

Views on Libyan national plan (LNP) to resolve water shortage problem (WSP). Part Ib: Great Man-Made River (GMMR) project — capital cost with interest rates

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Abstract

Libyan national plan (LNP) to resolve the water shortage problem will be illustrated through a quartet of a series of papers. The first series of papers (I) will deal with Great Man-Made River (GMMR) supplied from rich ground water reservoirs located in the southern desert regions. This paper (Ib) will conduct the cost analysis study by considering the influence of interest rates on capital costs, as compared to the first paper (Ia) which neglected the effect of interest rates and treated capital costs as sunk value. This will improve the ability to analyze the viability and feasibility of this mean in comparison with other means to resolve the water shortage problem.

Keywords: LNP; WSP; GMMR; Cost analysis; Sunk value; Interest rates; Feasibility studies

1. Introduction

1.1. Physical limitations

The challenge of providing fresh water resources suitable for modern life development is a continuous phenomenon as life itself. “See the water which you drink, who bring it down, in rain, from the cloud. We could make it brine (and unpalatable). Whom you should thank” [1]. This illustrates the limitation of fresh water resources on this planet which could be manifested in different ways as follows:

- Naturally
 - (a) Scientific Aspects, according to natural laws (second law of thermodynamic), earth’s fresh water resources are becoming salty.
 - (b) Fresh water resources on earth are limited, since:
 - Over 97% is sea water
 - Over 2% locked up in ice caps and glaciers.
 - Intrusion of saline ground water and inland saline seas further reduced this availability.

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- Modern life developments — put stress on fresh water resources as:
 - Population increases.
 - Food demands increases.
 - Standard of living improves.
 - Environmental awareness increase.
 - Industrialization increases.
 - Water quality of existing resources declines.
- Technological aspects (challenge confrontation)

Globally, the challenge of providing fresh water resources is resolved through the natural desalination cycle which occurs on this planet by the action of the sun, and this will be the ultimate goal to handle this challenge through man-made desalination. Mankind has very limited options to confront these challenges of the water shortage problem, these options includes:

- Desalination
- Water conservation efforts
- Recycling and reuse of process and wastewater
- Rainfall infrastructure projects (dams, reservoirs, and water carriers) [2].
- Underground infrastructure projects (water transfer projects such as Great Man-Made River—GMMR) [2].

1.2. Economical considerations

The cost analysis study for a foreseen water resource project begins with identifying several issues and criteria such as:

- Technical considerations to define the design criteria which is used in performing the conceptual technical design of feed and product water quality requirements, project size and capacity, input and output site specific designs, etc.
- Economical considerations to decide the cost criteria which will establish the key parameters used to calculate the capital and operating costs.
- Environmental considerations to discuss the ecological issue which necessitate that

all procedures undertaken are safe to the environment.

- Human development considerations to address the public issue to create positive awareness and gain their interest aiming for better development.

Using standard forms and formats for presenting cost data will aid in comparing cost for alternatives and ensure that the required features for each alternative are included, this is particularly important because the above considerations are specifically local and will vary between alternatives. The ability to modify these forms and formats when required to meet the needs of each particular investigation, should be executed at ease for the benefit of comparing the cost analysis for the different alternatives.

2. Theoretical study [3,4]

Table 1 presents the details of the different total costs used in the cost analysis study.

2.1. Annual cost of capital

The annual cost of depreciating capital normally includes the owner's cost for interest amortization. The annual payment necessary to repay principal and interest in a present sum of money is called the capital recovery factor (CRF). Eq. (1) calculates the CRF for different interest rates (i) and amortization periods (y).

$$\text{CRF} = \frac{i(1+i)^y}{(1+i)^y - 1}$$

The yearly payment for a loan is obtained by multiplying CRF by total capital cost at the indicated (i and y). The cost analysis is conducted for different interest rates (i) as shown in Table 2 to exhibit the influence of interest rate (i) on the cost of cubic meter of water. It is noted that the

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