Water and development
- approaches from Norwegian research institutions
Introduction

Water is crucial for development because it is the heart of food security and economic growth. Today, one billion people currently lack access to secure drinking water. By 2025, an estimated three billion will live in regions of acute water stress.

This impending water crisis is a critical issue for governments and societies worldwide – but it affects poor nations in particular, as they face the chronic struggle of getting enough water to sustain life. Lack of access to clean water constitutes a denial of the most essential of all rights, the right to life.

Norwegian water specialists have contributed substantially to improving water resources, both at home and abroad. Their expertise in securing potable water and treating wastewater is well documented, which enhances their potential to contribute significantly to the Millennium Development Goal (MDG). To realize this potential requires a concerted action that balances common perspectives with particular strengths. It is also essential that the target initiatives for improving water resources abroad – in particular the lesser developed countries (LDC) – are based on lessons learned from existing projects and integrated with established international networks.

Integration is the nucleus of water development projects, both in concept and in practice. In concept, integrated water resource management embodies a holistic view that ensures coordinated development and management of water and land resources, with the principle objective of improving social welfare without jeopardizing the environment. In practice, integrated water resource management benefits from the skills of water specialists as a synergistic team.

Our focus in development activities

Norwegian research institutions have a tradition for cooperating with developing countries within the water sector. This co-operation focuses on the following:

- Recipient orientation (to ensure local priorities)
- North-South partnership (to ensure collaborative approaches)
- Stakeholder involvement (to ensure the ownership)
- Capacity building (to ensure the sustainability)

Our strength as a unified group

In this leaflet, the Agricultural University of Norway, NIVA, and Jordforsk present several topics and projects highlighting their perspectives and approach to supporting sustainable development processes with relevance to water. Together, these institutions have more than 50 experts with international experience in water sector development projects. They have a long tradition for co-operation, both in Norway and abroad. Their combined network of LDC partners covers most of the countries where Norway has been involved in development programmes.
How can the problems of water scarcity and poverty be addressed? Emphasis must be shifted from developing new infrastructures to more efficient use of the water that is already available. Studies from developing countries have shown that substantial water savings and significant increases in crop productivity, and consequently farmers’ incomes, can be gained from implementing low-cost technologies such as drip/sprinkle irrigation, treadle pumps, and simple water harvesting systems.

Generally, it is not well known that a substantial portion of the food needs of urban populations is now being met by “urban agriculture.” Satellite photos of Dar es Salaam, for example, demonstrate that as much as a third of the land area is under cultivation at some point during the year. Production from such land meets basic needs, provides an inordinate amount of essential vitamins and minerals in daily diets (especially for the poor and for women and children), and helps ensure food security particularly during times of civil strife when urban areas can be cut off from rural food supplies. Clean water is a key limiting factor in urban food production systems. When polluted water is used to raise vegetables, for instance, human diseases are easily spread. Improving the supply and quality of water for urban agriculture should not and need not be seen as a separate challenge from that of improving sanitation and delivering clean water for personal consumption. Holistic strategies must be developed to address the total water needs in developing countries.

Better information needs to be provided concerning the availability and applicability of low-cost technologies to improve efficiency of water use, as inadequate information represents a major barrier to implementing more viable and sustainable water management for poverty alleviation. There is a need to focus on communication and sharing of knowledge in order to reach the poorest in rural areas. When selecting technical and management alternatives it is of vital importance that the community is involved from the start, both in the conceptualization of the problem, and in the design of solutions.

Apart from improving access to technologies and fostering management skills, the focus should be on creating and adopting comprehensive national and regional water management policies that ensure efficient, sustainable, and equitable water allocation. Particular emphasis needs to be placed on providing secure and unassailable water rights for the poorest, in order to secure their basic needs. Economic and institutional structures that encourage the wastage of water, such as subsidies for water-intensive crops in arid areas should be dispensed with, and public institutions strengthened. Furthermore, poor people would benefit from organizing themselves in order to gain more political clout - this requires support and financial assistance from local, national, and international bodies.

Scarcity of water is one of the most severe factors alleviating poverty. In rural areas, water is used for a variety of purposes: irrigating fields, raising livestock, small scale industry, drinking, bathing, cleaning etc. Increasing water scarcity will jeopardize not just many, but most, because less water will be available for arable land, more time will be spent fetching water from increasingly distant sources, and more people will be infected by waterborne diseases.
These daunting challenges can only be approached properly and efficiently through concerted action of the national governments based on the integrating concept of Water Resources Management (WRM). Establishing systems of good governance of water resources at the national and local levels is the first step towards improving the situation at the global scale. An important objective is to strike a sound balance between the various user-interests to prevent conflicts and non-sustainable resource use.

The responsibility for WRM should preferably be divided between the national, regional and local administrative levels. Conflicting water needs are then dealt within a context of political transparency and public participation, and with full integration of the local level.

Key components in the development of a well-functioning WRM system are:
- Water resources policies and strategies
- Legal framework and enforcement mechanisms
- Institutional arrangements, roles and responsibilities
- Capacity, coordination and resource-sharing
- Administrative and economic instruments and incentives
- Licensing and control systems
- Water resources master planning/watershed management planning
- Contingency/emergency planning (floods, accidental pollution etc.)
- Procedural aspects, e.g. stakeholder and public participation
- Surveillance, monitoring, information and research

Our Norwegian consortium has demonstrated WRM expertise in a variety of international projects, such as:
- Managing Water for African Cities, HABITAT, SSA Region, Ghana, Senegal and Zambia
- Strengthening of Water Resources Information Services (WRIS) in Ghana.
- Development of the National Hydro Power Plan for Vietnam
- Establishment of the Monitoring System of the China National Environmental Monitoring Centre, monitoring e.g. acidification of terrestrial ecosystems.
- Preparation and evaluation of irrigation projects in the Sudan, Eritrea, Ethiopia, Niger, Tanzania, Kenya and India
- Participation in projects related to agriculture, soil conservation and water management in Guatemala and Nicaragua

Water resource management

The world’s limited water resources are under increased pressure from population growth, changes in lifestyle and economic development. During the past century, the population has tripled, while the water usage has increased six-fold. These changes have high environmental costs – some rivers no longer reach the sea; half of the world’s wet-lands have disappeared; and groundwater aquifers are over-exploited or permanently damaged. The poorest countries and poorest people are the most affected.
Preservation of the vegetation cover increases the infiltration of water into the ground water reservoir. Since water is inextricably linked to all components of the environment (land, rivers, lakes, humans etc.), watershed management fully integrates these components and prevents a number of the water problems at their source.

There is need of a broad range of watershed management programs in developing countries to ensure the conservation and utilisation of water with an integrated system approach (involving biophysical, socio-economical and other factors and processes). Therefore, the purpose of our watershed management activities will be to combat land degradation to maintain or enhance the quantity and quality of surface and ground water.

Key components in the watershed management approach are:

• Capacity building in participatory watershed management, planning and monitoring.
• Mechanism for implementing indigenous soil conservation and watershed management techniques.
• Forest conservation, community forestry.
• Sustainable land management.

Our Norwegian consortium has diverse expertise and experience from several watershed management projects, including:

• High Altitude Integrated natural Resource Management in Pakistan.
• Education Research and Training for Sustainable Management of Natural resources in Watersheds of Nepal (The Shivapuri project)
• Dynamics of Forest and Soil Degradation and to develop sustainable Agroecological Strategies for Fragile Himalayan Watersheds in Nepal, India and Pakistan.
• Land use changes and forest/soil degradation effects on carbon sequestration in water-shed of Nepal.
• Soil and forest degradation in marginalized agriculture of Nepal
• Environmental Assessment of Mozambique National Water Development.
• Combating Nutrient Depletion in the Ethiopian Highlands.
• Environmental Planning and Competence Building in India.

Watershed management

The watershed management approach is a fundamental aspect of protecting water resources and ensuring stability in quality and quantity discharged through the waterways. For example, controlling soil erosion in the watershed prevents siltation of freshwater reservoirs, rivers, dams, irrigation channels, and, reduce the risk of flooding (by maintaining flow capacity) water contamination and conserve the water.
The methods applied for WH depend strongly on local conditions, and include a wide range of practices at various scales (e.g. watersheds and single residents). Many WH systems are designed on a “trial and error” basis, which may work fine, provided they are integrated with farming practices. A better, systematic approach uses an empirical background data (rainfall, runoff, topography) to construct a flexible WH system that adapts to erratic climate conditions.

*Rainwater harvesting*, a term derived from the more generic WH, focuses on capturing runoff from very small catchment areas, such as rooftops, artificial surfaces at ground level, and land surfaces with slopes less than 50 - 150 m in length.

There are also a number of measures that are not WH techniques in themselves, but support WH, either by inducing runoff or increasing infiltration in the catchment area. Such measures are often referred to as auxiliary techniques, which include soil conservation practices such as afforestation. Therefore, it is important for the overall development of catchment areas to assess auxiliary practices in relation to WH measures. If integrated properly, auxiliary techniques can increase water supply and protect the soil.

- Research on water harvesting systems has been conducted in Gujarat, India and Ti-gray, Ethiopia, and current projects seek to facilitate transfer of relevant water harvesting technologies between these two regions.
- Membership in the International Rainwater Harvesting Committee

Water harvesting

Rainwater management is a target initiative in arid and semi-arid regions. These drought prone regions are characterized by great variability water resources in general – and unpredictable rainfall in particular – leading to constraints in food production and water availability for households and industries. Water harvesting (WH) is one way of coping with this uncertainty by building up a buffer capacity. WH broadly refers to the concentration, collection, storage, and use of rainwater runoff for both domestic and agricultural use.
In many parts of the world, agricultural production is not possible without irrigation. Consequently, the requirement for irrigation water will also increase. Approximately 70% of the world’s water use is for agricultural purposes, this being mainly irrigation. Although, human activities and ecosystems both depend on the same water, their needs are only partly compatible. This makes trade-offs necessary.

**Hydro-solidarity**
Water use at the watershed level is divided into upstream and downstream interests, balancing the need between water impacting activities upstream and water dependent phenomena downstream. Examples of this are water use for agricultural purposes upstream, and flow dependent human needs and aquatic ecosystems downstream. Balancing is also needed locally, e.g., between water for city supply and water for irrigation.

**Environmental issues and irrigation efficiencies**
The efficiency of irrigation systems is generally low and estimated at only 30 – 60% of the water applied. The rest is lost to ground and surface water and will eventually flow back into rivers, causing pollution problems due the presence of dissolved nutrients and salts.

**Crop water requirements**
To produce 1 kg of grain crops, in for example northern Europe, approximately 1000 litres of water is needed, mainly from rainfall. Crops grown in arid or semi arid areas can sometimes require 2 – 3 times more through irrigation.

**Water scarcity**
The big challenge in areas already facing water scarcity will be to find a proper and fair allocation of water resources. The need for domestic and industrial water supplies will increase with the world population and economic growth.

The consortium has extensive experience in management of water resources related to agricultural production, both in Norway and abroad. Participation in projects in various agro-ecological zones (including arid areas) of Africa, Asia and South America and Asia have given valuable experience in water issues related to agriculture.

- In Nepal an interdisciplinary team analyzed the dynamics of forest and soil degradation to develop sustainable agro-ecological strategies for the fragile Himalayan Watershed.
- In China an integrated program monitored the acidification of terrestrial ecosystems.
- In Coastal Maputuland a joint university cooperation examined the role of biodiversity in nature conservation and management.
Our challenge is immediate. Today, conventional sanitation systems promote one of two practices: flush-and-discharge or drop-and-store. For the former, most LDC cannot afford the necessary resources in terms of water, money and institutional capacity to serve a large number of people. For the latter, health risks are high and difficult to manage, and the recovery of excretarich nutrients is low. Consequently, the leaders of LDC face two options: either ex-pand existing sanitation approaches, which are neither affordable nor sustainable, or seek alternative solutions. Often the chosen option is to use both approaches at the same time.

The most promising alternative is ecological sanitation or ecosan. This approach is based upon three fundamental aspects:
- Sanitizing human excreta.
- Preventing pollution (rather than attempting to control it afterwards).
- Recycling excreta nutrients for soil quality and agricultural purposes.

This sanitize-and-recycle approach is a sustainable, closed-loop system, because it:
- Treats excreta as a resource rather than a waste
- Relies on solar energy rather than fossil fuels
- Functions as a part of nature rather than apart from nature.

The consortium is a pioneer in ecological engineering and a leader in eco-technology education. Since the inception of the eco-san concept in the 1980’s, the consortium has advanced system design, for example, constructed wetlands, waterless toilets, and treatment of excreta and organic waste yielding fertilizer and bioenergy. Equally important, it has integrated the holistic philosophy of ecosan in NLH’s curriculum, most notably in Noragric’s Development Studies.

Research and development efforts are both broad and deep, with direct application both to LDC and DC. In addition to exploring the benefits of composting excreta and capturing energy from organic waste, projects have included the following:
- In Havana, Cuba, a state-of-the-art residential facility is applying the latest water-saving technology with solar powered vacuum toilets. At the same time, reclaimed nutrients from sanitized excreta are providing vital fertilizer for urban agriculture.
- In the slums of Bangalore, India, an innovative public toilet complex demonstrates the benefits of urine-diverting compost systems. By applying a fundamental ecosan principle (source separating treatment), pollution and water demand are reduced while hygiene and other standards of living are increased. For example, the economic value of excreta is realized as new employment opportunities develop at the compost-fertilizer facility.
- A comprehensive report evaluated the economic, technical and social issues of eco-san systems for the World Bank.
- In Pakistan, constructed wetlands were designed to treat both domestic and industrial wastewater.
Decades of negligence, leading to inadequate solutions, together with the expanding population in urban areas have focused upon urban sanitation as a priority issue. Conventional treatment facilities are not affordable for most communities, although they may be the preferred solution in many areas. However, Norwegian specialists have developed concepts that are feasible for at least two situations:

• Where the existing treatment facility is malfunctioning, due to overload from population increase and industrial activities
• Where the existing treatment facility is not efficient enough to cope with prevailing requirements

Most Scandinavian treatment facilities are based on chemical coagulation – a robust and efficient process for domestic wastewater treatment. This process represents an environmentally friendly and economical method for many situations. With minimum construction modifications the capacity of existing mechanical or biological wastewater treatment facilities can be increased by 50-100%. Equally important, treatment efficiency in mechanical treatment facilities can be drastically improved if coagulation is introduced as a low-cost CEPT (Chemically Enhanced Primary Treatment).

The consortium has been engaged in development and application of the coagulation method in Norway and internationally:

• In Poland, Czech republic and Hungary, it has demonstrated the upgrading concept to cope with increased population by introducing coagulation as an intermediate process
• In Zhejiang province in China, the CEPT concept was demonstrated as a feasible method to treat industrial and domestic wastewater from a medium sized city – a concept that is also used in Hong Kong and Mexico

Sanitation

Urban sanitation

The collection and proper disposal of domestic wastewater is a long neglected issue in many areas of the world. It is an issue that often loses out to other political priorities demanding short-term results. It is unrealistic and irresponsible to provide only large, conventional wastewater treatment to urban populations. Thus, creative and pragmatic concepts – which draw upon both conventional and alternative technologies – are required.
The private sector needs training in appropriate technical solutions and effective business management. 

The International Task Force on Educational Reforms in 2000 concluded that the LDC are falling behind. Their education systems are chronically under-funded, staff are under-qualified and poorly motivated, and students often badly taught. LDCs need to teach more students, to a higher standard, and develop the research capacity. There is a need to address water and sanitation problems in developing countries through educational reforms, such as:

- Educate children on water conservation and hygienic practices. Female education can bring great changes in this sector. There is also a need for expanding our knowledge of social and technical aspects of drinking water and sanitation
- Shift from conventional water and sanitary engineering to ecological engineering. At present, most universities in developing countries focus on conventional techniques without giving sufficient attention to other options. Each country taking part in the UN program for water and sanitation development should establish one or more education and research centres to lead the national development efforts
- Develop short-term courses and training for different practitioners in the water and sanitation sector
- Promote compatibility with already existing infrastructure and the possibility to achieve acceptance of alternative technical solutions by society
- Bring forward and encourage local practices on water, sanitation and waste handling and analyze how these practices can be improved or modified.
- Promulgate the links between religion, water and sanitation. Use people’s beliefs and customs to promote water and sanitation development.

NLH’s ecosan curriculum provides opportunities for both undergraduates (B.Sc) and post-graduates (M.Sc. and Ph.D). All courses are taught in English by an international faculty. This unique interdisciplinary program focuses on students understanding universal processes of science, while at the same time developing practical skills for transferring ecosan technology to their native environments. NLH is one of few universities worldwide offering these opportunities – opportunities desperately needed in LDCs.
Other education programmes

NLH offers other education programmes at MSc and PhD level that are of relevance to water management and watershed development. Special courses can be designed according to the needs of partners. Topics relevant to water management are also included in several of the existing education programmes:

Some examples:

MSc in development studies: The majority of the world’s population faces problems related to poverty, environment, resource constraints and social conflicts. These are problems that can only be understood and approached through an interdisciplinary approach. The Agricultural University of Norway can offer a unique 2-year Master of Science programme for those who are interested in development from a local and global perspective.

This MSc programme has 5 specialisations:
- Environmental technology and management
- Forest sector development
- Biodiversity
- Genetic conservation and biotechnology
- Conflicts and Development
- Rural Development Economics

The Master in natural resource management and sustainable agriculture (MNRSA) offers insight in environment, poverty and development issues. The study addresses the complex and interrelated topics of agricultural and rural development, poverty alleviation and the trade-offs and conflicts between development at large and the long term management and conservation of natural resources and biodiversity, also including water resources.
INSTITUTIONAL STRENGTHENING

The institutions behind this leaflet have long experiences in institutional collaboration with universities, NGOs as well as public institutions in the developing countries. This involves establishment of education programmes, joint research, capacity building and institutional development activities.

PUBLIC INSTITUTIONS

The sustainability of many interventions in development activities lies in the availability of local competence and resources to operate, maintain and further develop them. Unfortunately, experience has shown that many international programmes bring only temporary knowledge and resource bases which degrade rapidly after project completion. A major objective of many of the projects has been to enhance local resources.

The actual capabilities of local experts are often underestimated, and they are not given adequate opportunities for further development. To rectify this situation, we have purposely chosen to implement selected projects in a non-conventional manner. Norwegian experts have taken a strictly advisory role to cover planning, monitoring and quality assurance, while most of the work is carried out by local experts and organisations. The results have been unambiguous – a sustainability of the project and replication capacity developed within the local resource base.

However, it is a process that requires patience, careful planning and continuous dialogue between the local and international resource persons. All of us who have been a part of this approach appreciate the outcome and are motivated to utilise it again.

- In Sri Lanka, the first district level coastal zone management plan has been implemented at Hambantota. A team of Norwegian institutions have built up a well-trained local resource base capable of handling most activities
- In Sri Lanka, the national oil spill contingency plan was developed and a team of Norwegian institutions strengthened the national institution involved
- In Ghana and Croatia, a team of Norwegian organisations strengthened the Water Research Institute, supplying not only hardware but also providing sustainable training concepts to handle national programs
- In Palestine, a team of Norwegian organisations built the National Water Authority – transferring all know-how concerning a modern environmental management organisation

UNIVERSITY AND NGO COLLABORATION

The consortium has more than 30 institutional agreements with universities and colleges in developing countries and countries with an economy in transition, mainly through agreements established by NLH/Noragric. Some of these have been operational for more than 30 years. This network of partnerships represents a unique fundamnet for development of effective mechanisms for establishment of new programmes within the water sector, in the form of research and education activities, or in the form of development programmes. A large number of candidates have obtained their PhD and MSc degrees in Norway, and they constitute a very valuable network for establishment of new activities. The consortium also has a large network among NGOs in Norway and in developing countries. With some of these, collaboration has been ongoing for many years. Some of these contacts are of special relevance for water related projects, e.g. related to water harvesting and dryland agriculture.
Agricultural University of Norway
Department of Plant and Environmental Sciences

The two-fold objectives of the Department of Plant and Environmental Sciences (IPE) are teaching and research in the fields of geology, limnology, and soil science, management and fertility – and to a lesser degree tropical soils and their management. In addition to IPE’s undergraduate curriculum, master and doctoral students focus on a variety of topics related to LDC issues. IPE pays special attention to the relationships between terrestrial and aquatic processes - a necessity when managing water resources at catchment scale. In this context, the link between hydrology and water quality is essential to supply the growing population with potable water. Examples of relevant activities are a series of interdisciplinary research projects in the Africa and Asia that analyze the dynamics of soil degradation, develop sustainable agro-ecological strategies, and monitor acidification of terrestrial systems. Target locations for IPE’s research include: Nepal, China, Mozambique and South Africa.

Department of Mathematical Sciences and Technology

The Department of Agricultural Engineering, Agricultural University of Norway, is Norway’s prime academic institution for education and research in the fields of environmental physics and water resources engineering. It also specialises in structural design and architecture, and machinery design and process technology, as applied to the food and agricultural industries. Courses are offered at bachelor and master level, and researcher training to doctorate level is a central activity. Research focuses on environment issues such as renewable energy sources, water treatment and environmental monitoring, aquaculture and understanding biological processes using tools from physics, mathematics and computer science. Most of the projects are funded by the Research Council of Norway, the European Union, governmental and non-governmental funding, such as by small businesses and major industries. The department has earned an international reputation for its competency in ecological sanitation and technology transfer to developing countries, with current projects in Havana, Cuba and Bangalore, India. An annual one-week summer course on appropriate sanitation in developing regions is unique and has proved popular with NGOs and policy makers from home and abroad.

Noragric

Noragric is the Agricultural University of Norway’s (AUN) Centre for International Environment and Development Studies. It brings together research, education and development-related assignments with a focus on developing countries and countries with economies in transition. With more than 40 years of collaboration between AUN and academic and professional institutions in Africa, Asia and Eastern Europe, Noragric has established a broad network of worldwide contacts. Noragric aims to contribute towards equitable development, sustained well-being of women and men, and sound environmental

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practices through collaborative activities that generate and exchange knowledge and provide education in the area of agricultural development, livelihood security and natural resource management. How to assist poor people to enhance their livelihoods in a sustainable way is one of the greatest challenges we are facing in the world today. The majority of poor people in developing countries live in rural areas and rely on natural resources for their livelihoods. Rural development, improved natural resource management and strategies to make agriculture more productive are critically important if poverty is to be reduced. The overall rationale for Noragric’s activities in research, education and assignments is to contribute towards equitable development and community empowerment.

Jordforsk – Combining Soil and Environmental Expertise

Jordforsk, the Centre for Soil and Environmental Research, is a national centre of expertise for environmental issues concerning soil, water, and waste. The heart of the organization is applied research related to the long-term management of landscape resources both in Norway and in less developed and former East Block countries. In addition, it coordinates several EU programmes. The institute’s strength is its interdisciplinary approach in research, consulting and laboratory services, which enables it to tackle a broad range of challenges. Jordforsk receives core funding from the Ministries of Agriculture and Environment, with clients including private businesses, public authorities and agencies, consultants and individuals. Jordforsk is one of the five national environmental institutes cooperating within the Environmental Research Alliance of Norway (ENVIRA). It is also a member of the Norwegian Agricultural Research International (NARI), a cooperation between Norwegian agricultural and forestry research institutes. In addition, Jordforsk is linked to several international science networks via committees, working groups, and research efforts.

NIVA

NIVA is a private research foundation, and with a staff of 116 research scientists is by far the largest interdisciplinary applied research unit in Norway. Its scientific competence covers most fields of research and consultancy related to fresh and marine waters. A substantial part of NIVA’s activities abroad concerns Norwegian development cooperation to LDCs. NIVA is engaged in more than 50 countries in development projects, with focus primarily on Southeast Asia, Africa and Eastern Europe. These projects are financed by bi- and multilateral development aid agencies like NORAD, World Bank, Nordic Development Fund, Sida. The institute offers expertise in water resource management, pollution abatement strategies, water master planning, impact assessment analysis on water quality and aquatic ecosystems, monitoring and surveillance of water resources, drinking water supply technology and municipal and industrial wastewater treatment technology. NIVA’s strategies target seven priority areas: EU’s Frame Directive on Water, data presentation systems, new monitoring technologies, ecological modeling, effects of global climate changes, remediation of harbors, landfills, etc polluted by hazardous chemicals, sustainable management of the coastal zone.
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