An Overview: Water Quality, Environment and Climate Change

Alexandra Evans
International Water Management Institute, Colombo, Sri Lanka

Water management, the environment and climate change are all inextricably linked, and yet the issues covered within these areas are diverse, often debated and always interesting. Several of the papers in this volume of the conference proceedings discuss the difficulties of managing water for the environment and people, with some suggesting that integrated water resources management (IWRM) is the way to address the conflicts that are increasingly seen and others presenting new ideas about environmental flows (EFs). Atapattu, de Silva and Senaratna Sellamuttu (Atapattu et al.) for example focus on wetlands and the impacts that upstream activities, principally agriculture, have on wetland integrity. Wetlands provide a multitude of benefits including flood control, water purification, fisheries and recreation, and water is crucial for their maintenance. Likewise it is essential for agricultural production, which leads to water diversions, for what is considered by many to be more productive uses. Consequently conflicts can arise. Atapattu et al. suggest that environmentalists and agriculturalists have worked at crossed purposes but that they now need to enter a new era in which they collaborate, through IWRM processes, to attain benefits for all stakeholders. Abeywickrama has similar opinions and asks how wetlands and irrigation demands can co-exist. Most importantly he questions how to arrive at a balanced, un-politicized solution to water resources management. Both papers use examples from the south of Sri Lanka with Abeywickrama focusing on the Kirindi Oya Irrigation and Settlement Project (KOISP) and Atapattu et al. on Kirindi Oya and Bundala.

The actual water requirements that specific wetlands have is still not adequately known. Dissanayake, Weragala and Smakhtin (Dissanayake et al.) provide a means to assess this and to evaluate the costs and benefits of environmental water allocations, known as Environmental Flows (EF). This is particularly important as arguments for diverting water from the environment are often based on economic assessments but the environment, including wetlands, is not always adequately accounted for in such analyses. Environmental Flows are essentially environmental water allocations, and are discharges of particular magnitude, timing and frequency that are necessary to ensure a range of benefits from a river. Their assessment and provision is considered important for aquatic life but there has been limited exposure to the EF concept in Sri Lanka. Dissanayake et al., therefore, present two case studies of locations where EFs have been calculated. In the Walawe Basin, a simple method of calculating EF is used and the authors demonstrate the feasibility of using it in basins with limited hydrological data. In the Menik Ganga basin, EF assessment is used to evaluate the costs and benefits of water allocation.

Weligamage, Butcher, Blatner, Shumway and Giordano (Weligamage et al.) are also interested in how environmental benefits can be valued and use a non-market valuation method to estimate the economic value of a committed flow through a unique ecosystem, the Yala Protected Area Complex (YPC), also in the south of Sri Lanka. Maintenance of the YPC's ecosystem depends on the flow of the Menik Ganga, which could reduce in future years if farmers demand increased releases from the Veheragala Reservoir. Using a willingness to pay (WTP) survey, Weligamage et al. show that 65 % of the population is willing to pay to maintain the ecosystems, with a mean WTP for water releases of Sri Lankan Rupees (SLR) 435 per year, resulting in a present value of aggregate WTP of is SLR 12 billion over a 10-year payment horizon.

The impact of agriculture on wetlands not only arises as a result of water diversion but also due to pollutants, especially sediment and agro-chemicals. Atapattu et al. raise the issue of eutrophication and siltation of coastal water bodies, including the Kalametiya Lagoon, while Amarasekara and Kumarihamy look into this in more detail in a study of 150 farmers in Kurundy Oya in the Upper Mahaweli catchment. In this area both paddy and vegetable cultivation take place, but as is the case in many areas in Sri Lanka, increasing population pressure is leading to changes in practices. As a result farming is becoming more intensive, forest and riparian areas are being encroached, fallow periods are no longer maintained and fertilizer is being applied at higher rates. One suggestion to address these issues, especially that of over-fertilization, is to give fertilizer recommendations based on soil tests, rather than blanket recommendations for whole areas. This is of course expensive and difficult to undertake but in the survey farmers stated their WTP, which means that it may be viable for the private sector to become involved.

Sirisena, Rathnayaka and Bandara (Sirisena et al.) propose something similar in their study in Wilgoda, Kurunegala. There, the water used for irrigation is of marginal quality, as it receives urban drainage as the canal flows through the city. Sirisena et al. hypothesize that one of the reasons for the sub-optimal rice yield in Sri Lanka is the depletion and imbalance of nutrients in soils. They suggest that if this could be better understood then site-specific recommendations could be made. However, this is especially complicated in areas where the irrigation water is contaminated with upstream runoff and urban drainage and, therefore, contains unknown concentrations of nutrients, micro-nutrients and pollutants. Their study found that spatial distribution of chemicals is uneven and can vary from chemical to chemical but that in many cases, notably phosphorus (P), soil concentrations decline with distance from irrigation source.

Pesticides also cause pollution and potentially health risks but are much less well understood. Their fate and degradation in the environment is complex and is governed by several processes associated with atmospheric conditions, the surrounding environment, the nature of the chemical and farmer practices. Consequently it is not easy to determine the potential for residues to contaminate surface and groundwater and the impact of this on ecosystems and human health. Analytical techniques are often used to identify chemicals but they are extremely costly and may lack the sensitivity required to detect insecticides, herbicides and fungicides and their degradation products. An alternative approach, therefore, is to understand the fate of pesticides and to adopt best management practices that prevent their movement to sensitive locations while at the same time keeping agricultural productivity high. Watawala, Liyanage and Mallawatantri (Watawala et al.) tested the feasibility of using the Pesticide Impact Rating

Index (PIRI) in three areas in the Hill Country of Sri Lanka: Nuwara Eliya, Walimada and Bandarawela. They found that the PIRI estimated risk was extremely 'high to high' for surface water and extremely 'high to medium' for groundwater; while the toxicity in both surface and groundwater was 'high to medium'.

Watawala et al. propose that these findings can be used to explain to farmers how different soil and climatic conditions can influence pesticides. They can also build scenarios to show farmers how different management practices influence the outcomes. This is considered important in Sri Lanka because many farmers use more than the recommended doses 'to ensure results', while many in the study said that they were not aware of how the chemicals worked or what the ideal application methods were. Trying to change these practices requires good extension services which can be supported by PIRI. Amarasekara and Kumarihamy also call for more support to farmers, principally through the provision of more field-level extension officers under appropriate government departments as well as institutional strengthening to enforce laws associated with encroachment and soil erosion.

The papers presented in this volume also discuss groundwater quality issues, especially in relation to their suitability for drinking water. Wijesekara and Kudahetty took over 600 samples from shallow wells throughout the Attanagalu Oya Basin and analyzed them for 17 parameters including pH, electrical conductivity, lead and faecal coliforms. They found significant special variation in the quality of the well water and used this to create maps of the most suitable areas to exploit for drinking water.

This need to find more sources of safe drinking water is reflected in the paper on roof rainwater harvesting (RRWH) by Bandara, De Silva and Dayawansa, who assert that stored rainwater can provide accessible, reliable, timely and adequate supplies of water to households, and not only help households to cope at times of water scarcity but also reduce the distance that has to be travelled to collect rainwater. In the study area in Anuradhapura District, 93 % of the households interviewed preferred to use well water for drinking, but in the dry periods this reduced to 27 % and the majority (71 %) chose to use rainwater. However, the use of stored rainwater is limited because of consumer acceptability mainly due to uncertainties about water quality. The study analyzed stored rainwater and found that this concern was not unfounded, with bacterial quality, measured in coliforms, exceeding the Sri Lankan Drinking Water Standards. They also found that in many cases this related to inappropriate management of the system, for example not cleaning the roof and flushing the system or not keeping the tank sealed. If rain water harvesting (RWH) systems are used according to the recommendations then they can become an important part of an integrated water management system specifically to meet domestic water needs, as it has been shown that conditions are suitable for RWH throughout Sri Lanka. However, this will only be possible if people are able to have trust in the systems.

The issue of water scarcity, which has so far been discussed primarily in relation to population growth, competing demands and water pollution, will be considerably effected in the future by climate change. However, it is less clear exactly what those changes will be and many of the papers presented in this volume deal with this issue. It is notable that most projections are at global scales and, therefore, future climate scenarios for Sri Lanka are scarce. The review by Eriyagama and Smakhin found that there is evidence to suggest that Sri Lanka's climate has already changed with a mean air temperature increase from 1961-1990 of 0.016 ^{0}C (above the global average of 0.013 ^{0}C) and a mean annual rainfall decrease of 144 mm

(7 %) compared to the period 1931-1960. They discuss the implications of climate change predictions for agriculture, water resources, sea level, the plantation sector, the economy and health, suggesting, for example, that there could be reductions in paddy and coconut yields. One prediction is that although the mean annual water availability will increase in Sri Lanka its spatial distribution will not be equitable, so some areas will get drier and others will get wetter, which will have negative impacts on agriculture, with the brunt being borne by the North-East and East. Gunathilaka, Wickramanayake and Perera concern themselves with the potential for floods in Sri Lanka and the link with tidal variations. They consider the implications of these for economic activities and how to predict them and thereby minimize impacts.

Detailed analysis of rainfall data for 22 meteorological stations across Sri Lanka by Senalankadhikara and Manawandu provides some interesting findings. They observed an increase in total rainfall for Jaffna, Pothvil and Mulativue (although some data are missing), compared to a decline in total rainfall in the wet and intermediate zones. They also noted a decline in the number of rainfall days at all monitoring stations except Nuwara Eliya. These changes in rainfall patterns appear to be being felt by paddy farmers whose planting and harvesting patterns have changed over the past 20 years. Paddy is highly susceptible to variations in temperature, rainfall and soil moisture, and Panabokke (1974) proposed a stringent analysis of seasonal rainfall variability to specify the proper choice of sowing dates and the selection of optimum sowing-to-harvest duration, to ensure the maximum chance of rainfall satisfying the crop water demand. This was intended to address the long recognized yield variability in rain-fed agriculture in Sri Lanka. The optimal sowing dates for North Central Sri Lanka resulted in stabilization of yields but Panabokke and Runyawardana report in this volume that by 1986 aberrations in seasonal rainfall patterns were noted with rainfall becoming more varied and more extreme, to the extent that, rather than being occasional, extreme events are now the norm.

These observed changes make it difficult to rely on past experience in agriculture and, therefore, not only does more need to be known about likely future scenarios but it is essential that farmers are able to adapt to climate change and are supported in doing so. Eriyagama and Smakhin found that some adaptation measures had already been put in place in the agricultural sector, including development of low water consuming rice varieties and use of micro-irrigation technologies, and that tools have been developed for predicting seasonal water availability within the Mahaweli Scheme and annual national coconut production, but Sri Lanka has not yet undertaken a comprehensive national study on the vulnerability of its water resources and agriculture to climate change.

How adaptation actually takes place at the individual or household level is perhaps as dependent on local social conditions as it is on the physical environment and infrastructure. Senaratne and Wickramanayake encourage us not to forget this, describing the conditions in communities in the ‘Dry Zone’ of Sri Lanka, in Anuradhapura District, that rely on village tanks for farming. They observe two major adaption strategies: aligning of practices with seasonal rainfall; and management of rainwater in village tanks. How these adaptations take place and are governed is influenced by local institutions that develop around them. However, traditional farming contexts are being transformed by external influences and these introduce complex socioeconomic dimensions to climate change adaptation. Understanding the physical, socioeconomic and institutional aspects of adaptation to climate change will, therefore, be essential to maintain agricultural productivity and incomes.

One potential adaptation to increasing water scarcity brought about either by population pressure or climate change, that is receiving considerable attention in current literature, is that of wastewater reuse. In this volume Udagedara and Najim propose this as an option not only to address scarcity but also as a sound means of wastewater disposal, to protect receiving water bodies and to improve incomes from agriculture in peri-urban areas. The use of wastewater in agriculture is not new in Sri Lanka but was traditionally practiced in homesteads rather than on a town or city level. In Kurunegala, Udagedara and Najim observe that paddy lands are left fallow due to insufficient rainfall or lack of supplementary irrigation. Based on this and the quantity of wastewater produced in the city, they calculate the area that could be brought under production if the wastewater was properly managed.

Wastewater reuse is an interesting adaption option and one which brings the discussion back to water quality, environmental impacts and the sharing of water between various uses, including agriculture, the environment and cities. This volume presents a range of issues in this sphere and makes suggestions for how to tackle some of them, through, for example, IWRM, EFs, more refined climate change predictions, and both physical and social preparation for climate change and adaptation. In some cases the papers open debates and it is hoped the readers and authors will take up and continue to investigate.