An assessment of investments and financial flows to address climate change in the Gambian water sector

Prepared for:
Department of Water Resources
07 Marina Parade
Banjul, The Gambia

by
Momodou Njie
67 Ousman Jeng Street
Banjul, The Gambia

and
Ousman Dainaneh Jarjusey
Coastal Highway, Bijilo
Kombo North, WCR, The Gambia

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About the Authors:

Momodou Njie trained as a hydrologist in Africa and Europe and holds a doctoral degree from Imperial College, London. Dr. Njie's took early retirement from the Gambian civil service in 2005, after serving 23 years in various positions. In the last 10 years, he has carried out, directed and supervised MSc and PhD research related to climate change; taught part-time for six years in the University of the Gambia; co-written book chapters on climate change adaptation; put together the Gambian National Adaptation Programme of Action (NAPA); and made several presentations revolving around climate change at expert and outreach fora in The Gambia and abroad. He occasionally provides consulting services on environmental, natural resources, and risk management themes to public and private sector clients, and since 2009, is a member of European Capacity Building Initiative (ECBI) Finance Circle.

Ousman Dainaneh Jarjusey received his BEng (Hons.) in Civil Engineering from Fourah Bay College (University of Sierra Leone) in 1998, and an MSc in Water Supply and Sanitation Engineering from the UNESCO-IHE Institute for Water Education based in Delft (The Netherlands) in 2003. Mr. Jarjusey worked as a water distribution engineer with the National Water and Electricity Company (NAWEC) Ltd. for seven years before taking up the position of water supply Engineer under a UNDESA Project on Managing Water and Energy Services for Poverty Eradication in Rural Gambia. Since completion of his three and a half years assignment with UNDESA, he was employed, for four year ending June 2010, by the European Union Financed Rural Water Supply Sector Support Programme to provide programmatic coordination. Mr Jarjusey regularly provides extensive consulting services ranging from system designs and the supervision of the construction work to water supply project sponsors and owners in the Gambial.

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M. Njie
O. D. Jarjusey

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List of acronyms and abbreviations

AfDB	African Development Bank
AMAP	Arctic Monitoring and Assessment Program
ANAMS	Agence Nationale de Météorologie du Sénégal
ANR	Agriculture and Natural Resources
CBO	Community-based organization
CRR	Central River Region
DPPH	Department of Physical Planning and Housing
DWR	Department of Water Resources
EDF	European Development Fund
EWS	Early Warning System
GBoS	Gambia Bureau of Statistics
GCCI	Gambia Chamber of Commerce and Industry
GCMs	General Circulation Models
GDP	Gross Domestic Product
GEF	Global Environment Facility
GNAIP	Gambia National Agricultural Investment Program
GoTG	Government of The Gambia
I&FF	Investment and Financial Flows
IDB	Islamic Development Bank
IFMIS	integrated financial management information system
IPCC	Intergovernmental Panel on Climate Change
ISIC	International Standard Industrial Classification
IWRM	Integrated Water Resources Management
LDCF	Least Developed Countries' Fund
MHCH	Ministère de l'Habitat, la Construction et l'Hydraulique
MoTIE	Ministry of Trade, Industry and Employment
MoFEA	Ministry of Finance and Economic Affairs
NAPA	National Adaptation Programme of Action
NAWEC	National Water and Electricity Company
NGO	Non Governmental Organisation
ODA	Overseas Development Agencies
OMVG	Organisation pour la Mise en Valeur du fleuve Gambie (Gambia River Basin Development Organization)
PRSP	Poverty Reduction Strategic Paper
PURA	Public Utility Regulatory Agency
RWS	Rural Water Supply
SDRD	Support to Decentralized Rural Development
SNA	System of National accounts
SSHFC	Social Security and Housing Finance Corporation
TOR	Terms of Reference
UNDP	United Nations Development Programme
WRA	Water Resources Assessment
WRIAM	Water Resources Impact Assessment Methodology
WUGs	Water User Groups

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1. Introduction

The Gambia, 11,300 km² big, is located between the 13th and 14th parallels north, and longitudes 13 and 17ºW. More than 90% of its territory is situated within the Gambia River Basin, shared with the republics of Guinea, Guinea-Bissau and Senegal. Figure 1.1 shows a country dissected into northern and southern areas by the River Gambia running from East to West and flowing into the Atlantic Ocean.

At the last national population and housing census in 2003, The Gambia had a population of 1.36 million people growing at 2.7 per cent per annum. Three decades of census data showed an increasing percentage of the population living in urban agglomerations in the western part of the country (Source: GBoS).

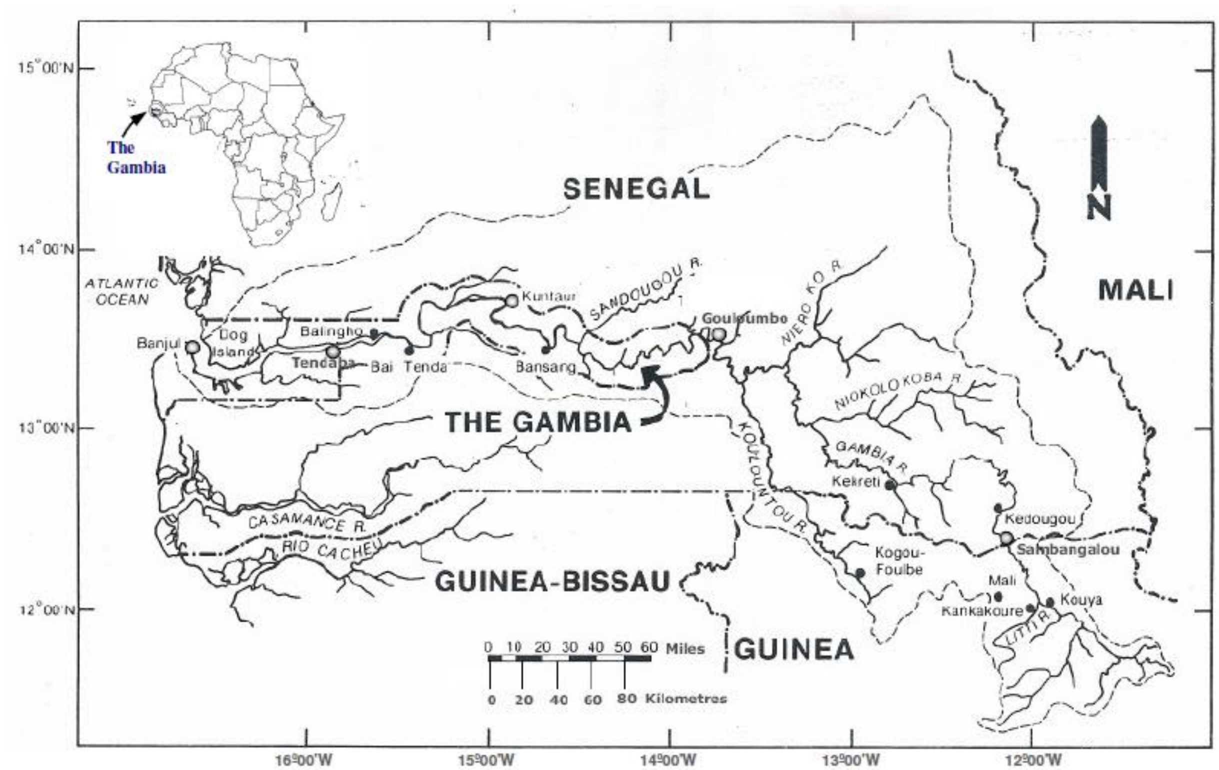

Fig.1.1: Hydrogeography of the Gambia. (Source: Njie, 2009b)

Annual rainfall varies regionally between 750 mm and 950 mm (1981– 2010 period), but roughly decreases from South to North. Most rainfall takes place over the period July to September. Recorded temperatures 12 to 43°C (1981– 2010 period) are characterized by diurnal cycles superimposed on annual cycles, and by local surface conditions. Thus, average temperatures are lower and ranges smaller on the coast in comparison to the hinterland. Little quantitative information on water resources in coastal catchments is available, but there is a consensus within the hydrological community to the effect that flashy flows have relatively negligible values, not to mention poor water quality problems (Njie and Corr, 2006). On average 6.5 km³ of water transit every year through the River Gambia and its tributaries, 85% of this water comes from the Senegalese and Guinean parts of the Gambia River Basin (Njie, 2009a). By contrast, ground water occurs in shallow and deep sandstone aquifers underlying the whole country. The shallow aquifer, found on average at depths between 5 and 50 meters[1], holds approximately 0.1 km³ in water reserves that are supplemented by annual groundwater recharge of 1.5 to 3.0 km³ (Njie, 2009a).

[1] Geological and topographic factors may expand this range in specific locations.

As in other countries, the Gambian economy can be divided into primary production (agriculture and natural resources), secondary (industry) and tertiary (service) sectors. Between 2006 and 2010, the Gambian economy experienced sustained growth of 4.5% per annum on average. Agriculture accounted for a significant part of this growth but also manifested significant fluctuations due to adverse weather conditions in 2006 and 2007. Industrial output fell between 2006 and 2010 but electricity, gas and water supply sub-sectors (combined as ISIC V E) grew by 43.7% (Source: GBoS). It is worth mentioning that the Gambia pursues a liberal trade policy consistent with its regional integration goals and economic globalization processes. Principal exports consist of groundnuts and fishery products, whilst imports are dominated by food, machinery, and transport equipment. The private sector which is the engine for economic growth accounts for approximately 88% of output and 94% of employment.

According to recent ministerial statements before the National Assembly, the Gambia government's broad policy is to ensure economic growth though low inflation and sound public finances through prudent monetary and fiscal policies (GOTG, 2005; 2007a; 2010). The government's policy is set in the context of the second medium term plan for poverty reduction, Poverty Reduction Strategy Paper (PRSP II), to be reviewed after 2015 (GOTG, 2007a). One of the government's objectives is the control of public expenditure in order to eliminate budget deficits. To this end, government rolled out in 2007 an integrated financial management information system (IFMIS) which prevents expenditure beyond available financial resources.

1.1. Objectives

The current assessment carried out under the aegis of the UNDP pilot project "*Strengthening National Capacity of Developing Countries to Develop Policy Options for Addressing Climate Change Across Different Sectors and Economic Activities*", seeks to establish the scale of investments and financial resource flows needed to address potential impacts of climate change in the water sector (using an elaborate and transparent computational framework); lay the foundations for integration of adaptation issues into national development and economic planning; and leverage international/external funding for adaptation. In doing so, this assessment produces a portfolio of priority projects circumscribed within an investment program that begins to fill in gaps left by the first-generation National Adaptation Programs of Action (NAPAs) on climate change. Potential users of published results include researchers, planners, and development practitioners addressing climate change challenges in the water sector.

1.2. Background

The water resources sector is selected for several reasons. Essentially, water fulfills indispensable socio-economic functions. Beyond obvious utilitarian functions, water is a key factor for safety and security in some under-serviced peri-urban areas (Njie, 2011). In the ever-changing interplay of natural processes, technological factors, social dynamics, Cotruvo *et al.* (2004) show that even developed countries are not immune to outbreaks of water-borne diseases.

Thus, it is hardly surprising that 4 out of top12 adaptation options ranked by a kaleidoscopic group of senior public officials, NGO and business community representatives, using a multi-criteria analytical approach, either belong to or are strongly related to the water sector (GOTG, 2007b). The hegemonic position of the water sector is further highlighted by findings of public consultations that took place country-wide during the preparation of the Gambia's NAPA. Despite a clear delineation of concerns expressed by urban and rural publics, both unequivocally include water resources in their list of priorities (GOTG, 2007b). According to the System of National Accounts (SNA), housed within the Gambia Bureau of Statistics (GBoS), water (and electricity) accounted for 2.5% GDP in the last five years, and posted an average value added/Gross Output ratio of 25% (GBoS, 2008).

Collectively, Manneh (1997), Njie (2002) and Verkerk and van Rens (2005) demonstrated that projected changes in the River Gambia's freshwater flow regime under specific climate change scenarios (IPCC, 1995; IPCC, 2001; GOTG, 2003), would alter the non-linear dynamics of saline water intrusion in the estuary of the River Gambia.

Explicitly incorporating climate change impacts in the OMVG Hydraulic Master Plan (Sogreah *et al.*, 1998), Verkerk and van Rens (2005) put the maximum intrusion length at river km 228 (26 km downstream of the upper limit saline excursion under unregulated flow conditions), under the most ambitious irrigation development scenario (i.e. 14,000ha rice, 3,700 mixed crops). Lower groundwater recharge associated with intra-seasonal rainfall distribution patterns (Sima, 2007; Njie, 1987; Wheater *et al.*, 1982) spell a long-term drop in water levels/piezometric heads that carry the risk of saline intrusion in coastal aquifers.

On the strength of the foregoing, that is, water resources sensitivity to climate change and vital contribution to socio-economic development objectives, the current administration is convinced that water resources is one of four key sectors to be included in the investment and financial flow (I&FF) assessment (Jarju, 2009).

1.2.1. Previous Analyses Utilized

The current study draws on previous work relating to water resources and climate change. To this end, we have identified four categories of studies from our focused literature review. Two out of these are concerned with identification and prioritization of water sector issues and management options in the face of non-stationary climate. The third and fourth groups individually address research issues and the prominent question of water supply and sanitation in urban agglomerations within the Gambia. It could be argued that sparse documentation does not allow for a four-way categorization of studies, but we differ. Our argument is that the themes addressed and need to draw generalizations warrant such distinction.

Diagnostic analyses of water resources management challenges (Verkerk and van Rens, 2005; Njie, 2003), identification, confirmation, and prioritization of adaptation options under a changing climate (Jarju, 2009; GOTG, 2007a; Njie, 2007; Njie, 2002) contribute information essential to the elaboration of scenarios, parameterization and elemental costing of selected adaptation options.

Deliberations of surface and ground water working groups complied in report form at the end of a WRIAM training workshop (Njie, 2008) are used for comparison, corroboration and scoping of the current study. Indeed, the identification of problem types, causative factors, impacts and prioritization of water resources issues by independent analysts increases the credibility of scoping described under § 2.1.

Strategic analysis of earth system research and supporting information systems (Njie, 2009a) identified capacity and knowledge gaps that point to critical infrastructure needed under the adaptation scenario of the water sector I&FF study. On the other hand, the water and sanitation study executed by SNC Lavalin International (2005) explores specific management measures although the problematic is not articulated in terms of adaptation measures. Thus, the SNC Lavalin study is of topical interest from several perspectives.

1.2.2. Institutional Arrangements and Collaborations

The current assessment was carried out under contract signed individually and severally between UNDP and report authors. Accordingly, contact persons were designated for the purpose of contract administration and including in particular information-sharing at the level of UNDP (Sponsor) and Department of Water Resources (Main Beneficiary).

Periodic reports prepared by the authors were submitted for review and feedback from the sponsor, main beneficiary and larger body of national stakeholders.

1.2.3. Basic Methodology and Key Terminology

To develop credible estimates of investments and financial flows in the water sector, the following key questions are addressed:

- the magnitude, sources and apportionment of investments in the water sectors;
- determinants of investment;
- nature and source of investment funds under a business-as-usual development pathway; and
- policy implications and imperatives of adaptation to climate change in the Gambian water sector.

Comprehensive guidance on methodology and process was obtained from www.undpcc.org, and literature provided by the main beneficiary. The basic methodology which consists of nine steps (see Figure 1.2) was adopted with modifications imposed by pragmatism and an overriding concern for efficient use of time resources.

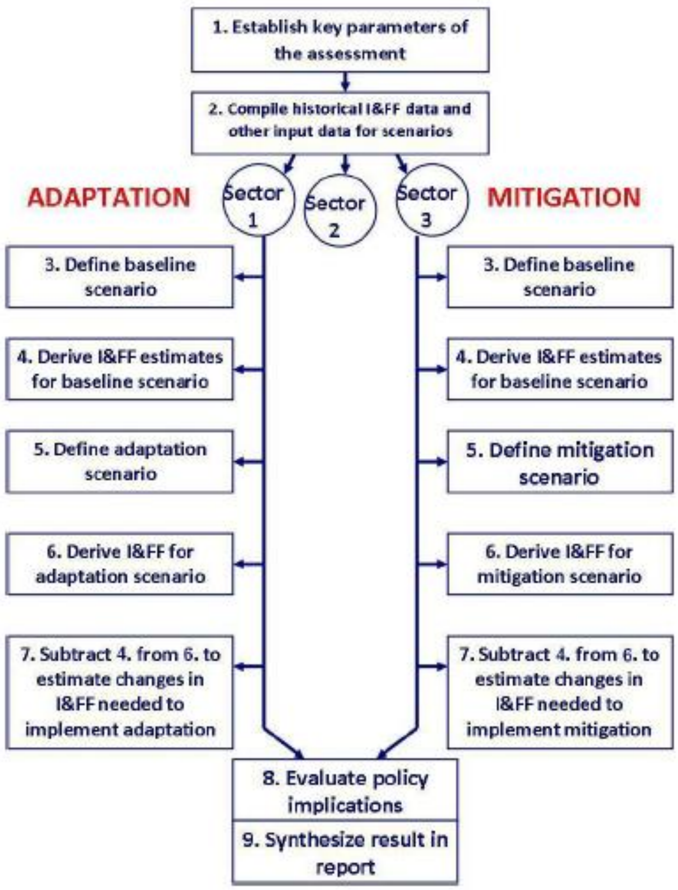

Fig. 1.2: Methodological steps for carrying out an I&FF assessment. The nine discrete steps shown represent dual entry and exit points at which intermediate outputs serve as input to the next higher step (Source: UNDP, 2009).

The basic methodology illustrated in Figure 1.3 coveys the idea of researchers moving progressively from problem concept to comprehensive documentation that encompasses alternative futures and financial resources associated with each scenario.

In practice, we adopted the overall framework, but introduced by-pass channels and feedback loops appropriate for efficient use of time resources. For instance, report chapters and sub-chapters were written in jigsaw fashion during the entire duration of our assignment. Furthermore, episodic compilation of data continued late into the study. To this effect, templates supported by the Excel™ computing environment using provisional data delivered significant gains in efficiency.

Key accounting terms used in the assessment that can be found in published guidelines at www.undpcc.org include the following:

Capital expenditure (CAPEX): A capital expenditure is incurred when households/businesses/governments spend money either to buy fixed assets or to add to the value of an existing fixed asset with a useful life that extends beyond the taxable year. CAPEX are used by a household/business firm/government to acquire or upgrade physical assets such as equipment, property, or industrial buildings.

Financial flow (FF): an ongoing expenditure on programmatic measures; financial flows encompass expenditures other than those for expansion or installation of new physical assets. This includes interest paid on money borrowed for procurement and installation of physical assets.[2]

Investment entity: Legally constituted and recognized entity responsible for an investment. These are the entities that decide to invest in, for example, telemetric systems, a groundwater research program, or a water supply network. This methodology utilizes three types of investment entities: households, corporations, and government.

Investment flow (IF) - a capital cost of new real assets with a lifetime of more than one year, for instance, capital expenditure on new agricultural irrigation system.

Operation and maintenance (O&M) costs include the following categories of costs:

- Fuel costs such as power and/or fuel for operations, fuel for production
- Public utilities such as telephone service, Internet connectivity, etc.
- Raw materials
- Maintenance and/or leasing of equipment
- Office supplies and consumables
- Advertising
- License or equivalent fees (such as corporation yearly registration fees) imposed by a government
- Real estate expenses, including:
    - rent or lease payments
    - office space
    - furniture and equipment
    - property taxes and equivalent assessments
- Operations fees, such as fees assessed on transportation carriers for use of highways, and production or operation fees, such as subsidence fees imposed on oil wells
- Insurance
- Damage due to uninsured losses, accident, sabotage, negligence, or terrorism.

System of National Accounts (SNA): Consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheets and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules.

In addition to definitions provided above, the following concepts have the interpretations:

Baseline or 'Business as Usual' scenario: a standard measurement or fact against which other measurements or facts are compared, assumes no new additional measures are taken to address climate change.

Adaptation scenario: incorporates measures to reduce exposure and vulnerability to adverse impacts of climate change and to take advantage of new opportunities arising from climate change.

[2] Authors' extension based on appraisal of Gambian situation.

2: Scope, Data Inputs, and Scenarios

2.1. Sectoral Scope

At the outset, we wish to put to rest definitional issues by pointing out that the term "water sector" referred to in this assessment extends beyond the traditional and accepted ISIC definition. In reality, the assessment covers the water resources management problemshed ("sector") from which specific issues ("sub-sectors") are taken up and studied in depth. For consistency and benefit of the current assessment, we have used a developmental lens to identify: 1) water resources assessment; 2) water supply; 3) drainage and sewerage; and 4) hydropower generation sub-sectors. For compelling reasons explained in the next few paragraphs, the study focuses on **water resources assessment** and **water supply** in the **Kombo Peninsula** and **rice-growing areas in the Central River Region** (CRR) which best epitomize water security hotspots within the country. Table 2.1 depicts a self-consistent framework highlighting sub-sectoral processes and activities as well as investment entities.

Table 2.1: Subsectors processes, activities and investment entities

Sub-sector	Processes	Activities	Investment Entities
Water resources assessment	Administration, knowledge management	systematic observations, field investigations, data management, research, provision of hydrological services	DWR
Water supply	water resources appropriation	exploration, engineering, source protection, operations (water abstraction)	NAWEC, MoA,** Water bottling/packaging companies, households, Equipment suppliers, Engineering/consulting firms
	water quality improvement	water treatment/purification (pH rectification, deferration, chlorination), laboratory analyses	NAWEC, DWR, Water bottling/packaging companies
	water distribution	metering, leakage control, marketing	NAWEC, Water bottling/packaging companies, Retail outlets

** MoA = Planner/Overseer for Farmer-Managed Irrigation Systems, Community farms/gardens operate independently of MoA could be considered as belonging, to either community-based organizations (CBO) or water user group (WUG) categories

Water scarcity is linked by a number of researchers to social dislocations including migration and conflicts, both latent and overt, between socio-economic/ethnic groups and countries in Africa (Meze-Hausken, 2000; Niasse, 2005; Osman *et al*., 2005; Njie, 2007), giving *gain de cause* to Postel (1992) who rightly observes that reliable water supplies are indispensable to the economic and social stability of any nation.

In 2003, the Kombo Peninsula, which covers 7.2% of the Gambia's land area, was home to 49.2% of the total population and all major hotels in The Gambia (Source: GBoS). Crucially, the trend towards greater population concentration continues unabated, and the public utility mandated to provide water services, NAWEC, is financially stretched to expand supplies in line with industry standards. As aggregate water demand in the Kombo Peninsula increases, the local hydrology is concomitantly altered by the built environment and climate change stressors.

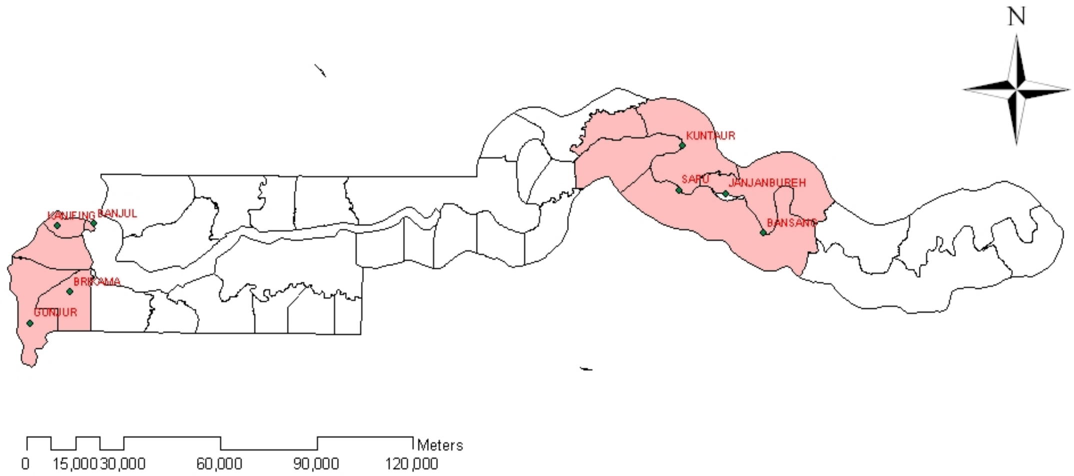

Fig. 2.1: Most water-stressed parts of the country with names of selected townships. Electoral/Administrative districts in the Kombo Peninsula (i.e. shaded area in western part of the country), home to 49% of population at last census in 2003, continually record the highest population growth rates. The five districts in the central part of the country covers 21% of the Gambia's land area, is home to 10% of country's population and currently produces 22% of rice grown in the country. Map produced with ArcMap 9, courtesy of Tombong Koma.

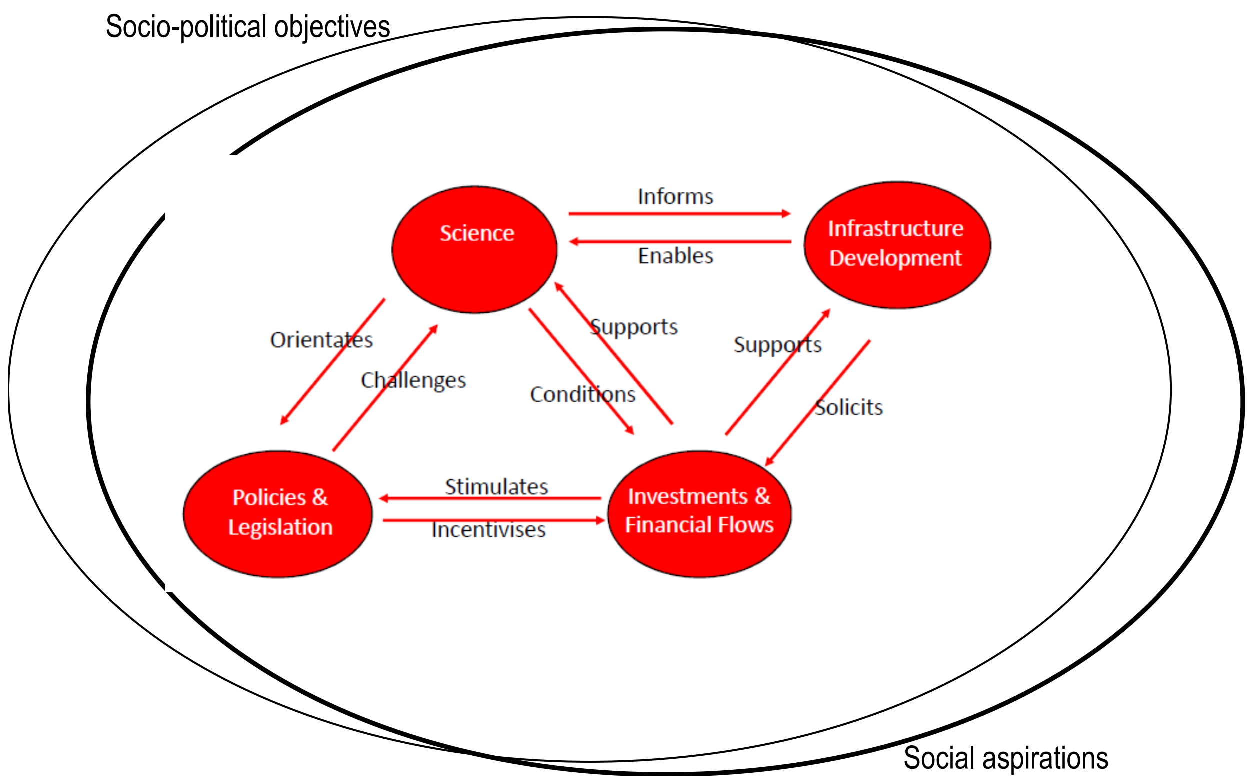

Fig. 2.2: SPLIID framework showing major elements and incomplete alignment of social political objectives of governments with social aspirations in a non-Utopian setting

Out of a total of 18,000 ha of cropland suitable for irrigation, less than 2,000 ha in the CRR are under full water control. Irrigation water supplies, deemed a central pivot in food security strategies, are constrained by the risk of enhanced saline intrusion in the River Gambia (in the absence of upstream flow regulation).

In the last three decades, the bulk of financial resources invested in the water sector has gone towards improving water security in under-served, isolated, rural communities, resulting in significant improvements in the well-being of beneficiaries (Njie, 2011, Anonymous, 2004). As the question of environmental sustainability looms large under a changing climate, and the recognition that "there is no future without natural capital" (*Il n'y a pas de futur sans nature*), reversing the effects of decades of under-investment in capacity building for water resources management becomes an urgent priority (Njie, 2009a, 2009b). The interactions between hydrological science, public policy, investments and infrastructure development are shown in figure 2.2.

2.2. Data Inputs and Scenarios

Two broad categories of capital used in the econometric literature, that is human and physical capital have been used as a point of departure in this assessment. Physical capital is then subdivided into: 1) infrastructure; and 2) equipment and machinery sub-categories.

The data used in the assessment are from the following sources:

Expenditure data on investments, financial flows and operation and maintenance (O&M) related to physical and human capital, in selected sub-sectors are from *Approved Estimates of Revenue and Expenditure with Development Expenditure* of the Gambia Government (for the years 2001 through 2010), NAWEC water assets inventory, contract documents and discussions with line managers in the public water utility and their counterparts in the major water bottling companies. Further information on investments in human capital was provided by graduates of overseas training programs in hydrology, hydrogeology, hydraulics, meteorology, insurance and travel agencies. NAWEC's operating budget was used to extract data on salaries and other benefits accruing to personnel.

Data on foreign exchange required to establish the 2005 benchmark used this study come from the Gambia Bureau of Statistics (GBoS). GDP data and public debt related to selected water subsectors are provided by GBoS and the Ministry of Finance officials, and the schedule of debt repayments extracted from annual series of *Approved Estimates of Revenue and Expenditure with Development Expenditure.*

Ancillary data were provided by a diverse group of entities. Characteristic infrastructure variables (e.g. age, specific design parameters, etc.) are from the NAWEC water assets inventory, line managers, consultants and contractors. Abstracts of agricultural statistics, demographic data, and hydroclimatological data were obtained from the Department of Planning (under the Ministry of Agriculture), GBoS, Department of Water Resources, and the latter's Senegalese counterparts, *Agence Nationale de Météorologie du Sénégal* (ANAMS) and *Ministère de l'Habitat, la Construction et l'Hydraulique* (MHCH). Verkerk and van Rens (2005) provide data on irrigation opportunities and limiting constraints. Basic information on critical scientific infrastructure investment is obtained from Njie (2009a), procurement plans of projects with approved funding.

Expenditure data which lie at the heart of this assessment are allocated to six investment types. In addition to human resources and infrastructure, we make use of the ISIC classification to further sub-divide "equipment and machinery" into four investment types, viz., non-electrical machinery including computers (ISIC 382), electrical motors, machinery apparatus, appliances and supplies (ISIC 383), transport equipment (ISIC 384), and professional and scientific instruments (ISIC 385). Extra-budgetary and programme support expenditure not reflected in financial statements (e.g. donated equipment and overseas training) is collected from key informants.

Data was painstakingly extracted from published material and databases and input in spreadsheet forms designed as a crucible for pre-processing of data entries. Validated data from these worksheet forms are finally linked to worksheets provided by the UNDP-PASS support team. Consistency checks employed include use of graphics, and comparison of row and column totals.

Scenarios developed and analyzed as part of this assessment are influenced by scholarly works and studies on creative thinking (Buzan and Buzan, 1993; de Bono, 1971), foresight (Berkhout and Hertin, 2002; Illbury and Sunter, 2001), water resources planning (Njie 2003; Sogreah *et al*., 1998; Goodman, 1984), and colleagues, especially those working in social sciences. The authors' intimate knowledge of the Gambian water sector aided by 30 years of experience in earth science, civil and hydraulic engineering practice provide unique insights into the outlook of the water sector for the period up to 2030. Scenarios independently developed by the lead author are refined with inputs from the second author and stakeholders.

2.2.1. Assessment Period and Cost Accounting Parameters

Investment and financial flows assessed in this study are for the period 2011 to 2030. Historical data for the period 2000 to 2010 are analyzed to uncover investment patterns that serve to inform projections over the assessment period. For purposes of comparability, constant 2005 US dollars, associated with the 365-day averaged floating exchange rate during that year, is used for conversion of expenditure made during other time periods.

2.2.2. Analytical Approach

The methods used in this assessment are influenced by characteristics of financial flow data at hand, and the period of analysis. One such characteristic is short series length, compounded by high occurrence/frequency of zeroes (i.e. intermittency).

The computation of capital investment streams (CAPEX) is based upon asset specifications and unit prices. "Operational Expenditure" (OPEX), comprising financial flows (FF) and operation and maintenance (O&M), is computed by two alternative methods. The first approximates OPEX as the difference of two depreciation curves of assets, one curve based on the useful life of the asset, and the second on an extension of the useful life of the asset by 20%. In the water resources assessment sub-sectors, OPEX, computed for the reference historical period measured as a fraction of GDP is used in making projections under the different scenarios[3].

At the sub-sectoral level, OPEX is disaggregated into FF and O&M streams using partition coefficients extracted from historical data. Corresponding sectoral data are obtained by summing up variables across sub-sectors researched in this assessment.

At asset level, we employ disaggregation factors based on: 1) the judgment of sector professionals; 2) historical expenditure on similar asset deployed in the relevant sub-sector; or 3) published literature. Under the best of circumstances, we analyze historical data using standard statistical methods to obtain (1 x N) coefficient matrices for disaggregating lumped amounts as illustrated in Table 2.2. This computational technique is built on the debatable assumption of invariant proportionality year in year out. We point out that the constant coefficient method is second best to real (unknown) coefficients, and when applied to financial resource flows under alternative futures, reflects our neutral rather than optimistic or pessimistic position vis-à-vis investment decisions.

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[3] We recognize that a ratio based on actual expenditure or revenue would be more appropriate, but the temporal dimension excludes use of these variables. Furthermore, revenue projections are usually done in a yearly time ahead of current fiscal year.

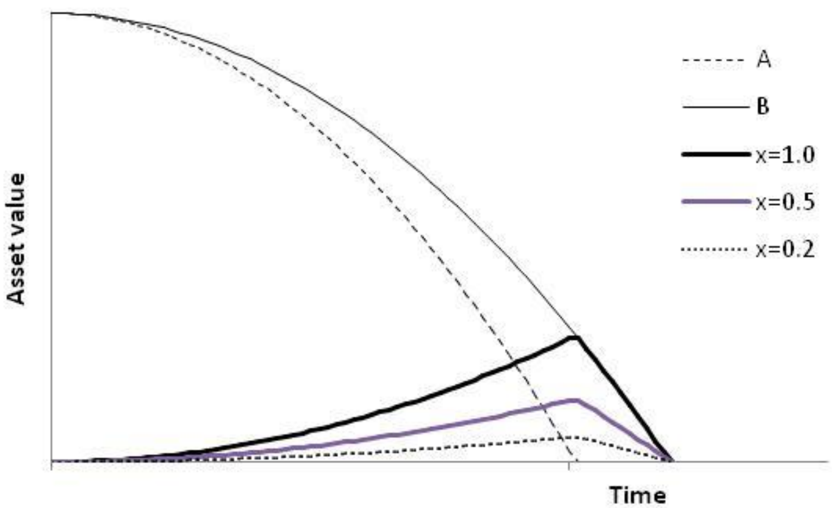

Fig.2.3: Illustration of OPEX estimation based on differential management response to depreciation of assets. *Curve A is associated with the useful life of a basket of assets, whilst curve B relates to an extension of the useful life of the same group of assets. The difference in life span of assets is explained by OPEX, shown here as fractions, x, of the difference between curves A and B. The descending limb for X=1 indicates that an investment entity will not spend no money on operational expenditure (OPEX) than the value of assets.*

Table 2.2: Illustrative example of use of constant coefficients, a_1 through a_6, with property $\sum ai = 1$

		Coefficients					
		a_1	a_2				a_N
		Asset Type 1	Asset Type 2				Asset Type N
Year	Flux stream						
2001	X_1	a_1X_1	a_2X_1				a_NX_1
2002	X_2	a_1X_2	a_2X_2				a_NX_2
2011	255.3	253.3 a_1	253.3 a_2				253.2 a_N
2012	168.9	168.9 a_1	168.9 a_2				168.9 a_N

2.2.3. Historical IF, FF, and O&M Data, and Subsidies

Data presented in this section does not include GOTG contributions to international organisations executing water-related programs, support from local IGO offices not reflected in annual budget, or NGO interventions in communities not connected to water distribution network in the Greater Banjul Metropolitan area. It also does not reflect the contributions of consumers installing stand alone water supply systems for domestic use.

Financial expenditures in the water resources assessment subsector for the period 2001 to 2010, disaggregated by asset type and financial streams are shown in Tables 2.3. Similar information of the municipal water supply subsector is shown in Tables 2.4. Historical data for the irrigation sub- sector is not featured due to failure to access such data.

Table 2.3: Historical expenditure (x1,000 constant 2005 USD) on physical and human assets deployed in the Water Resources Assessment subsector

	Non-electrical machinery including computers			Electrical motors, machinery, apparatus			Transport		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2001	0.9	4.8	0.0	0.0	0.0	0.1	94.9	0.0	3.3
2002	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	3.5

2003	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	3.0
2004	3.6	5.8	0.0	0.0	0.0	0.1	0.0	0.0	4.4
2005	0.0	8.8	0.0	0.0	0.0	0.6	0.0	0.0	6.2
2006	0.0	11.0	1.2	0.0	0.0	0.0	0.0	0.0	8.7
2007	12.4	13.6	1.8	0.0	0.0	0.0	0.0	0.0	9.3
2008	40.8	18.0	12.7	0.4	0.0	0.0	33.6	0.0	9.3
2009	0.0	22.6	10.9	0.0	0.0	0.0	0.0	0.0	12.4
2010	0.0	6.1	0.0	0.0	0.0	0.0	39.7	0.0	11.3
Average	5.8	9.9	2.7	0.0	0.0	0.1	16.8	0.0	7.1

Table 2.3: (cont'd)

	Professional and scientific instruments			Infrastructure			Human resources		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2001	0.0	1.3	0.0	0.0	0.2	5.0	8.0	34.7	0.0
2002	0.8	1.4	0.0	0.0	0.2	10.8	20.1	66.6	0.0
2003	0.0	2.5	0.0	1.2	0.3	2.3	43.5	42.6	0.0
2004	9.8	1.5	0.0	3.3	0.2	4.6	6.0	66.3	0.0
2005	4.6	2.1	0.0	111.6	0.2	5.0	2.6	69.8	0.0
2006	63.3	2.0	0.0	4.5	0.6	9.3	2.4	71.1	0.0
2007	67.8	2.5	0.0	10.3	0.7	9.8	3.3	95.2	0.0
2008	4.2	5.3	0.0	88.1	0.7	6.0	2.6	103.4	0.0
2009	59.9	6.1	0.0	14.0	0.5	5.3	8.9	93.0	0.0
2010	57.0	0.7	0.0	42.3	0.5	5.3	19.1	117.1	0.0
Average	26.7	2.5	0.0	27.5	0.4	6.3	11.7	76.0	0.0.

Sources: *Approved Estimates of Revenue and Expenditure with Development Expenditure* of the Gambia Government (for the years 2001 through 2010); IFMIS Financial Statements (2007 to 2010); DWR archives, Personal Communication (Fatou Sima, Lamin Mai Touray, Madi Sarr, Fatou John, Yusupha Bojang, Foday Conteh, Kebba Njie)

The following are read from Table 2.3: At 45% of total, expenditure on human resources is highest among investment categories in the sub-sector. Comparative expenditures on infrastructure (18%), and on professional and scientific instruments (15%), are ranked second and third highest respectively.

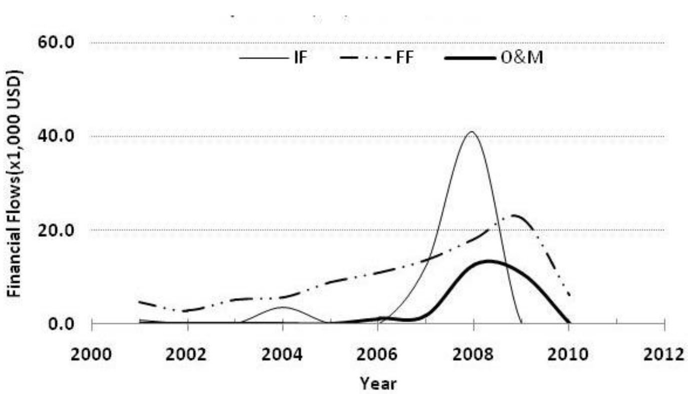

Fig. 2.4: Time plot of expenditure on non-electrical equipment including computers (ISIC 382) in water resources assessment sub-sector. Data shows intermittent investment flows (IF), a steady increase in financial flows (FF) and step trend in operation and maintenance (O&M) expenditure, the last two being followed by sharp drops in 2010.

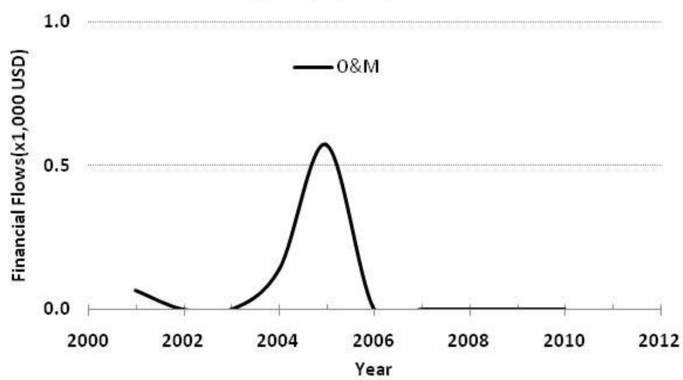

Fig. 2.5: Time plot of O&M expenditure for electrical motors, machinery and appliances (ISIC 383) in water resources assessment sub-sector. "Missing" data streams on investments (IF) and financial flows, reflects zero expenditure on these cost items. The exponential increase in O&M reflects increasing price of crude and refined petroleum products worldwide, between 2003 and 2005. The subsequent decrease is attributed to budgetary constraints on meeting costs of power generation and improved reliability of electricity supply through energy purchase from independent power producer, Global Electric Group.

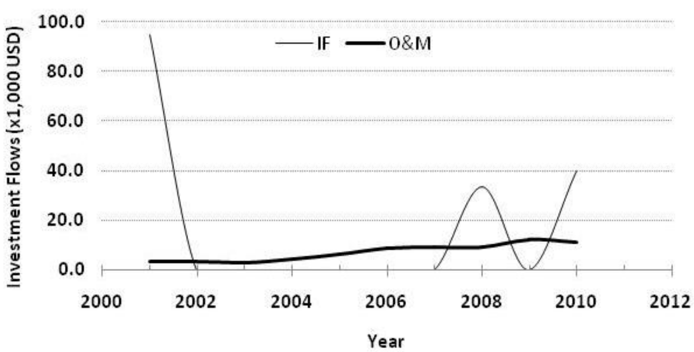

Fig. 2.6: Time plot of expenditure on transport (ISIC 384) in water resources assessment sub-sector. Data shows irregular interval between burst of investments and absence of FF (subsumed under O&M expenditure). It may be worth noting that GOTG rarely assigns new vehicles to DWR. Furthermore, DWR has not had a hydrographic/hydrological survey boat since 2002. Investment shown largely represents the value of vehicles inherited from phased-out projects, computed on basis of 20% p.a. depreciation effective from purchase date.

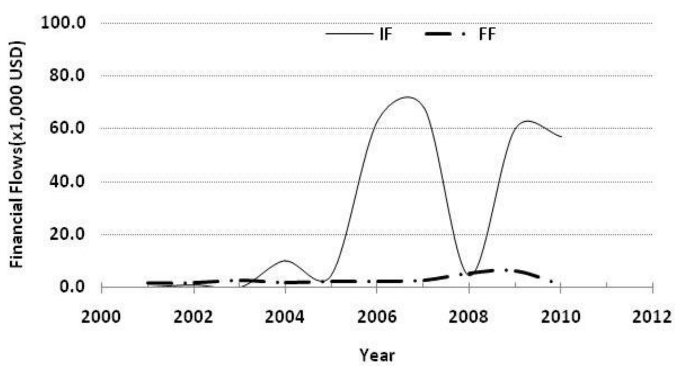

Fig. 2.7: Time plot of expenditures on professional and scientific instruments (ISIC 385) in water resources assessment sub-sector. Data shows low investment base (zero in some years), superimposed with irregularly spaced bursts (one to six-fold variation in magnitude, 3 in 10 years). Major bursts in investment flows are explained by procurement of new equipment through domestic and grant funding. The absence of O&M expenditure is explained by life cycle and robustness of technology in use, as well as asset replacement strategy.

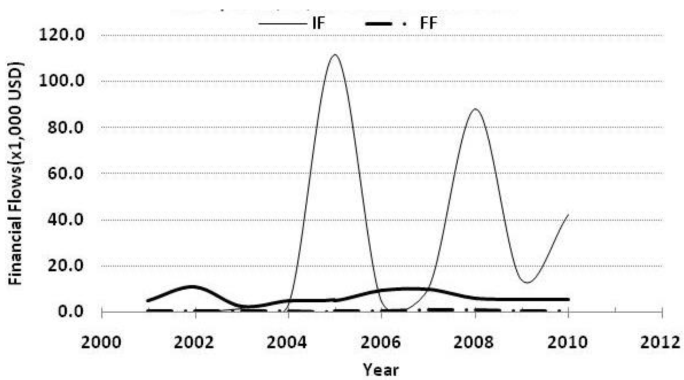

Fig. 2.8: Time plot of expenditure on infrastructure in water resources assessment sub-sector. Multiple investments (IF) peaks are associated with major injection of donor funding for communication systems (AFTN, MSG). GOTG contribution, 15% maximum in any single year is allocated to civil works. On the other hand, O&M expenditure is a reflection of renovation/refurbishment cost of staff quarters and office buildings. Financial flows (FF) represent rent paid by DWR for housing of staff in places where official housing is not provided.

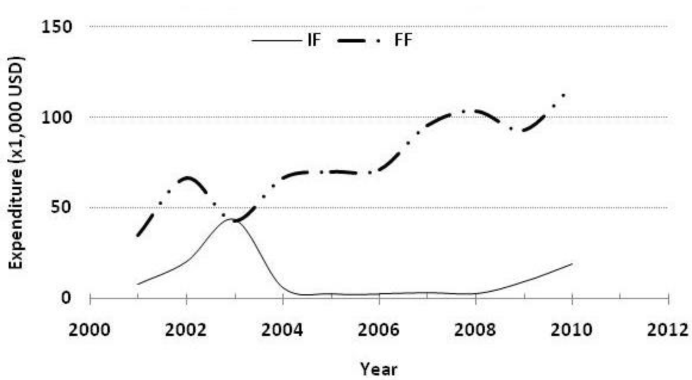

Fig.2.9: Time plot of expenditure on human resources in water resources assessment sub-sector. Financial flows (FF) are associated with personal remuneration, whilst investments flows (IF) are assigned to capacity building. The latter is generally low, receiving major boosts when personnel benefit from overseas training.

Table 2.4: Historical expenditure (x1,000 constant 2005 USD) on physical and human assets deployed in Municipal Water Supply subsector (Interest on loans not included)

	Non-electrical machinery including computers			Electrical motors, machinery, apparatus			Transport		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2001	7.9	0.0	0.0	12.3	0.0	3.3	35.1	0.0	6.0
2002	7.9	0.0	0.0	12.3	0.0	3.7	52.6	0.0	6.4
2003	8.0	0.0	0.0	12.3	0.0	3.9	70.2	0.0	6.5
2004	13.4	0.0	0.0	28.0	0.0	3.9	1.8	0.0	6.9
2005	14.3	0.0	0.0	28.0	0.0	4.2	54.4	0.0	10.9
2006	21.3	0.0	0.0	76.5	0.0	4.2	90.2	0.0	12.3
2007	41.8	0.0	0.0	80.7	0.0	4.7	148.6	0.0	12.6
2008	99.5	0.0	0.0	16.5	0.0	4.9	360.6	0.0	13.3
2009	12.2	0.0	0.0	4,410.5	0.0	5.1	163.6	0.0	14.1
2010	13.5	0.0	0.0	31.1	0.0	5.5	49.1	0.0	14.9
Average	24.0	0.0	0.0	470.8	0.0	4.3	102.6	0.0	10.4

Table 2.4: (cont'd)

	Professional and scientific instruments			Infrastructure			Human resources		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2001	0.0	0.0	3.3	175.4	0.0	2,275.8	10.4	252.9	0.0
2002	0.0	0.0	3.7	0.0	0.0	2,499.0	62.7	253.5	0.0
2003	0.0	0.0	3.9	1,438.6	0.0	2,640.1	94.0	256.8	0.0
2004	26.3	0.0	3.9	35.1	0.0	2,680.1	62.7	262.5	0.0

2005	0.0	0.0	4.2	565.6	0.0	2,854.1	83.6	266.1	0.0
2006	0.0	0.0	4.2	247.1	0.0	2,887.7	62.7	273.2	0.0
2007	0.0	0.0	4.7	338.5	0.0	3,242.5	20.9	9,174.2	0.0
2008	6.4	0.0	4.9	8,796.8	0.0	3,320.2	108.2	1,036.6	0.0
2009	423.0	0.0	5.1	2,484.5	0.0	3,515.4	108.2	1,288.2	0.0
2010	86.0	0.0	5.5	1,133.5	0.0	3,728.7	0.0	533.4	0.0
Average	54.2	0.0	4.3	1,521.5	0.0	2,964.3	61.4	1,359.7	0.0

Sources: NAWEC operating budgets, NAWEC assets database, SNC Lavalin (2005a), John Camara (Pers. Comm.)

The following are discerned from Table 2.4: Expenditure on infrastructure (68%) is clearly dominant, followed by human resources (22%) in distant second position. Careful study of the data shows that average decadal expenditure is boosted by spending between 2007 and 2010. In this table too, zero fluxes in at least five data streams are discernable. It may be significant to further note that O&M expenditures on infrastructure are almost double concurrent investments. This apparent anomaly is explained by the value of new investments compared to older assets.

Unlike illustrations above, the ordinate axes in figures 2.7 through 2.15 are log-transformed to display and emphasize the disparity between expenditure steams across asset types. As before, financial streams with decade-length zero fluxes are omitted.

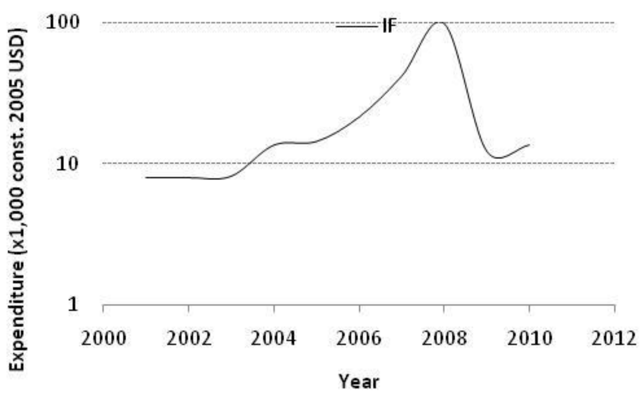

Fig. 2.10: Time plot of IF expenditure on non-electrical assets in the municipal water supply subsector. Data shows a step increase in investment flows (IF) between followed by a steady rise receding to 2005 levels in 2010. The observed expenditure pattern depicted here reflects the timing and scale of expansion of the water supply network.

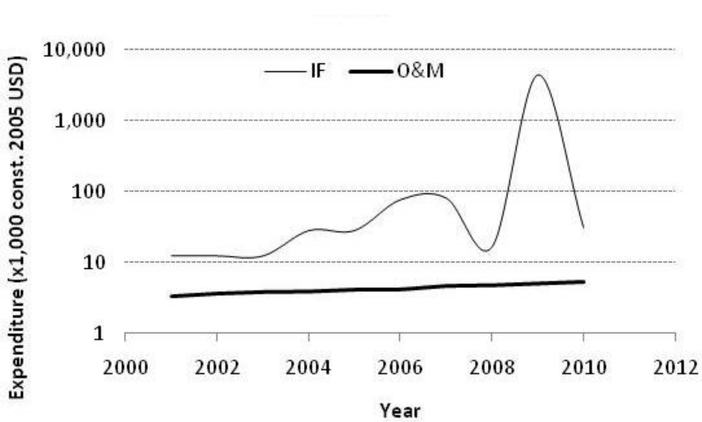

Fig. 2.11: Time plot of expenditure on electrical assets deployed in the municipal water supply subsector. Data shows a dentate pattern of investment flows (IF) associated with network expansions primarily driven by extension of mains to new housing estates. O&M shows steady rise correlated with a three year lag to investments during this decade.

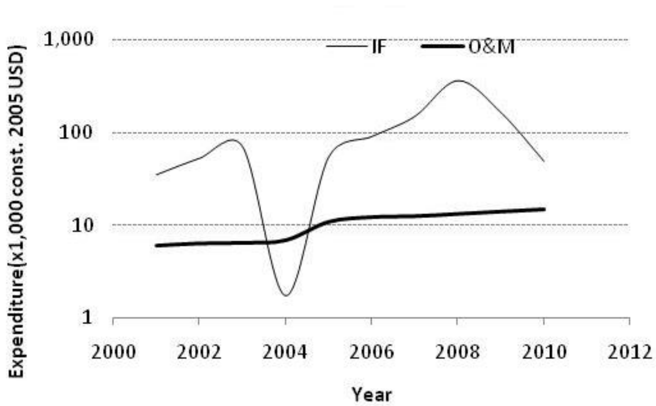

Fig. 2.12: Time plot of expenditure on transportation assets used in the municipal water supply subsector. Data shows a slump in investment flows (IF) in 2004, followed by a quick recovery in 2005. Investments in subsequent years are associated with the implementation of single largest project during decade. Sector professionals ascribe the 2004 slump to anticipation of dedicated financial resources for upgrading of vehicle stock. O&M expenditure rises steadily due allowance given to step increase between 2004 and 2005.

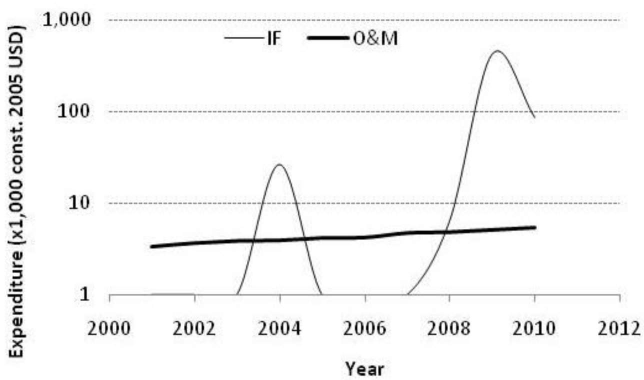

Fig. 2.13: Time plot of expenditure on professional and scientific instruments employed in the municipal water supply subsector. Data shows investment flow (IF) bursts of different duration and magnitude, peaking in 2004 and 2009 respectively. O&M expenditures rise steadily, bearing no relationship with IF during the decade.

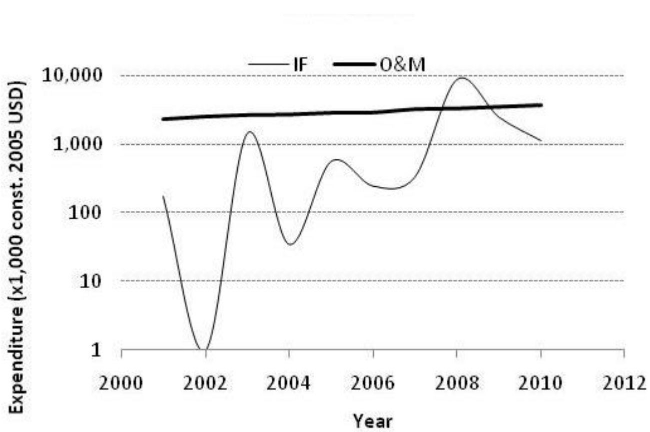

Fig. 2.14: Time plot of expenditure on infrastructural assets of the municipal water supply subsector. Data shows three distinct cycles of investment flows (IF). The last among these, between 2007 and 2010, dwarfs others by the sheer size of numbers involved. Similar to O&M expenditure on electrical assets and professional instruments illustrated above, the same metric on infrastructure displays a steady increase without exhibiting any dependence on investments during decade.

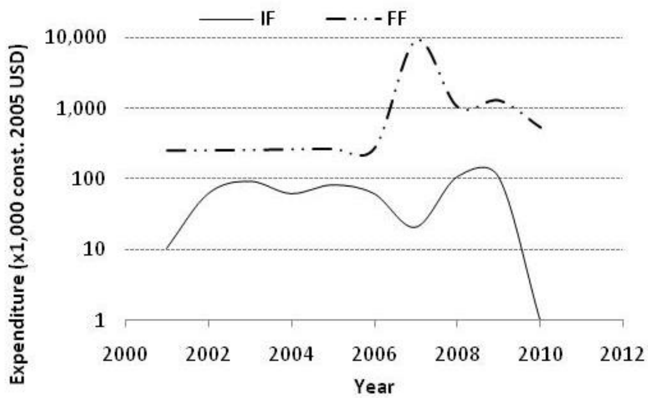

Fig. 2.15: Time plot of expenditure on human resources employed in the municipal water supply subsector. Beginning in 2002, the data shows investment flows (IF) fluctuating in a narrow range. This pattern is disrupted between 2008 and after 2009, when trained professionals actively engaged in 33.8 million Euro project as counterpart engineers or taking over as managers. Varying little initially, financial flows (FF) in the form of outlays for consultancy services increased significantly between 2006 and 2009, when FF starts decreasing.

We draw the reader's attention to the fact that during years of high investment flows, 90% to 98% of NAWEC investment funds are derived from GOTG loans accessible to NAWEC[4]. In the circumstances, IF streams are identifiable with disbursements from loans contracted. Repayment of interest on loans during the period 2001 to 2010, for which disaggregation into expenditure streams is constrained by inadequate access to official records, is shown separately in Table 2.5. This separation is maintained in explicit recognition of the contestable merit of constant decomposition factors used, and linked to that consideration, our strong desire to preserve the quality of data in Table 2.4.

Table 2.5: Theoretical redistribution of interest (x1,000 constant 2005 USD) on water supply subsector loans across investment categories. Current loans portfolio[5] shows that GOTG gets concessional loans at rates between 0 and 2%, payable over 20 to 50 years, with a payment lag of between 3 and 10 years. Yearly totals shown here represent 0.05 and 0.1% GDP in corresponding years.

Year	Non-electrical equipment including computers	Electrical motors, machinery	Transport	Professional and scientific instruments	Infrastructure	Human Resources	Total
2001	0.6	11.2	2.7	1.4	105.4	33.4	154.6
2002	0.4	8.4	2.0	1.0	78.9	25.0	115.6
2003	0.9	18.3	4.4	2.3	172.9	54.8	253.5
2004	1.7	33.8	8.0	4.2	319.5	101.2	468.4
2005	1.5	30.4	7.2	3.7	287.1	90.9	420.9
2006	1.5	29.9	7.1	3.7	282.4	89.5	414.1
2007	1.6	31.1	7.4	3.8	293.3	92.9	430.0
2008	2.1	42.5	10.1	5.2	401.7	127.2	589.0
2009	1.2	22.8	5.4	2.8	215.3	68.2	315.7
2010	1.3	26.3	6.3	3.2	248.7	78.8	364.7

Sources: *Approved Estimates of Revenue and Expenditure with Development Expenditure* of the Gambia Government (for the years 2001 through 2010), Loans Division, Ministry of Finance and Economic Affairs; GBoS, System of National Accounts

The three financial resource flow streams defined in the general project concept rarely have non-zero values concurrently. Indeed, some resource flow streams make no sense when applied to some asset types. While the

[4] The National Water and Electricity Company (NAWEC) is a public enterprise legally empowered to provide wholesome water supplies to urban settlements across the country. NAWEC charges user fees based on volumes consumed by customers in accordance with tariffs consented by Public Utilities Regulatory Authority (PURA). NAWEC also provides sewerage services and sewage treatment for the metropolitan area of Banjul and the Tourism Development Area (Source: IWRM Roadmap for the Gambia).

[5] Restricted access at Ministry of Finance and Economic Affairs

three-way disaggregation of expenditure (i.e., FF, IF, O&M) has its own merits, these zero flux streams and high volatility of expenditure from one year to the next as depicted in figures 2.1 through 2.15, suggest that aggregating financial flows (FF) and operation and maintenance (O&M) under "Operational Expenditure" is a more attractive way of approaching data analysis under future investment scenarios.

Analysis of data and feedback from stakeholders make it possible to identify some key determinants of financial flow streams. For instance, bi-lateral and multilateral programmatic support are major drivers of procurement for the purpose of replacing ageing non-electrical, professional and scientific equipment in the water resources assessment sub-sector. Very recent evidence also suggests that service chiefs need to formulate and champion requests to the Ministry of Finance and Economic Affairs for new transport[6] in order to break the current dependency on end of project-cycle acquisitions. On the other hand, O&M expenditure on relevant asset types is constrained by a cash budgeting approach pursued by GOTG. Major capital expenditure in the water supply sub-sector depends on access to foreign loans. One possible exception to this is human capital. In effect, bi-lateral ODA plays an important role in overseas training of professional cadre in the both water supply and water resources assessment subsectors.

2.2.4. Investment universe

This section of the report briefly discusses the underlying forces interacting with one another to produce the contextual background against which decision-makers, business leaders, and households make independent or conditional choices defining their relationship with water resources.

First among these is the phenomenon of climate change. A recent study published under the aegis of the Arctic Monitoring and Assessment Program (AMAP) on changes in the Arctic region[7] suggests that coastal areas in the Gambia could be exposed to 9mm/year rise in mean sea level. Such accelerated rise in sea level translates approximately into 18 centimeters in the next 20 years, roughly equal to the quasi-certain increase projected to occur in 2100 by the IPCC (Solomon et al. 2007). Using a suite of 14 general circulation models (GCMs), Sima (2008) computed a non-uniform seasonal pattern of warming that carries over into a positive inter-annual trend in the range of 0.3°C to 1.1°C by 2030. In contrast, country-average annual rainfall is projected to decrease by 0.1 to 4% over a similar time horizon. Although, these projections do not exceed the bounds of natural variability, the values may occlude changes in the statistical distributions of rainy days and daily rainfall (Njie, 1987). In effect, the tendency towards more frequent downpours and smaller number of rainy days is gradually becoming the norm.

As an integral part of the climate system, freshwater resources represent a major impact receptor of climate change. Furthermore, the superposition of climate change on urbanization significantly alters local hydrological processes. Specifically, the surface area conducive to groundwater recharge would decrease inversely with new housing construction and infrastructure development. The risk of salt water encroachment from saline surface water bodies is increased by lower recharge, continued water abstractions from ground and surface water sources, and sea level rise (van Rens and Verkerk, 2005; Njie, 2002). Additionally, the risk of NO_3-N pollution of groundwater is increased by leakage from ubiquitous on-site sanitation systems within the Kombo Peninsula. Paradoxically, such leakage partially compensates for reduced aquifer recharge associated with lower surface infiltration. In these circumstances, groundwater abstraction will be constrained by economy and efficiency of operations. Surface water quality objectives or pre-requisites will set the limit to expansion of irrigated agriculture before construction of a storage dam at Sambangalou (Sogreah et al., 1998). Practical measures to improve the water resources outlook up to 2030, including artificial recharge of aquifers, face significant environmental and economic constraints.
In addition to climate change phenomena and physical impacts, co-determinants and economic ramifications of population growth and distribution as well as societal aspirations are equally worth noting. An ensemble of population growth models provides population projections in the range 3.2 to 3.7 million by 2030 (Njie, 2002). Rising from the current level of 49%, approximately 63% of the population is projected to be resident in the Kombo Peninsula by

[6] According to televised opening address of the POTR-Gambia during Cabinet Retreat, Kanilai, 9 – 11 June, 2011.
[7] http://www.climatecentral.org/blogs/rapid-arctic-changes-increase-expected-rate-of-sea-level-rise/

2030. Such massive concentration of people in this small area can only be sustained by conversion of land uses from agricultural to residential and social use purposes. In this light, green belts and buffer zones will continue to shrink and eventually disappear under pressure from housing and urbanization policies. Concurrently, domestic water use is expected to rise in proportion to population growth and increased economic activity. Still, it is likely that high levels of unemployment among youth and unskilled will persist despite increasing gains in human capital. Economy-wide policy reforms and new investments would be required to match workers skills with job opportunities. Ultimately, poverty reduction under PRSP II (2011- 2015) and successor programs depend on the economically-active getting into long-term employment. Most rural parts of the country will also experience population growth and some improvements in labour productivity arising from current investments in water infrastructure. In the CRR "rice basin", irrigation water demand is expected to grow steadily and remain strong as high rice crop yields under tidal irrigation schemes remain stable. Food security aspirations riding on a successful agriculture and natural resources (ANR) policy and well-resourced Gambia National Agricultural Investment Program (GNAIP) would be critical variables in determining irrigation demand. Individual households and corporations with financial means to do so will continue to develop self supplies to compensate for shortages in the public supply system. The danger here is uncoordinated and unregulated development that prejudices the interests of other developers or threatens the aquifer system.

Noting that the Gambia's is an open economy, it is almost certain that developments in the rest of the world (ROW) will influence domestic policies. In particular, unstable commodity and financial markets, natural disasters and regional conflicts, could have a profound impact on access to external sources of finance on which the Gambia relies to implement capital-intensive water supply projects.

From the foregoing, decision- and policy-makers in the water sector face the following challenges: 1) safeguarding public health through access to water supplies that meet international norms, industry and national standards, 2) leveraging economic growth and stability, and reducing poverty by developing sufficient capacity to cater for productive uses of water, 3) mobilizing requisite financial resources for implementation of the GNAIP, and 4) planning medium to long-term investments with key uncertainties unresolved. Opportunities potentially accelerating convergence of social aspirations and national policy objectives include: 1) empowerment of water user groups (WUGs) in irrigated agriculture, 2) expansion of economic incentives spelt out in Gambia investment Promotion Act (2001) to individual and corporate investors in water supply infrastructure, water-saving and water purification technologies, amongst others. Limiting constraints on new investments include the number and financial management capacity of actors providing public water supplies, and GOTG debt servicing on loans contracted for construction and expansion of existing infrastructure. In conclusion, decision- and policy-makers face two specific choices: 1) carry on with a business-as-usual approach; or 2) to internalize climate change adaptation into investment policies and decisions.

2.2.4.1. Baseline Scenario

Over the next 20 years, population growth is expected to mirror changes in fertility rates and household sizes. Nonetheless, it is quite likely that population in the GBA will exceed 1.5 million by 2030. Benefitting from a surge of accelerated and sustained economic growth, GDP per capita slowly rises to USD500 by 2030. However, development planning is still burdened with fragmented sectoral policies. With regard to water resources, investment planning and decisions are based on the following premises:

- GOTG remains committed to socioeconomic objectives of universal access to safe water and food security.
- GOTG has access to adequate domestic and external sources of funding to execute flagship projects.
- Investments in infrastructure projects take precedence over research and monitoring ("People do not eat or drink information").
- The urgency of addressing climate change impacts for which ample empirical evidence exists is underestimated.

Over the planning horizon, domestic investments in scientific infrastructure and assets with the express objective of gaining improved scientific understanding of behaviour, distribution, and quality of water resources, remains low and intermittent. The greater share of GOTG budgetary allocations goes towards meeting personnel costs. Investments in human resources (capacity building) are driven by donor support and to an uncertain extent on student take-up of training courses offered by the University of the Gambia, beginning in 2014.

BOX 1: Baseline Scenario Management Measures

Water resources management in The Gambia faces several challenges. The public services' failure to sufficiently compensate for departure of experienced/qualified staff, compounded by years of under-investment in technological assets, has significantly eroded the performance of open-ended monitoring programmes designed to provide 'hard' data on which analysis and resource planning rest. Sectoral coordination is another big issue not to say handicap. Policy fragmentation, outdated sectoral legislation and inadequate institutional framework constitute additional layers of complexity to water resources management. Meanwhile, agricultural and municipal water demand continues to grow relentlessly under pressure from peoples' legitimate aspirations for improved quality of life.

Against this backdrop, two primary water resources management measures are adopted under the baseline scenario:

Institutional strengthening: Activities envisaged under this line of action consist of procurement of physical assets and professional services essential to the execution of measurement protocols, computation and data analysis, and generation of knowledge on water systems. In parallel, several sector employees will receive training from local or external institutions, and sectoral reforms to bring new water law into harmony with other sectoral policies will be pursued in earnest.

Supply augmentation: The development of new water sources and delivery at point of use with the objective of improving quantitative and qualitative aspects previous water supplies is achieved through of a web of activities that include exploration, recovery, treatment and distribution. In municipal water supplies, key assets comprise boreholes, water treatment plants, water pumping equipment, pipes and couplings and elevated storage tanks. For irrigation purposes, water delivery involves construction of water control structures (dam, dykes and sluice gates), distribution canals and access roads.

Institutional strengthening is an open-ended activity, sanctioned by regular independent assessments, which is funded through multiple sources to the tune of USD 67.0 million (constant 2005 US dollars) over the period 2011 to 2030. By comparison, the present value of supply augmentation costs is approximately USD 269.7 million, of which foreign/external sources account for 40% of the total. It is also worth noting that 96% of foreign/external funding is accessible through loans.

To meet rising municipal water demand, the public utility, NAWEC, periodically expands installed capacity from 77,680 to 240,000 m^3/day by 2030. Scheduling, sizing, and siting (3Ss) are based on effective demand and proximity of demand location(s). New investments restoring value to sub-optimally performing network infrastructure is expected to connect 100,700 households bringing NAWEC coverage to 60% of population in the Greater Banjul Metropolitan Area at 100 liters/day/capita, in 2030. The market share of bottling firms remains constant. Investments for these private sector entities are proportional to dynamic equilibrium between demand and production. Testing the quality of water quality flowing through the supply network will be carried out on a sub-daily frequency.

As cereal prices on the world market remain high, sustained by increasing demand from the bio-fuel industry and negative impacts of extreme weather in source countries, The Gambia embarks on an ambitious project to expand irrigated rice area from the current 2,000 ha to 18,000 ha by 2025. Such expansion will require construction of water control structures in and around irrigated areas, and crucially the construction of a dam reservoir at Sambangalou by 2015, when irrigated area reaches 3,000ha and the acceptable limit of negative externalities under unregulated flow conditions. Construction of Sambangalou dam takes place between 2015 and 2018 and the facility is commissioned by 2020 allowing accelerated expansion of rice irrigation in CRR.

In essence, activities listed in Table 2.1 fall into two broad water resources management measures: 1) institutional strengthening; and 2) supply augmentation, under the baseline scenario (see Box 1 for additional information).

By 2030, this scenario puts us in a world, where water supply networks are regularly expanded to service newly built-up areas and older un-serviced areas in conformity with domestic politics and international development climate. Technology-based solutions are no longer adequate, and sectoral adjustments to minimize adaptation deficits become imperative. Double cropping under irrigated conditions makes it possible for the country to meet its demand for rice paddy from domestic production. However, stewardship for rational management of water resources remains weak due to a combination of avoidable factors: observation networks are not designed optimally or operated cooperatively, DWR's continued reliance on conventional instruments/methods, and leakage/depreciation of human resources. Not surprisingly, integration and coordination of water resources assessment, climate change and water supply activities is minimal.

The Public Utilities Regulatory Authority (PURA) continues to perform its legal functions, without interference, ensuring that individual consumers and WUGs pay a fair price for services provided by NAWEC and the Irrigation and Drainage Agency created to take on technical and financial management of irrigation infrastructure.

In conformity with the above narrative, we include in our analysis projects/actions with approved funding[8], quasi-certain[9] funding and investment plans/development programs[10] from relevant water subsectors. Other projects/actions spurred by dynamic socio-economic changes are also included[11]. Funding streams associated with different sets of actions are grouped under water resources assessment, municipal water supply, and irrigation water supply in Table 2.6. To deal with heterogeneity in compiled datasets, we concentrate our efforts on annual financial flows[12].

Table 2.6 shows episodic IF (CAPEX) steams in water resources assessment and irrigation water supply sub-sectors. This is in sharp contrast to the quasi-periodic pattern of IF (CAPEX) in the municipal water supply sub-sector. Across all subsectors analyzed, FF and O&M streams increase monotonously with few exceptions. For concurrent, non-zero values of IF and O&M, the former, in general, is 2 to 5 times larger than the latter. For better visualization and ease of comparability (with IF) and synthesis, FF and O&M are pooled together as OPEX in Figure 2.16.

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[8] IDB Rural Water Supply Project, AfDB Water Sector Reform Project, Kotu Ring Project, Gunjur Water Supply Project.

[9] GEF/LCDF EWS Project, Venezuelan grant to municipal water supply sub-sector, Spanish grant to water resources assessment sub-sector.

[10] Gambia National Agricultural Investment Plan, OMVG Infrastructure Development Program.

[11] This group of projects refer to decisions to increase installed capacity in response to escalating water demand. In view of the Gambia's debt burden and ability to raise funds above certain amounts, new investments are considered to be in the same range as those in recent years.

[12] Detailed procurement plans are available for the water resources assessment subsector. In contrast, no designs or equipment specifications are available for municipal and irrigation water sub-sub-sector interventions.

Table 2.6: Sub-sectoral and aggregate sectoral I&FF streams under the baseline scenario. IF (Investment flows), FF (financial flows), O&M (operation and maintenance) and Totals are expressed in thousands of constant 2005 US Dollars. *A social discount rate of 2% is used to discount all financial flow streams. Investment behavior of the public water supply utility is predicated on responsiveness to growth in demand and optimal investment strategies. No major replacement of municipal water supply subsector assets is anticipated during the period of analysis. The IF (CAPEX) stream for irrigation does not cover flood protection, biodiversity and hydroelectricity objectives amounting to 85% of The Gambia's full contribution to the construction of a reservoir-dam at Sambangalou. OPEX disaggregation into FF and O&M streams under the irrigation water supply sub-sector uses partition coefficients derived for municipal water supply sub-sector . Additionally, O&M steams are linked to construction schedules of water control infrastructure. Observe that values may not add up correctly due to rounding errors.*

Year	Water Resources Assessment subsector				Municipal Water Supply subsector			
	CAPEX	OPEX		Total	CAPEX	OPEX		Total
	IF	FF	O&M		IF	FF	O&M	
2011	54.0	201.6	41.1	296.7	2,778.8	3,480.7	639.6	6,899.1
2012	1,023.0	1,660.6	363.5	3,047.1	6,645.9	3,216.8	1,072.3	10,934.9
2013	120.9	1,076.0	234.3	1,431.2	15,166.1	3,669.5	810.3	19,645.9
2014	0.0	232.3	47.9	280.2	11,099.4	3,781.4	911.3	15,792.1
2015	0.0	242.9	50.2	293.1	10,881.8	3,904.8	1,022.9	15,809.5
2016	0.0	252.9	52.4	305.3	1,611.1	4,039.8	1,145.0	6,795.9
2017	0.0	262.4	54.5	316.9	1,579.5	4,098.0	1,366.0	7,043.5
2018	0.0	271.5	56.5	328.0	14,607.0	4,344.7	1,420.6	20,372.3
2019	0.0	280.1	58.4	338.5	14,320.5	4,514.5	1,574.2	20,409.3
2020	0.0	288.3	60.2	348.5	14,039.8	4,696.1	1,738.2	20,474.0
2021	0.0	296.0	62.0	358.0	1,459.2	5,101.4	1,700.5	8,261.2
2022	0.0	303.3	63.6	366.9	13,494.6	5,093.9	2,097.8	20,686.3
2023	0.0	310.3	65.1	375.4	13,230.0	5,310.1	2,293.4	20,833.5
2024	0.0	316.8	66.6	383.4	12,970.6	5,538.1	2,499.4	21,008.1
2025	0.0	323.0	67.9	390.9	1,348.1	6,370.2	2,123.4	9,841.7
2026	0.0	328.8	69.2	398.0	12,466.9	6,028.8	2,943.0	21,438.7
2027	0.0	334.2	70.4	404.6	12,222.5	6,291.5	3,180.6	21,694.5
2028	0.0	339.4	71.5	410.9	11,982.8	6,565.9	3,428.6	21,977.2
2029	0.0	344.1	72.6	416.7	1,245.4	6,851.9	3,687.1	11,784.4
2030	0.0	348.6	73.6	422.2	1,221.0	7,149.5	3,956.1	12,326.6
All Years	**1,197.9**	**8,013.1**	**1,701.5**	**10,912.5**	**174,371.0**	**100,047.6**	**39,610.2**	**314,028.7**

Sources: IDB RWS Project Document, AfDB Water Sector Reform Project Document, GEF/LCDF EWS Project Document, Gambia National Agricultural Investment Plan (2011-2015), GOTG Loans Database, MOFEA, Njie (2009a), Aissatou Sylla (Pers. Comm.), Bernard E. Gomez (Pers. Comm.)

Table 2.6: cont'd

Year	Irrigation Water Supply subsector				Water Sector Priority Actions			
	CAPEX	OPEX		Total	CAPEX	OPEX		Total
	IF	FF	O&M		IF	FF	O&M	
2011	1,692.9	1.0	0.0	1,693.9	4,525.7	3,683.3	680.7	8,889.7
2012	1,876.2	1.4	0.0	1,877.7	9,545.1	4,878.8	1,435.8	15,859.6
2013	2,263.9	2.8	0.0	2,266.7	17,550.9	4,748.3	1,044.6	23,343.8
2014	3,144.3	5.0	0.0	3,149.3	14,243.8	4,018.7	959.2	19,221.7
2015	2,819.9	7.9	0.0	2,827.8	13,701.7	4,155.6	1,073.1	18,930.4
2016	2,525.0	11.9	0.0	2,536.9	4,136.1	4,304.6	1,197.4	9,638.1
2017	2,475.4	17.1	0.0	2,492.5	4,055.0	4,377.5	1,420.5	9,853.0
2018	606.7	23.3	0.0	630.0	15,213.7	4,639.5	1,477.1	21,330.3
2019	0.0	30.6	0.0	30.6	14,320.5	4,825.2	1,632.6	20,778.3
2020	0.0	38.8	0.0	38.8	14,039.8	5,023.2	1,798.4	20,861.4
2021	0.0	47.9	0.0	47.9	1,459.2	5,445.3	1,762.5	8,667.0
2022	0.0	1,724.2	246.3	1,970.5	13,494.6	7,121.4	2,407.7	23,023.7
2023	0.0	1,700.7	243.0	1,943.7	13,230.0	7,321.1	2,601.5	23,152.6
2024	0.0	1,678.5	239.8	1,918.3	12,970.6	7,533.4	2,805.8	23,309.8
2025	0.0	3,067.1	265.7	3,332.8	1,348.1	9,760.3	2,457.0	13,565.4
2026	0.0	3,040.4	241.6	3,282.0	12,466.9	9,398.0	3,253.8	25,118.7
2027	0.0	3,014.7	218.2	3,232.9	12,222.5	9,640.4	3,469.2	25,332.1
2028	0.0	2,989.8	195.8	3,185.6	11,982.8	9,895.1	3,695.9	25,573.8
2029	0.0	2,965.9	174.1	3,140.0	1,245.4	10,161.9	3,933.8	15,341.1
2030	0.0	2,942.7	153.2	3,095.9	1,221.0	10,440.8	4,182.9	15,844.7
All Years	**17,404.3**	**23,311.7**	**1,977.7**	**42,693.8**	**192,973.4**	**131,372.4**	**43,289.4**	**367,635.2**

Sources: IDB RWS Project Document, AfDB Water Sector Reform Project Document, GEF/LCDF EWS Project Document, Gambia National Agricultural Investment Plan (2011-2015), GOTG Loans Database, MOFEA, Njie (2009a), Aissatou Sylla (Pers. Comm.), Bernard E. Gomez (Pers. Comm.)

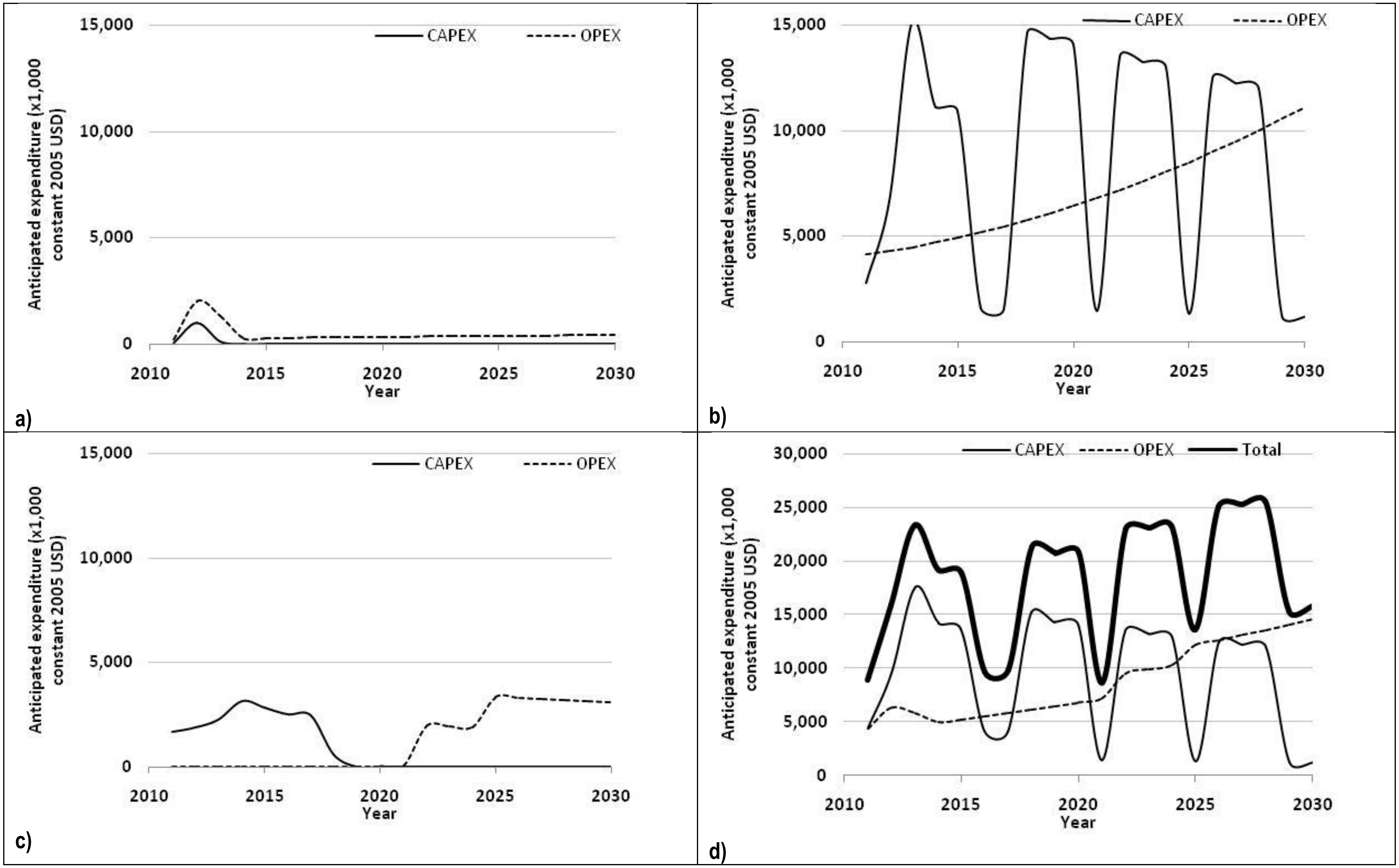

Fig. 2.16: Anticipated investments (CAPEX) and operational expenditure (OPEX) in: a) water resources assessment, b) municipal water supply, c) irrigation water supply subsectors. Use of similar vertical scale gives reader an instant fix on the comparative scale of expenditures. Fig. 2.16d depicts aggregate CAPEX and OPEX in these three sub-sectors and grand total for priority actions in water sector. Totals are not shown in other illustrations because OPEX is equivalent to "Total" time series, when CAPEX series take on zero values, during the second decade of this assessment (All illustrations are based on data presented in Table 2.6).

Table 2.7: Financial resource streams for critical assets deployed under the baseline scenario. *Entries express anticipated values of investments and operational expenditure on similar asset types across all three water sub-sectors analyzed*.

	Asset type ISIC 382			Asset type ISIC 383			Asset type ISIC 384			Asset type ISIC 385		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2011	51.5	22.4	6.7	942.3	0.0	1.1	215.6	0.0	20.3	124.7	5.8	0.9
2012	158.1	184.7	59.6	1,796.2	0.0	3.4	585.7	0.0	163.7	515.5	47.5	1.6
2013	194.9	119.7	38.4	3,672.7	0.0	2.3	823.5	0.0	106.0	459.1	30.8	1.2
2014	152.9	25.8	7.9	3,001.3	0.0	1.6	654.2	0.0	24.3	345.3	6.6	1.3
2015	147.0	27.0	8.2	2,887.1	0.0	1.7	629.3	0.0	25.7	332.2	6.9	1.5
2016	44.4	28.1	8.6	871.5	0.0	1.9	190.0	0.0	27.1	100.3	7.2	1.7
2017	43.5	29.2	8.9	854.4	0.0	2.3	186.2	0.0	28.7	98.3	7.5	2.0
2018	163.3	30.2	9.3	3,205.7	0.0	2.3	698.7	0.0	29.8	368.8	7.8	2.1
2019	153.7	31.2	9.6	3,017.5	0.0	2.6	657.7	0.0	31.2	347.2	8.0	2.3
2020	150.7	32.1	9.9	2,958.3	0.0	2.8	644.8	0.0	32.6	340.4	8.2	2.5
2021	15.7	32.9	10.2	307.5	0.0	2.8	67.0	0.0	33.2	35.4	8.5	2.5
2022	144.8	33.7	10.4	2,843.5	0.0	3.7	619.8	0.0	36.2	327.2	8.7	3.4
2023	142.0	34.5	10.7	2,787.7	0.0	4.0	607.6	0.0	37.5	320.7	8.9	3.7
2024	139.2	35.2	10.9	2,733.0	0.0	4.3	595.7	0.0	38.9	314.4	9.1	4.0
2025	14.5	35.9	11.1	284.1	0.0	3.8	61.9	0.0	38.2	32.7	9.2	3.5
2026	133.8	36.6	11.3	2,626.9	0.0	5.0	572.6	0.0	41.6	302.2	9.4	4.6
2027	131.2	37.2	11.5	2,575.4	0.0	5.3	561.3	0.0	42.8	296.3	9.6	4.9
2028	128.6	37.8	11.7	2,524.9	0.0	5.6	550.3	0.0	44.1	290.5	9.7	5.3
2029	13.4	38.3	11.9	262.4	0.0	6.0	57.2	0.0	45.4	30.2	9.8	5.6
2030	13.1	38.8	12.1	257.3	0.0	6.3	56.1	0.0	46.7	29.6	10.0	6.0
All Years	**2,136.2**	**891.4**	**279.0**	**40,409.6**	**0.0**	**68.9**	**9,035.1**	**0.0**	**893.8**	**5,011.0**	**229.2**	**60.5**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.7: Cont'd

	Asset type			Asset type			All asset types		
	Infrastructure			Human Resources					
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2011	3,061.7	0.9	651.6	129.9	3,654.2	0.0	4,525.7	3,683.3	680.7
2012	6,121.1	7.7	1,207.5	368.5	4,638.9	0.0	9,545.1	4,878.8	1,435.8
2013	11,906.3	5.0	896.7	494.4	4,592.9	0.0	17,550.9	4,748.3	1,044.6
2014	9,699.0	1.1	924.2	391.0	3,985.1	0.0	14,243.8	4,018.7	959.2
2015	9,330.0	1.1	1,036.0	376.1	4,120.5	0.0	13,701.7	4,155.6	1,073.1
2016	2,816.4	1.2	1,158.2	113.5	4,268.1	0.0	4,136.1	4,304.6	1,197.4
2017	2,761.1	1.2	1,378.6	111.3	4,339.6	0.0	4,055.0	4,377.5	1,420.5
2018	10,359.6	1.3	1,433.6	417.6	4,600.3	0.0	15,213.7	4,639.5	1,477.1
2019	9,751.3	1.3	1,587.0	393.1	4,784.7	0.0	14,320.5	4,825.2	1,632.6
2020	9,560.2	1.3	1,750.6	385.4	4,981.6	0.0	14,039.8	5,023.2	1,798.4
2021	993.6	1.4	1,713.9	40.1	5,402.5	0.0	1,459.2	5,445.3	1,762.5
2022	9,189.0	1.4	2,354.0	370.5	7,077.6	0.0	13,494.6	7,121.4	2,407.7
2023	9,008.8	1.4	2,545.6	363.2	7,276.3	0.0	13,230.0	7,321.1	2,601.5
2024	8,832.1	1.5	2,747.7	356.1	7,487.6	0.0	12,970.6	7,533.4	2,805.8
2025	918.0	1.5	2,400.4	37.0	9,713.6	0.0	1,348.1	9,760.3	2,457.0
2026	8,489.2	1.5	3,191.3	342.2	9,350.5	0.0	12,466.9	9,398.0	3,253.8
2027	8,322.7	1.5	3,404.6	335.5	9,592.1	0.0	12,222.5	9,640.4	3,469.2
2028	8,159.5	1.6	3,629.2	329.0	9,846.1	0.0	11,982.8	9,895.1	3,695.9
2029	848.0	1.6	3,864.9	34.2	10,112.2	0.0	1,245.4	10,161.9	3,933.8
2030	831.4	1.6	4,111.8	33.5	10,390.4	0.0	1,221.0	10,440.8	4,182.9
All Years	**130,959.1**	**37.0**	**41,987.2**	**5,422.2**	**130,214.8**	**0.0**	**192,973.4**	**131,372.4**	**43,289.4**

Table 2.8: Financial resources streams associated with water resources management measures under the baseline scenario. Totals are expressed in thousands of constant 2005 US Dollars. *Observe that values may not add up correctly due to rounding errors.*

	Specific water management measures								**All Measures**	
	Institutional building		**Supply augmentation**							
Year	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**					**CAPEX**	**OPEX**
2011	154.5	1,717.2	4,367.9	2,646.8					4,522.4	4,364.0
2012	1,098.5	2,417.0	8,440.7	3,897.6					9,539.3	6,314.6
2013	523.9	2,297.3	17,025.5	3,495.6					17,549.4	5,792.9
2014	341.7	1,875.0	13,902.1	3,102.9					14,243.8	4,977.9
2015	328.7	1,939.1	13,373.0	3,289.6					13,701.7	5,228.7
2016	99.2	2,008.8	4,040.1	3,493.2					4,139.4	5,502.0
2017	97.3	2,043.4	3,960.8	3,754.6					4,058.1	5,798.0
2018	365.0	2,165.2	14,848.7	3,951.4					15,213.7	6,116.6
2019	343.6	2,251.6	13,976.9	4,207.9					14,320.5	6,459.5
2020	336.8	2,343.8	13,703.0	4,477.8					14,039.8	6,821.6
2021	35.0	2,539.2	1,425.3	4,668.6					1,460.3	7,207.8
2022	323.8	3,312.7	13,170.8	6,216.4					13,494.6	9,529.1
2023	317.4	3,405.5	12,912.6	6,517.1					13,230.0	9,922.6
2024	311.2	3,504.1	12,659.4	6,835.1					12,970.6	10,339.2
2025	32.3	4,531.4	1,316.8	7,685.9					1,349.2	12,217.3
2026	299.1	4,365.0	12,167.8	8,302.8					12,466.9	12,667.8
2027	293.2	4,477.3	11,929.3	8,639.9					12,222.5	13,117.2
2028	287.5	4,595.2	11,695.3	8,970.4					11,982.8	13,565.6
2029	29.9	4,718.7	1,216.5	9,377.0					1,246.4	14,095.7
2030	29.3	4,847.8	1,192.7	9,775.9					1,222.0	14,623.7
All Years	**5,648.1**	**61,355.4**	**187,325.2**	**113,306.4**					**192,973.3**	**174,661.8**

Table 2.9: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in the water resources assessment sub-sector for the baseline scenario. *Allocations between domestic and foreign sources are based on budget data in project documents and clarifications from key informants. Government contributions represent counterpart funding as well as expenditure to sustain non-project activities of the host institution, Department of Water Resources (DWR). Observe that values may not add up correctly due to rounding errors.*

	TOTAL		**ISIC 382**		**ISIC 383**		**ISIC 384**		**ISIC 385**		**Infrastructure**		**Human Resources**	
	CAPEX	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**
Domestic		**7,048.3**		**841.5**		**5.4**		**479.1**		**170.5**		**453.0**		**5,098.8**
Households														
Firms														
Govt.		7,048.3		841.5		5.4		479.1		170.5		453.0		5,098.8
Foreign	**1,197.9**	**2,666.3**	**78.1**	**318.3**	**0.5**	**2.0**	**227.5**	**181.3**	**361.7**	**64.5**	**372.4**	**171.4**	**157.6**	**1,928.8**
Loans	54.0		3.5				10.3		16.3		16.8		7.1	
Bilateral ODA	43.2		2.8				8.2		13.0		13.4		5.7	
Multi-lateral ODA	1,100.7	2,666.3	71.7	318.3	0.5	2.0	209.1	181.3	332.4	64.5	342.2	171.4	144.8	1,928.8
All Sources	**1,197.9**	**9,714.5**	**78.1**	**1,159.9**	**0.5**	**7.4**	**227.5**	**660.4**	**361.7**	**234.9**	**372.4**	**624.3**	**157.6**	**7,027.6**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.10: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in municipal water supply sub-sector under the baseline scenario. *Aggregate CAPEX is based on a year-by-year assessment of investment needs and assumed investment behavior consistent with NAWEC's investments in the last five years. On-going network extensions undertaken by SSHFC and NAWEC are also included in the projections. CAPEX computations use a unit cost of GMD5/m³ of additional capacity. OPEX is computed as the sum of two components: 1) extrapolation of operation and maintenance costs without new assets, and 2) operation and maintenance of newly installed assets (see figure 2.3). In this, we assume that existing assets do not reach the end of their useful economic life during the period of analysis. Allocations between domestic and foreign sources are based on historic ratios and clarifications from key informants. Household contributions represent direct payments by aspirants who wish to get connected to NAWEC's water distribution network. Observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**65,843.6**	**139,657.6**	**388.2**		**7,622.6**	**139.6**	**1,661.4**	**334.1**	**877.0**	**139.6**	**54,301.2**	**95,321.0**	**993.1**	**43,723.4**
Households	29,667.8										29,667.8			
Firms	36,175.8	139,657.6	388.2		7,622.6	139.6	1,661.4	334.1	877.0	139.6	24,633.4	95,321.0	993.1	43,723.4
Govt.														
Foreign	**108,527.4**		**1,164.7**		**22,867.9**		**4,984.3**		**2,631.1**		**73,900.2**		**2,979.3**	
Loans	108,527.4		1,164.7		22,867.9		4,984.3		2,631.1		73,900.2		2,979.3	
Bilateral ODA														
Multi-lateral ODA														
All Sources	**174,371.0**	**139,657.6**	**1,553.0**		**30,490.5**	**139.6**	**6,645.7**	**334.1**	**3,508.1**	**139.6**	**128,201.4**	**95,321.0**	**3,972.4**	**43,723.4**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.11: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in the irrigation water supply sub-sector the baseline scenario. *Allocations between domestic and foreign sources are based on GNAIP-defined coefficients. For allocations between different sources however, GNAIP coefficients are only used when specified. To this effect, we assumed that the foreign component is evenly divided between grants and loans. Expert judgment was further used to discriminate between bilateral and multilateral sources of ODA. Allocation of the aggregate OPEX value rested on two key variables: 1) share of domestic resources vis-à-vis expected budgetary support; and 2) households' capacity to contribute to OPEX. Sources/Entities not logically associated with OPEX are excluded by use of partition coefficients already mentioned. In absence of historical data, asset disaggregation coefficients are assumed to be similar to those in the municipal water supply sub-sector. Observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**7,832.0**	**20,231.5**	**84.1**		**1,650.3**	**20.2**	**359.7**	**48.4**	**189.9**	**20.2**	**5,333.1**	**13,808.7**	**215.0**	**6,334.0**
Households	522.1	2,832.4	5.6		110.0	2.8	24.0	6.8	12.7	2.8	355.5	1,933.2	14.3	886.8
Firms	6,091.6		65.4		1,283.6		279.8		147.7		4,148.0		167.2	
Govt.	1,218.3	17,399.1	13.1		256.7	17.4	56.0	41.6	29.5	17.4	829.6	11,875.5	33.4	5,447.2
Foreign	**9,572.4**	**5,057.9**	**102.7**		**2,017.0**	**5.1**	**439.6**	**12.1**	**232.1**	**5.1**	**6,518.2**	**3,452.2**	**262.8**	**1,583.5**
Loans	4,786.2		51.4		1,008.5		219.8		116.0		3,259.1		131.4	
Bilateral ODA	3,067.2		32.9		646.3		140.9		74.4		2,088.6		84.2	
Multi-lateral ODA	1,719.0	5,057.9	18.4		362.2	5.1	78.9	12.1	41.7	5.1	1,170.5	3,452.2	47.2	1,583.5
All Sources	**17,404.4**	**25,289.4**	**186.8**		**3,667.3**	**25.3**	**799.3**	**60.5**	**421.9**	**25.3**	**11,851.3**	**17,260.9**	**477.8**	**7,917.5**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.12: Synoptic table of priority I&FF disaggregated to different entities and asset types deployed in the water sector under the baseline scenario. Values shown (in thousands of 2005 US Dollars) are totals of corresponding variables in Tables 2.9, 2.10 and 2.11. *Observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**73,675.6**	**166,937.4**	**472.3**	**841.5**	**9,272.9**	**165.2**	**2,021.1**	**861.6**	**1,066.9**	**330.3**	**59,634.3**	**109,582.7**	**1,208.1**	**55,156.2**
Households	30,189.9	2,832.4	5.6		110.0	2.8	24.0	6.8	12.7	2.8	30,023.3	1,933.2	14.3	886.8
Firms	42,267.4	139,657.6	453.6		8,906.2	139.6	1,941.2	334.1	1,024.7	139.6	28,781.4	95,321.0	1,160.3	43,723.4
Govt.	1,218.3	24,447.4	13.1	841.5	256.7	22.8	56.0	520.7	29.5	187.9	829.6	12,328.5	33.4	10,546.0
Foreign	**119,297.7**	**7,724.2**	**1,345.5**	**318.3**	**24,885.4**	**7.1**	**5,651.4**	**193.4**	**3,224.9**	**69.6**	**80,790.8**	**3,623.6**	**3,399.7**	**3,512.3**
Loans	113,367.6		1,219.6		23,876.4		5,214.4		2,763.4		77,176.1		3,117.8	
Bilateral ODA	3,110.4		35.7		646.3		149.1		87.4		2,102.0		89.9	
Multi-lateral ODA	2,819.7	7,724.2	90.1	318.3	362.7	7.1	288.0	193.4	374.1	69.6	1,512.7	3,623.6	192.0	3,512.3
All Sources	**192,973.3**	**174,661.5**	**1,817.9**	**1,159.9**	**34,158.3**	**172.3**	**7,672.5**	**1,055.0**	**4,291.7**	**399.8**	**140,425.1**	**113,206.2**	**4,607.8**	**58,668.5**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.13: Synoptic table of priority I&FF(in thousands of 2005 US Dollars) disaggregated by water resources management measures and investment entities under the baseline scenario. *CAPEX (IF) and OPEX (pooled FF and O&M) for institutional strengthening is identified with similar resource streams on building and maintaining human capital in all three water sub-sectors analyzed. Excluding those deployed in the water resources assessment subsector, all other capital assets and related operating expenditure are identified with supply augmentation. Observe that values may not add up correctly due to rounding errors.*

Specific Water Resources Management Measures

	All Measures		**Institutional strengthening**		**Supply augmentation**					
	CAPEX	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**				
Domestic	**73,675.6**	**166,937.4**	**1,208.1**	**57,105.7**	**72,467.5**	**109,831.7**				
Households	30,189.9	2,832.4	14.3	886.8	30,175.6	1,945.7				
Firms	42,267.4	139,657.6	1,160.3	43,723.4	41,107.0	95,934.2				
Govt.	1,218.3	24,447.4	33.4	12,495.5	1,184.9	11,951.9				
Foreign	**119,297.7**	**7,724.2**	**4,440.0**	**4,249.8**	**114,857.8**	**3,474.4**				
Loans	113,367.6	0.0	3,164.7	0.0	110,202.9	0.0				
Bilateral ODA	3,110.4	0.0	127.4	0.0	2,983.0	0.0				
Multi-lateral ODA	2,819.7	7,724.2	1,147.9	4,249.8	1,671.8	3,474.4				
All Sources	**192,973.3**	**174,661.5**	**5,648.1**	**61,355.4**	**187,325.2**	**113,306.1**				

Data in Table 2.6 depicted in Fig. 2.16 shows anticipated capital investment (CAPEX) streams in the water resources assessment and irrigation water supply sub-sectors ceasing by 2020. By contrast, the municipal water supply sub-sector exhibits periodic CAPEX streams up to 2030. Comparative magnitudes and volume of investments in the three sub-sectors represented in Fig. 2.16 is quite revealing. It is sufficient to point out that at least one order of magnitude difference exists between the highest and lowest capital intensive subsector peaks and cumulative investments.

The present worth of investments in priority actions in the water sector between 2011 and 2030, at 2% interest, is 367,634,900 US dollars (2005 base). This amount, disaggregated by asset type and investment entity in Table 2.12, is primarily made up of investments in infrastructure and electrical motors, machinery apparatus, appliances and supplies (ISIC 383) procured through loans (27.5%) and investments by private sector (33.8%). Anticipated capital expenditure by government amounts to USD1,218,300 far less than operational expenditure of USD24,447,400. On the other hand, households are expected to contribute USD33,022,300 over the planning horizon.

Tables 2.9, 2.10 and 2.11 show significant variation in the source of investment funds. The water resources assessment and municipal water supply subsectors provide extreme and contrasting cases, the first entirely dependent on foreign sources, whilst the second expects to receive 62% of investment funds from external sources, of which 98% comprise of loans. On the domestic front, investments by private firms range from 0 to 43% in water resources assessment and irrigation sub-sectors respectively, and stands at 21 % for the municipal water supply subsector. Household investments in network expansion account for 17% of total investments in the municipal water supply sub-sector. Almost all of the domestic investments are on infrastructure for service connections into compounds.

In the water resources assessment sub-sector, slowly rising OPEX flows are punctuated by a marked increase between 2011 and 2014, reflecting the cost of institutional support under the AfDB Water Sector Reform Project. Monotonously increasing OPEX in the municipal water supply sub-sector, during the period 2011 to 2030, mirrors the expansion of water supply networks and upgrading of installed capacity (see CAPEX series in Fig. 2.13b). Rising from virtually zero, OPEX time series in the irrigation water supply sub-sector increases in two steps between 2020 and 2025 to stabilize at around USD4.5 million/annum (at constant 2005 USD). In both cases, step increases are associated with loan repayments under the GNAIP and OMVG Development Plan. In general, projected funding of OPEX from domestic sources is two to four times higher than external/foreign sources. In the municipal and irrigation water supply sub-sectors, firms and households are expected to cover 6 to 14% of domestic OPEX, respectively.

Taking a different angle to the analysis culminating in Table 2.12, we show in Table 2.13 the distribution of CAPEX and OPEX among specific water resources management measures and sources of funding.

Aggregate CAPEX and OPEX in this table portray a sense of inequitable allocation of resources between institutional strengthening and supply augmentation. Whilst the numbers partly reflect under-investment in institutional strengthening, they also mirror the huge implementation costs of supply augmentation activities/actions. For both measures, accessibility to external/foreign sources of finance is critical. Indeed, foreign sources contribute USD114.9 million (61% of total CAPEX) to the provision of municipal and irrigation water supply services. In addition, foreign lines of credit, divided in equal measure between loans and grants, provide USD 8.7 million to institutional building activities. Regarding the latter, domestic sources account for USD 58.3 million, 77% of which comes from the public utility, NAWEC, 21% from central government, and the remaining 2% from households. For both NAWEC and the central government, operational expenditures (OPEX) are projected to be much larger than new investments (CAPEX) in physical and human assets.

Recalling that OPEX under institutional strengthening partly comprises salaries and incentive packages of personnel, one might question the contribution of this non-negligible fraction to institutional strengthening. We consider salaries and incentives as central elements of employers' job retention policies, and take the view that failure to retain personnel with right incentives could lead to a brain drain thus weakening institutions relevant to this study.

One quarter of household contributions, equivalent to USD 900,000, subsumed under institutional strengthening, is allocated to capacity building activities targeted at water user groups and irrigation and drainage bodies.

2.2.4.2. Adaptation Scenario

The main difference between this scenario and the baseline (BAU) resides in decision-makers' attitudes towards and expectations from investments in climate change actions. In addition therefore to GOTG commitment to declared food and water security objectives, and sustainability of its debt repayments (ratio debt/expenditure, debt/GDP within or below historical range) that are prominent in the baseline scenario, we also assume that:

- Previously identified sectoral adaptation options (i.e. proper location/re-location of abstraction points, artificial recharge, regulation and licensing of water withdrawals) represent significant opportunities to address anticipated water scarcity and quality problems. The exception in this case is artificial recharge of the Kombo Peninsula Aquifer considered by the authors as technically questionable and politically difficult to implement.
- The percentage of water lost through leakages will be minimized from current levels to 15% by 2015 and 10% by 2025 through investments in leakage detection activities and prompt repair of leaking mains.
- Industrial water demand in the next five years will be decrease due to water saving techniques.

Adaptation measures analyzed consist of institutional capacity building, loss and consumptive use reduction (n the municipal water supply sub-sector) and supply augmentation. Omitting on-going interventions, implementation of priority actions are expected to commence in 2012 and last through 2030 (See Appendix 2 for Project Portfolio). Approximately USD240 million is required in funding, 60% of which is expected to come from foreign sources, including grants and loans from bilateral and multi-lateral funding agencies.
Integrated Water Resources Management (IWRM) is used as a management paradigm and the SPLIID framework advocating application of scientific knowledge and methods to water resource management is actively promoted. Followed to its logical conclusion, this is the antithesis of "people do not eat or drink information".

The diagnostic analysis of Njie (2009a) is used as a reference for upgrading networks of sensors operated by the DWR (or successor Water Resources and Meteorological Agencies) and existing data and computation systems. In this regard, 4 new surface water observing stations,40 groundwater monitoring stations, 8 meteorological stations, 40 soil moisture measurement stations, 5 physical oceanography stations are to be installed and operationalized between 2012 and 2015. GOTG will also commit commensurate resources in computation and data systems and human resources during this period and in the years after.

Faced with rising sea level, increased variability of rainfall and lower groundwater recharge, adoption of a supply augmentation approach to meet rising water demand will need to be done with circumspection. Based on the outcome of risk assessments, new pumping rules introduced results in the closure of the Fajara wellfield by 2025. The "lost" production capacity is shunted to one or more newly established wellfields with aggregate capacity of at least 300 m^3/day. Greater protection of sources is ensured through establishment of "*cordons sanitaires*" deriving authority through legal purchase of land and hard perimeter fences.

On the immediate future, NAWEC picks up the challenge of establishing and consolidating loss reduction programme as a counter-intuitive measure for addressing water scarcity under climate change. Continual replacement and renovation of damaged, vulnerable and older parts of the distribution network is expected to cut losses from 25% to 10% of production by 2025. The hospitality and other water-intensive industries introduce management plans and technology to reduce their vulnerability to climate change and water footprints by 20%.

BOX 2: Adaptation Scenario Management Measures

Projected climate change and its impacts on the hydrological cycle add a new dimension to water resources management challenges faced by policy- and decision-makers. Management constraints epitomized by low capital accumulation and ineffective institutional framework(s) are compounded by development constraints such as reduced freshwater flows, lower groundwater recharge and the threat of saline intrusion into coastal aquifers, all three attributable to climate change. Leakages principally, and outflows from burst pipes, account for approximately 25% of the public utility's water production. Some major industrial water users also deploy intensive water use technologies adding to the pressure on water supplies. In agriculture, proven techniques with high water use efficiency are a rarity. Thus, climate change presents a challenge to "*do more with less (water)*" and opportunity to overturn the perception that "*one cannot eat or drink information*". In this regard, baseline management measures modified to take account of climate change impacts and two additional measures are adopted under the adaptation scenario.

Institutional strengthening: Physical and human capital crucial to meeting water sector objectives are mobilized through procurement of equipment and professional services. The majority of equipment will fall under the ISIC category of profession and scientific equipment. Similar to the baseline scenario, several sector employees will receive training from local or external institutions. One major difference from the baseline scenario is the proactive planning approach to institutional strengthening, and one direct consequence of this approach is the immediate initiation of a new project cycle in order to make up for infrastructure deficits foreseen by 2015. Sector reforms will seek to bring new water law and policy into a sustainable development framework through integrated water resources management principles and best practice.

Supply augmentation: Surface water resources developed for irrigated agriculture, and ground water resources for municipal water supply are upgraded to meet escalating demands. Critical irrigation infrastructure includes water control structures (dam, dykes and sluice gates), distribution canals and access roads. On the other hand, municipal water supply key assets comprise of boreholes, water treatment plants, water pumping equipment and distribution network. In contrast to the baseline scenario, expansion of water production capacity is postponed by at least two years due to water conservation activities.

Water conservation: This line of action is built on two approaches; leakage reduction, and increasing water use efficiency. In the municipal water supply sector, activities include sensitization campaigns for people to be reporting leakages, replacement of decades-old asbestos pipes and execution of leakage reduction programme. In addition the public utility will champion the replacement of flush tanks used in hotels with water-saving devices, and provide price incentives to major industrial consumers for using water saving production units and processes. Expansion of production capacity is thus expected to be less frequent and on a lower scale resulting in significant reduction of supply augmentation investment and operational expenditure. In irrigated agriculture, the shift from traditional flood irrigated rice production to system of rice intensification is expected to save water consumption per crop cycle by 40%. Assets needed for implementation of water conservation under the adaptation scenario include leakage detection equipment, repair toolkits, maintenance materials, retrofit equipment, utility and specialized transport.

Relocation of wellfields: Wellfields whose geographical location or individual boreholes whose pumping rates predisposed them to saline intrusion due to sea level rise will be closed down. In particular, the Fajara wellfield's production and treatment capacity will be relocated in Kombo East District by 2025. The main activities associated with this development consist of preliminary studies, design, construction and operation of new facilities. Major physical assets under this management measure/option include boreholes, a water treatment plant, and transmission and distribution networks.

Activities associated with management measures excluding relocation of wellfields are open-ended in nature. Institutional strengthening funded through domestic and other sources to the tune of USD 67.5 million (constant 2005 US dollars) over the period 2011 to 2030. Notwithstanding, financial flows of foreign/external origin represent 80% of the water sector's capital investment needs. In contrast, foreign/external sources account for 40% of the present value of supply augmentation costs, that is, USD 269.7 million, USD31 million less than under the baseline scenario. The present value of USD 3.1 million for implementing water conservation activities, exclusively from domestic sources, is shouldered by the public utility, industrial users and households. Government contribution in the form of subventions to irrigation water supply operational expenditures is less than 1%. Relocation of wellfields between 2019 and 2027, at the earliest and latest dates respectively, costing USD13.1 million is financed by domestic and foreign sources. The foreign component of capital expenditure with estimated present value of USD5.6 million is assigned to loans. The public utility, NAWEC is responsible for meeting all other costs.

GCM projections of rainfall turn out to be optimistic resulting in a longer filling-up period of the Sambangalou reservoir and inter-annual storage capacity. Studies on weather modification in the upper Gambia River basin fail to provide a way out because of complex legal, economic and environmental issues. Artificially-maintained dry season flows are cut down from 50 m^3/s to 30 m^3/s creating greater incentives for improved water use efficiency, exemplified by upscaling water-saving irrigation techniques. Food security challenges in adverse climate conditions provide an opportunity to introduce and upscale production techniques with multiple environmental and social benefits.

In summary, baseline scenario management measures are modified in their very concept, resource mobilization and allocation strategies with the objective of building greater resiliency to climate change, and synergies with the relocation of groundwater abstraction points threatened by saline intrusion, leakage control in water distribution networks, and water-use efficiency in irrigation and municipal water supply sub-sectors. The last two measures unified under the heading of 'water conservation', together with relocation of wellfields comprise novel water management measures under the adaptation scenario. As a result of this synthesis, activities listed in Table 2.1 fall into four broad water resources management measures: 1) institutional strengthening; 2) supply augmentation; 3) water conservation; and 4) relocation of wellfields (see Box 2 for additional information).

By 2030, current capacity and knowledge gaps vis-à-vis the institutional mandate of the DWR would have narrowed down significantly, restoring the institutional reputation it enjoyed in the 1980s. Signs of this positive image include modern working environment and tools, a high level of professionalization commensurate with high-value assets, products generated and public services provided.

Table 2.14: Sub-sectoral and aggregate sectoral I&FF streams under the adaptation scenario for subsectors in the study. IF (Investment flows), FF (financial flows), O&M (operation and maintenance) and Totals are expressed in thousands of constant 2005 US Dollars. *A social discount rate of 2% is used to discount all financial flow streams. Water resources assessment (WRA) sub-sector post-2015 IF are based on a performance review of sub-sector. Estimated costs make use of information contained in projects poised for take-off. OPEX stream is based on project budgets and extrapolation of government budget allocations to sub-sector, and disaggregated into FF and O&M streams using interdependencies suggested by historical time series. Investment behavior of the public water supply utility combine conventional investment strategies with no-regrets adaptation measures addressing water scarcity. The IF (CAPEX) stream for irrigation remains unchanged from the baseline scenario. As in the previous section, observe that values may not add up correctly due to rounding errors.*

Year	Water Resources Assessment subsector				Municipal Water Supply subsector			
	CAPEX	OPEX		Total	CAPEX	OPEX		Total
	IF	FF	O&M		IF	FF	O&M	
2011	54.0	201.6	41.1	296.7	2,778.8	3,480.7	639.6	6,899.1
2012	1,023.0	1,660.6	363.5	3,047.1	6,645.9	3,216.0	1,072.0	10,933.9
2013	120.9	1,076.0	234.3	1,431.2	6,515.6	3,667.4	808.4	10,991.4
2014	7.9	317.4	66.7	392.1	2,618.5	3,776.7	907.1	7,302.3
2015	289.5	409.7	87.1	786.4	11,805.6	3,896.5	1,015.4	16,717.5
2016	154.1	375.6	79.5	609.2	10,668.4	4,026.8	1,133.3	15,828.5
2017	26.4	302.5	63.4	392.3	10,459.2	4,071.4	1,357.1	15,887.7
2018	25.9	271.5	56.5	353.9	1,548.6	4,319.3	1,397.7	7,265.5
2019	0.0	280.1	58.4	338.5	1,518.2	4,481.4	1,544.2	7,543.8
2020	0.0	288.3	60.2	348.5	14,039.8	4,654.1	1,700.3	20,394.1
2021	0.0	296.0	62.0	358.0	13,764.5	5,027.5	1,675.8	20,467.7
2022	0.0	303.3	63.6	366.9	13,494.6	5,031.1	2,041.2	20,566.9
2023	0.0	310.3	65.1	375.4	1,402.6	5,235.6	2,225.9	8,864.0
2024	0.0	316.8	66.6	383.4	12,970.6	5,450.5	2,420.3	20,841.3
2025	0.0	323.0	67.9	390.9	12,716.2	6,225.2	2,075.1	21,016.4
2026	0.0	328.8	69.2	398.0	12,466.9	5,912.2	2,837.6	21,216.7
2027	0.0	334.2	70.4	404.6	1,295.8	6,158.9	3,060.6	10,515.2
2028	0.0	339.4	71.5	410.9	8,412.0	6,416.1	3,293.2	18,121.3
2029	0.0	344.1	72.6	416.7	8,247.0	6,684.0	3,535.3	18,466.3
2030	0.0	348.6	73.6	422.2	8,085.3	6,962.4	3,787.0	18,834.7
All Years	**1,701.7**	**8,427.8**	**1,793.2**	**11,922.9**	**161,454.1**	**98,693.7**	**38,527.1**	**298,674.3**

Sources: IDB RWS Project Document, AfDB Water Sector Reform Project Document, GEF/LCDF EWS Project Document, Gambia National Agricultural Investment Plan (2011-2015), GOTG Loans Database, MOFEA, Njie (2009a), Aissatou Sylla (Pers. Comm.), Bernard E. Gomez (Pers. Comm.)

Table 2.14. cont'd

Year	Irrigation Water Supply subsector				Water Sector Priority Actions			
	CAPEX	OPEX		Total	CAPEX	OPEX		Total
	IF	FF	O&M		IF	FF	O&M	
2011	1,692.9	1.0	0.0	1,693.9	4,525.7	3,683.3	680.7	8,889.7
2012	1,876.2	1.4	0.0	1,877.7	9,545.1	4,878.0	1,435.5	15,858.6
2013	2,263.9	2.8	0.0	2,266.7	8,900.4	4,746.2	1,042.7	14,689.3
2014	3,144.3	5.0	0.0	3,149.3	5,770.7	4,099.1	973.8	10,843.6
2015	2,819.9	7.9	0.0	2,827.8	14,915.0	4,314.1	1,102.5	20,331.6
2016	2,525.0	11.9	0.0	2,536.9	13,347.5	4,414.3	1,212.8	18,974.6
2017	2,475.4	17.1	0.0	2,492.5	12,961.0	4,391.0	1,420.5	18,772.5
2018	606.7	23.3	0.0	630.0	2,181.2	4,614.1	1,454.2	8,249.5
2019	0.0	30.6	0.0	30.6	1,518.2	4,792.1	1,602.6	7,912.9
2020	0.0	38.8	0.0	38.8	14,039.8	4,981.2	1,760.5	20,781.5
2021	0.0	47.9	0.0	47.9	13,764.5	5,371.4	1,737.8	20,873.7
2022	0.0	1,738.2	248.3	1,986.5	13,494.6	7,072.6	2,353.1	22,920.3
2023	0.0	1,714.6	244.9	1,959.5	1,402.6	7,260.5	2,535.9	11,199.0
2024	0.0	1,692.1	241.7	1,933.8	12,970.6	7,459.4	2,728.6	23,158.6
2025	0.0	3,075.1	272.9	3,348.0	12,716.2	9,623.3	2,415.9	24,755.3
2026	0.0	3,048.2	248.6	3,296.8	12,466.9	9,289.2	3,155.4	24,911.5
2027	0.0	3,022.3	225.2	3,247.5	1,295.8	9,515.4	3,356.2	14,167.4
2028	0.0	2,997.3	202.6	3,199.9	8,412.0	9,752.8	3,567.3	21,732.1
2029	0.0	2,973.2	180.8	3,154.0	8,247.0	10,001.3	3,788.7	22,037.0
2030	0.0	2,949.9	159.7	3,109.6	8,085.3	10,260.9	4,020.3	22,366.5
All Years	**17,404.3**	**23,398.5**	**2,024.8**	**42,827.7**	**180,560.1**	**130,520.0**	**42,345.1**	**353,425.2**

Sources: IDB RWS Project Document, AfDB Water Sector Reform Project Document, GEF/LCDF EWS Project Document, Gambia National Agricultural Investment Plan (2011-2015), GOTG Loans Database, MOFEA, Njie (2009a), Aissatou Sylla (Pers. Comm.), Bernard E. Gomez (Pers. Comm.)

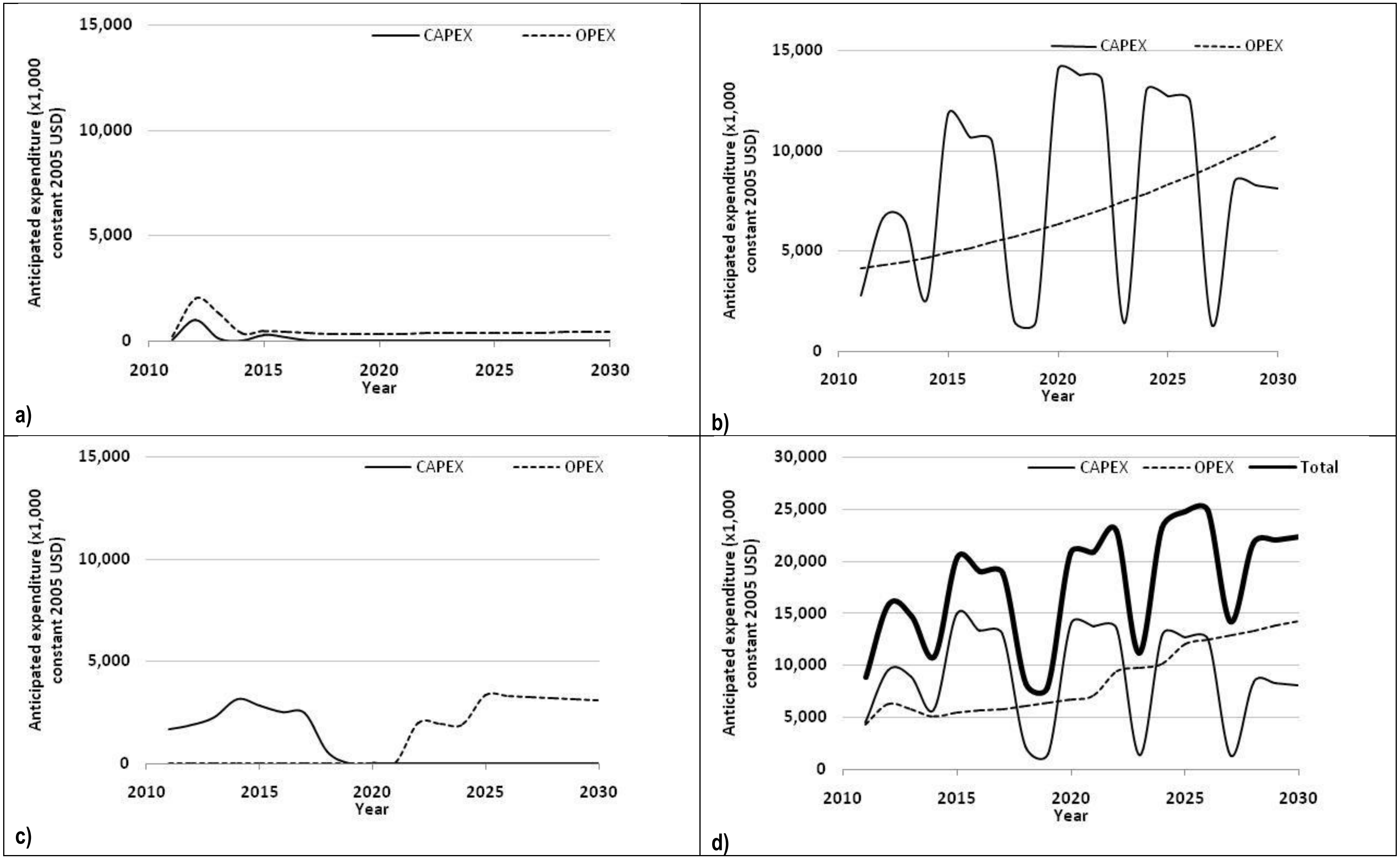

Fig. 2.17: Anticipated investments (CAPEX) and operational expenditure (OPEX) in: a) water resources assessment, b) municipal water supply, c) irrigation water supply subsectors under the adaptation scenario. Fig. 2.16d depicts aggregate CAPEX and OPEX in these three sub-sectors and grand total for priority actions in water sector. The reader's attention is drawn to the exact likeness of irrigation sub-sector CAPEX and OPEX series under baseline and adaptation scenarios. This situation is a reflection of the fact that demand management measures fall within the ambit of the agricultural sector. Totals are not shown in other figures because OPEX is equivalent to "Total" time series, when CAPEX series take on zero values, during the second decade of this assessment (All illustrations are based on data presented in Table 2.14).

Table 2.15: Financial resource streams for critical assets deployed under the adaptation scenario. *Entries express anticipated values of investments and operational expenditure on similar asset types across all three water sub-sectors analyzed*.

	Asset type ISIC 382			Asset type ISIC 383			Asset type ISIC 384			Asset type ISIC 385		
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2011	51.5	22.4	6.7	942.3	0.0	1.1	215.6	0.0	20.3	124.7	5.8	0.9
2012	158.1	184.7	59.6	1,796.2	0.0	3.4	585.7	0.0	163.7	515.5	47.5	1.6
2013	102.1	119.7	38.4	1,850.0	0.0	2.3	426.2	0.0	106.0	249.4	30.8	1.2
2014	62.4	35.3	10.9	1,214.3	0.0	1.6	266.2	0.0	32.5	142.1	9.1	1.3
2015	175.8	45.6	14.3	3,081.9	0.0	1.9	726.7	0.0	41.9	442.0	11.7	1.5
2016	151.6	41.8	13.0	2,780.1	0.0	2.0	635.2	0.0	38.9	366.4	10.7	1.6
2017	140.5	33.7	10.4	2,725.5	0.0	2.3	599.1	0.0	32.6	321.5	8.7	2.0
2018	24.8	30.2	9.3	454.2	0.0	2.3	103.9	0.0	29.7	60.1	7.8	2.0
2019	16.3	31.2	9.6	319.9	0.0	2.5	69.7	0.0	31.1	36.8	8.0	2.2
2020	150.7	32.1	9.9	2,958.3	0.0	2.8	644.8	0.0	32.4	340.4	8.2	2.5
2021	147.7	32.9	10.2	2,900.3	0.0	2.7	632.2	0.0	33.1	333.7	8.5	2.4
2022	144.8	33.7	10.4	2,843.5	0.0	3.6	619.8	0.0	36.0	327.2	8.7	3.3
2023	15.1	34.5	10.7	295.5	0.0	3.9	64.4	0.0	37.3	34.0	8.9	3.6
2024	139.2	35.2	10.9	2,733.0	0.0	4.2	595.7	0.0	38.6	314.4	9.1	3.9
2025	136.5	35.9	11.1	2,679.4	0.0	3.8	584.0	0.0	38.1	308.3	9.2	3.4
2026	133.8	36.6	11.3	2,626.9	0.0	4.8	572.6	0.0	41.2	302.2	9.4	4.5
2027	13.9	37.2	11.5	273.0	0.0	5.1	59.5	0.0	42.4	31.4	9.6	4.8
2028	90.3	37.8	11.7	1,772.5	0.0	5.4	386.3	0.0	43.6	203.9	9.7	5.1
2029	88.5	38.3	11.9	1,737.7	0.0	5.8	378.8	0.0	44.9	199.9	9.8	5.4
2030	86.8	38.8	12.1	1,703.7	0.0	6.1	371.3	0.0	46.1	196.0	10.0	5.7
All Years	**2,030.4**	**937.6**	**294.1**	**37,688.1**	**0.0**	**67.8**	**8,537.6**	**0.0**	**930.6**	**4,850.0**	**241.0**	**59.0**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.15: Cont'd

	Asset type			Asset type			All asset types		
	Infrastructure			Human Resources					
Year	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2011	3,061.7	0.9	651.6	129.9	3,654.2	0.0	4,525.7	3,683.3	680.7
2012	6,121.1	7.7	1,207.2	368.5	4,638.1	0.0	9,545.1	4,878.0	1,435.5
2013	6,015.9	5.0	894.8	256.9	4,590.8	0.0	8,900.4	4,746.2	1,042.7
2014	3,926.6	1.5	927.4	159.2	4,053.2	0.0	5,770.7	4,099.1	973.8
2015	10,049.0	1.9	1,043.0	439.6	4,254.9	0.0	14,915.0	4,314.1	1,102.5
2016	9,031.8	1.7	1,157.1	382.5	4,360.0	0.0	13,347.5	4,414.3	1,212.8
2017	8,815.8	1.4	1,373.2	358.6	4,347.3	0.0	12,961.0	4,391.0	1,420.5
2018	1,475.7	1.3	1,410.9	62.6	4,574.9	0.0	2,181.2	4,614.1	1,454.2
2019	1,033.8	1.3	1,557.2	41.7	4,751.6	0.0	1,518.2	4,792.1	1,602.6
2020	9,560.2	1.3	1,713.0	385.4	4,939.6	0.0	14,039.8	4,981.2	1,760.5
2021	9,372.7	1.4	1,689.3	377.9	5,328.6	0.0	13,764.5	5,371.4	1,737.8
2022	9,189.0	1.4	2,299.7	370.5	7,028.8	0.0	13,494.6	7,072.6	2,353.1
2023	955.1	1.4	2,480.5	38.5	7,215.7	0.0	1,402.6	7,260.5	2,535.9
2024	8,832.1	1.5	2,671.0	356.1	7,413.6	0.0	12,970.6	7,459.4	2,728.6
2025	8,658.9	1.5	2,359.5	349.1	9,576.6	0.0	12,716.2	9,623.3	2,415.9
2026	8,489.2	1.5	3,093.5	342.2	9,241.7	0.0	12,466.9	9,289.2	3,155.4
2027	882.4	1.5	3,292.3	35.6	9,467.1	0.0	1,295.8	9,515.4	3,356.2
2028	5,728.0	1.6	3,501.4	230.9	9,703.8	0.0	8,412.0	9,752.8	3,567.3
2029	5,615.7	1.6	3,720.7	226.4	9,951.6	0.0	8,247.0	10,001.3	3,788.7
2030	5,505.6	1.6	3,950.2	222.0	10,210.5	0.0	8,085.3	10,260.9	4,020.3
All Years	**122,320.1**	**38.9**	**40,993.5**	**5,133.9**	**129,302.7**	**0.0**	**180,560.1**	**130,520.0**	**42,345.1**

Table 2.16: Financial resources streams associated with water resources management measures under the adaptation scenario. Totals are expressed in thousands of constant 2005 US Dollars. *Observe that values may not add up correctly due to rounding errors.*

`	Adaptation scenario: Specific water management measures								All Measures	
	Institutional building		Supply augmentation		Water conservation		Relocation of wellfields			
Year	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
2011	155.0	1,738.4	4,339.9	2,595.6	30.9	30.0	0.0	0.0	4,525.7	4,364.0
2012	1,102.1	2,446.5	8,384.2	3,816.7	58.8	50.3	0.0	0.0	9,545.1	6,313.5
2013	317.3	2,324.7	8,522.5	3,426.3	60.6	38.0	0.0	0.0	8,900.4	5,788.9
2014	145.6	1,944.4	5,585.3	3,085.9	39.8	42.6	0.0	0.0	5,770.7	5,072.9
2015	605.9	2,054.3	14,208.2	3,314.6	100.9	47.7	0.0	0.0	14,915.0	5,416.6
2016	452.7	2,097.5	12,803.8	3,476.4	91.0	53.2	0.0	0.0	13,347.5	5,627.1
2017	334.5	2,079.1	12,537.2	3,668.7	89.3	63.7	0.0	0.0	12,961.0	5,811.5
2018	74.6	2,180.0	2,091.7	3,822.7	14.9	65.6	0.0	0.0	2,181.2	6,068.3
2019	36.5	2,264.0	1,471.2	4,058.2	10.5	72.5	0.0	0.0	1,518.2	6,394.7
2020	338.0	2,353.1	12,296.4	4,310.5	96.9	79.8	1,308.6	0.0	14,039.8	6,743.4
2021	331.3	2,536.1	12,055.2	4,494.5	95.0	78.7	1,283.0	0.0	13,764.5	7,109.2
2022	324.8	3,330.8	11,818.8	5,987.3	93.1	107.5	1,257.8	0.0	13,494.6	9,425.7
2023	33.8	3,419.2	1,228.4	6,261.1	9.7	116.0	130.7	0.0	1,402.6	9,796.4
2024	312.2	3,512.8	11,359.9	6,550.2	89.5	125.0	1,209.0	0.0	12,970.6	10,188.0
2025	306.1	4,523.4	11,137.1	7,405.6	87.7	110.3	1,185.2	0.0	12,716.2	12,039.2
2026	300.1	4,368.1	10,918.8	6,955.1	86.0	144.9	1,162.0	975.7	12,466.9	12,443.8
2027	31.2	4,474.2	1,255.7	7,204.3	8.9	154.3	0.0	1038.8	1,295.8	12,871.6
2028	202.5	4,585.5	8,151.5	7,465.2	58.0	164.2	0.0	1105.2	8,412.0	13,320.1
2029	198.5	4,702.0	7,991.6	7,738.6	56.9	174.5	0.0	1174.9	8,247.0	13,790.0
2030	194.6	4,823.7	7,834.9	8,023.3	55.8	185.3	0.0	1247.8	8,085.3	14,280.1
All Years	**5,797.4**	**61,757.6**	**165,992.2**	**103,660.7**	**1,234.2**	**1,904.3**	**7,536.3**	**5,542.5**	**180,560.1**	**172,865.1**

Table 2.17: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in the water resources assessment sub-sector for the adaptation scenario. *As in the previous section, observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**19.5**	**7,472.0**		**892.1**		**5.7**		**508.0**		**180.7**		**480.2**	**19.5**	**5,405.3**
Households														
Firms														
Govt.	19.5	7,472.0		892.1		5.7		508.0		180.7		480.2	19.5	5,405.3
Foreign	**1,682.2**	**2,749.0**	**109.6**	**328.2**	**0.8**	**2.1**	**319.5**	**186.9**	**508.0**	**66.5**	**523.0**	**176.7**	**221.3**	**1,988.7**
Loans	54.0		3.5				10.3		16.3		16.8		7.1	
Bilateral ODA	21.6		1.4				4.1		6.5		6.7		2.8	
Multi-lateral ODA	1,606.6	2,749.0	104.7	328.2	0.7	2.1	305.2	186.9	485.2	66.5	499.5	176.7	211.4	1,988.7
All Sources	**1,701.7**	**10,221.0**	**109.6**	**1,220.3**	**0.8**	**7.8**	**319.5**	**694.9**	**508.0**	**247.2**	**523.0**	**656.9**	**240.8**	**7,394.0**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.18: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in municipal water supply sub-sector under the adaptation scenario. *As in the previous section, observe that values may not add up correctly due to rounding errors.*

	TOTAL		**ISIC 382**		**ISIC 383**		**ISIC 384**		**ISIC 385**		**Infrastructure**		**Human Resources**	
	CAPEX	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**	**CAPEX**	**OPEX**
Domestic	**62,614.3**	**137,220.4**	**353.6**		**6,942.2**	**137.1**	**1,513.1**	**328.3**	**798.7**	**137.1**	**52,102.3**	**93,657.6**	**904.5**	**42,960.3**
Households	29,667.8										29,667.8			
Firms	32,946.6	137,220.4	353.6		6,942.2	137.1	1,513.1	328.3	798.7	137.1	22,434.5	93,657.6	904.5	42,960.3
Govt.														
Foreign	**98,839.7**		**1,060.7**		**20,826.6**		**4,539.4**		**2,396.2**		**67,303.5**		**2,713.4**	
Loans	98,839.7		1,060.7		20,826.6		4,539.4		2,396.2		67,303.5		2,713.4	
Bilateral ODA														
Multi-lateral ODA														
All Sources	**161,454.1**	**137,220.4**	**1,414.3**		**27,768.8**	**137.1**	**6,052.5**	**328.3**	**3,194.9**	**137.1**	**119,405.8**	**93,657.6**	**3,617.8**	**42,960.3**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.19: I&FF (expressed in thousands of 2005 US Dollars) disaggregated to different entities and asset types deployed in the irrigation water supply sub-sector the adaptation scenario. *As in the previous section, observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**7,832.0**	**20,338.6**	**84.1**		**1,650.3**	**20.3**	**359.7**	**48.7**	**189.9**	**20.3**	**5,333.1**	**13,881.8**	**215.0**	**6,367.5**
Households	522.1	2,847.4	5.6		110.0	2.8	24.0	6.8	12.7	2.8	355.5	1,943.5	14.3	891.5
Firms	6,091.6		65.4		1,283.6		279.8		147.7		4,148.0		167.2	
Govt.	1,218.3	17,491.2	13.1		256.7	17.5	56.0	41.8	29.5	17.5	829.6	11,938.4	33.4	5,476.1
Foreign	**9,572.4**	**5,084.7**	**102.7**		**2,017.0**	**5.1**	**439.6**	**12.2**	**232.1**	**5.1**	**6,518.2**	**3,470.5**	**262.8**	**1,591.9**
Loans	4,786.2		51.4		1,008.5		219.8		116.0		3,259.1		131.4	
Bilateral ODA	3,067.2		32.9		646.3		140.9		74.4		2,088.6		84.2	
Multi-lateral ODA	1,719.0	5,084.7	18.4		362.2	5.1	78.9	12.2	41.7	5.1	1,170.5	3,470.5	47.2	1,591.9
All Sources	**17,404.4**	**25,423.3**	**186.8**		**3,667.3**	**25.4**	**799.3**	**60.8**	**421.9**	**25.4**	**11,851.3**	**17,352.3**	**477.8**	**7,959.4**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.20: Synoptic table of priority I&FF disaggregated to different entities and asset types deployed in the water sector under adaptation scenario. Values shown (in thousands of 2005 S Dollars) are totals of corresponding variables in Tables 2.17, 2.18 and 2.19. *Observe that values may not add up correctly due to rounding errors.*

	TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**70,465.8**	**165,031.0**	**437.7**	**892.1**	**8,592.5**	**163.1**	**1,872.8**	**885.0**	**988.6**	**338.1**	**57,435.4**	**108,019.6**	**1,139.0**	**54,733.1**
Households	30,189.9	2,847.4	5.6		110.0	2.8	24.0	6.8	12.7	2.8	30,023.3	1,943.5	14.3	891.5
Firms	39,038.2	137,220.4	419.0		8,225.8	137.1	1,792.9	328.3	946.4	137.1	26,582.5	93,657.6	1,071.7	42,960.3
Govt.	1,237.8	24,963.2	13.1	892.1	256.7	23.2	56.0	549.8	29.5	198.2	829.6	12,418.6	52.9	10,881.4
Foreign	**110,094.3**	**7,833.7**	**1,273.0**	**328.2**	**22,844.4**	**7.2**	**5,298.6**	**199.0**	**3,136.2**	**71.6**	**74,344.7**	**3,647.1**	**3,197.5**	**3,580.5**
Loans	103,679.9		1,115.6		21,835.1		4,769.5		2,528.5		70,579.4		2,851.9	
Bilateral ODA	3,088.8		34.3		646.3		145.0		80.9		2,095.3		87.0	
Multi-lateral ODA	3,325.6	7,833.7	123.1	328.2	362.9	7.2	384.1	199.0	526.8	71.6	1,670.0	3,647.1	258.6	3,580.5
All Sources	**180,560.2**	**172,864.7**	**1,710.7**	**1,220.3**	**31,436.9**	**170.3**	**7,171.4**	**1,084.0**	**4,124.8**	**409.7**	**131,780.1**	**111,666.7**	**4,336.4**	**58,313.7**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.21: Synoptic table of priority I&FF(in thousands of 2005 US Dollars) disaggregated by water resources management measures and investment entities under the adaptation scenario. *CAPEX (IF) and OPEX (pooled FF and O&M) for institutional strengthening is identified with similar resource streams on building and maintaining human capital in all three water sub-sectors analyzed. Excluding those deployed in the water resources assessment subsector, all other capital assets and related operating expenditure are identified with either of supply augmentation, water conservation, or relocation of wellfield activities/actions. Values are first derived for subsectors analyzed before integration into one table. Observe that values may not add up correctly due to rounding errors.*

			Specific Water Resources Management Measures							
	All Measures		Institutional strengthening		Supply augmentation		Water conservation		Relocation of wellfields	
	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX	CAPEX	OPEX
Domestic	**70,465.9**	**165,031.0**	**1,139.0**	**57,416.7**	**66,208.6**	**100,217.6**	**1,234.2**	**1,904.3**	**1,884.1**	**5,542.5**
Households	30,189.9	2,847.4	14.3	886.8	29,582.2	1,956.0	593.4	4.7	0.0	0.0
Firms	39,038.2	137,220.4	1,071.7	43,596.3	35,441.5	86,246.5	640.8	1,885.2	1,884.1	5,542.5
Govt.	1,237.8	24,963.2	52.9	12,933.7	1,184.9	12,015.2	0.0	14.4	0.0	0.0
Foreign	**110,094.3**	**7,833.7**	**4,658.4**	**4,340.9**	**99,783.8**	**3,492.8**	**0.0**	**0.0**	**5,652.2**	**0.0**
Loans	103,679.9	0.0	2,898.8	0.0	95,128.9	0.0	0.0	0.0	5,652.2	0.0
Bilateral ODA	3,088.8	0.0	105.8	0.0	2,983.0	0.0	0.0	0.0	0.0	0.0
Multi-lateral ODA	3,325.6	7,833.7	1,653.8	4,340.9	1,671.8	3,492.8	0.0	0.0	0.0	0.0
All Sources	**180,560.2**	**172,864.7**	**5,797.4**	**61,757.6**	**165,992.3**	**103,710.4**	**1,234.2**	**1,904.3**	**7,536.3**	**5,542.5**

Fig. 2.17 illustrates OPEX and CAPEX entries in Table 2.14. A synopsis of priority investments in the water sector is also shown in the lower right hand panel of fig. 2.17. Generally speaking, there are few changes in the data and graphical illustrations. Two measurable changes occur one each in the water resources assessment and municipal water supply sub-sectors. The first change with respect to the baseline scenario is a secondary CAPEX peak, (Fig. 2.17a) and reduced OPEX (Fig. 2.17b) for these two sub-sectors. Slight modifications in the CAPEX time series have their origins in a needs assessment of the water resources assessment sub-sector (Njie, 2009b) making allowance for currently approved projects and others in the pipeline.

Scenario-insensitivity of OPEX flows in the irrigation sub-sector may appear surprising, but the response is consistent with the introduction and upscaling of the innovative system of rice intensification (SRI) in irrigated areas. In the circumstances, OPEX does not reflect the cost of agricultural extension, central to the upscaling/dissemination of SRI. Tables 2.17 and 2.18 show that additional contributions from government and multi-lateral donors account for all changes in CAPEX and OPEX related to adaptation. Crucially, the present worth of priority actions in the water sector is revised downwards to 353,425, 100 USD (2005 base) compared with 367,634,900 US dollars under the baseline scenario. Apart from a 4% drop in the present worth of priority investments in the water sector between 2011 and 2030, investment patterns under the adaptation scenario show great similarity to the baseline scenario. Infrastructural and ISIC 383 assets still attract the bulk of investments paid for through loans and private sources of funding. Households' as well as government's share of investments remain remarkably stable.

Although external sources account for the bulk of CAPEX, it is notable that domestic sources are used to build up capital in the water resources sub-sector. This is entirely feasible in the sense that training programs are being elaborated by the University of the Gambia and prospective students in water sciences are expected to benefit from government fellowships.

Under this scenario, financial resources are committed to water resources management measures enunciated earlier, and disbursed through projects listed in Appendix A. In decreasing order of magnitude, the present worth of financial resources committed to supply augmentation, institutional strengthening, relocation of wellfields and water conservation, stand respectively at 269.7; 67.6; 13.1 and USD 3.1 million (constant 2005 dollars). A closer look at the numbers shows however that the magnitude of resources flows directed towards institutional strengthening is largely determined by its OPEX component. That said, the contribution of OPEX to institutional strengthening is indisputable, as explained on page 42.

Entries in Table 2.21 show that foreign sources provide between 60 and 80% of CAPEX related to supply augmentation, institutional strengthening and relocation of wellfields. In the last two cases, loans are expected to be the principal source of funds. By contrast, water conservation activities/actions are exclusively funded through firms, represented by the public utility and intensive water-users, and households. It is worth noting that households also make significant contributions to supply augmentation through their contributions to water supply network extensions.

3. Results

3.1. Incremental Changes in IF, FF, O&M Costs, and Subsidy Costs

In conformity with previous sections of the report, investment flows (IF) are interchangeably used with CAPEX flows. For purposes of clarity however, OPEX is preferred in specific cases to its constituent FF and O&M. In practice, disaggregation of OPEX into FF and O&M is less straightforward matter for equipment and machinery assets than the case of infrastructure and human resources asset s, for which one stream is identifiably zero.

Incremental expenditures in the water sub-sectors studied are shown in Table 2.22 and figure 2.20[13]. Careful study of both shows incremental IF (CAPEX) varying over several orders of magnitude. Time series of the municipal water supply sub-sector in particular are seen to oscillate between -13,000,000 and 13,000,000 USD (2005 base). The irrigation subsector also commands attention for its comparative absence of IF (CAPEX) variations under baseline and adaptation scenarios. It may be worth noting that ratios of non-zero incremental FF to incremental O&M (not shown in Table 2.22) apparently have an asymptotic value of 1in sub-sectors with lumpy investments in long-lived infrastructure. A much higher value of 5 computed for the water resources assessment sub-sector.

Due to differences in the magnitude of incremental CAPEX and OPEX during the assessment period, the municipal water-supply's signature is clearly imprinted on the annual and cumulative totals for the water sector (see figure 2.19). Indeed, changes in the municipal water sub-sector is the driving force behind the negative trend line with slope of 960,000 USD/year fitted to cumulative CAPEX and OPEX totals.

On the matter of incremental CAPEX and OPEX for assets deployed under different sub-sectors, relevant data is shown in Tables 2.24, 2.25 and 2.26. We draw the reader's attention to the sparse character of these tables, in particular the one associated with the irrigation sub-sector. In a way, this sparseness confirms that adaptation and baseline scenarios are not completely disconnected.

In the water resources assessment sub-sector, new investments in professional and scientific instruments (ISIC 385) and physical infrastructure account for 70% of incremental IF (CAPEX). Nearly 12 of incremental OPEX is associated with non-electrical machinery including computers (ISIC 382), and little over 72 percent increase in human resources capitals is tributary to increased financial flows (FF). Overall, new investments and incremental OPEX are lowest for electrical machinery, equipment (ISIC 383).

The municipal water supply sub-sector stands out from others due to anticipated savings under the adaptation scenario. From Table 16, negative increments, interpreted as savings, are most significant for infrastructural assets. Together with electrical machinery, equipment (ISIC 383), investment decisions relating to the two asset groups account for 89% of all CAPEX savings. Entries in the same table indicate OPEX savings are tied exclusively to financial flows (FF) related to infrastructure and human resources capital formation. Non-electrical machinery including computers (ISIC 382) register the lowest aggregate CAPEX and OPEX savings.

Furthermore, incremental changes in the municipal water supply sub-sector are also enduring. This is in sharp contrast to short-term (2014 – 2018) changes in the water resources subsector, or medium-term ones (2022 -2030) in financial resource flows in irrigation water sub-sector.

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[13] We use this format instead of multiple tables indicating financial streams by asset type because detailed design and procurement plans are not available for municipal and irrigation water supply sub-sectors. In the circumstances, an aggregate value is more accurate than disaggregated ones derived by debatable methods.

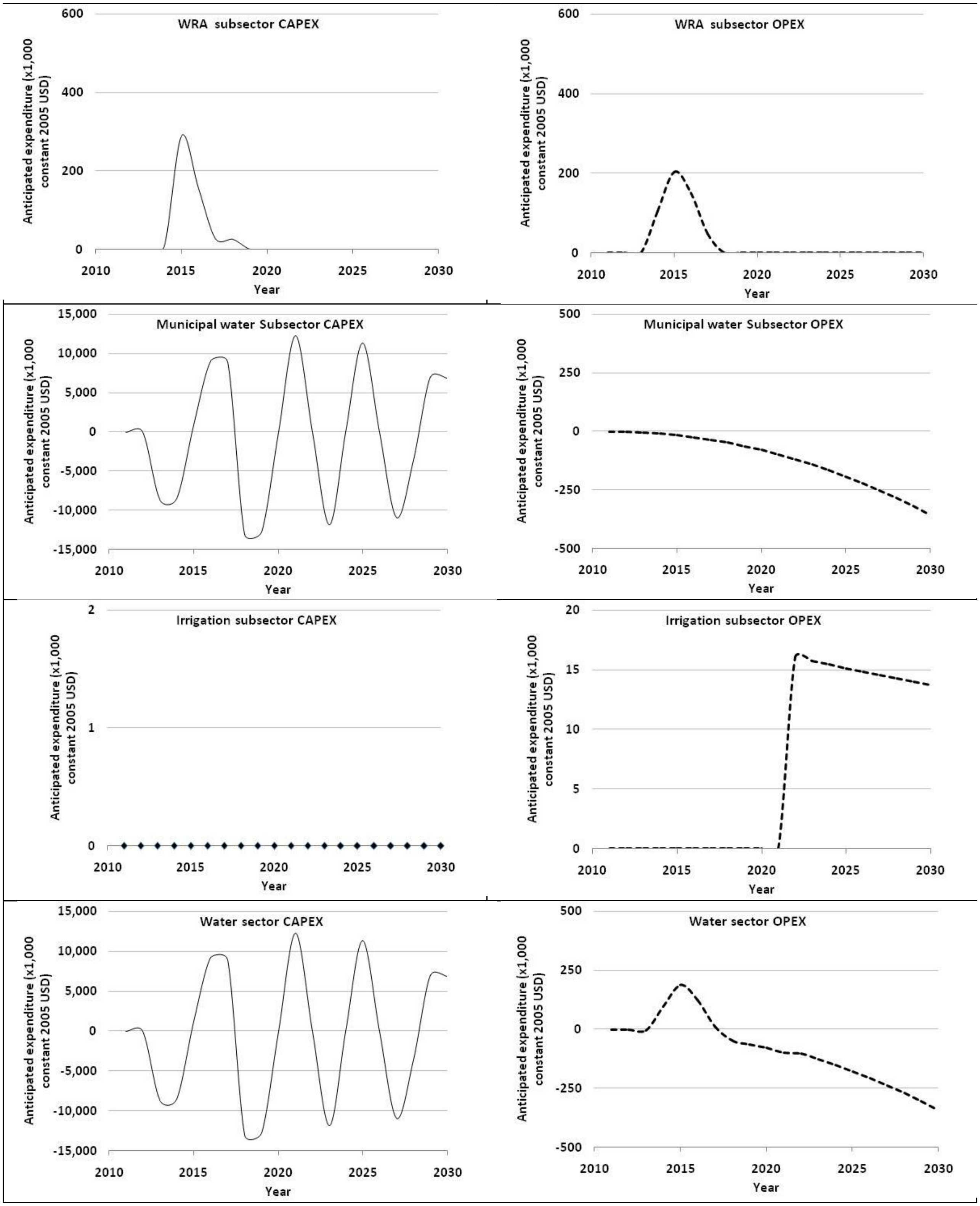

Fig. 2.18: OPEX and CAPEX incremental flows in various sub-sectors. Multiple patterns show complexity of the sector, dominated by the scale of resource flows in the municipal water supply sub-sector.

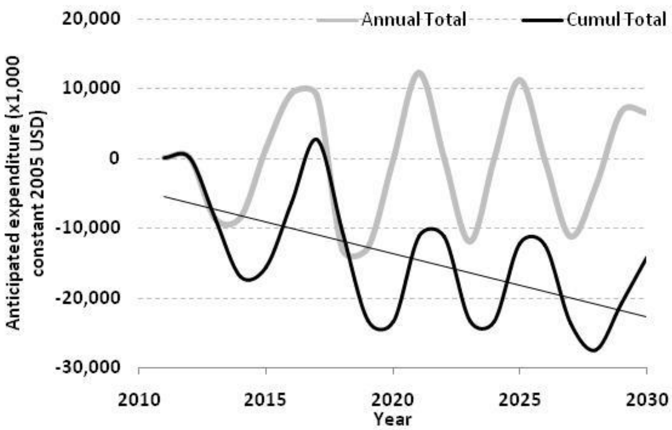

Fig. 2.19: Annual and cumulative incremental financial flows for the water sector. The negative trend line fitted to cumulative incremental values indicating potential savings has a slope of 960,000 USD/year.

The irrigation water supply sub-sector shows the least variation between adaptation and baseline scenarios. Apart from scenario specification, the results presented in Table 2.26 only reflect costs attributable to water delivery. Specifically, entries exclude costs associated with land development and agricultural extension. In the circumstances, incremental IF (CAPEX) is nil whilst incremental OPEX is distributed between infrastructural and human resources asset groups. Here, it is worth noting that OPEX can be disaggregated with high confidence into FF and O&M and assigned to human resources and infrastructure respectively.

Two major sources (Gambia government and multi-lateral ODA) and one minor source (households) of incremental IF (CAPEX) funding emerge from scrutiny of Tables 2.24, 2.25 and 2.26. More precisely, multi-lateral ODA is considered the major source of new investments in the water resources assessment subsector. Bi-lateral ODA in this subsector is expected to decrease and development assistance needs shifted to multi-lateral ODA. Incremental CAPEX taken up by government, roughly equal to 4% of the total, is earmarked upgrading its human assets.

From the results obtained, we foresee a leading role for the Gambia government in addressing incremental OPEX, particularly in the water resources assessment and irrigation sub-sectors. But incremental OPEX is expected to be partly covered by multilateral ODA, assuming that the Gambia continues to benefit from loan-grant combinations of the past. Households are expected to contribute a certain percentage, computed as 14% of the domestic burden, mindful of their ability to pay. In this regard, the Gambia government's anticipated share of OPEX in irrigation cannot be distinguished from a subsidy, albeit a minor one from the sectoral point of view.

Data on the municipal sub-sector shows that no additional sources of finance are needed under the adaptation scenario. Optimal investments made by the water utility lead to internal savings, and forestall the contracting of loans larger than necessary.

Table 2.22: Yearly incremental IF, FF, O&M and aggregate expenditure. All values except calendar years in table are expressed in thousands of constant 2005 US Dollars. Values are obtained by subtracting entries in Table 2.6 from corresponding entries in Table 2.14. *As in the previous section, observe that values may not add up correctly due to rounding error.*

Year	Water Resources Assessment subsector				Municipal Water Supply subsector			
	∆CAPEX	∆OPEX		∆Total	∆CAPEX	∆OPEX		∆Total
	∆IF	∆FF	∆O&M		∆IF	∆FF	∆O&M	
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	-0.8	-0.3	-1.0
2013	0.0	0.0	0.0	0.0	-8,650.5	-2.1	-1.9	-8,654.5
2014	7.9	85.1	18.8	111.9	-8,480.9	-4.7	-4.2	-8,489.8
2015	289.5	166.8	36.9	493.3	923.8	-8.3	-7.5	908.0
2016	154.1	122.7	27.1	303.9	9,057.3	-13.0	-11.7	9,032.6
2017	26.4	40.1	8.9	75.4	8,879.7	-26.6	-8.9	8,844.2
2018	25.9	0.0	0.0	25.9	-13,058.4	-25.4	-22.9	-13,106.8
2019	0.0	0.0	0.0	0.0	-12,802.3	-33.1	-30.0	-12,865.5
2020	0.0	0.0	0.0	0.0	0.0	-42.0	-37.9	-79.9
2021	0.0	0.0	0.0	0.0	12,305.3	-73.9	-24.6	12,206.5
2022	0.0	0.0	0.0	0.0	0.0	-62.8	-56.6	-119.4
2023	0.0	0.0	0.0	0.0	-11,827.4	-74.5	-67.5	-11,969.5
2024	0.0	0.0	0.0	0.0	0.0	-87.6	-79.1	-166.8
2025	0.0	0.0	0.0	0.0	11,368.1	-145.1	-48.3	11,174.7
2026	0.0	0.0	0.0	0.0	0.0	-116.6	-105.4	-222.0
2027	0.0	0.0	0.0	0.0	-10,926.7	-132.6	-120.0	-11,179.3
2028	0.0	0.0	0.0	0.0	-3,570.8	-149.8	-135.4	-3,855.9
2029	0.0	0.0	0.0	0.0	7,001.6	-167.9	-151.8	6,681.9
2030	0.0	0.0	0.0	0.0	6,864.3	-187.1	-169.1	6,508.1
All Years	**503.8**	**414.7**	**91.7**	**1,010.4**	**-12,916.9**	**-1,353.9**	**-1,083.1**	**-15,354.4**

Note: Negative values mean net savings.

Table 2.22. cont'd

Year	Irrigation Water Supply subsector				Water Sector Priority Actions			
	∆CAPEX	∆OPEX		∆Total	∆CAPEX	∆OPEX		∆Total
	∆IF	∆FF	∆O&M		∆IF	∆F	∆O&M	
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	0.0	0.0	0.0	0.0	0.0	-0.8	-0.3	-1.0
2013	0.0	0.0	0.0	0.0	-8,650.5	-2.1	-1.9	-8,654.5
2014	0.0	0.0	0.0	0.0	-8,473.1	80.4	14.6	-8,378.1
2015	0.0	0.0	0.0	0.0	1,213.3	158.5	29.4	1,401.2
2016	0.0	0.0	0.0	0.0	9,211.4	109.7	15.4	9,336.5
2017	0.0	0.0	0.0	0.0	8,906.0	13.5	0.0	8,919.5
2018	0.0	0.0	0.0	0.0	-13,032.5	-25.4	-22.9	-13,080.8
2019	0.0	0.0	0.0	0.0	-12,802.3	-33.1	-30.0	-12,865.4
2020	0.0	0.0	0.0	0.0	0.0	-42.0	-37.9	-79.9
2021	0.0	0.0	0.0	0.0	12,305.3	-73.9	-24.6	12,206.7
2022	0.0	14.0	2.0	16.0	0.0	-48.8	-54.6	-103.4
2023	0.0	13.8	2.0	15.8	-11,827.4	-60.7	-65.5	-11,953.6
2024	0.0	13.6	1.9	15.5	0.0	-74.0	-77.2	-151.2
2025	0.0	8.0	7.2	15.2	11,368.1	-137.1	-41.1	11,189.9
2026	0.0	7.8	7.0	14.8	0.0	-108.8	-98.4	-207.2
2027	0.0	7.6	7.0	14.6	-10,926.7	-125.0	-113.0	-11,164.7
2028	0.0	7.5	6.8	14.3	-3,570.8	-142.3	-128.6	-3,841.7
2029	0.0	7.3	6.7	14.0	7,001.6	-160.6	-145.1	6,695.9
2030	0.0	7.2	6.5	13.7	6,864.3	-179.9	-162.6	6,521.8
All Years	**0.0**	**86.8**	**47.1**	**133.9**	**-12,413.3**	**-852.4**	**-944.3**	**-14,210.0**

Note: Negative values mean net savings.

Table 2.23: Incremental analysis of baseline and adaptation water management measures. All values except calendar years in table are expressed in thousands of constant 2005 US Dollars. Values are obtained by subtracting entries in Table 2.8 from corresponding entries in Table 2.16. *As in the previous section, observe that values may not add up correctly due to rounding error.*

	Adaptation scenario: Specific water management measures								All Measures	
	Institutional building		Supply augmentation		Water conservation		Relocation of wellfields			
Year	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX
2011	0.5	21.2	-28.1	-51.2	30.9	30.0	0.0	0.0	3.3	0.0
2012	3.6	29.5	-56.6	-80.9	58.8	50.3	0.0	0.0	5.8	-1.1
2013	-206.5	27.4	-8,503.1	-69.3	60.6	38.0	0.0	0.0	-8,649.0	-4.0
2014	-196.1	69.4	-8,316.8	-17.0	39.8	42.6	0.0	0.0	-8,473.1	95.0
2015	277.2	115.1	835.2	25.1	100.9	47.7	0.0	0.0	1,213.3	187.9
2016	353.5	88.6	8,763.6	-16.8	91.0	53.2	0.0	0.0	9,208.1	125.1
2017	237.2	35.7	8,576.4	-85.9	89.3	63.7	0.0	0.0	8,902.9	13.5
2018	-290.4	14.9	-12,756.9	-128.8	14.9	65.6	0.0	0.0	-13,032.5	-48.3
2019	-307.0	12.3	-12,505.7	-149.6	10.5	72.5	0.0	0.0	-12,802.3	-64.8
2020	1.1	9.3	-1,406.6	-167.3	96.9	79.8	1,308.6	0.0	0.0	-78.1
2021	296.3	-3.2	10,629.9	-174.1	95.0	78.7	1,283.0	0.0	12,304.2	-98.6
2022	1.1	18.1	-1,352.0	-229.0	93.1	107.5	1,257.8	0.0	0.0	-103.4
2023	-283.7	13.7	-11,684.2	-256.0	9.7	116.0	130.7	0.0	-11,827.4	-126.2
2024	1.0	8.7	-1,299.5	-284.9	89.5	125.0	1,209.0	0.0	0.0	-151.2
2025	273.7	-8.0	9,820.3	-280.3	87.7	110.3	1,185.2	0.0	11,367.0	-178.1
2026	1.0	3.1	-1,249.0	-1,347.7	86.0	144.9	1,162.0	975.7	0.0	-224.0
2027	-262.1	-3.1	-10,673.6	-1,435.6	8.9	154.3	0.0	1,038.8	-10,926.7	-245.6
2028	-85.0	-9.7	-3,543.8	-1,505.2	58.0	164.2	0.0	1,105.2	-3,570.8	-245.5
2029	168.6	-16.7	6,775.1	-1,638.4	56.9	174.5	0.0	1,174.9	7,000.6	-305.7
2030	165.3	-24.1	6,642.2	-1,752.6	55.8	185.3	0.0	1,247.8	6,863.3	-343.6
All Years	**149.3**	**402.2**	**-21,333.0**	**-9,645.7**	**1,234.2**	**1,904.3**	**7,536.3**	**5,542.5**	**-12,413.2**	**-1,796.7**

Note: Negative values mean net savings.

Table 2.24: Water resources assessment sub-sector investment entities' incremental I&FF (in thousands of 2005 US Dollars) by asset type. *As in the previous section, observe that values may not add up correctly due to rounding errors*

	ΔTOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX	ΔCAPEX	ΔOPEX
Domestic	**19.5**	**423.7**	**1.3**	**50.6**		**0.3**	**3.7**	**28.8**	**5.9**	**10.2**	**6.1**	**27.2**	**2.6**	**306.5**
Households														
Firms														
Govt.	19.5	423.7	1.3	50.6		0.3	3.7	28.8	5.9	10.2	6.1	27.2	2.6	306.5
Foreign	**484.3**	**82.7**	**31.6**	**9.9**	**0.2**	**0.1**	**92.0**	**5.6**	**146.3**	**2.0**	**150.6**	**5.3**	**63.7**	**59.9**
Loans														
Bilateral ODA	-21.6		-1.4				-4.1		-6.5		-6.7		-2.8	
Multi-lateral ODA	505.9	82.7	33.0	9.9	0.2	0.1	96.1	5.6	152.8	2.0	157.3	5.3	66.6	59.9
All Sources	**503.9**	**506.5**	**32.8**	**60.5**	**0.2**	**0.4**	**95.7**	**34.4**	**152.2**	**12.2**	**156.6**	**32.6**	**66.3**	**366.4**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Negative values mean net savings.

Table 2.25: Municipal water supply sub-sector investment entities' incremental I&FF (in thousands of 2005 US Dollars) by asset type. *As in the previous section, observe that values may not add up correctly due to rounding errors*

	∆TOTAL		**ISIC 382**		**ISIC 383**		**ISIC 384**		**ISIC 385**		**Infrastructure**		**Human Resources**	
	∆CAPEX	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**
Domestic	**-3,229.2**	**-2,437.2**	**-34.7**		**-680.4**	**-2.4**	**-148.3**	**-5.8**	**-78.3**	**-2.4**	**-2,198.9**	**-1,663.5**	**-88.6**	**-763.0**
Households													`	
Firms	-3,229.2	-2,437.2	-34.7		-680.4	-2.4	-148.3	-5.8	-78.3	-2.4	-2,198.9	-1,663.5	-88.6	-763.0
Govt.														
Foreign	**-9,687.7**		**-104.0**		**-2,041.3**		**-444.9**		**-234.9**		**-6,596.7**		**-265.9**	
Loans	-9,687.7		-104.0		-2,041.3		-444.9		-234.9		-6,596.7		-265.9	
Bilateral ODA														
Multi-lateral ODA														
All Sources	**-12,917.0**	**-2,437.2**	**-138.6**		**-2,721.7**	**-2.4**	**-593.2**	**-5.8**	**-313.1**	**-2.4**	**-8,795.6**	**-1,663.5**	**-354.6**	**-763.0**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies;
ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments
Negative values mean net savings.

Table 2.26: Irrigation water supply sub-sector investment entities' incremental I&FF (in thousands of 2005 US Dollars) by asset type. *As in the previous section, observe that values may not add up correctly due to rounding errors.*

	∆TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX
Domestic		**107**										**73**		**34**
Households		15										10		5
Firms														
Govt.		92										63		29
Foreign		**27**										**18**		**8**
Loans														
Bilateral ODA														
Multi-lateral ODA		27										18		8
All Sources		**134**										**91**		**42**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Table 2.27: Synoptic table of incremental priority I&FF disaggregated to different entities and asset types deployed in the water sector. Values in this table (expressed in thousands of constant 2005 US dollars) are obtained by subtracting corresponding variables in Tables 2.12 (Baseline Scenario) from those in Table 2.20 (Adaptation Scenario). *Observe that values may not add up correctly due to rounding errors.*

	∆TOTAL		ISIC 382		ISIC 383		ISIC 384		ISIC 385		Infrastructure		Human Resources	
	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX	∆CAPEX	∆OPEX
Domestic	**-3,209.8**	**-1,906.4**	**-34.6**	**50.6**	**-680.4**	**-2.1**	**-148.3**	**23.4**	**-78.3**	**7.8**	**-2,198.9**	**-1,563.1**	**-69.1**	**-423.1**
Households		15.0										10.3		4.7
Firms	-3,229.2	-2,437.2	-34.6	0.0	-680.4	-2.5	-148.3	-5.8	-78.3	-2.5	-2,198.9	-1,663.4	-88.6	-763.1
Govt.	19.5	515.8		50.6		0.4		29.1		10.3		90.1	19.5	335.4
Foreign	**-9,203.4**	**109.5**	**-72.5**	**9.9**	**-2,041.0**	**0.1**	**-352.8**	**5.6**	**-88.7**	**2.0**	**-6,446.1**	**23.5**	**-202.2**	**68.2**
Loans	-9,687.7		-104.0		-2,041.3		-444.9		-234.9		-6,596.7		-265.9	
Bilateral ODA	-21.6		-1.4		0.0		-4.1		-6.5		-6.7		-2.9	
Multi-lateral ODA	505.9	109.5	33.0	9.9	0.2	0.1	96.1	5.6	152.7	2.0	157.3	23.5	66.6	68.2
All Sources	**-12,413.1**	**-1,796.8**	**-107.2**	**60.4**	**-2,721.4**	**-2.0**	**-501.1**	**29.0**	**-166.9**	**9.9**	**-8,645.0**	**-1,539.5**	**-271.4**	**-354.8**

Note: ISIC 382 = non-electrical machinery including computers; ISIC 383 = electrical motors, machinery apparatus, appliances and supplies; ISIC 384 = transport equipment; and ISIC 385 = professional and scientific instruments

Negative values mean net savings.

Table 2.28: Synoptic table of incremental priority I&FF disaggregated by water resources management measures and investment entities. *Values in this table (expressed in thousands of constant 2005 US dollars) are obtained by subtracting corresponding variables in Tables 2.13 (Baseline Scenario) from those in Table 2.21 (Adaptation Scenario). Observe that values may not add up correctly due to rounding errors.*

			Specific Water Resources Management Measures							
	All Measures		**Institutional strengthening**		**Supply augmentation**		**Water conservation**		**Relocation of wellfields**	
	∆CAPEX	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**	**∆CAPEX**	**∆OPEX**
Domestic	**-3,209.7**	**-1,906.4**	**-69.1**	**311.0**	**-6,258.9**	**-9,614.1**	**1,234.2**	**1,904.3**	**1,884.1**	**5,542.5**
Households	0.0	15.0	0.0	0.0	-593.4	10.3	593.4	4.7	0.0	0.0
Firms	-3,229.2	-2,437.2	-88.6	-127.1	-5,665.5	-9,687.7	640.8	1,885.2	1,884.1	5,542.5
Govt.	19.5	515.8	19.5	438.2	0.0	63.3	0.0	14.4	0.0	0.0
Foreign	**-9,203.4**	**109.5**	**218.4**	**91.1**	**-15,074.0**	**18.4**	**0.0**	**0.0**	**5,652.2**	**0.0**
Loans	-9,687.7	0.0	-265.9	0.0	-15,074.0	0.0	0.0	0.0	5,652.2	0.0
Bilateral ODA	-21.6	0.0	-21.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Multi-lateral ODA	505.9	109.5	505.9	91.1	0.0	18.4	0.0	0.0	0.0	0.0
All Sources	**-12,413.1**	**-1,796.8**	**149.3**	**402.2**	**-21,332.9**	**-9,595.7**	**1,234.2**	**1,904.3**	**7,536.3**	**5,542.5**

Negative values mean net savings.

Investment flow (IF) data shown as CAPEX in Table 2.27 imply savings in the order of 12.5 million USD (2005 base) distributed roughly 25% and 75% between domestic and foreign sources of capital sources, respectively. Under the scenarios that have been analyzed, 92% of savings on investments are attributed to a reduction in anticipated expenditure on infrastructure and electrical machinery assets (ISIC 383).

Maximum savings on operational expenditure (OPEX), associated here with financial flows (FF) are derived from infrastructural assets.

Overall, savings on professional and scientific equipment and human resources capital are low to moderate.. This fact is partly reflected in increased budgetary flows from government and multilateral ODA flows acting as counterbalance on capital formation in these two asset categories, under the adaptation scenario.

Viewed from a water resources management perspective, the summation of CAPEX and OPEX entries in Table 2.28 shows positive totals for three out of four water resources management measures. The cost of implementing supply augmentation activities/actions, which buck the general pattern, points to net savings of approximately 30 million USD (constant 2005 dollars), roughly divided into 15 million each between domestic and foreign exchange accounts.

The scaling down of financial resources shown in this table is tributary to the success of NAWEC's flagship leakage reduction programme. Chief amongst expected outcomes of this programme is a significant reduction in new capital investments in infrastructure and equipment (under the adaptation scenario). The public utility is also poised to make additional savings on external training and labour costs, as well as from unnecessary borrowing for the purpose of carrying out institutional strengthening activities. Concurrently, multi-lateral ODA to the tune of USD 0.6 million, matched by USD 0.5 million from government, is needed to implement institutional strengthening activities under the water resources assessment sub-sector. Furthermore, approximately USD16.8 million will be needed to implement adaptation measures through institutional strengthening, water conservation and wellfields relocation activities/actions. On balance however, implementation of new adaptation measures, optimal investments in new infrastructure, and filling adaptation gaps, result in cumulative savings of USD14 million over the 20-year planning horizon[14].

Household savings on network expansion are offset against investments in water-saving technologies at household level. Corresponding OPEX contributions are related to payments for sustainable irrigation water services.

3.2. Policy Implications

As shown in previous sections, the dominance of resource flows in the municipal water sub-sector is such that appropriate adaptation in this sub-sector holds the promise of significant investment savings in the water sector as a whole. In both baseline scenario and incremental expenditure analysis, external funding including loans varies between 14 and 59% of annual investment needs, averaging out over the 20-year study period to 44% of priority investments in the water sector. On the other hand, private investments in network expansion accounts for 9 to 27% of sector investments, higher figures coinciding with years in which public investments at relatively low. If interest on active loans, amounting to between 285,960 and 855,405 USD (2005 base), are taken into account, private sector participation drops a little to between 8 and 24%.

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[14] A quick back-of the envelope calculation shows that the difference in discounted infrastructure costs between baseline and adaptation scenarios is 11.8 million USD (see Appendix A). Adding this to revenue accruing from water recovered through leakage control that is priced at NAWEC's escalating tariffs GMD3.59/m3, GD7.48/m3, and GMD10.4/m3, we obtain savings of 13.2l 14.8 and 15.8 million USD (constant 2005 dollars). Note that the cost of leakage control is already included in the cost schedule of adaptation projects.

Under the circumstances, we focus our attention on domestic and international policy frameworks that have a bearing on mobilization of resources for adaptation, with specific emphasis on six key issues distilled from our findings.

The first (in no particular order of significance) is the inter-annual variability and scale of investment needs. The scale of investments and operational expenditures is linked to customer base/demand for services, status of capital stock, and relevant policies. From a domestic perspective therefore, operational and strategic policies geared towards slowing down deterioration of assets, encouraging optimal borrowing, and fiscal discipline should receive higher attention. To this effect, public utilities should develop dynamic asset management plans and make these available for scrutiny by legally mandated persons/bodies and informed publics.

The second is the issue of scheduling and sizing of water recovery and control projects. Considering that programmatic/project interventions are designed on the basis of certain assumptions/realities, timing of interventions is crucial. Subsidiary issues of unused capacity and cost of loans are quite important in this respect. Investment appraisal procedures need to be more rigourous by paying greater attention to alternative options (e.g. water conservation) and key non-sector specific variables.

The third issue is the urgency and benefits accruing from adaptation in the water sector. The indication that savings of nearly one million US dollars could be made annually by implementing without delay (Leary *et al*., 2008) no-regrets adaptation options, has a significant bearing on foreign borrowing, and government's margin of maneuver in servicing its relentlessly increasing domestic debt[15].

Fourth is the issue of resource allocation between entities/sector objectives and new/existing assets. Out of necessity of specialization, the water sector is divided into several thematic areas/sub-sectors handled by different ministries. In the absence of a strong coordinating body however, such fragmentation has made it difficult to undertake investment planning in a holistic manner. Since the government is ultimately responsible for public expenditure in all sub-sectors, implementation of a SPLIID-like framework is essential to optimal allocation of resources. Even before adoption of this general principle, this assessment already demonstrate that financial resources are best allocated to adaptation measures, principally water conservation, institutional strengthening, and wellfield relocation activities/actions.

Fifth is the reliability of foreign aid flows. Bi-lateral ODA in particular is dependent on the Gambia government's relations with contemporary governments in historic/potential donor countries, pressures from domestic policies and emergencies in donor countries. In this regard, multi-lateral ODA may be more predictable subject to the caveat that assessed or voluntary contributions from donor countries/major contributors stay above a minimum threshold for implementation of programs under disbursement organizations' remit. At this point, it is useful to recall that the 1970 commitment of develop countries to contribute 0.7% of GDP to ODA has been fulfilled by very few countries (Sachs, 2005). Related to the issue of resource allocation, the Gambia government's best interests are served by allocation of resources from its domestic budget as core funding for keystone programmes. For instance, funding requirements for implementation of institution strengthening measures suggest that it Gambia government allocation of USD 0.5 million (as matching funds over 4 years) could stimulate donors to contribute the outstanding amount of USD0.6 million.

Finally, the ability of end-users to pay for services derived from relevant institutions combined investment and operational expenditures. End-users ability-to-pay (ATP) should be viewed in the context of service providers' (public institutions and enterprises) own ability to meet costs, and the impact of service fees on household budgets. Against the background of widespread poverty, pricing policies must not pressurize households into zero-sum budget decisions. Owing to the Gambia's narrow revenue base, we draw attention to the fact that, through direct and indirect taxes, households ultimately shoulder public institutions'/enterprises' full costs, albeit in an apparently disconnected manner.

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[15] Unlike concessionary loans, domestic loans attract high interest rates. In the last 5 years the ration of domestic debt to GDP ranged from 18 to 26%

The national water policy (NWP) which is (currently) based on an open-ended time frame [16] for implementation broaches the issue of sizing of water recovery projects under the theme of licensing. However, its section 4.3.2 approaches the issue from a private developer's rather than general standpoint. Considering that abstractions under discussion in this report are by public institutions/enterprises, this policy and associated legal provisions should be extended to cover this user class, failing which externalities may not be accounted for in resources planning and allocation decisions.

We agree with section 6.3.5 of the NWP, that the Department of Water Resources (or other public institution so constituted) should be the focal point for (planning and) investment scheduling in the water sector. The alternative is fragmented development and loss of efficiency. Needless to say, the Ministry of Finance and Economic Affairs should be a privileged partner in the development and review of investment plans. That said, the DWR is far from ready to take on this role under its current capacity constraints.

It is often argued that pump irrigation is expensive, but no other solution that takes advantage of augmented dry season flows from Sambangalou dam has been advanced by tidal irrigation enthusiasts. Notice that agricultural land in CRR with high potential for tidal irrigation is 6,000 ha. At present, neither OMVG's Energy Development Plan nor Gambia government's rural electrification project includes in their design energy needs for water-lifting and distribution in irrigated areas. This omission needs correction in government's energy and agricultural policies if the Gambia is to maximize potential benefits from flow regulation. The fact that electricity is one of several priority investment sectors in the New Investment Code (1999) may help attract private sector participation in this effort.

We do not have information on irrigation water pricing or know whether anything of the sort exists, but it would be necessary for uniformity within the water sector to establish tariffs regulated by PURA. The water policy and PURA's mandate should also prescribe minimum service standards to allay risk-averse investors' concerns. We have found that recommended per-capita figures in the national water policy could be cut down significantly with water-saving technology without loss of social welfare. This finding needs consideration and action in terms of developing industry standards that are enforced after expiry of a reasonable transition period. To this end, the Standards Bureau needs to forge cooperative links with specialized public institutions, inasmuch as it needs strengthening in order to live up to its name.
In order to maximize investment opportunities and benefits under a changing climate, policy formulation, policy reforms and legislative amendments will be needed in the following sectors:

- Adaptation policy
- Agriculture policy
- Water policy and law
- Energy policy
- PURA Act.

In the post-2012 climate governance regime, the Gambia, like other least developed countries (LDCs) is looking forward to scaled-up and direct access to adaptation funding. In anticipation of fundamental and positive changes in the climate finance landscape (Ciplet *et al.*, 2010; Njie and Műller, 2010), front-line national institutions need to invest continuous effort in capacity building, networking, engaging stakeholders including the business community, The NWP echoes our analysis that "*future sector investments will be reliant on maintaining positive and constructive relationships with the international donor community and the United Nations (UN) family*" (Atkins International, 2006).

If our experience working in and outside the public sector is anything to go by, we draw attention to some potential obstacles to policy development/reforms and implementation. From an institutional perspective, deteriorating brain gain/drain ratios, policy fragmentation and institutional rivalries are antithetical to timely and dynamic response to water resources management challenges. There is enough empirical evidence to show that policy-making is routinely

[16] It is stated on page 41 that stakeholders have to agree on implementation time frame.

outsourced to consulting firms in order to overcome some of the barriers enunciated previously. The downside of this arrangement is that consulting firms' services do not come cheap and public budgets exceptionally cater for this category of services. Thus, policies rarely keep up with the evolving socio-economic landscape. Another emblematic problem for policy development is task managers' access to up-to-date observations/measurements/surveys of characteristic system data. As shown in the SPLIID framework (figure 2.2), the scientific/information basis of policy is equally relevant to investors and developers.

Policy implementation is also subject to resources constraints similar to those identified as critical for policy development, with one added dimension. Specifically, public authorities' commitment is a determinant factor once a particular policy becomes officially adopted. However, a strong monitoring and evaluation framework essential for rigorous performance reviews, is often lacking.

Ultimately, failure to circumvent or get over obstacles enunciated projects a poor image of public service (administration) and public enterprises to the general public which feels particularly disconnected from these institutions when their concerns remain unaddressed and aspirations unfulfilled. Consumer groups through which households can vehicle their grievances are being established here and there, but on the whole they still lack bargaining power to influence sectoral policy and decisions.

3.3. Key Uncertainties and Methodological Limitations

Although executed with due diligence, the piece of work presented in previous sections of this report is not a perfect one. Epistemic uncertainties regarding the relationship between OPEX and asset life still remain. Government budget allocations to the water resources assessment sub-sector constitute another area of uncertainty. Although we used a fixed ratio to GDP, the historical data indicates that the uniform distribution, $U(0.00018, 0.00036)$, describes the ratio more accurately. Whether or not government decides to create new institutions alluded to in the scenarios adds to this uncertainty.

We count our uncritical acceptance of some values presented in project budgets as a weakness in our approach, but our reasons are clear. First, these are officially adopted budgets, and second, budget reviews are outside the scope of our work. Specification bias in the context of scenario development, as well as partition coefficients applied to financial flow streams represent a methodological constraint imposed by lack of perfect foresight and absence of blue-prints for proposed interventions. In anticipation of case studies in which no or weak mathematical relationships exist between FF and O&M time series, it might be helpful to carryout a cross sectional analysis of FF, O&M and OPEX data with the objective of recommending default values[17] to analysts/researchers who find themselves in an impasses.

[17] Findings under this study suggest an O&M/FF ratio lying between 0.18 and 0.55

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Appendix A: Project Portfolios

Baseline Scenario

Project	Start	End	Total Project Budget (USD)	Priority Actions Allocation (USD)	Priority Actions Allocation (constant 2005 USD)
IDB Rural Water Supply Project	2009	2011	5,487,000	80,000	79,137
AfDB Support for Water sector Reform	2011	2013	2,092,738	2,092,738	2,070,151
GEF/LDCF Early Warning Project	2012	2012	2,583,500	2,583,500	2,555,616
Spanish Support to Climate Observing Network	2012	2012	22,446	22,446	22,203
GNAIP	2011	2015	306,855,000	39,381,541	38,956,497
OMVG Energy Development Program	2015	2018	394,521,264	16,528,825	16,350,430
Kotu Ring Project	2011	2013	6,000,000	6,000,000	5,935,242
Gunjur Rural Water Supply Project	2011	2013	4,000,000	4,000,000	3,956,828
Municipal Water Supply Extension Project 1	2013	2015	30,000,000	30,000,000	29,676,211
Municipal Water Supply Extension Project 2	2018	2020	45,000,000	45,000,000	44,514,317
Municipal Water Supply Extension Project 3	2022	2024	45,000,000	45,000,000	44,514,317
Municipal Water Supply Extension Project 4	2026	2028	45,000,000	45,000,000	44,514,317

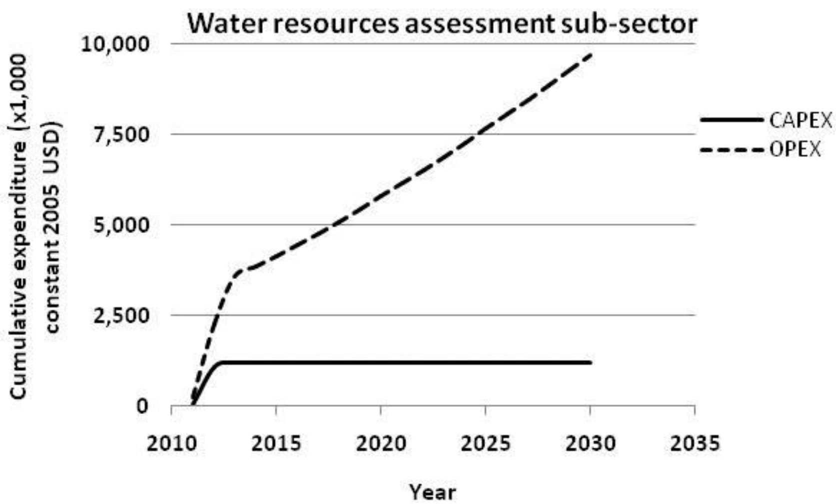
Adaptation Scenario

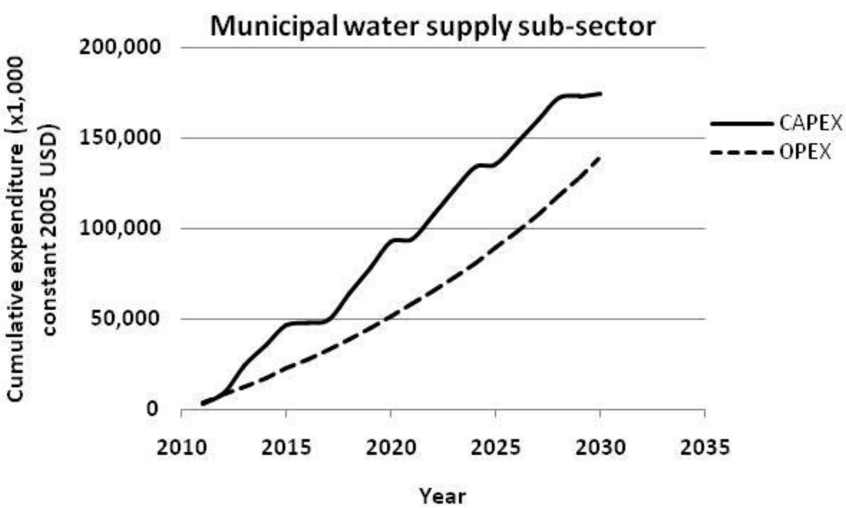
Project	Start	End	Total Project Budget (USD)	Priority Actions Allocation (USD)	Priority Actions Allocation (constant 2005 USD)
IDB Rural Water Supply Project	2009	2011	5,487,000	80,000	79,137
AfDB Support for Water sector Reform	2011	2013	2,092,738	2,092,738	2,070,151
GEF/LDCF Early Warning Project	2012	2012	2,583,500	2,583,500	2,555,616
Spanish Support to Climate Observing Network	2012	2012	22,446	22,446	22,203
R&SO Millennium Challenge Project	2014	2018	561,861	561,861	555,797
GNAIP	2011	2015	306,855,000	39,381,541	38,956,497
OMVG Energy Development Program	2015	2018	394,521,264	16,528,825	16,350,430
Kotu Ring Project	2011	2013	6,000,000	6,000,000	5,935,242
Gunjur Rural Water Supply Project	2011	2013	4,000,000	4,000,000	3,956,828
Leakage reduction Project	2013	2015	3,000,000	3,000,000	2,967,621
Industrial water reduction program†	2013	2015	50,000	50,000	49,460
Municipal Water Supply Extension Project 1‡	2015	2017	30,000,000	30,000,000	29,676,211
Municipal Water Supply Extension Project 2	2020	2022	45,000,000	45,000,000	44,514,317
Municipal Water Supply Extension Project 3	2024	2026	45,000,000	45,000,000	44,514,317
Municipal Water Supply Extension Project 4*	2028	2030	30,000,000	30,000,000	29,676,211

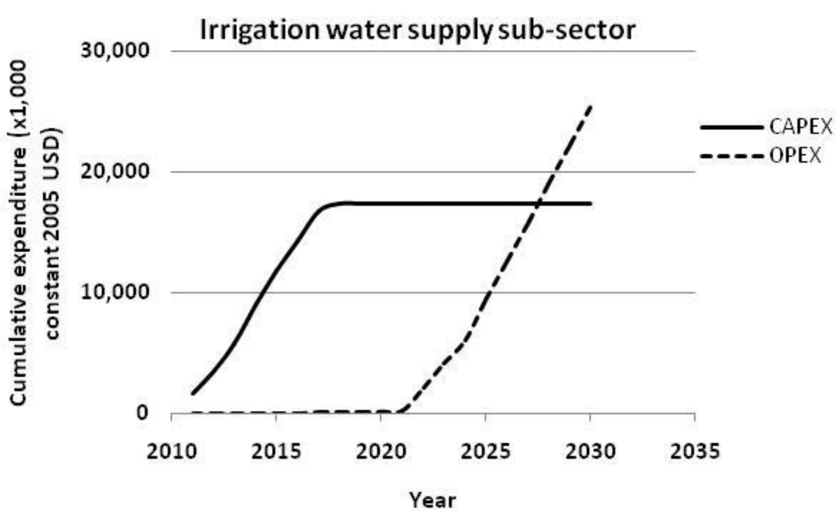
† Costs indicated are internalized in NAWEC's operating budget
‡ Project lagged with respect to baseline scenario as a result of capacity gains from leakage reduction program
* Project reduced in scope with respect to baseline scenario as a result of capacity gains in previous programs

Appendix B: Supplementary tables and graphs

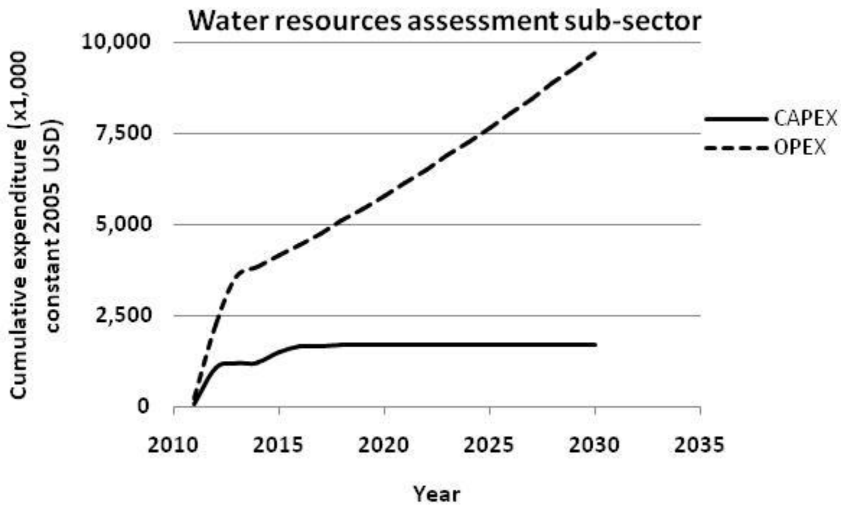
Baseline CAPEX and OPEX Nessie curves in different water sub-sectors analyzed

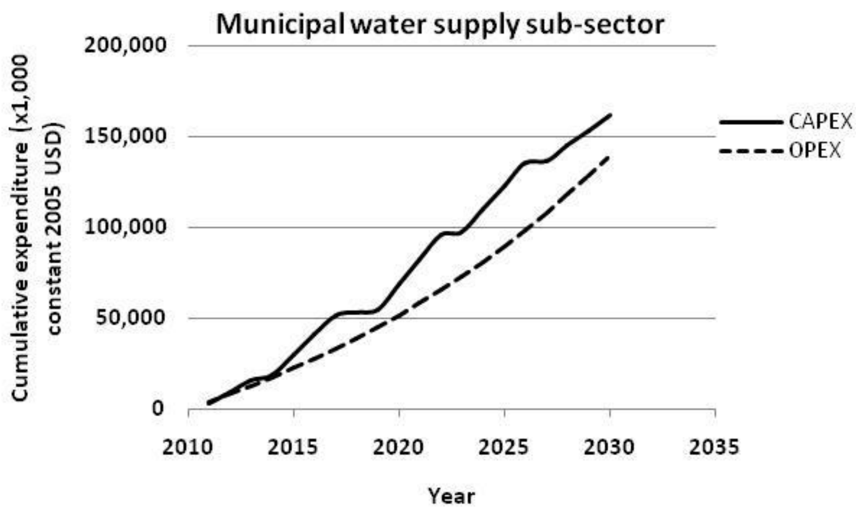


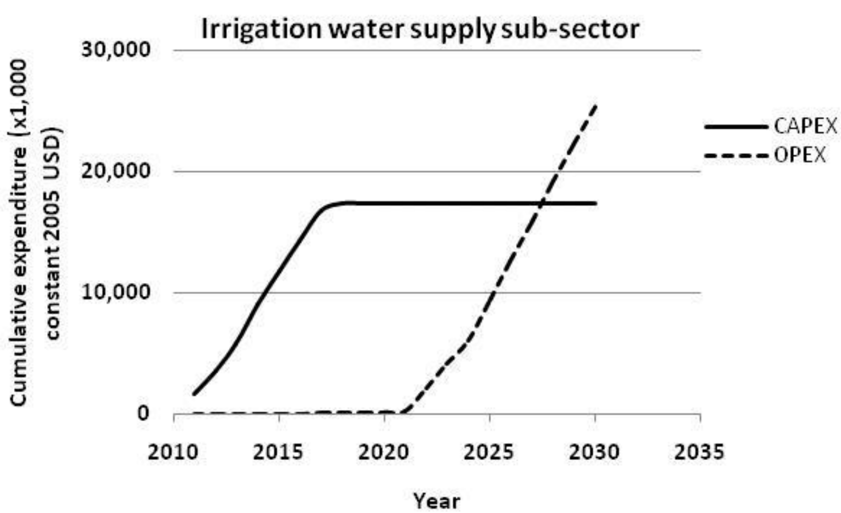




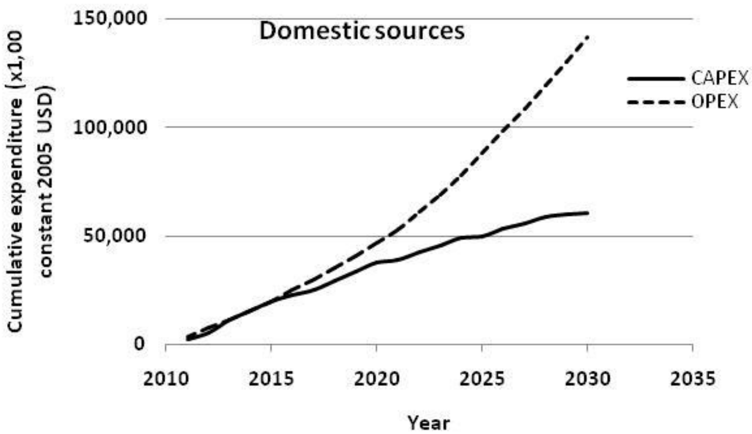
Adaptation CAPEX and OPEX Nessie curves in different water sub-sectors analyzed



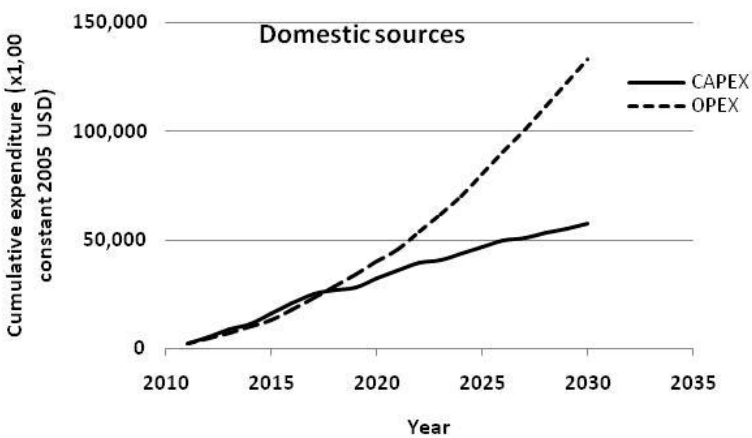




Baseline Scenario Domestic CAPEX and OPEX Nessie curves



Adaptation Scenario Domestic CAPEX and OPEX Nessie curves

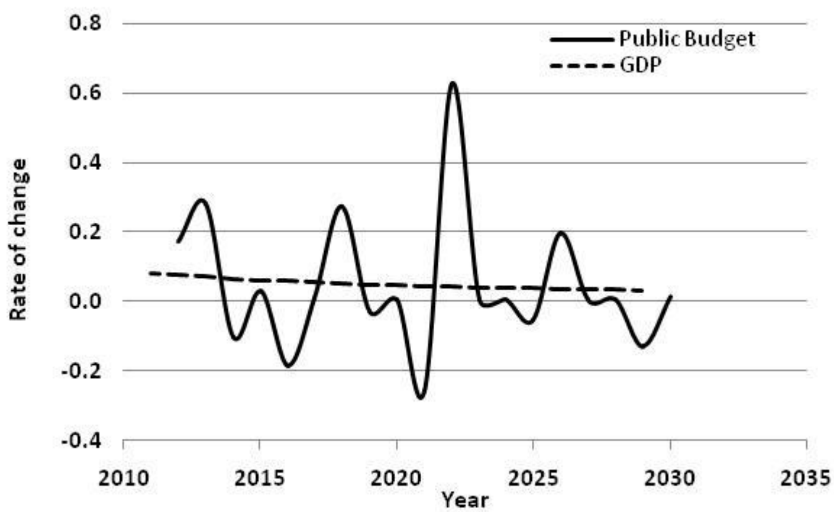


GDP and domestic financing growth rate under baseline scenario

	LDC graduation by 2030		USD700/capita by 2030		USD500/capita in 2030		Aggregate CAPEX and OPEX	
Year	GDP	d(GDP)/dt	GDP	d(GDP)/dt	GDP	d(GDP)/dt	DF	d(DF)/dt
2011	25,456.5		25,456.5		25,457		6,714.5	
2012	30,354.6	0.192	28,968.4	0.138	27,582	0.084	7,880.2	**0.174**
2013	35,252.7	0.161	32,480.3	0.121	29,708	0.077	10,100.4	**0.282**
2014	40,150.8	0.139	35,992.2	0.108	31,834	0.072	9,088.9	-0.100
2015	45,048.8	0.122	39,504.1	0.098	33,959	0.067	9,365.2	0.030
2016	49,946.9	0.109	43,015.9	0.089	36,085	0.063	7,644.6	-0.184
2017	54,845.0	0.098	46,527.8	0.082	38,211	0.059	7,737.6	0.012
2018	59,743.1	0.089	50,039.7	0.075	40,336	0.056	9,861.6	**0.274**
2019	64,641.2	0.082	53,551.6	0.070	42,462	0.053	9,592.5	-0.027
2020	69,539.2	0.076	57,063.4	0.066	44,588	0.050	9,641.6	0.005
2021	74,437.3	0.070	60,575.3	0.062	46,713	0.048	7,182.2	-0.255
2022	79,335.4	0.066	64,087.2	0.058	48,839	0.046	11,697.0	**0.629**

2023	84,233.5	0.062	67,599.1	0.055	50,965	0.044	11,751.1	0.005
2024	89,131.5	0.058	71,111.0	0.052	53,090	0.042	11,818.3	0.006
2025	94,029.6	0.055	74,622.8	0.049	55,216	0.040	11,181.9	-0.054
2026	98,927.7	0.052	78,134.7	0.047	57,342	0.038	13,397.8	**0.198**
2027	103,825.8	0.050	81,646.6	0.045	59,467	0.037	13,470.7	0.005
2028	108,723.9	0.047	85,158.5	0.043	61,593	0.036	13,553.5	0.006
2029	113,621.9	0.045	88,670.3	0.041	63,719	0.035	11,807.2	-0.129
2030	118,520.0	0.043	92,182.2	0.040	65,844	0.033	11,979.0	0.015

Notes:
LDC graduation (our fervent wish) requires at least USD900/capita. Highlighted cells indicating double digits of GDP growth puts the LDC graduation premise as well as USD700/capita assumption in doubt. GDP for 2012 through 2029 are obtained by linear interpolation of 2011 and 2030 values.
GDP and Domestic Financing (DF) are expressed in thousands of constant 2005 US Dollar
$d(GDP)/dt = GDP_t/GDP_{t-1} – 1$
Likewise, $d(DF)/dt = DF_t/DF_{t-1} – 1$
Values shown in red in the last column correspond to years in which the growth rate in domestic financing exceeds GDP growth. These “critical” years are clearly shown in figure immediately below.



GDP and domestic financing growth rate under adaptation scenario

	LDC graduation by 2030		USD700/capita by 2030		USD500/capita in 2030		Aggregate CAPEX and OPEX	
Year	GDP	d(GDP)/dt	GDP	d(GDP)/dt	GDP	d(GDP)/dt	DF	d(DF)/dt
2011	25,456.5		25,456.5		25,457		6,714.5	
2012	30,354.6	0.192	28,968.4	0.138	27,582	0.084	7,879.2	**0.173**
2013	35,252.7	0.161	32,480.3	0.121	29,708	0.077	8,017.9	0.018
2014	40,150.8	0.139	35,992.2	0.108	31,834	0.072	7,177.6	-0.105
2015	45,048.8	0.122	39,504.1	0.098	33,959	0.067	9,742.3	**0.357**
2016	49,946.9	0.109	43,015.9	0.089	36,085	0.063	9,802.3	0.006
2017	54,845.0	0.098	46,527.8	0.082	38,211	0.059	9,718.3	-0.009
2018	59,743.1	0.089	50,039.7	0.075	40,336	0.056	6,977.5	-0.282
2019	64,641.2	0.082	53,551.6	0.070	42,462	0.053	6,806.9	-0.024
2020	69,539.2	0.076	57,063.4	0.066	44,588	0.050	9,574.7	**0.407**
2021	74,437.3	0.070	60,575.3	0.062	46,713	0.048	9,624.9	0.005
2022	79,335.4	0.066	64,087.2	0.058	48,839	0.046	11,600.9	**0.205**
2023	84,233.5	0.062	67,599.1	0.055	50,965	0.044	9,307.7	-0.198

2024	89,131.5	0.058	71,111.0	0.052	53,090	0.042	11,689.4	**0.256**
2025	94,029.6	0.055	74,622.8	0.049	55,216	0.040	13,189.2	**0.128**
2026	98,927.7	0.052	78,134.7	0.047	57,342	0.038	13,232.9	0.003
2027	103,825.8	0.050	81,646.6	0.045	59,467	0.037	11,296.8	-0.146
2028	108,723.9	0.047	85,158.5	0.043	61,593	0.036	12,712.3	**0.125**
2029	113,621.9	0.045	88,670.3	0.041	63,719	0.035	12,808.9	0.008
2030	118,520.0	0.043	92,182.2	0.040	65,844	0.033	12,912.4	0.008

Notes:

LDC graduation (our fervent wish) requires at least USD900/capita. Highlighted cells indicating double digits of GDP growth puts the LDC graduation premise as well as USD700/capita assumption in doubt. GDP for 2012 through 2029 are obtained by linear interpolation of 2011 and 2030 values.

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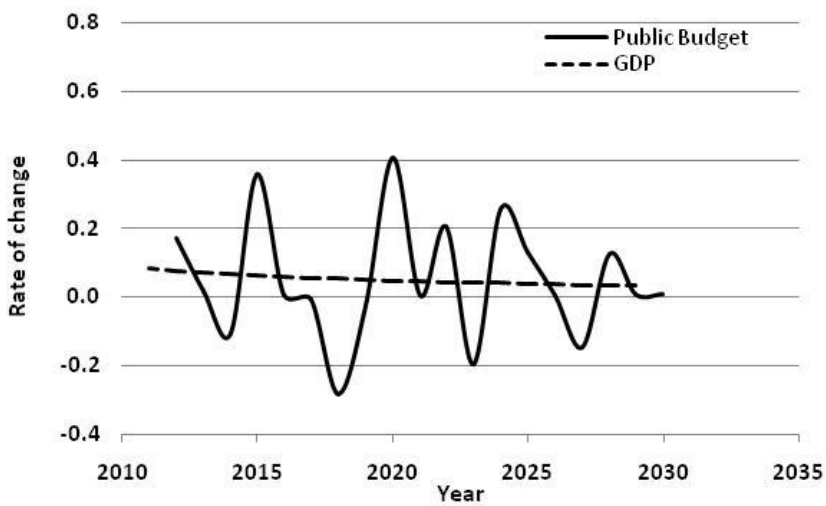
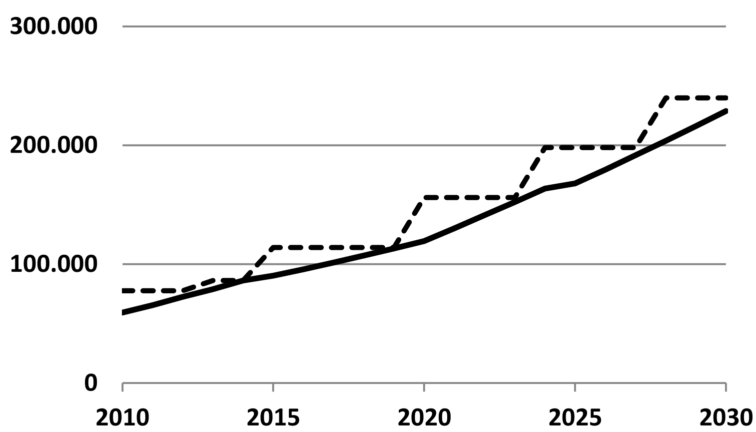


Illustrative example of municipal water supply sub-sector planning variables

Year	2010	2011	2015	2020	2025	2030
Population	852,600	890,498	1,059,700	1,208,700	1,393,150	1,577,600
Percentage to be served by NAWEC	42	42	45	50	55	60
Percentage domestic use with house connections	80	80	80	80	80	80
Percentage domestic use with tap connections	20	20	20	20	20	20
domestic Water Demand from house connection	75	76	80	85	90	100
domestic Water Demand from tap connections	35	35	35	35	35	35
Total Water Demand from house connection	21,485,520	22,739,752	30,519,360	41,095,800	55,168,740	75,724,800
Total Water Demand from tap connections	2,506,644	2,618,064	3,338,055	4,230,450	5,363,628	6,625,920
Total domestic Water demand (m3/day)	23,992	25,358	33,857	45,326	60,532	82,351
Commercial industrial demand (m3/day)	17,856	20,566	25,126	33,005	54,917	76,829
Institutional demand (m3/day)	5,580	6,448	9,918	12,888	16,785	20,682
Total water demand (m3/day)	47,428	52,372	68,901	91,219	132,234	179,862
Un accounted for water (%)	25	25	15	15	10	10
Unaccounted for water (m3/day)	11,857	13,093	10,335	13,683	13,223	17,986
Total demand required (m3/day)	59,285	65,465	79,236	104,902	145,458	197,848
Iinstalled Capacity (m3/hr)	3,884	3,884	4,316	5,700	7,477	10,977
Production capacity m3/h assuming 20 hrs pumping	77,680	77,680	86,320	114,000	149,540	219,540



Investment behaviour of public water utility vis-à-vis water demand

Solid line represents water demand (m^3/day), and dotted line installed capacity (m^3/day). Investment behaviour based on size of loans previously contracted by The Gambia vis-à-vis water demand in Greater Banjul Metropolitan Area.