Wetlands and Agriculture – A Case for Integrated Water Resource Management in Sri Lanka

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Abstract

Wetlands are habitats with temporary or permanent accumulation of water. The degradation and loss of wetlands is more rapid than that for other ecosystems, and wetland-dependent biodiversity in many parts of the world is in continuing and accelerating decline. They have been confirmed to deliver a wide range of critical and important services vital for human well-being. Therefore, it is clear that sound wetland management is now expected to not only consider conserving the ecological integrity of the ecosystem but also to pay specific attention to the well-being of local people, thereby contributing to poverty alleviation.

Wetlands, both fresh and marine, have a multitude of benefits, in addition to environmental benefits, such as for agriculture, flood control, water purification, fisheries and recreation. For the maintenance and sustainability of wetlands the crucial requirement is water – a resource that has multiple demands and competition. The main competitor for the water resource around the world is agriculture for food production, a basic requirement for human survival. Therefore, in a situation of wetlands versus food production, the balance tips towards food production without considering the adverse consequences to the wetlands or adequately appreciating the benefits from achieving a balance. This is where Integrated Water Resource Management (IWRM) should be adopted to facilitate this process and enable wetland management and agricultural management to fit into the picture along with the other multiple uses of water.

Integrated Water Resource Management should be of considerable interest for Sri Lanka, being a country which has agriculture very high on the agenda. The country is also home to a range of wetlands including 103 distinct river basins and 42 lagoons, which support a multitude of functions and services to people. The relationship between agriculture and wetlands in Sri Lanka is complex. The proliferation of village level water storage structures (small tanks) has created an unusually large number of man-made wetland habitats that add significantly to the natural wetlands that are concentrated mainly in the coastal belt. The absence of an integrated approach to water resource development however, continues to erode natural wetland systems. Two major problems, which concern downstream fisheries and livelihoods, are high levels of agricultural pollution, especially through the excessive use of fertilizers, and modifications to the hydrology.

The objective of this paper is to review the work of the International Water Management Institute (IWMI) on wetlands and agriculture in Sri Lanka, to look at the competing water demands between water for wetlands and water required for agriculture, keeping in mind the requirements for nature as well as the sustainability of livelihoods. The paper will address some impacts of agriculture on wetlands, the consequences for livelihoods and the benefits of adopting the IWRM approach, building a case on work carried out in the Kirindi Oya and Bundala wetlands.

Introduction

Environmentalists concerned about biological conservation and agriculturalists focused on food production have worked at cross-purposes in wetlands management for a very long time. It is now becoming increasingly clear that the common resource – water – needs to be managed in a manner that benefits all the concerned stakeholders in order to proceed beyond this level of conflict. While the International Water Management Institute's main focus is on water for food production, in terms of wetlands it mainly looks at the inter-relationships and the different uses (multiple uses) of water. Integrated Water Resources Management (IWRM[1]) has been identified as a mechanism to facilitate the balancing of such multiple uses of water. In this context, it is considered that the need to take account of the ecological aspects of agriculture in river basins arose through the realization that water and its uses had to be viewed in a broader integrated management context and all aspects of water use needed to be taken into account in water resources policies (Giordano et al. 2006). This paper will present the competing water demands between water for wetlands and agriculture in Sri Lanka in terms of a trade-off between geographically disjointed benefits and costs within a river basin. It will thus address some impacts of agriculture on wetlands, the consequences for livelihoods and the benefits of adopting the IWRM approach, based on work carried out in the Kirindi Oya and Bundala wetlands.

The Importance of Wetlands

Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is flowing or static, fresh, brackish or saline including areas of marine water, the depth of which at low tide does not exceed 6 meters (Ramsar Convention, Article 1.1, 1971). Wetlands are very important ecosystems due to the services that they provide. These include provisioning services such as food and water, regulating services such as flood regulation, supporting services such as soil formation and nutrient cycling, and lastly, cultural services such as recreation. Some of the major wetland functions identified (see Table 1) for Sri Lanka are mitigation of floods, protection from storms, prevention of coastal erosion; retention of sediments; purification of water; providing a carbon sink; and creating a breeding habitat for edible fish (Finlayson et al. 2005; Kotagama and Bambaradeniya 2006).

[1] "A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP/TAC 2000).

Two of the most important wetland ecosystem services benefiting human well-being are fish supply and water availability (Finlayson et al. 2005). A critical issue in the twenty-first century is the increasing competition for freshwater between agriculture, domestic use, industry and the environment. On a global scale, more than 70 % of available freshwater has been diverted to agriculture (CA 2007). Water for agriculture depends fundamentally on ecological processes and the services provided by many wetland ecosystems. These waters are often diverted away from inland and coastal wetlands (CA 2007).

Table 1. Wetland ecosystem services and examples.

Services	Examples
Provisioning	
Food	Fish, grain, wild game, fruits and vegetables
Fresh water	Storage and retention of water, agricultural, domestic and industrial use
Fiber and fuel	Logs, fuel wood, peat and fodder
Biochemicals	Medicines and other material from biota
Genetic material	Genes for resistance and ornamental species
Regulating	
Climate regulation	Sink for greenhouse gasses, influence local and regional weather patterns
Water regulation (hydrology)	Groundwater recharge and discharge
Water purification	Retention, recovery and removal of excess nutrients, waste treatment and other pollutants
Erosion regulation	Retention of soils and sediments
Natural hazard regulation	Flood control and storm protection
Pollination	Habitat for pollinators
Cultural	
Spiritual and inspirational	Source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystems Opportunities for recreation activities
Recreation Aesthetic	Beauty and aesthetic value in aspects of wetland ecosystems
Educational	Opportunities for formal and informal training
Supporting	
Soil formation	Sediment retention and accumulation of organic matter
Nutrient cycling	Storage, recycling, processing and acquisition of nutrients

Source: Adapted from Finlayson et al. 2005

Wetlands are an integral and vital part of Sri Lanka's ecological and biological diversity and they provide an important habitat for the local flora and fauna (IUCN 2004). The Asian Wetland Directory describes 41 wetland sites of international importance in Sri Lanka covering an area of 274,000 ha (Van Zon 2004). These wetlands can be broadly categorized as: inland natural freshwater wetlands (e.g., rivers, marshes and villus); marine and salt water wetlands (e.g., lagoons, estuaries, mangroves and coral reefs); and man-made wetlands (e.g., tanks, reservoirs, rice fields and salterns).

In Sri Lanka, wetland ecosystems are often indiscriminately exploited for commercial, agricultural, residential and industrial purposes and are also used as a dumping ground for garbage (IUCN 2004). The majority of wetlands in Sri Lanka are facing threats, especially those along the coastal belt (Van Zon 2004; Kotagama and Bambaradeniya 2006). It is important to realize that these issues are not brought about within the wetland itself but are due to activities in the lands adjacent to (Van Zon 2004; Kotagama and Bambaradeniya 2006) and upstream of the wetlands (Atapattu and Molden 2006; Falkenmark et al. 2007), with substantial input from agricultural practices.

However, there is also a necessity to recognize that water for agriculture does have multiple uses and benefits. Especially in countries like Sri Lanka, irrigation schemes and canal systems have made water more abundant and accessible for people. At the community and household level, this water is not only used for agriculture and livestock production but also for bathing, drinking and other domestic applications such as cooking and sanitation (Bakker and Matsuno 2001; DFID 2007). Irrigation contributes significantly to the country's economic growth both in terms of agricultural production as well as hydro-electricity generation. Irrigation infrastructure development has also created inland small-scale subsistence and commercial fisheries. For example, in the Uda Walawe left bank irrigation system in the Ruhuna Basin, there are a number of small and large man-made water bodies called tanks, which form part of the irrigation infrastructure. These tanks support an inland fishery – where the dominant species are tilapia. Before the Uda Walawe Irrigation Project, almost all the mature and large fish were caught during the dry period, leaving only the small juvenile fish during the other seasons, as tanks were seasonal in character. After tank rehabilitation and the creation of new tanks under the irrigation project, a perennial inland fishery was established. Fingerling stocking programs were initiated in these sites by the relevant authorities, in addition to providing communities with fishing gear and boats. Fisheries Societies have also been set up to manage these community fisheries, thereby supporting the livelihoods and the well-being of the local people (Sellamuttu., S. 2008, unpublished project report).

The extensive small tank-based irrigation system that spreads throughout much of the country's dry zone also provides biodiversity refuges, being home to a wide range of Sri Lanka's rich biodiversity, ranging from the Asian Elephant and other mammals to aquatic birds, fish and amphibians. The paddy cultivation systems themselves are considered as artificial seasonal wetlands, according to the Ramsar definition of wetlands, and are often referred to as agro-ecosystems (Falkenmark et al. 2007). The agriculture-wetlands relationship in Sri Lanka is consequently complex owing to both mutual dependence as well as competition for water.

Common Agricultural-related Stresses

The diversion and regulation of water for irrigation has brought about many changes in associated wetlands and ecosystems both internal and coastal (Finlayson 2007). In Sri Lanka, the disappearance of 'Villu' ecosystems[2] in the Mahaweli Floodplains (Kotagama and Bambaradeniya 2006) is an example of inland wetland loss due to irrigation development upstream changing the hydrology of the system, and affecting the environmental flow. Recently there have been several attempts to simulate environmental flows affecting the coastal lagoons, such as Karagan and Bundala, under limited data conditions (Smakhtin and Priyankarage 2003; Smakhtin et al. 2004).

[2]Relatively small and shallow seasonal water bodies formed in natural depressions and associated with flood plains (Kotagama and Bambaradeniya 2006).

Water quantity is not the only dimension of the wetland ecosystem that is affected by agricultural water use; rather, water diversions and storage structures also affect other aspects of water that are fundamental to downstream wetland ecology, the biodiversity of the wetlands and several coastal livelihoods. Therefore, it is important to look at the quantity, frequency, timing and quality of the water flow.

Agricultural activities in the river basin, especially the use of agrochemicals, which can leach out into the drainage water bodies, are often responsible for the degradation of water quality in the downstream wetland areas. Sri Lanka is known to be one of the highest users of fertilizers, thereby increasing the nutrient levels in wetlands, especially phosphorous and nitrates, leading to eutrophic conditions (Atapattu and Kodituwakku 2009). Excessive levels of nutrients have been reported from the Kirindi Oya area where upstream irrigation water was within the acceptable water quality standards, but the drainage and lagoon water had high values of phosphorous and ammonia, which exceeded the standards for aquatic ecosystems or aquaculture (Matsuno 1999). This also created eutrophic conditions in some parts of the lagoon (Priyankarage 2002; Priyankarage et al. 2003).The heavy use of pesticides is another major concern as these are more persistent and difficult to breakdown.

Soil erosion due to upstream agricultural practices is a concern the world over and is seen as a potential threat that will increase with the intensification of agriculture. In the Kirindi Oya study, levels of suspended solids were also found to exceed the standards for aquatic ecosystems or aquaculture (Matsuno 1999). Coastal erosion on the other hand is a much bigger problem in the region, which is brought about by altered currents and sediment loads, and can also be caused by changes in upstream coastal land uses (Atapattu and Kodituwakku 2009).

These agriculture-induced stresses have significant implications for ecosystem processes, which in turn affect the services that they can provide both to the environment and dependent communities. These conditions reduce the productivity of the wetland ecosystem and disturb the equilibrium of the system. Associated fauna and flora may be affected, the most obvious example being fisheries and water birds, while less obvious but important changes may also take place in the micro faunal communities that support the ecology of the system and the food chain (Matsuno 1999; Atapattu and Kodituwakku 2009; Falkenmark et al. 2007).

Wetland dependent communities rely on them for their income generation, for example through fisheries and tourism, as well as food, freshwater and recreation (see Table 1). The degradation of a wetland system can, therefore, have serious implications for the livelihoods of dependent communities. For example, in Kalametiya, on the southern coastline of Sri Lanka, lagoon fishermen from villages adjacent to the lagoon have revealed that conditions in the Kalametiya Lagoon have altered significantly since the early 1970s, particularly with the lagoon shrinking and becoming shallower. The changes were attributed to a combination of the development of the Uda Walawe and Kachchigal Ara irrigation scheme (1967), the subsequent creation of a permanent opening to the sea, and the building of two bunds along the banks of the Kachchigal Ara channeling all water to the sea outlet (Clemett et al. 2003; Senaratna Sellamuttu and Clemett 2003).

The fishermen attribute several impacts to these changes. The fish habitats and fishing grounds have shrunk as the lagoon has shrunk and paddy lands have replaced marsh and lagoon area. The increased inflow of fresh water and the higher velocity of the outgoing water, which has limited the exchange with seawater, have both reduced salinity. The latter has prevented the propagation of post-larvae shrimp and the fishermen cite this as the reason for the collapse of a previously thriving shrimp fishery. Another associated problem, according to the fishermen, was the influx to the lagoon of sediment carried in irrigation water running off up-stream paddy lands, which they say has reduced the depth of the lagoon (Clemett et al. 2003; Senaratna Sellamuttu and Clemett 2003; Senaratna 2007).

These changes in conditions were verified by aerial photographs of the Kalametiya Lagoon from 1956 and 1994 that show a decline in the lagoon area and the encroachment of mixed mangroves and homesteads. Studies undertaken around the lagoon have shown a decline in the number of people fishing, reaching as much as 60 % in the village of Wewegoda. Those who remain in lagoon fishing were found to be among the poorest in the area and daily incomes from lagoon fishing had declined from around Rs. 2,000 per day to just Rs. 100-150. Due to the reduction in income generation, the frequency of fishing has increased from 2-3 days per week to sometimes several times a day to generate a sufficient income (Clemett et al. 2003; Senaratna Sellamuttu and Clemett 2003; Senaratna 2007). Increased frequency of fishing can itself induce further environmental pressures.

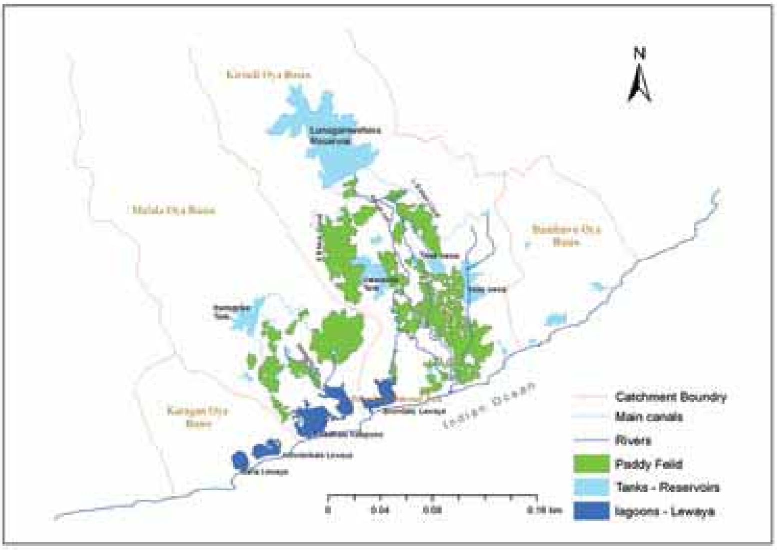
In considering the implications of agricultural activities on livelihoods, the inequities between upstream users and downstream users need to be recognized and understood. The upstream users are often not at the receiving end of the negative impacts but contribute towards them. This brings to the forefront the necessity for IWRM at river basin scale so that users and the environment benefit simultaneously to whatever extent is possible.

A Case for Adoption of Effective IWRM in Sri Lanka

The Kirindi Oya and the Bundala Wetland was selected as a case study to show the need for effective IWRM in Sri Lanka as it is a wetland of international importance and the first Ramsar site in the country. It also demonstrates both the qualitative and quantitative impacts of upstream agriculture water use. The Bundala National Park, which is located on the south coast of Sri Lanka, is made up of 6,216 ha of lowlands, including five shallow brackish water lagoons (Maha, Koholankala, Malala, Embilikala and Bundala) which cover a total surface area of 2,250 ha (see Figure 1). The Park supports important populations of water birds, elephants, crocodiles, turtles and other fauna which are reliant on the water bodies for their well-being. The lagoons are important nursery grounds for shrimp, fish and a variety of other aquatic organisms, which are an important component in the overall food cycle of the biological system (Jayawardene 1998; Rajapakse 1998; van der Hoek. 1998).

The study area is fed by surface runoff, streams and rivers, inflow from drainage channels of upstream irrigation schemes and inflow and seepage from the sea (Figure 1). Significant agricultural activities impacting on this wetland arise from the Kirindi Oya, which supports an old and new irrigation scheme with a number of ancient tanks that provide irrigation on the left and right banks, and another irrigation scheme connected to the right bank (van der Hoek. 1998). The Malala Oya and the Weligatta Ara feed directly into the Malala Lagoon and Embilikala Lagoon, which are interconnected and function as one hydrological body (Smakhtin et al. 2004).

Figure 1. Map of the Bundala National Park and surrounding catchment areas.



Source: Adapted from Matsuno et al. 1998

The main significance of Bundala is the presence of resident and migratory water birds. The biological productivity of the wetlands provides an ideal habitat for wintering for migratory birds (48 out of the 149 species of birds observed are migratory) sometimes accommodating rare species such as the black-necked stalk and flamingos. In the case of the latter, Bundala represents one of only a few sites where these birds are seen annually in Sri Lanka (Rajapakse 1998). The main characteristics of the lagoon system in Bundala wetland are summarized in Table 2.

Studies on water quality and hydrology show that the Embilikala and Malala lagoons have been affected by the Kirindi Oya Irrigation and Settlement Project (KOISP), which has reduced salinity levels and increased water levels, due to the inflow of irrigation drainage water (van der Hoek 1998; Maring and Schuurmans 2000; Kularatne 1999). Changes in the salinity levels have resulted in the decline in brackish water shrimp species, which was an economically valuable fishery, providing income to many of the surrounding communities (Matsuno et al. 1998).

Table 2. The characteristics of the lagoon system in the Bundala wetland system.

Lagoon	Characteristics	Significance/ Activities	Irrigation Influences	Impacts
Maha	Naturally formed hyper saline shallow lagoon	Feeding ground for migratory and resident water bird populations Elephant corridor Developed for salt production Cattle grazing	Unknown	
Koholankala	Hyper saline shallow lagoon (390 ha) Subject to highly varying water levels. Salinity exceeds 34 ppt during dry periods	Developed for salt production Little data available	Unknown	
Malala	Low saline lagoon (650 ha) connected to Embilikala Lagoon through small channel. Receives water through Malala Oya. Has direct link to the sea through the Malala Modera	Feeding ground for migratory and resident water bird populations Fishing Tourism	KOISP and Badagiriya Irrigation Schemes 1986 to 2009	Environmental - Drainage inflow causing salinity reduction and altering water quality and quantity. Changing assemblage and quantity of crustacean and fish species. Affecting water bird species and other fauna and flora. Socioeconomic - Prior to KOISP, about 400 families were involved in prawn fishing in both Malala and Embilkala lagoons
Embilikala	Low saline lagoon (420 ha) with no direct opening to the sea. Connected to Malala lagoon through small channel. Receives water through Weligatte Ara.	Feeding ground for migratory and resident water bird populations Fishing Tourism	KOISP and Badagiriya Irrigation Schemes 1986 to 2009	Environmental - same as Malala
Bundala	Brackish to saline lagoon (160-190 ha) with an opening to the sea. Seawater enters lagoon mainly through seepage. Parts converted for salt production	70 % is used for salt production Feeding ground for migratory and resident water bird populations Tourism Livestock grazing	None	Environmental - High grazing pressure Socioeconomic - Although traditionally an agricultural village, 90 % of the households in Bundala village depend on the Bundala saltern for their livelihood

Source: Matsuno et al. 1998; Smakhtin et al. 2004

Furthermore, studies that compared the Embilikala Lagoon and the Bundala Lagoon (which is not affected by irrigation) showed that even though both comprise the same water bird species, Embilikala is a lower quality feeding ground. The main cause of this is the input of excess freshwater, increased sediment loads and agricultural nutrients (Matsuno et al. 1998). The increased depth of the lagoons may make it difficult for birds to feed and fluctuations in water levels result in the Embilikala-Malala lagoon system regularly breaching its coastal sand barrier. This causes the system to empty into the sea almost completely within 6 to 7 days (Smakhtin et al. 2004). These artificial interventions affect the benthic fauna, mainly small crustaceans, on which the birds feed. Since Bundala National Park is a very important wintering point for migratory species, the degradation of the habitats can seriously hinder their ability to re-fuel before heading back to their breeding grounds, thus threatening the sustenance of that bird population (Mariagrazia Bellio 2009 pers com.).

Irrigated agriculture is not the only activity to impact on the lagoon. Livestock production may lead to overgrazing and eutrophication of water bodies when manure and urine enter the system. Livestock may also compete for grazing with wildlife in the park. Fuelwood collection can impact on the ecosystems around the lagoon or, if taking place upstream, on sediment loads reaching the lagoons.

To manage this system effectively, it is therefore important to understand the complex socioeconomic situation in the surrounding area. Agriculture, salt production, livestock rearing and fishing, all form part of the livelihoods of the Bundala community, which consists of approximately 170 families (Rajapakse 1998). With the hydrological changes that have taken place so far, the biggest impact felt by the community has been on the local fishing industry. Full-time lagoon fishers were forced to become part-time fishers, while others stopped fishing in the lagoon altogether. Some of these communities took up alternate livelihood activities such as shell mining and bird hunting, which often resulted in legal action being taken by the Department of Wildlife Conservation (Kularatne 1999). Another study reported that lagoon fishermen in Malala and those in associated trades, such as net makers, were badly affected by the changes in the lagoon and had been forced to diversify their livelihood strategies by undertaking agricultural labor, and lobster and deep-sea fishing. Those that continued to fish used non-sustainable fishing techniques and also increased the use of family labor, thus resulting in an overall increase in the number of fishermen using the lagoon (Kularatne 1999).

Discussion

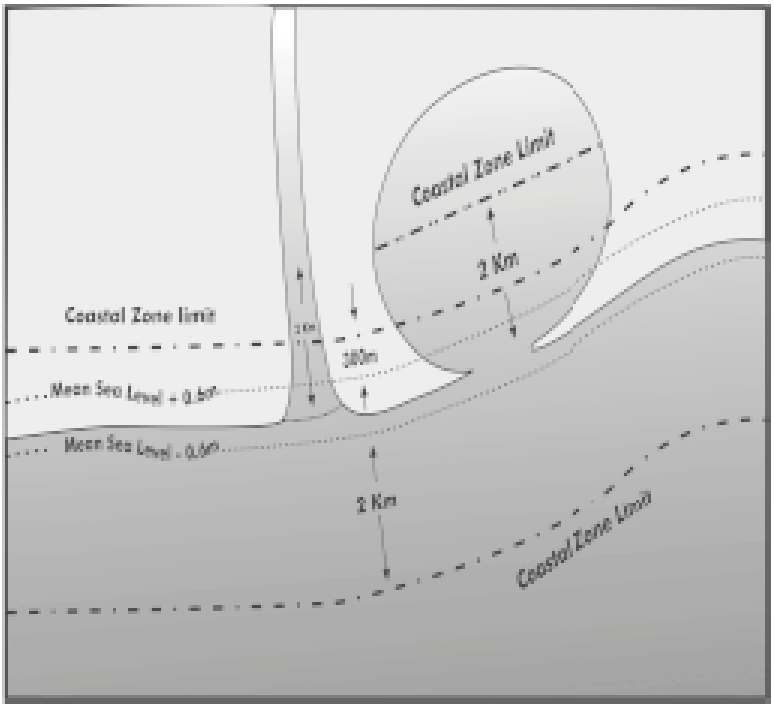
The Kirndi Oya-Bundala case study, and also Kalametiya help to illustrate the multiple impacts that could occur on downstream wetlands as a result of upstream agricultural water use when not planned within an IWRM framework. Apart from the impacts on the country's wetland biodiversity, the undermining of ecosystem services to local communities makes clear the trade-offs inherent in manipulating the hydrological regime in a river basin. Given the abundance of major and minor river systems in the country that often also include coastal wetlands such as lagoons and mangrove systems, learning from the Bundala and Kalametiya experiences should help to minimize the upstream-downstream tradeoffs (both ecological and economic) in future upstream irrigation interventions.

Further perspective can be given to these tradeoffs by considering the fact that wetlands in Sri Lanka are characterized by a rich diversity of wetland habitat types and a high number of plant and animal species. Out of the migratory birds that visit Sri Lanka, about 50 % are directly dependent on wetlands for food and shelter. More importantly, it should be recognized that approximately 32 % of the nationally threatened vertebrate species are dependent on wetland ecosystems (Kotagama and Bambaradeniya 2006). From a human development standpoint, Sri Lanka's coastal zone covers approximately 23 % of the total land area and accounts for as much as 4.6 million people or approximately 25 % of the country's population, many of whom derive direct or indirect services from wetlands for their income, food security and other aspects of well-being. Estimates show that the marine fishery provided approximately 91 % of the total fish production in Sri Lanka in 2003, of which 64 % was from coastal waters This fishery is important for local food security - in 2002, the fisheries sector including aquaculture, produced 302,890 tonnes of fish, of which 286,000 tonnes (94 %) were utilized locally, while the balance was exported. Furthermore, the fisheries sector provides direct employment to about 150,000 people, and sustenance to at least a million; while around 100,000 fishing families (nearly 450,000 people) inhabit the coastal zone. Of these, at least 30,000 people are believed to be engaged (part-time and full-time) specifically in the lagoon fishery. The marine and brackish water (mainly lagoon) fishery is also a key contributor at the macro level, contributing 2.7 % of Sri Lanka's Gross Domestic Product (GDP) in the 1998-2003 period and remains an important source of foreign exchange.

The competition for water between upstream and downstream users may be viewed as competition between two extremely productive systems, where hegemony of one over the other may not yield optimal results for the country's wetland biodiversity or its people. Adoption of IWRM principles thus offers a widely accepted planning framework for minimizing the trade-offs between the two. Perhaps most importantly, IWRM's emphasis on integrated planning challenges the hitherto sectorally segmented planning processes that have underpinned the Bundala and Kalametiya cases, as well as others. In this instance, the issue is not that responsibility for the management of wetlands, agriculture and water are dispersed among different institutions and legal frameworks, but the issue is the lack of an over-arching multi-sectoral institutional platform for bringing these sectoral objectives under a more holistic view for development.

Sri Lanka ratified the Ramsar Convention on Wetlands in 1990 and established the National Wetland Steering Committee (NWSC) in the same year. This Committee's reconstitution in 2003 to integrate plans for wetland areas and to coordinate development and conservation activities resulted in the formal adoption, in 2004, of a National Wetland Policy under the auspices of the Ministry of Environment and Natural Resources. The main objectives under this policy are to protect and conserve wetland ecosystems; prevent illegal utilization; restore and maintain biological diversity and productivity; enhance ecosystem services from wetland habitats; ensure the sustainable use of wetlands and traditional practices by local communities; and meet national commitments as a signatory to the Ramsar Convention on Wetlands. Principle 3.4 of the National Policy on Wetlands, 2004, provides formal recognition of the need to incorporate downstream impacts into the upstream development processes. While the role of the NWSC is confirmed by the National Policy on Wetlands (Section 5.2.2), it is suggested that the inter-sectoral integration envisaged through the NWSC alone will not be a sufficient institutional arrangement to engender effective planning as required by IWRM. In particular, given the central role played by a river's hydrology in the upstream-downstream relationships, planning at a river-basin scale appears to offer more opportunities to focus on basin-specific characteristics. Thus, the interplay between the basin scale and IWRM planning principles emerges as the proposed way forward. It is also interesting to note that the vertical spatial integration this calls for, runs contrary to the existing horizontal legal demarcation of the land between the coastal zone and the area landward beyond the coastal boundary as demarcated by the Coast Conservation Act (CCA), No. 57 of 1981 (Figure 2).[3]

Figure 2. The coastal zone as defined in the Coast Conservation Act.



From the perspective of coastal ecosystems and communities, it is already well documented that the definition of the coastal zone provides an inadequate geographical reach as a starting point for a truly integrated resource management strategy in Sri Lanka, particularly with respect to impacts from upstream activities. This definition envisages a mandate for the Coast Conservation Department (CCD) in a geographical area that runs parallel to the coastline, while the need under an IWRM approach is the opposite – extending influence inland and up to the northern boundaries of a river basin. This has meant that the CCD is dependent on

[3] The coastal zone is defined by the CCA as the area lying within 300 m landward of the 'Mean High Water Line', and up to 2 km seawards. Where another water body is permanently or seasonally connected to the sea, the landward limit is extended to 2 km as measured perpendicularly to the straight baseline drawn between the natural entrance points.

the co-operation of several other central and local government agencies if it is to influence decisions outside of the coastal zone. Although this function has been designated to the Coast Conservation Advisory Council (CCAC),[4] established under the CCA, its influence has been hitherto undermined by a focus on technical as opposed to political issues (Ranasinghe, pers com). While the need for specific institutional oversight for the coastal zone (as currently exists through the CCD) is not disputed, there is also a need for this jurisdiction to be meshed with a multi-institutional arrangement at the basin scale whereby the CCD and institutions with influence outside the coastal zone can 'talk' to each other within an IWRM framework and at a basin scale.

It is proposed that the case studies and supporting information presented above contributes to the case for adopting both IWRM and the basin scale as key tools for effective and equitable water management in Sri Lanka. It should be noted that some work towards developing both the tools and information towards this end is already being done, such as simulation models to determine environmental flows and valuing ecological services (Maring and Shuurmans 2000; Bakker and Matsuno 2001; Smakhtin and Priyankarage 2003; Smahktin et al. 2004), and which can be further built upon.

Conclusion

This paper emphasizes the urgent need for IWRM to be integrated effectively into the natural resources management policies of the national government. The urgency prevails due to the ecological as well as livelihoods tradeoffs inherent in manipulating a river's hydrological regime, and the fact that these are likely to increase as the demand for water intensifies. By replacing unplanned and ad-hoc water management measures, IWRM could allow the water requirements under situations of 'multiple use' to be balanced effectively as well as more equitably – water for the environment and water for human use – mainly agriculture. Given that achieving such a balance is central to sustainable development, IWRM thus emerges as a key tool for the government to optimize the developmental potential offered by both water and wetland resources. IWRM also emphasizes the necessity for practical solutions and techniques, which need to be researched and identified to ensure effective implementation that is suitable in the Sri Lankan context, and which may have to be further adapted to suit the individual river basins depending on the water uses, water resources and prevailing conditions.

[4] To be renamed as the Coast Conservation and Coastal Resource Management Advisory Council under S. 7, Draft Amendments to the Coast Conservation Act, No. 57 of 1981, L. D. O 47/99.

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