THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER AND IRRIGATION

WAMI RUVU BASIN WATER OFFICE

IMPACT OF CLIMATE VARIABILITY ON GROUNDWATER IN DAR ES SALAAM, TANZANIA.

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JUNE, 2008
KAMPALA, UGANDA

PRESENTATION LAYOUT

- BRIEF DESCRIPTION OF THE SITED AREA
  - ✓LOCATION
  - ✓PHYSIOGRAPHY AND CLIMATE
  - ✓GEOLOGY AND HYDROGEOLOGY
  - ✓CURRENT WATER SUPPLY
- EFFECT OF CLIMATE ON GROUNDWATER RESOURCES
  - ✓CLIMATE VARIABILITY WITH WATER SCARCITY
  - ✓GROUNDWATER RESOURCES UNDER PRESSURE
  - ✓AQUIFER RECHARGE WITH CLIMATE CHANGE
- FACTORS AFFECTING RIVER FLOW AND AQUIFER RECHARGE AS A RESULT OF CLIMATE VARIABILITY
- WATER RESOURCES MANAGEMENT
  - ✓CHALLENGES OF THE WRM
- NEW WATER SOURCE DEVELOPMENT
  - ✓CURRENT INITIATIVES
  - ✓NEW SOURCE DEVELOPMENT

BRIEF DESCRIPTION OF DAR ES SALAAM AREA

- **LOCATION**

✓ The cited Dar es Salaam city and areas around are located to the Tanzanian coastal area to the extreme east

✓ It is lying between Longitudes 37°10' to 39°30' E
Latitudes 06°15' to 07°40' S.

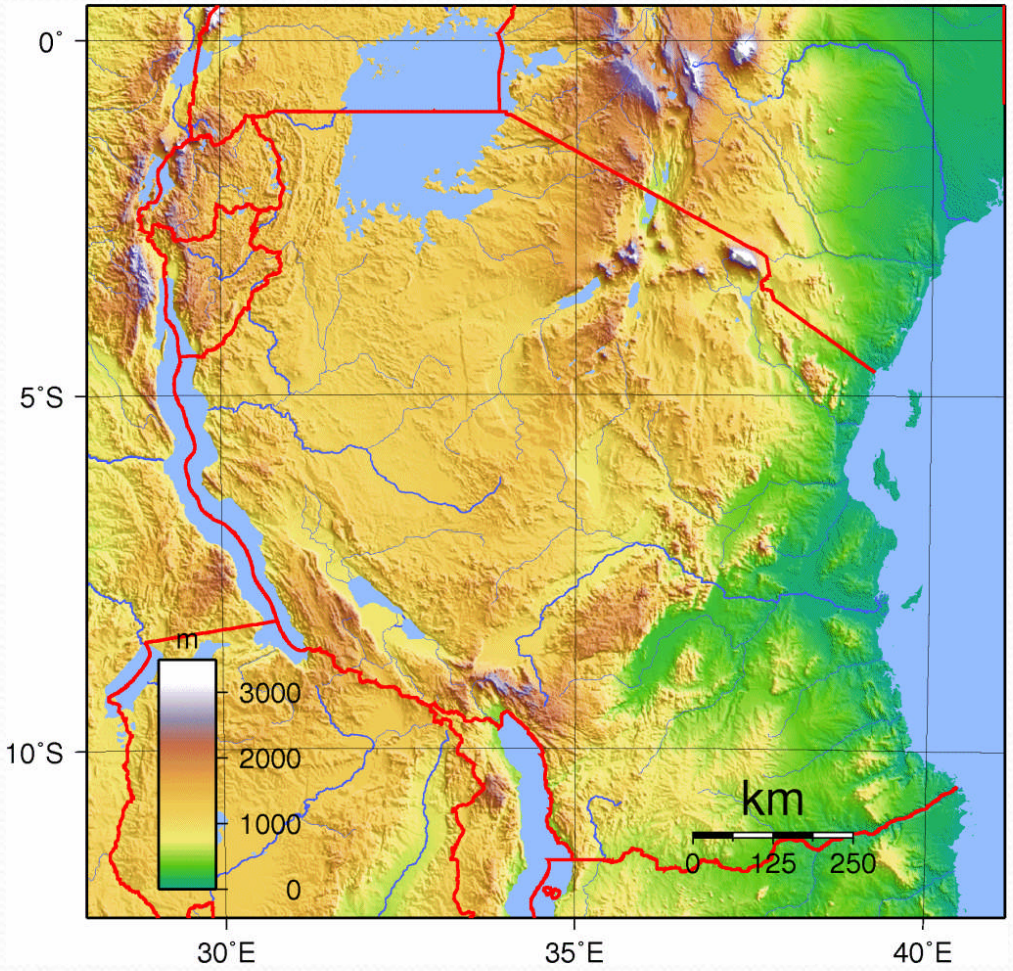
✓ The area covers the Ruvu Catchment and Coastal Rivers of the Wami/Ruvu River Basin.

PHYSIOGRAPHY AND CLIMATE

- **PHYSIOGRAPHY**

✓ The topography of the area range from flat land of coastal areas to mountainous features whereby the coastal area range from 0 to 100 meters above mean sea level (m.a.s.l) and 2500 m.a.s.l in the mountainous regions.

✓ Ruvu River catchment area is approximated to be 18,078 km² and coastal Rivers subcatchment (Mpiji, Sinza, Mlalakuwa, Msimbazi, Mbezi, Mzinga and Kizinga) area is approximated to be 4,796 km²

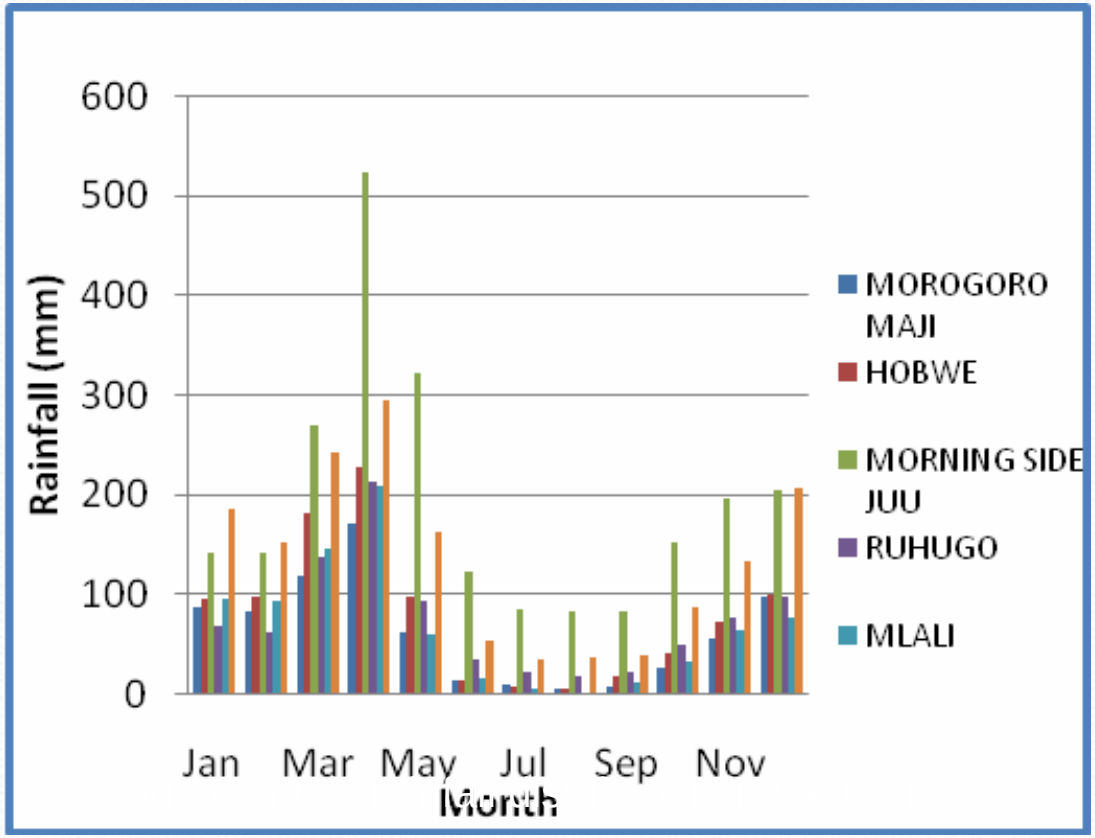


CLIMATE

- RAINFALL

✓ Rainfall occurs throughout the year, but variable and undependable, whereby two rain seasons are experienced. Heavy and long rains start from March to May while short and small rains occur during October to December,

✓The highest monthly and most reliable rainfall is in April. Average annual rainfall in the area range from 800 - 1200 mm in coastal areas to 1500 mm in the mountainous areas.



GEOLOGY AND HYDROGEOLOGY

- ***Precambrian: Mozambique Belt (Usagaran system-Tanzania);***

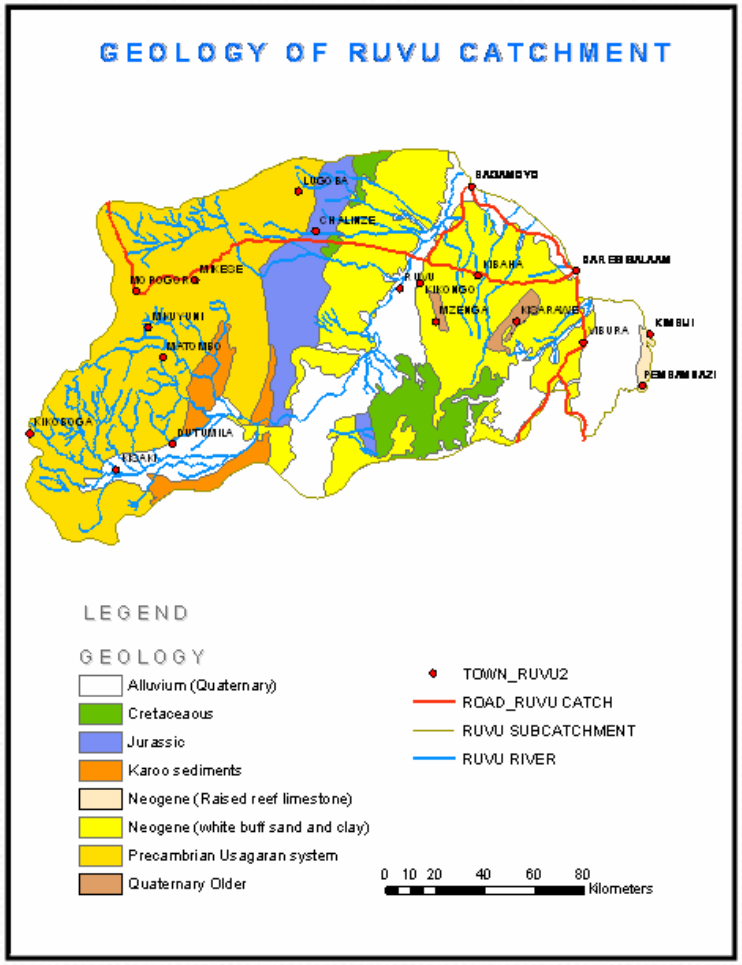
✓ Lower: Hornblende and Biotite gneisses and granulites. Upper: crystalline limestone often dolomitic, which may be graphitic or have associated graphitic schists and gneisses.

- ***Karroo:***

Sandstone, often coarse and gritty, with some shale, siltstone and conglomerate

- ***Mesozoic:***

Boulder-bearing sandstone - early Jurassic and Littoral limestone represented by coral reefs after Marine transgression-Middle Jurassic.



GEOLOGY AND HYDROGEOLOGY CONT….

- ***Neogene:***

✓ Interbedded sandy clays and clayey sands with minor lenses of pure sand or clay. Gravel, mostly quartz, some feldspar and Precambrian gneiss is scattered throughout but always in clay matrix.

- ***Quaternary:***
- Pleistocene to recent sediments exists in the area developing as alluvial deposits

AQUIFER CATEGORY

- **Quaternary aquifer**

✓ Geological unit of quaternary formation exists throughout the area, mainly the coastal plain of Dar es Salaam.

✓ In the Quaternary formation, the groundwater has been developing very actively, accordingly the number of well are the highest. Almost 50% of the wells in the area are tapped from Quaternary aquifer. The yield of these well is generally high, especially in Dar es Salaam Region

- **Neogene aquifer**

✓ Neogene sediments consist of interbedded sandy clays and clayey sands with minor lenses of pure sand or clay. The gravel of mostly quartz, is scattered throughout in a clay matrix. Since the formation is distributed extensively in the area, large number of wells has been drilled into the Neogene aquifer.

GEOLOGY AND HYDROGEOLOGY CONT….

- **WELL YIELD AND WATER QUALITY**

✓ Quaternary aquifer shows very high yield of more than 100 liters/min in average value.

✓ Neogene aquifer shows relatively higher yield. In Neogene aquifer, average yield is only 24.5 liters/min.

✓ For the geological formations of Precambrian, Cretaceous and Jurassic, the yields are generally low of about 10 liters/min in average.

✓ For the water quality, electric conductivity (EC) shows relatively low value in Neogene and Quaternary aquifers. It is 1150µS/cm in Neogene aquifer, and 1088µS/cm in Quaternary aquifers of Dar es Salaam region.

CURRENT WATER SUPPLY

- The City is currently getting water supply from the major Ruvu River, which originates from the Ulugulu Mountains lying to the North western side of the Dar es Salaam City, flowing towards the eastern side of Tanzania into the Indian Ocean.

- River recharge is mostly depending on rainfall falling on its catchment area and springs located in the Uluguru Mountains.

- The River is not regulated nor is the system managed adequately. Consequently, it remains vulnerable to adverse impact from draughts and occasional floods.

- The current water demand for Dar es Salaam service area is estimated to be around 410,000 m^3/ day while the actual water supply is about 126,900 m^3/ day from surface sources and 50,000 m^3/day from groundwater. The groundwater quality is generally good and within acceptable drinking standards, however, few boreholes have high salinity and conductivity exceeding 2000 µS/cm.

- It is projected that the population of Dar es Salaam City will be about 6 million in the year 2020, raising the water demand to about 970,000 m^3/ day

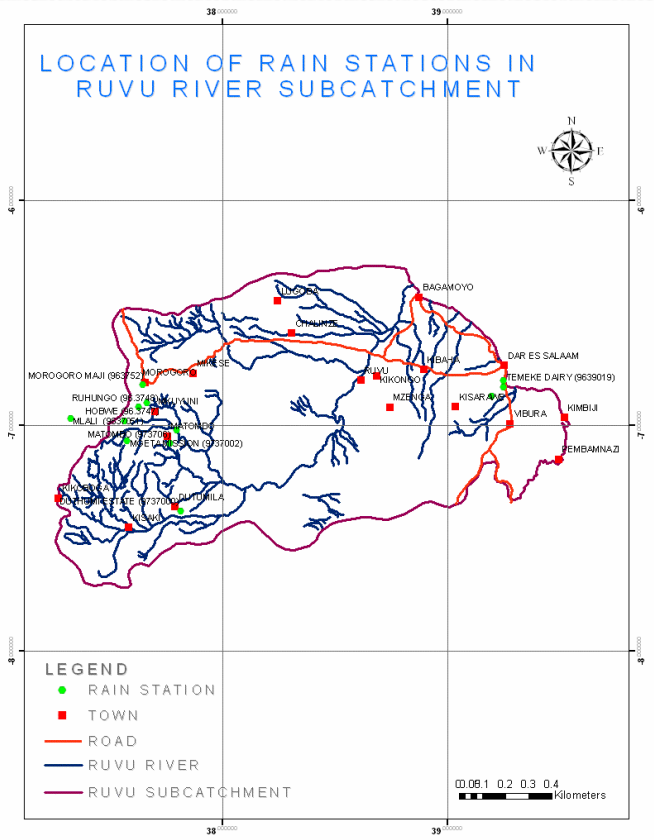
EFFECT OF CLIMATE ON GROUNDWATER RESOURCES

- **CLIMATE VARIABILITY WITH WATER SCARCITY**

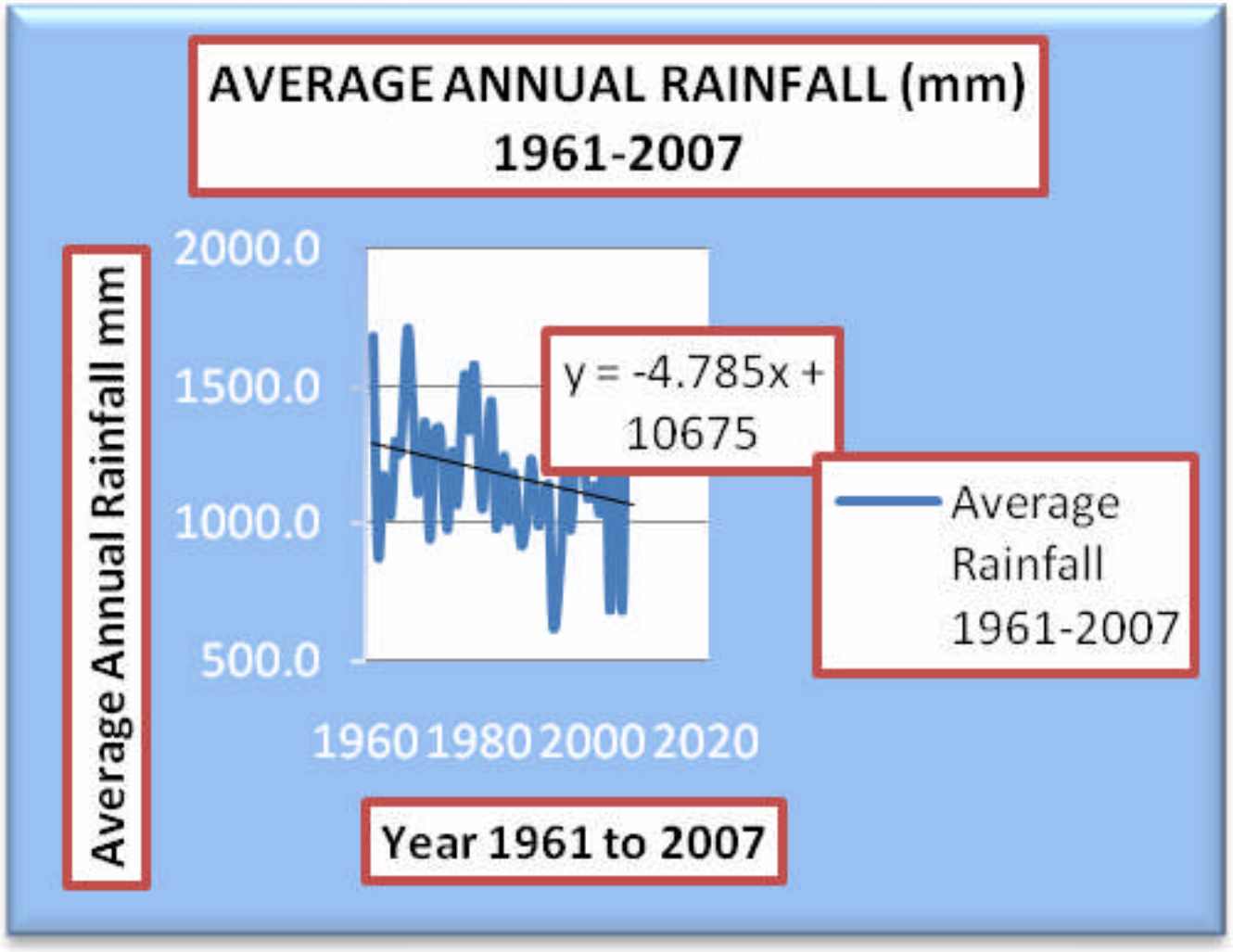
  - ✓ The analysis of rainfall data for the past forty six years (1961 to 2007) from six rainfall stations in the Ruvu River catchment were made, whereby general decrease of rainfall amount within the catchment was observed.

  - ✓ Other six rainfall stations showed the same trend of rainfall decrease although their data range differs from the first set of six rainfall stations.

Location map of Rainfall stations in the Ruvu Catchment area.



Average Annual Rainfall distribution in the sited area (1961 to 2007).



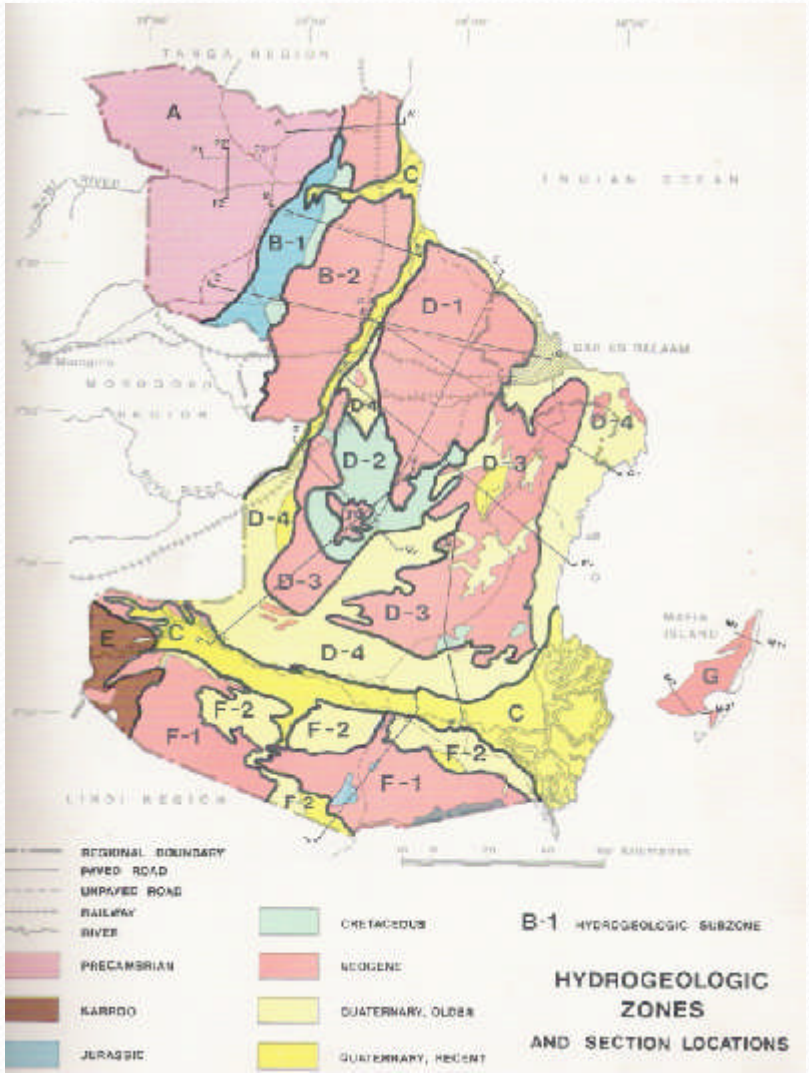
GROUNDWATER RESOURCES UNDER PRESSURE

- ✓ Climate variability affects River flow, causing uncertainty of water supply to the Dar es Salaam City.
- ✓ The current climate variability results into tremendous decrease of Rainfall amount falling on the Ruvu catchment.
- ✓ During the prolonged draught period of 1996/97 great number of Dar es Salaam residents shifted to groundwater source to augment surface water supply, which became insufficient and unreliable for different uses.
- ✓ Since then, it was proposed to use groundwater in conjunction with surface water since surface water source became unreliable and inadequate to fulfill the city residents' demand. This resulted a rampant increase of well drillings
- ✓ The Geological unit of Quaternary favors the formation of potential and easily exploitable aquifers of relative shallow depth (less than 100 meters below ground level). Groundwater is developed at a moderate coast, which a normal city resident can afford and use groundwater to augument surface water sources.

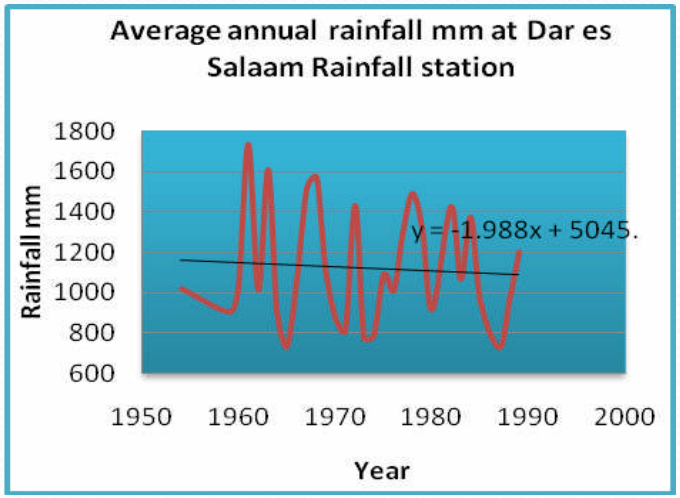
Borehole supplying one Secondary school in the Region.

AQUIFER RECHARGE WITH CLIMATE CHANGE

- ✓ The aquifer recharge in Dar es Salaam area depends on rainfall infiltration through superficial sand formation which dominates in great part of the Region. Ruvu and Coastal Rivers also contribute much in the aquifer recharge.

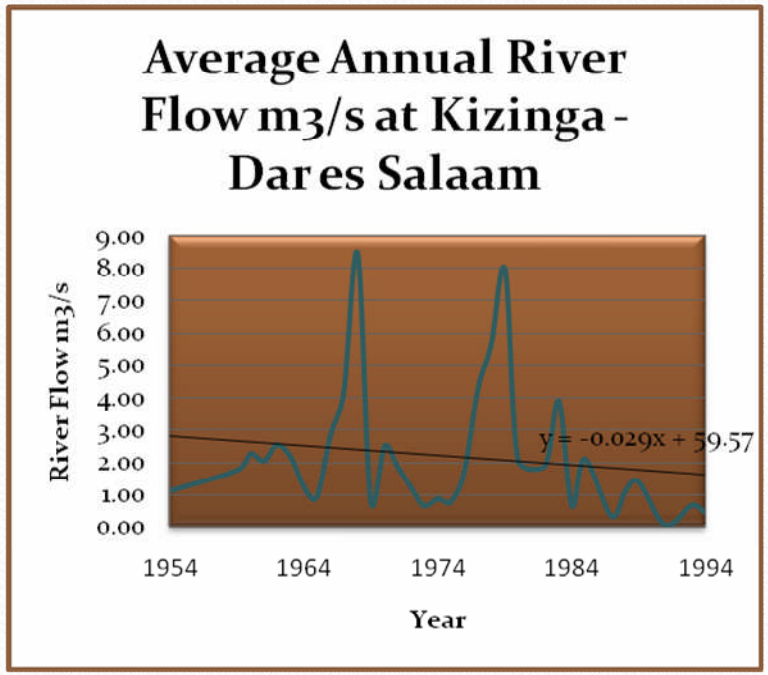


AQUIFER RECHARGE WITH CLIMATE CHANGE CONT…….



✓The average annual rainfall data trend from the Dar es Salaam international Airport rainfall station indicates general decrease of rainfall amount from 1954 to 1990.

✓This is supported by the general decrease of Kizinga River flow, located within the Kizinga River catchment, Dar es Salaam Region.



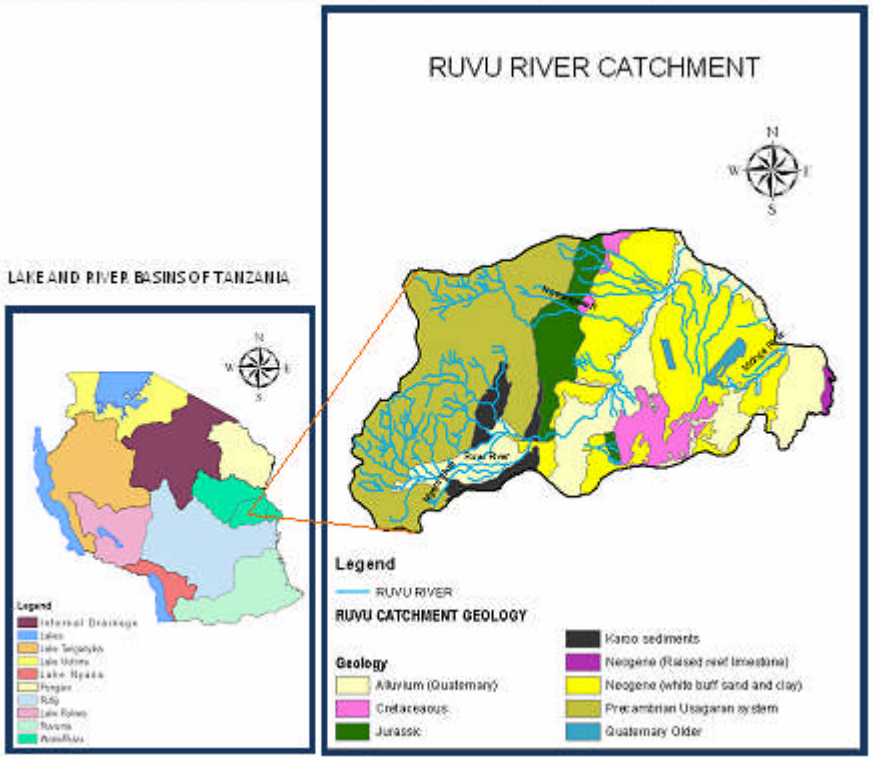
FACTORS AFFECTING RIVER FLOW AND AQUIFER RECHARGE AS A RESULT OF CLIMATE VARIABILITY

Human activities along river course contribute much in the destruction of Water sources. These activities includes.

- Farming along the river banks, springs and steep slopes in the basin due to dependence on river water for irrigation during the dry seasons result reduced minimum flows
- Urbanization by modifying the natural soil cover condition
- Soil erosion due to cultivation and mining in river basins, in turn cause siltation of watercourse thus water scarcity
- Uncontrolled tree cutting and bush fire in the Ruvu river recharge areas

WATER RESOURCES MANAGEMENT

- In order to manage water resources for sustainable use, five main levels were set according to the National Water Policy (NWAPO 2002) namely; National, Basin, catchment, District and community levels. Nine River and Lake Basins were established which do not follow the administrative boundaries, Dar es salaam being located in the Wami/Ruvu River Basin (WRBWO) in the coastal rivers sub catchment.



THE BASIN WATER OFFICES HAVE THE FOLLOWING RESPONSIBILITIES

- To monitor and regulate water use according to the availability
- To control and take legal measures against water source polluters
- To resolve water use conflicts
- To collect different water user fees and use them for office operation
- To sensitize on the sustainable use of water resources
- To facilitate the formation of Water User Entities.
- To facilitate the formation of catchment/sub-catchment committees
- Operation and maintenance of water resource monitoring stations
- Assess and monitor the quantity and quality of water in the basin
- Coordinate the Integrated Water Resources Management plans
- To participate in water sources protection programs
- To issue water use permit
- Facilitate formation of District Facilitation Teams (DFTs)
- Establish communication network with District Councils

In order to implement the above mentioned basin responsibilities, the WRBWO is currently doing the following;

- Facilitating the formation of the DFTs from different sectors, (Health, education, planning, fisheries, forestry, Community development, environment etc)
- Using the DFTs to strengthen the existing Water User Associations and establishing new ones at Community level.
- Creating awareness to communities on the issues of water resources management whereby communities will participate in the conservation, protection, efficient and effective water use, law enforcement and implementation of water right conditions.
- Involving communities in the implementation of IWRM plans.
- Helping the District Water and Sanitation Teams in the implementation of Rural Water supply and Sanitation Projects

CHALLENGES OF WATER RESOURCE MANAGEMENT

- Uncontrolled groundwater abstraction which could lead to over- pumping, seawater intrusion and thus damage to important aquifers
- Encroachment and degradation of important watersheds and groundwater recharge areas
- Growing contamination on water sources from agriculture, industries, and mining
- Basin capacity in terms of number of qualified personnel

CHALLENGES…..

- Inadequate information on quantity and quality of water to effect informed allocation
- Water permits with no timeframe; draft legislation which is addressing this shortfall is being revised
- Control of waste water disposal
- Lack of awareness among the key stakeholders on the NAWAPO and Legislation

NEW WATER SOURCE DEVELOPMENT

- **CURRENT INITIATIVES**

The Government of Tanzania through the Ministry of Water and Irrigation in collaboration with Dar es salaam Water and sewarage Authority (DAWASA) carried out a study for Future Water Source of Dar es Salaaam region and the areas around. A study was to evaluate the current water sources and recommend a Water source development Master plan. A Water Source Option Review (WSOR) looked into 26 different alternative sources of water from which construction of Low Kidunda dam on Ruvu River and deep groundwater exploitation in the coastal aquifers were given priority. Construction of dam at Kidunda intends to regulate flows in Ruvu River and thus ensuring optimal supply to the intakes.

- The study on groundwater potentials, covering major areas of coastal Tanzania, dealt with all aquifer alternatives of interest for Dar es Salaam's water supply. Three aquifer provinces were described and assessed:

- Hinterland Mesozoic Province (HMP) with
  - ✓ Ruvu Sandstone Aquifers
  - ✓ Kidugallo Limestone Aquifers

- Coastal Neogene Province (CNP) with
  - ✓ Kimbiji Coastal Aquifers
  - ✓ Bagamoyo (Machuisi) Coastal Aquifers

- Coastal Holocene Province (CHP) with
  - ✓ Coastal Plain Aquifer
  - ✓ Floodplain and Deltaic Aquifers

The CNP is a very large aquifer, and its recharge potential is also an essential part of the previous findings, which is unquestionably in the same league as the aquifer itself. All drainage from the hinterland has to pass the aquifer's sandy recharge areas, mainly the Tertiary sands of the Dar es Salaam Platform, the Ruvu Basin, the Wami Basin and the Kimbiji area.

One of the areas thought to be source of Kimbiji aquifer recharge situated to the southern part of Dar es Salaam Region.

NEW SOURCE DEVELOPMENT

- ✓ A wider and deeper knowledge of the entire aquifer is required in order to assess the scale of the resource, and to plan for its sustainable development and future use as a national asset.

- ✓ There is a need for an accurate assessment of the safe yield of the coastal aquifers and the existing ground water production and constraints on groundwater quality need to be fully delineated.

CONCLUSION AND RECOMMENDATIONS

- Introduction and implementation of Integrated Water Resources Management (IWRM) is a good approach in reducing the impact of climate change in the sub Saharan countries.
- Water is a resource of the common good; consequently, participation of all water resource stakeholders in the management of these resources results in more efficient use and effective conservation of water. This is because participation creates
  - a sense of ownership of the resource and accountability in the decisions made.
  - Reduced cost of enforcing the regulations
  - Public contribution to the long-term viability of management processes
  - Stakeholder participation reduces monitoring and administrative costs.
- Enforcement of water legislation and fully implementation of National Water Policy will reduce the unwise uses of water sources
- Public participation in water sources protection will reduce the impact of climate change with respect to environmental degradation.
- It is important to have a good and operational water resources monitoring network

THANK YOU