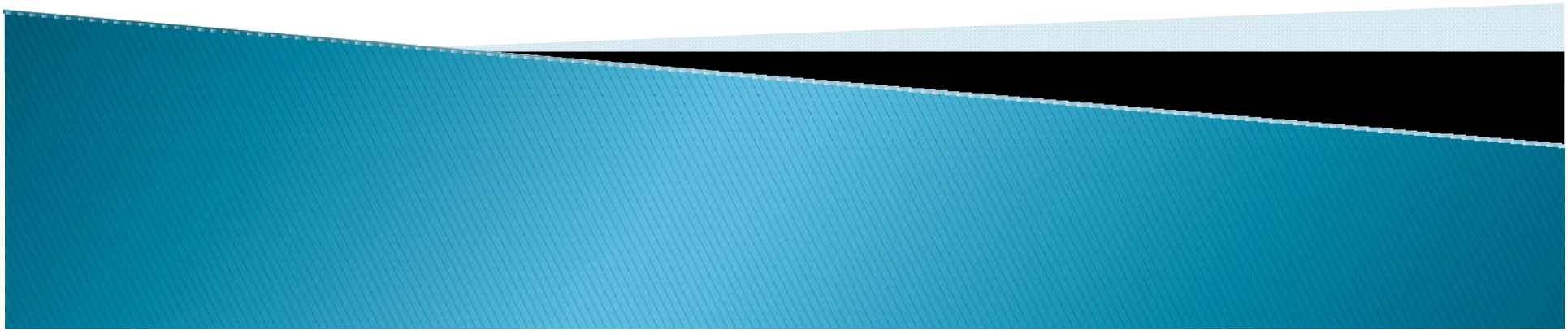
Lessons Learnt from Libyan Great Man Made River MEGA Project-8th Wonder of World: A Case of Water in Mountain

Dr Hadi M. Mgherbi*, Dr Ibrahim Mohammed Saleh**,
Ms Laila Magerbi, N. Magherbi & Dr S.P.Bindra***,
*Director Technical Education, Ministry of Education, Tripoli, Libya
** Director Higher Institute, A Garabouli, Libya
*** Professor Al Misurata University Campus 4, Al Garabouli, Libya



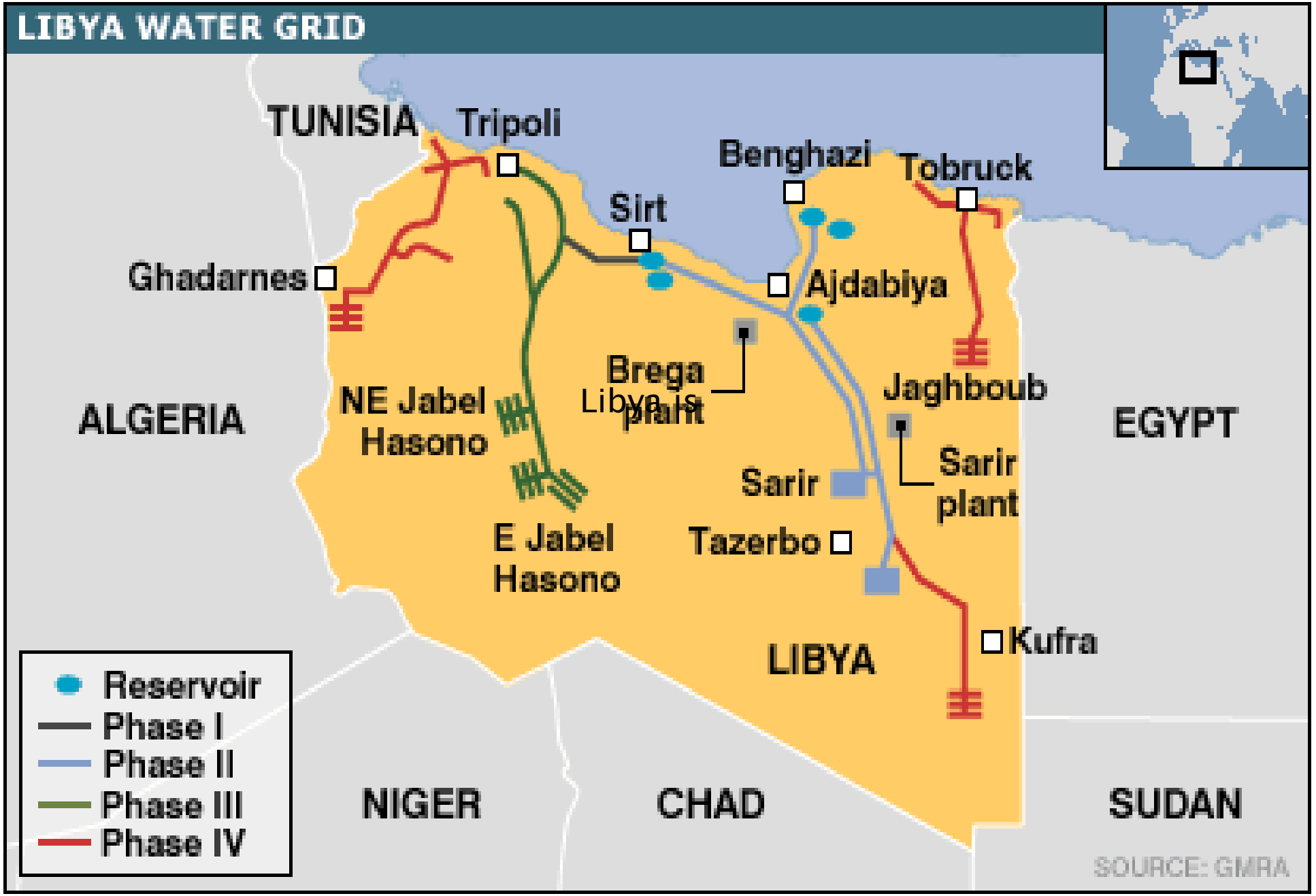
Libya is now a world leader in hydrological engineering, and it wants to export its expertise to other African and Middle-Eastern countries facing the same problems with their water.

Flag of Libya

Libya – an Arab/African nation with ready access to Europe and Africa

- Libya is a gateway to the Middle East and North African (MENA) region, which has:
  - MENA has Over 300million Arabic speaking population
  - Libyan Population is over 6 million and GDP USD 50 billion
- Libya is a major participant in the African Union

Libya water Grid is designed as “Gateway to both Europe and Africa",



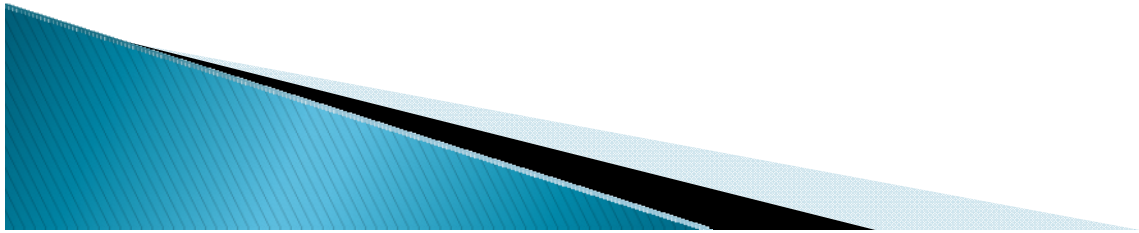
LET ME BEGIN WITH GREETINGS FROM MINISTRY OF EDUCATION

Libya – the second largest oil producer in Africa is committed to reform its higher education and scientific research systems through a US$9 billion five-year national strategic plan and international cooperation.

The aim of Libya's higher education strategy is to set up a knowledge-based Libyan society and to promote science-based industrial development. Numerous projects include the establishment of a National Authority for Scientific Research (NASR) and a Centre for Quality Assurance and Accreditation (COAA).

"The Libyan strategy also includes a $72 million project to use information and communications technologies to reform the higher education and scientific research system, which has the potential to become a model for the proper integration of ICTs in education and science.

Libya hosted French and British displays on higher education aimed at familiarising students and teachers with opportunities to and requirements for attending French and British universities in their specialised fields.



The two higher education cooperation plans were signed between Libya and Britain and France in 2007. Under the plans, British experts will help Libyan weapons scientists turn their expertise to radiological medicine and France will help Libya to use nuclear energy for peaceful purposes via a nuclear reactor to provide drinking water through seawater desalination.

The British, French and American collaborations are the latest to reflect a thaw in academic relations between Libya and the West, which began when Libya abandoned its pursuit of nuclear, chemical and biological weapons in 2003.

POLICY FOR LIBYAN MINISTRY OF EDUCATION AND RESEARCH

Our Ministry policies are been based on the best available knowledge using daring caring and sharing concept. Daring without knowledge is risky. Knowledge without daring is fruitless.

Knowledge gaps are addressed through the Libyan Programme for Research including the water research of which about one third directly related with climate change and sustainability.The Great Man-Made River (GMMR) in Libya is biggest and most important international engineering project to bring water to the inhabited fertile, coastal areas for municipal, industrial and agricultural use.

It aims to supply the country's needs by drawing water from aquifers beneath the Sahara.

The objective is to achieve self-sufficiency, food security and true independence.

It is an outcome of a triumph story against thirst and hunger.

It is a defeat against ignorance and backwardness.

It reflects the determination of Libyans, to acquire technology, to develop, to improve their lives, and to control their own destiny in accordance with their

Libya has complete "absence of permanent rivers or streams" – and it has "approximately twenty perennial lakes that are brackish or salty.

The country bears the distinction of holding the world record for hottest recorded temperature (136° F).

It has four major underground basins,viz Kufra basin, the Sirt basin, the Morzuk basin

Between 38,000 and 10,000 years ago the climate of North Africa was temperate, during which time there was considerable rainfall in Libya.

The excess rainfall infiltrated into porous
sandstone and was trapped between layers, forming reservoirs of underground fresh-water.

The Libyan climate ranges between Mediterranean to arid and semi-arid.

Rainfall ranges from 10 to 500 mm/yr

New threats for Great Man Made River (GMMR) water resources:
Climate change / global warming

CLIMATE CHANGE THREATS TO LIBYAN CITIES AND DESERT

Sea level rise due to global warming 1m only = Tripoli, Garabouli, Sirt, Misurata, Benghazi cities underwater

Expected: 7m (Greenland's icecap melting)

 Impact on desalination plants + coastal GMMR infrastructure

 Saline intrusions in groundwater table

THE GOAL OF THE LIBYAN GREAT MAN-MADE RIVER (GMMR) PROJECT

To make Libya a source of agricultural abundance capable of producing adequate food and water to supply its own needs and to share with neighboring countries.

GMMR Project is literally Libya's 'meal ticket' to self-sufficiency.

This mega project of Libya is planned way back in 1960 to serve as the largest water transport project ever undertaken and rightly described as the "eighth wonder of the world"

WHY GMMR ?

Water derived from desalination or aquifers near the coast in Libya is found to be of poor quality and sometimes undrinkable.

In addition a little water was available to irrigate land for agriculture.

2 percent of total land area is suitable for agriculture,
about 4 percent is suitable for grazing livestock and the rest is agriculturally not useful desert.

Most arable land lies in : the Jabal al Akhdar region around Benghazi, and the Jifarah Plain near Tripoli. Jabal al Akhdar receive between 400 and 600 millimeters of rain annually,

The central and eastern parts of the Jifarah Plain and the nearby Jabal Nafusah also average between 200 and 400 millimeters of rain annually. The remaining Libyan coastal average 100 to 200 millimeters of rain yearly.

Jifarah Plain is endowed with an underground aquifer that has made intensive well-driven irrigation possible. Desert in south of this strip, Al Kufrah, Sabha, and Marzuq has only occasional oasis cultivation

STUDIES IN THE LATE 1970S

About one-third of the total arable land remained fallow and that as many as 45 percent of the farms were under 10 hectares.

The average farm size was about 11 hectares, although many were fragmented into small, noncontiguous plots.

Most farms in the Jifarah Plain were irrigated by individual wells and electric pumps, although in 1985 only about 1 percent of the arable land was irrigated

Shortly after the Libyan 1969 revolution, the government nationalized all foreign -owned farms (about 38,000 hectares) and redistributed in smaller plots to Libyans.

The falling water tables in Libya's best agricultural lands caused by over-irrigation posed a severe long-term ecological threat to agriculture.

The government took measures to discourage citrus and tomato cultivation, both of which required large amounts of water

Desert landscape in Libya; 90% of the country is desert

Moving sand dunes in Tadrart Acacus

View from Jebel Akhdar in Libya near Benghazi is Libya's wettest region. Annual rainfall averages at between 400 and 600 millimeters.

Libya a land of desert and camels

Great Man-made River

- The Great Man-Made River, is a network of pipes that supplies water from the Sahara Desert in Libya to the northern part
- It is the largest underground network of pipes and aqueducts in the world.
- It consists of more than 1,300 wells, more than 500 m deep, and supplies 6,500,000 m^3 of fresh water per day to the cities of Tripoli, Benghazi, Sirte and others.

INTERESTING GMMR DATA

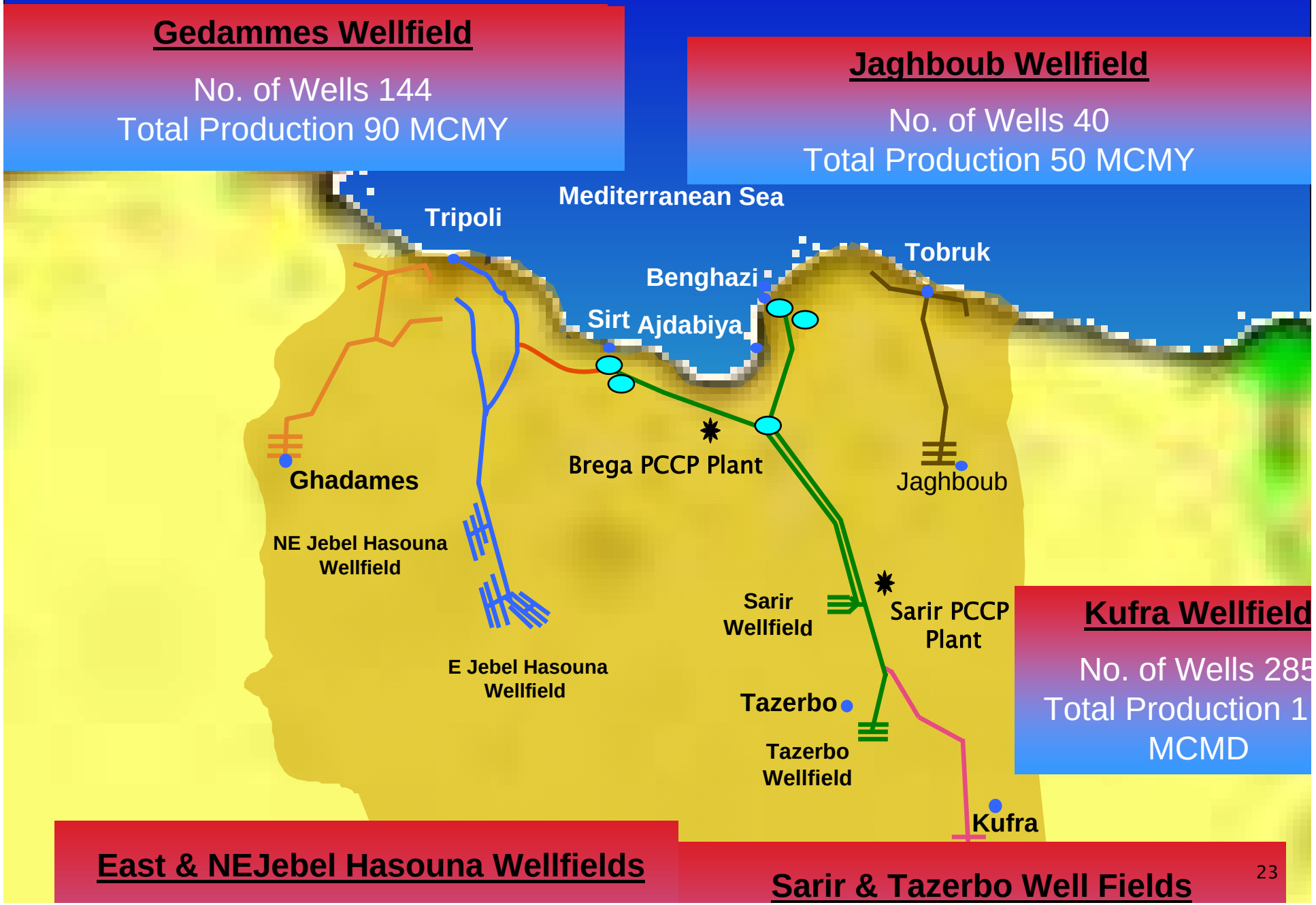
GMMR carries more than five million cubic meters of water per day across the desert to coastal areas.

The total cost of the huge project is over $25 billion (US). Brown & Root and Price Brothers gave the original design, and the primary contractor for the first phases was Dong Ah Consortium (a South Korean construction company) and present main contractor is Al Nahr Com.

Water in Libya till recent past came from underground Aquifers or desalination plants on its 2000km long coast. The fossil aquifer from which this water is being supplied is the Nubian Sandstone Aquifer System that accumulated during the last ice age.

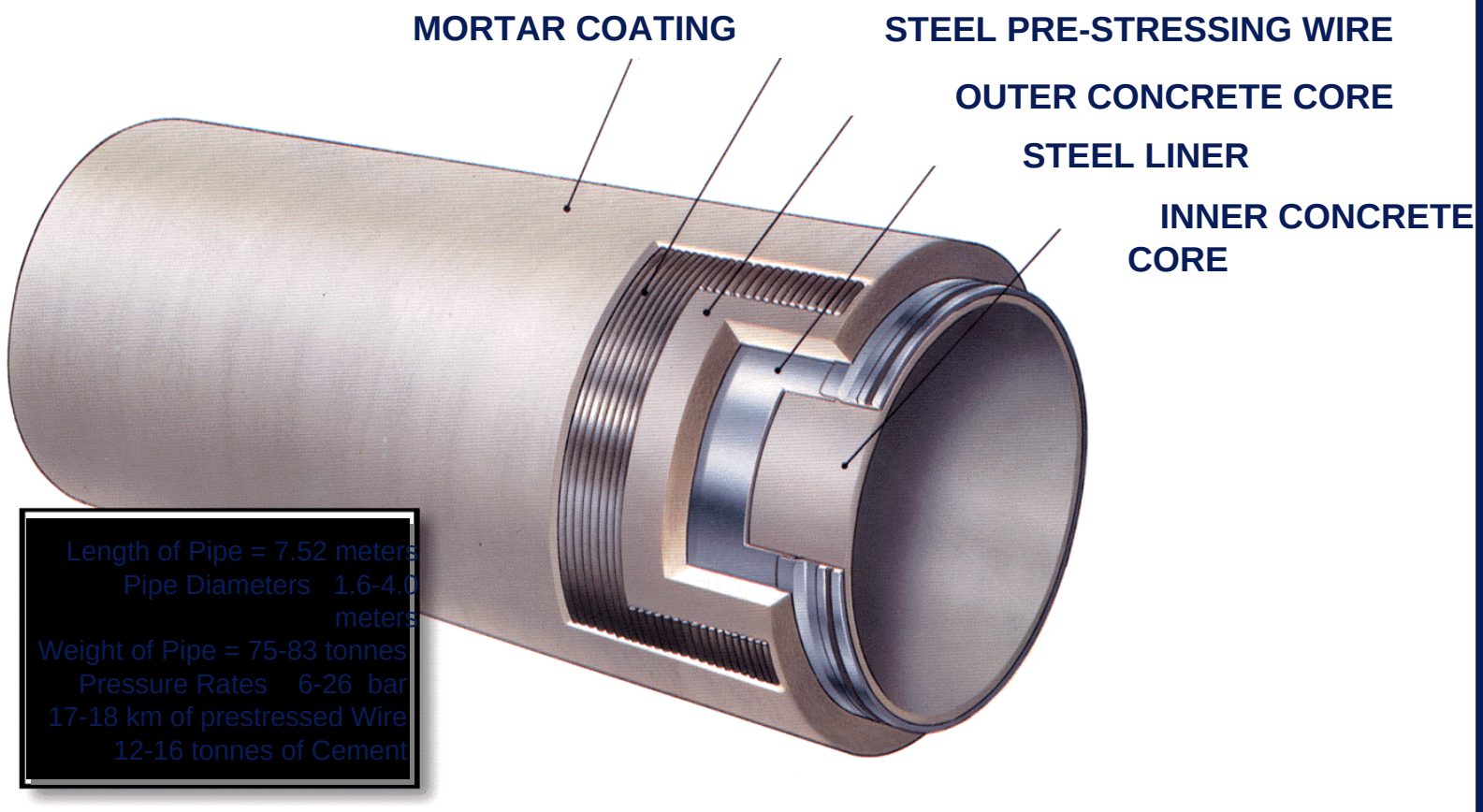
The water could last [illegible] thousand years

THE GREAT MAN-MADE RIVER PROJECT



Cut-away Section of a Pre-stressed Concrete Cylinder Pipe (PCCP)

PIPE MAKE-UP



Each pipe of the river project as shown below is buried in a trench approximately seven metres deep, excavation of which requires the removal of some 100,000 cubic metres of material each working day.

Excavation is carried out by large hydraulic excavators fitted with 7.6 cubic metre buckets. Once the trench has been prepared, prestressed concrete cylinder pipes 7.5 metres long and weighing up to 80 tons are brought to the site using a fleet of some 128 specially designed transporters.

large hydraulic excavator

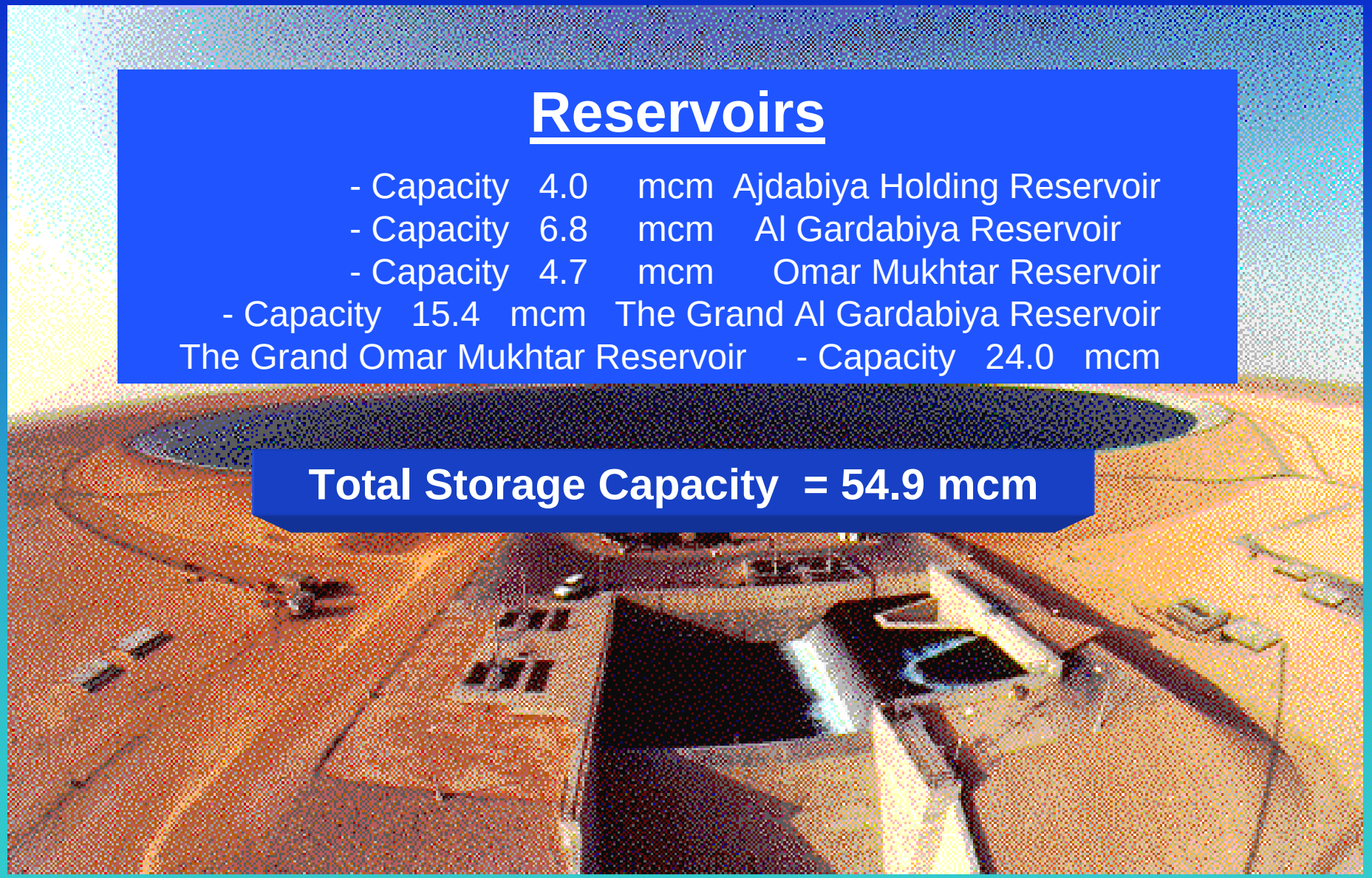

pipe being
delivered


Pipe Transportation


pipes on the way to extend the system

Reservoirs

- Capacity 4.0 mcm Ajdabiya Holding Reservoir
- Capacity 6.8 mcm Al Gardabiya Reservoir
- Capacity 4.7 mcm Omar Mukhtar Reservoir
- Capacity 15.4 mcm The Grand Al Gardabiya Reservoir
- Capacity 24.0 mcm The Grand Omar Mukhtar Reservoir

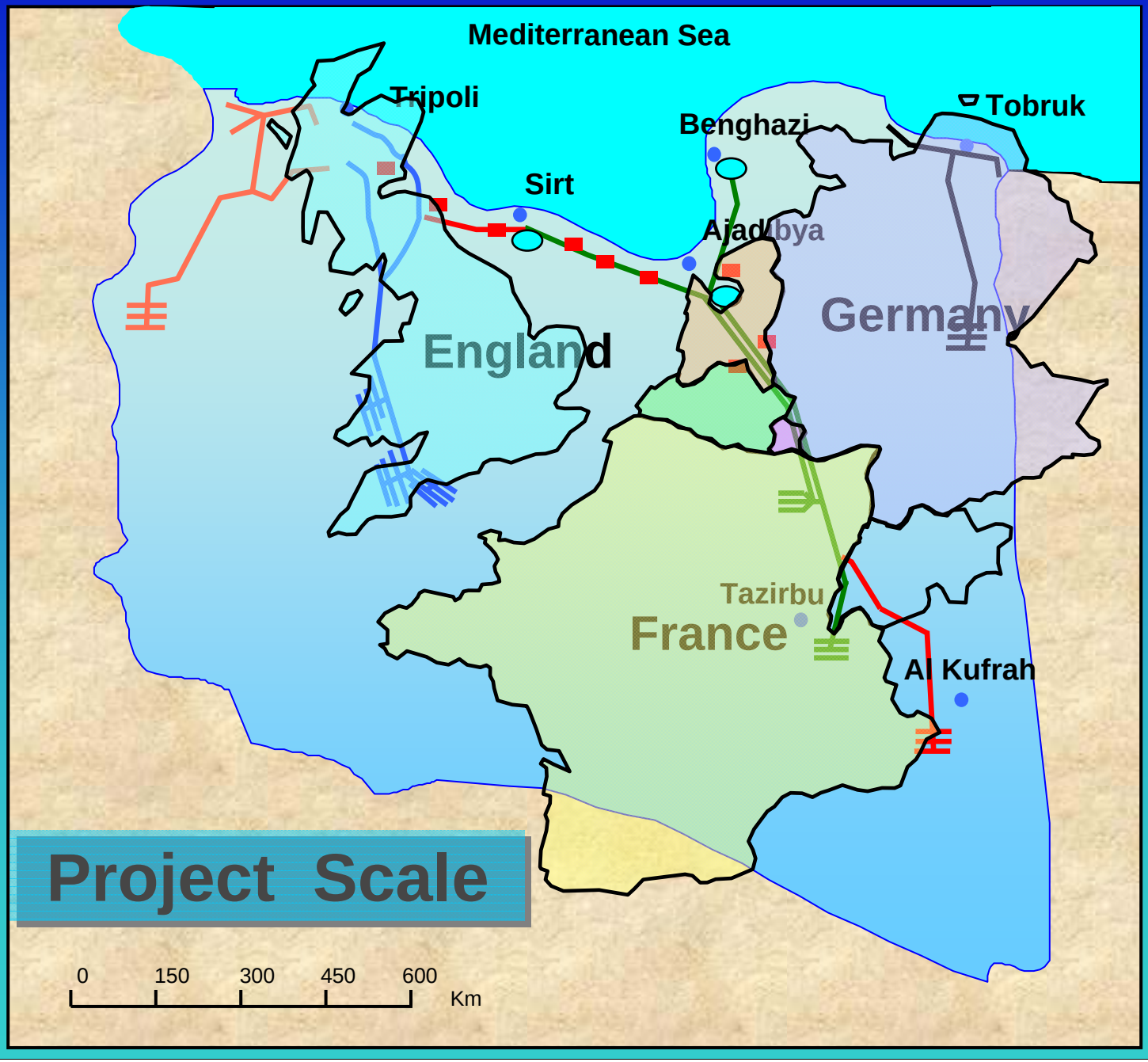


Total Storage Capacity = 54.9 mcm


one of the
reservoirs


Phase III is now nearing completion

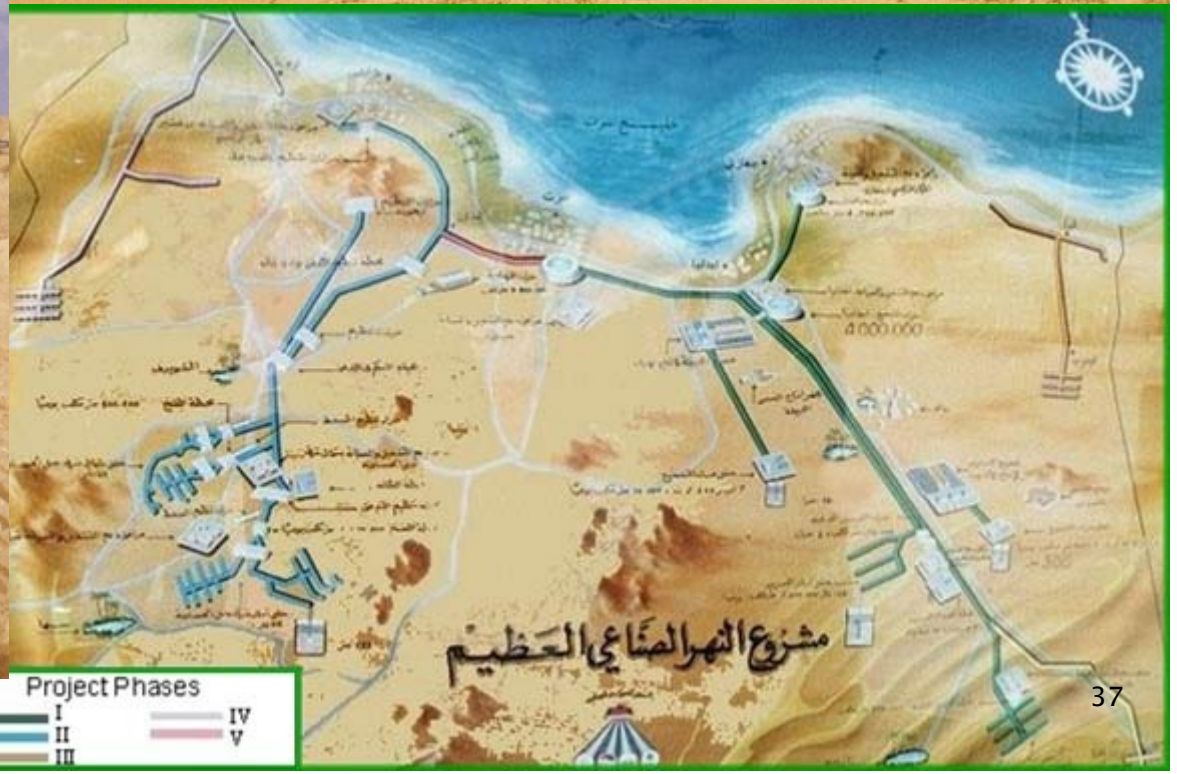
The Grand Omar Mukhtar will be Libya's largest man-made reservoir


Mediterranean Sea
Tripoli
Benghazi
Tobruk
Sirt
Ajdabya
England
Germany
Tazirbu
France
Al Kufrah
Project Scale
0
150
300
450
600
Km

This project offers good opportunities for scholars and graduate students to undertake and learn from Libyan experience

About 100,000 existing farms will be supplemented with irrigation water from the project which will have great impact on their productivity and encourage the settlement of farmers and their families, hence a positive impact on the value of their property

It is impossible not to be impressed with the scale of the project


مشروع النهر الصناعي العظيم
Project Phases
I
II
III
IV
V

CHARACTERISTICS OF GMMR PROJECT

The lessons leant and good practices evolved from the success story of the GMMR project is because of following unique characteristics:

- Strong vision of the country Leadership
- Unique
- Government involvement
- Organizational complexity
- High Capital intensive nature of investment
- High uncertainty and therefore the change
- Long project duration in 3 phases
- Technologically and logistically demanding
- Significant data management

LESSONS LEARNT AS I SUCCESS FACTORS FROM THE PROJECT

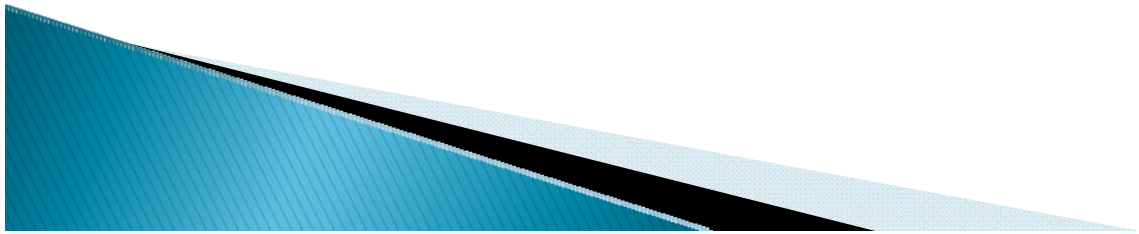
The main success lies in adopting 3Ps strategy i.e. Political will, practical steps and partnership.

1. Positive attitude from senior level staff
2. Political support
3. Immovable end dates
4. Flexible organization in tune with complexity and urgency
5. Flexibility
6. Better communication
7. Configuration, control, interface management and design review
8. Highly visible project control and user-friendly reporting
9. Experience engineering consultants
10. Timely and meaningful decision making
11. Formal control of change fundamentals
12. Back up strategy for high risk areas
13. Adoption of repeatable process
14. Common terminology
15. Feedback loops

WHAT TO AVOID/WHAT CAN GO WRONG

To get the best out of a project Libyan experience shows that we need to avoid the followings:

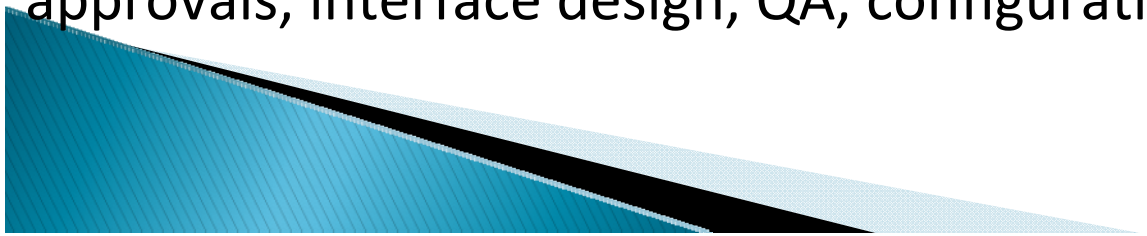
- Uncertainty and project drifts
- Organization and stakeholders unable to cope complex environment
- Communication voids leads to overlap and omissions
- Inability to manage change, interfaces and approvals
- Mega projects are non linear complex system and respond differently from how they are planned.
- Failure to understand and manage repetitive nature of design and rework cycle
- Failure to implement robust design review process



KEY PRINCIPLES

Our experiential learning shows that the key principles for getting the best value of the investment in a mega project like GMMR of Libya requires:

- Establish appropriate organizational structure with delegated authority and communication with stakeholders and regulatory bodies
- Build the intelligent process based teams
- Establish policy and technical standards align to client
- Apply capability maturity model to measure improvement over life
- Establish an effective coordination and decision making process based around project life cycle
- Ensure status review is factual and accurate reflection of planned accomplishments
- Develop backup strategies where appropriate
- Establish process for technical control of design including review & approvals, interface design, QA, configuration and change control



CAPABILITY MATURITY MODEL(CMM)

Libya has used CMM to enhance GMMR organizational competence, skills and abilities. It is found that organization can only be at one level of maturity out of the five levels as given below:

Level 1 Initial:

Project visibility and predictability are poor
Fire fighting is a way of life
Success depends entirely on competent team
Management system is shelf ware

Level 2 Repeatable

Some degree of project predictability
Start s making realistic commitment
Procedures are faithfully followed
Repeat the successful practices of previous projects

Level 3 Planned

Processes are documented standardized and integrated
Develops the capability to capture and share best practices

Level 4 Managed

Capability to set quality goals
Meaningful variations can be distinguished from random variations
Measurement system are in place

Level 5 Optimized

Supply chain focused on continuous process improvement
Data on effectiveness of process is used to improve the performanc
Defects analyzed to determine cause and improvement made to avoid recurrence

CLIMATE CHANGE IMPACTS FOR SUSTAINABLE WATER SUPPLY IN LIBYA

Libyan Technical Education Directorate of Ministry of Education in its march towards sustainable water supply development through number of initiatives to address challenges like growth, drought and climate change impacts.

Authors have presented several papers and deliberated during global, regional and national fora on Al Garabouli led Libyan initiatives.

The objective is

- To exchange knowledge and “know how” about adaptation strategies and measures;
- To understand the state of the science on climate adaptation tools;
- To provide Libyan water utility managers exposure to the international approach of adaptation;
- To foster debate, dialogue and conversations between climate scientists and utility managers and engineers to help fostering more applied research that can serve the water community; and
- To expose policymakers to information about water utility adaptation needs and strategies

CLIMATE CHANGE CHALLENGE

The uncertainties posed by climate change higher temperatures increase and the hydrological cycle require Libya to use many of the same tools that have allowed us to successfully address water resource challenges over the last decades.

This includes 3Ps

- Political will,
- Practical steps like Conservation, Innovation and
- Partnerships.

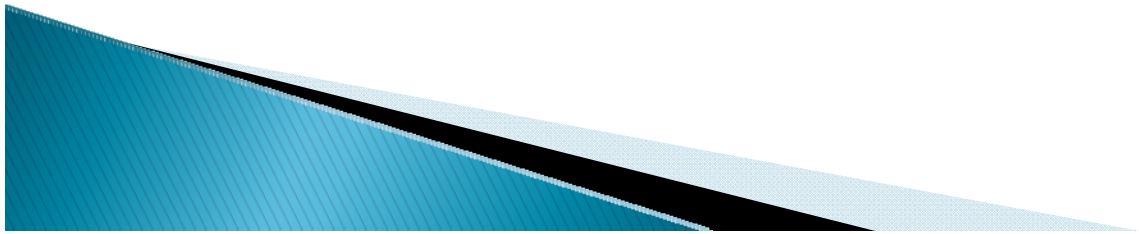
CONCLUDING REMARKS

The paper demonstrates lessons learnt from a GMMR mega projec

Secret of success lies in the fact that it takes time at the start to understand the scope and the plan how the work would be executed.

In estimating time scale we need to keep in mind the complexity and the fact that it takes disproportionate amount of time for tiding loose ends.

We must manage the rework cycle keeping in mind that forensic role of engineering management that looks for risks, problems and issues.



Quality Health Safety & Environment (QHSE) system is of no much use. Also time spent on man hours burnt which is measure of cost is not always proportional to progress made. This means squeezing the man hour's budget is not the best way to tackle financial constraints.

It is found that people work in an unsystematic way; therefore, project control system will not give an estimate of accurate picture of engineering progress.

The good practice is to record all minutes of meeting, discussion and decisions made for enhanced accountability and responsibility vital to outstanding performance.

Talent attraction, nurturing and retention is important and needs to be supported by open, free and frank debate and discussions.

Combating climate change, higher temperatures increase and the hydrological cycle impacts requires political will, practical steps like Conservation, Innovation and Partnerships

Thank You!