CHAPTER 1

PRESENT SITUATION OF CHAD'S WATER DEVELOPMENT AND MANAGEMENT

1 CONTEXT AND DEMOGRAPHY

With 7.8 million inhabitants in 2002, spread over an area of 1 284 000 km^2, Chad is the 25th largest country in Africa in terms of population and the 5th in terms of total surface area. Chad is one of the poorest countries in the world, with a GNP/inh/year of USD 2200 and 54% of the population living below the world poverty threshold[1]. Chad was ranked 155th out of 162 countries in 2001 according to the UNDP human development index.

The mean life expectancy at birth is 45.2 years. For 1000 live births, the infant mortality rate is 118 and that for children under 5, 198. In spite of a difficult situation, the trend in these three health indicators appears to have been improving slightly over the past 30 years (in 1970-1975, they were respectively 39 years, 149/1000 and 252/1000)[2].

In contrast, with an annual population growth rate of nearly 2.5% and insufficient growth in agricultural production, the trend in terms of nutrition (both quantitatively and qualitatively) has been a constant concern. It was believed that 38% of the population suffered from malnutrition in 1996. Only 13 countries of sub-Saharan Africa have a higher rate.

The net primary school attendance rate is 52.1%; however, only 38.8% of girls attended school in 1997-1998.

According to the Human Development Report (HDR), it was estimated that only 27% of the population had access to a developed water point. The detailed studies carried out in the context of the integrated plan for Chad's Water Development and Management (SDEA)[3] show that the overall rate of access to drinking water guaranteed throughout the year was in fact only 23% for the population of Chad as a whole in 2000.

Chad is a land-locked country with three major geoclimatic zones (Saharan, Sahelian and Sudanian) from north to south, in which the very different distribution of natural water resources, cultivable land and biomass has always determined the spatial distribution of the population. Regional planning in the SDEA is based on this breakdown for the following reasons: 1) This breakdown is consistent in terms of both natural and socio-economic regions; 2) These large zones are quite consistent from the point of view of hydraulic development and their method of management; 3) The breakdown is compatible with a large-basin approach as, according to the breakdown adopted for the SDEA, the "Sudanian zone" covers practically all of the only major active basin in the country, that of the Chari-Logone, limited downstream by N'Djaména; 4) Lastly, as far as possible, and for obvious planning reasons, the contours of these zones are based on the major administrative entities. Figures 1 and 2 illustrate the spatial distribution of the major geoclimatic zones, the administrative breakdown per prefecture and department. Main towns are also shown.

The Saharan zone, covering 780 000 km^2, concerns the entire northern part of Chad. The frontier with the Sahelian zone corresponds more or less to the 250 mm isohyet. From the climatic point of view, therefore, it corresponds to the Saharan and Saharo-Sahelian climate, the main characteristics of which, in addition to low rainfall, are the almost permanent occurrence of dry winds, the low humidity (<50%) and high day-time temperatures, all of which contribute to producing intense evaporation.

From the administrative standpoint, the zone covers the entire prefecture of Borkou-Ennedi-Tibesti (BET), most of the prefecture of Kanem, about half that of Batha and the western third of Biltine prefecture.

From the physical standpoint, there are four major entities:

- in the centre, a vast depression, the centre of which corresponds to the greatest extent of Lake Chad. It is filled with Continental Terminal formations (sand, sandstone and clay) buried under soft Quaternary sediments (sand and clay) of varying thickness. The altitude is below 500 m;
- to the east, the Ennedi range, a vast Paleozoic sandstone plateau culminating at 1450 m;
- to the north-east, the Erdi plateaux, a succession of low sandstone tablelands dating from the Secondary era, cut by sand-filled depressions;
- to the north-east, the lofty Tibesti range (maximum altitude: 3415 m), formed from a chain of volcanoes and basalt plateaux covering the Paleozoic sandstones and Precambrian granites.

[1] ECOSI survey, 95-96. "Human poverty index": proportion of households that cannot financially meet their own needs in terms of essential food and other commodities. This is in fact rather a "monetary poverty index" as in reality basic hydraulic infrastructure for drinking water (an unquestionably essential requirement) is still insufficient for 77% of the population of Chad.

[2] Population and Health Survey (EDS), 96-97.

[3] 17% of the population of Chad living in villages of less than 200 inhabitants have access to a hydraulic structure capable of guaranteeing permanent supplies of safe drinking water. This proportion is nearly 35% in urban and semi-urban areas with more than 2000 inhabitants - source: SDEA 2002.

The Sahelian zone, covering 374 000 km^2, corresponds to the portion of Chad located between the Saharan zone and the Chari-Logone catchment area situated between N'Djaména and Bongor. Mean annual rainfall is between 300 and 650 mm. From the climatic standpoint, the Sahelian zone corresponds to the Sahelian climate in the strict sense.

From the administrative standpoint, the Sahelian zone includes the Lac prefecture. It covers the southern parts of the prefectures of Kanem and Batha and most of the prefectures of Biltine, Guéra, Ouaddaï and Chari-Baguirmi.

From the physical point of view, the Sahelian zone is divided into two contrasting units:

- a vast plain that extends the Saharan depression southwards; this is filled with essentially loose sedimentary formations (sand and clay). The altitude is below 500 m;
- a rocky region with broken relief, consisting of the Ouaddaï range to the east and the Guéra mountains to the south, forming a sort of belt around the above plain.

The Sudanian zone, covering 130 000 km^2 corresponds to that portion of the catchment area of the Chari and its main tributary the Logone lying within Chad. It covers the entire southern region of the country as far as a boundary situated between Bongor and N'Djaména. Mean annual rainfall is between 650 and 1000 mm. From the climatic standpoint, it therefore covers the Sudanian zone, bounded by the 800 mm isohyet, the Sudano-Sahelian zone, with rainfall averaging between 650 and 800 mm, and the Sahelian zone in the strict sense, characterising the small downstream area below Bongor.

From the physical standpoint, it corresponds to a vast sedimentary basin rising at the edges on the borders of Sudan and Cameroon. This vast plain nevertheless has a slight meso-relief marked by two contrasting situations during high-water periods: areas that are above water, underlain by sandy formations where most of the housing and rainfed agriculture is concentrated, and inundated areas covered by heavy soils and characterised by multiple activities centred on flood-recession agriculture, migratory stock-rearing and fishing, the rhythm of which is dictated by the naturally occurring cycles of rains and flooding.

From the administrative standpoint, the zone includes the prefectures of Logone Oriental, Logone Occidental, Moyen-Chari, Tandjilé, Mayo-Kebbi, the southern parts of the prefectures of Ouaddaï, Chari-Baguirmi and Guéra and the northern part of Salamat.

It should be noted that the main area of oil drilling in Chad is at Doba, in the Sudanian zone. Oil drilling, which began at Doba in 2004 for a period expected to run to 2015 (one billion barrels of crude), represents a real opportunity but also a challenge to development in this region and for the country as a whole.

Demography

Table 1 shows the population distribution in Chad according to the administrative breakdown and also its expected growth over the period 2000-2020. These data are taken from an SDEA study concerning the population and based on 1993 census figures.

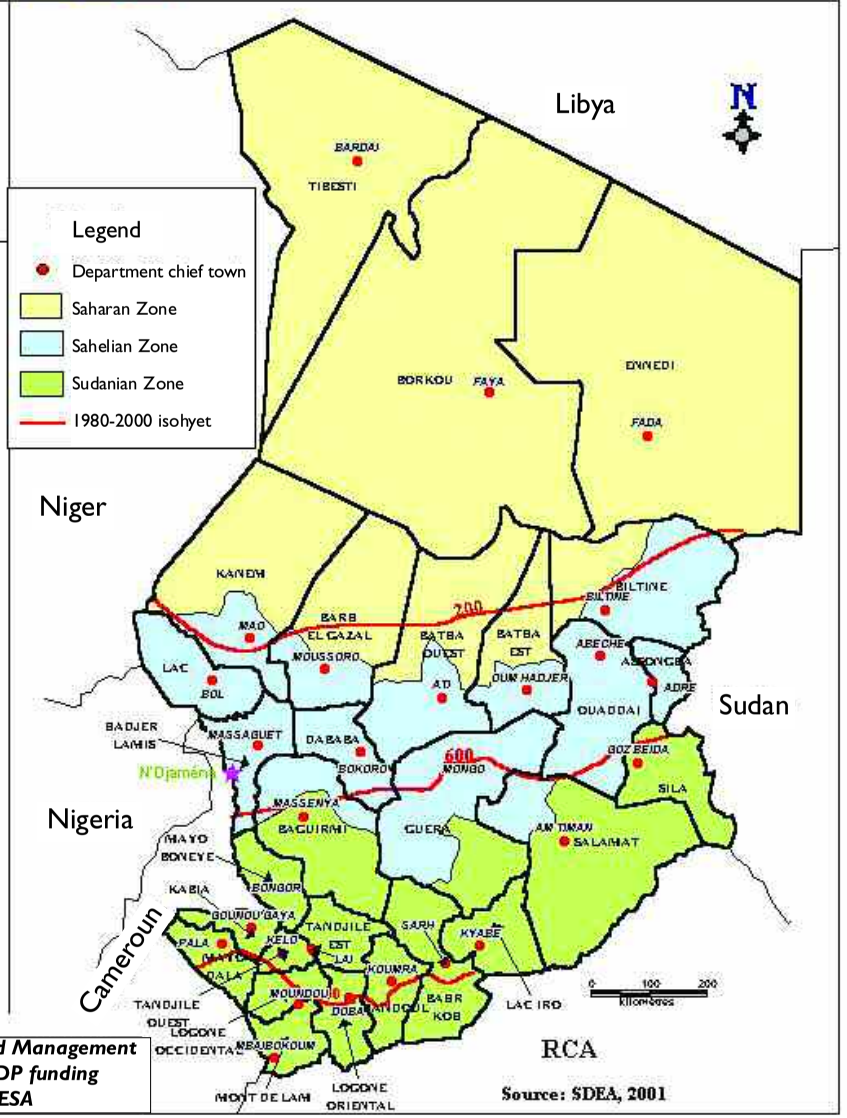
The demographic forecasts were processed using the DEMPROJ software. Three assumptions were made with regard to fertility rates:

- A low-case hypothesis for the period from 1993 to 2000, to take into account the low rate of contraceptive use in the country as a whole and also the Chadians desire to have children. Over this period, it is assumed that the fertility rate would remain constant.
- A medium hypothesis for the period from 2000 to 2015, during which it is assumed that the fertility rate will gradually fall, taking into account the various measures taken by the Government and development partners aimed at controlling population growth via a reduction in the fertility rate. This reduction is estimated at 0.5 children for each 5-year period, corresponding to a reduction of 1.5 children per woman for the 2000-2015 period.

Republic of Chad
Figure 1: Administrative breakdown by prefecture

Source: Atlas pratique du Tchad, 1972

Republic of Chad
Figure 2: Administrative breakdown by department
(unofficial breakdown)



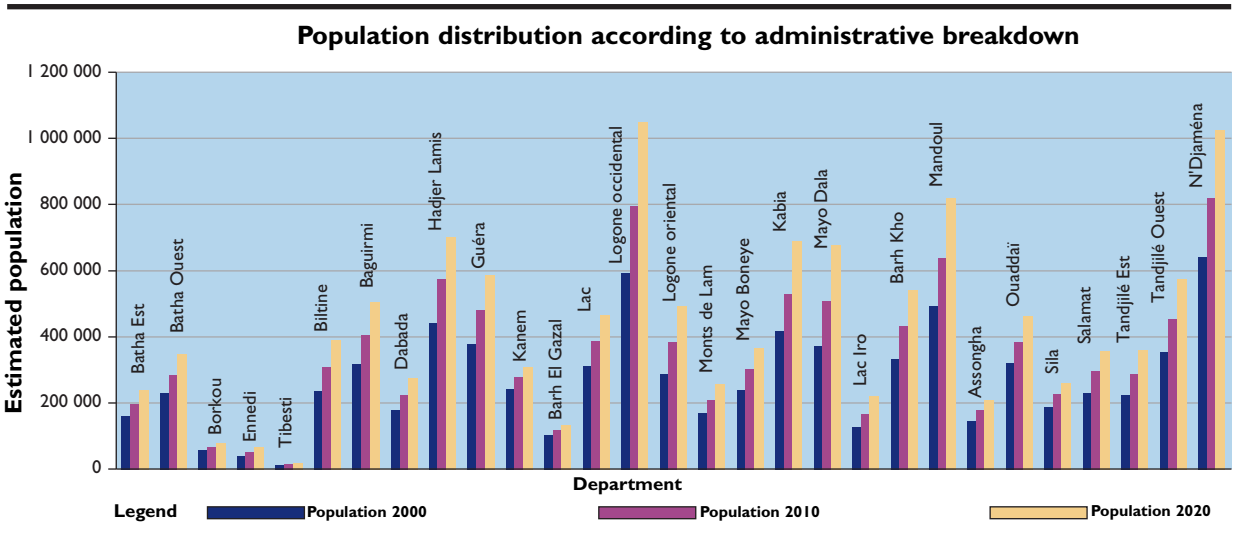
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA

Source: SDEA, 2001

Table 1: Population distribution according to administrative breakdown

Prefecture	Department	Estimated population in 2000			Estimated population in 2010			Estimated population in 2020		
		Villages less than 2000 inhab.	Towns of 2000 inhab. and over	Total population	Villages less than 2000 inhab.	Towns of 2000 inhab. and over	Total population	Villages less than 2000 inhab.	Towns of 2000 inhab. and over	Total population
Batha	Batha Est	143 455	14 508	157 963	175 852	19 969	195 821	212 667	24 529	237 196
	Batha Ouest	195 753	31 118	226 871	239 960	43 191	283 151	290 201	57 978	348 179
BET	Borkou	43 553	10 405	53 958	53 661	11 034	64 695	64 678	11 678	76 356
	Ennedi	33 163	3 816	36 979	40 860	7 583	48 443	49 250	15 381	64 631
	Tibesti	10 865	0	10 865	13 388	0	13 388	16 134	0	16 134
Biltine	Biltine	211 964	23 665	235 629	275 956	30 678	306 634	343 535	45 580	389 115
Chari-Baguirmi	Baguirmi	268 677	47 793	316 470	333 657	72 102	405 759	409 805	92 490	502 295
	Dabada	149 079	29 715	178 794	185 132	37 545	222 677	227 400	47 041	274 441
	Hadjer Lamis	375 300	64 401	439 701	466 063	106 083	572 146	572 465	126 757	699 222
Guéra	Guéra	309 866	68 073	377 939	373 075	106 230	479 305	442 974	141 829	584 803
Kanem	Kanem	221 902	17 822	239 724	255 632	20 262	275 894	284 910	21 783	306 693
	Barh El Gazal	81 309	19 130	100 439	93 669	23 285	116 954	104 396	26 618	131 014
Lac	Lac	288 545	22 345	310 890	347 744	39 343	387 087	409 789	54 169	463 958
Logone occidental	Logone occidental	438 415	154 053	592 468	562 620	230 309	792 929	706 222	343 435	1 049 657
Logone oriental	Logone oriental	237 375	48 283	285 658	297 370	84 535	381 905	366 146	125 606	491 752
	Monts de Lam	146 700	20 208	166 908	183 773	23 405	207 178	226 180	28 161	254 341
Mayo-Kebbi	Mayo Boneye	201 020	37 474	238 494	248 633	53 293	301 926	300 950	63 106	364 056
	Kabia	367 541	48 801	416 342	444 367	82 354	526 721	537 869	149 406	687 275
	Mayo Dala	296 409	73 758	370 167	358 363	147 231	505 594	433 772	243 495	677 267
Moyen-Chari	Lac Iro	109 773	16 773	126 546	135 726	28 693	164 419	164 610	54 895	219 505
	Barh Kho	217 833	113 058	330 891	269 332	162 379	431 711	326 648	211 698	538 346
	Mandoul	411 138	81 444	492 582	508 334	129 408	637 742	616 510	200 679	817 189
Ouaddaï	Assongha	135 797	9 689	145 486	161 711	14 494	176 205	187 218	19 251	206 469
	Ouaddaï	244 522	75 364	319 886	291 217	92 111	383 328	337 150	123 143	460 293
	Sila	177 663	8 065	185 728	211 565	11 949	223 514	244 939	15 365	260 304
Salamat	Salamat	183 080	45 768	228 848	221 640	72 879	294 519	262 170	93 614	355 784
Tandjilé	Tandjilé Est	185 735	35 778	221 513	229 838	56 941	286 779	281 749	76 711	358 460
	Tandjilé Ouest	286 700	65 809	352 509	354 785	97 200	451 985	434 918	136 593	571 511
N'Djaména	N'Djaména	0	639 000	639 000	0	818 600	818 600	0	1 024 000	1 024 000
Total		**5 973 132**	**1 826 116**	**7 799 248**	**7 333 922**	**2 623 086**	**9 957 008**	**8 855 255**	**3 574 991**	**12 430 246**

Source: SDEA 2001



Source: SDEA 2001

- A high-case hypothesis for the period from 2015 to 2020. During this period, it is assumed that the aim of controlling the birth rate would be reached by 2015 and that the level obtained would be satisfactory. Consequently, the fertility rate would be stabilised at the level achieved in 2015.

With regard to mortality, an analysis of the various indicators revealed a distinct tendency for the rate to fall. However, over the past few years, given the effects of the AIDS pandemic, there is no doubt that these indicators will rise once again. On the basis of these considerations, the following assumptions were made:

- A low-case hypothesis for the period from 1993 to 2010. Life expectancy at birth will fall by 0.5 years for each 5-year period, giving a fall in life expectancy at birth of 1.5 years. This hypothesis is based on contraceptive use of less than 10% and chronic poverty that prevents certain people from obtaining suitable medication.
- A medium hypothesis for the period from 2010 to 2015, during which life expectancy will fall relatively little in comparison with the preceding period. The fall is estimated at 0.3 years.
- A high-case hypothesis for the 2015-2020 period, during which life expectancy at birth will remain constant at the level achieved in 2015. This hypothesis is based on the fact that from 2015 onwards, sexually transmitted diseases will be largely under control.

Table 1 separates people living in villages of less than 2000 inhabitants (using village water supply systems) and those in towns of 2000 and more (using urban and semi-urban water supply systems), while table 2 shows the population distribution in the main geoclimatic zones. Thus, in 2000, 76.6% of the people of Chad lived in villages of less than 2000 inhabitants. This figure will fall to less than 70% by 2020.

Table 2: Population distribution by geoclimatic zone

Geoclimatic zone	Population in 2000		Population in 2010		Population in 2020	
	Population	%	Population	%	Population	%
Saharan	219 480	2.81	276 218	2,77	338 122	2.72
Sahelian	2 694 760	34.55	3 403 196	34,18	4 189 378	33.70
Sudanian	4 246 008	54.44	5 458 994	54,83	6 878 746	55.34
N'Djaména	639 000	8.19	818 600	8,22	1 024 000	8.24
Total	7 799 248	100.00	9 957 008	100,00	12 430 246	100.00

Source: SDEA 2001. N.B. the city of N'Djaména lies within the Sahelian zone.

The mean population growth rate applied to the estimated population of Chad is of the order of 2.5%. However, it should be pointed out that certain recent studies speak of a population growth rate of the order of 3.1%.

In table 2, which does not take into account movements from one department to another, it can be seen that the Sudanian zone accounts for more than 50% of the total population and the Saharan zone less than 3%.

2 THE NEED TO DEVELOP HYDRAULIC INFRASTRUCTURE IN CHAD AND THE FIGHT AGAINST POVERTY

2.1 Economic diversification

Chad's medium-term development strategy is characterised by the aim of entering the post-oil boom era so that the non-oil sector can take over from the oil sector. Indeed, sustainable economic growth stimulated during the oil boom era (a decade) will only be possible in future decades if there is greater diversification in the economy, which in Chad is essentially agricultural and rural.

The main sectors of activity in the country at present are:

- agriculture;
- stock-rearing;
- fishing.

These sectors (accounting for 40% of GDP) involve 80% of the active population and provide more than 59% of the average income[4] of households in rural areas, along with 80% of exported products. They govern economic growth and constitute the essential source of foreign currency for the country and the main source of food for its inhabitants.

[4] ECOSIT, 95-96 (including non-monetary income)

Diversification can only marginally affect development in the industrial sector. If it succeeds, it will concern essentially agriculture, stock-rearing, fishing and services (the consumption of business services in fact follows business development).

The three main diversification activities outside the oil sector, namely, agriculture, stock-rearing and fishing, are highly dependent on water and hydraulic infrastructure.

Controlling water is at the centre of the diversification sought. Investing in hydraulic infrastructure and its management is therefore a strategic economic choice.

2.2 The fight against poverty

This sustainable, planned and necessary economic growth will eventually help to improve health, education and people's incomes. However, this growth is not sufficient because economic development can only be fully and safely achieved if the human capital is strengthened at the same time. This must be done, in particular, via better public health and acceptable living conditions. It is necessary to invest, first and foremost, in basic infrastructure geared towards the essential needs of the population, wider and reliable access to drinking water and sanitation, and of course, education and access to knowledge[5], as poverty cannot be seen merely in economic and monetary terms.

[5] Education concerning environmental health via operations focused on water points is of fundamental importance.

Indeed, the lack of access[6] to safe and sufficient drinking water supplies and the lack of sanitation are directly or indirectly linked to most of the causes of the various aspects of poverty:

[6] In terms of basic modern hydraulic facilities, for which initial investment cannot usually be completely covered by poor people with little money available.

- **Health** - scarce access to safe water and an environment with little or no sanitation are often the causes of the major pathologies: malaria, diarrhoea (which accounts for 44% of the cases of mortality in children under 5), schistosomiasis, meningitis, cholera, etc. These factors result in a drop in productivity and number of days worked (and hence in income-earning potential) in people affected, together with a significant shortening of life expectancy.
- **Income and consumption** - the absence of reliable drinking water supplies means that:
  - a large proportion of the household budget is spent on medical treatment or in buying and treating water at a higher cost, reducing the net household income in proportion,
  - much time is wasted in looking for, collecting and transporting water, thus reducing the possibility of generating income and the chances of economic and social integration, especially for women.
- **Education** - the lack of hygiene and adequate sanitation increases the number of days taken up by sickness and fetching water, which also helps to reduce school attendance, in particular among girls.

If one adds to this the fact that water is a shared, vital, limited and vulnerable resource, plus the fact that it is an essential contributor to economic diversification as seen above, two conclusions cannot be avoided: **water is clearly a strategic sector of diversified development and poverty reduction, and it is *de facto* a sector in its own right in the Government's priorities.**

2.3 The place of water in the economy of Chad

The question of water in the economy of Chad arises in several respects:

- the well-being of the population,
- its effects on economic growth;
- as an economic activity.

These various points of view are not independent. For example, greater availability of drinking water improves people's health, which has an effect on both well-being and growth.

2.3.1 Water and people's well-being

At the time of preparing the Poverty Reduction Strategy Paper (PRSP), enquiries were conducted in December 2000 and January 2001 among people living in the 14 prefectures of Chad's 7 regions. These enquiries asked participants to rank a number of themes or aspects (around 20 in all) in order of importance for them. Drinking water was ranked third in terms of people's expectations.

If one adds to this the fact that health, ranked second, depends to a great extent on water and that reliable food supplies and agricultural development also depend to a great extent on water, it is clear that **the question of water is a priority for the population as a whole.**

Naturally, water has a cost. More specifically, given the major groundwater reserves in Chad, mobilising water has a cost. When it is a question of improving people's well-being, expenditure cannot be evaluated in terms of profitability but rather in terms of political choice. Nevertheless, the political decision must be taken in view of the costs of the various possible solutions. It is therefore important to back such a decision with complete information.

2.3.2 Water and economic development

Before being a factor of economic development, water is a vital resource without which there is no life. Towns and villages are created around water points. The availability of water has always been an unavoidable requirement for regional development.

Water is involved in economic development in several ways, either as an input for production processes, or as an element in the overall capacity of the economy. It thus combines the two roles of consumer good and infrastructure. Perhaps more fundamentally, water is a commodity whose multiple uses mean that it has to be analysed as an aquatic system. Indeed the same resource, e.g., a river, can:

- supply the population with drinking water,
- enable fish to live and fishing to take place,
- irrigate and/or flood cultivated land,
- serve as a means of communication for local and international transport and as a factor of regional integration.

Any decision concerning the use of water, for example the creation of a flood-spreading dam intended for agriculture, must take into account this characteristic of water of being a multiple-use system.

Water is also a permanent feature of a country's economic life, whereas oil is a very temporary resource. Sustainable management is of fundamental importance.

Water as an input to production processes

Water is an input to many production processes, notably:

- agriculture;
- stock-rearing;
- many types of industrial production.

Plant production, animal production and fishing depend largely on the extent and health of aquatic ecosystems (wetlands, rivers, large flood plains and lakes). Their operation depends on water resources (in terms of distribution and variability) but also on choices regarding hydraulic development schemes, on the management and protection of water. Production may therefore be increased by means of various types of investment.

In contrast to the improvement of well-being, investments in productive sectors raise the issue of profitability. This is often difficult to measure, but certain types of information may be of use in reaching decisions. For example, the per-hectare cost of agricultural development is a good indicator. In many cases it is preferable to lay emphasis on schemes with a low per-hectare cost.

The price billed to the user is linked to the cost of producing water.

Water as an element in the overall capacity of the economy

A number of types of physical and abstract infrastructure cannot be analysed as inputs to the production system but as elements of the economic environment in which economic agents operate, such as:

- road infrastructure;
- courts;
- administrative services.

From this point of view, water is an indirect element of the overall capacity of the economy via the well-being of the people, and in particular their state of health.

Lastly, water production, like any other economic activity, generates added value and thus contributes to the GDP. The water industry uses items of intermediate consumption, employs labour, invests, makes profits and pays taxes.

3 ANALYSIS OF THE BASIC HYDRAULIC INFRASTRUCTURE SITUATION IN 2000

3.1 The situation regarding village water supply schemes

Village water supply schemes aim to give access to water to people living in villages of less than 2000 inhabitants. In addition to increasing the supply rate, the Government's policy in this area involves in particular encouraging local initiatives in order to increase the development of private organisations for maintaining equipment, on one hand, and to involve users in the management and payment of equipment maintenance and renewal costs on the other.

In the villages, the current (2001) standards for allocating water points defined by the Government are as follows:

- the population must be over 300,
- villagers must accept the conditions of participation, i.e., the creation of a management committee and the setting up of a water fund.

In 2000, the number of people in Chad living in villages was estimated at around 6 million, i.e., 77% of the total population of the country. This figure will rise to 7 350 000 by 2010 and 8 855 000 by 2020 (see table 1).

These people live in nearly 28 500 villages of less than 2000 inhabitants. Thus, in 2000, 35% of the population lived in villages of less than 300 inhabitants, 53% in villages of between 300 and 1200 and 12% in villages of between 1200 and 2000. According to the current criteria for allocating drinking water points, 35% of the rural population of Chad is therefore ineligible to benefit from any of the major hydraulic infrastructure construction programmes.

The village population is also unequally distributed over the country. The Sudanian zone, covering around 12% of the total surface area of the country, accounts for 62% of the rural population. The Sahelian zone (28% of the country) is home to 35% of the population and the Saharan zone (60%) has only 3% of the population. Figure 3 illustrates the rural population density. It is clear that the village population is concentrated in the south-western departments of the country.

3.1.1 Drinking water supply facilities in villages

Village water supply facilities include traditional water points and modern water points (MWP). In all, 6871 MWPs have been inventoried, comprising 3467 wells and 3404 boreholes. However, it should be noted that nearly 74% of households draw drinking water from traditional water points, which are often vectors of illnesses such as diarrhoea and cholera.

Modern reinforced concrete wells are generally built according to standard codes of practice. However, they are not closed and mechanised means are not used for drawing the water. Traditional methods (using buckets and ropes) are used. In addition, these wells are often used for two purposes: supplying water to the villagers, on one hand, and watering cattle and other livestock (goats, sheep), on the other.

Because of the way in which these wells are operated, the type of equipment used to draw water and the well construction method (open well), the water is often of dubious quality. The wells may be listed as sustainable, permanent modern water points but, unless regular treatment is provided (i.e., disinfection by various processes), **they cannot guarantee permanent supplies of safe drinking water**, and because of this their impact on villagers' health is limited and sometimes negative. For these reasons, these structures cannot be considered as drinking water points.

The drinking water supply rate[7] is evaluated by taking into account only hydraulic structures that always guarantee safe water. These structures include 2580 boreholes equipped with a hand pump (HP), 44 equipped with a solar-powered pumping station and 6 equipped with a thermal pumping station. These facilities are all located in villages with populations of 2000 or less.

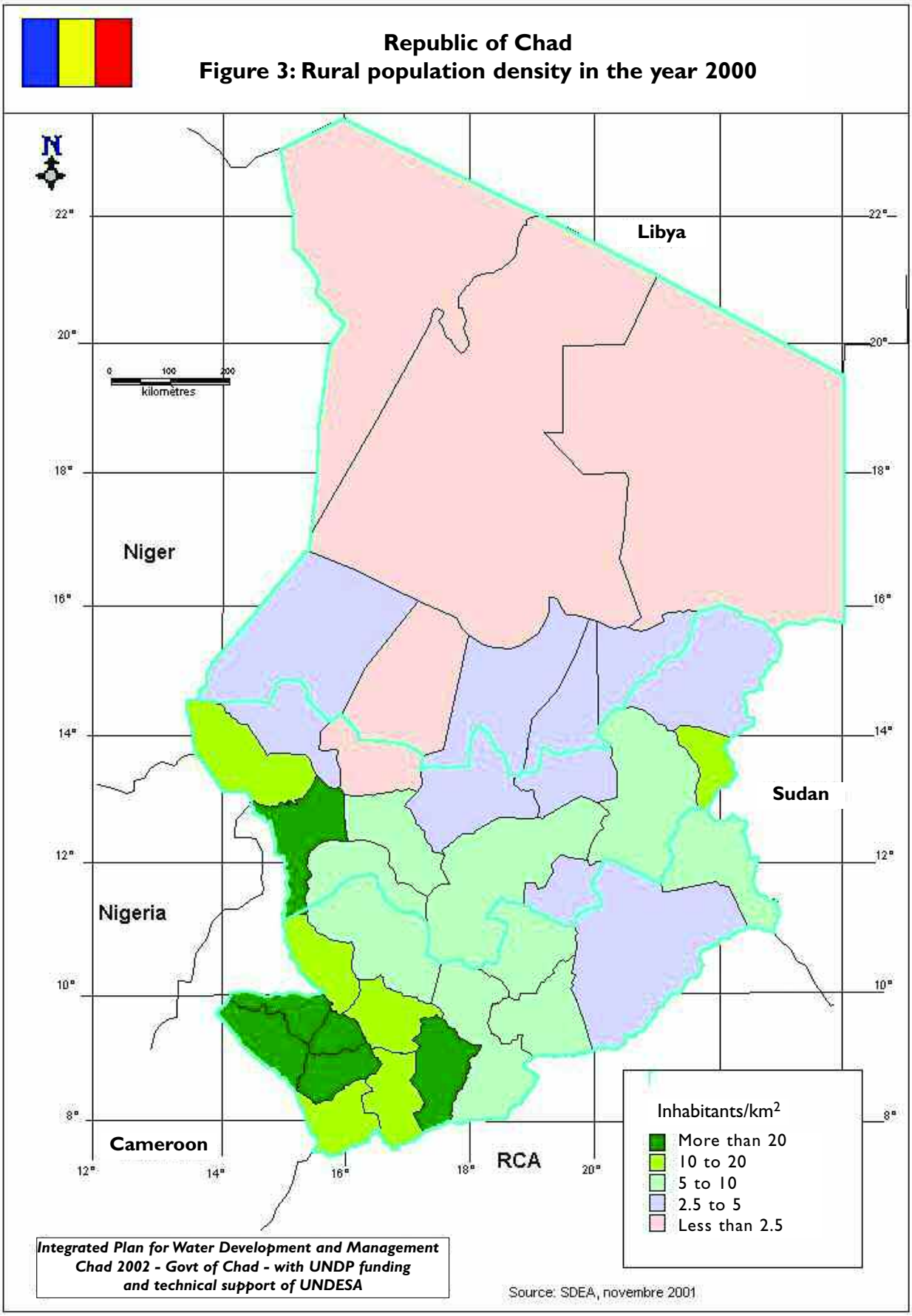
Table 3 shows the percentage of the village population that has access to a drinking water point in each department. It can be seen from the table that:

- **only 17% of the rural population in Chad has access to a hydraulic structure capable of guaranteeing safe drinking water on a permanent basis,**
- generally speaking, villages with 300-2000 inhabitants are the ones best supplied with drinking water (22% of the population in this group of villages) whereas only 7% of those with less than 300 inhabitants have supplies of this kind. This confirms the fact that the current standard for awarding drinking water points in the village water supply programmes is being applied;
- certain departments are better provided with water points than others. For example, more than 30% of the inhabitants in the departments of Hadjer Lamis, Lac, Logone Oriental, Monts de Lam, Mayo Boneye, Bahr Kho and Tandjilé Est have access to drinking water points. In contrast, more than 95% of the population in 15 departments (Salamat, Assongha, Guéra, etc.) have no access to this type of water point.

It should be pointed out that the departments in which the drinking water supply rate is relatively high are those in which the major hydraulic infrastructure construction programmes have been implemented. Three main reasons may partly explain the low drinking water supply rate in certain departments. These are:

- drinking water points have been created, but without setting up an environment in which they can be maintained (absence of spare parts for pumps, few if any trained stand-pipe managers, etc.), which has led the villagers to abandon them;

[7] *Supply rate: the percentage of the population that is supplied or has access to a hydraulic infrastructure defined as such in terms of technical characteristics of the structure used and recognised consumption standards.*


Republic of Chad
Figure 3: Rural population density in the year 2000
N
22°
20°
18°
16°
14°
12°
10°
8°
12°
14°
16°
18°
20°
0
100
200
kilometres
Libya
Niger
Nigeria
Cameroon
RCA
Sudan
Inhabitants/km2
More than 20
10 to 20
5 to 10
2.5 to 5
Less than 2.5
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA
Source: SDEA, novembre 2001

- departments with high concentrations of villages of under 300 people, which therefore do not meet the standards for being eligible for modern drinking water points;
- departments which, for various reasons, including certainly insufficient planning/scheduling of structures, have never benefited from programmes to construct drinking water supply systems. Often, the construction of new hydraulic structures is undertaken in accordance with available funding in departments selected by the funding agencies as a function of their preferences, without necessarily taking into account the priority drinking water requirements of the various regions.

A major conclusion emerges from this analysis: **considerable efforts need to be made to increase the drinking water supply rate in village areas in an equitable manner. Future programmes to construct hydraulic infrastructure must be geared towards departments that have few if any such structures.**

3.1.2 Equipment management and maintenance methods

In line with Government policy, which aims to empower users, the system for managing and maintaining modern water points equipped with hand pumps (HP) is based on the following components: Water Point Management Committees (WPMC), the network of pump repairmen, the spare parts marketing network and the Directorate of Hydraulic Affairs.

Responsibility for managing **boreholes equipped with hand pumps** lies with the WPMC, an entity that has no legal status and comprising 5-7 voluntary members. Their main duties are to make sure the equipment operates correctly, manage the funds obtained by selling pumped water and ensuring that the water point is kept clean and hygienic. Solar and thermal equipment is also managed by the WPMC.

The main observations arising from an assessment of the management and maintenance of the various types of pumping equipment (solar, thermal, HP) are the following:

- To ensure efficient maintenance, the design and type of pumping equipment to be installed in a village must correspond to the village's real water requirements, to the planned uses of the water point and the people's ability to take responsibility for it (from the financial, organisational and technical standpoints).
- Creating a WPMC and taking on responsibility for maintenance are the commitments required of villagers by the DH and funding agencies before a drinking water point is created in a village. In 2002, the operation of the WPMC relied primarily on the goodwill of a few local leaders and in many cases on the supervision provided by the projects. Thus, in sectors that had benefited from regular support from the main projects and where a suitable maintenance environment had been created (with available spare parts, repairmen, maintenance companies, etc.), the field enquiries showed that more than 90% of the pumping equipment was operational. In contrast, in sectors where such support had not been available, less than 10% of the pumping equipment was operational, a situation which had led people to abandon most of the water points. In order to guarantee the working life and sustainability of the equipment, it therefore appears essential to promote a local water point management organisation that is legally recognised, functional, aimed at the long term and for which the users feel responsible, and also to set up well-organised maintenance networks that are suited to specific regional features.
- The spatial distribution of water points must be taken into account right from the beginning of programme definition and during the implementation stage so that they are sufficiently concentrated to ensure the technical and financial viability of the equipment maintenance network.

- Project implementation methods, notably with regard to coordination and the creation of a suitable environment for structure maintenance, have a major impact on equipment management and maintenance and on the working life of the infrastructure, yet these methods are not always mutually consistent and vary depending on the funding agencies, NGOs and those responsible for their implementation. Hence it is of paramount importance to improve cooperation between the various ministries, funding agencies and project managers in order to harmonise methodologies for implementing hydraulic infrastructure development schemes at national level while at the same time taking into account specific local features.

3.1.3 Village water supply stakeholders

The various stakeholders involved in village water supplies may be grouped under several headings, namely institutions, funding agencies, local people, NGOs and charitable organisations, the private sector and the craftsman or informal sector.

The Directorate of Hydraulic Affairs (DH) of the Ministry of Environment and Water is the main institutional stakeholder. It comprises a **central level**, the Water Office, a Design and Planning Division, an Urban Water Supply and Sanitation Division, a Village and Pastoral Water Supply Division and a Maintenance and Equipment Division. The DH also includes an Administrative and Equipment Department. It is theoretically represented by a delegation in each prefecture and by a head of department but it should be pointed out that this type of representation was not effective in 2001. The system should therefore be introduced as part of the state decentralisation process currently underway.

Most of the funds allocated to the village water supply subsector (FCFA 96 billion) are provided by the major bilateral and multilateral funding agencies. The main provider from 1985 to 2000 was France, via the Agence Française de Développement (AFD) and Fonds d'Aide et de Coopération (FAC). The European Union (EU), via the European Development Fund (EDF), was in second place. However, from 2002 onwards, the EU will become the main funding agency in the field via the 8th and 9th EDF projects that provide for the construction of more than 5000 drinking water points in village areas.

Local people are both partners and users, acting as the Government's main correspondent during the project. After the hydraulic infrastructure has been completed, they become both users and managers. They must take responsibility for repairs and maintenance and must participate financially in any renewal operations. They thus have a vital role to play in ensuring the working life and sustainability of modern hydraulic infrastructure.

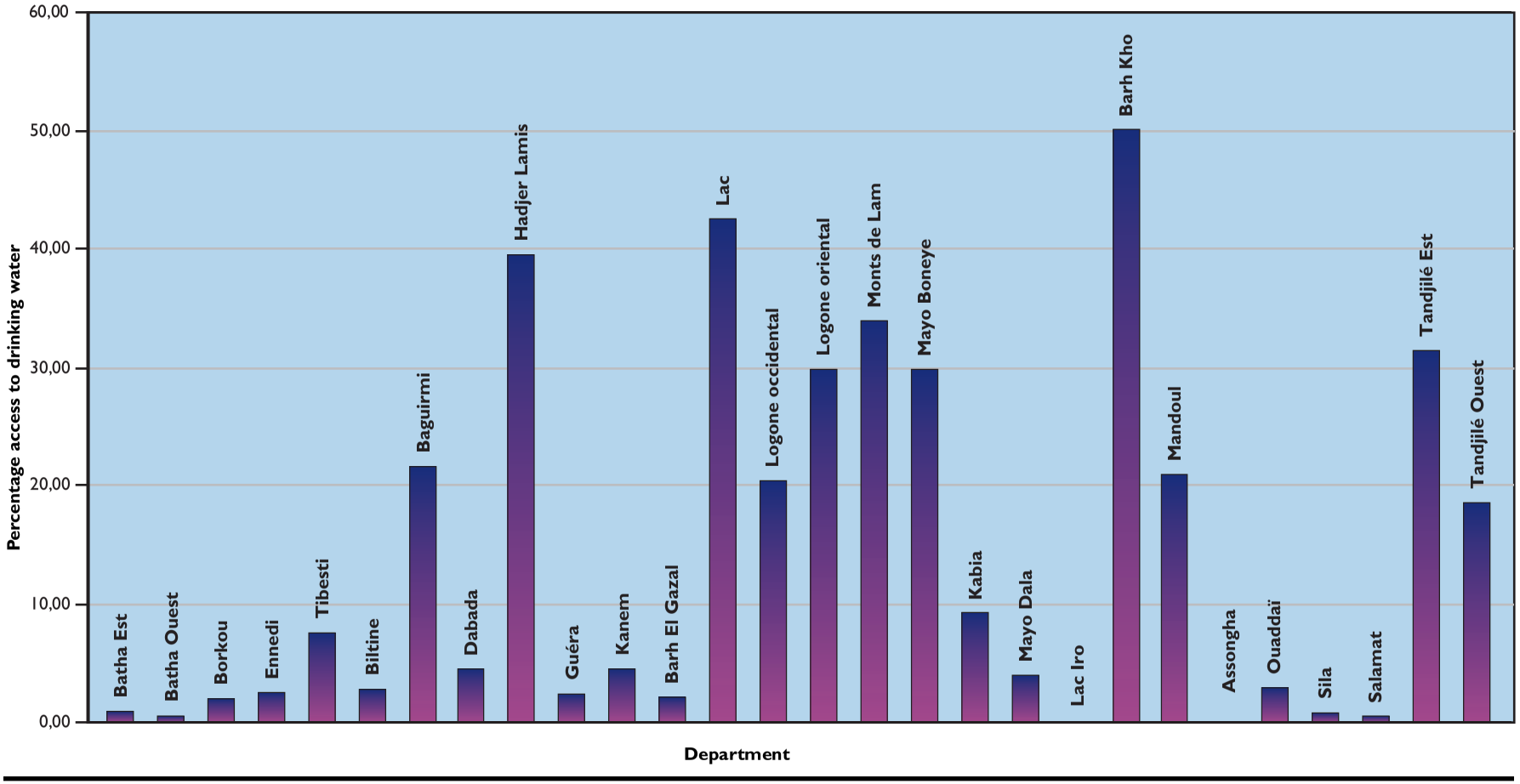
Twelve NGOs and charitable organisations have been identified working in the village water supply subsector. They provided a total of FCFA 3502 million in funds for various operations, including the construction of 2138 hydraulic structures (mainly wells) over the 1973-2000 period. The two major players in terms of both number of structures built and funding are the BELACD and SECADEV.

The private sector consists of national and international companies working on design studies, supervision and implementation of works. Companies specialising in the distribution of spare parts for pumping equipment are also active in the subsector.

According to the enquiry conducted among these national companies, all expressed the need for staff training and company management. It should be noted that they have difficulty obtaining money from the major international funding agencies.

The "craftsman" sector includes small companies, craftsmen's associations and cooperatives involved in digging wells and boreholes manually or using augers (boreholes) and in making local pumping facilities, in particular small hand pumps for boreholes and various pumping systems for wells (wheels, drums, buckets, etc.).

Table 3: Estimated percentage of rural population with access to drinking water in 2000 *(part 1)*



Source: SDEA 2001

Table 3: Estimated percentage of rural population with access to drinking water in 2000 *(cont.)*

Prefectures	Departments	Section 1: villages with a population of under 300						Section 2: villages with a population of between 300 and 1200			
		No. of villages with population under 300	No. of villages with a borehole	No. of boreholes	Population with drinking water supplies	Total population	% population with access to drinking water	No. of villages with population 300 to 1200	No. of villages with a borehole	No. of boreholes	Population with drinking water supplies
Batha	Batha Est	863	0	0	0	61 456	0.00	101	3	3	1 200
	Batha Ouest	1 042	0	0	0	83 830	0.00	170	2	2	800
BET	Borkou	142	0	0	0	12 324	0.00	53	2	2	800
	Ennedi	79	0	0	0	6 909	0.00	34	2	2	800
	Tibesti	64	0	0	0	6 073	0.00	17	2	2	800
Biltine	Biltine	1 428	0	0	0	102 483	0.00	187	14	14	5 600
Chari-Baguirmi	Baguirmi	1 406	53	53	13 250	152 729	8.68	223	38	79	31 600
	Dabada	366	7	7	1 750	57 145	3.06	180	12	12	4 800
	Hadjer Lamis	2 038	140	140	35 000	229 288	15.26	300	150	207	94 800
Guéra	Guéra	932	0	0	0	101 613	0.00	287	17	17	6 800
Kanem	Kanem	2 435	0	0	0	156 949	0.00	180	23	23	9 200
	Barh El Gazal	800	0	0	0	50 173	0.00	67	4	4	1 600
Lac	Lac	2 118	14	14	3 500	132 288	2.65	250	200	245	98 000
Logone occidental	Logone occidental	697	35	35	8 750	78 996	11.08	506	140	166	66 400
Logone oriental	Logone oriental	677	39	39	9 750	34 223	28.49	330	91	121	48 400
	Monts de Lam	723	32	32	8 000	41 492	19.28	256	73	97	38 800
Mayo-Kebbi	Mayo Boneye	533	48	48	12 000	55 187	21.74	149	73	98	39 200
	Kabia	236	28	28	7 000	32 138	21.78	333	42	57	22 800
	Mayo Dala	156	10	10	2 500	23 493	10.64	266	14	19	7 600
Moyen-Chari	Lac Iro	195	0	0	0	36 744	0.00	110	0	0	0
	Barh Kho	651	58	58	14 500	69 717	20.80	233	115	208	83 200
	Mandoul	749	45	45	11 250	95 807	11.74	392	92	164	65 600
Ouaddaï	Assongha	836	0	0	0	91 205	0.00	115	0	0	0
	Ouaddaï	925	0	0	0	108 067	0.00	201	17	17	6 800
	Sila	792	0	0	0	87 617	0.00	139	3	3	1 200
Salamat	Salamat	320	0	0	0	54 500	0.00	150	2	2	800
Tandjilé	Tandjilé Est	378	35	35	8 750	41 384	21.14	230	74	97	38 800
	Tandjilé Ouest	583	30	30	7 500	63 893	11.74	355	65	85	34 000
Total		**22 164**	**574**	**574**	**143 500**	**2 067 723**	**6.94**	**5 814**	**1 270**	**1 746**	**710 400**

Source : SDEA 2001

Section 2: villages with a population of between 300 and 1200		Section 3: villages with a population of between 1201 and 2000						Total					
Total population	% population with access to drinking water	No. of villages with population 1201 to 2000 hab.	No. of villages with a borehole	No. of boreholes	Population with drinking water supplies	Total population	% population with access to drinking water	Total number of villages	No. of villages with borehole	No. of boreholes	Population with drinking water supplies	Total population	% population with access to drinking water
74 286	1.62	5	0	0	0	7 713	0.00	969	3	3	1 200	143 455	0.84
101 402	0.79	9	0	0	0	10 521	0.00	1 221	2	2	800	195 753	0.41
25 038	3.20	5	0	0	0	6 191	0.00	200	2	2	800	43 553	1.84
20 543	3.89	3	0	0	0	5 711	0.00	116	2	2	800	33 163	2.41
4 792	16.69	0	0	0	0	0	0.00	81	2	2	800	10 865	7.36
97 016	5.77	8	0	0	0	12 465	0.00	1 623	14	14	5 600	211 964	2.64
99 752	31.68	10	8	8	12 800	16 196	79.03	1 639	99	140	57 650	268 677	21.46
76 352	6.29	9	0	0	0	15 582	0.00	555	19	19	6 550	149 079	4.39
124 543	76.12	13	11	22	17 600	21 469	81.98	2 351	301	369	147 400	375 300	39.28
173 840	3.91	23	0	0	0	34 413	0.00	1 242	17	17	6 800	309 866	2.19
52 803	17.42	8	1	1	400	12 150	3.29	2 623	24	24	9 600	221 902	4.33
26 174	6.11	4	0	0	0	4 962	0.00	871	4	4	1 600	81 309	1.97
120 704	81.19	23	7	46	20 800	35 553	58.50	2 391	221	305	122 300	288 545	42.39
300 734	22.08	39	23	34	13 600	58 685	23.17	1 242	198	235	88 750	438 415	20.24
141 791	34.13	47	24	31	12 400	61 361	20.21	1 054	154	191	70 550	237 375	29.72
101 256	38.32	3	2	7	2 800	3 952	70.85	982	107	136	49 600	146 700	33.81
117 728	33.30	20	8	15	8 400	28 105	29.89	702	129	161	59 600	201 020	29.65
234 966	9.70	60	5	10	4 000	100 437	3.98	629	75	95	33 800	367 541	9.20
176 988	4.29	55	3	3	1 200	95 928	1.25	477	27	32	11 300	296 409	3.81
59 564	0.00	8	0	0	0	13 465	0.00	313	0	0	0	109 773	0.00
128 706	64.64	16	11	28	11 200	19 410	57.70	900	184	294	108 900	217 833	49.99
252 429	25.99	37	8	22	8 800	62 902	13.99	1 178	145	231	85 650	411 138	20.83
40 737	0.00	3	0	0	0	3 855	0.00	954	0	0	0	135 797	0.00
120 961	5.62	10	0	0	0	15 494	0.00	1 136	17	17	6 800	244 522	2.78
87 348	1.37	2	0	0	0	2 698	0.00	933	3	3	1 200	177 663	0.68
107 480	0.74	13	0	0	0	21 100	0.00	483	2	2	800	183 080	0.44
117 418	33.04	20	12	18	10 400	26 933	38.61	628	121	150	57 950	185 735	31.20
181 226	18.76	30	11	16	11 200	41 581	26.94	968	106	131	52 700	286 700	18.38
3 166 577	**22.43**	**483**	**134**	**261**	**135 600**	**738 832**	**18.35**	**28 461**	**1 978**	**2 581**	**989 500**	**5 973 132**	**16.57**

3.2 The situation of urban and semi-urban water supplies

Urban and semi-urban drinking water supply systems concern towns of 2000 inhabitants and more. The Société Tchadienne d'Eau et d'Electricité (STEE) works in 11 centres (concessionary area) while the Directorate of Hydraulic Affairs is responsible for providing drinking water supply systems in other urban and semi-urban areas (non-concessionary area) that include both the main towns of the Decentralised Local Authorities (DLA) and villages with more than 2000 inhabitants.

Table 4 shows the population growth in the concessionary and non-concessionary areas.

Table 4: Population growth in concessionary and non-concessionary areas

Areas	2000	2010	2020
Population of concessionary area excl. N'Djaména	404 061	503 426	601 900
Population of N'Djaména	639 000	818 600	1 024 000
Total population of concessionary area	1 043 061	1 322 026	1 625 900
Population of non-concessionary area	783 055	1 301 060	1 949 091
Total population in urban/semi-urban areas	1 826 116	2 623 086	3 574 991

Source: SDEA 2001

In addition, in 2000 there were 175 urban areas with populations of over 2000. There will be 289 of them by 2010 and 462 by 2020.

At national level, administrative organisation is the responsibility of the Ministry of the Interior, Security and Decentralisation (MISD), whose duties are defined by decree 399/PR/MISD/97 of 10 September 1997. The institutional provisions are currently being modified after adoption on 16 February 2000 of law 002/PR/2000 concerning the status of Decentralised Local Authorities (DLA). Because of this, the term DLA now covers the regions, departments, a few communes that are to benefit from the "*moyen exercice*" and rural communities. Figure 4 shows the main towns of the "DLA" departments and sub-prefectures.

3.2.1 Equipment and estimates of drinking water supplies

The only urban drinking water supply (DWS) networks in 2002 were those operated by STEE serving the cities/towns of N'Djaména, Abéché, Sarh, Moundou, Bongor, Doba, Faya, Fianga, Kélo, Mao and Moussoro. All these urban centres have a developed distribution system consisting of public stand-pipes and individual connections. In all other cases, it is more a question of **embryonic networks,** based on the design of a village water supply system. These generally include a tapping structure, a solar or thermal pumping station, a water tower, a distribution network running for a few kilometres and 3-5 public stand-pipes. In certain cases, there are individual connections.

In addition to existing in the 11 urban concessionary centres operated by the STEE, facilities are spread over 85 of the 175 urban areas of over 2000 inhabitants. The field enquiries also showed that no more than 40% of the population in each urban area use or have access to water distributed via these systems. On this basis, about 417 000 people were supplied in 2000 by a DWS system in the concessionary area, while 204 000 people had access to an embryonic network in the non-concessionary area. In 2001, it was estimated that **the water supply rate for the entire population of Chad in towns of more than 2000 people was nearly 35%.**

3.2.2 Management of urban facilities

At present, there are two main types of DWS system management in Chad. The Société Tchadienne d'Eau et d'Electricité manages and operates 11 centres in the concessionary area; all the other centres with a DWS system in DLA and other areas are managed by a management committee.

3.2.2.1 STEE management

The STEE is currently undergoing thorough reorganisation. The following were signed on 28 February 2000:

- first, a **public service concession agreement** for producing, conveying and distributing water and electricity between:
  1. the "public authority", the Republic of Chad, represented by the Ministry of Industry, Trade and Crafts, the Ministry of Mines, Energy and Oil, the Ministry of the Environment and Water, and the Ministry of Finance;
  2. the "concessionary operator", the STEE, represented by the Ministry of Mines, Energy and Oil.
- second, as part of the privatisation of water supply and sanitation services in Chad, a **general STEE licensing and management contract** between:
  1. the "State", the Republic of Chad, represented by the Ministry of Industry, Trade and Crafts, the Ministry of Mines, Energy and Oil, the Ministry of Finance and the Ministry of the Environment and Water,
  2. the "contractor", the STEE, represented by the Ministry of Mines, Energy and Oil,
  3. and the "manager" the Vivendi/Dietsman consortium.

The Republic of Chad stated that it wished eventually to withdraw from the capital of the STEE and in this respect invited tenders from international companies with a view to selecting a consortium to take its place. This would involve **two phases:**

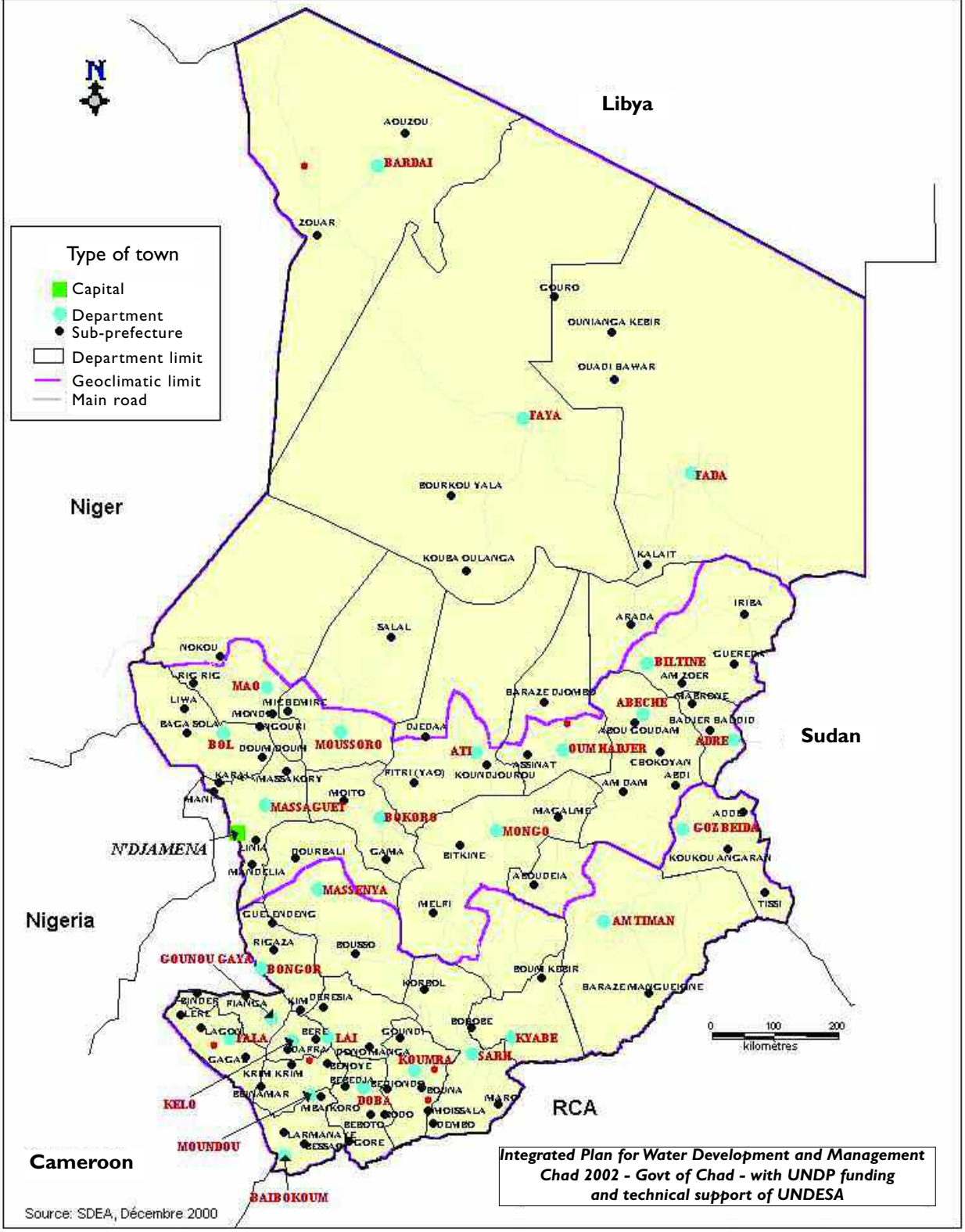
- The first phase would consist of private management, without any involvement by the consortium in the STEE's capital. The aim was to hand over part of the management of its operations to a third party without losing control of the conceded services. This phase in turn included two stages:
  - a "general management concession" signed the same day. This stage was to be completed with the commissioning of Farcha thermal power plant associated with the oil refinery for the Sédigui field "or any other means for reducing fuel costs on a lasting basis",
  - all operating risks would then be transferred to a company via an "operating contract" for which the contractual provisions (essentially management at its own risk) were defined in an annex (annex no. 21).
- A second phase in which the consortium would take a majority shareholding in the registered capital of the concessionaire, the STEE.

In the present situation, it is difficult to assess the planned new management system and the chances of all these stages being implemented. However, a **watchdog committee** to monitor the new company would be a guarantee that the mutual commitments of the concessionaire (STEE SA) and manager (Vivendi/Dietsman) were met, in particular with regard to the results and extensions expected of the service. Monitoring must be carried out effectively in return for the STEE's newly autonomous management. Independent, high-level back-up for the watchdog committee appears to be a prerequisite if monitoring is to be successful, minimising what is usually referred to as the "information dissymmetry" between that which is directly accessible to the private manager (and future concessionaire) and that which is actually controlled by the public authority. In addition, it would seem essential to clarify the legal framework for carrying out such monitoring, as provided for in the Water Code, in order to maintain consistency between the overall mechanism for monitoring sector performance levels and to anticipate the shortcomings that are always possible with such arrangements, in the interest of the Chadian consumer and in particular the poorest sectors of the population.

In contrast, the control maintained by the State over STEE tariffs may be a source of conflict when assessing the targets fixed in the introduction to the agreement.

Republic of Chad

Figure 4: Locations of the main towns of the departments and sub-prefectures (Decree No. 354 dated 01/09/99)



Integrated Plan for Water Development and Management Chad 2002 - Govt of Chad - with UNDP funding and technical support of UNDESA

3.2.2.2 Management committees

The management system is of the community type, drawn from the experience of the Directorate of Hydraulic Affairs. Water management committees consist of 7-10 members who are responsible for the various management functions. They are assisted by a technical team responsible for maintaining the equipment.

The main conclusion with regard to DWPs run by a management committee is usually that the management systems set up recently are not functioning properly. Operating, regular management and monitoring functions are not clearly dissociated. All village chiefs and dignitaries are directly involved in a manner which is inconsistent with their position and institutional role as arbiters. In addition, there is a regrettable absence of regular technical reporting, recording of elementary indicators and precise accounting.

Under-billing also occurs, as the price of water is fixed without taking into account real running costs. Free and unrestricted delivery of water to dignitaries and public services is all too common. There is little or no maintenance, with servicing being limited to oil changes and lubrication.

3.2.3 The cost of water

The basic prices of water and connections differ from one system to another. The management committees sometimes charge STEE rates when new connections, repairs or upgrades are carried out, in the absence of any real calculation of local cost prices and customer market studies. Generally, the price of water is broken down into three levels. The price of the first, so-called "social" level (15 m^3/month) is fixed at FCFA 105. The price of the second level (15 m^3/month to 100 m^3/month) varies from one town to another; it is FCFA 230/m^3 for towns covered by the STEE and may reach as much as FCFA 490/m^3 (at Pala). Lastly, the price of the third level is FCFA 110/m^3.

Generally speaking, the prices charged do not reflect the real costs borne by the owners. STEE prices have remained unchanged since 1984. Many towns are content to apply these rates, having no serious economic analyses that they can use as a reference. When they do not apply them, the prices they charge do not take into consideration the cost of replacement and major overhauls.

However, whereas prices are fixed when it comes to the basic producers (the STEE and management committees), this is not the case with **resale prices**. The least privileged sections of society may pay dealers **15-25 times more than subscribers who have an individual connection**. This situation is a major obstacle to achieving extensive, equitable access to drinking water for people in urban areas in the concessionary area.

3.2.4 The major stakeholders in urban water supplies

The various stakeholders involved in urban and semi-urban water supply can be grouped under several headings. These include institutions, producers, funding agencies, craftsmen and associations, the private sector and users.

In 2001, the main institutional stakeholders in the field of urban water supplies were the Ministry of the Environment and Water via the Directorate of Hydraulic Affairs, which works in the non-concessionary area, and the Ministry of Mines, Energy and Oil, which is responsible for the STEE that operates exclusively in the concessionary area.

The main producers were the Water Point Management Committees in towns with thermal or solar DWSs (in the non-concessionary area) and the STEE (in the concessionary area).

The main funding agencies involved in urban and semi-urban water supply systems over the past 25 years have been China/Taiwan (FCFA 15 346 billion), Germany (FCFA 10 756.6 billion), the EIB (FCFA 1486.8 billion), the EDF (FCFA 1395.3 billion), France (FCFA 985.8 million), Italy (FCFA 835.2 million), the IDB (FCFA 105 million) and the World Bank (FCFA 54 million). There are no NGOs working in the field of urban and semi-urban water supplies.

Craftsmen and associations include stand-pipe vendors and managers, who often act as intermediaries (in a way as "wholesalers") between network owners and water carriers ("retailers") or consumers who have no subscription.

The private sector consists of national and international companies involved in design studies, monitoring and implementation of works. Companies distributing spare parts for pumping equipment are also active in this subsector. Just as in the field of village water supplies, these companies have expressed the need for training and back-up.

Citizens are still the main consumers of water in urban and semi-urban areas. With 300 companies formally registered in Chad, there is little abstraction for industrial needs, but no accurate survey has been carried out so far in this respect. However, it should be noted that water used in industry is not recycled and wastewater is generally discharged into the environment with no prior treatment.

3.3 The situation with regard to sanitation

In **village areas**, leaving aside isolated efforts by a few projects, very few villages are equipped with improved traditional latrines or ventilated pit latrines or solid waste and wastewater collection systems. 10.6% of households use a rudimentary latrine, 0.6% use an improved traditional latrine and 88.5% defecate in open areas. There is no waste collection in the villages and household animals are left free to wander. Lastly, 65-70% of rural households draw water from traditional wells while only 17% of the rural population have access to a drinking water point. One notable feature of Chad is that past and present major village water supply projects are not always accompanied by a "village sanitation" component, which is not expensive but calls for specific local coordination and mobilisation programmes. The health situation is characterised by very high infant and maternal morbidity and mortality rates. They are among the highest in sub-Saharan Africa and indeed in the world.

Health statistics for Chad show that the lack of drinking water and the unsuitable hygiene conditions are the main causes of mortality and sickness within the population. The main illnesses that represent public health problems are malaria (49% of children), schistosomiasis, diarrhoea (44% of children), meningitis, tetanus, measles, etc. Cholera epidemics often occur. It is clear, therefore, that certain illnesses are directly related to the lack of a basic health infrastructure, which leads people to adopt habits and behaviour patterns that are contrary to hygienic, healthy living.

None of the **towns** has a functioning wastewater disposal system. The collection networks are outdated. Fewer than 2% of townspeople have sanitary installations with running water. There are no systems for removing excreta and household waste or for treating solid waste, and no systems (or very few) for disposing of rain water. Water stagnating in pools encourages the proliferation of mosquitoes, which are vectors of malaria, yellow fever and encephalitis. Flooded latrines and pits, as well as abandoned litter, increase the risks of infectious diseases spreading. In the centres and suburbs of urban areas, this situation may lead to serious problems of sanitation and pollution of the aquifers that are traditionally used for domestic needs (including, in certain cases, drinking water). Consequently, there is a high rate of diarrhoeal diseases and serious risks of epidemics, including cholera.

Only the cities of N'Djaména, Moundou, Sarh and Abéché drew up Urban Reference Plans (URP) in February 1997. These plans locate housing construction areas, define major road layouts and set out the main options for stormwater drainage.

The infrastructure (incinerators, treatment plants, etc.) operated by hospitals and health centres is far from being in perfect working order and these centres do not have well-defined procedures for treating and eliminating **biomedical waste**. Often, such waste can be found in the streets where it can be picked up by children or anyone who wishes to "collect" it. Wastewater from health establishments is rarely treated and is discharged into the environment, often into natural watercourses. In certain cases, these are reused for various purposes (watering small market gardens, etc.). All wastewater from N'Djaména hospital, containing microbes, bacteria, chemicals, etc., is released into the river without any prior treatment. This practice poses an obvious risk for human health and for the environment in general.

As far as **industrial sanitation** is concerned, there were no regulations in 2000 and no standards regarding industrial waste, especially liquid effluent. Chad has no developed industrial estates. In addition, it was noted that most industries discharged their effluent without any treatment into the main rivers such as the Chari and Logone.

3.3.1 Urban sanitation facilities

Only the four main cities (N'Djaména, Moundou, Sarh and Abéché) have a more or less organised secondary network of open channels for removing rain water. These channels are rarely in good condition. Often, they do not appear to have been built within the framework of an overall rain water disposal plan. Waste collection systems can be found, but they all appear to be hardly operational. In the other main towns of Chad, there are no working sanitation facilities in good condition. Everything needs to be done in this area.

From the industrial standpoint, no document referring to national policy refers to industrial pollution control as a priority or major concern. Chad has few industries. They are concentrated in Moundou, Sahr and N'Djaména. Wastewater is treated without any form of control. As stated above, all these industries discharge their wastewater into the Chari and Logone.

3.3.2 Stakeholders in the field of sanitation

The institutional framework with regard to urban sanitation in 2001 was more complex than that of the other subsectors, as several institutional stakeholders have a role to play. The main organisation involved is the Ministry of Public Health, which is responsible in particular for promoting environmental health, sanitation and the quality of water for consumption, and for drawing up legislation and regulations concerning hygiene and sanitation.

The Ministry of Public Works, Transport, Housing and Urban Planning is responsible for regulations concerning development, planning and construction and for defining levels of service access depending on type of neighbourhood.

The Ministry of the Environment and Water is responsible for coordinating and managing all activities connected with urban water supplies and sanitation, in particular identifying, designing and implementing sanitation programmes (wastewater, stormwater, solid waste, excreta) in collaboration with the other departments involved in this sector and with those responsible for health awareness and education campaigns directed at the population.

The Ministry of the Interior, Security and Decentralisation, via the sanitation department, is responsible for exterminating insects and rats and disinfecting homes, for intervening in the event of disasters (epidemics, floods, etc.) and for removing solid and liquid waste and excreta from towns and cities using hygienic processes.

The towns also play a role in the sanitation sequence, as do the townspeople; in certain places they have organised **Sanitation Committees** that work to maintain and lay stormwater drainage pipes, collect waste and repair streets after the rainy season.

In 2000, few NGOs were involved specifically in the field of sanitation. The main ones included the Institut Tropicale Suisse (ITS), CARE, BELACD and SECADEV. CARE provides assistance in particular for the Sanitation Committees in N'Djaména. The private sector is very small and funding for the sanitation subsector is almost always a component of projects where the main aim is to build hydraulic infrastructure. However, it should be noted that UNICEF stresses sanitation aspects in all its operations in the field of drinking water supply; in fact, these two operations are closely linked.

There are thus a great many institutional stakeholders involved in the field of sanitation, usually working with virtually no funding and often unable to coordinate their work and programmes. In recent years, initiatives by neighbourhood organisations have attempted to make up on a very small scale for the shortcomings of this subsector, where nearly everything remains to be done in rural, urban and semi-urban areas alike. Theoretically, the risk of epidemics breaking out is greater in the last two areas.

3.4 The situation with regard to pastoral water supplies

The pastoral areas of Chad in fact include all land below an altitude of 1000 m, above which the herds of goats never go (except in the case of a few water points in the Tibesti mountains) and excludes flood-prone areas. This part of the country corresponds to the edges of the Saharan, Sahelian and Sudanian zones that are the permanent or seasonal home of stock-rearers and farmer-herders, and to the southern regions that they cross on their way to winter pastures (linked to rains and floods) in accordance with the distribution of water points in these regions. Water is therefore a decisive factor in the movement of pastoralists. Consequently, decisions concerning the location of new pastoral water points are essential in combating desertification, preventing conflicts and promoting regional development as a whole. If the exceptional movements triggered by climatic disasters such as droughts are taken into account, there is scarcely any area of Chad that is not crossed by seasonal migrations.

3.4.1 Pastoral systems

In order to have an operational ranking suited to the aims of an integrated plan for water development, the pastoral systems were distinguished according to the preferred type of access to water resources, taking into account the geoclimatic breakdown. Adopting this classification principle gives a total of 12 pastoral systems spread over the three main zones. Figure 5 summarises and illustrates the main pastoral systems.

Saharan zone

Two pastoral systems were distinguished in the Saharan zone. These are the **piedmont type**, connected with water resources concentrated near relief and in the immediate vicinity of piedmont areas, and the **western Kanem** type, in which stock-rearers limit their movements to the wadis that they exploit and where they cultivate rainfed cereals and sometimes keep gardens.

Sahelian zone

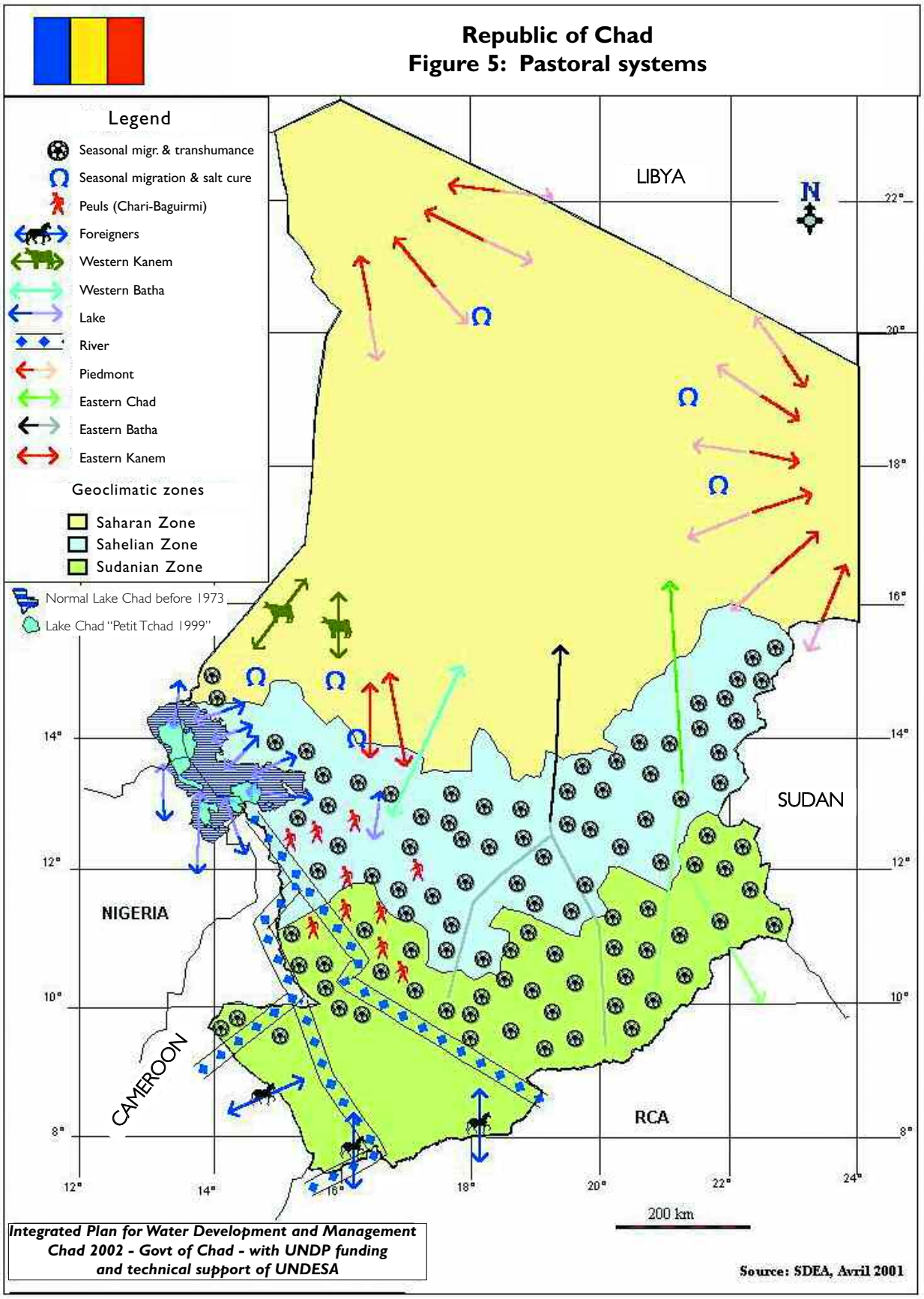
These pastoral systems become increasingly extensive the nearer they approach the border with Sudan. Movements range from a few kilometres a year in the case of herds in the large wadis of south Kanem to several hundred kilometres in the eastern part of Chad. **Six pastoral systems** coexist in the Sahel. They are often differentiated by regional flow patterns and the annual distribution of pastoral resources. These systems are as follows:

The lake sector pastoral system: around Lake Chad, cattle rearers exploit the hundreds of flood-recession grazing areas left on the islands and archipelagos that emerge as the lake water level falls.

The eastern Kanem pastoral system: rearers' movements within this system can be likened to annual oscillations along the Bahr-El-Ghazal route. At the end of the dry season, they move southwards to the Massakory road at Ati and wait till the rainfall front overtakes them. When they feel that there are sufficient ponds in the Saharan rangeland, they move back up to these areas following the surface water that concentrates in the Bahr-El-Ghazal valley.

The western Batha pastoral system: the rearers spend at least nine months of the year at Lake Fitri, where their herds graze on bourgou grass, complying with the traditional rules of the sedentary population.

The eastern Batha pastoral system: depending on the year, rearers spend 9-10 months away from their administrative main town, Oum-Hadjer, travelling south to avoid having to draw water from the wells in their own prefecture, as they possess very large herds. Depending on their starting position, they reach the lakes and large ponds of the Salamat by travelling east or west around the Guéra. They return quickly at the start of the winter season in order to avoid the floods on the main wadis, which would prevent them from reaching the grazing land further north.


Republic of Chad
Figure 5: Pastoral systems
Legend
Seasonal migr. & transhumance
Seasonal migration & salt cure
Peuls (Chari-Baguirmi)
Foreigners
Western Kanem
Western Batha
Lake
River
Piedmont
Eastern Chad
Eastern Batha
Eastern Kanem
Geoclimatic zones
Saharan Zone
Sahelian Zone
Sudanian Zone
Normal Lake Chad before 1973
Lake Chad "Petit Tchad 1999"
LIBYA
SUDAN
NIGERIA
CAMEROON
RCA
N
22°
20°
18°
16°
14°
12°
10°
8°
12°
14°
16°
18°
20°
22°
24°
200 km
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA
Source: SDEA, Avril 2001

The eastern Chad pastoral system: the migration distances are as great as those of the preceding systems. When rearers begin to move southwards, they often abandon hardly exploited grazing land because the wells in these regions, which are dug into hard and badly faulted formations, quickly dry out.

Lastly, **the seasonal migration and transhumance pastoral system:** in all villages with a sedentary population, there are stock-rearers who often possess large herds of zebus and small ruminants. During the dry season, they travel away from the villages searching for pasture. During the rainy season, the owners entrust their livestock to migratory rearers for the summer migration period, so that they can devote themselves to agrarian activities.

Sudanian zone

This part of the country is dedicated mainly to cotton growing, which is predominant in all the regions situated west of the river Chari. However, **four pastoral systems** are found there simultaneously. These are:

A generalised system of village stock-rearing and farming using animal-drawn equipment, (seasonal migration and transhumance). The closer one gets to the main provincial towns, the more one finds small herds raised for speculative purposes. These agro-pastoral situations are limited by the volume of locally available water resources.

The river pastoral system occurring along the main rivers and consisting of large zebu herds, as the animals are able to drink all year round from the permanent rivers. Very often during the rains, rearers migrate short distances. The main reason is to move the animals away from the crops and this cannot therefore really be called rainy season migration.

The Peul pastoral system, which is specific to the Chari-Baguirmi region. This follows regional dry-season movements but includes migrations to the bourgou grass areas around Lake Chad before the start of the rainy season. The longer the dry season, the earlier the migration begins.

Foreign pastoral systems, originating in Cameroon and the Central African Republic and involving sheep rearers and Peul cattle rearers. These pass through the southern sub-prefectures, entering Chad as soon as the first rains occur, and then head up to the Sahelian zone and even to the edges of the Saharan zone during rainy years. This "foreign" transhumance was reckoned in 1988 to represent one third of the animals in western Chad, but they do not use hydraulic infrastructure as they advance in accordance with the rainy season ponds.

The systems described above are a summary of the main types of movement by pastoralists in each major region. They do not reflect the true complexity of seasonal movements in each sub-prefecture and canton, but rather a regional overview. As an example, it would be possible to define a "camel-rearers" sub-group in each of the Sahelian pastoral systems described above. Such a sub-group would have its own types of movement in terms of time and direction, even though in most cases the route would be virtually the same as that taken by cattle-rearers. The herds would simply move less further south and return earlier.

In addition, before the first drought in 1969-1974, it was rare for rearers to move further south than the 13th parallel during the rainy season migration. Only those of eastern Batha and the prefectures of Ouaddaï and Biltine would go further south, as the places where they watered their herds dried out in November. After the dry season, the modification in the vegetation meant that all journeys shifted to different latitudes. Whereas previously most camps moved their herds in order to exploit three ecosystems (edges of the Sahara, Sahel and Sahelo-Sudanian regions), from 1975 onwards with the lack of grazing land, most camps stayed within the Sahel and Sudanian regions where they spent most of the time, preferring to make the most of their journey south to strike various types of contract with the villagers that they met at the end of the dry season.

At the present time, the Dourbali parallel appears to be the southernmost limit of "normal" seasonal journeys. A similar type of shift has occurred in movements in the Saharan zone, where the herds of dromedaries in turn spend more time in the Sahelian zone.

3.4.2 Livestock and pastoral resources

There is currently little information on livestock numbers and fodder resources, which is a serious limitation in developing the subsector and accurately evaluating water requirements and the hydraulic structures that need to be built. Thus, in 2000, the total livestock numbers varied from 9 million to 16 million tropical livestock units (TLU). In addition, the available data concerning fodder resources give between 600 and 1200 kg of dry matter/ha/year for the Sudanian zone, 400-900 kg of dry matter/ha/year for the Sahelian zone and 200-300 kg of dry matter/ha/year for the Saharan zone

Unfortunately, these values were determined on the basis of surveys carried out before the last drought in 1984-1985 and therefore need to be revised. Also, they concern only part of Chad up to the 17th parallel, and therefore give a very incomplete view of the Saharan zone.

Several authors of recent works estimate that in numerous regions the situation has hardly worsened since the last climatic disaster, even if there are signs of over-grazing in certain areas. The most recent forecasting documents concerning the management of pastoral resources in Chad consider that fodder resources may still support an increase in livestock of between 2.4 and 4.7 million TLU, i.e., increases of 40% and 78% respectively.

3.4.3 Pastoral water supply facilities

Depending on the season, rearers use two types of facility to water their herds: fixed water points with varying levels of equipment, and catch pits and ponds that appear after the first rains, some of them remaining for several months. However, one important point should be stressed straight away: whatever artificial structure they use, even when it is a pumping station where they have to make no effort to water their herds, as soon as they can gain access to surface water, they immediately do so, however small the ponds created by the first rains. By doing this, they shorten the exhausting pumping work that they have been obliged to carry out during the dry season.

The water points where herders water their animals are grouped into three categories depending on the level to which they are developed, namely traditional water points consisting of traditional wells, saniés and oglats, on one hand, and modern water points (MWP) including modern cemented wells, boreholes equipped with pumping stations and developed ponds on the other. Lastly, there are also undeveloped water points, namely natural ponds, lakes and permanent rivers and streams.

There is no inventory or data base concerning traditional water points. However, this type of structure appears to be the water point most commonly used by rearers, with groundwater abstraction. There is also no inventory concerning temporary or permanent ponds in the country. The surveys indicate that in many regions stock-rearers water their herds at ponds and marigots for periods ranging from 3 to 10 months. However, these reserves of water are so variable from one year to the next, rainfall so erratic and the differences in topography so great in Chad that it is pointless to imagine obtaining an exhaustive document covering these natural reserves of water.

However, an empirical method of evaluating the quantity of surface water used for livestock is to multiply the quantity of water consumed each day by the number of livestock. Using this calculation method, the estimated consumption of surface water by livestock in Chad is of the order of 57 milllion m^3 per annum, which satisfied about 25% to 30% of livestock water requirements in 2000. It should be noted that a small proportion of livestock in Chad drinks every day from the permanent rivers, the Logone and Chari. In the calculation carried out above, no account was taken of this aspect.

In all, 23 pumping stations used for pastoral water supply purposes were inventoried. These stations are located for the most part in the Sahelian zone to the north and east of N'Djaména. An enquiry carried out in 1999 showed that only four stations were still operating, while the others had been abandoned or were completely out of use. Another study showed that 17 of these pumping stations could be rehabilitated and brought back into operation. In 2001, no rehabilitation work had been undertaken.

The number of modern wells (cemented, reinforced concrete wells) throughout Chad is estimated at 3485. The distribution of these structures per geoclimatic zone and per use is shown in table 5 below.

Table 5: Distribution of modern wells per geoclimatic zone

Prefecture	Pastoral use	Village use	Mixed use	Total
Saharan	96	15	23	134
Sahelian	525	697	478	1 700
Sudanian	73	1 416	162	1 651
Total	**694**	**2 128**	**663**	**3 485**

Source: SDEA 2000

It can be seen from this table that 694 wells are used essentially for pastoral purposes. Combining wells used for pastoral purposes and those used for mixed purposes, 1357 modern water points distributed throughout Chad were used to water livestock in 2000.

These wells are centred mainly in the western part of the Sahelian and Sudanian zones. At present, the distribution of pastoral water points is very poor and does not correspond to the real needs of the subsector. The west is over-equipped and the east, where most major migration routes are found, is under-equipped.

3.4.4 Management of pastoral water points

Generally speaking the traditional wells do not pose any problem in terms of use and management as their usage is determined by the stock-rearer or group of users that ordered or built it. Similarly, the saniés, which are several centuries old, do not give rise to any significant conflicts. Usually, the manner in which they are used has been fixed by custom for centuries. However, the drawback of the saniés is that they require large amounts of wood for their lining, which **unnecessarily harms an environment made fragile by drought.**

The use of cemented wells is carefully codified by usage and local custom. Often, the people living in one or more cantons share water turns according to the number of "*chibés*" available.

Surface water and rainy period ponds pose no particular problems in terms of use or management as in general, and especially in the Sahelian zone, they are used on a "first come, first served" basis, particularly when they are small. If they are larger, sufficient numbers of herders are accustomed to camping there each year for customary usage to have been established and respected.

In 2002, there were three "major" types of modern pastoral water point management. The procedure recommended by the Directorate for the Development of Animal Production and Pastoralism involves operating in an organised environment in such a way as to transfer the management and maintenance of the structure to users **organised in groups**. The fact that the group is now responsible for the structure does not, however, exclude other users who are required to comply with the rules of access.

In eastern Chad, the management of pastoral water supply structures is based on discussion and negotiation between stakeholders rather than ownership of water points by a group or association. The pastoral water supply structures that exist (wells and ponds) are common property owned by all rearers whether they are sedentary or migratory. Two levels of management have been created: at water point level, a "joint management committee" involving sedentary and migratory rearers, which has enabled rules for using the structures (wells or ponds) and surrounding resources to be defined, and at sub-prefecture level a "joint committee" consisting of traditional chiefs (of both sedentary and migratory communities) and local government representatives. The aim of the latter is to solve conflicts between sedentary and migratory rearers and to define and mark out migration routes in the field.

A third type of management is currently being tried out in western Chad. Starting with the realisation that rearers in Kanem are already well-organised, the system for managing pastoral water supply structures provided within the framework of the Kanem Pastoral Water Supply Programme (PHPK) is based on the traditional system of pastoral well management. Each well has an **owner or manager**, who decides on its use and "opening it up" to migratory rearers. This type of management is also found in the geographical Ouaddaï.

These three experiments in pastoral water point management are relatively recent. Lessons should be learned from them for setting up future management systems which, while respecting customs and specific regional and local features, will guarantee the permanence of the structures and access to water for rearers and livestock.

3.4.5 Conflicts connected with access to water points

Generally speaking, and traditionally, users in a given region share access to water resources according to various combinations of criteria that through long usage have come to satisfy all native users. In certain regions, drinking time is allocated according to the canton from which the herders come, and in others according to the users' types of activity, while other communities of agropastoralists prefer to opt for time-sharing.

If conflicts should break out, they affect only small groups limited to a few families. They are generally very localised and short-lived. Most serious conflicts arise when the spatial distribution of grazing and/or cropping activities is hampered or upset by new arrivals or passing rearers who, because of their numbers, try and impose themselves by creating *faits accomplis*. Although such conflicts are sometimes violent and last several years, they are usually completely controlled by customary lawgivers, who have all the necessary means for settling such matters.

In contrast, conflicts that originate in clashes between two different strategies followed by groups that have decided to increase or shift their grazing areas are more difficult to solve, as long as the underlying motives of those involved is not clearly apparent. The main reason for such clashes is not always the water point(s), even if it is at such places that they break out.

Sometimes, one or more groups may start a conflict that serves their interest in one way or another, depending on how they see the situation. Such conflicts generally occur between rearers when the grazing land of one group has been reduced following repeated droughts or fires (which may be lit deliberately). When a serious conflict breaks out over a well, the matter is brought to justice. However, whatever the settlement, the group that is "foreign" to local usage, but a party to the conflict, is almost always granted access to the water point. This is why some cantons have developed extremely aggressive strategies for "occupying" certain wells to which they had no right of access through either usage or custom.

Equally intentional clashes also occur between sedentary farmers and rearers when the rearers consider that the farmers' fields enclose the water points. Fields and gardens become so interconnected that they gradually form tight mazes through which it is quite impossible to lead even a small herd. When such practices spread, rearers always try provocation, driving their animals into the fields of crops when they have the least opportunity. For their part, farmers intentionally block off certain paths and areas of land that they know to be unproductive but which would allow herds to pass through easily.

The only ponds over which conflicts arise are those in Mortcha. Here, it is not the ponds themselves that are at stake but the grazing land to which they give access. As they are used only once every 6-7 years, there is no clearly defined usage. So, when early heavy showers fall, making it possible to exploit a given sector, those benefiting from this brief advantage take the opportunity to spill over on to land that they do not usually graze. However, once the rains have filled all the ponds, rearers who have been affected last by the rains hastily try to redefine the boundaries of the grazing areas as they see fit. The result depends to a great extent on the balance of power existing between them.

3.4.6 Pastoral water supply stakeholders

The main institutional stakeholders in the pastoral water supply subsector are the Ministry of Stock-Rearing via the Directorate for the Development of Animal Production and Pastoralism, which is in particular responsible for defining and organising local joint management policies for pastoral resources including hydraulic infrastructure, in liaison with the parties concerned, and the Ministry of the Environment and Water via the Directorate of Hydraulic Affairs, which is responsible for planning and scheduling urban, village and pastoral water supply activities and sanitation.

There is also a para-public stakeholder involved in pastoral water supplies, the Farcha Veterinary and Zootechnical Research Laboratory (LRVZF). This is a public establishment of an industrial and commercial nature, with its own legal status and financial autonomy, supervised by the Ministry of Stock-Rearing. The LRVZF carries out scientific and technical research required to preserve, develop and improve the country's livestock and develop its by-products.

With regard to the donors, the main stakeholder in the field of pastoral water supply is France via the Agence Française de Développement (AFD) and Fonds d'Aide et de Coopération (FAC), followed by the Saudi and Kuwait Funds. Between 1985 and 2000, a total of FCFA 53.60 billion was invested in this subsector.

The main organisations in pastoral areas are health protection associations, pastoral interest groups and joint management committees. Few NGOs are directly involved in pastoral water supplies, while the private sector consists of national and international companies involved in studies, monitoring and construction work on water points.

3.5 The situation with regard to agricultural water supplies

3.5.1 The physical context of agricultural water supplies

The Saharan zone

The Saharan zone covers the entire northern part of Chad, representing some 60% of the country's area. From the climate point of view, it therefore corresponds to the Saharan climate in the strict sense, and to the Saharo-Sahelian climate. Because of its climatic characteristics, the Saharan zone is of limited agricultural potential in comparison with the Sahelian and Sudanian zones. By definition, it is the area in which date palms grow.

The Sahelian zone

From the agricultural point of view, the economy of the Sahel is based traditionally on cereals (millet) and oilseeds (groundnuts). Nevertheless, the long dry period that the region has experienced over the past three decades has led to a severe regression of groundnuts with a corresponding expansion of millet, without there being any apparent increase in yields. On the contrary, the frequent shortages of rainfall and impoverishment of the soil related to the abandonment of groundnut cultivation, not to mention the influx of cattle from the north, quickly put pay to any gains in production expected from the increase in cultivated land. But in any event, there is no avoiding the two main limiting factors for agriculture inherent in the climatic characteristics of the Sahelian zone, namely that **the range of rainfed crops is and will always remain limited, and no significant intensification in production can be expected without irrigation.**

The Sudanian zone

There is intense and varied agricultural activity in the Sudanian zone. The area cultivated each year with rainfed crops is of the order of 1.2 million ha, while flood-recession crops cover about 100 000 ha. The main crops, **outside irrigated areas,** are:

- cotton: covering more than 200 000 ha, this is the main cash crop and consequently the main source of foreign currency for the country. Nevertheless, it should be noted that cotton growing is one of the major factors contributing to the country's chronic food insecurity, owing to the increasing areas devoted to this crop and the deterioration of the soils resulting from its repetitive character;

- oilseed and legume crops, including groundnuts, cowpeas, sesame, earth peas and more recently soya, covering an area that fluctuates between 200 000 and more than 300 000 ha;
- cereals, the staple food of the country; annual production is subject to the whims of nature and is generally well below requirements. The area of land devoted to cereals covers between 450 000 ha and 800 000 ha;
- root vegetables (manioc, sweet potatoes, yams, taro), which are essential additional foodstuffs, occupy several thousand hectares;
- market garden crops.

3.5.2 Agricultural water supply facilities and assessment

Water is used for agricultural purposes in many different ways, depending on the environmental context. Most are traditional, possibly combining the use of surface water and groundwater. However, there are also areas that are quite modern in design and others that might be termed improved insofar as they feature limited innovations in comparison with traditional systems. Figure 6 illustrates the distribution of these various facilities throughout Chad. With reference to the classification criteria in use in Chad, i.e., the size of the area, the level of water control and the type of crops, the following seven irrigation systems will be adopted: flood-recession agriculture, depression rice-growing, traditional small-scale irrigation with complete water control, modern small-scale irrigation with complete water control, large irrigation areas with partial water control, large irrigation areas with complete water control and oasis systems.

Table 6 summarises the characteristics of the various types of irrigation facilities found in Chad. Leaving aside traditional schemes which, it should be remembered, nonetheless represent most of the irrigated land, Chad currently has only four modern irrigation schemes that are soon (2002) to be improved by the flooding of Mamdi polder (1600 ha). However, it should be noted that these large modern irrigation areas all have a serious drawback: the cost price is high (over FCFA 14 million/ha) which is difficult to justify from the economic standpoint. In principle, the State's withdrawal from production activities should put an end to this type of public investment, which has given rise to more disappointment than satisfaction, though this does not rule out the possibility of private investors taking its place.

The State may also take pride in the construction of four large irrigation areas with partial water control along the Logone, covering a total of about 4600 ha, and an improved traditional polder of 600 ha to the north-east of Lake Chad. Even so, the difficulties encountered in supplying water and managing the areas along the Logone suggest caution with regard to subsequent renewal of this type of scheme. In contrast, the low cost of the development works needed to transform a classical traditional polder into an improved traditional one (of the order of FCFA 1 million/ha) has led the Government to launch a huge project of this kind covering more than 8000 ha, with work scheduled to start in the coming months.

In addition to these State-initiated schemes that are important for institutional development, some of which (the polders) are still under its authority, there has been enormous public investment in the development of small communal water supply schemes of which little remains, unfortunately. Most of the 70 schemes implemented over the past three decades have in fact disappeared or are in such a state of dilapidation that they cannot be used rationally. Only about ten of the most recent, totalling some 350 ha, can still justifiably be termed small irrigation areas (SIA).

One positive aspect of the subsector is the success of small private irrigation schemes in the N'Djaména region, although these areas are of marginal importance and it remains to be seen whether they can be reproduced.

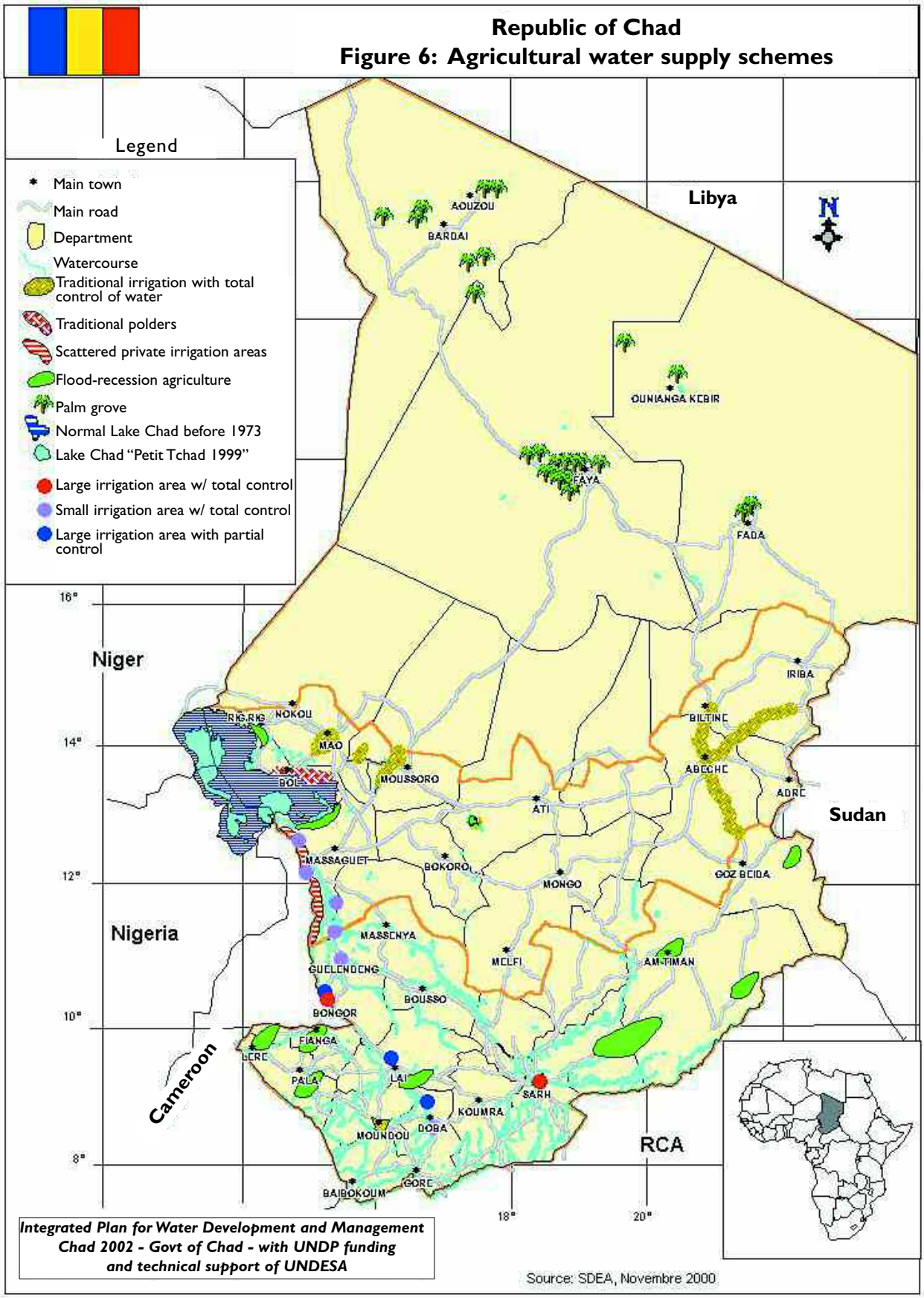

Republic of Chad
Figure 6: Agricultural water supply schemes
Legend
Main town
Main road
Department
Watercourse
Traditional irrigation with total control of water
Traditional polders
Scattered private irrigation areas
Flood-recession agriculture
Palm grove
Normal Lake Chad before 1973
Lake Chad "Petit Tchad 1999"
Large irrigation area w/ total control
Small irrigation area w/ total control
Large irrigation area with partial control
Libya
Niger
Nigeria
Cameroon
Sudan
RCA
AOUZOU
BARDAI
OUNIANGA KEBIR
FAYA
FADA
IRIBA
BILTINE
ABECHE
ADRE
NOKOU
RIG-RIG
MAO
BOL
MOUSSORO
ATI
MASSAGUET
BOKORO
MONGO
GOZ BEIDA
MASSENYA
MELFI
AM-TIMAN
GUELENDENG
BOUSSO
BONGOR
FIANGA
LERE
PALA
LAI
SARH
KOUMRA
MOUNDOU
DOBA
GORE
BAIBOKOUM
16°
14°
12°
10°
8°
18°
20°
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA
Source: SDEA, Novembre 2000

Table 6: Characteristics of agricultural water supply facilities (2000)

Type of irrigation	Name or type of scheme	Area (ha)	Crop area (ha)	Type of produce	Production (t/year)	Water consumption (m^3/year)	Comments
Flood-recession agriculture	Extensive agriculture in river overflow areas	1 700 000 (estimate)	125 000	Berbéré, maize	110 000	4000 m^3/ha or 600 million m^3/year	Water consumption not abstraction, as it would evaporate
Rice-growing in depressions	Depressions submerged by floods and runoff				A few thousand tonnes	Unknown	Cannot be determined in present conditions
Small-scale traditional irrigation with complete water control			15 000	Vegetables, fruit and sometimes cereals	Vegetables: 165 000; Fruit: 10 000	150 million	Irrigation using chadouf, or bucket from springs and surface water
Small-scale modern irrigation with complete water control			2000	Rice, vegetables, fruit, condiments	Rice: 3500. Vegetables: 6550. Fruit: 2900	24 million	Chari-Logone water
Large-scale irrigation with partial water control	Satégui-Déressia	2100	1500	Rice	3000	13.5 million	Logone water
	Section "A"	2000	200	Rice		2.7 million	
	Section "B"	300	300	Rice	700	17 million	Logone water
	Traditional polders	1800	Unknown	Wheat, maize	Wheat: 950/Maize: 2650	3.5 million	Lake Chad water
	Improved traditional polders	600	Unknown	Wheat, maize	Maize: 750		Lake Chad water
Large-scale irrigation with complete water control	Banda sugar-growing area	3700	3700	Sugar cane	330 000	40 million	Chari water
	Section "B"	500	420	Rice	2500	8 million	Logone water
	Modern polders at Bol		2500	Wheat, maize	Wheat: 3500/ Maize: 3 500	26 million	Lake Chad water
Oasis systems	Essentially in Saharan zone		5900	Date palm, vegetables, cereals, fruit	Dates: 15 000 Vegetables: 1000 Cereals: 300	96 million	Water abstracted from aquifers

Source: SDEA 2000

3.5.3 Summary of agricultural water consumption

Table 7 summarises the volumes of water abstracted to meet agricultural water requirements in 2000, for each geoclimatic zone and each origin.

Table 7: Summary of agricultural water abstraction in 2000

Geoclimatic zone	Surface water (million m³/year)	Groundwater (million m³/year)	Total (million m³/year)
Saharan zone		127	127
Sahelian zone	117	63	180
Sudanian zone	683	20	703
Total	**800**	**210**	**1010**

Source: SDEA 2001

Agricultural water consumption in 2001 was estimated at a little over 1 billion cubic metres. About 80% of this consisted of surface water. Agricultural water requirements in the Saharan zone are met entirely by groundwater, whereas in the Sahelian zone 35% of requirements are met by groundwater and 65% by surface water. Lastly, almost 100% of agricultural water requirements in the Sudanian zone are met by surface water.

3.5.4 Stakeholders in the field of agricultural water supplies

The Directorate of Rural Engineering and Agricultural Hydraulics (DGRHA) of the Ministry of Agriculture is responsible, among other things, for planning, programming, coordinating and managing studies and development works relating to irrigation schemes in the public and parapublic sectors, and for studying and carrying out (or supervising implementation of) agricultural water use programmes, including works carried out by the Soil Protection and Rehabilitation service.

Its duties, which in principle cover the entire spectrum of agricultural water supply operations, are nonetheless highly theoretical, as the DGRHA has neither the staff nor the financial resources to perform them in full. The nine regional subdivisions are those of Chari-Baguirmi, Guéra-Batha, Ouaddaï-Biltine, ***BET***, ***Lac-Kanem, Salamat,*** Logone occidental and Logone oriental, Mayo-Kebbi-Tandjilé, and ***Moyen-Chari;*** (the subdivisions in bold italics were not operational in 2001).

There are also two major stakeholders in the field of agricultural water supply, namely the National Rural Development Office (ONDR), responsible for implementing agricultural development programmes, and the Société de Développement du Lac (SODELAC), responsible for overall development of the Lac prefecture.

The African Development Bank (ADB), European Development Fund (EDF), Arab Bank for Economic Development in Africa (BADEA) and International Fund for Agricultural Development are the major donors in the field of agricultural development in Chad. More than 90% of the sums invested in the agricultural sector (FCFA 102.5 billion between 1985 and 2000) came from loans.

There are various types of peasant organisation. The main ones are village cooperatives. Their aim is to promote economic and social development in each village through the development and self-managed operation of each irrigation area. A second type of organisation is the Village Association (VA), which acts a go-between between members of the group and the Management Committee. A third form of organisation is the Economic Interest Group (EIG), the aim of which is to promote activities that have a general interest for the village, such as small businesses, cereal banks, exploitation of wadis. There is no type of formal organisation of farmers in private irrigation areas. However, the three types of organisation described below may be found: **direct operation**, where the owner invests his own resources, farms his plot and harvests his produce, **share-cropping**, where the owner rents his plot to a farmer who cultivates it, with the produce being shared equally between the owner and the farmer, and **tenant farming**, where the owner provides inputs and hires local labour; the harvest is then shared on the basis of the net produce, with the owner deducting the quantity corresponding to his investment and the rest being shared equally among the labourers and the owner.

3.6 The situation with regard to fishing

Fishing is also an activity that requires water. The figure normally taken for the production potential of Chad is 80 000 tonnes per year. A recent report concerning Chad quoted this figure, acknowledging that fishing is a dynamic sector but that reliable statistics are lacking. It ranks 4th in the economic activities of the primary sector, after cotton, stock-rearing and gum arabic, with an annual production of the order of 40 000 tonnes worth FCFA 20 billion and employing 250 000 people directly or indirectly.

Fish reproduction is linked essentially to the annual level of flooding and water quality. Flooding in the large flood plains is virtually uncontrolled at present, as there are almost no storage structures upstream and the effect of local diking is quite limited. There is considerable variation in flows and hence in major flooding, from one year to the next. In the long term, this is seen in the alternation of dry and wet pseudo-cycles, and over the past 20 years by the persistence of a long series of dry years.

Existing flow conditions in Chad are naturally favourable to fishing activities, which represent both an important economic activity and a major source of food for the country's inhabitants. Fish resources are often essential in the means of subsistence of the poorest people, especially those in the Chari-Logone and Lake regions.

3.7 The situation with regard to hydroelectricity

Early on, the Chadian part of the Mayo-Kebbi attracted attention, partly because of the suggestion of an offtake from the Logone via the Mayo Kébi river and partly because of the existence of the 45 m high Gauthiot Falls, that were suited to hydropower production.

The annual mean discharge at Mbourao just upstream of the falls was estimated at around 10 m^3/s for the 1964-1986 period. There are considerable seasonal variations in spite of the existence upstream of the Toubouri lakes, with discharge falling to less than 2 m^3/s for nearly half the year. The hydropower that could be produced by a plant would be less than 3.2 MW on average, with less than 1 MW during dry periods if the river was not regulated by a dam.

Furthermore, the valleys of the upper Logone are deep and narrow, cutting into steeply sloping granite formations, and therefore suited to the construction of hydropower dams. A project was put forward around 1968-1970 with the twofold aim of regulating the Logone in order to provide water for irrigation during dry-weather flow periods and also to produce electricity.

Two dams were suggested:

- Koumban, on the Vina upstream of the confluence with the Mbéré in Cameroon; this dam would be 57 m high, 2100 m long and have a capacity of 5 billion m^3;
- Goré, on the Pendé about 20 km after its point of entry into Chad; this dam would be 31 m high, 3400 m long and have a capacity of 2.8 billion m^3.

The volume of these dams represents about the annual discharges of their tributaries. Total electricity production would be about 100 million kWh/year and the discharge of the Logone at Laï would be:

- 150 m^3/s during dry-weather flows and 2600 m^3/s during flood peaks with a dam built at Koumban;
- 250 m^3/s during dry-weather flows and 1500 m^3/s during floods with both dams built.

These evaluations were **based on hydraulic conditions during the wet period**. In the present situation, the estimated hydropower production and flood and dry-weather flows would **need to be lowered**. The annual mean volume of flow of the Pendé at Goré was 4.6 km^3 between 1956 and 1972, and only 2.4 km^3 between 1972 and 1999.

In Chad, as in the upstream part of the Chari-Logone basin in the Central African Republic and Cameroon, water resources are not exploited for hydropower production. However, it should be noted that a master plan for the electricity subsector was drawn up for Chad in June 1996.

3.8 The situation with regard to river and lake transport

River traffic is essentially limited to floating firewood on the Chari upstream of N'Djaména[8]. In spite of its informal character, this activity is organised. The traffic is spread among several groups in accordance with rules based on customary law.

There is more traffic on Lake Chad than on the rivers owing to its special geographical position, but it remains informal.

There is no river transport industry worthy of the name or any Government department responsible for shipping, even partial or seasonal, on the two main rivers or on Lake Chad.

[8] Extract from the Geneva-IV Round Table document. Sectoral meeting on transport, housing and urban planning. Assessment and development strategies for the transport sector in Chad: N'Djaména, November 1999

3.9 The situation with regard to tourism

Tourism covers "activities carried out by people during their travel and while staying in places other than their normal place of residence for more than 24 hours and less than 4 months for leisure, business or other purposes"[9].

Chad has several tourist attractions. More specifically with regard to water, the lakes of the BET region and the Lake Chad area with its floating islands, aquatic and terrestrial fauna that can easily be reached from Douguia tourist centre are worthy of mention. Lake Fitri is a wetland of international importance, designated a biosphere reserve. The various types of natural areas such as national parks and wildlife reserves feature ecosystems that are also tourist attractions.

However, the lack of hotel infrastructure, coupled with ill-trained staff, high prices and the often defective state of the facilities, hinder the development of the tourist industry in Chad. The authorities have given no significant support to this activity. Development has been sporadic and isolated.

[9] National Action Plan for the Environment. Cahier du PNAE du Tchad No. 9 Transport and Tourism; September 2002.

4 WATER RESOURCES AND DEMAND SATISFACTION

Chad covers the Saharan, Sahelian and Sudanian climate zones. Rainfall therefore varies considerably both geographically, with a steep latitudinal gradient, and in time, with strong seasonal fluctuations and very significant differences from one year to another.

Accessible surface water is concentrated mainly in the southern part of the country (see figures 7 and 8), particularly in the Chari-Logone basin, where there are extensive flood-prone areas. However, following the drop in rainfall, mean inflows on the Chari at N'Djaména fell from 39 billion cubic metres a year during the 1950-1970 period to 21.8 billion cubic metres between 1972 and 2000. In addition, following successive years of drought, Lake Chad has split into two separate hydrological units, shrinking in area from 19 000 km^2 at the end of the 1960s to a mean flooded area that is currently estimated at 7500 km^2.

Chad has significant groundwater resources spread throughout the country. These are located in continuous aquifers covering about 75% of the country and discontinuous ones formed by the bedrock, particularly in the east of the country with small fractions in the south. Renewable groundwater resources are evaluated at nearly 20 billion m^3 a year, whereas exploitable resources in the major aquifers are estimated at between 260 billion m^3 and 540 billion m^3. However, it should be emphasised that based on the current state of knowledge concerning the hydrogeological systems, it is only possible to discuss the operation of the aquifers in broad outline (in particular with regard to recharge levels) and describe their approximate characteristics.

Water resources have many functions and uses. While surface water is essential in preserving biodiversity, it also plays a major role in agriculture, fishing and stock-rearing, key components of food security and also major segments of the country's economy. Groundwater is just as important, as in addition to making a significant contribution to stock-rearing and agriculture, it is used by nearly 90% of Chadians as drinking water.

4.1 Surface water

4.1.1 Rainfall

Rainfall is the origin of running or stagnant surface water. The distribution and movement of isohyets are shown on figure 9. Three periods are analysed: 1950-1970, 1971-1980 and 1981-2000. There is a clear southwards shift in the isohyets of the order of 120-150 km, corresponding to a decrease of 100-130 mm throughout the country south of the 14th parallel. This applies to the **average interannual rainfall intensity** values and would have little meaning for a given year in a specific spot, in view of the spatio-temporal variability in rainfall distribution.

Lake Chad may be considered to give a good indication of the climatic changes that have occurred in the basin, closely reflecting the changes in the regional rainfall indices used up to 1990. The variations in the lake level and inflow from the Chari therefore give a good idea of the climatic variations that have occurred in the recent period. After a very low point in 1984-1985, there was an increasing trend that was confirmed in 1998 and 1999 (see figure 10).

With regard to surface water, the general consensus is that a period of relative drought has occurred throughout the basin since 1972-1973, reaching a low point in 1984. In comparison with the previous relatively wet period, there has thus been a general trend towards more arid conditions. However, there has been no clear trend over the past 30 years.

4.1.2 River systems

The main hydrographic units fall within the Chad basin, which is bounded by a series of mountain ranges: the Tibesti, Ennedi and Ouaddaï to the north and east, the Central African ridge to the south and the Adamaoua mountains to the south-west (see figures 7 and 8). These comprise the basin of the Chari and Logone, with their flood plains and Lake Chad, the Batha basin with Lake Fitri, the Mayo Kébi basin with the Toubouri lakes and the basins of temporary rivers in the desert to sub-desert regions north of the 14th parallel.

In addition to these major units are smaller but sometimes numerous and locally important bodies of water: the wadis of Kanem and Ouaddaï, natural and artificial ponds, a few artificial reservoirs and the oases and lakes in the BET.

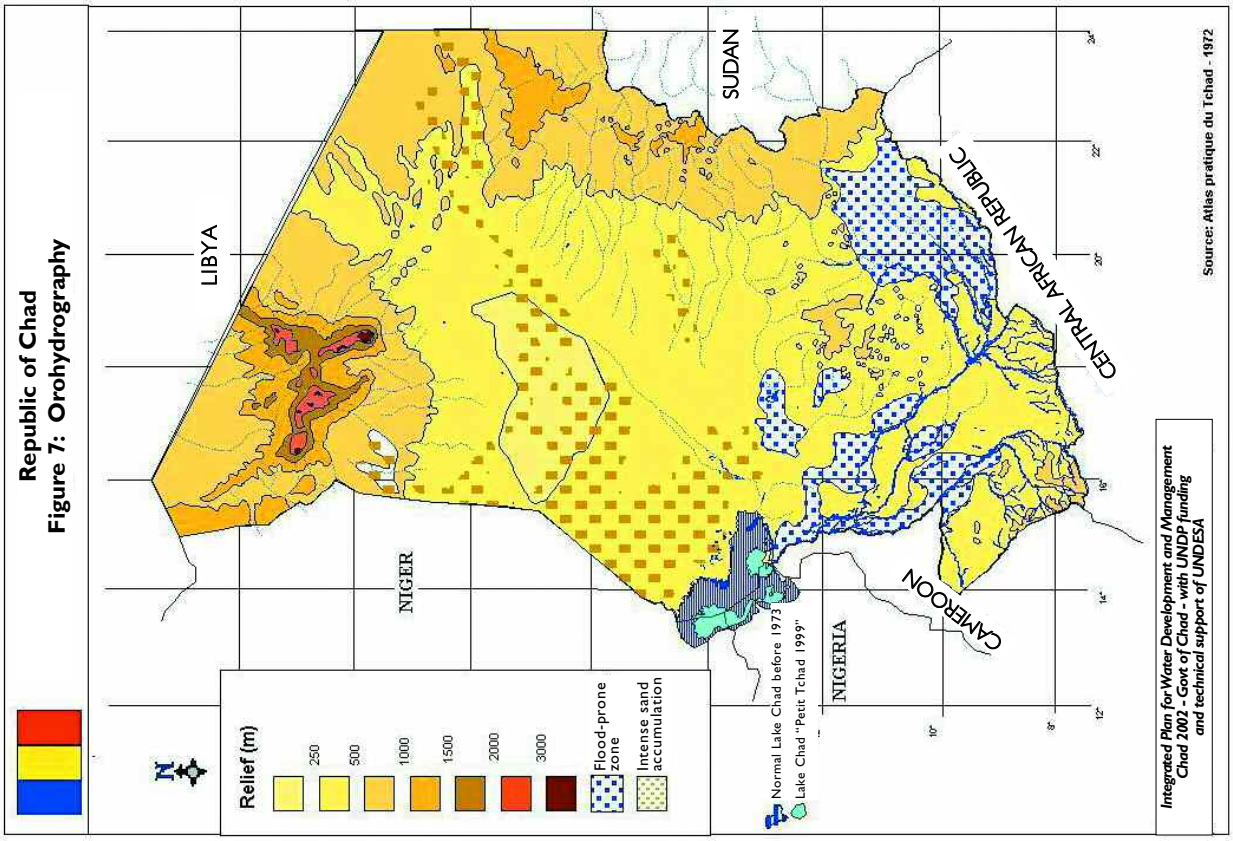
4.1.2.1 The Chari-Logone basin

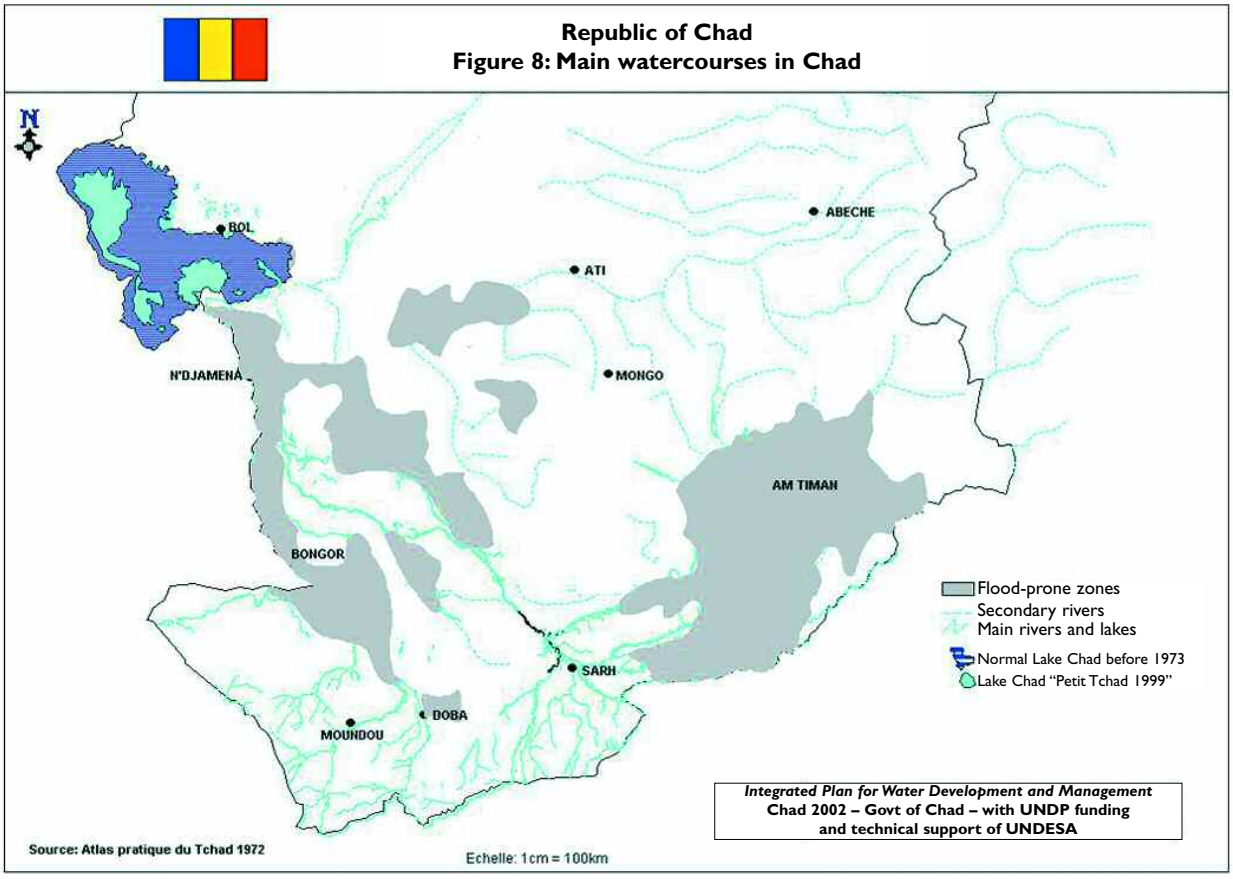
The rivers

At the point where it enters Chad, the Chari is formed by the combination of the Bamingui, Gribingui and Bangoran, which drain an 80 000 km^2 basin situated in the Central African Republic (CAR). It is joined on the right bank by the Bahr Aouk, which forms the boundary between Chad and the CAR, and drains a very gently sloping basin covering 100 000 km^2 that floods over large areas. From the confluence with the Bahr Aouk as far as Lake Chad, the mean gradient of the river is 0.10 m/km, which results in pronounced degradation of the river bed, with flood plains and effluents.

The Logone is also formed by the combination of two rivers flowing down from the Adamaoua range in Cameroon: the Vina and the Mbéré, which join at the frontier between the two countries. The Logone is joined on the right bank by the Lim (4500 km^2) downstream of Baïbokoum. Further downstream, the Logone is joined on the left bank by the Nya (3000 km^2) and again on the right bank by the much larger Pendé (15 000 km^2). The Continental Terminal flood plains then begin, with a highly degraded river bed and an average gradient of 0.25 m/km at Laï and 0.14 m/km between Laï and N'Djaména.

The mean annual volume of flow of the Chari at N'Djaména was respectively 39.1 billion m^3 for the 1950-1971 period and 21 billion m^3 from 1972 to 2000. There is therefore significant long-term and interannual variability in discharge. At N'Djaména there has been a tendency for flows to decrease since around the early 1960s, with a low point being reached in 1984-1985. Recently, however, it is worth noting that the trend has been for maximum and minimum levels and discharges to increase.


Republic of Chad
Figure 7: Orohydrography
LIBYA
SUDAN
CENTRAL AFRICAN REPUBLIC
NIGER
NIGERIA
CAMEROON
Relief (m)
250
500
1000
1500
2000
3000
Flood-prone zone
Intense sand accumulation
Normal Lake Chad before 1973
Lake Chad "Petit Tchad 1999"
Source: Atlas pratique du Tchad - 1972
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA


Republic of Chad
Figure 8: Main watercourses in Chad
BOL
ABECHE
ATI
N'DJAMENA
MONGO
AM TIMAN
BONGOR
SARH
DOBA
MOUNDOU
Flood-prone zones
Secondary rivers
Main rivers and lakes
Normal Lake Chad before 1973
Lake Chad "Petit Tchad 1999"
Integrated Plan for Water Development and Management
Chad 2002 – Govt of Chad – with UNDP funding
and technical support of UNDESA
Source: Atlas pratique du Tchad 1972
Echelle: 1cm = 100km

Republic of Chad
Figure 9: Long-term rainfall variability

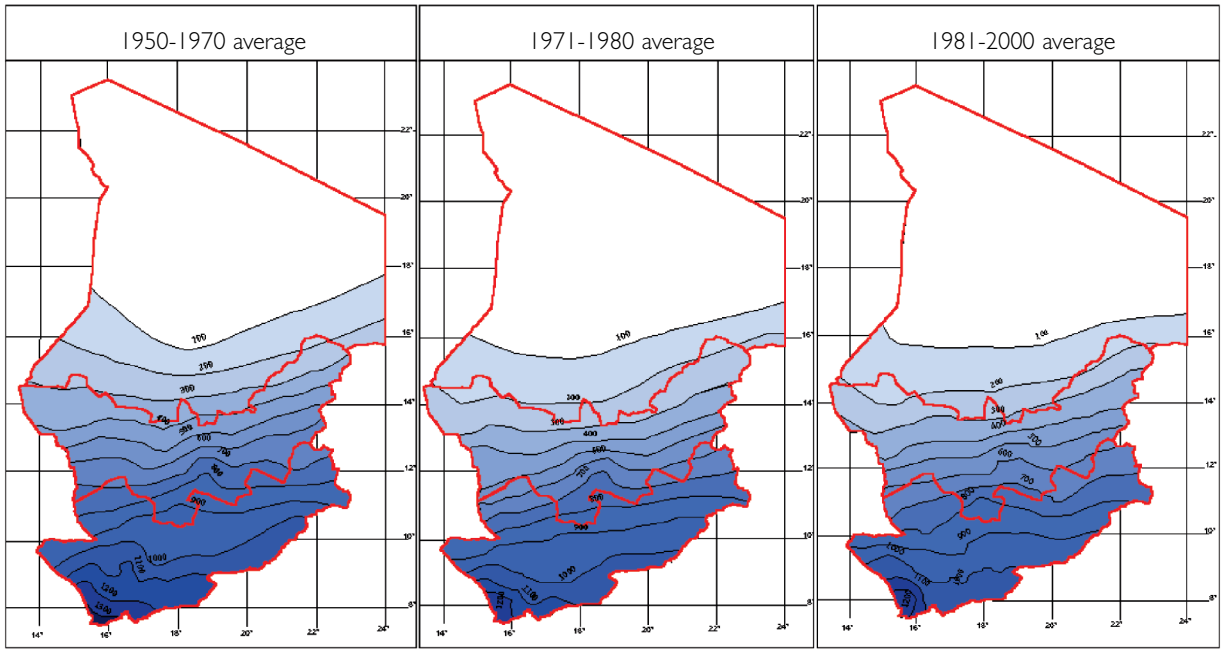
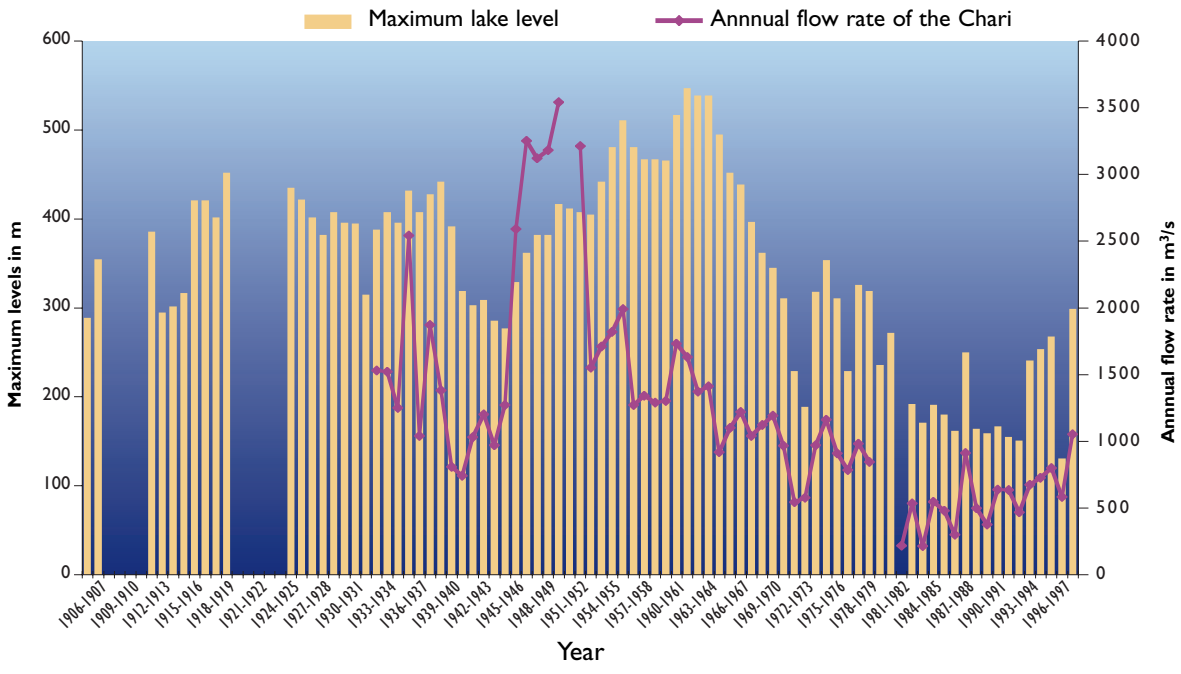


Figure 10: Annual flow rates of the Chari at Lake Chad



Integrated Plan for Water Development and Management
Chad 2002 – Govt of Chad – with UNDP funding
with the support of UNDESA

Source: DREM, November 2001

The flood plains

A feature of the Chadian basin is the extraordinary extent of the flood plains, resulting from the combination of tropical river flow conditions, with heavy annual floods, and the very gentle relief of the Chadian plain. The total floodable area is estimated at 95 000 km^2, including 50 000 km^2 for the Salamat basin. These data were valid for the rather wet period of the 1960s and need to be updated, but they give an idea of the order of magnitude involved. The data do not include the Grand Yaéré of northern Cameroon, which covers about12 000 km^2 and forms part of the same Chari-Logone unit.

Lake Chad

Because of the endoreic situation of Lake Chad, its water level depends to a great extent on the climate and rainfall over its catchment area. The "Normal Lake Chad" that existed at the end of the 1960s covered 19 000 km^2 with a water level at 281.5 m, and formed a single body of water.

Following successive years of drought in the Chari and Logone basins, the lake has split into sections with different types of hydrological behaviour and shallow areas drying out in the Grande Barrière between Baga Kawa and Baga Sola and between the open water in the south-east and the archipelagos in the east and south-east. This situation has been termed the "Little Lake Chad".

The current landscape in the Little Lake Chad area is the result of the topography and its recent history:

- the **open water areas** in the southern basin correspond to its deepest parts, which did not dry out at the beginning of the drought period. The average flooded area in the basin is 7500 km^2. It consists of three main bodies of water: one to the south-east upstream of the Chari delta, one to the south, in the south-west part of the basin and one to the south-west, between Baga Sola and Baga Kawa, on the southern side of the Grande Barrière;
- areas covered with marshy vegetation, which are flooded seasonally or permanently and areas that are flooded in a very irregular manner in the northern basin depending on season and year, and have a very different appearance: marsh vegetation, cultivated land or semi-desert steppe. The annual maximum area of water in the northern basin therefore ranges depending on year from 0 (in1985, 1987 and 1988) and 7000 km^2 (in 1979, 1989 and 2000).

In addition, the areas uncovered during the annual cycle of Little Lake Chad and potentially accessible for grazing and flood-recession crops amount to 4000 km^2 for the southern basin and between 0 and 6000 km^2 depending on year for the northern basin, including about 2000 km^2 for the Chadian part of this basin. These values should be compared with those of Normal Lake Chad, where the seasonal variations are less pronounced (about 1 m), corresponding to uncovered areas of 2500 km^2 for the entire lake at its mean level of between 280 and 282 m.

4.1.2.2 The Mayo Kébi basin

The Mayo Kébi is a right-bank tributary of the Benue and forms part of the Niger basin (see figure 8). It is at present the only link between the Chad and Niger basins. Its water supplies come mainly from left-bank flood overflows of the lower Logone, in particular around Eré, which spread over large areas. This water is drained by the rivers Kabia and Loka towards the lakes in the Toubouri depression (Fianga, Tikem, N'Gara). Depending on the quantity of rainfall and the volumes of water spilling over, flow between lakes Tikem and Fianga make take place in either direction. The Toubouri lakes, a succession of marshes and shallow lakes, give rise to the Mayo Kébi, a river with a wide bed flowing westwards. At M'Bourao, the river crosses a rocky area through a series of falls, the main one, the Gauthiot Falls, drops about 45 m. It then flows through lakes Tréné and Léré before reaching its confluence with the Benue.

4.1.2.3 The Batha and Lake Fitri basin

The upper Batha basin is situated in the east of the country, in the Ouaddaï range. Its boundary is situated approximately along the Guéréda-Adré line and its downstream point is Lake Fitri. It covers about 46 000 km^2 (see figure 8).

The Batha is an important temporary river that flows for about three months a year, from August to October, and carries a volume of around 1-2 km^3 into Lake Fitri. This quantity varies considerably on an interannual basis.

Lake Fitri is an endoreic lake supplied essentially by the Batha. It also receives significant inflows from the wadis running from the Aboutelfan. With an average surface area of 800 km^2, surface inflows must be at least a billion cubic metres. The lake operates in a similar way to Lake Chad. The considerable seasonal variations in inflows lead to seasonal variations in water level of the order of 2 m, giving rise to extensive recession areas that are used for grazing and cultivation. The same is true of the flood-spreading areas of the lake's main tributaries, both east, upstream of the dunes, and west.

4.1.2.4 Basins with temporary flows in desert and sub-desert areas north of the 14th parallel

Given the very irregular rainfall in this region, data concerning the recent period are insufficient to detect any significant variation in climate since the beginning of the 1970s. Discharges depend on the geological nature of the substratum, the relief of the basin and the degree of hydrographic degradation, which usually increase the surface area.

Two rivers (enneris) divide the Tibesti into the eastern and western sections. The Enneri Yebbigue runs northwards and is lost in a fossil plain. Major oases and gueltas are located on this river, namely: Yebbi Bou, Yebbi Souma and Omchi, the biology and ecology of which are still largely unknown. The main river running south is the Enneri Miski, which is joined from the east by the enneris draining the western side of the Emi Koussi, and from the west by the enneris Korom and Aouéi. It infiltrates in the Guérégé depression and then supplies the ponds and springs of the Borkou area.

The vast Ennedi plateau is mostly bare and desert, which contrasts with the numerous deep valleys resulting from collapses and from ancient and recent erosion, and which have lush vegetation. There are two main series of lakes. Archéi, 50 km south-east of Fada, is a deep valley. Its aquatic system consists of six main gueltas and strips of marsh. Permanent springs are situated at the head of the valley. 110 km south-east of Fada is Beskéré, a 2 km long gorge with a sandy mouth covered with a forest of doum palms. At the head of the valley are some 30 springs that supply one of the largest gueltas in the Ennedi, which has a system of permanent ponds and marshes. Discharges have been estimated at 600 m^3/day at Archéi and 1000 m^3/day at Beskéré. These systems are still poorly understood and even though humans have been there for a considerable time, at present there are only temporary camps of stock-rearers.

The altitude of the Borkou sandstone plateau drops progressively from 600 m in the north to 250 m in the south (at the Angamma). When rainfall occurs, it is mainly in August and the result of monsoons. Totally dry years are not exceptional. These local rains are not sufficient to supply the many ponds and springs in the Borkou.

4.1.3 Summary of surface water uses

The uses of surface water are not limited to abstraction. **They may also be extended to the benefits provided by aquatic ecosystems and even to uses for activities such as navigation and energy production.**

Table 8 summarises the quantities of surface water abstracted for the various types of use.

Table 8: Surface water in Chad: abstraction for each type of use (2000)

Use	Surface water abstraction (million m^3/year) in 2000	Surface water abstraction (million m^3/year) Indicative forecasts Year 2020
Village water supply	1	0
Urban water supply	1	0
Industrial water supply	2	3,5
Pastoral water supply	57	120
Agricultural water supply	800	1 727
TOTAL	**861**	**1 850**

Source: SDEA 2001

However, it should be noted that the figures given in the above table **do not take into account abstraction** in neighbouring countries, Central African Republic, Nigeria and Cameroon, which also exploit surface water flowing into Chad upstream or in Lake Chad.

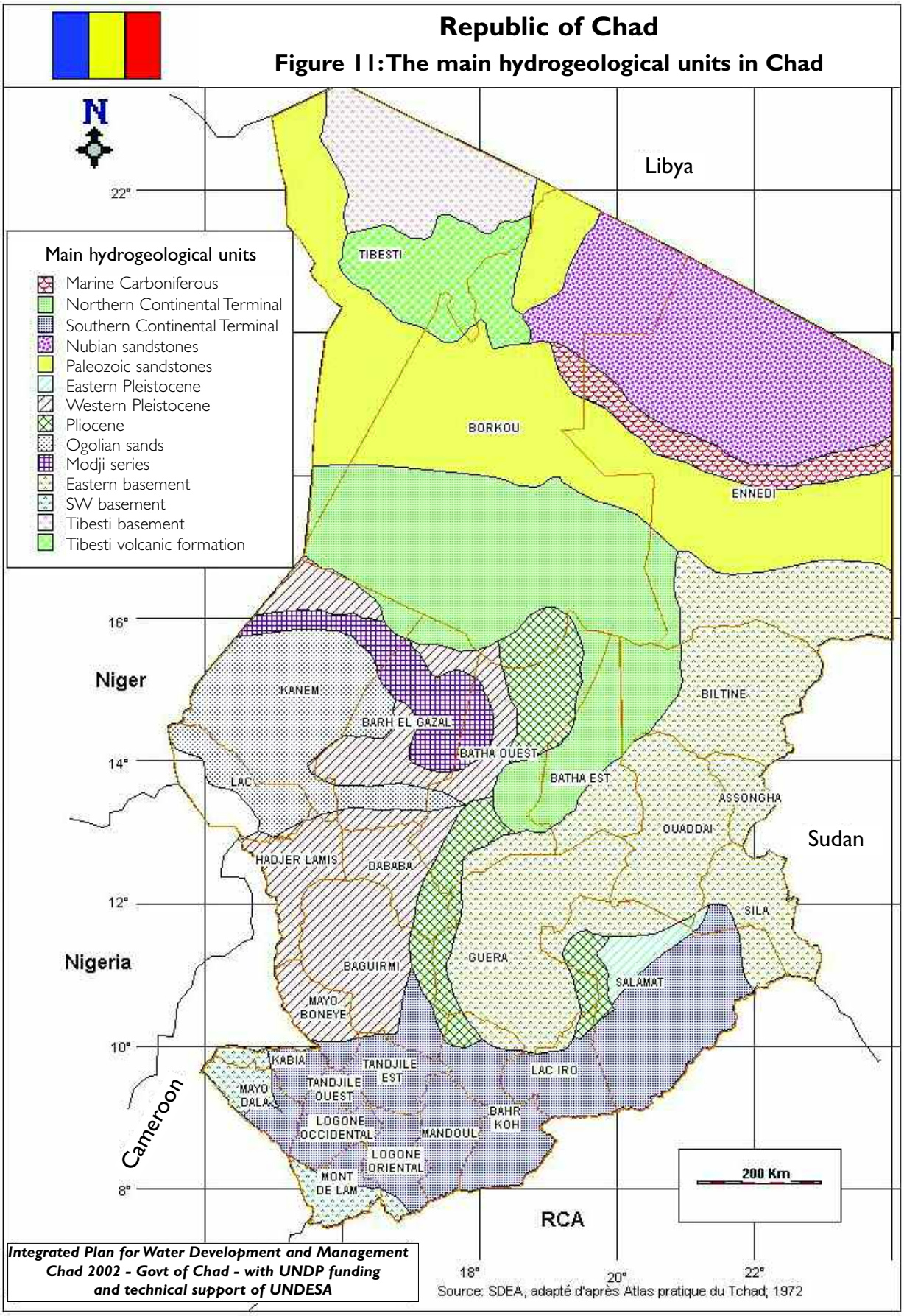
Lastly, these figures do not take into account in situ consumption of rain water for traditional rainfed crops, which is included in the operation of the various river systems observed and is not likely to change in any significant way.

4.2 Groundwater resources

Chad possesses major groundwater reserves. There are vast regions consisting of sedimentary formations (sand and sandstone), containing continuous aquifers of various forms: unconfined aquifers (often referred to as "water tables"), deep confined or semi-confined and artesian aquifers in certain hydraulic and topographical conditions.

Continuous aquifers represent almost three-quarters of the total surface area of the country. They are distributed over the three main geoclimatic zones but are found mainly in the north, west and south of Chad. They include in particular the aquifers of the Continental Terminal, Paleozoic Sandstones, Nubian Sandstones and Plio-Quaternary water-bearing system of the Chad basin (Pliocene, Ogolian Sands, Pleistocene, Modji Series). Figure 11 shows the locations of the main hydrogeological units in Chad.

Other regions are less fortunate as their substratum consists of eruptive and/or metamorphic rocks often dating from the Precambrian, where groundwater can only be found in weathered areas and fracture systems affecting the bedrock (discontinuous bedrock aquifers). The area concerned by this type of aquifer represents 340 000 km^2, i.e., about a quarter of the total area of Chad. These aquifers are found mainly in the Tibesti range, the central range (Guéra) and Ouaddaï; they are also found in the south of the country.


Republic of Chad
Figure 11: The main hydrogeological units in Chad
N
Libya
Sudan
Niger
Nigeria
Cameroon
RCA
22°
16°
14°
12°
10°
8°
18°
20°
22°
Main hydrogeological units
Marine Carboniferous
Northern Continental Terminal
Southern Continental Terminal
Nubian sandstones
Paleozoic sandstones
Eastern Pleistocene
Western Pleistocene
Pliocene
Ogolian sands
Modji series
Eastern basement
SW basement
Tibesti basement
Tibesti volcanic formation
TIBESTI
BORKOU
ENNEDI
KANEM
BARH EL GAZAL
BATHA OUEST
BATHA EST
BILTINE
ASSONGHA
OUADDAI
LAC
HADJER LAMIS
DABABA
SILA
GUERA
BAGUIRMI
SALAMAT
MAYO BONEYE
KABIA
TANDJILE EST
TANDJILE OUEST
MAYO DALA
LAC IRO
LOGONE OCCIDENTAL
MANDOUL
BAHR KOH
LOGONE ORIENTAL
MONT DE LAM
200 Km
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA
Source: SDEA, adapté d'après Atlas pratique du Tchad; 1972

4.2.1 The aquifers of Chad

Tables 9 and 10 summarise the potential of the main aquifers in terms of renewable resources and exploitable reserves. Table 11 summarises their main characteristics.

Table 9: Renewable resources (main aquifers)

Water-bearing formations	Renewable resources (extreme values) (mm/year)	Area (km^2)	Volume renewable resources (billion m^3/year)	Equivalent theoretical mean depth of infiltration (mm/year)
Plio-quaternary	0 - 100	235 000	3 500	15
Southern CT	25 - 150	145 000	12 000	83
Northern CT	0 - 25	130 000	0	00
Nubian sandstones	0 - 10	73 000	0	00
Marine Carboniferous	0 - 10	19 000	0	00
Paleozoic sandstones	0 - 10	115 000	0	00
Crystalline basement			3 700	14 (N); 55 (S)
Total			**19 200**	

Source: BRGM 1987

Table 10: Exploitable reserves (main aquifers)

Water-bearing formations	Storage coefficient ($x10^{-2}$)	Drawdown (m)	Exploitable reserves (billion m^3/km^2)	Area (km^2)	Exploitable volume (billion m^3)
Plio-quaternary Quaternary, unconfined	1 - 10	1/3 satur. thickness	0.28 - 0.6	235 400	66 000 – 141000
Lr Pliocene, confined	0.2 - 0.8	100 m/soil	0.2 - 0.5	130 000	26 000 – 65 000
Southern CT	5 - 10	10	0.5 - 1.0	145 000	72 500 – 145 000
Nubian sandstones	5 - 10	10	0.5 - 1.0	73 000	36 500 – 73 000
Marine Carboniferous	2 - 5	05	0.1 - 0.25	19 000	1 900 – 4 750
Paleozoic sandstones	5 - 10	10	0.5 - 1.0	115 000	57 500 – 115 000
Total					**260 400 – 543 750**

Source: BRGM 1987

The following observations may be made from these tables and figures:

- Annually renewable resources are estimated at nearly 20 billion m^3. Only the Plio-quaternary and southern Continental Terminal aquifers are recharged. The aquifers in the Sahelian zone and northern Continental Terminal are not recharged or at least if there is any recharge it is minimal considering the existing climatic conditions.
- Exploitable reserves are considerable, amounting to between 260 billion and 550 billion m^3 of water with relatively little drawdown of the piezometric surface.

Table 11: Main characteristics of hydrogeological units

Aquifer	Area (km^2)	Lithology	Thickness (m)	Type of aquifer	Hydraulic parameters	Hydrochemistry	Piezometry	Recharge	Discharge	Observations
NUBIAN SANDSTONE	73 000 (Erdis plateau)	Heterogeneous alternating sandstone and clay	700-1500	Unconfined to confined	Qs: 0.5-6 $m^3/h/m$	Springs RS: 300 mg/l calcium-sodium-bicarbonated	Flow: SW	Little (rainfall: <100 mm/year)	Springs; to Paleozoic sandstones	
PALEOZOIC SANDSTONE	115 000 (outcrop)	Essentially sandstone	800-1200	Regional aquifer; permeability due to fissuring; unconfined to confined*	T: ~200 m^2/day; Qs: 3-30 $m^3/h/m$; porosity (unconfined): ~5 to 10 %	RS< 0.3 g/l calcium-sodium-bicarb pH ~6; sometimes excess iron	Artesianism (Faya); Flow: SW	Little (rainfall: <100 mm/year); from Nubian sandstones	Springs; to low-lying areas	
TIBESTI AQUIFERS (basement and volcanic)	50 000 (small discontinuous aquifers)	Eruptive, metamorphic, volcanic rock, alluvium	Alluvium 10-20	Alluvium: unconfined Basement: confined		RS: probable 0.3 - 0.5 g/l, calcium-sodium-bicarbonated		Little (rainfall: 20-50 mm/year), flood infilt.	Springs; to Paleozoic sandstones	Weathered and fissured basement drained by alluvium
EASTERN BASEMENT (fissured Ouaddai and Guéra aquifer)	140 000 (discontinuous aquifers)	Regolith alluvium Fissured granite	Alluvium 9-33 m Alterites 0-50	Alluvium: unconfined Granites: confined	Alluvium Qs: 2-10 $m^3/h/m$ Granites: Qs: 0.5-2 $m^3/h/m$	RS: 0.1-0.5 g/l calcium-sodium-bicarbonated, NO_3 content sometimes excessive		Limited (rainfall: 100-1000 mm/year)	Springs; evaporation exploitation	
OGOLIAN SANDS	40 000	Eolian sands	20-60	Unconfined	Permeability high T: 300-1000 m^2/day Qs: 10 $m^3/h/m$	RS: < 0.4 g/l, calcium-sodium-bicarbonated		10-15 mm/year on piezometric domes	To north-east and south	Regular piezometric monitoring recommended

Source: SDEA 2000

Table 11: Main characteristics of hydrogeological units (cont.)

Aquifer	Area (km2)	Lithology	Thickness (m)	Type of aquifer	Hydraulic parameters	Hydrochemistry	Piezometry	Recharge	Discharge	Observations
MODJI SERIES	20 000	Limestones, marls, sandstones (lateral variability)	10-20	Semi-confined to unconfined	Low permeability	RS: often 5 g/l, may sometimes reach 8 g/l, sodium sulphated		Limited		Little information on aquifer
PLEISTOCENE (east and west)	235 000	River sand and clayey bands	30-70	Unconfined to semi-confined	T: 100-600 m^2/day Qs: 2-8 m^3/h/m	RS: 0.3-05 g/l		Rainfall and infiltration of surface water	Evaporation exploitation	Piezometric monitoring recommended
PLIOCENE	130 000	River sand interbedded with clay	30-70; 70-200 to north-west of Lake	Unconfined at sides and confined in centre	T: 60-450 m^2/day; Qs: 2-9 m^3/h/m	RS: 0.4-1.6 g/l Sodium-bicarbonated/suphated	Flow: to low-lying areas, artesianism	Infiltration	Evaporation exploitation	
CONTINENTAL TERMINAL NORTH	80 000	Sand lenses between clay	Batha: Lenses 6-15	Semi-confined	Low permeability Qs: <1-3 m^3/h/m, Exceptional. jq 5-16 m^3/h/m	Low-lying areas: RS: 0.2-3 g/l Mortcha, Batha: RS: low. calcium-sodium-bicarbonated		Limited to very limited; Low-lying areas: from south of Paleozoic sandstones	Low-lying areas: evaporation	
CONTINENTAL TERMINAL SOUTH	145 000	(i) water table, sand lens, heterogeneous; (ii) depth massive sands	(i) 70-260 (ii) Doba, Salamat: 150-900 Bousso: 50-300	(i) unconfined to semi-confined (ii) confined	(i) Qs: 4m^3/h/m (jq. 25) (ii) T, porosity probably high	(i) RS: < 0.1 g/l calcium bicarbonated to calcium-sodium-bicarbon; sometimes excessive iron, pH 6	Flow: towards rivers and north (ii) artesianism	Rainfall; flood spreading	Rivers Chari and Logone	(ii) insufficient knowledge of geometry and hydraulic conditions
SW BASEMENT	10 000	Alluvium, regolith, Fractured granites	Alluvium 10-25	Alluvium: unconfined Basement: confined	Qs alluvium: 1-8 m^3/h/m Qs granites: 0.1-1 m^3/h/m	RS: < 0.3 g/l		Infiltration (rainfall 900-1 300 mm/year) Infiltration of floods	To CT, springs, exploitation	Weathered and fissured basement drained by alluvium

Source: SDEA 2000

However, these observations should not hide the fact that current hydrogeological and hydrodynamic information concerning the aquifers of Chad is insufficient to do more than give the main regional outlines of aquifer recharge conditions and the potential for mobilising water resources.

There are few and only isolated quantitative data concerning estimated rainfall infiltration into the aquifers, which is often the main source of recharge. However, generally speaking, it is considered that **south of the 500 mm isohyet**, which in Chad includes the Sudanian zone and the southern third of the Sahelian zone, the balance between rainfall and evapotranspiration is usually positive so that aquifer recharge occurs through the infiltration of rainfall. One study in fact evaluates the fraction of rainfall infiltrating into the southern Continental Terminal aquifer at between 50 and 150 mm/year, i.e., 5-13% of rainfall.

North of the 500 mm isohyet, in the semi-arid Sahelian zone, the balance between rainfall and evapotranspiration on predominantly clayey soils is usually negative, which means that the rains do not infiltrate. Water losses through evaporation from the water table appear to be between 0 and 2 mm/year in these areas, which can be explained by the strong capillary forces in clayey materials.

In **predominantly sandy areas**, such as the Ogolian Sands aquifer, where rainfall is of the order of 150-350 mm/year, infiltration may be of the order of 10-15 mm/year.

In the Sahelian zone, renewable resources in the regional aquifers (Plio-quaternary, discontinuous bedrock aquifers) by infiltration of rainfall are generally limited to the southern part, between the 10th and 12th parallels. They are estimated at 3.5 billion m^3/year in the case of the Plio-quaternary aquifers with infiltration of 15 mm/year. In the crystalline basement area (north), infiltration is estimated at 14 mm/year. In the Saharan zone, with annual rains amounting to less than 200 mm and a severely negative balance, it may be assumed that there is no aquifer recharge by infiltration of rainfall.

4.2.2 Groundwater uses: total figures

Table 12 gives figures for groundwater abstraction for each aquifer and type of use. Abstraction is estimated indirectly, by estimating the water requirements of each of the subsectors concerned and identifying the origin of the water supplies.

An annual quantity of nearly 409 million m^3 of water is abstracted from groundwater resources to meet the various types of requirement. The Paleozoic Sandstones aquifer (non-renewable resources) is the one with the highest abstraction rate, the water being used mainly for agricultural purposes. The Pleistocene and Continental Terminal aquifers are also used, but mainly to help satisfy human and pastoral water supply requirements. **The water currently abstracted from aquifers in Chad represents only about 2.1% of renewable groundwater resources.** However, it should be noted that the above abstraction figures **do not take into account the quantities removed** in neighbouring countries (Nigeria, Cameroon, Niger and Libya), which also exploit these various aquifers.

Table 12: Estimated theoretical abstraction from the various aquifers (million m³ in 2000)

Aquifers	Village water supply	Urban water supply	Industrial water supply	Agricultural water supply	Pastoral water supply	Total
Ogolian sands	2.90	0.36	0.00	28.3	14.4	45.96
Modji	0.08	0.00	0.00	0.0	0.8	0.88
Pleistocene	8.60	22.20	0.7	0.8	30.9	63.20
Pliocene	0.40	0.00	0.00	0.3	5.5	6.2
Northern CT	0.63	0.03	0.00	0.0	3.5	4.16
Southern CT	20.00	8.50	0.60	0.0	19.8	48.90
Nubian sandst.	0.07	0.00	0.00	0.0	0.0	0.07
Paleozoic sandst.	0.10	0.19	0.00	133	1.6	134.89
Southern basement	2.90	0.85	0.00	0.0	1.3	5.05
Eastern basement	7.90	2.60	0.00	33.6	36.7	80.80
Tibesti basement	0.03	0.01	0.00	14.0	4.5	18.54
Total	**43.61**	**34.74**	**1.30**	**210.0**	**119.0**	**408.65**

Source: SDEA 2001

4.3 Water resources and use in 2000: total figures

Table 13 gives the total figures for surface water and groundwater uses in 2000.

Table 13: Total water resources and uses in 2000

Type of resource	Village water supply (million m³)	Urban water supply (million m³)	Industrial water supply (million m³)	Pastoral water supply (million m³)	Agricultural water supply (million m³)	Total used (million m³)	Renewable resources (billion m³/an)	% renewable resources used (2000)
Surface water	1	1	2	57	800	861.00	26 700.00	3.22
Ground-water	43.6	34.7	1.3	119	210	408.60	19 200.00	2.13
Total	**44.6**	**35.7**	**3.3**	**176**	**1 010**	**1 269.60**	**45 900.00**	**2.77**

Source: SDEA 2001

Total current abstraction[10] of all water resources to satisfy the various types of use, without taking into account the requirements of aquatic ecosystems, was estimated at 1.269 billion m³ in 2000. Of this quantity, 408 million m³ of water was abstracted from the various aquifers and 861 million m³ was obtained from surface water. This represents only about 2.8% of the average renewable water resources estimated over the past series of 20 dry years. In overall terms, therefore, Chad has considerable renewable water resources in comparison with its needs. However, these resources are distributed over the entire country and are extremely variable and fragile. The aquatic ecosystems, particularly the large natural flood plains and peripheral areas around the different lakes, require natural annual flooding by the rivers that supply them in order to guarantee their corresponding ecological, economic and social functions.

[10] These figures are an upper limit for real consumption, as the amounts for drinking water and domestic consumption in particular were calculated on the basis of theoretical per capita allocations, and pumped or diverted water that is not consumed and is returned to the river systems was not taken into account.

5 THE ENVIRONMENT AND HEALTH OF AQUATIC ECOSYSTEMS

5.1 Plant cover, desertification and water points

The plant and forest cover in Chad is estimated at 21 million hectares, i.e., 18% of the national territory. In the absence of affordable alternative energy resources, rural and also often urban dwellers use firewood as their main source of energy. This has major consequences in terms of degradation of vegetation, soil quality and its ability to withstand wind and rain erosion. Combined with natural causes (droughts), the rate of deforestation has reached 2000 km^2 per year, i.e., less than 0.9% per year. If this rate of deforestation were doubled and in the absence of any impact of the measures already begun to combat desertification (in particular those aimed at poverty reduction), it would in theory take about 60 years before the country's entire shrub and forest cover disappeared. Concentrations of people and livestock have a decisive impact on the health of the fragile plant cover. In Chad, such concentrations of rural activities, including sedentary and nomadic extensive agricultural practices, are highly dependent on the distribution of water points. It must be recognised that, in the present situation, decisions relating to the locations of water points are generally taken in the context of fragmented projects without there being any overall vision or policies for positioning and regulating water points.

5.2 Aquatic ecosystems

The surface aquatic systems of Chad, most of which are still in their natural state, provide society with many services, of which fishing is the most obvious example. Their operation is controlled for the most part by hydrological conditions and by seasonal rhythms. The seasonal and interannual variability of environmental conditions, which is a drawback in terms of usage, should be considered as a factor of biodiversity. Plant and animal populations in the various regions of Chad are the product of their environment and its variability.

With regard to aquatic biocoenosis, which is largely regulated by hydrological conditions, less seasonal and interannual variability would enable some species to dominate the populations while others would disappear. The reproductive cycle of many species of fish is regulated by river floods and the growth of their young is guaranteed by the flood plains. When floods are insufficient to inundate the plains, stock renewal is **severely reduced**. Fish reproduction depends on the existence of the river more than on that of the lake, to the extent that, from the ecological standpoint, Lake Chad is more like the flood plains of the tropical rivers than a true lake. **The river-lake system (Lake Chad, Chari-Logone) should therefore be considered as the spatial unit for fish stocks.**

In the climatic conditions existing in Chad, a mean value for production in the flood plains is of the order of 50 kg/ha per year (this figure concerns the flood plains directly linked with a river system). For a total flooded area of 20 000 km^2, connected with the rivers during the current period of relative drought, potential annual fish production from flooded areas in Chad would be of the order of 100 000 tonnes. Similarly, variations in the extent of flooding in the northern Lake Chad basin, between 0 km^2 in a dry year and about 5000 km^2 in a wet year, may result in variations in fish production of 0-25 thousand tonnes. These indicative values depend on the good health of the ecosystems (absence of pollution), their correct hydrological operation and the degree to which they are connected.

Significant regulation of the river, as in the case of the lower Senegal valley, would seriously disturb the fish population. There would be a decrease in biomass and in the diversity of the population. The diversity of the aquatic species therefore depends on ensuring that the natural operation of the river systems is maintained, and this is regulated primarily by the hydrological cycle.

The aquatic systems also help to preserve the terrestrial wildlife living in large numbers in these biotopes, which provide ample grazing. Many birds, especially waders, reproduce in the flood plains. In the Saharan zone, the presence of water on or near the surface supports plant and animal species that are far from their normal range and are sometimes endemic. The Sahelian zone is particularly rich in species reliant on aquatic environments, with Lake Chad (about 160 species of fish) and the Lake Fitri Biosphere Reserve, which is covered by the Ramsar Convention, hosting migratory aquatic birds.

5.3 Environmental risks and their prevention

Figure 12 shows the main environmental components of Chad: protected areas, wildlife reserves, the river system, the flood plains and the major components that are likely to have an impact on their operation (oil pipelines, current or likely future mining operations, etc.).

Two main types of risk have been identified: those of natural origin and those of human origin.

5.3.1 Risks of natural origin

Natural risks are due essentially to climate variations. Several time and space scales should be considered, as follows:

Climate change

The longest scale is that of climate change. The persistence and modification of the climate are decisive factors in the use of water resources. Human activities are modified in accordance with the climate and water resources, and they in turn affect it and the associated natural resources via the continuation of activities or the adoption of new practices using other resources. These medium-term climatic changes and their effect on water resources are in the present case natural risks that must be taken into account in a food security and development strategy.

Interannual variations in rainfall distribution

Interannual variations in overall rainfall through the country result in river floods of varying size, and large variations in the areas flooded and lake levels, in particular in Lake Chad. While such variability helps to maintain plant biodiversity by preventing a small number of species from taking over, rainfed agriculture is also very much affected by it, especially in the Sahelian zone. At smaller time and space scales, rainfall distribution over a single season may result in local inequalities within areas that are considered to be homogeneous from the climate point of view. Rural people partly protect themselves against this type of variability by diversifying their practices and moving (at last part of the family) to areas where conditions are better.

Protection against floods and intense rains

The damage caused by water in towns is often due to heavy rains that cannot be disposed of by suitable stormwater relief structures, especially when housing is put up on land not suitable for building. As in the case of river floods, this risk is caused less by nature than by man. In normal conditions, the floods on the Chari and Logone are damped by spreading over the surrounding flood plains. These plains therefore have an important hydraulic role if flood levels are to remain compatible with the current state of urban development. This damping function must be at least maintained for N'Djaména and the possibility of increasing it in the case of severe floods should be investigated. An increase of this kind could be achieved by excavating sills that would enable flood waters to overflow into adjoining plains, if the topography is suitable. In the event of exceptional floods such as those that occurred in the 1960s, solutions of this kind provide no security and emergency plans need to be introduced.

5.3.2 Risks of human origin

The question of urban, domestic and industrial wastewater and stormwater is only considered here as a chronic pollution factor affecting the natural aquatic systems or flood-prone depressions.

Urban wastewater

The WHO considers that there is a direct relation between access to good-quality water and infant survival, and more generally public health. The development of drinking water supplies in villages and urban communities, including the poorest that pay the most for water, is a priority in this respect.

Wastewater sanitation in villages can be separated from the supply of drinking water because of the low local population density. The same is not true of larger towns, where domestic wastewater and stormwater stagnate in certain places, leading to risks of malaria, cholera, parasitic diseases and diarrhoea when this water is used.

Industrial wastewater

In towns with industrial establishments, wastewater is discharged either directly into the rivers, which has a possible impact on the natural environment and the inhabitants who frequent it, or on to the ground, which may pollute the aquifer used for drinking water supplies.

Pollution from mining

Leaving aside oil, there is little mining activity in Chad. The main activities are diamond mining near the frontier with the Central African Republic and gold washing in the Tandjilé and Mayo Kébi regions. The search for diamonds increases the sediment load in rivers in places, and this could affect the migration or reproduction of fish in the temporary rivers in south-eastern Chad.

Recently, gold-mining has begun at two sites (see figure 12). Depending on the extraction processes used (leaching), this activity may potentially contaminate surface water and groundwater resources very seriously if appropriate and effective measures are not taken to treat the effluent and attenuate the corresponding impacts. Another type of risk that may be considered as industrial and/or mining pollution concerns the extraction of sediment and aggregates from rivers, in particular the Chari and Logone. In addition to disrupting aquatic life and significantly increasing the suspended particle load in the water, this activity contributes to bank erosion.

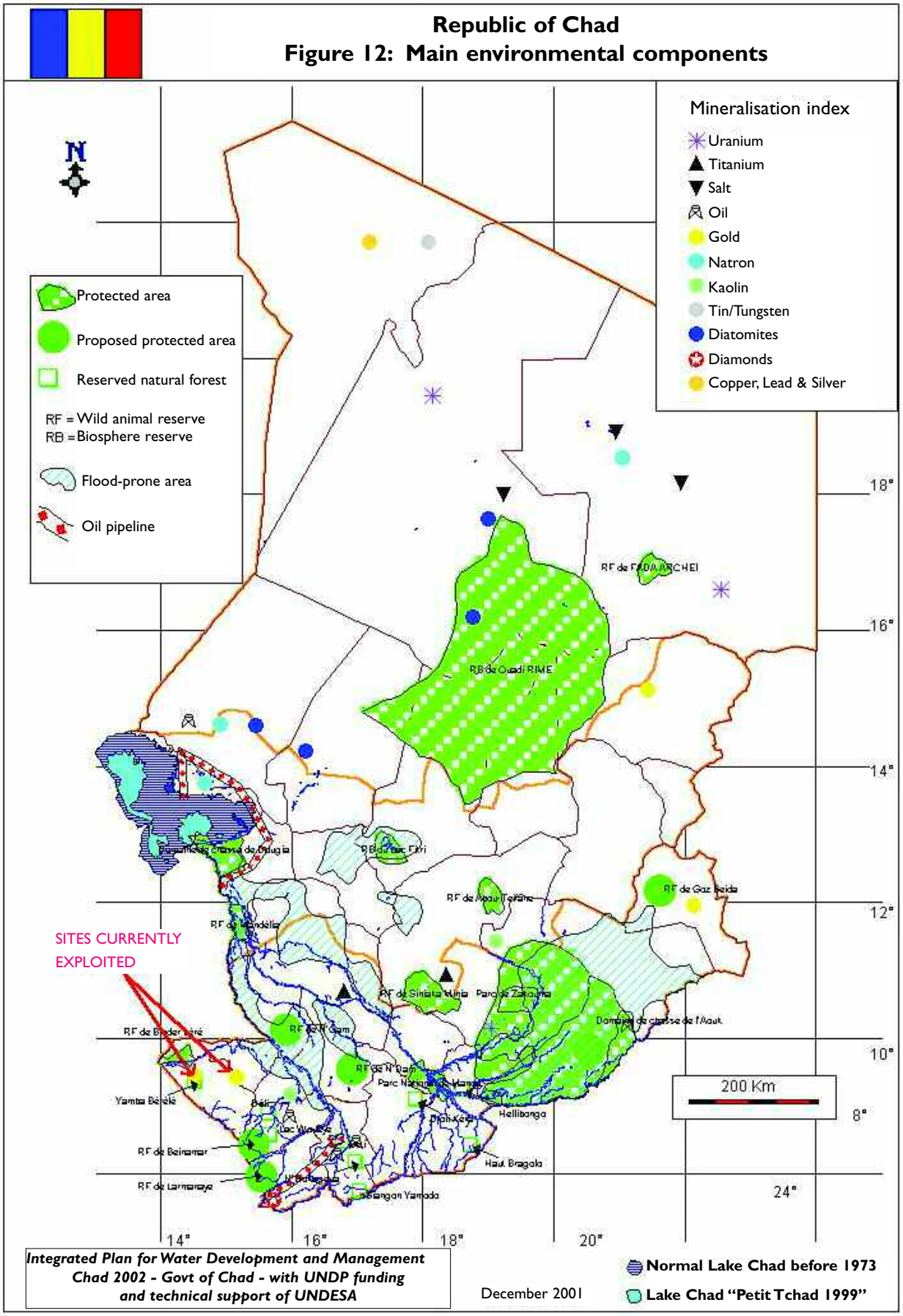
Contamination risks attributable to oil accidents

Figure 12 shows the routes of the oil pipelines. The first runs along Lake Chad as far as N'Djaména; the second concerns the Doba-Kribi section in the southern part of Chad and northern part of Cameroon.

Detailed environmental impact studies have been carried out for the oil exploitation projects, leading to the preparation of specifications for operations on site and conveyance via the pipeline. At Doba, the impacts identified as representing a risk for the aquatic environments are linked mainly with erosion caused by surface levelling and work to lay the pipeline, domestic and industrial wastewater from the site, process water and works to carry the pipeline across rivers.

Measures are planned to provide protection against erosion and to retain particles before they enter the rivers. The Doba site is to be provided with a domestic wastewater protection installation, perhaps the only one in Chad. Settling tanks are planned to separate the oil contained in industrial water. Residual water with the highest pollutant load is reinjected with the process water. Lastly, pipelines are buried under river beds to avoid disrupting their course.

Where oil pollution is concerned, zero risk does not exist, as can be seen regularly in many places in the world. The risk of massive accidental oil pollution in the rivers and in Lake Chad, due for example to a pipeline burst, needs to be considered and emergency plans drawn up in partnership with the oil companies and civil defence organisations.


Republic of Chad
Figure 12: Main environmental components
Mineralisation index
Uranium
Titanium
Salt
Oil
Gold
Natron
Kaolin
Tin/Tungsten
Diatomites
Diamonds
Copper, Lead & Silver
Protected area
Proposed protected area
Reserved natural forest
RF = Wild animal reserve
RB = Biosphere reserve
Flood-prone area
Oil pipeline
N
SITES CURRENTLY EXPLOITED
200 Km
18°
16°
14°
12°
10°
8°
14°
16°
18°
20°
24°
Integrated Plan for Water Development and Management
Chad 2002 - Govt of Chad - with UNDP funding
and technical support of UNDESA
December 2001
Normal Lake Chad before 1973
Lake Chad "Petit Tchad 1999"

Agricultural pollution

The cultivated land in Chad is relatively flat, except in the east of the country, which considerably limits the risks of erosion and transport of particles by water (this is not true of wind erosion in dry regions).

In contrast, a significant proportion of fertilisers and phytosanitary products used in the various types of industrial and other cultivation systems is carried by water. It may be washed through the soil in to the aquifers and rivers, where it is a cause of long-term pollution or eutrophication.

The existing state of pollution by metals and pesticides

Hitherto, the degree of pollution of surface water in Chad due to metals and pesticides was unknown. In the framework of the SDEA, UNDESA therefore took the initiative to carry out a limited survey to determine whether there were indications of pollution by pesticides or by mercury in the water of Lake Chad opposite the Chari delta. A fish sampling campaign was carried out in November 2000. The results obtained from this survey represent the baseline situation with which later analyses may be compared.

In terms of **practical conclusions,** the following points should be borne in mind:

- mercury concentrations are very low, increasing slightly according to level in the food chain. None of the fish analysed came anywhere near the limits indicated by the WHO;
- chlorinated organic pesticide concentrations in the two species analysed were also low. No risk for human health was identified in the event of normal or even heavy consumption of these fish.

6 MAJOR SHARED INTERNATIONAL WATERCOURSES

6.1 The River Niger

The Niger Basin Authority (NBA), based in Niamey, is represented by a focal point at the Directorate of Water Resources and Meteorology. The NBA works in the basin of the Mayo Kébi, a tributary of the Benue, which forms part of the Niger basin.

6.2 The Lake Chad basin

Lake Chad basin covers part of the territory of six countries: in first position Chad (1 046 196 km^2), followed by Niger (691 473 km^2), Central African Republic (219 410 km^2), Nigeria (179 282 km^2), Sudan (101 048 km^2), Algeria (93 461 km^2) and finally Cameroon (50 775 km^2).

The Lake Chad Basin Commission (LCBC), created in 1964, currently includes the member states concerned by the various active hydrological sub-basins: Cameroon, Central African Republic, Niger, Nigeria and Chad. A Strategic Action Plan (SAP) was adopted by the member states in 1988 (see box on next page).

With the SDEA and its national consultative mechanism, Chad is probably the first LCBC member state to implement at national level the recommendations of the SAP with regard to integrated management and water policy applied in each national sub-basin.

In addition, there is also the **Cameroon-Chad Joint Committee**. The main aim of this institution is to facilitate discussions between the two countries regarding the use of water resources in the River Logone, which form part of the resources of the Lake Chad basin. The Commission meets periodically. Recently, the two parties recommended actively engaging development of the Logone basin, and creating an expert technical committee to study, among other things, the feasibility of Foumbang dam in Cameroon and Goré dam in Chad.

STRATEGIC ACTION PLAN OF THE LAKE CHAD BASIN COMMISSION (LCBC)

Lake Chad, situated in the east of the African Sahel region and at the southern edge of the Sahara, is a vast expanse of fresh water shared between Cameroon, Niger, Nigeria and Chad. Lake Chad, the fourth largest lake in Africa and the third largest endoreic lake in the world, occupies a closed, shallow basin. It therefore has little depth, a relatively small volume and an area that changes considerably with each year's rainfall. It is supplied by a huge catchment area covering 2 381 635 km^2, which itself comprises numerous wetlands and vast flood plains of economic and environmental importance.

Given the exceptional importance of protecting the lake's environment, as well as that of the rivers and aquifers in its basin, and the need for concrete action in this field, the preparation of a Strategic Action Plan (SAP) was initiated in May 1996 following a request for assistance from the Lake Chad Basin Commission (LCBC) to the UNDP-GEF. The SAP was drawn up and validated during national and regional workshops with back-up from LCBC specialists and UNDESA support. The SAP in fact provides support for the LCBC's first target, which is "to exploit water in the Lake Chad basin for the well-being of the people concerned". The aim of the SAP is to define a regional framework for environmental protection and sustainable development of the various resources throughout the Lake Chad basin. This framework includes preventive and curative measures. The SAP aims to set up and at the same time organise a permanent process for reaching regional agreement on environmental changes, on real threats and on priorities to be considered at regional level. The SAP was adopted by the Council of Ministers of the LCBC in May 1998 and thus constitutes the reference document for LCBC member states' strategy regarding the protection of groundwater and surface water in the Lake Chad basin. A project to assist with the implementation of the first stages of the SAP was to be funded by the GEF at the request of the member states.

Assessment of the various cross-border problems led to the definition of a long-term strategic plan:

AIM OF THE SAP: SUSTAINABLE DEVELOPMENT OF THE LAKE CHAD BASIN

Main objective:

Lake Chad is protected in the long term by concerted and integrated management of the resources in its basin, ensured by getting all stakeholders in the basin to take responsibility and cooperate.

Objective 1: Concerted management of shared international watercourses, relying on regional cooperation and harmonised national policies applied in each sub-basin.

Objective 2: Integrated management of the use of the finite, vulnerable resources of the basin's ecosystem, based on better knowledge of these resources.

Objective 3: Stakeholders in the basin assume responsibility for protecting their shared heritage.

6.3 The Nubian sandstone aquifer

The sedimentary formation of the Nubian sandstones consists of essentially sandy and clayey continental deposits. This formation extends over a considerable geographical area. It covers the east and south of Libya, most of Egypt, the north and north-west of Sudan and the extreme north-east of Chad.

Although it is composed of alternating clay and sandstone horizons, the Nubian sandstone aquifer forms a considerable reservoir of water. In the present state of knowledge and owing to the extremely arid conditions that reign in these regions, the aquifer is said to be fossil, i.e., it is not recharged.

An aquifer of this size that provides good-quality water in such arid areas is of strategic interest for the socio-economic development of these regions. Aware of these challenges, the countries that share this resource have decided to combine their efforts in order to draw up a programme for monitoring and exploiting the aquifer.

Thus Libya, Sudan, Egypt and Chad have set up a joint committee with its head office in Tripoli. Its aim is to put in place the necessary instruments for ensuring sustainable operation of the aquifer's resources. The "Nubian Sandstone Aquifer System" project (NSAS) currently in progress is carrying out activities in this respect.

7 LEGAL AND INSTITUTIONAL FRAMEWORK

7.1 Existing legislation

There was little regulation of the water sector in general until the National Assembly passed law no. 016/PR/99 concerning the Water Code in 1999. This code is characterised by a determination to regulate the sector in the context of the decentralisation process, including widespread involvement of the private sector and associations via the principle of public service delegation. However, it should be noted that the delay in drawing up a land tenure code seriously affects the legislative framework.

WATER CODE

Law 016/PR/99 setting up the Water Code was promulgated on 18 August 1999, after being discussed and adopted by the National Assembly on 2 July 1999. The law was prepared and adopted in the context of delegation of the public drinking water service so that services previously provided by the STEE could thenceforth be provided by a private consortium working within an appropriate legal framework. This explains why the Water Code in its present form is much more detailed with regard to drinking water services in urban areas.

The Water Code deals with all questions relating to state ownership, restriction on private ownership, particular conditions relating to the abstraction, treatment, storage and supply of drinking water and sanitation, conditions for using water, protection of water quality, the use of water and water-related problems, the national water fund, procedures for approving hydraulics works contractors, infringements and sanctions. With regard specifically to drinking water and sanitation, the Code defines: the procedures for operating the public water service and public service obligations, public service monitoring and the regulatory body, the supply of drinking water and tariffs, public service delegation contracts, the legal conditions relating to structures, monitoring of the operator's activities, the drinking water and sanitation development fund and prerogatives and easements.

The main laws governing the sector are the following:

- Law no. 4 of 1 October 1959 outlining regulations concerning nomadism in the territory of the Republic of Chad.
- Law no. 23 of 22 July 1967 concerning the status of state-owned property. This law stipulates that national land comprises all property belonging to the State, public land and private land.
- Law no. 25 of 22 July 1967 concerning the limitation of land ownership rights. This law defines expropriation procedures and defines the principle of compensation fixed by mutual agreement.
- Law 14/PR/99 of 17 August 1998 defining the general principles of environmental protection; this deals with all aspects of the environment and cultural property.

- Law 016/PR/99 of 18 August 1999 concerning the Water Code. This law stipulates that all water resources are communal property and that their exploitation is subject to declaration or authorisation, in the framework of the law and compliance with customary law.
- The laws of 16 February 2000, namely no. 2 concerning the status of Decentralised Local Authorities and no. 3 concerning the electoral procedures relating to Decentralised Local Authorities.
- Order no. 23 of 22 September 1975 concerning the status of the commune of N'Djaména.
- Order no. 17/PR/85 of 24 July 1985 outlining the organisation of "*communes de moyen exercice*".
- Order no. 025/PR/92 outlining the general status of i) professional groups; ii) cooperative-type professional groups; and iii) cooperatives in the Republic of Chad.

7.2 Existing regulations

The political decision for the State to withdraw from the water and electricity sector helped to speed up the adoption of the Water Code, but it did prove to be an opportunity for widespread consultation with the main stakeholders in the sector, in keeping with its importance. It is therefore regrettable that there are a number of oversights in a text that was drawn up essentially in the context of privatisation of the drinking water supply systems managed by the STEE. The Water Code therefore concentrated on dealing more exhaustively with public drinking water services in urban areas. Given certain gaps and inconsistencies, in particular with regard to subsectors not concerned by drinking water, the Code should be supplemented and improved. Furthermore, the decrees concerning enforcement of the Water Code and governing the regulatory framework are not yet all up to date and this delay means that the regulatory framework is not fully operational.

Delegation of public drinking water services to decentralised local authorities and corresponding management procedures: decree 249/PR/MEE/02 of 28 May 2002.

[11] *Pending adoption of the law concerning the hand-over of authority as part of the decentralisation process.*

Presidential decree 249/PR/MEE/02 was signed on 28 May 2002. This defined the procedures and conditions whereby the State temporarily[11] handed over its authority to the Decentralised Local Authorities (DLA) with regard to the delegation of public drinking water services. In particular, this decree recalled that the hand-over was to encourage the introduction of a participatory operation and management method involving users of the public drinking water service and that a contract had to be signed between the DLA and the delegated manager and operator of the drinking water supply system (water users' associations or, failing this, independent operators) throughout the territory of the DLA in question. This decree also described the new role of the State, focusing on its prerogatives with regard to regulation and monitoring. In addition, the general framework of public drinking water service management procedures is defined on an industrial- and commercial-type basis with infrastructure operation managed in accordance with real direct running costs involving all expenses to cover supply, distribution and management functions and replacement costs.

The other main regulations concerning this sector are the following:

- Decree no. 12/PR/INT of 06/05/1970 outlining the status of the *"chefferie"*.
- Decree no. 399/PR/MISD/97 of 10 September 1997 concerning decentralisation.
- Decree no. 249/PR/MEE/02 defining the procedures and conditions whereby the State temporarily handed over its authority with regard to the delegation of public drinking water services to the Decentralised Local Authorities.
- Order no. 0292/MEHP/SE/220/DONHPV/88 of 02/05/88 fixing taxes on water consumption from ONHPV pumping stations.
- Order no. 138/MEHP/86 of 01/03/86 fixing taxes on water consumption from pumping stations.
- Order no. 034/PM/MEE/99/02 outlining the creation and organisation of a National Water Management Committee.

- Order no. 028/MEE/ defining the form of special agreement for handing over the power to delegate a public drinking water service from the State to a Decentralised Local Authority.
- Order no. 029/MEE/DG/2002 defining the form of special contract for delegating a public drinking water service to a users' association or private tenant.
- Order no. 030/MEE/DG/02 outlining the methods for setting up, organising and operating drinking water users' associations (DWUA).
- Circular no. 012/MISD/SE/DIAT/00, relating to the formal prohibition of the fees known as *zakat* and management of pastoral wells by tribal chiefs.

The water police: the *Agence pour la Régulation du Secteur de l'Eau* (ARE - Water Sector Regulation Agency)

According to article 42 of the Water Code, this Agency is placed under the responsibility of the Minister in charge of water. Its principal duty is to ensure that regulations relating to the water sector are applied impartially and to put forward water tariffs for approval by the State. The decree referred to in the Code concerning the organisation and operation of the Agency has not yet appeared.

7.3 General institutional context of the water sector

Management of the water sector is a public prerogative in Chad. Consultation of the various stakeholders (public and private organisations and associations) is institutionalised at central level via three committees (political, strategic and technical) placed under the authority of the Prime Minister (HCNE), the Ministry of the Environment and Water (CNGE) and Directorate of Hydraulic Affairs (CTIE).

Prime Minister's office

Two institutions at the Prime Minister's office are primarily concerned with water and water management:

High National Council for the Environment (HCNE)

The role of the HCNE is to make sure that the recommendations of Agenda 21 of the United Nations Conference on the Environment and Sustainable Development held in Rio de Janeiro in June 1992 are effectively applied. **The National Water Management Committee (CNGE)** is under the authority of the HCNE. Secretarial functions are carried out by the MEE.

Ministry in charge of Decentralisation

This new ministry is responsible for implementing the decentralisation policy that will enable participation and decision-making to take place at the lowest possible level.

Ministry of the Environment and Water

According to chapter 1 of decree no. 183/PR/PM/MEE/2001 of 30 March 2001, the Ministry of the Environment and Water is responsible for defining and implementing policies with regard to environmental protection, the fight against desertification, management of natural resources, application of policies concerning urban, village, agricultural and pastoral water supplies and sanitation, meteorology and hydrology.

At central level, the Ministry is responsible for five directorates: Hydraulic Affairs (DH), Water Resources and Meteorology (DREM), Fisheries and Aquaculture (DPA), Wildlife Protection and National Parks (DPFPN) and Forest Protection and the Fight against Desertification (DPFLCD). At decentralised level, eight regional Directorates of the Environment and Water were set up in 2001 (decree no. 183/PR/PM/MEE/2 001).

Directorate of Hydraulic Affairs (DH)

This Directorate is responsible for all activities relating to groundwater. These include planning urban, village and pastoral water supply and sanitation activities, conducting studies and centralising their results, inventorying and classifying aquifers, carrying out water supply and sanitation works on a direct labour basis, monitoring the maintenance of hydraulic facilities, checking the quantity and quality of groundwater abstraction. The Directorate's organisation and duties are set out in detail in order no. 9/MEE/DG/DH/98 of 3 July 1998.

At **central level**, the DH comprises a Water Office, a Studies and Planning Division, an Urban Water Supply and Sanitation Division, a Village and Pastoral Water Supply Division and a Facilities Maintenance Division. The DH also has an Administrative and Equipment Section. It is in principle represented in the various **prefecture branch offices** by a head of department. However, the prefecture branch offices had not been set up in 2001.

Most of the divisions do not yet completely fulfil their roles, especially the Urban Water Supply and Sanitation Division and Studies and Planning Division. The lack of sufficient well-trained middle managers prevents the Directorate from fulfilling its role in terms of designing and monitoring studies and works in the field. The Directorate also lacks sufficient means and an organisational framework for collecting the information that is essential for it to function correctly.

Directorate of Water Resources and Meteorology (article 20 of decree no. 183/PR/PM/MEE/2001)

This directorate is responsible in particular for planning and programming the exploitation of surface water and for promoting studies connected with determining surface water reserves and changes therein. Its only office is in N'Djaména (hydrology department). The hydrology teams only work out of N'Djaména, covering a fairly vast area with few logistical resources.

Directorate of Fisheries and Aquaculture (article 11 of decree no. 183/PR/PM/MEE/2001)

This directorate is responsible for developing and promoting fish resources and aquaculture, implementing national regulations and regional/international agreements relating to the fisheries and aquaculture sector and the corresponding biodiversity. It is represented via the fisheries department and hydrobiology department at central level and the fisheries sectors at the main lakes (Lakes Chad, Léré, Iro and Fitri). It lacks adequate logistical and human resources to carry out its activities. The directorate also lacks the resources for carrying out its supervisory duties and for collecting hydrobiological data.

Directorate of Forest Protection and the Fight against Desertification (DPFLCD)

Via the Environmental Protection Division, this directorate is in theory responsible for pollution-related issues. It is the directorate with the widest representation throughout the country. However, it lacks logistical resources and equipment, as well as a conceptual framework for carrying out its duties effectively.

Directorate of Wildlife Protection and National Parks (article 14 of decree no. 183/PR/PM/MEE/2001)

The role of this directorate is to implement and monitor national policy in terms of development and sustainable management of wildlife and biodiversity, plan and programme related activities, and apply national regulations in regional/international agreements concerning wildlife and biodiversity.

Since Chad adhered to the Ramsar Agreement on wetlands, the Directorate of Wildlife Protection and National Parks has assigned a focal point for the Ramsar Agreement. It is responsible for monitoring all questions relating to wetlands. The directorate is represented in N'Djaména via the Parks and Wildlife Reserves Division and in the regions with parks (Zakouma, Manda). Its capabilities are limited owing to its lack of logistical and human resources.

7.4 The consultative mechanism

Order 034/PM/MEE/99 signed by the Prime Minister on 3 September 1999, at the time of initiating the SDEA, was the first document aimed at organising an intersectoral, participatory consultative mechanism for protecting and managing water resources in Chad on an integrated basis, and at ensuring rational local exploitation of these resources by the many subsectors concerned. The consultative mechanism is organised under the supervision of the High National Council for the Environment (HCNE), with the creation of the National Water Management Committee (CNGE) - concerning strategic questions and at the level of the major administrative departments - and the Intersectoral Technical Committee for Water (CTIE) at the level of the technical directorates (10). These two consultative committees do not have the power to make or veto decisions but they are operational and demonstrated their vital importance during the preparation of the SDEA. Elected representatives and federations of users' associations are members of these committees by right. External resources may be brought in and external persons may be invited to take part in meetings and works. These committees should play a compulsory key consultative role with regard to major projects of general and strategic importance concerned by water and with regard to discussions on the introduction of a complete water governance system in Chad.

8 MAIN CONCLUSIONS, LESSONS AND CONSTRAINTS TO OVERCOME

The main conclusions of this assessment are as follows:

- **Chad has considerable reserves of water.** However, this should not hide the major constraints involved in mobilising water resources, in particular the unequal distribution of rainfall and surface water both geographically and in time, and the lack of knowledge about how the main aquifers work. As a general conclusion, it is clear that water resources are no hindrance to the economic and social development of Chad. However, **a prerequisite** to developing these water resources will be to carry out studies in order to provide more information on the relations between the main hydrological and hydrogeological systems in the country.
- **The drinking water supply rate** for the population of Chad as a whole was only 23% in 2001. It was a mere 16.5% in rural areas, 25% in towns in the non-concessionary area and 40% in towns in the STEE concessionary area. Major efforts need to be made for the entire population of Chad to have equitable and widespread access to drinking water and also to achieve the Millennium targets.
- **The absence of essential basic data,** such as livestock numbers and fodder resources, is a major constraint in evaluating water requirements and appropriate facilities in the field of pastoral water supplies, and in developing the entire stock-rearing sector.
- **The average increase in cereal production** has been only 2% per annum over the past 20 years in spite of major investment in the agricultural water supply sector, while the annual population growth rate over the same period has been 2.5%. Current cereal production satisfies only a little over 55% of requirements. Significant efforts must be made to increase the productivity of the existing irrigation areas and to develop new schemes in order to maintain and in particular to increase the level of satisfaction of cereal requirements for the population as a whole.
- **There is practically no basic sanitation infrastructure,** in either rural or urban areas. Everything needs to be done in this field. In addition, there are numerous institutional stakeholders involved in sanitation, working with almost no financial resources and too often without being able to coordinate their activities and programmes. However, in recent years, initiatives have been taken by neighbourhood organisations to make up on a very local scale for the shortcomings of this subsector.

- **The legal and regulatory framework is very scant.** The Water Code is the only law governing water. However, the decrees bringing this law into force had still not been promulgated in 2001. This hampers harmonious development in this area, especially with regard to defining and sharing responsibilities among the various stakeholders and with regard to managing the facilities for exploiting water resources.
- **There are many stakeholders ranging from private to public.** To develop and strengthen the private sector, it seems essential to encourage strategic partnerships between national and international companies. With regard to the public sector, it seems important to clarify the role and responsibilities of the various stakeholders in the water sector and to define the legal and regulatory context in detail.
- **National capacity-building** in all sectors is a priority and requirement in order to ensure the sustainable development of water resources and guarantee socio-economic development for present and future generations.

The main lessons to be learned from this assessment are as follows.

Village water supply programmes: success dependent on the quality of accompanying measures to support physical investments

The village water supply projects conducted in Chad over the past 10 years have proved to be very efficient, with the effective involvement of the people concerned via Water Point Management Committees, which guarantee to a certain extent that local people take responsibility for the schemes, and in particular ensure that they will be managed and maintained on a sustainable basis. An essential lesson is that, to be efficient and sustainable, any local development programme must necessarily involve the people concerned right from the moment of designing and choosing the technology to be used. Moreover, facilities must be managed by the users organised legally into management committees or associations, following clear and standardised contractual rules agreed upon with the State departments and private service providers, setting out the respective roles and responsibilities of everyone involved. Better geographical distribution of hydraulic facilities in order to reduce the regional imbalances revealed by the SDEA through improved knowledge of the existing situation, and harmonisation of project approaches following a single strategy and in particular with procedure and coordination guides, are aims that should be achieved in the next 5 years thanks to ongoing discussions and the methodological improvements made within the DH since 2000.

Urban and semi-urban water supply projects: a subsector that is lagging behind

Concessionary area

Lessons have already been learned concerning the chronic shortcomings in management of the STEE. The solution adopted is to delegate the public service to a private concessionaire. As a prerequisite, the private consortium demanded that the STEE's accounts should be cleared. A large part of the windfall from oil that the Government received in April 2000, i.e., FCFA 4.9 billion, was used to clear the STEE's debts. However, considerable uncertainty remains with regard to the funding of operations, network maintenance, rehabilitation and extension work, and the feasibility of the chosen solution. The price of water services is low and has not changed since 1984. The State's control over STEE tariffs is a constraint and could become a source of conflict over the understanding of the targets set out in the introduction to the agreement with the consortium. Discussions must be initiated to reach a consensus on adopting a progressive price structure that is equitable with regard to levels of services, socially acceptable and economically viable for the targets set.

The absence of any move towards a viable solution has created an inefficient, unfair situation and, given the population growth, is leading to a drop in the rate of access to drinking water in certain large towns in the country.

The STEE has initiated integrated planning studies for drinking water supplies in 11 towns in the concessionary area. To reach the Government and Millennium development goals in this area (40% rate of access in 2000 and 70% by 2015), major investment must be made and these integrated plans should examine them in light of the above target figures (to be included in the terms of reference for the studies). It is logical and fair to aim at goals that are to apply in principle to the entire country, as rural areas and towns of more than 2000 inhabitants in the non-concessionary area will be organised in accordance with these performance levels.

For reasons of good governance and transparency, it would be appropriate for the STEE SA to take an active part now in the consultative process concerning water management, via the CTIE and CNGE. This would enable it to present and discuss the main strategic options as a semi-public concessionary company that is to be privatised at a later stage. In the present situation, it is difficult to make any prediction regarding the planned new management system and the chances of all stages being implemented. Furthermore, operational control of the new company by the monitoring committee provided for in the contract would be an additional guarantee that the concessionaire (STEE SA) would fulfil its obligations, in particular with regard to the expected extensions. It would also be advisable for the contract-monitoring mechanism to be harmonised with the stipulations expected in this respect under the Water Code, in order to maintain a consistent overall mechanism for monitoring the implementation of activities throughout the sector by the public service.

Towns of more than 2000 people outside the concessionary area

The lessons to be learned from the innovative experiments carried out in the context of the projects entitled "Water and Services in the peripheral neighbourhoods of N'Djaména"[12] and "Drinking Water Supplies to Secondary and Semi-Urban Centres" are vital in organising the future maintenance and management of hydraulic structures in urban and semi-urban environments. These projects are in fact a starting-point for setting up a structure maintenance and management organisation based essentially on users and the private sector, with the role of the Directorate of Hydraulic Affairs being gradually shifted to supervision and regulation activities. This is all the more justified as the lessons learned from the management systems recently set up by the DH in centres outside the STEE area and from existing embryonic networks often reveal malfunctions. The roles of operation, regular management and control are not clearly dissociated, while local dignitaries and officials are all directly involved in ways that are hardly suited to their function and institutional role as arbiters. Accurate accounts, records of elementary indices and regular technical reports do not always exist.

[12] *In fact, inside the concessionary area, but with autonomous management.*

However, there are serious constraints linked with the introduction of a new operational management system for drinking water supply systems based on the empowerment of users, and these should not be underestimated. They entail concrete changes in or clarification of: the responsibility of the communes (competency with regard to public water services); the role of local dignitaries, committee chairmen and canton chiefs; local organisations (small companies, associations, etc.) that are often inexperienced and inadequately trained to take over management and operation from the Government; payment of water bills by State departments; the readiness of users to pay for the service, and the institutional framework. Lastly, the projects proposed by the donors should be analysed in detail by the DH right from the design stage so that they can be adapted to the country's strategy defined by the SDEA and to the procedural guides that still need to be studied, tested and validated once concrete management procedures that have proved successful in the field have been assessed and adopted. The public service could ensure the consistency of the various works, projects and cooperative ventures but, given the scope of the planned programmes, this means a capacity-building programme for managers and a recruitment and training plan for young people.

Pastoral water supplies: the absence of a clear institutional framework and inadequate knowledge of basic data in the subsector mean there is a lack of consistency in programmes and the distribution of pastoral water points.

There are at least two major institutional stakeholders, belonging to two different ministries, involved in the pastoral water supply subsector. These are the Directorate of Hydraulic Affairs of the Ministry of the Environment and Water, and the Directorate for the Development of Animal Production and Pastoralism of the Ministry of Stock-Rearing. In the past, this has been a source of needless tensions as their functions are complementary and much would be gained by clarifying the duties of these organisations and the manner in which they should work together in operational programmes.

Insufficient basic knowledge of fodder resources and in particular of livestock numbers has led to discrepancies observed on one hand between the major transhumance patterns and areas to be protected, and on the other in the spatial distribution of modern pastoral water points built in the past. Poor knowledge of these basic data also hampers the development of this sector and regional development in a wider sense, especially in pastoral areas.

Water resources: they are abundant and generally do not represent a restriction on development, but they need to be better known, protected and used rationally.

It is essential to manage the resources rationally in order to guarantee the health of the aquatic ecosystems on which most of the country's economic activities depend, as well as the biodiversity of Lake Chad. In semi-arid piedmont areas, such as oasis ecosystems, the fragile balance between water resources and uses could be jeopardised by the lack of integration of support operations or by the massive introduction of motor pumps. Vigilance is called for and appropriate measures must be defined and put into effect with regard to risks connected with floods and industrial (especially oil-related) pollution.

On the other hand, the mobilisation of water resources may be a constraint at local level owing to the investment costs involved for exploitation systems and the corresponding running costs. Both these types of cost depend on the accessibility of the water resources. User funding and management capability are a decisive factor in choosing each type of equipment to be installed.

Management of knowledge on water resources

Chad has paid much more attention to infrastructure for mobilising and exploiting its water resources than to managing knowledge of them. It is estimated that less than 1% of the total funding in the water sector between 1985 and 2000 was allocated to monitoring water resources. Not even minimal piezometric monitoring of the aquifers was carried out owing to the lack of resources. The same is true of hydrological measurements and processing. The water yearbook for Chad has not been published for several years because the small number of gauging operations limits the validity of the rating curves and the quantity and quality of water level measurements are insufficient, mainly as a consequence of the inadequate logistical resources. This subsector also suffers most from a lack of managers in relation to the other countries in the sub-region. However, what is probably most lacking in the institutions concerned is a clear view of the country's development priorities, enabling them to define on the basis of demand (and not supply) a work programme that is suited to requirements and available resources. With such an economic valuation of work carried out and in light of the results obtained, it would be advisable to increase the share of the budget devoted to these institutions progressively on the basis of a programme covering several years. This attempt at rationalisation should be based on the requirements defined by the SDEA for the next 20 years, **starting by identifying, collecting, processing, interpreting and computerising the considerable quantity of hydrological and hydrogeological data existing within the country, that are so far unused**. Specific requirements can be identified. For example, in the irrigation subsector, activities concerning among other things the potential for spreading floods on the Salamat, the hydrology of each event in arid piedmont areas, infiltration capacity and subsurface dams, could be initiated, not to mention everything concerning the pastoral water supply subsector and an inventory and study of the natural functioning of the main seasonal ponds.

With regard to the consistency of operations, it is certain that separating surface water and groundwater monitoring activities between two agencies (DREM and DH) has an adverse effect on the knowledge, modelling and integrated management of the same single resource involved in the water cycle.

Regional cooperation on shared international watercourses

At regional level, the Lake Chad Basin Commission enables regular discussions to take place between the member States that share the watercourses of the Lake Chad basin. Since May 1977, the Government has had a Ministry of the Environment and Water. If one adds the High National Council for the Environment (HCNE), the National Water Management Committee (CNGE) and the Intersectoral Technical Committee for Water (CTIE) to assist in the field of water, the Government of Chad has a complete framework for controlling its water and environmental policy with a view to achieving a truly integrated approach. This complies with the recommendations of the LCBC Strategic Action Plan of May 1998. However, the fact that the LCBC is only motivated by "project" approaches and that the Ministry of the Environment and Water of Chad has not been represented on it so far limits the continuity and efficiency of regional cooperation efforts.

Water policy: absence of a clear policy and single reference framework for developing and managing water

Table 14 summarises the contents of recent documents containing recommendations or a strategic order for the various water subsectors. For want of a reference framework, these objectives have often been produced without any analysis of the subsector concerned and without knowing the initial situation, or the costs and resources that can be mobilised, and obviously without being in a position to consider the characteristic interdependence of water and water management within each sub-system and between sub-systems, due to lack of information.

Approaches fragmented into subsectors and projects, that the SDEA needs to coordinate and rationalise

In the past, the water sector has been handicapped by too many malfunctions, by the relative inefficiency of the various interministerial committees, by insufficient consultation between the ministries concerned with the same development project, between the stakeholders and end users, between the funding agencies themselves and between regional and bilateral institutions, by a certain amount of confusion between monitoring, regulating and operating roles, by the lack of structure monitoring and by the lack of professionalism of certain charitable organisations. However, the preparation of the SDEA and the multisectoral and multi-stakeholder discussions that it has entailed, particularly via the CTIE and CNGE, has proved that these difficulties can be overcome and that the corresponding achievements deserve to be institutionalised in order to prolong the strategies adopted through good practice in concrete programmes.

Consequently, the SDEA is not limited to proposing an action plan. Through a holistic, integrated approach, it also establishes the reference framework of a water policy and rational control of the water sector in its entirety for the country, the funding agencies and all others involved. The following chapters will therefore concentrate on a view of long-term requirements, a Chadian water policy derived from the observations, requirements and resources identified above, a strategy for each subsector, an action plan, a strategy for implementing the SDEA (including a legal framework and strategy for mobilising funds) and finally a mechanism for monitoring performance in implementing the SDEA.

Table 14: Summary and analysis of strategy documents in the various water subsectors

Document	Village water supply	Urban water supply	Pastoral water supply	Agricultural water supply	Sanitation	Water management
Guideline Plan: Chad around 2000	Provide people with enough water points of sufficient quality. On the basis of requirements, the aim is: **one water point for 500 inhabitants** in rural areas. **Progressively increase to 10 800 by 2000** the number of water points, comprising 20% wells and 80% boreholes (currently about 4000 water points)	Aimed at urban development and sanitation **Health** Ensure that by 2000 **water is available no further than 15 minutes away on foot** **Housing and urban planning** Implement hydraulic infrastructure works in secondary urban centres (Sarh, Moundou, Abéché and others)	Create a sufficient number of water points to limit overgrazing and rationalise livestock migrations Considering the size and migratory movements of livestock: **requirements are estimated at about 3000 water points** (the country has 500 at the most at present)	Total area irrigated estimated at about 20 000 hectares spread more or less evenly between small and large irrigation schemes Given its decidedly voluntarist strategy to promote exports, the Government intends to: ■ help double the areas of small irrigation schemes, ■ rehabilitate half the area of large irrigation schemes, ■ reorganise the management and production methods of large areas. The State will: ■ focus its activities on supporting farmers and withdrawing from production ■ seek to encourage the development of market-garden crops near urban centres and out-of-season crops in low-lying areas and around wadis	Make villagers' groups take responsibility and become more autonomous so that they can keep pumps in good working order and thus benefit from water of constant quality. In urban areas, the programme is based on campaigns to educate people about the use of stand-pipes, disposal of stormwater and waste water, and the collection of household waste. **Housing and urban planning** Ensure that people, especially in urban areas, have hygienic, healthy living conditions. The Government intends to draw up urban planning documents for the main towns in the country as quickly as possible in order to proceed with **the most urgent sanitation works.** **In the short term** Urban development master plan for N'Djaména Initiate the process to define a national housing policy (urban planning, sanitation). Initiate the process to define a municipal policy (allocation, management). **In the medium term** Support municipal management of N'Djaména Rehabilitate sanitation and drainage infrastructure (waste water and stormwater). Rehabilitate services and road infrastructure in N'Djaména. Prepare urban development master plans for the other main towns.	Strategy strongly geared to small, inexpensive structures involving simple technologies that are well-suited to the physical and human environment. More generally: ■ encourage local and private initiatives, in particular in the area of agricultrual water supply ■ recognise rural communities as partners ■ raise the issue of payment for water

Table 14: Summary and analysis of strategy documents in the various water subsectors (cont.)

Document	Village water supply	Urban water supply	Pastoral water supply	Agricultural water supply	Sanitation	Water management
Revised Guideline Plan: Preparing Chad for the 21st century =>Geneva IV (1997)	Ensure that safe water is available no further than 15 minutes away on foot **for 50% of the population by 2001 and for 70% by 2015** Promotion of a water point for **250 to 300 inhabitants** representing the need for **16 000 structures by target year 2001**	Ensure that safe water is available no further than 15 minutes away on foot **for 50% of the population by 2001 and for 70% by 2015** Ensure **all urban dwellers have drinking water**	Implementation of **4000 additional water points** to secure drinking water for livestock in pastoral activity areas	**Rehabilitation of all large irrigation areas** Encourage the creation of small private or village irrigation areas	Increase the installation of latrines in houses and public services (schools, dispensaries) Ensure the removal of solid waste and waste water **Halve the number of water-releated diseases** caused by the consumption of poor-quality water	Create and **instil a sense of responsibility in users' groups,** village beneficiaries and nomads with a view to handing over **the management and maintenance of irrigation areas and water points** Introduction of the principle of **payment for water**

Table 14: Summary and analysis of strategy documents in the various water subsectors (cont.)

Document	Village water supply	Urban water supply	Pastoral water supply	Agricultural water supply	Sanitation	Water management
Geneva IV conference (reference document): strategic development options (1998-2001) 1998	**Water and sanitation (infrastructure)** Ensure the availability of **9800 village water points** by 2001 **Health** Ensure the availability of safe water no further than 15 minutes away on foot for 50% of the population by 2001	**Water and sanitation (infrastructure)** Three priorities must guide public action for the period: ■ make the necessary investments to ensure water supplies in large towns ■ progressively equip the main secondary towns with drinking water distribution and carry out urban development ■ ensure the availability of safe water no further than 15 minutes away on foot for 50% of the population by 2001	**Water and sanitation (infrastructure)** Ensure the availability of **3500 pastoral water points** by 2001	**Water and sanitation (infrastructure)** Carefully rank investment projects to be implemented in the various fields: ■ rehabilitate certain parts of large irrigation areas ■ develop small village irrigation areas ■ develop low-lying areas ■ flood-recession crops	**Water and sanitation (infrastructure)** **The priority is to define an institutional and legal framework for clarifying the duties of those involved in waste water, stormwater and solid waste** Priorities: ■ stormwater drainage ■ extension of latrines ■ organisation of waste collection and management circuits in the main urban areas ■ national policy in the field of waste disposal and waste water, in order to rank projects **Health** Halve the number of water-related diseases caused by the consumption of poor-quality water **Urban planning** Finalise the urban development master plan for N'Djaména and define a housing policy and development strategy for town councils (in the short term)	**Water and sanitation (infrastructure)** Capacity-building in the management of the sanitation subsector by relying on municipal services and promoting sanitation committees

Table 14: Summary and analysis of strategy documents in the various water subsectors (cont.)

Document	Village water supply	Urban water supply	Pastoral water supply	Agricultural water supply	Sanitation	Water management
Sectoral consultation on Rural Devt. 1999-2002 (1999)	Creation *of* **2000 water points** in the short term and **10 000** others by **2010**	**Subject not dealt with**	Equipping of grazing areas with **4000 structures by the year 2010** Mark out cattle tracks and migration routes	**Increase irrigated areas through scheme creation and rehabilitation**	**Subject not dealt with**	Local management Definition and adoption of a legal and regulatory framework Clairification of prerogatives and fields of competence
Action Plan for the Development of Chad (2001-2010) (2001)	Creation of a further **21 000 water points** to cover the country's drinking water requirements by **2010**	Investment to increase water supply rate in large towns Equipping of main secondary towns with drinking water distribution networks	Create **3250 water points in 2003 and 11 500 water points by the year 2010** each producing a yield of 30 m^3/day	Rehabilitate certain parts of large irrigation areas Develop small village irrigation areas Develop low-lying areas and extend flood-recession crops	Define a sanitation programme and **sanitation master plan** Strengthen capacities of town councils and hygiene/sanitation committees Include sanitation issues in all urban planning programmes Make people aware of hygiene measures Organise waste collection and management circuits in main urban areas and study appropriate technology	Involve the population via joint management committees responsible for operating and managing equipment Take into account the impact of hydraulic development works with a view to preserving ecosystems
Poverty Reduction Strategy Paper 2015 (in progress)	**Guarantee access to drinking water** Water policy project Integrated Plan for Chad's Water Development and Management	**Guarantee access to drinking water** Water policy project Integrated Plan for Water Development and Management Sanitation for the urban environment			Extend use of improved latrines Sanitation for the urban environment Water policy project Integrated Plan for Water Development and Management	Water policy project Integrated Plan for Water Development and Management