related to climate change, emissions, waste management, resource consumption, water conservation, biodiversity protection and ecosystem services" (UN, 2010, p. 9). Under this approach, organisations are considered to be accountable to their society at large for their stewardship of the environment. It is argued that in addition to adhering to laws and regulations, organisations also gain legitimacy through the performance of collective societal moral responsibility, and being environmentally responsible is a major part of this. Guimaraes and Liska (1995) find that companies showing higher degree of environmental stewardship tend to benefit more compared to companies that comply with minimum legal requirements. Jones (2003) argues that stewardship is a broader context than ownership, and organisations do not have the right to dispose-off natural assets, as there are wider societal concerns. The paper points out that an important part of environmental stewardship is the maintenance of an inventory of natural assets. Such a record of inventory can be used for extending the notions of double-entry book keeping to account for natural assets (for example, degradation of lands (Rubinstein, 1992)). In the management literature, the concept of environmental stewardship has been largely applied to businesses operated in the private sector, and the role of the government in environmental stewardship has been often ignored. However, application of the environmental stewardship concept in the public sector is not new. Rather, governments in different countries have already incorporated environmental

stewardship as a performance indicator (for example, Mohninger, 2000; in Ghana; Ramos *et al.*, 2007, in Portugal). This perhaps makes efforts to operationalise biodiversity accounting in the context of public sector even more relevant.

Jones (1996, 2003) has been the most prolific academic in the area of biodiversity accounting research. In an exploratory research paper published in the *British Accounting Review,* Jones (1996) pioneered the notion of mainstreaming biodiversity accounting into environmental reporting practices of an organisation. Using a multidisciplinary approach, Jones (1996) proposed a model for recording, monitoring, and reporting the inventory of natural capital. The objective of the model was to provide a comprehensive framework in which data regarding natural assets can be recorded for the purpose of stewardship.

Based on Gray's (1992) framework for natural assets, Jones' natural inventory model distinguishes between "critical" and "non-critical" natural assets. Critical natural capital is classified as comprising of "those elements that are essential for life on earth, and which for sustainability must remain inviolate" (Barton, 1999). Therefore, critical natural assets cannot be replaced. "Non critical" or "sustainable" natural assets, on the other hand, can be renewed. Natural assets in this category include managed woodland, and species of flora and fauna that have no threats to extinction. Jones (2003) reports that developed nations typically protect their critical natural assets through the creation of restricted areas. Also, the availability of data in the developed world makes quantification of some natural assets (such as flora) easier:

> Geographically, the picture is mixed. In developed countries, there is abundant taxonomic information. By contrast, in developing countries, information is more limited and fragmented (Jones, 2003, p. 768).

Once the critical and non-critical natural assets are classified, Jones (1996) then proposes a hierarchical six levels of natural inventory, classified in accordance to their criticality. The first level provides baseline information regarding types of habitats and natural assets. Level two then lists the critical natural assets in all habitats within the country. Level three provides an inventory of the types of species of flora and fauna of the critical habitat. Information regarding total population of the habitat's flora and fauna is then provided at level four. Level five lists the types of species of flora and fauna available in the country, and this is then converted into an inventory containing the total number of flora and fauna in the country. Thus, levels 4, 5, and 6 contain broader information regarding the inventory of natural assets. The extent to which an entity's natural inventory can be classified would actually depend on the availability of data. Therefore, although many organisations may not have sufficient information for inventories in levels 3, 4, 5, and 6, most medium and large size organisations should have the capability to come up with level 1 and 2 inventories. Jones (1996) mentions that level 6 inventories may be impossible due to unavailability of data even in the context of developed economies.

Once an inventory of natural assets has been developed, the next step is then to assign economic values to such inventories. This is, obviously, the most problematic stage as far as biodiversity accounting is concerned. Environmental economists have, for some time now, attempted to develop various methods of assigning economic values to natural assets. Such methods include use of market prices, use values, non-use values, and cost-benefit methods such as hedonic price method, travel cost method, contingent price methods etc. (Milne, 1991). However, Jones (1996) mentions

that although each of these methods was considered for the purpose of valuation of natural inventories, none of the methods were deemed appropriate. Rather, a five-point ecological grading, for both critical and non-critical assets, is used in the model for the purpose of valuation of the natural inventory. The last stage of the natural inventory system then involves organisations providing a summary of information relating to valuation of natural inventories for their stakeholders,

3. Institutional context

Bangladesh, located in South Asia, sits in the Ganges-Brahmaputra Delta – the largest river delta in the world. Due to this unique geophysical location, the country has been endowed with rich biological diversity (USAID, 2006). It is also one of the most densely populated countries in the world, with 986 people living per square kilometre of land[2]. Despite its impressive economic performances in recent years, Bangladesh is still classified as a least developed country with a GDP per capita of US$ 775. Like many other developing economies, factors such as rampant corruption and the volatile political environment seriously affect the country's economic progress. The corruption perceptions index prepared by the Transparency International has consistently ranked Bangladesh as one of the most corrupt countries in the world (TIB, 2012). Corruption is especially prominent in the public sector. According to a report by the US agency for international development (USAID), 70 per cent of the population of Bangladesh depend on natural resources for their daily livelihood. The rural poor are traditionally landless communities whose lives are totally dependent on natural capital. This leads to significant degradation of natural capital and biodiversity (USAID, 2006). Ahmed (2008) identifies corruption by local elites, members of political parties, forest administrators as well as law enforcing agencies as the most important cause for deforestation in Bangladesh[3]. This is consistent with Haque (2000) who attributes the depletion of mangrove forest in Bangladesh to the corruption and negligence of the some forest department staffs, illegal traders, local influential leaders, and some government officials concerned.

Geographically, Bangladesh is surrounded by its large neighbour, India, on three sides of its border, with Myanmar sharing a border with India on the eastern part of Bangladesh and the Bay of Bengal in the south. Due to its geophysical location, the country is susceptible to large-scale natural disasters such as cyclones and floods. Bangladesh is a low-lying country severely exposed to threats of climate change. According to Climate Change Vulnerability Index 2011, Bangladesh has been ranked as the most vulnerable country and placed in the "extreme risk" category amongst 170 countries due to the likely impacts of climate change over the next 30 years (TIB, 2012). It is estimated that a one metre rise in the sea level would inundate 17 per cent of Bangladesh (IPCC, 2007), forcing about 1 million coastal people to be climate refugees[4]. The global climate change has also resulted in the increase of frequency of high intensity cyclones in Bangladesh, and the country has already witnessed two level 4 (high intensity) graded cyclones over the last ten years. Considering these massive threats, the Bangladesh Government has recently formulated a "Bangladesh Climate Change Strategy and Action Plan". Also, a "Bangladesh Climate Change Trust Fund" (BCCTF) has been created from the national revenue budget. In addition, "Bangladesh Climate Change Resilience Fund" (BCCRF) has been established with the assistance of development partners, namely the UK, Denmark, the European Union, Sweden and Switzerland. Bangladesh has also been promised a significant share of the global

climate change fund, a US$ 10 billion fund proposed by the international community to help the least developed countries cope with the effects of climate change[5]. Although the BCCTF is monitored by the Government of Bangladesh, the World Bank will be acting as the fund manager for the BCCRF. Given Bangladesh government's poor record regarding accountability and corruption, a number of civil society groups have already flagged up their concerns regarding the way the climate funds will be managed (TIB, 2012).

The fragile economic condition, along with lack of skilled manpower in the public sector also puts Bangladesh in a relatively weaker position in international negotiations with neighbours such as India. As mentioned before, Bangladesh is surrounded by India on three sides of its border. Being a downstream country, 54 rivers flow from India through Bangladesh to the Bay of Bengal. India, being the upstream country, has the benefit of setting up barrages to produce electricity for her own economy. Such barrages change the intensity of water flowing into Bangladesh, thereby affecting the biodiversity of the country. One of the examples of such barrages is the Farakka barrage. Constructed by India in 1975, the Farakka barrage is used to divert water from the river Ganges towards the Indian city of Kolkata for irrigation purposes. When the project was initiated, objections were raised by Bangladesh on the grounds that the proposed project would severely affect the biodiversity of surrounding areas. Bangladesh also raised the issue in international forums such as the United Nations. However, Bangladesh's relatively weaker stature in the diplomatic arena meant that its objections were not considered. Although the exact cost of natural assets degradation from Farakka barrage was never determined due to unavailability of pre-Farakka biodiversity data, a number of studies (for example, Temple and Payne, 1995; Gopal and Chauhan, 2006) have reported that the barrage has almost completely eliminated *Hilsha Ilisa*, a common fish in this habitat, and significantly reduced other carp species. India has recently declared its intention to put up a similar barrage on the river Tipai, which also flows through Bangladesh. Experts have warned that if erected, the dam might have even more severe effects on the eastern parts of Bangladesh[6]. The Farakka dispute is important for understanding Bangladesh's relative bargaining position in the context of South Asia, as failure to negotiate with its powerful neighbours may further jeopardize the biodiversity in the region.

Bangladesh has a large reserve of natural gas, and a number of large multinational companies are engaged in the extraction of natural gas in Bangladesh. From time-to-time, such extraction causes huge explosions in the gas fields, resulting in significant biodiversity loss as well as human casualty. Recent blowouts in Magurchara in 1999 and Tengratila in 2007 have considerably affected the biodiversity of the adjoining areas. However, absence of accurate data regarding the inventory of natural assets before the blowout incidents have resulted in much lower compensation being paid by the multinational companies to the government (Siddiqui, 2001).

The above discussion indicates that the socio-political environment of developing countries such as Bangladesh necessitates greater environmental stewardship and accountability. Unlike many developed countries, the corporate sector in Bangladesh is largely dominated by small-scale family-owned firms. Due to scarcity of land, very few businesses own considerable amounts of it. Rather, most of the forests are owned, managed, and protected by the government of Bangladesh under the Wildlife Act (GoB, 1974). At present, the government of Bangladesh does not maintain a register for

its natural assets. However, for the first time in the history in Bangladesh, the incumbent political party in power mentioned conservation of biodiversity as one of its pre-election pledges. Accordingly, the government is currently revising the Wildlife Act of 1974, and there have been strong calls for the inclusion of a biodiversity register incorporating an inventory of the natural assets. An editorial in *The Daily Star*, Bangladesh's most circulated English daily newspaper, emphasises the need for registering the national inventory:

> Countries like Bangladesh should derive economic benefits from their rich biodiversity resource base. Unfortunately there is no proper inventory and monitoring of the country's biodiversity. Documentation, monitoring and conservation of local biodiversity and indigenous knowledge should be considered as the thrust area of activities since the said tasks remain significantly incomplete in the country (*The Daily Star, June 19, 2010*).

A number of environmental experts have also acknowledged the need for a biodiversity inventory, suggesting that such an inventory could be useful for "resource management and conservation" (Islam, 2008a) as well as for assessing damages from natural calamities, such as cyclones (Islam, 2008b). The national biodiversity strategy and action plan for Bangladesh, produced by the Ministry of Environment and Forests (GoB, 2008), also mentions the development of a natural inventory as one of its medium-term goals. The first forest resource inventory for Bangladesh was conducted by the World Bank in 1996 under the forest resource management project. Also, the Food and Agricultural Organisation (FAO) of the United Nations has produced a national forest inventory for Bangladesh, providing a "bird's eye view" of national forest inventories (FAO, 2007). However, neither of these surveys contains a detailed inventory of natural assets in specific geographic locations. At present, the Bangladesh chapter of the International Union for the Conservation of Nature (IUCN) is conducting a World Bank funded project to come up with a biodiversity conservation plan for the Sundarbans. The project aims at producing a natural inventory for the Sundarbans, based on secondary data (IUCN, 2011).

As in the case of many developing countries, there is lack of awareness amongst general public in Bangladesh regarding issues such as biodiversity conservation. However, Bangladesh has a very vibrant civil society, and many of these groups are vocal about the conservation of the country's natural assets. The civil society groups actively engage with the government regarding issues such as conservation of the country's biodiversity and monitor potential threats to biodiversity from projects undertaken by the government and neighbouring countries. Recently, one such civil society group, the *Bangladesh Poribesh Andolon* (Bangladesh environment movement) filed a case against the government asking it to stop a coal-fired power-plant project in Rampal near the Sundarbans (*The Daily Star, January 28, 2012*). The move was supported by other environmental groups as well as eminent citizens in Bangladesh who issued a press statement expressing concerns on the possible effects of the project on the Sundarbans' biodiversity:

> Although we welcome the government initiative to generate more electricity, we are seriously concerned over selection of Rampal as the project site. The power plant will pose danger to the forest's biodiversity well as wildlife, including Bengal tigers. The soil quality will fall, breeding of animals will be hampered and the growth of trees will be obstructed if the coal plant is built in Rampal (*The Daily Star, January 28, 2012*).

Similar calls were made by the Bangladesh chapter of the Transparency International, and other green activists (*The Financial Express, April 16, 2012*). The civil society groups alleged serious lack of transparency from the part of the government in the manner the site for the project was selected. The press statement pointed out that the primary selection of the project site was based on a report that did not even consider the potential impact of the project on the environment, although it was a legal requirement to do so. However, despite this, the government went on to complete the agreement for the project. The appeal was withheld by the court, and the project remains suspended. A similar petition was also earlier made by environmental groups against a similar project in another part of the country. The repeated occurrence of such events perhaps demonstrates the lack of commitment from the part of the government in performing its responsibility towards environmental stewardship.

In addition to proactive stakeholder groups within the country, the economic and socio-political context of Bangladesh have resulted in the emergence of powerful stakeholder groups such as foreign governments and donor agencies, who would seek more transparent information relating to environmental assets. Maintaining an environmental inventory may enable the Bangladesh government to put forward a quick assessment of losses from natural disasters to the donor agencies. At present, the economic models used by the World Bank or the Government of Bangladesh fails to account for any biodiversity losses arising from natural disasters, resulting in a significant undervaluation of actual impact. Therefore, the government of Bangladesh needs to produce dependable, authentic information regarding inventory of natural assets that can then be used as a legitimate tool for negotiations with neighbouring countries on issues that might significantly harm Bangladesh. Earlier Rahaman *et al.* (2004), using the case of Volta River Authority in Ghana noted that public sector entities in developing countries tend to make biased environmental disclosures to appease important stakeholders (in that case, the World Bank). It can be argued that an inventory of natural assets using acceptable biodiversity accounting techniques would perhaps be more objective compared to descriptive social and environmental disclosures that cannot be easily verified.

Like many other developing countries, there are significant weaknesses in the fiscal transparency of the public sector financial management system in Bangladesh (IMF, 2003), and decision usefulness of the public accounting system has been low (Chowdhury and Innes, 1998). Bangladesh is yet to adopt the international public sector accounting standards (IPSAS), and the World Bank (2007) has pointed out that the country needs to adopt full cash basis accounting first before it can attempt a transition towards accruals basis accounting in the public sector. Unsurprisingly, the concept of biodiversity accounting is absent in the national accounts.

As the above discussion has indicated, the government and the people of Bangladesh can perhaps benefit from a biodiversity accounting system that would help assign a numeric value to its natural assets inventory. Given the current state of public sector accounting in Bangladesh, it may not be possible to completely integrate biodiversity accounting into the national accounting system. Nevertheless, such information could still satisfy the needs of some of the stakeholder groups and allay some concerns regarding environmental stewardship of the government. For the purpose of this paper, the case of the Sundarbans, a large forest located in the southern part of Bangladesh facing significant threats of extinction due to the effects of climate

change, will be used as an illustration to explore the possibility of using the natural inventory model proposed by Jones (1996).

4. The case: the Sundarbans

The Sundarbans is the world's largest Mangrove forest[7] covering 10,200 square kilometres (60 per cent in southern Bangladesh, and 40 per cent in India). In 1997, it was classified as a world heritage site by the UNESCO (UNEP, 2011). The mangrove flora of the Sundarbans, which contains 27 species, is unique in comparison with non-deltaic coastal mangrove forests. The Sundarbans is also the natural habitat of the Royal Bengal tiger, one of the most endangered mammal species in the world. According to the WWF (2007), the area may now shelter about 350 tigers in the Bangladeshi section and an estimated 250 on the Indian side, though an IUCN Species Survival Commission study suggested that the latter may be fewer than 100 (UNESCO, 2002). The Sundarbans also hosts many other endangered species, including reptiles and dolphins. In 1996, the Government of Bangladesh declared the Sundarbans as a wildlife sanctuary under the Bangladesh Wildlife Act (GoB, 1974). The sanctuary is owned by the government and managed by the Bangladesh forest department. Therefore, the government is legally responsible for the stewardship of this forest.

Richards (1990) reported that in 1793, when the India (and Bangladesh) was a part of the British colony, the Sundarbans was estimated to be spread over a total area of 19,508 square kilometres. Gopal and Chauhan (2006) studied the state of biodiversity in the Sundarbans and the threats to biodiversity loss. The paper identified density of population in this part of the world as one of the major threats to biodiversity. The rate of population growth led to the over exploitation of the mangrove forest for commercial purposes. Also, fishermen harvest fish and shrimp heavily in this area. Bangladesh is a major worldwide exporter of shrimps, and collection of shrimp juvenile from this area has increased significantly in recent years (Haque, 2003; Hoq *et al.*, 2006). A number of studies (for example, Thornton *et al.*, 2003; Barbier and Sathirathai, 2004) have reported that the reduction of shrimp juveniles, and the farming of shrimp in this area for export purposes is having a direct impact on Sundarbans' biodiversity.

Increase in water salinity due to rise in sea water levels is another major threat to the biodiversity of the Sundarbans. Increased salinity has resulted in the significant growth of salinity tolerant, dwarf species of plants, which are gradually replacing the forest area. This also caused declines in the number of habitat birds and tree climbing animals such as monkeys (Gopal and Chauhan, 2006). In addition to population growth, Gopal and Chauhan (2006) mention other man-made activities, such as dams and embankments to have significant effects on the biodiversity of the Sundarbans. As mentioned before, the Farakka dam, a barrage constructed on the Indian side of its border with Bangladesh, have had a significant impact on Sundarbans biodiversity. Gopal and Chauhan (2006) point out that although due to the lack of information regarding inventory in the Sundarbans area before the Farakka barrage it is impossible to assess the actual amount of biodiversity loss due to the barrage, a significant drop in Hilsa (*Hilsa ilisha*) fish in the Indian side of the Sundarbans has been reported (Sinha and Khan, 2001; Payne *et al.*, 2004).

Gopal and Chauhan's study was published in 2006. However, since then, the biodiversity of Sundarbans was greatly affected by the cyclone SIDR of 2007. Also, the Sundarbans is one of the worst victims of the global climate change effect. These two

major threats to the Sundarbans' biodiversity will be discussed in the later parts of the paper. However, before those threats are discussed, it is important to understand economic models applied by the government of Bangladesh, as well as various donor agencies to assess the impacts of natural disasters.

The super cyclone SIDR of 2007

Bangladesh's vulnerability to natural disasters is well documented. In regular intervals, the country is affected by acts of nature such as cyclones, floods, and droughts. In last 20 years, Bangladesh has witnessed three major natural disasters: the cyclone of April 1991, that killed 138,000 people (Ali, 1996), the devastating flood of 1998, that inundated approximately 60 per cent of the country's land and affected over 30 million people (Kunii *et al.*, 2002), and the super cyclone SIDR of 2007. Amongst these, the cyclone SIDR significantly damaged the southern part of Bangladesh where the Sundarbans is located. SIDR, a category 4 cyclone, hit Bangladesh on November 15, 2007. The cyclone, accompanied by tidal surge that raised up to six metres in places, was the second most destructive of the fourteen cyclones that hit Bangladesh since the 1990 (GoB, 2008). However, despite being similar to the 1991 cyclone in terms of severity, the human loss caused by cyclone SIDR (reported death 3,406) was much lower compared to the cyclone of 1991. In 2008, the government of Bangladesh published a report on the assessment of damage caused by SIDR (GoB, 2008). The report pointed out that one of the major reasons for the low casualty caused by cyclone SIDR was the fact that it had hit the Sundarbans first before reaching the densely populated mainland. The Sundarbans forest had actually acted as a shield against the cyclone SIDR and helped in reducing human casualty significantly. However, this also meant that Sundarbans was severely damaged by the cyclone. The UNESCO estimated that the cyclone SIDR seriously damaged 40 per cent of this world heritage site, and that it would take the Sundarbans at least 15 years to recover and regenerate from the effects of the SIDR, if it is not affected further by any other natural or human caused incidents (UNESCO, 2007).

Table I presents a summary of the Bangladesh government's estimates of the damage caused by SIDR. The effect of the disaster through damage and loss of infrastructure, social sectors, productive sectors, and cross-cutting issues is estimated to be around US$ 1.6 billion. The table indicates that an overwhelming majority of the damage and loss is estimated for infrastructure, whereas environmental loss is estimated to be only US$ 6.1 million (about 0.4 per cent of total estimated damage and loss). The report acknowledges that actual economic value of environmental loss suffered due to SIDR cyclone could be significantly higher than this. The Forest Department (FD) estimated total forest resources damaged in the affected area of 110,000 hectare-acres to be US $145 million, which is significantly higher than the government estimate using the ECLAC method[8]. The GoB (2008) report mentions that the estimate of $145 million could be inaccurate due to lack of information regarding specific plant species and their market prices, and hence was not included in their assessment of damages. The report mentioned that destruction from cyclone SIDR could have been much higher if the Sundarbans had not acted as a natural shield against the cyclone SIDR. However, due to lack of information and methodological constraints, such full economic impact assessment was not possible.

Sectors	Damage US$ million	Damage US$ million
Infrastructure		1092.7
Housing	839.3	
Transport	141.0	
Electricity	13.6	
Water and sanitation	2.9	
Urban and municipal	24.6	
Water resource	71.3	
Social sectors		86.0
Health and nutrition	17.5	
Education	68.5	
Productive sectors		489.9
Agriculture	437.6	
Industry	33.2	
Commerce	18.2	
Tourism	0.9	
Cross-cutting issues		6.1
Environment	6.1	
Total		1,674.7

Source: GoB (2008)

Table I.
Damage assessment for cyclone SIDR

The UN-ECLAC method

Immediately after the SIDR, the Bangladesh government, with assistance from international development community, prepared a report on assessment of losses from the cyclone (GoB, 2008). The damage and loss assessment methodology used in the report was first developed by the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC) and is commonly known as the ECLAC method. This methodology is used by development agencies such as the World Bank and the UNESCO in assessing damage and loss from natural disasters in different countries. According to the ECLAC method, "damages" are estimated as the replacement value of totally or partially destroyed physical assets that must be included in the reconstruction program, whereas "losses" are estimated in terms of the flows of the economy that arise from the temporary absence of the damaged assets (GoB, 2008). The economic assessment of the impact of a disaster involves five stages (ECLAC, 2006). The first stage involves a description of the state of the environment before the disaster, which serves as a baseline for the assessment. This stage consists of collecting, classifying and describing the environmental conditions involved (resources, natural or artificial systems, biodiversity) specific to the area in question and other areas included within the perimeter officially recognised as affected. In the absence of any records or institutional database regarding the environmental inventory of the disaster affected area, this information is based on official reports of independent institutions, secondary sources (such as newspaper reports), and interviews with relevant personnel. Once a pre-disaster environmental inventory is produced, this data is then used to classify the disaster's impact on the environment in terms of direct and indirect damage, so to facilitate the economic valuation of such

damage. Direct damages are derived from change in the quantity and quality of the environmental assets, for example, loss of soil or vegetation, change in the dynamics of eco systems etc. (ECLAC, 2006). This involves the comparison between the current, post disaster inventories with the pre-disaster state of the environment. Indirect damage, on the other hand, refers to the "temporary inability to use the environmental resources due to the damage caused by the disaster up to restoration of natural and/or man-made capital" (ECLAC, 2006, p. 15). Once the environmental damages are identified and classified into direct and indirect categories, the next step involves the assignment of economic values to such damages. ECLAC (2006) mentions that this is the most difficult part of the assessment, and that the "quality of information is crucial" (ECLEC, 2006, p. 17). Also, time constraint is mentioned to be a major factor affecting such economic assessment:

> There is rarely sufficient time available for disaster assessments to obtain quantitative information about the impact on specific species (without use value) or on other variables that form part of the ecosystems' dynamic (ECLAC, 2006, p. 16)

In cases where such information is difficult to collect and identify, these items are excluded from the economic impact assessment, and are only recognised as "environmental effect", without assigning any economic value.

A number of methods are available for the estimation of economic values of environmental assets (Pearce and Turner, 1990). This includes direct estimates such as market values (replacement cost of environmental assets), and indirect estimates such as "surrogate market prices" (estimation of the price of related economic goods), and estimations based on discussions with relevant user groups. Turner *et al.* (2000) mention that as only a few environmental goods have market values and consequently, the indirect estimates are the predominant form of estimation methods to be used. Amongst the indirect methods available, restoration cost method, based on the economic benefits derived from an environmental or man-made attribute lost due to the natural disaster, is the most common. This method is also proposed by the United Nations as a possible approach towards environmental accounting (UN, 2000). However, the restoration cost method cannot be used in cases where there is no restoration cost for the lost environmental asset, as the natural assets are expected to be restored through natural processes (for example, in cases of damages caused to a forest due to a natural disaster (ECLAC, 2006, p. 24)). In such a case, other methods will need to be applied.

The ECLAC (2006) report provides guidelines for assessing the impact of biodiversity losses, including damage to mangrove forests. For mangrove swamps, the following guideline is provided:

> Mangrove forests provide environmental goods and services such as timber, fisheries and other species habitat, maintenance of estuarine water quality and shoreline protection. If actions are planned for the recovery of forests, mangroves swamps or urban parks, the assessment of direct damage is based on the restoration cost (ECLAC, 2006, p. 29).

If the mangrove swamps are expected to recover naturally, direct damages are assessed on the basis of "present value of forest services that would not be obtainable during the recovery period" (ECLAC, 2006). This, again, would require either a database for pre-disaster environmental inventory, or the assessment of such. Absence of such a database would lead to biodiversity losses being reported in a narrative manner and subsequently excluded from the final environmental damage assessment.

Thus, unless the government possesses a comprehensive database of natural assets, the application of the UN-ECLAC method would actually lead to an undervaluation of the actual loss suffered from the natural disaster. Another crucial problem with the UN-ECLAC method is its failure to distinguish between critical and non-critical natural assets. Consequently, critical and non-critical natural assets are assigned with similar economic values, resulting in significant undervaluation of the intrinsic values of some natural assets. Thus, from the stewardship point-of-view, the UN-ECLAC method is not very useful, as it results in almost minimal valuation of the environment.

As mentioned before, the Sundarbans' biodiversity was significantly affected by the cyclone SIDR of 2007. Also, the Sundarbans is predicted to be one of the worst victims of the global climate change. These two threats to Sundarbans' biodiversity and the corresponding economic assessment of losses will now be discussed.

Damage assessment using UN-ECLAC method

Environmental damage from SIDR was estimated through the application of the UN-ECLAC method. Table II presents the element-wise damage suffered in the environmental sector, as assessed by the GoB (2008) report. Due to lack of pre-SIDR inventory of natural assets in this area, the ECLAC method used a generic estimate. According to the assessment conducted by the forest department in Bangladesh, 3,500 hectare acres of coastal forest, 502 miles of strip plantation and 3.1 million nursery seedlings were either destroyed or severely damaged by the SIDR. The estimated value of damage, including affected infrastructure, is BDT 100 million (US$ 1.4 million). In addition, the FD estimated the damage to areas under social forestry programs at BDT 120 million (US$ 1.7 million). The physical damage includes 3,362 miles of strip plantation, 78 hectare acres of island-land plantation and nursery seedlings. Noticeably, the estimate used by the ECLAC method fails to distinguish between different types of plants present in the affected area. Rather, a generic rate is applied for the coastal forest and strip plantation. Also, the report used restoration cost method for assigning monetary value for natural assets. As mentioned before, the restoration cost method does not assign monetary values to natural assets if these are expected to be restored through natural processes. As the mangrove swamps are expected to recover naturally, direct damages should have been assessed on the basis of "present value of forest services that would not be obtainable during the recovery period" (ECLAC, 2006). However, this was not possible due to the absence of pre-disaster

Components	US$ million	US$ million
Infrastructure and watercrafts		3.30
Office and residential buildings	1.84	
Water vessels	0.41	
Others	1.05	
Damage to forest resources		2.81
Strip plantation (3,870 miles)	2.72	
Others	0.09	
Total		6.11

Source: GoB (2008)

Table II.
Damage to environmental sector from cyclone SIDR

environmental inventory of the Sundarbans. Due to such methodological constraints, a significant portion of the environmental damage assessment conducted by the GoB using the ECLAC method is actually attributed to the loss of a few residential buildings and water vessels, whereas the substantial loss of natural assets in this area remains hardly accounted for.

Biodiversity loss assessment from climate change impact

Even before SIDR hit the Sundarbans, this world heritage site was already facing a major threat to its survival. Bangladesh's geographic location, along with the presence of extreme poverty in the country, makes it extremely vulnerable to climate change. A recent climate change vulnerability index, developed by a private sector research organisation based in the UK in 2010, ranked Bangladesh as number one in the list of countries in "extreme risk"[9]. A report of the intergovernmental panel on climate change (IPCC), published in 2007, predicted that a one-metre rise in the sea level would inundate 17 per cent of Bangladesh's total land area (IPCC, 2007). Agarwala (2003) assessed the possible impact of climate change on the Sundarbans. It is reported that a 44 cm rise in the sea water level will significantly increase the salinity of the Sundarbans. A number of studies (for example, Karim, 1994; Siddiqi, 2001) have pointed out that maintaining the salinity level is critical for the Sundarbans, as the dominant species of mangrove swamps in the Sundarbans, the *Sundari* plant, can only survive in fresh water, and is likely to be completely eliminated. Also the rise in sea level would imply that plants producing quality timber would be replaced by inferior quality tree or shrub species (Agarwal, 2003). The general rise of sea level temperature would also increase the frequency of high intensity cyclonic storms which might have further devastating effects on the Sundarbans' biodiversity. It may be noted that the Agarwal *et al.*'s study was published in 2003, before the SIDR cyclone hit Bangladesh. Since then, another major cyclone, the AILA, has hit Bangladesh, indicating the increased frequency of such cyclones.

In 2008, the forestry department of the Bangladesh government published a report on the environmental cost of climate change. In the preface to the report, it is mentioned that lack of availability of data regarding environmental inventory had led to the use of judgement in assigning economic values to losses of environmental features to climate change. Using a method similar to the ECLAC approach, the report calculated the total economic value of climate change effects on the environment in Bangladesh (including that of the Sundarbans)[10]. However, it is mentioned that the total economic value does not include the intrinsic value of biodiversity loss, as it is "recognised that economics cannot fully account for all the values attributed to natural resources and environment" (GoB, 2008, p. 41). The report claims that available valuation techniques cannot place a monetary value on items such as biodiversity. Rather, it suggests the adoption of a cost and benefits approach for such items. However, the report does not clarify how such an analysis would be integrated with the economic analysis of the impact of the climate change. Therefore, the official report of the Bangladesh government fails to assign an economic value to impact of climate change on the biodiversity of Bangladesh including that of the Sundarbans.

Applying Jones' model to calculate biodiversity loss for the Sundarbans

In an effort to explore the feasibility of operationalising biodiversity accounting in the context of a less developed economy like Bangladesh, this section will now attempt to

prepare a natural inventory method for the Sundarbans, using the natural inventory model proposed by Jones (1996). Like many other emerging economies, availability of data regarding biodiversity of the Sundarbans is the major constraining factor. In 1985, Blower (1985) reviewed the wildlife conservation in the Sundarbans as part of the Sundarbans inventory project, jointly undertaken by the forest department of Bangladesh and the UK international development agency. This dated document, till now, is the only publicly available inventory record for the Sundarbans. However, researchers at different times have attempted to identify the species of flora and fauna available in the Sundarbans. For the purpose of the inventory report for the Sundarbans, data from these sources has been collated. Also, research staffs from the International Union for Conservation of Nature (IUCN), who are currently conducting a project aimed at producing a natural inventory for the Sundarbans, were consulted.

Table III presents a level 1 natural inventory statement for the Sundarbans. Compared to the report on Cosmeston Lake Country Park, as used by Jones (1996) as an illustration for natural inventory report, the level 1 inventory report for the Sundarbans, based on publicly available data, contains much less information as information is only available for the total land area for the Sundarbans and the areas protected by the Wildlife Act of 1974, and the basic composition of this area in terms of land and water.

Table IV presents a level 2 listing of critical natural assets in the Sundarbans. One of the problems with identifying Sundarbans' critical assets is the absence of any criteria for classification (for example, similar to the ones used in Jones (1996) and Jones (2003)). However, for the purpose of identifying critical assets for this study, the red list of threatened species, produced by the International Union for Conservation of Nature (IUCN, 2012) was used. The red list uses a seven point scale in order of criticality to categorise endangered species[11]. This list of critical natural assets presented in Table IV is produced by collating data available from the department of forest, Government of Bangladesh, and from newspaper reports as well as academic studies. At the moment, the list includes only critically endangered species. However, the list can be expanded to include critical assets falling in other categories as identified by the IUCN red list.

Table V presents a level 3 inventory of critical habitats by species. Due to non-availability of data, a complete list of inventory could not be produced. Nevertheless, the table indicates how critical some of the natural assets in the Sundarbans are. Also, lack of availability of data regarding total population of critical habitats prevented the production of a level 4 inventory for the Sundarbans.

Finally, Table VI presents a general inventory by species (level 5) of flora and fauna available in the Sundarbans. Using data collected from a variety of studies in this area,

	Total	Land	Water
Total area (hectare-acres)	595,000	419,727	175,273
Protected area	127,566	98,552	29,024
West wildlife sanctuary	65,297	50,442	14,855
East wildlife sanctuary	28,517	22,029	6,488
South wildlife sanctuary	33,762	26,081	7,681

Source: UNESCO (2007)

Table III.
Level 1 inventory: habitat statement for the Sundarbans, Bangladesh

English name	Scientific name	Critical species (number)	Critical species (IUCN classification)
Mammals		3	
Fishing cat	*Felis viverrina*		Endangered
Tiger	*Panthera tigris*		Endangered
Ganges river dolphin	*Platanista gangetica*		Endangered
Birds		10	
Baer's pochard	*Aythya baeri*		Critically endangered
Masked finfoot	*Heliopais personata*		Endangered
Spoon-billed sandpiper	*Calidris pygmeus*		Endangered
Nordmann's greenshank	*Tringa guttifer*		Endangered
Indian skimmer	*Rynchops albicollis*		Vulnerable
Greater spotted eagle	*Aquila clanga*		Vulnerable
Lesser spotted eagle	*Aquila hastata*		Vulnerable
Pallas's fish eagle	*Haliaeetus leucoryphus*		Vulnerable
Greater adjutant	*Leptoptilos dubius*		Endangered
Lesser adjutant	*Leptoptilos javanicus*		Vulnerable
Reptiles		11	
Spotted pond turtle	*Geoclemys hamiltonii*		Vulnerable
Crowned river turtle	*Hardella thurjii*		Vulnerable
Three-striped roof turtle	*Kachuga dhongoca*		Endangered
Yellow turtle	*Morenia petersi*		Vulnerable
Loggerhead sea turtle	*Caretta caretta*		Endangered
Green turtle	*Chelonia mydas*		Endangered
Olive Ridley turtle	*Lepidochelys olivacea*		Vulnerable
Ganges softshell turtle	*Aspideretes gangeticus*		Vulnerable
Softshell turtle	*Aspideretes hurum*		Vulnerable
Narrow-headed softshell turtle	*Chitra indica*		Endangered
Cantor's softshell turtle	*Pelochelys cantorii*		Endangered

Sources: Hussain and Acharya (1994), Khan (1986), Khan (1986), Sahgal *et al.* (2007), IUCN (2012)

Table IV.
Level 2 natural inventory: critical species statement for the Sundarbans, Bangladesh

	Sundarbans	Globally	Source
Mangroves			Spalding *et al.* (2010)
Avicennia	3	8	
Lumnitzera	1	2	
Nypa	1	1	
Bruguiera	3	6	
Ceriops	2	3	
Kandelia	1	2	
Rhizophora	2	6	
Sonneratia	3	7	
Total	16	35	
Mammals			
Fishing cat			
Tiger	350	2,154	IUCN (2012), WWF (2007)
Ganges river dolphin	240-300	240-300	IUCN (2009)

Table V.
Level 3 inventory of critical habitat's flora and fauna by species

	No of species	Critical species	Source
Flora	262		
Mangrove swamps	28 species, 50% area	Yes	Spalding *et al.*, 2010
Major components	16 (35 globally)		
Minor components	12 (29 globally)		
Cyanobacteria	5		Pasha (2004), Shayesta *et al.* (1999), Rahman (2001)
Fungi	43		
Algae	26		
Lichens	16		
Bryophyta	1		
Pteridophyta	21		
Angiosperms	122		
Fauna			Hussain and Acharya (1994), Khan (1986), Khan (1986), Sahgal *et al.* (2007)
Mammals	49	14	
Birds	355	84	
Reptiles	87	33	
Amphibians	14	2	
Ichtyo fauna	237	80	Rahman (2001), Bernacsek (2001), IUCN (2000), Chantarasri (1994)
Crustacean fauna	38	38	Bernacsek (2001), IUCN (2000)
Molluscan fauna	34	34	Bernacsek (2001), IUCN (2000)
Insects	240		

Table VI.
Level 5 general inventory for the Sundarbans, Bangladesh

the table identifies the critical or endangered species of flora and fauna that are currently found in the Sundarbans. This includes a summary of near threatened, vulnerable, endangered and critically endangered species. A full list of critical species of flora and fauna in the Sundarbans is available to the author. The list can be developed further on the basis of discussion with relevant researchers in this area. Also, the completion of the ongoing IUCN project may facilitate the production of a level 6 inventory statement for the Sundarbans, containing a general inventory of flora and fauna by total population. Jones (1996) also mentioned the difficulty of preparing a level 6 inventory statement due to unavailability of data even in the context of developed economies

Assigning an economic value to such an inventory would be difficult. As discussed in section 4, at the moment, the government of Bangladesh uses the UN-ECLAC method to assign economic values to natural assets. As information regarding market values (replacement cost of environmental assets) are not readily available, indirect estimates such as "surrogate market prices" (estimation of the price of related economic goods), or restoration costs are used. However, the restoration cost method does not distinguish between critical and non-critical natural assets resulting in less effective environmental stewardship. Also, an amenity value such as the one used by Jones (1996) is not available in Bangladesh. Considering the importance of acknowledging the critical assets in the inventory, the natural assets of the Sundarbans can be graded in a scale of 1 to 7 using the IUCN red list of critical assets. This is similar to the ecological grading used by Jones (1996) and can be used to assign appropriate economic values to natural assets.

As mentioned before, this inventory report of the Sundarbans is not accurate and foolproof, as this is based on secondary data. Also, scarcity of data does not allow production of inventory statements for all levels (as in Jones (2003)). However, after completion of the ongoing IUCN project, a more accurate picture of the inventory of the Sundarbans may surface. Also, in July 2012, the Government of Bangladesh introduced a Wildlife (Conservation) Act (GoB, 2012) that contains a list of critical and endangered species. This can assist in assigning a more accurate economic value to the natural assets. Also, although this report was prepared in consultation with environmental experts working in the forest department of the government of Bangladesh, the lack of expertise of the author in this field was an obstacle for the identification of critical resources. Earlier, Jones (1996) also pointed out that operationalising biodiversity accounting will be a multidisciplinary project where the accountant will be working as a part of a team of experts from different fields. Nevertheless, similar to Jones (1996, 2003), this inventory report, albeit inaccurate, can be used as an illustration for the feasibility of mainstreaming biodiversity accounting in the context of Bangladesh.

Once a natural inventory statement is produced, this can then be used by the Bangladesh government for reporting purposes. It may be noted that unlike many developed countries, the government of Bangladesh does not produce separate statements of assets and liabilities held by each entity owned by the government. Rather, an integrated national account is produced at the end of each fiscal year, combining assets and liabilities owned by the government (BBS, 2010). It may, therefore, not be feasible at this stage to integrate biodiversity accounting for reporting purposes. However, such a valuation of natural inventory can perhaps be added as supplementary information in the national accounts. Also, the Comptroller and Auditor General's office, the supreme audit institution of the country, needs to be aware of ways of auditing such national inventory statements.

The biodiversity of Bangladesh is significantly threatened by frequent natural disasters and effects of climate change. In addition, internal factors such as presence of extreme poverty, high density of population, and rampant corruption and lack of accountability in the public sector lead to significant degradation of natural assets in Bangladesh, and the government is sometimes accused for its failure to ensure transparency in the way the natural assets of the country are managed (TI, 2011). Also, failure to report the costs of biodiversity loss violates accounting principles, as noted in a recent observation relating to the absence of biodiversity accounting in emerging economies:

> Trading in virtual water, especially from semi-arid parts of the world, and loss of mangrove forest in Sundarbans due to the growing demand for tiger prawn from Japan and America, are some other well-known examples. While the foreign exchange earned in the national economies of India or Bangladesh reflect is reflected in their net income from abroad, the costs of biodiversity loss or coastal water pollution are not recorded – thus violating the accounting principles of double-entry book keeping (EEA, 2010).

From a stewardship perspective, developing countries, such as Bangladesh, can gain significantly by operationalising biodiversity accounting through the preparation of a natural inventory statement. Wildlife sanctuaries such as the Sundarbans are protected by law, and the government has the legal responsibility for stewardship of natural assets within this area. Preparing a statement of natural inventories will assist the government perform its environmental stewardship responsibilities by facilitating periodic

assessment of environmental degradation caused by natural disasters, or man-made reasons. This will also ensure more transparency and accountability in the way natural assets are managed, allaying some concerns regarding environmental stewardship and corruption. Producing a natural inventory would facilitate faster assessment of the impact of natural disasters like SIDR. As mentioned before, the government of Bangladesh is heavily dependent on foreign governments (such as Japan, the UK, and the USA) and development agencies (such as the World Bank, the ADB) for financial assistance after any natural disasters[12]. Naturally, these finances are based on the extent of damage caused by the disasters, and are hampered by absence of a pre-disaster inventory of natural assets. An inventory of natural assets using the Jones' model can provide the much needed information regarding the pre-disaster inventory of natural resources in an area. This can then be used as an input for the ECLAC method for quicker assessment of the actual damage caused by a natural calamity. Furthermore, due to methodological constraints in the ECLAC method, damage assessments conducted by the government and other institutional donors (as demonstrated by discussions on the impact of SIDR on the Sundarbans) does not incorporate biodiversity losses, and these are reported in a narrative manner that is not very useful for the users. Due to such violation of the full costing principle, the ECLAC method is not very useful from an environmental stewardship point-of-view, as it leads to minimal valuation of natural assets. Since the Jones' model distinguishes between critical and non-critical assets, and assigns an economic value accordingly, it might be more useful in assessing actual biodiversity loss caused by a natural disaster. Thus, the Jones' model can actually supplement the ECLAC method by providing a more accurate picture of biodiversity loss and subsequently, aid in better environmental stewardship.

5. Concluding remarks

The paper demonstrates that given the right attention, biodiversity accounting can be a useful tool for preparation of a natural inventory for regions in Bangladesh that are potentially vulnerable to natural disasters, sea level rises, or other man-made effects such as barrages constructed by neighbouring countries. Reporting such a natural inventory would enable the Bangladesh government respond to some criticisms regarding environmental stewardship. Also, production of a pre-disaster inventory of natural assets can form an objective basis for responding to stakeholders' demand for increased clarity in the assessments of the impacts from natural disasters and climate changes, and has the potentials of improving the negotiating capacity of the Bangladesh government in environmental issues. These are important implications for Bangladesh, which is in imminent danger of suffering significant biodiversity losses from global climate change as well as internal factors.

As mentioned before, the calculation of inventory of natural assets used in this paper is, by no means, accurate and complete. Among other things, the calculation is severely constrained by the unavailability of updated information. The author's lack of expertise in the area of biodiversity also acted as a significant constraint. However, these constraints can be overcome given the right level of attention from the government. Also, as suggested by Jones (1996), in a real life situation, accountants can be involved as a part of the multidisciplinary team which would have the necessary expertise regarding the environmental aspects of biodiversity accounting. It is acknowledged that current methods of biodiversity accounting are not completely objective. It still requires

judgement in the assignment of economic values to natural assets. Nevertheless, the case of the Sundarbans illustrates the potentials for the application of biodiversity accounting in an emerging economy like Bangladesh, and the possible implications it might have in terms of responding to stakeholders' needs. It is acknowledged that due to the current state of reporting practices in the public sector in Bangladesh, it may be difficult to incorporate biodiversity accounting in the main body of the financial reports produced by the government. However, as mentioned in the study, in recent years, the Bangladesh government has shown higher commitment towards protecting the biodiversity of the country, and there have been calls for the production of an inventory of natural assets. Given the policy-level of commitment and the media attention it seems to be attracting in recent times, it should therefore be possible to include an inventory of natural assets as a supplementary statement to the national accounts. If more countries start mainstreaming biodiversity accounting, it may form a legitimate basis for international issues such as disaster loss assessments and bilateral negotiations, and ensure greater environmental stewardship and management.

Notes

1. For example, Guilding and Kirman (1998) investigated the application of environmental accounting in the contracting industry in New Zealand; Russell and Thomson (2009) studied attempts to operationalise environmental accounting in Scotland.
2. United Nations World Prospects Report, 2005.
3. Between 1990 and 2010, Bangladesh lost 3.5 per cent of its forest cover, or around 52,000 hectre-acres (FAO, 2011).
4. Recent reports suggest that the sea levels were rising at least 60 per cent faster than that originally anticipated by the IPCC (*The Daily Star*, November 28, 2012).
5. www.reuters.com/article/2010/02/15/us-climate-bangladesh-idUSTRE61E23G20100215
6. www.theindependentbd.com/paper-edition/backpage/132-backpage/84213-bangladesh-can-raise-tipai-issue-at-un-assembly.html
7. Mangroves are various kinds of trees up to medium height and shrubs that grow in saline coastal sediment habitats in the tropics and subtropics – mainly between latitudes 25° N and 25° S.
8. Calculation is based on 500 trees severely affected at a unit replacement cost of BDT 400 and 200 trees partially affected at a unit replacement cost of BDT 250 (BDT is the official currency of Bangladesh). Since market values and pre-SIDR inventory of natural assests do not exist, these values are difficult to confirm.
9. http://maplecroft.com/about/news/ccvi.html
10. Similar to the ECLAC method, total economic value of climate change was calculated as a summation of use value, non-use value, direct use value, and indirect use value (GoB, 2008, p. 40).
11. In order of criticality, the categories are: least concern, near threatened, vulnerable, endangered, critically endangered, extinct in the wild, and endangered. Further details regarding the mode of classification is available at the IUCN website at: www.iucnredlist.org/
12. Immediately after the SIDR, US $ 241 million was pledged by the international community. Major donors included the United Nations, the USA, the UK, Japan, the EC, and Saudi Arabia (GoB, 2008).

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