Proceedings of the Eleventh International Conference on Rain Water Catchment Systems

Texcoco, Mexico

August 2003

Abstracts

1 Rainwater harvesting for agriculture

2 Rainwater harvesting for domestic and industrial use

3 Socio economic aspects of rainwater harvesting

1 RAINWATER HARVESTING FOR AGRICULTURE

1.1 Experiencias En La Captacion De Agua De Lluvia Para Consumo Humano, En El Estado De Oaxaca

Ing. Julián Rubén Ríos Ángeles
Gerente Regional Pacifico Sur, Comisión Nacional del Agua Reforma 905, Col. Centro, Oaxaca CP.68000

I.- Introducción

El almacenamiento de agua de lluvia, es una opción que está siendo aprovechada, en las zonas rurales del Estado de Oaxaca, especialmente en algunos municipios de las regiones de la Mixteca y Valles Centrales, mediante la construcción de sistemas de captación de agua de lluvia de bajo costo mediante la construcción de sistemas de captación de bajo costo, involucrando la participación de las comunidades en su planeación, construcción y operación, lo que representa una alternativa real para ampliar las coberturas de estos servicios básicos en el medio rural.

Debido a la dispersión geográfica de muchas localidades en las zonas altas de las sierras de Oaxaca, durante la época de escasez (Noviembre a Mayo), agotándose las fuentes tradicionales de abastecimiento como manantiales, dificultando el abasto de agua para cubrir sus necesidades y representa una alternativa que puede ser utilizada para proyectos productivos y para el ganado.

El presente trabajo describe las características del "Programa de construcción de Sistemas de Captación de Agua de Lluvia para Consumo Humano", implementado por la Gerencia Regional Pacifico Sur, de la Comisión Nacional del Agua, en localidades rurales de las Regiones de los Valles Centrales y de La Mixteca a partir de junio de 1997, habiendo seleccionado como localidades Piloto: El Carmen y La cañada en el Municipio de Santa Inés del Monte y la Reforma en el Municipio de Santa Inés de Zaragoza.

En el 2001 en coordinación con el Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional Unidad Oaxaca del Instituto Politécnico Nacional se construyeron tres cisternas de ferrocemento en la Agencia Municipal de San Francisco Yucucundo, en el Municipio de San Antonio Huitepec, distrito: de Zaachila, en la Región de los Valles Centrales de Oaxaca .

1.2 Water Harvesting For Improved Rainfed Agriculture In Sub-Saharan Africa: Potential, Constraints And Opportunities

Ines Beernaerts
FAO

Introduction

In 1996, at the World Food Summit, Heads of State reaffirmed the right of everyone to have access to food security, expressed as a secure access at all times to safe and nutritious food. They also committed themselves to halving the present number of 800,000 of undernourished people by 2015. The achievement of this goal is central to the Strategic Framework of the Food and Agriculture Organization of the United Nations.

In many semi-arid regions of the world, irrigated agriculture alone will not be able to satisfy the future demand for food. Rainfed agriculture still supplies about 60% of the world's food and will continue to play a major role in cereal production, which is by far the most important source of food, both for direct human consumption and livestock production. In sub-Saharan Africa, rainfed cereal production accounts for about 90% of total cereal production (IFPRI, 2002).

Since the mid-1960's, the world has managed to raise cereal production by a billion tonnes. Over the next 30 years, the challenge remains the same. As new land to put under agriculture is increasingly limited, improvement of yield will continue to be the largest source of increase in crop production. In sub-Saharan Africa, improvement of yield and area expansion account for 65 % and 35% of increased food production respectively. While external support for agriculture has considerably decreased over the last 20 years and resource-poor farmers have limited access to credit and other inputs, a number of scenarios have shown that more rapid growth in rainfed yield and production could compensate for reduced investment in irrigation (IFPRI, 2002). Hence, affordable technologies to increase crop yield in rainfed agriculture would make a significant contribution to food security.

Low and irregular rainfall is a permanent threat to agriculture in many (semi-) arid areas. However, as reported by Rockstrom (2001), even rainfed agriculture is characterized by low yields, generally oscillating around 1 T ha^{-1}, there are no agro-hydrological limitations to doubling or even quadrupling on-farm staple food yields even in drought –prone environments, by producing more 'crop per drop' of rain. Innovative rainfed management strategies are currently being identified to improve water productivity within present farming systems. At present, one of the main issues lies with the creation of an enabling environment for a wide dissemination of the available options.

1.3 The Use Of Demand-Side Irrigation Principle For Crop Irrigation – The Sustainable Use Of RWCS

Yu-Si Fok
Emeritus Professor Civil and Environmental Engineering, and Emeritus Researcher, Water Resources Research Center, University of Hawaii at Manoa, 2540 Dole Street, Honolulu, Hawaii, 96822-2303, USA. Fax: 808-956-5014 or 5044, e-mail: fok@wiliki.eng.Hawaii.edu

Abstract

According to Fok and Mou (2001), the demand-side irrigation principle has been defined that the water demand by crop determines the starting and stopping of irrigation water flow. In other words, when the crop needs water, its signal will cause irrigation water to flow. And as soon as the crop water demand is satisfied, the irrigation water will be turned off. This irrigation principle is an innovative formulation to correct the waste of water by the current supply-side irrigation principle that was based on the public water supply systems design principle. The design engineer determines the amount of water supply to users according to budgeted money and time without concerning the water users' need and environment. Supply-side irrigation principle has the built-in water wastage because irrigation scheduling does not tailored to crop water demand. The supply-side irrigation system works well when water is plentiful. However, when water is a limiting factor for crop production, Demand-side irrigation principle considers the crop as the decision maker, it can make every drop of water for maintaining good crop production. Rainwater catchment systems (RWCS) have been used to provide irrigation in semiarid and arid regions with very good results. This paper stresses the sustainable use of RWCS in arid and semi arid regions irrigation to ensure high crop production and to improve

farmers' drinking water supply and their income. Two successful examples of sustainable RWCS projects, one in Mexico and one in China, have been cited to fulfill the objectives of this paper. The importance to attend higher irrigation efficiency is stressed.

1.4 Plano De Convivência Com A Seca Abastecimento Da População Rural Difusa No Semi-Árido Do Nordeste Do Brasil

Dalvino Troccoli Franca
Brasília Maio 2003

Sumário

1.5 Water Harvesting In Southern Tunisia And Effect Of Soil Tillage On The Soil Water Balance In The Semi-Arid Zone Of The Loess Plateau Of Northern China

Donald Gabriels

W. Schiettecatte

W.M. Cornelis

K. Verbist

R.Hartmann
Department of Soil Management and Soil Care, International Centre for Eremology, Ghent University, Belgium

M. Ouessar
Institut des Régions Arides, Médenine, Tunisia

H. Wu

D. Cai
Soil and Fertilizer Institute, Chinese Academy of Agricultural Sciences (CAAS), Beijing, P.R. China

Abstract

Two case studies were conducted to investigate the effects of respectively water harvesting and soil tillage practices on the soil-water balance in semi-arid regions. In southern Tunisia, the effect of a jessr (consisting of a micro catchment, called impluvium, and a terrace) as water harvesting system at Amrich in the Oued Oum Zessar watershed was evaluated on the conservation of soil and water. Field rainfall simulations at the impluvium provided input data of infiltration and sediment transport which were used to estimate runoff and erosion during rainfall events. The results indicated that large amounts of runoff and sediment can be collected on the terrace, mainly depending on the rainfall intensity rather than the total rainfall amount. Because of the water retention on the terrace, the jessr system provides an efficient measure in reducing the transport of water and sediment downslope.

In the semi-arid region of the loess plateau of northern China, a field study on a winter wheat field was carried out near Luoyang (Henan Province), to measure soil erosion rates and to compare the water balance under different soil tillage practices. Analysis of the different components of the soil water balance enabled to determine the most suitable tillage practices for crop growth. The preliminary results show that subsoiling resulted in the highest increase in moisture storage and lowest evaporation during the fallow period. A two-crop rotation with peanuts also show promising results, mainly due to increased evaporation of the soil surface. No-tillage and conventional tillage gave intermediate results, whereas reduced tillage was the worst alternative.

Keywords: water harvesting, jessr, impluvium, terrace, catchment to cropping ratio,
Tunisia, water balance, rainfall simulation, tillage, loess plateau, P.R. China

1.6 Water Harvesting And Soil Carbon Sequestration

R. Lal

Carbon Management and Sequestration Center, OARDC/FAES, The Ohio State University, Columbus, OH 43210

Abstract

The world's drylands cover 6.2 billion hectares or 47.2% of the earth's land area and are a home to about 1 billion of its inhabitants. With low, erratic and highly variable rainfall of 200 to 500 mm/y, biomass productivity in dryland soils is severely constrained by the lack of adequate water supply. Low return of crop/plant residues and biosolids is responsible for generally low soil organic carbon (SOC) concentration of 0.2 to 0.8% in the surface horizon. However, soils of these ecoregions have relatively high concentrations of soil inorganic carbon (SIC) comprising carbonates and bicarbonates. Soil degradation and desertification are also severe problems in these regions. Water harvesting is a feasible option for improving the water supply in dryland ecosystems. It involves collecting and storing precipitation from sloping marginal lands for reuse on favorable soils in the valley bottom. Recycling stored water for supplemental irrigation can increase crop yields and biomass productivity 3 to 4 times. Increase in biomass productivity through water harvesting and recycling can set-inmotion soil restorative trends leading to an increase in SOC concentration and sequestration of secondary carbonates. Transformation of drylands into agricultural or forestry lands through water harvesting and recycling increases canopy cover, decreases ambient temperature and affects local and regional climate. In addition, soil C sequestration decreases the rate of enrichment of atmospheric CO_2. The rate of SOC sequestration in dryland soils may be 50 to 200 kg C/ha/y, although high rates >1 Mg/ha/y have been reported in intensively managed irrigated croplands. Additional nutrients (N, P, S etc.) needed for humification of C may be available through those contained in crop residues, and may also be supplied through fertilizers, biological nitrogen fixation and nutrient cycling. Soil C sequestration in dryland ecosystem is water rather than nutrient constrained, and a judicious use of water harvesting strategy can enhance SOC and SIC sequestration with a major impact on the global C cycle.

1.7 Multi-Faceted Use Of Rainwater Harvesting To Combat Water Problems

K.F. Andrew Lo

Dept. of Natural Resources, Chinese Culture University, Taipei, Taiwan. E-mail: ufab0043@ms5.hinet.net

Abstract

In most urban areas, supplying adequate water to meet ever-increasing population water demand and to ensure equity access to water is the most urgent and significant challenges faced by most decision-makers. There are two solutions to satisfy sustainable freshwater management: (1) finding alternate or additional water resources, and (2) utilizing the limited available water resources efficiently. Up till now much effort has been focused on the first option and only limited attention has been given to the second choice. Among the various alternative technologies to augment freshwater resources, rainwater harvesting is a decentralized, environmentally sound solution, which can avoid many environmental problems, associated with centralized, conventional, large-scale project approaches.

Rainwater harvesting is a technology used for collecting and storing rainwater for human use from rooftops, land surfaces or rock catchments using simple techniques such as jars and pots as well as engineered techniques. Rainwater harvesting has been practiced for more than 4,000 years. It is an important water source in many areas with significant rainfall but lacking conventional, centralized supply system. It is also a good option in areas where good quality fresh surface water or groundwater is lacking. Appropriate application of rainwater harvesting technology is a feasible solution for global water crisis.

1.8 Water Harvesting To Control Erosion And Enhance Vegetation In Tucson, Arizona

Dorothy Motheral
Wildworks Landscapes, Inc., Tucson, Arizona, USA, Azdotty@earthlink.net

Water in the desert is a treasure, yet it can be destructive in certain situations. Five years ago we were approached to remedy erosion and compaction problems on a quarter acre piece of a seven-acre residential property in the Northwest part of Tucson, Arizona. In this case water drained off of two large roofs and a huge patio and sheetflooded across a driveway. This flow joined sheetflooding from the neighboring desert, gaining momentum as it traveled across bare, impermeable ground, until it formed gullies on its way to a drainage ditch downstream. We developed a very simple water catchement system that directed the water, slowed it, down, detained it and stored it in the soil. After the construction of the water harvesting structures, we revegetated the area with native plants. Water that had created a nuisance now aided the establishment of a beautiful natural area.

1.9 Potential Role Of Rainwater Harvesting In Coping With Water Scarcity In West Asia And North Africa

Theib Y. Oweis
International Center for agricultural Research in the Dry Areas (ICARDA), P.O.Box 5466 Aleppo, Syria

Abstract

West Asia and North Africa (WANA) is probably the water-scarcest region of the world. Water scarcity in this region is increasing and approaching levels where economic and social development is seriously threatened. The drier environments of WANA, called steppe or badia, occupy the vast majority of the land areas and mostly inhabited by disadvantaged people. The natural resources are subject to degradation and the people's income, which depends mainly on grazing, is continuously declining. Due to harsh conditions, people have increasingly migrated to the cities inducing prohibited costs, social and environmental problems.

The most important natural resource in the drier environments of WANA is rainfall. Although limited, it is generally poorly managed and mostly lost with little benefits. To improve the living standards, prevent migration and to reverse land degradation in this environment, an improved management of the natural resources is essential. Improving the capture and the utilization efficiency of rainwater is crucial for any meaningful integrated development in these areas.

Rainwater harvesting is an ancient practice that improves the efficiency of rain through concentrating it for proper use. The region has a wealth of indigenous knowledge and traditional practices that can help in contributing to the solution. Implementing micro and macro-catchment techniques in several countries of the region has shown great potential for improving production and combating desertification. However, proper planning and ensuring farmers participation in the process were found to be vital for any success. Issues of existing land tenor, national policies and public support are often limiting the implementation of rainwater harvesting on a large scale.

1.10 Water Harvesting For Rural Livelihood Security Building Resilience And Managing Risk In Savannah Agro-Ecosystems

Johan Rockström
WaterNet, University of Zimbabwe, PO Box MP 600 Harare, Zimbabwe, email: rockstrom@eng.uz.ac.zw; tel: +263 (0)4 33, 67 25; fax +263 (0)9 33 67 40
Unesco-IHE, PO Box 3015 Delft, the Netherlands.

Abstract

There is an increased acknowledgement that there is a need of a green-green revolution in order to secure food and livelihoods for rural poor in an environmentally sustainable way. Water harvesting systems can provide an entry point to upgrading of smallholder rainfed farming systems in water scarce regions. Here, risks for water induced crop failures are extremely high, affecting not only livelihoods, but also risk perceptions. Water Harvesting can provide a tool for farmers to manage rain induced risks, and thereby build social and ecological resilience.

This paper presents the agro-hydrological rationale for focusing on water harvesting for upgrading of smallholder rainfed agriculture in tropical savannahs, identifies key management challenges in trying to upgrade rainfed agriculture, and presents a set of field experiences on water harvesting options for increased yields and water productivity while simultaneously building resilience in smallholder farming in drought prone environments. Implications for watershed management are discussed, and the links between water harvesting systems, and securing of water flow to sustain ecosystem services are briefly analyzed. Focus is on sub- Saharan Africa hosting the largest food deficit and water scarcity challenges.

The paper shows that there are no agro-hydrological limitations to doubling or even quadrupling on-farm staple food yields even in drought prone environments, by producing more “crop per drop” of rain. Field evidence is presented suggesting that meteorological dry spells are an important cause for low yield levels and it is hypothesized that this may constitute a core driver behind farmers risk aversion strategies, which contribute amongst others to the urgent soil fertility deficits due to insignificant investments in fertilization.

Results are presented from field research on smallholder system innovations in the field of water harvesting and conservation tillage. Upgrading rainfed production systems through supplemental irrigation during short dry-spells is shown to improve yields and water productivity. Downstream implications of increased upstream withdrawals of water for upgrading of rainfed food production are discussed. Finally it is argued that some of the most exiting opportunities for water productivity enhancements in rainfed agriculture are found in the realm of integrating components of irrigation management within the context of rainfed farming, e.g., supplemental or micro irrigation for dry spell mitigation. Combining such practices with management strategies that enhance soil infiltration,

improve water holding capacity and plant water uptake potential can assist in unlocking the potential of rainfed farming and thus constitute a first step towards a urgently needed green revolution, without jeopardizing water flows to sustain ecosystem functions.

1.11 Uma Nova Abordagem Para Conservação De Água E Solo No Espaço Rural Plantio Direto - Experiência Brasileira

Paulo Afonso Romano
Consultor/Oea/Srh

1) Introdução

2) Contextualização Do Problema Sob Os Aspectos: Ambiental,

Economico, Social, Político E Institucional/Legal

3) Perdas Pela Erosão Hídrica

4) Sustentabilidade Agrícola E Conservação De Água E Solo

5) Uma Perspectiva Otimista

6) Diretrizes Básicas Para Formulação De Uma Proposta De

"Agricultura Conservacionista"

7) O Plantio Direto Como Base Para Uma Agricultura Sustentável: A Experiência Brasileira

Trodução

No Brasil, em períodos recentes são muitos os casos de degradação pelo uso inadequado do espaço físico e notadamente pela falta de cuidados no uso do solo e água. Tendo sido iniciado o processo de ocupação territorial em condição de abundância de terra de elevada fertilidade, e com baixíssima a dotação tecnológica (derrubada, queimada e semeadura), a agricultura empírica aí instalada, entretanto, foi suficiente para abastecimento de uma pequena, porém crescente população e formação dos primeiros ciclos econômicos do Brasil (cana de açúcar, algodão, café e pecuária) até a década de 50.

Mais recentemente a partir da década de 70, a forte migração interna, de famílias de agricultores do Sul para o Centro OesteE PARTE DA Amazônia, de maneira organizada ou não, mas estimulada pela oferta de terras e créditos baratos e abundantes construiu-se uma nova fronteira agrícola – a da Região dos Cerrados, que hoje produz mais da metade dos grãos e carne do País, além de outros produtos relevantes como café, algodão, etc com alta e média tecnologia.

Diferente da fase anteriormente mencionada, trata-se de agricultura exigente em tecnologias porque implantada em solos pobres em nutrientes, mas altamente favoráveis à intensa mecanização. Além disso, é cada dia mais comum o cultivo em seqüência para obtenção de 2 safras/ano: a safra normal (primavera/verão) e a "safrinha"(verão/outono).

Um dos principais impactos sobre as águas é causado pelo assoreamento de cursos d'água e nascentes. Observa-se neste caso que as áreas em referência situam-se predominantemente no Planalto Central onde, por conseqüência da orografia, altitude e boas precipitações formam-se as principais bacias hidrográficas brasileiras. São conhecidas as "Águas Emendadas", no Distrito Federal, de elevado simbolismo e onde nascem as bacias Amazônica, do Paraná e do São Francisco.

Portanto, ao lado do uso intensivo do solo está a exposição da frágil rede hidrológica aos impactos do processo produtivo quando não baseado em práticas conservacionistas.

Há forte preocupação também com o especial ecossistema do Pantanal cuja qualidade e quantidade de água dependem dos processos de uso do solo nas chapadas (parte alta) a sua montante. São notáveis os prejuízos com o assoreamento daquele único e complexo ambiente, com incalculáveis prejuízos de toda ordem, como já evidente na sub-bacia do Rio Taquari.

É sempre oportuno salientar que na natureza é melhor “prevenir que remediar”. Os custos de recuperação são, às vezes, insuportáveis para a sociedade, e pior, raramente se consegue o retorno ao nível natural anterior à degradação.

1.12 Striving To Sustain The Soil Resource Base While Increasing Crop Production In Semiarid Regions

B.A. Stewart
West Texas A&M University, U.S.A.

Sergio Benedicto Valdes
Colegio de Postgraduados, Mexico

Introduction

Sustainability is an important word today in many writings. It is particularly important in agricultural discussions because even though world population has more than doubled in the past 50 years, the production of food and fiber has increased even faster. Many, however, question whether or not these production rates can be sustained, and more importantly, can the soil resource base be sustained as more and more intensification occurs? There are many different concepts of sustainable agriculture, but none is commonly accepted. Sustainability, to many, conveys the idea of a balance between human needs and environmental concerns. The American Society of Agronomy defined sustainable agriculture as one that, over the long term, enhances environmental quality and the resources base on which agriculture depends, provides for basic human food and fiber needs, is economically viable, and enhances the quality of life for farmers and society as a whole (Schaller, 1990). Similarly, the United States Congress defined sustainability in the 1990 Farm Bill as an integrated system of plant and animal practices having a site-specific application that will over the long term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agriculture economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers and society as a whole. Ruttan (1989) proposed, as a guide to research, that the definition of sustainability should include (i) the development of technology and practices that maintain and/or enhance the quality of land and water resources, and (ii) the improvement in plants and animals and the advances in production practices that will facilitate the substitution of biological technology for chemical technology. The first part of the Ruttan definition is similar to that of the United States Congress, but the second part of the Ruttan definition emphasizes more reliance on biological technology as opposed to chemical technology. Sustainability should be considered dynamic because, ultimately, it will reflect the changing needs of an increasing global population. The common thread among all definitions of sustainability, however, is that quality of the resource base should be *enhanced*.

1.13 Rainfall Harvesting Using Sand Ditches In Jordan

Dr. Majed Abu-Zreig
Associate Professor, Department of Biosystems Engineering, College of Engineering, Jordan University of Science and Technology, PO Box 3030, Irbid 22110, JORDAN, Fax: +962-2-7095018; e-mail: majed@just.edu.jo

Abstract

Rainfall harvesting in dry agricultural areas increases soil water availability for plant during the growing season, thus increases crop production. Collected rainfall can be stored directly into soil for crop production which includes the use of terraces, rippers, contour ridges, and similar types of water harvesting methods. However, the efficiency of these methods is limited by the infiltration characteristics of soil and climatic conditions. In rain-fed agricultural areas in the northern Jordan soils are predominantly clay having very low infiltration rate. In such cases the depth of water infiltration is very small and water may remain in the upper layer of the soil profile. With high evaporation rate, collected water is lost to the atmosphere in very short time and could not be available for plants.

A field experiment was initiated since 1996 to harvest rainfall in northern Jordan and store it deeper in the soil profile to reduce the effect of evaporation. The experiment consists of digging experimental trenchs with a depth of 80 cm, 5 m length and 1 m width across land slope between two rows of olive trees. The trenches are filled up to the original soil level using local deposits and sand with large infiltration rate. These filled trenches, called sand ditches, are expected to collect rainfall, intercept runoff and store water in the surrounding soil at higher depths to be used by plants for longer period of time. It can be a very efficient method since it increases water infiltration and prevents evaporation during the growing season. The efficiency of sand ditches in storing water was assessed by monitoring soil moisture condition and depth of infiltration in the sand ditch area, which is the 35 m^2 area located between four olive trees, and at a control area without sand ditch using an auger hole. The amount of water stored in the soil can be calculated in each time interval and compared with total rainfall. Experimental results indicated that sand ditches increased both the percentage of rainfall stored in soil matrix and the infiltration depth of water during winter seasons. At one of the experimental areas in February 23, 2000, the infiltration depth and water content in the sand ditch area were 100 cm and 28%, respectively compared to only 68 cm and 19% in the control area, respectively. During the same period, the calculated ratio of water depth stored in the sand ditch area

1.14 Barraginhas Para Captação De Água De Chuvas, Recuperação De Área Degradadas E Regeneração De Mananciais - A, B, C E D - Fases Da Mobilização

Introdução

O desmatamento desorganizado no Brasil Central, acelerado a partir da década de 70 para produção de carvão vegetal e a conversão desses ecossistemas naturais em lavouras e pastagens, sem a utilização de tecnologias adequadas, resultou em danos irreparáveis ao meio ambiente, principalmente em relação à conservação da água e do solo, em particular na compactação do solo causada por patas de bois e por pneus de tratores. A conseqüência imediata foi a redução da taxa de infiltração da água no solo; iniciando o escorrimento superficial da água de chuvas, provocando erosão, principalmente do tipo laminar, que degrada e empobrece o solo, Figura 1, além de carrear assoreamento e poluentes aos rios, também provocando enchentes e diminuindo a sustentabilidade produtiva agrícola.

Unidade Demonstrativa

Visando reverter esse quadro, durante o ano de 1995, em Sete Lagoas-MG, com média pluviométrica de 1350mm, foi criada uma unidade demonstrativa numa propriedade de 70ha na micro-bacia do Ribeirão Paiol, onde foram construídas dispersamente 30 barraginhas contentoras de enxurradas, Figura 2, complementadas com curvas de nível, que contêm também fontes poluidoras veiculadas pelas águas, além de forçar a recarga das reservas subterrâneas pela elevação do lençol freático, armazenando água de boa qualidade na esponja porosa do solo através da infiltração, Figura 3, revitalizando mananciais e rios, e ainda, amenizando os efeitos das secas e veranicos em lavouras localizadas nas partes baixas das propriedades. Cada barraginha recarrega 80m3, de 10 a 15 vezes ao ano, transferindo um volume de 800 a 1200m3 ao lençol freático, ao custo de R$0,03/m3 (três centavos cada m3 no primeiro ano), e R$0,01/m3 acumulados em 3 anos.

1.15 Microfarm Project Using Simplified Hydroponics And Fertigation In The Lerma Chapala Basin

Peggy Bradley
International Director, Institute of Simplified Hydroponics, Tehuacan Mexico

Raanan Katzir
Sustainable Agriculture Consulting Group, Tel Aviv, Israel

Abstract

Unsustainable water use in the Lake Chapala Lerma River watershed is reducing the lake levels and depleting some of the 37 watershed aquifers. Currently irrigation for agriculture is using 86.5 % of the water in the watershed, overusing an estimated 1.4 to 1.9 billion m^3 of water each year.

A microfarm project is proposed for the basin to increase productivity of farmers, utilize degraded lands and reduce water requirements for farming. The microfarm is designed for a family using a hectare of land to produce from 40 to 140 kg of agricultural products a day. The farm uses simplified hydroponics and Israeli fertigation techniques to reduce the amount of land and water required to grow produce.

Rainwater is captured for use on the microfarm. Fish ponds of 1060 m^3 capture and store rainwater and drip irrigation fields utilize the fish waste water. Watershed average precipitation of 736 mm a year provides 7360 m^3 of water falling on a microfarm hectare each year. The microfields are estimated to require about 1440 m^3 a year and fish pond evaporation is estimated at 1964 m^3 a year. The total 3344 m3 a year are less than available rainfall so if sufficient water can be captured, irrigation will not be required.

In the Lerma Chapala watershed, of the 78,000 farmers, 52,125 are classified as small farmers. Currently 820,000 hectares are irrigated and an estimated three million hectares are in agricultural production. These practices currently use at least 6.5 billion m^3 of water. If microfarms use 3444 m^3 of water per year, the estimated 52,125 small farmers would require total water of about .170 billion m^3 of water a year on 52125 hectares of land. Reduction in land space and water could relieve the excess

water use in the area, restoring both lake levels and aquifer waters. As estimated 3.2 billion m^3 of water could be saved with this change in practice.

1.16 Water Harvesting In Nature

Russ Buhrow
Curator of Plants, Tohono Chul Park

Abstract

Water harvesting predates humans by millions of years. Landforms and local microtopography concentrate water which enhances plant growth. Some plants have developed specialized forms that capture and direct rainwater where the plant's roots can absorb it. Foothill palo verde (*Cercidium microphyllum*) has upward reaching branches that rapidly drain water to the base of the tree. This semisucculent tree then rapidly absorbs the water and stores it internally. Water is effectively captured with as little as 0.01" (0.25 mm) of rainfall or even heavy dew. Soaptree yucca (*Yucca elata*) collects water with its upper leaves, brings the water to near its center, then sends the water outward from its lower leaves in a pattern resembling a pattern of modern drip irrigation emitters. The plant's roots are splayed outward in the area wetted. The water is also released more slowly than it falls onto the plant, at least in short rainfall events, allowing more of the water to infiltrate the soil. Other plants rapidly absorb and store what little water falls as rain from the soil. Saguaro (*Carnegiea gigantea*) and barrel cacti (*Ferocactus* spp.) stud the deserts with living "cisterns". Still other plants filter water droplets from fog, effectively "creating" rainfall. In Baja California, Mexico, the boojum or cirio (*Fouquieria columnaris*) supplements the sparse rainfall (as little as 4" (100 mm) annually) with water filtered from the occasional fogs by its numerous spiny branches. In Cabo Verde, West Africa pines planted an the mountain ridgetops of the islands collect enough water from passing clouds to provide sufficient water for themselves and to recharge groundwater. The function of specialized leaves of desert plants, especially creosote (*Larrea tridentata*) is postulated to be raindrop collector/absorbers. The reason for deep roots penetrating into perennially dry soil horizons is proposed as an "ectosucculent" mechanism

1.17 Development Of The Sinagua Garden At Tohono Chul Park

Russ Buhrow
Curator of Plants, Tohono Chul Park

Abstract

Tohono Chul Park is an educational, cultural and nature center located in northwestern Tucson, Arizona, USA. For many years, Tohono Chul has incorporated passive water harvesting into its gardens. We wished to develop an education/demonstration garden that was both beautiful and relied on little or no irrigation usage. We wanted to use only the rain that fell on the garden and what runoff could be collected from the adjacent parking lot and other upslope land. The site selected was the approximately ¼ acre former employee parking lot. An estimated 1.5 acres forms the watershed, with about ½ acre of paved parking lot, which generates most of the runoff in ordinary rainfall events. The site was prepared by stripping away the old paving and gravel. The soil was loosened to a depth of 3-6 feet to break up a nearly impermeable caliche layer and to provide a deep soil for soil water storage. The area was then graded into 6 terraced plots which could be watered from a canal which served as

the conduit form the watershed to the garden. After grading, about 3- 6 inches of silt loam topsoil was added to the surface of each plot. Initial water yields indicate that a 1" rainfall event will fill all the plots to a depth of 6" (150 mm). Water reaches the garden with as little as 0.05" (1.2 mm). Plants will be installed in the summer of 2003 with garden completion later that year.

1.18 Modelos De Prediccion Para Crecimiento En Plantas Del Semidesierto Con El Uso De Componentes Principales

Prediction Models For Growth In Semidesert Plants With Use Of The Principal Components

José Dimas López Martínez
División de Estudios de Posgrado, Facultad de Agricultura y Zootecnia, Universidad Juárez del Estado de Durango,

Román González Pérez
Apartado postal 142, 35000 Gómez Palacio, Dgo. E.mail: jose_dimaslopez@hotmail.com; roman_gonzalez@hotmail.com

Resumen

La región lagunera que tiene un clima árido con precipitaciones escasas durante el año (240 mm) tiene serias limitantes de agua para una agricultura intensiva, por lo cual debe también aprovecharse de una manera sustentable aquellas plantas nativas y así sus habitantes mejorar su calidad de vida. Por ello, en el período de mayo a noviembre de 1998, se estudiaron dos especies vegetales, una nativa que es la sangre de drago (Jatropha dioica) y una introducida que es la gobernadora (Larrea tridentata) en dos sitios de dos localidades del cañón de Jimulco ; San Antonio de Zaragoza, del municipio de Simón Bolívar Dgo y Juan Eugenio de Torreón Coahuila. En cada sitio se estudiaron 25 plantas in situ de cada especie, de inicio se hizo el análisis físico y químico del suelo, durante el periodo a cada planta se le midió el contenido de humedad en el suelo, , la altura de planta, y al final de la estación Húmeda, la cobertura por planta, número de tallos, longitud de raíz, diámetro de raíz, así como el peso húmedo y seco de la planta. Los datos finales se utilizaron para un análisis multivariado con Componentes Principales para cada especie y donde se buscó aquella variable que más explicará el crecimiento de la planta. Demostrando los resultados que tanto en la sangre de drago como en la gobernadora las variables predictoras de crecimiento no fueron altamente significativas siendo necesario eliminar la altura y o el diámetro de raíz por su baja relación así como incluir otras variables que pueden ser del aspecto suelo y clima.

Palabras clave: *nativas, introducidas , sustentabilidad, componentes principales.*

1.19 El Sistema De Pretiles De San Antonio Juárez, Puebla: Un Diseño Para La Formación Y La Utilización De Suelos Y El Manejo Del Agua.

MC Efraín Inzunza Inzunza
Estudiante de Doctorado del Programa en Edafología. Colegio de Postgraduados.
inzunza56@yahoo.com.mx

Dr. Fernando Manzo Ramos
Profesor Investigador Asociado, CP-Programa en Estudios del Desarrollo Rural. Carretera México-Texcoco Km. 35.5, Montecillo, Texcoco, Edo. de México CP 56230, México. e-mail: fmanzo@colpos.mx

Introducción

El propósito de este trabajo es describir los elementos del medio físico y los detalles técnicos, que sustentan la realización de una práctica que se realiza en terrenos de la comunidad de San Antonio Juárez, Puebla; ésta, en un primer contacto, podría definirse como una práctica mecánica de conservación de suelo y agua, y que localmente denominan *pretiles* (bardas de lajas de tepetate, construidas siguiendo curvas a nivel, que con el transcurrir del tiempo permiten la formación de terrazas). Conceptualmente, y desde el punto de vista práctico de los habitantes de esta comunidad, los pretiles son bardas que les brindan la posibilidad de disponer de una pequeña área de terreno con un suelo de espesor mínimo para realizar la actividad agrícola, mediante la cual pueden cosechar maíz, fríjol y trigo, que son granos básicos en su alimentación. Es decir, para ellos no es una práctica cuya finalidad es conservar suelo por el sólo hecho de conservarlo sino que los pretiles son mucho más que eso. También es objetivo del presente trabajo revisar las condiciones culturales, sociales y económicas que conforman el marco referencial dentro del cual se realiza esta práctica.

1.20 Research Progress Of New Modes And Materials For Rainwater Harvesting

Feng Hao Wu Pute Gao Jian'en Niu Wenquan Wu Shufang Yu Hailong
Institute of Soil and Water Conservation, Chinese Academy of Sciences; North western Sci-Tech University ofAgriculture and Forestry; National Engineering Research Center for Water Saving Irrigation at Yangling)

Abstract

Based on the research results of two kinds of rainwater utilization modes of increasing infiltration and increasing runoff, the paper suggest to combine and assemble two modes in space and time to supply a suitable soil environment and ensure available water resource for crops. In order to increase infiltration, it was sprayed on the surface of the soil some kind of macromolecule compound such as polyacrylic acid, polyvinyl alcohol and urea-formaldehyde resin. The results showed that soil structure and the performance index including soil aggregation, soil infiltration rate, soil bulk density and water conservation capacity were remarkably promoted, and the polyacrylic acid was excellent. In addition, new rainwater catchments materials as HEC (High Strength and Water Stability Earth Consolidator), organic silicone and low-grade plant were discussed. These materials have the advantages of convenient construction, simple craftwork, low cost, high efficiency and cause no pollution.

Key Words: Rainwater Catchments/ infiltration/runoff/ efficient utilization

1.21 Nutrient Residual In An Irrigation Pond - A Case Study Of Higashiike -

Ken Hiramatsu

Hiroshi Itagaki
Department of Land and Water Engineering, Gifu University, Gifu, Japan

Akihiro Sato

Toshihiko Kawachi
Division of Environmental Science and Technology, Kyoto University, Kyoto, Japan

Abstract

Irrigation ponds called 'Tameike' that are a kind of Japanese traditional RHW are built to store precipitations and supply them to farmland. About 11.4% of the total irrigation water is supplied from irrigation ponds in Japan. It has, however, been known that they work not only for water storage but also purification of water. The catchment area of most ponds consists of forests and mountains, but some ponds have paddy field or dry field in their catchment area. In such a case, the runoff contains considerable nutrients of phosphorus and nitrogen due to fertilizers and therefore, quite large amount of nutrients drift into the pond. Meanwhile, some of them settle down to the bottom and are consumed by phytoplankton and aquatic plants during the retention time. Consequently, nutrients move away from the water and stay in the pond. Then, the water that is reused for irrigation and miscellaneous purposes is purified. It is, however, still unclear that how much they stay behind. In this research, their residual ratios are discussed by investigating the balance of nutrients in a study pond, Higashi-Ike that is a small shallow pond with a capacity of 2,400 cubic meters and has paddy field with an area of about 5,200 square meters in its catchment area. As a result, 37.61kg of nitrogen and 11.90kg of phosphorus flowed into the pond and 7.5% and 50 % of them remained, respectively, in the research period. In addition, it becomes clear that the residual ratio is closely related with the fertilizing terms.

1.22 Water Harvesting And Management In Semi Arid Regions

Richard Jennings
Earthwrights Designs, Email:ezentrix@aol.com

Abstract

Santa Fe, New Mexico, is semiarid with an average of 250 to 350 mm of precipitation per year depending on proximity to the mountains. This amount is affected by 40 year drought cycles that have been shown by tree ring evidence over the last 2000 years. The City's water comes 40% from surface water in the watershed which is vulnerable to fire and ecological disaster. The other 60% is from groundwater which has problems of pollution and aquifer collapse. This makes every drop precious. The residents of Santa Fe have one of the lowest per capita water usage rates in the Southwestern USA, yet the city has come dangerously close to running short of water. Restrictions are now in place that limit new construction and use of water. Water harvesting, stormwater management, and effluent recycling are part of an integrated strategy for dealing with Santa Fe's water issues. Water is similar to money in that it is accumulated, saved, and spent. Like money, it can be budgeted. A water budget

accounts for the supply of ground and surface water, precipitation, and effluent reuse. It considers water expenditures both inside and outside of the built environment. In a sustainable water budget, rainwater harvesting is a key to design and planning. The harvesting must be considered as active systems using cisterns for storage, and passive harvesting using gravity and living soils for storage. Like most semi arid areas, Santa Fe's precipitation is seasonal and can come from just a few large events. This makes the process of budgeting critical to the success of any system. This paper will examine design principles, methods, and systems for water management. The themes of budgeting, passive vs. active systems, matching quality to purpose, and finding the simplest solution will be presented. Several new hybrid systems invented by the author will be included.

1.23 Sistemas De Aprovisionamiento De Agua Para Consumo Doméstico En Tres Comunidades, De La Porción Alta Del Río Temascatío, Estado De Guanajuato, México.

Mercedes Jiménez Velázquez
Profesora Investigadora. Especialidad en Estudios del Desarrollo Rural, Instituto de Socioeconomía, Estadística e Informática, Colegio de Postgraduados en Ciencias Agrícolas, Montecillo, México. C.P.56230. E mail: mercedes@colpos.mx

Gaiska Asteinza Bilbao
Profesor Investigador. Departamento de Fitotecnia, Universidad Autónoma Chapingo, México. C.P.56230. Email: mercedes@colpos.mx

Introducción

El presente trabajo se inicia con una breve introducción sobre la relevancia de la disponibilidad de agua a escala internacional, en la región latinoamericana, México y sus repercusiones. Posteriormente, se aborda el estudio del sistema de suministro de agua para consumo doméstico en tres comunidades de la porción alta del río Temascatío, Guanajuato, México. La investigación, analiza las formas en que estos habitantes cubren sus necesidades de aprovisionamiento cotidiano, destacando aspectos como el consumo de agua per capita semanal, tiempo invertido en el proceso de abasto, actividades por género, animales de carga involucrados; además, el valor implícito no remunerado de esas labores. Por otra parte, se examinan los efectos de programas de suministro de agua de los ámbitos estatales, municipales y civiles aplicados en la zona; su impacto, la complementariedad o antagonismo entre instancias gubernamentales y organismos privados; así como, respuestas comunitarias a dichos planes. Finalmente se da cuenta de la dotación actual y la proporción del agua recibida, derivada de los programas y formas tradicionales de aprovisionamiento. En la obtención de información se utilizaron técnicas de investigación de campo con entrevistas dirigidas y abiertas; se empleó la metodología Reflect-Action, útil en comunidades donde la mayoría de la población es analfabeta, localmente para conocer el sistema de trabajo familiar y el papel de las mujeres y niños, particularmente en el trabajo de acopio de agua (Archer, 1997:189) Los cálculos de los ingresos no remunerados (2002) para realizar el acarreo se obtuvieron, cuantificando los jornales necesarios en el proceso de colecta para consumo doméstico; así como la fuerza de trabajo animal empleada.

1.24 Rainwater Use Combined With Rooftop Vegetation Using Recycled Material

Ichiro Kita

Yasutaka Kihara
Faculty of Life and Environmental Science, Shimane University Matsue, Shimane 690-8504 JAPAN

Masaki Mikamo

Takanori Fujimura
Sanko Corporation
1128-50 Ejima, Yatsuka, Shimane 690-1401 JAPAN

Kunihiko Kitamura
Ishikawa Agricultural College, 1-308, Suematsu, Nonich, Ishikawa 921-8836 JAPAN

Introduction

In Japan for the last few decades we have considered our life of use-and-discard that is dependent on large-scale production and mass consumption to be common and enjoyed our life abundant in commodity. We, however, confront serious problems of increasing amount of waste, unlawful dumping of waste, and scanty place for dumping. Because such our life is dependent on the use of natural resources of which amounts are limited, it is necessary to increase efficiency of their use so that we can use them sustainably in future. It is not considered that waste has the value as a resource and we only discard it. Therefore, we must concern their recycling effectively as a resource to resolve the above-mentioned problems.

We have changed natural environment to artificial one to make our living environment more convenient and comfortable. As a result, artificial environment has been expanded, which has become clearly the main cause of environmental problems, e.g. urban flood, and heat island, etc. For example, large parts of ground surface in urban area have been covered with artificial structures constructed of concrete and asphalt. The ground surface with excessive cover prevents rain from permeating into ground quickly, which often causes the urban flood under heavy rain. Since increasing of the area of the covered ground surface has decreased the green space ratio and the areas of the uncovered ground surface, the amount of evapotranspiration from them has been decreased. The structures constructed of concrete and asphalt have large thermal storage effect because of a large thermal capacity of concrete and asphalt. The area of the ground surface covered with them has increased. Both facts above-mentioned are considered as one of cause of heat island.

Rainwater use facility is recognized as one of methods that contribute to the alleviation of environmental problems, i.e., prevention of urban flood, and saving city water of which main source is depending on the reservoirs located far from urban areas. Therefore large-scale rainwater use facilities installed in the public buildings are increasing in number. However, it is expected that much more rainwater use facilities will be installed widely in order to make remarkable effect by their installation. In the last several years number of local governments which subsidize all or part of costs necessary for their installations to the individuals or the companies has been increased for further promotion.

It is reported that rooftop vegetations can alleviate heat environmental problems, i.e., heat islands and they can also prevent causing of urban flood so that their drainage parts and soil where the vegetations are planted can temporary store rainwater. When rooftop vegetation is installed, several constraints, such as maximum loads, method to water, waterproofing, etc. are necessary to be met. Many methods have been developed and used to in practical to solve them.

In this paper, from a viewpoint of saving of water resource, prevention of urban flood, improvement of environment, and effective use of waste as a resource by recycling, a small-scale rainwater use facility with vegetation using a material made of waste glass as a culture soil was created.

The experiment was performed to observe whether vegetation grows in the combined facilities and whether vegetation is supplied with stored rainwater. The result suggests that it can possibly work as both of water storage and vegetation.

1.25 Water Harvesting and Institutional Strengthening in Tigray – Ethiopia

Fred A. Kraft
Director – International Projects, Agriculture and Agri-Food Canada, PFRA, Edmonton, Alberta, Canada, T6R 1P2, kraftf@agr.gc.ca

Introduction

The Government of Canada through its International Development Agency (CIDA) and Department of Agriculture, is providing technical assistance on water harvesting, to the Government of Ethiopia within the northernmost province of Tigray. The purpose of the project, entitled Water Harvesting and Institutional Strengthening in Tigray (WHIST), is to improve food security in the drought and famine prone areas of the province.

1.26 Estado Hídrico Del Cultivo De Frijol En Microcuencas De Captación De Agua De Lluvia

A. Legaspi

H. Nicolas

J.-P. Rossignol

J. L. Tovar.
Unidad Académica de Agronomía, Universidad Autónoma de Zacatecas. Jardín Juárez 147, Zacatecas, Zac. CP 98000, México. E-MAIL leg@cantera.reduaz.mx

Summary

The purpose of this study was to evaluate the effect of rainfall water collection techniques on hydric conditions of bean plants (Phaseolus vulgaris L.). The study was carried out under crop water stress index (CWSI), using four treatments and the control. Treatments consisted of four micro-watersheds that were separated by 1.0, 1.2,1.4, and 1.6 m and the control was a 0.8 m wide furrow without rainfall water collection. Results showed that yields decrease in response to the increase of this index value.

Index words: Plant temperature, infrared thermometer, micro-watershed, Phaseolus vulgaris.

1.27 Agua:Santuarios del Agua

Ciénegas del Lerma

1.28 Gestão Participativa De Recursos Hídricos No Vale Do Jequitinhonha: Estudo De Caso – Sub-Bacia Do Rio Calhauzinho

Valquiria Alves Smith Lima

Luiz Augusto Bronzatto

Alessandra Souza PerezRivera

Daniela Torres Ferreira Leite

Georgheton Melo Nogueira
Instituição: Cáritas Brasileira Regional Minas Gerais, E-Mail: Caritamg.Valquiria@Terra.Com.Br

Resumo

As formas de apropriação e uso dos recursos naturais pelos atores locais, revelam uma relação intrínseca entre o homem e a natureza, sendo essa responsável pelas mudanças estabelecidas no meio. Este aspecto leva-nos a refletir sobre a capacidade de transformação que as populações têm sobre o meio ambiente em que vivem, sendo na maioria das vezes desconsiderada na realização de intervenções. Neste sentido, este trabalho retrata a experiência do Projeto Gestão Participativa de Recursos Hídricos no Vale do Jequitinhonha - Estudo de Caso: Sub-bacia do rio Calhauzinho, que buscou considerar os produtores(as) envolvidos(as) como sujeitos, com capacidade de mudar determinada realidade, e não simplesmente como objetos passivos diante de mudanças externas. O Projeto também objetivou desenvolver referências técnicas e metodológicas de gestão e a construção de um Plano de Desenvolvimento, a partir de unidade geoambiental (sub-bacia), em detrimento da prática comum que atrela desenvolvimento a fatores geopolíticos. Realizou-se as etapas de Sensibilização, Diagnóstico (DRP e Estudo Geohidroambiental) e Planejamento Participativo, abrangendo as 23 comunidades rurais inseridas na sub-bacia, levantando-se informações referentes a aspectos sociais, ambientais, econômicos, culturais e políticos, caracterizando uma ampla base de critérios para a elaboração de um plano estratégico de ações.

PALAVRAS CHAVE: Gestão Participativa / Recursos Hídricos / Desenvolvimento Rural Sustentável

Abstract

The ways local users appropriate and use natural resources reveals an intrinsic relationship between men and nature, generating the changes produced upon the environment. This aspect leads to considerations on the transforming capacity of population on the environment where they live, what is often neglected when interventions processes are proposed. This work describes the experience derived from the project Gestão Participativa de Recursos Hídricos no Vale do Jequitinhonha – Estudo de Caso: Sub-bacia do rio Calhauzinho (Collaborative Management of Hydrographic Resources in Jequitinhonha Valley – A Case Study: Calhauzinho sub-basin), that considers the involved producers as subjects able to change their reality in steady of passively receptors of external changes. The Project also aims to develop technical and methodological references and the proposal of a

Development Plan based on a geoenvironmental (sub-basin) unit as an alternative to the common practice that links development to geopolitics factors. Awareness and Diagnose phases were already carried out with the 23 rural communities living in the place, gathering information on social, environmental, economic, cultural and politic aspects, comprising a wide range of criteria to be used for a proposition of a strategic planning of interventions.

1.29 Nivel Crítico Del Agua En El Suelo Para Decidirla Siembra En Agricultura De Zonas Aridas Stored Soil Water Critical Level For Sowing Time In Dryland Cropping Systems

José Dimas López-Mtz.

Ríos d Edmundo

Castellanos Pérez

Juan José Martínez
División de Estudios de Postgrado. Facultad de Agricultura y Zootecnia. Universidad Juárez del Estado de Durango. Apartado postal 142. CP 35000. Gómez Palacio, Dgo. México. e-mail: jose_dimaslopez@hotmail.com; joshualopez@prodigy.net.mx

Ricardo D. Valdez Cepeda
Universidad Autónoma Chapingo. Centro Regional Universitario Centro Norte. MCDRR. Apartado Postal 196. CP 98001, Zacatecas, Zac. México.

Enrique Martínez Rubin
Instituto Tecnológico Agropecuario No. 10. CIGA. Apdo. Postal 3F. CP 27000. Torreón, Coah., México

Resumen

Al tomar en consideración que la evapotranspiración potencial generalmente excede a la lluvia que se presenta durante la estación de crecimiento de cultivos anuales y el que una anormalidad negativa puede ocurrir, a menos que se almacene agua en el suelo en cantidad suficiente para satisfacer la demanda hídrica del cultivo antes de que se siembre, es apreciable que la cantidad de agua almacenada en el suelo al momento de la siembra es un factor crítico para el éxito en los sistemas agrícolas de secano. Con base en este supuesto, el objetivo principal en esta investigación fue determinar si la prueba de $\chi 2$ es una herramienta valiosa, al tomar en cuenta la cantidad de agua que se almacena en el suelo hasta una profundidad de 60 cm en un determinado momento, para tomar la decisión de sembrar o no. En este sentido se tomó en cuenta una base de datos, sobre la cantidad de agua almacenada en el suelo al momento de la siembra y los rendimientos de grano de maíz, producto de cuatro experimentos realizados durante 1995 y 1996 en el Ejido Francisco Villa, Durango, México, para efectuar una serie de pruebas de $\chi 2$. Se consideró un rendimiento mínimo de 1000 kg ha-1; 8.34 cm de agua almacenada en el suelo (0-30 cm) fue el nivel definido como crítico para los genotipos de maíz ‘Blanco Hualauises’ y ‘H-412’. La Prueba de interacción $\chi 2$ demostró ser una buena herramienta para determinar el nivel crítico de agua almacenada en el suelo al momento de la siembra para asegurar que el sistema de agricultura de secano fue exitoso en 92 % de los casos con rendimientos de grano en maíz mayores a 1000 kg ha-1 .

Palabras clave: Genotipos, prueba de interacción $\chi 2$, rendimiento de grano.

Abstract

By taking under consideration that potential evapotranspiration normally exceeds the growing season rainfall and that a water shortage can occur unless a reserve of soil water is stored before the crop is planted, it can be concluded that the amount of stored soil water at sowing time is a critical factor in the success of dryland cropping systems. The main aim of this investigation was to know if interaction $\chi 2$ test is a valuable tool, when taking into account stored soil (0-60 cm depth) water at sowing time and maize grain yield, in making decision for sowing or not sowing at a given time. Data on the amount of soil water at sowing time and maize grain yield from four experiments carried out during 1995 and 1996 at the Ejido Francisco Villa, Lerdo, Durango, Mexico were used to run the interaction $\chi 2$ tests. For a minimum maize yield of 1000 kg ha-1, the following level of stored soil water was defined as critical: 8.34 cm for cv. 'Blanco Hualauises' and cv. 'H-412'. The interaction □2 test is a good tool to determine soil water critical levels at the sowing time of corn to ensure success in the present dryland cropping system.

Keywords: Genotypes, interaction χ 2 test, grain yield.

1.30 Dry Land Wheat Production On Narrow Raised Beds; A Promising Option

Agustin Limon-Ortega
INIFAP-CEVAMEX, AP10, km 17.5 Carr. Mexico-Lecheria, CP 56230, Chapingo, Mexico; alimon@cimmyt.exch.cgiar.org

Kenneth D. Sayre
CIMMYT Wheat Agronomist, CIMMYT, Apartado # 370, PO Box 60326, Houston, Tx; k.sayre@cgiar.org (Corresponding author)

Summary

Dry land wheat and maize in the high valley of Mexico is produced using conventional planting systems involving considerable tillage. However, other new practices should be devised to increase effective use of limited rainfall. One such practice consists of planting wheat and maize on top of raised-beds that are 75-80 cm apart furrow to furrow and, with two-three rows per bed for wheat and one row per bed for maize. In this document we report results of three experiments conducted using this planting system. Experiment one, initiated in 1999 crop cycle and conducted under dry land conditions compared treatments with differential crop residue management with both tied-ridges and open furrows for the wheatmaize crop rotation. Experiment two, has been conducted for three years and compared the performance of a set of bread wheat genotypes planted in permanent beds versus planting with conventional tilled raised-beds but with occasional supplemental furrow irrigation. Experiment three, initiated in 2002 under dry land conditions in two locations estimated the effect of the timing in the establishment of tied-ridges on wheat planted in conventional tilled raised-beds. Combined analysis over years for the first experiment showed that the effects that explained most of the grain yield variation were year main effect for both crops followed by residue management for wheat and then for the year-by-residue management and yearby- ridges interaction for maize. On average, either retaining all residue or partial residue removal showed a tendency to produce greater wheat and maize grain yields than when all residues were removed. Results from experiment two showed a highly significant genotypeby- tillage interaction indicating that within the two tillage options studied for the bed planting system, wheat genotypes respond differently. Results from

experiment three indicated in one location (Texcoco, state of Mexico) that the timing treatments with tied-ridges produced similar wheat grain yields. However, the average yields for these treatments were greater compared to the open furrow treatment

1.31 Distribution Pattern Of Precipitation And Its Evolution Characters In The Yellow River Basin, China

Changming Liu
Institute of Environmental Sciences and Technology, Beijing Normal University, Beijing, China, 100857;

Hongxing Zheng
Institute of Geographical Sciences and Natural Resources Research, CAS, Beijing, China, 100101

Abstract

The spatial patterns of precipitation are of great importance in hydrology as well as in water resources management. Especially, with the developing of the distributed hydrological model and rationally utilizing rainwater, it has attracted more and more research interests. The Yellow river is the second largest river in China, lying in the climatic zones of semi-humid, semi-arid and arid. Rainfall in the Yellow River basin is highly uneven. This paper has focused on the spatial patterns of precipitation in the Yellow River Basin with the method of EOF (Empirical Orthogonal Function). Considering the impacts of climatic change, the evolution characters of the spatial pattern have also been shown herein.

1.32 Disponibilidad De Agua Para El Cultivo De Sorgo En Un Alfisol De Venezuela, Bajo Diferentes Sistemas De Labranza.

Deyanira Lobo Luján
Universidad Central de Venezuela, Facultad de Agronomía, Instituto de Edafología. Maracay, Venezuela. E-mail: lobod@agr.ucv.ve

Introducción

El manejo sostenible del suelo en la agricultura, consiste en el uso del suelo como recurso para la producción de bienes y servicios agrícolas con el fin de satisfacer las necesidades humanas, y así asegurar las funciones ecológicas y socioeconómicas del suelo a largo plazo (Grieder, 1995, citado por Delgado, 2001). Con relación a este aspecto, Pla (1995) afirma que el término sostenible implica rendimientos sostenidos en el tiempo, sin degradación de los recursos y la reducción de costos de producción.

Entre las opciones tecnológicas para el manejo conservacionista de los suelos, se encuentran las prácticas de labranza (labranza reducida, labranza vertical, labranza sobre cubiertas (mulch), siembra directa, entre otras), programas de fertilización, incorporación de restos de cosechas, incorporación de abonos orgánicos, abonos verdes, enmiendas para suelos ácidos y sódicos, cultivos de coberturas, rotación de cultivos, cultivos en contorno, manejo de residuos, etc.

El objetivo general de la labranza, es modificar por medios mecánicos las condiciones originales del suelo para mejorarlas, produciendo efectos directos sobre los procesos y propiedades físicas e indirectos sobre el crecimiento de los cultivos. El sistema de labranza a seleccionar debe incrementar los rendimientos del cultivo, reducir los riesgos de producción, facilitar la conservación de suelos y agua, mantener niveles adecuados de materia orgánica y controlar o revertir procesos de degradación FAO (1992).

Plaster (2000) señala que la labranza conservacionista, a pesar de ser una de las técnicas más beneficiosas para la conservación de suelos, presenta algunos inconvenientes, entre los que se destacan:

- Se requiere un nivel de manejo y especialización mas alto que para la labranza convencional.
- No está adaptada a todos los suelos, climas o cosechas
- La superficie ácida del suelo interfiere con la actividad de los herbicidas, necesitándose una supervisión cuidadosa del pH del suelo y un encalado mas frecuente.

Los sistemas de labranza influencian la disponibilidad de agua en los suelos. Ahuja et al, (1998) señalan que la labranza, generalmente, incrementa la porosidad del suelo y produce cambios en la distribución de tamaños de poros, promoviendo cambios en la curva de retención de humedad del suelo y en los valores de conductividad hidráulica

El objetivo fundamental de la presente investigación evaluar los efectos de diferentes sistemas de labranza sobre la penetración y disponibilidad de agua en el suelo en un Typic Haplustalfs en los Llanos Centrales de Venezuela.

1.33 Kenyan Small Scale Farmer Experiences On Poverty Alleviation Through Rainwater Harvesting

By John Mbugua
Director: IRCSA Africa, e.mail: jmbugua@africaonline.co.ke

Introduction

The millennium Development Goal (MDG) Declaration poses a great challenge to development planners and end users also. Population of Kenya is 30 million to day and water coverage is only 50%. People living below poverty level (1 usd per day) are also 50% according to the latest official government figures. Estimates indicate that Kenya must supply every year 1 million people with water to meet the MDG.

Kenyans in the rural area live in families of about 10 people who constitute a household. It is therefore clear that every year, to meet 1 million people's needs, 100,000 households will need to be reached.

In Kenya 95% of our people live in the rural areas and 80% of them live on agricultural activities for their livelihood security. It is therefore clear that to reduce poverty and hunger among the rural small scale poor farmers, intervention has to be agricultural based. To succeed in agricultural based interventions water is very essential. Providing water from surface or ground resources is often capital expensive and operations and maintenance may be well outside the local economy. However rainwater is the most widespread and accessible water resource around which poverty reduction package must be designed. Here below are examples of different interventions.

1.34 Negative Impact Of A Non-Regulated Privatization In Rain Water Management: Providenciales, Turks And Caicos Islands

Prof. Dr. Fernando Pérez Monteagudo
Centro de Investigaciones Hidráulicas, Cuba, fperezm@cih.cujae.edu.cu

Introduction

Turks and Caicos Islands (TCI) are located southeast of the Bahamas. The Capital, Cockburn Town, is in the Grand Turk Island. It is considered that these islands will experience a real estate and tourism boom in the near future and water surely will be a limiting factor for this expected development, due to the fact that the archipelago is composed by very small islands. The island of Providenciales is the engine of the economical development of the country due to its intense tourism and real state development.

Historically in the Turks and Caicos Islands there is a long tradition in rainwater management, although with differences among the islands that comprise the archipelago, depending on their characteristics.

From a water resources point of view Turks and Caicos Islands can be divided into two groups:

- The Salt Islands: Grand Turk, Salt Cay y South Caicos.
- The rest of the Caicos Islands: Providenciales, North, East y Middle Caicos.

Average precipitation is consequently less in the Salt Islands than in the rest of the Caicos Islands. For Grand Turk the 685 mm per year are estimated while for Providenciales reach 762 mm.

1.35 Effect Of Floodwater Spreading On Ground Water, Vegetation And Land Use In Zanjan Plain, Iran.

Farzad Bayat Movahhed
Scientific member of Research center of natural resources and livestock affair, No. 1216, 6th street, Phase 3, Shahrak Karmandan, Zanjan, IRAN. Fax: ++98 241 4248770, E-mail: Bayat_nrrcz@yahoo.com

Abstract

Floodwater spreading is an utilization and optimization methods that affects on some environmental factors. This paper is attempting to evaluate the impact of water spreading on groundwater (discharge of a qanat and groundwater level), vegetation (cover and production), and landuse (abounded and dry land to irrigated land) changes in part of Zanjan plain (between Sohrain and Gharecharian rivers) in northwest of Iran.

For this purpose, converted floodwater, discharge of a qanat, ground water level, and dryland area converted to irrigated lands were measured in a period of 6 years. Fifteen transects for studing vegetation cover and fifty 3x3 m2 plots (40 in floodwater spreading area and 10 in control area) for evaluating biomass production were stabilized in a period of 4 years. Vegetation cover percentage was measured by Line Intercept Method and foliage of plots were cut and weighted.

Although the amount of annual rainfall in study years was reduced (about 30% of mean annual rainfall of a period 32 years), but the reduction of ground water level of the plain was stopped and even started to increase. The discharge of qanat increased too. In downlands of spreading area, 4 deep wells were

constructed and about 120 ha of abounded and drylands were converted to irrigated lands. Increasing of qanat discharge caused in increasing alfalfa farm area, and starting the aguaculturing. Vegetation cover percentage and biomass production doubled in spreading area from 1999 to 2002.

Keywords: Biomass Production, Ground Water Table, Floodwater Spreading, Qanat, Landuse, Zanjan Plain, Iran.

1.36 Aspectos Hidráulicos Y De Diseño En La Construcción Del Colector De Agua De Lluvia De Yalentay, Municipio De Zinacantán, Chiapas, México

Martín D. Mundo Molina

Polioptro Martínez Austria
Instituto Mexicano de Tecnología del Agua. Paseo Cuauhnáhuac 8532, Jiutepec, Morelos, México. E. Mail: mumm6307@avantel.net.

Romeo Ballinas Avendaño

Miguel Raúl Ponce Martínez

Edgar Rafael Ferrer Penagos
Facultad de Ingeniería Civil de la Universidad Autónoma de Chiapas. Tel. (01 961 61) 5 42 47. Email: rballina@montebello.unach..mx.

Abstract

Yalentay is an indigenous Tzotzil community located in the municipality of Zinacantán, Chiapas, Mexico, with serious problems of water supply. However, in January 1999 The Mexican Institute of Water Technology and Chiapas State University constructed the Rain Water Collection (RWC) in the Yalentay Community, in order to supply drinkable to 500 inhabitants. This project was financed by Spanish International Cooperation Agency and designed by researchers of the Mexican Institute of Water Technology and Chiapas State University. In this paper is presented some hydraulics calculations about the main components of the RWC: underground cistern, roof collector, filters and distribution tank.

Resumen

Yalentay es una comunidad indígena de origen Tzotzil ubicado en el municipio de Zinacantán en el estado de Chiapas, México, que hasta 1999 tuvo problemas de abastecimiento de agua. En enero de ese año se inauguró un colector de agua de lluvia (CALL) comunitario en dicha población, para abastecer a 500 habitantes. Este proyecto fue diseñado y ejecutado por investigadores del Instituto Mexicano de Tecnología del Agua (IMTA) y la Universidad Autónoma de Chiapas (UN.ACH), en el marco de un convenio de colaboración financiado por la Agencia Española de Cooperación Internacional (AECI). En este trabajo se presentan aspectos hidráulicos y los cálculos para el dimensionamiento de alguno de los principales componentes del CALL, entre otros: cisterna subterránea, techo colector, filtros del sistema, tanque regulador e hidrantes.

1.37 Conceptos Fundamentales Para Evaluar Resistencia A La Sequía

Abel Muñoz Orozco
Profesor Investigador Titular, Programa de Genética, IREGEP. Colegio de Postgraduados, Montecillo, Méx. 56230. amuozo@colopos.mx

Abstract

It is discussed the convenience of fixing the concept of drought resistance, to avoid to confound drought with its effects and to avoid mistakes in the evaluations and in the inferences done in the drought resistance researches. The most conspicuous modifiers of the effect of drought from the atmosphere, soil and plant in agronomic experiments are included in a mathematical function, to show the relationship with the Model of genetic by environmental interaction (P = G + E + G*E) and with Model One to evaluate drought resistance. From this relationship it is inferred that many of the general plant breeding theoretical principles can be applied to improve the drought resistance. Similar procedure can be done to related drought in other field of human activity.

Resumen

Se presenta una discusión sobre el concepto sequía, haciendo ver la conveniencia de que éste sea fijo y no se confunda con los efectos de dicho factor adverso; lo cual puede conducir a errores en la evaluación de la resistencia y en las inferencias de las investigaciones. Se analizan los modificantes de los efectos de la sequía más conspicuos, de la atmósfera el suelo y la planta, encuadrándolos en una expresión matemática, con el objeto de mostrar su relación con el modelo de interacción genético ambiental y con el modelo 1 para evaluar la resistencia. De esta fase se infiere que la Genotecnia de la Resistencia a la Sequía, no es más que una derivación de la Genotecnia Convencional. Al establecer la conexión entre el concepto abstracto de la sequía y el campo de la genotecnia dentro de la agronomía, se deja ver que el concepto sequía puede vincularse con cualquier otro campo del desarrollo humano, bajo similar procedimiento. Con esto, se trata de remarcar la importancia de dilucidar este tipo de conexión, para el mejor entendimiento y manejo de fenómeno resistencia a sequía.

1.38 Rainfed Agriculture Towards Food Security - A Case Study

Namrata Pathak
AFPRO

Introduction

For years together, the foremost worry for the people of Kothapalli and Peddatundla, two small village on the border of the Ranga Reddy district in Hyderabad, was food, for which they foraged the nearby jungles, sold toddy illegally, and when all else failed, moved out to work on the fields of the neighboring villages. Most of the small landholdings were left fallow, as the input costs required to grow crops were prohibitive. A feeling of hopelessness prevailed. It was under such circumstances that an initiative was started to bring the fallow lands under the plough. Initial reactions were wary: "We thought the people from the city had come to take away our lands", says a villager. Over a period of time, the initial doubts have melted. .The plan was grounded by setting up groups of women farmers into Sanghas and bank accounts opened in the name of the group. A total of 156 women joined the two Sanghas and brought 197 acres under the plough. Vitally, the crops they decided to grow were from the minor millet family –crops that are naturally resistant to droughts and do not require much anti-pest treatments or fertilizers. Along with this, the women farmers were also capacitated in various practices for sustainable agriculture, like vermicomposting. In the very first year, the two villages had produced 748.04 quintals of food grains enough to prevent forced migration for the families of the Sangha members. The second cropping season saw an increase in production, as well as a diversification into vegetables and pulses – this in 2002, a drought year. The great confidence that is reflected in the behavior of the women is a direct result of that most important of securities – of having a full larder.

1.39 Las “Gavias” De Canarias Y Las “Cajas De Agua” Mexicanas: Dos Soluciones Semejantes En Distintas Orillas Del Atlántico.

The Gavias Of Canarias And The Mexican Cajas De Agua: Similar Solutions On Opposing Sides Of The Atlantic.

Antonio C. Perdomo Molina
Geógrafo e Ingeniero Técnico Agrícola. aperdomo@cabtfe.es

Jacinta Palerm Viqueira
Profesor-Investigador Adjunto del Colegio de Posgraduados de México, jpalerm@colpos.mx

Abstract

There is a world wide diversity of agricultural systems that have a common basis in the concentration of flood or spate water, allowing thereby an agricultural production in regions where it would be impossible or very difficult. Researchers world wide have adopted different terms to name and classify the various techniques employed, although they are all covered by the term water harvesting. I n the most arid isles of the Canaries archipelago, and in the most arid areas of the more humid isles, an agricultural system, called gavias, was developed. This system allows the crops in very adverse conditions. This systems still exists in Fuenteventura, as well as in Lanzarote. The gavia agricultural system has similarities with the Mexican entarquinamiento in cajas de agua. These similarities are not exclusive to Mexico and the Canaries, we also find them with the Bharatpur area in India, in areas close to the Canaries isles, like Tunisia: the meskat/mankaa and the m’goud systems, in the Iberian peninsula: spate irrigation was common in Almería, Alicante and Murcia. The discussion is open on the possibility of a technological diffusion between these world areas, or an independent technological solution in various world areas as a response to the same type of problem. This paper deals with the structural and functioning similarities that exist between the Canaries and the Mexican systems, as well as the differences. The systems described bear a series of principles that are basic and that allow a distinction with other many water harvesting systems. They are situated in flat lands, spate water is channeled to the agricultural plots so as to flood them days or months at a time, and structural elements such as plot earthen and/or stone bunds, drainage, canals, derivation dams, gates. The differences are dimensions (plot size, bund height, amount of stocked water). Differences probably due to geographic adaptation.

Introducción

Diseminados por todo el mundo existen una gran diversidad de sistemas que como base común presentan la concentración de las aguas de escorrentía con el propósito de obtener producciones agrícolas donde éstas serían imposibles de obtener o de muy difícil consecución. A nivel internacional han sido muchos los autores que han acuñado distintos términos para nombrar y clasificar los diferentes métodos empleados, en general al conjunto de ellos se les ha venido a denominar sistemas de recolección de aguas ("*water harvesting*"). En las islas más áridas del archipiélago canario, y en las áreas áridas de sotavento de las Islas más húmedas, se desarrolló un sistema de cultivo, llamado de "gavias", que permitió obtener cosechas donde las condiciones climáticas eran adversas a la producción de alimentos. Este sistema aún perdura en Fuerteventura y aparece también, aunque muy disminuido, en Lanzarote. El sistema de cultivo en gavias presenta una serie de analogías con el "entarquinamiento en cajas de agua" mexicano. El presente trabajo pretende reflejar las similitudes que existen entre ambos sistemas en cuanto a sus elementos estructurantes y funcionamiento básico, así como constatar la existencia de algunas diferencias.

1.40 Management Of Rainwater In Low Rain Fall Regions Of South India

S.T.Somashekhara Reddy
Indian Institute of Management, Bannerughatta Road, Bangalore –560 076, India Tel: 91-80-6993355, Fax: 91-80-6584050, email: **stsom@iimb.ernet.in**

Introduction

Seventy five per cent of Indian rainfall is received during June to September and this is known popularly as southwest monsoon or monsoon. This monsoon is not a period of continuous rainfall. Breaks of about a week or two in which the rainfall activity is the least is another feature of the monsoon. The more prolonged breaks are likely during the midmonsoon month i.e., August. When a long break occurs during July at the beginning of the cropping season, its effect on the growing crops is quite harmful. Only eight percent of geographical area in India receives assured rainfall. (ICAR 1997) Nearly 72 per cent of the area receives less that 1150 mm of rainfall and it is not assured (Table.1). Consequently, 1081131.38 square kilometres of area in 99 Districts is declared as drought prone (Table.2). Many a time the rainfall in monsoon is limited to 84 days and effective rainy days is only 34. In such situations, harvesting of every drop of rain is essential to harvest a crop. This paper attempts to bring in the activities/ practises of farmers in harvesting rainwater for effective crop management.

The paper is in three parts, the first part explains the practises followed in areas that receive rainfall below 600 mm in a year. Second part explains the status of such practises and the third part of the paper is conclusions and recommendations.

Rain water harvesting (RWH) refers, in this paper, to all such activities and practises followed to harvest, conserve, and consume water within the holdings or parcel of land owned by the farmer. Largely, these practises are related to rain fed farming (dry land) without any source of irrigation and where animal traction is largely adopted. These practises are categorised as pre-sowing, sowing and cropping. All those activities, which are initiated within the boundaries of the field to harvest every drop of water to enhance soil moisture levels before a crop is sown, are identified as "Pre-sowing activities and practises." Those activities and practises that are adopted to harvest, conserve, and consume water during sowing of a crop are called as "sowing season activities and practises". Those practises followed after

1.41 Impact Of Visual Models On Farmers Perceptions With Regard To The Understanding Of The In-Field Water Harvesting Technique

L.D. van Rensburg

J.J. Botha

J.J. Anderson
ARC-Institute for Soil, Climate and Water, Private Bag X01, Glen 9360 South Africa, Tel. + 27 51 861 1151; Fax + 27 51 861 1328; E-mail debruint@glen.agric.za

Abstract

Processes such as runoff, erosion, infiltration, drainage, evaporation and transpiration play a critical role in any crop production system. Farmers able to conceptualize the practical impact of each of the processes on crop yield, tend to adopt new sustainable technologies more readily. Consequently, packaging and exchange of information to communal farmers in rural areas hold the key to ensure socio acceptance of a particular technique. Some of the major factors influencing the packaging and dissemination of information are the varying levels of literacy and geographical location. These factors should be considered during technology exchange interventions. The aim of this study was to develop and evaluate a physical, interactive model to be used as educational tool to exchange crop production technology within communities.

The model described consists of two components namely a water supply and a cropsoil part. Rainfall is simulated through the water supply system using microsprinklers. During the simulation of a rainfall event, processes such as runoff and run-on into the basins are illustrated. The importance to store rainwater in the soil and to restrict evaporation are addressed during discussions.

A structured questionnaire was developed and a survey done in several communities east of Bloemfontein. Trained field workers facilitated the interviews. Results indicated that the visual demonstrations contributed significantly to conceptualizing the water component within the IWH crop production system. Approximately 90% of the 56 respondents indicated that they understand the in-field water harvesting concept, while 91% of the farmers endorsed that the demonstration illustrated that high energy rainstorms are conducive to soil erosion on a clay soil when conventional tillage is used.

1.42 On-Station And On-Farm In-Field Water Harvesting Research In Southern Africa Using Sunflower As A Reference Crop

L.D. van Rensburg

J.J. Botha

J.J. Anderson
ARC-Institute for Soil, Climate and Water, Private Bag X01, Glen 9360 South Africa, Tel. + 27 51 861 1151; Fax + 27 51 861 1328; E-mail debruint@glen.agric.za

A large area east of Bloemfontein (750 000) ha has been earmarked for developing farmers. This area is marginal for crop production. The rainfall is low and erratic (540 mm to 600 mm per annum), and

soils are dominantly clay soils on which high water losses occur due to runoff (R) and evaporation from the soil surface (Es).

Recent South African statistics showed that 70% of the poorest of the poor live in rural areas. These families depend heavily on old age pension funds and other social schemes as well as low input farming systems. It is estimated that approximately 3 million farmers are caught up in the spiral to produce food to meet their family's needs. This paper will report on research to seek agricultural solutions in the field of water harvesting with sunflower as a test crop.

Our hypothesis is that PUE can be enhanced to such an extent that sunflower production, with reasonably high yields, is possible on these high risk clay soils using a production technique that combines the advantages of infield rainwater harvesting, no-till, basin tillage, and mulching (IRWH). Significant higher sunflower yields were obtained with the IRHW technique compared to the conventional tillage technique (CON) on four different ecotopes. The experiment has shown that R and Es losses play an important role in sunflower production on these ecotopes. This new technique could lead to improved food security in marginal crop production areas.

1.43 Solid Rain

Sergio Jesus Rico Velasco
Solid Rain

Is water obtained from the rain, stored in a molecular form with the use of super absorbent acrylates, that can absorb up to 500 times it weight in water, with no modification of it is chemical structure. Having as a result rain in solid pieces.

1.44 Institutional Strengthening Through Water Auctioning

Dr. Sudhirendar Sharma
Wter expert and Director of the Delhi-based the Ecological oundation. He has been independently studying and assessing the watershed projects cross the country.
sudhirendar@vsnl.net

H S Lohan
Project Director of the World-Bank supported ntegrated Watershed Development Project based in Panchkula, Haryana.

Abstract

Despite setting-up community-driven institutional mechanisms for long-term sustainability of investments in watershed projects across India, the village watershed committees have not been able to perform their duties for want of adequate resources. A vast majority of projects find themselves in various stages of neglect as the beneficiary households in the watersheds fail to comply with their promise of contributing a portion of their enhanced income towards these committees. The paper examines one of the innovative ways of augmenting resources for the village committees without altering the project-beneficiary interdependence.

1.45 Rainwater Harvesting By Underground Tank For Subsistence Farming

Mesfin Shenkut

Introduction

Ethiopia is located in the Horn of Africa. Its geophysical set up is dominated by highland complex of mountains, plateaus, and rugged terrain with a surface area of 1.1 million square kilometer. It has a scattered settlement pattern with population of 65 million. The annual rainfall varies from 600 mm in the eastern borders to 2000 in the southwest highlands. There are also a few areas in the northeastern Rift Valley that receive less than 200 mm. The estimated yearly average rainfall is 744 mm. Agriculture, which employs 85% of the population and make up 90% of the GDP is based on rain fed. The agricultural sector is facing sever failures due to inadequate rainfall management and recurrent drought. The yearly increase in agricultural productivity is 1% while the population growth is about 3%; the Country is therefore living on persistent international food aid. Currently Ethiopia is experiencing one of the worst food shortage in recent history with estimated 15 million people are affected by food shortage. In ordered to avert this harsh situation the government of Ethiopia is promoting a huge rainwater collection and management program together with integrated livestock and crop production. The development of over 100,000 rainwater harvesting underground water tanks of sizes 50 – 60 m3 is the major components of the program. The paper presents a highlight of the most popular rainwater harvesting techniques for agriculture and discuses the technology, advantages and limitations of the underground tanks, which are now being promoted in mass in most parts of the countrty.

1.46 Rain Water Is The Main Source For The Economic Development Of Rural India.

Mylaram Narayana Swamy (MyNaa Swamy)
Senior Journalist and Vice-chairman; Rayalaseema Vikas Parishad, Tirupati, AP 517 501, India, E-Mail : mynaswamy@yahoo.com

Standard Definition Of Rainwater Harvesting

The term ‘rainwater harvesting’ appears to have originated from the word ‘harvesting’, used to cover all agricultural activities involving cutting, reaping, picking and gathering of grain of value from any fully-grown crop. Rainwater harvesting may be defined as any human activity involving collection and storage of rainwater in some natural or artificial container either for immediate use or use before the onset of the next monsoon. Runoff farming, microcatchment farming and contour catchment farming are some examples of rainwater harvesting used in irrigation. As the underlying principle of rainwater harvesting is to ensure direct use of most of the rainfall, this is achieved in certain natural catchments or modified existing catchments to produce maximum surface runoff and minimum evaporation, transpiration and infiltration.

Rainwater Harvesting As Understood In India

There are presently two different definitions of rainwater harvesting (also called water harvesting) in vogue in India, which are distinctly different from the standard definition in vogue in the rest of the world. Any aspect of water management and conservation is treated as water harvesting as per the first definition, while artificial recharge of groundwater alone is included under water harvesting as per the second definition.

1.47 Evaluation Of Atriplx Shrubs Growth In Semi Arid Area Using Rain Waterharvesting Systems

M.A. Razzaghi
Professor at University of Al-Fateh, Faculty of Agriculture, Tripoli, Libya

M.A. Rabti

H. Taleb

S. Abulkhair
Engineers at Agricultural Research Center (ARC), Tripoli, Libya

The growth of Atriplx shrubs in semi arid region in western part of Libya was evaluated using two of water harvesting systems (contour lines and negarim). Plant height, crown length, crown circumference and maturity were evaluated as measures to the effectiveness of water harvesting systems in semi dray land. Three micro-catchments area (10.2, 12.5, and 15.5 m2) for each system were used. The catchment area was calculated on the basis of plant water requirement, root zone area, surface runoff coefficient, and average annual rainfall. The ratio of the cultivated area to the catchment area was found to be 1:15. The growth of Atriplx shrubs was evaluated for two consecutive years. Both contour lines and negarim W.H. systems gave better results compared with the growth of the Atriplx shrubs that were planted outside the W.H. systems. The overall efficiency of the systems varied from system to system and from catchment area size to other size. The contour line system and the larger ratio of the catchment area to the cultivated area were found to be strongly related to the growth of the shrubs.

1.48 Development Of One Measurement And Model Supported Alternative Rain Water Management Using Trackbed Naturation For Railway Tracks

Felipe Omar Tapia Silva
Institute for Agricultural and Urban Ecology Projects (IASP) at the Humbold University Berlin, Invalidenstr. 42 Berlin., omartasi@hotmail.com,

Nikolaus Model
Leibniz-Institute of Agricultural Engineering Bornim (ATB) and IASP., NModel@atb-potsdam.de

Abstract:

For a naturation for Railway Tracks (TBN) the water balance is calculated. The examinations were carried out by readings of the automatic modernly equipped TBN-measuring stations (Institute for Agricultural and Urban Ecology Projects at Humboldt University Berlin) Berlin- Torstraße and Berlin-Malchow. For the calculation of the potential Evapotranspiration two models (Doorenbos-Pruit and FAO - grass reference Evapotranspiration) are used and compared with each other. A mathematical model for the calculation of the real evaporation TBN has been worked out. An alternative rain water management strategy has been designed. At first the drain reduction and

evaporation raise in urban areas is proven by TBN. The results of the model derivation and the check of the water balance model of the mentioned measuring stations are then analyzed. A computer and measurement supported model was used to answer the following question. How effectively can rain water be retained by a naturation of railway tracks (TBN) in selected urban traffic areas of the center of Berlin? The evaluation of the measurings by the program ANIRAIL shows the excellent effect of the naturation on the water balance of these quasi unsealed areas. The drain flow of the TBN is very small compared with an asphalt surface for typical summer months. The evaporation performance of the naturated traffic areas also could be proven as well.

Summarizing, a drain reduction or evaporation raise can be stated, which is caused by thinlayer TBN systems. The water retention ability of the vegetation mat plays the most important role. A water retention of at least 50% of the precipitation was proven.

This computing became generalized by comparison of the precipitation values per month with the long-standing ones. Half of this precipitation water can be retained by using TBN. The sewage system of these town areas can be relieved essentially and therefore the pollution of the waters can consequently be reduced. This includes that the humidity of sealed urban location is increased.

A computer-assisted model for the water balance calculation could be developed to be applicated in the TBN area. By checking the results using the measured values, the applicability of the evaporation and drain model could be confirmed for the two measuring stations. This proved the applicability of the derived precipitation and drain model in other locations.

1.49 “In Situ” Water Harvesting For Crop Production In Semiarid Regions

Captación “In Situ” Del Agua De Lluvia Para La Producción De Cultivos En Regiones Semiáridas

Eusebio Ventura, Jr.
School of Engineering - University of Queretaro. C.U. Cerro de las Campanas s/n. Queretaro, México. 76010. eventura@uaq.mx.

L. Darrell Norton
USDA-ARS-NSERL-Purdue University, 1196 Soils Bldg., West Lafayette, IN, 47906. norton@purdue.edu

Keith Ward
Sustainable Agricultural Technologies, LLC. P.O. Box 591, Corydon, IN. 47112.

Manuel López-Bautista

Alfredo Tapia-Naranjo
INIFAP-Queretaro. Av. Pasteur Sur # 414, Queretaro, 76040, México.

Abstract

Many arid or semiarid countries experience significant problems with water for rainfed crop production. Semiarid regions may receive sufficient rainwater to support crops, but it is distributed so unevenly in time and/or space that rainfed agriculture is not always successful. Developing technologies to increase agricultural water use efficiency through water harvesting and conservation is a need. The objective of this study was to develop and evaluate a new integrated Reservoir Tillage System (RTS) for crop production in semiarid areas. The system included the design of a horizontal-cut subsoiler, a modified row planter and a roller formed with plastic wheels to improve soil tilth and create minireservoirs on the soil surface for "In situ" rainwater harvesting. The roller was tested in laboratory conditions for soil and water conservation using simulated rainfall. The new RTS was implemented in field during the 2002 rainy season at three locations in semiarid Central Mexico. Five different varieties of common beans were planted. A control plot was planted according to the farmer´s conventional procedures. The roller was able to reduce soil erosion and runoff and increase infiltration significantly as compared to the control in the laboratory experiments. In the field, a more uniform seedling emergence and greater standing population was observed in the three sites where the system was implemented. Soil water content was greater in the new RTS than the conventional system, which resulted in greater crop growth and increments of yields in the average of 100% for the different beans varieties.

Keywords. Reservoir Tillage System, Water harvesting, Soil and Water Conservation.

1.50 Sistema De Información Para La Toma De Decisiones En Sectores Socioeconómicos Vulnerables A El Niño Y Otras Variaciones Del Clima En México

Francisco Villalpando
Gerente de Cooperación Técnica para Norte, Centroamérica y El Caribe, OMM, Ginebra, Suiza

Víctor Magaña
Profesor- Investigador, CentroX de Ciencias de la Atmósfera, UNAM, México

Jorge Ducci
Economista, Soluciones Integrales, Santiago, Chile

Resumen

El objetivo de un Sistema de Información para la Toma de Decisiones en Sectores Socioeconómicos Vulnerables a Variaciones del Clima en México (SICLIMEX), es establecer un marco de referencia a nivel nacional y o regional que aproveche las capacidades técnicas, institucionales y financieras en materia de diagnóstico y pronóstico del clima para la toma de decisiones encaminadas a atenuar los impactos potencialmente adversos de condiciones extremas del clima. Estos sistemas de información de clima generarán información climática a la medida de las necesidades de los diversos sectores socioeconómicos afectados, a partir de predicciones de variaciones del clima y de predicciones basadas en la señal de El Niño o La Niña.

Los esquemas de funcionamiento del SICLIMEX contemplan la interacción entre instituciones nacionales y estatales (CNA, Protección Civil, INIFAP, AGROASEMEX, Gobiernos de los Estados, Oficina de la Presidencia para la Planeación Estratégica y el Desarrollo Regional, UNAM, etc.), e internacionales (OMM, NOAA, IRI), con el fin de disponer de mejor información climática y elementos para toma de decisiones por sector.

El presente documento describe los elementos necesarios para el establecimiento de un sistema nacional de información climática en México (SICLIMEX) tomando en cuenta las necesidades de información de cada sector. La propuesta de proyecto es el resultado de tres años de trabajo,

analizando las necesidades de información, realizando reuniones con representantes de los sectores interesados e investigando formas de determinar el valor de la información climática con el fin de establecer bajo que condiciones conviene implementar acciones de prevención.

2 RAINWATER HARVESTING FOR DOMESTIC AND INDUSTRIAL USE

2.1 Remote Sensing: Methods And Techniques To Determine Potential Areas For Fog Water Collection*

Pilar Cereceda

Martín Farías

Pablo Osses
Instituto de Geografía, Pontificia Universidad Católica de Chile, Santiago, Chile

Robert S. Schemenauer

FogQuest : sustainable water solutions,
P.O. Box 151, 1054 Centre Street, Thornhill, Ontario, L4J 8E5, Canada

Horacio Larrain
Universidad Bolivariana, Sede Iquique, Región de Tarapacá, Chile

Introduction:

Chile has been a pioneer in the massive use of fog water collected by artificial devices for domestic use, forestry, agriculture and other purposes. After decades of experience, there are some considerations that can be analyzed in order to improve the scientific studies, the technology and the social and economical issues. In this paper, the use of satellite images for the determination of the stratocumulus cloud behavior and the potential areas for fog water collection will be discussed.

In Chile, the studies about fog have been undertaken since the middle of last century. In the sixties, in the northern Atacama desert, the studies began in relation to the possibilities of collecting fog water by artificial means (Espinosa, 1982) and several preliminary investigations were done in order to understand the hydrological potential of the clouds of Antofagasta. The geophysical aspects were also studied at that time, in relation to the origin and displacement of the low stratocumulus deck (Fuenzalida et al., 1988 and 1989), and the importance of the inversion layer in the cloud dynamics (Espejo, 2001). In the 80´s the geographers began to study the behavior of fog in its spatial and temporal dimension (Schemenauer et al., 1994, Osses et al. 1998) . Questions such as what type of relief, altitudes, slopes, and expositions are the most adequate for fog were investigated (Schemenauer et al. 2003).

Actually, there are geographical methods for detecting the best places with high frequency of fog , techniques to study the potential for fog water collection, and large or massive systems for the collection of the water. A project funded by the National Commission of Science and Technology of Chile has studied the possibilities of the GOES satellite images to explore the stratocumulus cloud behavior and the formation of fog.

Choosing places to evaluate fog water collection potential has been made until now in an empirical way, however in the last three years, the research done in the Atacama desert with remote sensing has given good results. Between May 2001 and April 2003, around 11.000 GOES-Imager scenes were stored and part of them has been digitally processed and analyzed. The first tasks were to define adequate algorithms to discriminate stratocumulus from the other elements and to define a methodology for analyzing spatial and temporal behavior of this type of low cloud . It is possible to calculate area and frequency of stratocumulus coverage and define places where fog can be used as an hydrological resource. Investigations have been don to know in what place in a mountain range has more cloud coverage, what season is the best for fog water collection, and what is the diurnal, monthly or annual behavior (Farías, et al, 2002). Also the definition and application of a methodology to test the results of GOES images in real time, from the study area, was done in 2002 (Osses, et al, 2002).

2.2 Remote Sensing: Methods And Techniques To Determine Potential Areas For Fog Water Collection*

Pilar Cereceda

Martín Farías

Pablo Osses
Instituto de Geografía, Pontificia Universidad Católica de Chile, Santiago, Chile

Robert S. Schemenauer
FogQuest : sustainable water solutions, P.O. Box 151, 1054 Centre Street, Thornhill, Ontario, L4J 8E5, Canada

Horacio Larrain
Universidad Bolivariana, Sede Iquique, Región de Tarapacá, Chile

1. Introduction:

Chile has been a pioneer in the massive use of fog water collected by artificial devices for domestic use, forestry, agriculture and other purposes. After decades of experience, there are some considerations that can be analyzed in order to improve the scientific studies, the technology and the social and economical issues. In this paper, the use of satellite images for the determination of the stratocumulus cloud behavior and the potential areas for fog water collection will be discussed.

2.3 Rainwater Catchment And Sustainable Development In The Brazilian Semi-Arid Tropics (BSATs) - An Integrated Approach

Johann Gnadlinger
IRPAA (Regional Institute for Appropriate Small-Scale Agriculture),
Secretary general of ABCMAC (Brazilian Rainwater Catchment Systems Association)
Vice-president of IRCSA (International Rainwater Catchment Systems Association).
Caixa Postal 21 48900-000 Juazeiro, Bahia State, Brazil, Tel: +55-74-611-6481, Fax: +55-74-611-5385, Email: ircsa@irpaa.org.br

Abstract

During the 1990ies, especially NGOs and grass-root organizations working in the Brazilian Semiarid Tropics (BSATs) have focused on rainwater catchment systems as an essential contribution to people's living under the region's climatic conditions with rainfall only during a few months. Rainwater catchment is seen as one important factor of sustainable development of the BSATs, called "living in harmony with the semi-arid climate." The organizations not only teach appropriate technologies, but

first speak about water and climate and then introduce rainwater catchment systems and look at the economic and socio-political conditions of the people involved. There has to be created a political willingness to build an infrastructure such as access to land, animal raising, rain-fed agriculture, water supply, education, health service, streets and commercialization of local products. A joint project was elaborated by the NGO Network ASA called Project for 1 Million Cisterns (P1MC) to be executed by the civilian society in a decentralized manner (at the community, municipal, micro-region, state and regional levels). At a fist stage, 12,400 cisterns where built by ASA and funded by the Ministry of Environment, and further 21,000 cisterns are planned until the end of this year. The goal of the project is to supply drought proof drinking water for 1 million rural households. It is strongly hoped that the new Brazilian government - with its program "Hunger Zero and Thirst Zero" - will promote rainwater harvesting not only for drinking purposes and for animals, but also for agriculture as part of an integrated development program of the BSATs.

Key words: rainwater catchment, semi-arid regions, sustainable development, water and environment, food-security.

2.4 Decision-Based Approaches For Selecting Sustainable Rainwater Harvesting Technologies

Dr. Hari Krishna
President, ARCSA & Senior Engineer, Texas Water Development Board, Austin, Texas, USA

Introduction

Rainwater Harvesting Systems (RHS) or Rainwater Catchment Systems (RCS) can mean different things in different regions of the world. That is because of varying climates and rainfall patterns, as well as different topographic, soil and land-use characteristics. In addition, water needs, priorities, and economic conditions can vary greatly from region to region. Decision-based approaches are necessary for selecting sustainable rainwater harvesting technologies that could be used in any part of the world. An RCS technology or system that is successful in one part of the world may or may not be directly transferable to another region, however when decision-based tools are utilized, there is a greater probability of success.

2.5 Innovative Sky Water Projects For Sustainable Development In Cities

Dr. Makoto Murase
Secretary General of People for Rainwater, Chief of Rainwater Utilization Promoting Section of Sumida City Hall

Introduction

The Session for Rainwater Harvesting & Utilization was held at the 3rd World Water Forum (WWF) in Kyoto International Conference Hall on March 20,2003. The Key Messages of this session ware as follows:

1. Harvested rainwater is a major water supply option, as important as surface and ground water.
2. Decentralize water utilization and resource management using rainwater harvesting for the sake of the people and the Earth.

3. No more tanks for war. Only rainwater tanks for peace.

The integrated systems of the storage, infiltration and utilization of rainwater mitigate urban flooding and water shortages in cities and alleviate coming water conflicts which are feared to arise in the 21st Century all around the world. Rainwater is a major key.

2.6 Rainwater Harvesting In Latin America And The Caribbean: Causes Of Failures, Recommendations And Trends

Luiz Rafael Palmier
Department of Hydraulic Engineering and Water Resources, Federal University of Minas Gerais, Avenida Contorno, 842/809, Belo Horizonte – MG, 30110-060 Brazil, Phone: 55 31 3238-1003, Fax: 55 31 3238-1001 e-mail: palmier@ehr.ufmg.br

Abstract

Water resources management in water scarce regions is of crucial importance for water assessments, water allocation, design and management of environmental systems. The overgrowing population, as is the case observed in Latin America and the Caribbean, and the prospective of climate change are calling for new approaches for water planning. Among the several strategies to cope with water scarcity, the water harvesting techniques have increasingly been used in many countries, although its full potential is far from being reached in Latin America and the Caribbean. Moreover, in numerous cases the water harvesting projects have not achieved their expected goal as the technologies and designs were not suitable for either the environment or the cultural habits of the beneficiaries. In addition, operation and maintenance of the schemes turned out to be either too costly and/or timeconsuming. In this paper a review of the difficulties in implementing the former water harvesting techniques in Latin America and the Caribbean is presented emphasising the most frequent errors which often cause failures. Some recommendations to avoid these errors are also discussed, including the use of an environmental impact assessment approach.

2.7 The Complementary Aspects Of Projects To Collect Rain, Fog And Dew

Robert S. Schemenauer
FogQuest: sustainable water solutions, P.O. Box 151, 1054 Centre Street, Thornhill, Ontario, L4J 8E5, Canada

Pilar Cereceda and Pablo Osses
Instituto de Geografía, Pontificia Universidad Católica de Chile, Santiago, Chile

Introduction

No one needs to be reminded that water is essential to life. As we enter a new millennium, the availability and usage of this commodity is the focus of increasing attention. Variable or decreasing amounts of precipitation, increasing population, and contamination of groundwater all put tremendous pressure on governments to find sustainable solutions to water supply issues. The problems are clearly most acute in countries with semi-arid or arid regions, limited government resources, and rapidly growing populations. These conditions currently exist in many developing countries. The options available to these countries are limited. Increases in river flows from adjacent countries are rarely possible to negotiate. The pumping of fossil water is an expensive short-term solution. Desalination of seawater is expensive and also requires substantial energy to both produce the desalinated water and to move it from the plant to the point of use. Weather modification has yet to demonstrate that substantial additional precipitation can be produced at ground level in a routine, managed fashion. Stories of large mounds of rock being used as places for water vapor to condense (dew collectors), in places such as the Crimean region of the Ukraine, have recently been discredited (Nikolayev et al., 1996). Other than water vapor and precipitation, there is only one other ground-level source of water from the atmosphere. It is fog.

2.8 Domestic Roofwater Harvesting In The Tropics: The State Of The Art

Terry Thomas
Warwick University, UK

Abstract

International statistics confirm the ongoing failure of many poor (and often tropical) countries to ensure all their citizens have access to affordable domestic water of adequate quality and quantity. The constraints on improving the situation are economic, organisational, climatic and topological. In several countries some of these constraints are worsening and in many countries resource and social sustainability are not assured. Although practised in antiquity, roofwater harvesting has resurfaced in recent decades as a 'new' technical option for water supply.

It has advantages and disadvantages whose strengths depend heavily upon such local factors as settlement structure, geology, community wealth, house design, seasonality and reliability of rains, government policy and water laws, and the perceptions of potential users. The paper reviews these advantages and disadvantages in the specific context of low-income

tropical countries, giving special emphasis to their more humid regions. Recent research findings concerning both the technique of roofwater harvesting and its application are reviewed.

2.9 Rainwater Harvesting Is An Integrated Development Approach For The Untainous Areas With Water Scarcity

Qiang Zhu
(Gansu Research Institute for Water Conservancy, Lanzhou, China 730000)

Abstract

China is a large country with serious water scarcity. Particularly in the semi-arid mountainous areas in the North and Northwest China, Karst regions in the Southwest China, the dry hilly areas in middle China as well as the Islands and rocky coastal areas, situation is even worse. The household based RWH projects have been developing rapidly in China's 1/5 territory in the past decades. It not only can provide water for domestic use but also can supply irrigation water to enhance agriculture production. The past practices of RWH in China indicate that RWH is an integrated development approach for the mountainous areas with serious water shortage. It could induce a breakthrough in developing rainfed agriculture particularly the dry farming in semi-arid areas. RWH is proved to be an indispensable component of integrated water resources management.

2.10 Rainwater Harvewsting In The Context Of Changing Social And Economical Trends In Colombo Metropolitan Area, Sri Lanka

Anusha Adhihetty
Civil Engineer, National Water Supply & Drainage Board, Sri Lanka., e.mail : adhihetty10@hotmail.com

Dr. S.S. Wickramasuriya
Department of Civil Engineering, University of Moratuwa, Sri Lanka, e.mail ; sunilw@civil.mrt.ac.lk

Abstract

The paper demonstrates how rainwater harvesting can satisfactorily reduce the social and economic impact on the population, resulting from development and increasing water tariff within the Colombo metropolitan area of Sri Lanka.

The vision of the government of Sri Lanka is to stimulate substantial growth, by the development of the Colombo metropolitan area, which will be a hub of economic and development activities in the 21st century. This will result in a major increase in the demand for suitable water, which is presently met by surface water resources. The population in the area will encounter serious problems of using ground water due to a lack of lands to dig wells and the issue of increasing ground water pollution.

Thus people will have to depend on pipe borne water for their domestic needs. However due to increasing water tariff, many have found difficulty in paying their water bills. Non-payment of water bills result in disconnection of water supply. Unlike other services such as electricity and telecommunication, water is a critical human need and people experience adverse social pressures without access to adequate amounts of water. Hence it is vital to seek alternative measures urgently.

The use of rainwater as a supplement to pipe borne water to fulfill the non-potable water demand, will be an attractive alternative for the water problem in Colombo metropolitan area. Developing rainfall frequency curves based on past rainfall data is a valuable tool for decision makers to make a rapid preliminary assessment about the likelihood of success of a rainwater harvesting project. The methodology requires daily demand, area harvested and storage capacity as parameters.

The cost effectiveness of using rainwater harvesting as a supplementary source to pipe borne water to alleviate the social and economic burdens of the population, is demonstrated by a cost analysis.

2.11 Impact On Society And Economy Of Rain /Snow Harvesting In (Sangatesh) Western Afghanistan

Eng. Khalil Ahmad
c/o World Vision International , Afghanistan.

Introduction

The writers experience deals mostly with SangAtesh in Badghis province of Western Afghanistan. SangAtesh covers the SangAtesh River valley and has about 11000 families living in 100s of small villages. Some of the villages live a partial nomadic life. They live about half the year in their permanent houses and half the year in a grass land ,in tents. A village consists of from any thing to up to about 300 families and invariably they are a extended family or tribe. In a village houses are located close to each other and presents a rather urban housing density , where as the land availablearound a village is always endless.

The precipitation in this area is estimated to be about 300 mm per year. Most of the rain and snow falls between December and May . Rest of the year is dry. Starting June the temperature and the wind increases . This results in high evaporation levels. Annual evaporation figures are estimated at over 2000 mm.

2.12 Rainwater Harvesting In Urban Cities Of South Eastern Nigeria

Peter Andrew Ani
"Mirindu", Enugu Catholic Diocesan Water Programme, Nigeria, *E-mail: padiks@infoweb.abs.net*

Abstract

Water is generally a panacea for good health hence water is health. Man is exceedingly in terrible jeopardy once water ceases to go round the body. Moreover it is equally used in various domestic, agricultural and industrial activities. Despite the fact that up to seventy nine percent of the entire earth surface, is covered with water, majority of the world population especially in developing countries like Nigeria are still confronted with unprecedented inadequacy of good potable water supply.

In Eastern part of Nigeria, more than before, people are getting conscious of rainwater harvesting as a good alternative to water supply instead of waiting for the government that has failed in their capacity to provide steady supply of water, even in their cities. Nowadays, people in the cities are getting much involved in harvest of rainwater that they consider it in many endeavours of their daily life. They no longer see it as an act better applied in the rural communities because of its previously crude system of harvesting. Some non-governmental organizations harvest rainwater to help the unprivileged people in the cities; reason being a function of government neglect in the provision of these all-important commodity.

There are different approaches both in system of its harvest and storage, and according to the capacity of each harvester. This study looks into these systems that are in vogue in the cities of the south eastern Nigeria and their implications to life.

2.13 Health Risk Due To Drinking Domestic Roof Water Harvested

Tanuja Ariyananda
Director, Lanka Rain water Harvesting Forum, 239, High Level Road, Kirulapone, Colombo 5, Sri Lanka, tanuja@sltnet.lk, lrwhf@sltnet.lk,

Introduction

Since rainwater harvesting systems are classified as individual systems there are no public health regulations for constructing, maintaining and testing the quality of the collected water. Lack of regulation results in variation in design, no incentive for maintenance or testing for water quality. As a result, the water quality of most systems is not know and varies from system to system.

Recommending domestic roof water collection for drinking has direct health concerns due to biological and chemical contamination and indirect health issue due to disease-causing insect vector breeding in the tanks. Contamination of rain water systems has been linked with a number of human infections (Brodrinbb et al, 1995; Murrell and Stewart, 1983) and chemical intoxication (Body, 1986). Many studies have looked at microbiological (Lye, 1987; Fujioka and Chinn, 1987; Fujioka et al., 1991; Hable and Waller, 1987; Waller et a., 1984) and chemical (Gumbs and Dierberg, 1984; Olem and Berthouex, 1989; Sharpe and Young, 1982; Young and Sharp, 1984) contamination of roofwater collection.

This paper will look at chemical and biological issues as well as specific health issues posed by very low cost domestic rainwater harvesting systems in a study conducted in 3 countries.

2.14 La Producción Campesina De Agua: Aportacion Para El Equilibrio Social, Económica Y Ecológica

David Barkin

Profesor de Economía, Universidad Autónoma Metropolitana, Unidad Xochimilco, México, barkin@cueyatl.uam.mx

Resumen

Muchas de las comunidades rurales de México se localizan en regiones apartadas e inasequibles de su territorio. Están relegadas a las áreas que los más poderosos estuvieron dispuestos a ceder o fueron incapaces de defender durante siglos de colonización y décadas del reparto agrario. Indígenas y campesinos intentan sobrevivir en tierras empobrecidas por la erosión o con reservas forestales reducidas por la demanda de una industria insaciable de productos de madera y sus derivados y los requerimientos impuestos por la pobreza. Irónicamente, muchas de sus comunidades se ubican en áreas de abundante precipitación pluvial; sin embargo, debido a prácticas inadecuadas de administración de recursos ambientales, no pueden emplear el agua para fines productivos. Peor aún, estas poblaciones carecen en su mayoría de fuentes confiables de agua potable para sus requerimientos domésticos básicos.

Este artículo examina una serie de propuestas para enfrentar estos problemas. Las iniciativas que permitirían a las comunidades la recolección y utilización de estas aguas para fines productivos pueden ser financiadas por usuarios mayores y reforzadas con un programa que garantiza el suministro agua potable a los participantes y la instalación de una capacidad para tratar a las aguas residuales. Los nuevos abastecimientos podrían elevar la producción primaria a la vez que incrementarían la disponibilidad del agua en las regions más bajas de las cuencas, donde los mantos freáticos han disminuido por debajo del nivel de filtración y captación de agua y donde los volúmenes de extracción son cada vez mayores. Este enfoque tiene otra gracia, ya que contribuiría a una estrategia de desarrollo sustentable fincado en los campesinos que mejoraría la calidad y el nivel de vida y reduciría las presiones migratorias.

2.15 Utilising Rainwater For Non-Potable Domestic Uses And Reducing Peak Urban Runoff In Malaysia

Ahmad Jamalluddin Bin Shaaban
National Hydraulics Research Institute of Malaysia (NAHRIM), Km 7 Jalan Ampang, 68000 Kuala Lumpur, Malaysia e-mail: ahmadj@mail.moa.my

Adhityan Appan
HYFLUX (S) Pte Ltd, 40 Changi South Street 1, Singapore 486764, e-mail: cappan@ntu.edu.sg

Abstract

Rapid socio-economic development has begun to put a strain on Malaysia's water supply and drainage facilities. This strain came to the fore on the back of the 1998 drought induced water shortages which brought unpleasant water supply disruptions for 1.8 million residents in the Klang and Langat Valley. This drought event jolted the nation to explore alternative water resources such as rainwater for conserving the public water supply. Similarly rapid urbanisation which brought an increase of impervious areas and reduction of natural storages has increased urban peak runoff, burdening city drainage systems and compounding city flash flood problems. Consequently, NAHRIM embarked on a study on rainwater harvesting and utilisation system (for non-potable household use), coupled with detention storage (to reduce peak storm runoff), for a double storey terrace house at Taman Wangsa Melawati, Kuala Lumpur.

The rainwater system comprises of gutters, downpipes, first flush storage, rainwater cum detention storage tank, a pump, a roof tank and separate distribution pipes. The rainfall and runoff from the roof are measured and the non-potable water use of the house occupants is also metered. Sizing of the storage tank is done taking into consideration reliability of the delivered water, roof catchment area and space constraints in the house compound. The economic aspect of the system such as unit cost of rainwater is also determined. The rainwater quality in the storage tanks are compared with the piped public water, WHO Drinking Water Guideline and the Interim National River Water Quality Standard.

The new Urban Stormwater Management Manual developed by the Department of Irrigation and Drainage (DID) is referred to in the design of the detention storage. The effect of the rainwater cum detention storage system when extended to every house in the housing area with regard to peak runoff reduction for a selected design storm is also investigated.

2.16 Captação De Águas Pluviais Na Cidade De Campina Grande – PB: Alternativa Para Uma Política De Enfrentamento Da Escassez De Água Nas Escolas Públicas

Pluvial Water Catchment In The City Campina Grande -PB (Brasil): Alternative Politics For Confrontation Of The Problem Of Water Scarcity In Public Schools

Ozéas Jordão da Silva

José Tavares de Sousa

Damião de Lima

Eli Brandão da Silva
Universidade Estadual Da Paraíba

Resumo

Este trabalho apresenta a proposta de que o sistema de captação de águas pluviais nas escolas públicas de Campina Grande é alternativa auxiliar para uma política de enfrentamento do problema da escassez de água na cidade. Partindo da discussão sobre o fenômeno da seca na região do Semi-Árido brasileiro, concentra o foco da pesquisa na problemática específica de Campina Grande, analisando 39 escolas. O resultado da pesquisa mostra: que as escolas dispõem exclusivamente do sistema de abastecimento de água da Companhia estadual – CAGEPA – e que suas condições infra-estruturais se apresentam precárias, sobretudo, em períodos de racionamento de água na cidade; que as providências tomadas pelos diretores das escolas na tentativa de combater os sérios prejuízos do complexo sistema educacional causados pela escassez de água são ineficientes; que os telhados dos prédios das escolas possuem capacidade de captação de água de chuva tamanha, que adotado o sistema nas escolas e considerada a relação captação X demanda, das 39 escolas pesquisadas, 15 seriam supra-suficientes, 15 quasesuficientes e 9 insuficientes, sendo a contribuição destas bastante significativa; que a comunidade estudantil conhece e concorda com a utilização do sistema de captação de águas pluviais na escola. Conclui-se, a partir disso, que o sistema de captação de águas pluviais se apresenta como alternativa auxiliar, viável, eficiente e econômica de combate à escassez de água nas escolas públicas de Campina Grande.

Palavras chaves: água de chuva, escassez, demanda, captação; escola pública.

Abstract

The present work presents the proposal that the pluvial water catchment in the Campina Grande's public schools is an alternative politics for confrontation of the problem of water scarcity in the city. Stating from the discussion on the phenomenon of the drought in the region of the Brazilian Semi-arid, this work concentrates its focus on the specific problem of Campina Grande's, analyzing 39 of its schools. The result of research show: that the schools make exclusive use of system of water supply of state Company – CAGEPA – and that her terms infrastructures conditions are precarious, especialy, in the periods water rationing in the city; that the steps by the directors of the schools in the attempt to fight the serious damages of the complex system educational caused by water scarcity are inefficient; that the schools buildings roofs posses such of the a great capacity of rain water catchment that by adopting the system of rain water catchment out of the schools, 15 would be supersufficients, 15

almost- sufficients and 9 insufficient, with respect to relation of water catchment versus water demand, that the student community knows buildings. Hence, it is concluded, that the system of pluvial water catchment presents a helpful, viable, efficient and economic alternative for combating the scarcity in the Campina Grande's public schools.

Key Words: water-demand-scarcity-catchment system-schools.

2.17 Beneficiado Húmedo Del Café Con Agua De Lluvia Integrado A Un Sistema De Producción Sustentable.

Roberto Licona Franco
Cafetal "La Herradura", Colonia El Haya, Xalapa, Ver. Mexico, Email: liconafr@hotmail.com

Antecedentes

El beneficiado húmedo del café en forma convencional utiliza altos volúmenes de agua que generalmente toma de fuentes o cuerpos que aseguren el abasto abundante, por lo que la ubicación de la infraestructura para el proceso se restringe a las hondonadas o áreas encañonadas a la orilla de un río o arroyo en donde se pueda disponer del agua preferentemente por gravedad. El acomodo de las maquinas y de la infraestructura para el desarrollo del proceso se diseña en "cascada" que al final lleva al café a la parte más baja en donde se realiza el lavado para separar al grano del agua residual, la que arrastra una importante carga orgánica a base de mucílagos con una Demanda Bioquímica de Oxigeno arriba de 2,000 mg./ l., que en la mayoría de los casos se devuelve al mismo cuerpo de agua de donde se tomó, con el consecuente daño que provoca la alta D.B.O. ya citada. El máximo permisible es de 200 mg/l. Por otro lado, las condiciones ambientales en las hondonadas donde se localizan los beneficiaderos tradicionales de café presentan humedad relativa alta y lento o nulo movimiento del aire, además de menor número de "horas de sol" debido al efecto de sombra por topografía, lo que puede originar presencia de "mohos" en el café "pergamino", deteriorando su calidad en forma irreversible. En cuanto al consumo de agua, el beneficiado del café en instalaciones tradicionales requiere generalmente desde 2,000 hasta 6,000 litros por quintal procesado, lo que es lo mismo, de 43 a 130 litros por 1 kg. de café verde (green coffe).

2.18 Producción Del Cultivo De Berro Y Captacion De Agua En La Cuenca De L Rio Cuautla, Morelos, México

Claudio Avalos Gutiérrez
Estudiante de doctorado. Colegio de Postgraduados, Montecillos, Texcoco, México. E-Mail: cavalosg@yahoo.com. Km. 36.5 carretera México-Texcoco, C.P. 56230, Montecillo, Texcoco, Edo. De México. México.

Jacinta Palerm Viqueira
Profesor investigador. Colegio de Postgraduados. Montecilos, Texcoco, México. E-Mail: jpalerm@colpos.mx. Km. 36.5 carretera México-Texcoco, C.P. 56230, Montecillo, Texcoco, Edo. De México. México.

Resumen

En la cuenca del río Cuautla los productores de berro aprovechan el agua tanto de manantiales como del propio cauce del río y de canales generales de riego; de aproximadamente 90 productores que cultivan una superficie de 60 hectáreas, unos 45 de ellos pertenecen a una Asociación Agrícola Local desde 1979, pero el cultivo se introdujo en la zona desde hace unos 70 años. Para la Asociación de Usuarios del Río Cuautla, Manantiales y Corrientes Tributarias "Gral. Eufemio Zapata Salazar" A.C., mejor conocida como ASURCO, que opera el Módulo de Riego 08 desde 1994 a raíz de la transferencia del Distrito de Riego 016 en el estado de Morelos, el cultivo del berro representa un problema en la disponibilidad de agua para los usuarios de aguas abajo porque los productores de berro realizan bordos de retención y ello no permite que el agua fluya libremente. En este reporte se exponen algunos antecedentes en la producción de berro en la cuenca, las limitaciones que tiene el cultivo desde la perspectiva de la falta de agua para los usuarios de ASURCO así como las ventajas que representan las obras de captación de agua en la recarga del acuífero.

Palabras clave: cuenca, acuífero, berros

2.19 Water Water Every Where But I Can't Take A Shower

Leroy F. Heitz
Professor of Water Resources Engineering, Water and Environmental Research Institute of the Western Pacific, University of Guam, UOG Station Mangilao, Guam 96923 (lheitz@uog.edu)

Laura Rumong
Research Assistant, Water and Environmental Research Institute of the Western Pacific, University of Guam, UOG Station Mangilao, Guam 96923

Abstract

Guam and many of the other islands in the Western Pacific are periodically struck by typhoons. On occasion these typhoons are so powerful that it can take many weeks before the islands' power systems can recover. These power interruptions can have a serious impact on the islands' water utilities that use electrically powered pumps to move the water through the transmission and distribution systems. In some cases people are without water for weeks or months after these typhoons strike. After Guam's last typhoon (Pongsona, December 8, 2002) it was a daily struggle for people to find enough water for drinking, showers and flushing their toilets. For many people this search for water lasted as long as four weeks. According to the Guam National Weather Service Office, in the four days during and following Typhoon Pongsona over 21 inches (533 mm) of rain fell on Guam. If a resident caught all the rain water that fell on a typical sized Guam roof during that period he would have captured nearly 20,000 gallons (75,700 liters) of fresh clean rainwater. That person would have had plenty of water not only for his own family but all of his neighbors as well. Fortunately during typhoon times huge quantities of rain fall just at the very time when the utilities have the most trouble delivering water in adequate amounts. This paper will report on a recently completed study by the University of Guam Water and Environmental Research Institute of the Western Pacific (WERI). This study evaluated the possibility of using household Rainwater Catchment Systems (RWCS) to supply emergency backup water during the periods following typhoon passage. We examined the period 1957 through 2002 and chose 25 typhoon events for further examination. The previously developed RoofRain RWCS modeling program was used to evaluate the effectiveness of various sized rain catchment systems to supply water for a thirty-day period following typhoon passage. Various RWCS configurations were explored to determine the number of people that could be supplied from various storage tank sizes. It was found that in most cases even a modestly sized system can serve as a very

dependable emergency back up water supply. The evaluation techniques used and the results of this study will be presented in the paper.

2.20 Research On Sedimentation And Particle Size Distribution Of Urban Rainwater In Beijing

Li Junqi

Che Wu

Liu Yan

Liu Song
Beijing Institute of Civil Engineering & Architecture, Beijing 100044, China, E-mail:shdaren@sohu.com or jqli6711@vip.163.com

Abstract

Sedimentation is one of the important technology for rainwater utilization and runoff pollution control. In order to design sedimentation facilities properly, the particles' size distribution and the physical characteristics must be well known. As noted, since many of pollutants are attached to the solids, removal of particles will also remove many other pollutants. Based on measurement stormwater pollutants from roof, pavement and residential sub-district of Beijing urban areas(1999-2002), the particle size distribution and removal efficiency of suspended solids or turbidity were studied.

KEYWORDS: rainwater, sedimentation, particles size distribution, suspended solids, turbidity.

2.21 Towards Achieving Human Security Through Rainwater Harvesting: Case Studies From India

Indira Khurana
Formerly coordinator of the Natural Resource Management Unit of the Centre for Science and Environment, New Delhi, and author of several publications, directory and a manual on rainwater harvesting. Co editor of the book 'Making Water Everybody's Business: Practice and Policy of Water Harvesting., Address: 708 Asia House, K G Marg, New Delhi 110001, India. E mail: indirashok@vsnl.com

Theme

Rainwater Harvesting For Food Security/Rainwater Harvesting Impact On Society, Economy And Ecology, Rainwater Harvesting For Irrigated And Dryland Agriculture

Key words

Humans security, livelihood security, food security, rainwater harvesting, rainwater harvesting and economy, rainwater harvesting and agriculture

Abstract

The water scarcity facing the world today has driven several institutions towards increasing access to water as a primary objective. These include the millennium development goals of the United Nations,

which include reduction in extreme poverty and hunger by half by 2015, halving the number of people that do not have access to safe drinking water and ensuring environment sustainability.

2.22 Turning Rainwater Into Drinking Water: Adapting Conventional Multi-Stage Water Purification Technology To Purify Rain

Indira Khurana, PhD

Technical and Communications Consultant, AquaSure, the Netherlands, Address: 708 Asia House, K G Marg, New Delhi 110001. e mail: indirashok@vsnl.com

Abstract

The water scarcity facing the world today in terms of both, quantity and quality, is serious. Several international efforts like the Millennium Development Goals of the United Nations and the declaration of the World Summit on Sustainable Development, are directed towards addressing the issue of lack of access to safe drinking water. Both aim to halve the number of two billion people who do not have access to safe drinking water by 2015.

One basic source of water that can achieve this goal is through harvesting the rain for drinking purposes. Rainwater harvesting is being successfully practiced in several developing and developed countries. However, this rainwater is usually used for non-potable purposes or for recharging depleting groundwater resources, not so much for potable purposes.

One of the main objections to the use of rain for drinking is that it is considered impure and polluted. While this may be true, it is ironic that secondary sources of water like rivers, lakes and groundwater, which are perhaps more polluted, are treated by applying state-of-the-art multi-stage water treatment technologies. Yet, we hesitate to apply the same to the rain. Moreover, our current strategies to deal with groundwater problems of fluoride and arsenic problems is by using filters that remove these dangerous elements. These filters however come with their own set of risks. In such cases, the use of alternate source of water – rain – makes more sense.

There is a need for a paradigm shift in the way we use rain. There is enough rain to meet at least drinking water needs and it must be used for drinking. Rainwatr use for drinking purposes will promote the use of a decentralised and low cost source of water, under user control. It will go a long way in meeting the Millennium Development Goals and achieving household and community level clean drinking water, in a sustainable manner. If impure, the rain can be treated by applying appropriate technology.

The present paper informs about rainwater quality and how rain can be purified to meet WHO drinking water guidelines using an innovative multi-stage water purification technology. It also describes the results of this technology on artificially created contaminated water.

Key words: Rainwater harvesting, rainwater quality, rainwater purification, drinking water

2.23 Evaluation Of Rainwater Harvesting Systems For Livestock Production In Uganda: A Case Of Mbarara District.

Nicholas Kiggundu

Grace Nakanjakko

Abstract

Rainwater harvesting is widely practiced in many parts of Uganda to supply water for domestic use, livestock and crop production. In the cattle corridor region rainwater harvesting is economically practiced for livestock production. The popularity of rainwater harvesting is attributed to the fact that other alternative sources are distant from human settlements and groundwater may be low in quantity, saline or an expensive venture. Despite the much runoff generated from the ground catchment, the systems are associated with inadequate proper integration of catchment characteristic properties and management practices leading to drying up of reservoirs during the dry period. The severe dry spell between the end of the first rains and beginning of the second rains results into pastoralists without permanent water sources migrating to watering places far away, which could be valley Dams Rivers or Lakes. Such type of movement results into conflicts between communities since the local community feels invaded by the new comers. Sometimes these pastoralists encroach on game reserve areas and they are never spared by the game rangers. Other times the pastoralists fail to trace their way back home easily at the end of the dry spell. Hence they get separated from their families for a long period of time. Although the Government of Uganda together with development partners have come in to alleviate the situation with water projects, the problem has not been solved. This is because some of these projects have been messed up during implementation or due to the "top-down" approach. Some of the constructed reservoirs have been vandalized through malice or due to negative cultural beliefs. On the other hand contour bunds in pasture fields have significantly contributed to the availability of fodder during the dry spells. This paper will address the available rainwater harvesting opportunities and the associated challenges in the cattle corridor region.

2.24 Development Of Rainwater Utilization System In Korea

Ree-Ho Kim

Sangho Lee

Young-Min Kim

Korea Institute of Construction Technology, 2311 Deahwa-Dong, Ilsan-Gu, Goyang-Si, Gyeonggi-Do, 411-712, South Korea

Abstract

Despite much rainfall over a year, Korea is classified as a water shortage country because of its large population and seasonal variations of precipitation. This has led to developing technologies for rainwater utilization in order to buffer extreme run-off situations in the watercourses and to reduce the costs for residential-area water supply and treatment. Rainwater utilization requires rainwater catchment, treatment, and infiltration technologies not only in buildings and houses (point source) but also in the whole area of interest (non point source). In this study, technologies have been developed to analyze the characteristics of rainfall runoff, collect and store rainwater, clarify the contaminated rainwater, and use the stored rainwater for sustainable and substitutional water resources. A rainwater

treatment system consisting of sedimentation, filtration, and disinfection has been developed to use the rainwater as water for toilet flush, washing, and roof garden systems.

2.25 Advanced Treatment Of Rainwater Using Metal Membrane Combined With Ozonation

Ree Ho Kim

Sangho Lee

Seog-Ku Kim
Korea Institute of Construction Technology, 2311 Deahwa-Dong, Ilsan-Gu, Goyang-Si, Gyeonggi-Do, 411-712, South Korea

Jong-Oh Kim
[2] Department of Civil Engineering, Kangnung National University, 120 Gangneung Deahangno, Gangneung-Si, Gangwon-Do, 210-702, South Korea

Abstract

This paper outlines a metal membrane system for removing contaminants from rainwater. The system consists of submerged metal membranes in a tank and an aerator or an ozone generator. Contaminated rainwater is introduced into the tank after an initial screening of solids and permeate is removed after passing through the membrane. Ozone bubbling as well as aeration in the feed side were applied to reduce membrane fouling, destruct organic pollutants, and inactivate microorganisms. The metal membrane appears to be suitable to be used with ozonation because of its excellent chemical stability. Experiments were performed to compare filtration characteristics of rainwater in storage tank, roof runoff, and roof garden runoff and to investigate the effect of ozone injection on the increase in transmembrane pressure and membrane fouling.

2.26 Rainwater Treatment Process For Building Drainage Using Fiber Filter Media

Ree Ho Kim

Sangho Lee
Korea Institute of Construction Technology, 2311 Deahwa-Dong, Ilsan-Gu, Goyang-Si, Gyeonggi-Do, 411-712, South Korea

Yeong-Kwan Kim
Division of Environmental and Biological Engineering, Kangwon National University, 192-1 Hyoja2-Dong, Chunchon-Si, Kangwon-Do, 200-701, South Korea

Abstract

The collection of rainwater from roofs, its storage, and subsequent use is a simple method of reducing the demand on both the public water supplies and waste treatment facilities. However, it is almost impossible to utilize rainwater directly without appropriate treatments because the rainwater contains substantial amounts of contaminants in the urban area. In this work, a treatment system for building drainage of rainwater using filtration media was investigate to clarify rainwater for use or discharge. The system consists of an initial settling tank and a separation tank containing the mat and the filter

media. The rainwater is either used or discharged after passing through the system. The system is designed to treat only the first flush of rainwater containing a substantial amount of contaminants. The filtration media based on lignocellulosic fiber filter mat was effective to remove heavy metals as well as suspended solids. The system appears to be promising to economically clarify contaminated rainwater from building drainage.

2.27 Rainwater Harvesting Used In Low-Impact Development Design Guidelines

Heather Kinkade-Levario

Location and Traditional Development Practices

The Phoenix Sky Harbor International Airport Rental Car Center (RCC) is proposed for a 54.6-hectare site located on the western perimeter of the airport south of Buckeye Road and east of 16th Street. The new RCC will provide a consolidated location for rental car company passenger processing functions, administration offices, and employee and rental car parking facilities. The building will allow a customer to be shuttled from the main airport terminals to a unified location of rental car companies where they may conduct rental business, pick up vehicles, and return vehicles. The proposed facility infrastructure consists of the main building, outlying separate rental car buildings, parking structures, and surface parking lots, all of which are proposed as impermeable surfaces. Landscape retention basins are proposed for the north and south ends of the site, allowing some softscape relief. With the knowledge that the impervious surfaces of the RCC project will induce an enormous amount of stormwater runoff and the fact that Phoenix is a desert community–currently experiencing a drought–Forgotten Rain L.L.C. has been given the task to create design guidelines to harvest and reuse the potential stormwater runoff.

2.28 RWH – Success Story From Chennai India.

Ram Krishnan
Akash Ganga Chennai (RWH group from Chennai India), Rkrishnan46@yahoo.com

Abstract

A grass-root citizen group was formed 2 years ago in Chennai (formerly Madras) India called "Akash Ganga Chennai" (Akash-> Sky Ganga-> River) to promote Rainwater Harvesting in the city of 5 million population and provide technical guidance to assist the residents to install RWH in their homes and buildings.

This presentation will describe the rainfall patterns, soil structure and demographics of the city of Chennai. It will describe the most common methods of RWH adopted in the city. It will describe the success stories in 3 suburbs of the city. A real existing house turned into a "Rain Centre" has been constructed to provide information and RWH design consulting, all offered free of charge. (Website: http://www.raincentre.org)

The ground water level in those parts of Chennai where people have installed RWH has come up 10-15 feet in 1 year. Currently, it is estimated about 3 to 4 % of the plots have installed RWH. If 10-20% of the residents install RWH, chronic water shortages in this city could be history.

2.29 Rainwater For Using In Sanitary Systems And In Industrial Processes

(Agua De Lluvia Para El Uso En Sistemas Sanitarios Y Para Processos En La Industria)

Prof. Dr. Peter M. Kunz, Dipl.–Ing.

Oliver Muders

Michael Finzer, cand.-chem.ing

Annette Schmid
Instituto para Desarollo Procesos Biológicos de la Universidad de Ciencias Aplicadas de Mannheim, Institute for Biological Process Engineering at the University of Applied Sciences, Mannheim, Windeckstr. 110, D-68163 Mannheim Tel. (0621) 292-6304/6471 Fax: (0621) 292-6470, p.kunz@fh-mannheim.de - www.che.fh-mannheim.de

Background

Water is vital - in addition to perfect potable water, people at least need water for body hygiene and in many processes of manufacture (steam production, as a solvent in water enamels, defatting baths and so on, but also for sanitary plumbing for the employees). In many countries water is brief - nevertheless, in some parts it rains - however the rainwater goes lost unused, because the people fears the growing of germs while it is stored in cisterns.

Aims

Therefore, the destination of the project of KARL-VÖLKER-FOUNDATION, Mannheim is to develop an economic modul for rainwater-preparation that allows a use in sanitary systems with the quality of bathing water alike the rules of the European Community. Nevertheless the second aim is to conserve the quality over a period of at least three months.

Bathing Water means:

1. excellent colour
2. no specific odour
3. microbial in order,
4. physical and chemical in order.

2.30 Improving Water Quality By Design

D. Brett Martinson

Terry Thomas
Development Technology Unit, School of Engineering, University of Warwick, Coventry, CV4 7AL, UK, d.b.martinson@warwick.ac.uk

Abstract

The quality of water in a rainwater tank is a matter of much speculation, however several techniques can be used to protect and enhance the quality. If these procedures are followed, tank water should conform to the World Health Organisation’s “Low Risk” category.

The primary contamination pathways are via vectors (such as lizards or frogs) directly entering the tank and via inlet water.

This first of these is easily blocked for larger animals by screening all inlets and overflows.

A more important path is via the water entering from the roof. As water passes through the air, onto the roof and flows to the tank, it picks up contamination and carries it into the tank. The contaminants tend to adhere to solid matter that is washed along with the water flow and can be filtered using simple techniques. There is also substantial evidence that water quality improves with time, therefore any system that prevents contaminated water from interacting with “aged” water in the tank will also enhance water quality.

This paper discusses inlet and outlet arrangements for water tanks that can easily be incorporated in low-income countries, yet will substantially enhance water quality both by preventing contaminants from entering the tank and by aiding natural water purification occurring in the tank. A brief discussion is also offered on system maintenance for quality enhancement.

2.31 The Roofwater Harvesting Ladder

D. Brett Martinson

Terry Thomas
Development Technology Unit, School of Engineering, University of Warwick, Coventry, CV4 7AL, UK, d.b.martinson@warwick.ac.uk

Abstract

The two most important barriers to further roofwater harvesting at the household level are high cost and inadequate service. Systems are too expensive for householders to afford them or, if the capacity is reduced to an affordable level, it is seen as too small to provide adequate service. As the cost of a rainwater harvesting system is a function of its capacity, these two problems are heavily interrelated.

For some years there has been in existence a “sanitation ladder”, a catalogue of designs of varying quality from which a project manager, a community or individual can select an appropriate well designed sanitation system to suit local conditions and the available funds. Such “ranges” are the norm in consumer products and usually form the basis for consumer choice.

Rainwater harvesting systems are very amenable to this product-range approach, as no account of local geology and topography need be taken: the water simply falls from the sky. They are however,

slightly more complex than sanitation systems as there are, in effect two ladders, one for service provision – mainly a function of system size and one for quality of construction. It is in fact this quality aspect that is predominant in the sanitation ladder whereas roofwater harvesting systems are dominated by the question of size with a certain quality taken as read. Systems of different sizes and qualities can be clearly presented alongside forecasts of the service they will provide and a community can decide on the solution that is best for them. This paper describes the making of such a ladder for presentation to a community.

2.32 The Creation Of The Database On The Internet For Further Promotion Of Rainwater Use In Japan

Kouhei Mochida

Ichiro Kita

Kouichi Takeyama
Faculty of Life and Environmental Science, Shimane University, Matsue, Shimane 690-8504 JAPAN, Email: a029505@matsu.shimane-u.ac.jp

Introduction

Since rainwater use has several benefits, e.g. saving of clean water, prevention of urban flood, and penetration of rainwater into underground, etc., it has attracted interest recently in Japan. Consequently large-scale rainwater use facilities installed in public buildings have been increasing in number. On the other hand, most of people hesitate to install it in their private residents. It is because that they can't realize the benefit correspond to the cost required for its installation. Then, in recent year, many local governments have established subsidy systems for further promotion of Rainwater Use. These subsidy systems are announced to community residents by pamphlets, public relation magazines, and Home Pages.

2.33 Integrated Development Initiated By Rainwater Harvesting

James Mwami
Busoga Trust, P.O. Box 232, Luwero, Uganda, Tel: 256-77-483264 Fax: 256-41-610212, E-mail: luweroproject@maf.or.ug

Introduction:

Nyabushozi is situated in South-Western Uganda and covers an area of 2930km2. the area is within the Lake Victoria catchment, in the rain-shadow of the Kabula hills. Precipitation is bimodal with rains in March to May and September to November, ranging between 750 and 875mm annually. Lake Mburo and Lake Kachera in the South and South-West of the county, respectively provide the only reliable permanent sources of water in the semi-arid environment.

During a census in 2002 the population of Nyabushozi County has been estimated at 105,845 people. A random sample of 361 households revealed an average household size of 9.8 persons, compared to the National average of 7.6.

Mbarara district is a centre of cattle production accounting for close to one fifth of the national cattle herd of 3.9 million. About one third of the population derives its main income from cattle.

Traditional inhabitants of Nyabushozi County are semi-nomadic Bahima pastoralists and sedentary Bairu cultivators who together form the people of the Banyankole. The pastoral system of the Bahima was based on annual migrations that were driven by seasonal availability of grass and water, and the prevalence of cattle diseases.

Even though the Bahima's average income per capita was slightly above the national average of US$200, they lived a miserable life and had almost given up anything to do with development.

Establishment of a joint project supported by both Uganda and German Government was a timely venture. The project was designed to assist the "squatters" go through a transition from living a semi-nomadic life to a sedentary one.

In this paper therefore it has been elaborated that provision of safe water for both domestic use and livestock can have lasting effects. It has also been demonstrated that having resources does not automatically lead to development. Development needs an integrated approach, involvement of stake-holders and does not take place overnight.

2.34 Rainwater Harvesting In Small Isolated Islands

M. D. Nowbuth

J. G. Perrine
Department of Civil Engineering, Faculty of Engineering, University of Mauritius, * Faculty of Agriculture, University of Mauritius

Abstract

Rainwater harvesting is defined as a method for inducing, collecting, storing and conserving local surface runoff for agriculture in arid and semi-arid regions (Boers & Ben-Asher, 1982). The potential of water harvesting for improved crop production received great attention in the 1970s and 1980s. Although domestic rainwater harvesting (DRWH) is not the definitive answer to household water problems, but it does help significantly to cater for primary water uses, in some cases. This paper critically assesses the importance of rainwater harvesting in two small islands, Mauritius and Rodrigues. The factors favouring rainwater harvesting are highlighted, together with the other possible measures that need to be implemented at national level for better success. The paper notes that though optimal use of water resources is a must for small isolated island, the driving force behind the implementation of optimal water usage is more policy than technical.

Keywords: rainwater harvesting, island, water demand management

2.35 Improving The Quality Of Harvested Rainwater By Using First Flush Interceptors/Retainers.

Dr. Henry K. Ntale

Contact address: Water Resources Department, P. O. Box 19, Entebbe Uganda, Email address: hntale.wrmd@dwd.co.ug

Nyakaana Moses

Department of Civil Engineering, P. O. Box 7062, Makerere University, Kampala

Abstract

Rainwater can be harvested from any simple clean roof surface and, if collected properly, requires little or no treatment before consumption. However, rainwater may become polluted and unhygienic if the dirty first flush is not separated from the clean rainwater especially after a long dry season. Some people do temporarily let the first flush run to waste before collecting clean water, but this does not easily apply for rainwater harvesting systems fixed with permanent collection and storage tanks. This study was set out to exam the problem and came up with pilot devices in prototype, which could be used to improve on the quality of rainwater collected for storage. The prototypes were designed to retain the dirty first flush before letting clean water flow to the main storage tank. The quality of the output rainwater, collected after installation of the first flush retainer, was analyzed and the overall benefits of the first flush retainer technology evaluated. Rainwater that was improved using first flush retainers was found to be of better microbiological and physiochemical quality compared to that collected in the storage tank without a first flush retainer/interceptor. Finally, the economics of the first-flush interceptor system were briefly discussed and found to be small addition to the overall cost of the rain harvesting system yet on the other hand bringing about very significant improvement in the quality of the harvested rainwater.

2.36 Nyando River Basin Food Security Initiative-Nyando District Case.

Johnson A. Ouko

Kenya Rainwater Association Lake Region

Introduction

The Nyakach escarpment of Nyando district is an area comprising 60,000 persons. With long rains of less than 700m p.a coming bimodally, the populace has to go through 7 months of drought. A time when women and children have to wake up at 3p.m and travel up to 7 kms in search of water which was also of low quality. Rates of waterborne diseases, cholera, diarrhoea, were quite high, food production was very low as amount of land put under cultivation was very low. Thus overall poverty levels were quite high.

To intervene, a pilot project on Poverty alleviation through rainwater harvesting was proposed by Kenya Rainwater Association in 1997.Divide into 2 phases, the first phase involved PRA, building of 57 water tanks, training of 35 local artisans, spring protection and sanitation improvement. The second phase was involved in catchment protection, sustainable agriculture, water, ecological sanitation, spring protection and capacity building of schoolchildren through health clubs and 4K clubs.

The community participated through giving of local materials, cash contributions and management.

2.37 Negative Impact Of A Non-Regulated Privatization In Rain Water Management: Providenciales, Turks And Caicos Islands

Impacto Negativo De Una Privatización No Regulada En El Manejo Del Agua De Lluvia: Providenciales, Islas Turcas Y Caicos

Prof. Dr. Fernando Pérez Monteagudo
Centro de Investigaciones Hidráulicas, Cuba, fperezm@cih.cujae.edu.cu

Introduction

Turks and Caicos Islands (TCI) are located southeast of the Bahamas. The Capital, Cockburn Town, is in the Grand Turk Island. It is considered that these islands will experience a real estate and tourism boom in the near future and water surely will be a limiting factor for this expected development, due to the fact that the archipelago is composed by very small islands. The island of Providenciales is the engine of the economical development of the country due to its intense tourism and real state development.

Historically in the Turks and Caicos Islands there is a long tradition in rainwater management, although with differences among the islands that comprise the archipelago, depending on their characteristics.

From a water resources point of view Turks and Caicos Islands can be divided into two groups:

- The Salt Islands: Grand Turk, Salt Cay y South Caicos.
- The rest of the Caicos Islands: Providenciales, North, East y Middle Caicos.

Average precipitation is consequently less in the Salt Islands than in the rest of the Caicos Islands. For Grand Turk the 685 mm per year are estimated while for Providenciales reach 762 mm.

Introducción

Las Islas Turcas y Caicos constituyen un archipiélago situado al sudeste de las Islas Bahamas. La distancia de este archipiélago respecto a Miami es de 925 km y respecto a la isla de la Española 161 km. La Capital, Cockburn Town, está en la isla de Grand Turk. Se considera que estas islas experimentarán un intenso desarrollo inmobiliario y turístico en el futuro cercano (Kiosseff, 1998) y el suministro adecuado de agua seguramente será un factor que limitará severamente este esperado desarrollo, dado que el archipiélago está compuesto por islas muy pequeñas. La isla de Providenciales es el motor del desarrollo económico del país por su intenso desarrollo turístico e inmobiliario.

No existe ninguna cifra exacta que clasifique a una isla en grande, pequeña o muy pequeña. Desde el punto de vista de los recursos hídricos (Falkland, 1992) se considera que una isla mayor de 2000 km^2 es grande. La mayoría de las islas pequeñas tiene menos de 200 km^2 de área y las que tienen un área de menos de 100 km^2 caen en la clasificación de muy pequeñas. Este es el factor que determina la complejidad en el manejo de sus recursos hídricos. De acuerdo con esta clasificación todas las Islas Turcas y Caicos pueden considerarse en general como muy pequeñas o entre muy pequeñas y pequeñas. Por ejemplo las dos islas principales: Providenciales y Grand Turk tienen un área de 97.2 km^2 y 18 km^2 respectivamente.

2.38 Rainwater Harvesting: An Appropriate Technology For Drinking Water In Water Scarce Area Of Rural Nepal

Nabin Prahda

Abstract

In Nepal, 71 percent of the population have access to water supply through piped water and tubewell systems. The topographical terrain of Nepal is predominantly hilly area. In the hills where there are no nearby water sources and conventional supply systems are inappropriate, a family spends an average of 2 hours every day for fetching water. Due to varied geophysical conditions and dismal financial resources of Nepal, improved rainwater catchment becomes one of the appropriate low-cost technological options for sustainable domestic water supply.

The collection and storage of rain from run-off areas such as roofs and other surfaces have been practiced since ancient times. Plan Nepal has been successfully facilitating the promotion of roof-catchment system for household level rainwater harvesting in rural areas using Ferrocement jars.

Women and children (especially girls) are the most vulnerable social groups in the water scarce areas as they are mainly responsible for fetching of water.

The hardware component of Plan Nepal interventions has been integrated with software, mainly capacity building for construction, operation and maintenance, water security, water quality conservation and hygiene education/promotion to ensure the sustainability of interventions and replication of actions.

The impacts of the interventions resulted into improved access to safe drinking water, considerable time-savings for women to focus on other productive and income generation activities, availability of time for girls to go to school for their education. Overall, this has resulted in positive socio-economic impact on the lives of rural communities that are involved in this program.

2.39 Appropriate Household Consumption Of Rainfall Water By Receiving A Soundly Treatment

Uso Del Agua De Lluvia En Combinación Con Agua Tratada En Una Casa Rural

Dietmar Rössel

Hipólito Ortiz Laurel
Campus San Luis Potosi, Colegio De Postgraduados, Iturbide 73, Salinas De Hgo.,S.L.P. 78600 Mexico, Tel: (496) 96-30448 Y Fax: (496) 96-30240, edietmar@colpos.mx, hlaurel@colpos.mx

Abstract

Man has destroyed the natural process for cleaning water because of his unsound activities. Consumption of clean water in many places of the world is higher than rainfall so there is a water shortage. Capture of rainfall water by non-permeable trapping surfaces and its usage right through municipality supply lines, is done firstly, by bringing in it to the household handling cycle and then discharged to the natural cycle. This means an improvement for the economic and environment aspects of water usage. Early research work on partial substitution of clean water consumed at home by using rainfall water, achieved good results and was presented in a previous paper. Continuing with this research, in this paper is presented an approach by combining partially treated domestic water with rainfall water. The objective is to use water treated in this way for everyday jobs at home. By recycling selected domestic sewage water, up to 80% of it can be integrated again into the cycle of household management. The installation for treatment domestic residual water is carried out by the principle of three storage sites all with a volume capacity for 21 days, when it is going to be consumed by a family of four persons. Time span is enough to successfully achieve a reduction of bacteria and viruses to acceptable standard. These results are expanded by increasing the performance of the treatment plant whose purpose is to mix treated water with rainfall water heated by solar energy by means of a sunrays collector.

Keywords: Recycling, capture of water, technical installation, domestic water, home.

Resumen

El sistema natural de limpieza del agua ha sido destruido por el hombre como resultado de sus diversas actividades y el consumo de este vital líquido en varios lugares del mundo es mucho mayor en comparación con la cantidad de precipitación. La recolección del agua de lluvia en áreas impermeabilizadas y su uso a través de las redes de suministro municipal se realiza, primeramente, por la introducción de ésta en el ciclo doméstico y posteriormente enviada al ciclo natural. Esto significa un mejoramiento de la economía del uso del agua y del clima. La substitución del agua utilizada en la casa se presentó en ponencia anteriores. Como continuación de ésa, se presenta un planteamiento para combinar las aguas domésticas tratadas con el agua de lluvia. Esto con el propósito de usar esta agua acondicionada de esta forma para darle diferentes usos en una casa habitación. Mediante el reciclaje del agua doméstica seleccionada, es posible integrar otra vez esta agua, hasta un 80% en el ciclo del uso en una casa-habitación. La instalación para el tratamiento de aguas residuales es llevada a cabo mediante el principio de tres espacios y con una capacidad de volumen para 21 días, para el caso de ser utilizada por una familia de 4 personas, lo cual es suficiente para la reducción de bacterias y virus a niveles estándar. Se encuentra en preparación un incremento de la planta de tratamiento con el propósito de mezclar el agua tratada con agua de lluvia calentada por energía solar mediante un colector además tratada mediante una radiación ultra violeta y una infiltración del aire en el último espacio del tratamiento aeróbico.

Palabras clave: captación de lluvia, reciclaje de aguas domésticas, instalación técnica, casa habitación

2.40 Rainwater Quality In Peninsular Malaysia

Yeap Chin Seong

Nasiman Sapari
Universiti Teknologi PETRONAS

Abstract

This paper presents rainwater quality in the tropical environment of Peninsular Malaysia. Samples of rainwater were collected monthly from 17 meteorological stations, distributed all over the country, over a period of ten years from 1990 to 1999. The locations of the stations represent both the urban and rural environment. All the samples were analyzed by the Department of Chemistry, Government of Malaysia. The water quality parameters include mineral compositions, pH, heavy metals, fluoride and ammonia.

Results of the analysis indicated that heavy metal concentrations for Hg, Pb, Cu and Ni were mostly below the limits of the Malaysia and WHO drinking water standards. However, Hg and Pb occasionally exceeded the limits in 6% and 8% of the samples collected respectively. Most of concentrations that exceeded the standard for mercury and lead were found in the samples collected from 1990 to 1997. Ninety eight percent of the samples collected from 1998 onwards did not exceed the limits for the heavy metals. This is coincided with the introduction of unleaded petrol.

Major elements namely K, Na, Ca and Mg were low, averaging from 0 to 0.8 mg/l. The averaged pH levels of the rainwater were above 4.4, which suggested that there were no serious acid rain problems in the country. Occasionally, 4 stations had pH values below 4.4. The low pH values were only found in rainwater samples from stations in urban environment, which has industries including oil refinery, heavy traffic, and heavy industries.

Rainwater quality in the rural environment of peninsular Malaysia is generally of good quality and suitable for drinking water sources. However for the urban rainwater, prior treatments are necessary in order to be used drinking water. Alternatively the water from urban sources can only be used for other benefit purpose such as toilet flushing.

Key words: Malaysia rainwater quality, urban and rural area, heavy metals, pollution, Lead, Mercury and ammonia.

2.41 Creativity, Contradictions & Conflict Water Resources Quandary In India

Dr Sudhirendar Sharma

Director, The Ecological Foundation, 7 Triveni, A6 Paschim Vihar, New Delhi 110063, India.
Tel: +91 11 25265212. Email: sudhirendar@vsnl.net

Abstract

In less than half a century of independent existence, the water rich society has been reduced to a water-insecure nation. Thanks to an electoral politics that sustains itself on a culture of subsidy; a bureaucracy that is saddled with inefficiency; and a society that is wasteful in resource utilisation, water has become the scarcest resource in India. Contradictions abound in the policies and programmes on water, reducing a society that has been credited for some of the most creative techniques in water conservation to the one that is now at the end of a pipe dream.

Between Cherrapunji's 11,000 mm in the north-east and Jaisalmer's 11 mm in the dry west, the country receives an average of 1,170 mm of annual precipitation. Though one of the wettest in the world by any standard, statistics hold little water as the moisture stressed conditions are now prevalent all across the country, be it rural or urban. A glimpse: ♦

Over 7 million litres of water per day will be carried by trains - 70 rakes each carrying 25,000 litres of water - to 72 drought-hit villages in Saurashtra, Gujarat. In the 50 days during the summer of 2003, over 350 million of water will be transported this way.

Not only far-flung villages, the capital city is water-stressed too. A shortfall of 160 million gallons of potable water per day is met through unreliable tanker supply to affected areas in a city of 14 million. However, the President's Estate has a rainwater harvesting system.

The state of Andhra Pradesh in the south has locked horns with the neighbouring Karnataka state over construction of a check dam across Chitravathi river in Paragodu of Kolar district, to supply drinking water to 100 villages.

For lack of appropriate groundwater legislations, villages have run dry due to overdrawing of groundwater for commercial purposes in several parts of the country. The latest being the village of Kala Dera, Jaipur where soft drink giant Coca-Cola has set-up a bottling plant.

By no means exhaustive, the cases bear ample testimony to the fact that the country's water bureaucracy has not been able to manage the finite supply of nature's bounty to meet growing demand. Neither have exigency measures been suitably developed to counter climatic changes leading to unforeseen moisture-stress. Though it hasn't been able to sustain supplies and meet the rising demand, the water bureaucracy hasn't let the hold on the button to control the total exploitable surface and to an extent the groundwater resources.

2.42 Sizing and optimally locating guttering for rainwater harvesting

Gwilym T.Still & Terry H. Thomas
DTU, Warwick University, UK, Tel.: +44-24-7652-2339; fax: +44-24-7641-8922; e-mail: g.t.still@warwick.ac.uk.

Abstract

Guttering is the most common method for conveying rainwater from the capture surface (normally a roof) to storage. The cost of such gutters is a relatively small fraction of the total system cost (typically under 20%) but guttering failure accounts for much loss in RWH system performance. The optimum gutter may be defined as that which minimises the system cost per litre of water captured. There are a series of gutter variables within the control of the installer, including: gutter shape, slope, width and position relative to the roof edge.

This paper focuses on an analysis of the sizing and positioning of gutters, based on several sources, including rainfall data from the humid tropics and experiments undertaken by the DTU at the University of Warwick and in Sri Lanka. For domestic RWH applications, it was found that relatively small gutters (around 5 to 8cm wide), if hung accurately, offer high performance. Typically an economically optimum gutter would intercept and convey only 90- 95% of roof run-off to the cistern. Indeed, it appears that gutters are often oversized in practice. The use of a dual slope can improve the performance of guttering.

Having concluded the technical analysis, rules of thumb and tabulated recommendations are presented, suitable for application by rainwater harvesting practitioners.

Keywords: Guttering; economic; optimisation.

2.43 UNICEF Role In Revitalization Of Jar Technique In Vietnam.

Le Quang Vinh
E-mail :lqvinh@unicef.org, Ass. Project Officer, Rural Water Supply Project, Phone : (84-4) 9425706-11, Ext. 236. Water,Environment & Sanitation Section - UNICEF Vietnam Mobile: 0913.005.003 Fax : (84-4) 9425705 72, Ly Thuong Kiet, Hanoi Web-site :http://www.unicef.org.vn/

Introduction

Vietnam is a tropical country, with a total area of 329,841 Km2 and a population of nearly 80 millions, of which 75% are in the rural area. Population Growth Rate is 1.6 % In 2001, the average income per capita was 412,9 US$, ranking number 8 in the region, 39 in Asia and 142 in the world. The annual average rainfall is approximately 1960mm but its distribution in regions is not even varying from 1,600mm to 3,200 mm. The country has 8 different social economic areas and about 54 different ethnics. The above factors and others affect and vary the way and habit of harvesting rain water in different areas and to certain degree among different ethnics in the country.

Although water is abundant in many parts of Viet Nam, safe drinking water is scarce. In fact, the majority of rural families in Viet Nam lack of access to safe drinking water and/or sanitation facilities. Inadequate sanitation facilities, poor hygiene practices, and the ingestion of contaminated drinking water are the cause of almost half of the deaths and disease among Viet Nam's youngest children, and are the main cause of child malnutrition in Viet Nam today. Malnutrition currently affects 36.7% of all Vietnamese children under five years of age.

In many parts of Viet Nam, water sources also contain dangerous levels of fluoride or arsenic. People drinking arsenic-contaminated water face especially serious health risks, including skin diseases, respiratory ailments and cancer. By emphasising community participation and promoting simple and cost-effective solutions to clean water access, such as rainwater jars, water filters, hand pumps or electric pumps, UNICEF encourages communities to take an active interest in local water supply issues.

2.44 Promoting Domestic Rainwater Harvesting In Sri Lanka

Dr. P. Aruni Weerasinghe,
Hon. Secretary, Lanka Rain water Harvesting Forum, 239, High Level Road, Kirulapone, Colombo 5, Sri Lanka aruni50@yahoo.com, lrwhf@sltnet.lk

Abstract

Sri Lanka has been traditionally practicing rainwater harvesting for both domestic and agriculture use for many centuries. Community Water Supply & Sanitation Project in 1996 introduced new technology for rainwater harvesting for domestic purposes in a systemic and scientific manner. Since then the government as well as NGO's island wide have taken up rainwater harvesting as a feasible water supply option for rural communities. Lanka Rain Water Harvesting Forum (LRWHF) formed in 1997, brought professionals and practitioners together to promote, research and foster rain water harvesting in the country. As a result of LRWH Forum's promotion, training and information network, over 14,000 tanks has been built throughout the country in the last 5 years.

2.45 Incorporating Rain Water Harvesting Into The Suburban Landscape

Joshua Weiner
WildWorks Landscapes, Inc., 827 E Adams St (Rear) Tucson, AZ 85719, josh72@earthlink.net

Abstract

In the summer and fall of 2001, we created a landscape in the suburban retirement community of Saddlebrooke, near Tucson, Arizona. One of our design goals was to maximize the potential for water harvesting. The home was a newly built one, and did not have an existing landscape. The bare lot was graded from front to back, to direct roof runoff from the back yard into the front yard, and then out into the street.

We created enhanced opportunity for water harvesting by significantly re-grading the site. We put slope in the landscape such that sheet-flow from roof runoff was directed clockwise, around the house from the South front side, to the back, and then to the North front side, before being directed out into the street. In the water's path we built a series of rock lined water retention basins which serve the purpose of allowing running water to pool up and soak into the surrounding soil, where it is gradually used by the adjacent plant materials over the days that follow.

The Saddlebrooke landscape has now been in existence for just under two years, and in that the time the visible effect of the enhanced water harvesting is astonishing. The water retention basins have become the site of abundant populations of volunteer perennials and wildflowers. This presentation will be a photographic document of the creation and evolution of this landscape and its rain water harvesting features.

2.46 First Flush Control For Urban Rainwater Harvest Systems

Che wu

Li junqi

Liu Yan

Wang Wenhai
Beijing Institute of Civil Engineering and Architecture, 100044 Beijing, China

Liu hong

Meng guanghu

Wang hongling
Beijing Urban Water Conservation Office, Beijing, China

Abstract

First flush control is a very important measure to control water quality of urban rainwater harvest system due to the pollution of rainwater in urban area. This paper analyzes the regularity of runoff flush to pollutants on roof and road surfaces, introduces an effective facility of first flush control, which was designed based on a lot of measurements and the analysis, and it's applications in several rainwater utilization projects in Beijing.

Key words : urban rainwater, harvest system, first flush, water quality control

3 SOCIO ECONOMIC ASPECTS OF RAINWATER HARVESTING

3.1 Community-Based Watershed Management: An Initiative In The Philippines

By Jessica Calfoforo Salas, M.B.A., Ed.D.[2]
Secretary-General, International Rainwater Catchment Systems Association
President, Philippine Watershed Management Coalition

For the past years, the focus of efforts of International Rainwater Catchment Systems has been the provision of a venue for exchange of information on utilization of rain for domestic use, agricultural use, commercial and industrial use. As the members became aware of the value of rainwater catchment systems as an environmentally sound technology, the issue of management and governance also became prominence. Part of the realization comes from the notion that management and governance, not scarcity, is the problem of water. According to the Prince of Orange, Willem Alexander, “The water crisis that is affecting so many people is mainly a crisis of governance, not water scarcity.”

To introduce this paper, watershed is simply defined as a land area bounded by ridges that form a catchment and create streams and rivers to allow water to flow to the sea or to another body of water. The river basin is a larger catchment composed of several microwatersheds. While the river basin stretches out over land crossing political boundaries until it reaches the sea, it is not only a case of head to tail. It includes short and long tributaries on the side that defines and redefines the character of the main river as the latter moves to its destination. Usage of these three terms vary in different places – watershed, river basin, and catchment. Watersheds may be large, medium, small or micro catchments. For the purposes of reading this particular paper the use of these terms are clarified.

3.2 Micro-Dams For Rain Water Catchment And Reclamation Of Degraded Areas - A, B C And D, Mobilization Phases

L. C. Barros[1]
cordoval@cnpms.embrapa.br Phone: + 55(31)779-1107 - Fax: + 55(31)779-1088, EMBRAPA - Caixa Postal 151, 35701-970 Sete Lagoas - MG, Brazil

Abstract

The accelerated and disorganized deforestation in Central Brazil and the transformation of these natural ecosystems into crop land or pastures, without adequate technologies, resulted in irrecoverable damages to the environment, especially with respect to water and soil conservation, with particular mention to compactation. As a consequence, the soil intake rate decreased and surface runoff increased, thus causing laminar erosion, low soil quality, silting up of rivers, floods and decreased sustainability of family properties.

With the objective of reverting this scenario, a demonstrative unit was implemented in Sete Lagoas MG, (1,350mm rainfall per year), with a predominance of”cerrado”(savannalike) areas, with porous deep acid soils, pH - 4,0 - 5,5, in 1995, in a property of 70 ha, where 30 micro-cachments

("barraginhas") were built to contain surface runoff damages.These micro-catchments also retain pollution sources carried by the waters and favor the recharge of good quality water tables, by means of improving soil intake rate, recovering water sources and alleviating droughts.

Due to the success of this demonstration unit, by means of field visits by farmers, NGO´s and publication of articles in journals and national/international congresses, a decision was taken to extend the experience and build the Pilot with 960 low-cost microcatchments, in 1998, in 60 small properties covering all the micro-basin of the Paiol stream (included in the São Francisco river basin), in the Community of Estiva. To present, that unit received 32 visits, with approximately 1,200 people, among extension service staff, rural communities and private organizations. That first contact of the public with this technology is called Phase A. Phase B (visit to the pilot) and Phase C (training), takes place in the communities, where 32 training events were conducted, And finaly Phase D consist of the field days at the villages or towns that have been mobilized, as a kind of celebration event for the constrution the 100th or 200th micro-catchment. Today, the pioneering region, has more than 10,000 micro-catchment.

Keywords: microcatchments, land degradation, infiltration, intake, Paiol.

3.3 Community Rainfed Water Supply Systems For Multiple Purposes

Mario Héctor Basán Nickisch
Ingeniero en Recursos Hídricos, Master en Ingeniería de Regadíos, Calle Bélgica 1907 – Barrio Los Inmigrantes, (4200) Santiago del Estero, Argentina, TE / FAX: 0054-385-4224430/4730/4596 interno 33 (INTA), TE: 0054-385-4224925 ó 0054-0385-156097162 (particulares), E-mail: mbasan@correo.inta.gov.ar o mariobasan@hotmail.com.

Summary:

This paper describes water supply systems that handle rainfall along with other sources of water in arid and semiarid environments. The objective of these systems is to definitely solve the dryland farmers problem of insufficient quality and quantity of water for human and livestock consumption and for irrigation of vegetable gardens and forage crops.

Historically, towns and settlements in arid and semiarid regions of northwestern Argentina have relied on wells and/or taken advantage of rainfall to supply water into community reservoirs. However, it has been demonstrated that in this type of systems water quality and quantity is not enough for fulfilling year-round demands because their little holding capacity. They soon dry out, specially during the months of higher demands. When this happens, people have to supply water manually from the wells, 3 to 8 hours per day. Sometimes, water of doubtful quality has to be bought at very high prices. Scarcity of water also cause reduction of the herd size or weight loss in animals.

In order to solve this problem, the Instituto Nacional de Tecnología Agropecuaria, a federal agency, developed water supply systems whose primary aim was to improve the traditional systems described above. Due to the precarious infrastructure, systems have simple designs, are cost effective, time enduring and easily adopted by the farmers. They also build the supply systems themselves.

The improved water supply systems are composed by:

- a rainfall catching area;

- an input area, consisting of a sediment decanter and an energy dissipater;
- one or several water reservoirs;
- one or several wells, located near the reservoirs;
- water mills and/or pumps, that use some source of renewable energy;
- water towers;
- slow speed filters;
- chlorine dosifiers;
- water troughs for livestock;
- drip irrigation facilities;
- fencing.

Introducción

Las poblaciones rurales de secano en regiones semiáridas y áridas del noroeste argentino históricamente se han abastecido de represas o balsas alimentadas por agua de lluvia y de pozos calzados o perforaciones para explotar el agua subterránea, dependiendo de los períodos hidrológicos y de la época del año.

Salvo honrosas excepciones, este tipo de sistemas ha demostrado falencias, ya sea en cantidad y/o calidad del agua disponible para suplir las demandas durante todo el año, ya que por lo general las represas tienen escasa capacidad y sistemáticamente quedan sin agua durante los meses de mayor demanda (junio-noviembre), mientras que la calidad hidroquímica de los pozos no permite o dificulta la utilización para determinados usos.

Cuando las represas quedan sin agua los pobladores deben “baldear” manualmente 3 a 8 horas promedio diarias de los pozos anteriormente mencionados para cubrir la demanda de sus animales y del consumo propio, o en su defecto, comprar el agua de camiones cisterna.

Según encuestas realizadas por el Instituto Nacional de Tecnología Agropecuaria (I.N.T.A.) en el Sector, el problema del agua es prioritario, y para suplir esta falencia necesariamente deben comprar agua a precios elevados con dudosas garantías de calidad, o disminuir el número de animales, o soportar pérdidas de peso en las majadas y rodeos.

Otro problema no menos grave que se detectó fue la falta de infraestructura necesaria de las represas para preservar la calidad del agua: alambrados perimetrales, y obras hidráulicas complementarias a la misma para mantener el volumen útil de almacenamiento.

3.4 Limitantes Técnico-Constructivas, Socioeconómicas, Culturales Y Políticas En La Construcción De Bordos En Tres Comunidades Del Río Temascatío, Estado De Guanajuato.

Gaiska Asteinza Bilbao
Profesor Investigador. Departamento de Fitotecnia. Universidad Autónoma Chapingo, México. C.P. 56230. E mail: mercedes@colpos.mx

Mercedes Jiménez Velázquez
Profesora Investigadora. Especialidad en Estudios del Desarrollo Rural, Instituto de Socioeconomía, Estadística e Informática. Colegio de Postgraduados en Ciencias Agrícolas, Montecillo, México. C.P. 56230. E mail: mercedes@colpos.mx

Introducción.

La Secretaría de Desarrollo Agropecuario y Rural de Guanajuato (SEDARG) en 1996, establece el Programa Estatal de Bordería con el propósito de aumentar la capacidad de almacenaje de agua de lluvia para fines múltiples en áreas de ganadería extensiva. En 1999 se intensifica en la parte alta del río Temascatío, municipios de Salamanca e Irapuato. En el 2001, se realizó una evaluación preliminar de los bordos y al encontrar un sinnúmero de fallas: alto porcentaje de bordos fracturados y fisuras, mínima retención de agua aún en periodo de lluvias; se consideró importante permenorizar causas de tales hechos. El objeto de estudio fue el Programa de Bordería, abordado como proceso de transferencia de técnicas para cosechar agua en bordos de comunidades rurales. El interés: abordar aspectos de conceptualización, presupuesto, operación, administración, ejecución, adopción e impacto del programa; además, fallas y efectos negativos de la mala ejecución de los bordos, enfatizando aspectos económicos y sociales, partiendo del concepto de transferencia de tecnología (Molnar, J. 1986:92-95) Establecer bases para sugerir procedimientos y acciones que mejoren resultados del programa. Considerando que la sobreexplotación de recursos naturales en el área de estudio ha conllevado a la destrucción de vegetación, pérdida de suelo y subutilización del agua, y de no adoptarse formas sustentables de manejo agropecuario, la pérdida irremisible de vegetación que ha sido reportada, proseguirá en forma más acelerada (Asteinza, G., M. Jiménez, 2002: 39-43)

3.5 Empowerment Of Rural Communal Farmers In South Africa Through The Application Of In-Field Water Harvesting

John J. Botha

Leon D. van Rensburg

Jan J. Anderson

Malerata Macheli
ARC - Institute for Soil, Climate and Water, Private Bag X01, Glen, 9360, South Africa, Tel. + 27 51 861 1172; Fax + 27 51 861 1328; E-mail botha@glen.agric.za

Godfrey Kudhlande
Department of Agricultural Economics, University of the Free State, Bloemfontein, 9300, South Africa

Abstract

Poverty and food insecurity is generic to the rural communities of poor countries in the Sub- Saharan African region. South Africa, with its huge rural population is not excluded from the adversity of poverty. In the semi-arid areas of Southern Africa water and soil fertility are the main factors limiting food production. Developing communities are the most seriously affected by the resultant unsatisfactory level of food security and sustainability, which prevails in these areas. This contributes to poverty in the rural areas.

A large area east of Bloemfontein (750 000 ha), sometimes termed the resettlement area, has been earmarked for developing farmers. A recent socio-economic survey in the Thaba Nchu district showed that the average consumption expenditure for a household is R278 per month. The equivalent poverty line for a household in the Free State that comprises of 5 members (including 3 adults) is R711 per month. In order to eradicate poverty it is clear that the consumption should increase with more than R5000 per household per year. The challenge is how?

The climate can be summarized as semi-arid, with a rainfall of 550 mm per annum and a potential evaporation of 2244 mm. Ninety percent of the rainfall events are less than 10 mm, which account to approximately a third of the total rainfall. Most of the rain events higher than 10 mm are erratic and normally have high intensity resulting in significant runoff from the clay soils. Crusting of the soil surface also aggravates losses through runoff. Results showed that runoff on these types of soils without surface residue (bare soil) can amount to 40% of the annual rainfall.

The ability to collect or harvest rainwater empowers women and men in many countries of the world to secure the livelihood of their families. It is proving a vital as pect of the fight against poverty. Rural communities can benefit largely from the use of the in-field water harvesting technique (IWHB) developed by the Institute of Soil, Climate and Water at Glen. The technique has undergone intensive research by the Institute for the past six years at Glen (on-station) and also in the Thaba Nchu and Botshabelo area (on-farm) with remarkable success from a scientific point of view.

The question that had to be answered was whether this technique would be applicable to the farmers in the target area. The aim of this study was to demonstrate and implement the technique in the villages around the two towns of Thaba Nchu and Botshabelo. During the 2001/2002 growing season demonstration plots were used to demonstrate the technique in a few villages and on a trust farm. The outcome has been impressive. To date, farm households from seven villages and one on the trust farm,

for example, have employed the technique successfully. At a recent water harvesting festival, members from twenty different villages in the resettlement area attended. Most of them want to prepare their fields to apply the IRWH technique.

3.6 Evaluating The Agronomic Sustainablity Of Mulching Of The In-Field Water Harvesting Crop Production System

John J. Botha

Jan J. Anderson

Leon D. van Rensburg

Malerata Macheli
ARC - Institute for Soil, Climate and Water, Private Bag X01, Glen, 9360, South Africa Tel. + 27 51 861 1172; Fax + 27 51 861 1328; E-mail botha@glen.agric.za

Malcolm Hensley
Department of Soil, Climate and Crop Science, University of the Free State, Bloemfontein, 9300, South Africa

Abstract

Dryland crop production in South Africa is liable to short seasonal or long annual droughts that lead to uncertain yields and frequent crop failures. There is a great need therefore to quantify risk and improve the rainfall use efficiency (PUE) by employing appropriate production techniques. A large area east of Bloemfontein (750 000 ha), sometimes termed the “resettlement area”, has been earmarked for developing farmers. The area is marginal for crop production. There are two reasons for this (a) low and erractic rainfall (520 mm to 600 mm per annum) and (b) dominantly clay soils on which the PUE is low due to high runoff (R) and soil evaporation (Es) losses.

Intensive field experiments on clay soils at Glen and Thaba Nchu demonstrated over a period of three years that, compared to conventional production techniques, the in-field water harvesting production technique could increase maize and sunflower yields by as much as 50%. The superiority of water harvesting is largely ascribed to soil crusting enhancing runoff from the twometre runoff strip towards the one metre basin strip. The accumulated water in the basin infiltrates the soil at its own rate; stopping runoff completely and maximizing infiltration with resultant lower evaporation rates and more plant available water.

Despite increased yields, two problems were observed, namely high evaporation losses in the basins and on the runoff strip as well as soil transportation towards the basins. The hypothesis was that mulches could alter the runoff process towards the basins to restrict soil movement and evaporation over the long-term. Various combinations of organic and stone mulches were experimented with to quantify their effects on the runoff area and in the basins. Results showed that mulching can further increase yield due to better R and Es control during and after a rainfall event. All the treatments with mulch in the basins as well as on the runoff area increased maize crop yields and PUE and decreased Es. This paper discusses the influence of different mulching techniques in a water harvesting crop production system in terms of yield, PUE and Es.

3.7 Reception Of Waters Of Rain, Strategy For The Balance Ecological And The Development

Captación De Aguas De Lluvia, Estrategia Para El Equilibrio Ecológico Y El Desarrollo

Arq. Rubén Camacho González

Ing. Alfonso Torres Ramírez

Water and environment

The rain play a main paper in the determination of the climate of any geographical area of the earth, it is the only source of renewable water that recharges the storage underground and it feeds to the rivers and channels. Recently new proposals have been developed, so much of the public sector as of the private sector guided to capture the rains directly, using the constructions or urban equipment.

The caused environmental alterations have worried the governments of the world who already took conscience of the necessities of carrying out a planning for a more balanced development that is based on the respect to the nature and the man's survival like species, maintaining appropriate levels of life.

The retrospective of the environmental conditions of the State of Mexico, show the forest and lacustrine deterioration that affect the atmospheric and environmental conditions of this region that perturb the hydrological cycle of the water, and for consequence the readiness of water in the State. The shortage of water particularly in the Valley of Mexico it is eminent, the consumptions are based for the most part on water of the aquifer that is sobreexplotado and of the superficial waters of the Cutzamala.

With sadness we see that our negligences and the wrong use of our natural resources has even brought I get the alteration of the ecosystems, the disappearance of animal and vegetable species, the decrease of the aquifer mantels, the impoverishment of the floor, the contamination of the water and air that alter the operation of the hydrological cycle of the water.

To take advantage of the water and to guarantee the development of future generations, it is important to promote alternative projects of supply, as capturing rain waters in constructions like residence developments, schools, public buildings, parkings and roadway. The experiences in this field are few and fragile for what is necessary of a bigger investigation, including theoreticalpractical activities; defined the quality and uses of the water, available spaces for their storage, period of rains of each region, the quantity of economically viable stored water and to identify areas of possible recharge of water to the aquifer.

Agua y Medio Ambiente

Las precipitaciones juegan un papel principal en la determinación del clima de cualquier zona geográfica de la tierra, es la única fuente de agua renovable que recarga los almacenamientos subterráneos llamados acuíferos y alimenta a los ríos y canales. Recientemente se han desarrollado nuevas propuestas, tanto del sector público como del sector privado encaminadas a captar directamente las lluvias, utilizando las edificaciones o equipamiento urbano.

Las alteraciones ambientales ocasionadas han preocupado a los gobiernos del mundo, quienes ya tomaron conciencia de las necesidades de llevar a cabo una planeación para un desarrollo más equilibrado que se base en el respeto a la naturaleza y a la supervivencia del hombre como especie, manteniendo niveles adecuados de vida.

La retrospectiva de las condiciones ambientales del Estado de México, mostran el deterioro forestal y lacustre que afectan las condiciones atmosféricas y ambientales de esta región, que perturban el ciclo hidrológico del agua, y por consecuencia la disponibilidad de agua en el Estado. La escasez de agua particularmente en el Valle de México es eminente, los consumos son basados mayoritariamente en agua del acuífero que se encuentra sobreexplotado y de las aguas superficiales del Cutzamala.

Con tristeza vemos que nuestros descuidos e incluso el mal uso de nuestros recursos naturales ha traído consigo la alteración de los ecosistemas, la desaparición de especies animales y vegetales, la disminución de los mantos acuíferos, el empobrecimiento del suelo, la contaminación del agua y aire que alteran el funcionamiento del ciclo hidrológico del agua.

Para aprovechar el agua y garantizar el desarrollo de futuras generaciones, es importante promover proyectos alternativos de suministro, como captar aguas de lluvia en edificaciones como desarrollos habitacionales, escuelas, edificios públicos, estacionamientos y vialidades. Las experiencias en este campo son pocas y frágiles por lo que es necesario de una mayor investigación, incluyendo actividades teórico-prácticas; donde se defina la calidad y usos del agua, espacios disponibles para su almacenamiento, periodo de lluvias de cada región, la cantidad de agua almacenada económicamente viable e identificar zonas de posible recarga de agua al acuífero.

3.8 Reduccion Del Escurrimiento Procedente De Construcciones Mediante Naturacion En El Valle De México.

H.J.Henze

G. Navas

M. Siemsen

U. Grau

Tapia O.

Introduction

El actual proceso de urbanización alrededor del mundo, ha causado que la población de los centros urbanos, sea en estos momentos, el mayor componente de la población mundial. Dicho desarrollo urbano ha ido acompañado del sellamiento progresivo (casi total) de la superficie y espacio de los biotopos urbanos, por lo tanto también de la pérdida paulatina del espacio natural, el cual, desde un punto de vista urbano-ecológico es muy importante para las mismas ciudades. Las consecuencias de este proceso de alta urbanización han originado un trastorno en los parámetros urbano-ecológicos: aumento en la contaminación del aire, del ruido, distorción en la economía hídrica urbana, desarrollo circadiano de la temperatura y de la humedad del aire. En países industrializados la pérdida de calidad de vida conectada con dichos trastornos ha originado un proceso de migración de la ciudad hacia fuera de esta. Aunque en algunas regiones aún se sigue dando el proceso de migración del campo a la ciudad, a pesar de la intensificación de las tendencias negativas provocadas por el desarrollo urbano intermitente y no regulado. La ciudad de México, es un ejemplo de esto último, es decir, de una tendencia en aumento del detrimento del desarrollo urbano-ecológico.

3.9 Rainfall Characteristic And Rainwater Utilization Measures In Hebei Plain

Yang Luhua
Associate professor, doctor in Wuhan University, 430072, P. R. China;

Chai Chunling

Gao Huiyan
Engineer in Agricultural University of Hebei, 071001, P. R. China

Abstract

Environments are deteriorating because of water resources severe scarcity in Hebei plain, and it has practical significance to make use of rain. The rainfall characteristic in Hebei plain were analyzed, it is characterized by seasonal rain, uneven spatial and temporal distribution, alternative flood and drought. The process of rainfall resourcefulization was studied from the viewpoint of hydrology and the connotation of rainwater utilization was also discussed in the paper. Rainwater in urban region are collected together for household use, Greenland irrigation, public facilities, man-made lake, etc. the main purposes of rainwater utilization in rural region prefer to agriculture irrigation, groundwater recharge, household use, etc. The environment impacts of rainwater utilization were also summarized finally.

Key word: Rainwater exploitation; Hebei plain; utilization pattern

3.10 Water For Akole Taluka, Maharashtra State, India

Frank Simpson,
University of Windsor, Canada,

Girish Sohani
BAIF Development Research Foundation, India

Abstract

The University of Windsor and BAIF Development Research Foundation worked with the tribal and rural people of Akole Taluka to design a strategy for access to a year-round water supply. Three villages, comprising 494 households, were selected as partners. Participatory management and evaluation were essential components of the project.

Water-harvesting and -spreading technologies were put in place at demonstration sites over an area of 1,000 ha. Fourteen masonry check-dams and 3 ferrocement gabions provided about 73,000 cu m of water for the partner villages and outlying areas. Twenty-six households utilized roofwater-harvesting systems. Up to 20 percent of households took water from six developed springs. Several dug wells were deepened and existing bore wells received workovers. The increase in water availability during the pre-monsoon period was about 750 l/d per capita. Runoff was diverted into shallow aquifers, by means of expanded terracing of hillsides, combined with systems of contour trenches and soil bunds, as well as 19 farm ponds. Infiltration pits were excavated, most notably on unterraced hillslopes.

Soil conservation in support of water-resource management involved the use of 75 gabions, 75 drystone bunds and 6,550 gully plugs. These measures averted erosion losses of up to 150 tonnes of soil per hectare. Grasses, such as vetiver, also were used as barriers across some slopes. Productive,

multipurpose tree species and shrubs were planted on agricultural lands, along selected soil bunds. Areas of wasteland were converted to pasture.

The demonstration sites satisfied the domestic water needs of the people. The increased soil moisture brought improvements to agricultural production. The project results are sustainable. The lessons learned were incorporated into workshops on watershed management for BAIF personnel, working in other parts of India.