# Abstract Volume

World Water Week
in Stockholm
23-28 August, 2015

Water for Development

SIWI WORLD WATER WEEK

# ABSTRACT VOLUME

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## Workshop 4:
## Freshwater Ecosystems and Human Development

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# Workshop: Freshwater Ecosystems and Human Development





# Reducing Nutrient Loads from Agriculture Using Pay-for-Performance Conservation

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Keywords: Nutrients, Agriculture, Eutrophication, Incentives, Market Mechanisms

## Introduction and objectives

Agriculture remains one of the leading contributors of nonpoint source (NPS) pollution to ground and surface waters around the world. Eutrophication and hypoxic zones cost billions of dollars annually and impair the use of surface water for millions of people.

Objectives:

- Present innovative approaches to address agricultural nutrient loads to water
- Display cutting edge applications of information technology to reduce nutrient loss from farm land
- Discuss economic incentives to motivate farmers to take action to reduce nutrient losses

## Methodology approach

The most challenging aspect to pay-for-performance conservation is accurately quantifying field-specific nutrient losses. Nutrient losses cannot be practically measured from each field. Using a constant coefficient for N or P loss reduction from a given BMP is useless, given the huge variability nutrient source and transport factors in each field, and would undermine the value of a pay-for-performance system. Our pilot-testing of pay-for-performance conservation has led us to the solution of modeling nutrient losses at the farm-level, which triggers a primary incentive payment, and water quality measurement at the watershed-level, which triggers a secondary incentive payment to participating farmers.

## Analysis, results, conclusions, and recommendation

The results from this pilot-testing work in Vermont indicate that an average of 0.24 lbs. of P loss can be reduced per acre per year from the simple actions that are good business decisions with a $25 per lb. incentive payment. The results from identical work in Iowa were much more striking; a $10 per lb. incentive payment was able to induce a 0.88 lbs. per acre per year reduction in P loss. These reductions are an average from across all of the participating farms’ acres, not just the acres on which changes were made.

Assuming that the Vermont result is representative across the larger Missisquoi River watershed, pay-for-performance conservation, using a $25 per lb. payment, would be able to reduce over 9 metric tons of P loss per year. This represents over 37% of the reduction required by agriculture in the watershed under its P TMDL. The initial evidence indicates that pay-for-performance conservation has the ability to motivate more farmers to implement conservation in an effective manner and to reduce nutrient losses from agricultural land in a much greater way than has been previously seen.

With pay-for-performance conservation, farmers profit from finding and implementing the most appropriate and cost-effective actions specific to their farm and fields. This profit motive induces innovation by farmers to use their knowledge and creativity to develop solutions that work well at the least cost. This same motivation to capture profits is the single most important aspect of a market economy

and what drives continual advancements in productivity. Unfortunately, this has been completely lacking in the delivery of our current conservation programs. Pay-for-performance conservation turns this around by harnessing the power of farmer ingenuity to solve problems through the profit motive.



# The contribution of wetlands to sustainable urban development

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Keywords: climate change, freshwater ecosystems, human development, SDGs, urban wetlands

## Introduction and objectives

Projections for 2025 suggest urban settlements will house 70% of the world's population, with large cities in developing countries accounting for more than 90% of future population growth. This will increase pollution loads and physical encroachment on urban and peri-urban wetlands, affecting ecosystem integrity, public health, and flood and climate resilience. The opportunities that wetlands provide for sustainable cities are, however, frequently overlooked or overwhelmed by the rapidity of changes. Better understanding and quantification of wetland ecosystem services in urban areas and dissemination of this knowledge is urgently needed to develop policy and its integration into urban planning.

## Methodology approach

"Wetlands and Urbanization" pilot projects implemented by the Ramsar Convention and UN-Habitat assessed the ecological and social impacts of urbanisation in Ghana, Senegal and Togo, providing an evidence-based framework for integrating wetland management into urban policy. The international Wetlands Forum in Rwanda in 2013 launched the Wetlandsforum.net initiative, as a platform for sharing knowledge on wetlands and support capacity development for their wise-use. These initiatives embrace holistic approaches connecting water, climate, biodiversity, poverty alleviation and health. Lessons learned support dialogue and integrated action on coastal and riverside urban wetlands to inform future directions for sustainable development.

## Analysis, results, conclusions, and recommendation

The uncontrolled expansion of the three coastal cities of Ga Municipality in Ghana, Somone in Senegal and Aneho in Togo heavily impact forests and freshwater ecosystems, increasing water pollution and disease. Wetland loss impacts socio- and cultural well-being and exacerbates infrastructural challenges and the effects of climate change.

The wetlands benefits to local communities in the pilot cities include supporting diverse livelihoods, mitigating impacts of flooding and providing a rich habitat for biodiversity; benefits within urban and peri-urban environments that are often not fully recognized.

The pilot projects, and the Ramsar Convention resolutions on "wetlands and urbanization", "wetlands and climate change" and "wetlands and health", underline the need to link local governance, ecosystem services, poverty alleviation, health, education and adaptation to climate change, for wetland management. The case studies on rapid urbanisation impacts show that wetlands in urban areas provide an integral part of a sustainable future.

Human society inevitably shapes the development of towns and cities. More explicit recognition of the benefits provided by wetlands, improves urban planning , decision-making, and livelihoods and making

cities more sustainable and pleasant places to live. Preserving urban wetlands from encroachment and restoring degraded or lost wetlands will contribute to the zero-draft of the SDGs calling for a 15% increase in wetlands, which clearly identifies their importance for sustainable development.

Africa has more than 60 international river basins, covering 64 % of its land area and home to 77% of the continent's population. It is also estimated that Africa counts more than 320 coastal cities with more than 10,000 inhabitants. With this scale of importance, incorporating wetlands ecosystems into policy and plans to adapt to the inevitable expansion of cities is important for both better protection of freshwater ecosystems and the human societies that depend on them.



# Restoring Lake Prespa - Common Vision to Long-term Success

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Keywords: watershed management, wetland restoration, cross-sectoral engagement, phosphorus, adaptive management

## Introduction and objectives

Since 2004, the goal of UNDP's Lake Prespa Restoration Programme has been to restore the health of the ecosystem. A broad set of objectives includes strengthening the regulatory and planning base, developing scientific datasets for decision-making, prototyping new management and restoration strategies, and sharing lessons learned. The Programme is a unique partnership of local and national governments, stakeholder groups, and international partners (UNDP, GEF and Swiss Agency for Development and Cooperation). Early emphasis on cross-sectoral participatory engagement built strong support for a common vision and helped change a centralized system of water management into a decentralized system of governance.

## Methodology approach

Building on initial pollution reduction successes, since 2012, the focus has been on restoration to optimize social and ecological benefits. Using social and scientific data gathered to date and ideas generated by multiple stakeholders, the approach includes design of an engineered wetland that will treat municipal waste and floodwaters, and coupled watershed and lake models that will help target a combination of additional interventions for achieving the greatest water quality benefits. The models are examining 4 primary scenarios and will be applied in concert with local considerations to help determine the mix of additional investments.

## Analysis, results, conclusions and recommendation

The engineered wetland was designed after a comprehensive analysis of physical, chemical, biological, land use, and socioeconomic data. Various options were ranked using an evaluation scheme that scored according to predicted phosphorus reduction, water storage potential, ancillary benefits for biodiversity, costs, municipal priorities for land use, and social acceptability of the design on the landscape. Initially the lake and watershed models are being used to simulate the phosphorus reductions that can be achieved from combinations of wetland restoration, fertilizer application management, irrigation practice management, and orchard waste management.

These scenarios were selected based on the interests of the stakeholders and the actions with the greatest potential to meet water quality goals. The results of the modeling will be presented to the stakeholders for final selection and preparation of implementation plans. A long term lake and watershed monitoring program is gathering data that will document improvements and inform an adaptive management approach. The monitoring team and laboratory is being institutionalized as part of the municipal government and local scientists will continue to use and refine the model as new data become available.

One of the most important factors in the longevity and success of the Lake Prespa Restoration Programme has been the close involvement of the stakeholder community through several cross-sectoral

watershed management mechanisms. The Prespa Lake Watershed Management Council, for example, represents the competing interests of over 25 groups affecting or affected by water, including water users and polluters. It has provided a forum for discussing water issues, overcoming conflicting interests, creating a common vision, and prioritizing interventions, from early actions to improve best practices, to the implementation of a complex and comprehensive restoration strategy. The Lake Prespa Restoration Programme is a model for long-term adaptive management around the globe.



# Hyper-Eutrophicated Reservoir and Sustainable Water Stewardship in Semi-Arid Region

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Keywords: Agricultural watershed, Ecological indicators, Invasive species, hyper-eutrophicated reservoir, sustainable water stewardship

## Introduction and objectives

Krishnagiri reservoir (KR) is located in an agricultural watershed, one of the drought prone zones in Tamilnadu, India. It is the only freshwater resource in the district and it plays a vital role in supplying water to the command area. It is severely affected by soil erosion and sedimentation problems. Thus its capacity was reduced from 66.10 $Mm^3$ to 39.26 $Mm^3$ in the last five decades. Inflow of agricultural runoff into KR resulted in accelerated eutrophication and subsequent reduction in ecosystem services. The present study is focused on ecosystem approaches for restoration and sustainable water stewardship of KR.

## Methodology approach

Water and sediments were collected and analysed from fifteen different locations of KR to study the physio-chemical parameters and nutrients for the period of 12 months. Ecological indicators chlorophyll a, phytoplanktons, fish yield data and Carlson's Trophic State Index (TSI) were selected to study the trophic status and cyanobacterial bloom. Experimental study was also carried out to find out the release rate of nutrients from the bottom sediments under present environmental conditions. PRA tools were used to collect socio-economic data from farmers, stakeholders, government officials and fisher men. Data analyses were carried out by using SPSS 16.0 software.

## Analysis, results, conclusions and recommendation

Water and sediment quality at the inflow point of KR clearly revealed the inflow of high load of both suspended and dissolved phosphorus from the watershed. High organic matter at the inflow point during summer season clearly indicates the inflow of organic rich untreated sewage disposal from the upper catchment.

Overall total phosphorus concentration in sediments was very high and highest (13.6 g kg-1) was observed at the dam site. Experimental study revealed that KR was acted as a sink for phosphorus in the past four to five decades and at present they are acting as a source for phosphorus. Carson's TSI was ranged between 71 and 84 and KR was ranked as hyper-eutrophic category. Reduction in crop productivity was observed due to water logging and salinity problems of KR water. There are 27 units of fishermen engaged in fishing in KR and it is the sole livelihood option for some of the fishermen in the units.

It was observed from the fish yield data that there was a greater reduction in the fish varieties and only three varieties of major carps Catla, Rohu and Mrigal and Tilapia are available at present. Invasive species includes African Tilapia fish, cyanobacteria, zebra mussels etc were identified during the study period in KR. This clearly depicts the impact of agricultural pollutants in the reservoir. To achieve

the goal of restoration of KR, the present research recommends development and implementation of numeric nutrient criteria for inflow water and enforcement of treatment of at source in the upstream side and algal harvesting. To achieve a sustainable water stewardship in KR economic instruments have to be provided in the forms of incentives and financial support to farmers in the catchment area to encourage soil conservation methods and organic farming.



# Ecosystem Based Adaptation: Sustainable Water Use in Urban Area

Author: Dr. Arvind Kumar, India Water Foundation, India

Keywords: Climate Change, Ecosystems, Water Scarcity, Urban Growth Impact, India

## Introduction and objectives

Ecosystem Based Adaptation addresses the crucial links between climate change, biodiversity, ecosystem services and sustainable resource management. Indian cities are expected to add 440 million more people by 2050. India has a population of 1.27 billion plus, and growing. Water Availability in India total precipitation 4000 BCM, water availability 1869 BCM, utilizable water resources 1123 BCM. To accommodate rapid urbanization, the Government of India has allocated USD 1.2 billion in fiscal year 2014-15 to build 100 new smart cities, and to develop satellite towns around existing cities and failure to tackle them successfully can have national and regional implications.

## Methodology approach

The analysis is the outcome of field research on linkages between the practice of Ecosystem Based Adaptation and sustainable water use in Urban Areas-to improve human living conditions and livelihoods and maintain biodiversity in urban/peri-urban areas. Need of Eco-sustainable integrated approach in water infrastructure development to achieve ecological & economic efficiency and Eco-efficient water infrastructure require shift in policies to integrated water supply, rain water harvesting, waste water treatment and recycling and flood control measures for sustainable urban planning.

## Analysis, results, conclusions and recommendation

Climate change impacts such as water scarcity can influence cross cutting sectors: e.g. agriculture, forestry, natural resources, energy and the economy, climatic factors (changes in rainfall patterns) and non-climatic stressors (deforestation, inadequate agricultural practices, etc.) will negatively affect urban communities, resulting in: i) decreased food security; ii) decreased water security; iii) inadequate sanitary conditions; iv) increased health risks etc.

Our findings demonstrate that effective institutional mechanismsare essential for successful sustainable urbanization in South Asia. Ecosystem based adaptation and sustainable water use in urban areas is linked with the degree of institutionalization, political will, infrastructure and networking. The development of infrastructure for treatment and reuse of discharged water is often lagging way behind the withdrawal of fresh water raising local issue with predominantly local solutions.

Ecosystems within urban areas – including wetlands, green spaces, agricultural land, coastal areas and woodlands – provide protective, recreational, and cultural benefits while improving the aesthetics of cities. These have enormous consequences on human health and well-being, safety, the environment, economic growth and development. Water has assumed unprecedented significance in South Asian development discourse. Its availability, consumption, distribution and impact on people's lives and livelihoods is closely associated with the region's major challenges in the present and future.

Green Mission: Meghalaya,Mission is designed to give leverage to the comparative advantage that Meghalaya has in that sector, to generate livelihood opportunities for every household and to accelerate growth and Capacity-building of sector and Actor through sensitization, incentivization and galvanization; for e.g. Enhancing sustainable green cover, Adoption of green technologies, Building up a green movement etc.



# Valuing Watersheds for Sustainable Development

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Keywords: ecosystem services, multiple benefits, human well-being, sustainable development, aquatic ecosystems

## Introduction and objectives

Healthy watersheds and freshwater ecosystems provide multiple ecosystem services that underpin economic development and human well-being. One of society's biggest challenges is to sustain these ecosystems while also managing them to maintain the suite of benefits that are needed for economic development. Better tools are needed to plan and manage development so that benefits are equitably shared, and trade-offs between development and ecosystem health can be transparently assessed and managed. We present a practical approach and set of tools that can be used to evaluate multiple benefits - particularly when detailed data in a watershed are lacking.

## Methodology approach

We present an approach for developing a comprehensive yet practical framework for assessing the multiple values provided by watersheds and freshwater ecosystems, using a combination of available biophysical data, scientific literature, best local knowledge - scientific and traditional, as well as through the participatory engagement of stakeholders. Inclusive categories of beneficiaries in a particular watershed are identified, beneficiary working groups define and rank a set of most valued ecosystem services. These values are linked to the landscape by identifying contributing ecosystems or land uses and ecological functions. Mapping allows areas important for service provision to be identified in development scenarios.

## Analysis, results, conclusions and recommendation

Applying this approach in the context of alternative development scenarios allows benefits in terms of water-related and other services to be evaluated in several ways.

We can look at how economic benefits are shared among different groups in the watershed; how development - for example allocating water across agriculture, industry, and urban users - impacts freshwater systems and the provision of ecosystem services; who benefits the most from maintaining ecosystem services; and how watershed management choices can enhance ecosystem freshwater health and livelihoods.

We illustrate the approach with applications in watersheds from different contexts - tropical Andes, coastal Mexico - and show how this approach supports the design of payments for ecosystem services that protect freshwater systems while also enhancing livelihoods. a strength of the approach is that decision frameworks can be developed at different levels of detail and quantification - depending on available data. In watersheds with little biophysical data, a general conceptual model based on stakeholder and expert knowledge can be used to make decisions - particularly in an adaptive management framework.

More predictive, quantitative models can be built on this foundation as more data become available. Early conceptual models can also be used in conjunction with hydrological models (SWAT) or ecosystem service models (INVEST) when these are available. Relatively simple yet rigorous decision frameworks can be developed, even in the absence of detailed quantitative data on ecosystem services, which allow communities and watershed managers to transparently assess the outcomes and impacts of alternative development scenarios - and make better decisions in balancing the water demands of economic development, ecosystems, and sustainable local livelihoods.



# Cumulative biophysical impact of small and large hydropower development

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Keywords: small hydropower, ecological impact, reservoir sediment management, ecohydraulics, decentralized energy, rural electrification, Clean Development Mechanism ower, water supply, cost reduction, energy management

## Introduction and objectives

Support for low-carbon energy and opposition to new large dams encourages global development of small hydropower facilities. This support is manifested in national and international energy and development policies designed to incentivize growth in the small hydropower sector while curtailing large dam construction. However, the preference of small to large dams assumes, without justification, that small hydropower dams entail fewer and less severe environmental and social externalities than large hydropower dams. Our objective is to evaluate the relative cumulative impacts of small and large hydropower, to support discourse and policies regarding renewable energy development and mitigation of environmental effects.

## Methodology approach

We investigate cumulative biophysical effects of 31 small (<50 MW) dams (totaling 417 MW installed capacity) and four large dams (totaling 10,400 MW installed capacity) in China's Nu River basin. We define potential for biophysical change according to a suite of metrics indicating absolute impact to freshwater systems, including habitat losses, catchment connectivity, conservation priority, landscape stability, change to hydrologic and sediment regimes, and water quality. We then normalize cumulative impacts of small and large dams by installed capacity to compare the cumulative impact of each megawatt of power generated by small and large dams.

## Analysis, results, conclusions and recommendation

Our results indicate that small and large hydropower dams, as defined by Chinese hydropower laws, affect aquatic ecosystems in different ways. Small dams (50 MW) related to total land inundation, potential sediment transport disruption, and potential for reservoir induced seismicity. Effects to catchment connectivity vary according to the scale of reference, with effects of small dams exceeding those of large dams at a sub-basin scale and opposite trends observed at the international scale of the Salween Basin. Despite data uncertainties and variability, our results indicate differences in cumulative biophysical impact of large and small dams that exceed both modeling uncertainty and sample variability.

Rooted in the assumption that the biophysical onsequences of small hydropower dams are fewer and less severe than those associated with large hydropower, current national and international development priorities often encourage growth in the small hydropower sector while discouraging construction of large dams. These policies often define small and large hydropower dams according to a simple metric of installed capacity. Our results indicate that this definition of small hydropower is inadequate for describing the scale of potential environmental impact.

Results of this study present evidence that further and more rigorous investigation of the cumulative effects of small hydropower and comparative effects of large and small hydropower are needed to develop coupled water and energy policies that more accurately define and support low-impact hydropower development.



# Ecosystem based approaches for Water-use efficiency development in Gaza Strip

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Keywords: Ecosystem, water harvesting, GIS DEM

## Introduction and objectives

Increasing of water use efficiency should be associated with real ecosystem development.
This methodology to be used to conduct a systematic map and digital elevation model map to evaluate the best location for harvesting of water in to the ground. Several criteria have been considered in this research; urban expansion, best water quality location including chloride and Nitrate concentration and meteorological conditions.

This research provides scientific evidence indicating the effective of approaches merging between water- use efficiency and ecosystem, which save the diversity of natural resources.

## Methodology approach

Water harvesting which is one of best methods to increase the water use efficiency involves the capture and storage of runoff rainwater, so that it can be channeled onto targeted land areas when needed, thereby improving agricultural productivity in Gaza Strip. Maps, based on Geographical Information Systems (GIS) and Digital elevation model, can give a clear picture of areas where rainwater can be effectively harvested at the community level based on agricultural needs and flooding control. The project methodology depends on dividing Gaza Strip by grids and cells.Each cell should be managed to collect runoff water to avoid flooding.

## Analysis, results, conclusions and recommendation

A Digital Elevation Model (DEM) will be used to estimate the elevation for all locations in Gaza Strip. This project research provides a new approach to estimate flow distribution over a continuous surface. This approach is based on the analysis of topographic form of a surface facet that dictates the flow distribution. In the case of a raster Digital Elevation Model (DEM), the facet consists of a center cell and its eight neighboring cells. If the form of the facet is convex, the water flow is divergent; thus the amount of flow is distributed to all cells that have a lower elevation where stormwater catchment and harvesting can be constructed. This technique is widely used in today's commercial GIS software. This model is used to Estimate flow accumulation over the land surface in Gaza Governorates.

Information from a digital elevation model (DEM) will be spatially joined with GIS and a satellite image resolution and determining the suitable sites. This enabled the average slope across each site to be calculated. Sites with a greater slope would generate more runoff per unit area per unit of time. The DEM will be also used to define the main catchments and subcatchments in the project area (using the Arc Hydro extension).

Satellite images for Gaza Strip also be used to build the digital elevation model. Image classification

will be one of the important digital image processing tools. Erdas has been used as digital image processing software to classify rural and urban area, paved and unpaved roads etc.

GIS is an important tool to find the best locations of stormwater harvesting and infiltration points. ArcGIS10.2 will be used to analyze data collection. GIS has been used in the creation of strategic water resource plans and food security for Gaza Strip.



# Groundwater Protection under New Situation in China

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Keywords: groundwater overexploitation control, strictest water management, China

## Introduction and objectives

To meet water demand for rapid development of economic society, groundwater is continuously and disorderly exploited to great extend for long time in some regions in China, plus faulty operation and management, as well as insufficient emphasis on protection, which lead to severe problems of groundwater over exploitation and contamination. In recent years the Chinese government attaches great importance to groundwater protection, and has announced a series of documents with clear instructions. This paper illustrates general idea of groundwater protection in China from the aspects of overexploitation control, quality protection, water ecosystem protection, and implementation of strictest water management system.

## Methodology approach

The18th National Congress of the CPC attached great importance to ecosystem protection, which brings new challenges to water resources management in China. Based on “National Groundwater Utilization and Protection planning” and “National Water Resources Protection Planning”, which will be announced by the State Council, this paper analyzes new challenges facing groundwater in China, and according to new water management policies proposed by President Xijinping, ‘Water saving, spatial equilibrium, system management, perform functions of government and market”, this paper analyzes goal, objectives and measures of groudwater protection, as well as measures to implement the strictest water management system.

## Analysis, results, conclusions and recommendation

This paper will introduce groundwater hot issues and management goals, objectives, and measures in China, based on summary analysis of “National Groundwater Utilization and Protection planning” and “National Water Resources Protection Planning”.

Firstly, the paper will illustrate hot issues of groundwater under rapid population growth, fast economic society development, industrialization and urbanization, including overexploitation, pollution, faulty management, etc.

secondly, the paper will illustrate the goal and objectives by 2020 and 2030 of groundwater management in China, including total utilization amount control, overexploitation control, pollution control and management system establishment.

Thirdly, the paper will illustrate methods and measures for groundwater protection in China from three aspects. first, implement integrated measures to control exploitation in both urban and rural areas, including water saving for industrial and domestic water use, recycling water utilization, water

transfer projects, high efficient irrigation methods, agriculture planting structure adjustment, especially reduce wheat planting in the north China plain, which is an important grain producing area and also being with severe groundwater overexploitation problem, and even irrigation land changed to dry land; Second, enhance groundwater quality protection, including control urban pollution, enhance key industries pollution prevent and control, agriculture non-point pollution control, etc., Third, groundwater ecosystem protection, especially for ecological sensitive areas, such as arid and semi-arid area, wetlands, land subsidence areas and sea water intrusion areas, groundwater table control limitation is decided and implemented;

Fourthly, the paper will illustrate groundwater management system establishment in China. In accordance to the strictest water resources management system, including water use amount control, water use efficiency control and pollution control, groundwater management and protection system will be established from aspects, such as improving supporting management legislation system, establishing technical standards system, strictly controlling water development and water use, as well as groundwater table control, and enhancing economy adjustment mechanism, etc.
(e.g. extended droughts).



# "Payment for Ecosystem Services" Initiative in the Cubango-Okavango River Basin

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Keywords: PES, Equitability of benefits, transboundary basin

## Introduction and objectives

Freshwater is the major environmental and socio-economic resource in the Cubango Okavango River BasiBasin (CORB), directly supporting all human activity, vegetation, wildlife habitats and their associated productivity. However, the 2012 Strategic Environmental Assessment (SEA) for the Okavango Delta Ramsar Site and the Transboundary Diagnostic Analysis (2011) for the CORB found that the system is under substantial threats.

The study aims at exploring the conversion of the CORB's bio-capital into a business model that expands the scope of business opportunities to improve the livelihoods of the CORB population while ensuring its ecosystem integrity.

## Methodology approach

A PES approach for the Cubango-Okavango River Basin will aid in bringing together communities across boundaries, between those in Angola, Botswana, and Namibia that rely on the river for its provision of freshwater, sustenance, and income opportunities. With the support of OKACOM, UNEP, SAREP and GRID-Arendal are working and involving local communities, government ministries and the private sector in order to value and prioritize the ecosystem services in the basin, tackle the threats and protect the CORB basin for the future.

## Analysis, results, conclusions and recommendation

The Okavango Delta provides a staging area for birds migrating to southern Africa during the boreal winter and is a storehouse of globally significant biodiversity, as well as a popular international tourism destination.

The productivity associated with freshwater use and its related aquatic ecosystems is estimated at approximately 25% of GDP in the basin, with considerable inter-country variability. Freshwater sources are the natural resource component most at risk since there is no substitute for the basin's watercourses and associated aquifers. Following the business as usual model, the system will be driven to surpass unacceptable thresholds for the maintenance of its ecological integrity.

Payments for ecosystem services (PES) are ways to financially internalize externalities, providing land managers with incentives to adopt land use practices that maintain or enhance ecosystem services. They can facilitate the transfer of financial resources from the users of ecosystem services (often downstream stakeholders) to those stakeholders who live in localities where the ecosystem services are produced and maintained (often upstream stakeholders), so that the users become the buyers of the services and the producers become the sellers, thereby optimizing the flow and equitability of

benefits derived from these services.
A PES scheme can be suited for the CORB and will create incentives for local communities to conserve and improve resource management, with the potential for:

- Secure livelihoods, by ensuring the delivery of critical ecosystem services throughout the basin and safeguarding both the environment and the people who rely on the river for economic opportunity;
- Achieve a thriving tourism industry, by safeguarding wildlife and fish populations that support safari travel, one of the key economic activities in the region; and
- Ensuring ecological sustainability, thus increasing resilience to climate change and reduc-ing threats from development.



# Watershed Management for Sustainable Water Sector Development Projects in Ethiopia

Author: Mr. Ketsela Estifanos, Ministry of Water, Ethiopia

Keywords: Sedimentation, Watershed Management, Projects, Livelihood, Sustainability

## Introduction and objectives

Water is vital for life, development and the environment. If water development projects are properly managed, it can be an instrument for economic growth, social development and environmental conservation. But inadequate quantity and quality due to poor management limits poverty reduction and national development, resulting in poor health, food insecurity and reduce energy production. Water resources protection needs appropriate mechanisms of reducing pollution caused by point and non-point sources. Sustainable use of water depends on the functionality of the whole ecosystem. The objective of is paper to integrated watershed management ,livelihood and reduction of sedimentation in reservoirs.

## Methodology approach

The methodology was based on dam projects in Ethiopia including water supply, irrigation and hydro power focusing on soil erosion and sedimentation in the reservoirs and its impact on the water quality and quantity. Both primary and secondary data including review of literature, study documents, field observations, and consultation with different stakeholders have been made to assess the problem. During the field observation existing conditions include the development projects activities, the natural environment, and the socioeconomic condition of the people living in and around the watershed areas was critically assessed for to identify solutions.

## Analysis, results, conclusions and recommendation

Analyses of the water development dam projects show that sedimentation is the major problem in the reservoir caused by poor water and land management. Lack of integrated planning and implementation of projects has a negative impact on the conservation and utilization of natural resources. Wise land and water resources utilization needs knowledge from the perceptive of multidisciplinary view and the full involvement of the stakeholders. Equitable benefit sharing of the community by creating incentive mechanisms in soil and water conservation activities in the watershed areas of the development projects. Multiple benefit including reduction of sedimentation in the reservoir, water quality improvement in general, increase in agricultural productivity, energy production and improving the livelihood of the watershed communities can be achieved.

The major problems caused by high rate of sedimentation in the reservoirs:

- Increases in turbidity and algae bloom in the reservoir of water supply dams increase the cost of water purification ;
- The cost of silt removal from irrigation canals;
- Reduce the water holding capacity and life of the dam;
- Reduce the energy production;
- Increase maintains cost of hydropower equipments and structures.

Water development projects planning and implementation is complex and requires adequate coordination efforts of various stakeholder and user groups. An integrated watershed management in holistic

approach must be considered to solve the problem of sedimentation in the reservoir and maximize the benefits from the integrated watershed management. The implementation of future Sustainable Developments Goal (SDG) should give priority for the conservation of watershed areas and freshwater ecosystem in general. Regular environmental impact assessment (EIA) is necessary to reduce the rate of sedimentation, to increase the life of the dam, for dam safety, water quality and quantity and improvement of livelihood of community in and around the watershed area.

## Stockholm International Water Institute

The Stockholm International Water Institute (SIWI) is a policy institute that contributes to international efforts to combat the world's escalating water crisis. SIWI develops and promotes future-oriented and knowledge–integrated policies, towards sustainable use of the world's water resources leading to sustainable development and poverty eradication.

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