WORKING PAPER 121

Environmental and Social Values of River Water: Examples from the Menik Ganga, Sri Lanka

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International Water Management Institute

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IWMI receives its principal funding from 58 governments, private foundations, and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). Support is also given by the Governments of Ghana, Pakistan, South Africa, Sri Lanka and Thailand.

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Acknowledgements: This study is part of the research project 'Environmental Flows: Theory and practice', which is supported by the core funds of IWMI. We thank Mr. M. G. Gunathilake, District Engineer, National Water Supply and Drainage Board, Kataragama, Sri Lanka; Mr. Wasantha Ratnayake, Director, and Mr. Edmund Wilson, Deputy Director, Elephant Conservation, Department of Wildlife Conservation, Colombo, Sri Lanka; Mr. B. V. R. Jayaratne, Divisional Assistant Director, Department of Wildlife Conservation (DWLC), Kataragama, Sri Lanka; Mr. Buddhika Vithana and Mr. Weragala, Department of Wildlife Conservation, Yala National Park, Sri Lanka; Ms. P. P. Dias, Head, Division of Hydrology, Department of Irrigation, Colombo, Sri Lanka; Dr. Champa Amarasiri, Head, Marine Biological Resources Division, National Aquatic Resources Research and Development Agency (NARA), Colombo, Sri Lanka; Mr. Anil Premaratne, Deputy Director-Planning, Coast Conservation Department, Colombo, Sri Lanka; Staff, Fisheries Statistics Division, Ministry of Fisheries and Aquatic Resources MFAR, Colombo, Sri Lanka, for the provision of useful information and insights during the course of this study. Mr. Ranjith Alankara, IWMI, Colombo, Sri Lanka, has constructed the map shown in Figure 1. We are grateful to Dr. Max Finlayson, Dr. Mark Giordano, both at IWMI, Colombo, Sri Lanka, and Dr. Anik Bhaduri, IWMI, Hyderabad, India, for their valuable comments on various drafts of this paper.

Dissanayake, P.; Smakhtin, V. 2007. *Environmental and social values of river water: Examples from the Menik Ganga, Sri Lanka*. Colombo, Sri Lanka: International Water Management Institute 15p. (IWMI Working Paper 121)

/ ecosystems / wetlands / rivers / wildlife / fisheries / water allocation / Sri Lanka /

ISBN 978-92-9090-674-2

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Abstract

Many decisions on water allocation in river basins are made on economic grounds. Environmental and social benefits of water should also be considered in river basin management, and attempts should be made to value them similarly. This is not a straightforward task and very few studies have directly addressed this issue to date. In this paper, the Menik Ganga (River) in southern Sri Lanka is used as a case study to attempt and evaluate the costs and benefits of environmental water allocations, referred to as 'environmental flows' (EF). In this study, a broad definition of EF is used: the components of EF evaluated include the requirements of the religious festival, the requirements of the Yala National Park, the requirements of the Pilinnawa Coastal Wetland and the requirements of the Yala Fishery Management Area, off the coast. Almost all estimates are based on use values of EF such as marketed goods and recreation. For some components multiple estimates have been attempted. The religious EF requirement is estimated using the cost of alternative water supplies. The benefits of the EF requirement for the Yala National Park are estimated using the forgone value of tourism in the dry season and the benefits of avoiding the Human-Elephant Conflict. The Additional expenditure for the park in the dry season is also presented as another proxy estimate of the benefits of EF. The Benefit Transfer method was used for the Pilinnawa Wetland and grassland due to data constraints. The market prices of lobster and income of chank divers are used as proxies for the economic benefits of EF to the Yala Fishery Management Area. Finally, the cumulative value of the individual components is presented and discussed. The paper intends to stimulate discussion and further research on the complex subject of valuing the social and environmental benefits of water – whether it is in the Menik Ganga, elsewhere in Sri Lanka or elsewhere in the world.

INTRODUCTION

'Environmental Flows' (EF) is a term which is normally used to refer to scientifically determined, ecologically acceptable flow regime in a regulated or otherwise modified river system (Knights 2002; Dyson et al. 2003). Many authors now suggest that social aspects, such as human well-being, should also feature in EF (e.g., Korsgaard 2006; Meijer 2007). All components of the hydrological regime have certain ecological/social significance and have to be mimicked in a modified flow regime, i.e., EF. High flows of different frequency are important for channel maintenance, bird breeding, algae control, wetland flooding and maintenance of riparian vegetation. Moderate flows may be critical for cycling of organic matter from river banks and for fish migration, while low flows of different magnitudes are necessary for fish spawning, water quality maintenance, the use of the river by local people, etc.

Protection of river ecosystems through assessment and provision of EF has moved high up on the world water agenda. Many methods for defining EF have been developed over the last two decades (e.g., Acreman and Durban 2004). Most of them originated from Europe, the United States, South Africa, and Australia. Practical application of EF assessment and actual provision of EF is still, however, progressing slowly due to the lack of data and understanding of hydrology-ecology linkages. Only limited exposure to EF assessment and management exists in developing countries (Tharme and Smakhtin 2003). Some obstacles here include the lack of relevant expertise and legislative support and the reluctance on the part of water resource developers to move away from past practices. Another important issue is that EF assessment methodologies effectively 'stop' once the EF regime for a river has been quantified. The next logical step would be to attempt and value the *costs and benefits* that EF can provide - in economic terms.

At present, there are no accepted methods for assessing the costs and benefits of EF and there are very few studies that have directly and explicitly dealt with the valuation of EF. Some studies valued the benefits of flow improvements, primarily with focus on recreational uses (Loomis 2000; Buchli et al. 2002). A river ecosystem, however, provides many other services and the economic value of EF is higher than the monetary value based on recreation alone.

The valuation of EF is much less straightforward compared, for example, with quantification of economic benefits of domestic, agricultural and industrial water uses, where the values can be expressed in market terms. Another difficulty is that similar to EF assessment methodologies *per se* most of the work on valuing environmental resources has been conducted in developed countries such as Australia, where the tradeoffs between irrigated agriculture and freshwater-dependent ecosystems are high on the political agenda (Schofield et al. 2003; Branson et al. 2005), but still not necessarily well understood or accepted by local communities. The use of non-market valuation methods in developing countries can also be practical (Petersen 2003), but factors considered for such valuations and the overall context of assessment may be different. This paper attempts to examine the issues involved in the valuation of EF in the specific context of Sri Lanka. The Menik Ganga (River), located in the southernmost semi-arid region of the country, where significant water resource developments are planned, is used as a case study area.

THE STUDY AREA

The Menik Ganga Basin, with a total area of 1,272 square kilometers (km^2), is located in the southern, semi-arid part of Sri Lanka (CECB 2004; Figure 1). The mean annual precipitation in the basin is 1,496 millimeters (mm) and the estimated natural annual flow is 347 million cubic meters (MCM) (CECB 2002; CECB 2004). The basin receives most of its annual rainfall during the northeast monsoon period from November to January and the dry season lasts from June to September (Figure 2).

More than half of the catchment area is covered by forests, which extends into one of the main attractions of the area – the Yala National Park (Ruhuna and Yala East) (Figure 1). The Ruhuna (Yala) (referred to hereafter as Yala) Park covers 1,512 km^2 (McMahon 2005), of which about 594 km^2 is within the Menik Ganga Basin. The area is rich in biodiversity and has the largest concentration of wild leopards in the world (McMahon 2005). The park supports a significant population of elephants. The Yala coastal region has two Marine Protected Areas (MPAs) (http://www.mpaglobal.com): Ruhuna and Yala East. A Fishery Management Area (Figure 1) of 450 km^2 is located within the Ruhuna MPA (NARA 2002).

Flow regulation in the basin is limited at present, even though a number of small dams ('tanks') have been constructed over the years. Rice farmers and sugarcane producers are the main water users. Several settlements use the river for domestic water supply. Due to the upstream water use, at present, the river can get dry naturally more often than as may be expected even in a semi-arid region like southern Sri Lanka (Figure 2; Smakhtin and Weragala 2005).

The Menik Ganga Diversion project, recently commissioned by the Government of Sri Lanka, intends to become the largest water diversion structure in the basin (USAID 2005). As part of this project, a reservoir will be constructed on Menik Ganga at Weheragala, 18 kilometers (km) upstream of Kataragama (Figure 1). The reservoir with a capacity of 75 MCM will command the [mean annual] flow of 135 MCM from the upstream catchment of 570 km^2. Water from the future reservoir will be transferred to the adjacent basins primarily to augment irrigation. The Environmental Impact Assessment (EIA) of the Menik Ganga diversion project concludes that there will be no adverse environmental impacts because only "excess wet season water" will be diverted, while the dry season flows will be regulated from storage to satisfy the downstream users in the basin (CECB 2004; USAID 2005). The total annual water requirement to meet various downstream demands, including water supply to Kataragama and coastal wetland flooding has been estimated as 63.0 MCM (CECB 2004). No scientific assessment of EF requirements in the basin has been carried out. Therefore, the basis for the above assumptions and estimates from the EIA remain rather uncertain. In the view of these developments, the Menik Ganga Basin represents an opportunity to examine the interactions among different water users and evaluate the costs and benefits of EF in more detail.

EVALUATING THE COMPONENTS OF ENVIRONMENTAL FLOWS IN THE MENIK GANGA BASIN

As mentioned in the *Introduction*, flows of different magnitudes have different ecological/social significance. All these flows form components of an ecologically, and socially, acceptable flow regime (EF) and they all have to be scientifically evaluated through a process known as Environmental Flow Assessment (EFA). When major water resource developments are proposed, the EFA has to be detailed and involve a number of specialists concerned with various aspects of river and wetland ecology. No EFA has so far been conducted in the Menik Ganga and, therefore, the full range of

Figure 1. A Schematic Map of the Menik Ganga.

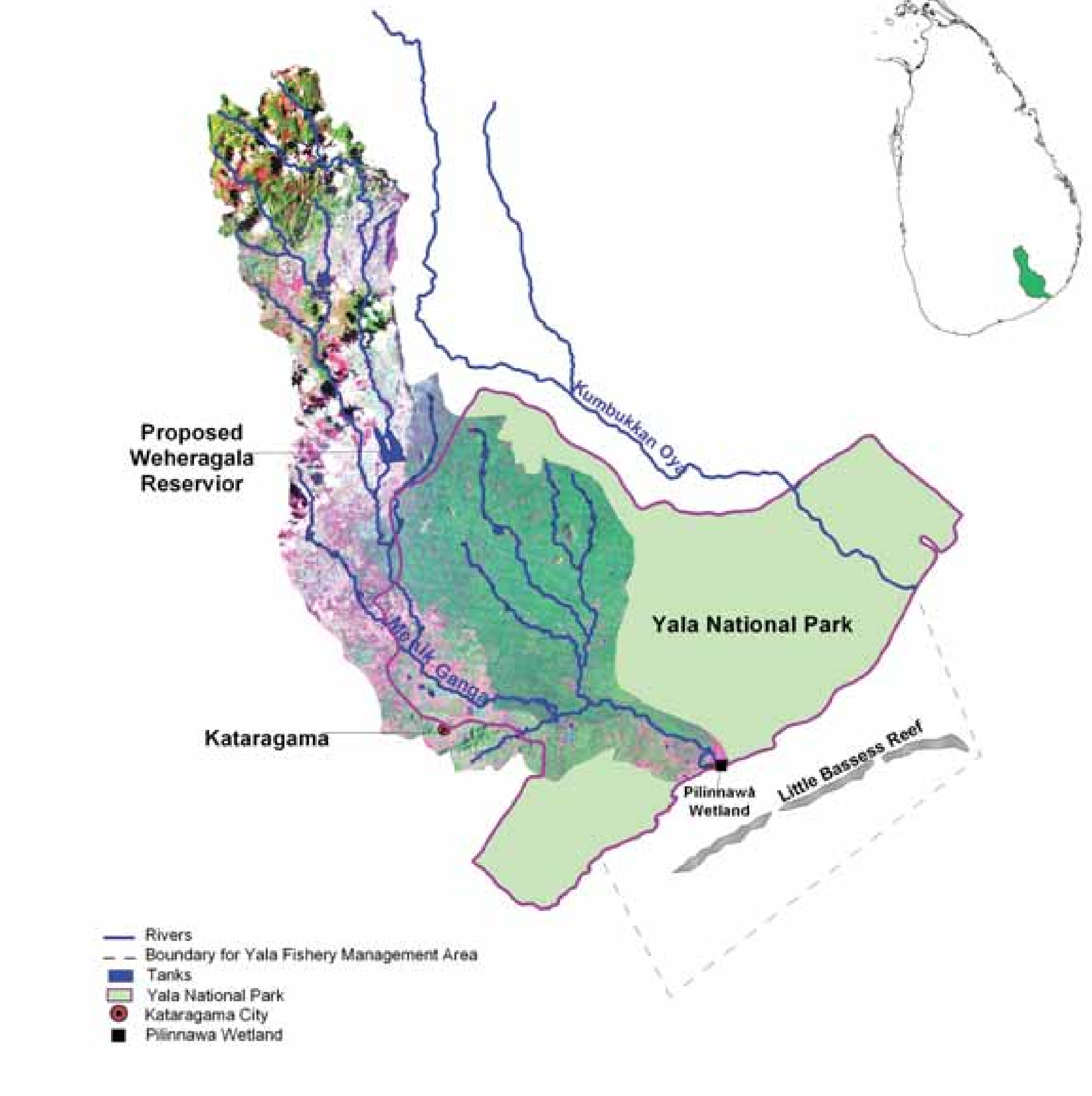
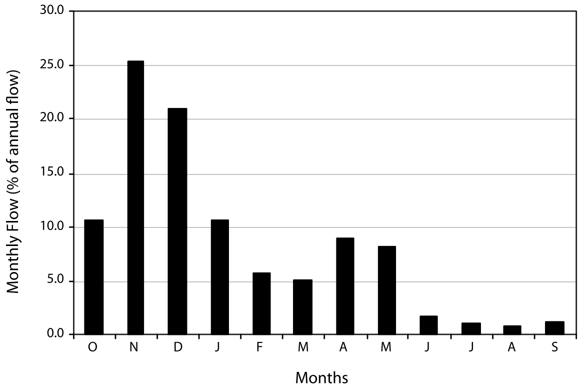
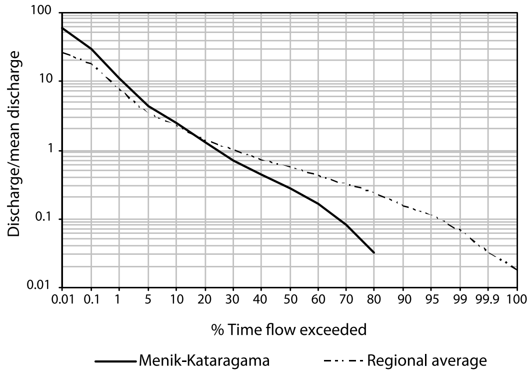


Figure 2. Long-term mean monthly flow distribution (left) and standardized flow duration curves in the Menik Ganga versus regional average curve (right). The graphs are constructed using the observed daily flow time series at Kataragama station for the available observation period of 1977-1998.





components of EF is not possible to ascertain. Therefore, for the purpose of this study, only several components have been used. Some of these components of EF are mentioned in the EIA. However, in this study, we use a broader than usual content for EF, which includes, apart from the requirements of aquatic ecology, the requirements for some traditional water uses as well as the needs of terrestrial ecosystems. The main components of EF in the Menik Ganga Basin, which are evaluated in economic terms in this section, include:

- the in-stream water requirement for the Kataragama religious festival;
- the requirement of the Yala National Park (primarily for the support of the large elephant population and other wildlife);
- the requirement for the Pilinnawa Coastal Wetland (Figure 1); and
- the requirement of the Yala Fishery Management Area (YFMA), including the needs of the Menik estuary.

Requirements for the Religious Festival at Kataragama

Kataragama is a sacred city for Sri Lanka's Buddhist and Hindu followers, in reverence to a god that believers of both religions worship. Each year, the Kataragama Festival attracts about 100,000 people per day over a 15-day period during July and August. The main event of the festival is the water cutting ceremony held in gratitude to God Kataragama. The water cutting ceremony ideally requires about 1.2 to 1.5 meters (m) of water in the river (USAID 2005). The minimum water depth required for the festival around Kataragama temple has been estimated as 0.6 m with the corresponding discharge at Kataragama gauging station of 2.0 cubic meters per second (m^3/s) (CECB 2004). However, over the last decade, the river did not carry this much flow at Kataragama during the months of the festival. Analysis of available flow records for a period of 1977-1998 shows that the long-term mean flow in a river during August, for example, is less than 0.6 m^3/s. Another cultural practice at the festival is the offering of pure water to gods and bathing in 'holy' water of the Menik Ganga prior to visiting God Kataragama to worship. Due to increasing levels of water pollution arising from low flows, festival officials have deemed the river water unsuitable for bathing. The 12 tube wells in the shrine premises alone cannot satisfy this requirement.

The satisfaction of the "bathing requirement" is the absolute minimum during the festival. This also caters to the avoidance of water-borne diseases in the Kataragama area where large crowds gather during the festival season (CECB 2002). This requirement is currently satisfied by bowser water supply. During the 15-day festival, around 25 bowsers in total are used by the National Water Supply and Drainage Board (NWSDB), several NGOs, and the police to supply water to the migrant populations (M. G. Gunathilake, pers. comm. 2006). The approximate cost per bowser is the estimate provided by the NWSDB (US$33). The total expenditure to supply water by bowsers is, therefore, US$12,375. Thus, the provision of the equivalent minimum amount of clean water in the river could have satisfied the religious requirement and therefore the expenditure above can be used as a proxy for EF in this case. However, alternative bowser supplies are unlikely to provide the same satisfaction as that received from using the river. It may also be suggested that alternative water supply options for the Festival are possible, e.g., the rehabilitation of nearby tanks. Therefore, the estimate above underestimates the true value of this component of EF.

Requirements of the Yala National Park

The Yala National Park requires water during a dry season to sustain its aquatic and terrestrial flora and fauna. However, according to the Department of Wildlife Conservation (DWLC), the stretches of the Menik Ganga that pass through the Yala National Park are completely dry throughout the months of July, August, and September (USAID 2005). This is reflected in the shape of the standardized flow duration curve at Kataragama, which shows that, on average, the Menik Ganga is dry for about 20 percent of the time throughout the year (Figure 2). The DWLC has to spend money to supplement for water shortages in the park, for animals and tourist bungalows, and must truck water into the park during these three months. The activities include bowser supplies and excavating the riverbed during severe drought periods (B. Vithana, pers. comm. 2006). The DWLC spends US$863 a month for maintenance of the Park. During a dry season, an additional allowance of US$490 a month is given to cope with the water shortages (B. V. R. Jayaratne, pers. comm. 2006). Maintaining EF in the Menik Ganga could avoid or reduce these costs and eliminate water shortages completely. Therefore, the additional allowance provided during the three dry months - US$1,470 in total - can be taken as a proxy for the benefits of EF to the Yala Park. However, the actual benefits to the park are much greater than this proxy value.

The main attraction of the Yala Park is the elephant herds. Therefore, the requirements of water and fodder for elephants have to be assessed. Being heavy consumers of water, elephants crowd the areas nearest to rivers and other remaining water bodies during the dry season. The DWLC suggests a total of 250 elephants for the entire Yala Park (E. Wilson, pers. comm. 2006), of which a maximum of 200 are living in the Menik Ganga portion of the Yala Park (i.e., 594 km^2). An elephant requires 200 - 255 liters of water per day for drinking and should spend 3-4 hours each day in the water for skin and general hygiene (http://www.elephantcare.org). Considering the maximum daily requirement of 0.255 cubic meters (m^3) for 200 elephants, we arrive at the estimate of 51 m^3/day, which is relatively minor. However, the actual flow of water in a river has to be higher for an elephant to access it. It is further assumed here that all this water has to be supplied solely by the Menik Ganga due to the lack of other significant water bodies, which elephants could also use as pools. Therefore, the water requirements of elephants are treated as part of the EF in the Menik Ganga.

The quantum of food required by an elephant daily ranges from 150 to 200 kilograms (kg) (an average of 175 kg) (http://www.elephantcare.org; http://www.nationalgeographic.com). For 200 elephants this translates into an average fodder requirement of 35,000 kg. The host area for 200 elephants is 594 km^2 and the vegetation is scrub jungle and grasslands. In the dry season only parched vegetation is available for elephants and is very much below the carrying capacity (B. V. R. Jayaratne, pers. comm. 2006). To ensure the long-term survival of this elephant population, it is important to maintain the vegetation in the park, during the rainless part of the year, by ensuring some flow in the river and thus some healthy riparian vegetation around it. The water flow together with other factors such as evapotranspiration and infiltration determine the stock of biomass (fodder).

During the dry season, the elephants in Yala migrate to other areas in search of fodder and water. Continued water scarcity in the Park may force elephants to travel long distances to the north (USAID 2005). Elephants destroy crops, home gardens (including fruit trees), houses and basic infrastructure of local residents. Thus, an indirect effect of the lack of water and/or fodder in the Park is the destruction of property by elephants. Both human and elephant lives are also occasionally lost due to this migration (http://www.dwlc.lk). Bandara and Tisdell (2004) have found that in the southern region, the elephants are responsible for about US$117 worth of crop damage for a cropping season, on average, per farming family. Assuming that only one cropping season is affected due to the lack of water, the economic value of EF could be quantified if the number of families affected by the Yala elephant migration is established. Also, the DWLC pays compensation in the case of a loss of a life (approximately US$1,000) and damage to property (houses) up to a maximum of US$500 (B. V. R. Jayaratne, pers. comm. 2006). However, data on the exact number of families affected by elephant migration and whether they are affected by the Yala elephants are not available.. These losses, therefore, cannot be quantified at present without introducing great uncertainty.

The DWLC is responsible for elephant conservation and mitigation of Human-Elephant Conflict (HEC) in Sri Lanka. At present, the DWLC spends an average of around 6 percent (US$1.6 million) of its annual budgetary allocation (http://www.dwlc.lk) to undertake on-site elephant management activities. The value of HEC mitigation measures for the Yala area should also be considered apart from the damage to crops and property. In Yala, approximately US$294 to US$392 a month is spent for mitigation measures over five months from June to October (E. Wilson, pers. comm. 2006). Therefore, it comes to a maximum of US$1,960 in the dry season. The value of crop damage, compensation paid for damages and the value of the HEC mitigation measures in Yala in the dry season could be used as proxy values for benefits derived by keeping the elephants in the park with the maintaining of EF in the river. Considering the attention given to elephant protection in Sri Lanka and the world, the expenditure for HEC mitigation used here is likely to be an underestimate of the benefits of EF.

The reputation of Yala for providing good elephant observation sites, as well as the annual festival, ensures that Yala is the most visited national park in Sri Lanka (Buultjens et al. 2005). In 2000, for example, there were 153,661 tourists, of which 81 percent were Sri Lankan. The corresponding income from visitors in 2000 was US$468,629 (Buultjens et al. 2005).

An approximate value of benefits from environmental water allocation could be derived from the fact that the Yala Park is closed from September to mid-October due to a lack of water. It is assumed that willingness to pay to visit the Park depends on the condition that water is available and hence the park is open. The loss in revenue from tourism during 1.5 months could be taken as a proxy for the value of benefits of maintaining EF in the Menik Ganga during the rainless season. Considering that the average monthly *revenue* from tourism in the Park is approximately US$44,632 (i.e., annual revenue of US$468,629 divided by 10.5 months), the benefits of environmental water allocation during the 1.5 months will be approximately US$66,948. However, the cost of entry to the park is only part of all costs associated with traveling to the Park, and it therefore underestimates the costs actually incurred. The user charges or fees are very small and does not reflect the value of an environmental asset. Therefore, it would be more appropriate to use the Travel Cost Method[1] (TCM) to derive the value of the benefits of EF to the Yala National Park.

As cited and quoted in CECB (2004), Steel (1996) has estimated the recreational value of Yala Park as Sri Lanka Rupees Rs. 250/ha/year. The CECB has inflated this by 160 percent to bring it in line with the 2004 October prices, which resulted in Rs. 400/ha/year. Subsequently, we inflated this by 111 percent to obtain the current (April 2006) price of Rs. 443.50 (i.e., US$4.35). Therefore, the recreational value of entire Yala may be calculated by multiplying US$4.35 by 151,200 ha, which results in US$657,720 per year. Therefore, the forgone recreational value in 1.5 months is US$82,215.

[1]TCM is an indirect valuation method where the travel costs of visitors to the recreational area are used as a proxy for the price of the recreational activity, together with participation and visitor rates and visitor attributes to estimate the recreational value of the site.

This estimate is greater than the one above based only on the cost of entry and the largest of the multiple estimates of benefits of EF to Yala National Park. It is, therefore, used to compute the total benefits of EF in the Menik River. The other two estimates based on additional expenditure in the dry season and the expenditure for HEC mitigation by the DWLC are also added to the above, even though they are relatively small compared to the value based on recreation. The total benefits of EF to the Yala National Park are, however, likely to be much greater than the sum of these three components as some non-use values of Yala Park have not been considered here.

Requirements of the Pilinnawa Wetland

The Pilinnawa Wetland is located on the left bank of Menik Ganga about 2 km before the river enters the sea (Figure 1). It is considered as an important site for waterfowl and a variety of other fauna including elephants (CECB 2004). The area of the wetland, which includes open water and marsh (areas which retain water throughout the year), is 1.0 km^2 (CECB 2004) and the Geographic Information System (GIS) estimate of the open scrub (grassland) area, which gets inundated occasionally during floods, is 5.8 km^2.

The EF required for wetland flooding has been estimated by the CECB (2004). The storage capacity of the wetland has been estimated as being 0.3 MCM. The wetland is not flooded if the flow of the Menik Ganga, at Pilinnawa, is less than 100 m^3/s. To replenish the wetland area, an excess flow of, at least, 125 m^3/s is required. The CECB (2004), therefore, has suggested that a discharge of 250 m^3/s is required to ensure the stable inflow of water into the wetland. It is proposed that a release of 300 m^3/s for a duration of three hours - once in every two years - is made through the spillway of the future Weheragala Reservoir to ensure a minimum flow rate of 250 m^3/s for at least 45 minutes at Pilinnawa to flood the wetland. However, the flooding requirement of the grassland area had not been considered in this calculation. The above estimates come from EIA (CECB 2004) and have not been verified through any EFA. Therefore, these estimates will need to be revised in the future taking into account water requirements for breeding and feeding of birds and fish and for the maintenance of wetland vegetation. It is important to note that the overall EF requirement of the wetland may, therefore, appear to be significantly higher as more frequent wetland flooding will be necessary.

The Pilinnawa Wetland is much less studied at present (CECB 2004). Therefore, an application of the Benefit Transfer[2] (BT) method - from a well-studied Muthurajawela Wetland (Sri Lanka) – is attempted (Table 1). BT involves the application of unit value estimates, functions, data, and/or models from existing studies to estimate benefits associated with the resource under consideration. The transferred value can be a value reported in an individual study or the average from a set of studies that address the same similar categories of resources or services (Ruijgrok 2001; Troy and Wilson 2006). BT is a secondary valuation method and is likely to be a feasible approach for many applications, because the data, budget and time requirements for primary valuation are often limited (Ruijgrok 2001). The land cover as a proxy estimate is used in the valuation of ecosystem services and unit values per hectare per year are applied in this case (Sutton and Costanza 2002; Troy and Wilson 2006). However, all BT studies are subject to uncertainties, in addition to those that exist in the results of the original valuation studies (Brouwer 2000; Rosenberger and Stanley 2006).

The selected ‘study’ site, Muthurajawela, is a coastal wetland located between 10 and 30 km to the north of Colombo. It covers an area of 3,068 hectares (ha) and its total economic value was

[2]Benefit transfer is the “application of values and other information from a ‘study’ site where data are collected to a ‘policy’ site with little or no data.”

estimated at US$8,072,000 by IUCN (2003). The services assessed in the 'study' site and unit values per hectare per year are given in Table 1. Pilinnawa is also a coastal wetland and is assumed to be physiographically similar to Muthurajawela, including location (coastal) and dominant vegetation types. Both Pilinnawa and Muthurajawela are protected areas which are frequently visited by tourists. However, Muthurajawela is close to an urban center while Pilinnawa is 'rural'. Therefore, some of the services provided by Pilinnawa may be less significant and only the significant services are considered for the value transfer. It is assumed that the hypothetical markets are similar for these goods and services in the 'study' site and 'policy' site. Therefore, the BT was done for the open water and marshy area of Pilinnawa (1.0 km^2), only for the significant services using the land cover as a proxy estimate. With this, the total value of Pilinnawa comes to US$13,400 (Table 1) (a site-specific primary valuation in the future would give a more realistic estimate, which could be used as a proxy estimate of the benefits of EF). The unit values of wetland services of the Millennium Ecosystem Assessment (MEA) (MEA 2005) are also presented in Table 1. With the average value transfer from MEA, the total value of Pilinnawa comes to US$315,100, which is likely to be a gross over-estimation of the overall value of the wetland due to the use of global average unit values and it not being considered in the total value of benefits of EF.

The grassland area is known as "Pallassa" and is an important feeding ground for cattle in the area (CECB 2004). The CECB (2004) has mentioned that the grassland will be adversely affected by the proposed development at Weheragala. The wild buffaloes and other wildlife in Yala National Park also depend on this pastureland - for fodder. There are no value estimates to be found for grasslands in Sri Lanka and, therefore, the global average unit value for grasslands (Costanza et al 1997) is used (232 US$/ha/year) as a very crude approximation. Therefore, when land cover is used as a proxy measure, the total economic value of the grassland is around US$134,560 per year, which is probably an over-estimation due to the global average unit values used. A future site-specific ecosystem valuation based on the grazing benefits would give a more realistic value of the grassland, which could be used as a proxy estimate of the benefits of EF.

Requirements of the Yala Marine Protected Area and the Yala Fishery Management Area

The Yala National Park coastal area includes a complex of brackish lagoons, several estuaries and 64 kilometers of shore; mangroves and abundant wildlife (Scott 1989). The YFMA is traditionally known as a good fishing ground for dermersal, semi-demersal and pelagic species. Lobsters, rockfish, skates, sharks, chanks and bait fish are often harvested from this area. Extensive collection of ornamental fish also takes place (NARA 2002). Protected animals such as turtles, dolphins and whales are also frequently sighted (NARA 2002). The Little Basses [coral] Reef has been identified as a highly environmentally sensitive area (NARA 2002). The least disturbed nature of the reef system suggests that it may have a high biodiversity value (NARA 2002). The mere existence of such a reef carries a high intrinsic value. The corals and most species of molluscs are exploited for commercial purposes. All the crustaceans are commercially important as they fetch higher economic returns to the fishermen in the area.

Freshwater has an important influence in the estuarine and in close offshore marine environments (Robins et al. 2005). The influence of river flow can extend into coral reef systems over 70 km offshore (LWRRDC 1998). Studies in eastern Australia have shown strong correlation between the magnitude of annual and/or seasonal discharge from rivers and fishing catches in estuaries and coastal waters (Robins et al. 2005). Loneragan and Bunn (1999) have confirmed that high river discharge can have a strong positive effect on the production of commercial and recreational coastal fisheries. Aleem (1972) indicates that fish and prawn catches were greatly reduced in the Mediterranean costal areas two years

Table 1. Economic value of the Pilinnawa Wetland (Area 100 ha).

Wetland service	Muthurajawela (US$/ha/year)	BT value from Muthurajawela (US$/year)	Values from MEA (US$/ha/year)	BT value from MEA (US$/year)
Fishing	23	-	374	37,400
Water supply	14	1,400	45	4,500
Raw materials	-	-	45	4,500
Fuelwood	29	2,900	14	1,400
Aesthetic information	-	-	881	88,100
Recreation and tourism	19	1,900	492	49,200
Flood control	1,758	-	464	46,400
Water treatment	-	-	288	28,800
Industrial wastewater treatment	588	-	-	-
Domestic sewage treatment	16		-	-
Nursery function	-	-	201	20,100
Support to downstream fisheries	72	7,200	-	-
Climate regulation	-	-	133	13,300
Habitat for biodiversity	-	-	214	21,400
Agricultural production	110	-	-	-
Total (US$/year)		**13,400**		**315,100**

Note: BT = Benefit transfer
MEA = Millennium Ecosystem Assessment

after completion of the Aswan Dam on the Nile River in Egypt. Therefore, impact on coastal fish catches should be weighed against the economic benefits of water uses upstream.

Another effect during the dry season is the saltwater intrusion due to the tidal effects. In the Menik Ganga, the intrusion extends approximately 7 km upstream from the mouth of the river (E. Wilson pers. comm. 2006), which could contaminate the groundwater. Reduced river flows and altered flow patterns may lead to the increased formation of sandbars at the mouth of the river, leading to accumulation of pollutants and deterioration of the water quality. The benefits of freshwater inflow from the Menik Ganga to the MPA and the surrounding mouth of the river should therefore be taken into account when assessing costs and benefits of the EF.

There is no published information relating to the present exploitation of fishery resources in the YFMA and it comes under the Tangalle fishing district (MFAR 2005) in southern Sri Lanka. Tangalle is one of the main lobster producing areas and is one of the most profitable fisheries in the area. There are about 40-50 fishing families who depend solely on the YFMA. Small-scale fisheries are mainly targeting for lobsters, chanks and skates. Such fishing occurs mainly from October/November to April and only permit holders are engaged in lobster fishing. In 2000, 78 fishermen were engaged in fishing and 63 fishermen were allowed in 2001. The lobster catch rate in the area is 1.99 kg/fishing day according to the 1991 catch rates (NARA 2002). The export value for 1 kg of lobster is around US$14 and US$2.40 for 1 kg of chanks, in 2005 prices (MFAR 2005). Assuming the above catch rate, export value, and also that about 70 fishermen engage in lobster fishing for some 20 days a month during a period of six months, the total export value of lobster catch in the area is US$234,024. This is an underestimate, because there are fishermen who engage in lobster fishing without a license. On the other hand, the estimates of lobster catch and its unit export value may appear to be too high and in any case - uncertain.

About 80 divers have been engaged in chank fishery during the 2000/2001 fishing season and a diver catches 30-40 chanks per day (NARA 2002). The daily income of chank divers in India has been used to approximate the value of chank catch in the YFMA due to unavailability of data. The CMCS (2000) indicates that each chank diver can earn between US$0.6 and US$4.6 per day. Therefore, the maximum possible earnings of chank divers in the YFMA is about US$44,160, assuming that they dive 20 days a month over the six-month fishing period.

The export value of lobsters and the income of the chank divers could be summed up and taken as a proxy measure of the benefits of EF to the MPA. In this proxy, it is indirectly assumed that these values are attributed to the current condition of the coastal waters, which, in turn is directly related to the amount of freshwater inflow into the YFMA. No research currently exists on the quantification of the impacts of freshwater inflow reduction on costal fisheries. In the absence of such information, it is assumed here that the current fish catch in the YFMA could be maintained by the total amount of EF that reaches the mouths of the main rivers flowing into the YFMA. Further research is necessary to quantify the relationships between freshwater inflow to the YFMA and fish catches. Another issue to consider is that the Kumbukkan Oya (the neighboring river basin to the east of the Menik Ganga bordering Ruhuna, Figure 1) also discharges a considerable quantity (on average 472 MCM per annum) of freshwater to the YFMA apart from the Menik Ganga (Dharmasena 2005). Therefore, Menik Ganga freshwater flow (347 MCM) only contributes to a portion (approximately 40%) of the benefits derived from the YFMA. Consequently, the benefits derived from EF in the Menik Ganga are estimated as 40 percent of the above values for lobster and chank fisheries, which translate to US$93,610 and US$17,664, respectively.

Houde and Rutherford (1993) have estimated the potential fish catches in coastal, estuaries and coral reefs as 0.0497, 0.102 and 0.0289 Mt/ha/year, respectively. Therefore, if the area of coral reefs and estuaries is known, a value could be derived for the total potential fish catch in the YFMA. When such a potential of fish catch is considered, the benefits of EF in the Menik Ganga to the YFMA estimated above become an underestimate. There is also a potential for developing ecotourism in this area in the sandy beaches, sand dunes, wetlands, mangrove fringed lagoons and for watching migratory birds, sea turtles, marine mammals and coral reefs. Therefore, the value of EF to the MPA is potentially greater than the above estimate.

DISCUSSION AND CONCLUSIONS

EF in the Menik Ganga provide many benefits, including benefits to pilgrims, benefits to the local community in the basin, benefits to local and foreign ecotourists visiting the area, benefits from biodiversity conservation and conservation of endangered species, etc. However, the benefits of only a few components of EF have been valued in this study (and not always in full) due to the absence of detailed EFA to date. Therefore, if the total value of EF in the Menik Ganga is to be obtained, other components should be more clearly identified and valued as well in the future.

Table 2 gives a summary of the economic benefits of various components of EF in the Menik Ganga Basin and the total estimate of these benefits. For some components, multiple estimates have been attempted using alternative approaches or data sources. At the same time, summing up the estimates of values for individual attributes to obtain the overall value of EF may raise some concerns. For example, the potential of double counting increases when estimates derived from different methods or proxies are added up. Substitution effects and budget constraints also lead to over-estimation even if double counting does not take place.

Table 2. A summary of the components of EF in the Menik Ganga and the estimates of their benefits.

Component of EF	Estimate of EF[1] (m³/s)	Estimate of EF[1] Volume	Evaluation method	Benefits of EF (US$)	Comments
Kataragama religious festival	2	63 MCM	Total expenditure of bowser supply (Avoidance cost as a proxy)	12,375	Underestimate - as satisfaction of pilgrims is not included
Yala National Park	2	63 MCM	Additional expenditure incurred by the Wildlife Department in the dry season as a proxy (Avoidance cost used as a proxy)	1,470	underestimate - as this expenditure cannot eliminate the water shortage problem in the park completely
		51m³/day (drinking water for elephants)	Expenditure by the DWLC for HEC mitigation in the dry season as a proxy	1,960	The estimate of EF does not include the water needs for fodder. The benefit estimate is much greater than expenditure for HEC mitigation
		63 MCM	Forgone revenue from tourism as a proxy	66,948	EF benefit estimate is an underestimate
		63 MCM	Forgone recreational value as a proxy	82,215	Based on an estimate by Steel (1996) cited in CECB (2004)
Pilinnawa Wetland	250 (m³/s) for 45 minutes every two years	3.7 MCM	BT of land cover as a proxy	13,400	BT based on IUCN (2003)
			BT of land cover as a proxy	315,100	Based on MEA (2005)
Pallassa (grassland)	NA	>3.7 MCM	BT of land cover as a proxy	134,560	Based on Costanza et al. (1997)
YFMA	NA	NA	40% of the export value of lobster catch as a proxy (Market Price Method)	93,610	The relationship between the flow and the potential lobster catch is not established
			40% of the income of chank fishermen as a proxy (Market Price Method)	17,664	The relationship between the flow and the potential chank catch is not established
Total Benefits of the EF in the Menik Ganga[2]				**US$222,694**	

Notes: [1] Estimates of EF from CECB (2004) are used
[2] Estimates considered in the total benefits of the EF in the Menik Ganga are shaded
NA = Not available

Some estimates have been obtained using primary methods such as market prices and cost-based approaches. Others employ secondary methods such as benefit transfer. The estimates of benefits derived using global average unit values of the MEA (2005) and Costanza et al. (1997) are associated with uncertainties when applied to local situations. However, these values could represent an upper bound of the benefits of EF to the wetland and grassland.

Almost all the estimates are based on use values of EF such as marketed goods and recreation. However, the river ecosystem supports many other ecosystem services, fauna and flora apart from recreation and the goods considered here. Direct values from EF generally arise from a type of economic value known as 'non-use' value. Non-use values of EF reflect the individual's 'willingness to pay' for this water, even though they do not expect to use it or benefit from it (at least immediately). Non-use values generally arise from three sources:

- the desire to preserve the option of the individual to enjoy the benefits of instream flows—e.g., recreation, experiencing a healthy ecosystem—at some point in the future (option value);
- the desire to leave this option as a legacy for others in the current generation and/or those in future generations to enjoy (bequest value); and
- the satisfaction derived simply from knowing that water flows will ensure that an ecosystem or habitat will continue to exist (existence value).

For example, the Option, Bequest and Existence values of the Yala Park have not been considered when calculating the benefits of EF to the Park. Hence, the actual benefits of EF to the Yala National Park are greater than the estimate based on the forgone recreation alone. The same is true in the case of the Pilinnawa Wetland and the YFMA. The benefits to biodiversity conservation and conservation of endangered species arising from EF, is the most significant of the streams of benefits and is remained unvalued. The non-use values and option values are much greater than the use values and, therefore, the estimates based on use values alone are underestimates.

The choice of the valuation techniques were largely dictated by the characteristics of the case, data availability and the budgetary constraints. Where information gaps arise (as in the case of the Pilinnawa Wetland, for example) future data collection and primary research is necessary. The use of the TCM in the future is expected to give a more realistic value of the component of EF required for the Yala National Park. The major difficulty in valuing the component of EF to the YFMA is the lack of understanding of the exact nature of the relationship between the flow and the fish catch. The production function approach is suggested for the YFMA as a more reliable methodology to value the EF. However, the complex nature of the ecological relationships involved in the context of coastal wetlands and fisheries is a major difficulty even in the case of the production function.

With the new developments, in the future, the main water user in the Menik Basin would be agriculture. The water transferred from the Menik Ganga to the future Weheragala Reservoir will be transferred (60 MCM) to the adjacent basins primarily to augment irrigation and is expected to cultivate 1,220 ha. The total estimated paddy production is 9,150 tonnes, if only paddy is cultivated during both seasons (CECB 2004). Considering the dry season yield as 50 percent of the total and the price of paddy as US$0.124/kg (CECB 2004), the total value of the dry season yield comes to US$567,000. The total value of the components of the benefits valued in this study (approximately US$223,000) is already significant when compared to the total value of the dry season yield and the total value of EF (if non-use values and other components of EF are included) is likely to exceed US$567,000. Therefore, the economic value of EF should be given due consideration in future decision making in the allocation of water in the Menik Ganga among various users.

Many decisions about water allocation are made today on economic grounds. EF have economic opportunity cost for agriculture, hydropower, urban and other activities. Understanding the opportunity cost implications of water supply and allocation is, thus, central to making informed decisions on development and allocation trade-offs. Economic benefits of domestic, agricultural and industrial water demands are generally straightforward to quantify, as their values are expressed in market terms. The economic benefits of EF are more difficult to quantify as their values are generally not expressed in market terms (as is the case in other sectors) and for this reason is often ignored in decision making. Also, valuing the benefits of EF is a relatively new and challenging area of research.

The authors are well aware of the limitations of the current approaches they used, which inevitably affect the results. Despite all this, we are convinced that it is important to develop economic dimension of EF, if water allocation decision making process is to be strengthened, if the information base for such decisions is to be improved and if the risk of incurring untenable future costs and unnecessary expenditure is to be avoided. The current study details the work in progress and the authors welcome any new suggestions on how to improve the economic valuation of environmental and social water allocations, how to make them more transparent and more 'operational' rather than 'academic' (and in this context, the paper should be seen as a discussion document). This is particularly important in conditions where aquatic ecosystems continue to degrade worldwide while uncertainties and complexities surrounding the valuation of ecosystem services still prevail.

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ISBN: 978-92-9090-674-2