ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية
2008

working paper series

# MEASURING WATER-POVERTY RELATIONSHIP IN ALGERIA USING ROC CURVES

Samir Maliki and Abderrezak Benhabib

Working Paper No. 423

# Measuring Water-Poverty Relationship in Algeria Using ROC Curves

Samir B.E. Maliki and Abderrezak Benhabib

**Working Paper 423**

**August 2008**

Samir Baha-Eddine Maliki, Faculty of Economics and Management, University Abou Bekr Belkaid of Tlemcen, Algeria
Email: sb_maliki@mail.univ-tlemcen.dz

**Abstract**

Recent literature on poverty alleviation policies has focused on one direction of discourse by considering poverty as a dependant variable based on some objective (monetary) and subjective (social contacts). Results have not been satisfactory so far.

The importance of factors, other than income, in determining living conditions such as education, gender, water and characteristics inherent to society can contribute greatly to explaining the acuteness of poverty (Benhabib, Ziani, Maliki, 2006).

The aim of this paper is to quantify the subjective poverty of Algerian households by taking into consideration one of the factors— namely water domestic characteristics — as the direct focus[1].

We attempt to apply the Receiver Operating Characteristics ROC to determine the truly poor household through the water factor. This method has the advantage of eliminating the poverty line which is based on monetary factors. The methodology consists of classifying, as a first step, the households into two categories, subjective poor and non subjective poor. In the second step a graded scale is applied. In this case, the responses from the heads of the households are the basis of the scaling process. Finally we introduce the household's water factors.

**ملخص**

ركزت البحوث التي كتبت عن سياسات القضاء على الفقر على جانب واحد من الخطاب حيث اعتبرت الفقـر متغيرا ثابتا يرتكز على عامل موضوعي (المالي) وآخر ذاتي (العلاقات الاجتماعية) إلا أن النتـائج لازالـت دون المستوى المطلوب. وأهمية العوامل الأخرى بخلاف عامل الدخل، في تحديد مستوى المعيـشة كـالتعليم والنوع والماء والصفات المتأصلة في المجتمع قد تسهم كثيرا في تفسير حدة الفقر (بين حبيب زياني، ماليكي، 2006).

وتهدف هذه الورقة إلى قياس درجة الفقر الذاتي للأسر الجزائرية آخذة في الاعتبار أحد العوامـل المـذكورة وهي عامل استهلاك المياه في المنزل.

ونحاول أن نطبق معدل التغير لنتعرف على الأسرة الفقيرة حقا من خلال عامل المياه. هذه الطريقة تتميز بأنها طريقة تحد من استخدام خط الفقر كطريقة تعتمد على العوامل النقدية. وتقسم هذه المنهجية، كخطـوة أولـى، الأسر إلى فئتين: فئة تتسم بالفقر الذاتي وفئة فقرها غير ذاتي. ثم تأتي الخطوة الثانية بتطبيق متواصلة متدرجة وفي هذه الحالة تكون إجابات أرباب الأسر محددة لعملية القياس. وأخيراً ندخل عوامل استهلاك الميـاه فـي الأسرة الجزائرية.

1 We can note, in this context, that Algeria is located on a semi arid region with stressful water conditions.

## Introduction

Since the announcement of the eight objectives of the Millennium Development Goals( MDGs), where access to safe water is considered an important part of the first objective linked to the elimination of extreme poverty and hunger, (United Nations, 2000), water and poverty have been driven to the forefront of public debate. The last report of the UNDP 2006, entitled "Beyond Scarcity: Power, Poverty and the Global Water Crisis" confirmed the necessity of taking the water factor as a central element in combating poverty, particularly in Algeria. Actually, in terms of climate, Algeria is characterized by a semi-arid nature, which brings along with it a high degree of scarcity in water availability.

Theoretically, the availability of water has been given a critical threshold estimated at $500m^3$/capita/year, representing less than half the scarcity threshold fixed by the World Bank at $1000m^3$/capita/year, and less than a fifth of the threshold of 2000 $m^3$/capita/year.There is a general consensus that this issue is caused by bad governance of water.

Poverty measurement has always relied on one or multi-dimensional methods that are computed on the basis of the poverty line, although the fuzzy set method tackles the poverty line by integrating it within a graded range on the basis of membership functions (Benhabib et al., 2007)[2]. However, as measurement problems persist, we propose the Receiver Operating Characteristics method called ROC as a better tool to quantify poverty. In this case we look at the relationship between water and poverty and thus attempt to know more about water characteristics which may better explain household poverty levels.

Literature on international data gathering can sometimes obscure the way poor households have access to water. International statistics help draw a distinction between "improved" and "unimproved" access. The improved encompasses three dimensions of water security: quality, proximity and quantity. For international reporting purposes, people are classified as enjoying access to water if they have access to at least 20 liters per day of clean water, from a source which is located less than one kilometer from their home (UNDP, 2006)[3].

This paper aims to study the relationship between households' subjective poverty and water access conditions for better quantification of their interactions. The higher aim is helping policy makers set adequate policies for poverty alleviation in Algeria.

The study consists of classifying the households on the basis of real subjective poverty according to water access conditions by applying the ROC curve. The first section deals with poverty measurements in Algeria. Section two presents poverty alleviation policies experienced in Algeria. In the third section, water as a central dimension for reducing poverty is presented. This is followed by the application of ROC curves to the region of Tlemcen in section four. Conclusions and policy options are offered in section five.

## 1. Measurement of Poverty in Algeria

Literature on poverty is extremely abundant and characterized by an unusual level of ambiguity relative to economic theory. As such, it provides many different definitions of what poverty is. Each conceptualization obviously leads to a particular identification of the poor (Asselin, & Dauphin, 2001). Generally, the level of poverty can be measured on the basis of two approaches: the material and non material or the utilitarian and non utilitarian.

The first approach deals only with the material side on the basis of the economic welfare function, and defines poverty in terms of scarcity of goods and resources (Bey, 1999) that put

2 Benhabib et al. 2007, MEEA conference, 2007 in https://netfiles.uiuc.edu/esfahani/www/MEEA/Conferences/MEEA%202007%20Program.htm

3 Human Development Report, 2006, « Beyond Scarcity : Power, Poverty and the Global Water Crisis"

some limits on the satisfaction of basic needs such as nutrition, clothing and housing. This definition implies two important aspects of "material" poverty regarding small revenues and non-satisfaction of basic needs.

In short, this approach is set exclusively on the basis of revenue and does not give enough importance to non marketable goods and services that have a positive impact on the household level of living. Thus, this approach contributes to increasing or decreasing the poverty level bias. For this reason it is completed by a conceptualization based on satisfaction, as far as fundamental needs are concerned.

(Sen 1985) avoids this approach by relying on social justice, equity and inequalities. His definition of poverty, based on the capacity approach, takes into account not only the economic factors, but also legal, political, social and individual dimensions.

The second approach, the utilitarian, generates some indicators set upon goods and services consumed by a household. This limits the notion of "utility" only to the economic well-being and ignores the non-quantifiable aspects of utility such as the non-tradable goods and the non-material elements of human condition such as freedom.

The indicator that derives from the utilitarian approach is consumption expenditure in goods and services, normalized to take into account price differences and households' characteristics. The non–utilitarian approach and those based on capacities help determine the ability to get goods as an explanatory variable of well-being, while keeping consumption as an indicator.

In Algeria, the actual indicators confirm the existence of some improvements in poverty level. According to the Ministry of Employment and National Solidarity, there is a decrease of 2.3 % between 2000 and 2006.

Yet, in contrast, the UNDP maintains that the number of poor exceeds 10 million, a figure that is far beyond the 72302 proposed by the Ministry of Employment. Moreover, the latest (CNES 2007) shows that the proportion of the population living below the nutritional poverty threshold has moved from 3.6% in 1988 to 1.6% in 2004, representing 518000 individuals.

The global poverty threshold that impacted 3.98 million individuals in 1995 decreased to 2.2 million by 2004, with an annual average decrease of 6.37%.

Despite these statistical improvements, poverty research in Algeria has so far focused on the consequences of poverty, namely bad nutrition, unemployment, exclusion etc…, ignoring the forces behind the existence of this phenomenon. As such, understanding the existing relationships between the causes of poverty as well as the forces standing behind these relationships can help decision makers with targeting the poor, and consequently enforce efficient resource allocation.

This brief outline puts forward the following questions: Is poverty measurement in Algeria linked to the chosen methods, or to the statistical data used, or to the sample surveyed, or, from a conceptual angle, to the diversity of institutions in charge of the measurements?

## 2. Combating Poverty: The Experience of Algeria

In 1998, the number of social net beneficiaries, including those under employment assistance programs, was evaluated at about 12 million persons (Banque Mondiale, 1999).

Moreover, Algeria initiated, with international partners, some sustainable projects in rural areas— mainly the forest sector. The main projects are listed in (Ferroukhi, 2000).

Despite these initiatives, the level of poverty remained high and was a triggering factor in the organization of the 1st national conference on poverty and exclusion held in Algiers in October 2000.

Algeria has, in the past, carried out some poverty alleviation policies like the social net, pre-employment contracts, community development, housing policies and pilot projects.

### *2.1. National Activities of Solidarity*

The mission of the Ministry of National Solidarity consists of reducing inequalities through poverty alleviation policies. Some pertinent initiatives were elaborate like for example the assistance to the education sector, the assistance for housing, credit for job creation and the aid directed to the weaker categories (old persons and disabled) for housing and medication.

### *2.2 The Social Net*

From the beginning of 1991 Algeria started realizing some social protection programs to bring immediate help to the poor and help them reintegrate socio-economic life by way of reemployment. This system comprises two types of measures:

The Solidarity Basic Allowance (S.B.A) and
The Allowance for Community Work (A.C.W)

#### *2.2.a. The Solidarity Basic Allowance (S.B.A)*

The S.B.A is offered to the heads of households aged 60 years and more who have no income, as well as to the handicapped and to those who are unable to work.

The amount of the allowance is fixed at 900AD per month with a premium of 120 AD for each member of the household. Over 933000 people benefited from this scheme.

#### *2.2.b. The Allowance for Community Work (A.C.W)*

This allowance is paid to active people with no income, in return for community work within workshops organized by local authorities. The value of the allowance is 2800 AD per month, which represents half the Algerian minimum wage. More than 588000 people are involved in such programs. Despite its benefits, these schemes show some drawbacks.

#### *2.2.c. Drawbacks of the S.B.A & A.C.W*

A-The S.B.A

There are some difficulties in targeting the deserving. Close record examination helped to disqualify the non-eligible individuals. The latest study (CENEAP, 1999) reported that 64.4% of all beneficiaries were not eligible, with 11% for retired people The study shows some inequality to the disadvantage of the female gender: 35.8% against 64.2% for males.

B- The A.C.W

There are some difficulties in setting up workshops within communities that are under-staffed and struggling to perform their daily duties. The CENEAP study revealed that 40% of all beneficiaries were not poor and, thus brought to light the inefficiency of the policies, which cannot, on their own, contribute to alleviating poverty, and should, therefore be supplemented by other policies like the participatory community service scheme, which will be presented hereafter.

The Algerian authorities have introduced the pre–employment contracts in 1998 targeting 400000 unemployed graduates. Only 20% were finally employed.

### *2.3. The Participatory Community Service Scheme (PCSS)*

The Participatory Community Service Scheme comprises a multi-disciplinary team involved in alleviating poverty in a targeted district. The program consists of four modules: hygiene and health, social rights assistance, education, and sports and cultural activities (Maliki, 2005).

However, as the results were not significant as far as poverty alleviation is concerned, achieving the MDGs in this way is far from pertinent. In fact, the relevant problem for developing countries rests not only in the improvement of heath and education but, and fundamentally, in the management of the basic constituent of life, namely water.

## 3. Water as a Central Dimension for Reduce Poverty

The provision of water is principally related to health as its mobilization causes Hydric Transmission Diseases HTD. According the WHO, 80% of illnesses are of hydric origin. Nowadays, water is becoming a concern in the poverty debate. Thus, access to water can have a positive impact on the eradication of extreme poverty and hunger (United Nations, 2000).

This relation enables us to encompass the frontiers within which water can be a factor of production and reproduction of poverty through its scarcity, its quality, its increased price, its difficult access etc.

The year 1996 has been the international year of poverty eradication as proclaimed by the United Nations. Organizations like UNDP and the World Bank set the mechanisms to make international comparisons with regards to poverty gaps. The phenomenon has become variable in time and space, and consequently the real causes of poverty remain superficial and the interactions between variables, fuzzy. The first index to introduce the water factor was the UNDP's Human Poverty Index HPI[4,5]. It allows the calculation of the population percentage without access to drinking water.

The Water Poverty Index (WPI) introduced by Sullivan (2002 ,2003) is presented in the framework of an interdisciplinary approach which integrates the availability of water with economic and social variables that reflect some level of poverty. The principal objective of the index is to explore some links between access to water and the incidence of poverty.

Generally the index is expressed as follows:

$$WPI = \frac{\sum_{i=1}^{N} wixi}{\sum_{i=1}^{N} wi} \qquad 0 < WPI < 1 \qquad (1)$$

With:

*wi* : represents the weight applied to each component .

4 We note the existence of the human poverty index for developing countries (HPI-1) and the human poverty index for selected OECD countries (HPI-2) which include the average of the population without sustainable access to drinking water.

5 The UNDP's Human Development Index HDI measures the average achievements of a country in the three basic dimensions of human development – longevity, knowledge and a decent standard of living. It contains three variables: life expectancy, educational attainment and real GDP per capita. The HDI would seem the best available intermediate proxy, not only for institutional capacity, but also for the level of social resources in a country. Life expectancy would serve as a proxy for the general level of welfare and development; educational attainment as a proxy for institutional capacity; and real GDP per capita as a measure of economic performance.

*X :* the value of each component of the index.

The components $xi$ of the index are: Resource (R), Access (A), Use (U), Capacity (C) and Environment (E) (Table 1).

Each of the components is first standardized so that it falls in the range 0 to 100; thus the resulting WPI value is also between 0 and 100.

Lawrence et al. (2002) used the WPI in order to make a comparison between different countries. What we can draw from this comparison is the dominance of the resource variable.

Another index, the SWSI (Social Water Scarcity Index) developed by (Ohlsson, 1998), serves to highlight the importance of a society's social adaptive capacity to face the challenges of water scarcity. The formula attempts to divide the Water Stress Index WSI (commonly evaluated by comparing the volume of renewable water resources per capita at a national level) by HDI. Table 2 shows the results for some countries including Algeria and shows how the SWSI differs on the basis of different social resource, as measured by the HDI.

We can see the relationship between water indicators and poor households in Figure1.

## 4. Targeting the Poor Households by Water: The ROC Curves

The preceding section enabled us to know that all Algerian households currently benefit from a price preference of water. From this situation, the measurement of poverty becomes more complicated if we want to dissociate poor households from the rest of the population.

So even if one devotes a great amount of money to implement social programs, the soundness can only be real if we manage to achieve real targeting of vulnerable individuals (households).

We think that a measurement of poverty can be greatly improved if we take into account water access conditions, which can in turn help in putting better social programs. The advantage of this method rests mainly on computing a household's classification without using a poverty line.

### *4.1. The ROC Analysis*

The use of the ROC makes targeting more effective and also makes it possible to determine truly poor households on one side, and the variables to select as pertinent targeting indicators on the other.

The ROC approach is a graphical non-parametric technique which has been originally developed in signal detection, psychology theory and medicine among other fields. The first application of ROC curves to economics, and more specifically in poverty monitoring and targeting, was made by Wodon (1997) using household expenditure survey data from Bangladesh. Since then, the ROC methodology has generally been used in economics to assess the accuracy of a diagnostic test performed to differentiate between two states or conditions, say the poor and the non-poor.

#### *4.1.a. The ROC Curve*

A ROC curve is a graph that resembles an inverted Lorenz curve. It plots, on arbitrary cutoff points known as sensitivity (SE), the probability that a poor household will be classified as poor on the vertical axis, against the probability that a non-poor household will be classified

as poor (one minus specificity (SP), on the horizontal axis[6]. It is conventional to link the ROC analysis to the incidence of Type I and Type II statistical errors (Wodon, 1997 and Baulch, 2002).

The probability of Type I error is 1 minus SE (which is namely the probability of identifying a poor household as non-poor) whereas the probability of Type II error is 1 minus SP (the probability of identifying a non-poor household as poor).

The ROC curve illustrates how the two types of errors (exclusion of some poor households and inclusion of some non-poor households) vary with the choice of a particular level of indicators (Minot and Baulch, 2002). Hence, the ROC curve summarizes SE and SP errors obtained along a range of cutoff points delimited by zero and unity.

The area under the ROC curve can be used to provide a statistical summary measure of the overall performance and predictive value of the underlying poverty targeting model (Tuan *et al*., 2004). The area below the ROC curve can take on values between zero and one. The greater (smaller) that area, the better (worse) is the power of the model used in prediction. A 45-degree line, corresponding to an area of 0.5, has no explanatory power since the probability that a poor household is classified as poor is no higher than the probability that a non-poor household is classified as poor. A vertical line from the origin followed by a horizontal line to the upper-right corner (equivalent to an area of one) has perfect predictive power (Baulch, 2002).

The comparison of the areas under the ROC curves (AUC) is important in the explanation of the overall performance of diagnostic. The overall performance of the diagnostic of the different tests can be assessed by comparing their AUCs. The bigger its AUC, the better the overall performance of the diagnostic test.

*4.1.b. Comparing ROC Curves by the Bi-normal ROC Curve*

The most common way of smoothing a ROC curve is using the bi-normal model. It assumes a normal distribution with mean $\mu_1$ and variance $\sigma_1^2$ for the poor households and a mean $\mu_\circ$ with variance $\sigma_0^2$ for the non poor.

Then using $G(t) = \phi((\mu_0 - t)/\sigma_0)$, it follows that the threshold t can be written as a function of x as follows: $t = \mu_0 - \sigma_0\phi^{-1}(x)$. Since a threshold t corresponds to the sensitivity, we can write the functional form of the ROC curve as:

$$F(t) = \phi\left(\frac{\mu_1 - t}{\sigma_1}\right) = \phi\left(\frac{\mu_1 - \mu_0 + \sigma_0\phi^{-1}(x)}{\sigma_1}\right) = \phi\left(a + b\phi^{-1}(x)\right) \quad (2)$$

Where

$$a = \frac{\mu_1 - \mu_0}{\sigma_1}$$
$$b = \frac{\sigma_0}{\sigma_1} \quad (3)$$

The area under the curve for the bi-normal model also has a closed-form expression:

[6] SE is the true-positive rate, which is the proportion of positive cases that are correctly classified by the diagnostic test and SP is the true-negative rate, which is the proportion of negative cases that are correctly classified. Therefore, the ROC curve discloses the relationship between the true-positive and the false-positive rate across different cutoff points.

$$AUC = \phi\left(\frac{a}{\sqrt{1+b^2}}\right) \quad (4)$$

### *4.2. Poverty Water Linkage in Algeria*

The poverty alleviation package implemented since 1994 in relation to the gradual elimination of basic good subsidies would trap people in poverty in a way that revenue transfers for poor people's income do not move faster than the poverty line. .A few real life examples would prove this point. Starting by wage earners, the legal monthly minimum wage of 8000 AD[7] applied since January 2001 represents approximately 4 times the poverty line. This salary will keep a family of four, just on the poverty line. Given the fact that in Algeria, the average family is composed of seven people, it is clear that a single minimum wage earner could not keep his family out of poverty, if not extreme poverty. In fact even for an average earner, the outlook is not much different. In 1996 the average wage was five times the poverty line that was marginally higher than a minimum wage earner. The situation is even worse for people in public working programs, where the wage is only half the legal minimum (Laabas, 2001).

We applied the ROC method to household data in order to find out whether water indicators can determine true subjective poor households. For that, the rule of decision applied for the six parameters is in Table 4.

We chose, in this study, a classification of each parameter compared to a reference variable that can be given through a frequency control and a social consensus. Townsend (1979) explains that the items selected must belong to the ordinary living patterns. He considers that one item belongs to an ordinary way of life, if it is carried out by at least 50% of the members of the society.

The results are presented in Figure 3. We present only the 20 indicators of the six parameters which have a relation with water, on a unit which contains other factors in addition to water (see Appendix 1). AUC shows us the effectiveness of each indicator through the ROC value.

### *4.3. Sample and Data Collection*

A two-level method of survey is adopted. The first level relates only to the group that faces a real problem of access to water resources. On the basis of the last Algerian official census indicators (1998), we chose only the groups of *wilayat* Tlemcen that are confronted with serious handicaps as far as availability and access to water are concerned. In the second step, we introduce the criteria to measure the size and the rank of the groups. This first level enables us to sort out 15 out of the 53 groups of Tlemcen.

Thus, the sample corresponds to 28% of Tlemcen's community. The 15 groups add up to 78 622 households in 1998. As we decide to question 1% of the households we finally get a sample of 786 households (see Appendix 2).

### *4.4. Results and Discussion*

The result shows that 26, 97% of household heads consider their households as poor and very poor. We prefer to use a subjective measurement, knowing that the price differentials of goods between areas are not objectively observed.

[7] Actually the legal monthly minimum wage is 12000 AD. A recent study in 2006, made by the General Union of Algerian Workers, shows that the monthly food invoice for a family of six people has risen to 11210 AD: 6 loafs of bread/day with 8 AD / unit: 1080 AD, 2 liters of milk / day at 28 AD/liter: 1680 AD, 1 kg of potato / day at 70 AD / kg: 2100 AD, 10 kg of tomatoes at 70 AD/kg:700 DA, 50 kg of semolina of average quality: 2300 AD, water:350 AD, electricity: 3000 AD.

Truly subjective poor households are the households which have access to drinking water through wells. The water complement indicator shows that even though households are connected to the drinking water network, they use water complements due to water pressure.

The means of storage reveal that truly poor households use only jerry cans, or plastic tank.... because of their low revenue. These households cannot have tanks, with or without pump.

The results explain that households fitted with a mobile tank are mostly in the area of the poor (ROC Area = 0.4714). The poor households seek water in the wells or are constrained to buy a mobile tank (on average the price moves between 600 AD and 1000 AD).

The figure of water complementary utilizations shows the dominance of the purchase from a water tank vehicle. Paradoxically, we find that poor households use both types of water sanitation, which implies that the connection of households to the official sanitation network is not a potential indicator for targeting the poor.

Finally, the indicator of the presence of a kitchen in the house indicates that its absence is a sign of subjective poverty compared to the water conditions.

Traditionally, the provision of water supply and sanitation services in developing countries has been the responsibility of national and municipal governments. Substantial private sector involvement was considered inappropriate for five important characteristics of the water and sanitation sector (Rees, 2001):

• The natural monopoly that characterizes the water sector and the lack of substitutes;

• The public and merit goods supplied by the sector;

• The crucial relationship between water infrastructure and urban/economic development;

• The highly capital-intensive nature of the sector and the overwhelming presence of sunken-costs, which increase private-sector risks;

• The multi-purpose and hydrological interconnected nature of the water resource itself.

Achieving allocative efficiency is difficult and should involve more than pure economic consideration. If the highest valued users are allowed to purchase all the water in a purely free market, some groups, typically farmers and farm workers are going to lose water and their economic support base. This requires that the economy and the political system be able to provide alternative methods, compensate third parties affected by market transactions and judge between diverse claims for allocation (Lundquist, Gleick, 1997).

**Conclusion**

The purpose of our paper is to quantify the relation between subjective poverty and water deprivation of Algerian households. The Receiver Operating Characteristic (ROC) used in this study brings to light the importance of water as a measurement factor in the poverty evaluation process compared to other multidimensional axiomatic methods such as fuzzy sets with graded membership functions, (Maliki, 2007) and non axiomatic methods (indices). Results show that the frequency of water, the storage and the access type are considered better indicators of poverty and thus can be used for targeting poor household.

Moreover, as far as policy implications are concerned, we urge the Algerian state to look more into the organization of the hydraulic sector, which is lacking in management and governance. The Algerian water organization (l'Algérienne des Eaux) which manages water must be part in the process of conception and implementation of poverty alleviation policies by: improving the water supply for households, controlling wells and water sources, applying

a water solidarity pricing for low- income households and re-examining pricing on the basis of differential district living standards.

**References**


Asselin, Louis-Marie & Anyck Dauphin (2001), Poverty Measurement: A Conceptual Framework, IDRC, Canada.

Banque Mondiale (1999), Note stratégique de protection sociale , version préliminaire, octobre.

Baulch, Bob (2002), Poverty Monitoring and Targeting Using ROC Curves: Examples from Vietnam, IDS Working Paper 161, Institute of Development Studies, University of Sussex, England.

Benhabib A., Ziani and T.,Maliki S.B.E (2006), Poverty Evaluation in Algeria : A Logit Probit Model Applied to Multidimensional Field Survey in the Region of Tlemcen, CROP and the International Social Science Council/ UNESCO and Democritus University of Thrace , Zed Books, London & New York, March, chapter 13, PP 350-373.

Benhabib et al.(2007), The Analysis of Poverty Dynamics in Algeria : A Multidimensional Approach , Middle Eastern and North African Economies, electronic journal, Volume 9, Middle East Economic Association and Loyola University Chicago,USA, September.

Bey M. (1999), Recherches sur la pauvreté : état des lieux. Contribution à la définition d'une problématique, *Tiers Monde*, n °180, Paris.

C.N.E.A.P. (1999), Programme d'ajustement structurel et ses effets sur l'économie nationale, Algiers.

CNES (1998), Projet de rapport nationale sur le développement humain, PRNDH Algiers.

CNES (2001), Projet de rapport nationale sur le développement humain, PRNDH, Novembre, Algiers.

CNES (2007), Rapport national sur le développement humain en Algérie 2006, en coopération avec le PNUD, Algiers.

Destremau, Blandine and Pierre Salama (2002), Mesures et démesure de la pauvreté , Presses Universitaires de France, Paris.

Ferroukhi, S.(2000), Le développement rural régional, une approche appropriée pour reculer la pauvreté en zones rurales , INRA, Alger, présentée à la conférence nationale de lutte contre la pauvreté et l'exclusion, Octobre.

Foster J., J. Greer and E. Thorbecke (1984), A Class of Decomposable Poverty Measures, *Econometrica* Vol. 52, 3: 761-766.

Hsieh, F. and B.W. Turnbull (1996), Non-parametric and Semi-parametric Estimation of the Receiver Operating Characteristic Curve, *Annals of Statistics* 24: 25-40.

Laabas, B. (2001), Poverty Dynamics in Algeria , Paper presented at ERF/World Bank Conference on Poverty and Its Determinants in MENA Countries, Sanaa, Yemen

Lawrence, P. J. Meigh and C. Sullivan (2002), The Water Poverty Index: An International Comparison, Keele Economics Research Papers, KERP 2002/19.

Lundqvist, J., Gleick, P. (1997), Sustaining our Water into the 21st Century, Background Document of the Comprehensive Assessment of the Freshwater Resources, World Stockholm Environmental Institute (SEI), Stockholm.

Maliki S.B.E. (2005), Politiques de lutte contre la pauvreté en Algérie , in Revue *Les Cahiers du MECAS*, n° 1, Avril, Université de Tlemcen, Algérie, pp.143-157.

Maliki S.B.E. (2006), Politique de l'eau en Algérie : les modèles marchands face à la pauvreté , in Revue *Les Cahiers du MECAS*, n°2, Avril, Université de Tlemcen, Algérie, pp.105-114.

Maliki S.B.E. (2007), Conditions eau et pauvreté subjective en Algérie : analyse non paramétrique par les courbes ROC , in Revue *Les Cahiers du MECAS*, n°3, Avril, Université de Tlemcen, Algérie

Maliki S.B.E, Charmes J. & Benhabib A. (2006), Pauvreté et eau: réalité et interactions en Algérie, communication in *10èmes Rencontres Euro-Méditerranéennes,* "Inégalités, pauvreté et développement économique dans les pays méditerranéens", Université du Caire, 4-5 novembre.

Minot N., & Baulch B. (2002), The Spatial Distribution of Poverty in Vietnam and the Potential for Targeting, Policy Research Working Paper 2829, Washington D.C, the World Bank and IFPRI.

Ohlsson, L. (1998), Water and Social Resources Scarcity, an Issue Paper commissioned by FAOAGLW.

PNUD (2003), Rapport mondial sur le développement humain, Oxford University Press, New York.

Rapport National sur les Objectifs du Millénaire pour le Développement (2005), Gouvernement Algérien, Juillet, Algiers.

Rees, J. A. (2001), Regulation and Private Participation in the Water and Sanitation Sector, Global Water Partnership

Sen, A. K. (1983), Poor Relatively Speaking, *Oxford Economic Papers* Vol. 35, 2:153-159.

Sen, Amartya (1985), Commodities and Capabilities, Amsterdam, North-Holland

Sullivan, Caroline (2002), Calculating a Water Poverty Index, *World Development* Vol.30, 7:1195 – 1210, Elsevier.

Sullivan, Caroline et al. (2003), The Water Poverty Index: Development and Application at the Community Scale, *Natural Resources* 27:189 – 199.

Swets. J.A (1986), Form of Empirical ROCs in Discrimination and Diagnostic Tasks: Implications for Theory and Measurement of Performance, *Psychological Bulletin*, 99:181-198.

Townsend P. (1979), Poverty in the United Kingdom: A Survey of Household Resources and Standards of Living, Penguin Books, Harmondsworth, London.

Tuan, T., T., Harphan & N.T. Huong (2004), Validity and Reliability of the Self Reporting Questionnaire 20 Items in Vietnam, Hong Kong, *Journal of Psychiatry,* Vol. 14, N° 3

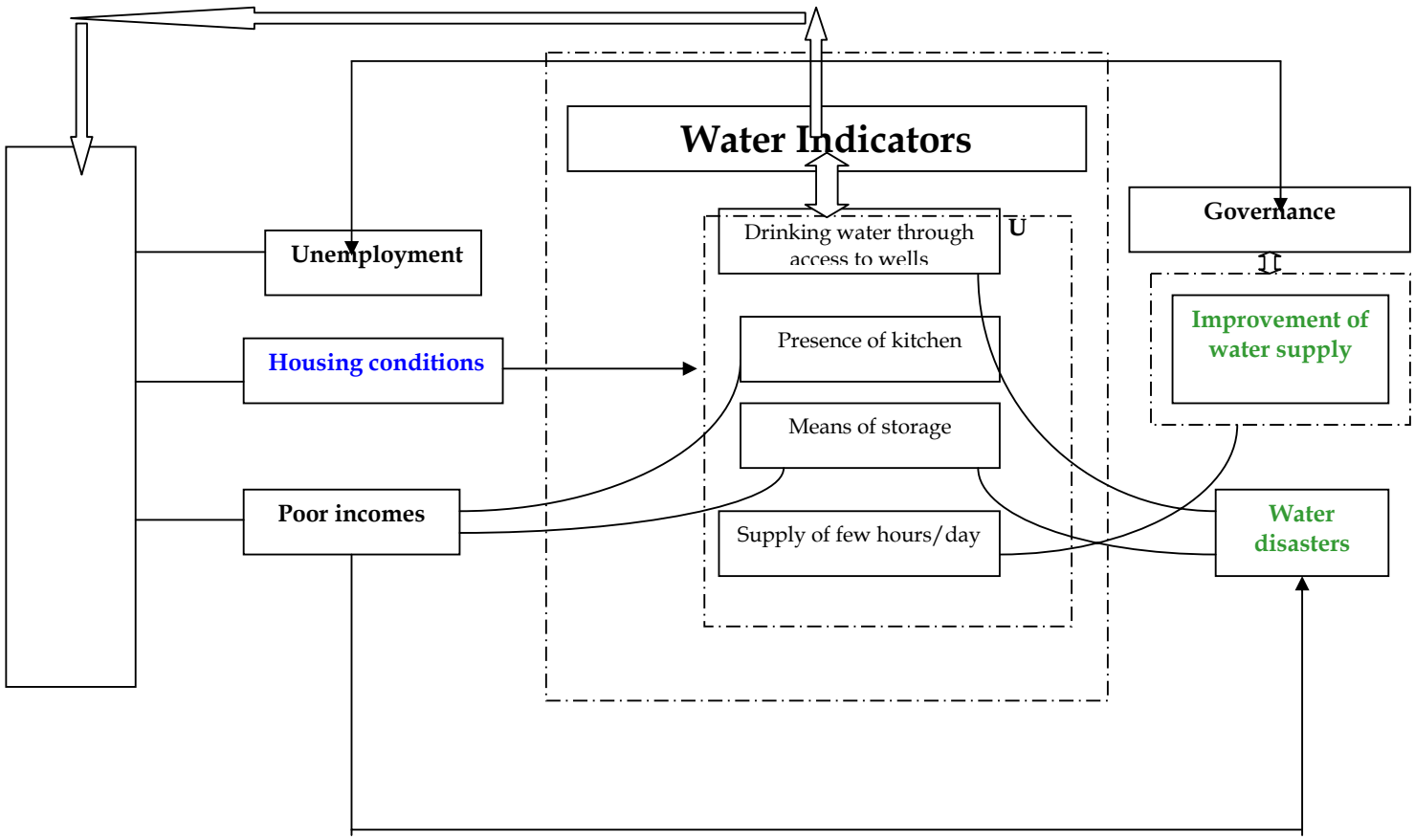
UNDP (2006), Beyond Scarcity: Power, Poverty and the Global Water Crisis, Human Development Report, USA

United Nations (2000), United Nations Millennium Declaration (55/2), available at

http://www.un.org/millennium/declaration/ares552e.pdf.

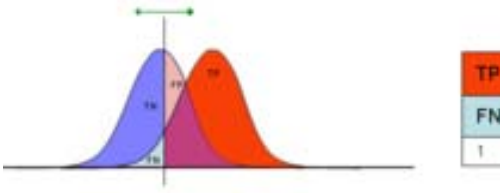
Wodon Q.T. (1997), Targeting the Poor Using ROC Curves, *World Development* Vol. 25, 12: 2083-2092.

**Figure 1: Water Indicators for Poor Households in Algeria**

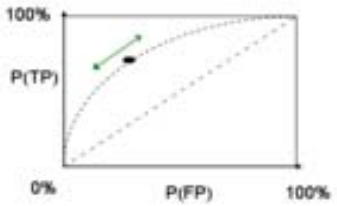



HOUSEHOLDS POVERTY

**Figure 2: The ROC Curve**



| TP | FP |
|---|---|
| FN | TN |
| 1 | 1 |



## Appendix 1: Variables of Households' Water Conditions

| Water conditions | |
|---|---|
| **Variables** | **Description** |
| | ***Water access*** |
| **ACS1** | Connection to the drinking water network |
| **ACS2** | Drinking water through access to wells |
| **ACS3** | Drinking water through access to water tank vehicles |
| | ***Water frequency supply*** |
| **FREQ1** | Supply of few hours /day |
| **FREQ2** | Supply of one day / week |
| **FREQ3** | Supply of 2 days / week |
| **FREQ4** | Supply of 3 days / week |
| **FREQ5** | Supply of more than 3 days / week |
| | ***Storage means*** |
| **STOK1** | Built-in water tank with pump |
| **STOK2** | Built-in water tank |
| **STOK3** | Mobile Tank |
| **STOK4** | Various household storage means (Jerry-cans – plastic tank….) |
| | ***Water complementary utilizations*** |
| **COMPLEM1** | From Wells |
| **COMPLEM2** | Purchase from a water tank vehicle |
| **COMPLEM3** | Provisioning from water natural sources |
| **COMPLEM4** | Purchase of mineral water |
| | ***Water drain & sanitation*** |
| **EUSE1** | Drain through sewer net |
| **EUSE2** | Drain through a skeptic tank |
| | ***Kitchen – housing characteristics*** |
| **CUISINE1** | Normal Housing with kitchen |
| **CUISINE2** | A one room-kitchen Housing |

## Appendix 2: Households' Sample Distribution

| Departments | Number of households surveyed | Area♦ |
|---|---|---|
| Tianet | 9 | R |
| Djebala | 17 | R |
| Ain Fezza | 16 | R |
| Beni Bousaid | 18 | R |
| Beni hediel | 7 | R |
| El Fehoul | 11 | R |
| Maghnia | 172 | U |
| Souahlia | 38 | R |
| Tlemcen | 234 | U |
| Remchi | 69 | U |
| Ghazaouet | 63 | U |
| Sebdou | 55 | R |
| Sidi Djillali | 8 | R |
| Nedroma | 59 | U |
| Marsa Ben m'hidi | 10 | R |
| Total | **786** | |

Our sample is composed of 10 rural departments (R) and 5 urban (U) according to Algerian National Territorial Agency (ANAT, Tlemcen).

## Cartography of Tlemcen Representing the Percentage of Households Connected to the Drinking Water Network

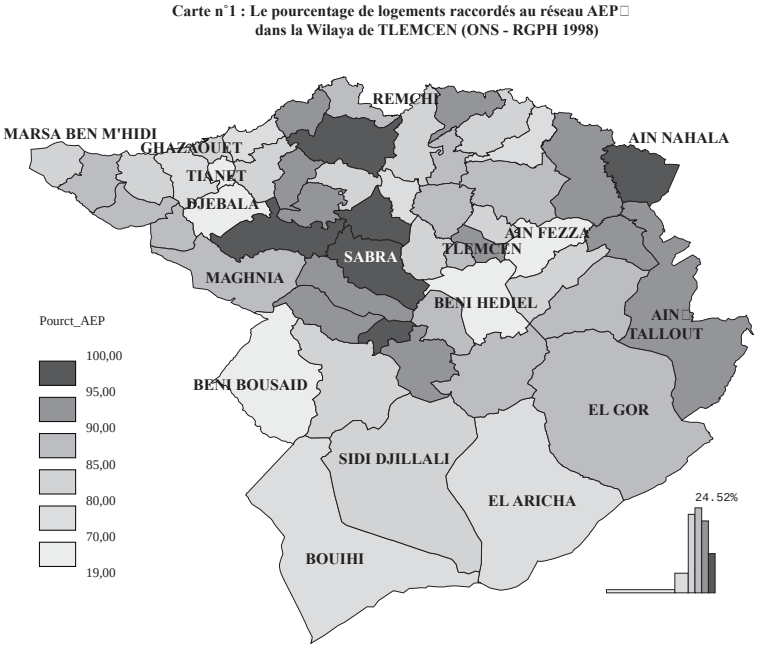
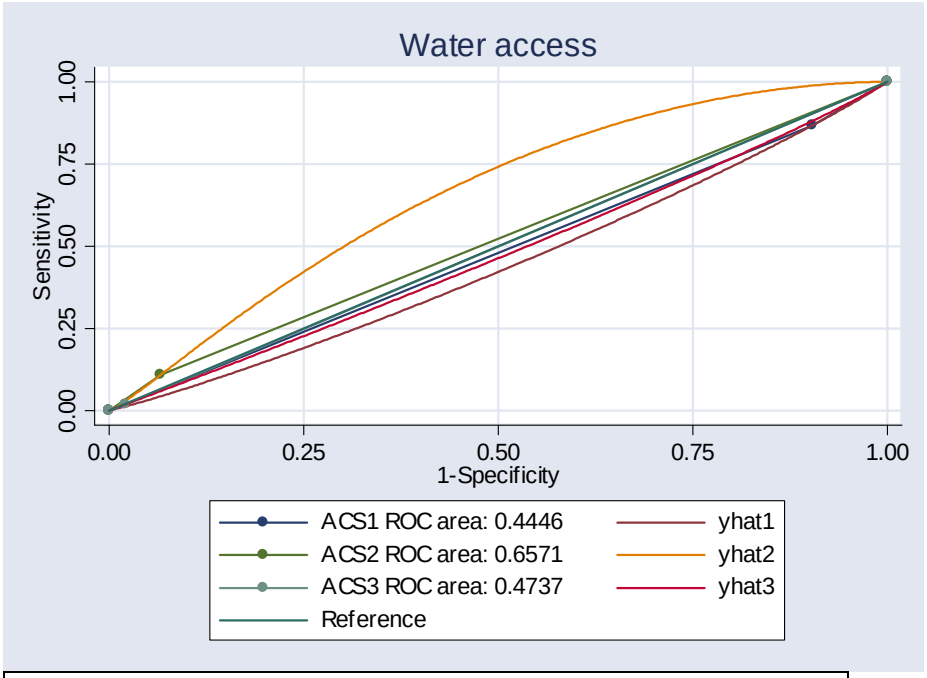


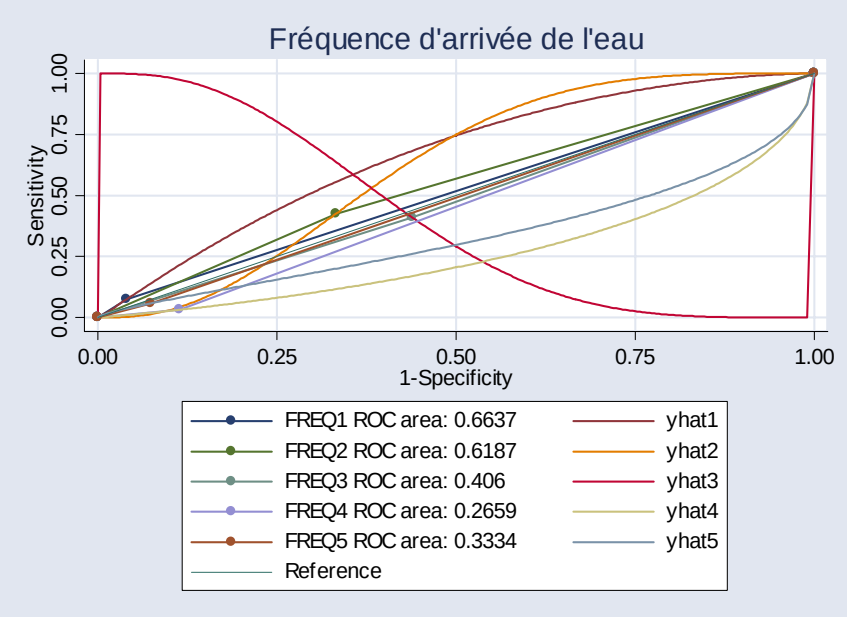
**Figure 3 : Curves & Statistics of the Six Parameters**




| | Obs | ROC Area | Std.Err. | [95% Conf.Interval] | |
|---|---|---|---|---|---|
| **ACS1** | 786 | 0.4446 | 0.0028 | 0.43918 | 0.44999 |
| **ACS2** | 786 | 0.6571 | 643.7214 | -1.3$^{e}$+03 | 1.3e+03 |
| **ACS3** | 786 | 0.4737 | 0.0015 | 0.47074 | 0.47664 |

Ho: area(ACS1) = area(ACS2) = area(ACS3)
chi2(2) = 98.24 Prob>chi2 = 0.0000

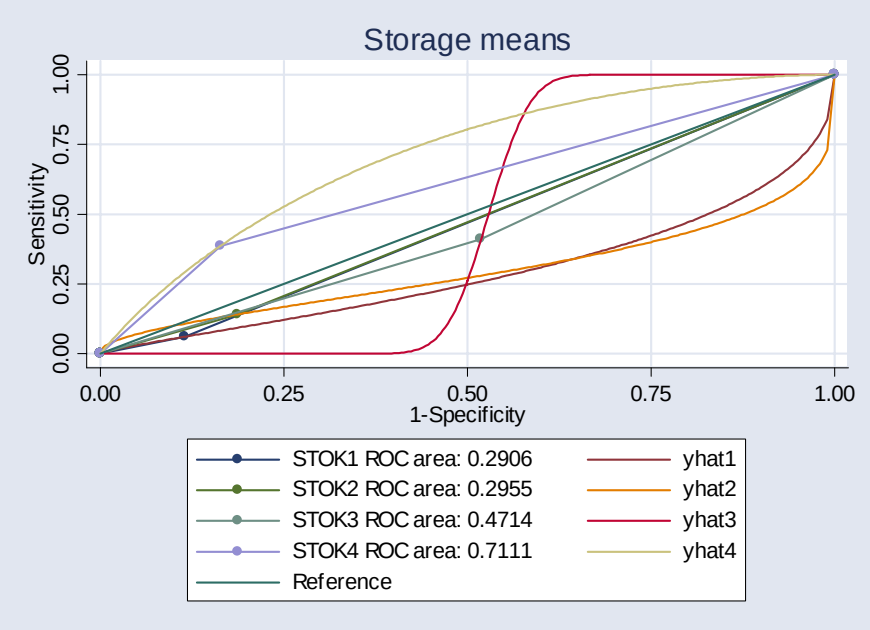
```
roctab POV_Subj ACS2, detail table graph

                ACS2
POV_Subj        0           1       Total

0             536          38         574
1       189          23         212

Total         725          61         786


Detailed report of Sensitivity and Specificity

                                                Correctly
Cut point      Sensitivity    Specificity    Classified    LR+       LR-

( >= 0 )           100.00%         0.00%        26.97%  1.0000
( >= 1 )            10.85%        93.38%        71.12%  1.6388
0.9547
( >  1 )             0.00%       100.00%        73.03%
1.0000
```




| | Obs | ROC Area | Std.Err. | [95%Conf.Interval] | |
|---|---|---|---|---|---|
| **FREQ1** | 687 | 0.6637 | 0.0079 | 0.64817 | 0.67923 |
| **FREQ2** | 687 | 0.6187 | 0.0253 | 0.56914 | 0.66827 |
| **FREQ3** | 687 | 0.4060 | 0.0251 | 0.35687 | 0.45518 |
| **FREQ4** | 687 | 0.2659 | 0.0160 | 0.23459 | 0.29721 |
| **FREQ5** | 687 | 0.3334 | 0.0081 | 0.31748 | 0.34933 |

Ho: area(FREQ1) = area(FREQ2) = area(FREQ3) = area(FREQ4) = area(FREQ5)
chi2(4) = 158.99 Prob>chi2 = 0.0000

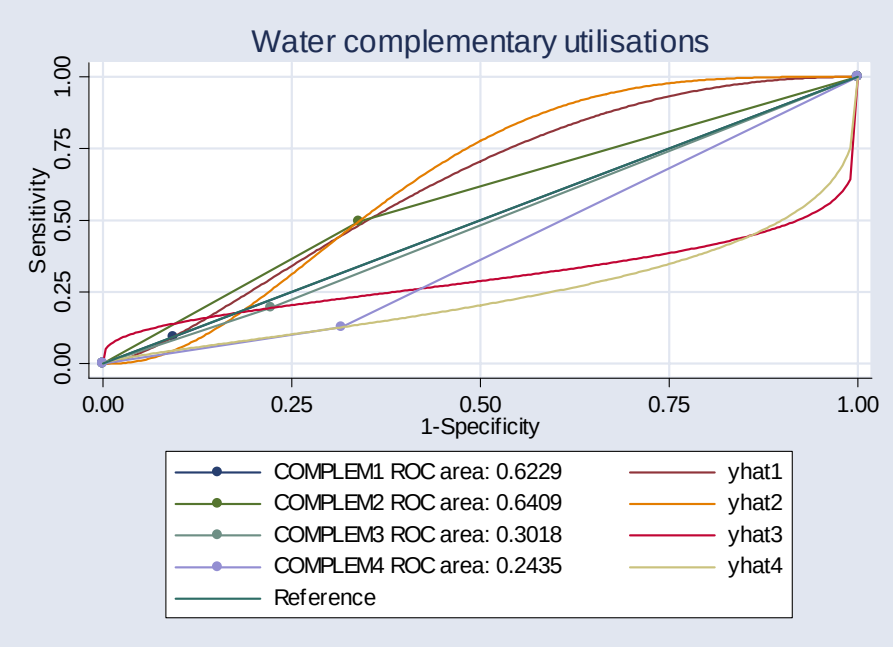
```
roctab POV_Subj FREQ1, detail table graph

             FREQ1
POV_Subj   0          1        Total

0        479         20          499
1        174         14          188

Total    653         34          687


Detailed report of Sensitivity and Specificity

                                          Correctly
Cut point     Sensitivity   Specificity   Classified  LR+    LR-

( >= 0 )          100.00%         0.00%       27.37%   1.0000
( >= 1 )            7.45%        95.99%       71.76%   1.8580
      0.9642
( >  1 )            0.00%       100.00%       72.63%             1.000
```




| | Obs | ROC Area | Std.Err. | [95%Conf.Interval] | |
|---|---|---|---|---|---|
| **STOK1** | 768 | 0.2906 | 0.0108 | 0.26934 | 0.31180 |
| **STOK2** | 768 | 0.2955 | 0.0341 | 0.22863 | 0.36231 |
| **STOK3** | 768 | 0.4714 | 0.0214 | 0.42949 | 0.51330 |
| **STOK4** | 768 | 0.7111 | 316.6035 | -6.2e+02 | 6.2e+02 |

Ho: area(STOK1) = area(STOK2) = area(STOK3) = area(STOK4)
chi2(3) = 173.29 Prob>chi2 = 0.0000

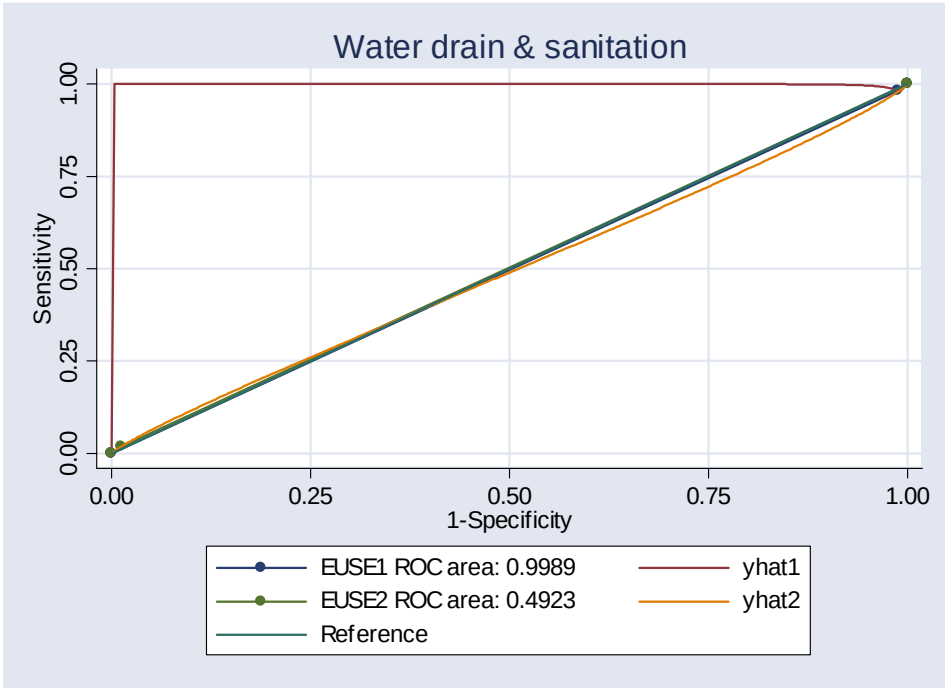
```
roctab POV_Subj STOK4, detail table graph

             STOK4
POV_Subj   0          1      Total

0        465         91        556
1        130         82        212

Total    595        173        768


Detailed report of Sensitivity and Specificity

                                                 Correctly
Cut point     Sensitivity   Specificity   Classified    LR+     LR-

( >= 0 )          100.00%         0.00%       27.60%   1.0000
( >= 1 )           38.68%        83.63%       71.22%   2.3633
0.7332
( >  1 )            0.00%       100.00%       72.40%
1.0000
```




| | Obs | ROC Area | Std.Err. | [95%Conf.Interval] | |
|---|---|---|---|---|---|
| **COMPLEM1** | 544 | 0.6229 | 0.0080 | 0.60716 | 0.63864 |
| **COMPLEM2** | 544 | 0.6409 | 123.3171 | -2.4e+02 | 2.4e+02 |
| **COMPLEM3** | 544 | 0.3018 | 0.0392 | 0.22497 | 0.37873 |
| **COMPLEM4** | 544 | 0.2435 | 0.0362 | 0.17255 | 0.31443 |

Ho: area(COMPLEM1) = area(COMPLEM2) = area(COMPLEM3) = area(COMPLEM4)
chi2(3) = 121.71 Prob>chi2 = 0.0000

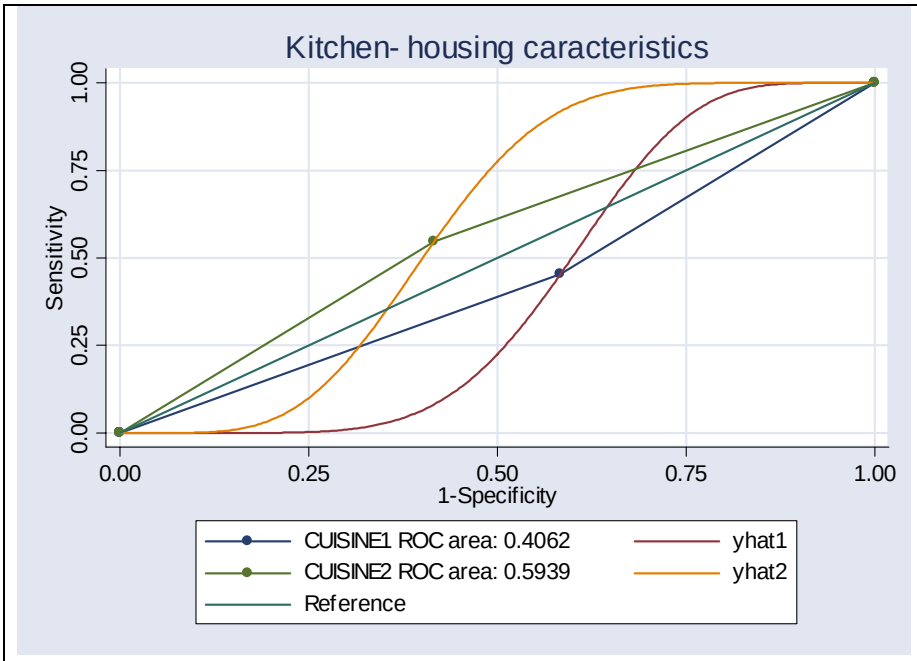
```
roctab POV_Subj COMPLEM2, detail table graph

             COMPLEM2
POV_Subj   0          1      Total

0        261        134        395
1         75         74        149

Total    336        208        544


Detailed report of Sensitivity and Specificity

                                              Correctly
Cut point      Sensitivity   Specificity   Classified     LR+    LR-

( >= 0 )          100.00%         0.00%       27.39%    1.0000
( >= 1 )           49.66%        66.08%       61.58%    1.4640   0.7618
( >  1 )            0.00%       100.00%       72.61%              1.0000
```




| | Obs | ROC Area | Std.Err. | [95%Conf.Interval] | |
|---|---|---|---|---|---|
| **EUSE1** | 786 | 0.9989 | 0.3346 | 0.34302 | 1.65471 |
| **EUSE2** | 786 | 0.4923 | 0.0004 | 0.49149 | 0.49311 |

Ho: area(EUSE1) = area(EUSE2)
chi2(1) = 141.24 Prob>chi2 = 0.0000

```
roctab POV_Subj EUSE1, detail table graph

                EUSE1
POV_Subj    0           1       Total

0           7         567         574
1           4         208         212

Total      11         775         786


Detailed report of Sensitivity and Specificity

                                                 Correctly
Cut point      Sensitivity    Specificity    Classified     LR+    LR-

( >= 0 )            0.00%        100.00%        73.03%           1.0000
( >= 1 )           98.11%          1.22%        27.35%   0.9932  1.5472
( >  1 )          100.00%          0.00%        26.97%   1.0000
```




| | Obs | ROC Area | Std.Err. | [95%Conf.Interval] | |
|---|---|---|---|---|---|
| **CUISINE1** | 786 | 0.4062 | 0.0221 | 0.36295 | 0.44951 |
| **CUISINE2** | 786 | 0.5939 | 0.0221 | 0.55061 | 0.63716 |

Ho: area(CUISINE1) = area(CUISINE2)
chi2(1) = 21.75 Prob>chi2 = 0.0000

```
roctab POV_Subj CUISINE2, detail table graph

             CUISINE2
POV_Subj   0          1      Total

0          335        239        574
1           96        116        212

Total      431        355        786


Detailed report of Sensitivity and Specificity

                                                Correctly
Cut point      Sensitivity    Specificity    Classified     LR+    LR-

( >= 0 )          100.00%         0.00%        26.97%    1.0000
( >= 1 )           54.72%        58.36%        57.38%    1.3141   0.7759
( >  1 )            0.00%       100.00%        73.03%              1.0000
```

**Table 1: Components of WPI**

| | |
|---|---|
| **Resources** | The physical availability of surface and ground water, taking account of the variability and quality of the resource as well as the total amount of water. |
| **Access** | The extent of access to water for human use, accounting not only for the distance to a safe source, but for the time needed for domestic water collection, and other significant factors. Access does not simply mean access to safe water for drinking and cooking, but also to water for irrigating crops or for industrial use. |
| **Capacity** | The effectiveness of people's ability to manage water. Capacity means the allowed income to purchase improved water, education and health. |
| **Use** | The ways in which water is used for different purposes; it includes domestic, agricultural and industrial use. |
| **Environment** | An evaluation of an integrated environment related to water within an ecosystem. |

**Source:** Sullivan, 2003.

**Table 2: Social Water Stress Index**

| Countries | Water Stress Index* (WSI) | Standard hydrological categorization of water stress or water scarcity | Human Development Index (HDI) | Social Water Stress Index** (SWSI) | Social resource scarcity categorization of water stress or water scarcity |
|---|---|---|---|---|---|
| Algeria | 19 | Water scarcity | 0.737 | 26 | Water-scarcity |
| Egypt | 11 | Water-scarce | 0.614 | 17 | Water stressed |
| Jordan | 31 | Absolute water scarcity | 0.730 | 43 | Absolute water scarcity |
| Morocco | 9 | Water stress | 0.566 | 16 | Water stress |
| Syria | 3 | Relative sufficiency | 0.755 | 4 | Relative sufficiency |
| Tunisia | 23 | Absolute water scarcity | 0.748 | 31 | Absolute water scarcity |
| Palestinian Ter. | 16 | Water-scarce | 0.733 | 22 | Water-scarce |
| Turkey | 3 | Relative sufficiency | 0.772 | 4 | Relative sufficiency |
| Israel | 26 | Absolute water scarcity | 0.913 | 28 | Water scarce |

* The Water Stress/Scarcity Index (WSI) used here equals hundreds of persons per flow unit (one flow unit is one million cubic meter of renewable water):
- Relative sufficiency: 0-5
- Water stress: 6-10
- Water scarcity: 11-20
- Absolute water scarcity: >20

** The Social Water Stress/Scarcity Index suggested here is arrived at by dividing WSI by HDI:
- Relative sufficiency: 0-9
- Water stress: 10-19
- Water scarcity: 20-29
- Absolute water scarcity: ≥30

**Source:** Ohlsson, L. 1998.

**Table 3: Sensitivity, Specificity and Type I and Type II Errors**

| | *Non-poor* | **Poor** |
|---|---|---|
| **Predicted Non-poor** | $SP = NP^{-}/NP$ | $1 - SE = P^{-}/P$ |
| **Predicted Poor** | $1 - SP = NP^{+}/NP$ | $SE = P^{+}/P$ |

**SP** *specificity;* **SE** *sensitivity;*
**P** *number of the poor;* **NP** *number of the non-poor;*
**P+** *number of the poor classified as poor;* **P-** *number of the poor classified as non-poor;*
**NP+** *number of the non-poor classified as non-poor; and* **NP-** *number of the non-poor classified as poor.*

**Source :** Wodon (1997)

**Table 4: Decision Matrix for Subjective Poverty and Water Deprivation**

| | **No water deprivation** | **Water deprivation** | |
|---|---|---|---|
| No poor household | **No consistent poverty SP TN** | **Water deprivation FP** | TN +FP=1 |
| Poor household | **Subjective poverty FN** | **Consistent poverty SE TP** | FN+ TP=1 |

**Table 5 : Household Subjective Poverty in the Region of Tlemcen**

| **Subjective household poverty** | **Number of household** | % |
|---|---|---|
| Non poor household | 574 | 73,03 |
| Poor household | 212 | 26,97 |
| Total | 786 | 100 |