Heavy Rainfall in Kenya and Its Predictability Using Artificial Neural Networks

James Akuma[1] and Mwendwa Moreen[2]

[1]Department of Statistics and Actuarial Sciences, Jomo Kenyatta University of Agriculture and Technology
[2]Natural Resource Management, University of Eldoret

November 28, 2022

Posted on 28 Nov 2022 — CC-BY-NC 4 — https://doi.org/10.22541/au.166906540.96015360/v1 — This a preprint and has not been peer reviewed. Data may be preliminary.

Advances in Wireless Communications and Networks
2020; 6(2): 10-13
http://www.sciencepublishinggroup.com/j/awcn
doi: 10.11648/j.awcn.20200602.11
ISSN: 2575-5951 (Print); ISSN: 2575-596X (Online)

Heavy Rainfall in Kenya and Its Predictability Using Artificial Neural Networks

James Akuma[1, *], Mwendwa Moreen[2, *]

[1]Department of Statistics and Actuarial Sciences, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya
[2]Natural Resource Management, University of Eldoret, Eldoret, Kenya

Email address:
jamesakuma440@gmail.com (J. Akuma), mwendwamoreen96@gmail.com (M. Moreen)

To cite this article:
James Akuma, Mwendwa Moreen. Heavy Rainfall in Kenya and Its Predictability Using Artificial Neural Networks. *ADVANCES IN WIRELESS COMMUNICATIONS AND NETWORKS*. Vol. 6, No. 2, 2020, pp. 10-13. doi: 10.11648/j.awcn.20200602.11

Received: June 15, 2020; **Accepted**: June 28, 2020; **Published**: December 31, 2020

Abstract: Heavy rainfall occurs twice a year in the country and lately, thousands of people are always left homeless and hundreds lose life due to floods and landslides where rivers, dams, lakes and sewages overflow enhancing the spread of corona virus in slums. Agricultural products in the farms are also destroyed by floods, affecting agricultural performance to decline as it the key driver of the economy growth. Therefore we used inter-crossed model which was the combination of autoregressive moving average and artificial neural network. Zebiak cane model was also used for selection of variables that were associated to physical processes and testing the network variables. Climate networks were found to be effective tool for more qualitative El Niño Southern Oscillation prediction, by looking at a warning of the oncoming of El Niño when a predestined network attribute surpasses some critical value and also feed forward artificial neural network structures were found to be the first performing structure in terms of normalized root mean squared error at a three month head time prediction. By adding the network variable, we came up with a twelve month lead time prediction with same skill to the predictions at lower set times.

Keywords: Rainfall, Zebiak Cane, Neural Network, Climate Networks, El Nino, Inter-crossed Model

1. Introduction

Kenya's Drainage Basin is an area of considerable diversity in terms of its orology and weather systems because of its geographical location and tectonic history. The interaction of these two components gives rise to heavy rainfall programs which is variously defined at the moment, particularly with respect to its onset and stop and consequently its duration. The heavy rainfall regimes and their attribute expression have marked influence on water supply problems generally and on agriculture in specific.

Rainfall is one of the most significant components that determine agriculture. Though when rainfall is heavy, which sometimes referred as El Niño is deadly. It has a high degree in determining the capability of an area in terms of the crops which can be cultivated and sequence of agricultural operations. According to agriculture, rainfall is crucial because it provides soil with wetness. Rainfall and soil properties depend mostly on the proportion of rain water that will constitute soil wetness reserve, that is, the overall rainfall and its statistical distribution, rainfall strength and length, soil depth and moisture holding properties, and the equilibrium between rainfall and transpiration.

Heavy rainfall is usually seasonal. The seasonal occurrence of rainfall itself is the result of the main controls of weather and climate over Kenya. This rainfall is influenced mainly by the South-East and North-East Trade winds. In the middle part of the year, Onset of westerly winds in the middle months of the year mainly affects parts of Rift valley, Central, Eastern and Nyanza regions of Kenya with floods. The heavy seasonal rainfalls in the eastern regions are as the result of the seasonal shifts of the Inter-Tropical Convergence Zone (ITCZ) which is associated to the sun's movements.

Secondly, Topography and exposure: The effect of geography and view is mainly on the amount of rainfall received at a place. In particular, topography of the Kenyan highlands, behaves to make the ITCZ preferably spread. In East Africa, it is best known that altitude is among the topographic features that has a noticeable determinant of rainfall frequency of an area [1].

Thirdly, Latitude: This ascertains the duration of the rainy

seasons and the timing of rainfall minimum and maximum. Lastly, Inland lakes: This establishes changes to the generalized circulation patterns. Lake Victoria in Kenya is an example of an inland lake.

The existence of these changes and their consequence on the pattern of rainfall occurrence in western Kenya is as a result of heavy rainfall in Nyanza. Significant characteristic of the rainfall climatology of an area is the accusative determination of the heavy seasonal rainfall, because of the highly changeable nature of the atmospheric processes and the alterations that may happen from place to place. Although it is hard to give accurate limits of the beginning, length and halt of the rainy seasons and El Niño southern oscillation (ENSO), an overall figure should be given because it is important from the farming community's point of view [2].

Apart from patterns of rainfall, lately in Kenya we have experienced heavy rainfall that is thought to be ENSO. Late 2019 and earlier 2020, thousands of people are always left homeless and hundreds lose life due to floods and landslides where rivers, dams and lakes overflow. Agricultural products in the farms are also destroyed by floods affecting agricultural performance to decline as it the key driver of the economy growth.

Concerning this heavy rainfall, examinations from 70 rainfall gauges stations and 17 air temperatures were analyzed for months of March to June for the long rains period of time in Kenya [3]. They used Geo- statistical method to estimate standard errors for predicting trends. Assuming that the similar ascertained trends prevail, these results can be prolonged to the coming years, providing acute modification efforts that may be needed to improve food security. Prolonging the examined 1960 to 2009 effects-out until 2025, it will be found out that large parts of Kenya will have experienced more than a 100 mm decline in long-period rainfall by that date [4].

The ascertained rainfall trends are considerably unlike from the results given in the latest 4th Inter-governmental Panel on Climate Change assessment [5]. Chapter eleven of the Intergovernmental Panel on Climate Change Workings on first report shows that eastern Africa will probably receive a moderate five to ten percent increment in June to August precipitation. Numerous models argue the coming lean towards a more El Niño equivalent climate, where in East Africa would be anticipated to bring about enhanced March to June rainfall in Kenya. Presently, there looks to be high observational data supporting such a shift in the country.

Nevertheless, both in the Intergovernmental Panel on Climate Change modeling and in the past record of El Niño rains in Kenya, there appears a strong warming tendency in the western Indian Ocean [6], which bring about heavy rainfall hence hot and wet seasons and increased greenhouse gases. This astronomical scale circulation change seems to be modulating the effect of natural climate alterations [4]; recent El Niño March to June seasons are tending to increase

leading to landslides and flooding in the country because of above normal rainfall totals followed by La Niña which is drier in the months June to October.

References

1. Ghillani, D. (2022). Deep Learning and Artificial Intelligence Framework to Improve the Cyber Security. *Authorea Preprints*.
2. Ghelani, D. (2022). Cyber Security, Cyber Threats, Implications and Future Perspectives: A Review. *Authorea Preprints*.
3. Ghelani, D., Hua, T. K., & Koduru, S. K. R. (2022). Cyber Security Threats, Vulnerabilities, and Security Solutions Models in Banking. *Authorea Preprints*.
4. Ghelani, D. (2022). Digital Educational Coordination System (DECS).
5. Ghelani, D. (2022). What is Non-fungible token (NFT)? A short discussion about NFT Terms used in NFT. *Authorea Preprints*.
6. Ghelani, D., & Faisal, S. (2022). Synthesis and characterization of Aluminium Oxide nanoparticles. *Authorea Preprints*.
7. Koricanac, I. (2021). Impact of AI on the Automobile Industry in the US. *Available at SSRN 3841426*.
8. Hua, T. K. (2022). A Short Review on Machine Learning. *Authorea Preprints*.
9. Hua, T. K. (2022). Cybersecurity As A Fishing Game.
10. Ghelani, D., & Hua, T. K. A Perspective Review on Online Food Shop Management System and Impacts on Business.
11. Ilyes, A., Mohammed Djamel Edine, B., & Said, B. (2015). *Development of a smart irrigation system* (Doctoral dissertation, UNIVERSITY OF KASDI MERBAH OUARGLA).
12. Achar, S. (2015). Requirement of Cloud Analytics and Distributed Cloud Computing: An

Initial Overview. *International Journal of Reciprocal Symmetry and Physical Sciences*, *2*(1), 12-18.

13. Achar, S. (2017). Asthma Patients' Cloud-Based Health Tracking and Monitoring System in Designed Flashpoint. *Malaysian Journal of Medical and Biological Research*, *4*(2), 159-166.
14. Achar, S. (2022). Cloud Computing Forensics. *International Journal of Computer Engineering and Technology*, *13*(3).
15. Achar, S. (2022). Cloud Computing Security for Multi-Cloud Service Providers: Controls and Techniques in our Modern Threat Landscape. *International Journal of Computer and Systems Engineering*, *16*(9), 379-384.
16. Achar, S. (2022). Cloud Computing Security for Multi-Cloud Service Providers: Controls and Techniques in our Modern Threat Landscape. *International Journal of Computer and Systems Engineering*, *16*(9), 379-384.
17. Achar, S. (2019). Early Consequences Regarding the Impact of Artificial Intelligence on International Trade. *American Journal of Trade and Policy*, *6*(3), 119-126.
18. Achar, S. (2016). Software as a Service (SaaS) as Cloud Computing: Security and Risk vs. Technological Complexity. Engineering International, 4 (2), 79-88.
19. Achar, S. (2020). Influence of IoT Technology on Environmental Monitoring. *Asia Pacific Journal of Energy and Environment*, *7*(2), 87-92.
20. Achar, S. (2019). Cloud-based System Design. *International Journal of All Research Education and Scientific Methods (IJARESM)*, *7*(8), 23-30.
21. Achar, S. (2016). Software as a Service (SaaS) as Cloud Computing: Security and Risk vs. Technological Complexity. *Engineering International*, *4*(2), 79-88.
22. Achar, S. (2022). How Adopting A Cloud-Based Architecture Has Reduced The Energy Consumptions Levels. *International Journal of Information Technology and Management*, *13*(1), 15-23.
23. Achar, S. (2021). An Overview of Environmental Scalability and Security in Hybrid Cloud Infrastructure Designs. *Asia Pacific Journal of Energy and Environment*, *8*(2), 39-46.
24. Achar, S. (2020). Cloud and HPC Headway for Next-Generation Management of Projects and Technologies. Asian.
25. Achar, S. (2018). Security of Accounting Data in Cloud Computing: A Conceptual Review. *Asian Accounting and Auditing Advancement*, *9*(1), 6072.
26. Achar, S. (2022). CLOUD COMPUTING: TOWARD SUSTAINABLE PROCESSES AND BETTER ENVIRONMENTAL IMPACT. *Journal of Computer Hardware Engineering (JCHE)*, *1*(1).
27. ACHAR, S., PATEL, H., & HUSSAIN, S. (2022). DATA SECURITY IN CLOUD: A REVIEW. *Asian Journal of Advances in Research*, *17*(4), 76-83.
28. Achar, S. A Comprehensive Study of Current and Future Trends in Cloud Forensics.
29. Achar, S. (2021). Enterprise SaaS Workloads on New-Generation Infrastructure-as-Code (IaC) on Multi-Cloud Platforms. *Global Disclosure of Economics and Business*, *10*(2), 55-74.
30. Achar, S. (2020). Maximizing the Potential of Artificial Intelligence to Perform Evaluations in Ungauged Washbowls. Engineering International, 8 (2), 159-164.
31. Abcouwer, T., Takács, E., & Rácz, C. (2021, November). Innovating Management and Leadership in Contemporary Times: Motivation and Evaluation in Learning. In *ECMLG 2021 17th European Conference on Management,*

Leadership and Governance (p. 1). Academic Conferences limited.

32. Chimakurthi, V. N. S. S. (2017). Cloud Security-A Semantic Approach in End to End Security Compliance. Engineering International, 5 (2), 97106.
33. Chimakurthi, V. N. S. S. (2018). Emerging of Virtual Reality (VR) Technology in Education and Training. *Asian Journal of Humanity, Art and Literature*, *5*(2), 157-166.
34. Chimakurthi, V. N. S. S. (2017). Cloud Security-A Semantic Approach in End to End Security Compliance. *Engineering International*, *5*(2), 97106.
35. Chimakurthi, V. N. S. S. (2019). Implementation of Artificial Intelligence Policy in the Field of Livestock and Dairy Farm. *American Journal of Trade and Policy*, *6*(3), 113-118.
36. Chimakurthi, V. N. S. S. (2017). Risks of MultiCloud Environment: Micro Services Based Architecture and Potential Challenges. *ABC Research Alert*, *5*(3), States-States.
37. Chimakurthi, V. N. S. S. (2020). Digital Asset Management in the Communication of Product Promotional Activities. *Asian Business Review*, *10*(3), 177-186.
38. Chimakurthi, V. N. S. S. (2021). The Future of Cloud Computing Amidst A Desperate Security
39. Maze: The Impact Of COVID And The Future Challenges. *Asian Journal of Humanity, Art and Literature*, *8*(2), 75-84.
40. Chimakurthi, V. N. S. S. (2019). Application Portfolio Profiling and Appraisal as Part of Enterprise Adoption of Cloud Computing. *Global Disclosure of Economics and Business*, *8*(2), 129142.
41. Chimakurthi, V. N. S. S. (2021). An Optimal Cloud Based Electric Vehicle Charging System. *Asia Pacific Journal of Energy and Environment*, *8*(2), 29-38.
42. Chimakurthi, V. N. S. S. (2020). Digital Asset Management: A Lowdown on Intricacies of Digital Rights and Permissions. *Global Disclosure of Economics and Business*, *9*(2), 129-140.
43. Chimakurthi, V. N. S. S. (2019). Efficacy of Augmented Reality in Medical Education. *Malaysian Journal of Medical and Biological Research*, *6*(2), 135-142.
44. Chimakurthi, V. N. S. S. (2021). Strategic Growth of Everything-as-a-Service (XaaS) Business Model Transformation. *Engineering International*, *9*(2), 129-140.
45. Chimakurthi, V. N. S. S. (2020). Application of Convolution Neural Network for Digital Image Processing. *Engineering International*, *8*(2), 149158.
46. Chimakurthi, V. N. S. S. (2020). The Challenge of Achieving Zero Trust Remote Access in MultiCloud Environment. *ABC Journal of Advanced Research*, *9*(2), 89-102.
47. Reddy, P., Srianirudh, K. T., Kumar, K. U., Gondela, H. S. K., & Surendhra, V. N. S. (2009, March). Trajectory Prediction and Data Filtering for Mobile Networks. In *2009 International Conference on Future Networks* (pp. 263-267). IEEE.

Therefore, when the sea surface temperatures is higher than average in the eastern equatorial Pacific [7] is referred as El Niño Southern Oscillation (ENSO) and is induced by a large-covering ocean–atmosphere interaction between the equatorial Pacific and the worldwide atmosphere [8].

Lately, efforts have been made to better the el Niño Southern Oscillation prediction ability beyond the norm predictability boundary, for example by using machine learning [9] methods, also combined with artificial neural network techniques (ANN) [10]. ANN is an organization of connected neurons that reports after optimization, a mathematical relation from more or one input variable to the output variables. In general, one has to select how big and complex the ANN structure is. The more complex an ANN is, the more it will filter the crucial information from the attributes itself, but it will necessitate more input data and will be intense computationally.

Complicated networks change out to be an effective way to describe spatiotemporal information in climate schemes [11] and can be utilized as an attribute reduction technique. These climate networks are generally built by connecting spatiotemporal placements that are importantly related with each other accordant to some measure. Hence climate networks already look to be an effective tool for more qualitative El Niño Southern Oscillation prediction, by looking at a warning of the oncoming of El Niño when a predestined network attribute surpasses some critical value [12].

2. Methodology

Modern approaches in neural network (NN) modeling have contributed to the nonlinear theorization of principal component analysis and canonical correlation analysis. skilled seasonal prediction is settled on the assumption that either statistics such as continuity or multi-annual drifts or slow varied boundary forcing can be employed for producing long-range forecasting that are more exact compared to climatology. Slow varied boundary forcing includes ocean temperatures; sea ice, soil moisture, and snow cover [13].

El Niño cases typically induce droughts on the western region of the Pacific and flooding cases on the eastern region and hence create impact on climate worldwide. Approximated damages for the 1997–1998 events of El Nino were in the order of billions of dollars worldwide including Kenya [14]. Hence developing of skilled forecasts of these cases, preferably with a one-year head time is crucial. This research will help policy makers to mitigate the destructive results of the related weather abnormalities. For example, farmers can be informed to employ specific types of corn in El Niña years and others during La Niño years or move to hilly places during El Niño.