

Contents

Irrigation for Food Security

Agriculture, environment and food security Dr. P. B. Dharmasena	2
Natural rhythm (rain fed agriculture) cultural rhythm and food security in the North-Central Province of Sri Lanka Professor H.M.D.R.Herath	3
Participatory approach to minimise flood and drainage Impacts on Agricultural Lands - Case study of Walawe Basin Eng W. J. Prematunga.....	4
Holistic approach to ensure food security through cascade system development in the dry zone of Sri Lanka – A practice from Plan Sri Lanka K.H .Jagath Kumara Harischandra.....	5
Instability of paddy production and regional food insecurity in Sri Lanka. A.P.S.Fernando ¹ , A.M. S. Perera ² and K. Karunagoda ³	6
Food security and rural irrigation rehabilitation experiences from rural irrigation rehabilitation in Ratnapura District of Sri Lanka B. V. S. K. Bopitiya	7
Utilization of aquatic plants: A method to enhance the productivity of water in seasonal tanks in Anuradhapura District J. U. Munasinghe ¹ , M. A. A. B. Dilhan ² and T.V. Sundarabharathy ¹	8
Sustainable land use patterns of the traditional village tank cascade system in the Dry Zone of Sri Lanka: Case study of the Paranahalmillewa Cascade at Medawachchiya Division Dr. K. W. G. Rekha Nianthi.....	9
Water shortage in the Lower Deduru Oya Basin K. N. J. Katupotha.....	10
System of rice intensification (SRI) and food security among the poor: opportunities and constraints Dr W. G. Somaratne	11
Impact of water saving irrigation systems on water use, growth and yield of irrigated lowland rice W. M. W. Weerakoon, Priyadarshani T. N. N., Piyasiri C. H. and L. S. Silva	12

Ancient irrigation technology and water management techniques in Sri Lanka – Appropriate theories and practices for application Chandana Rohana Withanachchi	13
Potential for zero tillage technique in rice and other field crop cultivation in rice based cropping systems in dry and intermediate zones of Sri Lanka. S. N. Jayawardena, S. W. Abeysekera, N. Gunathilaka and K. Herath	14
Integrating agroforestry characteristics in to agro well based agriculture Muditha Prasannajith Perera	15
Importance of seasonal planning on irrigation water productivity: Inginimitiya experience W. G. Gnanadasa.....	16
Temporal variation of Agroclimatological zones in Sri Lanka H. M. J. K. Herath	17
Improved paddy production by optimizing use of water in major irrigation systems W. M. G. B. Giragame.....	18

Water Quality, Environment and Climate Change

Wetlands and agriculture – a case for IWRM in Sri Lanka Sithara S. Atapattu, Sanjiv de Silva and Sonali S. Sellamuttu.....	20
Improving biodiversity and productivity in dry zone home gardens through rain water harvesting Tanuja N. Ariyananda	21
Environmental flows assessment and valuation – Recent examples from Sri Lanka P. Dissanayake, N. Weragala and V. Smakhtin	22
How to minimize the negative impacts on Bundala National Park (Ramsar Wetland) by irrigation development of Kirindi Oya River basin in the southern part of Sri Lanka Mr. W.D.S. Abeywickrama	23
Non-user benefits emanating from enhanced water flow to Yala Protected Area Complex P. Weligamage ^a , W. R. Butcher ^b , K. A. Blatner ^b , C. R. Shumway ^b and M. Giordano ^a	24
Treatment and non-treatment options to improve the quality of irrigation water contaminated with wastewater: example from Kurunegala, Sri Lanka P. Dissanayake and A.E.V. Evans.....	25
Consumer acceptability and household water security through stored rainwater: A case study in Anuradhapura District M.A.C.S.Bandara ¹ , Ranjith Premalal De Silva ² and N.D.K. Dayawansa ²	26
Potential to increase the area under paddy cultivation with domestic and municipal wastewater irrigation in Kurunegala District U. S. C. Udagedara and M. M. M. Najim.....	27

Availability and spatial variability of plant nutrients in paddy fields of Wilgoda irrigation scheme in Kurunegala D. N. Sirisena.....	28
Cost effective approach to assess water pollution potential by fungicide residues using three agricultural environments in upcountry of Sri Lanka Ransilu C Watawala ¹ , Janitha A Liyanage ¹ and Ananda Mallawatantri ²	29
The impact of inappropriate soil management on river water quality M. G. T. S. Amarasekara	30
Distribution of Fluoride in groundwater in some selected areas of Anuradhapura District R. M. S. Ratnayake	31
Preliminary groundwater assessment and water quality study in the shallow aquifer system in Attanagalu Oya basin R. S. Wijesekera and C. Kudahetty.....	32
Vulnerability to climate change in Sri Lanka: Adaptation strategies and layers of resilience Frank Nirajan	33
Climate change, local institutions and adaptation experience: The village tank farming community in the dry zone of Sri Lanka Athula Senaratne and Kanchana Wickramasinghe.....	34
Identify the impact of tide level for river basin flooding M. D. E. K. Gunathilaka, D. N. D. Perera and W. A. L. Wickramanayake.....	35
Rainfall fluctuation and changing pattern of agriculture practices L. Manawadu	36
Climate change and rainfed agriculture in the dry zone of Sri Lanka C. R. Panabokke and B. V. R. Punyawardena.....	37
How prepared are water resources and agricultural sectors in Sri Lanka for climate change? A review Nishadi Eriyagama and Vladimir Smakhtin	39

Policies, Institutions and Data Needs for Water Management

Sri Lanka's water policy: Themes and issues V. K. Nanayakkara	41
Enhancement of capacity of farmer organizations for sustainable irrigation systems in Anuradhapura and Kurunegala Districts Dr S. Thiruchelvam	42
Multiplier impacts of irrigation Investments Deeptha Wijerathna and Kamal Karunagoda.....	43

Interventions necessary in capacity building in existing water organizations to improve productivity and access to water Badra Kamaladasa.....	44
Contribution of food markets and their behavior for food security: a comparative study on marketing arrangements in different irrigation systems T. A. Dharmaratne.....	45
Local Governance for effective and productive water management process Sisira Saddhamangala Withanachchi	46
Sri Lanka's water future to 2025-2050 - scenarios and issues Upali Amarasinghe.....	47
Economic valuation of irrigation water under a major irrigation scheme (Gal Oya) in eastern Sri Lanka A.L.Ameer Ali, A.N.Ahamed and P.Sivarajah.....	48
Sand barriers and access to water – community pressure and policy interventions in river sand mining in Sri Lanka Kusum Athukorala.....	49
Irrigation infrastructure management by public funds - How it can be made justifiable? Eng Namalee Madawalagama and Eng Badra Kamaladasa.....	50
Managing irrigation with farmers - history, present status and future review of participatory irrigation management in Sri Lanka K.Jinapala, Lal Premadasa, P. G. Somaratne and M. Samad	51
Policy alternatives of the management of minor and medium irrigation schemes to develop groundwater systems in restricted catchments for the improvement in food productivity in the dry zone of Sri Lanka Subramaniam Sivakumar	52
Irrigation development, food security and poverty alleviation in Sri Lanka: past trends and future directions Madar Samad.....	53
Development of a water resources assessment and audit framework for Sri Lanka Matin M., Smakhtin V., Pallyagruge M., Mohideen S., Yapa N., Ranjith A., Gunasinghe S.	54
Green Accounting System for Sri Lanka Athula Senarathna	55
Effects of land use/land cover on the water source vulnerability: The cause study on intermediate zone of Matale District S.I.S Subasinghe	56
Data and information management for water management Rev. Mawila Anomadassi Thero.....	57

**Surface runoff estimation over heterogeneous canal commands applying medium resolution remote sensing data with SCS-CN method
Priyantha Jayakody and Nilantha Gamage.....59**

**Benchmark basin research in Walawe River Basin
B. R. Ariyaratne, P. G. Somaratne, K. Jinapala.....60**

Irrigation for Food Security

Agriculture, environment and food security

Dr. P. B. Dharmasena

**Free Lance Consultant, No. 227, Government Agriculture Quarters, Mahalluppallama,
dharmasenapb@yahoo.com**

Agriculture requires inputs, which can be found within the system or are supplied from outside. The latter, referred to as the 'Green Revolution' in the 1950s and developed as high external input agriculture, has spread over the world as a solution to the food crisis which arose due to World War II. The drive embraced a special package including high yielding crop varieties, inorganic fertilizer, agro-chemicals and farm machineries. As a result farmers in many developing countries began to practice mono-cropping with high external inputs. This has turned traditional ecological agriculture into environmentally destructive food production systems, which provided huge amounts of produce causing serious environmental damage. During the Green Revolution traditional crop varieties were replaced by high yielding new improved varieties. However, natural pest resistance of these high yielding varieties was generally poor and nutritive requirements were also high. Increased use of pesticides and chemical fertilizer is a matter of concern. Some of the issues and problems due to indiscriminate use of pesticides are pest resistance, pest resurgence, health hazards, environmental pollution and lower profits to farmers. Overuse of chemical fertilizer has created environment issues such as nitrate leaching, release of greenhouse gases and eutrophication of inland water bodies. The Millennium Development Goals earmark the eradication of extreme poverty and hunger, while ensuring the environmental sustainability. This dispels the concept of achieving food security in any country through the adoption of high external input agriculture. Sri Lanka remains vulnerable to natural disasters such as floods, droughts, cyclones, landslides and epidemics, causing substantial threats to the food security situation of the country. Challenges posed by external factors due to globalization and open economic policies have directed the country's agriculture to move away from the self-reliance. This situation demands a firm and perfect policy for the country's agriculture. Further, present agriculture does not show any indication of sustainability as it has ignored the centuries old wisdom of traditional agriculture. Farmers' dependency-mentality evolved due to modern agriculture and the government policies dealt with agriculture from time to time should gradually be removed by developing self-confidence, self-motivation and empowerment. There is great potential to increase productivity in Sri Lanka as only 40% of the average grain yield of its potential was achieved in different ecological and hydrological regimes. By narrowing this yield gap, Sri Lanka will not only increase productivity but also increase the competitive advantage for rice with the other countries in the region. The experiences of the present productivity improvement program of the DOA have clearly shown that the average yield could be increased. In achieving food security in the country major setback of the development process is that institutional linkage among agencies responsible for water, land, agriculture and environment is very much poor and they work in isolation setting their own targets. Need is felt for urgent attention to formulate a firm policy to implement sustainable agricultural production program in the country in order to ensure the food security in Sri Lanka.

Natural rhythm (rain fed agriculture) cultural rhythm and food security in the North-Central Province of Sri Lanka

Professor H.M.D.R.Herath

Department of Sociology, University of Peradeniya, Peradeniya, herathsoc@yahoo.com

Food production is the main behavioral adaptation of human beings from the ancient stage of human civilization. They converted nature into culture and produced energy and goods for human life. Nutritional food is the main life securing component of human beings. In the North Central Province people practiced seasonal cultivation of food production with monsoon rains and irrigation water. The main objective of this paper is to examine the relationship between the local people's food habit systems, health management and rain fed food cultivation method used in the N.C.P. Sri Lanka. The main research method used to collect data was focus group discussion and interviews. Peasants in the N.C.P, Sri Lanka their cultivation or food production cycle is mainly dependent on the monsoon rains. They organize food behavior in terms of food availability of food varieties in nature, and then convert nature into cultural preparations, such as main foods, additional foods, seasonal foods, curries, sweets, prestige foods and normal foods. Further they classify foods in terms of the seasonality and the life cycle associated practices. This food behavior pattern is assumed to prevent health problems during the year, reduces disease occurrences and seasonal ailments. According to this analysis the months of January, February and March belong to Gingelly cultivation system which expresses low consumption levels, which is mainly dependents on stored volumes of grains, yams, availability of green leaves on the seasonal monsoon rains. After the 15th of March rice consumption increases gradually up to three meals per day because after the main rice harvesting period grain availability increases. After the 15th May the new food cycle will be further improved with forest fruits becoming available for collection and consumption. At least 18 fruit varieties can be added to the dietary system. This period enables higher consumption of rice, fruits and vegetables. After the month of July the consumption of rice needs to be reduced; the pattern of food preparation and consumption is adjusted to save at least a small amount to survive during this period. From August to December food consumption patterns dramatically change. People use stored food of diverse varieties in dried form and green leaves, tank fish and mushrooms are prepared in different food consumption behavior patterns help to maintain body health and prevent different types of health problems. The study examines how monsoon rains, Chena cultivation food security exists within the time and space in the rural area of the NCP, Sri Lanka.

Participatory approach to minimise flood and drainage Impacts on Agricultural Lands - Case study of Walawe Basin

Eng W. J. Prematunga

Irrigation department, Irrigation Engineer's office, Ridiyagama Raod, Ambalantota,
wjprematunga.id@gmail.com

The middle reach and lower reaches Walawe Ganga are rich with irrigation reservoirs and serve more than 4000 ha of farmlands. The river meets the sea at Ambalantota where densely populated urban areas are located on both banks. The agricultural land and surrounding urban area in this lower reach is vulnerable to frequent inundation due to overflow of Walawe River or due to blockage of the local drainage. The main reason for this situation is the blockage of the river mouth by the sand bar making water stagnate and not flow freely to the sea. The practice to prevent flooding was for the Irrigation Department to use machinery to cut open the sand bar, but systematic operational procedure was established for flood mitigation and no dedicated source of funds allocated. In early 2008, a non-governmental organization which was engaged in disaster management in the area initiated an action to develop a systematic flood operation plan in the lower reach. The Divisional Secretary facilitated all the stakeholders to form one platform to draw up a participatory approach in managing the floods. A committee was appointed comprising all technical institutions responsible for drainage, other administrative organizations who usually engage in social welfare activities, farmers and urban dwellers who are victims of the floods. This committee agreed upon for a systematic flood management plan after several deliberations. Roles and responsibilities were defined for each stakeholder in the process. A common fund was established with the financial support of government and non-governmental sector. The community based organizations were assigned to get the readings of the gauges established in a water level reader network. A feedback system was introduced to all the stake holders during and after the floods. Frequent inundation of agricultural areas in low lands especially in the coastal belt of the country is to be arrested to achieve the cultivation targets to have the food security. Since this is the first time a joint mechanism enforced for management of river flood in the Walawe basin, many lessons can be drawn from this case to replicate the system in the other river basins. The objective of this paper is to discuss the challenges faced during the planning stage and the experience gained during the operation of the flood management plan during the last year.

Holistic approach to ensure food security through cascade system development in the dry zone of Sri Lanka - A practice from Plan Sri Lanka

K.H .Jagath Kumara Harischandra

Plan Sri Lanka, 621/13, Godage Mawatha, Anuradhapura,
jagath.harischandra@plan-international.org

Lack of food security is caused by the disruption of agrarian systems, land fragmentation, lack of irrigable land, indebtedness and poor post harvest technology. Additional factors shown in secondary data are variable and erratic precipitation, poor development of hydraulic infrastructure and lack of access to water for domestic and productive uses which exacerbate factors that contribute to poverty. The economy of the dry zone is principally dependent on agriculture, with over 85% of its population dependent on the sector. As the rainfall distribution is largely unpredictable and uneven, communities rely on rainfall and a system of complex cascade system consisting of interdependent reservoirs (tanks) that dates back 2,000 years. This ancient system strikes a delicate balance between water management and the physical and social environment. The condition of the cascades is vital to improving the availability of water in the community throughout the year. Tanks not only support the irrigation needs of farming households but a variety of other uses including drinking, bathing, cooking and fishing. The water body also nourishes vegetation and provides water for domestic and wild animals. It is a deep rooted idea that physical intervention or infrastructure development is vital to address water related development issues, but it is only a part of a broader range of necessary actions. In addition to physical improvement or physical capital improvements, provision, retention and management of water in a water scarce environments depends on the social, financial, natural and human capital that require equal priority in development and protection. Having realized the integrated nature of the systems, Plan Sri Lanka has implemented a holistic community development approach to cascade rehabilitation in Anuradhapura District. The program involves restoration activities in five cascades covering 29 irrigation tanks that were selected based on hydrological viability. Farmer organizations that carry out tank restoration activities were provided technical support to ensure continuing operation and maintenance, and were given training on appropriate farm technology and watershed management. Linkage with other development agencies was promoted. Cascade management committees composed of stakeholder representatives were organized to coordinate development activities and resolve conflicts. Integrated agriculture schemes that incorporate suitable farming systems and improved cropping practices were introduced. The approach came up with challenges and learning that conventional approaches to water and food scarcity need to be addressed through comprehensive strategies that address a more holistic spectrum of issues. This approach puts the integrated concept and ancient tank eco systems as the nucleus and the Cascade System Development Project of Plan Sri Lanka puts the social and human capital as equally important components in the rehabilitation process. The paper discusses the Plan Sri Lanka's experiences and lessons learned in implementing social, financial, physical and natural capital interventions putting the cascade as the operational unit for development. It examines constraints and limitations practically faced in the implementation stage and institutional and operational requirements which are to be discussed for further improvement in this kind of approach.

Instability of paddy production and regional food insecurity in Sri Lanka.

A.P.S.Fernando¹, A.M. S. Perera² and K. Karunagoda³

¹ *Lecturer, Department of Agricultural System, Faculty of Agriculture, Rajarata University*

² *Programme Assistant, Socio Economics and Planning Centre, Department of Agriculture*

³ *Agricultural Economists, Socio Economics and Planning Centre, Department of Agriculture*

Addressing food insecurity has become an important policy issue due to host of factors such as climate change, export restraints, alternative uses of food such as bio-fuels and income induced demand changes. The world has to find avenues to provide sufficient food catering for the new development in the food sector and bearing the risk of the changes in production of the environment. Paddy, the staple food crop of Sri Lankans, plays a significant role in stabilizing food security in the country. The production levels of paddy have been accompanied with wide regional variations due to irregularities in the rainfall patterns and cyclical effects of the production fluctuations. More thrust has been placed on irrigated paddy production in the areas of dry zone and traditional areas of the wet zone have been subjected to immense population pressure amidst various institutional arrangements. At present, more than half of the paddy output comes from the major irrigation schemes. The wide fluctuations in paddy production levels in these areas indicate the potential for regional vulnerability for food insecurity. This paper examines the growth of paddy production and evaluates the instability of paddy production in terms of area cultivated, production and yield for dry zone (DZ), intermediate zone (IZ) and wet zone (WZ) and districts. The growth rates for different zones were estimated using a log linear function. The instability of area, production and yield was measured using coefficient of variation (CV). The CV of production, area and the yield for three major climatic zones and seasons are estimated. In addition, indices for risk of cultivation and amount of green vegetation on the island were derived as indicators of instability. Paddy production has increased at the rate of around 2 per cent and 1 per cent per annum in the DZ and IZ respectively; and has decreased in the WZ at the rate of 9 per cent per annum. The CVs for paddy production in the DZ, IZ and WZ in *maha* and *yala* seasons are 18.15, 18.36, and 9.2 and 30.33, 25.38 and 19.22 respectively. The results indicate that instability of paddy production in the WZ is much lower than those of other two zones. The lowest instability with respect to production (*Matara*), yield (*Kegalle*) and harvested extent (*Ratnapura*) was observed in the wet zone districts. The highest level of instability with respect to area, yield, production and harvested extent was observed in *Anuradhapura* district. In the *maha* season, the IZ shows the lowest variation in sown extent and highest variation in the harvested extent and it indicates the higher risk of production at the later stage of the crop. The IZ shows the general risk in paddy production in the *yala* season, indicated by the highest instability in both sown and harvested extent. Similar observations for the IZ were observed in sown to harvest and CV of vegetation index. The negative growth rate observed in the WZ was brought about by the reduction of cultivated area. The higher stability in production could be utilized to augment regional food security as well as supply of seed paddy for other regions. Thus the results highlight the importance of maintaining WZ as a buffer zone of production and investments in irrigation in the IZ to secure availability of paddy.

Food security and rural irrigation rehabilitation experiences from rural irrigation rehabilitation in Ratnapura District of Sri Lanka

B. V. S. K. Bopitiya

Department of Agrarian Development, Agrarian Services Center, Ratmalawinna, Balangoda,
bvsk.bopi@hotmail.com

wksl=a Èia;%slalj,g idfmalalslj r;akmqr Èia;%slalh IDIsmdrißl l,dmhka w;ska úúO;ajhla olakj fiau tAyd neÿkq IDIs ld¾ñl iy wd¾:sl úúO;ajhlao ks¾udkh ù mj;S 'tfiau fuys jdßmoaO;s ie,ISfi§ uyje.s " uydjdßud¾. jHdmdr iy .%dóh jdßud¾. wldr ;=klu mj;S 'ta w;r .%dóh jdßud¾. 1753 IA l=vd jeú56 la iy 1697wuqKq f,i mj;S' tu u.ska fmdaYs; iim%udkh fylaghd¾ 13452 ls' by; IS jdß moaO;s w;r w;ayßk ,o jdßmoAO;s .Kk 362 ls tksidfjka mqrj jk ii m%udKh fyla' 497 ls' tu jdß moAO;s w;ayer oeóug m%Odk lrekg jkafka .xj;=r iy kdh hEi" ueKsla l¾udka;h" jeä wdodhu iys; jeú,s fnda. ioyd fhduquú" ksisf,i kv;a;= fkdlsú" c, ys.h wdÈh fõ' jdß l¾udka; 315 la h,s il%Sh lsífuka mqrjxj we;s l=Tqre fyla'432 la h,s wiajeoAúug bvla we;' oekg ls%hdldrS;;ajfhka mj;sk jdrs moaO;s \$h,s ilS%h lrk ,o jdrsIraudka;hka wdydr iqrlals;;djh ioyd ldrahlaluj odhl lr.ekSug Iraudka;h w^;ajevshdj\$mqkre;a;dmkh fukau wod, jq f.dú ixúOdkh l%shldlj mj;ajdf.k hEu ;=,ska ukd fufyhqí iy kv;a;= jevigykla ls%hd;aul lsú" kj IDIs ld¾ñl ;dlalKh yÿkajd \$u ;=,ska wiajekak m%udKd;aulj iy .=Kd;aulj j¾Okh" ldk;a;d iyNd.s;ajh fmdalK ;;ajh jeäÈhqKqIsú wvx.=jk ls%hdldrí meflachla l%shd;aul lsú l,hq;=nj 2001-2007 ld,fha fuu Èia;s%alfha tlai;a cd;Skaf.a f,dal wdydrjevms,sfj, hgf;a ls%hd;aul l, .%dóh jdß mqkre;a;dmk jevigyk 40 la iinkaOfhka l, miq we.hSu ;=,ska ;yjqre úh'

Utilization of aquatic plants: A method to enhance the productivity of water in seasonal tanks in Anuradhapura District

J. U. Munasinghe¹, M. A. A. B. Dilhan² and T.V. Sundarabarathy¹

¹Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University, Mihintale.

²The Study Centre, The Open University of Sri Lanka, New Town, Polonnaruwa, buddhika_dilhan@yahoo.com

Heavy infestations of aquatic plants in a water body cause considerable economic and ecological losses. Many seasonal tanks in Anuradhapura District suffer from this problem and cannot be neglected in water resource development and management schemes. This study focused on the uses of aquatic plants and the problems caused by heavy infestations. It was conducted in four seasonal tanks: Galkulama, Tirappane Maradankadawala and Tibbatuwewa, in Anuradhapura District. Information on utilization of aquatic plants, exploitation level and harmful effects were gathered by interviewing people in the study sites. The attitudes of the public towards the aquatic plants i.e. conservation of aquatic plants, the potential uses of native plants and harmful effects of invasive aquatic plants were collected. Twelve species were identified as economically important aquatic plants through the questionnaire survey. Among the 50 respondents, 92% utilized aquatic plants for foods, 58% utilized flowers for offerings and decorations, 52% utilized aquatic plants for medicinal purposes, 42% utilized them as ornamental plants, 30% as bio-fertilizers and 28% for weaving. The edible aquatic plants consumed by the rural community in the Anuradhapura district are *Ipomoea aquatica* (72%), *Alternanthera sessilis* (66%), *Nelumbo nucifera* (64%), *Nymphaea pubescens* (60%) and *Aponogeton* spp., (52%). Some edible aquatic plants, namely *Neptunia oleracea*, *Ottelia alismoides* and *Ceratopteris thalictroides*, which are present in the Anuradhapura District are not consumed although these are popular foods in many other countries. *Nelumbo nucifera* is the most commonly used flower for offerings in the temples and decorations. In addition, *N. pubescens*, *Nymphaea nouchali* are also used for flowers. *Baccopa moneri*, *N. nucifera*, *Acanthus illicifolia*, *N. nouchali* and *Aponogeton* spp. have been recorded as medicinally important plants. Though there are many ornamentally important aquatic plants, only *N. pubescens*, *N. nouchali*, *B. monnieri*, *Nymphaoides hydrophylla* are used. *Salvinia molesta* and *Eichhornia crassipes* were the two aquatic plants commonly used as bio-fertilizers. With reference to the questionnaire survey, seven major problems existed due to heavy infestations of aquatic weeds in the water bodies viz., sedimentation, unsuitability for domestic use, interference with navigation, effects on fisheries and blocking irrigation canals and evapotranspiration. Most problematic plants in Anuradhapura District include *E. crassipes*, *N. nucifera*, *S. molesta*, *Pistia stratiotes* and *Ceratophyllum demersum*. Economically important aquatic plants available in the shallow water bodies are marginally utilized but not to a satisfactory level, when compared with the utilization of aquatic plants globally. There is no well organized action plan to improve this situation, and the public suffer from the problems created by a mass of aquatic plants covering in their village tanks. They are willing to get organized and to engage in a participatory approach to restore their water bodies. There is a need for research and the development of management strategies for sustainable utilization of these valuable resources. Awareness programs should be conducted to promote sustainable utilization of aquatic plants. Such awareness of the people about the nutritional and economical benefits of these natural resources will be useful for Sri Lanka.

Sustainable land use patterns of the traditional village tank cascade system in the Dry Zone of Sri Lanka: Case study of the Paranhalmillewa Cascade at Medawachchiya Division

Dr. K. W. G. Rekha Nianthi

Department of Geography, University of Peradeniya, Peradeniya, bnishanthi@yahoo.com

Sustainability of the traditional village tank system had continued in the past not only from structural protection but also each and every component of the eco systems of the village tanks cascades in the Dry zone of Sri Lanka. The attention was paid by the traditional community not only on macro-land uses, such as paddy lands, settlement areas, chena lands, forest lands and tank beds but also to micro-land components such as *goda-wala* (water break), *iswetiya*, *gasgommana* (grove trees), *perahana* (filter), *diyagilma* (tank bed) *kattakaduwa* (interceptor), *tis-bambe* (*common ground*) and *kiul-ela* (drainage channel). The main objective of this research was to identify the different components of the land use pattern of the traditional village tank cascade systems of the Paranhalmillewa cascade. Primary data and information was collected from field investigations, based on the baseline survey conducted in 2007/2008. Secondary data was collected from (F1/TS) and (F-3/) data sheets of the Rural Minor Irrigation Survey conducted by Govijana Seva Department in 2006, and office of the A.G.A Division at Medawachchiya. Data of the extent of catchment, command and water spread areas of the individual tanks were also collected. Existing traditional mechanisms of land use practices of the tank ecosystem is identified through participatory observational methods, conducting discussion with members of the farmer organizations and focus group interviews with relevant persons. Thirty five tanks have been identified in the cascade with its own traditional components with various extents of the individual tanks. About 23 tanks are basically occupied for paddy cultivation in various sizes in the cascade. Some of the tanks were identified as abandoned, silt trap, forest and animal exploit tanks. Flora and fauna is identified in the individual tanks using Random Line Transect Method. Out of thirty five tanks in the cascade 15 were examined for flora classification and 20 were examined for fauna classification. The study revealed that the traditional sustainable land use practices have been deteriorating at this village tank cascade due to various reasons. Indigenous farming heritage needs to be built-up through a newly introduced cascade committee for the sustainability of village tank cascade. This may comprise an attitudinal change of our cascade nation through enormous efforts.

Water shortage in the Lower Deduru Oya Basin

K. N. J. Katupotha

Department of Geography, University of Sri Jayewardenepura, Gangodawila, Nugegoda

Acute water shortage for agricultural, domestic, industrial and other activities is evident in the Lower Deduru Oya Basin (LDOB) due to changes in land use, abandonment of irrigation structures, extensive use of tube wells and lowering of ground water levels. This situation has been instrumental in slowing down the agricultural development, weakening the socio-economic activities and social milieu and also in controlling the improvement of living standards of the area. In the early 1990s farmers had agro-wells dug in their own farmlands. Subsequently, farmers obtained water from shallow tube wells and then shifted to deep tube wells due to the lowering of the ground water levels following micro morphology. Initially, the ground water level in the area was around 8-12 m and this increased to 30m. Consequently, the amount of water in Deduru Oya also reduced. In some places the water was not flowing due to low amount of water and deepening of the river. About 20 years ago this river bed was about 6-8 m from the surface level, but today this level is at 12-15 m in many places. This has resulted in the flowing of ground water into Deduru Oya through lateral seepage. Many farmers have reported that turbidity, pollution and salt water intrusion are the major issues in tube wells. In some instances, due to high salt concentration in the water of tube wells closer to Deduru Oya and river mouth, extracting water for irrigation has become a problem. In order to evaluate the quality of water in the LDOB, the study team examined the electrical conductivity, salinity and pH values of the water of 33 water samples from different locations. The result of these samples revealed that the quality of water is not suitable for drinking. In some locations, for example, where the electrical conductivity is below 2000 and the salinity is also below 5.85, indicate that such water cannot be used for bathing and even for washing purposes. Inability to use soap and similar material and discolouring of white cloths are the major problems in many locations. If this water is used for leafy vegetables, they will be easily exposed to sun-burning. Further, laboratory analysis reveal that the salinity exists even in water samples obtained from tube wells 10-15 m deep, where the tidal water flows up to Ariyagama, Rambepitiya (left bank) and Dematapitiya (right bank), about 8-10 km inland from the Deduru Oya mouth. It has been revealed that the village society in the past has had a well linked social coherence. Accordingly, construction, maintenance and rehabilitation of rural tanks, roads, community work and other infrastructure improvements have continued with the participation of all. This has been changed due to the introduction of market based economic activities, especially plantation of commercial crops. This process was aggravated due to excessive sand mining during the last decade, and damaged the self sustaining economic activities. The social milieu was also destroyed creating several social issues, for example, increased use of alcohol, hashish and similar things.

System of rice intensification (SRI) and food security among the poor: opportunities and constraints

Dr W. G. Somaratne

Advocacy and Programme Policy Manager, Oxfam Australia

The Global Triple 'F'—Fuel, Food and Financial Crises caused food prices to escalate in the global food market over the past two years. It created detrimental effects in developing countries including in Sri Lanka and its food market in general and food security in particular. The objective of this paper is to examine the opportunities and constraints in promoting a System of Rice Intensification (SRI) to maintain food security among the poor in Sri Lanka. The economics of SRI, opportunities and constraints in maintaining food security among poor in Sri Lanka was analysed. The upward productivity shift, eco-friendliness, saving scarce water resources, and reduction of cost of production created opportunities for farmers to maintain food security among the poor. The constraints in promoting food security through SRI are analysed. Further, the strategic policy and operational options to promote SRI and maintaining food security among poor in Sri Lanka are proposed. It is absolutely necessary to promote SRI to enhance sustainable and eco-friendly food production to maintain food security among the poor in the country. It will be a new paradigm shift in the right direction to maintain increased food production and food security among the poor in the country.

Impact of water saving irrigation systems on water use, growth and yield of irrigated lowland rice

W. M. W. Weerakoon, Priyadarshani T. N. N., Piyasiri C. H. and L. S. Silva

Rice Research & Development Institute, Batalagoda, Ibbagamuwe, rice@sltnet.lk

To meet the growing demand to feed the increasing population and other needs, rice production in Sri Lanka which was 3.87 million tons in 2008 has to be increased to 4.2 million tons in 2020. This requirement could be achieved by increasing productivity and/or by increasing the cultivated extent. In 2008, about 77% and 68% of the total paddy land extent was cultivated with either partially or fully irrigation during Maha and Yala respectively. A considerable paddy land extent was either not cultivated or cultivated to other crops due to scarcity of water in the Dry and Intermediate Zones. Further the competition for water for domestic and industrial needs will continue to increase while changing climate will result in a demand for more water and a further reduction in water for rice cultivation. Conserving irrigation water would allow increasing the cultivated extent while reducing the probability of late season water stress to the cultivated rice crop. We studied the impact of different soil water regimes on water use, nutrient uptake, growth and grain yield of 3 - 3½ age low land rice at Rice Research and Development Institute, Batalagoda. There was no significant difference in grain yield in rice when grown under either saturated and flooded conditions but decreased significantly with alternate wetting and drying. However, under saturate conditions, the irrigation water requirement was significantly lower than the flooded condition. The lowest irrigation water requirement was recorded with saturate to dry conditions. Irrigation water requirement under flooded conditions when compared with saturated conditions increased by 39% during yala. During maha season, even though the total irrigation requirement was lower, when compared to saturated conditions, four times more irrigation water was required under flooded condition. There was a significant increase in plant dry matter production and leaf nitrogen (N) under saturated conditions when compared with conventional flooded conditions. However the weed incidence was significantly greater under saturated conditions. These findings suggests that when soil water is maintained at saturated level in lowland rice, a considerable amount of irrigation water could be saved without sacrificing grain yield but it needs better weed management options.

Ancient irrigation technology and water management techniques in Sri Lanka - Appropriate theories and practices for application

Chandana Rohana Withanachchi

Senior Lecturer, Department of Humanities and Social Sciences, University of Rajarata, Mihintalaya, withanachchi@yahoo.com

ශ්‍රී ලංකාවට ආවේණික වූ දේශීය වාරි ක්‍රමයක් බිහි කිරීමෙහි ලා භාවිත කරනු ලැබූ තාක්ෂණික හා ශිල්ප ක්‍රම සම්බන්ධයෙන් වූ දැනුම අපගේ පැරණි උරුමයකි. දියුණු තාක්ෂණයෙන් අනුභව වැඩි ඉදිකිරීම් සඳහා වූ දැනුම හා මානසික ශක්තිය පැරණි දේශීය ජනතාවට තිබුණි. මේ පිළිබඳව දෘශ්‍ය සාක්ෂි දිවයිනේ වියළි කලාපයෙන් හමුවේ.

වර්තමාන ජල කළමනාකරණ ක්‍රියාවලිය සඳහා පුරාතනයේ භාවිත කළ ගංගා, අමුණු සහ ඇළ මාර්ග වාරි තාක්ෂණයේදී යෝග්‍ය උදාහරණයක් ලෙස භාවිතා කළ හැක. ඒ සඳහා වාරි නිර්මාණ වටා ගොඩනැගුණු දේශපාලන පද්ධතියත්, ශිල්ප ක්‍රමත් වර්තමාන ජල කළමනාකරණ ක්‍රියාවලිය සාධනීය තලයකට ගෙන ඒමට අධ්‍යයනය කළ යුතු වසසරියකි. මෙම පර්යේෂණ පත්‍රිකාව මගින් දැනුරු ඔය ආශ්‍රිතව පළමු පරාක්‍රමබාහු රජතුමා විසින් සිදුකළ අමුණු නිර්මාණ ශිල්පය පිළිබඳව විද්‍යාත්මක ගවේෂණයක් ඉදිරිපත් කිරීමට අපේක්ෂිතය.

Potential for zero tillage technique in rice and other field crop cultivation in rice based cropping systems in dry and intermediate zones of Sri Lanka.

S. N. Jayawardena, S. W. Abeysekera, N. Gunathilaka and K. Herath

Rice Research and Development Institute, Batalagoda, Ibbagamuwa,
senarathjayawardena@yahoo.com

High cost of production and scarcity of water for crop cultivation are some of the major problems faced by the farmers in many rice based cropping systems in the country. In many crop production systems, of the total cost of production, around 15-20 % accounts for tillage/land preparation, which also consumes around 15% of the total water requirement. Hence, it is important to adopt technologies that would save the water and reduce the cost of cultivation without sacrificing the yield. This paper discusses experiences with the adoption of zero tillage (without tillage) crop establishments in rice and other field crop cultivation in paddy field in the dry and intermediate zones. Zero tillage conditions were created by application of total weed killer “Glyphosate” after the field was drained and establishment of crops thereafter without tillage. Six season results on rice cultivation show that the rice crop could be established under zero tillage conditions without significantly affecting the yield. This practice helps to cut down the total cost of cultivation by around 15%, and save water at least for the period of 1-2 weeks and shorten the time taken for land preparation considerably. In the same way, many crops such as green gram, cowpea and blackgram and maize could be cultivated under zero tillage conditions. Experiences shows that zero tillage technology has many advantages over conventional tillage and needs to be given more attention to develop appropriate machinery suit to this conditions and fine tune the technologies to suit to different cropping systems.

Integrating agroforestry characteristics in to agro well based agriculture

Muditha Prasannajith Perera

Department of Geography, University of Peradeniya, Peradeniya, mudithpras@gmail.com

The major challenge for the Dry Zone farmers in non-irrigated areas in Sri Lanka is water scarcity. This situation is a major barrier to the sustainable use of resources and maintaining income generation activities throughout the year. In this context these farmers realized the need for another source of water. The strategy was the construction of large diameter wells (agro wells) to tap the shallow ground water, in low lying areas, either near the small tanks or the small streams. The rate of construction of agro wells has accelerated with the interventions of the Agricultural Development Authority and the provincial council, since 1982. Generally, cultivation of perennial crops using agro wells is not common. Only seasonal crops are cultivated and income was obtained only during a particular period. As a new trend, some farmers in the dry zone of Sri Lanka used this shallow ground water opportunity to cultivate perennial crops as well as seasonal crops throughout the year. Further, farmers aimed to grow woody tree species for their timber requirements and economic purposes in their own agricultural land. A lot of farmers have realized that these woody trees such as teak and halmilla may be disturbing their crops. Therefore they moved these trees to the marginal areas or tail end of the lands. In addition some farmers attempted to maintain animal husbandry such as rearing cows under the perennial crops, using the shade and grasses under the trees. This context provided a unique opportunity to explore this new land use pattern revealed in the Dry Zone of Sri Lanka, recently. Field research for this study was conducted covering 20 agro well based agricultural lands out of the total of 68 in the "Aluth Divulwewa sub watershed" in "Yan Oya watershed", in the dry zone of Sri Lanka. The collected data was analyzed using qualitative and quantitative methods. The land equivalent ratio (LER) has revealed that 90 % of lands represent more productivity and canopy cover has increased up to 41.5 % from 7.9%. Further, evolution, composition, characteristics, layers, and spatial arrangements of these land use patterns, represent 100 % of agroforestry characteristics according to the Nair's classifications. Thus, this context has successfully proven that these Agro well based agricultural lands have converted into "more productive and diversified agricultural systems" with agroforestry characteristics.

Importance of seasonal planning on irrigation water productivity: Inginimitiya experience

W. G. Gnanadasa

Department of Irrigation, Co-PD's Office, PEACE Project, Irrigation Department, Air Port Road, Anuradhapura, wggnanadasa@yahoo.com

In very simple terms, the operation of water level in a reservoir for a whole season is called seasonal planning. For this purpose, the prospective water level of the reservoir, for a particular season should be forecast. For this forecast the water balance equation of the reservoir should be known. The terms in this water balance equation are, inflow to the reservoir, evaporation from the reservoir surface, percolation from the reservoir bed, seepage through the dam and irrigation requirement of the crop. It is common that cultivation in many schemes is delayed due to less storage at the beginnings of the season. These delays decrease the yield, which leads to continuous poverty for farmers. Therefore, if one can predict the prospective conditions accurately, especially the inflow to the reservoir, cultivation can be started even with a less storage expecting the balance. According to this by starting the cultivation at the proper time the optimum yield can be obtained where other conditions are right. Hence seasonal planning has a big importance as far as yield and water productivity is concerned. There are some barriers in seasonal planning: some key persons are not interested in seasonal planning; or the necessary data and other facilities are not available. The inginimitiya scheme, a water scarce scheme in Puttalam District, was commissioned in 1986. In 2000 only every other season was cultivated because of water scarcity and the average cropping intensity was 0.98, although the designed cropping intensity was 2. I studied the inflow pattern to the reservoir for more than 10 years. According to it I calculated monthly average inflow to the reservoir. The command area of Inginimitiya had been divided into four zones, so that they can be cultivated one by one according to the availability of water. If, in one particular season the cultivation stops at No 3 zone, in the next season the cultivation was started in the zone 4. I calculated the irrigation requirement for these four sections separately. In the same time I calculated the losses such as seepage, percolation and evaporation. Finally applying these data in the reservoir water balance equation, I forecast the prospective water levels for the whole season. Then in the Kanne meeting before starting the cultivation, I explained this plan in very simple terms in front of the District Secretary (DS) and farmers. The DS gave me the full authority to increase the cultivation area as he was quite conversant on my calculations. Hence we started cultivations with very small storage was in the reservoir. We monitored the forecast water level daily. It was more than 95 % successful. In this way I could complete 2000 Yala in a very successful way. The farmers trusted me. Likewise I did Yala and Maha until 2003. Just because of this method by 2003, I had cultivated full extent of the scheme for three consecutive seasons. Hence I could increase average cropping intensity to 1.19 during this period. The farmers were very happy. Their income was increased by considerable amount. If one engineer works in this way by doing seasonal planning, even in difficult periods under climatic change he can have very good results. It will cause to increase farmer income and food security.

Temporal variation of Agroclimatological zones in Sri Lanka

H. M. J. K. Herath

Hector Kobbekaduwa Agrarian Research and Training Institute, HARTI, 114 Wijeramamawatha, Colombo 7, herathda@yahoo.com

This paper analyses the temporal variation of Agroclimatological zones in Sri Lanka using rainfall data, collected by the Meteorological Department from 1900 to 2005. It also explains the demerits of existing Agroclimatological zones which are being used in the field of climatological study. The kriging method was employed to achieve its main objective, introducing new Agroclimatological zones into Sri Lanka. The investigation about the changes of Agroclimatological zones into Sri Lanka provides some guideline for researchers to target their research based on actual figure of Agroclimatological zone in the country. Finally as a result, maps were created to depict this new delimitation of wet zone, intermediate zone and dry zone in Sri Lanka. Understanding new Agroclimatological zones is also important for policy makers and implementing agencies to target their sustainable agricultural policy planning and other agro based policy planning process with accurate level than today.

Improved paddy production by optimizing use of water in major irrigation systems

W. M. G. B. Giragama

Hector Kobbekaduwa Agrarian Research and Training Institute, P.O. Box 1522, Colombo, gbgiragama@gmail.com

...~ 1954 ...k 2007 s_CE,y f² □Š_ý"Š ũ "ayúq□u □ {Ÿ^ ëP w±{ýo} W_CE_~ 1,031,611 ...k 1,298,864 s_CE,y, □Ī ũ W□q. "{k w±týu Ū}_qCE}_CE ...w}y W□qCE"qCE {t,□□~ ĪuP, □m...k†uñ. ũ W...□,□uCEu s "{ { ,_yüŸ, qφ □ "†_CEk}ý~}k "{.kýuCE 1.5 ...k 4.385 s_CE,y ,Rtu} ũ W□q. úfý□ ú{s(CE s~íuCE ...□w"}u g□} w±f...q, zýúqý _~ Zwō{ w±Ō□ýz}_CE ~kk "au Ý} }Ÿqφ, W□q. A ...vtý "Ÿ{Ÿ ,£ Wtμ}u}_CE XÝōwqCE _~u "{ wŌ²_y, ...vtý †Ÿ~□,□,, uýEeà,, uŸ,~, □,, ~ýgýŠau ,□,, _pMŸ□◊□, w~ý_2{ ...{Ÿâ} ...† íuCE"uCEō} g□ýf Wýf²q, ...ſ _~u □Ÿ. ,ýō{ýRa "swýRq"PuCEqφ",uCE †ý ,ýō g□ _†{uý_~o WŠf"}◊ "qý~qφ~□ wsuP _~"au "{ { Wtμ}u"}◊ † g□} "yÚ†□ō"PP ...† }□ ...† {†_uCEu qφ† g□} "yÚ W□Ō Wý_ý~}, W...□,□uCEu †ý ,ay Ō²,±qý, ú{...y y□u □Ÿ. }□ †ý {†_uCEu qφ□ g□ ...□w}Ÿ{ †ý ũ ,ay ëP w±{ýo} Wq~ ...PyuCEtqý, "...ũ{ ...vtý w±q~wý}u úfCE"□,□, ...ſ _~ W□q. \{aTMuCE W_CE_~}_ ũ ,ay »ō{ ...vtý ...□wñ} }Ÿqφ,□ g□ w±{ýo} auu} _~ W□q. {†_uCEu} qφ□ g□ ...□w}Ÿ{ †ý ũ ,ay ëP w±{ýo} Wq~ ...PyuCEtqý, w²Ōwý}u (Regression) úfCE"□,□, sqCEq 35 _CE W□...ŸōuCE ...ſ _~ ,ýō g□ ...□w}Ÿ{ †ý ũ ,ay ëP w±{ýo} Wq~ ...PyuCEtqý, A = 3.349558 IWS - 1578.8 y, □□ì W□q. "{†TM IWS = ,ýō g□ ...□w}Ÿ{ (W_CE_~ WĪ) †ý A = ũ ,ay ëP w²{ýo} (W_CE_~) "S. {†_uCEu} qφ□ çRu} ...Šaφo_} (Coefficient of Determination R²) 0.831201 ũ w±Ōwý}u ...Šaφo_} (Regression Coefficient R) 0.911702 ú}. {†_uCEu"}◊ † ũ ,ay »ō{ ...vtý WĪ 3.35 _ w{os ,ýō g□ w²{ýo}_CE ...□wñ} }Ÿqφ y, □□ì W□q. \{uCE{ }□ _uCEu} qφ□ g□ ...□w}Ÿ{ †ý ũ ,ay ëP w±{ýo} Wq~ ...PyuCEtqý, A = 4.492131IWS + 2391.724 {aTMuCE Ū_CE"S. \uP }□ _uCEu} qφ□ ũ ,ay»ō{ ...vtý WĪ 4.49 _ w{os ,ýōg□ w±{ýo}_CE ...□wñ} }Ÿqφ y, "wè}ñ. çRu} ...Šaφo_} (R²) 0.911702 ũ w²Ōwý}u ...Šaφo_} (R) 0.950616 ú}. ,R,,ý g□} □□"yu ç...ý {†_uCEu"}◊ Wa} }□ _uCEu"}◊ Wa}k ,mý WmŸ ũ W□Ō y, "wè}ñ. "{ { Wa}uCE _uCEu} WuŸ, "{uCE{ g□ýf} †ý □□yŸoi ,□...~ w±{ýo} WuŸ, "u...◊ "S. uýEeà"Š 2004 }□ _uCEu"}◊ † g□ WĪ 0.9 _CE w{os 2007† g□ WĪ 10 _CE w{os ũ ,ay, ...vtý "Ÿsú{k ...ſ ũ{uCE \} w□†□Ÿ□~ "S. ũ ç,,wýsu"}◊ † g□ x□Ūñqý, }uCE"uuCE ,ýō g□ bu ík~}_CE {aTMuCE çwsú} †□» ũ _~□□ aou s_CE,y W□q. }□ _uCEu"}◊ "{ { Wa}uCE ...□□_! úk Zwō{ Wa} ,u bu ík~}k ũ »"□□ 0.61 "wuCE,y W□qCE"qCE 2007 uŸ,~, □,ñ. uýEeà, g□ x□Ūòqý, WŌuCE W,{ {Ik{ _ W□q. \} 2005 † 0.12 _CE ũ W□q. g□ x□Ūñqý, ,□Ī g□ýf, □ WŌ"R_ ,ay ëP W□qCEuP ,ay »ō{k g□} □yý†{ ũ ç,,wýsu WŠf"}uCE ,mýqCE †TMq_~ "ñ. {†_uCEu"}◊ Zwō{ Wa} ,u g□ bu ík~}k ũ »"□□ 1.1 "wuCE,y W□qCE"qCE 2003/04 ,... "R uýEeà, □,ñ. 2002/03 † uŸ,~, □, x□Ūòqý, WŌuCE bu ík~}k ũ »"□□ 0.21 ,□ç w†† {Ik{ _ W□q. ũ ç,,wýsu} ...□_uúk g□ x□Ūñqý, ,□Ī g□ýf, □k ,ýō g□} □yý†"P w²{Ÿqý}_CE Ū_CEŪ{ ,mýqCE †TMq_~ "ñ. g□ýf, □ g□} †TMd }□ _uCEu ,□† w□,Ō} †□» ,R,,ýwqu} ,□Ī uP w{os _CE ũ ,ay, ...ſ »ō{kqCE \} WmŸ uP aou} »ō{»uCE w...Ÿ "Ÿk..._ " ,uqCE "ž□a ,ay»ō{qCE x□Ūò y, "wè}ñ. ...•{ ,□,_{ ,ay,uCE ...vtý W,fμ g□ w²{ýo}, □□ë} †□» ,R,,ý, †ý w,Ōu g□ w±{ýo} W□...ŸōuCE ,ay _~u ëP w±{ýo} aou} _~ ,ay, W□~i} }Ÿqφ}. w...Ÿ, ...Ōwqý g□} ç_çqCE _~ ç_çqCE »ō{k †□» "fCE,,, W□Ō g□ w±{ýo}qCE ,ýō g□ ...Pwýsu} ...vtý "ŸyÚ aq}Ÿqφ w²{ýo}qCE ...□_ý WŌ"R_ ,ay,uCE ...vtý g□} ç_çqCE »ō{ Xqý w±"Šf"}uCE ...ſ _~□ }Ÿqφ "S.

Water Quality, Environment and Climate Change

Wetlands and agriculture - a case for IWRM in Sri Lanka

Sithara S. Atapattu, Sanjiv de Silva and Sonali S. Sellamuttu

***International Water Management Institute, 127, Sunil Mawatha, Pelawatte, Battaramulla,
s.s.desilva@cgiar.org***

Wetlands are habitats with temporary or permanent accumulation of water. The degradation and loss of wetlands is more rapid than 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 cover conserving the ecological integrity of the ecosystem but also pay specific attention to the local people's well-being, thus contributing to alleviating their poverty status. Maintenance and sustainability of wetlands, both fresh and marine, have a multitude of benefits in addition to the environmental benefits such as for agriculture, flood control, water purifications, 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 for agriculture (70 %) - for food production - the basic requirement for human survival. Therefore, in a situation of wetlands versus food production the balance tips towards food production without realizing the consequences and appreciating the benefits derived from achieving a balance. This is where Integrated Water Resource Management (IWRM) should be adopted to facilitate this process where wetland management and agricultural management all fit into the picture along with the other uses of water - multiple uses. Sri Lanka being a country with agriculture very high on the agenda, IWRM should be of vested interest. It also is 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 which are concentrated mainly in the coastal belt. The absence of an integrated approach to water resource development however continues to erode natural wetland systems through high levels of agricultural pollution especially through the excessive use of fertilizers and modifications to the hydrology which are often felt on downstream fisheries and livelihoods. The objective of this paper is to review IWMI's work on wetlands and agriculture in Sri Lanka to look at the competing water demands between water for wetlands and agriculture keeping in mind the requirements for nature and livelihoods sustainability. It will address some impacts of agriculture on wetlands, the consequences for livelihoods and the benefits of adopting the IWRM approach. In doing so, the paper will review Sri Lanka's existing wetland policy in the context of the above.

Improving biodiversity and productivity in dry zone home gardens through rain water harvesting

Tanuja N. Ariyananda

Director, Lanka Rain Water Harvesting Forum, No. 28/3A, Subadrarama Lane, Nugegoda,
tanuja@sltnet.lk

Water scarcity is a major constraint for multi-cropping practices of home gardens in the dry zone of Sri Lanka. Therefore, home garden activities are either poorly maintained or totally neglected by the rural farming community of the dry zone. As a result, home gardens in these areas become marginal with low productivity. Poor carrying capacity, poor crop and animal diversity (agricultural biodiversity) and poor soil microbial diversity in home gardens, lead to losses of species, lack of food security and poor standard of living of the community. Changes in the rainfall pattern as predicted by climate change will worsen this situation. To address the water scarcity problem, for drinking needs as well as maintenance of home gardens for food and livelihoods, the only solution is preserving the available rainwater. Due to the bimodal pattern of rainfall in Sri Lanka rain water harvesting which collects, store and save rain water during the rainy seasons for use during the dry season is feasible. This project introduced different methods of preserving rain water within the home garden, in promoting and maintaining the multi-layering home garden systems in 2 villages, Meewellawa and Palugolla in Kotaveheral Divisional Secretariat of Kurunegalla District in the North western province situated in the dry zone of Sri Lanka. A typical 2-acre plot of land in this area, which received annual rainfall of 1000 mm, were constructed with a roof water collection tank for drinking water needs and a traditional “pathaha” (pond) of 100 m³ volume to collect the surface rain water run-off for agriculture purposes. By using effective water conservation irrigation methods such as drip irrigation and pot irrigation, the home garden with its multi-layers of vegetables, fruits, medicinal herbs and timber trees are maintained. In addition the excess water is guided to recharge the ground water table. The project was implemented through ‘The Community Network Project’ of the government and facilitated by Care Sri Lanka in the area. The Community Network Project has made a platform for co-ordination of all existing CBOs (Farmer Organizations, Mahila (Women’s) Societies, Samurdhi Society and Death Donation Societies,) in the area through a strong network with respective bodies. The project introduced the concepts of rain water harvesting, water conservation and biodiversity to develop and maintain the home gardens of rural households in the dry zone of Sri Lanka. Through introduction of these techniques and practices the water needs for domestic, agriculture and environment, were met. Preservation of rain water and development of home gardens also reduces soil erosion. Collection of rain water and preserving for the dry season will equip the households to be better prepared for unpredictable change in weather pattern resulting from climate change.

Environmental flows assessment and valuation - Recent examples from Sri Lanka

P. Dissanayake, N. Weragala and V. Smakhtin

International Water Management Institute, 127, Sunil Mawatha, Pelawatte, Battaramulla,

Assessment and provision of Environmental Flows (EF) is important for the protection of aquatic ecosystems. EF are a set of discharges of a particular magnitude, frequency and timing, which are necessary to ensure a certain range of benefits from a river. Such flows need to be scientifically justified and attempts should be made to value them in economic terms as many decisions on water allocation are made on economic grounds. Limited exposure to these concepts exists in developing countries like Sri Lanka. This paper gives two recent relevant example studies which were conducted by IWMI with foci on EF assessment and valuation of EF benefits in Walawe and Menik Ganga river basins located in a semi-arid zone of southern Sri Lanka. The Walawe example illustrates the simple method for estimation of EF. The EF are approximated at two sites along the main stream of the Walawe River, which are located below the two main reservoirs. A desktop method, based on simulated, unregulated daily flow time series and their flow duration curves is used. The study illustrates how the required hydrological information can be generated for the locations where EFA is intended—quickly and in conditions of limited observed data (which is the typical case in most of Sri Lanka). Based on the lessons learned in this case study, suggestions are made for improved quantification of water resources in Sri Lanka as a whole. The second, Menik Ganga example is used as a case study to evaluate the costs and benefits of environmental water allocations. The EF components evaluated include the water needs of religious festival, the requirements of the Yala National Park, the requirements of the Pilinnawa coastal wetland and grassland 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. The paper intends to stimulate discussion and further research in the fields of EF assessment and economic valuation.

How to minimize the negative impacts on Bundala National Park (Ramsar Wetland) by irrigation development of Kirindi Oya River basin in the southern part of Sri Lanka

Mr. W.D.S. Abeywickrama

Irrigation Department, Regional Director of Irrigation Office Deberawawa, Tiisamaharamaya

The environment sector is an important water user, and one that often finds itself at the bottom of the list of priorities when supplies become scarce. This research studied how the needs of wetlands can coexist with parallel human and irrigation demands. Sri Lanka is a signatory to the convention on Wetlands of International Importance for migratory waterfowl (Ramsar Convention) the high species richness of birds associated with the Bundala lagoons resulted in it being declared as Sri Lanka's first Ramsar site - a wetland of international importance for migratory waterfowl in 1990. The delicate ecological balance of these lagoons will be severely affected by the on-going Weheragala Reservoir Project, which is diverting excess water from Manike Ganga River basin to Kirindi Oya river basin, as well as the Malaa River Basin Development Project. The main negative impacts are lagoons converted to fresh water bodies, eutrophication, accumulate pesticide and insecticide and siltation of lagoons. This research deeply studied how to minimize negative impacts on Ramsar Wetlands using social, economical and engineering tools. The outcomes of the research will be helpful to researches, policy-makers and decision-makers to find opportunities to improve farmer income and national food production and at the same time, sustainable management of wetlands ecosystem in Sri Lanka.

Non-user benefits emanating from enhanced water flow to Yala Protected Area Complex

P. Weligamage^a, W. R. Butcher^b, K. A. Blatner^b, C. R. Shumway^b and M. Giordano^a

^aInternational Water Management Institute, p.weligamage@cgiar.org

^bWashington State University, College of Agricultural, Human and Natural Resource Sciences.

Water is a multiple use resource. Increasing scarcity and competition from different sectors is an important dimension to be considered in its management. Understanding of the values generated by different water uses is therefore necessary to assist decision making in water allocation among sectors. Although water used in agriculture can be valued using production function approaches, such direct valuation methods are not available for environmental uses. This paper uses non-market valuation methods to estimate the economic value of a committed flow through a unique ecosystem, Yala Protected Area Complex (YPC). YPC is an important wildlife refuge situated in Southeastern Sri Lanka. Its large land extent, undisturbed nature and abundance and diversity of fauna contribute to its uniqueness. Partially as a result, Yala is also the most visited national park in Sri Lanka. However, maintenance of the parks ecosystem depends on the flow of the Menik Ganaga. This flow is regulated by Veheragala Reservoir Project, and there is now discussion of reducing flow into the park by about half of the current level. The proposed plan also ensures dry season flow into YPC and has therefore been deemed as it ensures water flow during the dry season. However, there is a potential that farmers will demand further water releases during the dry season endangering the realization of the downstream water releases so there is a potential trade-off between environment and irrigation. Willingness to Pay (WTP) survey was conducted in ten districts of Sri Lanka during the Fourth Quarter of 2008 to estimate the WTP of the general population of the country towards maintaining this important environmental resource. In the hypothetical market presented, participants were told of the need for contributions from general public to ensure the release of minimum downstream flow commitment of 50 MCM. Participants were also informed of how this flow would enhance the ecosystem of YPC. A Dichotomous Choice Contingent Valuation was used as the elicitation format. Non obligatory voluntary contributions were solicited towards a trust fund to ensure release of the required quantity of water downstream during dry months. According to results, 66 percent of respondents were willing to pay. Estimated Mean Willingness to Pay (WTP) for water releases to enhance YPC is 541.67 SLR per annum with 95% confidence interval between SLR 535.12 and SLR 545.22. During the requested payment horizon of ten years, the current value of aggregate WTP for Sri Lankan population to enhance the ecosystem of YPC is 18.78 Billion SLR. This quantity greatly surpasses the estimated 0.93 billion SLR net benefit from rice farming which would be generated if the same quantity of water was used with current prices and input intensities. Thus there is a clear opportunity for national welfare gain. Results of Binary Logistic Regression indicate that educational status, income- class, age and religious attachments as important factors affecting the decision to contribute to environmental flow maintenance to YPC. Graduates are more likely to contribute while respondents from middle income classes and older respondents are less likely to contribute. Religious attachments contribute positively towards contribution. Non significance of the visitor status indicates that non-use values are appreciated by the general population irrespective of their previous experience as a visitor to YPC.

Treatment and non-treatment options to improve the quality of irrigation water contaminated with wastewater: example from Kurunegala, Sri Lanka

P. Dissanayake and A.E.V. Evans

International Water Management Institute, 127 Sunil Mawatha, Pelawatte, Battaramulla,
p.dissanayake@cgiar.org

Many cities in developing countries do not have the resources to install sufficient wastewater collection and treatment facilities. The wastewater flows are discharged mostly untreated or only partly treated into surface water bodies. Downstream these water flows are often a source for urban and peri-urban agriculture. The use of marginal quality water in agriculture is an increasing reality with millions of urban small scale farmers around the world using this water often because they have no alternative water source or their irrigation water sources are contaminated with urban wastewater discharges. Therefore improving the quality of irrigation water by improving the quality of wastewater discharges is of utmost importance for long term sustainability of urban agriculture downstream of cities. Lack of resources (financial and technical) and legislation are impediments both to the regulators and to the wastewater generators when it comes to wastewater management. The paper addresses these issues and suggests options for effective wastewater management to achieve the desired water quality for agricultural end use. The example from the city of Kurunegala examines the roles of treatment and non-treatment options to improve the quality of urban wastewater discharges that contaminated the irrigation water. Treatment and non-treatment options should to be used in combination to achieve the desired results in a cost effective manner and within a short period.

Consumer acceptability and household water security through stored rainwater: A case study in Anuradhapura District

M.A.C.S.Bandara¹, Ranjith Premalal De Silva² and N.D.K. Dayawansa²

¹Hector Kobbekaduwa Agrarian Research and Training Institute, Colombo, Sri Lanka

²Department of Agriculture Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka

Rainwater harvesting has expanded its popularity in rural as well as urban areas of Sri Lanka during the last two decades through a number of water supply projects funded by government and NGO's. The stored rainwater can provide accessibility, reliability and timely availability of adequate water to households. Even though stored rainwater reduces water security for the consumers, the constraints in further popularising it are safety (rainwater quality) and consumer acceptability. Safety of rainwater can be measured at household level by people's perception and in the laboratory by absolute measurements. This study was conducted in Anuradhapura District which is a major district of the dry zone. A questionnaire was used to gather information about the household Roof Rainwater Harvesting (RRWH) situation and filled by asking questions from the household and by observing the existing rainwater harvesting system. Simultaneously, stored rainwater quality and existing domestic water source quality were also analyzed. To assess the consumer acceptability of stored rainwater for households purposes the rainwater quality test was conducted in a laboratory. A population of 746,756 is dispersed among 21 DS divisions in Anuradhapura District. The majority of households meet their drinking water requirement from protected wells (59.6%) and (13.7%) from unprotected wells. Agriculture is the main income generation activity for 75% of the total population. In the pre-project period the most prioritised water source for domestic purposes was open wells and the other was tube wells, because people believe that water in open wells are good quality and drinkable. However, stored rainwater has become the priority source now and the study revealed that more than 85% households used stored rainwater for drinking although some have concerns on the quality and used only after boiling. Easy accessibility of water, cleanliness and quality assurance given by project partners have been the main reason for increasing use of stored rainwater for drinking. The acceptability of stored rainwater for consumption was very high in water scarce areas and with the increasing distance to the nearest good quality water sources. Adequate water was received in wet season by 84 % of those interviewed due to judicious water management and control. Households used water during wet season for domestic activities with a proper understanding of water availability of tank. In the case of dry season, only 21% responded favorably for the adequacy and that water was used for mainly drinking and cooking. Water quality analysis revealed that the chemical and physical quality parameters of stored rainwater are in an acceptable range with respect to Sri Lankan Standards (SLS: 614) of portable water quality. Further, biological condition of stored rainwater was always poor when compared to the quality of other domestic water sources.

Potential to increase the area under paddy cultivation with domestic and municipal wastewater irrigation in Kurunegala District

U. S. C. Udagedara and M. M. M. Najim

Environmental Conservation and Management Degree Program, University of Kelaniya,
mnajim@kln.ac.lk

Wastewater disposal, especially municipal and domestic, paves the way for environmental pollution in many parts of the country. Use of domestic wastewater for agriculture was a traditional practice in Sri Lanka where leafy vegetables and medicinal plants were cultivated in the backyards. The use of domestic and municipal wastewater will be an environmentally sound means of wastewater disposal if utilized in paddy irrigation and this practice will help to increase the economic productivity of the water and land. Therefore, a study was conducted in selected divisional secretariat divisions in Kurunegala District in order to explore the potential increment of land that can be brought under paddy cultivation with the utilization of municipal and domestic wastewater. The wastewater generation was estimated based on the population and water consumption data. The extent of paddy land under minor irrigation and rainfed agriculture, potential asweddumized extent, land area cultivated in maha and yala seasons and the areas harvested were collected from the District Agriculture Department. It is noted that all the available lands were not cultivated and not harvested in both maha (wet) and yala (dry) seasons. Lands left without any production is higher in the yala season than the maha season. Only a part of the land area is harvested from the total area sown. One of the major reasons for crop failure is shortage of supplementary irrigation water, inadequate rainfall and irrigation water. The difference between asweddumized extent and harvested extent shows the potential land availability that can be brought under irrigation using municipal and domestic wastewater. The wastewater irrigation potential is much higher closer to the cities where the storm water and other forms of wastewater is drained through common canal systems. The municipal wastewater can be either diluted with the available irrigation water to meet the total irrigation water requirement or can be used without any dilution. In addition to the increment of the land area under cultivation, there is a possibility of increasing the cropping intensity.

Availability and spatial variability of plant nutrients in paddy fields of Wilgoda irrigation scheme in Kurunegala

D. N. Sirisena

Rice Research and Development Center, Department of Agriculture, Batalagoda, Ibbagamuwa, dinaratnesirisena@yahoo.com

Considerable differences in grain yield have been observed between upper, middle and lower parts of the Wilgoda irrigation scheme in Kurunegala where waste water is used to irrigate paddy fields. Therefore, a study was carried out in maha 2008/2009 season to identify the plant nutrients status and their spatial variability in paddy fields of Wilgoda irrigation scheme. Paddy fields were classified into upper (Peelalwala), middle (Illuppitiya) and lower (Galeyaya) sites along the major irrigation channel, soil samples were collected from fifty six sampling points (17 from upper, 16 from middle and 19 from lower) and geographic positions of the sampling points were recorded using a GPS. Soil samples were analyzed for pH, Electrical conductivity (EC), available P, exchangeable concentrations of K, Ca, Mg, Na, and Zn. Results revealed considerable variability in soil properties between sites as well as within the site. pH values of 5.6, 5.1 and 5.6 and EC values of 71, 69 and 59 were recorded in the Peelalwala, Illuppitiya and Galeyaya respectively. Variability within the site was very high in EC in comparison to pH. The availability of K was low ($< 78 \text{ mg kg}^{-1}$) in all the sites and the lowest K concentration (41 mg kg^{-1}) was recorded in Illuppitiya site. Availability of P and Zn were different in three sites while low concentrations of P and Zn ($< 1 \text{ mg kg}^{-1} \text{ P}$, and $1 \text{ mg kg}^{-1} \text{ Zn}$) were recorded in the Galeyaya situated in the lower part of the irrigation channels. The highest concentrations of Ca, Mg and Na were observed in the upper and lower parts (Peelalwala and Galeyaya) of the feeding area but concentrations were significantly low at the middle part. It can be suggested from these results that soil K, P and Zn levels of the Wilgoda Irrigation scheme are not at the optimum to achieve the maximum rice yields. Within a site differences in plant nutrients were particularly evident in the map of spatial variability so that site specific fertilizer recommendations are needed to achieve the maximum yield. Soluble nutrients (Ca, Na and Mg) are high in upper and lower parts and less soluble nutrients (P and Zn) are high at upper and middle site and as such regular monitoring is needed to study the movement of such nutrients through waste water.

Cost effective approach to assess water pollution potential by fungicide residues using three agricultural environments in upcountry of Sri Lanka

Ransilu C Watawala¹, Janitha A Liyanage¹ and Ananda Mallawatantri²

¹*Department of Chemistry, University of Kelaniya, Kelaniya, janitha@kln.ac.lk*

²*United Nations Development Programme, Colombo, Sri Lanka*

Surface and groundwater contamination due to agrochemicals are a major environmental threat in central agricultural areas of Sri Lanka. Knowledge on the relative risks of agrochemicals used near water bodies is helpful to decide on the less polluting options and to improve management. Lacks of studies of potential contamination and understanding of the processes have been major drawbacks. In literature, simple risk assessment tools have been employed to generate information on relative risks due to the use of different chemicals under varying climatic, soil and management conditions. This study estimated the potential surface and groundwater contamination of widely used pesticides in potato cultivation using a simple risk assessment model named PIRI (Pesticides Impact Ranking Index) for three major agricultural areas in the up country. PIRI is a simple indicator model capable of ranking pesticides according to their leaching ability and toxicity based on climatic, environmental, pesticide chemical data for different application procedures. Three cases of contamination risk of fungicides using the environments of Gregory's Lake, Nuwara Eliya, Oma Oya, Welimada and Poona Wewa, Bandarawela have been evaluated using PIRI. Soils of the study areas were sandy clay loam with 4% organic carbon (OC) in Nuwara Eliya, sandy loam with 3% OC in Welimada and sandy clay with 3.4% OC in Bandarawela. Based on a survey of 69 farmers conducted prior to the study, widely used fungicides in the area have been identified as propeneb and mancozeb. According to the PIRI assessment Gregory's Lake reported an extremely high risk of contamination by mancozeb with high toxicity. The risk to surface water in Oma oya in Welimada was characterized as high for mancozeb while that of the Poona Wewa recorded an extremely high risk. PIRI results also indicated high risk with a medium level of toxicity for water resources at Gregory's Lake, Oma Oya and Poona Wewa, when Propeneb is used. The PIRI approach can therefore be used to evaluate potential pesticide contamination of water bodies as a management tool. In addition the above fungicides contain heavy metals that could also harm humans and the environment. Hence an approach complementary to PIRI is needed to evaluate the fate of metals. In conclusion, results of these modeling efforts along with limited water quality testing for verification are useful as a cost effective way to promote best management practices to reduce water pollution.

The impact of inappropriate soil management on river water quality

M. G. T. S. Amarasekara

Postgraduate Institute of Agriculture Peredeniya, Sirinivasa, Mandawala Road, Radawana,
thusithamarasekara@yahoo.com

Degradation of land and water resources in the up country of Sri Lanka is considered to be a major environmental hazard. The increasing trend of organic and inorganic fertilizer application coupled with the encroachment of riparian zones for exotic vegetable cultivation might aggravate the situation. The results of many studies revealed that intensive farming on steep slopes with over application of fertilizers increase the accumulation of nutrients in water bodies down-stream, mainly due to soil erosion. It is suspected that the renal infections reported in the North Central Province are closely associated with the poor quality of drinking water contaminated with cadmium. Most of the tanks in the Anuradhapura District are fed by Mahaweli River water which flows through intensively cultivated areas in the Upper Mahaweli Catchment (UMC). It is also found that the phosphorus fertilizers commonly used in Sri Lanka contains a considerable amount of cadmium as an impurity. Therefore this study was conducted in the Kurundu Oya catchment (a micro catchment of the UMC) to investigate the soil management of the farming systems and their impact on river water quality. Three villages namely Mahakudugala, Kumbalgamuwa and Batagolla along the Kurundu Oya to represent lower, middle and upper parts of the stream were selected. A questionnaire survey was carried out with a sample of 150 households, selected randomly to represent different farming systems. A soil survey was carried out during 2007/08 to analyze the soil fertility situation on farmlands. Soil samples were analyzed for their physical and chemical properties using standard laboratory methods. At the same time water quality parameters were also tested periodically in the different sections of the stream. The results revealed that nearly 50% of the riparian zones in the upper catchment of the Kurundu Oya were encroached to cultivate potato and other exotic vegetables. The soil analysis indicated that the gravel (>2mm in diameter) content of the 15 cm soil depth was more than 25%. At the same time nutrient accumulation in the soil due to over application of fertilizers was also observed in the vegetable growing plots. High levels of available P (above 75 ppm) were recorded in many vegetable and paddy growing farming systems. Results of the water quality analysis showed that N, P, K levels of the tested samples remained within the standard limits. However, it was found that the P level is closer to the upper level of the standard limit. Therefore, soil test based fertilizer application is strongly recommended for these areas. Moreover, encroachment of riparian zones especially in the upper catchment area has to be considered seriously and the priority should be given to strengthen the institutional capacity in order to implement the existing environmental legislation.

Distribution of Fluoride in groundwater in some selected areas of Anuradhapura District

R. M. S. Ratnayake

Water Resources Board, 2A, Gregory's Avenue, Colombo 7

In Sri Lanka, the vast majority of people depend on groundwater for their drinking and domestic requirements. These water supplies are generally not subject to any treatment except for boiling, particularly at the village level. Therefore, the chemical composition of drinking water in a particular area would almost certainly influence the health of people living in that area. In the previous and present projects completed by Water Resources Board, it has been observed that there were severe social and hygienic problems prevailing mainly in Anuradhapura District in the North Central Province, due to the poor quality of groundwater, especially due to high amount of Fluoride in deep and shallow wells. This has been caused mainly by stagnation of groundwater due to low precipitation and high evaporation and also the influence of mineralogy, weathering and structure of the underlain rock formation of the area. Geologically, high fluoride concentrations area observed in well water were associated with rock types such as biotite gneiss and granitic gneiss. Dental fluorosis has been identified as endemic in the dry zone of Sri Lanka, especially in Anuradhapura District, the cause of which is the excessive Fluoride in the groundwater. By Sri Lankan standards, a Fluoride content of more than 1 mg/l is considered as Fluoride-rich water. In addition, a number of cases reported with Chronic Kidney Diseases (CKD) in Anuradhapura District. In the past few years, some possible causes have been identified by researchers, but not scientifically proven. Among those, scientists assumed that excessive amounts of Fluoride in groundwater is one possible cause for CKD. Water Resources Research and Training Centre commenced with community based awareness programmes including water clinics to mitigate water related health hazards and to study water quality in selected villages in Anuradhapura District. This will be useful to identify areas with poor water quality with particular emphasis for the presence of high Fluoride contents in groundwater. A number of awareness programmes were conducted covering villages in Padaviya, Mihintale, Medawachchiya, Horowpothana, Rambawa, Nochchiyagama and Nuwaragampalataha (Central) D.S. Divisions in the Anuradhapura District. The results clearly showed that more than 40 per cent of drinking water wells in the study area have Fluoride-rich water. More than 70 per cent of wells in Horowpothana, Nuwaragampalatha (Central) and Padiviya areas contain high Fluoride (>1 mg/l) and are not suitable for drinking purposes. It also indicated that Fluoride levels of most of wells (about 40 per cent) occur within the range of 1 - 2 mg/l and, it could be used for drinking purposes with using defluoridator.

Preliminary groundwater assessment and water quality study in the shallow aquifer system in Attanagalu Oya basin

R. S. Wijesekera and C. Kudahetty

Water Resources Board, 2A, Gregory's Avenue, Colombo 07

Attanagalu Oya basin is situated between two major river basins, Kelani and Maha Oya in the Western Province of Sri Lanka with an extent of 779 km². Four streams; Diyaeli Oya, Attanagalu Oya, Uruwala Oya, Kimbulapitiya Oya discharge into the Negambo Lagoon as Dandagamuwa Oya. A study was conducted at Attanagalu Oya basin in order to assess the groundwater potential of the area and to characterize the water quality of the shallow aquifer system of the basin. The available qualitative and quantitative data on groundwater were collected and compiled. A groundwater database was developed for the basin. The total basin area was divided into five major divisions and shallow groundwater monitoring network was designed for each division. Representative shallow dug wells were selected for the monitoring network and 100 samples were collected from each division. Samples were analyzed for 17 physical and chemical parameters (appearance, temperature, turbidity, pH, EC, total hardness, total alkalinity, total dissolved solids, Na⁺, Ca²⁺, K⁺, Mg²⁺, total iron, Fluoride, SO²⁻₄, Cl⁻, salinity, nitrate). In addition to that: 10 samples were collected from surface and groundwater bodies in the paddy cultivated areas and analyzed for pesticides; 10 samples from an industrialized area were analyzed for lead (Pb); and 10 samples from urban areas were analyzed for bacteria. Based on the data collected, geochemical maps (pH, EC, Na, K, F, Fe, salinity, TDS) were prepared for the entire basin. The geo-chemical maps indicated that the pH value of the shallow groundwater in some parts of the Attanagalu Oya basin was very low. The pH value varied from 4 - 8.5 and high EC values were reported in the coastal area. Bacterial contamination was reported in groundwater sources in urban areas. No pesticides contamination was detected in any of the water samples collected in paddy cultivated areas. The occurrence of Pb in shallow groundwater was reported within the range of 0.01 - 0.02 ppm. The major aquifer types that exist in the basin are river alluvium, costal sand and fractured basement hard rocks. The existing NE - SW trending lineaments were identified as promising areas for groundwater development.

Vulnerability to climate change in Sri Lanka: Adaptation strategies and layers of resilience

Frank Niranjan

Senior Research Officer, Sri Lanka Council for Agricultural Research Policy, 114/9 Wijerama Mawatha, Colombo 7, niranjanfr_03@yahoo.com

Agricultural production is sensitive to climate because it depends, for its production process, on heat for energy and on water, both climate-related variables (Dinar, 2007). Global climate change will potentially result in higher global temperatures, changing hydrological regimes, and increasing climatic variability. Key findings of the Inter-governmental Panel on Climate Change (IPCC) show the direct effects on water, plants and animals and the impacts on global scale on the world's food supply. Overall, agricultural productivity for the entire world is projected to decline from levels otherwise reached by between 3 to 16 percent by 2080s as a consequence of global warming (Cline, 2007). Given Asia's heavy dependence on agriculture, the effects of climate change could put millions of people in this region at greater risk of poverty and hunger. According to the coordinated research studies by the Climate Institute, Washington DC, with cooperation from Asian countries and support from the Asian Development Bank, Asia is likely to be hardest hit by the impacts of global warming (with temperature increases in parts of Asia double the global average), with serious regional implications on the livelihoods of poor farmers in India, China, Sri Lanka, Bangladesh, Pakistan, Indonesia, Malaysia, Vietnam and the Philippines. Farmers in these countries will need to adjust to a climate that is changing (with rising sea levels and changed weather patterns) and accordingly adapt with layers of resilience in their farming practices and investment decisions. Climate change is the most important global environmental challenge facing humanity today. The objectives of this study are to improve understanding of climate variability and its impact on the rural poor in Sri Lanka, identify the best practices and institutional innovations for mitigating the effects of climatic change and develop strategies to address socio-economic problems relating to climatic change. The methodology to address the complex challenges and emerging constraints due to climate change in agriculture will require a multifaceted approach that encompasses innovations in policy, institutions and new technologies. This study tackles the urgency of identifying adaptation strategies and layers of resilience at the micro and macro level with critical interventions to reduce vulnerability to water scarcity, drought, desertification, land degradation and further marginalization in the rural areas. Both qualitative and quantitative data and methods will be used to understand key relationships of social and biophysical inter-linkages with reference to drivers of change: socio-economic, institutional and political. Villages are selected randomly from Hambantota (DL5-arid), Monaragala (DL1a-semi arid), Puttalam (DL3-semi arid), Anuradhapura (DL1b-semi arid) and Polonnaruwa (DL1c - semi arid) Districts. Primary data on farmers' perceptions and vulnerability data will be collected from a structured questionnaire. Secondary data will be analyzed using climatic data collected from the Department of Meteorology. The expected outputs are: (1) an improved understanding of the climate variability and its impact on cropping pattern, structures of income and employment, and adaptation-coping strategies of the rural poor in these villages; (2) best practices and institutional innovations for mitigating the effects of climate change; (3) strategies to address socio-economic problems relating to changing weather patterns and availability of a range of initiatives for their alleviation.

Climate change, local institutions and adaptation experience: The village tank farming community in the dry zone of Sri Lanka

Athula Senaratne and Kanchana Wickramasinghe

Institute of Policy Studies, 99, St. Michael's Road, Colombo 03

Farmers are inherently adaptive and are in a continuous process of adjusting to observed variability in climate patterns in the short and long term. Farming communities that depend on local rainfall are naturally more vulnerable than those who are supported by major irrigation schemes. This study examines the climate adaptation responses of village tank farming communities in the dry zone of Sri Lanka and attempts to identify the challenges they may have to encounter in the face of the looming threat of global climate change induced by anthropogenic causes. The study was conducted in 6 Divisional Officer areas in Anuradhapura District of the North Central Province. Both primary and secondary data were collected in the study and major sources of primary data included a series of focus group discussions and key informant interviews conducted with village tank farmers and local officers. Results of the study describe the historical adaptation responses of village tank farmers to the vagaries of climate in the dry zone. This has been facilitated by adaptation facilities such as village tanks and other supportive structures as well as local institutions that helped to develop collective adaptation responses. Accordingly, local farming systems, resource tenure and access rights to resources, have evolved enhancing the adaptation process. However, recent dynamics of transformation brought about by macro scale changes such as population increase, spread of commercial opportunities and change in agricultural technology have drastically altered socio-economic conditions in village tanks generally favoring privately oriented commercial farming systems. As a result, local institutions that facilitated the climatic adaptation efforts of farmers are also being fast modified. Therefore, while the farmers are beginning to face the alterations in more familiar patterns of climate during recent years, the local institutional setting is also undergoing simultaneous drastic changes. These dual shocks of climate and socio-institutional change pose a major challenge to farmers' efforts of adaptation by affecting their adaptive capacity. It implies that not only the physical measures of adaptation but innovative local institutional arrangements are also necessary to face the threat of climate change. The paper discusses the policy implications emanating from the findings of the study, indicating key aspects to be addressed through appropriate policy measures to enhance the adaptive capacity of farmers.

Identify the impact of tide level for river basin flooding

M. D. E. K. Gunathilaka, D. N. D. Perera and W. A. L. Wickramanayake

Department of Surveying and Geodesy, Faculty of Geomatics, Sabaragamuwa University of Sri Lanka, erandakan@sab.ac.lk

Different parts of Sri Lanka are being subjected to a wide range of natural disasters every year, of which flooding is most common. Time to time flooding decreases the economic and social development of the country and also the government of Sri Lanka has to spend huge amount of money each year for relief, rehabilitation and reconstruction activities. Flood occurred mostly due to heavy rainfall and various other human induced factors in the catchment areas. In this project, the tidal level variation is considered as a factor for floods in the river basins. Tidal level changes periodically due to the gravitational attraction from the Sun and the Moon and the centrifugal force due to the Earth's rotation. From this project, it is studied to identify a relationship between the changes of the tidal level and the river water level. The study area was the river mouth area of the Kelani River. Here, the tidal data was collected from the Colombo harbor and the water level data and the river flow data was obtained at the Nagalagam Street gauge and Hanwella gauge. All these data were analyzed and it is found that there is a direct relationship between tidal level and flood level in the river mouth area. Therefore it is proposed to consider the tidal variation for accurate flood predictions in the river mouth areas.

Rainfall fluctuation and changing pattern of agriculture practices

L. Manawadu

Senior Lecturer, Department of Geography, University of Colombo,
lasan_m@webmail.cmb.ac.lk

Rainfall is one of the influencing factors for human activities not only in agriculture-based regions but also in industrialized urban areas. Rainfall received in any region can vary with physical factors as well as human interactions. Physical factors could be micro-climatic phenomenon or global changes such as Ozone depletion and global warming. Recent observations indicate that there are significant changes in rainfall patterns both in the dry zone as well as in the wet zone in Sri Lanka. Since average rainfall is highly influenced by the extreme cases of rainfall, it is very difficult to identify the significant changes of average rainfall. However rainfall patterns have changed whilst the average rainfall is unchanged. This study attempts to examine the changes in rainfall patterns from different viewpoints using daily rainfall data collected at the 22 main meteorological stations of the Department of Meteorology. This paper identifies spatio-temporal trends in the rainfall received during the four rainy seasons - i.e. the Southwest monsoon, the first inter-monsoon, the Northeast monsoon and the second inter-monsoon during the period from 1961 to 2002. It translates rainfall trends into trends in water volume by river basin using different GIS techniques, so that the practical implications of climate variability and change in recent decades are clearly identifiable. The study finds that the number of rainy days has decreased at all the meteorological stations except at the Nuwara Eliya station. It also finds that the 2000mm isohyet - demarcating the Wet zone of the country has shrunk. Water volume by watershed shows a clear dichotomous distribution with watersheds in the north part of the island having increasing trends, and watersheds in the south part of the island having decreasing trends, in water volume. Rainfall fluctuations directly affect agricultural activities in any region. This study attempted to examine the changing pattern of agricultural practices indicated by the crop calendar with response to the rainfall changes. Significant changes can be seen in the crop calendars in both Dry and Wet regions of the country.

Climate change and rainfed agriculture in the dry zone of Sri Lanka

C. R. Panabokke and B. V. R. Punyawardena

Even prior to the advent of climate change, the very high annual variation in yield of rainfed arable crops in the weakly poised rainfall systems of Sri Lanka's dry zone had been recognized by several agricultural scientists, especially those stationed in the different districts of this country's dry zone. Abeyratne (1962) clearly brought out the essential nature of this variation when he showed that over a 25 year period at Maha Illuppallama, rainfed rice yields had ranged between 74 and 8 bu/acrea, while over a 12 year unbroken period rainfed cotton yields had ranged between 1,120 to 220 lb/acre. He further showed that almost the whole of this variation could be ascribed to the chance of obtaining a satisfactory trend of soil moisture during the growing season. In order to even out these wide fluctuations in yield, and to also stabilize rainfed farming in the dry zone, Panabokke (1974) had proposed a stringent analysis of the real nature of the variability of the main "maha" season rainfall, and to then specify (a) proper choice of sowing dates, and (b) a selection of optimum "sowing-to-harvest" duration or "age-class" of the main crops, so that there could be a maximum likelihood of the rainfall satisfying the "crop water" demand at every stage of its growth and development. Accordingly, the probability of rainfall for the growing seasons in the different regions of the dry zone were specified by using the 3-weekly moving totals of the 1:1 rainfall confidence limits calculated according to Manning's (1956) method which transforms "skew" data to give approximately "normal" distributions. By matching the crop water requirement against the 1:1 confidence limits of rainfall it was possible to propose the age-class for any particular crop so that its water demand fitted as closely as possible with the probable seasonal supply of soil moisture. Four rainfall stations in North Central Sri Lanka which had a 25 year unbroken record of rainfall were selected for working out the 3-weekly moving totals of 1:1 confidence limits of rainfall. Selection of optimum sowing dates, as well as optimum "sowing-to-harvest" duration of different crops was then proposed by Panabokke (1974). A field testing and validation of the proposed "time-of-sowing" as well as the "sowing-to-harvest" duration of the main coarse grain and grain legume crops was carried out in collaboration with the Extension Division of DOA of North Central Province in collaboration with the Regional Technical Working Group, the (RTWG) of the NCP over the period 1975 to 1979. An adoption of these recommended dates of sowing as well as the age class of the commonly grown rainfed crops resulted in a significant stabilization of the seasonal performance of these crops throughout the nine year period 1978 to 1987. However, commencing the year 1989 it was reported by Panabokke that an unprecedented aberration in the seasonal patterns of rainfall had been taking place to the extent that the August/September rainfall of 1986 had fallen even outside the 90 percent confidence limits. Furthermore, Panabokke (1989) in his presentation titled "Potential Impact of Climate Change on Agricultural Production in Sri Lanka" stated that "up to 1987 it is observed that both "within" season as well as "between" season variation in rainfall could be statistically accommodated within the 1:1 confidence limits of expected rainfall on a weekly basis. But that after the year 1988 the rainfall in the main season October-January was becoming more variable and more extreme, thus resulting in a destabilization of rainfed agriculture especially in the dry zone of this country. In effect the popular dictum that "the past is a key to the future" is no longer applicable because what will happen in the future is no more conditioned by what happened in the past. In order to bring out the contemporary condition in respect of rainfall

variability in the dry zone, the 95 percent confidence intervals of weekly rainfall for the years of 2006, 2007 and 2008 for two selected stations in the north central and southern dry zone, namely Maha Illuppallama and Weerawila were analyzed. The results which are presented graphically show that for the period between the 40th and 52nd week, a drastic degree of aberration could be observed. In other words, extreme events are now the normal pattern, rather than the rare occasional as they were in the past. Correspondingly, severe aberrations in seasonal crop production in respect of the maize and cowpea crops has also been recorded.

How prepared are water resources and agricultural sectors in Sri Lanka for climate change? A review

Nishadi Eriyagama and Vladimir Smakhtin

***International Water Management Institute (IWMI), P O Box 2075, Colombo, Sri Lanka,
n.eriyagama@cgiar.org***

Climate is changing world wide and the science community in Sri Lanka has come up with ample evidence to suggest that Sri Lanka's climate has already changed. During 1961- 1990 its mean air temperature has increased by 0.016 °C per year (higher than the global average of 0.013 °C), and annual average rainfall decreased by 144 mm (7%) compared to the period 1931-1960. In addition, daytime annual mean maximum and night-time annual mean minimum air temperatures increased. However, the bigger question of national importance is what Sri Lanka's climate will look like in 50 or 100 years and how prepared is the country to face it. Apart from the IPCC projections at the coarse global scale, few studies attempted to project future climate scenarios for Sri Lanka and to identify climate change impacts on agriculture, water resources, the sea level, the plantation sector, the economy and health. Vulnerability and adaptation to climate change are the least studied areas. The paper reviews the status of climate change research/activities in Sri Lanka with respect to future climate predictions, impacts, mitigation and adaptation, and identifies existing knowledge gaps. Messages emerging from this review suggest that Sri Lanka's mean temperature during the North-East (December-February) and South-West (May-September) monsoon seasons will increase by about 2.9 °C and 2.5 °C respectively, over the baseline (1961-1990), by the year 2100 with accompanying changes in the quantity and spatial distribution of rainfall. Extreme climate events are expected to increase in frequency. These changes are expected to bring about widespread impacts on the country's agriculture and economy. For example, a 0.5°C increase in temperature can reduce rice yield by approximately 5.9%; extended dry spells and excessive cloudiness during the wet season can reduce coconut yield so that annual losses can range between \$32 and \$73 million. Pilot studies in the Galle District suggest that sea level rise could inundate about 20% of the land area of coastal District Secretariat Divisions. Adaptation measures already undertaken in the agricultural sector include development of low water consuming rice varieties and use of micro-irrigation technologies. Tools have been developed for predicting seasonal water availability within the Mahaweli Scheme and for predicting annual national coconut production. However, Sri Lanka is yet to undertake a comprehensive national study on the vulnerability of its water resources and agriculture to climate change. Formulation of detailed and reliable future climate scenarios for the country is and urgent need in this regard.

Policies, Institutions and Data Needs for Water Management

Sri Lanka's water policy: Themes and issues

V. K. Nanayakkara

Director, Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI)

Fresh water resource in Sri Lanka remains a free public good with the state acting as its trustee and custodian. Although the country is blessed with a seemingly plentiful supply of water, it encounters severe problems of temporal and spatial scarcity. Nearly five decades of efforts at formulating a national water policy with a view to introducing a bulk water allocation system have failed mainly due to a lack of understanding of the basic issues confronting certain elements that constitute the basic policy. This paper presents selected key themes and issues which help stimulate the formulation and adoption of an improved water resource policy statement. The author argues that what is important in the case of water is not the question of "ownership" of water but clarity regarding user rights of this common property resource which is always in a state of flux. In the course of its movement in the hydrological cycle, it can only be owned when it is captured in a receptacle or in an impounding tank or as treated water in a reservoir and water conveyed in an irrigation channel. But, it is this very right to abstraction of bulk water from its natural state which is not defined and left to the will of individuals and agencies - virtually resulting in the creation of a "free for all" situation. While the domain of water is characterized by over 51 legislative enactments and a plethora of agencies numbering over 40, there is no single neutral agency to determine the appropriate balance between the demands for off stream consumption and the volume of water flows needed by the river system. Further, the roles and responsibilities of the existing water agencies would have to be re-oriented to reflect their revised mandates of service delivery separated from resource management function as the institutional responsibilities remain unclear and partly overlapping. The need for separation of the policy making and regulatory role from the implementation, operation and service management is paramount.

Enhancement of capacity of farmer organizations for sustainable irrigation systems in Anuradhapura and Kurunegala Districts

Dr S. Thiruchelvam

Department of Agricultural Economics, Faculty of Agriculture, University of Peradeniya, Peradeniya, sthiru@pdn.ac.lk

Over the past decades public investment in major, medium and minor irrigation systems has not given expected results. The solution to the growing water crisis lies in the institutional changes that alter social systems to manage the demand for water. In recent times capacity building of farmer organizations (FO) was emphasized in the irrigation projects rehabilitation. This study focuses on investigating the institutional and technical capacities of FO, membership participation and performance of operation and management (O&M) in Anuradhapura and Kurunegala Districts. Using a semi-structured questionnaire primary data were collected from a stratified random sample of 48 FOs selected from major, medium and minor irrigation systems in 2008. Descriptive statistics and non-parametric analysis were employed as analytical tools. The organizations registered under the Agrarian Development Act no. 46 of 2000 are the recognized FOs. This replaced the Agrarian Service Act no 4 of 1991 and enabled tenant cultivators to become owner operators and authorized FOs to be informed of any construction projects. FO officials did not have a clear understanding of the provisions of this new Act. In both districts most of the FO members were landowners in the FOs and there were strong powerful farmers with dominance of position. Generally there was a marginal participation in FO activities of about 38% in both districts. The most common causes for the low participation were the lack of accountability and transparency of the FOs. FOs in major and medium irrigation systems had 51% and 29% higher performance in O&M respectively than FOs in minor irrigation systems. The values of Gini coefficients in major, medium and minor irrigation systems were 0.38, 0.43 and 0.48 respectively, indicating that FOs play important role in minimizing inequalities among the farmers. There was no significant difference of water productivity ($0.19 - 0.20 \text{ \$/m}^3$) between major and medium but low ($0.07 \text{ \$/m}^3$) in minor irrigation system. FOs of medium size (30 - 40 members) and economically homogeneous members had better irrigation management. Breakdown of the traditional FO management with the government involvement made farmer participation minimum in O&M. FOs lack management capacity to perform their general duties. Because of dependency syndrome of FO and providing hardware infrastructure facilities without sufficient software training programmes result in counter unproductiveness. Comparatively major irrigation systems FOs were well organized. Poor capacity was found mainly found in minor irrigation systems in both districts. The success of the irrigation systems depends mainly on the efficiency of the FOs. Thus a well coordinated approach between FOs and Government organizations in irrigation as an entry point to capacity building and encouraging a self-help approach to community planning and utilization of local resources is needed. There is a need to establish strong linkages between the FOs and the Irrigation Department for successful irrigation management. Behavioural change required for the adoption of technology can be affected through institutional changes. It is recommended that FOs need a lot of capacity building on technical and institutional issues to sustain the irrigation systems.

Multiplier impacts of irrigation Investments

Deeptha Wijerathna and Kamal Karunagoda

Department of Agriculture, dwijerathna@gmail.com

In recent history, many developing countries have made huge investments in irrigation development. These irrigation development projects created numerous impacts on the region where they are implemented as well as inter regions and national and even global level. Many studies have attempted to analyze the development potential of irrigation mainly using the traditional cost benefit analysis and impact on poverty reduction. These methods evaluate the direct effects and provide little evidence on irrigation's full potential in developing the regional economy. Most of the evaluation studies conducted in Sri Lanka and other countries have not captured the multiplier effects generated by irrigation. This study is carried out to evaluate the full development potential of irrigation investments using a social accounting matrix for the region. Uda Walalawa left bank irrigation development project area was selected for the analysis. The social accounting matrix, which is developed for the region, provides a comprehensive picture of this regional economy. Gross domestic product of this regional economy in 2001-2002 is Rs. 3,837 million. Disaggregated income account shows that households in this regional economy are highly diversified and nearly 50% of their income is coming from non-agricultural sources. The construction sector is induced by the development project. Service and industry sectors are the main non-farm income sources. Average annual per capita income is Rs 3,779, which is above the poverty line, indicates that an average individual in this economy is non-poor. But the analysis on distribution of income (gini coefficient of 0.355) indicates that the lowest three income deciles come below the poverty line. Household account of the SAM is disaggregated in two different ways: income deciles and poor and non-poor. Desegregation of household into income deciles is important in understating income and expenditure links of different income groups and appropriate development interventions for the different income groups. Classification of households as poor and non-poor within each stratum is important in understanding area specific economic linkages and development interventions appropriate to different areas. Level of poverty within non-irrigated area is twice that of irrigated area, which confirms the hypothesis that irrigation can result in positive welfare impacts and cut down poverty. Prevailing poverty within irrigated areas highlights the need of some other pro-poor policy interventions. Results of the study support the hypothesis that agricultural production activities induced by irrigation development projects are highly correlated with other activities of the rural economy. The average multiplier of 1.3 for any crop production activity indicates that a rupee of additional value added in crop production sector leads to an income increase of 30 cents within other production activities of this economy. Results of cost benefit analysis with and without multipliers clearly show the Importance of consideration of multipliers in project evaluation. If only direct benefits are considered, Uda Walawe development project has taken 27 years to come to a breakeven point at which total cumulative incremental income can cover total financial costs. But when income generated with multipliers are also taken into accounts the project was able to come to a breakeven level in 20th year of implementation.

Interventions necessary in capacity building in existing water organizations to improve productivity and access to water

Badra Kamaladasa

Irrigation department, Assets Management Branch, Irrigation Department, PO Box 1138, Colombo, bkamaladasa@gmail.com

To improve the accessibility, productivity and sustainability of water services capacity building of existing organizations and stakeholders has become a priority requirement in the water sector. To fulfill the local, regional and national level needs it is needed to enhance the capacity of individuals, organizations and sectoral groups as well. Installation of physical infrastructure and implementation of direct training sessions would not derive the social and economic benefits of the water services, unless proper intervention is made to improve the legal, regulatory and institutional environment. Further it is needed to set up the organizational frameworks that provide suitable forums to bring along views of all the stakeholders for continuous up keeping of the local requirements. In current water sector investments this aspect is identified as the 'software component' which is listed as a separate activity. It is estimated that there are more than 40 institutions dealing with the subject related to water in Sri Lanka. These organizations have evolved under different historical backgrounds to fulfill the need of the day. Their intervention in the water sector may be at different levels in different forms. When translating their individual policies into action, it is always confronted with the issues related to interdependent nature of the water resources. There are many instances that demonstrate the need of integration of the decisions taken by the organizations. Hence it is no more possible to operate in a secluded environment for a particular organization as done at the beginning when the organization was formed, but to develop close ties with all those engaged in water activities. It is necessary to assess the role and responsibilities of each organization and identify their position in the water sector which is a dynamic matter relative to the time and region. It is needed to understand the complex process of changing the requirements within all the levels. There are some areas that no institution has direct responsibility for. These gaps can be filled by the existing organizations if incremental capacity development is introduced. It is possible to transform the existing institutions to more accountable entities without undermining the current position, but by enhancing their capacity. It is time to identify the 'software component' in the current water sector investments that would address the current needs of the country. The objective of this paper is to discuss gaps that appear in the current system and interventions necessary in capacity building in the water sector to fill these gaps, drawing the good practices from successful water environments.

Contribution of food markets and their behavior for food security: a comparative study on marketing arrangements in different irrigation systems

T. A. Dharmaratne

Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI), 144, Wijerama Mawatha, Colombo 7, tadharna@yahoo.com

{ýú, W,fµqý},uCE"auCE w±{ÿ q{ íç... < Z,{uý, "□... □_uÿ"}< "Wýtý~", u y□úuCE íú... < ,Ra}ý"áCE ... }^ { WýRØ_ »²ý_ý~_P, W,...ýú ,f"}uCE "_CEuCEâaq ú W□qCE"qCE {ýú, ,Ra}ý"áCE Áúq"}< }†wqCE w□,□qCE{ ...† "uýu□...} Á,qCEú!" Z"s...ý Wýtý~ □y a□è{k}. ly□úuCE, "Wýtý~" }uCEu {µ□_ W,fµqý}_CE {uCE{, "ýú, WñÕ}_CE "□...k "□y, w†~au W□q. Wýtý~ □y a□è{ {µ□_ {ýú, WñÕ}_CE "...CE{, {ýú, ,Ra}ý ...v†ý "wýß"S w,q~u "Wýtý~ †™í_{ (" (Food Entitlement) "†,qCE "Wýtý~ □yá□è"P ...{ýú †□}ý}_CE Ôè} }ÿqç"} }uCEu ÚuCE "wýß"S w†~aqCE ...Š,ýsfœ□ }uCE{ ú,ýsfœ□ }_~□o_Ce ú W□q. "P ç...ý{, Wýtý~ ç,,wýsu}, Wýtý~ "yU †□ò, Wýtý~ ...ÿ~~,~qzý,} (Food Security), Wýtý~ †™í_{ ,□ç ...Š_□w{ }»²ý_ýö_P Xqý, □saqCE ú W□q~ Wq~, "Wýtý~ ...ÿ~~,~qzý,} }uCEu "{ ...Š_□w{ }»²ý_ýö_P WqöuCE ,mýqCE w±{ÿ q{ ...Š_□w} ú W□q. Wýtý~ ...ÿ~~,~qzý,} }uCE"uuCE "{†™P Wst... < ,uÿ"}< {ýú, ...{ýg"}< ...{ wps□a□}_çk{ "Wýtý~ □yá□è"P ...{ýú †□}ý}_CE Ôè} }ÿqç y,qCE, ...•{ a\$† A__}_CE qç□ ç~uCEq~}uCE{, Wýtý~ "uý{□Ô ú{uCE sôâqý,} W□Ôú w~mý,uCEk wqCE "uýú} }ÿqç y,}.

"{{ upý}ýqCE{ _ tý ...Š_□w{ } w...ÿè{ qç□, "{ { wR"}<,o wÖ²_ý"S {µ□_ W~{ÿoj ,uÿ"}< f²} □Š_ý"S _Š,,_ýRí_ guý,ý...}uCE qç† w,qCEuý {†ý ,ýò{ýRa ws□Ô, _çmý ,ýò{ýRa ws□Ô, ...† ,R,,ý g□}uCE "w□,,q,u _Š,,_ýRí_ w±s□f}uCE†™ Á,qCE ,u a²ýi} w±gý,"áCE Wýtý~ □y a□è"P †□}ý, "†,qCE "Wýtý~ ...ÿ~~,~qzý,} w†~yv qç□uýqCE{ _ Wtu}u}_ }P{. A ...v†ý }□Áq {µ□_ wsu{ ,uÿ"}< , "{ úút ,ýö _²}uCE†™ Úuk »²ýqCE{ _ ,u " _Š,,_ýRí_ W"□ú~_o ws□Ô" {d™uCE "{ { _Š,,_ýRí_ guý,ý...}uCE"áCE Wýtý~ ...ÿ~~,~qzý,} " " _R " _y@ß y□w•_CE W□q_ ~_ Ô"Os? " }uCEu w†~yv qç□uýqCE{ wR"}<,o Wtu}u}_ }P{. A Wuÿ,, "{ { _Š,,_ýRí_ W"□ú~_o ws□ÔuCE {d™uCE "{ w±gý,uCE"áCE Wýtý~ ...ÿ~~,~qzý,} " _q_Ce ß~k q†,p~□ _~ W□qCE"qCEs }uCEuqCE, Úuk w,qCEuý "{ { _Š,,_ýRí_ ,;†vw□ _²}uCE {d™uCE "{ "ayú guqý,"áCE "Wýtý~ ...ÿ~~,~qzý,} " _q_Ce ß~k W,ÚuP ...†™q w~mý,k wqCE ~ W□s□s? }uCEu w†~yv ú{Rfu} »ò{qCE, "{ { wR"}<,o wÖ²_ý"S {µ□_ W~{ÿoj ,uÿ W□q. A Wuÿ, "{ { qçCE,} úfCE"□<,o"}< ,p, úút ,ýö _²}uCE†™ w,qCEuý Wýtý~ ...ÿ~~,~qzý,} w†~yv ...{ýú W...{ýú_P {uCE{ Wýtý~ ...ÿ~~,~qzý,} ...v†ý Wuÿa{u}_~uÿ □yu Zwý} {ýRa™_ úâ_²}uCE (Coping Strategy) w†~yv ...□□□□k zýgu}_~u Wq~ A A ,ýö _²}uCE†™ w,qCEuý úút g□ {µýf² "□... {†ý ,ýR{ýRa, _çmý ,ýò{ýRa tý ,R,,ý "w□,,q g □ ZqCEwýs_²}uCE"auCE "P w†~yv, w,Öu y□w•P a□u W,týu} }ý{ÿ _~uÿ W□q. "P ...v†ý úút ,ýö _²}uCE }kqCE w,Öu w±s□f}uCE†™, ,ýö _Š,,_ýRí_ ç,,wýsu}uCE"áCE w±{ýoqCE{ _†□...~ò, _Š,,_ zýoCEm ,;†vw□ qç□ w,Öu ú" fCE,,q □~,,o tý _Š,,_ýRí_ WÖö_CEq, ,;†vw□ _²{ "Ss}uCE, W"□ú~_o {ýRa, í □†□...~òP ~ký,uCE, W"□ú~_o WýuCEq_} ...† ~ýgu {□ÿ†qCEúP WýP úút ,;†vw□} ...Š_□w} (Agricultural Marketing Concepts and Theories) úfCE"□<,oýqCE{ _Zw_~o "□...k zýuqý _~u Wq~ \{d™uCE "{ { w±s□f}uCE†™ guqý,"áCE Wýtý~ ...ÿ~~,~qzý,}k _~u □s y□w•P W□dò{k □_CE _~uÿ W□q.

"{{ Wtu}u}_ {µ□_ _²{ "Ss}uCE "□...k "_İuP a□í ú{...ÿP" (Rapid Rural Appraisal) _²{ "Ss}, {µ□_ ,f"}uCE zýuqý _~u Wq~, "...†zýæqCE, a□í ú{...ÿP" (Participatory Rural Appraisal) _²{ "Ss} s, ...ÿß...ÿ W,...<ý,uCE†™P }ýÚ a□è{k W"w~,,ý _~uÿ W□q. "\...<{, "{ { Wtu}u "qý~qç~□ ...v†ý _Š,,_ýRí_ W"□ú~_o "qý~qç~□ □yáq †□» w²ýu, s□úÖ} {µýf²}uCE "□... "†_CEkR "_yOy~mÿ, "ayú_k}ÿqç wR"}<,o tý wÿ†ÿoj »ò"P Wýqu"}<, W"□ú tý Wýtý~ wÖwqCEÖ WSf"}< ,;†vw□ sqCEq tý "qý~qç~□ ...{d™,uqCE s□úÖ} {ÿýf²}uCE Zw"}<ace _~ a□è{k Wst...< _~uÿ W□q. _Š,,_ýRí_ ,;†vw□ _²{ "Ss}uCE {uCE{ w±s□f"}< _çkPz A__}uCE"áCE Wýtý~ ...ÿ~~,~qzý,} w□†□ÿ□~ »ò{ ...v†ý ú...q~ýqCE{ ...Š_µýu _²{ "Ss}uCE (Statistical means, Frequencies, Ranks and Percentage) "{†™P zýuqý _~uÿ W□q.

Local Governance for effective and productive water management process

Sisira Saddhamangala Withanachchi

Assistant Lecturer, Department of Political Science and Public Policy, University of Colombo, Colombo 03, sisirasaddhamangala@gmail.com

m%dfaoYSh wdKavqlrKh kj woyila fkdjk w;r th úoHd%Òka w;r idldÉPdJg n`ÿka jkafka ;sridr yd m%cd;ka;%Sh wd%Ól ixj%Okh ms<sn`o woyi biau;= ùu;a iu`.h' hy wdKavqlrKhl meje;au Wfoid uOH.; md,k l%uhlg jvd úuOH.;jQ m%cd;ka;%jdÈ jHqyhka f.a wjYH;dj wjOdrKh úh. m%dfaoYSh wdKavqlrKhl mqrjeishka yd rdch w;r in`o;d f.dvk.k l%uföohla f,i muKla fkdj m%;sm;a;s iïmdokfhaš yd j.lSi fnšhdfi § wdKavqlrKfha my< wdh;k j,g jeä n,hla ,nd fok l%uföohla o ù we;' YS% ,xldj ;=< fuu m%dfaoYsh wdKavqlrK wdh;k m<d;a md,k wdh;kh f,i y`ÿkajhs'

m%cdmdol c, iim; Ndú;h uQ,sl jYfhkau m<d;a md,k wdh;k iu. nef we;' miq.sh ld, jljdkqj ;=< isÿl< n,;, mjrd .ekSi ;=< c, iim; fnodyeÍu yd c,dmjdyk lghq;= uOHu rch fj; mjrd .;af;ah' we;eï m<d;a md,k wdh;k fuu c, l<uKdlrk l%shdj,sh yd c, iim; fnod yeÍfi l%shdj,sh ;u wdh;kh fj; mejšh hq;= nj ;%l lrhs' we;eï m<d;a md,k wdh;k m%foaYfha úNj c, W,am;a Ndú;fhka m%cdjg c, iim; ,ndfoa' fuu m%fhaIK m;%sldj ;=<ska nKavdrfj, k.r iNdj yd udjke,a, m%dfaoYSh iNdj ;=< ;=<kd;aul wOHhkhla isÿ lr we;'

Sri Lanka's water future to 2025-2050 - scenarios and issues

Upali Amarasinghe

International Water Management Institute, Hyderabad, u.amarasinghe@cgiar.org

This paper presents water futures scenarios for Sri Lanka at the river basin level and the associated water management challenges. A study by the International Water Management Institute in 1999 assessing water scarcities of Sri Lanka (Amarasinghe et al 1999) showed a substantial spatial variation of water supply and demand between dry and wet zones of Sri Lanka. This study used districts as the spatial unit of analysis for water demand estimation, 1991 as the base year, and trends in the 1980s for assessing future water demand projections. Sri Lanka has 25 administrative districts, and they cut across 103 river basins. Thus, estimates at the district level are too coarse for accurately estimating river basin water demand. Moreover, many important water demand drivers such as economic, demographic and food consumption patterns, and land use and cropping patterns have changed substantially in the 1990s. This study updates the base year to 2005 and uses the Divisional Secretariat Division as the primary spatial unit to estimate the water demand in different river basins. Sri Lanka's 25 districts are further divided into 321 Divisional Secretariat Divisions. This study uses the PODIUSim methodology for assessing water supply and demand scenarios. The PODIUSim, the Policy Dialogue model (IWMI 2001) simulates alternative water future scenarios with respect to changes demographic and food consumption patterns and other water demand drivers. The PODIUSim model has four major components: crop demand, crop production, water demand and water accounting. The model estimates demand and supply for 12 crops (rice, wheat, maize, other cereals, pulses, oilcrops, roots and tubers, vegetables, fruits, sugarcane, tea). Water demand is assessed for the irrigation, domestic, industrial and environmental sectors. Finally, the model accounts for the utilizable water supply. The study also assesses, through scenarios, various water management options that Sri Lanka can rely on to meet future water demand.

Economic valuation of irrigation water under a major irrigation scheme (Gal Oya) in eastern Sri Lanka

A.L.Ameer Ali, A.N.Ahamed and P.Sivarajah

Department of Agricultural Economics, Faculty of Agriculture, Eastern University, Chenkalady-30350, sivaponniah@yahoo.com

Water is an essential factor for plant growth. About three fourths of Sri Lanka comes under dry zone, in which water becomes a limiting resource during the dry 'Yala' season. Therefore, it is very important that a farmer in the dry zone uses water at an optimum level. Even though, up to now irrigation water in Sri Lanka is un-priced, views have emerged that it has to be priced due to its scarcity and increasing demand for both farming and residential use. The Sri Lankan government has been investing large amounts of money in irrigation development and subsequent supply of water to farmers since independence. Lack of participation of water users in system management and inadequate funds for operation and maintenance (O&M) activities had resulted in inefficient use of water on one side and the excessive use of water on the other. Hence the economic value of water has to be estimated in order to price water, a scarce resource in paddy farming. The objective of this study was to estimate the economic value of irrigation water in crop farming in the Senanayake Samudra (Gal-Oya) Right Bank System area through a sample survey, using a pre-tested questionnaire. The sample consisted of 30 farmers selected on a random sampling (multiple stage sampling) procedure. Linear programming technique (GULP software) was used for the analysis, and profit maximization through crop cultivation was considered as the objective under constraints of land, labour, capital and water availability. Technical crop water requirement were calculated using CROPWAT, a computer programme. The results indicated that based on current condition of crop cultivation and market for inputs and products (1996), the economic value of irrigation water was Rs. 2,246 per two acre feet. Hence it is suggested that the government of Sri Lanka can consider pricing water under major irrigation schemes at a rate compensate with its economic value, at least at 25 to 50% of the above estimated value. This could help in reducing wastage and over use of scarce irrigation water form major tanks.

Sand barriers and access to water - community pressure and policy interventions in river sand mining in Sri Lanka

Kusum Athukorala

NetWwater, No 7, St Mary's Lane ,Colombo 15, kusum@itmin.net

Sri Lanka's construction industry contributing over 8% to its GDP requires over 7 million cubic meters of sand annually which is obtained from the country's river beds, riverbanks or mined from previous riverbeds and sand dunes. Though until recently manual harvesting was the norm, increasing mechanized and often illegal, river sand harvesting has caused major loss of water security and ecosystem damage due to lowering of water tables, bank erosion, land degradation and salinity intrusion; damage to infrastructure; increased health hazards and negative impacts on women. The steep cost increase of sand (over 250% over the last decade) has encouraged the growth of a politically powerful " Sand Mafia " operating uncontrolled in a country already saddled with a plethora of laws and regulations covering of natural resource use, within a poor regulatory environment which is further complicated by the prevailing security concerns. A women's volunteer organisation, NetWwater (Network of Women Water Professionals) who engaged in a Gender and Water Dialogue in North Western Province in 2005 was initially requested by affected community groups to initiate an advocacy program to highlight damage due to river sand mining (RSM). Women, who previously had access to drinking water literally at their doorstep, now were forced to travel 3-4 kms in search of water due to impacts of RSM. After studying the extent of negative impacts in Deduru Oya, NetWwater activists catalyzed the formation of an awareness and advocacy network through intensive national media coverage, building critical mass among activists, building a national profile for the issue and enhancing awareness on the need for alternatives. A linkup with other active civil society groups (Sri Lanka Water Partnership and Capnet Lanka), religious institutions and universities led to the linkage of RSM action committees for three affected rivers, the staging of two National Sand Mining Dialogues in 2006 and 2007, highlighting the issue at national level through media programs and profiling community needs with political decision-makers. Video documentaries were produced; school, community, agency as well as RSM related awareness programs for the Police were carried out, highlighting the impacts of negative impacts of RSM related corruption. A recent collaborative activity with support from the Global Water Partnership (GWP) and Water Integrity Network (WIN) has developed training modules for enforcement staff and police. The cumulative impact of this and other activities have given an added impetus to ongoing changes in policy. Though RSM continues to be a major threat to water and livelihood security, the control of which varies with the rise and fall of the politically motivated pressure groups, the ongoing activities of the networking initiative thus established with its media linkages continues to give a platform for RSM affected communities.

Irrigation infrastructure management by public funds - How it can be made justifiable?

Eng Namalee Madawalagama and Eng Badra Kamaladasa

Irrigation department, Assets Management Branch, Irrigation Department, PO Box 1138, Colombo

Investment for irrigation development is considered to be the responsibility of the government, especially in a welfare state like Sri Lanka. Once developed, responsibility for operation and maintenance is also shouldered by the government. Subsidiaries are also arranged by the governments in many forms from time to time to attract inhabitants for agriculture or attract the votes. When the inputs for other agrarian services are taken into account, a colossal sum of funds is diverted for survival of irrigated agriculture. It is not possible to measure the benefits of an irrigation system in financial terms merely taking the cultivation output into account. The social and environmental benefits are also to be accounted in a proper Cost Benefit Analysis. There is a trend of increasing the need of maintenance funds due to many reasons. Most of the schemes have reached the guaranteed life span of a system, demanding revitalizing the physical system. Many recently rehabilitated projects have shown symptoms of deteriorated conditions demanding another round of rehabilitation while many other systems are in bad need of attention. Since the government alone can not bear the operation and maintenance cost, participation of the farmers was expected. This paper aims to compare the actual annual fund requirement to operate and maintain a system and the funds received by various sources to highlight the necessity of filling the gap for the sustainability of the system. An analysis will be done comparing a few systems under the purview of different organizations where different types of methodologies adopted for operation and maintenance.

Managing irrigation with farmers - history, present status and future review of participatory irrigation management in Sri Lanka

K.Jinapala, Lal Premadasa, P. G. Somaratne and M. Samad

***International Water Management Institute (IWMI), P O Box 2075, Colombo, Sri Lanka,
k.jinapala@cgiar.org***

Agriculture development has been the main strategy for the socioeconomic development in the country since time immemorial even though its contribution to GDP has been declining in recent times. Irrespective of the magnitude of contribution of agriculture sector to GDP, successive governments of Sri Lanka since independence have invested heavily on this sector to ensure food security for the country. For this purpose, every government was observed to be heavily involved in construction of large scale irrigation systems and the management of the existing ones utilizing both national funds and foreign funds acquired mainly from donor agencies like the World Bank and Asian Development Bank. The continuous investment in irrigation was required to address problems such as spatial and temporal variations in monsoonal rain fall in the country, which has serious negative impacts on food production and livelihoods of people. It had been understood that even in the past, rain-fed agriculture could not generate adequate food supplies for and kings in ancient times pursued irrigation development in response to this challenge. Therefore, managing irrigated agriculture to ensure food security has been considered important irrespective of time, ancient or modern. The need to pursue such a strategy has become more important in the country in the face of rapid population growth and increasing food prices in the world market. In this context, managing irrigation schemes for productivity increase is becoming more and more important and different irrigation management models have emerged through attempts made in this direction by countries including Sri Lanka where irrigation plays a leading role in food production and national development. Farmers' active involvement in irrigation management, especially operation and maintenance and decision-making, has been identified as a key requirement to attain productivity goals and sustainability of irrigation systems. The democratic states in the modern world seek to address this is through promoting farmer participation to share O&M responsibilities. In Sri Lanka, participatory irrigation management was introduced formally in late 1980s, at first in small tanks which were constructed and managed by farming communities and which later fell in to the hands of the government. This was later expanded in to medium and major tanks as well as systems like Mahaweli covering an entire river basin. This paper aims to review participatory irrigation management approaches adopted in medium and major irrigation systems in Sri Lanka with the view of identifying its past and present trends and future directions. The review will contribute to improved understanding by policy makers, managers of irrigation schemes and farmers, of the evolution of participatory irrigation management, including institutional structures, responsibilities and performances and the directions it should take to meet future challenges as a dynamic organization. As all the irrigation schemes in the country are jointly managed by the farmers and government agencies, the inferences drawn from the review would be important for the agencies and farmers alike to introduce necessary changes in their programs to address future needs and requirements.

Policy alternatives of the management of minor and medium irrigation schemes to develop groundwater systems in restricted catchments for the improvement in food productivity in the dry zone of Sri Lanka

Subramaniam Sivakumar

Deputy Director of Irrigation, Mullaitivu, 38/39 D Pilliyarkovil lane, Ukkulankulam, Vavuniya, sssivaddim@sltnet.lk

Food scarcity is a pressing problem in many countries especially less developed countries with low agricultural production and fast growing populations. To meet food requirements, efforts should be made to increase food production. This can be done by the use of more viable seeds, development and cultivation of improved crop varieties, use of proper fertilizers, pesticides and herbicides, improved on-farm water management, use of agricultural implements, provision of extension services, strengthening of the existing institutions and introduction of new socio-economic legal and organisational support to improve productivity. Proper management of water is of overriding importance, as the success and efficiency of most other measures are dependent on the quantity, quality and timing of the irrigation water supply, the way it is used and the degree of control over it. Many field experiments conducted by agronomists reveal that the increase crop yield depends (in addition to other factors) on dissolved nitrogen in irrigation water supplied. More frequent and less intense irrigation tends to give a better crop yield due to reduced moisture stress, requires less water to fill the root zone to field capacity and reduces solute movement. The general relationship between crop yield and water applied to the crop shows a linear increase to about 50% of the full irrigation and then a convex curvature to the optimum yield, followed by reduced yield with increase in applied water. Farmers whose objective is to get an optimum net income, tend to spend the minimum on their irrigation water to get optimum productivity of their crop, hence any research on optimum crop yield should economize the cost of the irrigation water and increase the extent of cultivation per unit of irrigation water. A study was carried out for a catchment (185.23 km²) in Vavuniya to find an operational policy for minor and medium irrigation schemes to conserve surface water by storage as groundwater, reducing the extent of cultivation using surface water and increasing the extent using groundwater to achieve optimum crop yield with creation of an artificial boundary to lift the water table. The aquifer was divided into 41 polygons by connecting the perpendicular bisectors of adjoining observation wells. Seven year seasonal water levels and 1 year monthly water levels, tank storage, field issues and total withdrawal from agro and domestic wells were taken for the water balance of each polygon. A regional aquifer simulation model in integrated finite difference method was formulated for this network and calibrated using non-linear optimization method. The calibrated model was run to predict the water levels for boundary treatment to reduce the transmissibility in steps, change in operational policy of irrigation schemes by keeping a certain percentage of the storage at any time and combination of both. The economic feasibility was analyzed taking the energy saved in pumping of raised groundwater as return and boundary treatment cost and income loss due to change in operational policy of irrigation schemes as cost. The present worth of benefit and cost for various interest rates and implementation periods were calculated and compared. In conclusion: change in operational policy of irrigation schemes by keeping 25% of the storage at any time together with 40-50% reduction in boundary permeability, will recover an average of 60-70% of the loss of water table in any consecutive season in almost 95% of the area under consideration.

Irrigation development, food security and poverty alleviation in Sri Lanka: past trends and future directions

Madar Samad

Director for South Asia, International Water Management Institute Colombo, Sri Lanka

Sri Lanka, historically, has placed a high value on *basic human needs*. This policy has resulted in one of the highest levels of human welfare among low income countries. Food security, poverty alleviation, and other welfare goals have been achieved by expanding irrigation and introducing new technologies to increase yields and move toward rice self sufficiency. From 1960 to 1995, the irrigated area rose by 50 %. Most of the new investment was in major irrigation. The Mahaweli scheme, initiated in the late 1970s, accounted for three-quarters of the total investment. The percentage of rice area irrigated rose from 56 % to 72 % and the irrigated area accounts for almost 80 % of the total rice output of the country. The percentage of total cropped area in major irrigation schemes in this period rose from 30 to 50 %. The era of construction of major irrigation schemes and expansion of irrigated area has come to an end. In recent years the output growth in the food crop sector has stagnated. There is uncertainty about the future directions for agriculture and irrigation development, an uncertainty intensified by the growing scarcity and competition for water. The issue is not one faced by Sri Lanka alone but by many Asian countries that experienced rapid agricultural growth from the mid-1960s to the mid-1980s. The Green Revolution, which depended heavily on irrigation, did benefit all farmers, but the scale-bias in favor of large holders was clear in the distribution of these benefits. These impacts have been well documented in all early studies in several countries in South Asia. The cumulative evidence suggests that the poor do benefit from irrigation development, but often less than the non-poor. The poor are also hit harder by the instabilities inherent in irrigated agriculture, such as fluctuations in the supply of water, commodity or input prices and technological change. This paper examines trends in irrigation development from a food security and poverty reduction perspectives. The role of irrigation in poverty alleviation has many dimensions: food security, employment, agricultural development and economic development. What have been the policy objectives? What have been the benefits and costs? What are the implications for the future development of irrigated agriculture and for poverty alleviation and food security? The paper begins with an overview of the poverty problem in Sri Lanka focusing particularly on rural poverty. The role of irrigation in poverty alleviation is reviewed, the trends in irrigation investments analyzed, and the performance of the irrigation sector assessed. The growing water scarcity problem and its implications for irrigated agriculture are highlighted and finally, options for the future are presented, especially pro-poor strategies for increasing the productivity of irrigated agriculture. It is argued that despite the growing competition for water, in aggregate terms, Sri Lanka is well endowed with water resources. Nonetheless, there is evidence of spatial and temporal water scarcity. The potential for increasing land and water productivity in irrigation schemes through better water management is very large. This requires effective policy support and innovative institutional arrangement to enhance management performance of irrigation schemes. Adopting improved management strategies is necessary but not sufficient to increase the productivity of agriculture so as to benefit the poor. Better management of water resources must be accompanied by investment in infrastructure other than irrigation, such as roads and electricity, and provision of support services for production and marketing of farm produce including adequate investments in research and extension.

Development of a water resources assessment and audit framework for Sri Lanka

Matin M., Smakhtin V., Pallyagruge M., Mohideen S., Yapa N., Ranjith A., Gunasinghe S.

International Water Management Institute (IWMI), PO Box 2075, Colombo, Sri Lanka,
m.matin@cgiar.org

The demand and use of water resources is permanently increasing, while water quality drops and water availability in the context of climate change is becoming uncertain. To meet these growing problems it is necessary to carefully assess the existing water stocks and future trends in a country. The accuracy of such assessment depends on the quality of data and information used for it. In other words - “we cannot manage what we do not measure”. In most developing countries, the lack of readily accessible and quality controlled data is the major obstacle for scientifically-based water resources assessments, water development planning and evaluating the status and trends of water resources. Sri Lanka is in a similar position. Recently IWMI initiated the development of a prototype system for managing national water resources data and information to provide online access to them for various users and interested stakeholders. The data and information in the system is being organized in modules to provide user friendly access. The ‘*overview*’ module includes information on topography, soil, land use, land cover, river network and settlement pattern. The ‘*water availability*’ module contains data on various components of the hydrological cycle, including rainfall, runoff, evaporation, ground water, river basin characteristics, per capita water availability and trends, and water scarcity. The ‘*Demand and use*’ module focuses on information about the driving forces that impact demand. These include population growth, sectoral demand, irrigation requirements and withdrawals. The ‘*Water quality*’ module provides information on salinity, water quality constituents and water related diseases. The ‘*Governance and Management*’ module contains information on institutions, legislation and finances in Sri Lankan water sector. The ‘*Disaster and Risk*’ module focuses on characteristics of floods, landslides and tsunami. Finally, the ‘*Climate Change*’ module covers information on the impacts of climate change on rainfall, salinity and sea level rise to guide adaptation planning. The system is designed with a view to facilitating assessments of water resources at various administrative levels (provinces, districts) and hydrological (e.g. river basin) units. The map-based interface ensures quick access to available data and allows its display and downloading. The system is currently “work in progress” and only an illustration of what can be achieved. It is envisaged that through cooperation with national agencies, the system will be enhanced into a unified platform for maintaining and sharing data by various participating agencies and will be used to conduct a systematic assessment of water resources in Sri Lanka. By developing a concept of comprehensive water audit nationally, Sri Lanka may show an example to other developing countries too.

Green Accounting System for Sri Lanka

Athula Senarathna

**Environmental Economic Policy Unit, Institute of Policy Studies, 99, St. Michael's Road,
Colombo 03**

Despite the fact that the natural environment plays a number of important roles in the economy, the conventional System of National Accounts (SNA), which is critical in the process of formulating economic policies, has a tendency to underestimate the contribution of the environment as well as the damage/losses inflicted by economic activities on the environment. Failure to incorporate the role of natural capital in the SNA has led to the neglect of environmental resources by policy makers, thereby resulting in further degradation of environmental and natural resources. Recognizing this situation, the UN Department of Statistics in collaboration with a number of other international agencies introduced the "System of Environmental and Economic Accounting (SEEA)", which is popularly known as green accounting (GA). SEEA, an integrated system of accounts, is expected to provide a systematic way to incorporate environmental benefits and costs into the decision making process of economic and environmental policy. The Ministry of Environmental and Natural Resources (MENR) has taken steps necessary to initiate a green accounting framework for Sri Lanka with the collaboration of other relevant government agencies. As a first step towards achieving this goal, the Ministry has commissioned the Institute of Policy Studies (IPS) to undertake an assessment of the current situation and draft a proposal for establishing a green accounting system in Sri Lanka. This proposal presents a green accounting framework for Sri Lanka and mechanism for implementation. The proposed green accounting framework for Sri Lanka is based on three criteria: priorities of the environmental sector from a macro perspective; situation of the existing SNA; and the feasibility of green accounting subject to the data availability. This framework identifies the key areas of interest and major components (i.e. key accounts) for accounting environmental and natural resources in Sri Lanka. The proposed framework includes a system of internal satellite accounts based on the information that already exists in the current SNA, hybrid flow account for the whole economy, specific resource accounts (i.e. land, forestry, fisheries, water and mineral resources) and development of a few carefully selected environmental aggregates. Given the current data limitations, the proposal acknowledges that this framework needs to be implemented in a stage-wise process beginning from the information already available in the current national accounts. A detailed implementation mechanism is proposed as a measure of achieving a green accounting system based on this framework. It includes an institutional setup, stakeholders, institutional coordinating mechanism, steps of implementation and supportive research. Based on this implementation mechanism, ensuing project activities, a tentative timeframe and gross budgetary requirements were also identified. A stage-wise implementation plan that includes pre-preparation, development and implementation phases is proposed for establishment of a green accounting system for Sri Lanka.

Effects of land use/land cover on the water source vulnerability: The cause study on intermediate zone of Matale District

S.I.S Subasinghe

Hector Kobbekaduwa Agrarian Research and Training Institute, 114 Wijerama Mawatha,
Colombo 07, shyam_geo@yahoo.com

This paper analyzes how the land use/land cover affects water source vulnerability using geographical information system and remote sensing techniques. The area selected for the study is the intermediate zone of the Matale District. The objective of this study is to find out what are the land use/land cover patterns that impact on the water source vulnerability, using remote sensing data and generated locations through Global Positioning Systems (GPS). Two maps were created to depict the spatial distribution of water source vulnerability through land use/land cover in the selected area. Initially, the distribution of 50 non-vulnerable and vulnerable water source is plotted on a map. Secondly, vulnerable points with colours to indicate spatial variation within the land use/land cover in the study area are created. Twenty five vulnerable water sources are analyzed to understand the effects of land use/land cover on the water source vulnerability, using the GPS points of the water sources within land use/land cover that are mapped using satellite images in the study area. The results show 20 vulnerable water sources located in the abundant tea estates, three vulnerable water sources in the home gardens and others that are in the vegetable cultivation areas. Finally, it can be concluded that the abundant tea estates impact more on the survival of water sources than the other land use/land cover in the study area. The vulnerable water source maps within land use/land cover provide some guidelines to land use planners, policy makers and implementing agencies to target their sustainable water resource initiations and safety net programmes to most vulnerable areas.

Data and information management for water management

Rev. Mawila Anomadassi Thero

Sri Sudarshanaramaya, Nilpanagoda, Minuwangoda, saranakumara@yahoo.com

g□, £ _□› "...ýý s tP {ýqý, "aCE Wua™q{ Ú}ýs}». {ýu, f™, CEkýeý~"}{ Zwq }P q□_ú s g□"}{ ZwqqCE \□□u}. ÁúuCE" aCE w{o_CE "uý, ,§~,,□qý,uCE" aCE w□,□qCE{ s \{a™uCE qt,p~□ "S. g□} Wauý ...Pwq_CE ,p, s ú" k_ úuýf_ýö }. g□ a□□{ íç...{ Áúq w{o_CE "uý, "z"Ö_ ...PwqCE s úuýf _~ñ. \ "† ñuCE g□ ...Pwq úsmýqCE{, tý ...□□...ÝP ...†aq, _†{uý~o} _† }Ýqç }. \úk □□ë} †□» w"Öx□ s W...}íq }.

g□} à,,o} û" {uCE "O~ý "au w"ö...~ß ...Pwq_CE "□... Wuýaq w~wp~k zý~ P" P ,a¼{ Ws w{o_CE Xkp ,£_CE "uý"S. {uý ...□□...Ý}»uCE }Ýqç , ...Ýwö~,,ý_ýö , g□ ...PwqCE wõ†~o} tý g□ _†{uý~o} " _~†™ WÖq"}{ ...k {yÝß ...} s_CE,u Wý_□{w} w²fŠ...è} }. \} ...□_úuCE Ú_CEû{ "{ ...Š~,,w«q ...ý~ýŠf"}†™ W~{Ýoñ.

"...ýý s t{†™ "s,□ç w±y□ ...ýt_}, £ g□} " _~†™ yÝß ...} "y"†úuCE ...íw }. aŠay - W□† - "Ú† - †Š - ,□S - "wý_çoj wõ...~} ...{d yÝß ...~õq y□□P w,Ö. {†yz™ç,,_²{o} tý yÝs□tqCE,} ...~ß,£"}{ s aŠayf²q wõ...~}_}. wõçR,ýo}k "{y"†ýq_k "w~ w□uCE w,... ç,y auCEuk yÝß †™í"}□ {†qCE ,•}{_ }ßot. "y□â...qCEqCE, W,P"}{ P w,y g□ ...Pwq w"†yv, Zs□"}□a™{qCE ,£ y,k gýq_ rý ó..._CE ...ý~,,µ s~ñ. "P \ñuCE W,...«rý "s_».

~□ß~□ {~□ _q~_ g□...ñuCE w"Íq ,£ ", †v w"ö..._CE W†|Ý "□... Bkp qşo w□†•Ě}_CE {a™uCE wşØú WzµuCEq~ g□ Z□{wq_CE Ú_ _^a□ wpwp~□,ý g□ "aýy}_CE wýÚ açíuCE ZqCErýu úR)} ...x□ _~ aqCE "oCECEojwr gýq_}" _CE çs...Ýu».

"b...u gýq_}" s _CE "qý~qç~_CE "au ñ. ad_k u□í a™} ...Ýú...□{ WqCEq_ ,ý...} _†_ç~□ø ...{†}_aCE {□ {£ (...Ý~□) {a™uCE aŠ Ý} Wwúq² ú{ ,†_ý aq "uý†□» ,£ ~□_CE "sú}_ç \{ aŠ Ý} Zo; _"ýk ,ý,,w g□}uCE _ç~□□{□uCE w"mý,k wqCE _~,,ý w□,ý †õuCEuk aqCE ZqCE...ý†}_CE †™ »}□,ñ. "a™ç çû{k auCEuý g□} { Ws a™ç Zws,ñ" »}íuCE _ç~□□{□□ {† ~□_†□~ Ú }Ö.

"y's □t ,qCE w"†",qCE,□ s wýõfçs□â}k †™í,uÝ"}{ w±{Ý...«rýu}». z™_CE,,p Áúq"}{ wýõfçs□â} Z"s...ý Z"w□...«rýay~}_ P " _~u ...•{ úu} _R{ }_CE { W□~"íuÝ"}{ Ý} y©ßu_CE s ...†™q, { }. wýè} Ý} y©ßu»uCE "qý~ úu} _R{ } s Ww"ö...~ß }. wýè} g□ wõ"z□gu} ...vtý "w~†u_CE (w"□{k~}_CE) (wõ...«...ý,u}_CE - wý□") zýúq »ö{ Wqµ,fµ }. z™_CE,,Ý,"aCE Wç,ýR} zýoCEm ...Š_çq ,£ Wkw"ö~k "w~†u_CE ç}{ , W□qCE"qCE \†ñç. ""sç_ wýè} g□ W,fµqý ...vtý "w~†u zýúq}k yÝs□t f²ý,_)ý y□□P ..."Í. eýõ_ý e~o"}{P "w~†u Wç,ýR} ,£"}{ ~,,pâ ÁúuCE" auCE ó_~o} □yý a□è{k tý ç"~□a™qý , ZÚ _~ a□è{k }.

Wýtý~ WuÝz,"uCE w...Ý , XÖö ,u X©ß□{ _...□ g□}k ú...~ "ö{ tý g□}†™ {□ {† w† »ö{, " _† a□...}{ úu} èÖ {a™uCE ...wp~ý q†uP _~ W□q. g□ ...Pwqk Wýs~} s}ý, Ú_CEú} }ÝqCE"qCE \wös□"sç. yÝß ...{ }†™ \u ...q~ {tý ziq (wlú-W"wy~"q"gy~,ý")ý} ,□ "W"wy" }uÝ s g□} wÚRr} ñ. " }□ay,e~ýk (zý,uý,"uCE {u... ,muCEuýk} g□} s zý,uý _R{...«rýu}k WÚ† ,uCEuý ,£ áfµyýt~}». "†"q" P s g□} úút W}ÝõuCE ,k tý auCEuk ZqCE...ý† _~ñ.

g□} wōt-o} _‡} ŸqCE"qCE W-wō{□...{ç. y©βuCE wō XŌö }u wōÝ Ý} w~û{, \"...{ »ö" Pp W,k
...~Ë}, puCEk "t□ q{ý" aCE W□©βP, ...~□~□ "q" {uCEuk ...□□□...û{ "uý_‡} ŸqCEq». ú†ý~"} †™ wýè} †ý
wō"z□a }uÝ", uCE g□ y©βuCE "s} ý_ý~ñuCE ...Œrýu aq »ö{, WýauCEqç_} uCEk \y©β q□uCE ...uCEç" Ssu}
»ö{, aŸ†}_k w~ú...} "Pp "swý "...□Ú w~ú...}{, ú†ý~"}{ ‡~v çyv ...Š~r, ~q, qyý a□è{, g□ýw, †u wsŒtŌ
2{, qCE , zýúq »ö{ z~r, Ÿ, "aCE ""sç _ýR} ý, □} k W} qCE }.

g□ ...PwqCE ZqCEwýsu} w±} Ō w±" {□s} "au "suŒu». ...□{ Ú w~uCE ,□"mu "...Ú wpi□i w, Jnu"
_k} ŸqCEq». ...~q qçkβ w†kβ _~u w~□w_ý~}». ep□◊□ , aŒEa wý□""{ ...Šb "zŒEs_ wōE" Fs"}{s}
"aýúq□uk w, ý g□} ") P" _2{" Ss} a□u yŸβ †™f"}□ _~□o; s_Œ, Ō.

"ýýŒEâ w£gý, Wq w□uCE , qCE »öP, "z□gu ...Ša2† Wý~ýtuý, {† {a } "uu su w, ... ç, u w□uCE qý□~ XÝ »ö{
Wýp ...}∅ _k} Ÿqç, □P Ww ~kk Z~□{ , W□qCE"qCE s g□} k "w□uCE" }u "a~, y†Ÿ{ýu Wý{uŒEa2o}ñ. ç} Š
...{ }_p s†ŌÚ {ý†~ay,, f2} {†ý "y□â} , □ç w£gè} ...rýu, □ ú" fŒE,, w£gý w, qCE, ý , □...~ x□ Zws, ý a□è" P
†□»} ý, s Wwk Z~□{. wōqCE "wý" q†™ \u " , □...~ wōq" s \y©β WuŸzý, ...PwuŒEu fýuŒEŌ _R{ }».

{†ý, Šf} 66 wōE"Fs} 11 aýrý, k WuŸ, w†{Ÿ w□~_çPyý ~g " , □...~ Ý} _ ev_çβ x□Úñqý", uCE "qý~, ...} Ÿ~k
"uý"}{, ý" ñ w□, ...Ÿ"}{ s yŸβ...{ } †™ \u Zw"s□f} k a~□ _~íç.

Wúsµý qýŸ,, o {m "aý"†ý~□", †™ a~ø"o□ Wauý g□ ...Pwq , u...Ō. wōuý{ qç~□ {Ÿβ"uCE " ; ...u íç...ý Ws
_ýuŒEaqý~ çR{ýo} _~íuCE ...~Ëñ. \y□úuCE g□ ...PwqCE _‡{uý_~o} w~‡~yv , yŸβ ...{ } s~u Ws†...{ s
"†™ □ý ...□□»□◊□k a□è{ †ý Wtu}u} »ö{ s Xqý , Ì.

Surface runoff estimation over heterogeneous canal commands applying medium resolution remote sensing data with SCS-CN method

Priyantha Jayakody and Nilantha Gamage

International Water Management Institute (IWMI), PO Box 2075, Colombo, Sri Lanka,
p.jayakody@cgiar.org

Precise estimation of surface runoff from rainfall is critical for water resource management. In the recent past, remote sensing (RS) and Geographic Information System (GIS) technologies have been widely used in surface runoff estimation of watersheds, particularly from agricultural fields. This is due to the inherent ability of remote sensing to capture spatial heterogeneity of surface parameter such as landuse/landcover. This could lead to a sound surface runoff simulation model to perform better. Surface runoff volume/rate estimation involves quantifying the amount of rainfall exceeding infiltration and initial abstractions which must be satisfied before the occurrence of runoff. There widely accepted SCS curve number method was employed to calculate surface runoff using a combination of remotely-sensed landuse/landcover and hydrometrological data in Punjab canal command areas. Landuse/Landcover maps for four cropping seasons, which are Rabi 2004-05, Kharif 2005, Rabi 2006-07 and Kharif 2007 were derived using red and near infrared bands of MODIS 8 day products. The existing soil map was reclassified into hydrological soil groups and rainfall data was interpolated using inverse distance method to represent spatial rainfall values of each canal command. Results show CN values varied 70 to 95 during the study period. The highest CN value of the study area is 94.4 during Kharif 2005 season. Mean while runoff-coefficient is changing from 0.01 to 0.25 and 0.01 to 0.43 respectively during Rabi 2004-05 and Rabi 2006-07. During Kharif 2005 and 2007 runoff-coefficient varies from 0.01 to 43 and 0.01 to 0.45 respectively. The study shows that SCS curve number method can be used for runoff estimation with the help of remote sensing products and GIS technologies from catchments where gauging data is not available

Benchmark basin research in Walawe River Basin

B. R. Ariyaratne, P. G. Somaratne, K. Jinapala

International Water Management Institute, Sri Lanka, r.ariyaratne@cgiar.org

With the growing importance of the river basin concept in water resources management, IWMI research in Sri Lanka is focused on the Ruhuna Basin, which encompasses the southern river basins from Kachchigal Ara to Menik Ganga. Benchmarking allows IWMI to compare the performance of irrigation institutions in Ruhuna Basin with the other IWMI benchmark basins the world over, learn lessons and make recommendations for their improved performance. As there are no river basin organizations established in Sri Lanka for the management of river basin, various organizations such as the Irrigation Department, the Mahaweli Authority, the Agrarian Development Department, the Electricity Board and the Water Supply and Drainage Board, are all involved in different water resource development activities. Therefore, IWMI formed a forum in the Ruhuna Basin area with the participation of the agencies concerned to carry out research and discuss findings to contribute to water resources management efforts in the basin area. The studies carried out with the participation of water resources development and management institutes and universities included the conflict over water sharing between different uses such as power generation and agriculture, impacts of irrigation development on downstream ecosystem like lagoons and wetlands, poverty in different parts of the basin, present performance of minor tanks systems in the context of major irrigation development, impact of irrigation development on biodiversity and socioeconomic conditions, diffuse agricultural pollution, an assessment of hydrology and environmental flows and ground water, and water and health related issues. The findings of these studies have highlighted many issues and contributed to considerable awareness among the stakeholder agencies with respect to water resources management problems and associated institutional and other aspects.