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The Expected Time of Immigration to the New Delta in Egypt

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Abstract

Nowadays Egypt faces two big problems, the first one is the global changes of weather, sea level will rise and some areas of the Nile Delta will inundate by water. The second one is the starting filling of grand Ethiopian renaissance reservoir (GERR), this will effect strongly the estimated life span of the Aswan High Dam Reservoir. The objective of this research is to estimate the expected time of immigration people to the new delta on the basis of the mentioned variations.

Recently many scientists and researchers (Susan Solomon;2009, Mohamed El Raey;1997, Stanley and Warne;1993) studied the effect of sea level rise and subsidence of the Nile Delta in Egypt regarding to the effect of the Ozone hole that been exist from increases in carbon dioxide concentration during the last few decades. The mean value of sea level rise (SLR) were collected and found to be 40 cm/100years. The subsidence rate of the Nile Delta was determined by Stanley and Warne (1993) and given as 2mm/year. The expected time of submergence of Nile Delta can be determined.

Life Span of Aswan Reservoir was studied by many researchers during the last three decades of the last century. There results obtained on the basis of different studies and according to many approaches. It ranges from 362 years to 365 years (Shalash,1980, Makary;1982 and Moussa;1985).

According to the volume of sediment that will be retained by grand Ethiopian renaissance dam (GERD) which studied during the last few years by civil engineering department at M T C and was found to be 57.50 X 10^6 m^3 for one storm/year .Then the life span of Aswan Reservoir can be estimated according to the establishment of this dam. The time difference between submergence of the existing Nile Delta and the filling of Aswan Reservoir by sediment will be helpful for determining the suitable expected time of immigration to the new delta in Egypt.

Keyword: Greenhouse, Hydrological model, Sediment yield, Life span, Sea rise, Subsidence.

1. *Introduction*

The Nile Delta in coastal zone is characterized by relatively low land elevation. This low land elevation will be affected strongly by sea level rise which produced from the increases of greenhouse gases. Moreover, this coastal shoreline suffers from local land subsidence of the delta region (El-Raey M.; 2010, 1997).

Sediment measurement methodologies and assessment strategies including measurement and computational techniques were applied to determine average rate of accretion. Sediment accumulations rate in Aswan High Dam Reservoir (AHDR) were measured by documenting the change in the level of the reservoir bed in response to sediment deposition. The volume of deposition, converted to weight and divided by the duration between sampling, will give the average rate of accretion.

Based on field observations, dead storage capacity (m^3); average specific gravity (tons /m^3) ; average annual inflow load (tons) and average annual outflow load(tons), life span of the AHDR was estimated by Shalash, 1980. On the other hand, Makary(1982) and Moussa(1985) determine life span of AHDR from the cross-sectional area of the reservoir, that been measured by water research institute in Egyptian ministry of irrigation, at different stations and for different years.

According to the volume of sediment that will be retained by grand Ethiopian renaissance dam which studied during the last few years, then new life span of AHDR can be estimated according to the establishment of this dam and suitable expected time of immigration to the new delta (AHDR) in Egypt can be determined.

2. *Sea level Rise*

Results from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report indicate that a global sea level rise of 18 to 59 centimeters is expected by the end of this century (El-Raey, 2010).

Sea level rise of at least 0.4 – 1.0 m if carbon dioxide concentration exceed 600ppm by volume for the 21 century and 0.6 – 1.9 m for peak CO2 concentration exceeding 1000ppmv (Susan et al,2008).

Results indicate that sea level rise varies from one region to another because of the difference in the land subsidence effect (El-Raey, 2010).

The Shuttle Radar Topographic Mission Digital Elevation Model (SRTM DEM) data indicated that 1 m SLR will affect about 3900 km^2 of cropland, 1280 km^2 of vegetation, 205 km^2 of wetland, 146 km^2 of urban areas and cause more than 6 million people to lose their houses. The overall vulnerability assessment using Advanced Space borne Thermal Emission and Reflection Radiometer- Global DEM Version 2(ASTER-GDEM-V2) indicated that the influence of SLR will be intense and confined along the coastal areas. For instance, the data indicated that 1 m SLR will inundate about 580 Km^2 (6 %) of the total land cover areas and approximately 887 thousand people will be relocated. Accordingly, the uncertainty analysis of the DEM's elevations revealed that the ASTER-GDEM-V2 dataset product was considered the best to determine the future impact of SLR on the Nile Delta region (Hasan E.,et al,2015).

3. Subsidence of Nile Delta

Some estimates indicate that the northern delta region is subsiding at a rate that varies from about 2 millimeters annually at Alexandria to about 2.5 millimeters annually at Port Said (El-Raey,2010).

Tide gauges measurements from the coastal research institute of Alexandria revealed a land subsidence of about 1.6 millimeters per year at Alexandria and 1.0 millimeter per year at Burullus, while at Port Said the value is 2.3 millimeters per year (El-Raey,2010).

Survey measurements carried by Stanley and warne (1993) has revealed subsidence rates greater than 4 mm per year at Port Said and about 2 mm per yaer at Alexandria.

Tide gauge measurements at Alexandria, Burullus, and Port Said have been collected and statistically analyzed to estimate land subsidence over the last three decades at each of these regions as shown in Figure 1.

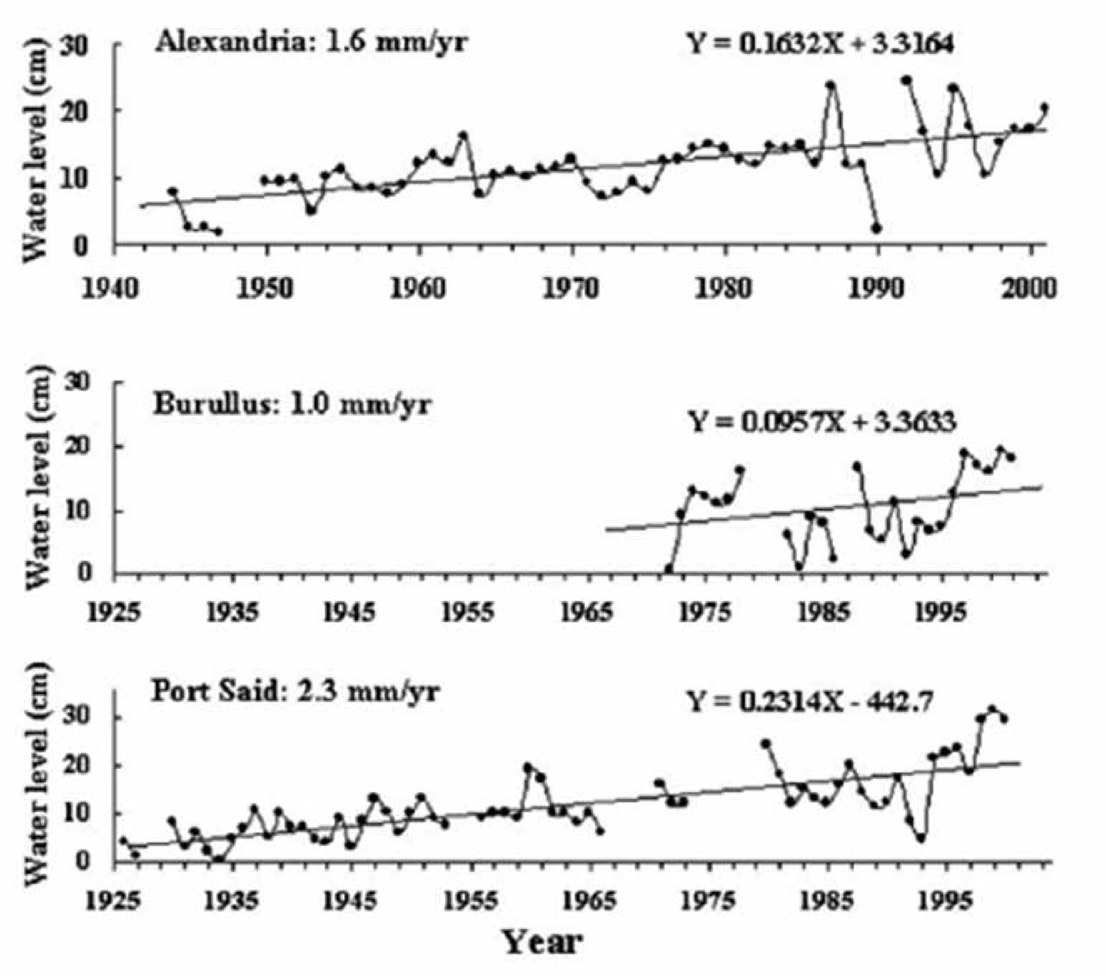


Figure1 Land Subsidence Rates as Estimated at Alexandria, Burullus, and Port Said

(Sorce : El Raey, 2010and Frihy O.,2003)

Results of research done by Hassaan and Abdrabo (2012) indicate that about 22.49, 42.18, and 49.22 % of the total area of coastal governorates of the Nile Delta would be susceptible to inundation under different scenarios of SLR. Also, it was found that 15.56 % of the total areas of the Nile Delta that would be vulnerable to inundation due to land subsidence only, even in the
absence of any rise in sea level

4. Life Span of Grand Ethiopian Renaissance Reservoir

The maximum rainfall at Jemma station (287 mm) with duration 24 Hours gives volume of water = $2633365X10^{3\ m3}$ and sediment volume = 57495094.34 $m^{3.}$

Since the capacity of GERR was estimated by the Ethiopian Government by the value of $63X10^9\ m^{3,}$ then the following assumptions will be taken in consideration:

1- The Grand Ethiopian Renaissance dam will retain sediment into GERR.
2- No water losses from evaporation.
3- Effect of permeability is minimum.
4- No consumption of the stored water behind the reservoir for public use or irrigation purposes.

According to the resulted values of water volumes and sediment weight (weight in tones should be converted to volume) and under the mentioned conditions, the required filling time is found to be:

I) In case of filling of water and sediment :

*Since the reservoir capacity is $63X10^{9}\ m^3$

*And the total volume of water and sediments for 1 storm = $2.69\ X10^{9}\ m^3/yr$

*The required filling time of the reservoir is $(63X10^{9}) / (2.69\ X10^{9})$ = 23.42 years

*The required filling of the reservoir for 4 storm /year = 5.86 years

II) In case of filling of sediment only, the life span (LS) will be as follows:

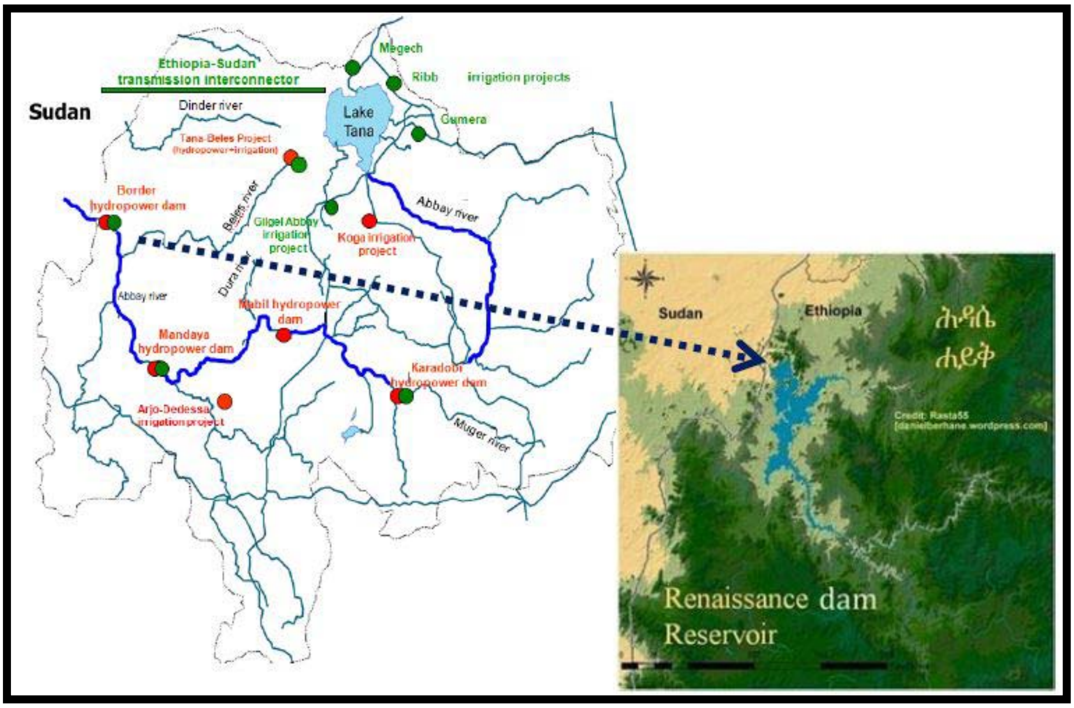
*Since the reservoir capacity is $63X10^{9}\ m^3$

*And the total volume of sediments =57495094 m^3/yr

*The estimated life span of the reservoir for one storm/year = $(63X10^{9}) / (57495094)$ = 1095.74 years

* The estimated life span of the reservoir for 4 storm/year = $(63X10^{9}) / (4X57495094)$ = 273.94 years

The area of GERR is shown in Figure 2.



Source: Ana Elisa Cascao,2011. Grand Renaissance Dam in Ethiopia-Stokholm.

Figure 2 The area of Grand Ethiopian Renaissance Reservoir (GERR)

5. Life Span of Aswan High Dam Reservoir

Designer of AHDR expected that the total load of Suspended Solids(SS) will deposite in the reservoir and fill the dead storage in 400-500 years. Based on field observations, Shalash(1980) was estimate the life span of the AHDR. In order to estimate rate of sediment deposition within the next 100years in AHDR(started from1979) Shalash had considered three assumptions:

1- Assume that the next 100 years run-off of the Nile will be similar to the last 100 years 1869/70 – 1978/79.
2- Estimating of total load of SS by the following equation:

$$Q_s = 0.328 \times Q_f^{1.49}$$

Where Q_f : the total discharge of the Nile during flood season(at El-Gaffra discharge station) August to October in Km^3 .

Q_s : Total sediment load in 10^6 tons and represent 96% of the total annual sediment load.

3- Forecasting the total load of SS which will pass in future (500 years).

From recorded data of the run-off of the Nile for the months August to October for the period 1879/80 to 1978/79 and applying the previous equation, values of Q_s were estimated.

The following results were observed by Shalash after forecasting the SS load passing AHDR :
*Average rate of inflow Qs = 142 X 10^6 tons
* Average rate of outflow Qs = 6 X 10^6 tons

*Therefore the average rate of SS deposition in AHDR is 136 X 10^6 tons.

Life span of AHDR was estimated by Shalash according to the following data:
- Dead storage capacity = 31.6 X 10^9 m^3
- Average specific gravity within 500 years = 1.56 t/m^3
- Average annual inflow Load = 142 X 10^6 tons
- Average annual outflow load = 6 X 10^6 tons

Therefore estimated Life span for AHDR may be 362 years.

6. Results and Conclusion

From results that been discussed in the previous sub-titles we conclude that:
- Sea level rises were collected and found to be 40 cm/100years.
- Subsidence rate of the Nile Delta was determined and given as 20cm/100year.
- Then after 500years there will be 3m sea rise.
- Based on Hasan E., et al. (2015) about 580 Km^2 (6 %) of the total land cover areas will be inundate by water for 1m SLR.
- The Nile Delta region, which occupies an area of 23,850.76 km^2 (El Nahry and Doluschitz 2010),
- Based on assumptions given in 4 & 5
- And Life span of the Grand Ethiopian Renaissance dam =273.94 years.
- And Life span of the AHDR = 362 years.
  And since SS which passed down stream AHD was decreased gradually until it reached 1.0% (out off 142 X 10^6 tons) in 1973. Then the life span of AHDR will increase and simply can be calculated based on the following assumptions:
  Starting filling of SS in AHDR is the year 1973.
  Starting filling of SS in GERR is the year 2016.

  Then life span of AHDR= 362 – 43 + 274= 593 years
  This life span is started from the beginning of filling GERR.

- It is concluded that a wide area of Delta Region will be inundate by water and many thousands of people will immigrate to the Nile Valley until the new Delta (AHDR) filled by SS, 593 years. Then, the Expected Time of Immigration to the New Delta in Egypt will be about 600years.

7. Recommendations

It is recommended to review researches done by scientists in SLR and to use advanced methodology to obtain DEM very accurately in order to determine actual area which will be inundate by water.

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