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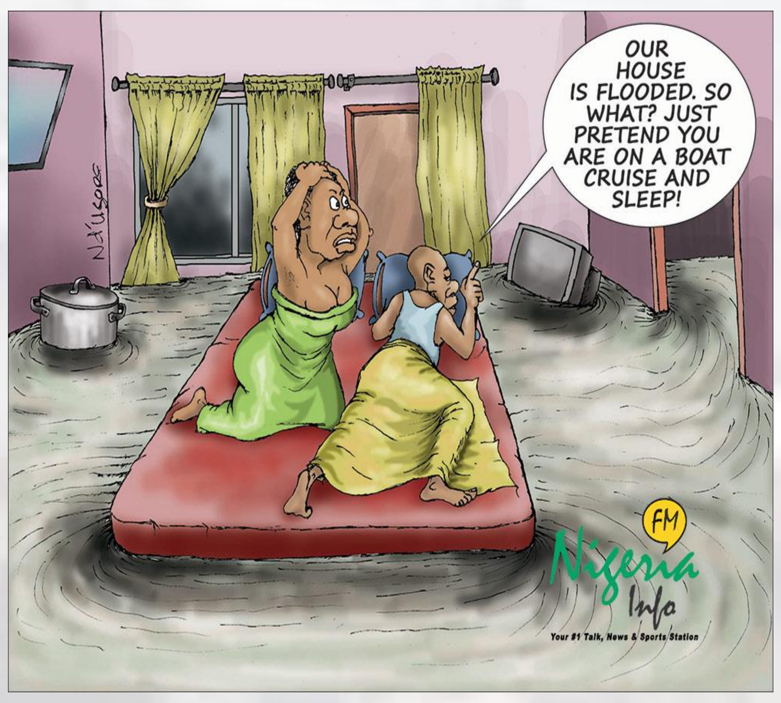


# Multivariate Frequency Analysis of Flood Risk in the Poor Coastal Communities of Lagos State, Nigeria.

**EMMA EMODI**

*Department of Civil and Environmental Engineering*

*Imperial College London*

## 1. MOTIVATION AND OBJECTIVE

The frequent floods that occur in the coastal city of Lagos, Nigeria are driven by extreme precipitation and storm surges along the Atlantic Ocean coastline. In this paper, a copula-based methodology is applied to estimate the joint hazard flood return period in the case study of the Lagos Lagoon. The impact of these floods on residents of nearby impoverished coastal communities by the lagoon is also considered for a comprehensive analysis of flood risk to be used as a framework for better management practices in Nigeria.

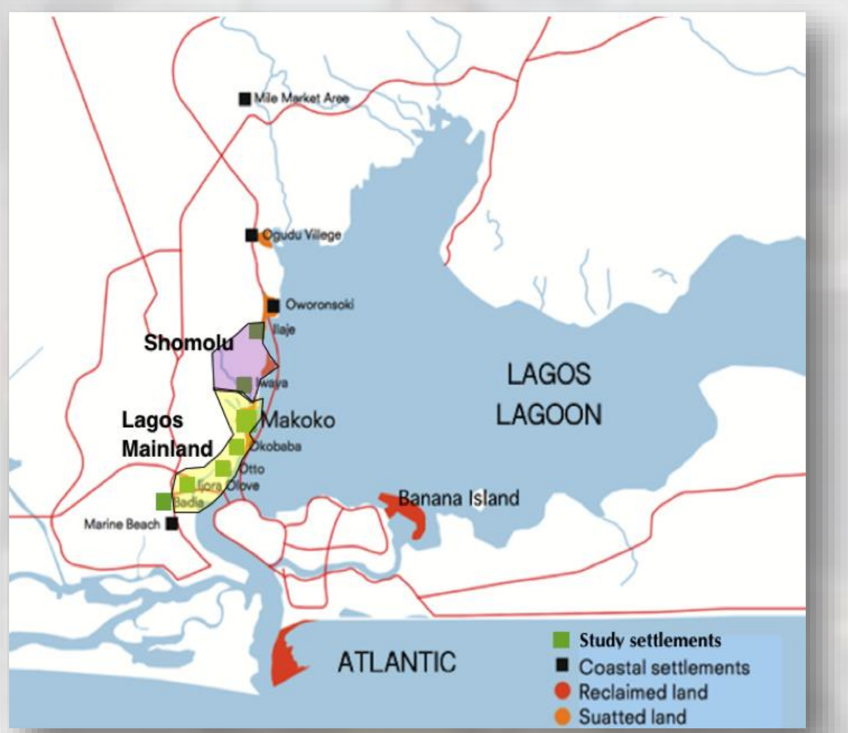


Fig 1: The Lagos Lagoon and location of the poor coastal communities

## 2. DATA

The data available for this risk study was rain gauge data collected from the Nigerian Meteorological Agency (NIMET), TRMM and CHIRPS rainfall data, tide data collected from the Nigerian Institute for Oceanography and Marine Research and field data collected from a questionnaire distributed to the residents of the coastal communities.

## 3. METHODOLOGY

**STEP I:** Find a satellite-based product that can complement the sparse rain gauge data in the study region for more reliable data input.

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**STEP II:** Trend analysis testing of the precipitation and tide data to account for changing environments (climate change, land-use change etc).

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**STEP III:** Joint dependence modelling of tide + precipitation using copula.

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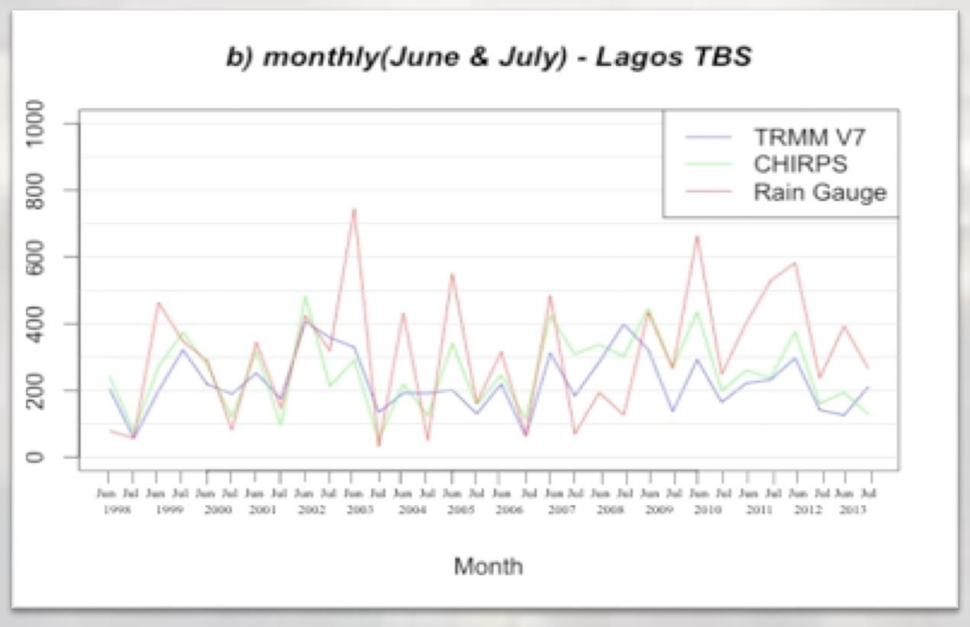
**STEP IV:** Vulnerability analysis of residents to the calculated flood hazard.

### TABLE 1: Theoretical Framework

| | THEORIES APPLIED |
|---|---|
| Precipitation Analysis | Continuous Statistics<br>Categorical Statistics<br>Variance Explosion |
| Trend Analysis | Mann-Kendall trend test<br>Mann-Kendall change point test<br>Pettitt's change point test |
| Joint dependence modelling | Extreme Value Theory<br>Archimedean Copulas |
| Vulnerability Analysis | Interviews<br>Questionnaires |

## 3. RESULTS

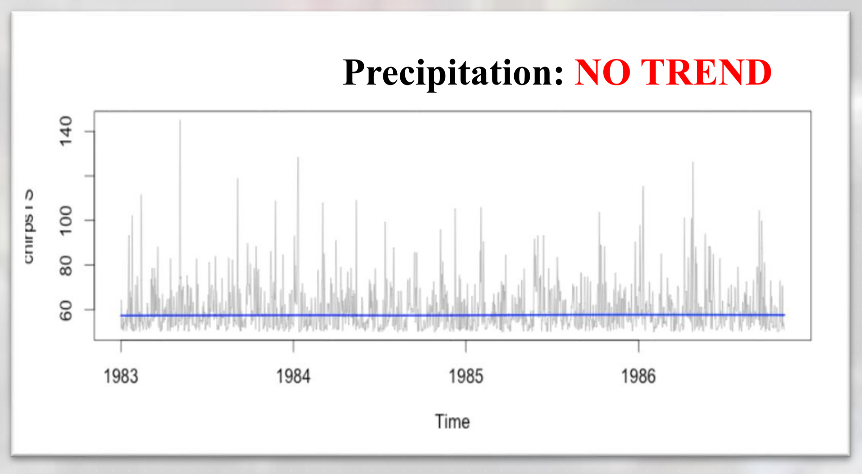
### Precipitation Data Analysis

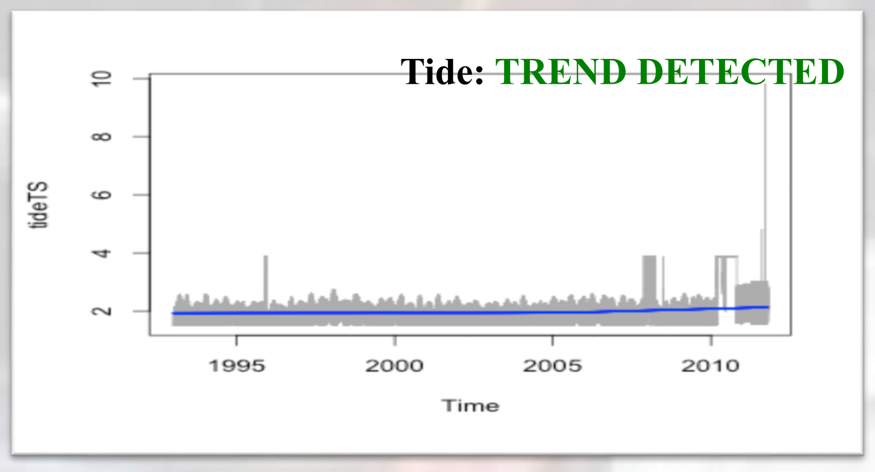



- CHIRPS represented rain gauge data better.
- Its variance was "exploded" to represent peaks like the rain gauges using the linear regression equation:

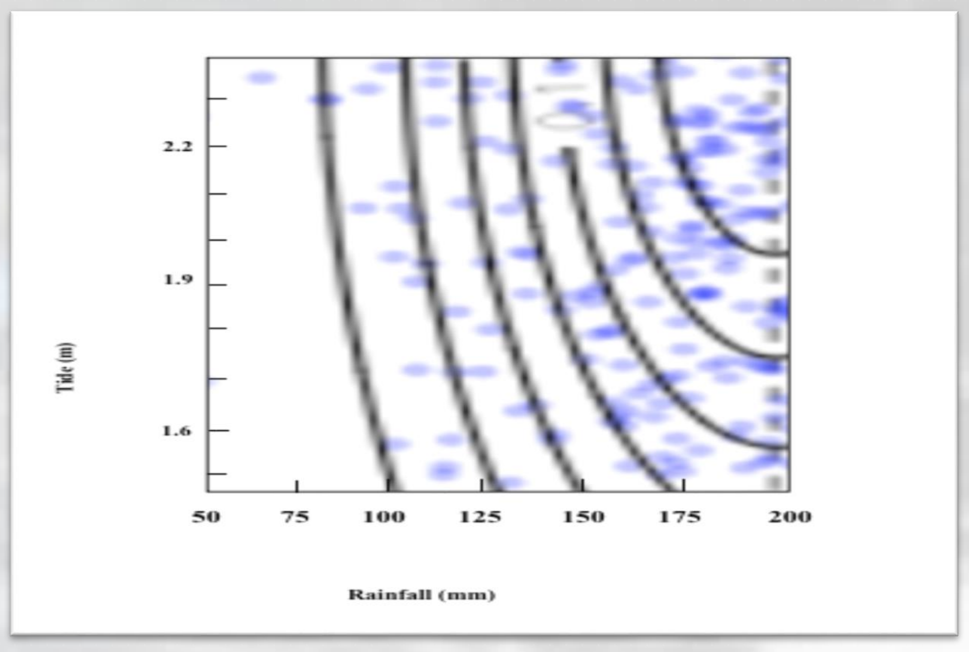
$$\text{rain(rain gauge)} = 38.7 + 0.9 * \text{rain(CHIRPS)}$$

### Trend Analysis



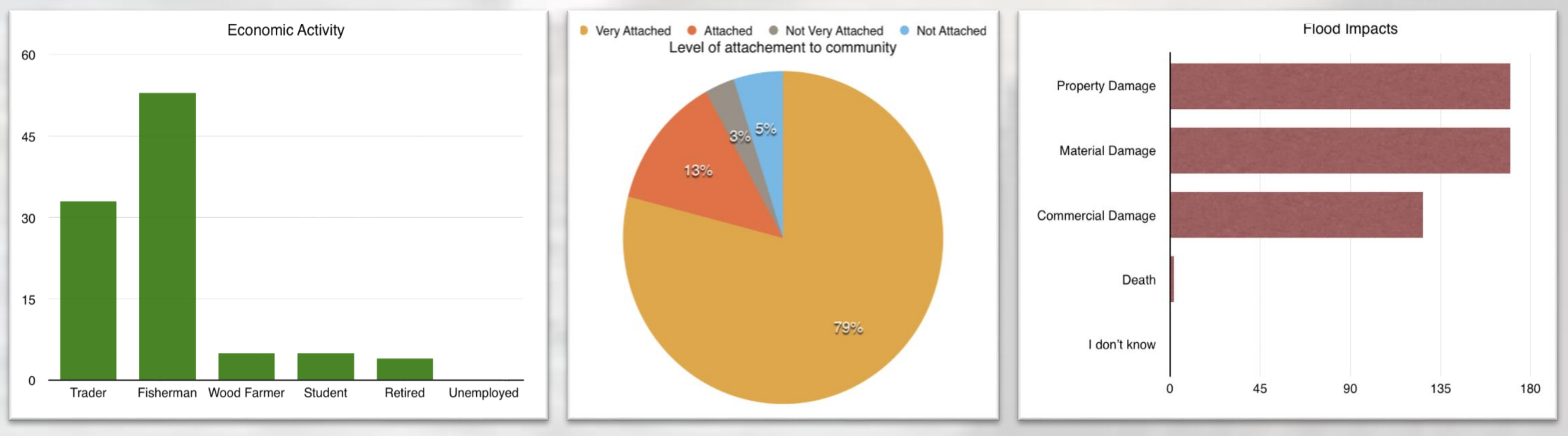




### Joint dependence modelling




- Extreme tide and rainfall show positive dependence, $\tau = 0.2376$
- Their extremes are best fit by the Gumbel Archimedean copula.
- The joint return period flood for a combination of tide and rainfall is shorter than univariate case.

### Vulnerability Analysis




Residents are barely able to cope with flood impacts financially.


## 4. CONCLUSION

- Flood risk management should take a holistic approach which recognises and accounts for all categories of flood hazard – geophysical, human and meteorological effects.
- A bottom-up approach should be used to encourage community participation in flood mitigation measures.

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