

Dili (East Timor) Re-establishing the water supply after the events of September 1999

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Chronology of recent events²

On 4 September 1999 the results of the referendum of 30 August were announced by UNAMET. Twenty-two percent of the East Timorese registered to vote accepted the Indonesian Government's autonomy proposal and 78% were against it. A period of general violence followed until INTERFET troops were deployed in Dili on 20 September. The ICRC delegates were forced to leave East Timor on 6 September. On 14 September most of the UNAMET staff had to evacuate their compound, taking with them the 1,300 refugees who had fled there in the face of paramilitary attacks. Only 12 staff members remained in the former Australian Embassy. On their arrival in Darwin, they reported that Dili was totally destroyed and looted, with only the walls left standing. Two ICRC delegates returned the same day.

The first peacekeeping units, numbering 1,190, arrived in Dili. Within 24 hours a total of 2,300 were deployed. The ICRC was allowed to carry out a limited survey in Dili town on 20 September, under the protection of the

TNI Army. The Dili General Hospital was intact but most of the equipment had been looted or damaged. On the same day, three engineers and technicians arrived, together with other ICRC staff. On the 22nd, the ICRC decided to take over responsibility for the management of the hospital and established its headquarters on the premises. On the same day, the engineers began their initial survey of the Dili water supply system.

Background

The city of Dili is located on an E-W coastal plain with three major rivers flowing through it from the Guguleu-Milimanu mountain range. The older part of the town is located on the eastern side. The main expansion of the town has taken place to the west, where land has been reclaimed from the Bemori river delta and in the airport area, where some housing projects have been put up.

Figure 1 is a topographic map of the city³ showing the urban areas and the limits of the districts. This map has been used to generate the 3D model shown below and to georeference the recent mosaic obtained from



Figure 1
Topographic map of the town of Dili

¹ ICRC engineers involved in this context. Special thanks to Graham Jackson (UNTAET), to Paul Naylor (OXFAM), Peter Ruff (INTERFET), Edoardo X., P. Ribeiro and Joaquim MC. (WAET)

² For the chronology prior to the events see East Timor, The Price of Freedom, J.G. Taylor, Pluto press, 1999

³ Topographic map of Dili. Ministry of Interior, 1986

aerial digital images. The newly built areas are easily recognised by comparing the boundaries of the urban area of the 1986 map with the recent digital aerial image. Figure 2 shows the new urbanised areas of western Dili, drawn over the georeferenced mosaic obtained from the geomatic division of the Australian Army. Population estimates for 1996, 1998 and according to a recent census carried out by UN OCHA/WFP in November 1999 and February 2000 are given above in table 1.

Table 1
Population estimates, number of customers for several Dili suburbs

District	Population	No. of connections
Comoro	21,200	249
Fatuhada/Kp.Alor	7,600	1,170
Bairo Pite	15,900	613
Colmera/Motael/Vilaverde	15,800	588
Caicoli/Lecidere	5,700	77
Lahane/Timur/Barat/Mascarenhas	17,400	439
Becora/Santa Cruz/Santana/Dili	36,900	855
Total	112,500	3,991

Population⁵ 1998: 156,488
Population Feb. 2000: 138,777

General situation of the water supply before the events⁶

The rivers are almost dry throughout the year and water flows visibly toward the sea only during the rainy season. Rivers and alluvial plains are fed by rainfall from November to March with, on average, between 1,200 and 1,500 mm/year. Rainfall is less in the northern areas, with averages between 500 to 1,000 mm/y, increasing in the mountains to 2,000 mm/y. Rainfall patterns were affected by the El Niño phenomenon in 1997/98 when a severe drought was observed.

The city of Dili is supplied from several sources: three water treatment plants (WTP) collecting water from intakes located uphill on the rivers Bemori, Bemos and Benemauk and from several boreholes scattered throughout the city which pump groundwater from the alluvial aquifers. Shallow wells equipped with hand pumps are also used to tap into semi-confined aquifers. Figure 3 on the following page shows a 3D model of the physiography, computed from the 50 m elevation iso-lines of the 1:50000 topographic maps of the city, where the main rivers are easily located.

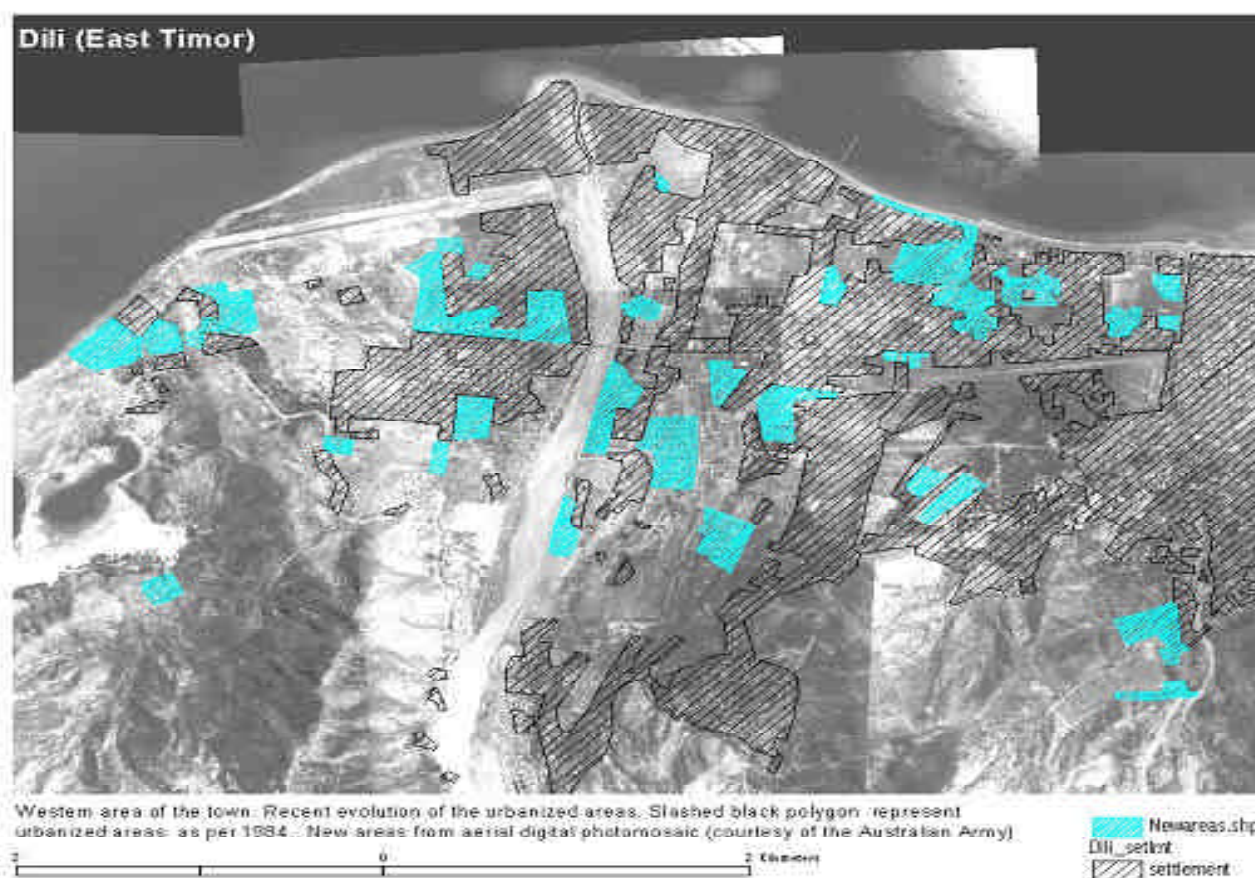


Figure 2
Expansion of the town since 1986

⁴ www.reliefweb.int

⁵ Master plan water supply for Kota Dili, BPAM Dili

⁶ Most of the data available on the situation prevailing before the events of September 1999 were obtained from USAID reports and more detailed information can be found in the references listed in the footnotes.



Figure 3
Topographic 3D model of the city showing the main rivers and the location of the main water production facilities

The productivity of the main WTP is affected by the flow of the rivers and decreases significantly during the dry season. The boreholes are less affected by changes in rainfall and their productivity can be considered constant throughout the year, the rate of pumping of the different bores representing only a small proportion of the natural and artificial discharge onto the coastal plain⁷. Besides the usual operating costs (chemicals, fast-running spares, etc.) only the unreliable power supply is responsible for the decrease in productivity.

The water treatment plants treat the water in a conventional way: from the intake at the river the raw water reaches the stations through steel transmission lines. To remove turbidity, coagulants are then added, the water is mixed and flocs are sedimented using upflow inclined lamellar plates. The water is then filtered through rapid sand filtration units, disinfected with the addition of chlorine and stored. Several dosing pumps add aluminium sulphate and chlorine and filters are cleaned with a backwash pump and air blowers. Two stations (Benemauk and Bemos) are compactly designed steel units and Lahane is a conventional concrete one. All these stations were completely refurbished and recommissioned in 1995 with funds from the Australian Development Project. Table II on the following page summarises the main water sources of the town and also shows the daily productivity in m³ of each unit, the year it became fully operational and the main areas supplied by the network.

The total theoretical capacity of all these facilities is up

to 23,000 m³/day. However, total production varies during the year and may change drastically during the dry season. Data regarding monthly productivity of the different sources are available from January to September 1998⁸ and suggest that this figure was never reached, even during the good months, such as January, when "only" 500,000 m³ were produced, representing an average of roughly 16,000 m³/day. For the three WTPs, productivity is partially affected by rainfall. Most rainfall is received during the north-eastern monsoon from November to March, in the wet season. According to data collected from 1992 to 1995, given in figure 5, rainfall in Dili varies from 840 mm/y to almost 2,000 mm/y and is close to zero between May and the end of October. Heavy rainfall may also decrease production as landslides can break the transmission lines for several days at a time. A lack of chemicals can also result in an interruption of the treatment process as turbidity increases significantly during heavy rains, with a consequent decrease in production.

Boreholes are not affected by variations in rainfall, as the aquifer can tolerate a long-term withdrawal within the defined pumping capacities⁹. Most of the boreholes supply elevated storage reservoirs. To increase operational efficiency and to supply the constantly expanding Comoro area, a new reservoir was built in 1994 with a capacity of 1,000 m³, served by the new Comoro C well. Comoro A and Comoro B were also connected to a newly rehabilitated storage reservoir of 1,000 m³ located at Bemos WTP, to improve distribution through the network and to increase pressure throughout the city. Almost all the pumping stations were also rehabilitated under the Australian project.

⁷ Hydrogeology of Dili and Suai, ETWSS Project, L.W. Drury, Australian International Development Assistance Bureau and Government of Indonesia, September 1993

⁸ ETWSS Project: Dili water supply

⁹ Hydrogeology of Dili and Suai, ETWSS Project, L.W. Drury, Australian International Development Assistance Bureau and Government of Indonesia, September 1993

Table II
Main water sources of the town of Dili

WTP	Type of treatment	Year of const.	Year of full operation	Capacity m3/day	Operators	Intakes Distance in Km	Suburbs supplied
Bemos	C+S+F+D	1'984	1'995	3'500	3	4 Bemors river 100-200 l/sec	Bairro Pite, Caicoli, Villaverde, Central Dili
Lahane	C+S+F+D	1'954	1'995	2'600	3	9 km Bemori 10-40 l/sec and Benemauk 15-50 l/sec	Taibessi, Culu Hun, Acadiru Hun, Santa Cruz, Bemori, Audian, Bidau and Central Dili
Benemauk	C+S+F+D	1'993	1'995	900	1	Benemauk	Becora
Total WTP				7'000			
Comoro A	P		1'995	3'000	1		Comoro area
Comoro B	P		1'995	3'500	1		Comoro area and network to central Dili
Comoro C	P		1'999	2'160	1		For Comoro C reservoir
Comoro D	P		1'997	2'850	1		To Comoro C Réservoirs
Comoro E					1		
Kuluhun A (Becora)	P		1'996	1'730	1		Becora reservoir and network
Kuluhun B (Bemori)	P		1'998	2'600	1		
Hera II	P		1'999	430	1		
Hospital					1		
Total boreholes				16'270			

P = Pumping, C = Coagulation, S = Sedimentation, F = Filtration, D = Disinfection,
Total theoretical production (WTP and boreholes) 24 hours of operation: 23,270 m3

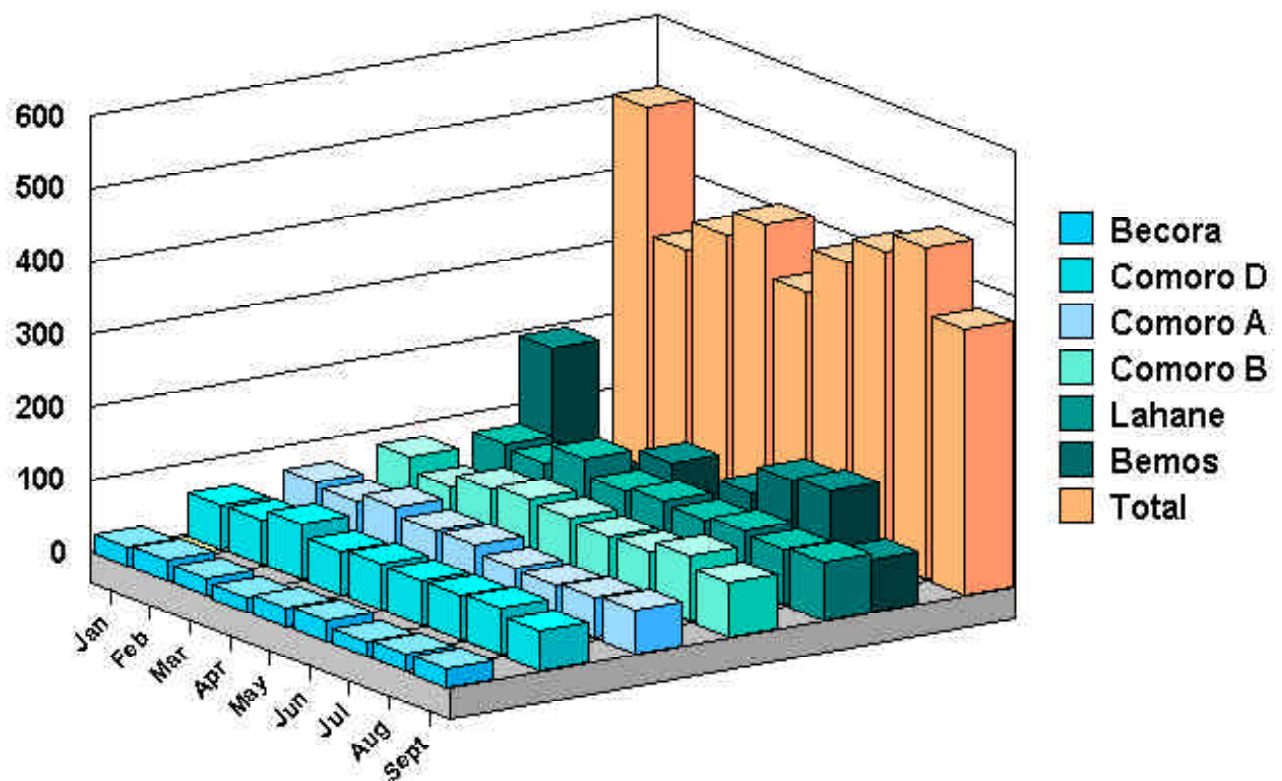


Figure 4
Dili urban water supply 1998 water production m3/month (Adapted from ETWSS project)

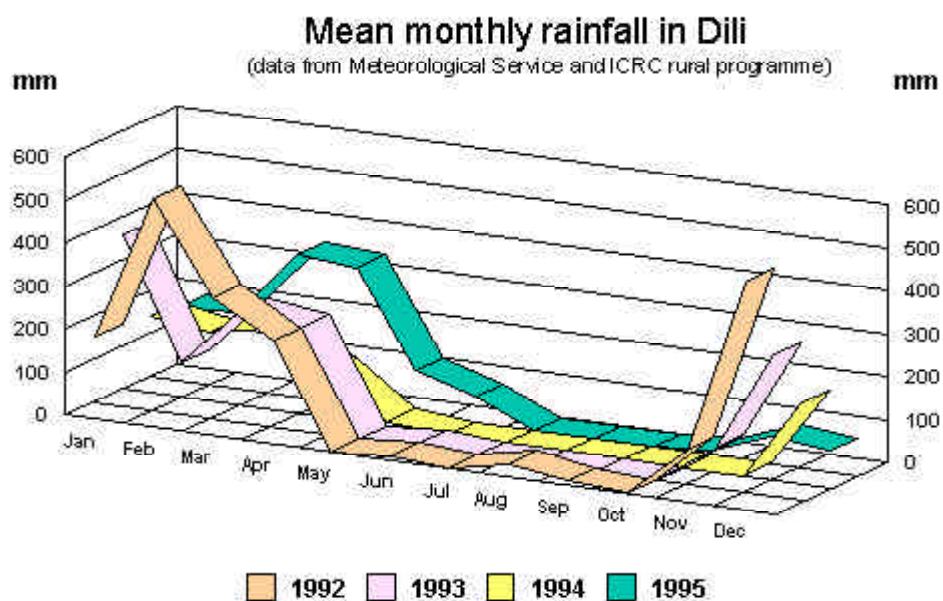


Figure 5
Rainfall patterns in Dili

Network problems

The city network consists of different types of pipes, some of them laid before the 1975 annexation. The main network grid has been digitised using ARCVIEW[®] (ESRI) geographical information software and transferred onto the georeferenced image, where the main streets are easily recognisable. Districts can also be plotted for analysis of the evolution of the leaks and for reporting.

In 1994, total leakage from the Dili distribution system was estimated to be at least 60 l/s (about 5,000 m³/d)¹⁰. Precise tests carried out in West Dili during the night showed leaks of around 33 l/s and suggest that the value of 60 l/s was probably underestimated. A leakage control programme was launched in 1994 targeting mainly central Dili, where water was due to flow again once the Lahane WTP was fully operational, in early 1995. According to the ETWSS Project report the leakage team was almost overwhelmed by the number of leaks springing up every day due to the increased operating pressure and areas where significant portions of the mains would have to be replaced were identified. Illegal connections were also numerous, close to 1,500 of a total of about 4,000 legal connections.

Shallow wells

Hundreds of shallow wells equipped with hand pumps had been dug within the city. They were in poor condition and many of the hand pumps were out of order and needed to be replaced or rehabilitated. The quality of the water was poor.

Evaluation of the state of the infrastructure after the events

Power¹¹

The two power generation facilities of Dili (total capacity 25 MW) did not suffer major damage, though poor maintenance has left them in a precarious state. Office buildings suffered only minor damage and could be reopened quite quickly. Engineers and technicians from the Power and Water Authority of the Northern Territory Government managed to reorganise the former staff of the PLN in a new structure that started progressively to restore a safe and reliable source of supply. The high voltage distribution system (20kV) and the low voltage (380/220 V) overhead reticulation suffered major damage but could be repaired relatively quickly by the former teams of line-men, which were managed by extremely efficient PAWA

technicians. A major problem was to repair, before restoring power, the low voltage house connections that had been burnt down along with the residences, and posed a serious threat to the lives of the inhabitants. Moreover, several distribution transformers were damaged by gunshot and had to be removed or repaired.

Water supply

The various units were no longer operational but had suffered only limited damage. Two water treatment plants were partially looted and only one was in working condition, but without sufficient chemicals to carry out proper treatment. Production was limited to water with low turbidity and disinfection was carried out manually. Only a few items had been looted, such as the dosing pumps for the addition of chemicals to remove turbidity and disinfect the water, and almost all the maintenance tools.

With the exception of the hospital borehole, only one (Comoro B) was in reliable working order and was used by INTERFET to cope with the immediate needs of the units. All the others were either disconnected from the power supply due to damage to the premises or suffered from the general lack of power in the area. Neither any of the pumping stations nor the WTP were equipped with standby generating sets.

Following the post-referendum violence, the staff, fearing for their safety, were forced to abandon their homes and leave the town to seek protection in the hills. Technicians began progressively to return to their work but all the senior management, engineers and administrative staff of the PDAM had left the country. Of the head office, only the walls were left and all the documents had been looted or burnt.

The distribution network was severely damaged and leaks occurred everywhere. Vehicles and repair tools had been looted.

Chronology of rehabilitation activities

Rehabilitation started almost immediately after the arrival of the ICRC engineers and the reorganisation of the former PDAM staff. A supply-driven strategy was chosen, with priority given to production, followed by a programme to detect the main leaks in the larger diameter pipes, the repair and suppression of leaks in the secondary network and finally the repair of losses at the household level. An engineer from Oxfam assisted the different teams in assessing the main electrical problems of the pumping stations and the WTPs.

¹⁰ ETWSS Project: Dili water supply

¹¹ UNDP, East Timor, Plan of action for rehabilitation, operation and maintenance of key infrastructures in East Timor, Power and Water Authority, Northern Territory Government, Australia, November 1999

Chronology of the rehabilitation of Dili's water supply: main activities from September 1999 to February 2000

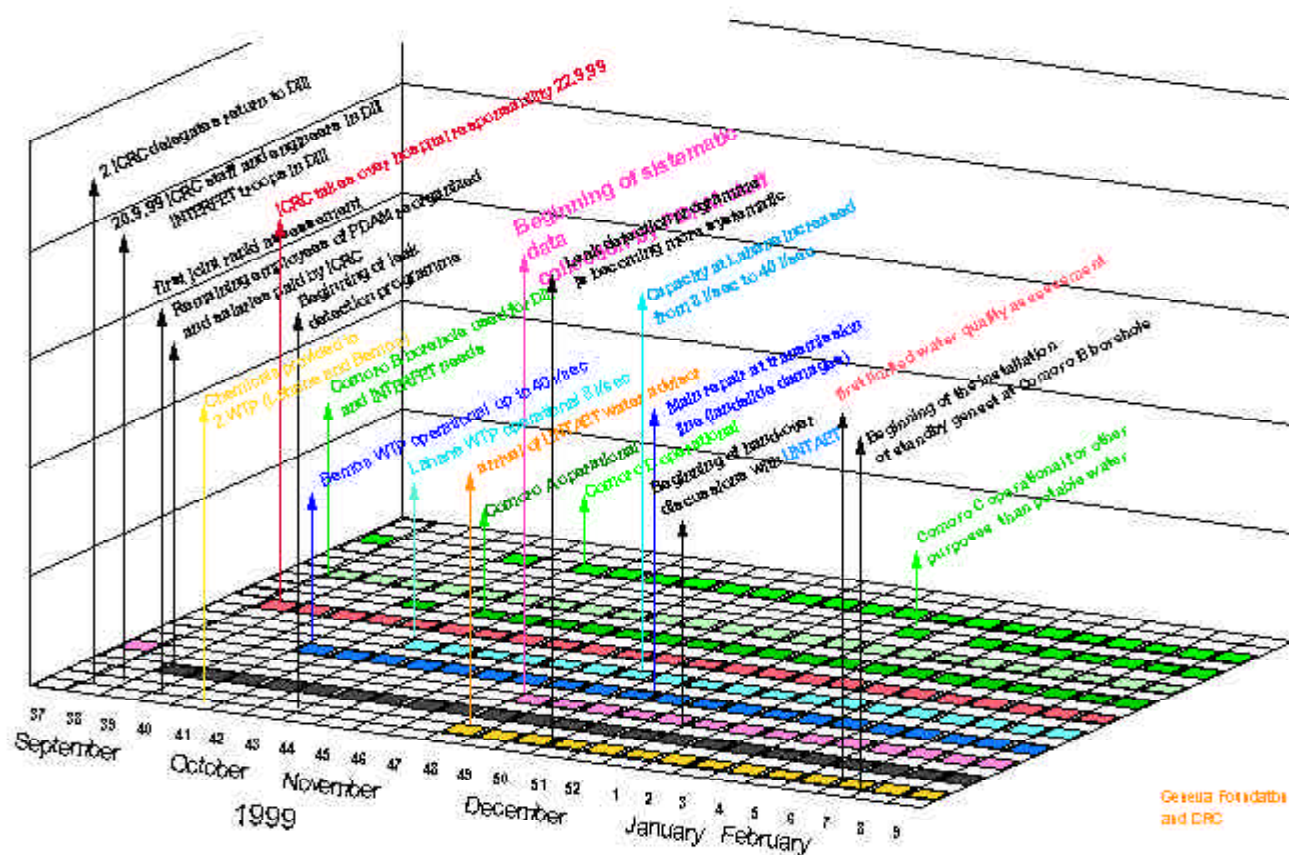


Figure 6
Chronology of the rehabilitation of Dili's water supply

Between weeks 38 and 48, most of the water facilities were again operational, with only a few producing less than their design capacity. Figure 6 shows the chronology of the activities carried out to restore the water supply to the city.

At the end of November, with the continuous support of the ICRC and, to some extent, of other NGOs, the reorganised water utility (PDAM) was in a stronger position than it had been prior the events, in terms of water production.

Impressive achievements were made possible by the rapid reorganisation of former PDAM technical personnel through the establishment of a new temporary organisational structure, and the provision of continuous administrative and financial support to this structure. The role of the engineers was mainly to set priorities regarding the tasks to be carried out, together with all the actors and particularly with the INTERFET liaison officer, the electrical engineers of the Northern Territories and other NGOs, and to co-ordinate the efforts of all the participants. Two vehicles were made available to PDAM teams, as were radio facilities that enabled better co-ordination of the planned activities.

In early December, key flowmeters were installed and the existing ones repaired, making it possible to quantify the improvements and to measure the performance of the supply strategy that had been adopted. Data collection forms were introduced and daily water production recorded as an indicator of the performance of the utility. One motorbike was put at the disposal of PDAM for this specific purpose.

Thirty MT of aluminium sulfate and 7 MT of HTH (high title hypochlorite) were procured to ensure adequate supplies for the continued operation of the Lahane, Bemor and Benemauk WTPs.

In order to re-establish customer contact PDAM began, in early December, to inform the population about the ongoing maintenance of the municipal water system by using loudhailers in localities directly affected by maintenance work. At the same time, light rehabilitation of the former PDAM offices was carried out to provide at least a focal point to discuss issues of water supply, leaks etc. with customers. The pump houses were also repaired to allow attendants to carry out their duties normally.

In mid December, leak detection became more systematic with the repair teams operating on a zone-by-zone basis using motorbikes to improve co-ordination and facilitate intervention on the network.

All the relevant documents held by the ICRC concerning the water supply system of Dili were handed over to UNTAET, as well as the two motorbikes. The two pickups were returned to the ICRC.

At the end of January 2000, after lengthy negotiations, INTERFET agreed to return the Comoro B borehole for the sole use of the public service and to shift its tanker trucks to Comoro E, which can only be used for that purpose. This will solve the current shortages in the Fatuhada district of Dili.

With the arrival in Dili (week 48) of the UNTAET water coordinator, the issue of the hand-over of the ICRC's responsibility in the management and support of the PDAM was raised. At the end of the year, PDAM was in a position to maintain the current standards of service provision in a reasonably autonomous manner and the transfer of responsibilities was feasible. For organisational reasons the hand-over could not take place before the end of February, when UNTAET took over the payment of salaries.

Three 100 kVA stand-by gensets were installed by the ICRC at the two Comoro borehole pumping stations (B and D) and one at Kuluhun B, to be used in case of power failure, and officially handed over to the water utility. The 50 kVA gensets belonging to PDAM were due to be repaired and installed as back-up gensets at the two main WTPs, to operate the dosing pumps and the back-wash pumps in case of power failure.

A letter of agreement was signed at the beginning of March between WAET (Water East Timor, the new designation of PDAM) and the ICRC. All the equipment procured (dosing pumps, tools, etc.) and the 21 MT of chemicals still in the ICRC warehouses were transferred to the newly rehabilitated WAET warehouse.

March 2000: end of ICRC involvement in the rehabilitation of the urban water supply.

Performance of the different water facilities

Water treatment stations

At the beginning of December most of the facilities were equipped with metering systems and the operators were trained to collect data and report them using the appropriate forms. Of particular interest were the quantities produced per day or per week in order to monitor the results of the adopted supply strategy and to identify the origin of any problems that might arise. Comparison with previous data would allow the future management of the utility to take appropriate measures to improve production and define the future strategy.

In the next figure (figure 7) we have plotted the daily production of the three WTS and in figure 9 the production of the main boreholes in operation from December to end of February. Daily production records are of paramount importance during this initial phase as they may explain why the outcomes were lower than expected. The causes of lower production could be a lack of power, problems in the main transmission lines because of damage, lack of chemicals to treat the water, or other causes. Of particular interest is the decrease in production due to power failures. Information regarding their frequency and duration will allow the management to decide whether it is necessary to install stand-by gensets and to plan fuel consumption. Other information will help determine the amount of chemicals to purchase, which is essential to the continuity of distribution.

For instance, production was almost down to zero at Bemós during week 50. A landslide did occur 8 km upstream from the plant and a 20 m section of the 10-inch main steel transmission linking the intake works to the plant was damaged and had to be replaced. PDAM staff were able to repair the damage and restore the normal delivery of about 80 l/s of raw water to the plant within two days. In the meantime, the boreholes were able to meet demand temporarily. The figures also show that heavy rain can result in reduced production. Heavy rain increases the turbidity of the water and alum must be added to remove the suspended particles. Operators are instructed to start the dosing pumps when turbidity is higher than 20 NTU (nephelometric turbidity unit), as chlorination may be ineffective. If there is a power failure the pumps cannot be operated and production must be stopped to avoid further problems in the distribution mains. The turbidity of the water is measured three times a day in most of the plants and at least at Lahane WTP, where the operator is very well trained.

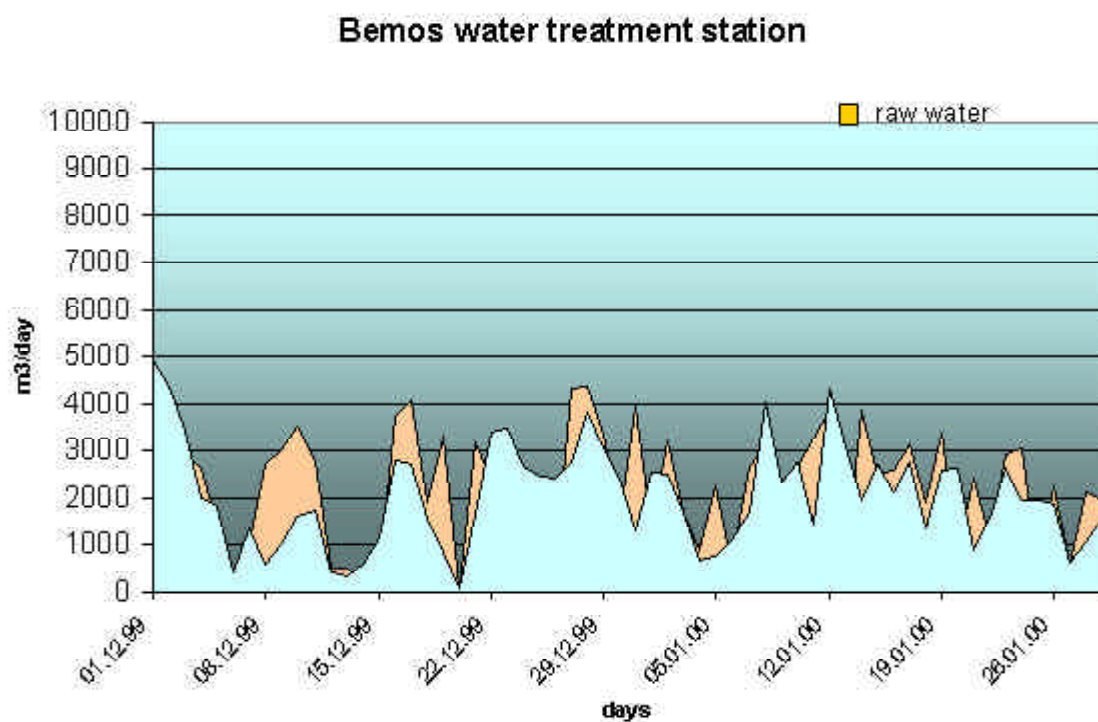
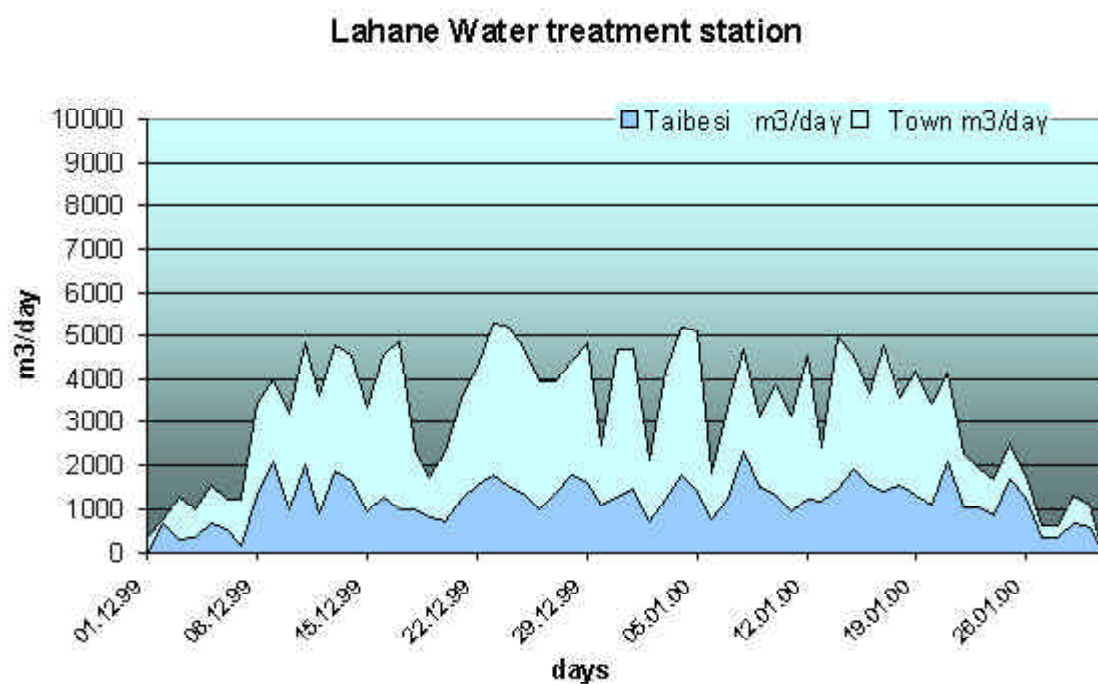


Figure 7 a, b
Daily production at Lahane, Bemos and Benemauk WTPs in m³ from December to February

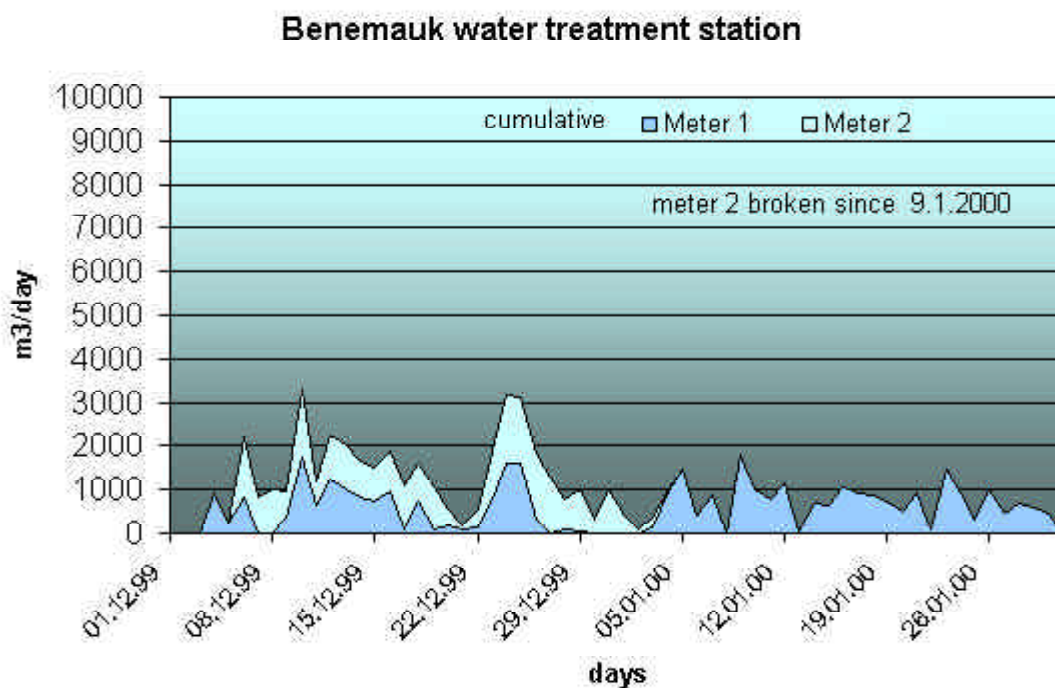


Figure 7 c
Daily production at Lahane, Bemoss and Benemauk WTPs in m3 from December to February

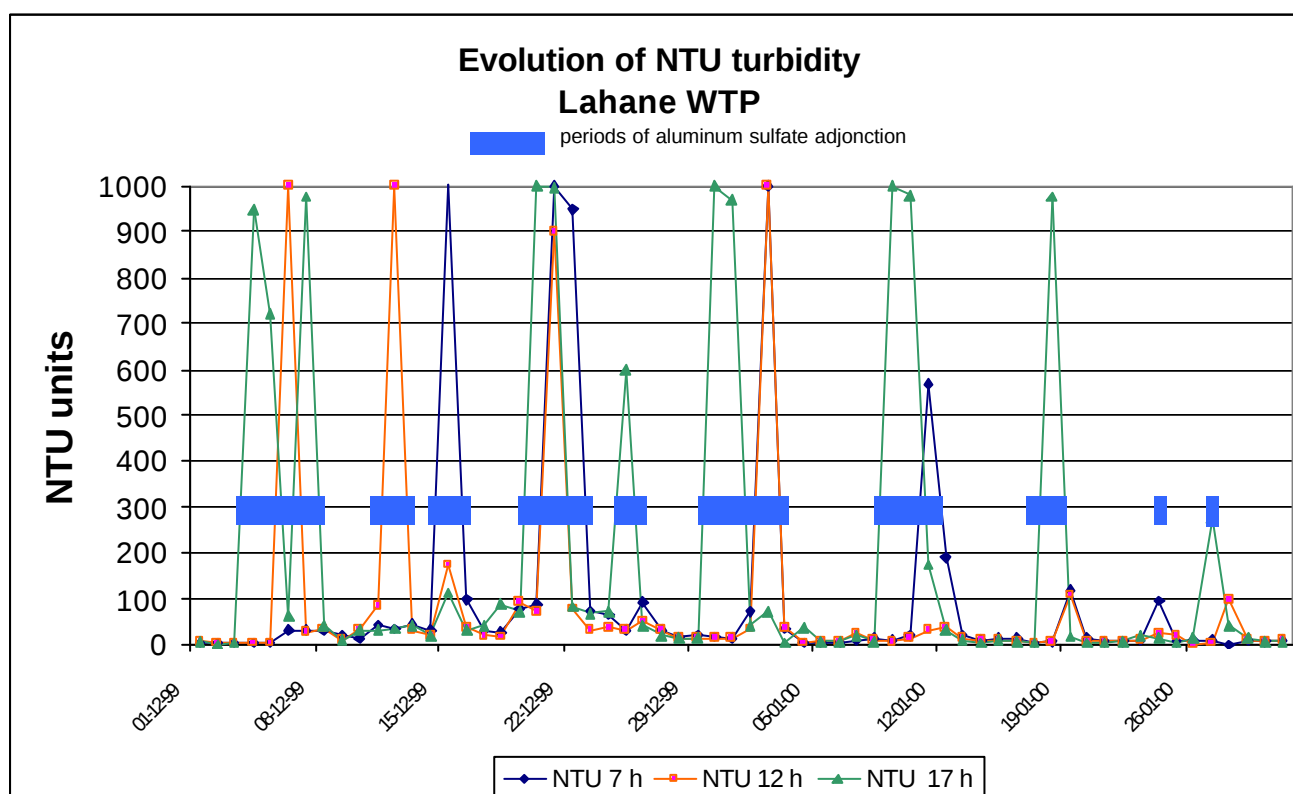


Figure 8
Evolution of the turbidity of the raw water feeding Lahane WTS, due to rainfall

Data for December 1999 and January 2000 are reported in figure 8 where the increase in turbidity due to the heavy rains is easily observed.

Peaks of turbidity levels higher than 100 NTU requiring the use of alum were observed during roughly half of the month. Most of them resulted in only slight decreases in production as power was fairly constant during this month, chemicals were available and the dosing pumps were working. Significant drops in production are generally due to a combination of lack of power and heavy rains, but reports are not precise enough to identify the origins of the problem. Only when the transmission line suffered heavy damage could the origin of the drop be clearly identified.

Boreholes

The contribution of the different boreholes depends on the productivity of the well and on the type of pump installed. Production data from the beginning of the pumping operations are lacking. Results of the hydrological study carried out by Drury in 1993¹² showed that the aquifer could sustain pumping rates of up to 40 l/sec and even higher. Spare pumps were ordered before the events and were luckily found in the PDAM warehouse. New pumps were installed at Comoro A where

the old pump had failed due to normal wear just before the events, and at Kuluhun B. Most of the operational capacity of the boreholes was in fact resumed between weeks 38 and 44. Lacking data for the beginning of the operation, we may assume that they were operating at full capacity, i.e. at design capacity.

Data collected at Kuluhun A in November show that this was not really the case, the mean daily production of 720 m³ (8.3 l/sec) being much lower than the normal capacity of the well (20 l/sec). The results are presented in figure 9. According to the data sheet, the borehole was operated for 17 hours during the first 3 weeks, reaching 24 hours a day during the last week (mean production up to 14 l/sec), probably with some power failures, which would explain the "poor" results.

The quality of the water pumped from the underground is not affected by rainfall, at least as far as turbidity is concerned. Treatment is less important as compared to surface water. If disinfection through the addition of chlorine is in principle recommended, particularly in a network where negative pressure may occur, disinfection can be temporarily bypassed. In fact, the dosing pumps had been stolen from all the boreholes and disinfection could not be carried out. However, this would not affect production figures.

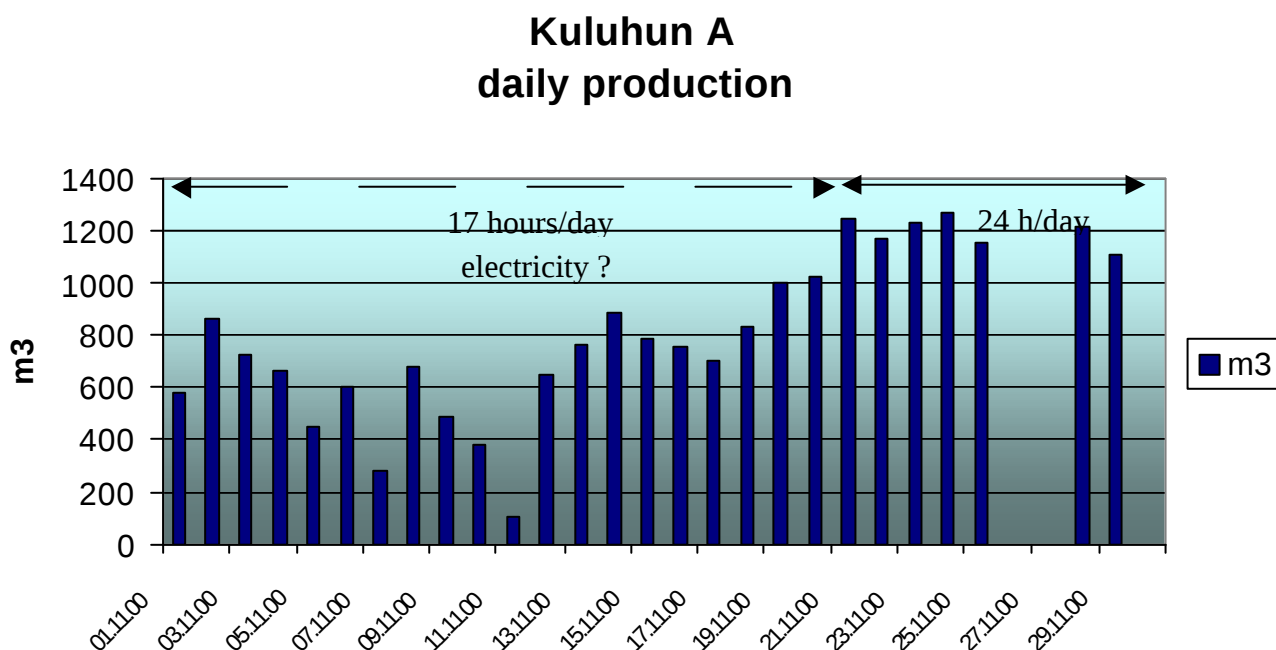


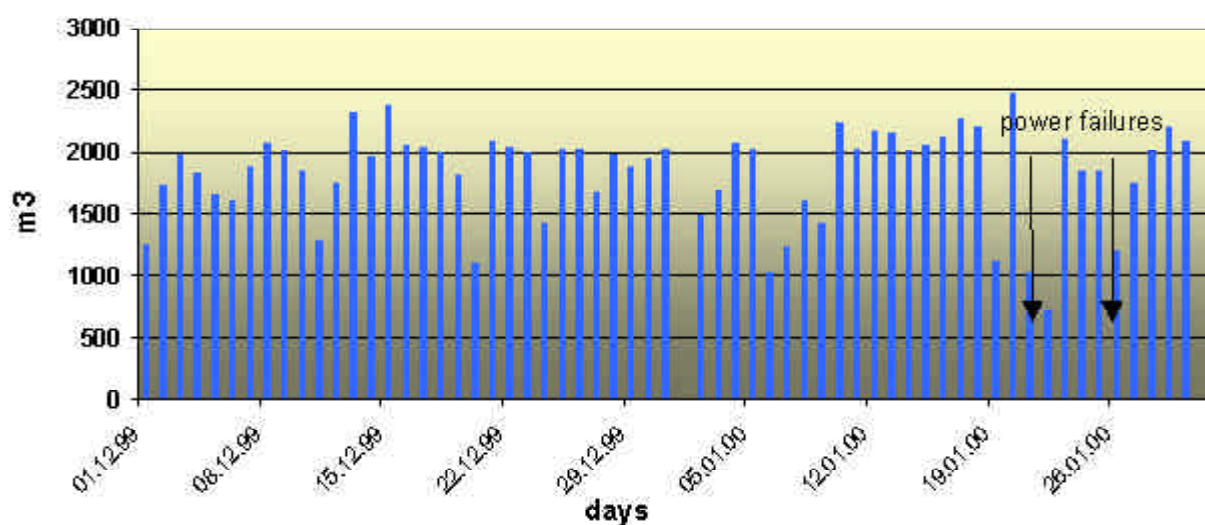
Figure 9
Daily production at Kuluhn A borehole during November 1999

¹² L.W. Drury, Hydrogeology of Dili and Suai, op.cit.

Productivity then only depends on the reliability of the power supply and on technical problems. Daily production of the different boreholes, from the data sheets collected at the beginning of December, is reported in figure 10.

All the boreholes reached their design capacities and were operating quite regularly. Any drops in production were due to power failures. Some of these failures were reported in the data sheets, as for Comoro B on 28 January. Other drops are not reported very precisely but are certainly also due to problems of power distribution, but their importance in the overall production is minor.

Comoro A borehole Daily production



Comoro B borehole Daily production

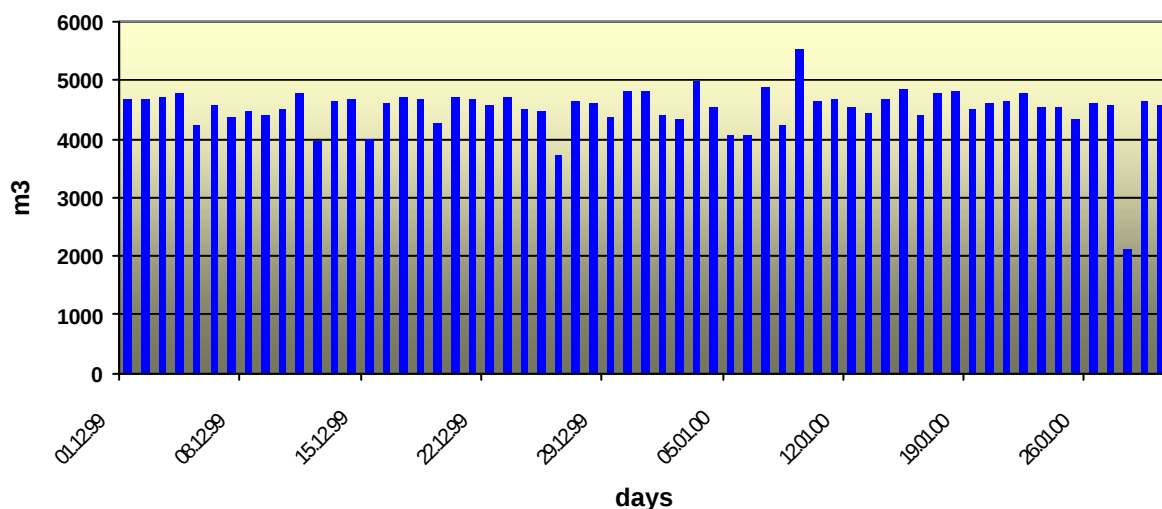
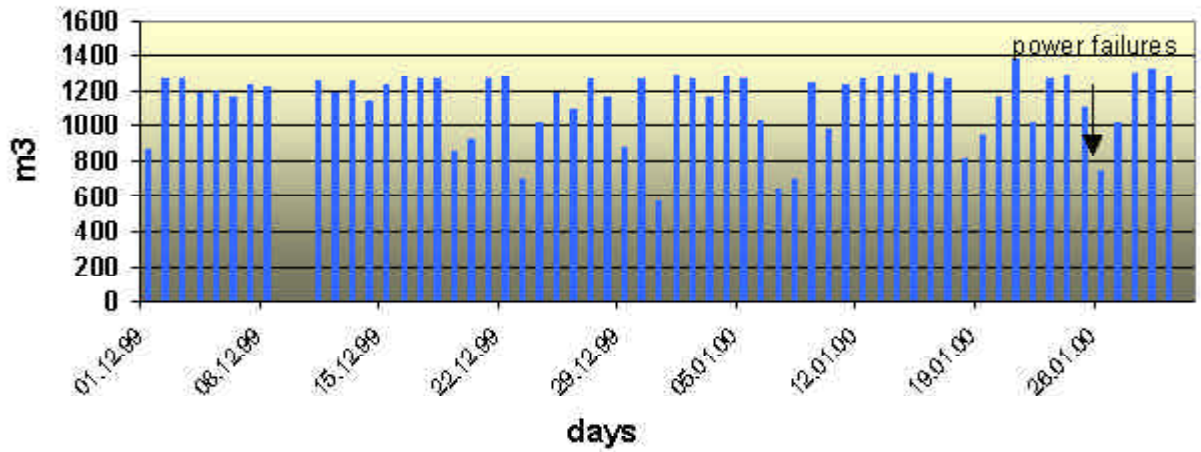


Figure 10
Daily production at Comoro A and B

Kuluhun A

Daily production



Kuluhun B

Daily production

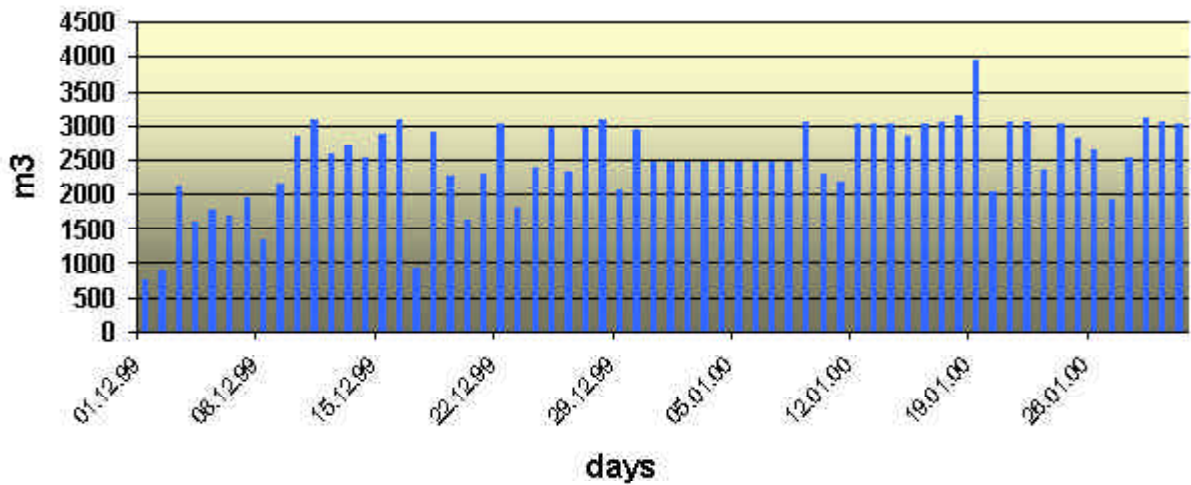


Figure 10
Daily production at Kuluhun A,B boreholes from December to February

Of particular interest at Comoro B are the amounts delivered to INTERFET. This borehole was immediately operational and was used to cover the needs of the intervention force, which took control of the pumping station and installed emergency equipment designed to treat water in any condition. Despite the impressive set-up and the queue of tanker trucks at the filling station, the quantities used by the army were quite small compared to the capacity of the borehole. Out of a mean daily production of about 4,500 m³ barely 500 m³/day were used, which still represented 25 tankers of 20 m³ each. At the end of January the borehole at Comoro E was ready to cover

these needs and INTERFET eventually shifted all its equipment to the new location, leaving the full production of Comoro B for public purposes. By the end of January the consumption of the army was down to about 100 m³/day, at least as far as tanking was concerned.

The production of the WTPs in April is given in figure 12. It is striking to notice that daily mean production decreased slightly, from 3,074 to 2,978, for Lahane despite being affected by the rains, particularly at the end of the month, but dropped more significantly for Bemos, from 1,893 to 1,378 m³/day, also due to frequent rains, but certainly also because of power cuts.

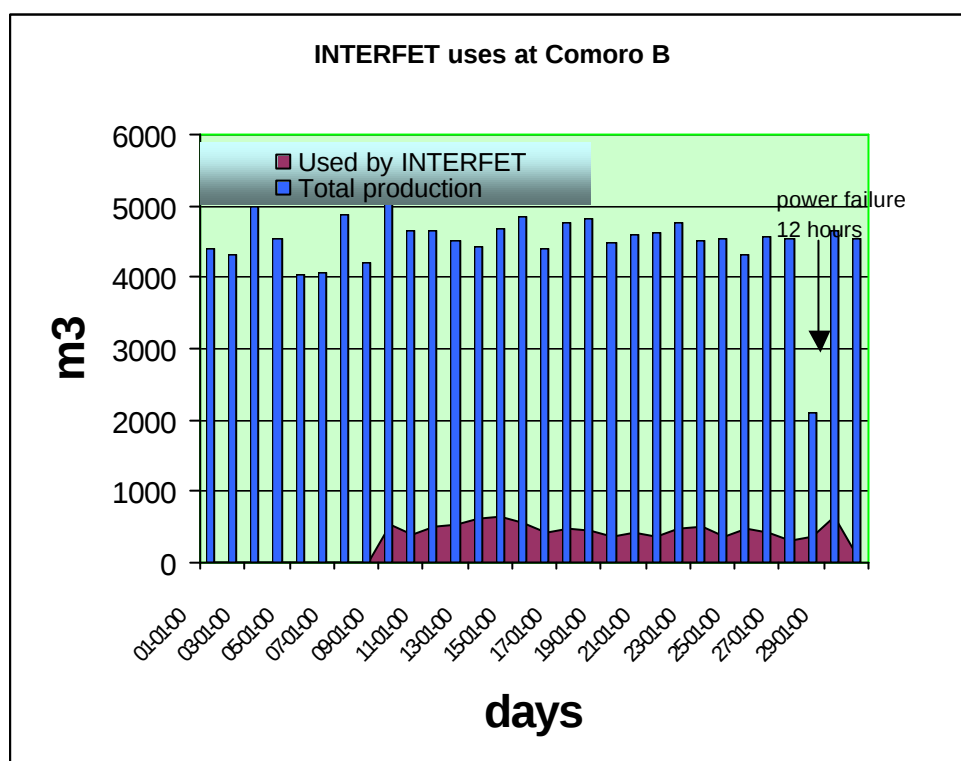


Figure 11
Daily production at Comoro B and amounts used by INTERFET

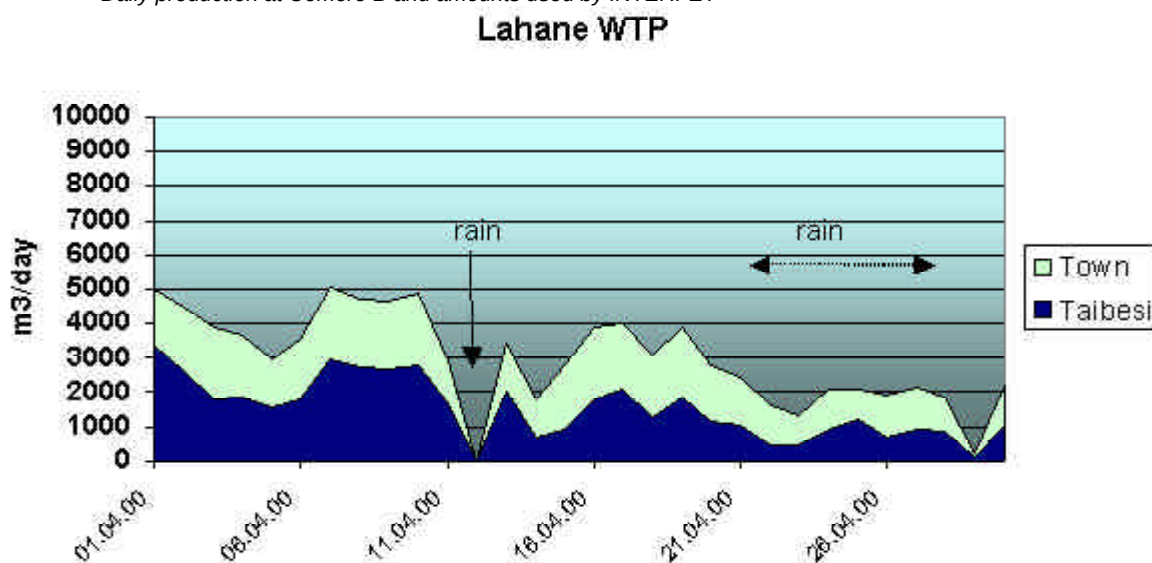


Figure 12
April 2000 daily production in m³ for Lahane WTP

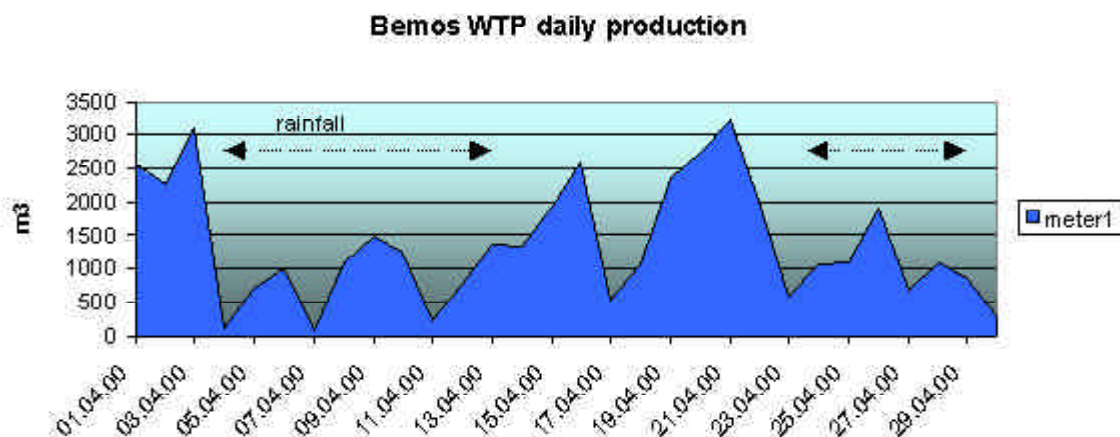


Figure 12
April 2000 daily production in m3 for Bemos WTP

The same cannot be said for the boreholes, as they are less affected by rain. On the contrary, data show that their production increased, probably because of the use of the standby gensets installed at Comoro

B,D and at Kuluhun B. At this last borehole there are no data for about 17 days but it is not known if any water was produced or if they are lacking because the meter was out of order.

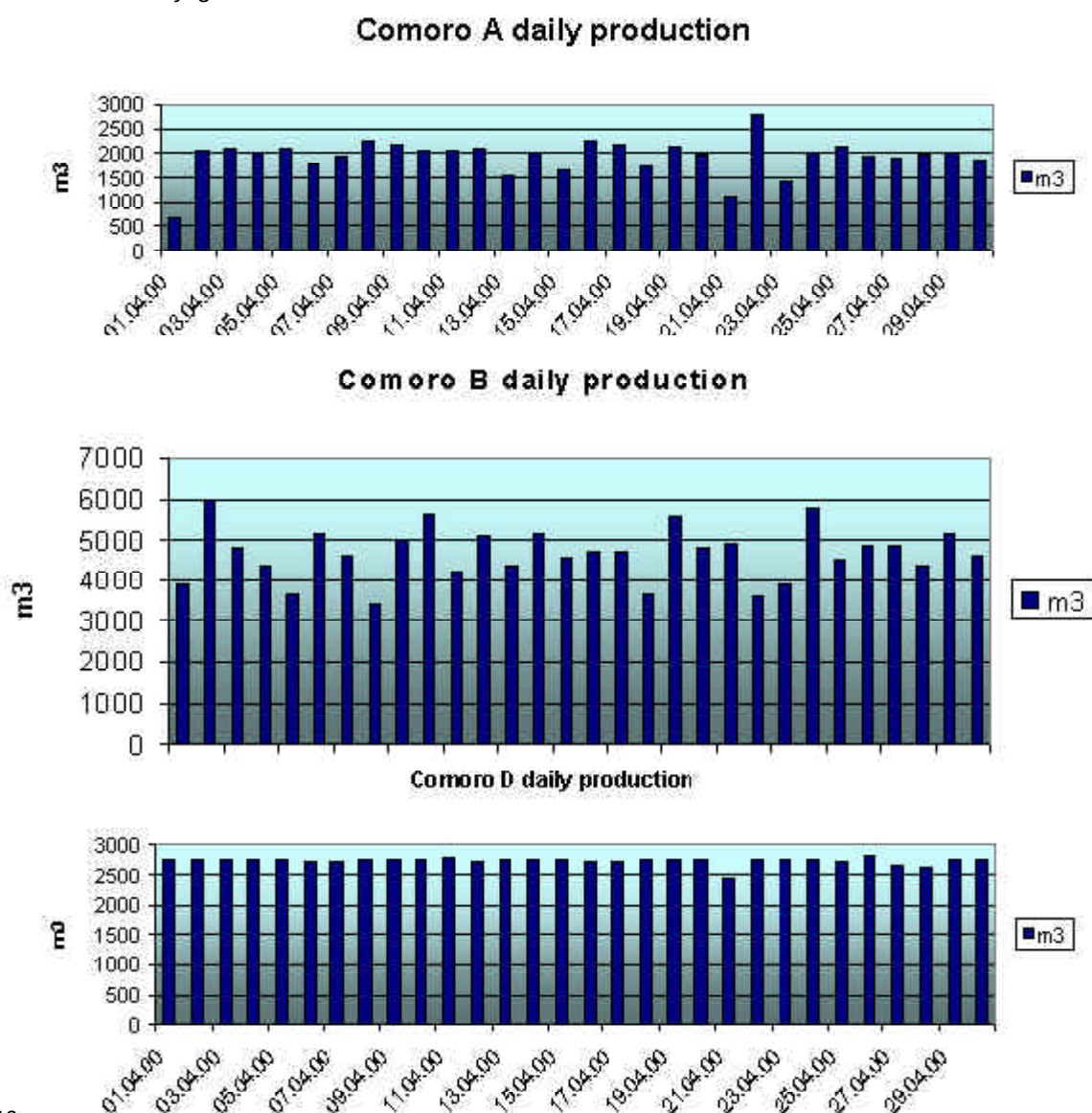


Figure 13
Daily production at Comoro A, B, and D

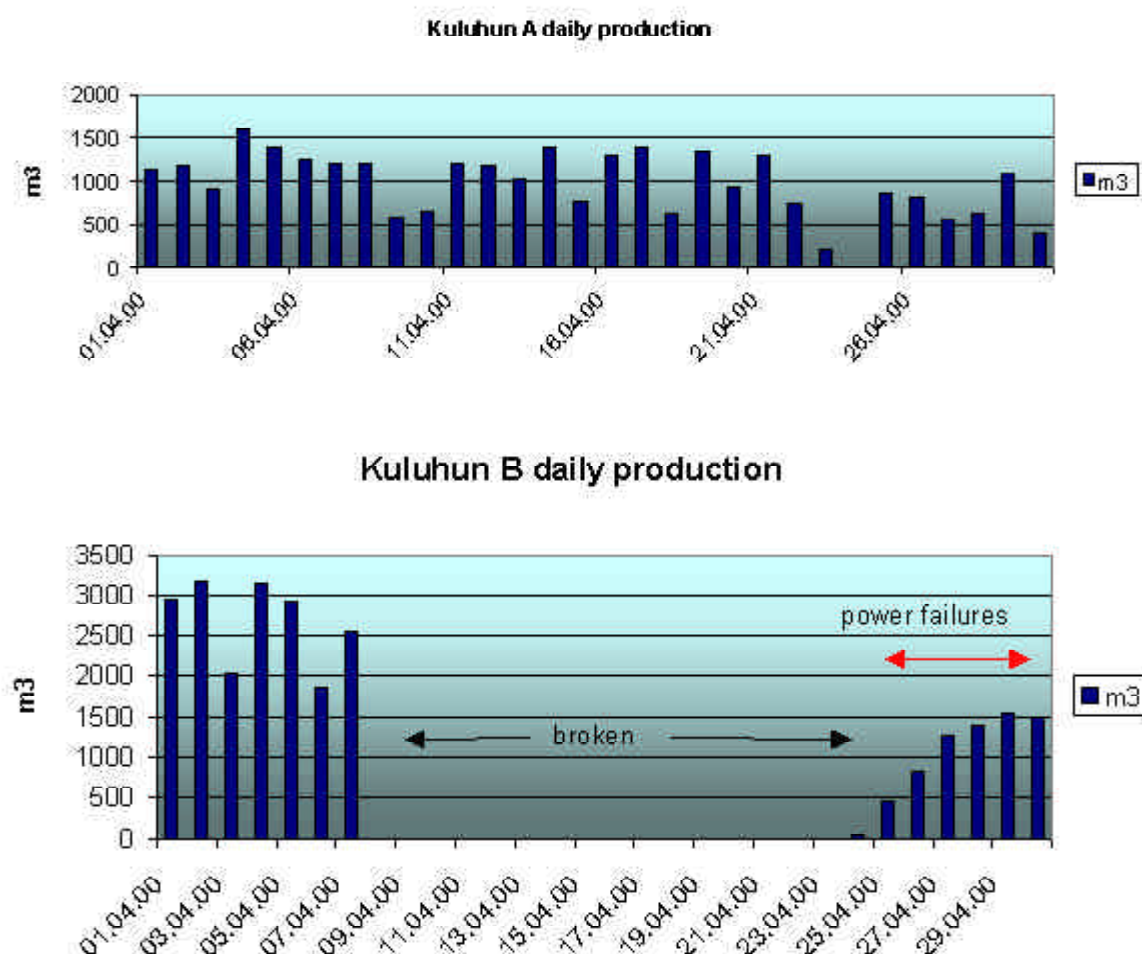


Figure 13
Daily production at Kuluhun A and B in April 2000

Interventions in the distribution network

A leak detection and suppression team was set up as soon as the network was put under pressure. Logistics and tools were made available to carry out repairs on the main transmission lines and to cap all the in-house damaged connections. From the very beginning two teams were established to cover East and West Dili. An impressive job was done to suppress all the leaks in the empty houses, due not only to damage but also to taps left running when the inhabitants were forced to flee to safety. Table III gives the type and number of interventions of the two teams.

About 542 house connections were suppressed from the time of the constitution of the teams until the beginning of December. Data for December are lacking but the number of connections capped decreased to 72 in January and probably decreased further in the following months. At the very beginning of the operation priority had to be given to the larger diameter pipes and to those near the ground surface. Leaks or damages to the main distribution lines decreased from 77

in November to 60 in December and finally to 15 in January. Leaks in the secondary distribution network decreased from 35 to 18 but went up to 42 in January, probably due to an increase in the operating pressure of the network in some areas. It is anticipated that there will continue to be a great deal of this type of activity in following months, particularly in some sectors where water will start to flow at higher pressure.

By the end of January, 444 metres had been removed. This last activity will continue in the following months. This is in accordance with the UNTAET's intention to re-introduce nominal charges for utility services as quickly as possible, with new contracts and, certainly, disconnection in the event of non-payment. The first step is then to disconnect, revise and re-establish a new connection with a new contract and billing procedure. The latter is of main concern to UNTAET as it would be difficult to introduce any billing system too soon, bearing in mind the poor economic situation of the majority of the population and the lack of the usual high consumption customers, such as breweries, soda and soft drinks manufacturers, industries, etc., which generally

Table III
Type and number of interventions in the distribution network

	November 1999	December 1999	January 2000
Suppression of connection at empty houses	321 Dili East 221 Dili West	--	52
Leaks repaired	35	18	42
Distribution lines repaired	77	69	15
New connections	1	1	2
Removal of meters	--	--	444

bear most of the taxes. Expatriates, NGOs, hotels, institutions, etc. will probably be the main service payers, but some sort of charges to all the customers will have to be re-introduced soon, first to cover operating costs and, in the longer term, to allow WAET (Water East Timor) to become self-sufficient.

Water quality

Systematic control of water quality began only at the end of January. Oxfam took over this specific responsibility and trained several operators to measure residual chlorine and carry out bacteriological tests using a Del Agua portable incubator. As interest grew in the water quality issue and to avoid any misinterpretation, UNTAET started to collect samples at a few sampling points at the end of February, checking residual chlorine and bacteriology at the WTPs' storage reservoirs. Results were then published under the sole responsibility of UNTAET.

Chlorination was carried out using dosing pumps, or manually in case of power failure. Consumption of HTH in Lahane was consistent with the residual chlorine measured in the storage reservoir at the station. Figure 14

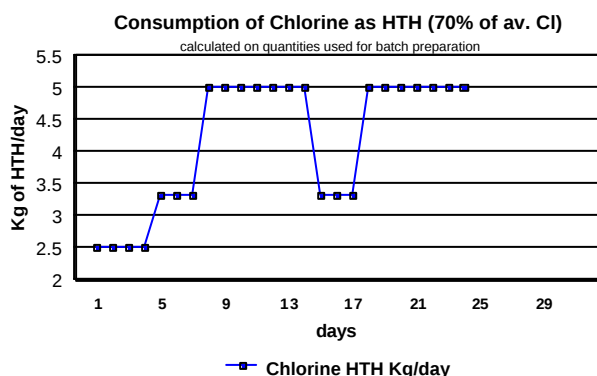


Figure 14
Consumption of HTH (High title hypochlorite) in January at Lahane WTP

shows the consumption of HTH at Lahane for the first 24 days of January. A total of 100 kg of HTH 70% was used to disinfect 95,710 m³ of treated water with turbidity levels lower than 5 NTU.

If we disregard the chlorine demand this quantity corresponds to roughly 0.8 mg/l. Residual chlorine measured at the station was between 0.6 and 0.8 mg/l and consistent with the dosage. However, punctual measurements carried out on 26 February at different sampling points in the town highlighted several problems. At Bemós WTP the operator had to switch from automatic chlorination to manual, with water flowing without added chlorine for several hours, with consequent low levels of residual chlorine – down to zero for the whole eastern network. Lahane WTP had to stop production due to problems in the transmission lines. Resumption of production and chlorination showed a correct level of residual chlorine at the WTP storage reservoir and along one distribution line, with levels decreasing from 0.9 to 0.2 mg/l, but almost no residual chlorine at collection points downtown. At Benemauk manual chlorination also had a limited effect as residual chlorine was down to 0.2 at the bridge collection point, disappearing a few hundreds metres further down the main distribution line. The situation will certainly improve soon, when the dosing pumps and standby gensets will make it possible to maintain regular disinfection.

At the beginning of May, the quantities of Aluminium sulfate and HTH handed over to WAET (ex-PDAM) were sufficient to operate all the WTPs and boreholes for at least three months, leaving UNTAET enough time to set up its own supply chain.

Shallow wells

In early December 1999, UNICEF completed a survey of the shallow well situation in Dili. Eight hundred and fifty wells were surveyed in the district and a plan was prepared to install new pumps and repair the existing ones. The rehabilitation work was carried out by a team of local technicians, with the assistance of international NGOs (Christian Children Fund and ACF – Action against hunger) and by local NGOs. ICRC handed over 150 hand pumps (Dragon of Singapore origin) to UNICEF and again later to ACF to avoid duplication of programmes and because its involvement in Dili was due to end. According to UNICEF, by mid March 493 hand pumps were installed and a further 60 were ready by beginning of April.¹³

¹³ UNICEF update 7.4.2000, Water and environmental sanitation. <http://www.reliefweb.int/> East Timor

Outbreaks of water-related diseases

Epidemiological data collected by WHO¹⁴ at the beginning of week 13 (reported in figure 15) showed an outbreak of water-related diseases between week 14 (3-9.4.2000) and week 20 (15-21.5.2000), with the number of cases increasing from about 100/week up to about 500/week for watery diarrhoea and from a few to about 100/week for bloody diarrhoea. The lack of previous data makes it difficult to draw any conclusions as to the origins of the outbreak, which was probably linked to the onset of the dry season.

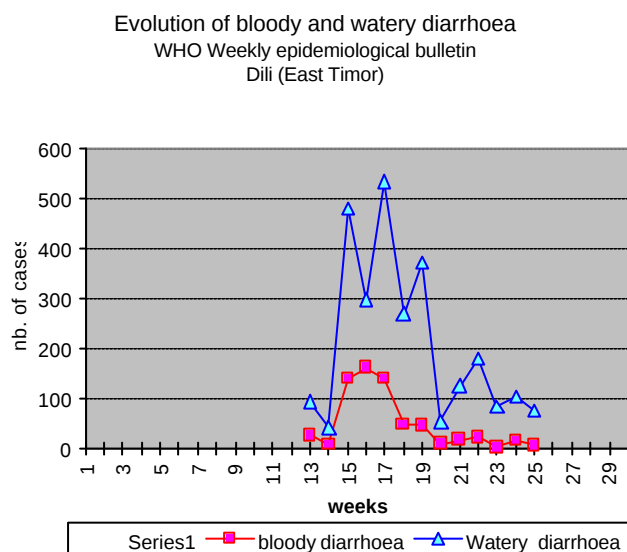


Figure 15
Evolution of bloody diarrhoea in Dili district

Transitional organisation of former PDAM personnel

During the events all the middle and top management left East Timor. Out of 83 people only 45 remained in Dili, but had to seek safety in the surrounding hills. As soon the situation became more stable a few of them were located in the hills and convinced to return to town. In the following days other members of the technical staff reported spontaneously to the former PDAM offices. The extent of the looting and the damages to the premises were considerable, with the exception of the main store, which was found intact. They were reorganised in a temporary structure. A new simplified salary scale, based on the former one, was set up and responsibilities defined according to individual ability. The ICRC agreed to cover the salaries and manage the structure until a UN body was able to take over. Of the former utility's staff, only operators and technicians were left, along with some unskilled workers. Three main sectors of the system were defined in the new temporary structure:

	Number of people
• production at WTP, electrical installation and borehole operation	14
• distribution, logistical support and warehousing	7
• Several unskilled workers on a temporary basis	16
	4

The organisational chart of the utility before the events is shown in figure 16. Some of the administrative positions are not precisely defined but the entire left-hand section of the organisational chart, as well as all the directors, had left. When water distribution was resumed, only part of the technical staff (right side) could be located. By the end of September, almost all the former technicians and operators had been integrated into the new structure, with the exception of the planning and public relations sections. Forty-three people were reported on the payroll in October for a total amount of about 18,580,000 IR (11,000 USD at an exchange rate of 1 USD = 7000 Indian Rupees) and the payment of salaries continued until end of February, when UNTAET was organised to take over.

The temporary structure was quite simple, somewhat similar to the former one in order to avoid tensions among people and facilitate the work of the new body taking over this activity. The definition of technical responsibilities and particularly those related to management would otherwise be quite difficult. The temporary job description of the technical operators would certainly help UNTAET at the beginning of the hand-over, but the entire management and administrative sections would have to be rebuilt, with a large part devoted to the setting up of reporting and administrative procedures and, of course, training.

The situation of the water supply in Dili at the end of April 2000

Despite the extensive destruction of the buildings and despite the generalised looting observed in Dili during the events of September 1999, physical damage to the water supply system can now be considered relatively minor. ICRC engineers, in close co-ordination with INTERFET, Oxfam and with the technical personnel of the former water utility, were able to restore water production in a relatively short time, distributing water from some of the main sources already in early October 1999. The network was then progressively put under pressure as further facilities were restarted. At the same time, an impressive job was done by the teams repairing transmission lines and leaks, decreasing the losses due to running taps, leakage and damaged pipelines. Losses into the ground could not be assessed but it is reasonable to assume that they were similar to what was ob-

¹⁴ WHO Weekly epidemiological bulletin for East Timor, www.reliefweb.int/section/East_Timor

Organisational structure of the water utility of Dili (East Timor)

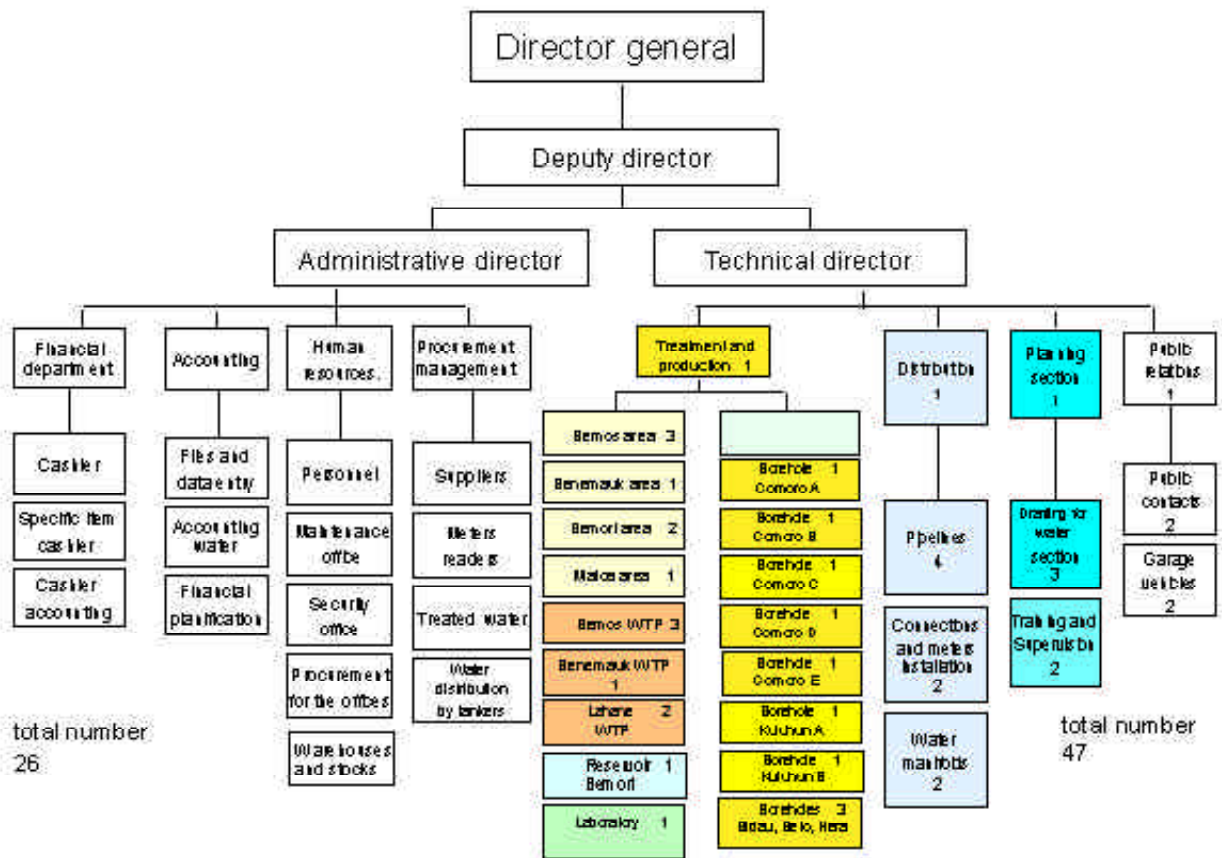


Figure 16
Organisational chart of the Water utility Adapted from BPAM Dili, Maret 1996

served before the events and probably over 50%. These losses are due to poor maintenance of an ageing network which will have to be replaced, particularly where old materials were used.

Table IV gives a comparison between total production prior to the events and that measured in December, January and April 2000. Even if the respective production rates in m³/day for 1998 are gross estimates (+/- 100 m³/day) it is worthwhile to note that the levels obtained after the events are slightly higher than those extrapolated from monthly productions reported by ETWSSP¹⁵.

A mean daily production of about 17,000 m³ can be obtained, with an important part produced by the boreholes, equalling roughly 2/3 of the total production. At the end of March production at the boreholes was almost unaffected by the frequent power failures as several of them were equipped with standby gensets, making it possible to switch over from the network whenever the power was cut. Recent data show that they were running at least 4-5 days/month, i.e. roughly 100 hours and even more, maintaining production rates at "normal" levels. The evolution of the relative proportion

of the production of the boreholes compared to that of the WTPs is given in the next figure (figure 17) where the technical achievements during those early months are clearly visible.

Production before and after the events Boreholes versus WTP

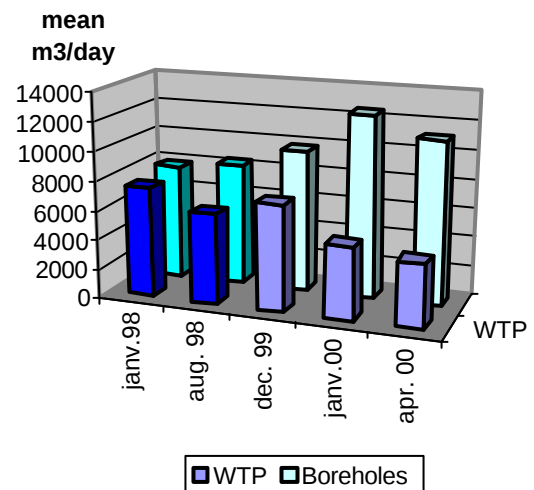


Figure 17
Comparison between the production of the boreholes and WTPs

¹⁵ See quoted reference

Table IV
Mean daily production of the WTPs and boreholes before and after the events

Stations/ Boreholes	January 1998 mean m3/day	August 1998 mean m3/day	December 1999 mean m3/day	January 2000 mean m3/day	April 2000 mean m3/day
Lahane	1'000	1'666	3'180	3'074	2'978
Bemos	6'500	4'500	4'077	1'893	1'378
Comoro A	2'000	2'000	1'857	1'855	1'959
Comoro B	2'600	3'100	4'513	4'507	4'673
Comoro D	2'000	2'300	N.A.	2'253	2'733
Kuluhun A	1'300	1'000	1'128	1'131	961
Kuluhun B	N.A.	N.A.	2'257	2'707	855*
Total	15'400	14'566	17'012 ¹	17'420	15'770**

Data for 1998 from East Timor Water and Sanitation Project, April 1999 and WAET (Water East Timor)

1 If Benemauk is included (1421 m3/d) total production reaches 18433 m3

Data for 1998 are from ETWS Project report (+/- 100 m3/day).

* First 7 days the mean daily production was 2660 m3 and then technical problems occurred until 24th of the month

** Including 233 m3 at Comoro E used for INTERFET needs

Future challenges

With the present technical set-up and a minimum of management it appears that it will be quite easy to maintain these levels of productivity throughout the year. Despite these achievements, obtained with the assistance of foreign engineers, the technical level of the operators and technicians will have to be improved by means of training courses and the appointment of several engineers capable of managing the operation of the entire system and of planning future developments.

As previously outlined, the main task of UNTAET will be to rebuild the managerial section of the new water utility and to try to achieve some sort of financial sustainability. This may take years as everything will have to be set up. The success of the supply-driven part of the overall operation was quite easy to achieve as is demonstrated by the above-mentioned results. The difficult part of the operation is now beginning, as a demand-driven approach will have to be adopted with programmes involving the public – and this may take quite a long time, certainly years.

The work carried out before the events in the framework of the ETWSS Project will have to be resumed and strengthened but the context has changed. People will not immediately be in a position to pay important charges for water (as well for electricity) as their economic situation is precarious and will remain so for a while. New approaches will have to be tested and explained, as has been done in other countries in similar situations¹⁶.

Lessons learnt

Luckily, damages to the water infrastructures were relatively minor. At the same time, the effects of the impressive work carried out before the events (funded by AUSAID) were not completely lost and the technical staff was in position to resume the majority of the normal tasks needed to operate the systems. Access to relevant documents describing the system in detail, obtained from the previous co-operation between PDAM and AUSAID, facilitated the different interventions as technical specifications about the stations, the boreholes, the distribution systems and the capacities of the aquifer were readily available and did not have to be redone.

Having ensured a fairly reliable production covering the immediate needs of the population, there was less pressure on the engineers and technicians and time could be devoted to a smooth hand-over. The relatively early presence at the rehabilitation stage of an organised body (UNTAET) to take over the management of the utility made the transition easier, five months after the events. Knowing that UNTAET was due to take over, care had been taken to avoid setting up procedures that would create difficulties for the organisation in charge of the temporary management of the utility and responsible for its future set-up and eventual sustainability.

If nobody had been ready to take over, the involvement of the ICRC or of any other actors more focused on technically oriented activities would have had to shift towards the creation or strengthening of the institutional management of the utility and steps would have had to be taken to prepare for such challenges.

¹⁶ Lyonnaise des eaux, Water supply for low income communities