Water Matters

News of IWMI Research in Sri Lanka

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Water Matters looks at the environment and its water needs, focusing on the Bundala Lagoons, rich in biodiversity and frequented by migratory birds, presently at risk because of changes in water quality. The issue of water pollution through agricultural activity, and IWMI's wetland mapping initiative are also highlighted.

IWMI
International Water Management Institute

Giving Voice to Environmental Water Needs

Sri Lankan King Parakramabahu I (1153-1186 AD) is believed to have said "Let not even a small drop of water that comes from rain flow into the ocean without being useful to man". Similar statements have been made by many political leaders before and after him in many countries through centuries. And the normal engineering interpretation of this has always been "Let's harness as much water through dams and diversions as we possibly can… regardless".

Dams and water management schemes are no doubt designed for a variety of good reasons including hydroelectricity, irrigation, domestic water supply, flood management, etc. But they also have a downside. They can compromise river ecology and associated livelihoods. Most often, the negative impacts of water resources development on ecosystems and people stem from not taking into account the ecological and social consequences. In developing countries like Sri Lanka, people rely on resources provided by natural waters. Consequently, adverse environmental impacts readily translate into impacts on human welfare through nutrition, health and culture. These impacts can and should be reduced by releasing the right amount of water at the right times – to cater for requirements of fish, birds, etc - i.e. tailor-made 'environmental flows'. These flows may be seen as a compromise between water resources development and maintenance of river ecology and communities that depend on the river. It is obvious that rivers will and should be developed. The question is – to what extent? Does it make sense, for example, to build a dam upstream of a National Park or religious site frequently visited by tourists or pilgrims, and where water flow can be reduced to a trickle, affecting aquatic and terrestrial fauna and revenue?

Environmental flow management is an emerging area of river basin management worldwide. Sri Lanka presently has neither a clear legislation related to environmental flows, nor accepted approaches or expertise for this. Meanwhile, the issue of balancing the needs of aquatic environments and other users, like hydropower generation and irrigated agriculture, is becoming critical. Many of Sri Lanka's rivers are regulated already. Some have large dams that effectively reduce the flows in downstream areas. In the vast majority of cases, if not all cases, there are no arrangements made to provide water for ecological purposes. There are increasing instances where river regulation is causing declines in biodiversity, with knock-on socio-economic implications (e.g. saline intrusion of lower rivers affecting drinking water supply).

At the same time, Sri Lanka is a rather humid country, and pressures from a growing population and economy on water resources and ecology are still not as pronounced as they are in some other, drier, countries of the region. This creates good opportunities for implementing some pro-active water management measures and testing water management innovations, like developing and implementing environmental water management regulations. Many things are easier to achieve in a small country of which Sri Lanka is one. Sri Lanka has a great history of water resources development. Some of its numerous tanks go back as far as BC. With some extra bit of good will and resources, the country may become a pioneer of environmentally sustainable water resources development, where water can still flow to the ocean and be useful to man, or else all water developments may end up being… rewardless.

I am sure that this is what King Parakramabahu meant, anyway.

Dr. Vladimir Smakhtin, Principal Researcher,
Global Research Division

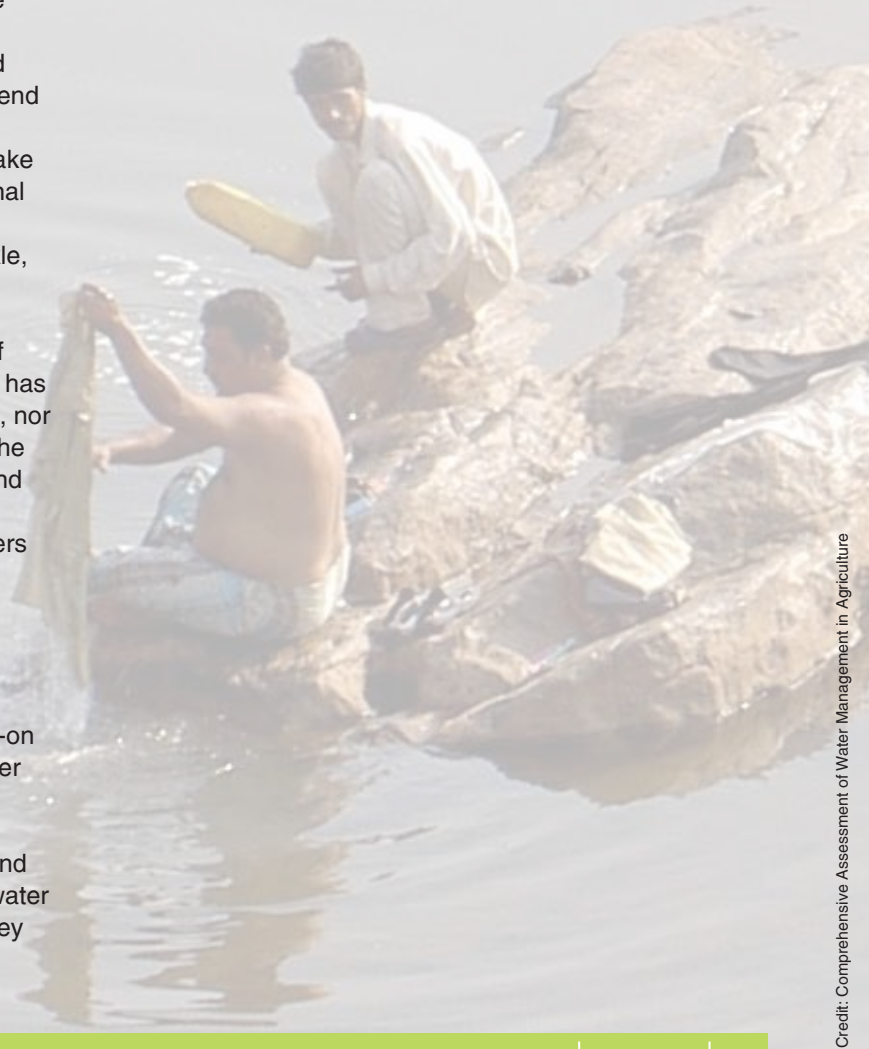

Photo Credit: Comprehensive Assessment of Water Management in Agriculture

Understanding and Documenting Cross-Disciplinary Research in Wetland Systems

Nidhi Nagabhatla and Sonali Senaratna Sellamuttu

Wetlands are important ecosystems with several beneficial functions. Agriculture and fisheries have been identified as being among the most important drivers of past and current wetland loss and degradation. However, no one really knows the full extent of loss these wetlands are subject to, as there are many knowledge gaps.

The Millennium Ecosystem Assessment confirmed that the extent of wetland mapping and inventory was inadequate and there was no accurate or reliable global assessment. In response to this need, IWMI developed a Global Wetland Inventory and Mapping (GWIM) project to work with partners through the framework of the Ramsar Convention. The project undertook a comprehensive multiple purpose and multi-scale wetland inventory and mapping exercise. In Sri Lanka this was carried out at a local scale which subsequently expanded to a regional scale. The adopted framework was developed in line with Ramsar resolutions using an integrated inventory, assessment and monitoring approach though partnerships with local stakeholders. IWMI also identified capacity building opportunities to implement through its local partner, the Central Environmental Authority- a key institution involved in wetland analyses and inventory in Sri Lanka.

In the past, conventional research on natural resource systems was mostly discipline-based. More recently, increasing cross-disciplinary processes have opened new vistas, offered new insights and posed new challenges both in resource management and conservation planning. The present case study addresses the change dynamics in a coastal wetland system using an integrated approach in a geo-spatial medium.

A pioneering study was carried out from 1987 to 2002 to monitor wetland change in urban coastal wetland systems such as the Muthurajawala Marsh bordering the Negombo lagoon, located on the West coast of Sri Lanka. The study looked at both the environmental and livelihoods/poverty aspects using a combination of satellite remote sensing data and socioeconomic parameters such as information on population, poverty, employment patterns and natural resource consumption. A tool was developed to detect environmental change and establish links between spatial and social dynamics. This approach is currently being upscaled and diversified for inland wetland systems, focusing on Kolleru Lake –a Ramsar site in Andhra Pradesh, India.

The study also aimed at improving understanding of the major drivers of change or “stress indicators” by combining spatial data with social data at different scales, eg. village level or household level. Research showed that significant changes in land cover use had occurred over the period of study, clearly seen in the temporal GIS maps. The conversion of the Negombo lagoon into a shallow water body with sediments and the fragmentation and conversion of marshland into settlements and industrial areas were highlighted, using a spatial analysis which was supported and validated by socio-economic data collected through both conventional household surveys and participatory methods. Changes have been observed and experienced by local communities and these have had an impact on livelihood systems.

Household data showed that the change in the lagoon though sedimentation had adversely impacted the productivity of fisheries. The shrinking of areas under marshy land was perceived with mixed opinions. On one hand , the increasing settlements constructed by filling marshy land brought in greater development such as road accessibility and connectivity for the area. On the downside, the decline of natural marshy areas which are important for draining excessive rainwater, resulted in annual flooding due to reduced water retention and the flow of floodwaters. Environmental change as perceived by people was driven by the magnitude of their dependence on the wetland.

The integration of socio-economic data collected at different management scales to refine and validate the process of spatial change was an example of how to address environmental issues using a cross-sectoral approach in natural resource systems. The earth observation satellite data provided a synoptic overview of the landscape while the socioeconomic data helped to understand the change in livelihood systems driven by change in land cover use units. The rationale behind using a cross disciplinary research approach in this case was to foster increased efficiency and equity in addressing wetland management issues.

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Study findings showed that the change in the lagoon though sedimentation had adversely impacted the productivity of fisheries.

Bundala

Why "Development Drainage" can Compromise Water Quality

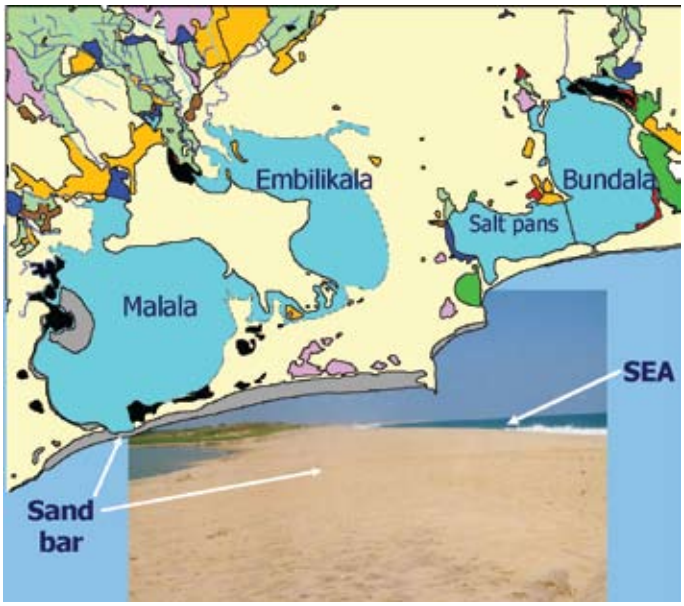
Based on a study on impacts of agricultural drainage and water quality in the Bundala Ramsar Wetland Lagoon System by S.C. Piyankarage et.al.

The addition of nutrients to water bodies and changes in water quality, salinity levels and land use due to agriculture, human settlements and livestock rearing may induce reversible or irreversible ecological changes in wetlands. A better understanding of wetland characteristics and potential impacts can allow policy makers and wetland users to implement policies, legislation and management systems leading to suitable use of wetland resources for economic gains, while preserving biodiversity and natural habitats. IWMI and local partners studied the seasonal variations of water quality of the Bundala, Embilikala and Malala, lagoons and the processes affecting water quality and quantity during three agricultural seasons.

The brackish coastal wetlands of the Bundala National Park in Southern Sri Lanka are an important economic zone as well as a habitat for water birds. The Bundala Lagoon, which is one of the three key lagoons of the Bundala wetland system, remains largely intact and pristine while the other two interconnected lagoons are impacted by drainage from upstream agricultural lands. While Bundala is an important area for migratory birds, the Kirindi Oya Irrigation and Settlement Scheme (KOISS), also located in the upstream part of the wetlands, was established to help uplift poor rural communities. Agricultural drainage in the newly developed settlement area is diverted into the Embilikala and Malala lagoons as a management practice, but it affects the water balance, nutrient status and ecology of the wetlands.

Because the Bundala Lagoon is not directly connected to the upstream irrigation scheme, impacts are felt less here. However, the salinity level of the Bundala lagoon is more than that of the other two lagoons due to the connection to the sea, nearby salt farms and less dilution of salt from low surface run-off and rainwater. Agricultural drainage to the Embilikala and Malala lagoons, includes dung and urine from cattle which graze on nearby lands. In addition, the breaching of the sandbar by farmers to protect upstream paddy lands results in fluctuating water levels and increased salinity. This in turn affects wading birds and other wildlife dependent on food sources in the shallow mud flats of the lagoons.

Freshwater from the Lunugamwehera agricultural scheme (pictured here) flows into the Embilikala and Malala lagoons as drainage water often carrying runoff from cattle refuse.



Map showing the Bundala lagoon and the two interconnected lagoons of Malala and Embilikala. The salinity level of the Bundala lagoon is more due to its connection to the sea and the nearby salt farms.

Tests showed that while the Ph quality of the three lagoons ranged between 7.1 and 8.2 from 1999 to 2000, there could be pressure put on aquatic life forms – especially fish. There has been a decrease in fish and shrimp populations owing to a significant drop in salinity levels, the accumulation and enrichment of nutrients in the lagoons, and the extinction of species as well as changes to habitat diversity. The economic and social impacts have also been felt by local communities with the ensuing decline in eco-tourism and fisheries. Phosphorus additions were also noted during the early months of paddy cultivation, with higher levels reported in the Embilikala lagoon, related to upstream agricultural activity. Even the average nitrogen concentration in the Embilikala lagoon was more than that of the Bundala and Malala lagoons.

What solutions can reduce these adverse impacts? Agricultural influences have been noted primarily at the beginning of the growing seasons. Research shows that reducing agricultural drainage water to the system through proper management during these periods could prevent the need for breaching the sandbar and also mitigate negative impacts on the lagoon ecosystems. The estimated nutrient loads and water inputs from upstream agricultural systems can be used to design suitable practices to minimize the addition of agricultural waste into the lagoons. In addition, the provision of suitable pasture lands for livestock outside the wetland area could decrease cattle grazing within the National Park. Excessive agricultural drainage water could be used to irrigate and fertilize these pasture lands. Buffer zones, if set up between the Bundala wetlands and the upstream agricultural lands, would help decrease the amount of agricultural drainage coming into the lagoons.

Waterbirds at Risk?

Maria Grazia Bellio

Waterbirds are wetland-dependent birds, and a key component of wetlands such as those in the Bundala National Park. Waterbird populations around the world have been declining and are largely affected by the continuous loss, degradation, and alteration of wetland habitats as a result of agricultural expansion and development activities.

The ecological significance of Bundala National Park as a habitat for waterbirds, and in particular migratory shorebirds was recognized by the listing of the Park as a Ramsar site in 1991. In the last two decades, however, as a result of agricultural expansion, following the implementation of the large KIOSP agriculture scheme upstream of the Ramsar site, it is believed that the hydrology of the Ramsar wetlands has been modified by irrigation drainage flows. These have endangered the natural ecosystems. Other pressures, such as invasive plant species, and pollution from fertilizers used in agriculture are known to have altered and deteriorated the environmental integrity of the Bundala lagoons.

Although agriculture and irrigated agriculture in particular, have been critical in supplying the food needs of an ever increasing human population, the conversion or drainage of wetlands for agricultural development, altered hydrological cycles, and pollution resulting from the use of fertilizers, have been the principal causes of inland wetland loss and habitat degradation worldwide.

Water regime modification has made some wetlands permanently flooded and many wetlands more permanently drier. It has also reduced the diversity of wetlands in the landscape. Manipulating the water regime

Redshank looking for food in Embilikala Lagoon. Fluctuating water levels affect wading birds dependent on food sources in the shallow mud flats of the lagoon.

Flamingoes landing near Malala lagoon. IWMI is assessing the effects and potential impacts of hydrological changes on waterbirds and their habitats.

of wetlands has ecological consequences. For many waterbird species, wetlands become more productive when they are shallow, as their potential as a hunting habitat increases significantly. Prey concentrate and contribute to the productivity of the habitat. Such temporal variation produces more diverse and dense waterbird communities across most feeding groups. If we aim to maintain the diversity of wetland communities, we need to understand and investigate the effect of such alteration to water regimes on the survival and composition of different species of flora and fauna.

A PhD project was started in 2006, as a joint collaboration between the University of New South Wales in Australia, IWMI and the Department of Zoology of the University of Colombo. The project is assessing the effects and potential impacts of hydrological changes on waterbirds and their habitat in two of the lagoons at the Bundala National Park. These changes have occurred as a result of agricultural expansion in the Kirindi Oya settlement area. Research examined the waterbird responses to cycles of flooding and drying in wetlands, in order to determine what happens to the waterbird community when these cycles are modified or disrupted by irrigated agriculture. Mechanisms that regulate and drive resource use, including habitat selection, spatial distribution and , from broad landscape scale (within the basin) through local scale to within-habitat fine micro-scale have been investigated. The data collection will be completed at the end of September 2007, covering two wet and two dry seasons. The preliminary results suggest that hydrological changes have potential negative impacts for the waterbird community. The final analysis of the data aims at developing ecologically meaningful models for examining management options and developing priorities for monitoring and managing waterbirds and their habitat in Bundala National Park.

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Pesticide Pollution:
Mitigating the Negative Impacts

Alexandra Clemett

In 2005-2006 a joint collaboration between IWMI and Mott McDonald studied diffuse agricultural pollution in Kachchigal Ara in southern Sri Lanka. The results suggested that pesticide pollution of water resources is not a problem in the area, but other agricultural activities such as irrigation and fertilizer application may have greater impacts on water quality.

Studies on the health impacts of pesticide poisoning in Sri Lanka found that the majority of the 11,000 pesticide poisoning cases admitted to hospital each year are self-inflicted and that 24% of farmers surveyed had suffered at least once from acute occupational pesticide poisoning (Smit, 2002). However, less research has been done on water pollution from irrigated agriculture and its subsequent impacts on health, despite it becoming a major worldwide concern due to the increasing use of agro-chemicals.

IWMI's research involved farmer interviews, livelihoods analyses, and water and sediment monitoring. Findings revealed perceptions that water quality in the area was declining due mainly to reduced water flows and sedimentation. Communities using canal water for bathing and washing encountered difficulties during periods of decreased water flows in irrigation canals, with a high concentration of sediments. Groundwater quality was an issue, with women complaining about its salinity and difficulties in washing and cooking with it. Concerns over agrochemicals related more to perceptions of pollution - usually due to knowledge of pesticide use - rather than any clear health or livelihoods impact. The water pollution scenario would have been different if the study area were grown with non-paddy, or other seasonal crops such as vegetables, that require a high intensity and high frequency of agro-chemical application. The study area is grown predominantly with paddy and banana crops. This does not suggest that the issues are not real, but simply that they are more difficult to account for.

Water samples collected from field drains and various tanks in Kachchigala Ara, and from the Kalametiya Lagoon, showed the presence of six pesticides in the middle of the cultivation season, but at levels below the FAO limit, probably because the new generation of pesticides degrade quickly (within 3 days) leaving low residual levels.

Research conclusions were that impacts of diffuse agricultural pollution do exist, but pesticide pollution may be more significant in areas where there is higher pesticide use, for example where vegetables are grown. To mitigate the impacts of pesticides on health and the environment, improved handling and storage practices; and prevention of spills or ingestion when applying fertilizers are important. This project was funded by the UK Department for International Development (DfID).

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Agricultural activities such as irrigation and fertilizer application can have greater impacts on water quality.

Working Partnerships

An interview with Chandanie Edussuriya and Ajith Gunawardena of the Central Environmental Authority (CEA) on a wetland mapping project carried out between IWMI, IUCN and the CEA.

Wetlands are a sanctuary for biodiversity, also contributing significantly to human well-being in many ways. Conserving wetlands has now become important on both a local and global scale. Proper planning and management with the help of spatial and aspatial data are necessary to save wetlands. Chandanie and Ajith are both Senior Environmental Officers of the CEA who worked together with IWMI to map wetlands in Sri Lanka (boundaries and vegetation cover) using GIS-remote sensing technology. IWMI's task was to develop the methodology at basin scale, and transfer this knowledge to the CEA who would use it to map wetlands in Sri Lanka on a national scale. The maps were incorporated into the first National Wetlands Directory of Sri Lanka published jointly by the CEA, IUCN and IWMI in 2006. The project therefore had a dual purpose: that of building the capacity of the CEA, while generating new knowledge on wetlands in Sri Lanka.

Can you tell us more about the collaborative research between IWMI and the CEA?

The wetland mapping methodology was developed by IWMI's GIS Lab and as part of our training, we carried out a field survey to test and refine the methodology and to collect "ground truth" points. Simply put, this means matching the GIS satellite imagery with the ground reality in the study area. We did 5 days of this field work around the Weerawila, Tissamaharama, Debara and Yodha Tanks in the Ruhuna Basin, together with members of IWMI's GIS Lab. This paved the way for a more detailed mapping of a hundred wetlands in Sri Lanka. To date, nearly 85 wetlands across Sri Lanka, except for those in the Northern and North-Eastern Provinces, have been mapped by us using this methodology.

Photo Credit: Aminul Islam

Environmental officers of the CEA working with members of IWMI's GIS lab to map wetlands in Sri Lanka.

Photo Credit: Aminul Islam

Ajith Gunawardena and Chandanie Edussuriya of the Central Environmental Authority (CEA) on a field survey with IWMI.

What were the outputs of this project and how would they help meet the CEA goals?

One of the key outputs was the development of a Wetland Directory which was the first of its kind. The project sought to identify wetland boundaries and vegetation cover for the year 2000. Knowledge transfer was equally important to build the capacity of the CEA by transferring mapping methods. The CEA gained a lot of technical knowledge and was made aware of the IWMI DSP database which has a wealth of information. The knowledge gained by the CEA on wetland mapping and monitoring can be used to map other ecosystems. In addition, following this collaboration, Chandani worked for the GIAM Workshop on Irrigated Area Mapping in the Ruhuna Basin for 3 months and, together with Ajith, also worked with IWMI researchers to develop a wetland monitoring model for the Muthurajawala and Negombo Lagoons. (See page 3 of Water Matters for details on this project.) This involved collection of ground information and extensive field tours and a research paper on this project was published by IWMI.

What are your impressions of IWMI and the work it does, especially in the area of GIS/RS and wetlands?

We found staff at IWMI very helpful and we gained a lot of valuable knowledge. We also realized the importance of GIS tools and data. More awareness needs to be created about this among policy makers and those who can benefit from the technology. As most of IWMI's GIS work is carried out in the Ruhuna Basin, it might be good to extend the work to other areas of Sri Lanka s well. The database of wetlands that we developed together with IWMI is very useful. There is, however, a need to differentiate between wetlands that are important for biodiversity and wetlands that are important for agriculture. There are species of birds and animals that are currently under threat due to agricultural expansion and other human interventions, and the data derived from a wetlands inventory could be used to help determine the right type of conservation practices necessary.

Interviewed by Sanjiv de Silva & Dawn Rodriguez

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Photo Credit: Sharmani Gunawardena

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Research Reports

RR 96. Locating the Poor: Spatially Disaggregated Poverty Maps for Sri Lanka

RR 94. Balancing Irrigation and Hydropower: Case Study from Southern Sri Lanka

RR 87. Economics and Politics of Water Resources Development: Uda Walawe Irrigation Project, Sri Lanka

RR 77. Simulating the Hydrology of Small Coastal Ecosystems in Conditions of Limited Data

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RR 62. Irrigation Sector in Sri Lanka: Recent Investment Trends and the Development Path Ahead

RR 55. Water Scarcity and Managing Seasonal Water Crisis: Lessons from the Kirindi Oya Project in Sri Lanka

RR 51. Valuing Water in Irrigated Agriculture and Reservoir Fisheries: A Multiple-Use Irrigation System in Sri Lanka

RR 32. Water Scarcity Variations within a Country: A Case Study of Sri Lanka

Working Papers

WP 103. An Assessment of Hydrology and Environmental Flows in the Walawe River Basin, Sri Lanka

WP 92. Small Tank Cascade Systems in the Walawe River Basin

WP 89. Adaptive, Participatory and Integrated Assessment (APIA) of the Impacts of Irrigation on Fisheries, Evaluation of the Approach in Sri Lanka

WP 69. Institutional Changes to Reduce Land Preparation Delay in the North Central Province of Sri Lanka

WP 61. Anicut Systems in Sri Lanka : The Case of Upper Walawe River Basin

WP 59. Multi-Level Participatory Consultative Approach for Institutional Change in River Basins: Lessons from the Deduru Oya Case Study

WP 58. Developing Effective Institutions for Water Resources Management: A Case Study in the Deduru Oya Basin, Sri Lanka

WP 44. Simulating Impacts of Irrigation on the Hydrology of the Karagan Lagoon in Sri Lanka

Websites

The International Water Management Institute is a nonprofit scientific research organization focusing on the sustainable use of water and land resources in agriculture and on the water needs of developing countries. IWMI works with partners in the South to develop tools and methods to help these countries eradicate poverty through more effective management of their water and land resources.
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Global Irrigated Area Mapping (GIAM)
http://www.iwmigiam.org/info/main/index.asp

Integrated Database Information System (IDIS)
http://dw.iwmi.org/dataplatform/home.aspx

Malaria Control
http://www.iwmi.cgiar.org/malariacontrol/index.asp

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Model for National Level Water and Food Policy Dialogue
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