Folder Title: Demand for Water in Tunis, Tunisia and Rabat, Morocco (RPO # 675-40) - 1v

Folder ID: 1447703

Dates: 07/01/1989 – 07/31/1992

Series: Impact Evaluation Reports

Fonds: Records of the Office of Operations Evaluation

ISAD Reference Code: WB IBRD/IDA OPE-07

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A L L - I N - 1   N O T E

DATE: 23-Jul-1992 12:08pm

  TO: Julio Kipnis   (JULIO KIPNIS)

FROM: Clara Else, RAD   (CLARA ELSE)

EXT.:   31049

SUBJECT: PCR for 675-40 sent

       Just to let you know that Harvey ("Mike") Garn called about
close-out reporting on the Tunis and Rabat Water Demand project
carried out by Alex McPhail. Edith carried a PCR to him 7/22/92.

  CC: Edith Thomas   (EDITH THOMAS)

OFFICE MEMORANDUM

DATE: June 20, 1991

TO: Mr. Alexander McPhail, EAS

FROM: Gregory Ingram, Administrator, Research Advisory Staff

EXTENSION: 31052

SUBJECT: Research Project 675-40 "Demand for Water in Tunis, Tunisia and Rabat, Morocco"

      In response to your June 6, 1991 memorandum, your research project closing date has been extended from June 30, 1991 to December 31, 1991, without allocation of RSB funds for FY92. Under the extended closing date, you will now have until June 30, 1992 to submit the final completion report on the project. I note, however, that you intend to submit the reports earlier, and you will be able to do so.

cc: Messrs/Mmes: H. Garn, J. Briscoe, INUWS
                       C. Else, V. Mataac, E. Thomas, RAD

THE WORLD BANK/IFC/MIGA

OFFICE MEMORANDUM

DATE: June 6, 1991

TO: Mr. Gregory Ingram, RAD

FROM: Alexander McPhail, EAS

EXTENSION: 82125

SUBJECT: Request for Extension of Time: RPO 675-40

1.   I am the principal investigator for the above-referenced project which is scheduled to close June 30, 1991. However, the research for the project is not yet complete and I would request an extension of the closing date until December 31, 1991.

2.   To date, the project has been an unqualified success. At this point, the research has produced the largest data set on household water consumption known to exist for the developing world. In all, over 4,000 household surveys were completed during eleven months of fieldwork. The surveys were for households with and without water connections and contain the responses to over 60 questions concerning household water use and general socio-economic characteristics.

3.   As of today, the project is approximately 75 percent complete with all the field work and data entry and verification finished. However, the econometric work is progressing slower than expected. There are two reasons for this. First, as mentioned above, the field portion of the research went extremely well with the result that the sample size was more than tripled over that initially set out in the research proposal. This, in turn, has greatly complicated the data entry and checking phase of the project because of the much greater number of household surveys and related water consumption records.

4.   Second, the preliminary econometric results for the project are encouraging, but also present new and unexpected findings that remain to be satisfactorily explained. This is partly because no one has ever had such a good data set to work with from the developing world and, hence, many of the results are not comparable to previous findings. Therefore, I have had to seek out advice from many experts outside the Bank. The model analyses have continued throughout the last five months and it now appears that we are moving toward a consensus on how to interpret many of the results. Thus, I expect that in the next couple of months the econometric portion of the work should be completed.

5.   Please note that this is not a request for additional funding, only for a six month extension of time to complete the analysis and write the reports.

6.   Thank you very much for your attention to this matter and I
look forward to your response in the near future.

cc: Garn, Briscoe (INUWS).

AMcPhail

The World Bank/IFC/MIGA
O F F I C E   M E M O R A N D U M

DATE: 17-Jun-1991 01:26pm

  TO: Gregory Ingram   (GREGORY INGRAM)
  TO: Shekhar Shah   (SHEKHAR SHAH)

FROM: Clara Else, RAD   (CLARA ELSE)

EXT.:   31049

SUBJECT: RPO 675-40 extension

        I believe that this request meets the requirement that a
sponsor request an extension "on the basis of a proper
justification" (sic). They have new and problematic econometric
findings that require adjustment of their models, and I would not
want to stand in the way of their consultation with 'outside
experts' to make the most appropriate corrections. They ask for
no additional funds and had a RSB budget of only $19,900. (I
must admit I wonder how they created "the largest data set on
household water consumption know to exist for the developing
world" with only $39,750 of USAID and Bank funds, but that's
their problem.)

        I attach a draft approval memo.

DATE: June 6, 1991

TO: Mr. Gregory Ingram, RAD

FROM: Alexander McPhail, EAS

EXTENSION: 82125

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cc: Garn, Briscoe (INUWS).

AMcPhail

THE WORLD BANK/IFC
BUDGET TRANSFER REQUEST

Log No. (For CTRMI Use Only)

To	Requested by (Name and Signature)
Management Information Division, CTR	Ph1 Anh Plesch _(signature)_

Person to Contact	Ext.	Dept./Div. Nos.	Room No.	Date
Ph1 Anh Plesch, RAD	31063	623/99	s-3025	8/15/89

AMOUNTS

EXPENSE CATEGORY	FROM DEPT. NO.	DIV. NO.	EXP. CODE	LEAVE BLANK	AMOUNT $	TO DEPT. NO.	DIV. NO.	EXP. CODE	LEAVE BLANK	AMOUNT $
1. Regular Salaries			AA	–				AA	+	
2. Temporary			AF	–				AF	+	
3. Overtime			AG	–				AG	+	
4. Staff Travel			CA	–				CA	+	
5. Consultant Travel			CB	–				CB	+	
6. Consultant Fees	671	99	EA	–$19,900		675	40	EA	+$19,900	
7. Contractual Services			EB	–				EB	+	
8. Communications			HC	–				HC	+	
9. Internal Computing			XA	–				XA	+	
10. Translation Services			XB	–				XB	+	
11. Office Machines-Purchase			KA	–				KA	+	
12. Office Machines-Rental			KB	–				KB	+	
13. Office Machines-Maintenance			KC	–				KC	+	
14. Office Machines-Depreciation			KD	–				KD	+	
15. Office Machines-Software/ Supplies			KS	–				KS	+	
16. Office Supplies			LA	–				LA	+	
17. Contingency			VA	–				VA	+	

STAFFYEARS

Staff Category	FROM Staffyears	Dept. No.	Div. No.	TO Staffyears	Dept. No.	Div. No.
Professional (Grades 18 and above)						
Others (Grades 11 to 17)						
Special						

POSITIONS

FROM Dept. No.	Div. No.	Position No.	Title	TO Dept. No.	Div. No.	Position No.	Title

Remarks: For FY90 RPO 675-40 "Demand for Water in Tunis, Tunisia and Rabat, Morocco"

cc: Mataac, S-3021

General

The Budget Transfer Request Form is designed to systematically collect the information necessary to properly revise the original authorized budget. The columns and lines of this form are designed to accomodate the most common transactions. Should exceptional cases arise, please use either blank lines, erase preprinted lines, use remarks section or use an additional form to transmit the necessary information for your transfer request. Budget transfers should be requested for amounts of $1,000 and above for any one expense category.

Responsibility for Completing the Form

The completion of the form is not a means for seeking CTR approval to transfer the budget but a means of informing CTR about a budget reallocation. The authority to transfer, as explained below, lies with the department or vice-presidency, depending on internal delegation of authority arrangements within the VP-Unit (or VP complex). This form should be filled out by an organizational unit requesting transfers of its approved and distributed budgeted amounts, staff years and positions. If the transfer is between two departments, consultation with the receiving department is always necessary. All forms should be copied to the Chief Administrative Officer in the VP's front office and to the budget officers in all other departments. The authority to sign the budget transfer forms and its distribution may vary for each Vice-Presidency according to specific instructions issued for this purpose by the Chief Administrative Officer and the responsible budget officers. Forms for budget transfers from the Contingency Accounts to the various organizational units will be filled out by the responsible CTR/PBD Officer.

Amount Transfer

As a general rule, vice-presidents and department heads have the authority to transfer discretionary funds from one expense category to another without CTR or PBD approval, except that the representation and hospitality budget may not be increased.

The expense categories which are printed on the form are only those most frequently requested. A transfer, however, may involve other expense categories. The complete list of expense categories which are budgeted in the various department and the corresponding codes is provided below for information:

Expense Category	Code	Expense Category	Code
Regular Salaries	AA	Local Staff Costs	AL
Temporary	AF	Office Occupancy	GA
Overtime	AG	Office Machines:	
Staff Travel	CA	Purchase	KA
Consultant Travel	CB	Rental	KB
Representation	DA	Maintenance	KC
Hospitality	FB	Depreciation	KD
Consultant Fees	EA	Software/Supplies	KS
Contractual Services	EB	Office Supplies	LA
Communications	HC	Other Miscellaneous	MF
Internal Computing	XA		
Translation Services	XB		

General Contingency (960-30) VA(099-30)* *Code for IFC

If a budget transfer involves allocated expenses (benefits or overhead), the requestor should consult the Budget Implementation Guide for the proper expense name and code.

Staffyear Transfer

The information requested under this category for professionals (grades 18 and above), others (grades 11 to 17) and special will be used to make adjustments in the administrative budget staffyears and will be reflected in the Report of Expenses and Budgets. Staffyear information is necessary when transfers are made from the Contingency Accounts because such transfers constitute additions to the authorized staffyears.

Position Transfer

Normally, a position transfer involves also transfers of amounts and staffyears. A request for a position transfer is necessary when the transfer is from one department to another, that is, whenever two departamental codes are involved; i.e. the transfer is from 122-05 to 126-10. Position transfers within a department (from one division to another) are made automatically through the Personnel Action Form and, therefore, no budget transfer is necessary.

Recodings of position titles and changes of position numbers of occupied positions which are usually for intradepartamental changes should not be requested through this form. These changes are not consideed budget transfers and are to be communicated to the Personnel Officer who will, if necessary, inform CTR appropriately.

Remarks

The remarks section should be used for a brief description of the transfer or for explanations necessary to clarify the entries made in the other sections of the form.

THE WORLD BANK/IFC/MIGA
OFFICE MEMORANDUM

DATE: August 10, 1989

TO: Mr. Harvey Garn, INUWS

FROM: Phi Anh Plesch, RAD

EXTENSION: 31063

SUBJECT: Research Proposal: Tunis and Rabat Water Demand Study

I am pleased to inform you that your request for $19,900 from the Research Support Budget to finance a study on water demand in the cities of Tunis and Rabat has been approved. The project's account number and financial authorization are now issued as follows:

i)	Account Number	675-40
ii)	FY90 Authorization	$19,900
iii)	Total Authorization	$19,900

Expenses related to the project may be charged to the above account number up to the total amount authorized. Please use the account number also as an identification code in all documents and correspondence related to the project, including letters of appointment to consultants.

Since the project is shceduled for completion on December 31, 1990, according to the rules, it will be closed on June 30, 1991. You will be required to file a completion report on the project no later than its closing date.

cc: Messrs/Mmes.: L. Pouliquen, C. Carnemark, B. Gross, INU
E. Rodriguez, M. Tonson, PBD
J. Fernandez, K. Hannemann, CTR
S. Thavamoney, OPNMI
S. Shah, V. Mataac, RAD
Research Committee Members

OFFICE MEMORANDUM

Approved

8.4.87

DATE: July 12, 1989

TO: Dennis de Tray, RAD

THROUGH: Louis Pouliquen, INUDR

FROM: Curt Carnemark, INUWS

EXTENSION: 33105

SUBJECT: Research Proposal: Demand For Water in Tunis, Tunisia and Rabat, Morocco

1.   Attached are five copies of a proposal to study the demand for potable water in the cities of Tunis and Rabat which INUWS is submitting to the Research Committee for consideration. The main objective of the research is to collect data (through household surveys and water utility consumption records) and to estimate the residential demand and income and price elasticities for water in fast-growing urban centers located in arid climates. Using both the surveys and utility records, a large data base will be constructed and then various econometric techniques will be used to try and estimate single-equation demand functions and the resulting income and price elasticities.

2.   The research will also address the issues which surround the decision to connect to a water system when there is no supply constraint. In this regard, the study will identify and interview several hundred households in the two cities that are not connected to the improved water network to try and determine the barriers to connection for these people. On this important topic, the research would be a pioneer in the literature. This part of the research will also examine related questions, such as what alternative water sources exist and how, and at what cost, informal markets provide water to those who do not use either the improved water system or traditional sources.

3.   The use of the techniques proposed in the project will be one of their first applications in developing countries. As such, the proposed research is expected to make valuable and timely contributions to the literature on these subjects and to provide a better analytical framework for the Bank's operations in this sector.

4.   The primary investigator for the project, Mr. Alexander McPhail (currently a consultant for INURD), has already received written approval to conduct the research from the President of the national water utility in both Tunisia and Morocco. These letters are included in Annex 1 of the proposal. Also attached are memos in support of the project from Mr. Peter Ludwig, Division Chief, EM2IN and Mr. Alberto Antonini, Economist, EM2CO. A Bank advisory panel composed of senior water engineers and economists from the EMENA and INU Departments has also been formed to oversee and direct the

DATE: July 12, 1989

TO: Dennis de Tray, RAD

THROUGH: Louis Pouliquen, INUDR
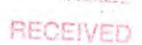
FROM: Curt Carnemark, INUWS

EXTENSION: 33105

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advisory panel composed of senior water engineers and economists from the
EMENA and INU Departments has also been formed to oversee and direct the

research. This advisory panel and its responsibilities are described further in section 7 of the proposal.

5.   The proposal requests a total of $19,925 from the Research Committee. The research is also being supported by the Tunis, Tunisia office of USAID's Regional Housing and Urban Development Office that is expected to contribute between $20,000 to $25,000. In addition, staff time contributed by EMENA and INU departments is expected to total $46,800 and $32,900, respectively.

6.   Thank you for your time and consideration of the attached proposal. Please feel free to contact either myself or Mr. McPhail (ext. 33952) if you have any questions or if you require additional material for your review.

Attachments

CCarnemark/AMcPhail

Distribution
(without attachments):   Messrs.   Garn, Zavala (INUWS); Pommier (EM3IN);
                                      Ludwig, Contreras, Velderman (EM2IN);
                                      Grais, Antonini (EM2CO); Ljung, Buckley,
                                      K.S. Lee, Whittington, McPhail (INURD)

THE WORLD BANK RESEARCH PROGRAM
REQUEST FOR RESEARCH SUPPORT BUDGET (RSB) FUNDING

DATE OF SUBMISSION:
7/12/89

PART I : PROJECT IDENTIFICATION

1. TITLE:
Tunis and Rabat Water Demand Study

2. DEPARTMENT(S) RESPONSIBLE: Infrastructure and Urban Development Department

3. STAFF PARTICIPATION:

(a) Principal Supervisor: Harvey Garn, INUWS

(b) Others Responsible:

(c) Administrative/Budget Staff: Bruce Gross, INUWS

4. SOURCES OF FUNDING:

RSB: $ 19,925

Country: $

Sponsoring Dept. $

Other: $ 19,825 USAID

Other Dept. $

TOTAL: $ 39,750

5. ESTIMATED STAFF COST 1/ AND TIME REQUIRED IN WEEKS BY EACH DEPARTMENT:

Department	Staff Economist		Departmental Consultant		Staff Research Assistant		Total Staff	
	(a) Time	(b) Cost	(a) Time	(b) Cost	(a) Time	(b) Cost	(a) Time	(b) Cost
INURD	2	9,400						
INUWS	5	23,500						
EM2IN	7	32,700						
EM3IN	2	9,400						
EM2CO	1	4,700						

6. ESTIMATED TOTAL COSTS ((4) + (5b)): 79,700

1/ See Footnote on page 3, Part IV.2.

PART II : COORDINATION AND CONSULTATION

REGIONAL COORDINATION AND CONSULTATION

A. Did Regional Consultation take place? [X] Yes   [ ] No

B. Comments by the Region(s): See attached memos from EM2IN and EM2CO

C. Did any workshop take place?   /_/Yes   /x/No

D. Date(s) of workshop(s):

DEPARTMENTAL APPROVAL

DIVISION CHIEF (Type Name): Curtis Carnemark	SIGNATURE:	DATE:
DEPARTMENT DIRECTOR (Type Name): Louis Pouliquen	SIGNATURE:	DATE: 7/20/89

Record Removal Notice

File Title	Barcode No.
Demand for Water in Tunis, Tunisia and Rabat, Morocco (RPO # 675-40) - 1v	1447703

Document Date	Document Type	
12 July, 1989	Attachment	

Correspondents / Participants

Subject / Title
Request for Research Support Budget Funding - Financial and Staff Resources

Exception(s)
Personal Information

Additional Comments

The item(s) identified above has/have been removed in accordance with The World Bank Policy on Access to Information. This Policy can be found on the World Bank Access to Information website.

Withdrawn by	Date
Ann May	24-Feb-17

IV.2: ESTIMATED DEPARTMENTALLY FUNDED STAFF TIME IN WEEKS AND COSTS 1/, BY FISCAL YEAR

	FY (1) Time (d)	FY (1) Cost (e)	FY (2) Time (d)	FY (2) Cost (e)	FY (3) Time (d)	FY (3) Cost (e)	FY (4) Time (d)	FY (4) Cost (e)	Total FYs (5) Time (d)	Total FYs (5) Cost (e)
(a) Staff Economist	9.5	43,700	7.5	36,000						
(b) Departmental Consultant										
(c) Staff Research Assistant										
Total IV.2	9.5	43,700	7.5	36,000						

1/ Staffweeks should be costed as follows ($1000 per staffweek): Staff Economist and Departmental Consultant: FY88-4.2; FY89-4.4; FY90-4.6; FY91-4.8. Staff Research Assistant: FY88-1.8; FY89-1.9; FY90-2.0; FY91-2.1.

IV.3: ESTIMATED COMBINED COSTS (FINANCIAL [IV - 1] + STAFF COSTS [IV - 2e]) BY FISCAL YEAR

FY (1)	FY (2)	FY (3)	FY (4)	Total FYs (5)
78,850	40,600			

PART V: STAFF TIME IN WEEKS COMMITTED TO ONGOING RPOS

	RPO No.	FY (1)	FY (2)	FY (3)	FY (4)	Total FYs (5)
(a) Principal Supervisor	None					
(b) Other	None					

OFFICE MEMORANDUM

DATE: June 15, 1989

TO: Dennis de Tray, RAD

FROM: Alberto Antonini, Economist, EM2CO

EXTENSION: 32283

SUBJECT: Tunis and Rabat Water Demand Study

1.   I have reviewed Mr. Alexander McPhail's research proposal on the Tunis and Rabat Water Demand Study which INUWS is proposing to submit to your office for research grant funding. This research topic is both very interesting from a study view as well as of great relevance to the operational and analytical work of the EMENA region.

2.   The financial viability of public utilities is a major goal of our work in both Tunisia and Morocco and, therefore, studies to help ensure their success should be undertaken whenever an adequately developed analytical framework is developed -- as is the case with this INUWS study. In the past, such a framework has not always been available, and perhaps the shortcomings of so many previous water projects are in part due to this problem. The proposed study should contribute valuable new information on identifying determinants of water demand and provide new tools to quantify their importance in specific instances. Therefore, the outputs of the research will be of great interest and significant value to the Bank.

3.   In summary, I am satisfied that this research is soundly designed and that the outputs will be of great interest and value to EMENA and the Bank in general. Therefore, I fully support the proposed research.

cc & cl/w: Grais
cc: Mr. McPhail (INURD)

THE WORLD BANK/INTERNATIONAL FINANCE CORPORATION
OFFICE MEMORANDUM

DATE: June 14, 1989

TO: Dennis de Tray, RAD

FROM: Peter Ludwig, EM2IN

EXTENSION: 32817

SUBJECT: Tunis and Rabat Water Demand Study

1.   This memo is to express my support for the Tunis and Rabat Water Demand study which INUWS is submitting to your office for research grant funding. Several of my staff have been working with Mr. Alex McPhail on this project over the last year and, therefore, we have had a chance to review drafts of the proposal and make suggestions to improve its usefulness for or ongoing operations in Tunisia and Morocco. In addition to working with my division, Mr. McPhail has also been in contact with the Président Directeur Général of both national water utilities in the two countries and, as they have both expressed a keen interest in this work and pledged their full cooperation, I am confident that the project will proceed without problems.

2.   The Bank has a long and amicable relationship with SONEDE and ONEP, and this project compliments our ongoing projects with them. As such, the results from Mr. McPhail's study will find immediate application in our operational work. The estimation of demand elasticities is a timely exercise for these two utilities and the outputs should be of a great benefit for not only Tunisia and Morocco, but other water systems as well. And, as part of the project's Bank Advisory Panel, members of my staff and I will have the opportunity to evaluate intermediate findings and conclusions from the project to insure the study mainframe its relevance to our needs during execution.

3.   If you have any questions concerning the proposal and its applicability to our operations, please feel free to contact Messrs. A. Velderman or S. Contreras in my division.

RPO # 57540

RPO #

DATE: July 12, 1989

TO: Dennis de Tray, RAD

THROUGH: Louis Pouliquen, INUDR

FROM: Curt Carnemark, INUWS

EXTENSION: 33105

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(b) Others Responsible:

(c) Administrative/Budget Staff: Bruce Gross, INUWS

4. SOURCES OF FUNDING:

RSB: $ 19,925   Country: $

Sponsoring Dept. $ Other: $ 19,825   USAID

Other Dept. $ TOTAL: $ 39,750

5. ESTIMATED STAFF COST 1/ AND TIME REQUIRED IN WEEKS BY EACH DEPARTMENT:

Department	Staff Economist		Departmental Consultant		Staff Research Assistant		Total Staff	
	(a) Time	(b) Cost	(a) Time	(b) Cost	(a) Time	(b) Cost	(a) Time	(b) Cost
INURD	2	9,400						
INUWS	5	23,500						
EM2IN	7	32,700						
EM3IN	2	9,400						
EM2CO	1	4,700						

6. ESTIMATED TOTAL COSTS ((4) + (5b)): 79,700

1/ See Footnote on page 3, Part IV.2.

PART II : COORDINATION AND CONSULTATION

REGIONAL COORDINATION AND CONSULTATION

A. Did Regional Consultation take place?   [X] Yes   [ ] No

B. Comments by the Region(s): See attached memos from EM2IN and EM2CO

C. Did any workshop take place?   /‾/Yes   /x/No

D. Date(s) of workshop(s):

DEPARTMENTAL APPROVAL

DIVISION CHIEF (Type Name): Curt Carnemark	SIGNATURE:	DATE
DEPARTMENT DIRECTOR (Type Name): Louis Pouliquen	SIGNATURE:	DATE. 7/20/89

Record Removal Notice

File Title	Barcode No.
Demand for Water in Tunis, Tunisia and Rabat, Morocco (RPO # 675-40) - 1v	1447703

Document Date	Document Type	
12 July, 1989	Attachment	

Correspondents / Participants

Subject / Title
Request for Research Support Budget Funding - Financial and Staff Resources

Exception(s)
Personal Information

Additional Comments

The item(s) identified above has/have been removed in accordance with The World Bank Policy on Access to Information. This Policy can be found on the World Bank Access to Information website.

Withdrawn by	Date
Ann May	24-Feb-17

IV.2: ESTIMATED DEPARTMENTALLY FUNDED STAFF TIME IN WEEKS AND COSTS 1/, BY FISCAL YEAR

	FY (1)		FY (2)		FY (3)		FY (4)		Total FYs (5)	
	Time (d)	Cost (e)	Time (d)	Cost (e)	Time (d)	Cost (e)	Time (d)	Cost (e)	Time (d)	Cost (e)
(a) Staff Economist	9.5	43,700	7.5	36,000						
(b) Departmental Consultant										
(c) Staff Research Assistant										
Total IV.2	9.5	43,700	7.5	36,000						

1/ Staffweeks should be costed as follows ($1000 per staffweek): Staff Economist and Departmental Consultant: FY88-4.2; FY89-4.4; FY90-4.6; FY91-4.8. Staff Research Assistant: FY88-1.8; FY89-1.9; FY90-2.0; FY91-2.1.

IV.3: ESTIMATED COMBINED COSTS (FINANCIAL [IV-1] + STAFF COSTS [IV-2e])
BY FISCAL YEAR

FY (1)	FY (2)	FY (3)	FY (4)	Total FYs (5)
78,850	40,600			

PART V: STAFF TIME IN WEEKS COMMITTED TO ONGOING RPOS

	RPO No.	FY (1)	FY (2)	FY (3)	FY (4)	Total FYs (5)
(a) Principal Supervisor	None					
(b) Other	None					

Proposal to the Research Committee
of the World Bank

TUNIS AND RABAT WATER DEMAND STUDY

Submitted By:

Infrastructure & Urban Development Department
Water and Sanitation Division

July 1989

TABLE OF CONTENTS

1. RESEARCH SUMMARY

Introduction and Importance of the Research

1.1.   This proposal describes a research project to study the water demand characteristics of the residents of Tunis, Tunisia and Rabat, Morocco. The proposed project will field test and assess the accuracy of a model for estimating residential demand for potable water in two large and fast-growing cities of the Maghreb. The model to be tested expands on current statistical methods by incorporating new techniques for estimating single equation demand functions when consumers are faced with block rate tariffs [paragraphs 4.9 to 4.11]. This application would be one of the first in the literature for a developing country setting.

1.2.   The research also plans to test the applicability of the family of Stone Geary demand functions for estimating subsistence levels of water necessary in arid utility service territories. Only one application of a Stone Geary functional form for estimating a subsistence level of water for a developing country appears in the literature. However, this study was for Kuwait which has a GNP much higher than most developing countries and, therefore, the results from this study were inconclusive on the application of the Stone Geary model [Al-Quanaibet & Johnston 1985]. The research proposed here uses the much lower income countries of Tunisia and Morocco as the study sites and, therefore, will be a better test of this functional form for estimating subsistence water amounts in developing countries [paragraphs 4.3-4.7]

1.3.   The research will also make a major contribution to the meager literature which exists on economic demand estimation for water in developing countries [section 2 and annex 4]. The research proposed here takes advantage of a unique opportunity to study two utilities with universal reputations for possessing large and accurate consumer consumption data which is available for at least the last five years. Thus, the publications which result from this project will make a major and significant contribution to the literature in this field.

1.4.   The research also will spend a significant amount of time examining the question of what determines the connection decision in these two large and fast growing cities where supply constraints appear to be relatively unimportant [paragraphs 3.11 to 3.14, 3.23 and 6.3]. Despite the importance of this topic, it appears that the literature on this subject is extremely small as no studies have been uncovered. Therefore, the proposed study would be the first in the general literature on what decisions and impediments the urban consumer faces when deciding whether or not to connect to an existing water distribution system.

1.5.   From an operations viewpoint, this research is important for several reasons. First, despite having lent over $7.1 billion for the water supply and sewerage sector during the last thirty years [World Bank 1988d, p. 150], the Bank has found that the financial success rate of these projects remains often disappointing. For example, a recent study prepared by the World Bank's Infrastructure and Urban Development Department found that, for 54 IBRD-financed water projects started during the period 1966 to 1981, overall

revenues had not reached the 80 percent level of their predicted level even after six years of operation [*Garn* 1987]. This implies that, despite the substantial money and time investment in this sector, little is really known about the determinants of water use in developing countries.

1.6.   Acknowledging that the project may make a significant contribution to the understanding of demand and the improvement of the Bank's investment in the water and wastewater sector, the proposed research has the strong support of three EMENA Divisions and two divisions INU. There is a total of ten staff weeks in the proposed research budget from EM2IN, EM2CO and EM3IN, and a total of seven staff weeks from INUWS and INURD [section 8].

1.7.   The project also has received enthusiastic support from the President Directeur Generals of the national potable water utilities in both Tunisia and Morocco. These organizations have pledged full support for the project and therefore access to consumer records and the conducting of the research will be greatly facilitated [paragraph 2.35 and Annex 1].

1.8.   The United States Agency for International Development also considers this project to be of great importance and relevance for its ongoing investment in urban water and wastewater projects. As such, A.I.D. has agreed, through the Regional Housing and Urban Development Office in Tunis, Tunisia, to co-sponsor and co-finance the project [section 8].

1.9.   The total budget for the project is $39,750. Of this USAID will be responsible for $19,825 and RAD for $19,925. In addition, ENEMA and INU will contribute $57,500 and $37,200 respectively in staff time and travel costs [section 8].

The Research Question

1.10.   For developing countries, very little is known about the characteristics of the water demand curve and where significant changes in its slope occur. To overcome this lack of knowledge, agencies which make significant investment in the water sectors of developing countries (such as the Bank and USAID) have held that as long as the portion of household income spent on potable water remains below five percent, then the price is in the inelastic portion of the curve and other non-economic determinants are not relevant [*Briscoe and deFerranti* 1988, p. 13]. However, this assumption has in many cases been proved incorrect for both lower and middle income customers who have shown unexpectedly strong decreases in consumption when faced with tariff hikes [*C.I.D.* 1988, pp. 5, 15-18].

1.11.   In addition, the gradual elimination of government subsidies to utilities in less developed countries has meant national water companies must now implement frequent and large price increases in order to remain (or become) solvent. However, because very little is known about customer reactions to water tariff revisions in these settings, the changes often cause unexpected revenue shortfalls for the effected utility as consumers reduce their consumption in response to increased prices [*C.I.D.* 1988].

1.12.   This scenario is exacerbated in some countries where free, or almost

free, water which had traditionally been considered a "right" [*Hammoudi* 1985] is now thought of as any other commodity and the financial self-sufficiency of the water utility has become an important national priority. However, the ability and willingness of customers to pay for water tariff increases remains largely unknown [*Briscoe and deFerranti* 1988].

1.13.   An additional concern is the estimation of the demand for connections to the water system as differentiated from the demand for the amount of water consumed once connected. For example, in most countries the magnitude and/or ability to finance the connection charge plays an important role in forecasting eventual demand, yet this aspect of water system design is rarely separately considered. As a result, an accurate estimate of the volume demanded may be rendered meaningless if the anticipated number of consumers are prevented from connecting to the system by a high connection charge.

1.14.   Thus, a knowledge of the characteristics, economic and otherwise, which determine demand is crucial to the long-term success and expansion of water utilities. Despite widespread acknowledgment of this fact [*Meroz* 1968; *Hubbell* 1977; *Churchill et al.* 1987; *Palencia* 1988], the estimation of the customer water demand parameters remains largely unexplored in developing countries. The proposed research attempts address this problem by field testing and documenting a method which accurately gauges not only economic, but also demographic, sociological and geographic demand determinants in the urban water systems of developing countries.

The Research Strategy

1.15.   The proposed effort will use a large empirical data base for analysis and for this reason alone represents an important improvement over most studies performed in developing countries. This data will be obtained from over 400 household surveys administered in each of the two study cities [section 3]. The purpose of the surveys is to gather primary and accurate information on the socio-economic variables considered important in predicting water demand. This data will then be matched with customer billing records that will be supplied by the local water utility. Next, the proposed research will use new econometric forecasting techniques to estimate single equation water demand models and the associated income and price elasticities [section 4].

1.16.   The research also plans to examine a large sample of households not connected to the improved water system to try and determine the cost and sources of water to this part of the cities' population as well as the impediments to connection. This part of the research will again consist of household surveys as well as in-depth discussions with selected persons on their water use habits (which will be contrasted to those households connected to the system), their perceptions of the water utility and how the informal market is organized to meet their water needs [sections 3 and 6]. This part of the research will be the first known study of the household connection decision for large cities where there is no supply constraint.

Outputs Useful For Bank Operations

1.17.   Outputs from the proposed research fall into three areas, all of which will have an immediate impact on Bank lending and operations. Initially, the results of the demand study will be used by the national water utilities in Tunisia (SONEDE) and Morocco (ONEP), both of which have already expressed a keen interest in the project.

1.18.   The results of this research should also find an immediate application in water utilities with similar weather and demographic characteristics to those of Tunis and Rabat. For example, it is anticipated that the Algerian water utilities will have a great interest in this project for application in Algiers, Constantine and Oran. In addition, because the project takes place in two utilities where the importance of specific independent variables can be verified, the proposed research methodology should be transferable to other developing country water systems.

1.19.   Lastly, the proposed research also forms an integral and complementary part of concurrent work now being designed by the Infrastructure and Urban Development Department (INU). The INU study is being undertaken to improve the effectiveness of investment in the water supply sector by examining the relationship between demand, on the one hand and technical choices (scale, timing, technology choice, operation and maintenance and supply costs) and financial choices (tariffs, subsidies, and cost-recovery targets) on the other. The proposed project will be an initial first field test of the design strategy for the sector investigations.

Publishable Outputs from the Research

1.20.   The proposed research will contribute to two distinct academic fields and their associated literature. First, the econometrics of demand for public utility services is undergoing continual improvement and the project will contribute to this literature needed case studies, and virtually the only recent examples from a developing country perspective.

1.21.   To the water supply engineering field, the project will make contributions to the ongoing debate of proper system sizing, expansion timing and level of service, as well as provide needed case studies to illustrate changes in water consumption after tariff increases. These case studies will also be used in the context of water demand management through the pricing mechanism.

1.22.   Likely publications for the research include *Water Resources Research*, *Water Resources Bulletin*, *Land Economics*, *World Bank Research Observer*; *Economic Development and Cultural Change*, the INU Report series and other economic journals.

2. BACKGROUND, OBJECTIVES AND STRATEGY FOR SITE SELECTION

Background and Origin of Interest At the Bank

2.1. There are various methods used to determine the amount of water which will be demanded by the consumers enclosed in, or in proximity to, a given service territory. The simplest of these methods is to extrapolate the past growth in per capita consumption and the expected rate of increase in customer population. This method, commonly referred to as the "requirements" approach, is presently widely used inside the Bank and other institutions to estimate eventual water demand. However, the requirements approach cannot give a true picture of water demand because:

    1) there is no mechanism for the price of water to affect demand;

    2) there is no mechanism for changes in customer income to affect demand; and

    3) demand can only be crudely adjusted for seasonality or weather.

2.2. Reviews by the Bank [*Churchill et al.* 1987; or *Garn* 1987] bilateral donors [*WASH* 1986] and water supply agencies in developing countries [*Katzman* 1977; or *Velez* 1983] have shown that the simple assumptions of the requirements approach have usually proved incorrect for two reasons. First, in urban systems, the number of actual connections is frequently far below the one forecast at appraisal. The lack of customer connections can be caused by inaccurate customer demand forecasts or supply constraints as a result of construction delays and other factors which limit capacity. Second, for the three reasons stated above, the requirements approach usually results in grossly overestimated commodity sales for those customers who do eventually connect to the system.

2.3. This smaller than forecast customer base and commodity sales volume as a result of the requirements approach often leads to an almost immediate fiscal crisis for the affected utility and, for lack of any alternative, to the need for sharp tariff increases. And, in order for a rate increase strategy to be successful, it is necessary to have an almost price inelastic demand curve, but this is in fact seldom the case.

2.4. Therefore, the use of incorrect demand information can, in some cases, affect water supply project design as well as make the supply that becomes available much more expensive than was forecast at appraisal. Thus, the effectiveness of the sector's assets (choice of technology and level of service, the timing and scale of capacity expansion, and failure to reach overall rate of return targets) and the availability of the sector's assets (high prices restrict the access of those who could benefit most) are both compromised by the inability to accurately determine demand. This problem has come increasingly to the forefront of planning in this sector, as is illustrated by the following:

The Bank has made substantial progress in focusing attention of
borrowers on the need to seek "least cost" approaches to providing a
"required" level of output. The problem is, in large part,
determining the "required" level which depends on effective demand.
Shortfalls in sales volumes, apparent in many Bank-supported projects,
suggest that insufficient attention has been given in investment
planning to levels of service appropriate to the ability and
willingness to pay of various target customer groups...A recent WUD
paper indicates that substantial investment cost savings might be
realized (possibly as much as 20%) by improved estimation of
"required" production [*INUWS* 1988, p. 10].

2.5. Thus, what is needed for better success in this sector is much better
information on the consumer demand curve and the associated price and income
elasticities of demand for this sector.

Water Demand Estimates in Industrial Countries

2.6. There is a relatively large body of literature on water demand in
industrial countries which has largely been conducted in the United States and
concentrates almost exclusively on residential customers. The most
sophisticated of these studies are single equation models designed to estimate
income and price elasticities of demand. The studies have addressed issues
such as the correct variables for specifying demand [*Howe and Linaweaver* 1967;
or *Foster and Beattie* 1979], methods to address flat decreasing and increasing
block rate schedules [*Agthe and Billings* 1980], statistical and econometric
techniques [*Howe* 1982 or *Agthe and Billings* 1980], production and consumption
viewpoints for demand analysis [*Howe and Linaweaver* 1967] and the
incorporation of subsistence consumption into the demand model [*Al-Qunaibet
and Johnston* 1985].

2.7. An overview of the findings of previous studies is contained in *Al-
Qunaibet and Johnston* 1985. The major advantage of this number of studies is
that many of the variables and techniques developed and confirmed there can be
either adopted directly or modified for use in the proposed research project.
For example, household size, income and weather probably all affect water
demand in both developing and industrial countries. In addition, the
subsistence level of water assumption can be modified to specific country
conditions and expectations.

Water-Demand Estimates in Developing Countries

2.8. In contrast to the industrial country studies, water demand analyses
performed in developing countries suffer from four major problems. First,
despite the large investment made each year in this sector, there appear to be
only five urban economic water demand studies from developing countries in the
literature [*Meroz* 1968; *Hubbell* 1977; *Katzman* 1977; *Al-Qunaibet & Johnston*
1985; *Palencia* 1988]. This small number of studies on such an important topic
may be an indication that the concept of paying the full cost for water supply
is a relatively recent one in many developing countries. In addition, there
appears to be little priority given the estimation of water demand by

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economists and engineers in developing countries which may, in turn, increase the difficultly of identifying the relevant variables to be used as indicators of water use in these settings. It is also possible that sufficient funds have not been available to conduct detailed studies in less developing countries. For example, it is only very recently that the World Bank and USAID have begun to formally examine the importance of elasticities in predicting water demand [*Garn* 1987; *WASH* 1986].

2.9. Second, the quality of the data used in three of these studies is very poor and the quantity of observations examined so small that the reliability of their results must be seriously questioned [*Meroz* 1968; *Hubbell* 1977; *Palencia* 1988].

2.10. Third, there appears to have been little attempt to modify the demand equations developed for industrial countries to reflect a developing country context. A possible exception is *Katzman* 1977, who included a variable in his demand equation for the number of persons in the household, yet other variables which may be relevant for lower income areas have, so far, been largely ignored. For example, there may be alternative sources of water available to the household (especially in Tunis where, according to the national water utility SONEDE, many households are thought to have drilled shallow wells) which should be considered in predicting water demand. Also ignored in almost all models are education levels of the household residents which may help to determine water demand based on the assumption that better educated persons are more cognizant of the health benefits from increased water use [*WASH* 1987, p. 85.]. In addition, type of residential structure has never been considered, yet this variable would also seem to make a significant contribution in determining water use.

2.11. Despite these shortcomings and because the studies performed in developing countries are still relevant for the research proposed, each of them is discussed in Annex 4.

Summary of the Literature for Developing Countries

2.12. Perhaps the most striking feature of the studies performed in developing countries is the wide range of demand elasticities estimated between the studies. These results are summarized below for ease of comparison along with the *Howe and Linaweaver* estimates (as an indication of what elasticities would be in an industrial country context).

Table 2.1 Price and Income Comparisons for
Industrial and Developing Countries

Author	Year	Price Elasticity	Income Elasticity
Howe & Linaweaver, Howe	1967, 1982	-0.06	0.32
Meroz	1968	-0.40	0.40
Hubbell	1977	-0.48	0.36
Katzman	1977	-0.10 to -0.22	0.00 to 0.39
Al-Qunaibet & Johnston	1985	-0.77	0.21
Palencia	1988	Not Estimated	Not Estimated

2.13.   From Table 2.1 it is seen that with *Katzman's* larger sample size and more accurate data the estimated demand elasticities are significantly lower than the three other studies and compare well with the winter elasticity estimates of *Howe and Linaweaver*. This is a reasonable assumption if the consumer in developing countries is constrained by the amount of water available or if the price for water is relatively high in terms of the overall household budget. In other words, given a sample size big enough to meet conventional significance and power tests [see *Cohen* 1977] and the assurance of accurate water consumption and household characteristic data for this sample, then one would expect that the price and income elasticities for essential quantities would be very inelastic.

2.14.   Table 2.1 also suggests that an accurate determination of household income is critical to the estimation of demand elasticities and that without this control the results may no longer be consistent with the character of the study area. For example, the elasticity estimates of *Meroz* and *Hubbell* appear to fit fairly well with those of *Howe and Linaweaver*, which is a surprising result because of the completely different economic and demographic characteristics of the three study areas. In contrast, *Katzman's* Malaysia findings are significantly different than those of *Meroz* and *Hubbell* and include a range for income groups. The major differences in research method between the three developing country studies is the sample size used and the surveying of every household in the sample to determine income. Therefore, for studies performed in less developed countries, and given the results shown in Table 2.1, it may not be appropriate to use household income estimates from anywhere but a survey of the households of the sample set.

2.15.   Thus, the literature reveals that the number of water demand studies for developing countries is scant and of generally poor quality. More specifically, there are only five such studies in the general literature and they suffer from multiple combinations of precision, size, technique or research design problems. In addition, it appears that several significant variables in determining water consumption have been ignored in their analyses. For example, even though *Katzman* had a separate sample group for those households which have combined domestic and business use, there was no attempt to make this an explanatory variable for estimating income elasticities. Another example is the availability of alternative sources of

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water. It appears that all the studies assume that the distribution system is the only source of water, yet many households in developing countries gather water from a variety of sources [Briscoe and deFerranti, 1988; Churchill, 1987]. An additional missing variable is the education level of the household which may also effect water consumption.

2.16. Another variable which should be included is household building structure. This variable is important to consider because it is thought that apartment dwellers have significantly different water consumption patterns than those households which live in detached single family structures. In addition, the distance from the central business district may also have a significant effect on water consumption because of the condition of the distribution system in developing countries is thought to deteriorate the further it is from the core business area.

2.17. To summarize the existing literature on this topic, there is a need to improve both the number and quality of water demand studies performed in developing countries. Although it appears that the subject has been of interest to economists and planners for over twenty years, the sophistication of the models employed and the quality of data gathered for the foundation of analysis is very poor considering the enormous investment which is made in this sector each year. Further, none of the studies in the literature have examined methods to predict rates of connection despite the obvious importance of this issue.

Current Bank Literature

2.18. Recent IBRD studies on water demand have focussed on interpreting the weak economic and financial results of Bank-supported water projects [Gorman 1980; Garn 1987; Churchill et al. 1987; Briscoe and deFerranti 1988; and INUWS 1988]. As a result of these later analyses, the focus of the water sector is now shifting to improving the foundations of demand determination used for project planning. The following remarks are typical of statements addressed to increasing the Bank's research in this area:

> ...achieving an improved understanding of factors which explain the level and rate of change in effective demand for sector service and can assist in forecasting is an important aspect of all the suggested themes. Expected demand conditions capacity utilization, signals the need for capacity expansion, and determines revenue levels for given changing structures [INUWS 1988, p. 14].

> High priority needs to be given to research on demand estimation and improving methods of benefit-cost analysis of water supply and sanitation projects [Churchill et al. 1987, p. xvi.].

2.19. The proposed research would be the first Bank field study on water demand determinants since Hubbell's 1977 effort. It appears that such a study is now timely because of the advances in econometrics and the increased emphasis at the Bank to improve the effectiveness of investment in the water and wastewater sector.

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Relationship to Other Current Bank Research

2.20.   At the present time, there is no known field research by the Bank into the demand for urban water in developing countries. There is a large ongoing study (RPO 674-35) of the willingness to pay for rural water services (including those areas on the urban fringe), but its research objectives are quite different in scope and purpose than the proposed project.

2.21.   For example, RPO 674-35 is based on an approach which emphasizes hypothetical future actions of the consumer while the proposed research is based on empirical consumer behavior patterns over a previous five year period. Also, RPO 674-35 concentrates on the prediction of demand and willingness to pay for water services in rural areas and often in places with no improved water supply. In contrast, the project described here is urban in its focus and concentrates on the study of consumer behavior in the presence of an improved and well maintained water distribution network. Finally, RPO 674-35 uses the contingent valuation method which is being simultaneously developed in both developing and industrial countries. The effort described in this proposal is the modification of a proven method for estimating water demand in industrial countries for a developing country context.

2.22.   Despite these differences, RPO 674-35 and the proposed study have some similarities. For example, both are attempting to improve the Bank record of investment in the water and wastewater sector by developing methods to better address the demand question. In addition, consumer behavior for public utility services in developing countries is very complex and not well understood and it is very possible that the results from one study may help advance the other. For example, even though education has not been shown to be a significant variable in determining water consumption patterns in industrial countries, and therefore perhaps would not have been considered as an independent variable in the proposed research, preliminary results from RPO 674-35 have shown that education is a strong predictor of water demand. With these findings, education is now an integral part of the proposed research design.

2.23.   The principal field investigator for the proposed research [paragraph 7.6 and Annex 2] has also had some Bank experience with the contingent valuation method, is familiar with the relevant literature, and co-supervised the design and survey effort for a RPO 674-35 willingness to pay study in Nigeria during the month of May, 1989. Therefore, there is likely to be some cross pollination between the two projects and the knowledge gained from one effort should be of benefit for the other.

2.24.   The proposed research project also compliments upcoming work in PPR INUWS is in the process of designing, organizing, and staffing a large scale study of urban water demand and its effects on sector investments. This study is planned for the next two to three fiscal years and may perform field studies in five or more selected sites. The cities of Tunis and Rabat are two of those selected for the upcoming INU study and the research proposed here will provide the first two case examples to be incorporated into the overall project.

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2.25.   Because the proposed research project is under the auspices of INUWS (with the collaboration of EM2IN, EM2CO, EM3IN and INURD), the proposed Tunis and Rabat studies will incorporate many of the design features of the eventual INU research projects and provide an initial assessment of their applicability and the ease with which they can be replicated.

Study Objectives

2.26.   Against this backdrop of previous and upcoming research on the topic, and acknowledging the need to better explore demand characteristics for developing country water sector projects, the proposed research seeks to fulfill the following goals:

1) To develop a model for residential urban water demand in fast growing cities of the developing world by the application of state-of-the-art econometric techniques to a much larger and better quality data set than has been previously attempted. This project would therefore make a major contribution to the scant literature on demand modelling for public service commodities in developing countries [paragraphs 2.8 to 2.19 and Annex 4].

2) To try and determine the applicability of single equation Stone Geary family of demand models which attempt to determine a subsistence amount of water [paragraphs 4.3 to 4.8].

3) To try and ascertain the connection decisions and impediments which face consumers when the water distribution system is accessible [paragraphs 3.11 to 3.14].

3) To provide an urban water and sewerage sector demand model which can be used in the Bank's project preparation procedures [paragraphs 6.5 to 6.7].

4) To make a major empirical contribution to the literature for use in improving the effectiveness of investment in the water and wastewater sector by providing better technical and financial choices to planners, engineers and economists [paragraphs 6.1 to 6.4].

Strategy For Site Selection

2.27.   The research design requires several specific parameters such as: data availability and quality; the size of the industrial customer class; a relatively stable climate without much seasonal variation; and regular tariff increases. Therefore, all of these factors had to be taken into consideration and cities chosen which met these *a priori* requirements. Tunis, Tunisia and Rabat, Morocco were eventually chosen for the research site as each met the requirements of the research design. These design constraints are now discussed vis-a-vis the two cities.

2.28.   Previous studies, with one exception [*Katzman* 1977], have suffered from scant data sets upon which the research was based [paragraph 2.9]. Therefore, one of the aims of the proposed research is to find water utilities

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in developing countries with a large and well maintained customer consumption data base which could be roughly comparable in quality to that of an industrial country data base. Both Tunis and Rabat which have continuous and computerized customer billing records for at least the last ten years. In addition, there is every indication that these records are unusually accurate for a developing country utility.

2.29.   Another reason that utilities with an extensive data base of consumer consumption records was desired is that with the ability to use empirical data over a five-year period, it is possible to approximate permanent income price and income elasticities of demand for water for these customers. Thus, the elasticities estimated using five years of observations will be more stable than those produced with a shorter time frame for analysis.

2.30.   The water utilities in these two cities have a large enough residential customer base to facilitate the construction of the desired sample size, but are also small enough to avoid much of the data "noise" associated with cities containing a large number of industrial customers. With a very large proportion of water sales going to industrial customers, e.g. as in Casablanca, then the utility management bias is toward that customer class at the expense of other customer classes. Therefore, as just one example, in a city where there is such a large industrial class, there may be a reduced incentive for meter accuracy in the residential class. In addition, the decision of domestic customers to connect to the system may also be influenced by the perceived utility emphasis on serving industrial customers which would distort the planned research into other aspects of the residential connection question. Finally, with the very large volumes of water which normally go to industrial customers, it makes differentiation of the utility's daily production volumes between customer classes very difficult.

2.31.   Both cities are in arid climates which significantly reduces the problems associated with seasonality of water demand. As is well demonstrated in the literature (e.g. see *Howe and Linaweaver* 1967), water demand varies substantially in those areas where there is a large variation in temperature and rainfall. As they are already well established, the focus of this research is not to document these seasonality reasons for water demand variation. Rather, the research hopes to isolate the effect of other independent variables which have not been so well studied. Therefore, it was important to find sites for the project which have relatively little temperature and rainfall changes.

2.32.   In this regard, both Tunis and Rabat are relatively mild and have a modest amount of rain each year. Average monthly temperatures in Tunis range from a low of 43°F in January to a high of 91°F in August. Average rainfall is about 17 inches a year. For Rabat, the average monthly low temperature is 45°F in January and the average high monthly temperature is 81°F in August and average rainfall is approximately 20 inches per year [*Pan Am* 1984].

2.33.   For comparison, Los Angeles, CA has an average low temperature of 47°F in December and an average high temperature of 77°F in August. The average yearly rainfall is approximately 12 inches. Washington, DC has an average low temperature of 27.5°F in January and an average high temperature

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of 88°F in July. It also receives an average 39 inches of rain a year
[*Ruffner & Frank* 1984]. For a discussion of the seasonal variation in water
demand between Los Angeles, California and Fairfax County, Virginia, see
Whitcomb 1988.

2.34.   Both cities have experienced enough tariff increases over the
proposed study period to allow the estimation of relatively long-term price
and income elasticities. For example, Tunis had tariff changes in 1984, 1985,
1987 and 1988. Rabat has raised domestic tariffs in 1984, 1985 and 1986.

2.35.   Once it was established that Tunis and Rabat would satisfy the
research design criteria, the utilities were then contacted to ascertain if
they would be interested in the study and if cooperation from them would be
forthcoming if the research went ahead. This contact was made easier because
the Bank has a long and good working relationship with both the utilities and
has made substantial investments in the water sector in each country. As a
result, both SONEDE and ONEP have expressed a keen interest in the project and
are therefore likely to lend every assistance to insure its successful
completion. See Annex 1 which contains copies of letters of support for this
project from the President Director Generals of both utilities.

3. RESEARCH DESIGN

Current Bank Practice on Water Demand Forecasting

3.1.   Current practice at the World Bank concerning water demand forecasting is largely centered around the requirements approach modified for known changes in consumption patterns or planned increases in per capita consumption. A review of 28 World Bank Staff Appraisal Reports, dating from 1980 to 1988, showed that only two had attempted to predict demand incorporating income or price elasticity estimates. In addition, in each of these reports which suggested increasing tariff levels, there was seldom any indication that the price elasticity of demand was anything other than zero. INURD is currently studying whether or not demand elasticities are incorporated into tariff studies financed with Bank loans and, in the over thirty such tariff studies examined, only two estimated income or price elasticities for the purpose of setting tariff levels.

3.2.   Certainly part of the reason for omitting these variables is that there is no standard procedure available to the Bank's engineers, economists and financial analysts to incorporate this information into planning and design activities. And even if such an algorithm was available, there are currently very few case studies available with which to compare and validate the results. The proposed research addresses both of these problems by providing an important first component in an overall INU project to formulate such procedures and improve Bank lending for the water and sewerage sector.

Research Components

3.3.   The principal components of the research are: 1) the identification of the household sample connected to the water distribution system from the utilities' billing records and those households not connected to the water system by on-site invesitgation; 2) conduction of the household surveys for customers both connected and unconnected to the system; 3) the data analysis using the pooled data from the utility-supplied consumption records and the surveys; 4) econometric analysis and demand equations estimation; and 5) the writing of the reports for publication and presentation.

3.4.   Those tasks related to the surveys are described in this section and those dealing with the model specification and econometric work are described in sections 4 and 5. An estimated timetable and budget for the research are presented in sections 7 and 8, respectively, as well as annex 3.

Sample Selection -- Connected Customers

3.5.   The research will build a large and reliable customer consumption data base for analysis in each of the two cities to be examined. As was discussed in section 2 [paragraphs 2.27 to 2.35], this motivation was important in selecting Tunis and Rabat as sites for the research because the water utility in both organizations have large and well maintained customer records. It appears from conversations with financial analysts in EM2IN who

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are familiar with both utilities that computerized billing records will exist for all residential customers for the proposed five-year study period which is January 1, 1984 through December 31, 1988. Therefore, the sample frame is the utility's customer billing record data base.

3.6.   It is proposed to select a stratified random sample from the utility billing records using the predetermined distance ranges from the central business district as the strata. In other words, the sample will be randomly selected without replacement from customers in each of say, five, ranges of distance from the central business district. The sample is chosen in this way to try and mitigate a consumption bias and to determine the relevant strength of the independent variables within each geographical range. The exact number of ranges will be decided for each utility on-site in consultation with the utility engineers to take into account geographical and system particulars.

3.7.   The only initial element selection criteria is that the same customer name appear at the household address for each year in the study period. After this guideline is met, the sample will be analyzed for data problems such as outliers and missing values and those elements found not acceptable will be eliminated.

Sample Size -- Connected Customers

3.8.   The selection of sample size is a process of evaluating the trade off between the desire not to mistakenly reject the null hypothesis (Type I error), accept the null hypothesis when it is false (Type II error) and the availability of resources to conduct the research.

3.9.   Following the algorithm for choosing sample size with multiple independent variables suggested by *Cohen* [1983 pp. 116-119] each billing strata will require a sample size of at least 75 elements. Thus, if there are five geographical strata for residential customers, then the total sample size should be approximately 375 for each utility. In Tunis residential meters are read every quarter, therefore for the five-year study period and using five residential blocks [*JORT* 1988, p. 714], the total number of observations will be approximately 7,500 [4 x 5 x (75 x 5)]. However, in order to allow for the later exclusion of some customers from the sample (e.g. the house is unoccupied during the period allowed for surveys) and about 40 elements for each trial survey [paragraph 3.24], a twenty percent margin will be allowed and thus each block will have a random sample of 90 which means approximately 450-500 customers per utility.

3.10.   This number of households to survey will probably between five to seven enumerators working approximately two weeks to complete, assuming that each enumerator completes about ten surveys a day. This number and time frame is manageable for the project administration and budget.

Sample Selection -- Unconnected Customers

3.11.   Unlike the sample set for connected customers, there is no frame for selection of elements which are not connected to the water distribution system. However, it is still possible to find a representative sample of such

households. One approach for element identification is to randomly select households in each geographical strata by walking down the street and inquiring at every third house until one is found which is not connected. Another approach, albeit much more difficult, is to examine the utility's customer billing address record and to try and determine where households are likely to be located which are not connected to the system. If this method of sample selection is chosen, then a short computer program can be tried to help find likely gaps in addresses.

3.12. Because there is no frame for unconnected customers, the sample selected in this manner will not be comparable to the sample selected from the billing record frame. However, this is not a problem as the question of what determines connection frequency is, for purposes of this research, considered a separate topic. Certainly there will be inferences which can be made about the correlation among independent variables of the two groups and this will be examined in pooled analysis of the survey results.

3.13. What presents more of a problem when there is no frame is obtaining a large enough sample of unconnected customers to be statistically representative of this class. To try and avoid some of the more obvious biases, such as income, every attempt will be made to get a balance of unconnected customers in each geographical strata selected for the connected customer sample. However, ultimately the constraints of time and budget will determine the distribution of this sample.

Sample Size -- Unconnected Customers

3.14. The research design calls for obtaining as many sample elements in the unconnected group as time and budget allow. It is hoped to obtain at least 300 such household surveys, and ample time exists in the research time table to accomplish this task--even if it takes six weeks. However, this cohort is an important one for study and therefore, the more sample elements identified the better will be the answers to the decision concerning and impediments to connection. Therefore, a substantial investment in time and effort will be made in finding and identifying those households which are inside the water utility's area of service but have not connected to the distribution system.

Selection and Training of Enumerators

3.15. Because over 750 households must be interviewed in each utility, it is necessary to use a survey interview team. With five interviewers plus the principal investigator, it should be possible to conduct the connected customer surveys in approximately two weeks. This is also not an unreasonable time for the utility data processing staff to be available to help select more sample elements if this need arises (e.g. a household selected for the sample is unoccupied during the period allotted for conducting the survey). It will probably take longer to survey the target number of unconnected customers because of the problems of physically locating them. However, the survey team size should not be expanded beyond five because of the increased problems of supervision. For the unconnected customers, it is desirable to instead expand the time for completion of these surveys.

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3.16.   With only five enumerators it is reasonable to expect that each can
be adequately trained and supervised and, if the areas of the city to be
covered are carefully planned, neighborhoods can be covered in one day which
reduces the chances of households talking about responses before the
questionnaire is administered. The covering of an entire neighborhood in one
day reduces the chance for respondents to discuss the survey questions before
they are asked. (This issue of strategic bias has been shown to be important
in some results from RPO 674-35 as the variance of willingness to pay bids
from respondents who had time to collaborate was significantly smaller than
that of groups which did not collaborate.)

3.17.   The identification of enumerators to help in the study will be
facilitated through Centre d'Etudes Maghrebines in Tunis and another similar,
but yet to be identified, institution in Morocco. ***** Insert name of
institute in Morocco *****

3.18.   At least one week will be spent training the enumerators. The
training will involve role playing and detailed discussion of the possible
answers which will be anticipated. In addition, substantial time will be
spent on ascertaining with the enumerators the best way to determine various
variables, be it by direct questions for a specific answer, direct questions
with answers to be indicated within a range, indirect questions, direct
observations, or other indicators.

3.19.   An additional advantage of having a small interview team is that
only an estimated 50 surveys will be completed each day. This means that it
is possible to examine every questionnaire each evening and analyze the
quality of the responses and interviewers and, if necessary, make timely
adjustments before the next day's interviews are started.

Survey Design and Execution

3.20.   Once the sample household has been identified (either through bill
address in the case of connected customers or street number or location in the
case of unconnected customers) then each element will be surveyed for
particular household water consumption, socio-demographic and physical
characteristics. The formulation of the survey questions is now being
undertaken jointly in INUWS and INURD and should be finalized in late summer.
Based on the experience of previous survey work, the survey will likely be
between 50 to 70 questions and take about 30 minutes to administer. At least
one pretest will be performed before the survey is finalized [paragraph 3.24].

3.21.   For connected households, the survey questions will be designed to
identify eligible households for inclusion in the sample by first confirming
that the resident family has occupied the dwelling continuously for the study
period (January 1, 1984 through December 31, 1988). A five-year period is
chosen because consumers have better opportunities to adjust to price
increases over the long-run [Carver and Boland 1980].

3.22.   For each household which meets this condition, then the survey will
pose questions designed to the other relevant variables. Questions are likely

to address such items as information on the household including education attainment of all participants, income or income proxies, housing structure type, geographical situation and tenure.

3.23.   For unconnected households, the survey will explore attitudes toward the water utility, perceptions of service levels which are available and the desirability of having a house connection. It is also likely that a few willingness to pay for connection questions will be asked. For this group, there will be questions on tenancy and length of time in the current residence and several questions on where the household gets its water and what it pays. These questionnaires will also ask demographic, education, income and housing structure type questions.

Pretest of the Survey

3.24.   Once the initial survey format and questions are decided and the interview personnel selected and trained, at least one test of the survey questions will be performed for both the connected and unconnected cohorts. For each test survey, the number of questionnaires administered will be the number completed in one day (hopefully over 40) by the interview team. The trial responses will then be analyzed over one or two days, modifications made to the questionnaire as needed and, if warranted, re-training of the interviewers accomplished. As suggested above in paragraph 3.9, those households interviewed for the trial survey are excluded from the sample set and not re-interviewed.

4. MODEL SPECIFICATION

4.1.   The composition of the water demand variables found significant in previous studies performed in industrial countries include income, household size, average price, marginal price, block differential and weather [*Howe and Linaweaver* 1967; *Katzman* 1977; *Billings and Agthe* 1980; *Howe* 1982; or *Al-Qunaibet and Johnston* 1985]. All of these variables have been used to try and determine linear approximations of the consumer demand curve for water at some relevant price range. However, with the exception of one study [*Al-Qunaibet and Johnston* 1985], these all assume that an infinite tariff increase would lead to a level where no water is consumed at all--which is a situation inconsistent with the human need for water--or to the point where customers simply refuse to pay for the water consumed. Thus, there is a minimum amount of water needed for survival and it would be best if the demand model takes this fact into consideration.

4.2.   Despite this argument, the specific functional form to estimate water use is not currently well-defined, but all are single equation models designed to examine a small relevant portion of the consumer's water demand curve. Most studies assume that there is some functional relationship between the amount of water consumed and other variables (most frequently price, household income and weather) [*Howe and Linaweaver* 1967; *Meroz* 1968; or *Hubbell* 1977] while others have attempted to show that different model specifications produce better statistical results [*Agthe and Billings* 1980; or *Howe* 1982]. However, only one known study in the literature includes a subsistence component [*Al-Qunaibet and Johnston* 1985]. Consumer demand theory states that the ordinary (i.e. Marshallian) demand function is derived from the maximization of a utility function subject to the consumer's budget constraint [*Deaton and Muelbauer* 1980]. Therefore, any theoretically correct demand function for water is basically a two-commodity case, that of water and all other goods. In the case of municipal water, there is an implicit assumption that there are no significant substitutes for water in the other commodity bundle [*Foster and Beattie* 1979].

4.3.   One utility function that allows the possibility of a subsistence level is the family of Stone-Geary functions [*Phlips* 1983]. These functional forms allow the calculation of a subsistence level of water by not allowing the demand for water to vanish as the price approaches infinity. They also have the property that some of them can be estimated using ordinary least squares [*Phlips* pp. 122-128]. For purposes of this research, they require price and quantity of water demanded, the cost of living index (in this case 1984=100), the nominal per capita income, and a predicted relative humidity (found using temperature, minutes of sunshine and wind speed). All of these variables can be found or computed for both utilities proposed for the field research.

4.4.   However, most other studies on water demand are of the single equation linear or double log form and include income, water price, bill difference and weather variables. In addition, *Katzman* 1977 found that the number of persons per household variable was very important in determining

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increasing block rates, difference represents a savings to the consumer compared to what would be paid if all water were priced at the marginal rate, which provides a subsidy for water consumed in the intramarginal blocks.

4.10.   Since the early 1980's most estimates of price and income elasticities have included a bill difference variable. However, the proposed research would be only the second known use of the bill difference variable for a developing country setting. The other known study was *Palencia* 1988 and as is discussed in Annex 4, its research design and results must be questioned.

4.11.   Thus, the proposed research hopes to add significantly to the current knowledge of the correct functional form for predicting water demand in developing countries by: 1) testing the robustness of a single equation version of a Stone-Geary functional form to predict subsistence water amounts; 2) the application of Nordin's bill difference variable to a large and reliable consumption record data base in a single equation Marshallian demand function; and 3) matching this record base with corresponding household survey information.

5. DATA HANDLING

5.1.   The raw information from the household surveys will be compiled in a Lotus 1-2-3 or dBase III Plus data base for ease of handling and all econometric analysis will be performed using SAS.

5.2.   Customer billing records in both utilities are computerized and it will be possible to transfer the selected billing records directly from the utilities' computer to that of the researcher. The customer records from the utility will initially be placed in a SAS readable data base (either Lotus or dBase III Plus) for irregularity analysis. This will be then combined with the relevant household survey file for the statistical analysis and eventual model specification. All of the required information and appropriate programs can be contained on and run using a laptop computer with a 40 megabyte hard disk.

6. FINAL PRODUCTS OF THE RESEARCH

6.1.   Final products of the research will have both theoretical as well as practical applications. From a theoretical standpoint, the research will make a contribution to the determination of the correct functional form for use in predicting residential water demand curves in developing countries. It will do this by testing the robustness of the single equation Stone-Geary functional form for determining subsistence amounts of water as well as making one of the first applications of Nordin's bill difference to a large and reliable data base of empirical records.

6.2.   The research will also help to determine the relevance of conducting household surveys in order to determine income variables. This is accomplished by gathering specific income information from individual respondents as well as including more marco income variables such as housing structure type and geographical location. Currently, specific macro observations are considered sufficient (e.g. housing value, or the use of regional aggregate income figures), but as *Katzman* has demonstrated [annex 4, paragraphs A4.4 to A4.9] actual income figures may be important.

6.3.   The research will also address the issues which surround the decision to connect to an available water supply system. The research will attempt to answer such questions as: what are the perceptions of the utility?; what role do connection charges play in the decision to connect?; what are the alternative sources and what is the cost of water for those not connected to the distribution system?; how do informal markets serve the water needs of the these households?; what is the effect of tenure on the connection decision?; or, what is the range of willingness to pay bids for water service among this group? There appears to be no recent empirical literature on this question in the context of these two utilities--i.e. where sufficient supply exists but people are still not connected. Therefore, the research will make a valuable start to this important area.

6.4.   The results of the research will be submitted for publication in economic journals as well as journals targeted to the water and wastewater sector. These publications might include *Land Economics, Environmental Behavior, World Bank Research Observer, Environmental Planning, Water Resources Bulletin, Water Resources Research, Economic Development and Cultural Change* or the INU Report Series.

6.5.   There will also be many practical applications for the Bank and its policy formulation for the water and wastewater sector. The estimates of income and price elasticities for the two utilities involved will be immediately incorporated in revisions of tariff design in the two cities. In addition, the results from the surveys conducted with the unconnected population should help in formulating policies to increase connection rates for Tunis and Rabat as well as other cities.

6.6.   The research will also provide the first step in revising the demand projection procedure the Bank now uses in appraisal. Current practice at the Bank rarely includes a household survey before loan implementation to

determine demand. The research results would should show whether or not such a survey is necessary. And if this procedure is shown to be advisable, the research will help formulate the design of such surveys by identifying the relevant variables and indicating what sample sizes may be necessary.

6.7.   The research will also provide an initial first component of the larger INUWS research agenda into methods to improve the Bank's investment in the water and wastewater sector. The INUWS program is concerned with many facets of the effectiveness of investment for this sector and the correct formulation of demand lies at the heart of many of these issues. Therefore, the proposed research will compliment INUWS programs which will be implemented over the next several fiscal years.

7. SUPERVISION AND TIMETABLE

Division Sponsorship

7.1.   INUWS is the sponsor of the research. In this division, Mr. Harvey Garn, the Coordinator of Applied Research in INUWS, will be the Principal Supervisor.

Collaborators and Advisors

7.2.   Collaborators and advisors will play a major role in all phases of the project both inside the two countries and here at the Bank. This collaboration will insure first an overall theoretical consistency and the development of useful outputs, and second allow an efficient use of resources and ease of data gathering while in Tunisia and Morocco.

7.3.   A major goal of the proposed project is to address concerns which are of interest at the Bank. For this reason, it is proposed that a Bank Advisory Panel be formed and that the following Bank Staff members serve on the Panel:

    Infrastructure and Urban Development Department:

        Dale Whittington, INURD
        Alfonso Zavala, INUWS

    Europe, Middle East and North Africa Department:

        Peter Ludwig, Chief, EM2IN
        Michel Pommier, Chief, EM3IN
        Alexander Velderman, Senior Sanitary Engineer, EM2IN
        Sergio Contreras, Senior Financial Analyst, EM2IN
        Alberto Antonini, Economist, EM2CO

7.4.   It is proposed that the Advisory Panel meet four times during the course of the project to: 1) review project design and coordinate monitoring responsibilities during the course of the project; 2) review the Tunisian country results at the project's half-way point; 3) review the Morocco results near the project's end; and 4) review drafts of the project's final reports.

7.5.   The Bank's Advisory Panel responsibilities will be as follows:

Dale Whittington. Mr. Whittington's role will be to give general operational advise for the project and especially in the areas of the survey implementation and data organization. He will also provide expert advice on the design of the willingness-to-pay portion of the questionnaires to be given the unconnected sample.

Alfonso Zavala. Mr. Zavala's role will be to review all aspects of the proposed project to insure that it meets the Bank's needs for ongoing research into the role of water demand, and to help orient the proposed research to compliment future Bank studies on this topic in other countries as well as upcoming INUWS demand investigations now being formulated.

Peter Ludwig. Mr. Ludwig will review the project design to insure it meets the needs of those who work with these utilities in his division. He will next help identify the areas in which the research can benefit utilities other than those of SONEDE and ONEP. Mr. Ludwig will also help coordinate the smooth flow of information between the engineers and financial analysts who work with these utilities in his division.

Michel Pommier. Mr. Pommier will review the project design, be the primary Bank contact with ONEP and will assist in the execution of the Morocco portion of the proposed research.

Alexander Velderman. Mr. Velderman will review the project design, be the primary Bank contact with SONEDE and assist in the execution of the Tunisia portion of the research.

Sergio Contreras. Mr. Contreras will review the project design and assist in assessing the financial impact of the projects's findings on the affected utilities.

Alberto Antonini. Mr. Antonini will review the project design from a macroeconomic standpoint and assess the relevance of the project's outputs for incorporation into the overall fiscal planning for EMENA countries. He will also assist in the incorporation of the project's results into the policy sections of the final reports.

Principal Investigator

7.6.   The principal investigator and field supervisor is Alexander McPhail, a consultant in INURD and a Ph.D. candidate in the G.W.C. Whiting School of Engineering at the Johns Hopkins University in Baltimore, MD. Mr. McPhail was also a Summer Assistant in LA1IE and consultant to EM3IN. Mr. McPhail's resume is included with this proposal as annex 2.

Timetable

7.7.   The proposed project will commence in September 1989 and be completed in December 1990. Annex 3 contains the proposed project schedule as part of the budget worksheet.

8 BUDGET

8.1   The proposed project will cost approximately $39,750 of which the $19,925 would come from the Research Administration Department (RAD). The estimated budget is as follows:

Estimated Total Costs
(U.S. Dollars)

Research Task	Total	A.I.D.	RAD
Insurance	600	0	600
Tunisia Fieldwork	18,200	9,100	9,100
Morocco Fieldwork	17,950	9,225	8,725
Contingency	3,000	1,500	1,500
Total	39,750	19,825	19,925

8.2   Annex 3 contains a more complete budget (dollar as well as staff time) for each task and a proposed timetable for their execution.

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العنوان التحري : 33.645
تلكس : 12.262

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MB/SA/DEG

Tunis,   Le 15 AOUT 1988

Monsieur Alexander McPhail

THE JOHNS UNIVERSITY
BALTIMORE, MARYLAND 21218

U.S.A.

Monsieur,

En réponse à votre lettre du 8 Juillet 1988 concernant la préparation d'une thèse de Doctorat à la SONEDE sur l'Elasticité des Tarifs de l'Eau, Nous vous donnons par la présente notre accord et vous assurons que la SONEDE ne ménagera aucun effort pour vous faciliter la tâche, afin de mener à bien votre étude à laquelle nous manifestons un grand intérêt.

Nous espérons que vos démarches auprès de l'USAID soient couronnées de succès afin de commencer votre étude au plus tôt.

Recevez Monsieur, nos sincères salutations.

Le Président Directeur Général

31

INFRASTRUCTURE DIVISION - CO2

B.I.R.D
1313 H Street, N.W., Washington DC
20.433 U.S.A

Date Rec'd ___9/13/88___
Date Ack'd _____
Assigned to: ___Poumier___

(A L'Attention de Mr Michel FOMMIER)

Log No. ___MISC-8-57___

OBJET/ : Préparation de la these de doctorat de Mr Alexander
Mc FHAIL Septembre 1989.
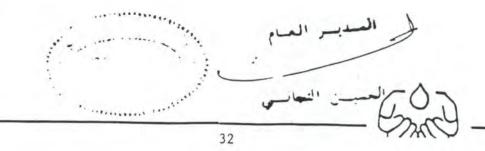
J'accuse réception de votre lettre du 26 Juillet 1986
soilicitant une collaboration de l'ONEP pour permettre de mener
à bien la réalisation de la these de doctorat qui a pour titre
" Elasticité des prix et des revenus de l'eau dans les pays
arides " que compte réaliser au Maroc Mr Mc FHAIL.

Comme vous le savez, le thème relatif aux élasticités
" prix - Consommation " a toujours été considéré par l'office
comme un aspect à maîtriser par des analyses très fines et
constructives dont les conclusions sont très importantes pour
toute prévision de la demande .

L'ONEF est très honoré de l'interèt de l'université de
JOHN HOPKINS à Baltimore, Maryland et ne voit qu'avantages à
autoriser un étudiant de préparer une these sur ce theme
d'élasticité au Maroc en général et à l'ONEP en particulier.

Comme mentionné dans votre lettre , le demarrage de
cette étude sur place à l'ONEP peut être prévu en Septembre
1989, aussi pour permettre à Mr Alexander Mc FHAIL de poser sa
condidature pour une bourse Fulbright en Septembre prochain ,
Je vous prie de trouver ci-joint une attestation assurant
l'intéréssé de l'entière collaboration de l'ONEP.

Veuillez agreer , ma considération la plus
distinguée .

<div dir="rtl">المدير العام

الحسين النجاسي</div>

Record Removal Notice

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Withdrawn by	Date
Ann May	24-Feb-17

	TOTAL A.I.D.	TOTAL IBRD	BANK DEPARTMENTS			TOTAL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
			RAD	EMENA	INU														
I. PROJECT PREPARATION																			
INSURANCE & RELATED	0	600	600	-----	-----	600	600												
TECHNICAL SUPPORT - INU	0	3,450	-----	-----	3,450	3,450		3,450											
PRINCIPAL SUPERVISOR	0	1,150	-----	-----	1,150	1,150		1,150											
TOTAL FOR TASK I.	0	5,200	600	0	4,600	5,200	600	4,600	0	0	0	0	0	0	0	0	0	0	0
II. TUNISIA FIELDWORK																			
TRAVEL	1,250	1,250	1,250	-----	-----	2,500		2,500											
ENUMERATORS - SELECTION & TRAINING	250	250	250	-----	-----	500			500										
PILOT SURVEY(S)	200	200	200	-----	-----	400				400									
ENUMERATORS - SURVEY WORK	1,500	1,500	1,500	-----	-----	3,000				1,500	750	750							
SURVEY EXECUTION EXPENSES	500	500	500	-----	-----	1,000					500	250	250						
PRINCIPAL INVESTIGATOR	4,500	4,500	4,500	-----	-----	9,000		1,500	1,500	1,500	1,500	1,500	1,500						
OFFICE EXPENSES & PHOTOCOPYING	900	900	900	-----	-----	1,800		300	300	300	300	300	300						
TOTAL FOR TASK II.	9,100	9,100	9,100	0	0	18,200	0	4,300	2,300	4,200	2,800	2,800	1,800	0	0	0	0	0	0
III. TUNISIA TECHNICAL SUPPORT & SUPERVISION																			
TECHNICAL SUPPORT - INU	0	2,300	-----	-----	2,300	2,300							2,300						
TECHNICAL SUPPORT - EMENA	0	15,330		15,330	-----	15,330			3,066	3,066	3,066	3,066	3,066						
PRINCIPAL SUPERVISOR	0	4,981	-----	-----	4,981	4,981			1,006	1,006	1,006	1,006	956						
TOTAL FOR TASK III.	0	22,611	0	15,330	7,281	22,611	0	0	4,072	4,072	4,072	4,072	6,322	0	0	0	0	0	0

| | TOTAL A.I.D. | TOTAL IBRD | BANK DEPARTMENTS | | | TOTAL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | AFR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
			RAD	EMENA	INU																		
IV. MOROCCO FIELD WORK																							
TRAVEL	375	375	375	-----	-----	750							750										
ENUMERATORS - SELECTION & TRAINING	250	250	250	-----	-----	500								500									
PILOT SURVEY(S)	200	200	200	-----	-----	400								200	200								
ENUMERATORS - SURVEY WORK	1,500	1,500	1,500	-----	-----	3,000									1,500	750	750						
SURVEY EXECUTION EXPENSES	500	500	500	-----	-----	1,000									500	250	250						
PRINCIPAL INVESTIGATOR	4,500	4,500	4,500	-----	-----	9,000								1,500	1,500	1,500	1,500	1,500	1,500				
OFFICE EXPENSES & PHOTOCOPYING	900	900	900	-----	-----	1,800								300	300	300	300	300	300				
TOTAL FOR TASK IV.	8,225	8,225	8,225	0	0	16,450	0	0	0	0	0	0	750	2,500	4,000	2,800	2,800	1,800	1,800	0	0	0	0
V. MOROCCO TECHNICAL SUPPORT & SUPERVISION																							
TECHNICAL SUPPORT - INU	0	2,400	-----	-----	2,400	2,400													2,400				
TECHNICAL SUPPORT - EMENA	0	18,670	-----	18,670	-----	18,670								3,066	3,066	3,066	3,072	3,200	3,200				
PRINCIPAL SUPERVISOR	0	3,019	-----	-----	3,019	3,019								1,006	1,006	1,006							
TRAVEL	1,000	500	500	-----	-----	1,500													1,500				
TOTAL FOR TASK V.	1,000	24,589	500	18,670	5,419	25,589	0	0	0	0	0	0	0	4,072	4,072	4,072	3,072	3,200	7,100	0	0	0	0
VI. REPORT PREPARATION & REVIEW																							
BANK REVIEW & CONSULTATION - INU	0	6,000	-----	-----	6,000	6,000																2,400	3,600
BANK REVIEW & CONSULTATION - EMENA	0	12,800	-----	12,800		12,800														3,200	3,200	3,200	3,200
PRINCIPAL SUPERVISOR	0	9,600	-----	-----	9,600	9,600																4,800	4,800
TOTAL FOR TASK VI.	0	28,400	0	12,800	15,600	28,400	0	0	0	0	0	0	0	0	0	0	0	0	0	3,200	3,200	10,400	11,600
CONTINGENCY	1,500	1,500	1,500	-----	-----	3,000																	
TOTAL PROJECT COST	19,825	99,625	19,925	46,800	32,900	119,450	600	8,900	6,372	8,272	6,872	6,872	8,872	6,572	8,072	6,872	5,872	5,000	8,900	3,200	3,200	10,400	11,600

ANNEX 4 -- PREVIOUS WATER DEMAND STUDIES IN DEVELOPING COUNTRIES

Meroz's 1968 Analysis

A4

A4.1.   In 1968, Avigdor Meroz prepared Economics Department Working Paper No. 17, *A Quantitative Analysis of Urban Water Demand in Developing Countries*, which attempted to estimate the effects of income, price and weather on the consumption of water in urban developing country service territories. The goal of this study was to try and "derive the functional relationships between the factors and the demand for water which can be used for forecasting" [p.1]. This study, which was a pooled cross sectional sample taken from 38 cities in Africa, Asia and Latin America, suffered from many data and reliability constraints. For example, the data limitations prevented a differentiation between domestic, industrial, commercial and government customers.

A4.2.   The resulting price and income elasticities for this project (-0.40 and 0.40 respectively) were more elastic than those found in a very comprehensive study completed in the United States just one year earlier by *Howe and Linaweaver* [1967] which found price and income elasticities of -0.23 and .32 respectively (the winter (domestic) price elasticity was later re-estimated to be -0.06 in *Howe* 1982).[1] Meroz's result is initially the one expected, i.e. that customers in developing countries are more sensitive to price changes than those in the United States, but when one realizes that both the water price and customer incomes were very roughly estimated and that no distinction was made between customer classes [*Meroz* 1968, p. 5], then the validity of the results are put in doubt.

Hubbell's Case Study of Nairobi

A4.3.   The next study in the literature was performed by L. Kenneth Hubbell in 1977 for the Urban and Regional Economics Division of the Development Economics Department of the Bank. Hubbell's paper, titled "The Residential Demand for Water and Sewerage Service in Developing Countries: A Case Study of Nairobi," was designed to answer three specific questions: 1) is the demand for water and sewerage services responsive to income changes; 2) is site value a good proxy for income when estimating residential water demand; and 3) how elastic is the price demand for water and sewerage services? Hubbell found a positive response to the first two questions and for the third he found that the results resembled those of Meroz with price elasticity estimated at -0.48 and income elasticity at 0.36 [p. 15]. Unfortunately, Hubbell's study also suffered from data reliability and classification problems. For example, the original 400 observations had to be compressed by income classification to a sample size of only 23 observations [p. 14].

Katzman's Case Study of Penang Island

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[1]The Howe and Linaweaver study was performed on residential customers only and is generally considered one of the most reliable estimates of household income and price elasticities of water demand in the literature.

A4.4.   The results of these two studies are in sharp contrast with the next research performed by M.T. Katzman at roughly the same time (1977). Katzman conducted his analysis using residential households on Penang Island, Malaysia and, according to Katzman, one advantage of this utility was "the efficiency of [City Water] Department's billing, metering, and collection system" which gave "reliable" consumption records over the study period [p. 48]. To determine income elasticities of water demand, Katzman selected a five percent random sample from most of the utility's metering districts and a twenty-five percent sample from districts of special interest. The total sample size for determination of income elasticities was 1,400 customers, and the period examined was February through April, 1972.

A4.5.   Each household in the sample was surveyed for water consumption patterns, and other family behavioral and status characteristics including the determination of a range of household income. To discourage non-responses to the income question, each survey respondent was asked to place the home into an yearly income bracket: "very poor" (less than US$600/year), "poor" (US$600 to US$2,000), "middle" (US$2,000 to US$3,200) or "rich" (more than US$3,200). The resulting arc income elasticities were as follows [p.50]:

Very Poor to Poor	0.00
Poor to Middle	0.24 - 0.30
Middle to Rich	0.32 - 0.39

A4.6.   Thus, for the very poorest of families water is essentially a necessity, but for higher level incomes the results resemble those of studies performed in industrial countries.

A4.7.   To determine price elasticities, Katzman modified his study base by examining 164 households selected evenly from four different "ideal-type" customers. These were rich families, households with domestic and business activities, poor and very poor urban residents and very rural poor rural residents. For each of the households selected, water consumption was monitored for three years before and two-and-one-half years after a price increase (over the period May 1970 to November 1975). The households were next grouped by rate class and neighborhood and then water consumption was regressed in a linear equation where the independent variables were rainfall and a dummy variable to indicate whether or not the price increase led to a once-and-for-all depression in consumption or to a reduction in the sensitivity of water use to rainfall. Price elasticities of demand were calculated by changing the value of the dummy variable to represent the tariff increase, setting rainfall equal to its mean over the study period and then calculating the percent change in gallons divided by the percent change in marginal price [pp. 50-54].

A4.8.   Results of this process show price elasticities of demand ranging from -0.1 for domestic-business customers to -0.22 for very poor urban households [p. 54]. This method of calculating price elasticities would have been improved if household income had been available for each consumption period, but despite this procedure, the results are in the expected range.

A4.9.   In summary, Katzman's research was more precise than previous

studies in the determination of the income variable and had the advantage of a relatively large sample size and accurate meter readings to gauge consumption for each household. His resulting income and price elasticities appear more reasonable than those of Meroz and Hubbell given that a certain amount of water is needed for survival and basic domestic uses and the relative income levels in developing countries. This study could have been improved with better income information over the study period for price elasticities and with the use of a *Nordin* 1976 price difference variable [Paragraphs 4.9-4.14].

Al-Qunaibet and Johnston and a Level of Subsistence

A4.10.   The next study in the literature did not appear until 1985. In this research, M.H. Al-Qunaibet and R.S. Johnston examined monthly water consumption in Kuwait over the period 1973 to 1981. This study is characterized by several factors. First, the authors used a Stone-Geary utility function to derive the demand model which allowed an explicit consideration of the minimum amount of water necessary for survival [pp. 433-437]. Next, the study area was Kuwait which, although still considered by most to be a "developing" country, is hardly lower income as the annual per capita income level is cited by the authors to be US$20,578 in 1981 dollars (compared to the United States with US$11,347) [p. 433]. Finally, this study concluded that even with such high per capita incomes, price could still be used as a tool to control demand up to the point of essential daily needs [p. 437].

A4.11.   The sample size for this study was 108. The independent variables were real per capita income taken from official government statistics, the marginal water price, an estimated relative humidity factor and included a term to determine whether or not there was a positive subsistence level of water [p. 435.].

A4.12.   Price elasticities of demand were calculated by Al-Qunaibet and Johnston to be -0.77 and income elasticities were found to be 0.21 [p. 436]. The price elasticity results are higher than one would expect for a developing country, but in Kuwait where nominal per capita income is high and water cost is low (approximately US$0.60 per 1,000 liters [p. 433]) this seems reasonable as people are probably consuming far more than is the minimum necessary (estimated by the authors to be 42 liters per capita per day at the mean humidity level [p. 436]). The income elasticity is relatively inelastic which is also what one would expect given the high per capita income.

A4.13.   This study could have benefited from additional or more specific variables in the demand model, e.g. household size and actual (as opposed to average) per household income figures. There is also no information on the number of households examined or on the water use characteristics of these households. Despite these drawbacks, it is the first known study to address the minimum amount of water needed for survival in a developing country context through a Stone-Geary specification of the demand model.

Palencia's Manila Case Study

A4.14.   The most recent study in the literature is an analysis of the