


A Horsfield
Village water supply scheme - Senegal
INTRODUCTION

The paper describes the study which commenced in 1983 for the water supply to 24 village areas for human, animal and agricultural purposes in Senegal. Both the study and the construction work is being implemented using local counterpart staff and local labour to ensure satisfactory operation and maintenance

The study included a considerable input to ensure that the social and economic environment of the country and of the villages was fully understood and taken into account.

The proposals have been put forward based on experience gained from a previous project constructed in the neighbouring country of Mali 9 years ago.

PREVIOUS PROJECT

In the early 1970's my firm, Balfours Consulting Engineers of London, were employed on a major water supply sector study for the World Health Organisation for the Republic of Mali. The study recommended a priority list of practical water supply projects for both towns and villages. The top priority town was Sikasso, the chief town of the 6th Sector. The proposal to construct the works by direct labour was originally made because of the remoteness of Sikasso and the lack of experience of local contracting firms in this type of work.

The involvement of local engineers and labour enabled them to have a much better understanding of the design and construction and consequently the project has continued to operate satisfactorily.

The main problem has been the occasional lack of fuel for the pumping station. The money for the fuel should be provided by Energie du Mali but the funds provided have sometimes been either too small or too late. The local operations manager has no access to funds raised by the provision of water.

SENEGAL VILLAGE WATER SUPPLY SCHEME
Study Team

The study is funded by the Overseas Development Administration and our proposal was submitted in March 1983. The team

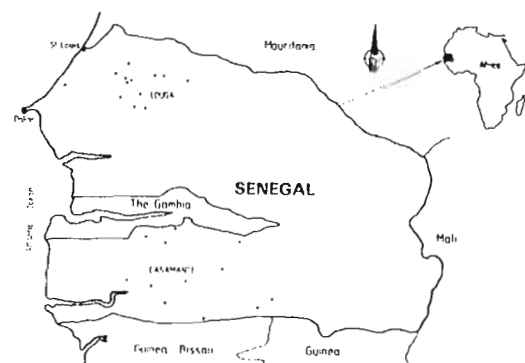
arrived in Senegal early in May 1983 and completed their studies in September of that year. Following the submission of a draft report in English and subsequently in French the report was approved in January 1984.

Whilst in Senegal our engineering staff worked closely with local counterparts whose knowledge of the area and the customs of the peoples was most helpful.

The study team in Senegal comprised a co-ordinating leader who was a Civil Engineer supported by two engineers, one Civil and a Mechanical and Electrical; an economist and a social anthropologist. Hydrological input was supplied by two specialists who visited for short periods and a borehole pumping test supervisor.

Topography

Senegal is situated in the extreme west of Africa on the Atlantic coast between latitudes 12° and 16° north. It is bordered by Mauritania, Mali, Guinea and Guinea Bissau. Senegal has a population of about 5 million and an area of 197 000 sq.kms.

Figure 1 - General Map


Study areas indicated thus •

The rainfall varies between 300mm and 1 200mm per annum. The number of dry months varies between 6 and 9.

The rock strata beneath Northern, Central and South-West Senegal form part of the large Mauritania, Senegalese, Guinea Basin

of Secondary and Tertiary sediments which overlay ancient basement which is exposed in the South-East. Within the sedimentary piles there are several aquifers of which the Maestrichtian sands are of particular significance. These sands under-ly a large part of Senegal, are generally medium to coarse grained, of moderate transmissivity $1-2 \times 10^{-2} \text{ m}^2/\text{s}$ and receive considerable re-charge from river infiltration. The quality of contained water is only moderate with total dissolved solids of 700-1500mg/l being typical.

The economy of Senegal is largely based on agricultural production and the rearing of livestock. The number of cattle, sheep and goats being more than the overall population with some areas having a very high cattle production.

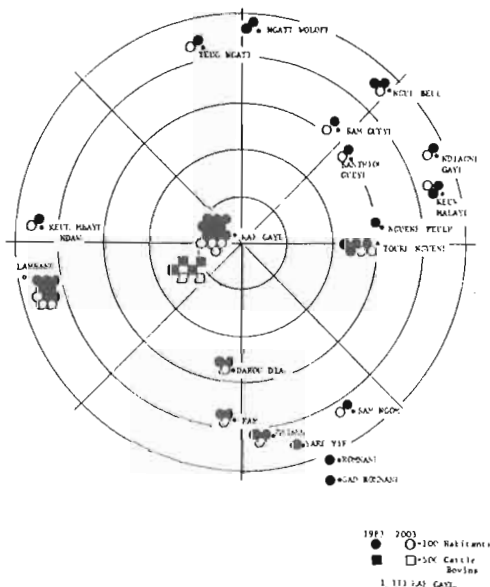
Investigations

In Senegal all work of water supply comes under the Ministère de l'Hydraulique with village water supplies coming under the Direction de l'Hydraulique - Rurale (DHR) which has several regional offices responsible for construction, operation and maintenance.

The villages studied were 12 villages in the semi arid northern Louga area and 12 further villages south of the Gambia River in the open forests of the Casamance area. Water supplies are from underground aquifers.

A village area was defined as the area within a .5 km radius of the main village or the borehole.

Figure 2 - Typical village plan - showing distribution of population and livestock.



The villages to be studied had been previously agreed between the British and Senegalese Governments. No suitable maps existed and there was difficulty in locating some of the village areas. The first task was to locate the village and produce a 'map' which indicated the relative positions of all houses and relative population distribution - Fig. 2 shows a typical 'target' plan for Kab Gaye. Whilst the positions were located using a four wheel vehicle the economist and the social anthropologist completed questionnaire based enquiries with the help of the local administration, the village chiefs and elders and also the men and women of the village. These meetings provided sufficient information on which to base human and livestock water requirements and to provide sufficient design information on which to estimate the future volume demand required. It also provided sufficient information on which to base economic comparisons of various alternative engineering solutions.

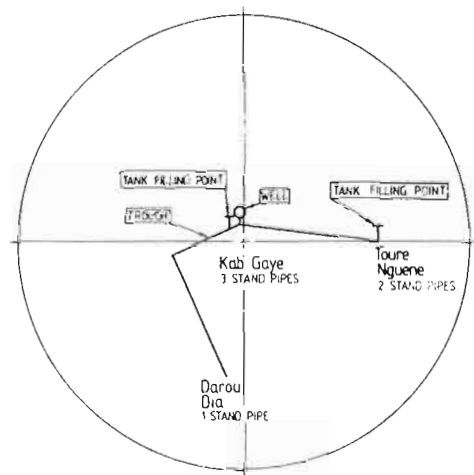
Figure 3 - Typical water demand summary

GLOBAL WATER DEMAND : BESOIN EN EAU GLOBAL				
Group Groupe	Max.		Min.	
	1983	2003	1983	2003
Human/Humain	130.3	186.1	86.9	124.1
Sheep & Goats/ Ovins/caprine	24.7	54.0	24.7	54.0
Cattle Troughs/ Abreuvoirs	104.9	155.5	86.3	127.9
TOTAL	259.9	395.6	197.9	306.0

NOTES:
1. Values in m³/d (en m³/jour)

After many alternative proposals had been compared, we finally recommended that eighteen village areas be supplied with a limited distribution system, comprising a borehole equipped with a diesel driven axial drive pump, a sectional steel water tank of 250m³ capacity mounted on a 30m tower and trunk distribution mains discharging through standpipes and cattle troughs and tank filling points.

Figure 4 - Typical distribution system



Social and Economic Considerations

Although the study team were provided with a significant amount of data which formed a useful framework and background, the team found a considerable difference in the customs, habits and requirements of each village area.

The main ethnic groups were the Wolof (74%), Peulh (19%).

The variations in the circumstances of 24 villages made it impossible to generalise on the existing availability of water. It is readily available throughout the rainy season in some village communities but at other times there are substantial migrations of cattle and humans caused by complete lack. Particularly in the Louga area many womens hands are deformed by the continual raising of water from depths up to 100 metres.

To obtain comparable data village by village, a comprehensive questionnaire was drawn up. We were thus able to identify the villages which fall into the 5 km catchment area, their population and an assessment of the livestock population, and to review the agricultural patterns and any particular topographic or socio-economic features for comparison.

The following is an example of the population structure of a village in the Louga region.

Males	14 - 65 years	227
Females	14 - 65 years	80
Male children		60
Female children		27
Over 65 years		3
		<u>397</u>

Much individual research was done on the structure of each village and family unit. The population forecasts for the Louga and Casamance areas are summarised as follows:-

Village	Human Population		Cattle		Sheep & Goats	
	1983	2003	1983	2003	1983	2003
Louga	56 965	79 855	79 890	118 770	82 610	177 470
Casamance	34 400	49 275	66 845	120 710	40 580	123 955
Total	91 360	129 130	146 735	238 480	123 190	301 425

In order to forecast per capita consumption the following figures were used.

Population	Per Capita Consumption (litres/days)	
	High	Low
Human	30	20
Cattle	40	30
Sheet & Goats	5	5

Using this data, detailed design figures were prepared equating the estimated well outputs with the present and future requirements for humans, animals and agriculture. The sizes of pumps, distribution pipes and power or fuel requirements were also calculated.

LIII 6 KAB GAYE			
Water demand 2003	= 306m ³ /d	Water available	= 1500m ³ /10 hrs
Water tower:			
Water tower volume	= 250m ³	Regulating volume	= 66.9m ³
Standby volume	= 183.1m ³	Irrigation volume	= 120m ³
Height to bottom water level	= 30m	Height of base above borehole	= 10m
Distance from borehole	= 500m		
Inlet connection	= 100m dia.	Outlet connection	= 150m dia.
Outlet connection	= 200m dia.	Washout connection	= 100m dia.
Special fittings	: Cascade aerator		
Pumping Equipment Water Demand 1983	= 198m ³ /d	Initial pumping rate	= 25m ³ /hr
Borehole static level	= 35m	Lowest dynamic level	= 55m
Pump setting level	= 60m		
Total head	= 110.6m		
Pump type	: Mono BR 2500	Pump speed	= 700 rpm
Pump absorbed power	= 12.5 kW		
Engine type	: Lister diesel BRW2	Engine speed	= 1500 rpm
Site derated engine output power	= 15.3 kW		
Fuel consumption	= 3.57 l/hr		
30 day fuel consumption @ 10 hrs/day	= 170l 1/30 days		
Lubricating oil consumption	= 12 l/30 days		
Water Outlets:			
Drinking troughs	= 1 x 2 No. troughs	86.3m ³	} throughput/day
Bornes Fontaines	= 6 No.	41m ³	
Tank Filling points	= 3 No.	70.6m ³	

After much research, it was considered unreasonable to expect villagers to contribute more than 5 per cent of cash incomes to water supply costs. This was the basis on which the level of service and recharge rates were calculated.

Implementation

In view of the location of the villages and the level of technology applied we reasoned that the proposals would not attract serious international competitive tenders. We therefore recommended standardisation of equipment, materials and structures and all works being carried out by local labour under our supervision. We considered that this would provide local jobs, a better understanding by the locals of the works and a better performance of operating and maintenance tasks. In addition all the plant and equipment required during construction would be handed over to the Senegalese at the end of work possibly enabling further schemes at relatively low cost.

The construction will be undertaken in sequence so that certain key construction workers can be moved from village to village and so that instruction on operation and maintenance can be given over an extended period.

Unfortunately I cannot yet report on actual construction progress as the orders for plant and equipment for other than survey purposes have not yet been made.

Acknowledgements

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