United States
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Geological Survey

GROUND WATER IN THE AZZAHRA - ANNASIRA - AL AMIRIA AREA, TRIPOLITANIA

Prepared Cooperatively
by
United States Operations Mission to Libya
and
United States Geological Survey

Open File Report

April

1961

المياه الجوفية في مناطق الزهرة - النصيرة - الامرة طرابلس الغرب

وضع

ماريو بريتولا، معاون هيدرولوجي
الخدمات الليبية الامريكية المشتركة
بعثة الاعمال الامريكية الى ليبيا

اعد بالتعاون من قبل

بعثة الاعمال الامريكية الى ليبيا
ومصلحة المساحة الجيولوجية الامريكية

نشرة إدارية
ابريل
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GROUND WATER IN THE AZZAHRA - ANNASIRA - AL AMIRIA AREA, TRIPOLITANIA

by

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PREFACE

The following report was prepared by Mr. Mario Bertaiola, who began working with the Libyan-American Joint Services ground-water investigation group in 1955. These investigations were part of the United States Overseas Mission to Libya technical assistance program. Mr. Bertaiola's training in hydrology was entirely with the ground-water investigative unit and is an example of successful training of a host country national.

The report was written in Italian and subsequently translated into English and edited by D. J. Cederstrom of the Foreign Hydrology Section, Water Resources Division, U. S. Geological Survey.

INTRODUCTION

The area described in this report includes the village of Azzahra (formerly Bianchi), Annasira (formerly Giordani) and Al-Amiria (formerly Micca). It has area of about 17,000 hectares and lies between latitude 32°41' north and latitude 32°35' south and between longitude 12°48' west and longitude 13°00' east, as shown on the map (fig. 1).

The purpose of the report is to describe the hydrologic development, the changes of water level that have occurred, factors of recharge and the chemical character of the ground water. In so doing all available information was obtained from officials of the Italian bureau (INPS) that formerly administered these villages, from well drillers, from documents of the now defunct Italian Hydrographic office, and from other pertinent sources. Data were obtained on 350 of the 600 to 650 existing wells. Their locations are shown in figure 2.

For a distance of 10 to 15 kilometers from the coast the ground is semi consolidated but farther inland the surface is generally made up of a thick cover of sand, largely wind borne origin. These sands are in large part derived from a breakdown of the rocks making up the Gebel Nefusa and have been emplaced by action of wind and water.

The area considered in this report, about 20 kilometers south of the Mediterranean, is partly level and partly hilly. The hilly zone is largely a sand dune area which is stabilized in largest part by natural or cultivated plant cover. In general the altitudes of these hills range from 15 to 25 meters. There exists also a zone of recently formed dunes where agriculture is practised only with difficulty, although with the

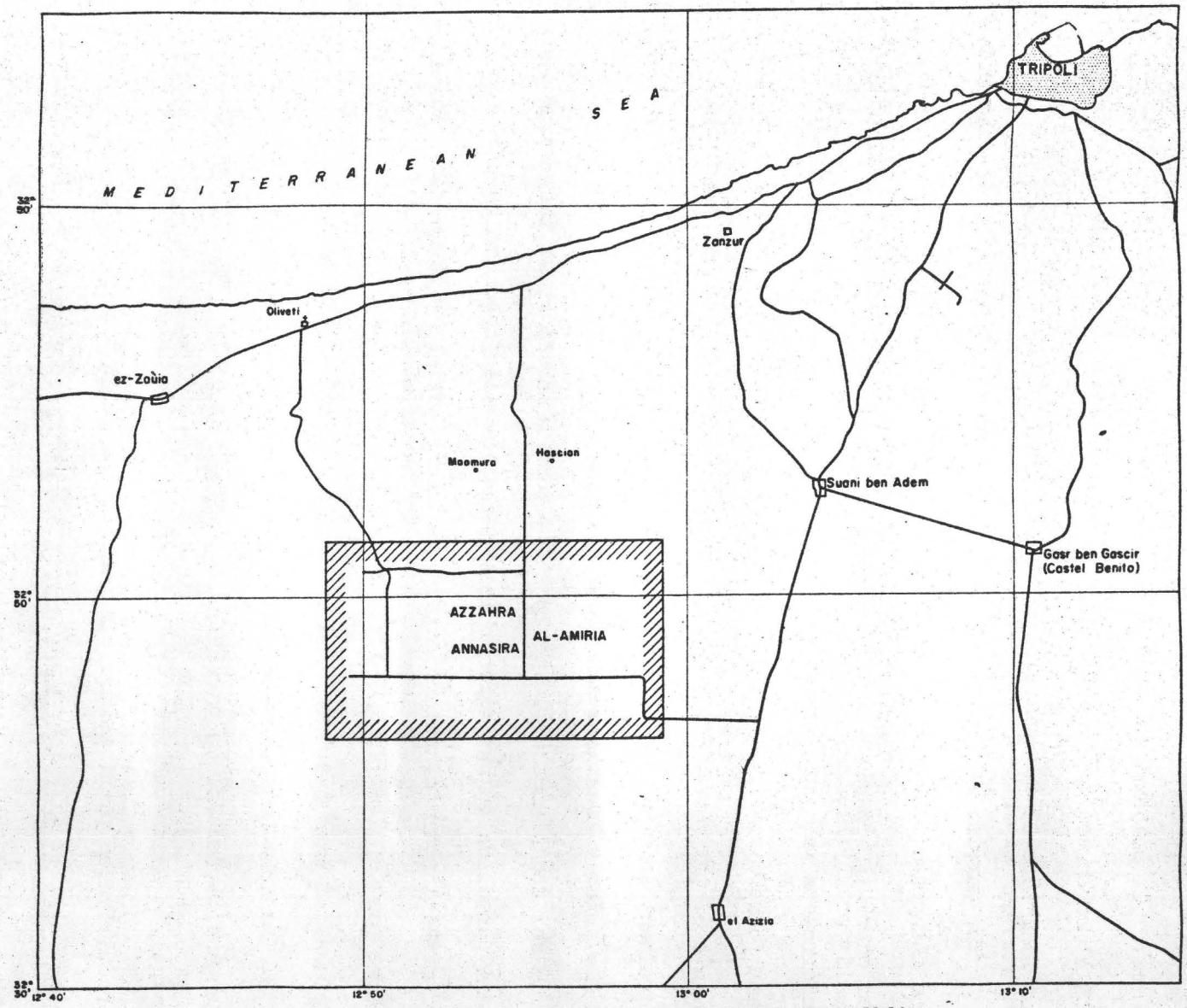

FIG. I MAP SHOWING LOCATION OF AREA WITH REFERENCE TO THE CITY OF TRIPOLI

help of machinery much of this area is being leveled and transformed year by year into productive ground.

That part of the cultivable ground under irrigation amounts to 3,000 to 3,500 hectares. Both small canal and overhead (artificial rain) irrigation is practised although the latter method of irrigation is gradually replacing the former everywhere. From 2,000 to 2,500 hectares are not irrigable on account of roughness of terrane or because of the presence of moving dunes. The greatest part of the remaining 10,000 hectares are dry farmed. The ground put to agricultural use is sufficiently good, with proper fertilizers, to produce grain, barley, peanuts, fodder, peas, beans, onions, tomatoes, oranges and lemons.

The rural population is estimated to be from 4,000 to 4,500 inhabitants.

Temperature and Rainfall

The climate is that of the coastal steppe, that is without excessive differences in temperature in any 24-hour period. The average temperature is quite similar to that of Tripoli. Figures for temperature at Tripoli are given in Table 1.

Table 1. Average Maximum and Minimum Temperatures (°C.) at Tripoli, 1935-1955.

	Jan.	Feb.	Mar.	Apr.	May	June
Tripoli (Maximum)	16.9	18.6	20.4	23.4	26.2	29.3
(Minimum)	7.3	8.5	10.0	12.8	15.8	18.8
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tripoli (Maximum)	30.8	31.8	30.6	28.4	23.2	19.1
(Minimum)	20.8	21.7	20.5	17.7	13.0	8.8

The rainfall record given is that taken at Azzahra, the most complete record in the immediate area. (See Table 2). In the period 1944-59 annual rainfall ranged from 91 mm (millimeters) to 311 mm; the average annual rainfall based on these records is 205 mm with greatest rainfall being generally recorded in the months of October thru February. June, July and August are essentialy without rainfall. It should be noted that the rainfall pattern is highly irregular from month to month and year to year. Under such conditions it is commonly necessary to irrigate some crops that might otherwise mature if the annual rainfall had followed the average annual rainfall pattern.

Geological Setting

Surficial sediments in the area are of Quaternary age and are continental in origin. Wind-deposited sands extend to a depth of 25 to 35 meters. The underlying sediments are alluvial. Stratification is highly irregular. Most of the sediments are semi-consolidated but easy to excavate. In general the water-bearing beds are made up of fine to coarse sand and sandstone.

Ground Water Supplies

The wells in the area range from 17 m (meters) to 77 m in depth. The average measured depth of 236 wells is 31 m.

The wells in the area, like most wells in Tripolitania, are dug from the surface to a few decimeters above the original water table. The drilled portion of the well is begun at the bottom of this shaft which is termed an "avampozzo." Water is pumped to the surface by a centrifugal pump at the bottom of the avampozzo.

Table 2. Rainfall at Azzahra, Tripolitania, in millimeters, 1944-1959.

Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1944	1018	455	213	402	20	0	0	0	0	80	355	190	268
1945	440	745	50	0	105	0	0	0	0	805	200	725	256
1946	300	325	140	5	0	0	0	0	465	25	(60)	615	166
1947	100	0	0	0	0	0	0	0	25	55	473	430	91
1948	37	0	130	158	0	0	0	0	165	40	1139	467	178
1949	534	1435	340	50	25	1	0	2	0	360	185	315	272
1950	980	275	795	20	135	1	0	0	0	165	617	735	311
1951	495	25	30	0	25	0	0	0	95	300	330	1455	230
1952	440	975	1	90	0	0	0	0	290	85	168	520	232
1953	762	31	113	18	62	02	0	07	0	212	753	545	209
1954	104	87	153	87	03	150	0	0	0	178	731	398	158
1955	17	293	02	487	0	0	0	0	06	249	66	657	148
1956	64	144	295	0	01	0	0	0	57	203	0	698	124
1957	1294	0	86	497	138	3	0	0	0	664	336	634	306
1958	219	03	195	0	0	0	0	0	40	157	1178	380	181
1959	541	607	22	01	0	0	0	0	0	134	101	312	143
Average	458	337	161	116	32	10	0	Tr	71	232	417	567	203

Many wells ending in sand have given trouble and many have pumped sand after a period of use to the extent that they become useless. In such instances it was necessary to construct a new well but, since the new well was built in the same manner as the old well, no permanent solution of the problem was effected. Conditions are better where wells end in sandstone. These are more difficult to sink but if the sandstone is the porous type, the yield is ordinarily abundant.

Water level is an average depth of 16 meters below land surface.

The average yield of 320 wells is about 30 cu/m/hr (cubic meters per hour) with drawdown of 2.7 m. The highest yield well (120a, Azzahra) furnishes 70 cu/m/hr with a drawdown of 4 m. However, the most efficient well is no. 28 at Azzahra which yields 40 cu/m/hr with .6 m of drawdown.

Commercial agriculture began in this area in 1938-39 at which time electrical energy to activate the pumps was obtained from Tripoli through a central station at Azzahra. Electrical energy was available less than 7 to 8 hours per day was not sufficient as a result of which 40% of the farmers equipped themselves with generators thereby increasing well discharge time to 16 to 18 hours and at certain periods 24 hours out of 24. There is reason to believe, therefore, that in the last ten years the water discharge was doubled.

According to information gained by interviewing 350 farm proprietors, the average well is pumped 9 hours a day for 7 months of the year and for 3 hours a day the remaining 5 months. The yield of the average well is about 30 cu/m/hr. Thus, the annual discharge of the average well is about 66,000 cubic meters (over 17 million U.S. gallons).

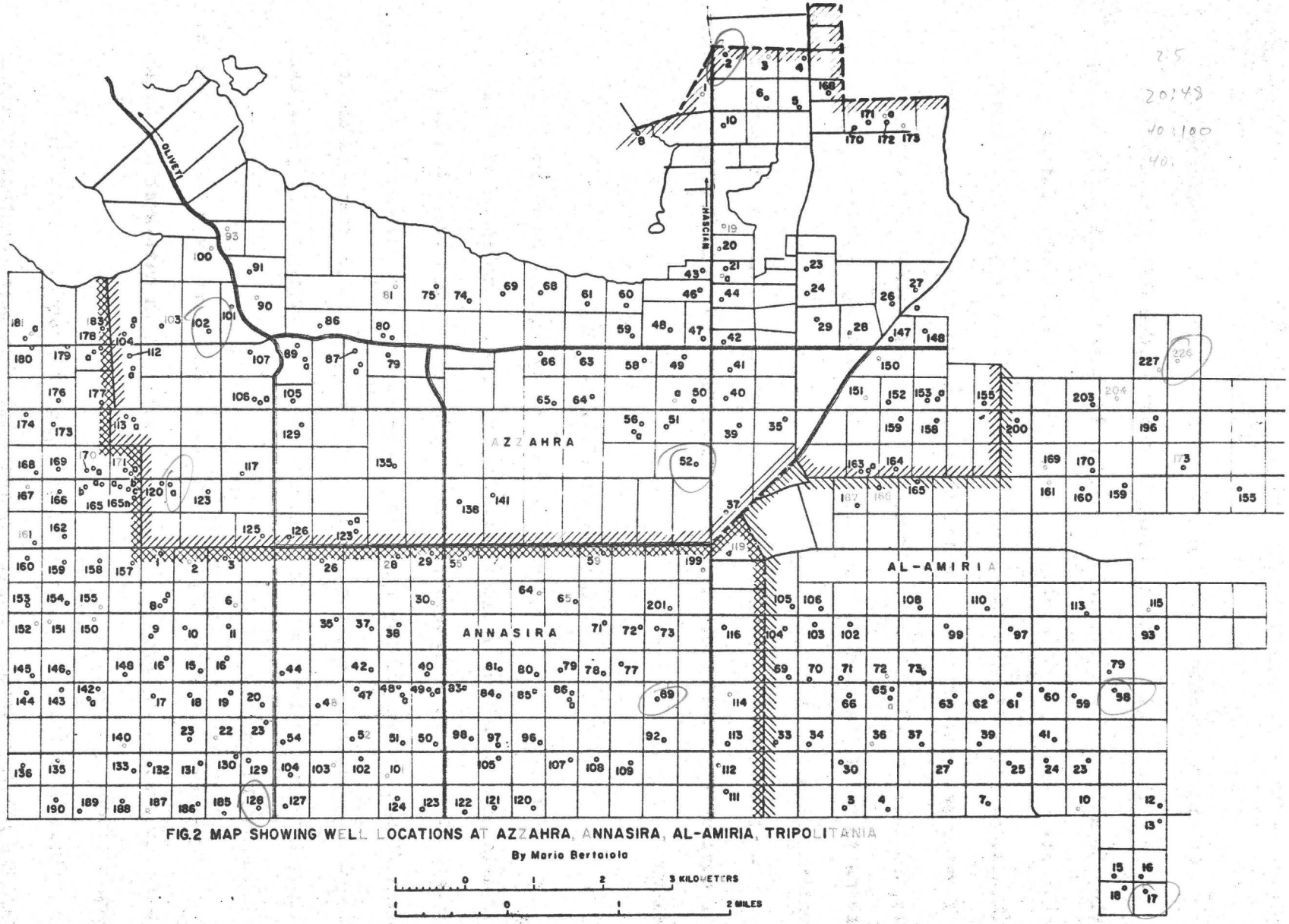

FIG.2 MAP SHOWING WELL LOCATIONS AT AZZAHRA, ANNASIRA, AL-AMIRIA, TRIPOLITANIA

By Mario Bertaiola

0 1 2 3 KILOMETERS

0 1 2 MILES

On the reasonable assumption that there are 600 irrigation wells in the area, the total discharge would be about 40,000,000 cubic meters (10,560 million U.S. gallons). Based on 3,500 hectares of irrigated land, this gives about 12,000 cubic meters per hectare per year. Casadio (Lewis, p. 55) indicates that oranges require about 20,000 cubic meters of water per year whereas alfalfa, peanuts and potatoes require around 15,000 cubic meters annually. Hence the total discharge arrived at above seems to be of the correct order of magnitude and may even be a conservative estimate.

Considering the continued development of agriculture in the area, it is obvious that the reservoir will be drawn upon to an increasingly greater extent.

Decline of the Water Table

At the time of the beginning of the colony Sig. C. Borgognoni obtained data on a number of wells in the Azzahra area. Comparison of these levels with the water levels (table 3) today shows that there has been a significant decline of water levels in the entire area under consideration. These data indicate that the lowering of the water table averages about 5.5 m throughout the area. The average annual lowering for 20 years has been about 27 cm.

To illustrate the decline of the water table from 1939 to 1959, cross-sections were drawn through the group of wells, both east-west and north-south (figs. 3 and 4).

Wells existing at the time of Borgognonis' study have been considered but the overall picture includes other wells that were constructed since that time. The decline is estimated fairly closely by the deepening of the

Table 3. Depth to water below land surface in wells in the Azzahra area, Tripoli, 1939 and 1959.

Well No.	Water level 1939 (meters)	Water level 1959 (meters)	Decline (meters)
2	7.50	12.25	4.75
7	7.20	12.94	5.74
9	8.50	14.16	5.66
10	7.30	13.73	6.43
19	8.60	13.83	5.23
20	8.55	13.56	5.01
45	7.10	12.10	5.00
46	7.60	12.70	4.90
47	10.20	15.11	4.91
42	9.55	15.11	5.56
48	10.70	15.14	4.44
49	10.60	15.61	5.01
50	12.10	16.63	4.53
51	13.00	17.86	4.86
52	15.00	20.74	5.74
53	14.50	20.28	5.78
59	9.60	14.03	4.43
62	8.60	12.99	4.39
67	9.10	13.44	4.34
70	9.90	16.98	7.08
73	8.40	14.22	5.82
80	7.30	14.22	6.92
102	10.70	14.30	3.60
103	8.80	16.61	7.81
104	9.10	15.33	6.23
32	10.30	14.77	4.47
29	9.15	13.37	4.22
28	9.70	15.29	5.59
27	8.90	12.95	4.05
26	9.00	13.11	4.11

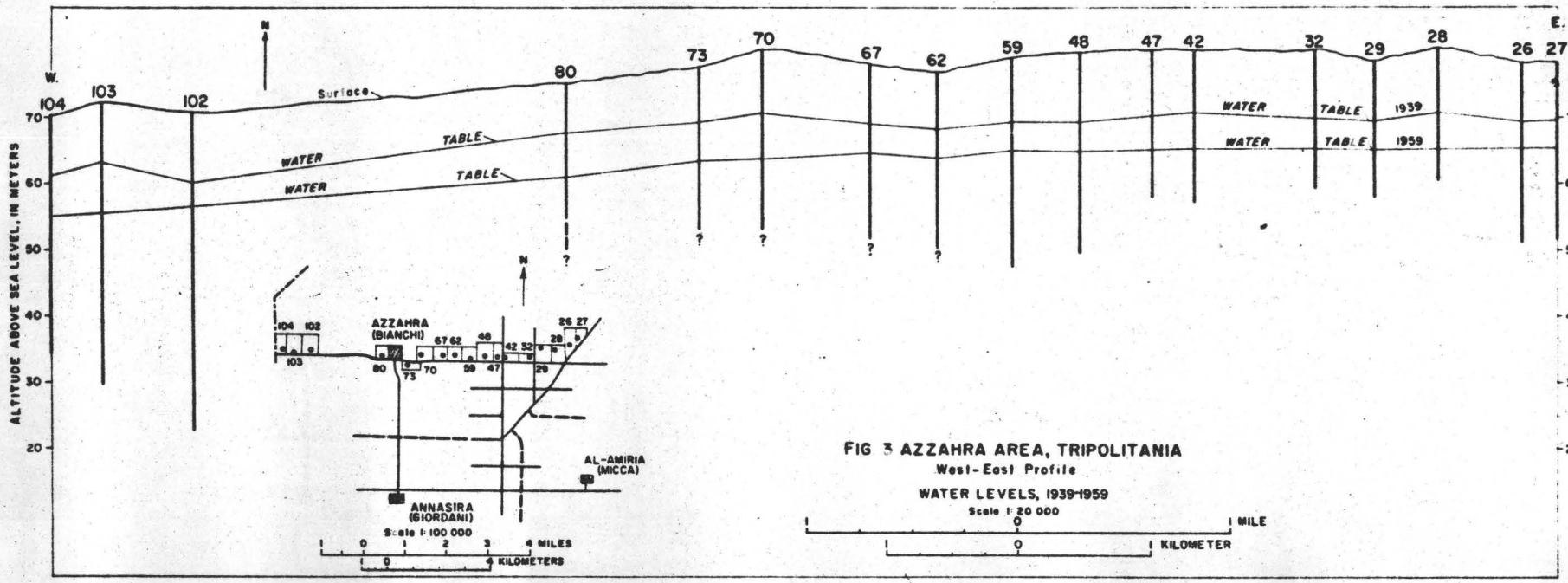

FIG 3 AZZAHRA AREA, TRIPOLITANIA
West-East Profile
WATER LEVELS, 1939-1959

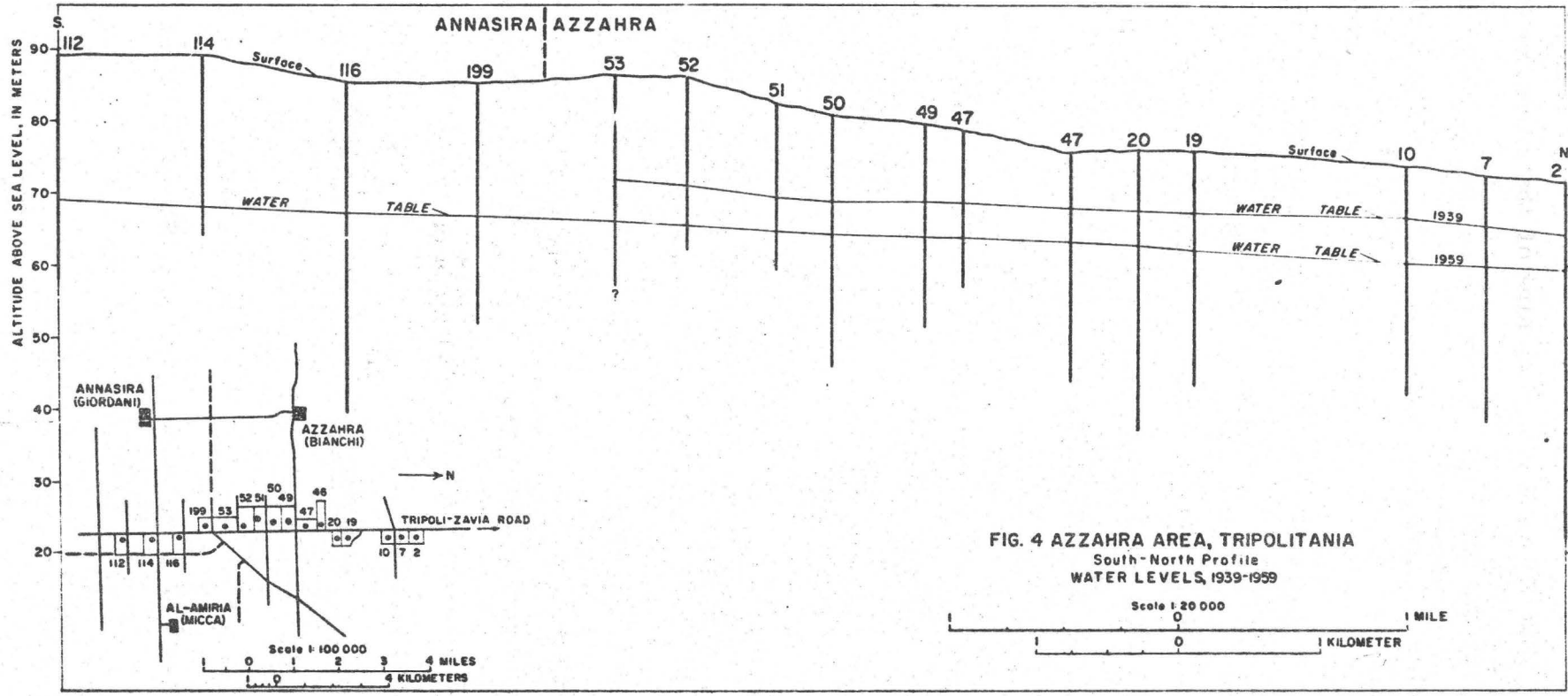

FIG. 4 AZZAHRA AREA, TRIPOLITANIA
South-North Profile
WATER LEVELS, 1939-1959

avampozzo. The year and amount of deepening of the avampozzo is given in tables 6-8. It was noted that in these other wells the water level also declined in an almost identical manner to the wells noted, regardless of the depth of the well or the stratum in which it is finished.

Water levels in wells in October 1958 and October 1959, made as part of the inventory, declined as shown in Table 4.

Data on 15 wells out of 600 may not be sufficient to give a completely accurate average decline. However, the wells listed in table 4 are widely scattered throughout the area and therefore the "average" decline of 33 cm may be considered as reasonably representative.

It may be noted that the depth of any well may be greatly different from another in the same vicinity but whether these differ or whether the static level or the yield and pumping level differs slightly, all data lead to the conclusion that every well draws from the same large resevoir in which impermeable lenses throughout the mass shut out access to the water, as a result of which wells vary greatly in depth from place to place. For this reason wells ending in the "first," "second" and "third" stratum, all draw from a single hydrologic resevoir.

The record of water levels in well 24 at Azzahra, on which an automatic water level recorder is installed, yields the following data;

In the September-October period water levels reached the lowest levels of the year after which water level rose to a maximum at the end of the February-March period. In general the water level rises for 4 months out of 12 and coincides with the rainy season of the winter, at which time discharge of ground water is at a minimum. Such gain in water table cannot be ascribed exclusively to recharge by rainfall but rather,

Table 4. Depth to water below land surface in wells at Azzahra and Annasira, October 1958 and October 1959

Well No.	October 1958 (meters)	October 1959 (meters)	Decline (meters)
Azzahra			
24	12.16	12.42	.26
42	14.47	15.11	0.64
44	11.48	11.65	0.17
46	12.43	12.70	0.27
47	14.93	15.11	0.18
52	20.11	20.74	0.63
103	16.35	16.61	0.26
91	10.72	10.92	0.20
93	10.02	10.15	0.13
100	11.28	11.56	0.28
133	16.08	16.57	0.49
135	16.39	16.60	0.21
Annasira			
21	19.57	20.08	0.51
23	18.80	19.25	0.45
119	17.29	17.70	0.41
199	18.30	18.52	0.22

is largely dependent (possibly entirely dependent) upon flattening of the cone of depression consequent upon temporary cessation of pumping.

As noted, the decline of water levels is uniform throughout the area and of the order of 5.5 meters in the 1939-1959 period. The fact that the decline is about the same at the outer edge of the area as it is near the center leads to the conclusion that the area lies within a cone of depression that is much larger than the area covered by this report. Keeping in mind the sharp declines of water level shown at Suani ben Adem and Gasr ben Gascir (Cederstrom and Bertaiola, p. 77-81) in the same latitude and 12 and 24 km distant, it is concluded that the decline of water levels in those two localities and in the area covered by this report are parts of an identical phenomenon, ie, a widespread irregular cone of depression.

Chemical Quality

The chemical quality of ground waters in the area is generally good for irrigation purposes. Total dissolved solids range from 456 ppm (parts per million) (89, Azzahra, Table 5) to a maximum of 2,010 ppm (17, El Amiria). However, most samples contain less than 1,000 ppm total solids. It may be noted that the most highly mineralized waters were found in the easternmost part of the area (El-Amiria 13, 17, 173 and 226). In every sample taken, calcium and magnesium are high relative to sodium.

Most of the samples from Azzahra and Annasira contain from 150 to 250 parts of bicarbonate, sulfate and chloride as may be seen from inspection of table 5. Chloride is low, around 50 ppm, in three of these samples and in one both sulfate and chloride exceed 300 ppm. Most of the waters

Table 5. Analyses of ground waters in the Azzahra - Annasira - Al Amira area, Tripolitania, Libya

(Results expressed in parts per million. Analyses by Agriculture and Water Resources Laboratory, LAJS, at Sidi Mesri, Tripoli, Libya)

Well No.	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Hardness (as $CaCO_3$)	Dissolved solids	Spec. conductance (at 25°F.)	SAR
Azzahra													
2	15	114	53	128	8	203	252	252	23	519	1004	1430	2.5
21	16	81	33	82	11	169	128	167	21	339	654	950	2.4
37	16	148	59	75	6	170	89	149	26	294	562	920	1.4
52	16	69	15	75	5	173	89	131	..	286	556	..	2.4
63	17	76	26	83	3	185	118	131	20	297	610	940	2.5
74	16	66	19	65	5	163	50	131	26	245	472	810	2.0
89	17	54	22	60	5	161	43	114	27	224	456	690	2.0
93	14	59	21	64	4	161	51	114	63	231	464	737	2.0
102	14	71	31	95	5	174	148	138	40	303	628	995	2.6
117	14	71	31	102	5	165	148	152	63	303	683	1053	2.9
148	14	125	68	159	8	214	309	294	40	591	1169	1755	3.2
Annasira													
14	14	75	39	98	6	165	214	135	63	348	746	1053	2.5
55	14	65	37	87	6	159	148	246	63	316	678	995	2.5
89	16	75	23	82	4	151	66	152	..	282	600	...	2.3
122	14	92	70	122	8	157	353	328	63	517	978	1463	3.8
128	14	103	51	130	7	187	272	270	40	467	966	1404	2.7
144	14	105	33	101	5	170	216	170	63	398	794	1170	2.3
167	14	69	30	83	4	160	110	135	63	296	600	936	2.2
181	14	80	31	92	5	161	147	149	63	328	704	1053	2.3
190	14	81	34	89	5	172	176	153	63	340	682	1053	2.2
Al Amiria													
3	17	78	32	88	5	183	116	167	27	329	660	1040	2.2
13	17	185	123	228	9	339	583	385	..	971	1089	2340	3.4
17	20	216	103	262	10	331	652	408	20	966	2010	2570	3.8
65	15	101	47	113	8	197	175	234	28	445	844	1360	2.5
58	15	148	59	142	6	250	285	287	26	612	1134	1650	2.5
173	14	177	102	194	8	373	547	305	40	863	1718	2223	2.9
200	14	177	102	148	6	258	370	445	40	623	1228	1755	2.2
226	17	171	92	186	6	365	484	298	40	805	1550	2106	2.9

from Al-Amira contain more of these constituents. Two waters analyzed contain more than 400 ppm of chloride and three contain more than 500 ppm of sulfate.

The suitability of the waters for irrigation can be shown by plotting the analyses on the diagram developed by the U.S. Salinity Laboratory (U.S. Salinity Laboratory Staff, p. 80). The sodium-adsorption-ratio (SAR) is determined by the formula

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

in which constituents are expressed in equivalents per million. SAR is plotted on the vertical scale and the specific conductance, which is a measure of the salinity, is plotted on the horizontal scale, as shown in figure 4.

Most of the samples fall in the High Salinity-Low Sodium class. Reference to the diagram showing the use of waters of varying degrees of mineralization (Cederstrom and Bertaiola, p. 149) show that in the Tripoli area such water is used successfully to irrigate oranges, a crop of low salinity tolerance, as well as the other common crops of the area. However, four samples from Al-Amiria have a fairly high specific conductance, 2,106 to 2,570. Two of these four samples fall in the Very High Salinity class and all four of these waters may be unsuitable for such crops as citrus fruits.

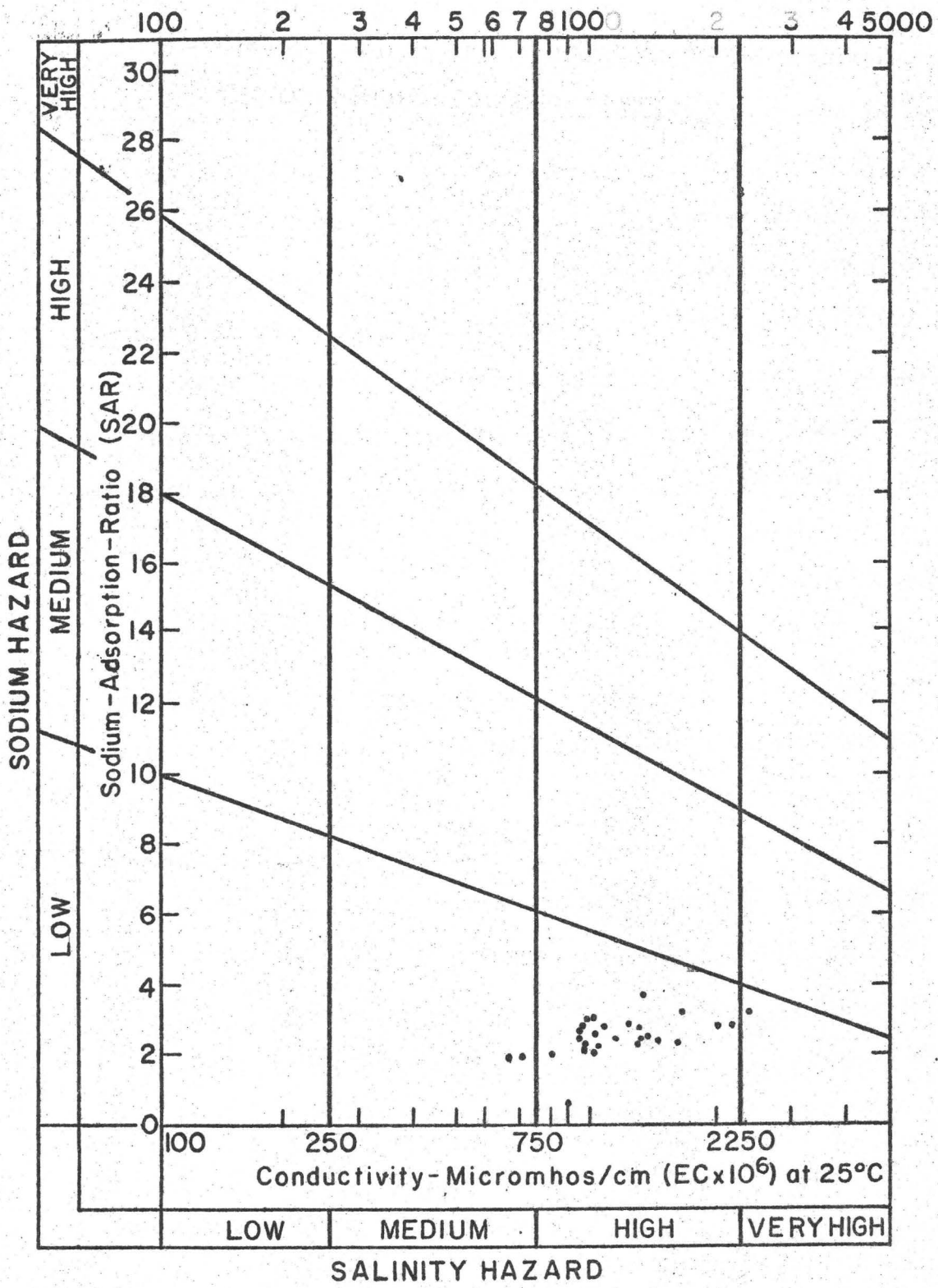

Figure 5. SAR diagram with plot of analyses from the Azzahra-Al-Amira area.

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CONCLUSIONS

The lowering of water levels in the agricultural area has been about 5.5 m. If we assume that the porosity of the 5.5 m of formerly saturated beds is 5%, we see that .27 meters of water has been used. The agricultural area considered is about 150,000,000 square meters. Thus a minimum of 41,000,000 cubic meters of water that was not replaced by rainfall infiltration has been used in that area alone. However, water has percolated in from all directions to the pumping field; hence we may assume that an area of about 8 times the size of the agricultural area has suffered a water level decline of about half of 5.5 meters. Hence the total water from storage (water not replaced by recharge from rainfall) may be over 200,000,000 cubic meters.

The total water discharged in the agricultural area from 1939 to 1959 is estimated to be about 600,000,000 cubic meters. Thus about 1/3 of the water may have been pumped from storage and 2/3 of the total discharge represents recharge from rainfall.

The figure obtained cannot be accurate (except by chance) because it is based on several assumptions. However, it is considered to be a good suggestion of the order of magnitudes involved and may well be a conservative estimate of the amount of water lost from storage.

It may be noted that Cederstrom and Bertaiola (p. 33) suggest that the amount of water pumped from storage in the Gasr Ben Gascir - Suani Ben Adem area may amount to 1/3 of the total. Later, Stuart (p. 20) concluded that about 40% of the water pumped in the Tripoli area was taken from storage.

It has been established that declines of water level are continuing in the amount of 27 to 30 centimeters a year and that the water discharged represents not only recharge from rainfall but loss from storage as well.

As of to-day one may assert that the water present 20 years ago in a 5.5 meter thickness of sand and sandstone formations over an indefinitely wide area is no longer present and no one may suppose that it can be replaced. Rather it is certain that this thickness of water-exhausted strata will increase in thickness from year to year.

It seems clear that continued excessive discharge will almost certainly result in economic consequences difficult to resolve.

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Stuart, Wilbur T., 1960, Significance of decline of ground-water levels in Tripolitania, Libya, as determined by pumping tests, U.S. Geological Survey administrative report, 29 p.

Table 6. Records of Wells in the Azzahra Area, Tripolitania.

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares a Irrigated W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
1	Dalfino, Augusto	71.70	25.4	1954	11.63	March 58	40	3	5 - 3	45.000	-
2	Fortini, Giovanni	71.26	49.6	1936	11.46	March 58	30	2.5-3	4	60.000	1953-4 m
6	Merola, Michele	-	35.2	1936	10.95	March 58	36	3	7 - 13	168.000	1950-3 m
7	Sardella, Ottavio	72.33	34.4	1938	12.94	September 59	34	2.50	4	60.000	1951-3 m
9	Cavallucci, Alberto	73.69	25	1938	14.16	September 59	30	2.50	10	150.000	1957-4.5 m
10	Milani, Massimiliano	73.69	32.17	1939	12.60	March 58	30	2.50	9 - 10	145.000	1950-3 m
17	Polidori, Alfredo	74.66	-	1938	13.91	September 59	30	3	8	120.000	1957-5 m
19	Brisotto, Severino	75.76	32.3	1957	13.83	September 59	38	1.5	10	150.000	-
20	Fiorito, Angelo	75.64	39.4	1936	13.56	September 59	30	3	8	120.000	1954-4 m
21	Mastrogiacomo, Vito	-	16.9	1940	12.46	March 58	22	3.5	7	105.000	1954-4 m
21a	Mastrogiacomo, Vito	74.83	31.8	1947	11.34	March 58	40	3	13	195.000	-
26	Scorrano, Angelo	76.96	40.3	1937	13.11	October 59	36	3	4 - 2	40.000	1957-3 m
27	Mezzi, Angelo	77.09	29.7	1937	12.95	October 59	33	2.5	3 - 4	55.000	1957-3 m
28	Tilomelli, Antonio	79.24	20.3	1939	14.75	March 58	40	0.60	6 - 9	120.000	1956-3 m
29	Pozzi, Gildo	76.83	20.6	1937	12.58	March 58	25	3	2 - 1.5	25.000	1953-2.8 m
37	Blo, Agostino	85.01	29.4	1941	18.99	October 58	33	1.5	5	75.000	1955-5.5 m
39	Cavalin, Giovanni	83.71	42.9	1936	19.16	October 58	30	3.6	2 - 3	40.000	1952-3 m
40	Paladin, Antonio	82.74	24.2	1939	18.53	September 58	40	3.5	5	75.000	1954-4 m
42	Guiduzzi, Erminio	78.42	23 ?	1936	14.47	October 58	30	2	3	45.000	1956-4 m

Table 6. Records of Wells in the Azzahra Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
44	Giannone, Giovanni	73.89	51.2	1936	11.48	October 58	40	2	5	75.000	-
45	Damini, Attilio	73.65	30.5	1936	11.16	March 58	35	4	2 - 2	30.000	1957-4.1 m
46	Pin, Antonio	75.36	32.2	1936	12.43	October 58	30	3	4	60.000	1954-3 m
47	Andreola, Felice	78.47	22.3	1936	14.93	October 58	40	2.5	3	45.000	1956-2 m
48	Guidoreni, Federico	78.30	30.6	1937	15.14	September 59	28	3.5	2 - 2	30.000	1958-4 m
49	Gava, Ottavio	79.19	28	1937	15.61	October 59	31	4	2 - 4	50.000	1954-4 m
50	Zanesco, Giovacchino	-	36	1936	-	February 58	20	4.5	1.5 - 2	30.000	1957-5 m
50a	Zanesco, Giovacchino	80.60	35.3	1957	15.86	February 58	38	2	4	60.000	-
51	Cavalin, Giuseppe	82.09	23.1	1939	17.25	April 58	32	1	3 - 4	55.000	1951-3.5 m
52	Zanesco, Erminio	85.86	24.2	1936	20.11	October 58	33	2.7	7	105.000	1954-4 m
56	Schito, Sebastiano	-	42.3	1939	17.23	April 58	27	2	5 - 6	85.000	1954-3 m
56a	Schito, Sebastiano	-	34.5	1957	17.34	April 58	55	2.8	7 - 8	115.000	-
59	Perri, Antonio	77.52	32.3	1937	14.03	October 59	32	2.2	2 - 2	30.000	1954-4.5 m
60	Delfiho, Giacomo	-	26.77	1938	13.61	April 58	32	3	3 - 3	45.000	1956-5 m
63	Cucciccello, Lorenzo	-	19.3	1937	12.58	March 58	35	3	4	60.000	1957-4 m
66	Schito, Antonio	-	-	1937	12.02	March 58	40	3	3	45.000	1950-3.5 m
66a	Schito, Antonio	-	30	1956	12.6	56	30	-	4	60.000	-
68	Afanetti, Sebastiano	-	36.6	1937	-	April 58	40	3	14 - 7	140.000	1956-3.6 m
74	Mellacina, Uber	-	26.8	1938	-	April 58	26	3	4 - 6	80.000	? 4 m

Table 6. Records of Wells in the Azzahra Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
79	Migliore, Antonio	-	-	1939	-	September 58	35	2.5	6	90.000	1958-6 m
80	Migliore, Giorgio	74.48	40.2	1942	14.33	October 59	40	2.5	7 - 5	85.000	1952-2 m
80a	Migliore, Giorgio	-	29.3	1957	13.45	February 58	40	3	7 - 5	85.000	-
86	Dell'Ungaro, Angelo	-	32	1939	12.90	February 58	40	3.5	5 - 10	125.000	1956-4 m
89	Diene	-	32.4	1957	11.98	February 58	30	1.5	4	60.000	-
91	Dimitrio, Pietro	-	32.5	1958	10.72	September 58	40	2.5	15	225.000	-
93	Nuri, Sadik	-	34.5	1939	10.02	September 58	40	2	3	45.000	1957-5 m
102	Migliaro, Rosario	69.10	48.6	1939	14.30	October 59	28	3	5	75.000	1958-6.3 m
103	Hamed, Suri	70.60	43.1	1939	16.35	September 58	25	2	3	45.000	1953-3 m
104	Bardelle, Emilio	69.28	-	1939	15.33	October 59	35	3	2.5 - 4	52.000	1957-3 m
106	Tine Paolo	-	38.7	1939	16.19	February 58	30	2.5	4 - 5	70.000	1954-4 m
106a	Tine Paolo	-	28.8	1957	12.16	February 58	45	2	6 - 12	150.000	-
112	Silverio, Fabio	-	43	1939	15.58	February 58	30	2	2 - 4	50.000	1952-3 m
113	DeFranceschi, Antonio	-	30.7	1939	16.19	February 58	30	2.5	3.5 - 7	90.000	1954-4 m
117	DalFiho, Guido	-	29.2	1939	13.14	February 58	30	3	2.5 - 5	62.000	1952-4 m
120	Ricci, Primo	-	28	1939	13.80	February 58	30	2	3 - 2	35.000	1956-5 m
120a	Ricci, Primo	-	30.2	1956	15.51	February 58	70	4	3 - 10	115.000	-
123	Agosta, Corrado	-	28.9	1939	16.93	February 58	33	-	2 - 1.5	22.000	1956-3.2 m
133	Campailla, Guglielmo	-	39.2	1939	16.08	September 58	38	3	2	30.000	1954-4.5 m

Table 6. Records of Wells in the Azzahra Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated[a] W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
133a	Campailla, Guglielmo	-	-	1958	-	September 58	35	3	9	100.000	-
148	Cancian, Pietro	-	27.5	1937	13.20	March 58	25	2	2 - 2	30.000	1955-3.2 m
158	Giani, Giovanni	-	21.1	1938	17.32	March 58	30	2	3	45.000	1954-3.6 m
163	Carallini, Rino	-	-	1938	18.95	March 58	25	2.5	2 - 3	40.000	1955-3 m
163a	Carallini, Rino	-	31	1957	18.75	March 58	50	2	8 - 11	150.000	-
164	Branker, Luigi	-	30.9	1938	18.51	March 58	20	3	2 - 1	20.000	-
172	Guesato, Luigi	-	20.3	1937	14.04	March 58	16	8	3 - 4	45.000	1957-4.3 m
173	Pertile, Giuseppe	-	18	1938	11.61	March 58	33	3	2.5 - 2.5	40.000	1955-4 m
153	La Penna	-	21.8	1938	17.49	March 58	25	3	4	60.000	1957-3 m
153a	La Penna	-	26	1957	17.95	March 58	60	3	7 - 9	125.000	-

a/ Hectares irrigated - "W" refers to 4 winter months and "S" to 8 summer months irrigation.

Table 7. Records of Wells in the Annasira Area, Tripolitania

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated[a] W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
2	Zantedeschi, Giuseppe	-	34.6	1938	16.57	March 58	36	3	6	90.000	1954-5 m
3	De Michele, Oronzo	-	25.9	1956	19.21	March 58	30	3	8 - 8	120.000	-
8	Bertelli, Aurelio	-	19.7	1938	15.89	March 58	20	1.5	2	30.000	1949-4 m
8a	Bertelli, Aurelio	-	31.6	1957	15.17	March 58	40	1.7	7	105.000	-
14	Mazzuccato, Giovanni	-	39	1939	23.41	February 58	25	2	3	45.000	-
16	Pedrini, Giuseppe	-	20.7	1938	18.15	March 58	30	3	10	150.000	1955-7 m
17	Durian, Fiorino	-	41	1939	15.69	February 58	30	3.5	3 - 2	35.000	1954-4 m
18	Cancian, Giovanni	-	25.1	1939	19.00	February 58	16	2	2 - 1	20.000	-
19	Consolaro, Rino	-	32	1939	16.69	February 58	40	3.7	2 - 2	30.000	1954-4 m
20	Peretti, Leone	-	36.1	1939	21.81	September 58	30	2.2	4	60.000	1955-3 m
23	Moleha, Carolina	-	45.5	1939	18.80	September 58	33	2	5	75.000	1953-3.6 m
30a	Scifo, Giovanni	-	37.8	1957	17.2	1957	30	-	5	75.000	-
36	Corbonese, Emilio	-	31.3	1938	17.58	March 58	27	3	2 - 1.5	25.000	1954-4 m
37	Corbonese, Giovanni	-	26.8	1939	17.15	March 58	40	2.5	2 - 2	30.000	1954-3.5 m
40	Frazzato, Modesto	-	32.8	1939	16.93	February 58	30	3.5	6 - 7	100.000	1955-4.5 m
42	Nezzo, Alfonso	-	22.3	1940	16.36	February 58	40	1.4	2 - 2	30.000	1955-3.2 m
44	Previati, Giacomo	-	30.4	1939	17.04	February 58	25	3	2 - 1.5	25.000	1957-6 m
47	Guzzon, Giovanni	-	30.5	1954	14.37	February 58	45	1.9	3 - 2.5	40.000	-
49	Pacelli, Guglelmo	-	33.1	1939	17.00	February 58	30	2	4	60.000	1951-3.5

Table 7. Records of Wells in the Annasira Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares a Irrigated W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
49a	Pacelli, Guglelmo	-	31.4	1956	15.26	February 58	35	3	8 - 8	120.000	-
51	Molea, Giuseppe	-	21.2 ?	1939	16.71	January 58	25	2	3	45.000	1955-3 m
54	Fidone, Guglielmo	-	28.8	1938	16.81	January 58	25	2	2	30.000	1956-4 m
63	Apostoli, Giovanni	-	26.8	1937	17.52	April 58	30	2	4 - 2	40.000	1955-4 m
72	Rigon, Ferruccio	-	31.1	1938	16.74	April 58	30	2.5	6 - 5	80.000	1955-4 m
73	Refaho, Marcello	-	-	1939	17.42	April 58	31	3	4 - 3.5	55.000	1956-5 m
78	Bisol, Mario	-	25.5	1939	18.81	March 58	40	2	5	75.000	1956-4 m
79	Rigon, Lorenzo	-	26.9	1939	19.75	March 58	25	3.5	1 - 1	15.000	1954-3.2 m
80	Bevilacqua, Hatale	-	37.5	1939	19.48	March 58	30	2.8	2 - 2	30.000	1953-3 m
81	DoHo, Ehore	-	36.2	1938	20.57	March 58	28	3	4 - 5	70.000	1957-6 m
83	Stevanato, Gabriele	-	33.2	1938	17.50	March 58	30	1.5	4 - 2.5	45.000	1956-4.2 m
85	- -	-	32.5	1957	17.2	March 58	-	3.4	4	60.000	-
86	Bongiovanni, Orazio	-	36.3	1938	20.34	March 58	18	4	1 - 1.5	20.000	-
89	Finazzo, Paolo	-	30.5	1938	20.51	March 58	20	3	2 - 1.5	25.000	1958-3 m
97	Magri	-	31.5	1939	15.59	March 58	33	2.5	4	60.000	1958-2.8 m
101	Pomeho, Mario	-	30.5	1939	17.10	January 58	30	2	2.5	35.000	1956-3.6 m
102	Delmastro, Alindo	-	29.7	1939	16.40	January 58	22	1.5	2	30.000	-
103	Codemo, Alvise	-	23.6	1940	18.53	January 58	25	1.5	2 - 2	30.000	-
105	Marcoto, Cesare	-	31.3	1938	18.58	March 58	27	3	2 - 1.5	25.000	1956-3 m

Table 7. Records of Wells in the Annasira Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated[a] W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
107	Baiamonte, Salvatore	-	30.2	1939	17.99	March 58	20	2.8	1.5 - 1	15.000	1958-4 m
108	Stocco, Anna	-	30.5	1938	18.39	March 58	42	3	2 - 2	30.000	1956-4 m
109	Scomparin, Giuseppe	-	29.9	1957	20.27	March 58	45	2	1 - 10	105.000	-
113	Momesso, Luigi	-	27.8	1939	19.09	March 58	33	1.5	2 - 2	30.000	1956-3 m
116	Pertile, Santo	84.53	46.1	1937	17.29	March 58	33	3.5	2 - 2	30.000	1957-3.2 m
121	Rosseho, Riccardo	-	33.2	1939	15.72	March 58	31	2	2 - 2	30.000	1955-2.5 m
123	Pomeho, Mario	-	26.8	1939	17.19	January 58	30	2.5	12	180.000	-
124	Freg, Mohamed	-	21	1939	17.13	January 58	30	3	2.5	35.000	1958-4 m
128	Sacilohо, Alfredo	-	36.2	1946	16.93	January 58	34	2	1.5	20.000	-
129	Boscheho, Palmerio	-	23.7	1940	16.77	January 58	33	2	2	30.000	1950-2 m
131	Frizzo, Giovanni	-	25	1939	18.62	February 58	10	2	1	15.000	1958-5.5 m
131a	Frizzo, Giovanni	-	34.4	1958	-	1958	-	-	4	60.000	-
133	Lando, Leontino	-	20.6	1939	18.67	September 58	33	3	5	75.000	1955-3 m
135	Mohamed, Suda	-	47.2	1936	18.00	February 58	25	1.5	3	45.000	-
140	Mercante, Francesco	-	29.1	1939	18.28	September 58	32	3.5	2	30.000	1953-3 m
142	Giuriati, Bruno	-	28.9	1956	13.75	February 58	50	1.8	8 - 13	170.000	-
142a	Giuriati, Bruno	-	29.2	1956	13.93	February 58	40	2	4 - 6	80.000	-
143	Fontanella, Cherubino	-	27.9	1939	14.92	February 58	20	2	1.5 - 2	25.000	-
150	Cavallini, Amedeo	-	32.8	1939	17.30	February 58	25	3	4 - 4.5	65.000	1954-4 m

Table 7. Records of Wells in the Annasira Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated[a] W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
152	Taddio, Luigi	-	32.3	1952	15.44	February 58	33	2	2 - 2	30.000	-
154	Sassi, Amur	-	24.4	1939	15.00	February 58	27	2	2 - 1.5	25.000	1957-3.2 m
155	Zulianello, Giovanni	-	22.3	1939	15.80	February 58	28	3.5	3.5 - 3.5	50.000	1957-4.6 m
161	Perehi, Felice	-	21.2	1939	14.17	February 58	33	2.4	3 - 1.5	30.000	1957-3.1 m
162	Salomone, Rosa	-	30.8	1941	14.92	February 58	30	3.5	10 - 5	100.000	1957-4 m
164 N(a)	Belgassem, Medi	-	22.3	1957	13.75	February 58	30	2.6	2 - 1	20.000	-
164 N(c)	Milud, Ali	-	34.3	1957	16.63	February 58	28	-	1	15.000	-
165(a)	Paternoi, Giuseppe	-	29.8	1939	20.37	February 58	20	-	2.5 - 2.5	35.000	1957-6 m
165(b)	Paternoi, Giuseppe	-	32.9	1954	13.91	February 58	50	5.5	10 - 10	150.000	-
169	Gambarelli, Giuseppe	-	-	1957	-	February 58	70	4	8	120.000	-
170a	Camarco, Nicola	-	33.6	1957	12.80	February 58	52	5.5	6 - 6	90.000	-
171	Branchehi, Emma	-	29.8	1939	15.94	February 58	20	3.3	5 - 1	35.000	1958-6.7 m
171a	Branchehi, Emma	-	35.6	1957	14.58	February 58	35	2.7	5 - 5	75.000	-
173	Bidone, Giovanni	-	42.2	1939	17.00	February 58	25	3	1.5 - 1.5	25.000	1955-3 m
177	DeFranceschi, Silvano	-	38	1957	15.20	February 58	-	-	4	60.000	-
179	Bidone, Giovanni	-	46.4	1940	11.40	February 58	25	4.6	5 - 7	95.000	1957-3 m
185	Pavani, Giuseppe	-	22.1	1939	20	January 58	25	7	1.5	20.000	-
186	Pernigohi, Giuseppe	-	50	1956	20.1	January 58	50	5	10	150.000	-
189	Saad Massaud	-	33.9	1939	18.45	February 58	25	-	3.5	50.000	-

Table 8. Records of Wells in the Al Amiria Area, Tripolitania (continued)

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
3	LaBagnara, Filippo	-	-	1939	-	March 58	30	2.5	2 - 2.5	35.000	1950-4 m
7	Pegoraro, Arturo	-	26.7	1938	22.92	March 58	35	3	2.5 4	50.000	1958-4.2 m
13	Rizzi, Guido	-	34	1939	22.5	February 58	33	1	5	75.000	-
15	Tatone, Rubina	-	27.5	1941	22.84	February 58	18	1	1.5	20.000	-
17	Rizzo, Domenico	-	26.7	1941	22.72	February 58	32	1.5	3 - 2	35.000	-
18	Ruberti, Francesco	-	26.7	1940	22.79	February 58	30	1.8	3	45.000	-
24	Belfiore, Ernesto	-	30.1	1938	20.79	March 58	25	2	2 - 2	30.000	-
25	Rizzi, Lgnazio	-	30.5	1938	19.85	March 58	33	-	2 - 2.5	35.000	-
33	Pegoraro, Giuseppe	-	33.8	1939	22.63	March 58	40	2.2	2 - 2.5	35.000	1957-3.5 m
34	Ciaglia, Giovanna	-	33.8	1939	22.51	March 58	38	3	3	45.000	1956-4 m
36	Marinelli, Alessandro	-	32.6	1938	19.33	March 58	40	2.5	3	45.000	1956-3 m
37	Paio, Ermenegildo	-	27.5	1938	20.23	March 58	22	2.5	2.5 - 1.5	30.000	-
39	Lucente, Alberto	-	24.2	1938	18.00	March 58	40	1.5	5 - 5	75.000	1958-1.5 m
58	Santin, Giovanni	-	30.1	1939	19.73	March 58	16	1.5	1.5 - 1	15.000	-
59	LaCorbona, Giuseppe	-	28.5	1939	19.69	March 58	40	2	3 - 3	45.000	1957-4 m
63	Bovo, Alvise	-	32.5	1939	20.42	March 58	33	1	5 - 5	75.000	1957-3 m
65	Gravina, Raffaele	-	26.8	1939	17.88	March 58	40	2.7	5 - 6	85.000	1956-3 m
65a	Gravina, Raffaele	-	28.4	1959	18.51	March 58	45	3	5 - 9	115.000	-
79	Marinelli, Mario	-	31.6	1939	20.70	March 58	36	2.5	3.5 - 2.5	40.000	1956-4

Table 8. Records of Wells in the Al Amiria Area, Tripolitania

Lot Number	Owner	Elevation (Meters)	Depth (Meters)	Year	Water Level (Meters)	Date	Yield (cubic meters per hour)	Drawdown (Meters)	Hectares Irrigated[a] W - S	Annual Discharge (cubic meters)	Avampozzo Deepened
97	Neve, Giovanni	-	33.8	1938	19.76	March 58	45	3	2 - 2	30.000	1957-4.7 m
99	DiCarlo, Donata	-	25.3	1938	17.63	March 58	30	2.5	3 - 3.5	50.000	1957-3 m
105	Barzini, Llario	-	42	1937	18.3	March 58	22	2.5	2 - 2	30.000	-
106	Lodise, Maria	-	29.9	1937	16.98	March 58	40	3	1.5 - 2.5	30.000	1957-3 m
110	DeGivli, Givlio	-	31.8	1938	17.19	March 58	33	2	2 - 2	30.000	1957-4 m
115	Musba, Aiad	-	32.9	1938	20.24	March 58	18	3	1	15.000	-
155	Muffato, Abramo	-	27.8	1938	20.83	March 58	30	2.5	4	60.000	-
161	Pignaf, Aliseo	-	33.1	1938	19.62	March 58	20	1.5	1.5 - 1.5	20.000	-
165	Gaglio, Giuseppe	-	31.9	1938	17.98	March 58	40	3.5	3 - 3	45.000	1956-4 m
167	Molena, Ohorino	-	28.3	1938	17.37	March 58	30	3	3 - 2	35.000	1950-3 m
169	Stievano, Antonio	-	35	1957	18.2	March 58	30	5	4	60.000	-
170	Favalli, Albino	-	29	1938	22.19	March 58	32	3	3	45.000	1957-4 m
173	Milan, Giovanni	-	29.5	1938	21.50	March 58	20	-	2	30.000	-
200	Artico, Pietro	-	29.5	1938	17.85	March 58	22	1.5	2.5	35.000	-
204	Peron, Romeo	-	33.1	1939	19.57	March 58	40	5	2.5	35.000	1955-3.6 m
226	Peron, Ahilio	-	24	1938	20.14	March 58	30	1.3	2	30.000	1957-4.5 m

a/ Hectares irrigated - "W" refers to 4 winter months and "S" to 8 summer months irrigation.

L'ACQUA DEL SOTTOSUOLE NEL AREA DI AZZAHRA

ANNASIRA, E DI AMIRIA, TRIPOLITANIA

di

Mario Bertaiola

L'area descritta in questo rapporto comprende i villaggi di Azzahra (ex Bianchi), Annasira (ex Giordani) e Amiria (ex Micca), per una superfice di circa 17,000 ettari compresa nella Latitudine 32° 41' Nord, 32° 35' Sud e nella longitudine 12° 48' Ovest e 13° 00' Est. Nel rapporto e' acclusa una carta dell'area su indicata.

Lo studio dell'attuale sfruttamento idrico e di conseguenza i possibili mutamenti di livello statico, ricarico, variazioni chimiche della qualita' dell'acqua ecc. sono gli scopi di questo rapporto.

A tale fine sono state prese tutte le informazioni possibili presso: 1) gli uffici del I. N. P. S., da cui dipendevano tali villaggi, 2) da privati interessati nelle perforazioni, 3) da documenti del ex Ufficio Idrografico Italiano, 4) tutti gli altri dati necessari sono stati rilevati sul posto.

Sono stati rilevati oltre 350 pozzi dei 600 - 650 presumibilmente esistenti; al rapporto e' acclusa una carta con la locazione dei pozzi.

NATURA DEL TERRENO.

Per una profondita' di 10 - 15 Km. dalla costa il terreno si presenta sufficentemente consolidato, mentre inoltrandosi per altri 20 - 25 Km. il territorio e' generalmente costituito da una spessa coltre di sabbia prevalentemente di origine eolica. La natura di questa spessa coltre e' in massima parte dovuta allo disgregarsi delle rocce del Gebel e che da questo vengono continuamente portate a valle dalle acque e dai venti.

La superfice di queste zone e' in parte piana ed in parte collinosa. Le zone collinose sono dovute a vecchie dune di origine eolica ora in massima parte consolidate dalla vegetazione spontanea o dalle colture. In genere l'altezza di queste colline varia dai 15 - 25 m. Esistono inoltre zone di dune di recente formazione dove non e' possibile ottenere delle buone coltivazioni, grazie pero' a spianamenti meccanici molte di queste aree vengono trasformate anno per anno in zone coltivabili.

L'area coltivata ad irriguo si aggira sui 3000 - 3500 ettari, irrigati in parte a scorrimento e in parte con sistemi a pioggia artificiale, questo ultimo sistema va gradualmente sostituendo il metodo a scorrimento.

Circa 2000 - 2500 si possono considerare zone non coltivabili per il terreno troppo accidentato o per la presenza di fasce di dune mobili.

Buona parte dei restanti 10,000 ettari sono sfruttati con colture del tipo a seccagno. Il terreno agli effetti dell'agricoltura e' sufficentemente buono ed aiutato con appropriati fertilizzanti da ogni genere di prodotto: grano, orzo, arachidi, erba medica, piselli, patate, fave, cipolle, pomodori, arranci, limoni, mele ecc.

La popolazione rurale e', grosso modo, calcolata sulle 4000 - 4500 unita'.

CLIMA E PRECIPITAZIONI

Il clima e' da considerarsi steppico littoraneo, quindi senza eccessivi sbalzi di temperatura tra il giorno e la notte e dove la media delle temperature non differisce di molto da quelle di Tripoli (Vedi Tabella 1). Per le temperature in ogni modo non si hanno dati attendibili.

Per le precipitazioni la sola stazione di Azzahra e' quella che ha maggior continuita' di dati (Vedi Tabella 2) e da una media annua di 205m/m di precipitazioni. Si ritiene che anche per Annasira e Amiria possano far fede i dati di Azzahra.

CENNI GEOLOGICI

La natura quaternaria di queste zone e' di origine continentale, eolica quella superficiale fino a 25 - 35 m. e alluvionale quella piu' profonda. La stratificazione e' piuttosto caotica, predominano le sabbie in genere poco compatte quindi facili a franare. In genere lo strato acquifero e' costituito da sabbie piu' o meno grosse o da arenarie.

L'ACQUA DEL SOTTOSUOLO

La profondita' dei pozzi in queste area varia da un minimo di 17 m. per il No 21 di Azzahra ad un massimo di 77 m. per il No 136 di Annasira.

La media delle profondita' su 236 pozzi misurati e' di M. 31.

I pozzi esistenti in questa area, come del resto la massima parte dei pozzi trivellati della Libia, sono tutti muniti di avampozzo, il cui fondo in origine si fermava a poche decine di centimetri dal pelo dell'acqua.

Dal centro dell'avampozzo inizia la perforazione.

L'acqua viene portata alla superfice a mezzo di elettro-pompe centrifughe. Lo strato acquifero e' per massima parte contenuto in sabbia o arenaria porosa. Spesso si hanno fastidi in molti di quei pozzi la cui falda e' contenuta in sabbia. Il problema dei filtri non e' stato risolto, per cui molti pozzi dopo un certo periodo di erogazione di acqua mista a sabbia franano in maniera irreparabile. L'agricoltore e' quindi costretto a perforare un nuovo pozzo, le cui caratteristiche tecniche non sono pero' molto differenti da quelle usate in precedenza e di conseguenza e' da prevvedere che dopo un certo periodo di sfruttamento si ritrovino nelle medesime condizioni. Per i pozzi la cui falda e' in arenaria le condizioni sono migliori, difficilmente si hanno franamenti e, se l'arenaria e' porosa, l'erogazione di acqua in genere e' abbondante.

Attualmente la media delle profondita' dell'acqua dalla superfice del suolo e' di m. 16, media ottenuta su 232 pozzi rilevati.

La media di erogazione su 320 pozzi e' di mc/hr 30 con un abbassamento medio di m. 2,70.

Il pozzo con il massimo scaricamento e' il no. 120 Azzahra - questo da 70 mc/hr con un abbassamento di 4 m. Tuttavia, il pozzo piu' efficiente e' il no. 28 Azzahra con uno scaricamento di 4 mc./hr e un abbassamento di 6 cm. L'attivita' agricola in queste zone ebbe inizio nel 1938-39 e l'energia necessaria al sollevamento dell'acqua era fornita dalle centrale elettrica di Azzahra e da quella di Tripoli, le quali non erogavano piu' di 7 - 8 ore di energia al giorno nel periodo estivo, riducendo l'erogazione a 2 -3 ore al giorno nel periodo invernale. Come detto sopra l'attivita' agricola ebbe inizio nel 1938-39, pero' lo scoppio della seconda grande guerra e in seguito per altre ragioni, come l'assenza dei titolari dei poderi, la mancanza di aiuti economici ecc. fecero si che praticamente

fino al 1949-50 l'attivita' agricola fosse molto limitata. A partire dal 1949-50 si ebbe quindi la ripresa delle coltivazioni e di conseguenza l'intensificarsi dello sfruttamento idrico. Nuovi pozzi vennero trivellati per soddisfare le maggiori esigenze d'acqua, l'energia elettrica erogata per 7 - 8 ore al giorno non era piu' sufficente per cui almeno il 40% degli agricoltori si attrezzarono di un gruppo generatore, portando lo sfruttamento da 7 - 8 ore al giorno a 16 - 18 e nei periodi di punta anche a 24 su 24. Si ha ragione di ritenere che negli ultimi anni lo sfruttamento idrico sia stato il doppio dei primi 10 anni.

A seguito di informazioni prese sul posto, intervistando oltre 350 proprietari di podere, si puo' ritenere che ogni pozzo venga in media sfruttato per nove ore al giorno per sette mesi e per tre ore al giorno per i rimanenti cinque mesi, la media di erogazione di un pozzo e' di circa mc./hr 30, per cui annualmente un pozzo eroga circa mc. 66,000.

Calcolando a circa 600 pozzi esistenti l'erogazione totale annua sara' di circa mc. 40,000,000. Considerando il continuo sviluppo dell' agricoltura e' facile prevedere che nel futuro il bacino idrico sara' sfruttato in maniera sempre maggiore. Da un documento dell'epoca a firma del Sig. C. Borgognoni si hanno alcuni livelli statici di pozzi dell' area di Azzahra. Confrontando tali livelli a quelli attuali (vedi tabella 3) si ha la conferma di quanto era stato rilevato suo posto e cioe' il non indifferente abbassamento di livello statico su tutta l'erea in considerazione. Dai dati dei pozzi sopra elencati a dalle informazioni prese sul posto si puo' considerare che l'abbassamento medio si di circa m. 5,50. La media annua di abbassamento per venti anni si aggira quindi a centimetri 27 circa.

Per meglio osservare l'andamento della profondita' dell'acqua e relativo abbassamento di livello dal 1939 ad oggi sono state rilevate le quote di pozzi, da Nord a Sud (fig.2) e da Est ad Ovest (fig.3). Sono stati considerati pozzi gia' rilevati a suo tempo dal Sig. Borgognoni (1939) ed a questi sono stati aggiunti pozzi di recente trivellazione. Da questi spaccati si puo' osservare come il livello dell'acqua si sia abbassata in maniera quasi uniforme su tutta la superfice presa in considerazione, indipendentemente da quella che e' la profondita' dei pozzi e quindi lo strato aquifero in cui si attinge.

Per i sotto elencati pozzi misurati nell'Ottobre 1958 e rimisurati nell'Ottobre 1959 si hanno i seguenti abbassamenti (vedi tabella 4). Il numero di 15 pozzi su oltre 600 esistenti non e' sufficente a dare una media esatta dell'abbassamento annuo. Essendo pero' questi 15 pozzi dislocati in vari punti dell'area considerata, possono dare una idea approssimata di quello che pup' essere l'abbassamento annuo e che risulta di circa centimetri 33.

Osservando i su menzionati spaccati si nota che la profondita' dei pozzi varia molto anche per pozzi relativamente vicini uno all'altro, mentre non variano o variano di poco i livelli statici, le portate ed i livelli dinamici. Tutto cio' puo' far supporre che tali pozzi attingano ad un unico bacino idrico di notevole spessore in cui lenti di materiale impermeabile rendono varia la profondita' di intercettazione dell' acqua. Per cui le cosi' chiamate falde I II e III appartengono ad un unico bacino idrico. Per il pozzo No. 24 di Azzahra in cui e' stato istallato un Recorder, si hanno i seguenti dati; Nel periodo Settembre-Ottobre si raggiunge il massimo abbassamento annuale, quindi il livello statico dell'acqua comincia a risalire fino a Febbraio-Marzo, periodo in cui si raggiunge il massimo ricarico. In genere il livello dell'acqua risale per quattro mesi su dodici e coincide con il periodo invernale, quando cioe' grazie alle pioggie lo sfruttamento idrico si riduce al minimo. Tale ricarico non e' pero' esclusivamente dovuto all'afflusso di acqua piovana precipitata nel frattempo ma anche (e' forse in maggioranza) ad una naturale forma di livellazione dell'acqua sotteranea dovuta al cessare, temporaneo, di sfruttamento del bacino.

Notato che l' abbassamento e' uniforme su tutta l'area considerata e che cioe' la media di m. 5,5 di declino di livello statico vale sia per i pozzi situati nel centro della zona di sfruttamento, come per quelli posti ai margini, si puo' di conseguenza arguire che l'abbassamento interessa una zona molto piu' vasta di quella presa in esame in questo rapporto. Per cui, ricordando i forti abbassamenti riscontrati nelle zone di Suani ben Aden e Gasr ben Gascir, posti geograficamente alla stessa latitudine e distanti rispettivamente circa 12 e 24 Km.; non e' da escludere che l'abbassamento di livello statico delle zone di Azzahra, Annasira, Amiria, Suani ben Aden e Gasr ben Gascir non faccino parte di un unico fenomeno idrico, rappresentato da un grande cono di depressione.

Qualita' Chimica

La qualita' chimica dell'acqua del sottosuolo e' generalmente buona per l'irrigazione. I dissolvamenti solidi vanno da 456 ppm (parte per millione) (89, Azzahra) fino ad un massimo di 2,010 ppm (17, El-Amira). Cosi' la maggior parte dei campioni contiene meno di 1,000 ppm di solidi. Si puo notare che l'acqua piu' mineralizata e' situata all'estremo est dell' area (El-Amira 13, 17, 173, 226.)

In quasi tutti i campioni il calcio ed il magnesio sono molto alti, relativalmente al sodio.

La maggioranza dei campioni da Azzahra a Annasira contiene da 150 a 200 parte di bicarbonato, solfato e cloruro, come si e' visto nella ispezione della tavola 5; il cloruro e' basso, circa 50 ppm in tre di questi campioni, e' in un quarto campione il sulforo e il cloruro superano 300 ppm. La maggioranza dei campioni dell'acqua dell' Amira contengono di piu' di questi tre constituenti. Due campioni dell' acqua analizati contengono piu' di 400 ppm di cloruro, e tre contengono piu' di 500 ppm di solfato.

L'adattabilita' dell'acqua per irrigazione, si dimostra mettendo i dati dell'analisi nel diagrama sviluppato dai Laboratori sulla Salinita' degli Stati Uniti (U.S. Salinity Laboratory Staff, p 80). Si determina la proporzione adsorbimento-sodio dalla formula

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

I costituenti si devono usare in "equivalenti per mille" e si prepara un grafico usando i valori SAR come ordinate e la conducibilita' specifica, con la quale si misura la salinita', come ascissa- (Fig. 4). La maggioranza delle acque analizate si trova nella classe di Alta Salinita'-Basso Sodio.

Il diagrama che mostra l'uso delle acque delle varie classe (Cederstrom and Bertaiola, p.149) si e' stato presentato per la zona di Tripoli; tale acqua si usa con grande successo per l'irrigazione delle arancie, che hanno una bassa tolleranza di salinita', e anche per i comuni raccolti della zona. Tuttavia, quattro campioni dell'Al-Amira mostrano una conducibilita' specifica abbastanza alte, da 2,106 a 2,570. Due di questi quattro campioni si trovano nella classe di Salinita' Molto Alta, e crediamo che queste acque non siano adatte per l'irrigazione delle arancie.

Conclusione

L'abbassamento del livello statico nell'area coltivata era approssimativamente 5.5m. Se si assume che le falde gia' saturate hanno una porosita' del 5% si e' visto che lo scapito d'acqua ammonta a .27 m. L'area coltivata e' circa 150,000,000 metri quadrati e in questa zona si e perso 41,000,000 m.cu. d'acqua soltanto. Tuttavia, l'acqua e' entrata da molte direzioni verso il campo di scaricamento e percio' possiamo assumere che abbracci un areo 8 volte piu' grande della zona Azzahra-Annasira-Al Amira- e che abbia subito un abbassamento della meta' di 5.5 m. Percio' l'acqua totale che non e' integrata sia forse di piu' di 200,000,000 metri cubi.

Si valuta che l'acqua scaricata nell'area coltivata, dal 1939, fino 1959 ammonti a 600,000,000 m. cu., percio' un terzo dell'acqua pompata e' stata persa nel "deposito". Non e' possibile che la conclusione sopra citata sia "corretta", salvo che per caso, perche' (per la mancaza dei dati completi) abbiamo usato diverse supposizioni che possono essere o non essere vere, consideriamo che fornisca un idea della quantita' implicata, ed e' forse un apprezzamento conservativo.

Si puo notare che Cederstrom e Bertaiola (p.33) suggeriscono che nell'area del Gaso Ben Gascio-Suani Ben Adem un terzo del'acqua pompata sia stata persa nel "deposito". In altro luogo Stuart (p.20) ha concluso che circa 40% dell'acqua pompata nell'area di Tripoli non sia stata restituita dalla pioggia.

Accertato che gli abbassamenti sono continui e cioe' anno per anno il livello statico declina di centimetri 27-30 si conclude che non solo viene sfruttata tutta l'acqua dovuta alle precipitazioni annuali che vanno a rinvigorire la falda, ma anche il bacino stesso, cio' che si dovrebbe considerare un patrimonio in cui attingere con prudenza, viene invece ad essere continuamente e fortemente intaccato.

A tutt'oggi si puo' asserire che per queste aree l'acqua esistente 20 anni fa nelle arenarie e nelle sabbie acquifere per uno spessore di oltre m. 5,5 e per una area non facile a calcolarsi oggi non esiste piu', e niente fa supporre che possa essere riintegrata, mentre e' certo che questo spessore di prosciugamento vada anno per anno aumentando.

Lo sfruttamento eccessivo a lungo andare creera', quasi sicuramente, delle conseguenze difficili da risolvere anche dal punto di vista economico oltre che da quello tecnico per cui un maggior interessamento alla situazione idrica odierna e' piu' che giustificato.

Ground-Water Section
LIBYAN-AMERICAN JOINT SERVICE

TRIPOLI LIBYA

ملخص

تشمل المنطقة الموصوفة في هذا التقرير قرى الظهرة و النصيرة والاميرة الواقعة على بعد ١٥ كيلومتراً تقريباً جنوبي شاطىء البحر الابيض المتوسط و ٢٥ كيلومتراً جنوبي غزي ومدينة طرابلس . وتقدر المساحة الزراعية بـ ٥٥٠٠ هكتاراً منها ٢٥٠٠ هكتاراً تقريباً تحت الري . وقد تم الحصول على المعلومات المتعلقة بـ ٢٥٠ بئراً من جملة الـ ٦٠٠ بئر . ويتراوح عمق هذه الابار من ١٧ الى ٧٧ متراً . ويبلغ ارتفاع المياه فيها ، بوجه عام ، الى عمق ١٦ متراً تقريباً من سطح الارض . ويبلغ معدل انتاج هذه الآبار ٢٠ متراً مكعباً في الساعة الواحدة . وكان اقصى انتاج تم تسجيله ٧٠ متراً مكعباً في الساعة الواحدة . ويبلغ معدل التصريف السنوي لكل بئر نحو ٦٦٠٠٠ متراً مكعباً والمجموع خلال سنة واحدة لهذه المنطقة نحو ٤٠ مليون متراً مكعباً .

وتبين السجلات الدقيقة بان مستوى ارتفاع المياه قد انخفض بمعدل ٥,٥ متراً منذ سنة ١٩٢٩ . ومن سنة ١٩٥٨ الى ١٩٥٩ بلغ الانخفاض ٢٢ سنتيمتراً .

تصلح مياه الآبار هذه من حيث نوعها الكيماوي لاغراض الري . انما ملوحة بعضها قد تكون عالية جداً كي تصلح لري البرتقال .

ان كثيراً من كميات المياه المسحوبة بالمضخات صدرت من مستودعات مياه الخزن الطبيعية التي لن يستفاد عنها بالاوطار . وتدل المعلومات التقريبية بان ثلث هذه الكميات المسحوبة يأتي من هذه المستودعات الطبيعية . وقد قدّر سابقاً السيدان سيدرستروم وبرتيولا في تقريرهما بعنوان « موارد المياه الجوفية لمنطقة طرابلس الغرب، ليبيا » نفس المياه المسحوبة في منطقة قصر بني غير وسواني بن عظم من المستودعات الطبيعية بهذه الكمية نفسها . كما ان السيد ستوارت في تقريره « الحمية انخفاض مناوب المياه الجوفية في طرابلس، ليبيا » الناتجة عن اختبار عمليات السحب » قدر كمية المياه المسحوبة في منطقة طرابلس بـ ٤٠ بالمئة من مجموع المياه المسحوبة بالمضخات .

وزارة الداخلية الأمريكية
مصلحة المساحة الجيولوجية

المياه الجوفية في مناطق الزهرة - النصيرة - الأمرية
طرابلس الغرب

أعدها بالتعاون من قبل
بعثة الأعمال الأمريكية في ليبيا
ومصلحة المساحة الجيولوجية الأمريكية

نشرة إدارية
أبريل
١٩٦١