



BAHRAIN SOIL AND WATER RESOURCES: AN OVERVIEW

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Acting Director**

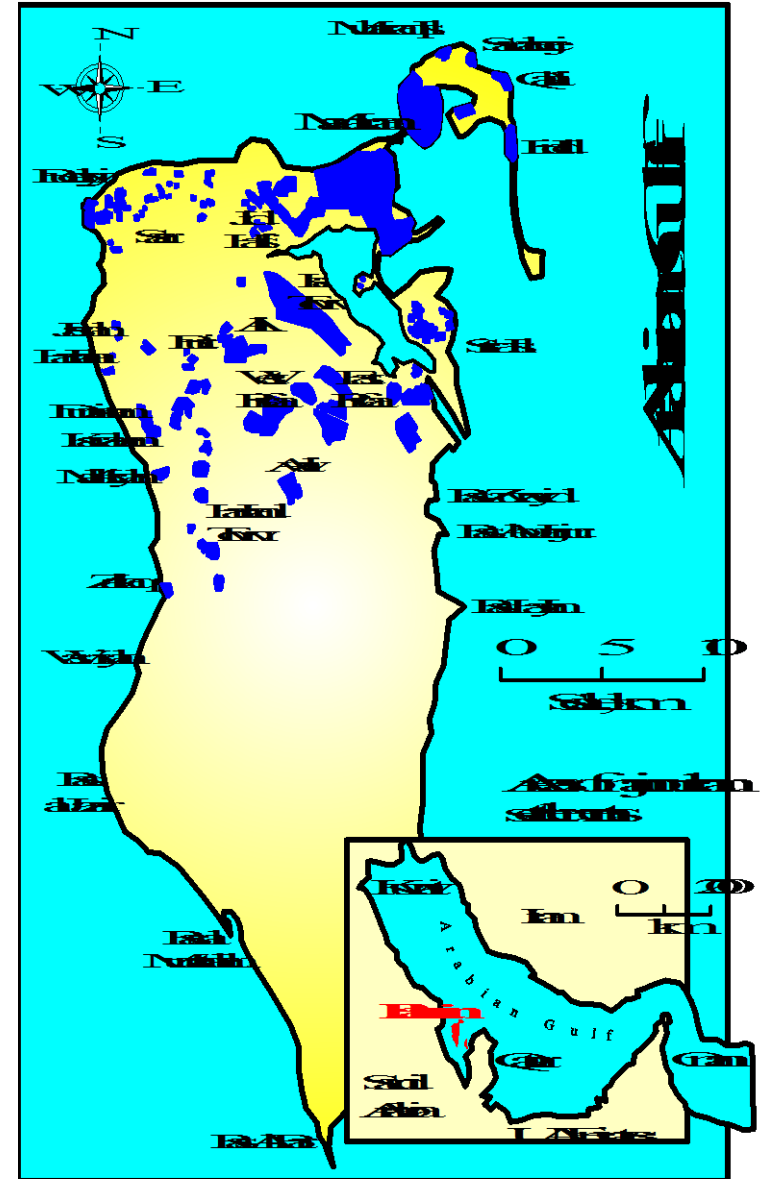
Agricultural Engineering & Water Resources

Ministry of Works and Municipality & Urban Planning

Kingdom of Bahrain

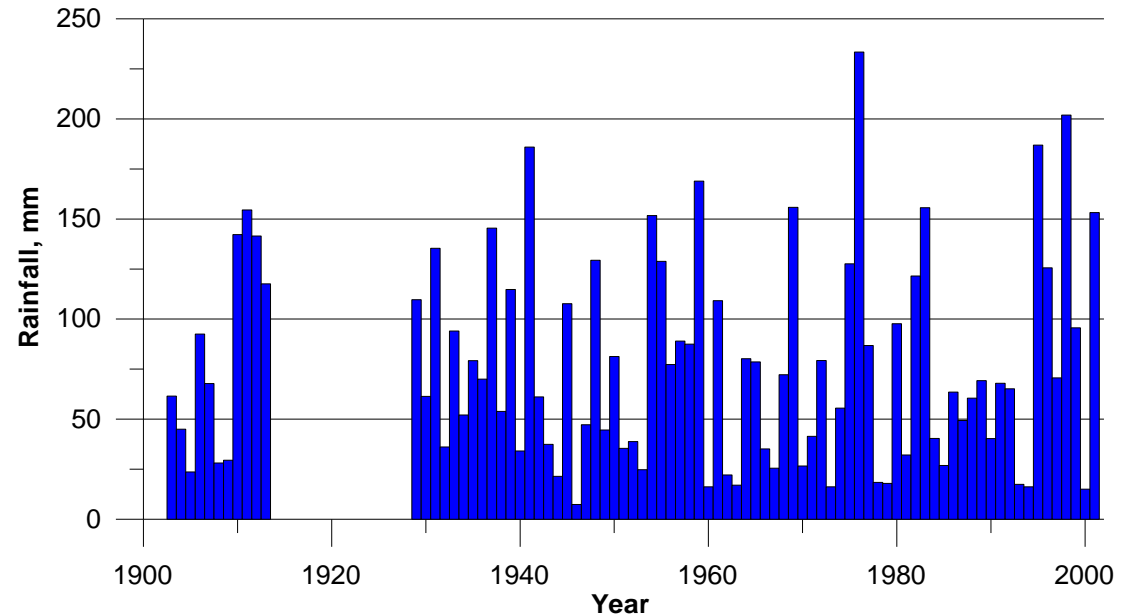
Introduction

- Location (Arid Region)
- Area (712 Km²)
- Population (1.234 million)
- High population density
- Accelerated development growth since early 1960s
- Rapid population growth associated with rapid urbanization and industrialization



Introduction

- Bahrain has an arid to extremely arid climate
- Rainfall is low and irregular, average annual is about 75 mm
- High evaporation rate, 1840 mm/y
- No surface water
- Groundwater is the only natural available source for freshwater supply



Recorded Rainfall in Bahrain, 1903-2002

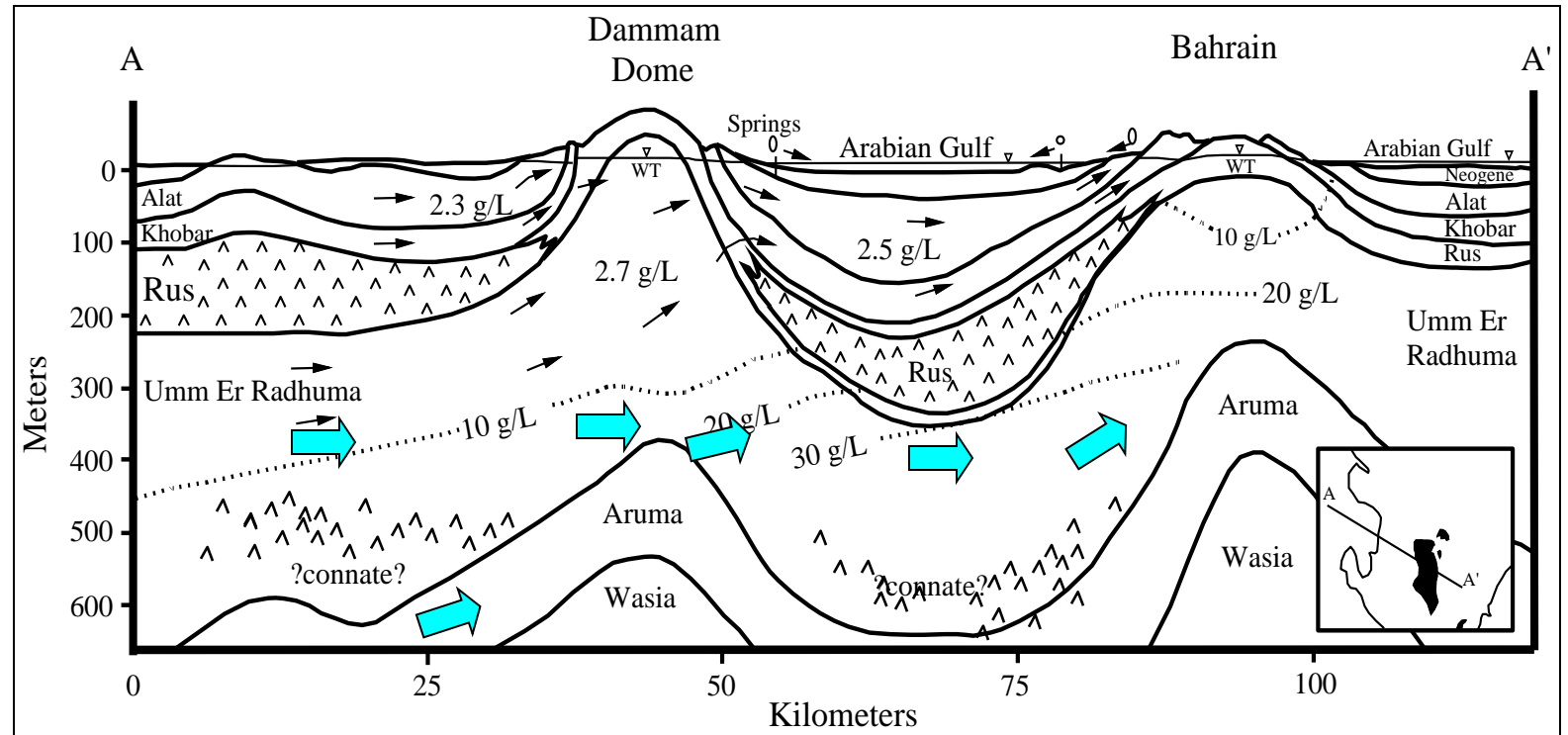
Water Resources

■ Groundwater

- **Dammam aquifer system: safe yield is between 90 - 112 Mm³ year⁻¹ – average abstraction per year (last 30 years) is about 190 Mm³ – normal salinity distribution varies from 2,300 – 4,800 ppm TDS. ural resources**
- **Bahrain depends principally on the Dammam aquifer system (70% of total consumption as a natural resources)**
- **Recharged by the Eastern Arabian Aquifer System**
- **Rus – Umm Er Radhuma aquifer: lens type aquifer virtually non-renewable – average abstraction per year is 39 Mm³ - normal salinity distribution varies from 7,000 – 15,000 ppm TDS.**

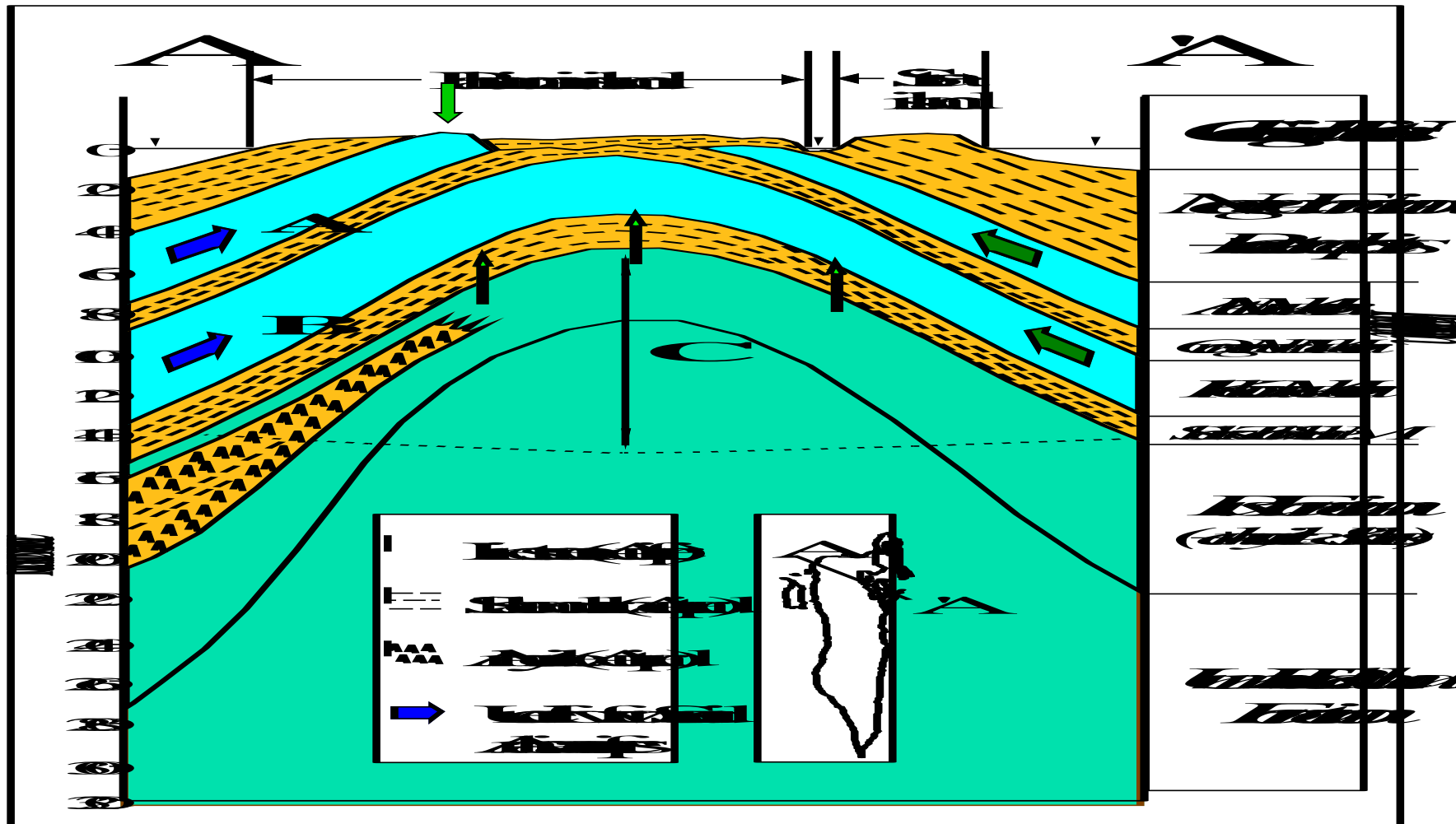
Groundwater

The Eastern Arabian Aquifer System
(Eastern Saudi Arabia – Bahrain)



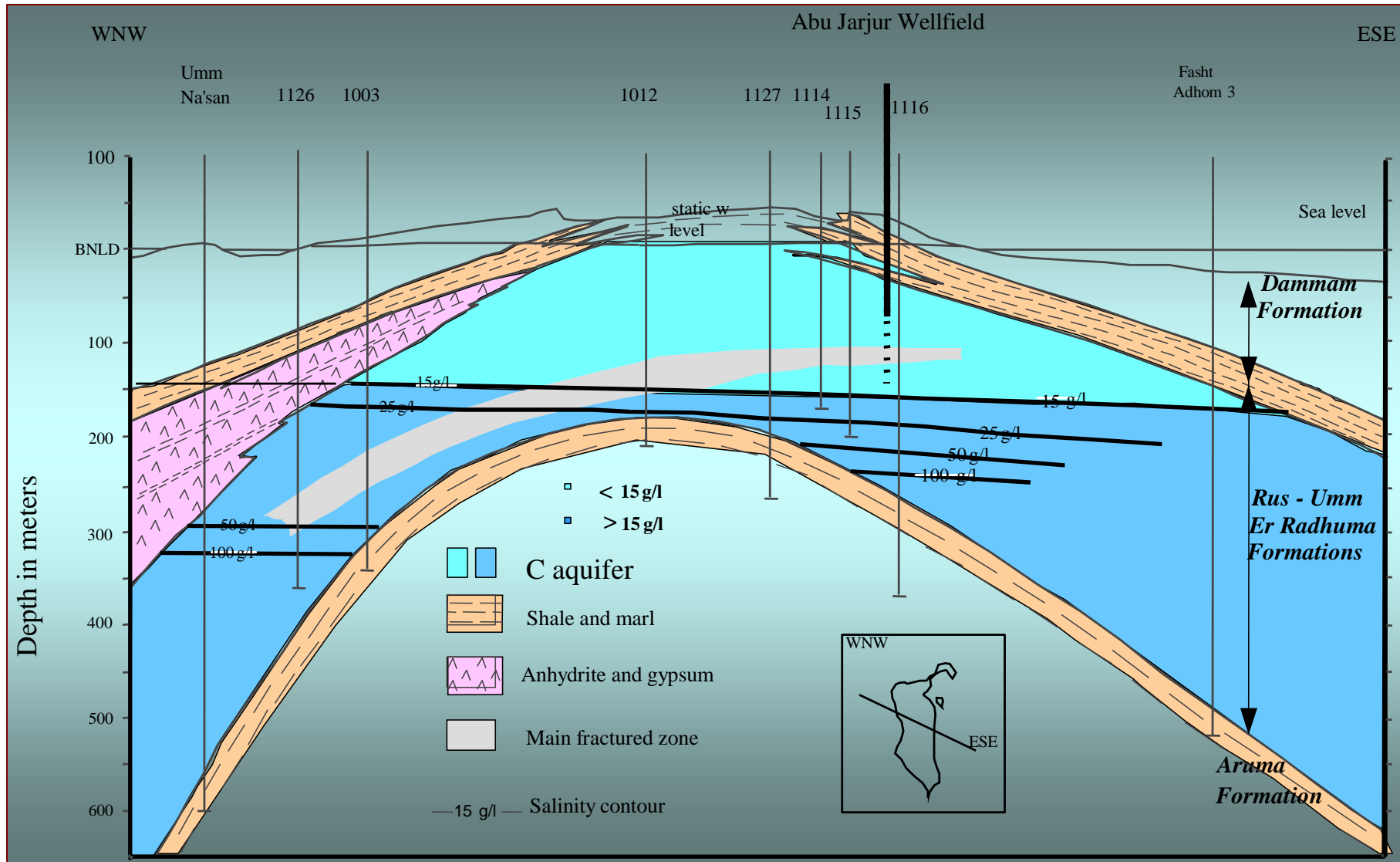
Groundwater

Aquifer System in Bahrain



Groundwater

Hydrogeological cross section showing the C aquifer



Agricultural sector

- Bahrain's agriculture contributes about 1% to the GDP
- Total area under cultivation is approximately 4200 hectare out of 11,000 hectare of arable land of the country
- The crop production is concentrated on three categories of products: fruit mainly date palm, vegetables mainly winter and fodder (alfalfa)
- The crop production is reducing due to harsh climate, unavailability of irrigation water and high soil salinity
- The farms are owned by private and public authorities
- Date palms are the most important crop of the country followed by vegetable



Land Use for Agriculture

- The total cultivable land is about 4762 ha in 1997
- Bahrain main crops are dates, vegetable and fodder crops
- Dates are the most traditional food crop.
- In addition to date palms, various kinds of fruit are grown in Bahrain.
- These includes citrus, mango, guava, chiku .. Etc
- The total area of dates and fruit is about 51% of total cultivatable area.
- Vegetable are the most important cash crop, 80 percent of vegetable are grown during the winter time when temperature is favorable.
- The total area of vegetable is about 23% of the total cultivatable land.
- Tomato is the most important vegetable, other vegetable are cucumber, lettuce, okra, onion ...etc.
- Alfalfa is the main fodder crop but sudan grass, rhodes grass, bermuda grass and others are also grown.
- The area of the green fodder is about 16% of total cutivable area.

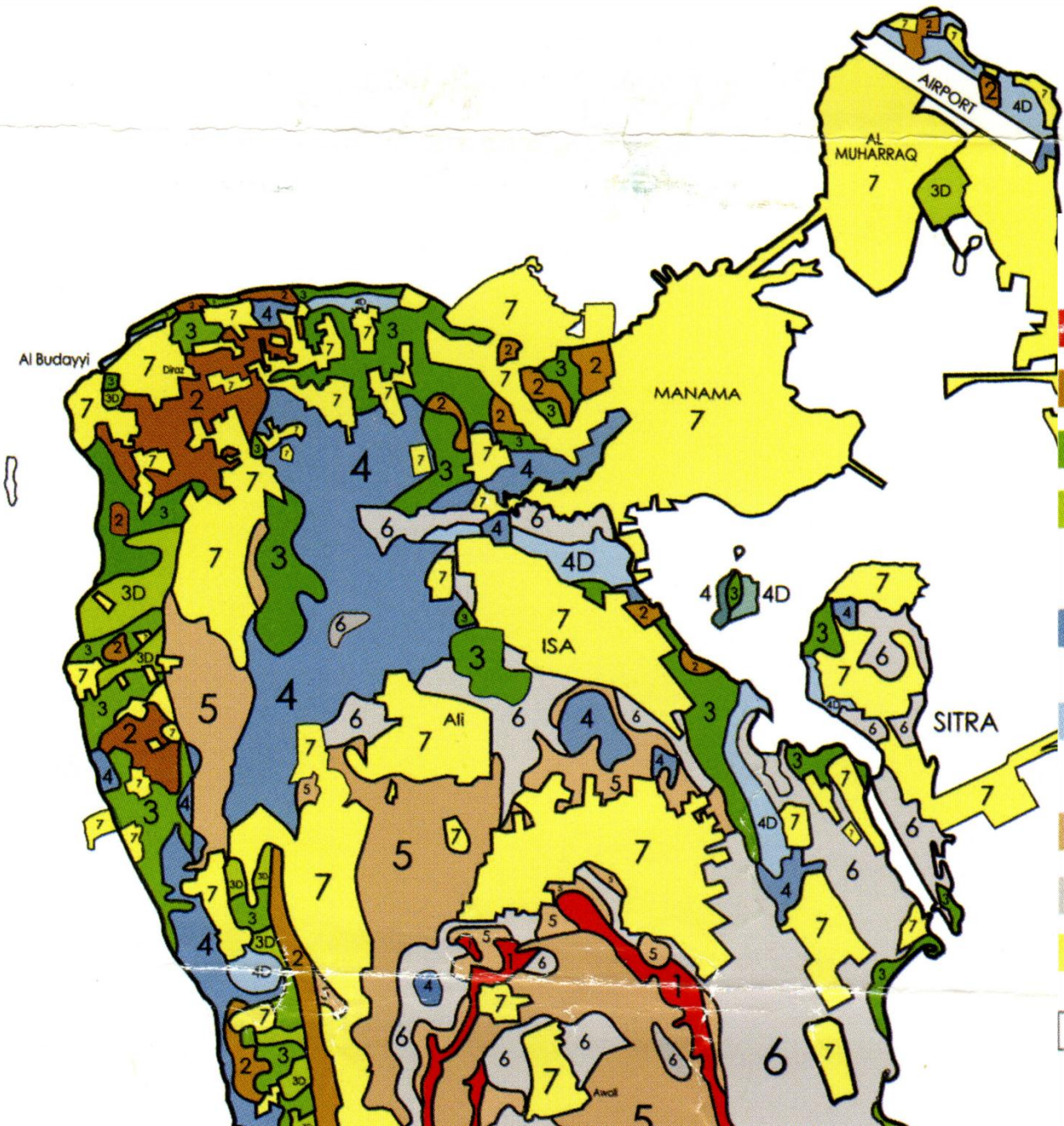
Land Use Pattern

| Cultivated Land | Area in ha |
|------------------------|-------------------|
| Vegetables | 1110 |
| Fodder and Others | 780 |
| Dates and Fruit trees | 2410 |
| Landscaping | 308 |
| Fallow and Abandoned | 154 |
| Total cultivated area | 4762 |

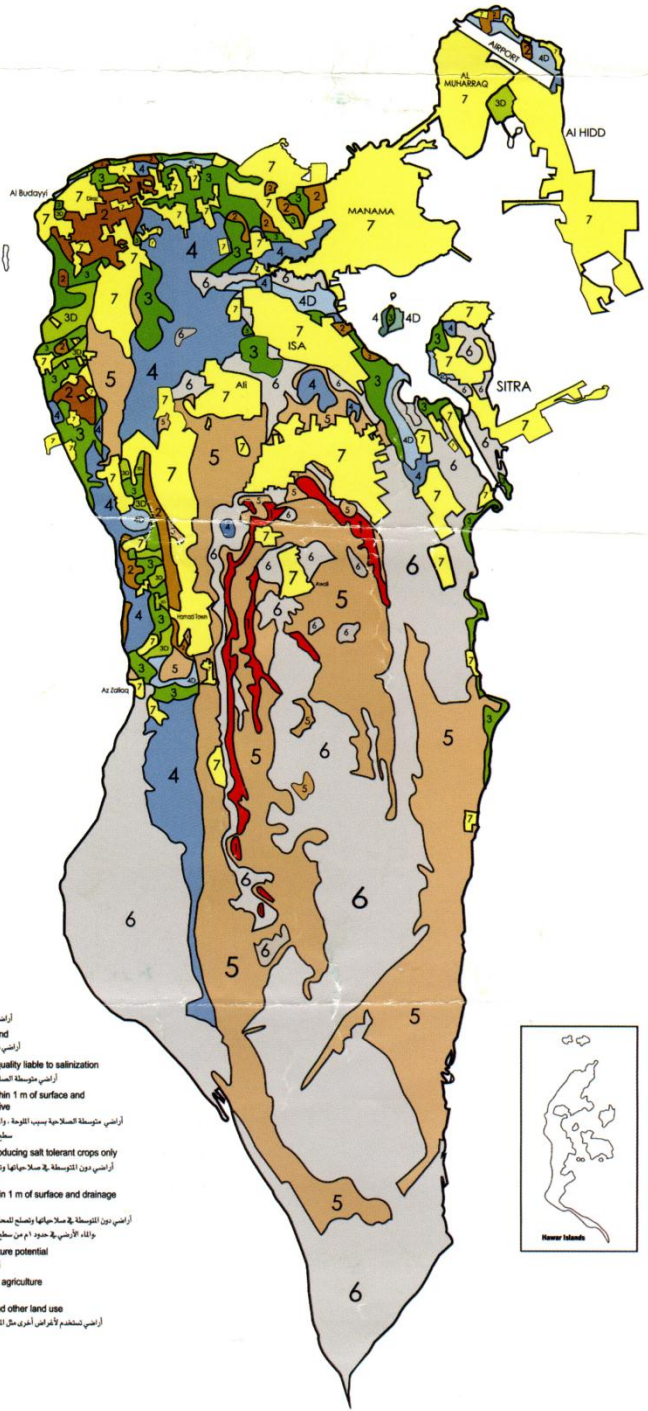
Soil

- Most of the soils are coarse textured and are highly permeable
- Soil texture varies from sand to loamy on the top whereas the subsoil texture varies from loamy sand to sandy loam.
- Most of the deeper soils are underlain by sands
- Soil salinity is very high due to application of highly ground water salinity in the past.
- Infiltration rate and hydraulic conductivity are very high to 12 cm/ hr.
- Water holding capacity is very low requiring frequent irrigation water application.





- Class 1** Good quality land
 أراضي جيدة الصلاحية للزراعة
- Class 2** Moderate quality land
 أراضي متوسطة الصلاحية للزراعة
- Class 3** Land of moderate quality liable to salinization
 أراضي متوسطة الصلاحية للزراعة بسبب الملوحة
- 3D** Water - water is within 1 m of surface and drainage is imperative
 أراضي متوسطة الصلاحية بسبب الملوحة ، والماء الأرضي في حدود ١م من سطح الأرض ، والأولى للصرف للملوحة فقط
- Class 4** Land capable of producing salt tolerant crops only
 أراضي دون المتوسطة في صلاحيتها وتصلح للمحاصيل المتحملة للملوحة فقط
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- Class 5** Land of low agriculture potential
 أراضي منخفضة الصلاحية
- Class 6** Land unsuitable for agriculture
 أراضي لا تصلح للزراعة
- Class 7** Urban, industrial and other land use
 أراضي تستخدم لأغراض أخرى مثل المناطق العمرانية والصناعية
- Unsurveyed land**
 أراضي غير ممسوحة



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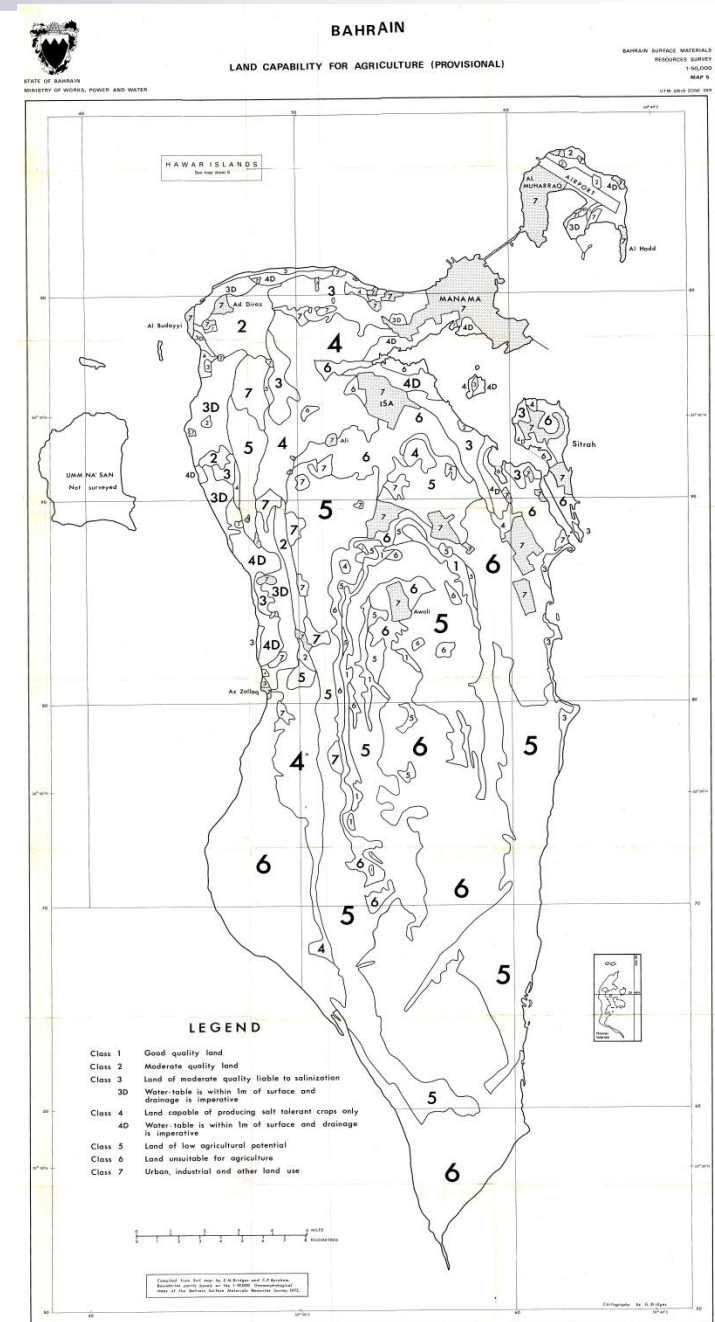
أراضي
land
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other potential
أراضي
and other land use
أراضي تستخدم لأغراض أخرى مثل المناطق العمرانية والصناعية



Land Capability for Agriculture

With regard to land capability for agriculture, the soils of Bahrain could be classified as follows

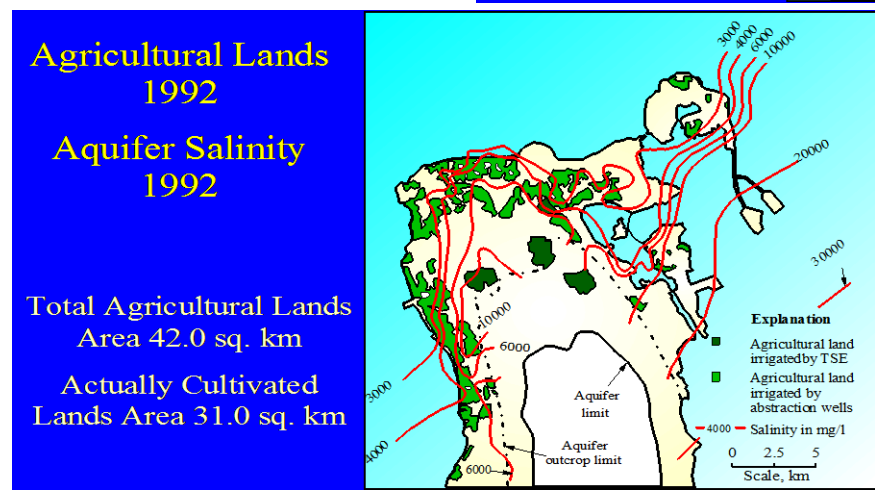
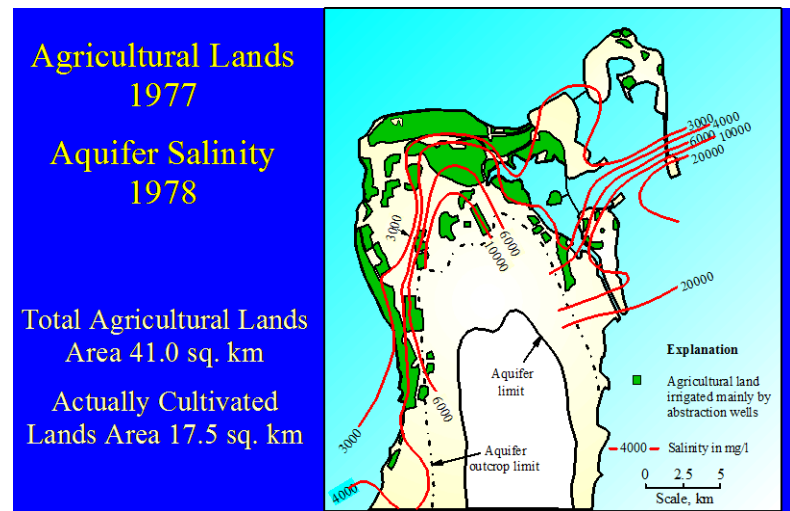
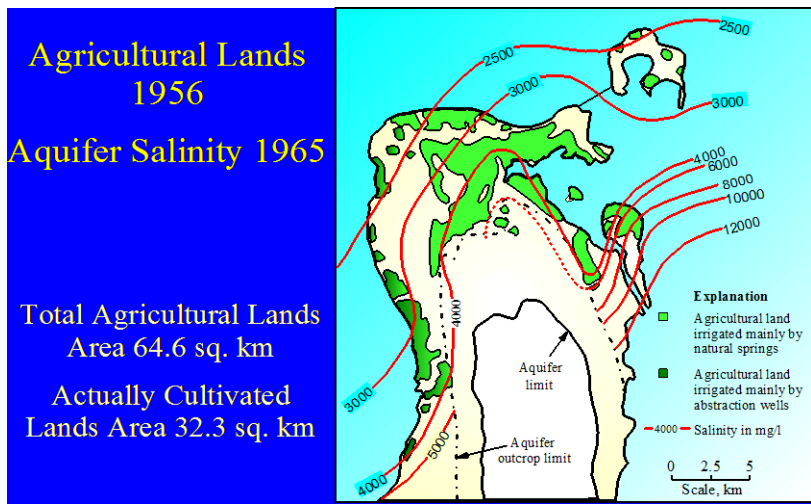
| Class No. | Class | Area,ha | %the soi |
|-----------|---|---------|----------|
| 1 | Good | 1055 | 1.49 |
| 2 | Moderate | 350 | .50 |
| 3 & 3D | Moderate, liable to salinization | 3100 | 4.39 |
| 4 & 4D | Moderately Low salt tolerant crops only | 6250 | 8.85 |
| 5 | Low | 17540 | 24.82 |
| 6 | Unsuitable | 22473 | 31.8 |
| 7 | Urban/Industrial | 19892 | 28.15 |
| | Total | 70660 | 100 |



Problems of the soil

- Taken into consideration that the quality of the irrigation water is low, in general the soils of Bahrain have low potential for agriculture due to the following:
 - The soil are moderately saline to saline.
 - High gypsum and calcium carbonate content of most soils.
 - The PH values are moderately alkaline.
 - The soil texture mainly sandy and the soils generally have low water and nutrient holding capacities.
 - The soil have low fertility potential. Organic matter contents is very low and the soils are deficient in most of macro and micro nutrient elements.
 - The presence of shallow and saline water table.
 - Soil profiles depths are limited by the presence of petrocalcic horizons at variant depth. Also the presence of compacted or cemented layers of gypsum and lime at shallow depths acts as a barrier to maximum root penetration and water movement which create severe limitations for agriculture.

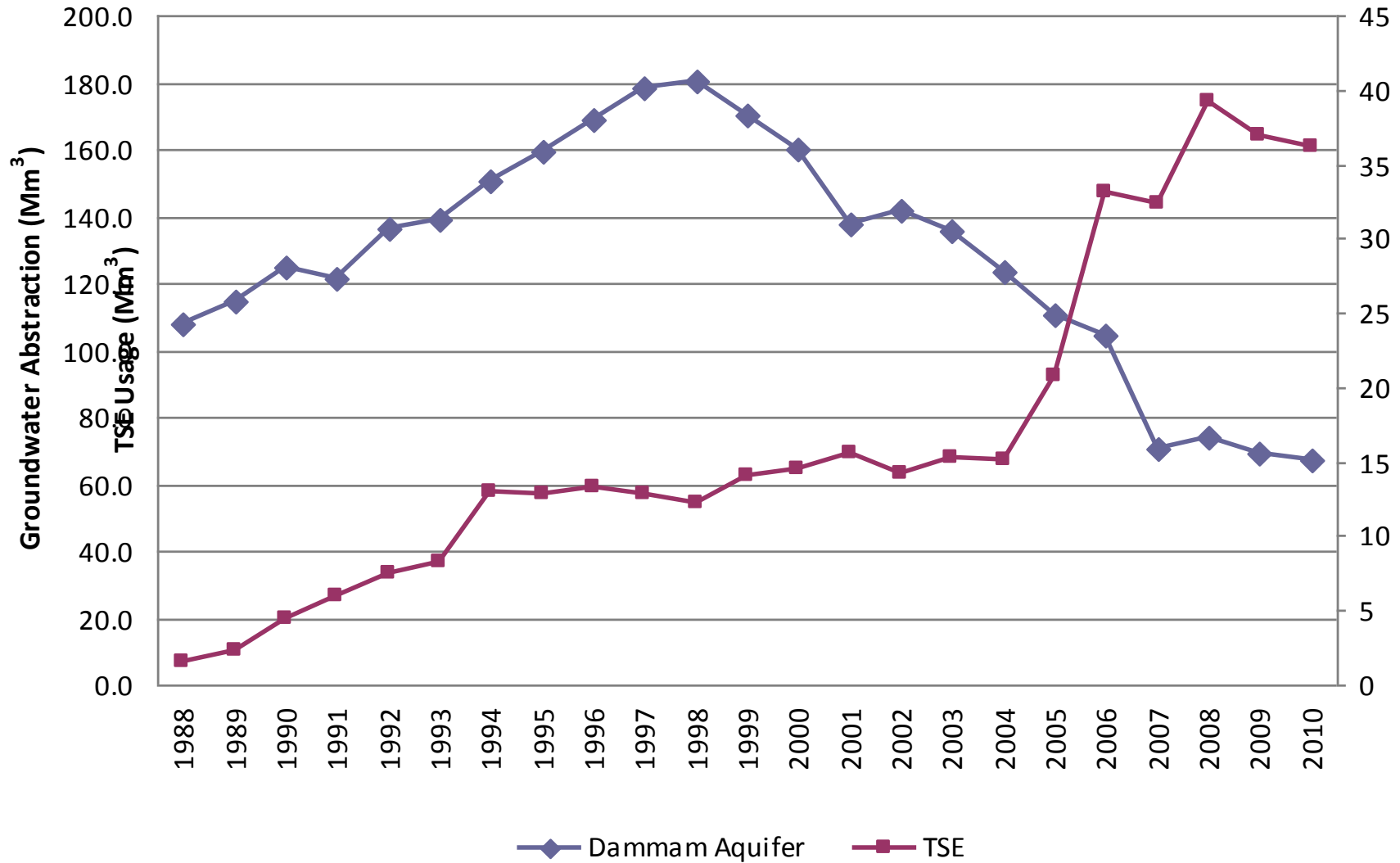
Loss of agricultural lands



■ Treated Sewage Effluent (TSE)

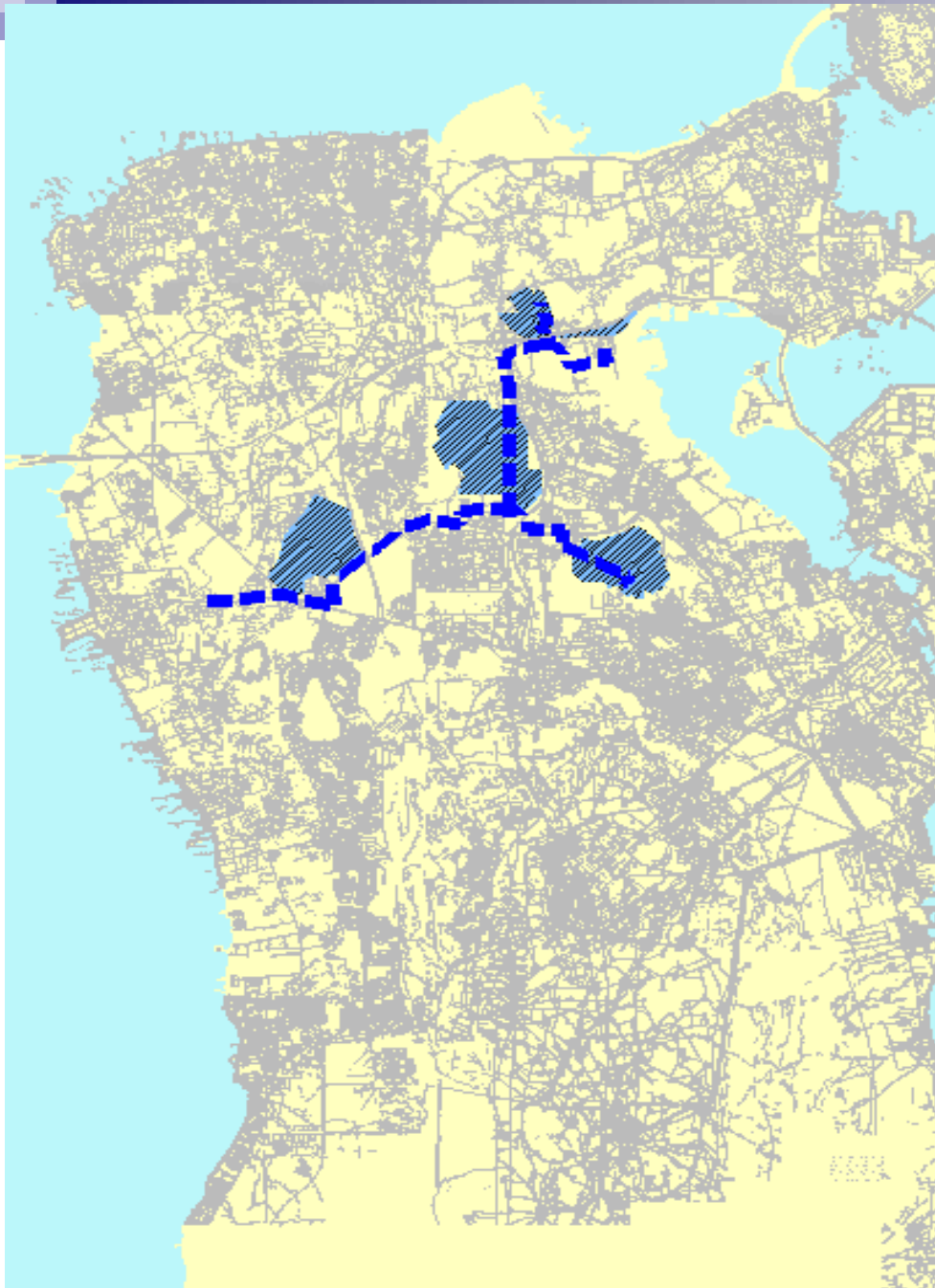
- **Major Treatment Plant: Tubli**
- **TSE Utilization: Started since 1987-88.**
- **Production capacity (2005) 160,000 m³ day⁻¹ of secondary effluent**
- **Present TSE Production: 101,000 m³/day (Tubli)**
- **TSE Quality: As per WHO standard for irrigation**
- **Primary User: Agriculture (85-90%)**
- **Secondary User: Municipal Landscaping, others**
- **Coverage under TSE: ~3,000 hectares (out of 4200 ha).**
- **Projection for 2015: 390,000 m³/day**
- **Projection for 2030: 500,000 m³/day**

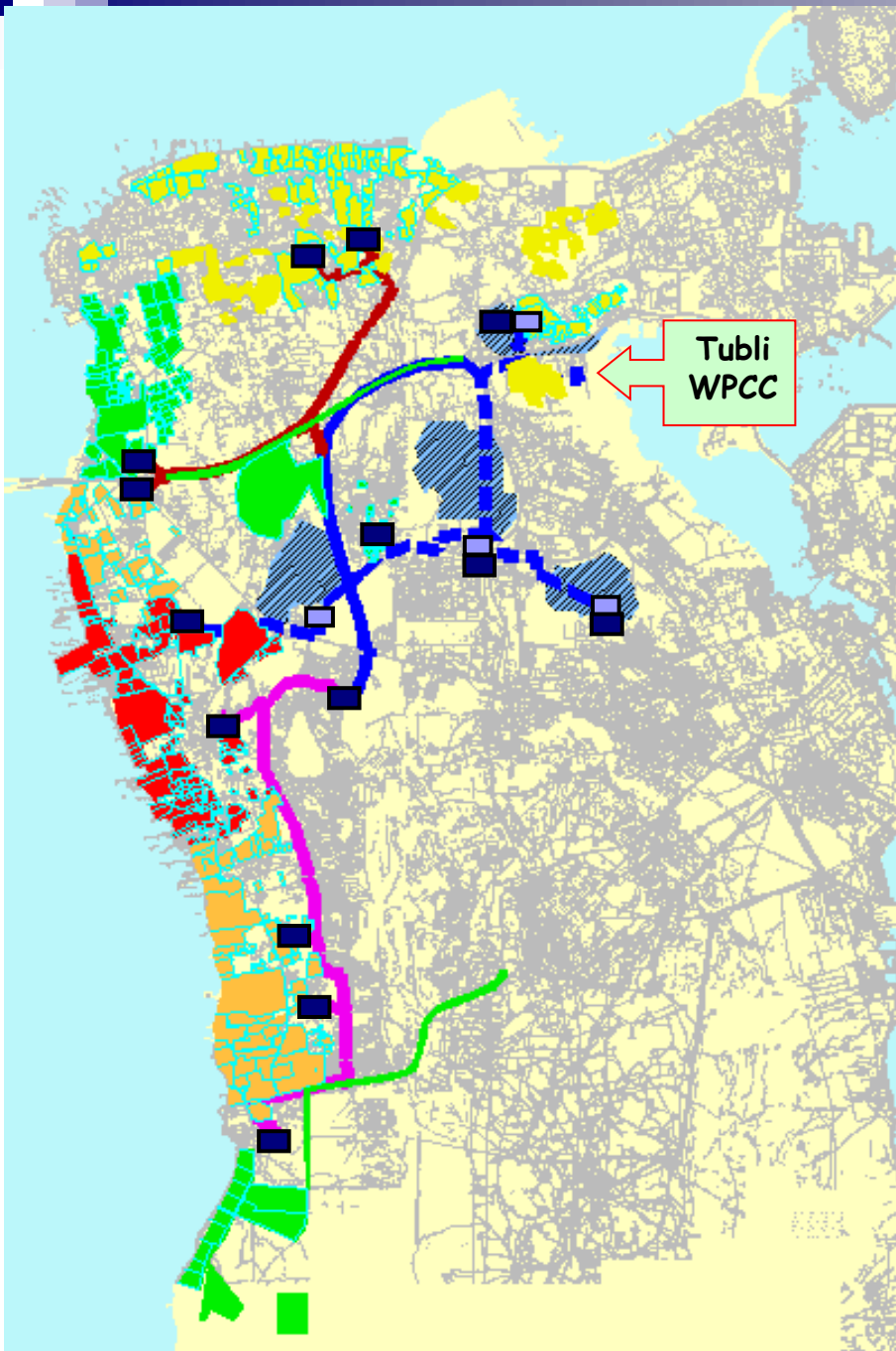
Groundwater and TSE Usage for Agriculture



TSE Phase - I












- TSE RESERVOIRS
- TRANSMISSION LINES
- ▨ AGRICULTURE AREAS SUPPLIED BY TSE





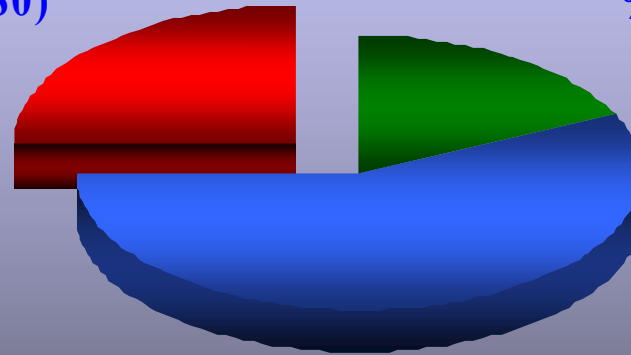
The Extent of the TSE scheme (Irrigated Farms)

Legend:

-  EXISTING TSE RESERVOIRS
-  EXISTING TRANSMISSION LINES
-  EXIST. AGRICULTURAL AREAS SUPPLIED WITH TSE
-  TSE RESERVOIRS
-  TRANSMISSION LINES - 1
-  TRANSMISSION LINES - 2
-  TRANSMISSION LINES - 3
-  DISTRIBUTION LINES - 1
-  DISTRIBUTION LINES - 2
-  DISTRIBUTION LINES - 3
-  DISTRIBUTION LINES - 4

مزارع غير موصلة
%25 (180)

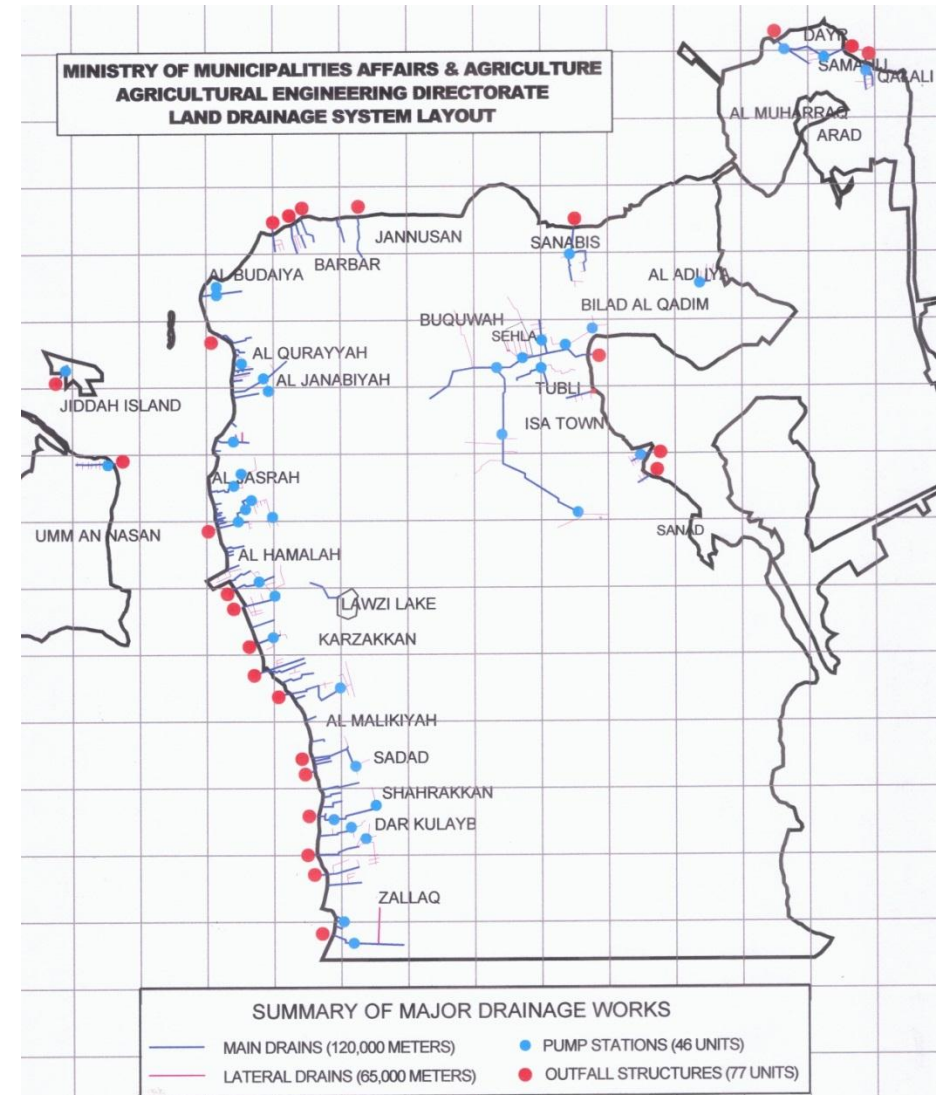
المرحلة الأولى (130)
%18



المرحلة الثانية (410)
%57

Agricultural drainage

- Large areas of agricultural land in Bahrain are underlain by impervious marine(neogene lime stone) formation.
- Such areas tend to become water logged when irrigated
- The rise in subsoil water table and accompanying salinization of the root zone restrict the yield of crops and the problem is further aggravated by the saline nature of the irrigation water.
- Due to high salinity of the soil and the irrigation water farmers tend to abandon their farming.
- Main drains of 125 km length, lateral drain of 72 km, field drains of 76 km along with 49 electromechanical lift pump station have been constructed.



Agricultural Drainage

- Further establishment of improved drainage system network, environmental friendly with increased food production and aesthetically acceptable like underground drains are underway
- Efficient working of drainage system including efficient and regular maintenance for desired lowering of subsoil water table depth and salinity is the priority of the Ministry
- .



| REGION of Work Sites | Northern Region | | Central Region | | Western Region | | Area, hec. | Total Quantity |
|---|------------------------|---------------|-----------------------|---------------|-----------------------|---------------|-------------------|-----------------------|
| | Length (Km) | Number | Length (Km) | Number | Length (Km) | Number | | |
| Main(Open+ +Underground Drain) | 53 | 44 | 34 | 25 | 38 | 27 | 2400 | 125 |
| Lateral(Open+ Underground Drain) | 36 | 40 | 17 | 21 | 19 | 22 | 1900 | 72 |
| Field Drains (Open+ subsurface) | 23 | 110 | 45 | 103 | 9 | 36 | 570 | 76 |
| Pressure Pipeline | 11 | 14 | 7 | 9 | 9 | 9 | | 23 |
| Culvert (Circular& Rectangular | | 77 | | 66 | | 512 | | 195 |
| Pump Station (Pump sump, Control panel, Valves etc.) | | 20 | | 17 | | 12 | | 49 |
| Outfall Drainage structures | | 33 | | 29 | | 18 | | 81 |
| Stone Pitched Drain | 2 | 2 | 5 | 2 | 2 | 8 | | 10 |
| Drainage Structure Drops, foot bridges etc | | 164 | | 205 | | 251 | | 620 |
| Drain Discharge, MCM/year | 8.0 | | 7.5 | | 6.0 | | | 21.5 |

إستخدام نظم الري الحديثة



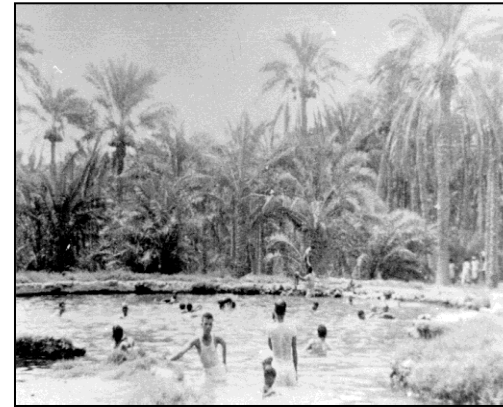
Recommendation

- Enhance the quality and availability of soil data and information
- Activate laws and regulations (Regulations should consider soil as valuable none renewable resource)
- Increase farmer supporting
- Increase programs and projects which sport the agriculture and agricultural affairs .
- Training
- Alternative water resources for irrigation (TSE)
- Alternative lands for development
- Encourage Agri_investments by private sector

Loss of agricultural lands due to salinization



Loss of natural springs and their surrounding habitats (biodiversity, migratory birds, etc..)





*Thank You
for your
attention*