GEOMATICS SUPPORT VIEW IN UNLOCKING THE POTENTIALS FOR MULTIPLE UTILIZATION OF DAMS AND RESERVOIRS IN NIGERIA

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PRESENTATION OUTLINE

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- ✓ Dams in Nigeria
- ✓ Environmental Consideration in the use of Dams for Water Resources, Energy and Food
- ✓ Effective Utilization of Dams and Reservoirs for Multiple Use
- ✓ Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria
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INTRODUCTION

- Nigeria currently with a population of about 170 million people require a large volume of portable water for drinking and energy particularly for electricity and enough food to feed such a large population.
- The demand for water, food and energy will continue to rise as a result of increase in population growth.
- In order to derive the needed energy supply, many more multi-purpose Dams need to be developed not only for water supply but Hydropower generation as well as for irrigation and fishery.
- Geomatics data and tools are key ingredients within cross sectorial outcome and acts as a key support mechanism for the development of an integrated multi-sectorial strategy for effective water use.

DAMS IN NIGERIA

Table 1:Classification of Dams in Nigeria Based on I Cold Classification

Dam size	Dam Height in meters	Reservoir Capacity in million cubic meter	Flood discharge in cubic meters per second	Crest length in meters
Large	>15	>1	>2000	>700
Small	<15	<1	<2000	<500

Table 2: Distribution of Dams per hydrological zones

S/N	Hydrological Zone	No of Large Dams	No of Small Dams	Total No	Remarks
1	1	8	15	23	
2	2	26	14	40	
3	3	3	4	7	
4	4	12	21	33	
5	5	1	6	7	
6	6	13	35	48	
7	7	2	9	11	
8	8	13	16	29	
	Total	**78**	**120**	**198**	

DAMS IN NIGERIA

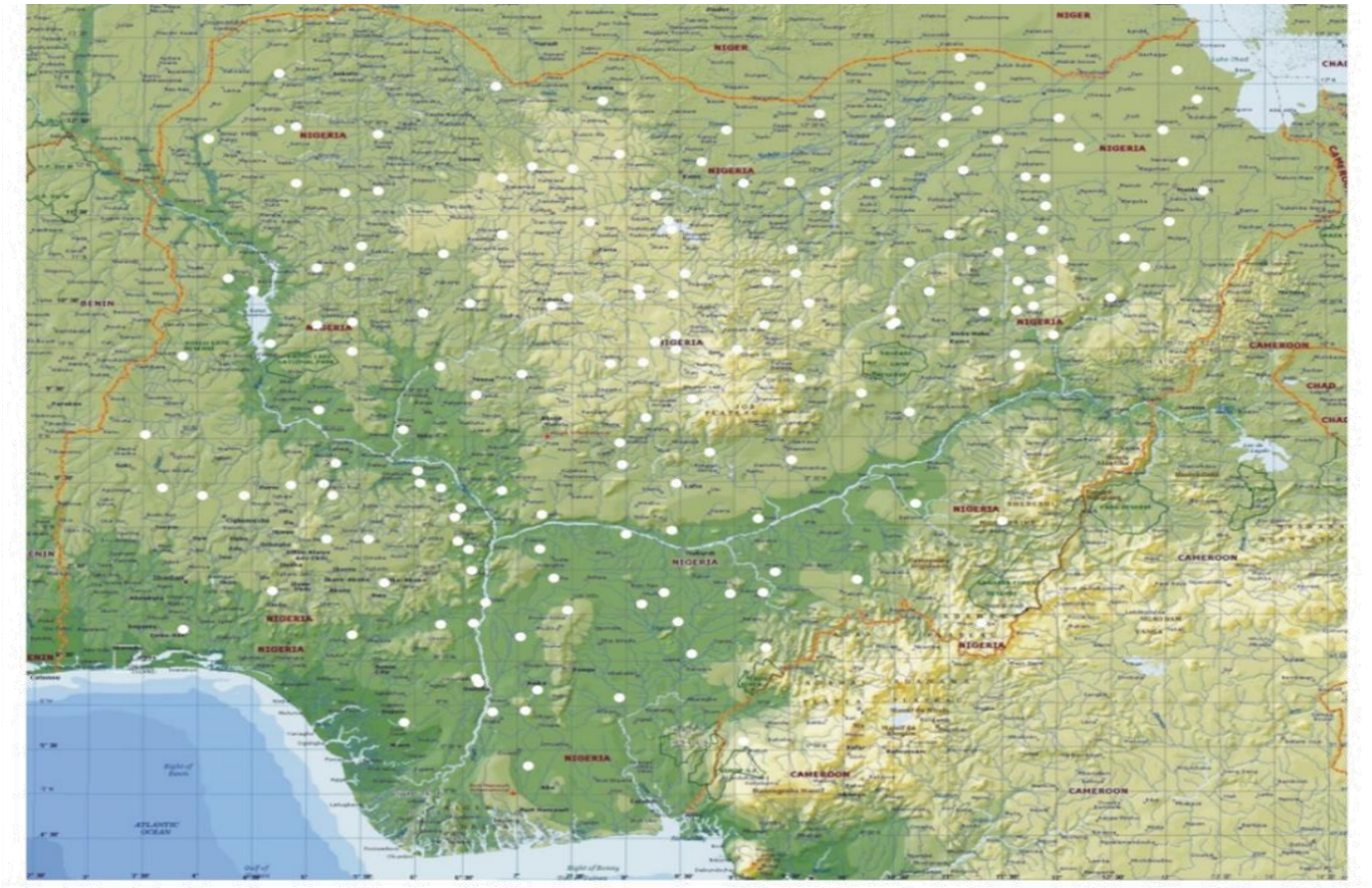

Figure 1: Map showing Dams in Nigeria

Problems of Data Availability for Design and Conversion of Dams and Reservoirs in Nigeria

- River flow records are vital assets critical for the sustainable management of water resources.
- The completeness of such record is critical for the effective utilization of dams.
- Even very short gaps precludes the calculations of important summary statistics.
- The establishment of 12 River Basins in Nigeria was to harness the nation's water resources and carryout hydrological data collection and management.
- But Over the years however, the River Basins and other rivers in Nigeria have been poorly gauged and poorly mapped.

Problems of Data Availability for Design and Conversion of Dams and Reservoirs in Nigeria (Contd…)

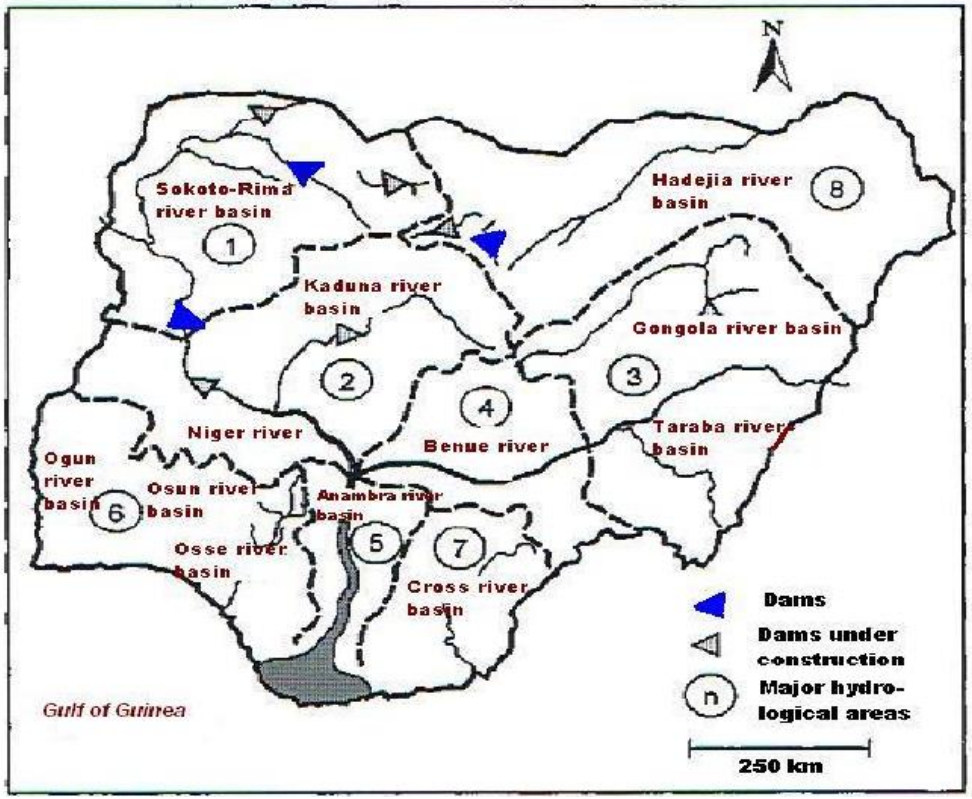

Figure 2: Map showing River Basins in Nigeria

- But Over the years however, the River Basins and other rivers in Nigeria have been poorly gauged and poorly mapped.

Environmental Consideration in the Use of Dams for Water Resources, Energy and Food

- Construction of dams particularly large dams involve tradeoff between economic, social and environmental benefits and costs.
- Essentially, impact occur consequent upon inundation storage, changes to flow and the flow regime, water quality impact, and changes to the morphology of the river system.
- Climate change also has an implication for existing dam infrastructure and also has the capacity to increase the intensity of extreme weather events.

EFFECTIVE UTILIZATION OF DAMS AND RESERVOIRS FOR MULTIPLE USE

- To unlock the potentials for multiple utilization of dams and reservoirs in Nigeria, there is the need to ensure mapping of river basins at appropriate scales.
- This will help in the following ways:
  - Provision of sufficient portable and qualitative water from Reservoir
  - Groundwater recharge from Reservoir
  - Effectiveness of Dams and Reservoir utilization for hydropower development
  - Study of siltation in Reservoirs
  - Effective utilization of Dams in flood control and regulation of river flow
  - Monitoring for structural integrity in Dams

Effective utilization of dams and reservoirs for multiple use (Contd…)

- Water resources planning must take into account multiple users, multiple purposes and multiple objectives.
- This will usually involve experts from various fields - Engineers, Hydrogeologists, Geomatics Engineer/Surveyors, planners and other professionals.
- The task of the Geomatics Engineer or Surveyor here is a servicing one, which involves the use of Geomatic and Geodetic Instruments and Methods.

GEOMATICS SUPPORT FOR MULTIPLE UTILIZATION OF DAMS AND RESERVOIRS IN NIGERIA

[A] Control Surveys for Water Development Schemes

- Planimetric and vertical controls are established along the river banks especially in the area where a dam is to be constructed and covering the area to be encompassed by the reservoir.
- A type of control established around **Ikpoba Dam** and reservoir in Benin City, **Nigeria** is presented in Figure1.

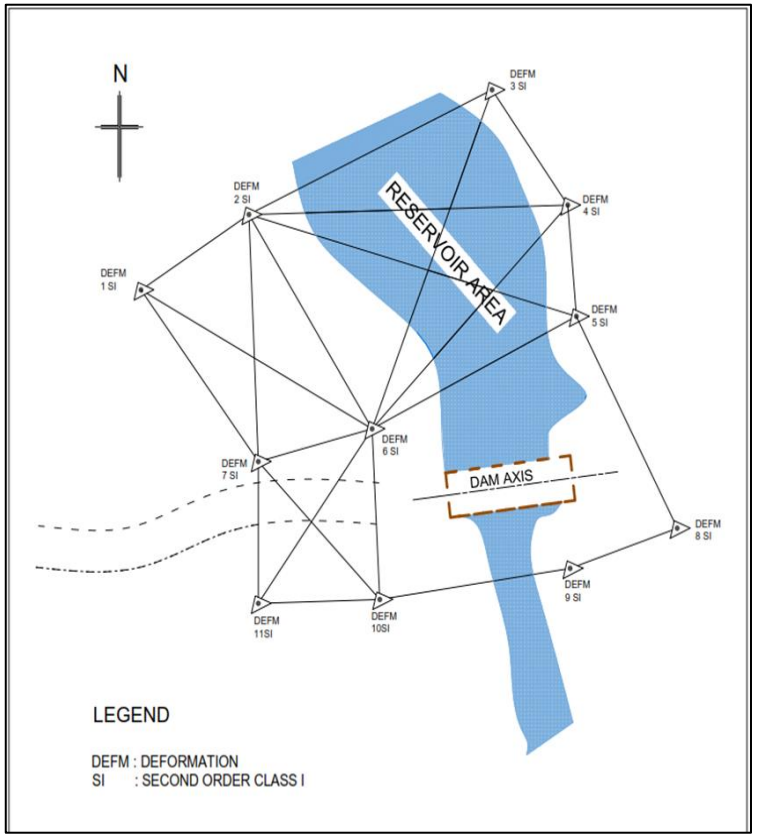

Figure 3: General Layout Plan of Control Monuments for Deformation Studies at the Ikpoba River Dam

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

- In designing the above network, a good apriori estimate of the accuracy standard instrument requirements and methodology for field measurement was carried out.
- The network has been reobserved by Differential GNSS observation method.
- The data collection of the GNSS campaign required the use of LEICA 500 dual frequency GNSS receivers to coordinate the eleven control points by static Differential GNSS technique.
- The reference and control points were occupied simultaneously while the dual frequency receivers and observations were carried out for not less than 1 hour and with a sampling rate of 15 seconds in each case.
- GDOP was set below 5.0 in each case and the window for the vertical angles of the satellite observations was limited to 15°.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

- The data processing procedure included:
  - Model validation
  - Ambiguity resolution which was carried out using FARA statistics
  - Coordinate computation with the variance-covariance matrix
- The software used for computation and adjustment SKI PRO with MOVE 3 reads the navigation file and then the observation file epoch by epoch.
- The baseline adjustment and the quality control are cycled through event epoch.
- The estimation output consisted of 3-D coordinates of the rover position for the eleven control points while the quality control component consisted of the variance – covariance matrix which gave the quality of the coordinate estimator.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[B] Geodetic Information Required for Reservoir Development

- In order to fully develop a reservoir for optimum utilization, the following problems should be solved by generation of adequate data and plans.
- Some of the area requiring Geomatics support include the following:
  - The establishment of the contour line defining the catchment area of the reservoir.
  - Determination of area under flooding and the capacity of the reservoir
  - Establishment of boundaries of area likely to be overflooded and preparation of master plans.
  - Preliminary surveys for the design of engineering defense walls against over flooding.
  - Preliminary and final surveys for the design of projects for the development of fishing industries within the reservoir areas.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[B] Geodetic Information Required for Reservoir Development (Contd)

- In the mapping of the Ikpoba dam reservoir area, analysis was carried out using data from GNSS surveys in combination with SPOT imageries.
- In the mapping of the reservoir area, the GNSS control coordinates were used as ground controls for imageries interpretation and analysis.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[B] Geodetic Information Required for Reservoir Development (Contd)

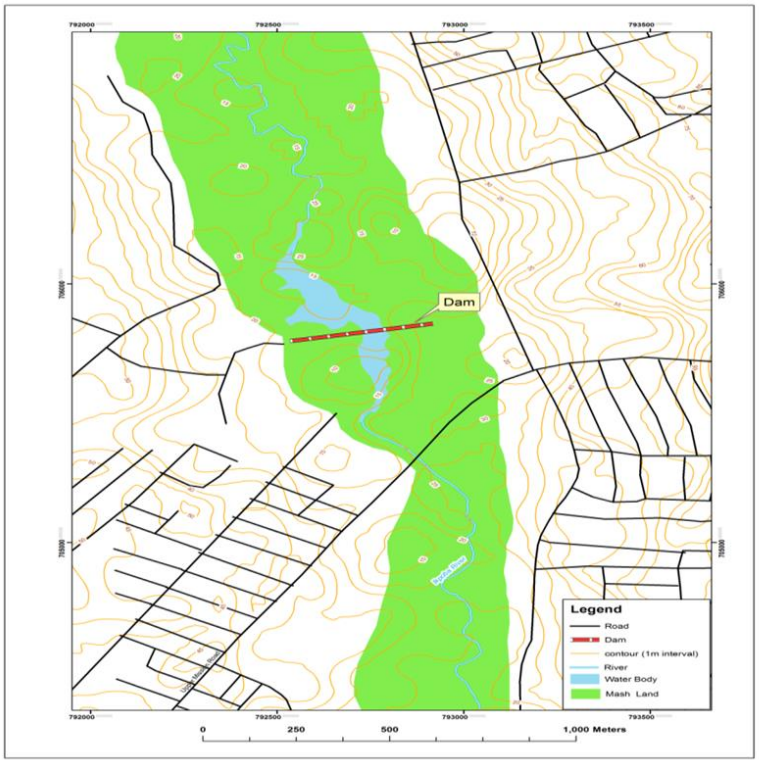

Figure 4: Topographical map of Ikpoba dam and reservoir area

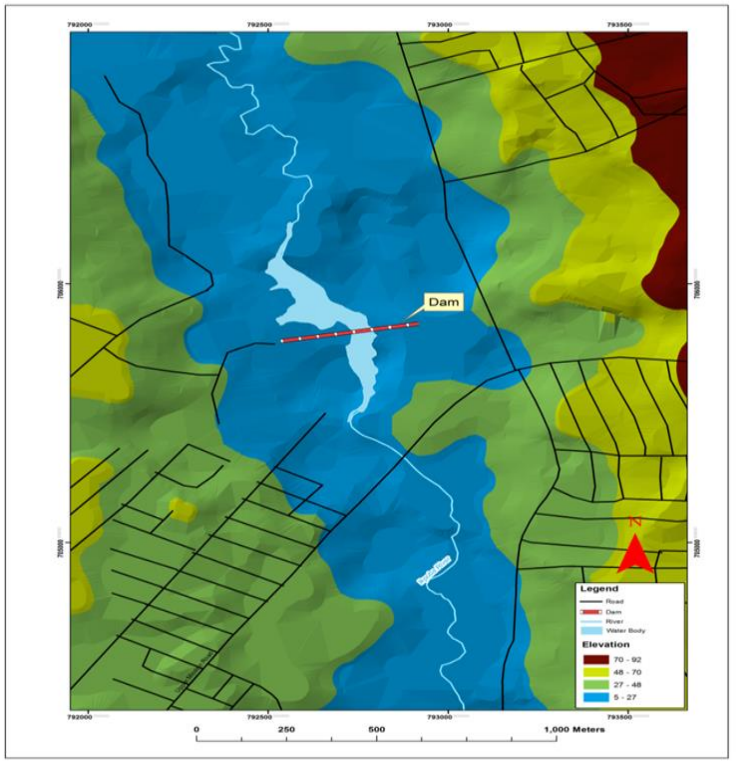

Figure 5: TIN of Ikpoba dam and reservoir area

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[B] Geodetic Information Required for Reservoir Development (Contd)

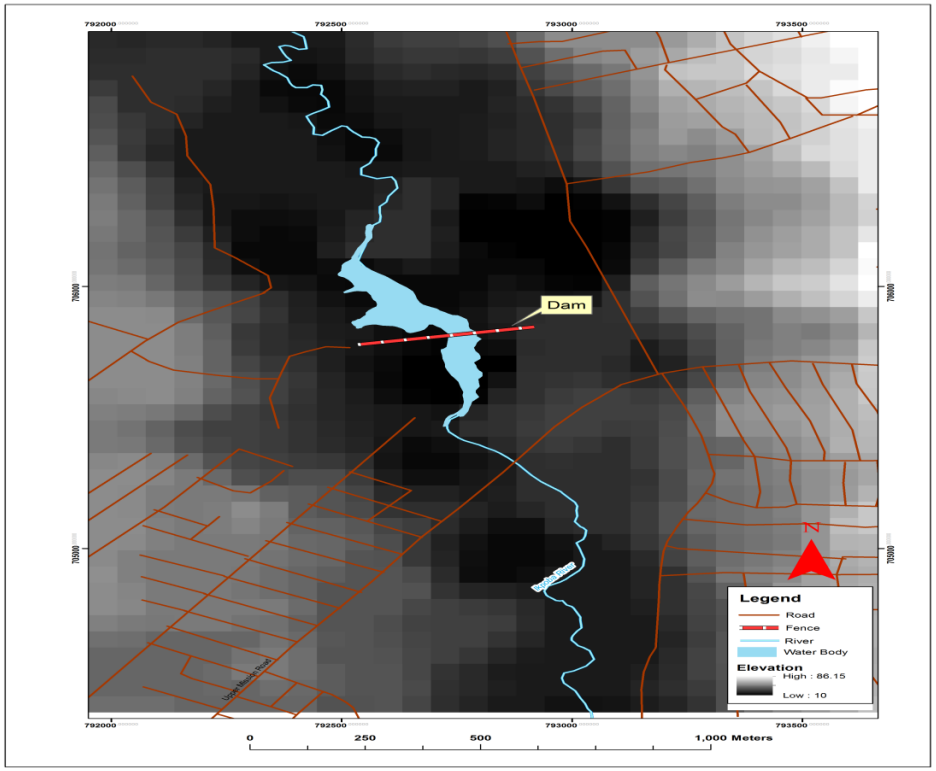

Figure 5: DEM of Ikpoba dam and reservoir area

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[C] Hydroelectric Power Production

- The production of hydro-electric energy during any period at any particular reservoir site is dependent on the production storage head (H), the flow (Q) through the turbine, the effective reservoir capacity (V'), the Transitional runoff (W_T), plant efficiency etc.
- Error in the measurement of H in the order of 1% can be accommodated for dams of height greater than 50m.
- But in low Head Dams, the effects of this error can be serious and thus precise levels should be used to determine the height of the Head.
- Also, the error in the measurement of V' depend on the scale and accuracy of producing the map of the reservoir, planimetric error in area and final computation of volumes.
- Hence for accurate power estimation, accurate geomatic measurements is required.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[D] Determination of the Longitudinal Section of a Stream

- The longitudinal profile of a stream consists of a vertical section of the stream by a line of dynamic flow.
- In order to effectively carry out the task of producing the longitudinal profile of a stream, it is first necessary to run a high order level line along one of the river banks for small streams and along both banks for larger rivers.
- From these higher order stations we can establish lower order points close to the stream.
- These are in turn used as controls for taking water levels in the stream.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[E] Geodetic Information in the Determination of Water Levels in Streams

- Water level measurement posts are usually fixed at some defined points along the stream.
- The length of sections between gauge stations will depend mainly on the intensity of changes in water level.
- Levels are run from known points to the gauge stations in order to reduce the water height and the shore control stations to a common datum.

Geomatics Support for Multiple Utilization of Dams and Reservoirs in Nigeria (Contd…)

[F] Acquisition of Geodetic Information in an Irrigation District

- In an irrigation district containing various soil types, it is necessary to decide which crops should be grown in which zone.
- It is therefore necessary to divide the whole irrigation districts into blocks.
- To do this, the first step is to run a third order planimetric traverse control around the boundaries of the irrigation district.
- Thereafter, subsidiary traverses which are tied to the National Geodetic Framework of higher accuracy are run to divide the district into blocks in accordance with soil types.
- Grid leveling of the area is then carried out for effective planning and flood and erosion control.

CONCLUSION

- In acquiring Geospatial information for irrigation and water development schemes in meeting the demand for water, food and energy, it is necessary that adequate pre-observation analysis be carried out in order to effectively design the measurement system required in the design, construction and management of all water schemes.
- Such a measurement system involves a combination of survey designs, instrumentation, calibration procedures, observational techniques and data reduction methods.
- The demand for water, food and energy is increasing not only in Nigeria and Africa as a whole but in the world at large.

Conclusion (Contd…)

- In order to cope with the challenges posed by this demand, it is necessary to understand the interconnectivity between the demand and the supply for the three i.e. water, food and energy.
- As water becomes scarce as a result of the multiple usages, there will arise competition between clean water supply, energy and agriculture.
- There is therefore the need to develop cross sectorial research that will address the problem and ensure that decision taken in one sector does not adversely impact on the other sectors as well as on the environment.
- with proper collaboration and research in the above thematic areas and provision of adequate geospatial data we will be able to unlock the potentials for multiple utilizations of dams and reservoirs for water supply, Irrigation, flood control, energy (Hydropower generation) tourism, mine tailing, etc.

THE END…

THANK YOU!