SECTION G: NATURAL RESOURCES

Introduction:

Jordan as a whole is lacking in major natural resources. Jordan imports 97% of its petroleum and natural gas and of its extractive resources it is phosphate and potash that top the list. The former comes from open cast mines in southern Jordan while the latter is extracted from the salts of the dwindling Dead Sea. Cement is produced from the widely available limestone. The Badia has plenty of limestone and a number of locations where minerals are extracted on a small scale in association with the volcanic intrusions. It is conceivable that the N.E. Badia, representing 30% of Jordan has the potential for the extraction of oil shale in future.

Distance from the more densely populated areas of Jordan is also a factor in the development of the Badia's natural resources. The remote villages are not connected to the national grid and rely on electricity produced locally by diesel generators.

Potential Land Use:

As a result of an in-depth study of the resources of the Azraq basin a potential land use map has been produced (Fig. G1). The findings of this research are summarised below[1].

Sources of power:

Wood:
Traditionally wood was collected by the nomadic population and still is to a lesser degree. It does not take much dry wood to provide heat for a kettle or cooking pot. However the availability of dry (as opposed to green) wood has significantly decreased as the population has grown leading to a reliance on paraffin or liquid gas as alternatives. The winters in this area can be extremely cold at which time some nomadic populations retreat to concrete houses in villages.

Animal dung:
On a very small scale dried goats dung is used to provide fuel for domestic use.

Hydrocarbons:
All Bedouin families have pick-up trucks these days and rely on the availability of petrol or diesel. None of this is locally produced or refined and the pipelines once running from Iraq and Saudi Arabia across Jordan to Haifa have long since ceased to exist. Prospecting for oil in geologically favourable locations has revealed possibilities in places where there are gently dipping basins. Currently the Jordanians are prospecting for oil in shale deposits in the barren interior of the Badia (see Task GX) in the El-Hazim basin.

Wind:
Wind power is harnessed in the Badia but not as extensively as one might expect given the open nature of the terrain. It is used for pumping water from underground rather

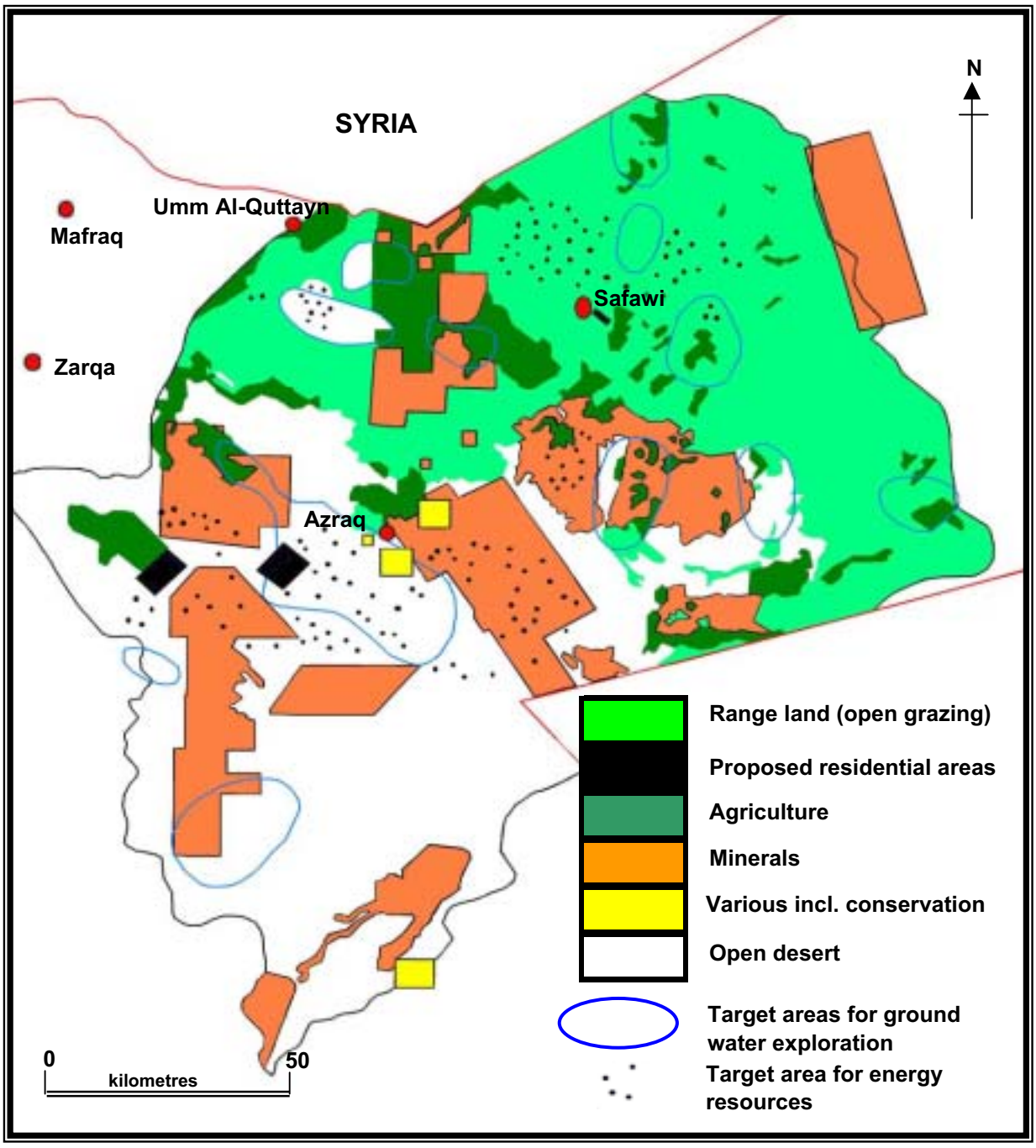


Fig.G1: Potential land use map of the Azraq basin (after Bassam Sunna*)

*"Integrated studies of the Azraq basin for optimum utilization of the natural resources". In Dutton RW and Shahbaz MI (2008) "Jordan's arid Badia: deepening our understanding." Smith-Gordon & Co.

than to provide electric power. Nevertheless the average wind speeds are not very high (average 7.2m/sec at Safawi) so that it would perhaps be best used in conjunction with photovoltaic production and in both cases, given the unreliability of wind, there would be the need to maintain battery storage of electricity.

Solar:
There is a high potential for the use of photovoltaic (solar) energy in the Badia but as yet it is relatively little used. The high cost of initial installations is a deterrent. Nevertheless the big skies and high incidence of incoming radiation make this source the best option for future energy production in these remote rural areas.

Geothermal:
The thermal gradient within some rock structures looks suitable for tapping geothermal energy.

Minerals:

Diatomite: Residual deposits of the remains of microscopic organisms that lived in the once more extensive Azraq playa lake. It can be used as an industrial filter or as a filler in paper production.

Rock Salt: The Romans extracted this from the Azraq springs to pay the soldiers their *salary* (Literally their salt ration). The accumulations, if properly managed could be pumped to surface evaporation pans for processing and marketing.

Evaporites: The former seasonal lake Azraq contains various deposits produced as a result of the muddy waters evaporating to leave residue. These include gypsum, kaolinite and bentonite, which can be used as an absorbent of heavy metals and as animal feed.

Basalt: In humid areas basalt is not a good building stone but here in the arid Badia it has been widely used over the centuries and could be more so today. In future it may be possible to produce rock wool from these volcanic rocks.

Volcanic tuffs and zeolites: this material, found adjacent to former eruptive volcanic cones, is difficult to quarry in view of its loose nature but it can be used in the manufacture of cement and concrete and as an aggregate in construction work. Some deposits can be used to produce fine table salt.

Limestone: The limestone is extensively quarried for both building and facing stone. In some places there are natural concretions, which are in high demand as purely decorative features in building. The extraction of limestone is largely uncontrolled at the moment. Some of the limestone is extremely fine (chalk and porcelanite) and useable as a filler in the paint, plastics and rubber industries.

Water:

Surveys have located potential zones for fossil water that may in due course be used to establish new agricultural and settlement areas. However not all subterranean water is

suitable being charged with dissolved salts from the evaporite beds above. In some cases the water has a distinctly sulphurous smell.

Areas of Outstanding Natural Value:

This topic is covered in Sections H (Tourism) and J (Sustainability) but mentioned here because, as tourism grows as a source of national income the value of these areas needs to be factored in to any long-term land use planning.

References:

1. Sunna', Bassam (2008) Integrated studies of the Azraq basin for optimum utilization of the natural resources. In Dutton RW and Shahbaz M: Jordan's arid Badia: deepening our understanding. pp.29-44. Smith-Gordon, Cambridge (UK).

Task G1: Locating Mineral Resources:

Study the land use map (Fig. G1), geological cross-section (Fig.E4) and the satellite photograph (Fig. G2). The extensive white areas are where surface water draining into the seasonal Azraq playa lake have evaporated to leave sediment.

1: What rock forms the black area just north of the lake? How was it formed and what are its characteristics? (See Task A7)

2: The highest ground in this region lies to the north in Syria in the Jebel al-'Arab (1803m). In winter this upland receives snow. When the meltwater seeps into the rocks where will it reappear? Does this explain the location of the agricultural areas?

3: The photograph clearly shows that water periodically drains into the basin from other directions. What rock will this water be flowing over? What characteristics of that rock, if any, might the water convey to the Azraq basin?

4: Once the rain and melt water has reached this centre of this internal drainage basin what will happen to it? What will be left behind? Draw a cross-section diagram to show this.

5: Does your answer to Question 4 explain the location of the large area to be targeted for mineral exploitation?

6: You are given the responsibility for developing geothermal energy sources and the extraction of diatomite in this large central area. In considering the factors that will have to be taken into account organise the 18 boxes in Figure G3 into a logical sequence.

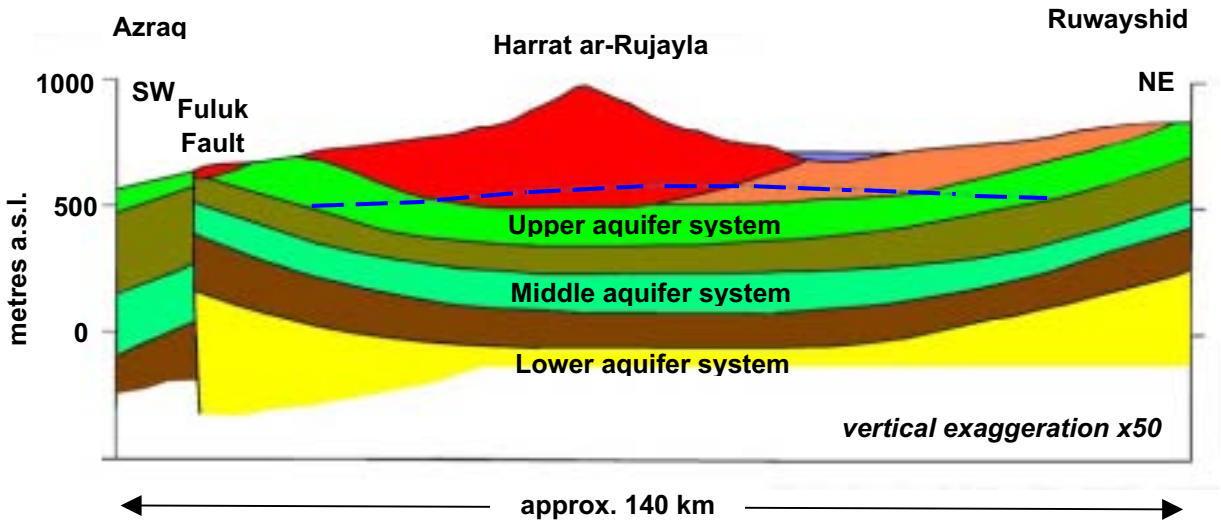
7: Have you omitted any other factors that should be taken into account? If so add them to your plan.

8: Decide where you will locate the base for your operation and prepare a sketch map of the Azraq basin to support the decisions made in question 6.

9: Make a formal presentation to demonstrate your ideas (essay or PowerPoint).

Fig. E5: Simplified geological cross section runnning SW - NE

(after Jane Dotteridge*)



Quaternary sediments
Basalts

TERTIARY

Chalky or marly limestone
Chert, marl, limestone
Soft marl. Limestone intercalated with chert & phosphate

CRETACEOUS

Chalky limestone, dolomite, chert
Limestone, marl, sand incalation
Sandstone

Water table level in the upper aquifer

*Dotteridge, Jane (1998) "Water Resources Quality, Sustainability & Development" in Dutton RW et al: Arid Land Resources & Their Manangement. Keegan Paul International

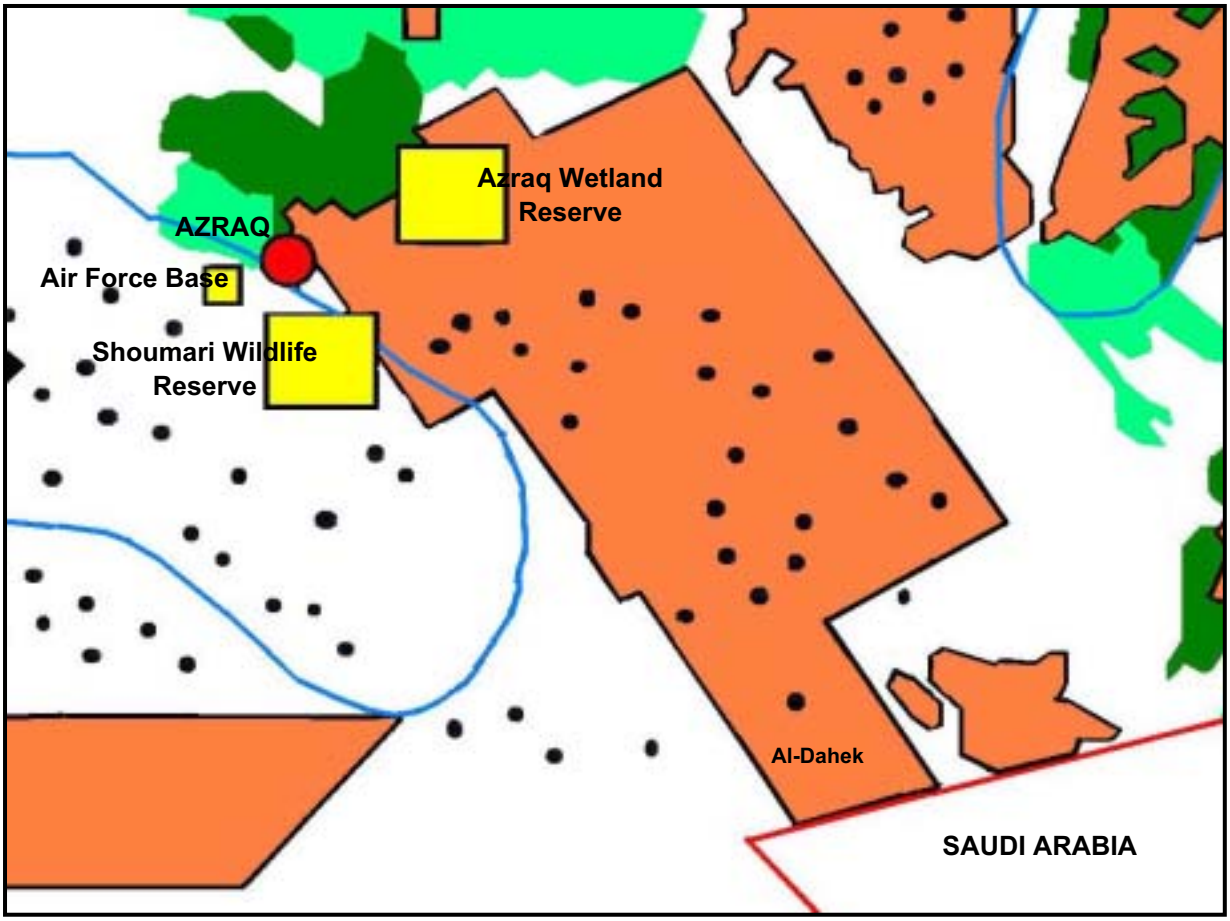
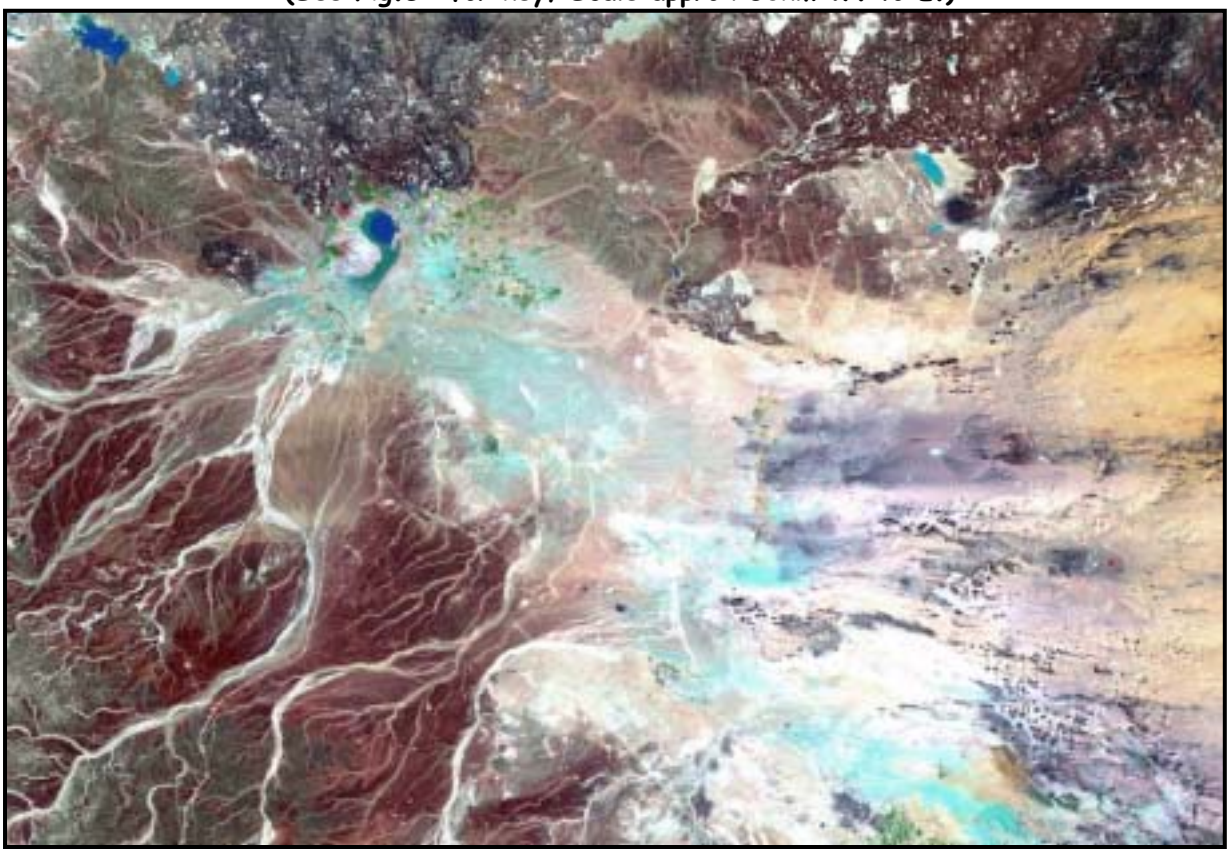


Fig.G2: The approximate area covered by the satellite image below.
(See Fig.G1 for key; Scale approx 50km W. to E.)



raise the finance to carry out exploration and exploitation	process the minerals	transport the minerals to markets
ensure that funds go back into the local community	provide power for the site	obtain your labour force
protect the environment	provide defence against flash flooding	train up a local labour force
sample and analyse the surface rocks	involve local people in the decision-making process	extract the minerals (quarrying)
protect the landscape appearance	gain access to the site	test drill for geothermal heat
carry out an environmental assessment survey	provide housing and facilities for the labour force	Liase with relevant NGO's*

Fig. G3: Developing Resources

*Non-Governmental Organisations such as the Royal Society for the Conservation of Nature; the Badia Research and Development Centre.