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UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

SYRIAN ARAB REPUBLIC

AGRICULTURAL DEVELOPMENT OF THE AKKAR PLAIN

PART III - ENVIRONMENTAL ASSESSMENT

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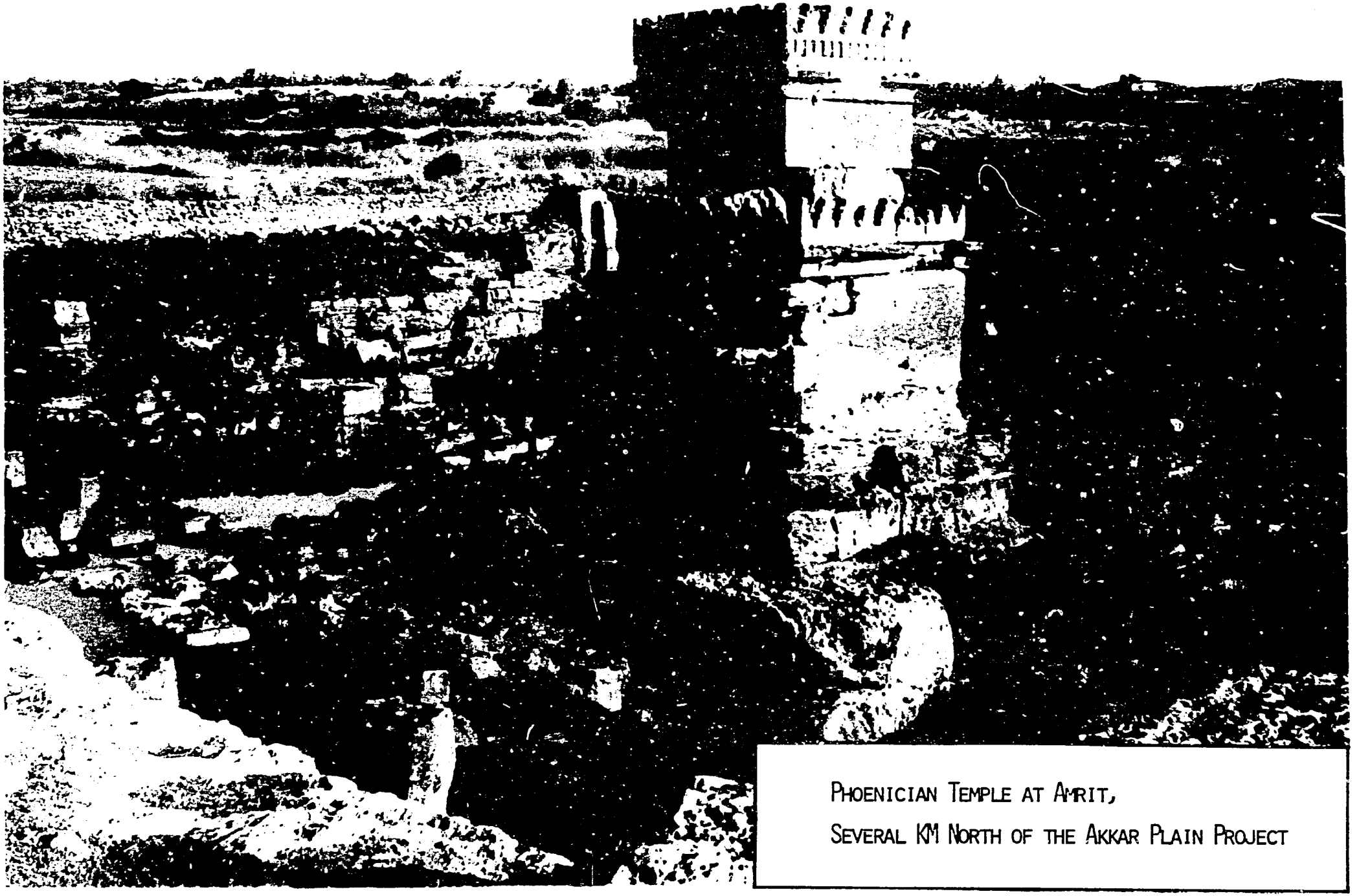

PHOENICIAN TEMPLE AT AMRIT,
SEVERAL KM NORTH OF THE AKKAR PLAIN PROJECT

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ENVIRONMENTAL ASSESSMENT

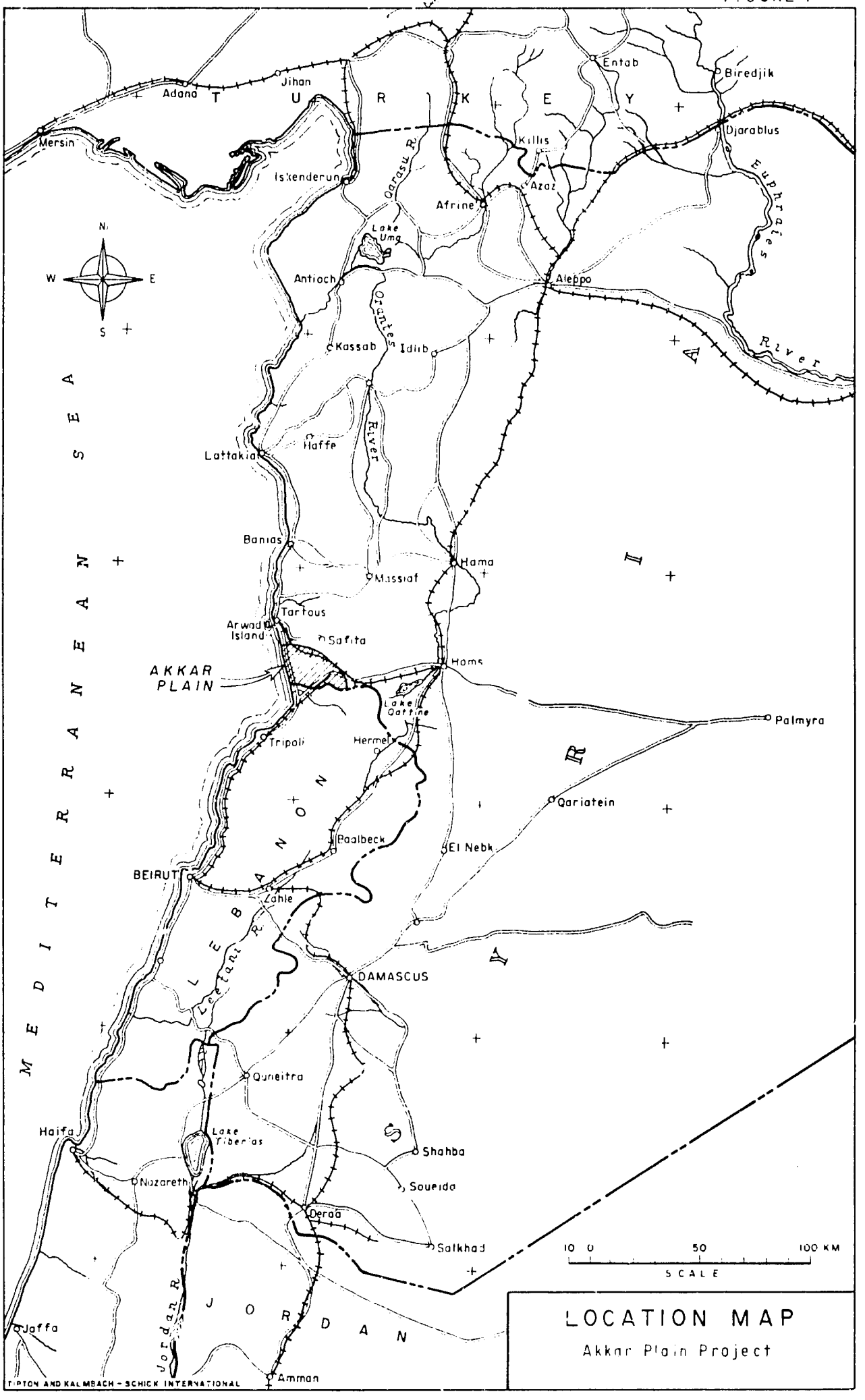
INTRODUCTION

The Akkar Plain is located on the Mediterranean Coast of Syria north of Lebanon. The Janoubi River forms the border between Lebanon and Syria and forms the border of the Akkar Plain on the South, Figure 1. The Plain is generally flat but has some gently rolling slopes and some small hills or mounds called tells, which are actually sites of ancient cities or fortresses. The Plain covers some 23,000 hectares of which 75 percent is presently cultivated on a limited basis.

Agriculture is the main economic enterprise on the Plain but has never been able to reach its full productivity because of the arid conditions occurring during the summer growing season. General field crops are grown on the rain fed areas and intensive vegetable cultivation is practiced where a good water supply is available from open pit wells, drilled shallow wells, and by small diversions of streams and river. The surrounding hills are used for the growing of olives due to good drainage and the low water requirement of the olive trees. The hillsides are also used to some extent for grazing.

Farming practices are semi-modern, although some operators continue using the old conventional methods of farming by draft animals and by hand labor. Some grains are harvested by machine but hand labor remains predominant. The farmers at present have some of the essential inputs to increase their production including fertilizers, quality seeds, good soil, and adequate labor, but they lack the physical factors, drainage, water in sufficient

FIGURE I



LOCATION MAP

Akkar Plain Project

quantity at the right time, accompanying industrial support facilities, and technology for weed, disease, and pest control to help them with their farm cultural practices.

The estimated population of the project area is 18,000 persons, with a density of 81 persons per square kilometer. The project area consists of 32 villages dispersed over the entire Plain. The lifestyle is agriculturally centered with large households, averaging 9.8 persons per household. The people are hard working, with all the family members participating in the farm operation, because most of the farm work is done by hand.

In brief, the climate of the Akkar Plain is arid in summer with heavy rains in winter. There is a drastic contrast in the wet and dry season, with 89 percent of the average annual rainfall coming in a six-month period from October to March. Temperatures in summer are moderately high and during the winter are mild. Being situated on the seacoast, the Plain receives almost a constant sea wind which at times is very strong and damages trees and some field crops. The Plain is also subject to high wind from the east during certain seasons.

At present, the farmers are somewhat restricted as to what they can grow, not so much by the climate, but by other factors. They grow fall grains and good quality vegetables on small areas where they have irrigation, and they have made good selections of varieties. The farmers in general are energetic and willing to work, and when the restraints they now face are removed by implementation of the project, the Akkar Plain will reach its productivity potential.

PROPOSED PLAN OF DEVELOPMENT

The Development Plan outlines a program of project works which, when constructed and placed in operation, will considerably increase the integrated development of water and land resources of the Akkar Plain, Figure 2. The principal features for the development of the land and water resources of the Akkar Plain are:

(1) Channel improvement along the lower reach of the Janoubi River to prevent flooding of cropland;

(2) Surface drains to control excessive precipitation on the entire 23,000 hectares of the Plain and to reclaim the Ramit Laha Swamp for agricultural use;

(3) Diversion of the Abrache River for irrigation after it is regulated by either a dam at Yazdieh, or by a dam on the Abrache River immediately north of the Tartous-Homs highway crossing- either damsite alternative would include the diversion of the Arouse River into the Abrache River drainage basin by a feeder canal;

(4) A canal system designed to carry water to 6,000 to 10,000 hectares of irrigable land on the Akkar Plain;

(5) Drilled water wells in both the shallow and deep aquifers at locations on the Plain that have potential groundwater;

(6) Future extension of the canal system to transfer surface water replaced by the development of groundwater within the original area served from the Abrache River;

(7) Infrastructure facilities necessary to achieve full economic benefits from development of the water resources.

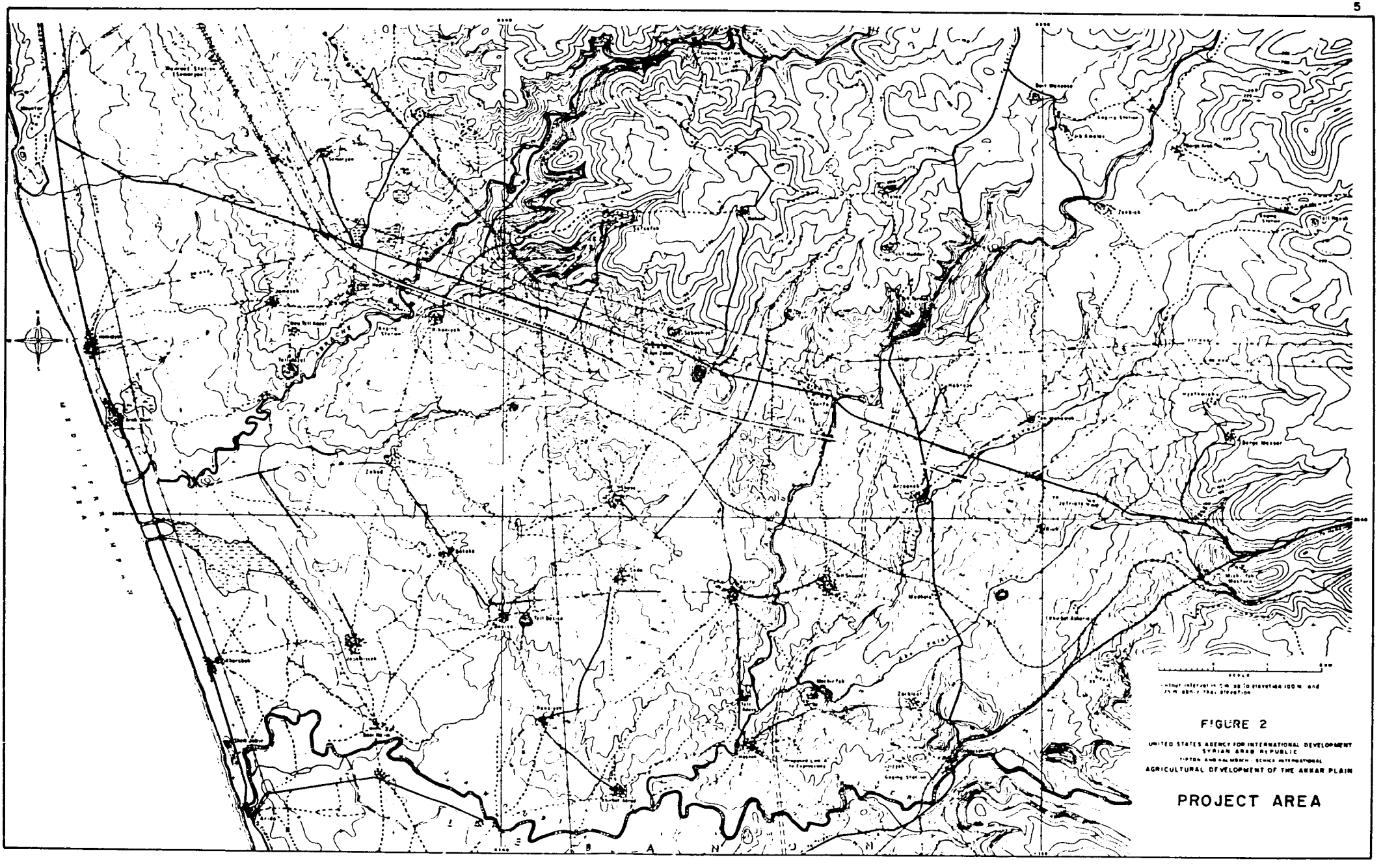


FIGURE 2
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
SYRIAN ARAB REPUBLIC
AGRICULTURAL DEVELOPMENT OF THE AKKAR PLAIN
PROJECT AREA

A plan to bring all seven principal features to completion would involve two phases of work, with the second phase further divided into two stages. Phasing the construction work would facilitate completion of initial segments of the project, which are not dependent on other portions, so that economic benefits would start to flow sooner than may occur if all of the development works were to be initiated together.

Phase I

The initial construction phase consists of channel improvement on the Janoubi River and surface drainage for the entire Plain. These works are interrelated since the Janoubi Channel Improvement would protect the drainage channels from flood damage, and the drainage would increase the benefits from the area protected by the channel improvement by elimination of the Ramit Laha Swamp. There would be no requirement for additional irrigation development or for improvement of the project infrastructure before the start of construction in this phase. However, implementation of the Agricultural Service Center in Phase I is recommended to provide ancillary drainage works and other technological skills related to irrigation development.

Janoubi River Channel Improvement

The channel improvement of the Janoubi River would be the first priority for construction in Phase I development. It is essential that this structure be completed prior to excavation of drainage channels in the Ramit Laha area. The physical construction would require a limited capital investment and would be done by the Syrian Government. Benefits from the channel improvement would be realized the first winter after completion.

Drainage Development

Development of adequate drainage on the entire Akkar Plain could begin

concurrently with construction of the Janoubi River Channel Improvement. Existing drains would be improved and additional drains would be added to provide outlets for surface water from on-farm drainage facilities. Farmers or cooperative groups, under the supervision of the Agricultural Service Center, would be responsible for the construction of grassed channels on their own lands to convey surface water to the main drainage channel developed by the project.

Subsurface drains would be constructed as needed while surface drains were being improved or constructed. The respective subsurface drains would empty into a deep surface drainage channel near the Homs highway and the Abrache River below the proposed diversion for the surface irrigation system.

The improved drainage system would lessen the winter damage to existing roads and would improve the crop yields without the future development of irrigation or infrastructure facilities. Drainage must be provided prior to the development of the surface irrigation systems or before significant quantities of groundwater are utilized for irrigation, because the drains are essential to control the increased application of water that would result from the full development of these water resources. For this reason, the Phase I works have priority over the other development phases.

Phase II

Development of facilities for intensive surface water and groundwater irrigation would be completed in this phase. Because of the complexity of the water resource development, it was divided into Stage I for surface water and Stage II for groundwater development, but the two may proceed concurrently or separately. Since sustained irrigated agriculture of the magnitude that

would exist on the Akkar Plain with full development would require supporting infrastructure to ensure full economic benefits, it is assumed that infrastructure development would be concurrent with water resource development.

Stage I

Stage I would consist of a storage reservoir on the Abrache River with a dam located either near Yazdieh or below the mouth of the canyon near Rihaniyeh. Either dam would include a diversion structure on the Arouse River and a feeder canal to the Abrache basin. A gravity irrigation system would convey all water regulated by the reservoir to farms on the Akkar Plain. If the dam at Yazdieh is built, a diversion dam would be necessary on the Abrache River about 2.5 kilometers above the crossing of the Tartous-Homs highway. Either dam location would utilize the same gravity distribution system for 6,000 to 10,000 hectares of cropland. Pumps would be required to lift water from the main canal to the distribution system serving some portions of the service area.

Infrastructure: Intensity of farming operation would be increased significantly; therefore, development of infrastructure facilities including roads, an agriculture service center, processing and packing plants, medical facilities, communication systems, and electric power facilities would be started concurrently with water development. Benefits would accrue at a better rate if the infrastructure is operating at the time when water resource development is completed.

Stage II

Stage II consists primarily of groundwater development from both the

shallow and deep aquifers for the purpose of irrigating 5,000 hectares. Some existing wells in the shallow aquifer would be improved with higher capacity pumps.

Under that part of the program which is intended to make a greater use of the groundwater resources of the area, some of the existing wells to be improved, as well as new wells to be constructed, will lie within areas under command of canal irrigation systems, and other wells in both categories will lie in areas above or beyond the command of those systems. It is contemplated that in those canal-commanded areas where significant amounts of additional groundwater can be developed, it will be used directly in lieu of canal supplies. The surface water that is replaced makes it possible to later extend the canal system to serve areas beyond those embodied in the initial project described herein. It is further assumed that at the time the canal systems become operational, the numerous existing dug wells and small-capacity drilled wells, which because of geologic or other constraints present little opportunity for improvement in production, would either be abandoned, retained to augment surface supplies, or diverted to domestic or other specialty uses.

The foregoing listing of works embodied in the Development Plan is predicated on the assumption that certain supplemental explorations and investigations that have not yet been undertaken will substantiate the technical and economic feasibility of the several features of the plan. There are two areas in which further field investigations will have to be completed before the definitive development plan can be finalized. Firstly,

it is essential that sufficient mapping and exploratory drilling be undertaken at the Rihaniyeh site on the Abrache River to ascertain if it is technically and economically feasible to construct a major storage reservoir at that site, or whether it would be more attractive to develop the Yazdieh site which was earlier studied by Sofrelec. Secondly, it will be necessary to construct a number of test wells at various locations on the Plan to better define the extent and characteristics of the underlying shallow and deep aquifers in order to evaluate their water development potential.

At the outset of this study, it was assumed that investigations that had been carried out earlier would adequately define the best storage site and provide sufficient information to evaluate the potential yield of the groundwater resource. This was not the case, and further investigations will be necessary in order to define the best site for reservoir storage and the scope of the groundwater development program.

Ancillary Works

Lesser irrigation and drainage works required to extend the systems to individual farms and all land preparation activities are classified on-farm or ancillary works. As design and construction of ancillary works are the responsibility of the Agricultural Service Center, their costs are included in project costs. Ancillary works are recognized as vital factors in the development program and are scheduled for Phase I construction.

PRESENT NATURAL ENVIRONMENT OF THE PROJECT AREA

Vegetation Characteristics

The Akkar Plain would be classified as a Mediterranean coastal zone.

The climate and water supply thus limit the area to vegetation suitable for this climatic type. Synanthropic flora and vegetation is defined as that part of the flora and vegetation that occurs in habitats created or strongly affected by man and his livestock. This flora is largely a result of man's agricultural activity, but it existed in natural habitats long before man was on the scene. It consists of three large groups: 1) the cultivated flora; 2) the segetal (or weeds); and 3) the ruderal flora and vegetation (plant association).

The cultivated flora of the Akkar Plain coastal region is typical of a temperate zone. Many of the world's grain crops originated in this area and the varieties are as old as the practice of cultivation. The zone is perfect for most vegetable and field crops, approximately 1,500 species. Instead of giving an extensive plant list, it is sufficient to say that the area of the Akkar Plain will produce the common temperate zone crops.

The segetal plants are most commonly referred to as weeds, but that definition can be misleading. Some have defined a plant as a weed if, in any specified geographical area, it grows entirely or predominantly in localities markedly disturbed by man, or if it grows spontaneously in a habitat that has been greatly modified by human action. Even the definition that it does harm to man or animal or harbors other diseases is not sufficient because many of the local plants do not fit these categories. The term segetal, therefore, refers to plants that occur in cultivated habitats mostly among crops.

In Syria, which has a relatively small flora because of the great

expanse of desert, about 20 percent of the total number of indigenous species are segetal. Most of the families of higher plants have representatives in the segetal flora. There is a wide distribution of these plants; especially outstanding are species of Cruciferae, Leguminosae, Umbelliferae, Compositae, and Graminease. About 80 percent of the segetals are annuals, the bulk of which are winter annuals, and a few are summer annuals or bi-seasonals. These segetal plants have only a few characteristics in common and react in very different ways to heat, light, soil, and moisture requirements.

Ruderal vegetation is made of many plant associations or groups of plants held together by a micro-climate or some other restricting factor. They are defined in four large groups: 1) roadside communities, Malvo-Carduetalia; 2) communities of dry refuse heaps, Atriplicetalia Rosease; 3) abandoned vegetable gardens, Chenopodietalia Opulifoli; and 4) shady walls and ditches, Urticetalia Urentis.

Animal Life

Wherever crops are cultivated, man upsets the natural balance causing some species to migrate out of and others to migrate into an area. A region intensely cropped in vegetables generally forces the wilder animal species out and encourage birds, small rodents, and other small animals to enter the area to obtain food.

The present wildlife situation on the Akkar Plain has been greatly influenced by man's presence. Due to the climate, the Plain has been cultivated for centuries, almost from the beginning of man's history. Many animal species are native to the area, and many other species can

be found in stage of migration. Because of man's presence, many of the mammals observed in the area are not in their natural habitat (e.g. the Red Fox or Jackal occasionally crosses the Plain or ventures out for food but lives in the mountains to the east and north of the Akkar Plain). Furthermore, the absence of fish and wildlife conservation laws has greatly reduced the overall population of wildlife and replaced it by agricultural and domestic stock. The most common mammals found on the Plain are the jackal, red fox, bobcat, squirrel, rabbit, badger, mole, gopher, rat, and mouse. The reptile family is represented by many species of small turtles which are found close to the drains, dug wells, and water sources along with frogs, lizards, and snakes.

Many non-migrating species of birds are native to the area. These include: sparrows, pigeons, hawks, owls, crows, seagulls, quail, and doves. The migrating species include: swallows, blackbirds, starlings, ducks, geese, terns, swans, and cranes. The fact that virtually all land on the Akkar Plain is either cultivated or grazed has removed much of the birds' natural habitats. Trees and brush are located along stream or drain banks and only a few trees are found in the villages, thus limiting the nesting area and ground cover necessary for a successful population. As a result, the bird population is generally located close to the water sources. Also, birds are under constant pressure as prey for hunters, and, therefore, the majority of the species inhabit the more isolated areas of the Plain.

The only significant fish population on the Akkar Plain is found in the Janoubi River. The other streams and rivers have such low flows by the end of summer that the fish cannot survive. Even in the Janoubi

River the combination of heavy winter and spring runoffs with low flow in late summer make it difficult for the fish to become established. Fish in the Janoubi River are trapped in many of the small diversions by reed fish traps made by the farmers, although the farmers do not rely heavily on fish as a food source.

As can be seen, the wildlife, in general, on the Akkar Plain is not well established due to man's presence. The major animal populations are found on the fringe areas between vegetation types, where there is a break in cultivation (i.e. stream banks), or at the edge of a village. In the balance between man and wildlife on the Akkar Plain, man has forced the wildlife into limited habitats and the balance is tipped to his advantage.

Archaeological Conditions

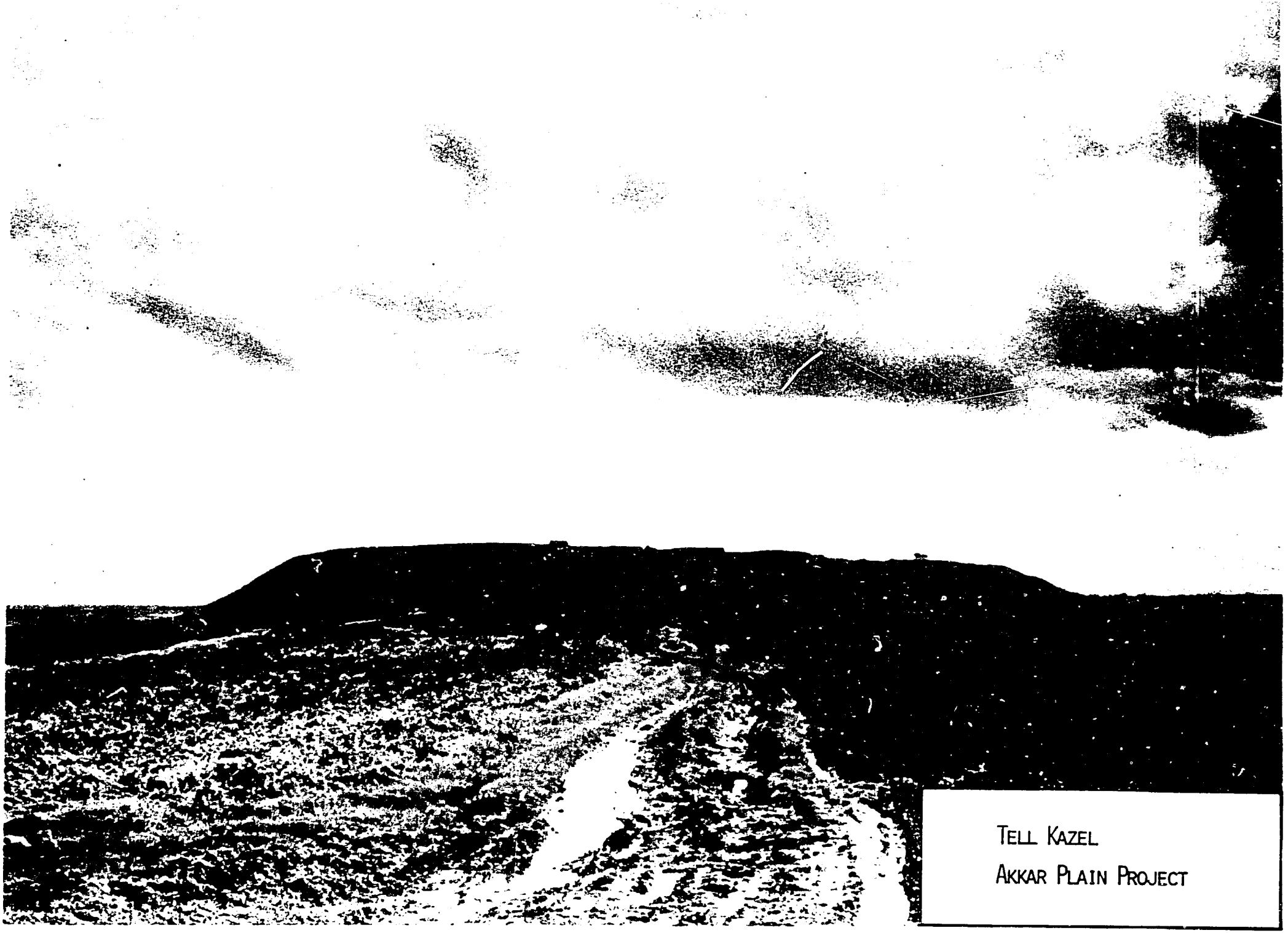
Syrai has a rich archaeological heritage which dates back to the earliest history of man. Clay tables excavated at Ebla, a village near Alleppo, show that civilization in the area dates back to at least the 16th Century B.C. Since that time, Syria has been the host (not always by chance) to all the great civilizations of the Mediterranean area. During the thirty-six centuries of recorded history, the area now occupied by Syria has been invaded and/or occupied by the Akkadians, Armenians, Assyrians, Babylonians, Persians, Greeks, Egyptians, Romans, Byzantines, Turks, and French. Most of the civilizations have conquered, plundered, and rebuilt city upon city.

Damascus, the capital of Syria, is considered to be one of the oldest continuously occupied cities in the world. Tartous, located 18 km north of the Akkar Plain Project, has had an important historical role because

of its harbor. It also boasts a rich archaeological heritage which has only been superficially investigated to date. The Island of Arwad, which is located 2 km west of Tartous, was established by the Phoenicians, who are mentioned in Genesis as being the earliest known shipbuilders. The Island has continued as a center for trade, transport, and shipbuilding.

The original port city was Amrit, which was located approximately 10 km south of Tartous, only a few kilometers north of the Akkar Plain Project. The city reached a population of 10,000 and its suburbs no doubt included project land. About all that remains of the city at the present time are two burial structures, called sprindles, and the remains of the temple frontisepiece. Explorations of the site conducted during 1860 and 1926 indicated that advanced civilizations had occupied the region since the 5th Century B.C.

The fertile Akkar Plain no doubt served as the agricultural base for the many civilizations which once occupied the region. There are ten Tells on or adjacent to the project which have served as the foundation for cities or fortresses throughout the ages. Some are man-made and some are natural mounds. The most important Tells within the project area are Tell Kazel, Tell Basisa, Tell Adass, Tell Snoon, and Tell Shiek El Batel. Exploration of Tell Kazel during 1956 by the Ancient Monuments Administration SARG produced artifacts which indicate the Tell has been occupied since the late Bronze Age. The SARG plans to continue excavations at Tell Kazel as soon as several farm residences are relocated. Exploration of additional Tells is scheduled for the near future. Other Tells on the project are currently being used as residences, culinary water tank sites, and burial grounds.



TELL KAZEL

AKKAR PLAIN PROJECT

Geology

The area of interest is dominated by the Ansariye Mountains which trend in a north-south direction, paralleling the Mediterranean coastline. The mountains are formed by a huge anticline with a major fault on the eastern flank. On the western side of the anticline, the strata dip gently toward the Mediterranean and are cut by a number of lesser faults. The core of the mountains is Jurassic limestone, which is quite karstic, covered with a section of upper Cretaceous limestone (Turonian and Cenomanian), which is also karstic. On the western flank of the anticline, the Akkar Plain, Tertiary limestone and basalts are deposited against an unconformity within the Cretaceous limestone, probably as marine terrace deposits. The surface rocks of the project area consist of various facies of Pliocene limestone and several types of extrusives, along with some recent alluvial deposits.

The Tertiary sedimentary deposits range in facies from limey sandstones, clastic limestones, and marls, to quite pure, white to blue limestones. Some of the limey sandstones along the Mediterranean Sea are mapped as Quaternary in age.

The crystalline rocks range from very hard, black, columnar-jointed basic rock to soft, reddish material which appears rhyolitic. No petrographic examinations were made. The rocks are all mapped as basalts.

Some faulting is present on the Plain and some apparent facies changes may actually represent faults. Knowledge of the subsurface was gained only through translation of the farmer's recollections of the lithology of their wells. In many instances, no reasonable correlation from well to well could be made; whether this is because of faulty information, rapid facies change,

or faulting is not known.

The slopes of the moutains are relatively steep, dropping 100 meters in less than one kilometer in some places. In the central portion of the Plain, north of Shass, the topography is typified by low basalt hills; but south and west of the hills the Akkar Plain slopes gently and regularly toward the sea.

Soil Characteristics

A general World Soil Map places the Akkar Plain in the two dominant soil orders of aridisols and vertisols. Aridisols are soils without horizons of clay accumulations, that are low in organic matter, and generally are dry for six or more months of the year. Aridsols are especially responsive to irrigation and make up much of the irrigated land throughout the world. Vertisols (previously called grumosols) are characterized by a high content of swelling-type clay. The clay in vertisols swells when moist and shrinks when dry. Deep, wide cracks develop in these soils during the dry season, from May to November, on the Akkar Plain. Inadequate drainage and poor physical soil conditions are constraints limiting crop production on the vertisols.

Bottomlands bordering the major streams are found by alluvial deposits and are deep, medium-textured soils of excellent structure and fertility. Alluvial bottomlands such as these are capable of being very productive where they are well-drained and not subject to flooding.

Large, undulating land areas have lacustrine deposits over sandy limestone and basalt bedrock. These deposits form productive soils except where they are shallow. Rolling hills and steeper areas have residual soil formed principally from decomposed basalt and, to some extent, from decomposed limestone. These residual soils are well-drained and are generally used for olive groves.

Basalt, limestone, and sandy limestone are the predominant bedrock materials, although much of the arable lands are of transported soils of alluvial or lacustrine origin. Limestone or sandy limestone are the predominant underlying rock in the western portion of the Plain. The eastern portion of the Plain is largely underlain by basalt.

Detailed Soils Investigation

Soil examinations were made by boring to depths of 160 cm or more to barriers preventing auger penetration. Occasionally, the presence of rock or dense clay layers limited borings to shallower depths, but roads, railroads, surface wells, and drainage cuts frequently made deeper observations of soil conditions possible. From one to five soil examinations were made in each square kilometer in the project area. At each boring, observations were made of the land use, slope, relief, and subsurface drainage. Soils were examined in the field and laboratory for texture, depth to gravel or fractured rock, presence of bedrock, reaction (pH), salinity, soil structure, compaction, and fertility of the soil material.

During the course of the survey, samples of representative soil profiles were collected throughout the project area. Samples were sent for laboratory analyses to confirm the field determinations. Numerous mechanical analyses were made at Latakia Soil Laboratory to check the field estimate of soil texture. Soil pH was determined for the same samples. Results of the mechanical analyses and pH were tabulated for some representative profiles as shown in Table 1. The pH values show the soils to be neutral or slightly basic.

Textural analyses indicate the Akkar Plain soils to be predominantly fine textured with an exceptionally high clay percentage. The granular

Table 1. Textural Analyses and pH from Latakia Soils Laboratory, Syria

Soil Location		Depth	Silt	Clay	Sand	Textural Class	pH	Land Class
		cm	%	%	%			
B4	#1	0-20	31	41	28	clay loam	7.8	2sd
		20-50	31	38	[illegible]	clay loam	8.0	
		50-100	25	38	27	clay loam	7.7	
C4	#1	0-30	25	38	37	clay loam	7.9	3d
D3	#1	0-90	27	52	21	clay	7.5	3sd
		90-110	30	48	22	clay	7.3	
E11	#1	0-15	31	37	32	clay loam	7.9	5d
		15-60	31	38	31	clay	7.8	
E12	#1	0-20	15	31	54	sandy clay loam	7.5	2d
		20-30	11	33	56	sandy clay loam	7.2	
		30-80	7	40	53	sandy clay loam	7.5	
E13	#1	0-30	33	45	22	clay	7.7	2sd
		30-70	27	52	21	clay	7.5	
G5	#1	0-35	32	18	50	loam	7.2	2rs
		35-50	27	41	32	clay loam	7.2	
G9	#3	0-20	27	49	24	clay loam	7.2	3sd
		20-60	27	46	27	clay	7.4	
G12	#2	0-15	14	34	52	sandy clay loam	7.5	3sd
		15-60	23	35	42	clay loam	7.7	
I8	#1	0-20	24	51	25	clay	7.8	3sd
		20-50	47	48	25	clay	8.0	
I15	#1	0-30	51	26	23	clay loam	7.6	2sd
		30-70	43	37	20	clay loam	7.6	
J6	#1	0-60	37	23	40	loam	7.5	2d
		60-90	33	32	35	clay loam	7.5	
J12	#1	0-50	21	46	33	clay	7.5	3sd
		50-70	25	26	49	sandy clay loam	7.8	

Table 1, continued. Textural Analyses and pH from Latakia Soils Laboratory, Syria.

Soil Location		Depth	Silt	Clay	Sand	Textural Class	pH	Land Class
		cm	%	%	%			
K15	#3	0-30	20	30	50	sandy clay loam	6.5	2rs
		30-60	16	42	42	clay	6.8	
K16	#1	0-30	38	34	28	clay loam	7.7	1
		30-80	34	34	32	clay loam	7.7	
		80-110	40	24	36	loam	8.6	
L13	#2	0-50	23	48	29	clay	7.5	2s
		50-80	23	50	27	clay	7.3	
M12	#2	0-70	27	48	25	clay	7.0	3sd
		70-90	30	48	22	clay	7.4	
M15	#1	0-30	30	48	22	clay	7.3	2rs
		30-100	27	50	23	clay	7.4	
M16	#1	0-60	36	18	46	loam	7.7	1
		60-120	23	22	55	sandy clay loam	7.8	
N10	#2	0-20	29	46	25	clay	6.9	3sd
		20-50	27	46	27	clay	6.9	
O15	#1	0-20	35	44	21	clay	7.8	3s
		20-50	37	40	23	clay loam	7.9	
Q12	#2	0-60	28	46	26	clay	7.4	2s
		60-80	26	42	23	clay	7.6	
R9	#1	0-40	31	38	31	clay loam	7.4	2rs
		40+	24	26	50	sandy clay loam	7.5	
R9	#3	0-30	24	48	28	clay	7.0	2s
		30-80	25	44	31	clay	7.2	

structure of the clay, after the saturated soils dry to field moisture capacity and less, is an unusual characteristic. This granulating of the dry clay permits drainage to be more effective than would be normally expected in heavy soils. An exception to the above characteristic is found in the heavy bottomland soils on the west side of the Plain. These soils consist of clays with compact massive structure that expand when wet and shrink when dry to form wide cracks in the surface.

Climate Conditions

The climate of the Akkar Plain can be classified as humid. The two most important features determining the climate are the Mediterranean Sea and the Jabal al Nusayriyah Range (1,500 M) which parallels the coastline. Moist air masses which generate over the ocean move inland to the east. Precipitation occurs along the coastal area when the moist air cools as it is forced to rise over the mountains. The average annual precipitation at Tartous is 862 mm, which ranges from a mean monthly of almost 200 mm for December and January to a mean of only 1 mm for July and August, Figure 3. The ocean has a levelling effect upon the temperature, cooling the air in the summer and warming it in the winter. Mean monthly temperatures range from a minimum of 12°C during January to 27°C during August, Figure 4. The maximum and minimum temperature at Tartous for 23 years of record is 41°C during June and -1°C during January. Relative humidity of the Akkar Plain is fairly high and constant throughout the year, ranging from 60 to 74 percent. The months of lowest relative humidity are October through December, Figure 5.

Wind direction is from the northeast and west from November through February and from the southwest for the remainder of the year. Maximum

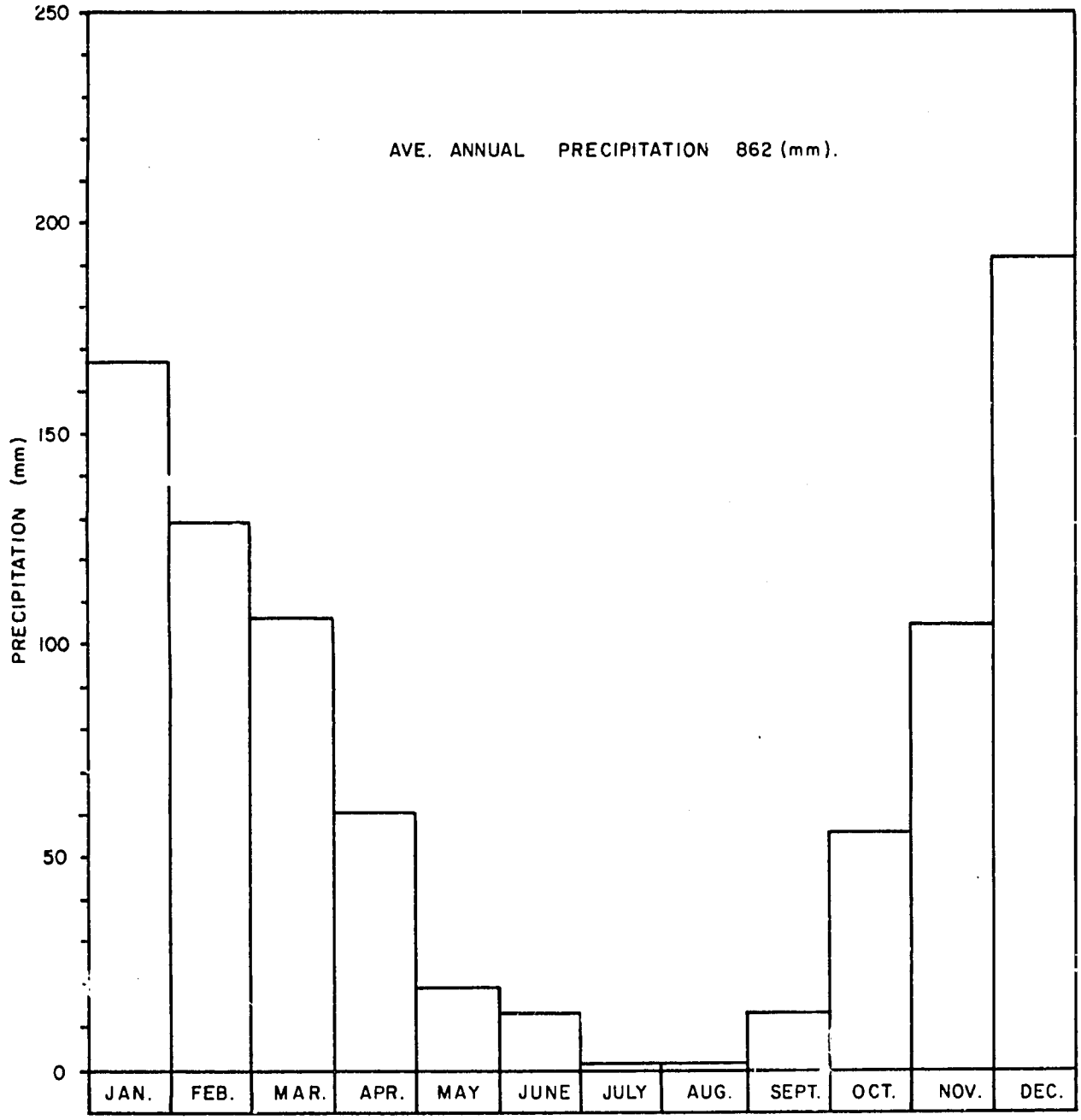


FIGURE 3
MEAN MONTHLY PRECIPITATION — TARTOUS
(1955–1977)

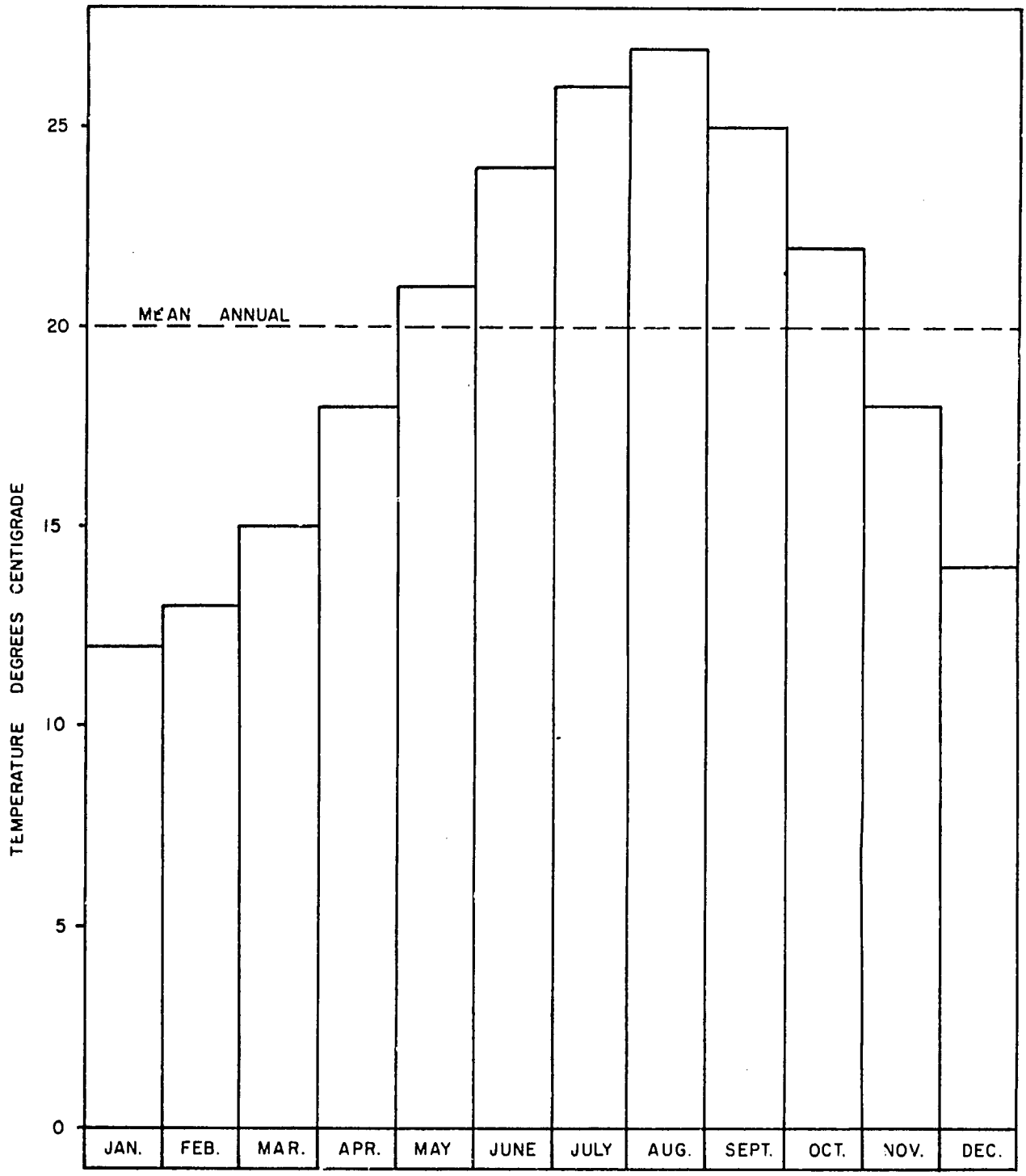


FIGURE 4
MEAN MONTHLY TEMPERATURE — TARTOUS
(1955–1974)

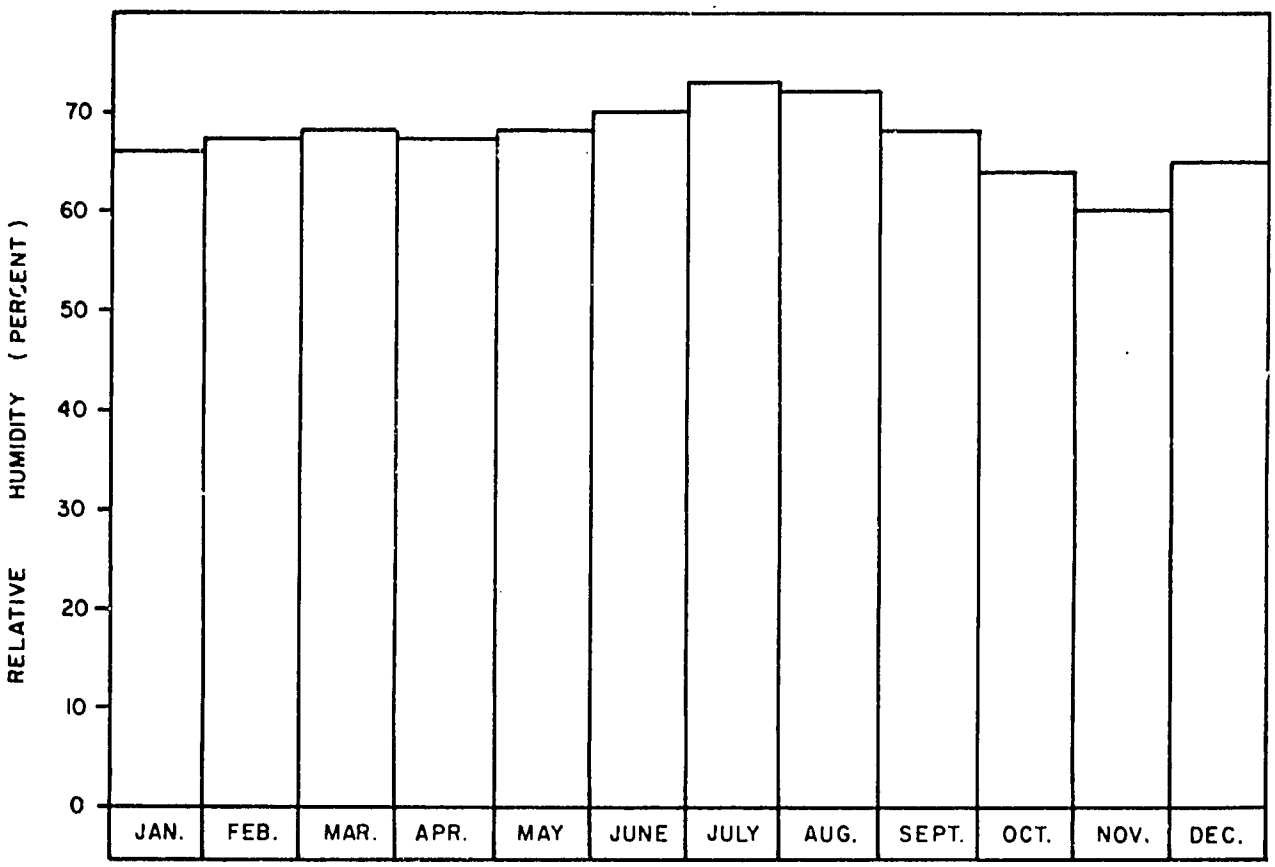


FIGURE 5

MEAN MONTHLY RELATIVE HUMIDITY — TARTOUS
(1969-1971)

monthly measurements range from a 10-year average of approximately 9 m/s (33 km/hr) in July to 16 m/s (58 km/hr) in December. Wind direction and velocity are summarized in Table 2. The table indicates the weather is calm approximately 28 percent of the time.

PROBABLE IMPACT ON THE ENVIRONMENT

The impact of the project would be felt in many areas if the development plan is implemented. Alteration of the water regime on the Plain would be the most significant impact. On the flatter lands of the Akkar Plain there are about ten major and minor depressional areas in which water ponds following each series of major storms. Some of these depressions have no gravity outlet and remain ponded for an extended period following the wet season. Such areas create an excellent breeding habitat creating a general risk of malaria to the local people. Under project development, major depressional areas will be drained by artificial gravity channels or by pumps. The land could then be used for farming.

Another health hazard in the project area develops from poor drainage conditions within and around the individual villages. Such inadequate drainage is very unsanitary and multiplies the incidence of infection and disease. Improvements under project development should greatly reduce the sanitation problems.

As a result of the project, the additional infrastructure should have a positive impact on the health and well-being of the residents of the Akkar Plain. The proposed health center at Karto would extend health services to approximately 25,000 persons living on or adjacent to the Akkar Plain. These medical facilities will improve general health

Table 2. Wind Velocity and Direction

Wind Speed in m/sec.	Percent Time Wind Blowing From Direction Indicated Degrees from North (Clockwise) - Safita - 1960 - 1969 1/																
	350°- 011°	012°- 034°	035°- 056°	057°- 059°	080°- 101°	102°- 124°	125°- 146°	147°- 169°	170°- 191°	192°- 214°	215°- 236°	237°- 259°	260°- 281°	282°- 304°	305°- 326°	377°- 349°	TOTAL
1-5	0.9	0.8	1.3	3.7	5.2	1.3	0.8	0.6	1.0	1.2	2.2	7.4	16.3	2.8	1.2	0.8	47.3
6-13	0.0	1.0	0.5	4.8	5.2	0.1	0.1	0.0	0.2	0.5	0.9	3.5	6.3	0.3	0.1	0.1	23.6
14-23	0.0	0.1	0.0	0.3	0.4	0.0	-	-	0.0	0.1	0.0	0.1	0.1	0.0	-	-	1.0
24	-	-	-	-	0.0	-	-	-	-	-	-	0.0	-	-	-	-	-
TOTAL	0.9	1.9	1.8	8.8	10.8	1.4	0.9	0.6	1.2	1.8	3.1	11.0	22.7	3.1	1.3	0.9	71.9

Calm 27.7%

1/ Safita is located on the north rim of the Akkar Plain at elevation 300 m.

and reduce the mortality rate by providing the following services:

1. Maternity care and postnatal care for mother and child.
2. Ambulance service and emergency care.
3. First aid facilities.
4. Field nurses and doctors who would provide general physical examinations at public schools, give innoculations, and supply timely aid in case of epidemics and emergencies.
5. Dental services.

Concrete-lined irrigation canals would provide a relatively potable water supply to villages which do not have a piped culinary water supply. The canal water would usually be less contaminated than the shallow wells, small streams, and drains presently being used.

Irrigation would permit double-cropping and would increase the yield of most crops. This would result in increased income to the farmer and provide funds for service facilities. Surplus income also could be used to supplement the present diet, to purchase refrigerators to prevent food spoilage, to construct pit-type latrines, and to install water closets, septic tanks, and/or sewer systems. All of these improvements would better the general health of area residents. In addition, current nutritional levels could be improved by the use of inspected meat from the proposed animal processing plant and by the use of dairy products from the dairies. Adequate storage of grain products would prevent spoilage and disease caused by rodent infestations.

Construction of new roads and widening and upgrading of existing roads would permit famers to travel to the project health center of other medical and dental facilities during the winter season. Such travel is presently restricted because of the lack of surfaced roads to many of

the villages, which can be especially troublesome during epidemics and emergencies.

Construction of a vegetable and fruit cannery on the project would permit farmers to process farm products which would supplement their diet, especially during the winter season. Energy for processing would be from electricity and oil. The electricity would come from an oil-thermal-generation plant.

Under full project development, employment would be created for approximately 236,000 man-days annually, as shown below:

Employment	Man-Days
Agriculture	175,000
Health Care	4,420
Cannery	1,350
Roads	2,000
Animal Processing Plant	2,500
Grading and Packing Facilities	3,600
Grain Storage	2,160
Dairy	4,320
Agricultural Service Center	3,480
Educational Facilities	15,660
Service Facilities	20,000
TOTAL	236,000

The changes in the peoples' lifestyle resulting from a different land use pattern, mainly through double-cropping a significant percent of the farmland, will have a beneficial effect on the population. Most of the farm operators and their families will be able to work year-round rather than only periodically due to the increased population. Additional farm labor will be hired from nearby rural or urban areas as needed.

This should ultimately be about 5,000 laborers each year, particularly during harvesting of vegetables. Also, the additional farm production will open up more jobs in agriculturally-oriented industries as well as in administration, traffic control, and other new areas of public services. Adjustments in population through movement and relocation due to the new working conditions in the area will take some time, but the eventual impact will be very beneficial (the growth rate for the Akkar Plain with project development is estimated to be 5 percent compared with only 3 percent for Syria as a whole).

Living conditions in the Akkar Plain should improve with a significant increase in farm income on a stabilized basis. Homes could be remodeled to make more room for household members. More and better food and clothing could be obtained. Radios, television sets, automobiles, and motorcycles would become more commonplace. Better education will increase the literacy of the people. There will be expanded participation in public affairs and improved relations between various social groups in the area.

Archaeological Sites

Implementation of the Akkar Plain Project would have minimal effect upon known archaeological sites within the project area, specifically the aforementioned Tells. None of the proposed project works or structures encroach upon the Tells. If presently unknown archaeological sites are found during excavation for the irrigation distribution system, construction of farm-to-market roads or other infrastructure facilities, the work will be discontinued and the Department of Ancient Monuments Administration SAR would be notified to evaluate the findings before continuing the work.

Improvement of existing roads and construction of new roads under the project would bring tourists to the area to visit the Tells. This could possibly result in adverse effects upon archaeological sites, unless surveillance and maintenance programs are instigated.

Scenic Beauty

An improved standard of living will enable farmers to modernize existing residences or build new ones. Further evidence of their new wealth will be evidenced by landscaping. Improved communication and training will give farmers knowledge of better tillage and weeding practices which will also help to enhance the beauty of the area.

The serene agricultural setting could be detracted from by the construction of the Agricultural Service Center, Health Center, grading and packing facilities, grain storage bins, farm-to-market roads, and irrigation distribution system, unless these are well-landscaped and constantly maintained.

Water Quality and Hydrology

In any irrigation development plan there will naturally be an impact on water quality. The anticipated effect on the water quality as a result of drainage and flood control in the Akkar Plain would be minimal. Water quality samples of the shallow groundwater, taken during investigations, showed a range in electrical conductivity of about 500 to 1,900 micro-mhos/cm during the irrigation season when the shallow wells were being pumped. There are essentially no adverse effects under existing conditions from the use of this water for irrigation, since the amount of leaching provided by the excessive winter precipitation is about three times more than is needed to maintain adequate salt balance.

Under project development, the leaching water would be reduced by approximately 5 to 10 percent as a result of more expeditious removal of precipitation runoff. This would lower the general water table but would not create reverse gradients from the sea or any other measurable adverse water quality effect.

As an area comes under irrigation, the quality of drainage water can be expected to be lowered at an increasing amount each year. This is due mainly to the loss of nitrogen from soils where irrigation water is applied. Under irrigation, cropping would be intensified and the use of agro-chemical fertilizers increased. A study in the Northwestern U.S.A. over a 30-year period (1940-1970) showed a nitrogen net flow that was five times greater in 1970 than at the beginning of the study in 1940. This increased nitrogen loss amounted to 2.5 kg/ha in 1940 and 12.4 kg/ha in 1970. Nitrate nitrogen was freely mobile in soil water and went though the soil into the drainage system. The outflow of other constituents, such as phosphorus, potassium, and sulfur from the soil, which could alter the quality of water, was minor.

The impact to the general hydrology of the Akkar Plain as it relates to erosion and stream control would be positive. Excessive sheet and rill erosion on the Akkar Plain results from high precipitation and inadequate drainage outlet and collection systems. Erosion is also prompted by poor on-farm cultural practices such as improper seedbed preparation, no surface smoothing operations, and substandard irrigation methods. The project plan would correct all of these deficiencies and thus would reduce the amount of sheet and rill erosion which is presently occurring.

The annual amount of erosion now occurring on the cultivated lands of

the Akkar Plain is estimated to be 0.9 metric tons/ha. It is estimated that the current erosion will be reduced by 0.36 metric tons/ha under project development. This would result in a project decrease in erosion on 17,179 irrigable hectares of 6,200 metric tons annually which will give greater crop yields and a more stable base for sustained agriculture.

Stream Hydrology

The streams which flow through the area of the Akkar Plain are the Abrache River and Janoubi River. The Abo Falat and Kalife Rivers are tributaries to the Arouse River, which in turn is tributary to the Janoubi River.

Flow records are available for the Arouse and Abrache Rivers for the years 1966 to 1977, but the 1974-75 data are missing on the Abrache River, and the 1974 data is missing on the Arouse River. The stream gage on the Arouse River is located at Berg Arab near the proposed feeder canal diversion to the Yazdieh basin. Two typical years of record, 1965-66 and 1966-67, for these rivers, Table 3, shows the average, maximum, and minimum daily flows for each month of the year.

Daily flow records for the Janoubi River are available for the upper station at Arida for the period 1962-1977, but for the lower station of Dabouseh, located on the Akkar Plain Project Boundary, there are only three years of daily record, 1975-1977. The 1974-75 and 1975-76 records, Table 4, shows the average, maximum, and minimum daily flows for each month of the year. Average monthly flow data at the Dabouseh station is also available for the period 1961-62 through 1977-78 except 1973-74.

Project Effect on Stream Hydrology

As a result of development and project operation, stream flows will be altered on the Abrache, Arouse, and Janoubi River as discussed

Table 3. Arouse River Flows at Berg Arab Gage

Month	(1965-66) Daily Flows m^3/s			(1966-67) Daily Flows m^3/s		
	Average	Maximum	Minimum	Average	Maximum	Minimum
October	-1/	-	-	1.1	1.6	0.2
November	-	-	-	0.9	1.1	0.7
December	1.1	7.7	0.1	2.8	9.4	0.8
January	1.7	5.4	0.9	2.7	9.0	1.1
February	2.1	4.7	1.5	3.3	8.2	1.4
March	1.7	2.8	1.2	2.6	5.9	1.1
April	1.3	1.8	0.9	2.3	6.9	1.3
May	0.9	1.0	0.8	1.1	1.3	0.8
June	0.8	0.8	0.7	0.8	0.8	0.8
July	0.6	0.7	0.2	0.7	0.8	0.7
August	-	-	-	0.7	0.7	0.6
September	-	-	-	0.6	0.6	0.6
Abrache River Flows at Rihaniyeh						
October	-	-	-	0.0	0.0	0.0
November	-	-	-	0.0	0.0	0.0
December	3.6	8.7	0.0	7.9	20.2	0.0
January	6.6	14.3	4.1	7.6	16.7	3.0
February	6.6	18.0	4.9	8.7	28.5	5.7
March	4.7	6.6	3.8	10.0	28.5	5.8
April	3.5	4.3	2.4	6.7	9.4	5.1
May	1.7	2.4	1.4	4.2	5.0	3.6
June	1.1	1.4	0.5	2.8	3.5	2.3
July	-	-	-	1.9	2.3	1.6
August	-	-	-	1.5	1.6	1.2
September	-	-	-	0.9	1.2	0.9

1/ Dash marks indicate months when no flow record was available.

Table 4. Janoubi River Flows at Dabouseh 1/

Month	(1974-75) Daily Flows m^3/s			(1975-76) Daily Flows m^3/s		
	Average	Maximum	Minimum	Average	Maximum	Minimum
October	-	-	-	7.6	9.2	7.2
November	-	-	-	8.8	12.5	7.6
December	6.2	31.5	2.0	21.4	87.2 2/	9.6
January	9.1	86.1 2/	3.7	32.8	57.6	23.2
February	27.1	69.9 2/	4.2	47.5	166.3 2/	18.5
March	15.5	45.0	10.8	17.5	59.2	7.2
April	7.1	13.2	4.7	11.7	73.6 2/	3.8
May	3.7	6.7	2.0	3.4	4.8	2.4
June	2.7	3.7	1.4	1.8	3.2	1.0
July	0.7	0.9	0.6	2.9	3.6	2.4
August	0.7	0.9	0.6	0.5	1.8	0.1
September	0.7	0.9	0.6	0.2	0.6	0.1

1/ Janoubi River at Dabouseh represents the total Janoubi River flow immediately above the confluence with the Arouse River.

2/ Generally flood waters overtop the Janoubi River bank when flows at Dabouseh exceed 60 m^3/s.

in the material which follows:

Abrache River

Under project operation, flows of the Abrache River would be stored in the project reservoir and the stream would be essentially dried up immediately below the diversion dam or the lower reservoir, depending on which dam is developed. During the wet season, the lower Abrache River channel would continue to function as a drainage way for storm runoff, but the amount of flood water would be reduced by the amount of the river flows to be intercepted in the project reservoir.

Currently, the lower river channel dries up during the latter part of the dry season as indicated in Table 4. Under project operation, return flows from irrigation water would return to the river channel, as well as to many other existing drainage ways and new project drains. It is anticipated that most of the return flow will be rediverted or pumped for irrigation at lower points along the channel. As a result of the return flows, more grass and other vegetative growth will be produced for wildlife habitat along the river channel.

Arouse River

With the project in operation, the flows of the Arouse River at Berg Arab would be diverted to the Yazdieh basin via a 7.8 m^3/s feeder canal. Based on the Arouse River flow record, Table 1, for 1965-66, all of the flows would have been diverted, leaving a dry stream immediately below the dam. However, in the 1966-67 year there were excess flows in December, January, and February of 1.6, 1.2, and 0.4 m^3/s, respectively, which would have spilled past the diversion dam and remained in the river. There are generally more accretions to the Arouse River below this point, as most of the streams in the eastern portion of the project are spring fed.

Janoubi River

After the channel improvement is completed along the Janoubi River, the stream hydrology will change materially. Under present conditions, the river overtops its banks when the flow at the Dabouseh Gate, Upper Bridge to Lebanon, exceeds approximately 60 m^3/s, Table 3. The two years of record, 1974-75 and 1975-76, were considered typical years and show there was spills of 26.1 and 9.9 m^3/s in January and February 1975, respectively. During 1975-76, the spills increased to 27.2, 106.3 and 13.6 m^3/s, respectively, for December, February, and March.

Under project conditions, the improved channel would contain the 10-year frequency storm of approximately 274 m^3/s measured at the Dabousi station, which is equivalent to the flows immediately above the confluence with the Arouse River. This flow corresponds with a flow of 300 m^3/s estimated for a point on the Janoubi River just below the confluence with the Arouse River.

It is to be recognized also that the stream hydraulics would be changed considerably as a result of a requirement to remove all of the brush and trees from the north and south banks. Until the river bank can be re-established with appropriate grass varieties following construction, erosion of the new surface would develop a sediment load which would be deposited at the Janoubi River estuary. However, since the sea is very rough during the stormy periods, very little local sedimentation is expected and no adverse environmental effects are anticipated.

It has been estimated that, under present conditions, about two-thirds of the spills from the river flow to the north on Syrian lands and the remaining one-third flow to the south on Lebanese lands. Under complete channel improvement, all floodwaters will be contained within the improved channel except for

high flows which exceed the 10-year frequency. Under such conditions flood damage could be expected on both sides of the River.

Fertilizers, Herbicides and Pesticides, Air Contaminants and Noise

Fertilizers:

With the additional hectares being brought into production and the intensification of agriculture, the use of chemical fertilizers would greatly increase. Table 5 shows the comparison between present use of chemical fertilizer and the recommendations for the future. The recommendations were made for the future-with-project conditions based on the soil analysis and the desired yield for each major crop.

Chemical fertilizer applied correctly would greatly increase the fertility of the soil and would make it possible to obtain high yields. The overuse of chemicals can increase the toxicity of the water. This problem is especially true where nitrogen is concerned. Nitrogen fertilizers that remain soluble in water and are not retained in the soil unless used by plants and soil organisms and changed to an organic form can contribute to water toxicity. Phosphates are not mobile in the soil; consequently, there is little loss of soil phosphate in drainage water. Phosphates applied to the soil do not move more than an inch or two, regardless of the form of phosphate fertilizer applied. Potassium is considered fairly immobile in soils, although it can be leached with excessive soil water. Zinc, iron, manganese, magnesium, copper, and boron are micro-nutrients. Their small application rates would not cause any significant problem with the drainage water.

With high amounts of nitrogen going into the sea, it is thought that this would stimulate more algae growth. In some areas of the world this has created problems for the fish that live in water overgrown with algae,

Table 5. Rate and Cost of Fertilizer

Crop	Type	Price per available kg (SP)	US $	Condition: Present Application (kg/ha)	Present Cost (SP)	Present Cost (US $)	Future w/o Dev. Requirement (kg/ha)	Future w/o Dev. Cost (SP)	Future w/o Dev. Cost (US $)	Future w/ Dev. Requirement (kg/ha)	Future w/ Dev. Cost (SP)	Future w/ Dev. Cost (US $)
Pasture	N	2.34	.60	-	-	-	-	-	-	168	393.12	100.80
	P	2.26	.58	-	-	-	-	-	-	56	126.67	32.48
	K	.86	.22	-	-	-	-	-	-	112	96.10	24.64
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL										726.38	186.25
Forage	N	2.34	.60	-	-	-	-	-	-	56	131.04	33.60
	P	2.26	.58	-	-	-	-	-	-	100	226.20	58.00
	K	.86	.22	-	-	-	-	-	-	84	72.07	18.48
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL										570.38	146.25
Citrus	N	2.34	.60	-	-	-	-	-	-	216	505.44	129.60
	P	2.26	.58	-	-	-	-	-	-	56	126.67	32.48
	K	.86	.22	-	-	-	-	-	-	112	65.52	16.80
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL										838.70	215.05

1/ 10% increase in application.
2/ Based on NPK (25-15-10) compound 7.6 kg/ha total application.
3/ Based on NPK (25-15-10) compound 23 kg/ha total application.

Table 5, continued. Rate and Cost of Fertilizer

Crop	Type	Price per available kg (SP)	Price per available kg (US$)	Condition: Present — Application (kg/ha)	Present — Cost (SP)	Present — Cost (US $)	Future w/o Dev. — Requirement (kg/ha)	Future w/o Dev. — Cost (SP)	Future w/o Dev. — Cost (US)	Future w/ Dev. — Requirement (kg/ha)	Future w/ Dev. — Cost (SP)	Future w/ Dev. — Cost (US)
Wheat	N	2.34	.60	5.72 3/	13.38	3.43	6.29	14.70	3.77	168	393.12	100.80
	P	2.26	.58	3.43	7.76	1.99	3.77	8.54	2.19	56	126.67	32.48
	K	.86	.22	2.29	1.95	.50	2.52	2.15	.55	112	96.10	24.64
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL				22.46	5.76		24.73	6.34		756.95	194.09
Tomatoes	N	2.34	.60	19 2/	44.46	11.40	21	49.14	12.60	50	117.00	30.00
	P	2.26	.58	11.4	25.78	6.61	12.5	28.28	7.25	100	234.00	60.00
	K	.86	.22	7.6	6.51	1.67	8.4	7.22	1.85	100	85.80	22.00
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL				74.69	19.15		82.33	21.11		577.86	148.17
Sorghum	N	2.34	.60	-	-	-	-	-	-	213	498.42	127.80
	P	2.26	.58	-	-	-	-	-	-	84	190.01	48.72
	K	.86	.22	-	-	-	-	-	-	112	96.10	24.64
	S	2.07	.53	-	-	-	-	-	-	56	115.75	29.68
	Micro-Nut	2.30	.59	-	-	-	-	-	-	11	25.31	6.49
	TOTAL										925.59	237.33

1/ 10% increase in application.
2/ Based on NPK (25-15-10) compound 7.6 kg/ha total application.
3/ Based on NPK (25-15-10) compound 23 kg/ha total application.

but the volume of nitrogen is small compared to the volume of water that could be affected.

Herbicides and Pesticides:

Many insecticides are in use at the present time on the Plain, mainly on vegetable crops. Herbicides are used only on a limited basis, as most of the weeding is done by hand. At present, the farmers apply chemicals by hand units on a small scale and only after the symptoms of a serious problem are evident. The use of agro-chemicals on the Plain will increase yields and better the quality of all crops. Standard procedures for application of agro-chemicals should be practiced at all times to avoid needless contamination of the crop or harm to the people applying the chemicals.

Table 6 shows the rates of application for some common and recommended chemicals to be used on the major crops.

Air Contaminants and Noise:

The only type of air contamination and noise that would result as a direct cause of the project would be during construction. The contamination would only be temporary and any smoke or dust would be quickly dissipated. The increased vegetation should aid in slowing any air contamination that might take place on the Plain.

Fish and Wildlife

The environmental impact of the development of the Akkar Plain on fish and wildlife would come as habitats are created or destroyed. The natural habitats that would be destroyed with the implementation of the project would mainly be those areas affected by the construction of the canals, drains, channel improvement, and the infrastructure.

Table 6. Rates of Application and Cost of Agro-Chemicals (Per Hectare)

Chemical	Unit	Unit	Cost	Wheat (unit/ ha)	Wheat cost	Tomatoes (unit/ ha)	Tomatoes cost	Sorghum (unit/ ha)	Sorghum cost	Pasture (unit/ ha)	Pasture cost	Forage (unit/ ha)	Forage cost	Citrus (unit/ ha)	Citrus cost
Insecticides															
Malathion (50%)	(gal)	US	$ 21.79	-	-	1.5	32.69	-	-	-	-	1.62	35.36	1.5	32.69
		SP	84.98				127.49						137.90		127.49
Sevin (50%)	(kg)	US	$ 3.34	-	-	3.5	11.67	-	-	-	-	-	-	3.5	11.67
		SP	13.03				45.51								45.51
Gusathion (50%)	(gal)	US	$ 13.59	-	-	-	-	-	-	-	-	-	-	1.62	22.02
		SP	53.00												85.88
Herbicides															
2, 4-D (20%)	(gal)	US	$ 12.56	1.62	20.35	-	-	.6	7.54	-	-	-	-	-	-
		SP	48.98		79.37				29.41						
Linuron	(kg)	US	$ 10.00	2.8	28.00	-	-	-	-	-	-	-	-	-	-
		SP	39.00		109.20										
Treflan	(gal)	US	$ 33.08	-	-	.3	9.92	-	-	-	-	-	-	1.62	53.41
		SP	129.01				38.69								208.30

About twenty-nine kilometers of new roads and improvements on existing roads will take about 67 hectares out of production, although some of the area was already taken by existing rights-of-way. New drains would total 71 km and 120 km of existing drains would be improved. Channel improvement on the Janoubi River would be 10 km in length and the existing river channel would be widened. In each of these areas where construction takes place, the natural environment will be changed, and, in some cases, lost forever. The drains and the channel improvement, however, will revert to a natural habitat after a few years.

A good example of a change in the natural habitat would be the improvement of 11.4 km of existing drains. At present, these drains are overgrown with brush and grass, providing cover for small birds and animals. In cleaning these drains and making them more functional, much of this natural habitat will be removed, and a temporary migration will take place. During construction, and for a year or two, many of the species will leave some immediate areas. But a drain is a micro-habitat, and as soon as the natural vegetation returns, the drain once again will become inhabited by the same species, both bird and animal. In addition, some amphibians and reptiles will migrate into the newly-created aquatic habitat.

The area lost irretrievably to man, and which will not be inhabited again by bird or animals, would be that area taken for roads, schools, factories, or other permanent construction sites.

Land Use

The irrigation of the Akkar Plain will bring into production, on a more intensified scale, lands which are now only productive as water is

available. Land left fallow or only dry farmed will be cropped intensively, and this will have a definite impact on the environment. At present, about 17,000 hectares are under cultivation, of this 3,500 are irrigated. With the development of the project, about 10,000 hectares will be irrigated and can be double-cropped.

The additional vegetative growth will add to the aesthetic beauty of the area and have a minor change on the micro-climate of certain areas. The added area under production would create a more humid zone due to increased transpiration from plants and the presence of more irrigation water.

Land presently inundated by floods annually from the Janoubi River, some 800 to 1,300 hectares, will be protected by the proposed channel improvement. This land, some of the very richest in all the project, will become more productive. The Ramit Laha Swamp, which fills from flooding and runoff, will be drained and many hectares brought into production.

The surface drainage program is designed to alleviate drainage problems on the entire project area. This plan, in conjunction with the irrigation plan, will change the Plain from a poorly-drained low-intensity cropped area, to a well-drained high-intensity vegetable crop operation with double-cropping.

ALTERNATIVE PROPOSALS

A possible alternative proposal for the use of the natural resources of the Akkar Plain would be to find some other use for the water in industry instead of irrigation. Nothing has been proposed, but it may be possible to utilize the water in another way.

A smaller plan of development would also be an alternative with the development of the groundwater resources and the drainage and flood control. This plan would significantly reduce the size of the distribution system.

The Akkar Plain could be left as it is at present, but this would not satisfy the need to raise the standard of living and increase the self-sufficiency of Syria.

SHORT-TERM USES VERSUS LONG-TERM NEEDS

The long-term needs of the Syrian Government is to increase the agricultural production on the Akkar Plain and become more self-sufficient. They want to rely less on imports in the future and raise the standard of living of the farmers on the Akkar Plain. Another long-term need of the country is to increase the number of jobs available, which is related to the raising of the standard of living.

To reach these long-term goals and satisfy the needs of the future, the water and land resources of the Akkar Plain must be used carefully. The canals for the distribution system and the construction of drains are designed to utilize the land without taking land needlessly out of production.

The short-term use of the land resources (the intensification of vegetable cropping) will satisfy the need for more jobs by creating a need for a larger labor force. This will raise the standard of living on the Plain, as more men will be employed and each individual operator will increase production. No resource will be destroyed or made unusable. The implementation of the project will utilize the resources to their potential.

IRRETRIEVABLE EFFECTS

Infrastructure

To upgrade existing infrastructure facilities and provide additional facilities commensurate with full project development would require rights-of-way totalling 84 hectares. Farm-to-market roads would require more good agricultural land than the other infrastructure facilities which would be constructed on high ground, which is usually rocky and poorer class soil.

Lands which would be taken out of production for agriculture by development of infrastructure facilities are tabulated below:

Infrastructure Facility	Hectares
Agricultural Service Center	0.20
Grain Storage Bins	1.20
Health Center	0.15
Animal Processing	0.30
Fruit and Vegetable Cannery	0.15
Grading and Packing Plants (2)	0.40
Farm-to-market Roads	66.90
Educational Facilities	15.00
Dairy	10.00
TOTAL	84.41

On-Farm Irrigation

Based on the Dakaka Model Farm Study, on-farm irrigation laterals, ditches and access roads will require approximately 70 hectares of irrigable land.

Drainage

The proposed action to correct the drainage problems on the Plain includes the improvement of 120 km of existing drains and the construction of 63.3 km of new surface drains and 8.3 km of subsurface drains. The total drainage requirement would also include an ancillary drainage plan to serve all of the project area, which would be the responsibility of the Agricultural Service Center.

The ancillary drainage plan would include a drainage waste ditch collection system to serve each farm tract with a surface water outlet which would convey the water to the nearest project drain. These waste water collection ditches would be very shallow, grass-covered, waterways and could be used for grazing as well as for drainage purposes. It has been determined that about 4 km of drainage collection ditches would be required for each 100 hectares of cultivated lands. Approximately 68 hectares would be taken out of production by construction of the project drains.

LAND TAKEN OUT OF PRODUCTION BY LAND CLASS

	Land Class					
	1	2	3	5	Total	
Drains	2.1	20.0	19.9	26.5	68.5	hectares
Flood Control	18.0	2.0			20.0	
Total	20.1	22.0	19.9	26.5	88.5	

Janoubi River Flooding

The proposed action to correct flooding from the Janoubi River includes channel improvement on both sides of the Janoubi River for a distance of 10 km extending from about 2 km above the River's mouth to

the vicinity of Khirbet Akrad. The spoil bank would be 1.3 meters high with side slopes of 4:1, and the material would be excavated from the river bank. Trees and brush would also be cleared from the bank to provide good stream hydraulics. The disturbed areas would be seeded with appropriate grass varieties for erosion control and to provide habitat for the local wildlife. About 20 hectares of cultivated land on the Syrian side would be irretrievably lost by this proposed development. Approximately the same area would be lost on the Lebanon side.