

Food Clustering Analysis: The Impact of Typhoons in Food Production and Utilization in the Philippines

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Abstract

Objectives: Food has been a major concern in the Philippines regarding production and utilization. The main purpose of this research is to develop a model to venture the future of food production and consumption. **Methods/Analysis:** This study explored using data mining technique using regression and cluster analysis to establish a new knowledge from a data set ranging from 1990 to 2013, where the data taken and extracted into a software readable format from the Philippine Government repository like the PhilFSIS and PAGASA. This research utilized software such as MiniTab 13.20 and Weka 3.7 to facilitate model generation. **Findings:** The data generated were analyzed and found out that only poultry products were not affected by the typhoons. This result is considered to be unique in nature considering that the Philippines is the most visited strong typhoons in the world, and can affect the poultry production. In the model generated, a significant finding also reveals that root crops, poultry products, and hog production increase if there is an increase of typhoons that enter the PAR. Finally, a theory was created based on the interpretation of the generated data from the data mining processes. **Novelty/Improvement:** These results only suggest that the authorities should look into the risk of declining of the production of other commodities and create a more climate resilient plan of production to sustain the future needs of the consumers. Further study must be conducted to establish the validity of the result of this study.

Keywords: Cluster Analysis, Climate Change, Food Security, Regression, Typhoon, Theory Development

1. Introduction

World leaders around the world for the last two decades brought about the issues on the effects of climate change. In a recently concluded United Nations Climate Change Conference, also known as COP21 or 2015 Paris Climate Conference, it aimed to have a better, greener, sustainable world and its primary objective was to review the Convention's implementation. With this endeavor, the world leaders and other NGOs aimed to reach a legally binding and general agreement on climate, with the intent of preventing global warming below 2°C¹¹. The European Commission on Climate Change has shown in the agreement made at the Paris Climate Conference³. Among those essential elements were Mitigation: reducing emissions, transparency and global stock take, adaptation, loss and damage, and support³. The world leaders, including the European Union and other

developed countries who joined the COP21, agreed to the terms and will set for 2020. This new development of climate change actions made by our world leaders is evidence that the world's climate is rapidly changing and has shown its mighty through stronger natural disasters experienced around the globe.

Weather patterns have shown significant effects on many aspects of our lives. Many African populations were experiencing widespread of hunger and malnutrition⁷. Also, they were always facing the threat of acute food crisis and famine due to reduced rainfall in the area and a longer and hotter El Niño events in the tropical Pacific regions, creating droughts and food reduction in the agricultural and aquacultural production. Food supplies energy and nutrients, but its acquisition requires energy expenditures⁹. In the Philippines, it was reported in a study that El Niño significantly affects the rice production depending on the length and strength of the scarcity and

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the temperature¹³. These findings imply only that climate change has a significant impact on our agricultural production like rice being the Filipino's staple food. In Asia and the World, the Philippines is considered to be the most vulnerable to natural disaster considering its geographical local as one of the several countries that are in the ring of fire and facing the Pacific Ocean. The Philippines sits at the western tip of the Pacific Ocean, the most dynamic area of tropical cyclones because of the huge area of rich, warm ocean water¹⁷. A major television network in the Philippines, through its Public Affairs, shows in an infographic of the Top 10 deadliest and costliest typhoons that hit the Philippines⁶. These were Super Typhoon Haiyan – locally known as Yolanda in 2013, Bopha or Pablo in 2012, Washi or Sendong in 2011, Parma or Pepeng in 2009 and others has in including the typhoon Nona in 2015 has shown how storms were getting stronger and destructive, costing millions in US dollar in damages of properties, agricultural and aquacultural productions, natural resources, businesses, and lives⁶. These natural disasters have undesirable economic and environmental including food production impact to the Philippines. Furthermore, it was reported that from 2000 to 2010 the national agricultural area affected by typhoons, rising tides, and droughts in the Philippines has been trending up. The total area increased from 683,440 hectares in 2000 to 977,208 hectares in 2010, with a rise of 142.98 %⁸. In the same survey, it was shown that at the national level, storms, rising tides, and droughts do not significantly influence agricultural production and costs. This paper attempted to discover knowledge as to what are those agricultural and aquacultural products that were affected by typhoons and which were not affected in the Philippines.

2. Conceptual Framework

The process anchored in this study was the Theory of Knowledge Discovery in Database (KDD). KDD field shows concerned with the development of methods and techniques for making sense of the data⁵. Significant demand exists for a young generation of techniques and instruments with the ability to automatically support humans in analyzing the data set of useful knowledge. Thus, KDD and Data Mining (DM) are tools that allow identification of valid, useful, and previously unknown patterns to help researchers analyze the large amount of

construction project data¹⁵. Figure 1 shown in Appendix A, present the conceptual process from the source to extraction and implementation of data mining technique used in the research up to the generation of theory. This concept adopted the top-down approach of information processing.

3. Methodology

The data sets used in this research were the secondary data available from the Philippine Government. Specifically, the Philippine Food Security Information System (PhilFSIS) and the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) under the supervision of the Department of Science and Technology (DOST). The data sets were from 1990 to 2013 such as the Tropical Cyclone Frequency (TCF), Rice, Corn, Sweet Potato, Cassava, Pork, Chicken, Chicken Eggs, Tilapia and Milkfish (Bangus). The data sets were captured and extracted from the cloud through the government websites, which holds as are pository of these information needs. However, there are certain issues in using a secondary data before taking or handling such data¹⁶. Among ethical considerations in using a secondary data were, that the data should come from reputable sources like the government, Non-Government Organization (NGO), private organizations and the like. But make sure to ask permission from the source if it requires and has limitations. In utilizing the data mining in this research, this study employed Cluster Analysis to determine the similarity or relativity complex and big data¹⁰. Moreover, the main purpose of using clustering in data mining is to divide the data into groups of the same object¹ to find our hidden patterns in the data clusters. This research utilized the MiniTab v.13.20 software for clustering analysis. Finally, the information generated was interpreted and made a theory out of the data taken from the source.

4. Results and Discussion

The model suggests in Appendix B Figure 2 that an increase of Tropical Cyclones that enter the Philippine Area of Responsibility (PAR) also increases the availability of Cassava, Pork, Chicken, Chicken Eggs, and Tilapia, but decreases in Rice, Corn, Sweet Potato, and Milkfish

(Bangus). While in term of utilizing these products, there is an increase of consumptions of Rice, Corn, Sweet Potato, and Milkfish (Bangus) and Low in consumption in Cassava, Pork, Chicken, Chicken Eggs, and Tilapia.

This graph in Appendix C Figure 3 suggests a “Positive Serial Correlation” among the error terms generated in the data set. That is, a positive serial correlation exists when residuals tend to be followed, in time, by residuals of the same sign and around the same magnitude. The plot suggests that the assumption of independent error terms is violated¹⁴. It is very evident that the plot is increasing, this indicates that the Tropical Cyclones that enters the PAR is increasing its effects to some agricultural and aquacultural products. Moreover, this scheme is called a Normal Probability Plot which forms a nearly linear pattern, and it suggest that the model is suitable for this data set².

Moreover, this model will be confirmed using another set of data mining, predictive analytics called Clustering Analysis. The purpose is used to determine the similarity and linkage of the clusters, and amalgamation of the observations has shown in Appendix D Figure 4. The graphical presentation of the single linkage of amalgamation illustrated in Appendix E Figure 5 called dendrogram. The groupings of observations into clusters having three (3) of them as depicted in Appendix F Figure 6. Cluster 1 has eight (8) observations consisting 1, 2, 3, 5, 8, 9, 10, and 4. While cluster 2 has two observations consisting 6 and 7. Lastly, cluster 3 which has 14 observations such as 11, 12, 13, 14, 15, 18, 17, 19, 24, 16, 22, 23, 20, and 21.

5. Interpretation

In Figure 7 shown at Appendix G, revealed the cluster centroids by the cluster. It is very evident that Cluster 1 demonstrates that an increase of Tropical Cyclones increases the Availability of Chickens and increases the Utilization of Chickens and Chicken Eggs, and the rest of indicators displays a decrease in its availability and use like Rice, Corn, Sweet Potato, Cassava, Pork, Tilapia, and Milkfish. In Cluster 2, shows the least among the three (3) clusters regarding Tropical Cyclones that enter the PAR, however, it displays an increase in the Availability of Rice, Corn, Pork, Tilapia, and Milkfish (Bangus). Moreover,

regarding Utilization, it presents an increase of Rice, Corn, Pork, Tilapia, and Milkfish (Bangus). While other indicators like Sweet Potato, Cassava and Chicken Eggs decreases both its Availability and Utilization. Finally, Cluster 3 is considered to be not too high nor too low regarding Tropical Cyclone that enters the PAR, however, it shows an increase of Availability of Sweet Potato and Cassava and increases in utilization of Sweet Potato and Cassava. While other indicators show a decrease in its availability and utilization.

6. Educational Interpretation

The Philippine Government must look into the agricultural and aquacultural products especially the staple foods like Rice, Corn, Cassava, Sweet Potato, Tilapia, and Milkfish regarding productions needed in the Philippine Market whole year round due to an increase of demands or consumption. The trade liberalization does not mean to translate into more imports, but rather this only means that the price of the commodity, like rice in the country has no difference abroad¹⁸. The quality of products matters in choosing and buying by the Filipinos. In a report, the Philippines have just agreed to buy 150,000 tons of rice from Vietnam instead of the potential spike in prices of the staple foods due to climate change. Moreover, the National Food Authority (NFA) also made another approval to buy 250, 000 tons of rice in preparation for the El Niño weather phenomenon⁶. The shortage of these staple foods will continue to rise if the people and the government will not do anything. The challenge is to get upward with a national development program calling for all entities, including Local Government Unit, State Universities and Colleges, National Agencies, NGOs and other International Organization on how to offer a long-term solution brought by climate change.

7. Theory/Conclusion

A country that is in the firing line of meteorological conditions increases the yield and consumption of poultry products. Meanwhile, staple foods of the Filipinos decrease overtime regarding production but increases in consumption.

Appendices

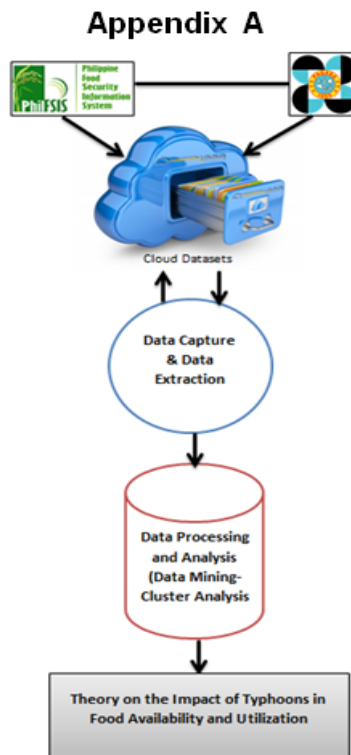


Figure 1. Data Processing Concept on the Impact of Typhoons in Food Availability and Utilization.

Appendix B

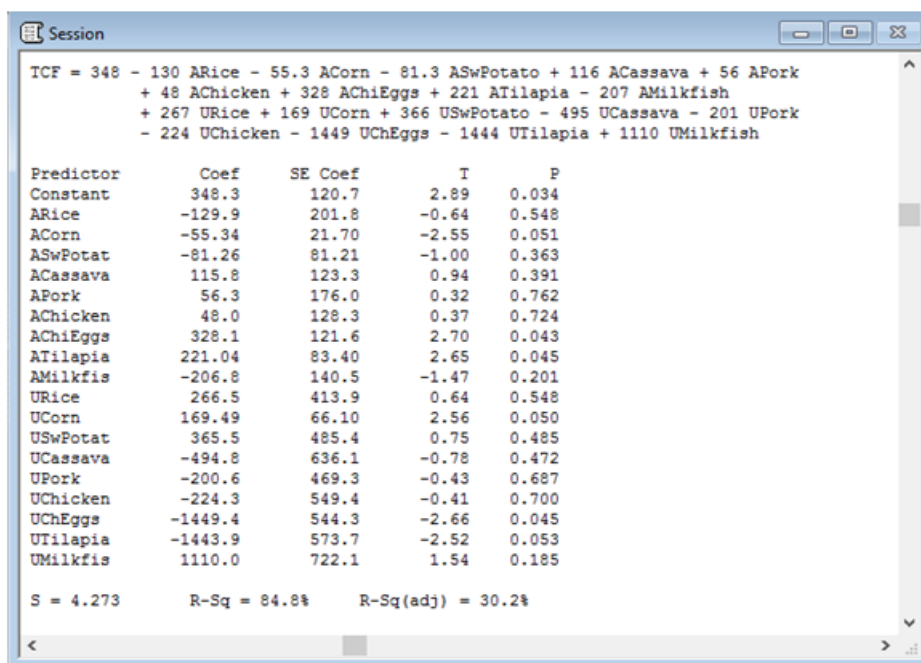


Figure 2. Model Generated Using Regression.

Appendix C

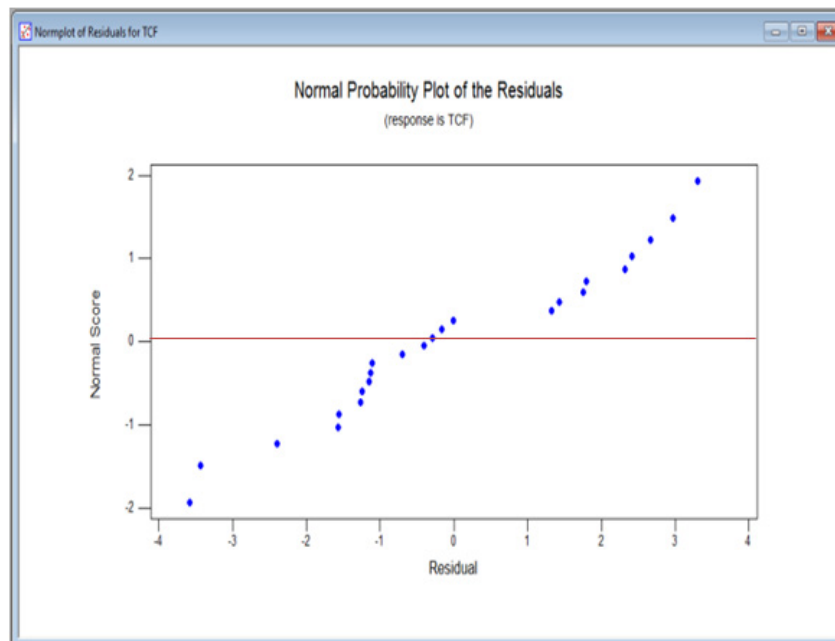


Figure 3. Normal Probability Plot of the Residuals – Response in Tropical Cyclone Frequencies.

Appendix D

Session

Amalgamation Steps

Step	Number of clusters	Similarity level	Distance level	Clusters joined	New cluster	Number of obs. in new cluster
1	23	94.54	2.732	15 18	15	2
2	22	93.94	3.034	5 8	5	2
3	21	92.94	3.532	2 3	2	2
4	20	92.40	3.802	15 17	15	3
5	19	91.09	4.456	2 5	2	4
6	18	91.05	4.479	14 15	14	4
7	17	90.62	4.692	13 14	13	5
8	16	90.31	4.848	19 24	19	2
9	15	89.15	5.430	2 9	2	5
10	14	89.11	5.449	1 2	1	6
11	13	88.66	5.672	13 19	13	7
12	12	88.54	5.734	13 16	13	8
13	11	88.41	5.800	22 23	22	2
14	10	87.53	6.240	12 13	12	9
15	9	86.70	6.654	12 22	12	11
16	8	86.14	6.933	1 10	1	7
17	7	84.55	7.733	20 21	20	2
18	6	84.27	7.871	12 20	12	13
19	5	83.81	8.101	1 4	1	8
20	4	83.06	8.478	6 7	6	2
21	3	82.21	8.900	11 12	11	14
22	2	82.15	8.930	1 11	1	22
23	1	81.96	9.025	1 6	1	24

Figure 4. Amalgamation Steps of Final Grouping of Clusters.

Appendix E

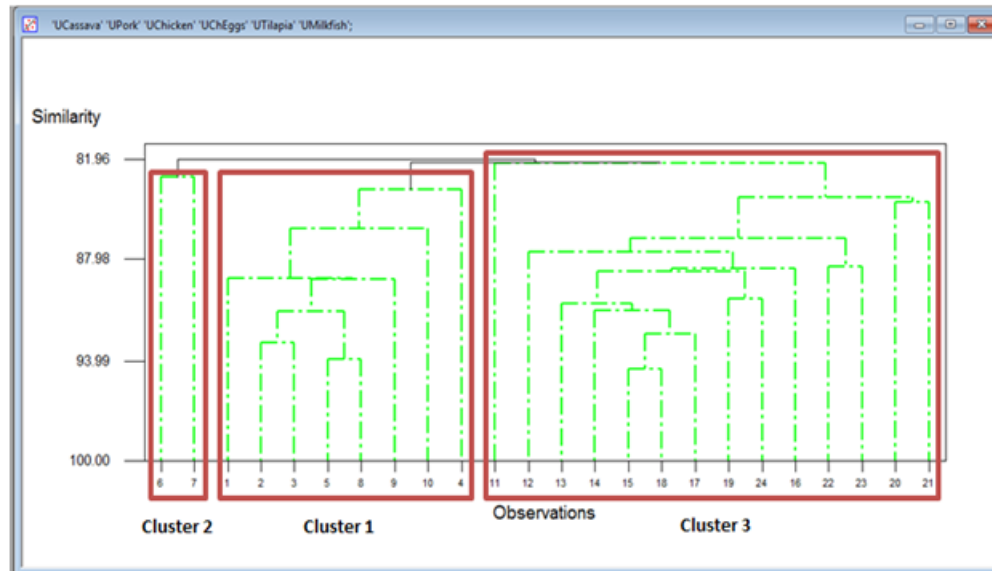


Figure 5. Dendrogram – Graphical Presentation of the Final Grouping of Clusters.

Appendix F

Session

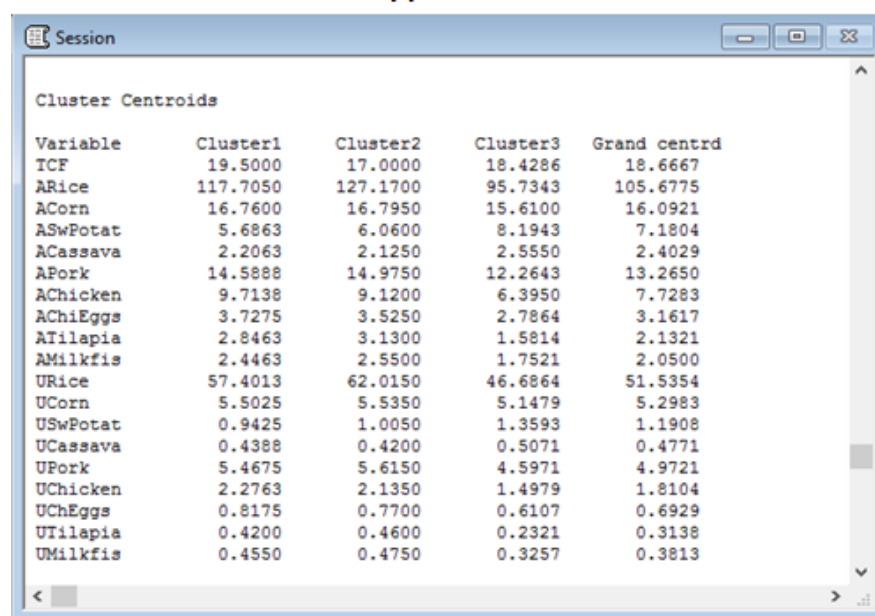
Final Partition

Number of clusters: 3

	Number of observations	Within cluster sum of squares	Average distance from centroid	Maximum distance from centroid
Cluster1	8	242.223	5.015	9.155
Cluster2	2	35.942	4.239	4.239
Cluster3	14	1528.372	9.590	15.907

Figure 6. Final Partition of Clusters.

Appendix G



Variable	Cluster1	Cluster2	Cluster3	Grand centr
TCF	19.5000	17.0000	18.4286	18.6667
ARice	117.7050	127.1700	95.7343	105.6775
ACorn	16.7600	16.7950	15.6100	16.0921
ASwPotat	5.6863	6.0600	8.1943	7.1804
ACassava	2.2063	2.1250	2.5550	2.4029
APork	14.5888	14.9750	12.2643	13.2650
AChicken	9.7138	9.1200	6.3950	7.7283
AChEggs	3.7275	3.5250	2.7864	3.1617
ATilapia	2.8463	3.1300	1.5814	2.1321
AMilkfis	2.4463	2.5500	1.7521	2.0500
URice	57.4013	62.0150	46.6864	51.5354
UCorn	5.5025	5.5350	5.1479	5.2983
USwPotat	0.9425	1.0050	1.3593	1.1908
UCassava	0.4388	0.4200	0.5071	0.4771
UPork	5.4675	5.6150	4.5971	4.9721
UChicken	2.2763	2.1350	1.4979	1.8104
UChEggs	0.8175	0.7700	0.6107	0.6929
UTilapia	0.4200	0.4600	0.2321	0.3138
UMilkfis	0.4550	0.4750	0.3257	0.3813

Figure 7. The Cluster Centroids by Cluster.

8. References

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