CHANGE

THE WAY WE THINK

ABOUT WATER AND AGRICULTURE

agriculture, nature
and food quality

WATER IS MORE THAN 'JUST A RESOURCE'

World wide there are more than 800 million people whose basic human right of access to sufficient food is infringed or at risk, and one in three people face water scarcity. These are findings of the CGIAR's Comprehensive Assessment of Water Management in Agriculture. Generally, it is the poor who are most affected by food shortages and the extremes of water shortage or flooding.

Demand for fresh water is growing rapidly. Different water uses are increasingly in competition with each other and this is leading to increased conflicts. Moreover, vital ecosystems are being degraded or destroyed in many parts of the world. The competing claims on water – which have social, agronomic, economic and environmental implications – are globally recognized as one of the most serious problems this millennium.

Water provides and sustains functions and services that are critical to human life and ecosystems. Water should, therefore, not be seen as just one of the many natural resources on this earth, but as an integral part of the resource base that should be wisely managed.

The Consultative Group on International Agricultural Research (CGIAR) issued the Comprehensive Assessment of Water Management in Agriculture in 2007. This assessment critically examines policies and practices of water use and development in the agricultural sector by evaluating the costs, benefits and impacts of the past fifty years of water development for agriculture.

Rainfall

The key message in the CGIAR Comprehensive Assessment is that we have to change the way we think about water and agriculture. Instead of the traditional focus on water in rivers, lakes and the groundwater, the assessment

CONTENTS

recommends that rainfall be viewed as the primary source of water. This means that land use should become an integral part of water management. The CGIAR assessment also recommends broadening our perspective on agriculture. Instead of viewing agriculture solely as a system that produces crops, we should regard it as an agro-ecosystem that provides many ecological services, in interaction with other ecosystems.

Another recommendation is to replace the rigid boundary between irrigated and rain-fed agriculture by a much wider range of irrigation options. This is a direct consequence of viewing rainfall as the primary water source. The failure of a rain-fed crop due to lack of rainfall represents unproductive use of the primary resource. This ascribes a much greater role to supplementary irrigation.

International projects

The CGIAR Comprehensive Assessment provides an important policy framework for international land and water management. Through its international research projects, the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) has obtained hands-on experience of the issues raised by the assessment. This brochure highlights some of LNV's bilateral international projects on land and water in view of the Comprehensive Assessment, and identifies synergies and discrepancies between the results obtained from these projects and the policy guidelines arising from the assessment. It presents some of the experiences and difficulties encountered. The information can serve as a source of inspiration for similar projects and help to set future research agendas.

THE DUTCH MINISTRY OF **AGRICULTURE, NATURE AND FOOD QUALITY**

The international water-related policies of the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) are aimed at strengthening cooperation between the Netherlands and international partners on wise use of water. LNV's objective is to contribute to integrated water resources management, sustainable development and to international water policy frameworks and conventions. It does so by funding international water-related projects and programmes.

The projects built on the long experience record of water management in the Netherlands. Triggered by profound changes in the (bio)physical, socio-economical and cultural boundary conditions in the past decades, new paradigms on water management had to be adopted and materialized in Dutch water policies. They are characterized by a more holistic approach of water management, reform of water institutions, shared responsibility for water management among all stakeholders and intersectoral cooperation. Partnerships between governments, civil society organizations, research institutes, private sector and local communities are considered the key to successful implementation international water-related projects and sustainable results.

Thematic areas of support include sustainable development, integrated management of water systems, integrated approach to water chains, and creating an enabling environment for good water management. Geographical areas targeted by LNV are e.g. the densely populated river deltas and low-lying fragile coastal zones in Asia, Africa and Latin America; the transboundary river basins and inland seas in Asia, Africa and Latin America; and river catchments in Eastern Europe and Northern Africa.

THE INTERNATIONAL WATER POLICY FRAMEWORK

LNV is one of the partners of the Netherlands Water Partnership (NWP), in which Dutch governmental and non-governmental organizations, the private sector, educational and research institutions work together. It acts as a national coordination and information centre for water-related issues abroad. Within the NWP the Ministry focuses on issues related to water, food and ecosystems.

In the past decades LNV has participated in international conferences, summits and conventions. Its commitment to the international theme of water, food and ecosystems was made clear through the FAO/Netherlands Conference Water for Food and Ecosystems, held in 2005. At this conference practical approaches were discussed on how these commitments could be implemented and how water for livelihoods and ecosystems could be balanced effectively while achieving equity, environmental sustainability and economic efficiency.

As a follow-up to the second World Water Forum in 2000, the Dutch government had already launched the Water for Food and Ecosystems programme, aiming at cross-disciplinary knowledge development and dissemination to promote food security whilst protecting ecosystems within a river-basin context. The programme was co-funded by LNV and implemented by a large number of specialized institutes within Wageningen University and Research Centre and their partners from local and international knowledge institutes.

The Water for Food and Ecosystems programme was developed to assist countries in coping with water scarcity by harmonizing water demand across all sectors of the economy – including agriculture – with the water requirements of sustaining the resource base. The programme also co-operated with international initiatives such as the Dialogue on Water, Food and Environment, the Dialogue on Water and Climate and the CGIAR Challenge Programme on Water and Food.

The FAO/Netherlands conference produced recommendations for concrete actions, which would advance the implementation of international commitments related to water, food and ecosystems. The resulting agenda for action centred on fostering implementation of know-how, a new economy for water, and creating enabling institutional conditions. It was acknowledged that technical solutions alone do not suffice to address the intricate and complex problems faced in today's water management. Good governance is equally important for identifying feasible technical options, and implementing them by means of fair and equitable distribution and management of water resources. This requires awareness raising, stakeholder engagement, know-how for action, and capacity building of individuals and key organizations and institutions.

LNV RESEARCH PROJECTS

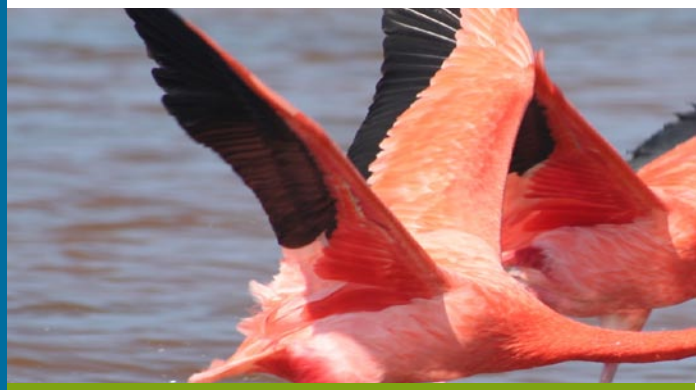
The Dutch Ministry of Agriculture, Nature and Food Quality (LNV) finances a wide range of research projects aimed at policy support. The projects aim at strengthening the agricultural sector, nature conservation organizations, food and non-food industries, knowledge institutes, and provincial and municipal governments.

International cooperation projects are also implemented under the LNV policy support research programme. These international projects cover eighteen research themes, four of which are concerned with sustainable development and management of land, water and related natural resources.

Every year, LNV identifies its focal themes in accordance with the international agenda. A specific theme is 'Bilateral Projects', in which agricultural councillors working in the Dutch embassies can initiate water-related research projects jointly with local partners. These must coincide with regional and local policy priorities, and existing Memoranda of Understanding. These partnerships are the follow-up to the FAO/Netherlands Conference Water for Food and Ecosystems. The following chapters describe three projects, highlighting some of crucial issues encountered in the search for new ways of managing water in agriculture.

International projects of the Dutch Ministry of Agriculture, Nature and Food quality.

CASE: **ETHIOPIAN CENTRAL RIFT VALLEY**



The Central Rift Valley in Ethiopia is one of the environmentally very vulnerable areas in the country. It covers an area of approximately 10 thousand square kilometres and has a population of approximately 1.5 million people. The total livestock population amounts to about 850 thousand Tropical Livestock Units. The situation in the Central Rift Valley is a typical example of competing claims for land and water resources. There is an urgent need for improved resource use, where land and water management takes into account the carrying capacity of the valley's ecosystem. The challenge is to manage the different resource claims so that sustainable development pathways are achieved for the area.

The Central Rift Valley encompasses a chain of three large lakes – Ziway, Langano and Abyata – and streams that are spatially and temporally strongly interlinked. The Meki and Ketar Rivers in the upstream portions of the catchment discharge their water into the freshwater lake Ziway. From there water is discharged into the Bulbula River, which flows to Lake Abyata, the saline terminal lake. Together with the nearby Lake Shala and the surrounding woodlands, Lake Abyata forms a National Park, famous for its biodiversity and water fowl.

The project goal is strengthening local authorities, development organizations and the private sector in the field of sustainable land and water use and in sound environmental planning and management, thereby contributing to the sustainable development of the Central Rift Valley.

Change the way we think about water and agriculture

The bilateral project 'Ecosystems for water, food and economic development in the Ethiopian Central Rift Valley' provides a perfect illustration of the need to shift the focus from 'blue' water management to 'green' water management and to regard rainfall as the primary and most important water resource. The Central Rift Valley is a closed basin, which means that the consequences of land and water interventions accumulate in the downstream areas, while also accumulating over time. Although the scale is much smaller than in the Aral Sea basin, the same environmental degradation problems, associated with overexploitation of water resources, are occurring.

Blue water: Surface and groundwater that is available for irrigation, urban and industrial use, and environmental flows.
Green water: The fraction of rainfall that is stored in the soil and available for plant growth.

The experiences in the Central Rift Valley show that it is critical to distinguish between blue and green water for agriculture, as is advocated in the Comprehensive Assessment of Water Management in Agriculture of the CGIAR. The majority of the blue water withdrawals (90 percent) are used for irrigated agriculture. Livestock, domestic and industrial water uses together account for approximately 10 percent.

The total amount of water used for irrigated agriculture is less than 2 percent of the total volume of rainfall, leaving 98 percent of the rainfall in the Central Rift Valley to nature, rain-fed agriculture and evaporation from the lakes. Nevertheless, the relatively small fraction of these blue water withdrawals has disturbed the hydrological and ecological balance in the area.

As the valley is a closed basin, it is very sensitive to changes in land and water use. While irrigated agriculture consumes less than 2 percent of the total blue water, it has a far greater impact on the ecosystem than rain-fed agriculture does, even though the latter uses far more land and water.

This is explained by the different interaction between land use and the green or blue water. In rain-fed agriculture, the variability of rainfall is directly reflected by the variability in actual evapotranspiration. Periods with low rainfall result in low actual evapotranspiration, which obviously results in reduced harvests. The rain-fed agriculture and terrestrial ecosystems thus act as a buffer. Irrigated agriculture, however, has the opposite effect. During dry periods, the consumption of blue water increases and the negative impacts of irrigated agriculture on water availability amplify.

In closed basins these impacts accumulate in the downstream areas. Farmers (of irrigated farms) and households frequently experience water shortages during the dry spells, and the downstream ecosystems have been severely degraded. In the past decade the terminal Lake Abyata has gradually shrunk to less than half of its original size.

Increase water productivity

Many African countries are experiencing similar problems. Poverty and degradation of natural resources are the result of a vicious downward cycle. People seem to have no choice other than to deplete natural resources and irreversibly destroy the resource base in their struggle for survival. In Ethiopia, the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) is working together with other partners to support the development of alternative livelihoods that place a lower claim on the water resources, such as fishery and ecotourism.

The development of floriculture and horticulture also seems a promising alternative for development and poverty reduction. As advocated in the CGIAR Comprehensive Assessment, floriculture and horticulture generate a high output value per unit of

water. Through a public-private partnership programme, LNV supports the development of good agricultural practices in these new agricultural sectors.

Upgrade rain-fed systems

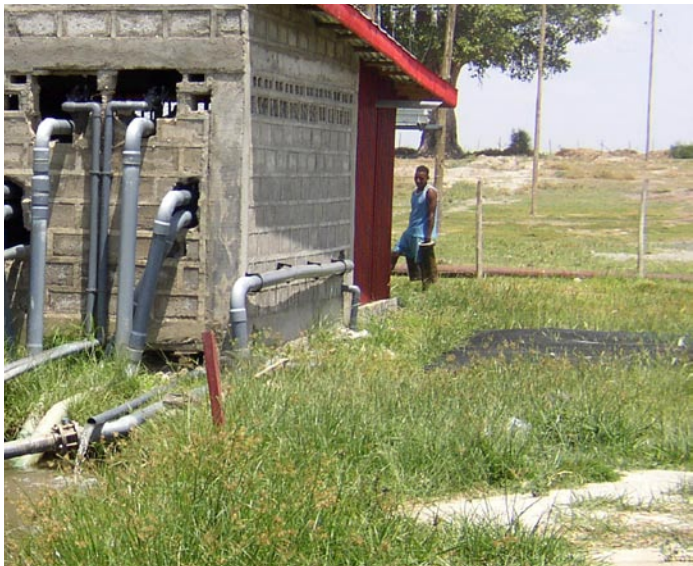
It is widely acknowledged that rain-fed agriculture in Africa must become more productive, also in Ethiopia. According to the CGIAR Comprehensive Assessment, the impact of improving rain-fed farming can be huge: yields can double or quadruple. Despite the land degradation that is occurring in the Central Rift Valley, the physical environment still has good potential for increasing production from rain-fed agriculture. Critical issues that need to be addressed are land rights, access to markets, credit facilities, access to inputs, access to knowledge and improved rainwater management, for example through water retention and water conservation in the catchment.

Increased productivity of rain-fed agriculture will obviously have huge social, economic and environmental impact, as more than one million people in the Central Rift Valley depend on this form of agriculture. Options to upgrade rain-fed systems are being investigated through the partnership programme between the Directorate-General for International Cooperation of the Dutch Ministry of Foreign Affairs (DGIS) and Wageningen University and Research Centre, supported by LNV.

Reform the process-targeting state institutions

The CGIAR Comprehensive Assessment advocates adaptive, multilevel, collaborative governance arrangements to cope with the diversity of competing values and political and economic interests in basins. On a global scale, however, progress on establishing these arrangements has been slow, and cooperation between sectors is not common practice.

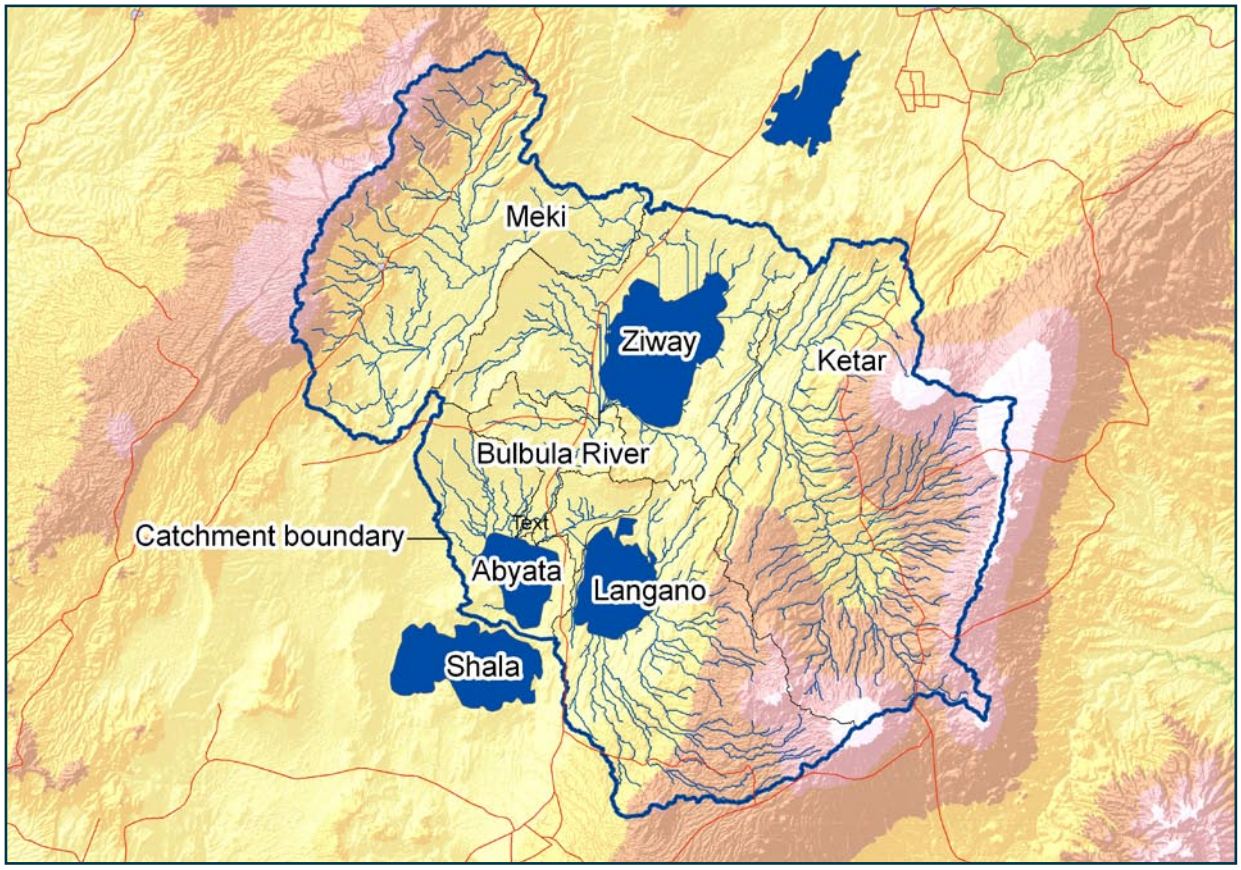
In 2006, the multi-stakeholder Working Group Lake Ziway was established to promote an integrated water resources management approach, contributing to a more sustainable development of the Central Rift Valley. This Working Group consists of professionals from the private and public sector involved in the development of the Central Rift Valley. LNV supports the Working Group in the development of a sound knowledge of water and land related issues. A well-founded knowledge base is imperative to support decision-making with respect to the use and management of resources and to set the right priorities for policy and research. As part of this LNV initiative, a participatory land-use plan for the western shoreline of Lake Ziway has been developed. This has created more awareness on environmental protection and has empowered local stakeholders in their efforts to achieve more sustainable development. This plan also resulted in the identification of a number of 'on the ground' research priorities and the development of activities aimed at improving resource use and management in the Central Rift Valley.



Deal with trade-offs and make difficult choices

The Central Rift Valley faces a dilemma. The pressure to develop irrigated agriculture that would alleviate the extreme poverty is huge. At the same time, however, the natural resources are limited and the resource base is at risk. The further development of irrigation will lead to the overexploitation of surface water resources and eventually result in the salinization of Lake Ziway, which is the largest freshwater reservoir in the area. Many people depend on this lake for their drinking water supply, as the groundwater resources are either brackish or contain high-risk concentrations of fluoride.

Wise and sustainable water management should thus not just aim at conserving the natural beauty and unique ecosystems. It is needed to conserve the resource base. The Ethiopian government is aware of the risks of further expansion of blue water use. It recently issued a Water Master Plan which recommends placing restrictions on irrigation. At the same time opportunities for alternative livelihoods are being explored.



The lakes Ziway, Langano and Abyata in the Central Rift Valley.

CASE: **BAVIAANSKLOOF MEGA RESERVE, SOUTH AFRICA**

The Baviaanskloof is a valley that stretches 75 kilometres between two mountain ranges in the Eastern Cape Province in South Africa. The area is a biodiversity hotspot and is recognized as a unique World Heritage Site because of its beauty and biodiversity. Over a thousand plant species have been recorded, including at least 52 on the IUCN Red List and 20 endemic plant taxa, and a rich faunal diversity. The area is part of the envisaged Baviaanskloof Mega Reserve of about 500 thousand hectares, which comprises a cluster of state-owned protected lands within a network of private and communal land.

There is a strong desire to secure and conserve the natural beauty of the Baviaanskloof, while at the same time rural livelihoods need improvement. The rural population is experiencing increasing pressure on land and water resources and declining returns on agricultural investments. Various land and water problems have already become manifest in the area, such as increased stream bank erosion and water shortages, and these are having detrimental effects on ecosystems and agriculture. These problems are likely to become worse as global climate change continues.

Water is a crucial factor for the present environmental and economic functions of the Baviaanskloof and its downstream areas. Both the Baviaanskloof and the neighbouring Kouga River catchment supply water to the Kouga Dam, which supplies irrigation water to the downstream agricultural lands and drinking water to the Nelson Mandela Bay Metropolitan Municipality. It is expected that the existing pressure on water resources will further increase in the near future.

The main objective of the project is to conserve the biodiversity in a more sustainable way, by optimizing water use for ecosystems, agriculture and domestic use, in such a way that rural livelihoods are also improved.

Manage agriculture to enhance ecosystem services

Good agricultural practices can enhance ecosystem services. Agro-ecosystems provide opportunities to promote services beyond the production of food and other traditional agricultural products. As agricultural production is coming under increasing pressure in the Baviaanskloof, some of the land is being taken out of production and alternative income generating activities are being developed, such as tourism and ecotourism.

The feasibility of Payments for Environmental Services is being investigated as an alternative policy to protect nature and to strengthen rural livelihoods. In this kind of a payment scheme those who benefit from environmental goods and services pay those who provide these services, thus creating

win-win situations. Environmental goods can then be allocated to the most productive economic sectors and/or to the most valuable environmental systems. The ecosystem of the Baviaanskloof provides all environmental functions (De Groot, 2006).

- *Regulation function,* e.g. essential ecological processes, water and soil
- *Habitat function* for flora and fauna (biodiversity)
- *Production function,* e.g. biomass and energy
- *Information function,* e.g. reflection and recreation
- *Carrier function,* e.g. settlements, infrastructure, agriculture

Payments for environmental services schemes should preferably focus on environmental services that cause or can cause conflicts. In the Baviaanskloof these are the regulation, habitat and carrier functions. The payment schemes can generate a higher environmental and economic return than land acquisition, as larger areas can be targeted with the same financial resources. Experiences in the Baviaanskloof project show that the balance between costs and benefits should be evaluated at the farm level. Another finding was that monetary compensations are not always the most appropriate incentive. A good service provision, such as waste management service, free technical consulting and tourism marketing, sometimes better suits the needs of suppliers of environmental services.

Increase the productivity of water

The project investigated the options for increasing the overall water productivity in the catchment rather than trying to increase the water productivity on-farm, for example through alternative irrigation practices or farming systems. The rationale was that a more holistic approach would enhance the scope for improvement, as ecosystems could then be better incorporated and possible reallocation of resources between the various uses better assessed. Payment schemes are being investigated as a possible reallocation model.

A key principle in payments for environmental services is that receiving sectors (the sectors to which land and water resources and services are allocated) pay compensation to the supplying sectors. Obviously a payment scheme is only feasible if the compensation

Environmental services and main stakeholders

Ecosystem function	*Main problems and constraints*	*Main interested and affected parties*
Regulation	Water availability (assurance)	Farmers upstream (Baviaanskloof) Farmers downstream (Gamtoos) Urban population Nature
	Water variability (floods and droughts)	Rural communities and settlements Farmers upstream (Baviaanskloof) Farmers downstream (Gamtoos) Urban population (Nature)
	Water quality (turbidity)	Farmers upstream (Baviaanskloof) Farmers downstream (Gamtoos) Urban population
	Land erosion	Farmers upstream (Baviaanskloof) Farmers downstream (Gamtoos) Nature
Habitat	Pressure on biodiversity (including territory land for fauna)	Nature
Carrier	Pressure on land for livestock and crops	Farmers upstream (Baviaanskloof)

Groot, de, R, 2006. Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. Landscape and Urban Planning, Vol. 75, pp 175-186.

is lower than the receivers' economic or environmental gains but greater than the suppliers' economic or environmental losses. The overall effect then is more optimal use of scarce resources.

In the Baviaanskloof it was relatively easy to identify the interested and affected parties that should be incorporated in the payment schemes. The main receiving sectors are the urban population of Nelson Mandela Bay Metropolitan Municipality and the downstream farmers who grow high-value crops such as citrus and vegetables.

Although the concept of payments for environmental services is clear to everyone, we still face major challenges when it comes to increasing overall water productivity:

- Scientific deficiencies: it is difficult to quantify both the primary impacts of environmental services (reduced erosion, water availability, water quality, etc) and secondary impacts (e.g. increased resilience of ecosystems, reduced purification costs for drinking water).
- The environmental benefits are not constant over the year, particularly for irrigated agriculture and ecosystems. Irrigation water is an insurance rather than a commodity. Benefits of environmental services can never be guaranteed, but should be quantified in terms of 'increased assurance' and 'reduced risk'.
- The obvious high priority to urban domestic water users is under debate, due to disproportional losses in the conveyance and distribution system.
- Social and cultural resistance: not all farmers (suppliers of environmental services) are willing to transform their farming practices towards agro-ecosystems and develop alternative sources of income.
- Skills and attitude: not all farmers have the capacity or interest to develop alternative activities such as ecotourism, which would significantly change their management practices and lifestyle.
- Trust: transformation of farming systems implies long-term investments and long-term agreements with governmental agencies.
- Legal framework: complex current situation with respect to formal and informal water rights.
- Financial framework: provincial agencies responsible for nature conservation have insufficient long-term financial sustainability. Financial schemes that guarantee long-term income should be developed to enable payments for nature conservation.

These challenges are currently being addressed through further technical and socio-economic investigations, stakeholder participation, pilot no-regret measures and monitoring.

Deal with trade-offs and make difficult choices

In addition to extensive participation of the local communities, the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) is supporting PRESENCE, a multi-stakeholder networking initiative incorporating government departments, national agencies, local and international universities and research institutes (including Wageningen University and Research Centre), executive and implementation bodies, NGOs, the private sector and community-based organizations. Cooperation and exchange of knowledge and information are promoting transparency in the process of reconciling competing claims on land and water resources.

CASE: **MULTIPLE USE AND FUNCTIONS OF WATER SERVICES IN COASTAL VIETNAM**

The coastal areas in Vietnam are experiencing intensified use of water. Intensification of irrigated rice schemes and shrimp farming in the brackish water zone has led to severe environmental pollution and degradation, which is resulting in a decline in shrimp production. Degradation of the coastal mangrove forest is also taking place.

Moreover, the Intergovernmental Panel on Climate Change has placed Vietnam in the top five countries in the world most affected by climate change. It is particularly vulnerable to rising sea levels, typhoons and associated storm surges, high-intensity rainfall and higher peak river discharges.

By focusing on the water interactions and interdependencies between the different agro-ecological subsystems, the concept of Multiple Use and Functions of Water Services is envisaged as a way of providing for maximum climate change adaptation functions from a systems approach, together with optimization of food production. To apply the system approach in terms of the different possible functions of water services, various domains of the natural environment are distinguished:

- Irrigated agriculture and aquaculture
- Freshwater floodplain agriculture and aquaculture
- Brackish water zones
- Coastal forests.

The irrigated rice fields are used for crop production and aquaculture, producing rice and shrimps. However, the fields also have a water regulation function. During the rainy season, on-farm water retention takes place. In addition, the water quality of the brackish water zone can be improved through drainage management.

Agriculture in the freshwater floodplains is also combined with aquaculture. This type of 'recession agriculture' can also enhance water regulation, especially seasonal freshwater retention.

In the areas with brackish water, aquaculture uses polyculture techniques, producing multiple species. The water regulation function of these areas refers to the retention of the dynamic brackish water. In addition mangroves are being regenerated. They serve as a natural water filter and also have important ecological functions.

The food production of the coastal forests consists of extensive clam culture and fisheries. For water regulation the forests serve as coastal protection, while they also purify brackish water. The forests also have an important environmental function, as they enhance biodiversity.

The project aims at establishing an institutional and operational framework through which the different sectors – water, agriculture and environment – can collaborate at national and provincial level. This collaboration is aimed at coordinating and integrating the Vietnamese sectoral policies and programmes into a consistent Water for Food and Ecosystems strategy for sustainable integrated water resources management.

Change the way we think about water and agriculture

The multiple case studies conducted in the Mekong delta, the Tam Giang Cau Hai Lagoon in Hue and the Red River Delta have shown how important it is to view agriculture as an integrated multiple-use system and as an agro-ecosystem that provides services to other ecosystems and interacts with them. Through an integrated water management and climate change adaptation strategy, the potential of the various sectors can be enhanced whilst the natural resources can be managed more sustainably.

The case studies revealed that there are beneficial interactions between freshwater (rice) agriculture, brackish aquaculture and brackish/salt nature conservation, which are currently not explicitly acknowledged and exploited. When managed from a multiple-use perspective, these interactions can provide substantial mutual benefits to the sectors involved. Fresh drainage water from rice agriculture can be highly beneficial for the management of the brackish water zone in coastal areas, in particular for maintaining the water quality (salinity levels) required for aquaculture.

The aquaculture sector can introduce innovations towards sustainable waste management and disease control, such as polyculture and the restoration of mangroves. Mangroves can act as biological water filters – which supports aquaculture – while they also enhance biodiversity as they create a regenerative environment for coastal forests.

Integrated multiple-use agro-ecosystems can also play an important role in combating the impacts of climate changes. The foreseen salinization of the coastal zones can be mitigated, while mangroves can provide natural protection against floods.

THE WAY FORWARD

The knowledge and experience gained in the bilateral research projects by the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) and the results of the CGIAR Comprehensive Assessment show that water scarcity is to a large extent related to the way water is managed and the choices that are being made. The current challenges to alleviate the world's water and food problems, in view of the global climate change, environmental degradation, population growth and increased competition for natural resources, require a **fundamental rethinking** of the conceptual framework of water and agriculture.

To sustain water and the environment as the resource base, it is critical to **recognize agriculture as an agro-ecosystem that generates food and ecosystem services**, rather than to consider merely the food production function.

The broader scope of agricultural systems will require tough decisions on allocation, reallocation and/or prioritization of land and water resources, especially for irrigated agriculture. The 'equity' paradigm should be considered with a view to the **wise allocation** of resources and risks among stakeholders, rather than the equal distribution of scarcity. The age in which water can be wasted or only sub-optimally used by sectors or areas must come to an end, despite the reforms that will be required in many cases, and that will entail serious risks of social tension and conflicts.

The necessary reform process represents a major challenge. Active and genuine participation of stakeholders is imperative in the search for consensus and to create commitment to land and water management options, especially for interventions that have large social impacts. Stakeholders will be affected differently: some will benefit more than others, while certain stakeholders may even be deprived of resources or existing rights.

New decision-making processes, which enable fair and transparent decision-making practices, are needed and must involve both the public and private sector. Special attention has to be paid to vulnerable groups. They are most affected and most limited in their capacity to respond to a changing environment. More inter-sectoral and multiple-level cooperation is needed to balance the needs of the various sectors and to balance local interests with regional, national and global interests. This imposes huge demands on all levels of governance.

However, the reconciliation of competing demands on land and water resources and the reform of the agricultural sector **towards agro-ecosystems** will bring more social and economic welfare, and will contribute to coping with the current water, food and ecosystems challenges.

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