Introduction

- Rivers and estuaries have always been the focus of human settlement and recreation.
- The waters are used for recreation, transport, boating facilities and for development of ports.
- The catchment often supports a range of land uses such as housing, agriculture and forestry.

- These activities become sources of pollution of the waters.
- Waste discharges, accidental spills, urban and agricultural runoff, and ground water introduce pollution agents into waters and rivers.

Influence of flooding on the microbial water quality of the Calabar River and the Cross River Estuary, Nigeria

Ama-Abasi, Daniel, Jack Showell & Eze Bassey

University of Calabar, Nigeria

Introduction contd

- Organic matter in storm water runoff is associated with pathogens and other contaminants.
- Their discharge into rivers during storm events may constitute a source of near-shore pollution that may continue after the wet season is over.
- Storm water runoff from urban watersheds can continue after the rains have stopped leading to a major potential for human exposure to pathogens by those using the water body for recreation or drinking.

The City of Calabar

- The city of Calabar was the first capital of Nigeria
- Missionaries from Europe first landed in Calabar
- The population is over 371,022 people.
- It is within the tropical rainforest with mean annual rainfall of 4,021mm.
- The city is sandwiched between two rivers- the Great Kwa River in the East and Calabar River in the West.
- The drainage system is quite good as flood water easily finds itself into the rivers after rainstorm.
- The river estuary has a semi diurnal tidal regime with tidal range of about 3.0m.

Anthropogenic events along the River system.

- The shore of Calabar River hosts many industrial and recreational facilities.
  - CICC- Calabar International Convention Centre
  - Tinapa- Business Consortium.
  - Marina Resort
  - Export processing Zone
  - Ports and transporting facilities.
  - Metropolitan market.



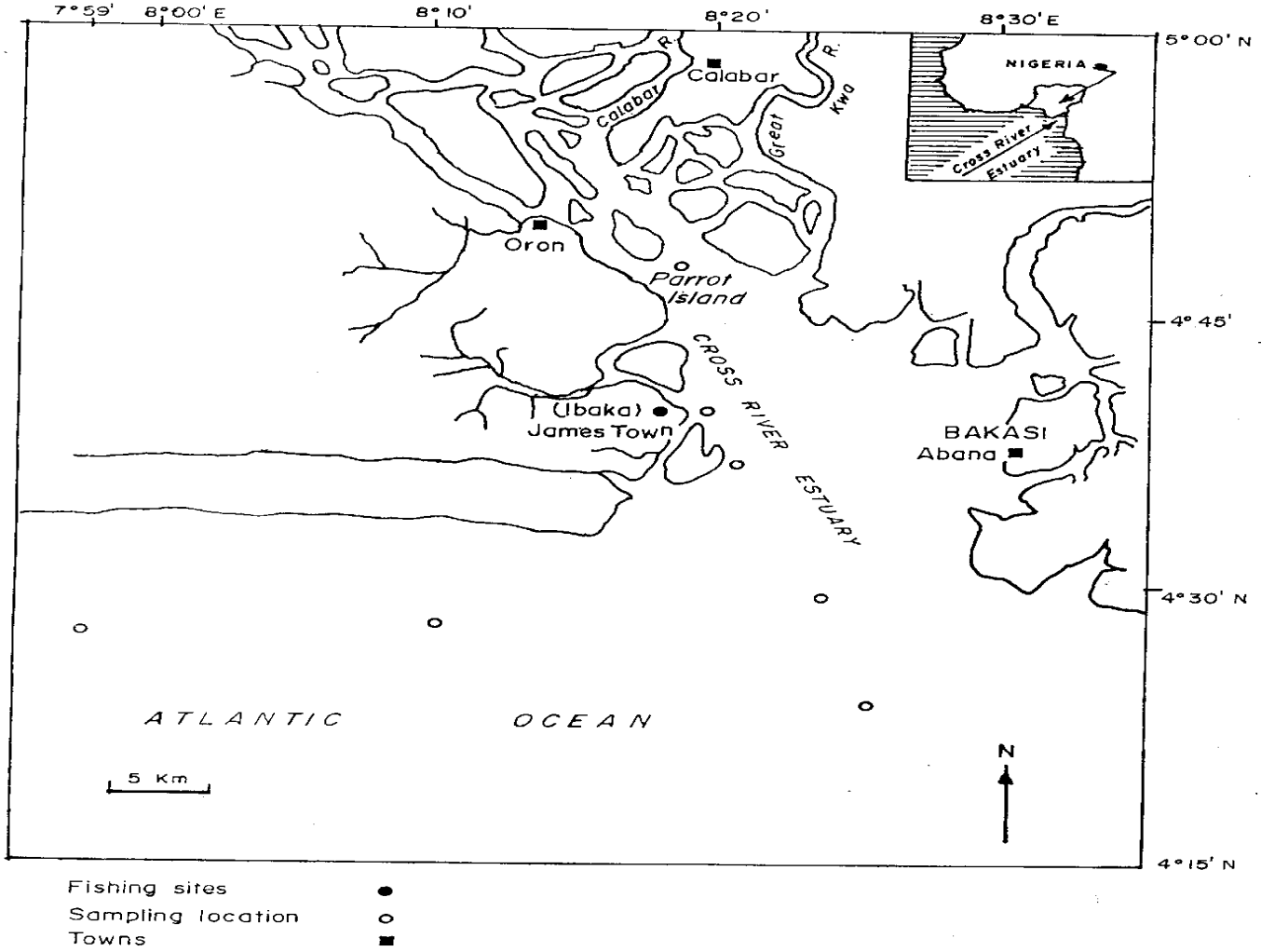
Open and brimming dumpster



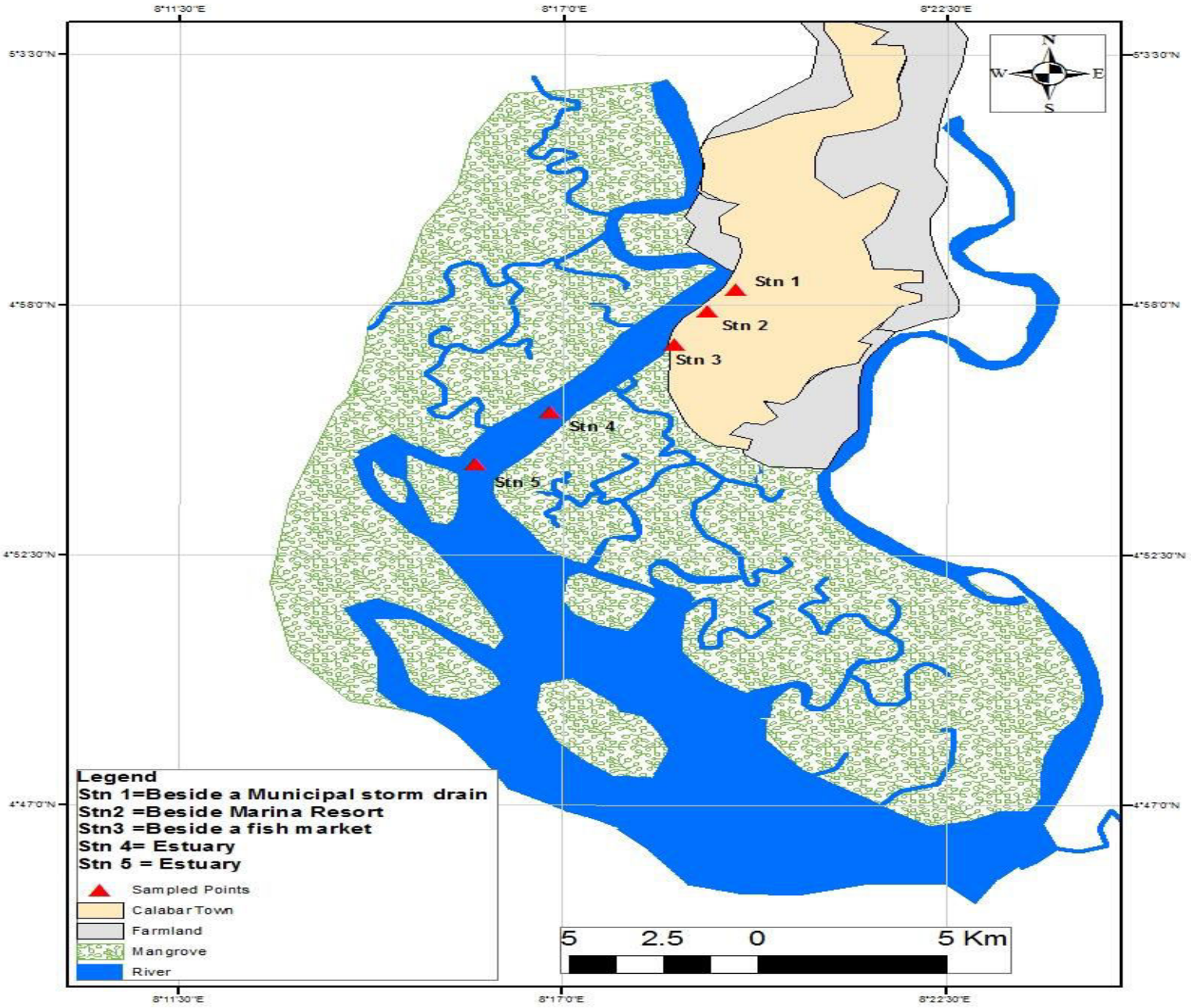
An abattoir at a beach beside Calabar River



A drainage facility that empties into the Calabar River.



Cross River Estuary



Map of the study area showing the sampling points

Objectives of the Study

- To assess the relationship between the bacteria load in the water body and the rainfall
- To assess the tidal influence on the bacterial load in the water body.

Methodology

- Sampling was carried out fortnightly for twelve months.
- The sampling depth for water samples was 15cm to 30cm below the water surface.
- Sediment samples were also collected using the Eckman bottom grab sampler.
- Sampling spanned the dry and wet seasons in order to observe seasonal trends.
- Sampling was also done during ebb and flood tides to observe tidal influence on the quality of the water.

Methodology

- The water and sediment samples were immediately transported in an ice box to the laboratory where they were processed.
- A total of 240 water samples were collected
- 144 water samples were collected near-shore while 96 were collected at the estuary section of the river.
- Rainfall data were obtained from the meteorological department of the University of Calabar.

Methodology contd

- Serial dilutions of water and sediment were made using sterile water.
- Dilutions of 10^{-3} and 10^{-4} were used to prepare pour plates using nutrient agar.
- The plates were labeled and incubated for 48 hours at a temperature of 30^{0}C.
- Colonies on the plates were then enumerated.
- Sub-cultures of the different colony types were made on fresh nutrient agar plates and incubated for 48 hours at a temperature of 30^{0}C.

Methodology contd

- The cultures were then macroscopically examined taking into consideration the shape, edge, size and pigmentation of discrete colonies formed.
- Pure strains of the bacteria obtained were used for subsequent characterization to genus level using the scheme of Oliver (1982) and Buchanan, & Gibbons, (1974).

Table showing the Bacteria species and their relative abundance in the Cross River system

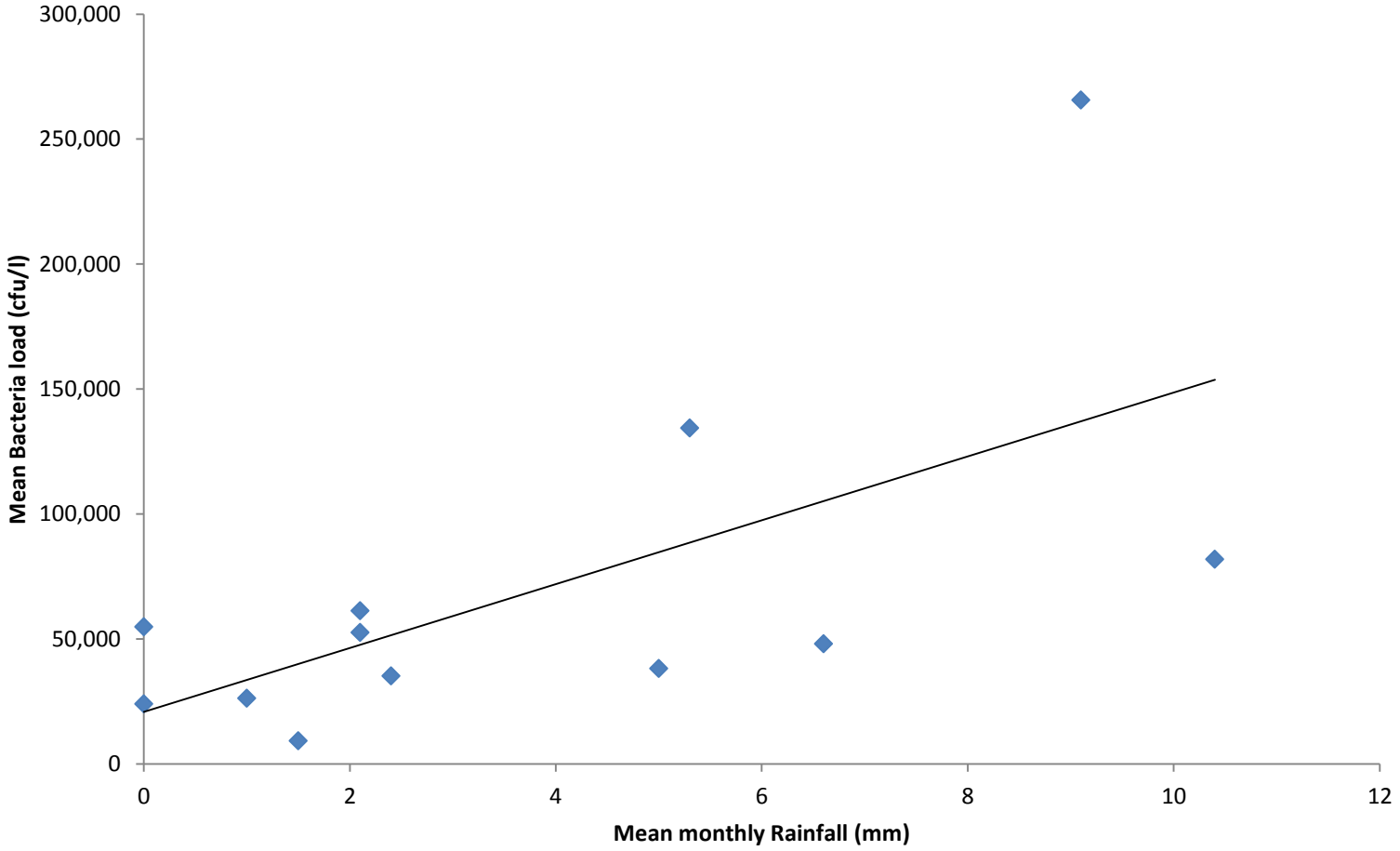
Isolate	Percentage(%)
Acinotobacter	25.7
Pseudomonas	21.2
*Micrococcus***	16.9
Bacillus spp	15.6
*Aeromonas***	10.8
Achromobacter *Enterobacteriaceae* *** Indigenous to rivers and estuaries*	6.5 3.3

Results contd.

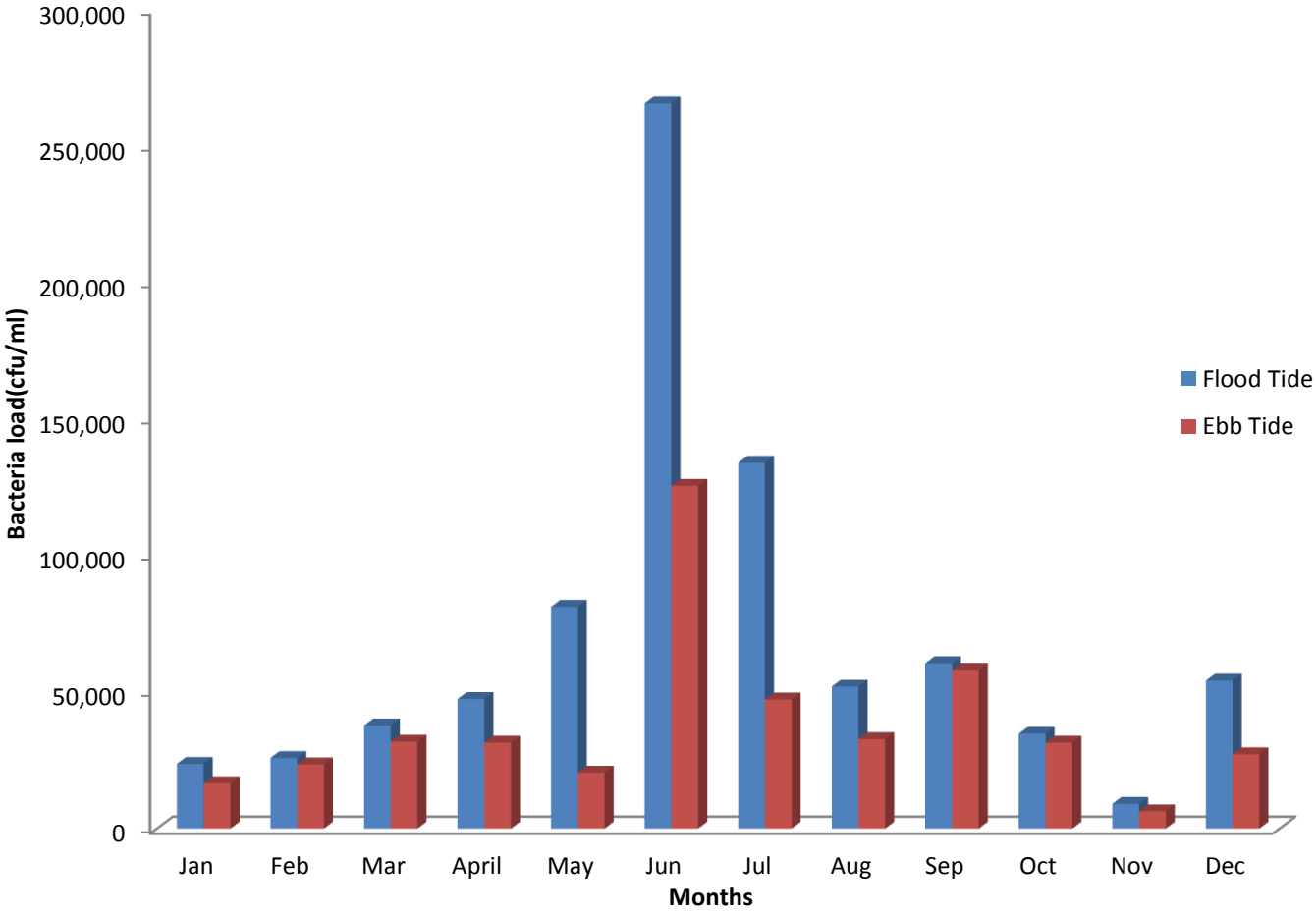
- Total heterotrophic bacteria counts were moderately high.
- Highest counts of $5.8x10^5$ cfu/ml was recorded during the rainy season and during flood tide.
- The lowest count of $1.2x10^3$ was recorded during the dry season months and during ebb tide.
- The lowest count was $1.2x10^3$ at station 3 during ebb tide.

Results contd.

- The highest counts were as in the water samples recorded in the rainy season.
- The highest count was $9.6x10^5$cfu/ml in June during flood tide.
- The lowest counts $4.1x10^3$cfu/ml were in the dry season months with the lowest in March.



Bacteria load against monthly rainfall showing that the higher the rainfall the higher the bacteria load



Monthly bacterial load showing higher population in floodtide than ebb tide

Conclusions

- High counts in rainy season is enhanced by surface run-off
- Similarly high tidal regime enhances the bacteria load in the water.
- Organic debris with attached bacteria are washed both by surface run off and flood tide into the rivers and estuary.
- Some of the bacteria are pathogens of human diseases.

Conclusions contd.

- The implication is that flooding occasioned by climate change may lead to outbreak of water borne diseases.
- Some food fishes and shellfishes will contract more diseases at such time.
- Consumption of such food fishes may further endanger human health.
- Proactive and ameliorative measures must be set up in the riverine and coastal communities as adaptation to climate change.