Advanced Training Workshop on Reservoir Sedimentation

Sedimentation in the Nile River

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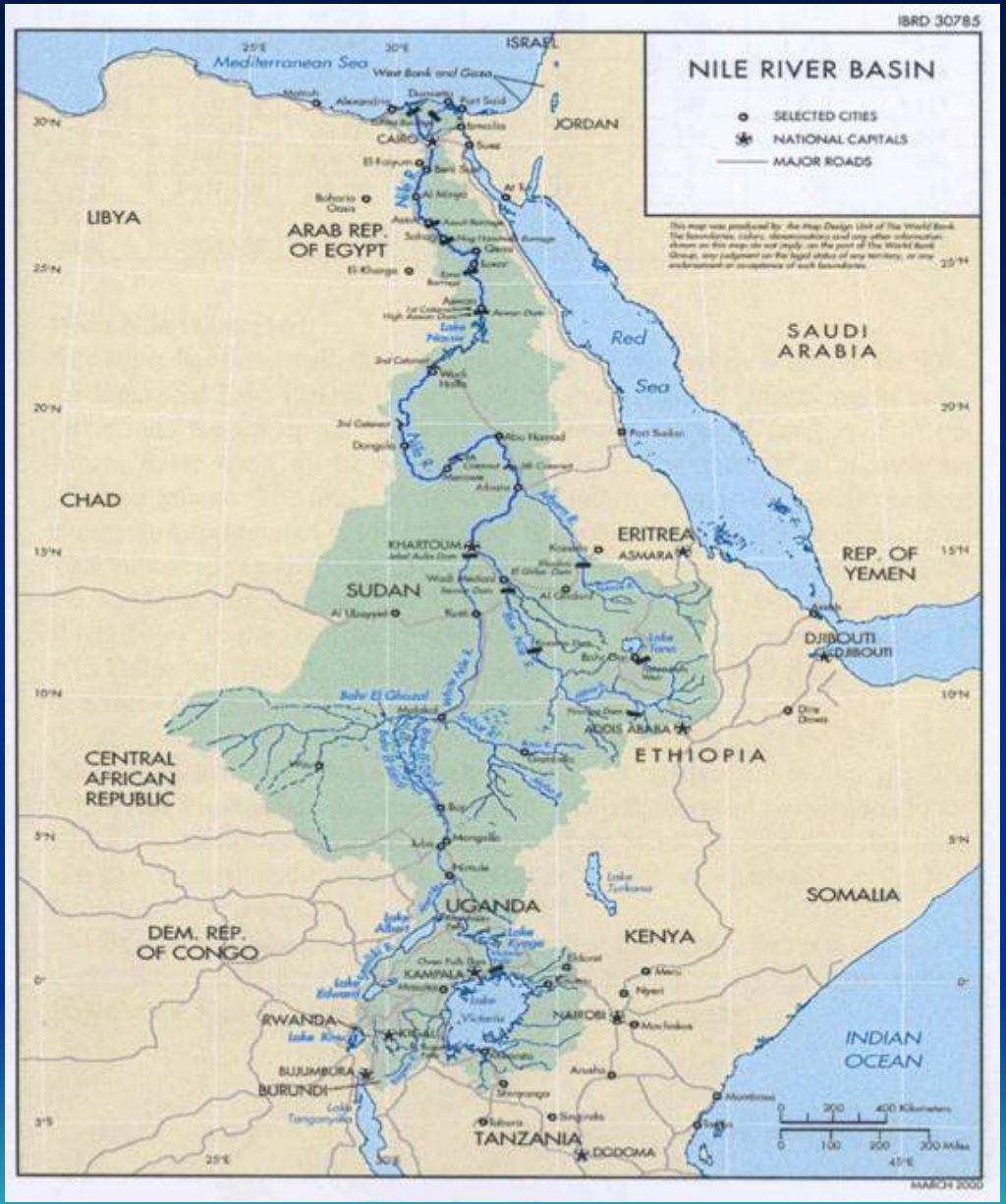
- **Water is essential for mankind survival and the development of civilizations.**
- **The population of the world continues to increase by 100 million people each year, with a corresponding demand of water.**
- **Environmental pollution and water contamination make the situation very critical.**
- **Sediment, among its many advantages and disadvantages, is considered one of the main water pollutant factor.**

Sedimentation impacts

Sedimentations has its impacts on the utilization of the Nile Basin water resources, ranging from watershed degradation, sediment deposition in reservoirs to management difficulties of irrigation canals networks.



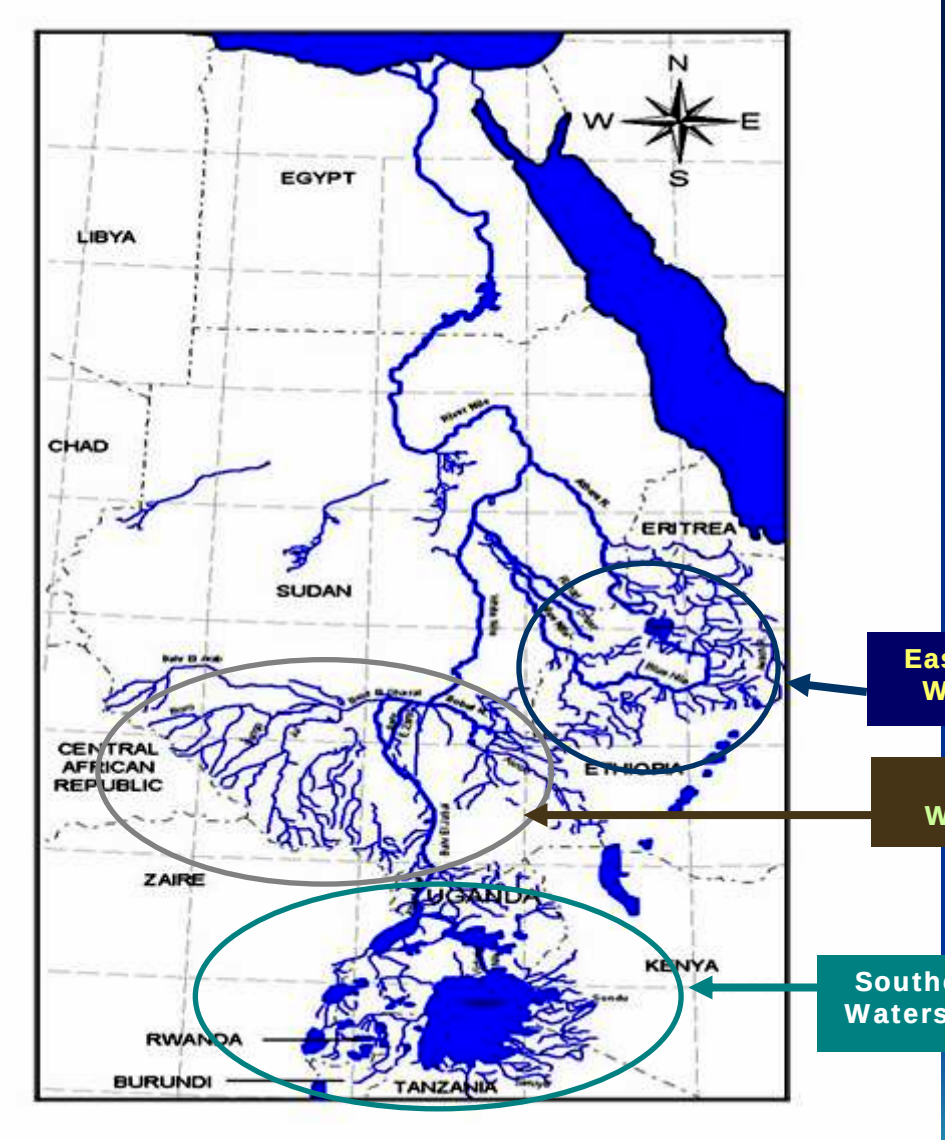
General Layout of the Nile Basin

Nile River receives its flow from three main distinct watersheds:-

I. Equatorial lakes plateau in the South.

II. Sudd region in the Center.

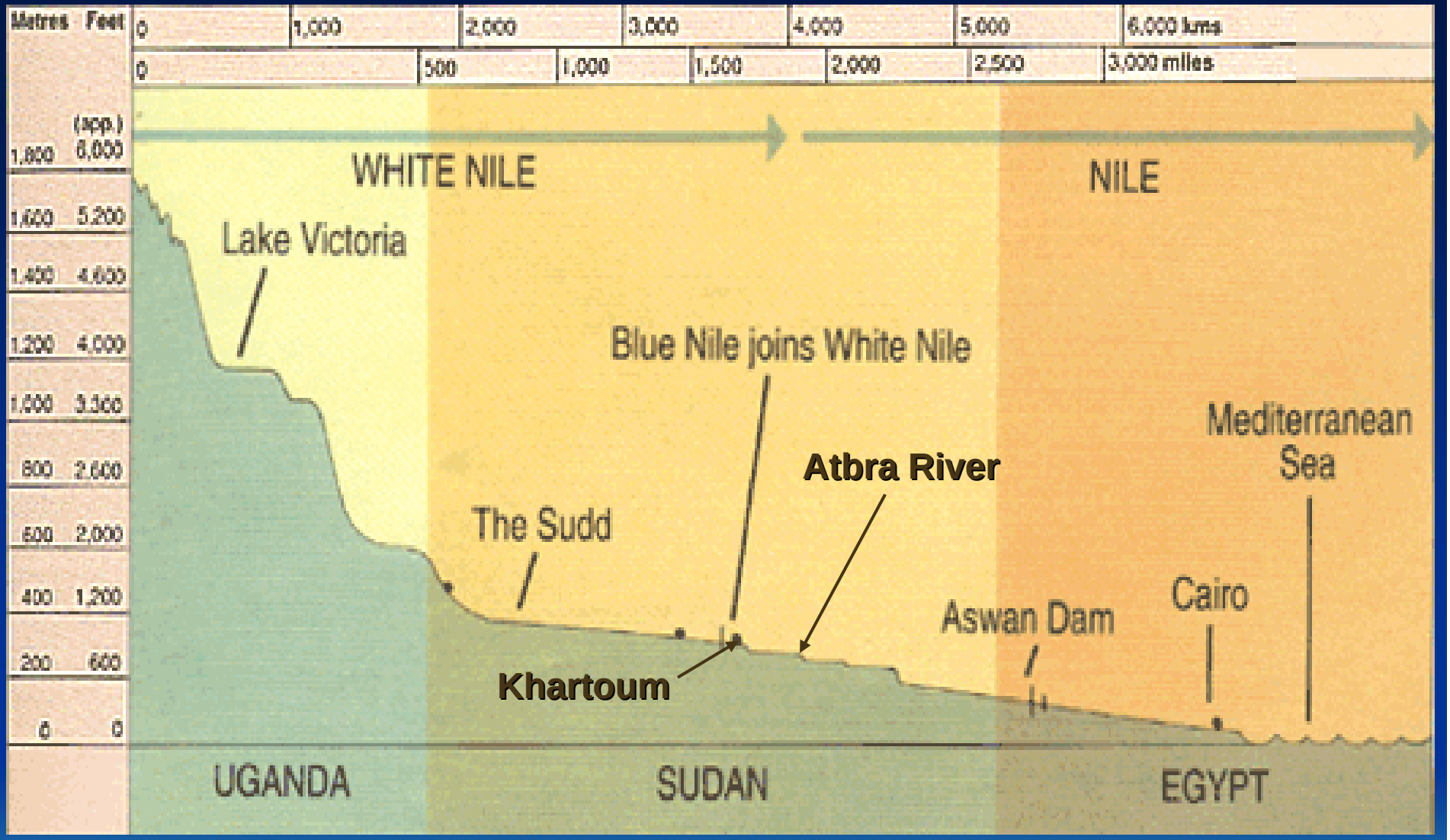
III. Ethiopian Highlands in the East.



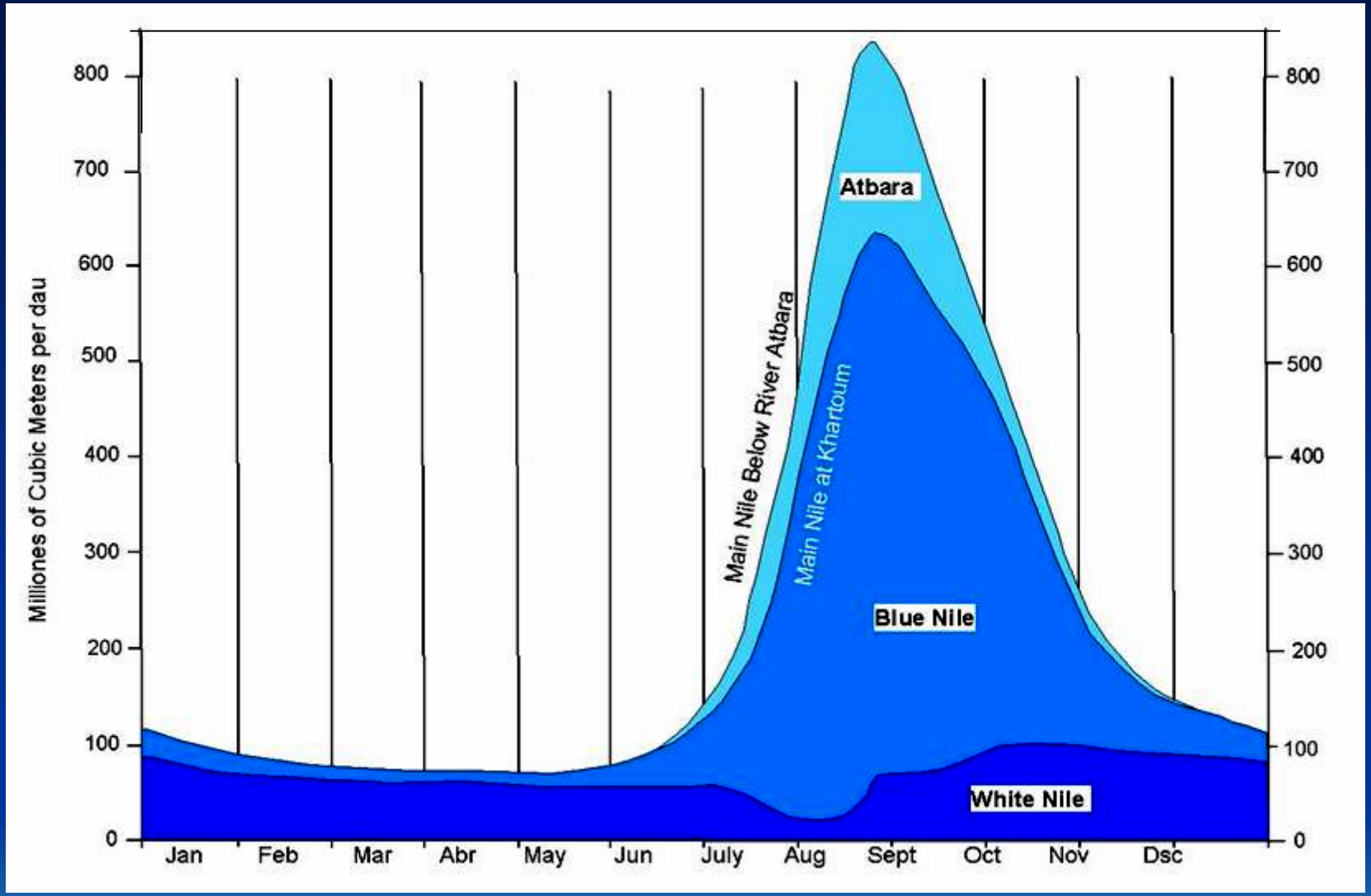
Main Watersheds of Nile River Basin

The share and distribution of the 10 riparian countries to the Nile River

Country	Total area of the country (km2)	As % of total area of basin
Burundi	27 834	0.4
Rwanda	26 340	0.6
Tanzania	945 090	2.7
Kenya	580 370	1.5
DR Congo	2 344 860	0.7
Uganda	235 880	7.4
Ethiopia	1 100 010	11.7
Eritrea	121 890	0.8
Sudan	2 505 810	63.6
Egypt	1 001 450	10.5
Nile basin	8889 534	100.0



Cross-section of the Nile River from Equatorial Source to Drain



Nile River Hydrograph

The process of sedimentation usually happens in the following stages

- Erosion
- Entrainment (drawing of particles into fluid)
- Transportation
- Compaction or/and Consolidation (deposition)

The amount and rate of deposit are determined mainly by:-

i. Detention storage time.
ii. The shape of the reservoir.
iii. The operating procedure of the reservoir.
iv. The depositional pattern usually starts with the coarser material depositing towards the reservoir headwater.

- The aggradations continues more and more until a delta is formed, as it happens in Roseires reservoir in the Blue Nile (Sudan) and Aswan High Dam reservoir in the Main Nile (Egypt).

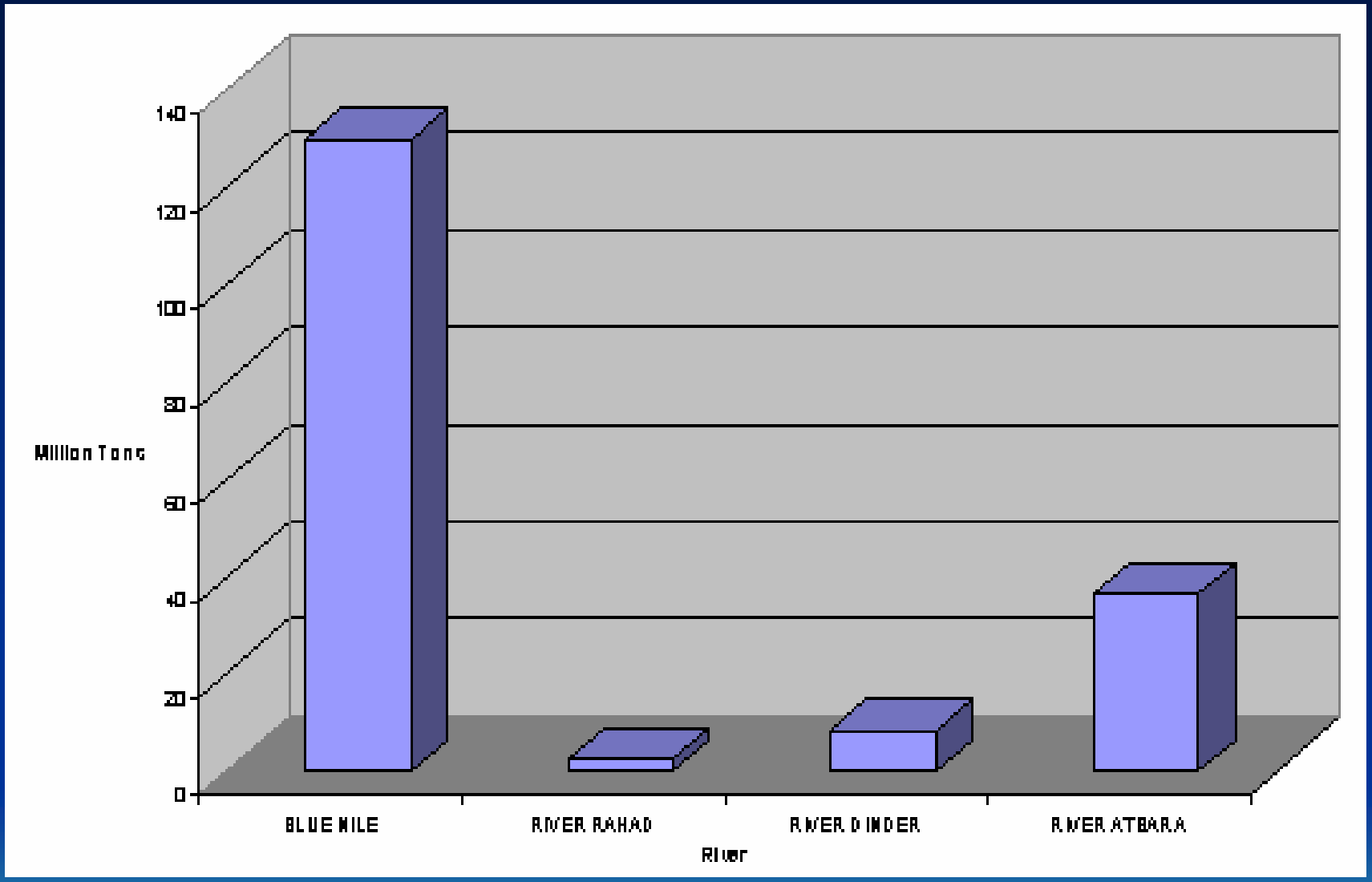
Causes of sediment in watersheds can be summarized as follows:-

- Removal of forests or other vegetation sharply reduces water retention and increases erosions resulting in reduced water availability in dry seasons and more sedimentation downstream.
- Absence of trees provides bad effects on shrubs which lost shelters and some times die out under burning sun.
- Charges in river flow, sediment and pollutant loadings resulting from activities for inland degrade downstream ecosystem. Dams are the worst hit by sedimentation.

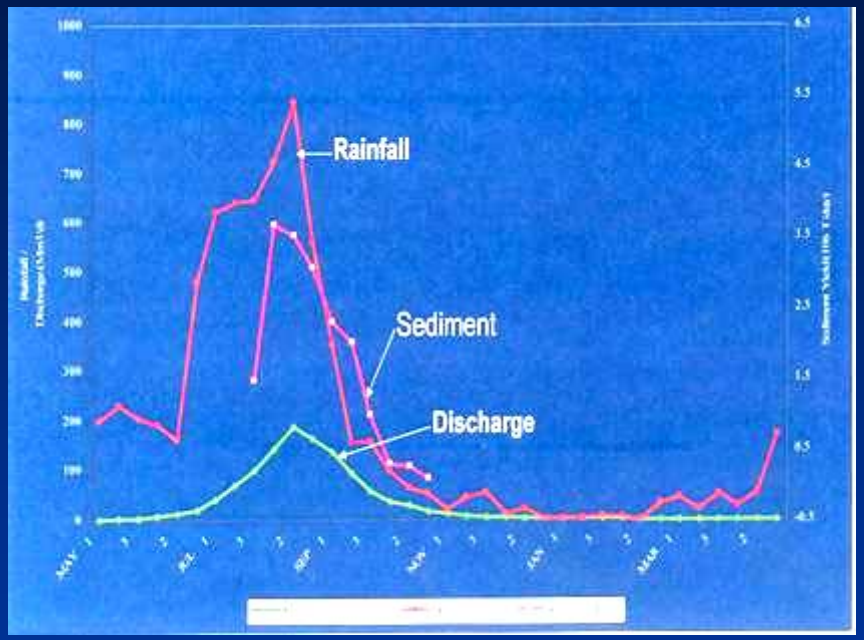
Nile River Sediment

- Most of the sediment in the Nile flows from the Ethiopian Highlands through the Blue Nile and Atbara River.
- The White Nile and its tributaries lose most of its sediment load by spilling and deposition over flood plains, lakes and marshlands inside Sudan.
- Nearly all of the sediment (~ 90%) comes from the Blue Nile during the flood season (July- Oct.)
- The sediment load of the Blue Nile at El Diem is 140 million tons per year.
- The sediment load at Aswan High Dam was 160 million tons taking into consideration the amount of sediment transported by Atbara River.

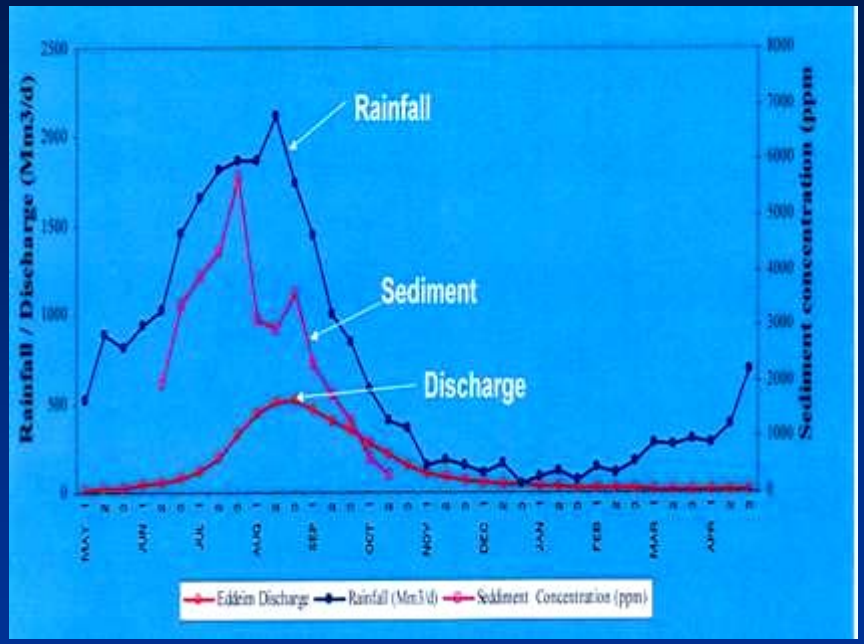
- This is compared to 150 Million tons for Mississippi River, 250 Million tons the Colorado River and 2000 (1600) Million tons for Yellow River in China.
- there is no reliable means of bed load information in the Nile River. However, the bed load is believed to be negligible.
- The coarser sand usually deposits in the upper portion of the Blue Nile near the Ethiopian/Sudanese boarder.
- The lighter sediment is carried by the flow to the downstream.
- The suspended sediment load distribution is 30% clay (<0.002 mm), 40% silt (0.002 – 0.02 mm) and 30% fine sand (0.02 – 0.2 mm). Therefore, it may be considered in general wash load.



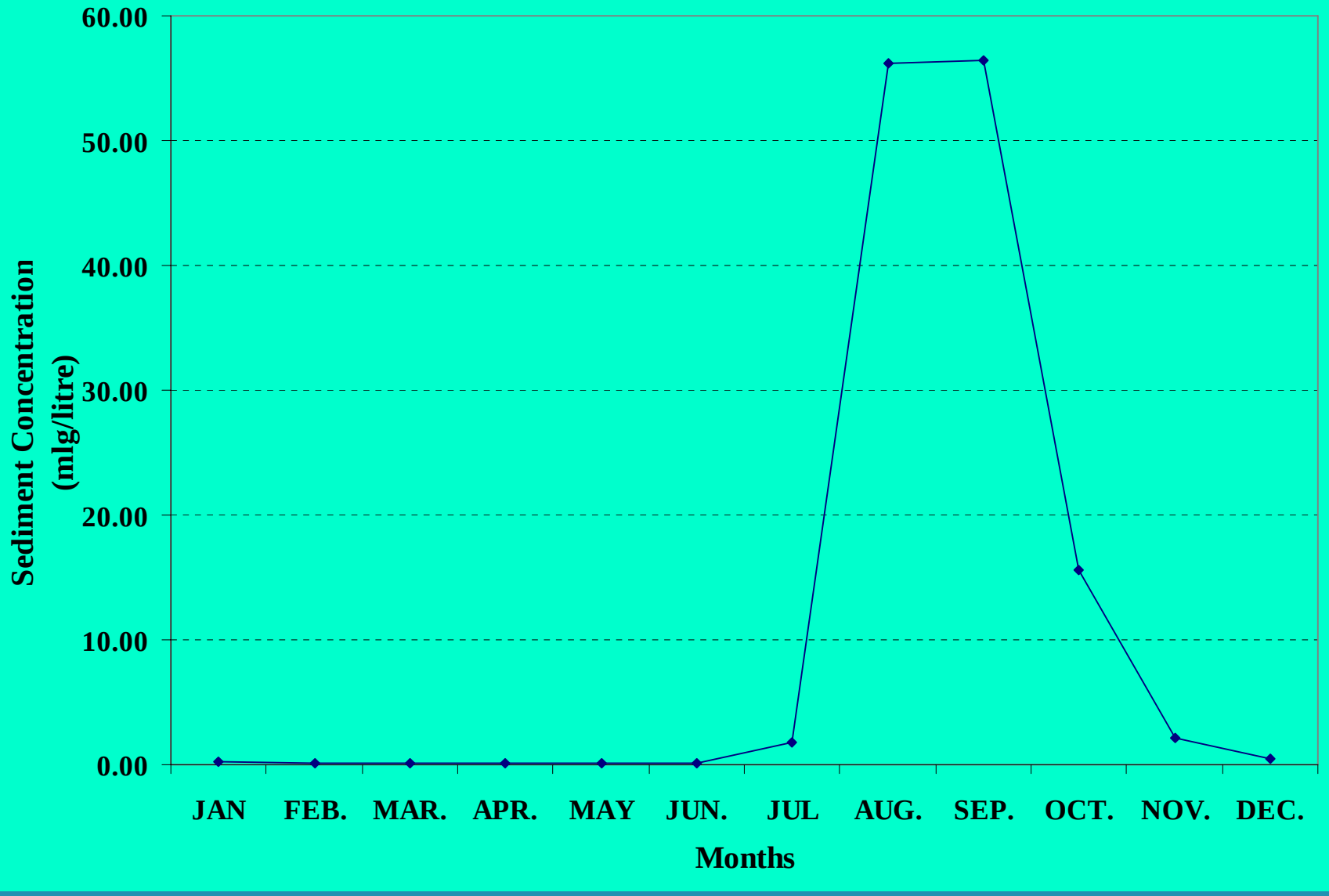
Total Annual Sediment Load (million tons) in The Nile River



Comparison of rainfall, Discharge and Sediment Yield in the River Atbara



Comparison of Rainfall, Discharge and Sediment Yield in the Blue Nile

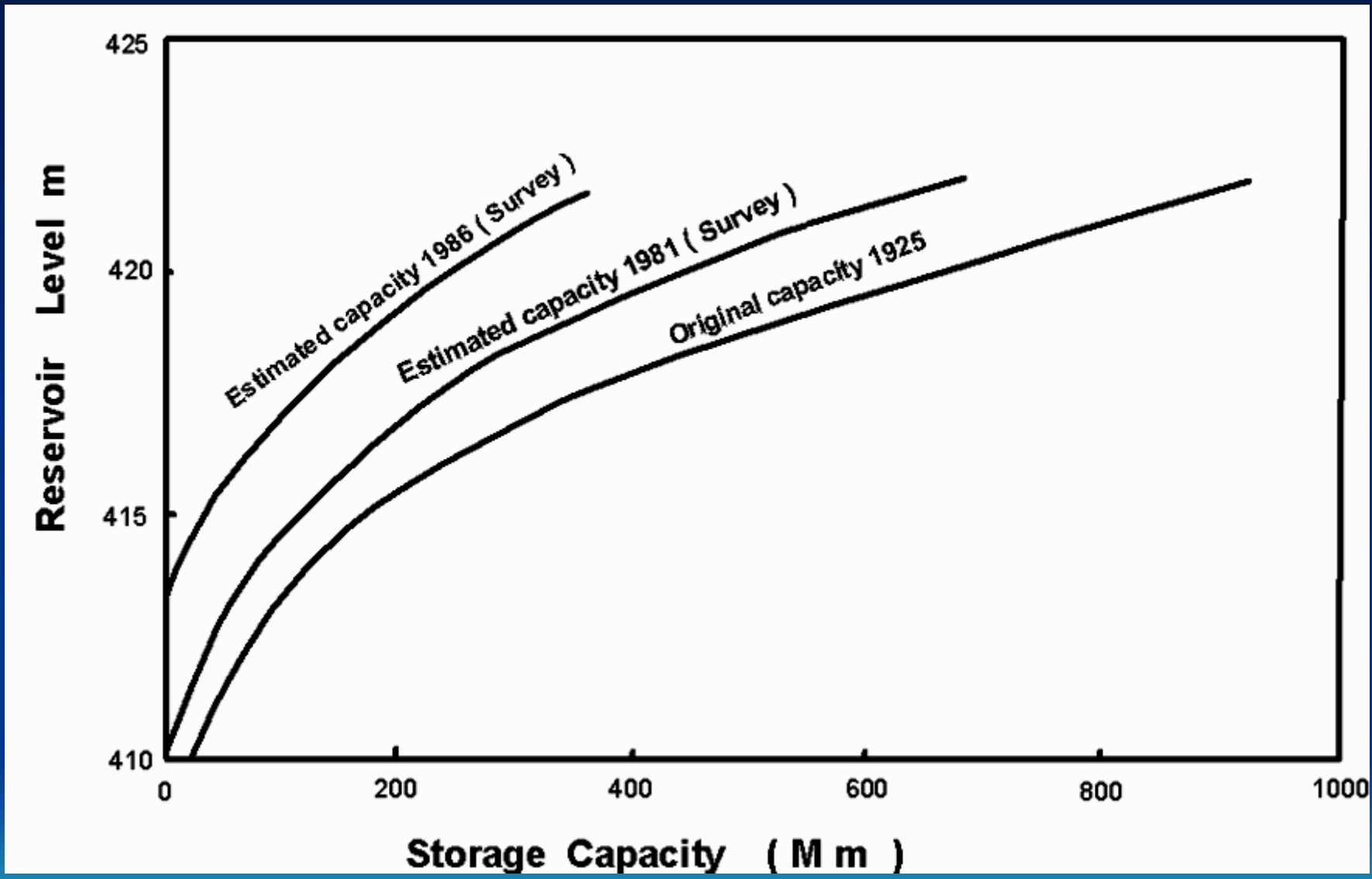


Suspended Sediment Concentration in AHD Reservoir

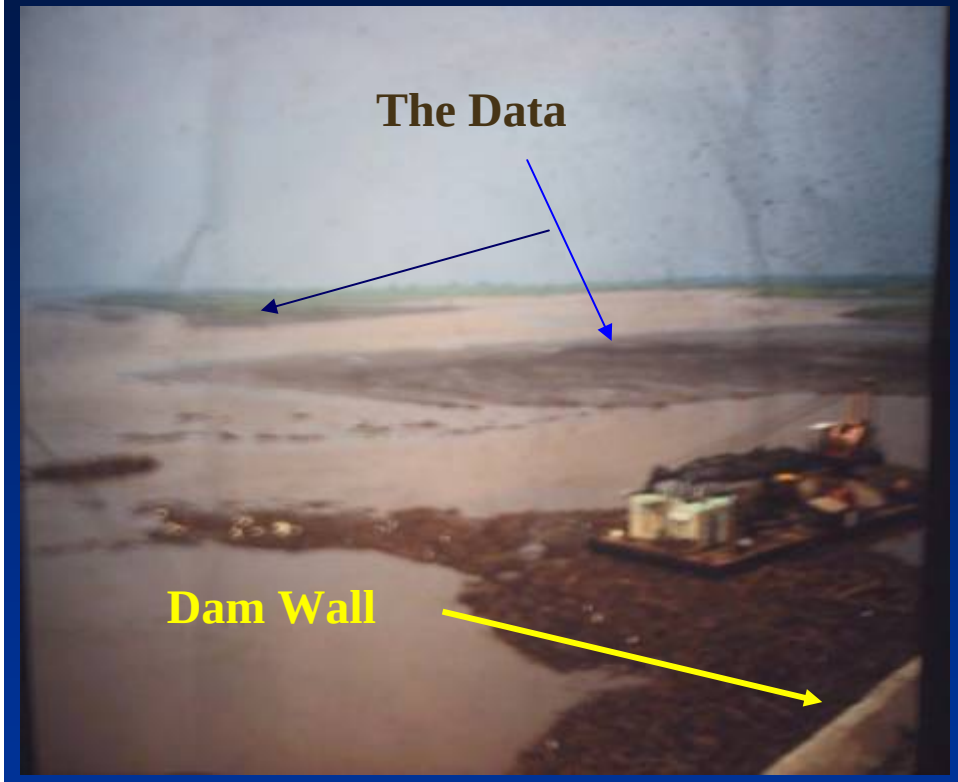
Impacts on Downstream Countries

- **Here in Sudan the problem has been reflected downstream in terms of sediment deposition in the reservoirs and the irrigation canalization networks, causing:**

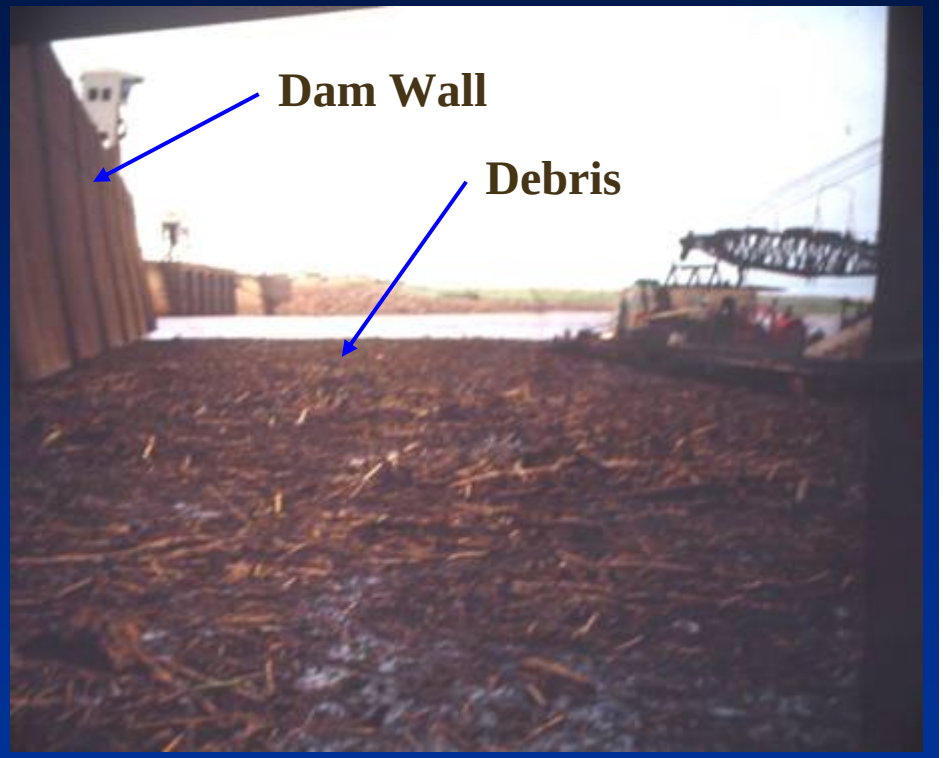
- **flood risks**
- **crops damage**
- **pumps intakes blockage**
- **low production**
- **hydropower generation difficulties**



Sediment Volume and Content of Sennar Dam



Delta Formation Upstream, Roseries Dam



Debris in the Reservoir Upstream, Roseries Dam

Reservoir Sedimentation

- **Sennar dam in 61 years lost 71% (660 million m^3) of its original reservoir capacity.**
- **In the first ten years the drop in the capacity of Roseires dam was 550 millions m^3 with a rate of 55 Mm^3 per year.**
- **In the second period (1976-1981) the reduction in the capacity was 100 Mm3 with a rate of 20 Mm3 per year.**
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- **In the period (1981-1985) the reduction in the capacity was 120 Mm^3 with a rate of 30 Mm^3 per year.**
- **However, a drastic increase in the sedimentation rate occurred in the period (1985-1992) with a rate of 60 Mm3 per year and a reduction of 427 Mm3.**

Irrigation Difficulties due to Sedimentation - Gezira Scheme - Sudan

Inadequate Sedimentation Clearance

Sediment Socio-economic and Environment Impacts

- Changes in sediment quantity and quality can have a significant impact on a range of social, economic and environmental systems.
- The deposition of sediment in irrigation canals and its subsequent built-up of aquatic weeds results in losses in production of great magnitude.
- The cost of sedimentation includes loss of hydropower potential.
- The most serious effect, is the loss of agricultural production.
- In Sudan the sediment clearance from the irrigation canalization system costs more than 60% of the total cost of the operation and maintenance.

Conclusions

- The sedimentation in the reservoir and the irrigation systems within the Nile Basin has environmental and socio-economic impacts.
- Suitable sedimentation management is a key for the sustainable water resources management.
- Changes in human activities within the catchment can have detrimental effects on both sediment quantity and quality .
- It is very important to evaluate environmental impacts involved in sediment management properly and mitigate them as much as possible.
- Sedimentation rate in the last decade (1990s) increased rapidly, indicating that huge and wide land degradation is occurring in the catchment area of the Nile River system.
- Integrated sediment management is found to be the best policy to minimize the adverse impacts of the sedimentation within the entire Nile River Basin.

Thank you for your attention