3

Regional views for investment

Water for agriculture and energy in Africa: The challenges of climate change

Report of the ministerial conference - 15-17 December 2008 - Sirte, Libyan Arab Jamahiriya

Introduction

The ministerial Conference on Water for Agriculture and Energy in Africa: the Challenges of Climate Change was an opportunity to discuss water development projects within the framework of the Comprehensive Africa Agriculture Development Programme (CAADP) and to mobilize the required financial resources. It specifically focused on concrete programmes and the assessment of their financing costs, both in terms of feasibility studies and implementation of works. The Conference preparation included the production of National Investment Briefs for all the African countries, in which estimated investment needs for agriculture and energy were given. The preparatory work for this Conference allowed the production of new estimates for investment needs at national, regional and continental levels. Concrete projects and programmes for water for agriculture and energy at different stages of implementation (recently implemented, ongoing and pipeline) have been compiled for each African State and aggregated at continent level. The compiled project portfolios have been reviewed and validated by government representatives on the occasion of the five Regional Workshops held prior to the Conference, in which national and regional representatives from the water, agriculture and energy sectors participated.

The objective of these workshops was primarily to help the compilation and validation of project portfolios and their review, as well as the estimation of investment envelopes for water in the agricultural and energy sectors at country and regional levels. More specifically, the workshops aimed to:

- define the investment needs with regard to water for agriculture and energy at country level;
- define priorities of investment in water control;
- share knowledge on national strategies for water, energy and agriculture and investment plans; and
- promote regional integration, particularly concerning large hydropower projects and integrated water resources management in transboundary river basins, and to harmonize actions on a regional scale.

Challenges

An overview of the challenges that Africa as a whole faces, is presented and should serve as a framework for action.

These challenges are summarized below.

- an increasing population projected to reach 2 billion in 2050;
- extreme poverty which, although especially persistent in the rural areas, is shifting towards the urban areas where rural-urban migration increases the need for affordable food for poor people that no longer produce it themselves;
- undernourishment is pervasive in the continent with malnutrition particularly diffuse among infants and children; 24 percent of the population suffer from chronic hunger; and
- many countries on the continent have economies based on agriculture with, on average, more than 50 percent as value added to their GDP (AQUASTAT, 2008). Despite having essen-

tially agriculture-based economies, the agricultural trade balances are often negative;

- climate change poses a significant threat to the continent with more droughts and floods and changes in ecosystems taking place. Building capacities in climate change prediction, promoting mitigation and adaptation technologies is already seen as a must for enhanced agricultural development;
- poor governance and poor management of available water and land resources, which cause productivity to fall below full potential. Irrigation potential is largely untapped. Rainfed agriculture still prevails and is now being affected at various degrees by climate change;
- the continent suffers from limited access to electricity: 77 percent of households in sub-Saharan Africa are without access to electricity, and most rural households still rely on traditional fuels wood, dung and agricultural residues that are strongly affected by the climate variability; and
- despite the enormous hydropower potential of about 1 750 TWh, and the opportunity to ensure energy security through hydropower generation, only 5 percent of the potential is currently tapped.

Water resources for agriculture and energy in the context of climate change

The regional distribution of the African countries adopted for the purpose of the Regional Workshops and for the Conference is shown on Table and Annex 1.

Table 1: Regional distribution

Central Africa	West Africa	East Africa	North Africa	Southern Africa
Cameroon	Benin	Burundi	Algeria	Angola
Central African Republic	Burkina Faso	Djibouti	Libyan Arab	Botswana
	Cape Verde	Egypt	Jamahiriya	Comoros
Chad	Gambia	Eritrea	Morocco	Lesotho
Congo	Ghana	Ethiopia	Tunisia	Madagascar
Equatorial Guinea	Guinea	Kenya		Malawi
Gabon	Guinea Bissau	Rwanda		Mauritius
Democratic Republic of Congo	Ct e d Ivoire	Somalia		Mozambique
	Liberia	Sudan		Namibia
Sao Tome and Principe	Mali	Uganda		Seychelles
	Mauritania			South Africa
	Niger			Swaziland
	Nigeria			United Republic of Tanzania
	Senegal			Zambia
	Sierra Leone			Zimbabwe
	Togo			

Poverty is common and sometimes extreme in Africa (a summary of the results is provided in Table 2). Thirty-four of the 49 least developed countries (LDCs) are African and 315 million people,

or 36 percent of the total population, survive on less than US$1/day. The sum of national GDPs of all African countries in 2007 amounted to approximately US$1 200 000 million, or barely 10 percent of the GDP of the United States of America in the same year. It corresponds on average to a per capita GDP of US$4 800. in North Africa, US$4000 in Central Africa, US$2 600 in Southern Africa, US$700 in West Africa and US$600 in East Africa. The differences amongst countries are marked, with the per capita GDP ranging from US$190 in Liberia to US$8 564 in Seychelles. The human development index (range = 0-1) varies from 0.336 in Sierra Leone to 0.843 in Seychelles (ranked as 50th out of a total of 177 countries globally), while the 22 countries with the lowest HDI are African (UNDP, 2007).

In 2007, the added value of the primary sector (agriculture) contributed, on average, 24 percent to the GDP in Africa, ranging from 18 percent in Southern Africa to 30 percent in East Africa. Some countries, show a very high reliance on agriculture with a contribution to the GDP of the sector higher than 65 percent, e.g. Somalia and Liberia. More than half of the economically active people are engaged in the farming sector, with the only exception of North Africa (21 percent). At the country level, where 90 percent of the total labour force is engaged in the primary sector, Burundi and Rwanda are the two countries with the most limited cultivable area per inhabitant on the continent (less than 0.2 ha/person). Conversely, Namibia and Gabon, with the largest cultivable area per person (12.4 and 11.2 ha/person respectively), have less than 40 percent of their economically active people working in the primary sector. With 5 percent of economically active people engaged in agriculture and cultivating about 23 ha per active agricultural worker, the Libyan Arab Jamahiriya is the country with the lowest percentage of economically active people in this sector.

Table 2: Regional indicators

Variable	Unit	North Africa	Central Africa	Southern Africa	West Africa	East Africa
Total area	1 000 ha	475 144	536 598	751 954	614 321	626 560
Population - current	1 000 inhabitants	80 287	93 702	186 409	263 631	280 777
Population - predicted	1 000 000 inhabitants	160	689	1 000	228	374
Rural population as % of total population	%	32.51	52.13	63.62	58.90	67.30
Gross domestic product (GDP)*	million US$	301, 913	66 764	416 323	249 417	243 087
Value added in agriculture	% of GDP	18.21	21.34	17.92	32.88	29.44
Number of undernourished persons**	million inhabitants	3.20	49.20	53.40	37.20	69.30
Poverty headcount (share of population) - rural **	%	19.23	58.45	64.05	55.52	50.17
Poverty headcount (share of population) - urban **	%	7.60	42.55	43.73	32.71	29.67
Water resources: total renewable (actual)	(10^9 m^3/yr)	46	2 858	1 032	1 315	385
Total dam capacity	(10^9 m^3)	25	16	316	256	185
Irrigation potential	1 000 ha	2 774	10 346	13 172	9 159	11 343
Area equipped for irrigation: total	1 000 ha	2 918	83	3 436	1 069	5940
Agricultural water managed area: total	1 000 ha	2 918	211	3 944	2 148	6 173
Agricultural managed water as a % of cultivated area	%	13.18	3.83	8.57	6.68	25.64

* World Bank, 2007

** FAOSTAT, Food Security Statistics, 2006

Source: AQUASTAT, 2008

Annual precipitation in Africa is estimated at 20 360 km^3, which constitutes an average for the continent of 678 mm. Disparities between countries and regions are very important. The driest

country is Egypt with 51 mm/year on average, followed closely by the Libyan Arab Jamahiriya (56 mm/year) and Algeria (89 mm/year), with Morocco (346 mm/year) and Tunisia (207 mm/year) as the most advantaged countries in the northern region. This is the driest region on the continent with an average of 96 mm/year.

Renewable water resources for the whole of Africa amount to about 3 930 km^3, or less than 9 percent of global renewable resources. The central region is the best endowed, with 48 percent of Africa s resources for only 18 percent of its area. On the other hand, the northern region is the most disadvantaged with less than 1 percent of the renewable water resources. The Democratic Republic of the Congo has 900 km^3 of internal renewable water resources, 23 percent of the total for Africa, while the Libyan Arab Jamahiriya has only 0.01 percent of these resources.

The irrigation potential of the continent is estimated at more than 42.5 million ha, considering irrigation potential by basin and renewable water resources. One-third of this potential is concentrated in two very humid countries, Angola and the Democratic Republic of the Congo with a potential of 3.7 and 7 million ha respectively. Most of the regions in Africa are highly dependent on rainfed conditions, as shown below.

- Central Africa is the region that shows the highest dependency on rainfed agriculture and, with the exception of S o Tom , Chad and, to a lesser degree, Cameroon, the regional irrigation potential is largely underexploited. Only 212 000 ha, or just over 2 percent of the 10 000 000 ha of potentially irrigable land are under water management.
- Central Africa About 50 percent of the 11.3 million ha of irrigable land in the East African region is equipped; however it ranges between the 77 percent of Egypt to only 2 percent in Rwanda and Eritrea. Note that only two countries, Egypt and Djibouti, completely rely on irrigated agriculture, while in other countries such as Uganda, Ethiopia and Kenya, water control is still not significantly developed.
- Instead North Africa appears to be an exception to the previously indicated trend with very large areas of land, in terms of irrigation potential, under water management regimes, ranging from just over 75 percent in Tunisia to around 90 percent in Morocco. In the case of the Libyan Arab Jamahiriya, because the country exploits its fossil fuel deposits, the controlled areas far exceed the irrigation potential based on renewable freshwater resources, and the potential exploitation rate is around 1 175 percent.
- West Africa suffers from chronic water shortages because of uneven rainfall distribution, low levels of water mobilization (less than 2 percent) and poor water management. Only 10 percent of the potentially irrigable lands are equipped for irrigation, with the agricultural water managed area ranging from 28.8 percent of the cultivated area in Sierra Leone to less than 1 percent in Benin, Ghana and Togo.
- Less than 7.5 percent of the Southern African region s vast irrigation potential has been equipped. Only in a few countries (Madagascar, Mauritius and Swaziland) more than 20 percent of the cultivated area is equipped for irrigation, while in countries with great potential such as Zambia or Mozambique less than 5 percent of the cultivated land is equipped.

The technically feasible hydropower potential of Africa is around 1 750 TWh which is about 12 percent of the global capacity. Only 5 percent of this technically feasible potential is exploited. The demand for electricity in Africa grows at an average annual rate of 3.1 percent, while the rapid exploitation of this enormous potential is hampered by dispersed population and ever-increasing demand for electricity.

Climate change is already recognized as an important factor impacting the agricultural and energy sectors in Africa. Increased climate variability already affects its water resources, land, forests and biodiversity, and these impacts are likely to worsen over time. According to the Intergovernmental Panel on Climate Change (IPCC), the cost of adaptation in Africa could be as high as 5 10 percent of the continent s GDP. Agricultural production and food security in many African countries are likely to be severely compromised by climate change and climate variability, and projections indicate reduced yields of up to 50 percent in some countries by as early as 2020, with small-scale farmers being the most affected.

Some countries have already experienced an increase in frequency, extent, and magnitude of droughts and floods. Also, coastal areas and island states will increasingly be affected by sea level rise while, in a wide range of countries, erosion of natural resources resulting from climate change will increasingly burden traditional agriculture and pastoral livelihoods. Furthermore, throughout the Sahara Belt climate change is expected to further reduce food production, due to declining rainfall and increased variability, with a fall in crop yields of up to 70 percent in the most vulnerable areas. Climate change has also impacted on hydropower generation: soil erosion, in fact, has directly affected the total storage volume of many of the reservoirs in Africa, as exemplified by the case of the Koka dam in Ethiopia, resulting in a reduced power generation capacity and in a reduction of the benefits obtained from irrigated agriculture.

Investment programmatic framework and envelope

The Regional Workshops have stressed the need to move from a project-based approach to a programmatic and integrated overview for the water and energy sectors. The important contribution that irrigation can make to food security has to be recognized, especially given that rainfed agriculture, which currently accounts for the bulk of agricultural production, is highly vulnerable to climate change. If lower yielding and extensive rainfed production can reliably meet demand in food staples, then stabilizing rainfed production, particularly small scale, should be the most economic means of achieving food security. But, if the volatility of rainfed production becomes intolerable, irrigation of staples whether promoted through economic incentives or structural planning or a combination of both becomes necessary. This makes it urgently necessary to encourage complementary irrigated agriculture (off-season production, etc.) by both small-scale and large-scale irrigation, which more than ever now are closely geared to local and regional demands and conditions.

With the foregoing in mind, the programmatic framework for investment can be synthetically presented as follows:

- Actions undertaken can be based on the individual National Investment Briefs but must be seen within the context of a shared regional vision, and eventually an overall African one.
- The objectives of the investment plan should aim to address poverty alleviation through food security and upgrading health services, agricultural development supported by hydraulic and energy infrastructure, the promotion and scaling up of renewable and alternative energies, and the protection of ecosystems and the environment.

- While priorities necessarily vary from country-to-country, conjunctive use of water resources must be a key consideration in all efforts. Likewise, all water projects should address the viability of power generation components, and reflect a river basin perspective. Thus, an integrated water resources management approach shall be an embedded component of the investment plan.
- A capacity development component should be inherent to every element of the investment plan. Indeed, the needs are broad: i) enhancing institutional and managerial capacity for the absorption of investment funds at both country and regional level; ii) upgrading capacity to deal with climate issues, such as variability and impact of change, mitigation and adaptation for both rainfed and irrigated conditions, predictions and early warning systems, etc.; and iii) support for adoption and implementation of climate change adaptation action plans at national and regional levels; already under various degrees of preparation.
- As shown in the preparatory work of the Conference, the cumulative amount of investments for ongoing and pipeline projects in water for agriculture and energy on the continent reaches about US$64.6 billion. The investment framework specifies the size of irrigation infrastructure (small-scale irrigation, rehabilitation of irrigation, large hydraulic projects) and distinguishes between projects and programmes in the short (< 4 years), medium (between 4 and 8 years) and long term (> 8 years). The highest proportion of the cost is noticeably allocated to large-scale projects including large-scale irrigation schemes development and hydropower projects. Similarly, 56 percent of the total investment envelope is expected to be exhausted in the medium term, showing a clear need to enhance the planning for investments in the long term to ensure sustained and permanent growth in the agriculture and energy sector to meet the food and energy security goals.

Table 3: Investment Envelope (million US$)

Time frame/size of project	Small scale water control	Rehabilitation of irrigation	Large scale	Total
Short-term	2 385	778	7 818	10 981
Medium-term	7 041	3 509	28 207	38 758
Long-term	1 491	1 329	12 042	14 862
Total	**10 917**	**5 616**	**48 067**	**64 600**

- As demonstrated by the results of the preparatory work for the Conference, Western Africa, with the great hydropower potential to be exploited, accounts for 32 percent of the continental investment envelope. Southern Africa, East Africa and North Africa have a share of 26, 24, and 15 percent respectively, while the residual 3 percent is for Central Africa, indicating that more effort should be made in the region to undertake project formulation and feasibility studies in the water sector, particularly considering the enormous hydropower potential not yet exploited.

Table 4: Regional distribution of the investment envelope

Time frame/size of project	North Africa %	East Africa %	West Africa %	Central Africa %	Southern Africa %
Short-term	16%	10%	35%	11%	28%
Medium-term	12%	29%	29%	2%	28%
Long-term	23%	19%	37%	1%	20%
Total	**15%**	**24%**	**32%**	**3%**	**26%**

Institutional environment

It is necessary to harmonize sectoral policies (water, agriculture, energy and economic development, among others). The approach entails very close sub regional cooperation and countries will therefore need to align and integrate their agriculture and energy policies accordingly. Thus, this makes it appropriate for the countries to embark on high-level institutionalized regional cooperation.

Regional cooperation and integration will play a vital part in the joint management of water resources, the development of agricultural product markets and energy. This would make it possible to create free-trade areas and introduce the mechanism needed to encourage trade and the exchange of experiences. In practical terms, supplementary human and financial resources must be marshaled more than ever, and conflict prevention and management mechanisms must be put in place. Likewise, regional standards for irrigation must also be developed and promoted.

The countries possess different and complementary areas of expertise, and exchanging them would be mutually beneficial. Establishing regional centers specializing in research and training, and collectively mobilizing financing will make it possible to make up for the knowledge deficits at the lowest cost. Scientific and technical cooperation, and the harmonization of rules and procedures, will also be promoted to encourage trade. Unfortunately, national institutions are often weak and are unable to produce robust field-based projects. Therefore, an investment-friendly framework must be created for the construction of economically profitable and socially and environmentally justifiable infrastructure, and the quality of investment feasibility studies must be improved.

The Regional Workshops have recognized that an Integrated Water Resources Management (IWRM) approach needs to be put into practice, both with regard to inter-sectoral management and the management of the large transboundary basins. For this, the African countries proposed establishing a subregional structure to coordinate the various IWRM plans. Promoting multipurpose works and a framework for concerted action and coordination between water users should also make it possible to control the competition between energy and irrigation needs.

Therefore, in summary, a successful institutional environment for the implementation of the investment plan will require, in addition to its promotion, the facilitation to ensure that a number of conditions are met: i) to have a favourable institutional framework with a strong emphasis on governance; ii) to seek and secure effective involvement of regional bodies to balance the issue of sovereignty and ensure equitable access to resources (water and energy); iii) to ensure wide market access, both agriculture and energy-related; iv) to include a strategy for better land care (soil and water conservation, watershed and river basin management, including agro-pastoral and forestry considerations); and v) to strengthen the capabilities for intervention, with emerging and proven water technologies playing a lead role.

Finally, countries recognize that in general there is a lack of information, which prevents them from making informed decisions. Therefore, countries stress that the obligation to collect data in order to have reliable databases at national level and implement monitoring and evaluation should be governed by law.

Implementation strategies and financing mechanisms

Investment programmes must be designed taking into account the food, energy security and climate change adjustments; but they also need to include economic development, health care, education and environmental objectives in general. Factors such as population density, the vulnerability of the population to climate variations, the types of agricultural producers and the options available for both public and private intervention in the matter of energy and agriculture need consideration.

Any attempt to accelerate investment for food and energy security must remain coherent with the principles of the Paris Declaration on Aid Effectiveness and the Accra Agenda for Action, and therefore build on available funding mechanisms. Examples exist of vertical funds to address specific issues at regional level. The question, as to whether such vertical funds should be promoted or existing financing mechanisms should be scaled up to accommodate the additional financing, is worth considering.

A priority for all countries in Africa is to effectively allocate their own resources as part of the investment envelopes in order to signal the seriousness of their commitment to donors and partners; such action should be a key element of any investment implementation strategy. In addition, sub regional pool funds to support agriculture and energy components need to be designed and incorporated as part of a broad investment plan financing mechanism. More innovative approaches, such as taking advantage of carbon trade and funding opportunities or specific renewable energies-related incentive funds, among others, need to be seized to support hydropower in Africa.

The five Regional Workshops stressed the following:

- Approaching the implementation of the overall African Investment Plan based on the respective Regional Plans through the development of a shared vision that has both regional and continental bodies playing, overseeing and coordinating roles that create synergy, trust and provide confidence towards fair and balanced interventions.
- The emphasis on the Investment Implementation Plan must reach into the realm of food security and poverty alleviation while underpinning the need to protect the environment. The Plan must be directed towards the optimization of water resources utilization for which human and institutional capacity building is essential.
- The need for massive Regional Capacity Development efforts, aggregating eventually at the continent level, should be seen as an integral component of the Investment Plan and cut across disciplines and projects.
- In general, each country will be strongly committed to develop and emphasize water technology options and packages that provide, *in primis*, a clear added value to their own conditions, but always adopting a synergic approach to implement optimal solutions on a national, regional and continental scale.
- Concrete opportunities should be provided for an increasing role of the private sector, in itself or through private-public partnerships, for both water for agriculture and energy.

- A clear and transparent monitoring and evaluation mechanism at regional level, as well as national data collection mechanisms and databases, is required to convey a sense of fairness in prioritizing activities and to provide guidance of when and where further interventions should be forthcoming.

With regard to energy security, work must begin on framing appropriate policies and strategies, stressing: i) the diversification of energy sources; ii) the development of renewable energy sources with particular focus on the exploitation of the currently untapped small and large hydropower potential; iii) the interconnection of networks as a factor for regional integration; and iv) the role of micro-power plants to facilitate rural electrification and for the decongestion of the large networks.

Conclusions

African governments, financing institutions and other development partners would need to undertake firm commitments to initiate and guarantee the financing of projects to improve food security and energy security (accompaniment measures).

Recently, substantial progress has been made in terms of national, regional and international commitments. In 2002, NEPAD s Comprehensive African Agriculture Development Programme (CAADP) offered a framework for investment in agriculture in Africa, with special emphasis on water control. In Maputo, in 2003, the Heads of State and Governments of the African Union committed themselves to allocating at least 10 percent of their national budgetary resources for agriculture and rural development. In 2004, the Sirte Declaration focused on ways to implement integrated and sustainable development of agriculture and water in Africa. In 2005, the Report of the Commission for Africa titled Our Common Interest highlighted the need for investment in water and energy infrastructure.

So far, based on available information, only five countries have achieved the Maputo budget allocation target. Estimates indicate that about a dozen countries have reached or exceeded half of the Maputo budget target. The African regions have the necessary experience and expertise, and encouragement and incentives must be provided to share it (South-South Cooperation). The same applies to cooperation between the African Regional Economic Communities. The recommendations made at the earlier international fora have not yet been implemented. The causes of this situation must be analysed in order to ensure that the Sirte 2008 Conference reaches concrete and operational plans of action.

Successful implementation of the proposed African water sector investment plans clearly requires a major new round of commitment not only from the various development partners; but also the private sector as investors, operators and users of water sector infrastructure. Moreover, the success of the national and regional investment plans will be ensured only by focusing more on funding structural investments in water management for the highly interconnected sectors of agriculture and energy, without neglecting the importance of emergency measures, which necessarily act in synergy with long-term investments. Governments should clearly set out their priori-

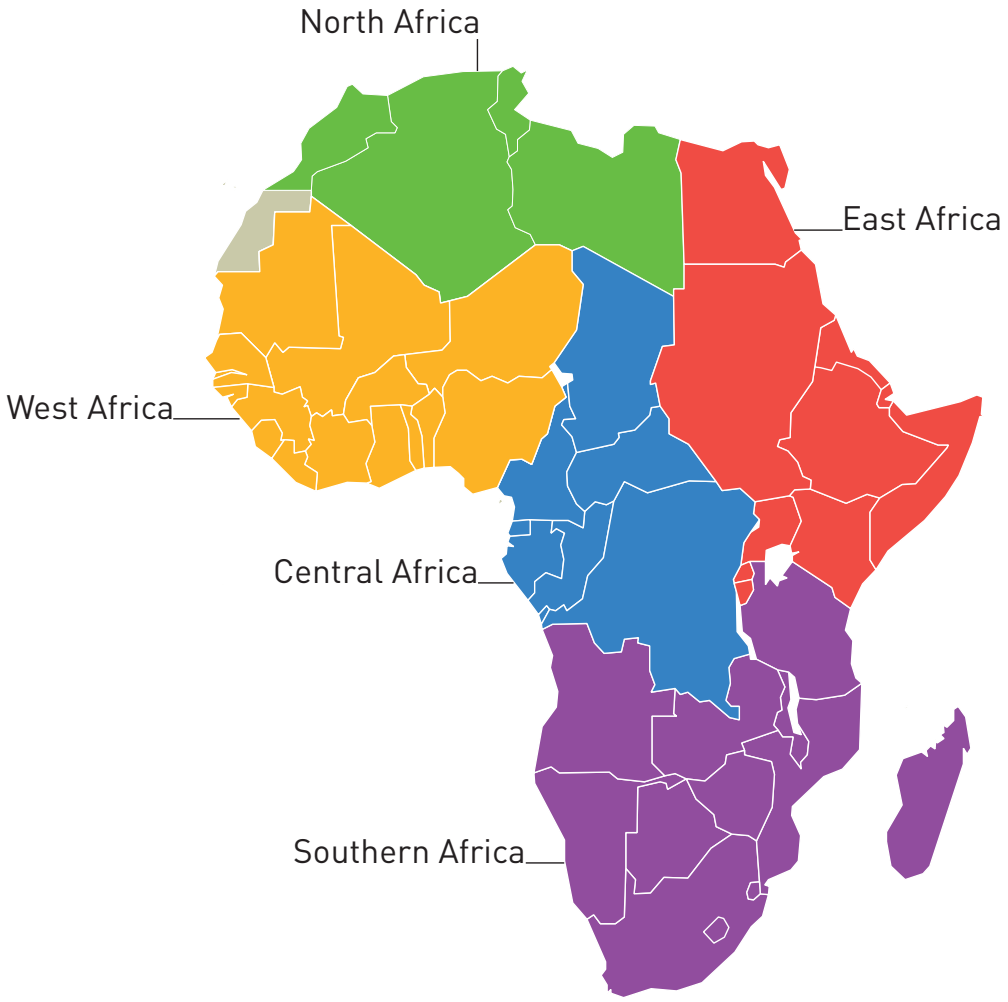
ties and take them into account when framing their investment programmes. Each government needs to promote and develop suitable policy and strategy documents for developing the water for the agriculture and energy sectors that are in line with the respective investment envelopes. The policies defined to implement the national investment programme should be incorporated into wider and holistic regional initiatives, particularly in the context of regional power pools and river basin organizations.

External investment, both public and private, should be promoted in countries with plentiful water and land resources still awaiting exploitation, particularly those that cannot afford to finance water mobilization infrastructure. A measure of this kind would help to increase food production, and would benefit both sides investors and proprietors alike. The development partners should support countries in post-conflict situations to help finance their priority projects.

There is a strong need for expanded irrigation while enhancing water control in rainfed agriculture which represents the bulk of farming activities in the continent; but care should be taken to embed climate change adaptation measures from the outset. Governments should develop climate change adjustment action plans. Similarly, in areas where the opportunity costs of water can be expected to increase, care must be taken to ensure that farmers and extension services are able to adapt to aptly valued farming systems. It should be noted that irrigation expansion will, in most cases, require storage. This suggests opportunities for multi-purpose dams at various scales, from community up to basin level. This in turn calls for greater inter-sectoral planning and cooperation than may have been the case to date.

There is a clear need to raise existing levels of expenditures on agriculture and food security, which are far below NEPAD-CAADP initial projections, while massively increasing investments in hydropower and introducing a new focus on general water resources management, especially where there are transboundary issues. Mechanisms (political, fiscal and economic) must be put in place to create a framework to encourage private investment in agriculture and hydroelectricity and to forge private-public partnerships in this area.

Annex 1: Regional Distribution



Annex 2: Africa and the World

Variable	Unit	Africa	World	Africa as % of the world
Total area	1 000 ha	3 004 084	13 442 788	22
Cultivated area	1 000 ha	210 697	1,540 708	14
in percentage of total area	%	7	11	
per inhabitant	ha	0.24	0.24	
per economic active person engaged in agriculture	ha	1.03	1.16	
Total population 2004	Inhabitants	868 094 000	6 377 646 000	14
Population growth 2003-2004	%/year	2.2	1.2	
Population density	Inhabitants/km^2	29	47	
Rural population as percentage of total population	%	61	51	
Economically active population engaged in agriculture	%	56	21	
Precipitation	mm/year	678	818	18
Renewable water resources	km^3/year	3 931	43 744	9
per inhabitant	m^3/year	4 521	6 859	
Irrigation	ha	13 444 875	277 285 000	5
in percentage of cultivated area	%	6	18	

Source: Irrigation in Africa in figures, AQUASTAT, 2005

Annex 3: Investment envelopes

North Africa				
Time frame/size of project	**Small-scale water control**	**Rehabilitation of irrigation**	**Large-scale**	**Total**
Short-term	555	163	1 059	**1 777**
Medium-term	1 803	820	2 216	**4 839**
Long-term	481	200	2 711	**3 392**
Total	**2 839**	**1 183**	**5 985**	**10 007**

East Africa				
Time frame/size of project	**Small-scale water control**	**Rehabilitation of irrigation**	**Large-scale**	**Total**
Short-term	299	153	599	**1 051**
Medium-term	1 117	596	9 605	**11 318**
Long-term	94	105	2 680	**2 878**
Total	**1 510**	**854**	**12 883**	**15 247**

West Africa				
Time frame/size of project	Small-scale water control	Rehabilitation of irrigation	Large-scale	Total
Short-term	710	134	3 025	**3 869**
Medium-term	1 794	684	8 648	**11 126**
Long-term	458	333	4 718	**5 509**
Total	2 962	1 150	**16 391**	**20 504**

Central Africa				
Time frame/size of project	Small-scale water control	Rehabilitation of irrigation	Large-scale	Total
Short-term	159	83	991	**1 234**
Medium-term	167	63	526	**756**
Long-term	9	1	162	**171**
Total	**335**	**148**	**1 679**	**2 161**

Southern Africa				
Time frame/size of project	Small-scale water control	Rehabilitation of irrigation	Large-scale	Total
Short-term	661.95	244.29	2 144.47	**3 050.70**
Medium-term	2 160.57	1 345.93	7 212.63	**10 719.13**
Long-term	449.36	691.23	1 771.11	**2 911.69**
Total	**3 271.88**	**2 281.45**	**1 1128.21**	**16 681.53**

4

Irrigation projections for 2030-2050

Water for agriculture and energy in Africa: The challenges of climate change

Report of the ministerial conference - 15-17 December 2008 - Sirte, Libyan Arab Jamahiriya

The baseline

This paper presents the results of an analysis of irrigated agriculture in Africa on the basis of agricultural trends data compiled by FAO as part of its World Agriculture: towards 2030/2050 programme (FAO, 2006a), referred to here as AT2030/2050. The AT2030/2050 study presents a perspective on future agricultural supply and utilization on the basis of national demand and production of the main agricultural products in each country. It is driven by two key variables, population and income. Because the AT2030/2050 analysis is undertaken for 93 developing countries, South Africa is not a part of the detailed projection analysis for individual crops but has been incorporated to prepare the final estimates of irrigated areas and associated costs.

This analysis updates the work presented for sub-Saharan Africa (FAO, 2006a) and has been developed from two principal sources:

- the agricultural trends data generated for *World Agriculture: towards 2015/2030 an FAO Perspective* (FAO, 2003); and
- FAO s AQUASTAT database, which specifies irrigated areas at national level in geographic regions over which there is a degree of physical and climatological homogeneity

Current data for agricultural water management was taken from AQUASTAT and is summarized in Table 1:

Table 1: AQUASTAT Irrigated Areas, 2008

	Areas equipped for irrigation		Non-equipped cultivated wetlands and inland valley bottoms		Non-equipped flood recession cropping area		Total area under water management	
Region	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of total	Area (ha)	% of all Africa
Central	122 739	28	1 000	0	322 500	72	446 239	3
Eastern	616 143	73	233 195	27	-	0	849 338	6
Gulf of Guinea	542 699	39	167 238	12	681 914	49	1 391 851	9
Islands	1 132 123	99	-	0	9 750	1	1 141 873	7
North Africa	6 339 756	100	-	0	-	0	6 339 756	41
South Africa	1 498 000	100	-	0	-	0	1 498 000	10
Southern	565 427	75	181 900	24	8 510	1	755 837	5
Sudano-Sahelian	2 639 728	88	96 724	3	257 984	9	2 994 436	19
Total	**13 456 615**	**87**	**680 057**	**4**	**1 280 658**	**8**	**15 417 330**	**100**

Table 1 indicates that the whole of sub-Saharan Africa (all regions except North Africa and islands) has a total area equipped for irrigation of 5 874 267 ha.

However, in order to establish consistency with the regional groupings adopted for the Sirte 2008 Conference it was necessary to cluster country data from both AT2030/2050 as indicated in Table 2. Countries shaded are those for which AT2030/2050 data do not exist. Given the importance of South Africa in regional statistics, the current 1.5 million ha of area equipped for irrigation has been added to the projection analysis and expanded at a growth rate of 0.5 percent per year given the limited land and water availability in the country.

Table 2: Africa regional groupings for the Sirte Conference			
Region	**Countries**		
Central Africa	Cameroun	Congo Democratic Republic	Sao Tome and Principe
	Central African Republic	Equatorial Guinea	Tchad
	Congo	Gabon	
West Africa	Benin	Guinea	Nigeria
	Burkina Faso	Guinea Bissau	Senegal
	Cape Verde	Liberia	Sierra Leone
	Cote D Ivoire	Mali	Togo
	Gambia	Mauritania	
	Ghana	Niger	
East Africa	Burundi	Ethiopia	Sudan
	Djibouti	Kenya	Uganda
	Egypt	Rwanda	
	Eritrea	Somalia	
North Africa	Algeria	Morocco	
	Libya	Tunisia	
Southern Africa	Angola	Mauritius	Kingdom of Swaziland
	Botswana	Tanzania	Tanzania
	Comoros	Mozambique	Zambia
	Lesotho	Namibia	Zimbabwe
	Madagascar	Seychelles	
	Malawi	South Africa	

Projections

Irrigated areas

For every country, the AT2030/2050 projections assume that a food supply utilization account can be closed and demand for calories is met by domestic production and through imports from world markets for all major crop types. Assumptions are made for individual crop yields and cropping intensities to the extent that the areas for rainfed and irrigated production can be projected. These projections assume that current growth trends are maintained and are therefore policy neutral as they make no assumptions about policy changes, constraint removal or trade regimes. The only constraint is that the supply utilization accounts have to close and that physical limits of land and water are respected. The 2030/2050 projections indicate that from a 2000 baseline of 12 816 million ha, an annual growth rate of some 0.9 percent is maintained. This is in line with actual growth rates recorded for the period 1992-2000 (FAO, 2005). The increases in the areas equipped for irrigation are shown in Table 3.

Table 3: Projections of areas equipped for irrigation by region					
Region	**Projection Year**				
	2000	**2030**	**2050**	**Increase 2000-2030**	**Increase 2000-2050**
	(1 000 ha)			**%**	
Central	84	98	113	14.3	25.7
West	923	1 197	1 502	22.9	38.5
East	5 807	7 403	8 057	21.6	27.9
North	2 721	3 251	3 546	16.3	23.3
Southern	3 281	3 740	4 244	12.3	22.7
All Africa	12 816	15 689	17 462	18.3	26.6

Associated costs

Assumptions on unit costs have been compiled from the FAO AQUASTAT database and applied across an investment typology similar to that used for the CAADP estimates prepared in 2003 (NEPAD, 2002). These unit costs, at 2008 prices, are presented below in Table 4.

Table 4: Cost estimates and distributions of different types of agricultural water management

	Local cost (Mostly labour)	Non local cost (Capital) %	Central Africa	West Africa	East Africa	North Africa	Southern Africa
Type of investment	Unit Costs ($Us/ha)						
Large-scale irrigation development	25	75	10 000	12 500	12 500	6 000	9 000
Large-scale irrigation rehabilitation	25	75	3 000	4 000	4 000	2 000	3 000
Small-scale irrigation development	50	50	3 000	3 500	3 500	2 000	2 500
Wetland development: inland valley bottoms etc.	65	35	600	600	600	600	600
Water harvesting, soil and water conservation	70	30	300	300	300	300	300
Land improvement	100		100	100	100	100	100
	Distributions (% of total area)						
Large-scale irrigation development			2.36	1.71	2.16	19.41	3.12
Large-scale irrigation rehabilitation			5.87	8.19	8.63	22.84	7.26
Small-scale irrigation development			9.64	5.33	6.41	9.41	7.98
Wetland development: inland valley bottoms, etc.			16.57	10.90	11.62	0.00	6.62
Water harvesting, soil and water conservation			9.98	23.14	22.69	7.01	23.44
Land improvement			55.59	50.73	48.48	41.34	51.58

The overall investment estimates (at 2008 costs) required to bring the additional AT2030/2050 projected irrigated areas into production and maintain them through at least one cycle of rehabilitation are calculated at approximately US$56 billion for the whole African continent. The assumptions are that current trends in irrigated and rainfed production are maintained and that the entire 2000 baseline is rehabilitated during 2000-2030, split between large and small scale, and that 50 percent of the entire resulting 2030 baseline is rehabilitated between 2030 and 2050. (Table 5)

Table 5: Cost estimate assumptions based on 2008 costs				
Region		Costs (US$1 000)		
		Increment to 2030	Increment to 2050	
Central	New	64 218	62 117	
	Rehabilitation	109 907	64 586	
West	New	1 462 255	1 626 089	
	Rehabilitation	1 572 039	1 019 980	
East	New	8 983 289	3 680 455	
	Rehabilitation	10 454 881	6 664 767	
North	New	2 033 651	1 132 057	
	Rehabilitation	3 480 668	2 079 276	
Southern	New	2 046 172	2 244 321	
	Rehabilitation	4 868 327	2 775 192	
All Africa	New build	14 589 586	8 745 039	23 334 625
	Rehabilitation	20 485 822	12 603 801	33 089 623
Total		**35 075 408**	**21 348 840**	**56 424 248**

Analysis

Irrigated areas

As a guide, physical water scarcity becomes apparent when withdrawals begin to exceed 40 percent of the annually renewable resource (ARR 40%). With the exception of North Africa and several of the drier Sahelian countries, the projected growth is within available land and water limits, although expansion of irrigated areas in already committed river basins and aquifers needs to be avoided or alternative sources of water supply sought.

However, high volumes of water can be seasonal, meaning that they cannot be used without storage. Given the increasing demand for energy, it is likely that some water will be allocated for hydropower generation for which operating rules may be inconsistent with the seasonal demands of irrigation; and from which evaporation losses may be significant. This challenge is particularly relevant in the African context given that much of the irrigation potential is situated upstream of the hydropower potential. Because irrigation is a consumptive use of water, uncontrolled expansion can compromise existing generation capacity or reduce hydropower potential. However, wherever irrigation potential lies downstream of the hydropower potential, and despite evaporation losses from the reservoir surface, the dams may be designed and operated in such a way that downstream irrigation can be expanded.

The nature of the national production data used in AT2030/2050 prevents any meaningful assessment of temporal, or vertical expansion of irrigation (by increasing cropping intensities). Without annual hydrographs and local cropping patterns, it is difficult to be sure about the possibilities of multi-cropping. However, where storage is already in place, or planned, the possibility of multiple cropping is increased.

A comparison between the total potential irrigable areas (AQUASTAT) and those projected in the 2030/2050 data showed that only Madagascar s projections exceeded the available land while remaining within water resource limits. For all other countries the projections are generally consistent with current rates of growth. Further, it is clear that the assumed increases in equipped areas are modest with some 70 percent of all countries equipping 55 percent or less of their potential areas.

Yield gap closure

Closing yield gaps on existing irrigated areas still needs to be seen as the first step towards increased productivity and food security, agriculture based economic growth and market stimulation. To this end, the analysis shows that simply closing prevailing yield gaps could save a total of more than 922 000 ha new build by 2030, and additionally more than 866 000 ha by 2050. It is emphasized, however, that these projections are based on target yields only for a range of selected crops. Yet, the potential benefits of yield gap closure will be clear, even if the actual target yields are not achieved.

Regional trade

Regional trade of surplus production or the allocation of water amongst riparian countries according to specific technical comparative advantage in a particular crop could be a complement to domestic production.

An example of the regional trade of surplus production can be derived from FAO projections to 2015 (FAO, 2003) for the countries of the Eastern Nile Basin (Egypt, Ethiopia and Sudan). These projections included estimated country shortfalls, which have yet to be provided for the AT2030/2050 projections. These are needed for an assessment of regional trade potential. This shows for instance that in this region:

- surplus rice grown in Egypt could be more than enough to satisfy demand in Sudan and Ethiopia;
- surplus sorghum (already irrigated in all three countries) grown in Sudan could fill shortfalls in Ethiopia; and
- Ethiopia s coffee surplus could satisfy demand in Egypt and Sudan.

The deployment of technical comparative advantage can occur if a nearby country can increase its production of a specific commodity with greater natural resource efficiency. Wheat provides an example of how this may work.

Under business-as-usual conditions, the data indicates a total shared deficit for wheat of over 8.5 million tonnes in the Eastern Nile Basin. In 2007 production in this region was as follows:

- Egypt produced 7 379 000 tonnes on 1.139 million ha (6.478 t/ha);
- Sudan produced 642 000 tonnes on 0.250 million ha (2.568 t/ha); and
- Ethiopia produced 3 000 000 tonnes on 1.353 million ha (2.217 t/ha)

This gives a weighted average yield of just over 4 000 tonnes/ha. At this level of yield, regional self-sufficiency would require an additional 2.1 million ha of cultivated land. Although the weighted yield includes rainfed and irrigated production, even Egypt s high yielding irrigated wheat would require over 1.3 million ha of additional land under irrigation. This suggests that prospects for regional trade in wheat under conditions of business-as-usual are limited to nil. A similar calculation confirms that this also holds for maize and sugar. These together with wheat comprise the three biggest deficits in the Nile Basin.

So far, the discussion has focused on trade between countries that are located within the same subregion. FAO s Water Report No 31 (FAO, 2006b) applies a similar analysis to the prospects for trade between regions and finds that if target yields can be achieved by 2030, then for instance:

- barley shortfalls in Central and East Africa could be improved by increased production in West Africa;
- millet shortfalls in West Africa could be improved by increased production from the other regions;
- rice shortfalls in South Africa could be improved by increased production elsewhere in the southern region; and
- sorghum shortfalls in Central Africa could be improved by increased production in East Africa.

In each case, the producing region may have a clear technical comparative advantage for the crop in question, but realization of physical trade could be severely limited by transport infrastructure.

Climate change

Although the various climate change models have yet to show convergence, with respect to rainfall and periods of drought, temperature projections are generally more reliable and will have pronounced implications. Increased evaporation and evapotranspiration with associated soil-moisture deficits will impact rainfed yields. In addition, increased open water evaporation on stored water can be expected to reduce water availability for irrigation and hydropower generation. While ocean-atmosphere coupling is generally reliable and indicates increased precipitation in areas influenced by monsoonal circulation, it is the unreliable land-atmosphere coupling over areas such as the west which give rise to uncertainty over future rainfall trends. Modeling of the emission scenarios, with respect to rainfall, already justify the adoption of some key operational principles when planning new irrigation on the assumption that there would be no regrets since they would contribute to overall resource management in any event.

First, the possibility that schemes could be provided in areas where water resources may be compromised by reduced precipitation and hence runoff. There is therefore a real risk of investing in schemes that fail due to water shortages. This risk can be offset, however, by selecting investments that can be supported at a later stage, by seasonal or trans-annual storage, subject to satisfactory social and environmental impact assessment.

Second, another effect of reduced water resources is increased competition for their use. This could increase their resource price and/or, where storage proves necessary, the added value or

service cost. When this becomes the case, it may become economically inefficient to use scarce, valuable water for additional production.

Third, the need to think ahead and avoid building schemes that will be difficult to retro-fit with more precise water management technology at a later stage.

Finally, it is also necessary to think ahead in areas that are expected to become wetter, with more extreme hydrological events becoming the norm, not just because of climate change itself, but also because of the expected increases in soil moisture, which in turn will both increase and intensify runoff. In such locations it will be necessary to include adequate drainage facilities when new schemes are built, and in all likelihood to retro-fit the same to existing schemes. With this in mind, paradoxically it is necessary to note that good drainage facilities should be provided in the areas expected to become drier. This is in order to increase return flows for re-use downstream.

Conclusions and recommendations

Notwithstanding the assumptions of the AT2030/2050 projections, three principle conclusions can be drawn. First, the projections are conservative in comparison to the natural resources available for the continent as a whole. In most cases, growth can be accommodated within available land and water limits if adequately planned with respect to basins and aquifers where resources are not already stretched. However, the land and water scarcity in both North Africa and South Africa, in particular, are expected to constrain the AT2030/2050 projections significantly.

Second, irrigation development is only one path, among others, towards increased production, regional food security and overall economic growth. Other options include yield gap closure and regional trade, which could be complementary to irrigation development. Regional trade could lead to increased economic growth as a result of the livelihood diversification that is usually associated with increased market size and activity.

Finally, the prospect of climate change will need to be anticipated through more flexible and adaptive water management practices that allows irrigated production to respond to more variable water supply inputs and buffer greater volatility of rainfed production.

Following these conclusions several recommendations emerge.

- Food security can be assessed on a regional or transboundary basis to mobilize comparative advantage in specific staple crops and thereby spread production risk and lower economic costs.
- There is potential for improving the productivity of existing equipped irrigated areas. Where appropriate, this approach should be prioritized before new-build is contemplated. Accordingly, it is recommended that capacity building becomes an essential component of any irrigation based food security and economic growth strategy. Further, such capacity building should not concentrate on the traditional skills of engineering and agronomy, but extend to institutional initiatives that respond to demand and add value, including water pricing, market research and adaptive programme financing.

- Where there is competition between irrigation and hydropower, then multi-objective operating rules can allow expansion of irrigation while maintaining planned generation capacity.
- The private sector should be encouraged to play a larger role in irrigated production and irrigation service delivery. There is a lot that governments can do to increase private sector involvement by establishing policy-backed enabling environments, appropriate incentives and transparent risk sharing mechanisms. Public-private partnerships should be forged to allow the continent to escape hunger and poverty.

References

FAO. 2003. *World agriculture: towards 2015/2030. An FAO perspective*, by J. Bruinsma, ed. Rome. 289pp

FAO. 2005. *Irrigation in Africa in figures. FAO Water Report No 29*. Rome. 74pp plus CD-ROM

FAO. 2006a. *World agriculture towards 2030/2050. Interim Report*. Rome. 71pp

FAO. 2006b. *Demand for products of irrigated production in sub-Saharan Africa*. FAO Water Report No. 31. Rome. 129 pp

NEPAD. 2002. *Comprehensive Africa agricultural development program (CAADP)*. Available at http://www.fao.org/docrep/005/y6831e/y6831e00.htm