Universidad Popular Autónoma del Estado de Puebla

Vicerrectoría de Posgrados e Investigación

Posgrados en Ingeniería y Negocios

Maestría en Logística y Dirección de la Cadena de Suministro

An Analysis of Inventory Levels on Humanitarian Relief for Vulnerable Municipalities of Puebla, Mexico

Presenta

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Se aprueba la Tesis llamado:

An Analysis of Inventory Levels on Humanitarian Relief for Vulnerable Municipalities of Puebla, Mexico

Comité de Revisión.

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Resumen en Español

La presente investigación está basada en una rama de la Logística que se ha introducido recientemente, la Logística Humanitaria. El término fue introducido hace poco en la literatura y todavía hay un camino largo con respecto a aplicar métodos que ya han sido utilizados en la logística tradicional en la Logística Humanitaria.

El artículo contenido en este trabajo está basado en la aplicación del modelo del Newsboy para calcular un inventario de ayuda humanitaria en Municipios del Estado de Puebla que son afectados por fenómenos Hidrometeorológicos. Se determinó la demanda a través de probabilidad basado en frecuencias absolutas y relativas y se determinó un kit de ayuda basado en recomendaciones del proyecto Esfera.

Abstract

The present research is based in a logistic area that has been introduced recently, the Humanitarian Logistic. The Humanitarian Logistic term is relatively new in the literature and there are still more work to do to apply methods that are used in the traditional logistic into the Humanitarian Logistic.

The paper contained in this document is focused in the application of the Newsboy model to calculate an inventory level for humanitarian relief in some municipalities of Puebla that are affected by hydrometeorological phenomena. The demand was determined using probability based in absolute and relative frequencies. A kit was determined based in Sphere project recommendations.

Índice General

Capítulo I. Introducción

La República Mexicana está expuesta a diversos fenómenos que han causado desastres de gran magnitud. La información obtenida para la realización de la investigación del proyecto contenido en este documento, muestra que los fenómenos hidrometeorológicos afectan considerablemente varios estados de la República. El presente trabajo se basó en el Estado de Puebla, México creando un plan para la compra de inventario de ayuda humanitaria para la población en caso de alguna emergencia causada por algún fenómeno Hidrometeorológico.

Dentro de la investigación, se tomaron en cuenta las normas propuestas por organizaciones no gubernamentales de ayuda humanitaria que tienen como fin el mejorar la respuesta a desastres y se aplicó un modelo matemático para determinar el nivel de inventario necesario para ayudar a la población afectada en caso de emergencia. El modelo aplicado fue el de Neswboy ya que la compra de ayuda humanitaria se realizaría como compra única.

Para las emergencias o desastres causados por fenómenos naturales no es posible predecir la cantidad de población que será afectada, así como tampoco cuantificar los daños anticipadamente. Es por ello, que en esta investigación se determinó por medio de estadística, basada en información histórica, un rango de población mínimo y máximo con lo cual se pudo aplicar el modelo y determinar la propuesta del nivel de inventario necesario de ayuda humanitaria.

La investigación realizada se presenta en el artículo llamado “An Analysis of Inventory Levels on Humanitarian Relief for Vulnerable Municipalities of Puebla, Mexico”, la cual se presenta en el siguiente capítulo.

Capítulo II. An Analysis of Inventory Levels on Humanitarian Relief for Vulnerable Municipalities of Puebla, Mexico

Abstract

Recently, the concept of the humanitarian relief was introduced, and there remains work to do to help people in any situation of disaster. The present research is focused on determining an inventory level for relief kits that can benefit 24 municipalities that belong to the State of Puebla, Mexico. Historically, these municipalities have been vulnerable to hydrometeorological phenomena. From 2001 to 2017, Puebla has had 1,632 emergency declarations of which 59.7% were classified as a hydrometeorological issue. According to this historical, the disasters increased during August, September, and October, so it is proposed with this research to have an adequate inventory level of kits before the disasters happen in the months above. There are no records of affected people of these municipalities, so to determine a demand the frequency was found using the historical data regarding affected people by hydrometeorological phenomena of all the nation. The lot size was calculated using the Newsboy Inventory Model, and the demand was separated in different age range and gender to make kits in accordance to the necessities.

Keywords: Humanitarian Relief, Newsboy Inventory Model, Disaster.

1. Literature Review

The emergencies caused by natural disasters are unpredictable, an adequate and timely delivery help in goods or services, and a correct administration in the relief operations are required to minimize the human suffering and loss of lives. For any disaster type, some logistics decisions have to be made and structured according to each the community needs (Ilhan, 2011).

During an emergency, the humanitarian relief consists of donor a large number of medicines, clothes, foods, and non-necessary articles or not priority articles. The donations received after a disaster, if it is not necessary, generates serious logistics problems (Pan American Health Organization, 1999). So why not foresee what is necessary before the disaster?

The number of victims and damages caused primarily by natural phenomena as torrential rains, flood water, high winds, and droughts has increased because these kinds of disasters are more frequent and appeare with high intensity. According to the United Nations and Humanitarian Relief (UNHR), the 70% of the natural disasters are related to the climate change, this is double than 20 years ago (ONU, 2013).

The UNISDR (United Nations Office for Disaster Risk Reduction) inform that the available information about disasters sometimes is limited because is not taking into account the little disasters although they caused losses and occurred very frequent (UNISDR, 2013). This omission will cause that people cannot imagine the real dimension of the problem and sometimes the problem is passed over, and it could cause the most significant problem (UNISDR, 2013).

The experiences regarding disasters for other nations and the help of international organizations represent a valuable source of knowledge (Moore *et al.*, 2009). This knowledge has to contribute to improving the humanitarian relief. Useful and appropriate coordination is the essential element for successful disaster relief (Moore *et al.*, 2009).

According to UNICEF, children are very vulnerable to crisis, violence and instability situations. From birth and until the age of six (especially the first two years) are fundamental for the intelligence, personality, and social behavior development. The arm conflicts and natural disasters have serious consequences, and the highest risk that children have in these cases is that they have to grow up in an environment that limits their creativity and their physical and mental development (UNICEF, 2009).

According to Pan American Health Organization, the most vulnerable groups are formed by children, pregnant women, breastfeeding mothers and elderly; the survival for that group is threatened by a slow recovery of services (Pan American Health Organization, 1999).

Is demonstrated that natural disasters and climate change are forcing children to escape from home, this puts them at considerable risk of disease, violence and child exploitation (UNICEF, 2017). In any emergency, children required protection that could guarantee their wellness and security. The hydrometeorological phenomena like hurricanes, typhoons, and tropical storms could cause damage in the developing nations, but in places with poverty, the damage for children could be more significant (UNICEF, 2017).

Women are vulnerable to natural disasters too, climate change and industrial hazards because of her position in society and some sensitive periods of the life cycle. Women are discriminated against and excluded by culture and social norms (PNUD, 2014).

Nowadays, there is a need to deal with all the disaster´s phases: prevention, response, and recovery (Canyon, 2017). In this research, we deal with a prevention proposal because prevention is focused on identifying disaster risks and developing strategies to improve resilience. Resilience is the ability to adapt and react to changes in a system. It becomes imperative when the cities are vulnerable and exposed to disturbing events caused by climate change (Da Silva Stefano *et al.*, 2017).

According to the "Manual to Develop More Resilient Cities," published by UNISDR, a resilient city can minimize the disaster because the people and local authority know and share information about disasters, threats, and risks. Therefore, the people can anticipate the disasters and mitigate their impact (UNISDR, 2012).

The Humanitarian Logistics (HL) is very similar to corporate logistics. Therefore, there is an excellent opportunity to advance in this field. The HL refers to "process and involved systems to mobilize people, resources, abilities, and knowledge to help vulnerable people that were affected during a natural disaster and complex emergencies" (Thomas, 2005).

Nowadays, there is an intense pressure to develop the better coordination to respond to disasters; there is still some work to do to standardize logistics practices regarding humanitarian relief (Canyon, 2017).

Every time a natural disaster occurred, people come together in good faith to help the affected people with goods donations or in cash, no matter the disaster magnitude people are always willing to help others. However, this activity can cause severe logistics problems that can cause delays in the humanitarian relief and cause negative consequences in human life. Accordingly, the present research has the goal of help 24 municipalities in the State of Puebla that is vulnerable to hydrometeorological phenomena determining an optimal inventory level for relief kits early. Solving that we can in this way solve a Logistics and Relief Humanitarian Problem.

2. Problem Description

The State of Puebla is located in the center of the Mexican Republic. Puebla has 217 municipalities, and according to the National Institute of Statistics and Geography (INEGI), it represents 1.7% of the total Mexico territory (INEGI, 2016). The National Council of Evaluation of Social Development Policy (CONEVAL) situates the State with a high percentage of the population living in poverty, between 50% and 65% (CONEVAL, 2017).

According to information provided by the Official Journal of the Federation (DOF), the State of Puebla has had 1,632 emergency declarations during 2001 to 2017. As can be seen in Table 1, these 1,632 declarations, 567 were declarations of contingency, 527 declarations of disaster and 538 were declaratory of Emergency. An Emergency declaration is addressed to the attention of the life and health of the population, and the Disaster declarations are referred to damages caused to houses and public infrastructure. The data divided by phenomena type indicates that the majority of declarations are due to hydrometeorological events (Tropical cyclone, Floods, Rains, Snowfall, Frost, Hailstorm); Puebla is affected with 974 events of this kind. In the Table 1 are shown the Event and the Emergency type during the period 2001-2017.

Event/Emergency Type (2001-2017)	Low temperatures	Tropical cyclone	Floods	Rains	Snowfall, frost or hailstorm	Drought	Earthquake	Total
Contingency				145	123	299		**567**
Disaster		192	1	135	17	70	112	**527**
Emergency	65	189	1	116	55		112	**538**
Total	**65**	**381**	**2**	**396**	**195**	**369**	**224**	**1,632**

Table 1. Declarations divided by emergency and phenomenon type from 2001 to 2017.

Once the hydrometeorological event was identified as the most impacting event for Puebla, the declarations were analyzed by month. The data divided by month showed a significant increase during August (24.13%), September (12.42%), and October (40.76%). This data is shown in the Figure1.

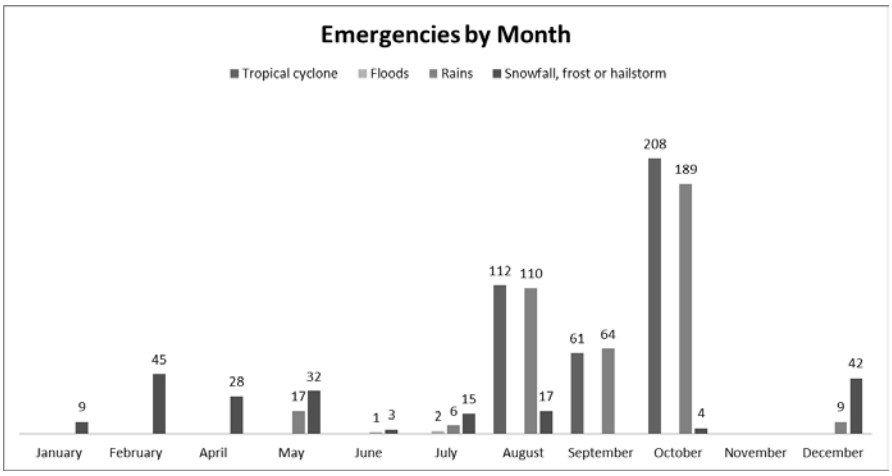


Figure 1. Emergency declarations

The information of 2013 – 2017 offered by the National Water Commission (CONAGUA) shows that the months where the atmospheric precipitation of water increases in the State of Puebla are June, July, August, and September. This information agrees with the information obtained of the Emergency declarations because the precipitations start on June and the disasters begin to reflect on August until October Figure 2 refers the data regarding rainfall for the State of Puebla for the period (CONAGUA, 2018).

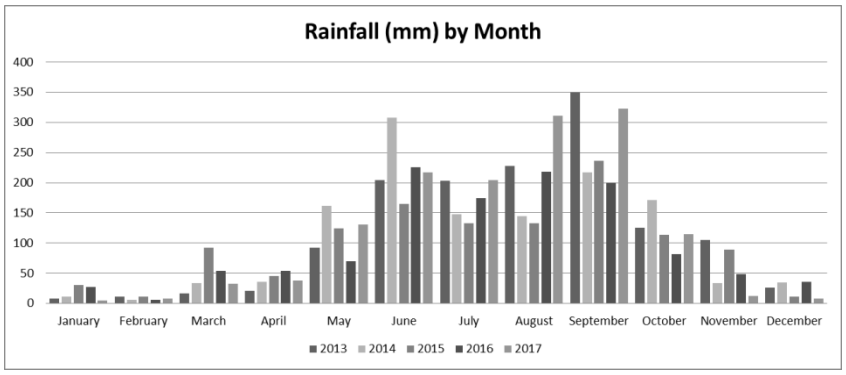


Figure 2. Atmospheric precipitation of water (CONAGUA)

Once corroborated that the hydrometeorological phenomena affect the State of Puebla during summer and part of autumn, and taking into account the declarations during those months, 24 municipalities were determined as the most affected with the most significant number of declaratory. This information is shown in Table 2.

MUNICIPALITY	Tropical cyclone	Floods	Rains	Snowfall, frost or hailstorm	Total of Declaratory (2001-2017)
Tlatlauquitepec	7		6	3	**16**
Zacapoaxtla	7		6	1	**14**
Huauchinango	5		7	2	**14**
Xicotepec	5		7	1	**13**
Atempan	6		6	1	**13**
Zautla	3		6	3	**12**
Chignautla	4		7	1	**12**
Tetela de Ocampo	5		6	1	**12**
Tlaola	3		8	1	**12**
Tlapacoya	4		7	1	**12**
Chiconcuautla	4		7	1	**12**
Zaragoza	3		6	2	**11**
Chalchicomula de Sesma	3		3	5	**11**
Cuetzalan del Progreso	5		4	2	**11**
Hueyapan	4		6	1	**11**

Jopala	4	6	1	**11**
Tenampulco	6	4		**10**
Ayotoxco de Guerrero	7	3		**10**
Esperanza	2	3	5	**10**
Hueytamalco	7	3		**10**
Acateno	5	3	1	**9**
Huehuetla	3	5	1	**9**
Guadalupe Victoria	1	4	3	**8**
Tecamachalco	2	1	2	**5**

Table 2. Emergency Municipality by 2001-2017

Figure 3 refers the location of the 24 municipalities, and figure 4 refers the total declaratory for those municipalities.

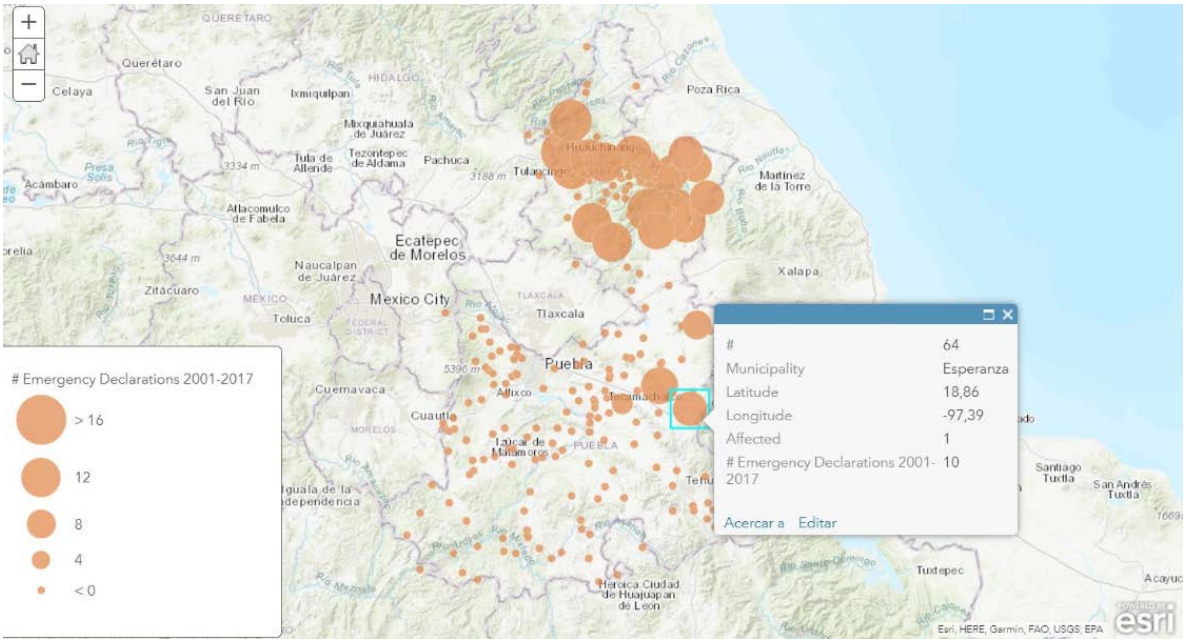


Figure 3. Location of the 24 municipalities

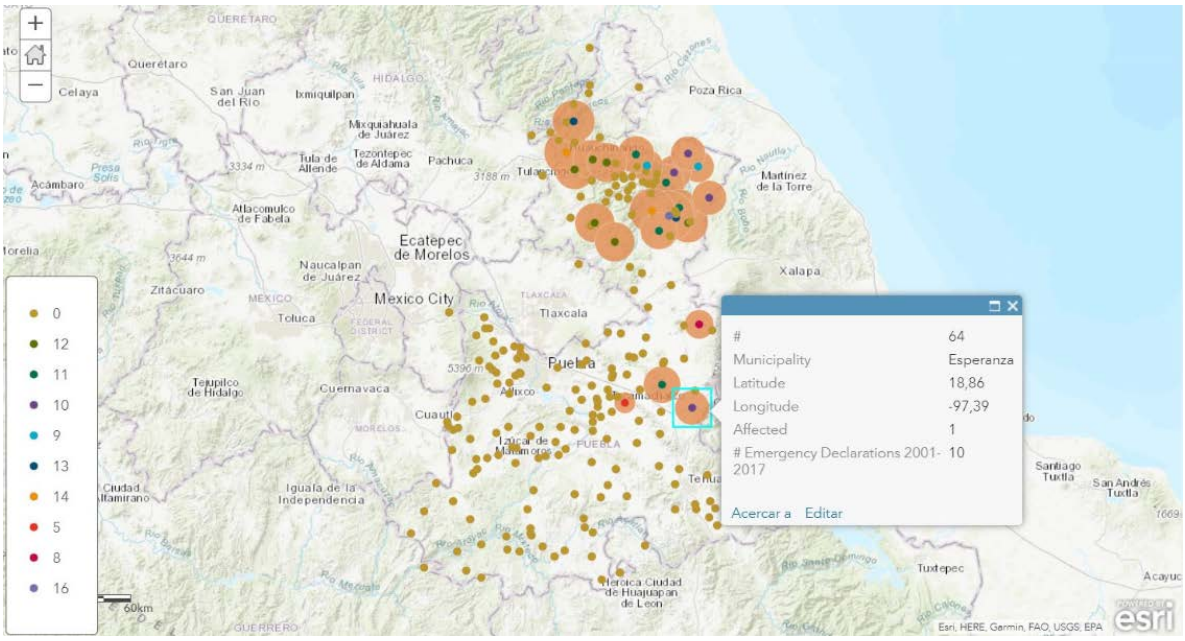


Figure 4. Total declaratory of 24 municipalities

The National Risk Atlas, managed by Mexico´s National Center for Prevention of Disasters (CENAPRED) measures resilience with a 5 points scale, where 1 represents the lowest grade, and 5 represents the higher grade of resilience. The opposite meaning of this measure represents the social vulnerability. The vulnerability is defined as “Lack of access to prevention and resilience” (CENAPRED, 2015). The 24 affected municipalities have a resilience average of 3, they are in the middle of the scale, so they still have some work to do to anticipate the disasters in a better way, and 37% of the municipalities have a high grade of social vulnerability, they do not have enough prevention culture. In Figure 5 the resilience average is shown, and social vulnerability is shown in Figure 6.

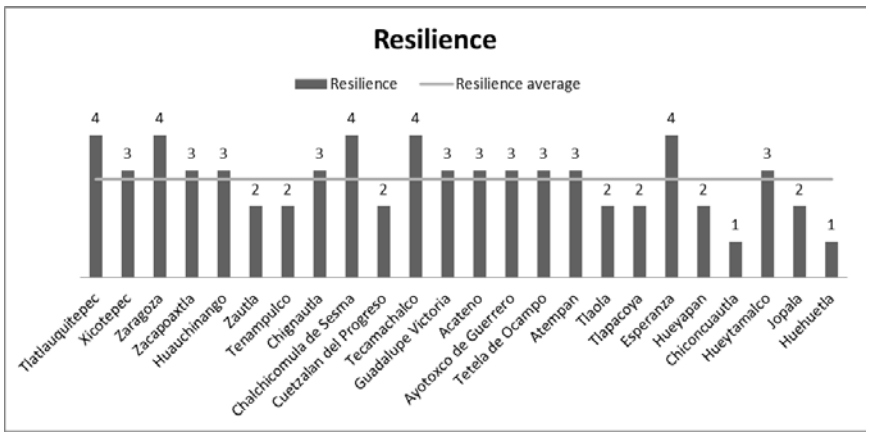


Figure 5. Resilience grade for 24 municipalities of State of Puebla

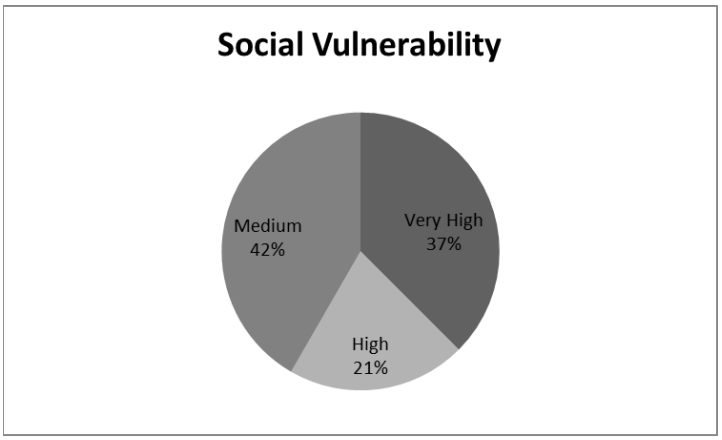


Figure 6. Social Vulnerability for 24 municipalities of the State of Puebla

Hence, after analyzing the information obtained, the principal municipalities to help are 24 with high social vulnerability and low resilience grade.

3. Methods and procedures

Even though the emergency declarations derivate by hydrometeorological phenomena presents seasonality in the municipalities studied, the number of affected population is uncertain. Thus the emergency magnitude cannot be predicted.

The necessary data to determine the inventory of the kits that need to be ready to help the affected population is the demand estimation. The demand is entirely uncertain, and the purchase of the kits will be only once per year. Because of these characteristics, the lot size will be calculated using a stochastic model called the Newsboy Model. This model can be used to calculate a single purchase or purchase with seasonality (Hillier and Lieberman, 2001).

This unique inventory model, also called the Newsboy Model, consider the risk that a person is willing to take to run out of inventory (Chase, Jacobs and Aquilano, 2009).

The Newsboy Model has two assumptions: first, immediately the demand occurs the order is received, and second, there is not a preparation cost (Taha, 2012).

The equation for the Newsboy Model according to (Axsäter, 2015) is as follow:

$$Q = D_{min} + (D_{max} - D_{min})\left(\frac{p - c}{p}\right) \qquad (1)$$

Where:

Q= Unit quantity to buy

D_{min}= *Minimum registered demand.*

D_{max}= *Maximum registered demand.*

p= Sale value for inventory unit

c= Purchase cost for inventory unit

(1) Newsboy Model equation to calculate the lot size to buy when the minimum and maximum demand is know

There are no records of affected people in the State of Puebla, so to determine the maximum and minimum demand, the data regarding the affected population that were hit by hydrometeorological phenomena in all the Mexican Republic was analyzed. This information is reported by Mexico´s Fund for Natural Disasters (FONDEN). The data regarding the population census reported on 2010 by the National of Statistics and Geography Institute (INEGI) was analyzed as well. The purpose of analyzing the complete Mexican Republic data is to approximate the demand for each of the 24 municipalities of the State of Puebla.

4. Experimental Setting

Estimation of the Demand

First, the data for the emergency declaratory in all the Mexican Republic was obtained during 2014 to 2016, with a total of 783 declaratory. Then, the proportional relationship was calculated taking into account the total of the affected population against the 100% of the population. For each of the 514 municipalities involved made this calculation, and we obtained the percentage of affectation.

Once obtained the proportional relationship, it was divided into ranges. The frequency was calculated to verify the limits were the significant numbers of the observations were located. The range where the probability to help the 84% of the population was between 0.31 – 0.4; thus 30% and 40% were used to approximate the minimum and maximum demand of the 24 municipalities of Puebla. The Frequency data is shown in Table 3 and Figure 7 the frequency, and accumulated frequency is shown.

Range	Frequency	Relative Frequency	Accumulated Frequency
0.001 - 0.1	289	37%	37%
0.11 - 0.2	108	14%	51%
0.21 - 0.3	97	12%	63%
0.31 - 0.4	167	21%	84%
0.41 - 0.5	10	1%	86%
0.51 - 0.6	5	1%	86%
0.61 - 0.7	4	1%	87%
0.71 - 0.8	24	3%	90%
0.81 - 0.9	2	0%	90%
0.91 - 1	77	10%	100%

Table 3. Frequency table (affected population/total population)

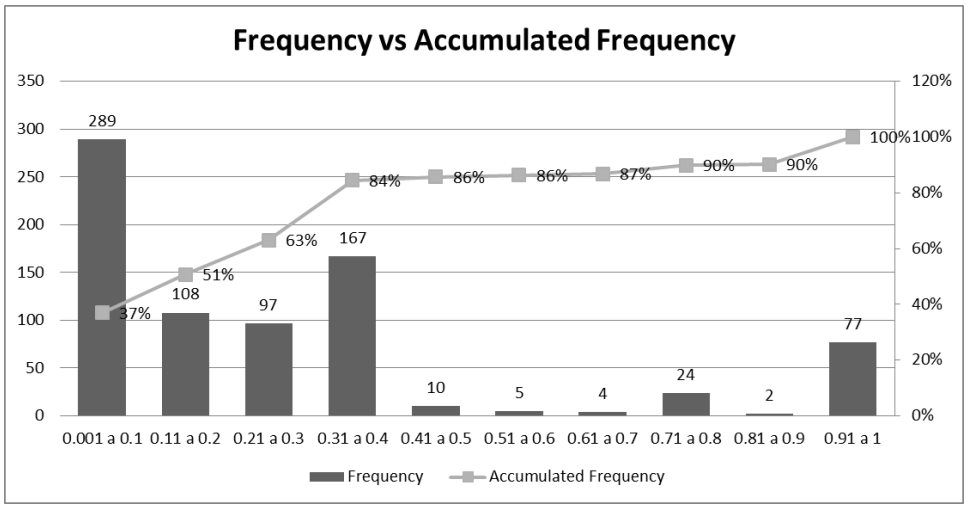


Figure 7. Frequency vs. Accumulated Frequency

The probability to assist the 84% of the population is between 30% and 40%. Thus, the minimum percentage will be 30% to estimate the D_{min} and 40% to estimate the D_{max}.

According to the last population census executed in 2010, the involved municipalities have a population of 720,764 people (INEGI, 2010). Figure 8 shows the population divided by age according to INEGI data.

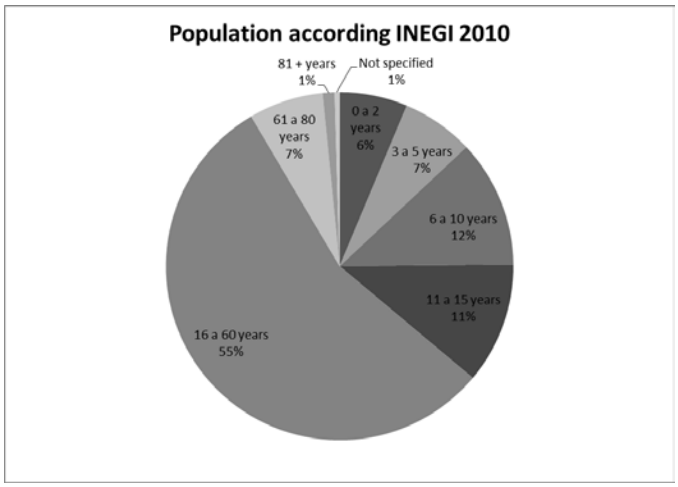


Figure 8. Distribution of population by age (INEGI 2010)

With this probability of 84% of demand, the calculations were made to obtain the optimum lot size of relief kits separating by gender and age.

Defining the Relief Kits

To define an adequate relief kit for gender and age, in this research the kits were classified as follows:

- 0 - 2 years
- 3 - 5 years
- 6 - 10 years
- 11 - 15 years Men
- 11 - 15 years Women
- 16 - 60 years Men
- 16 - 60 years Women
- 61 - 80 years
- 81 y more than years

Table 4 contains the proposed articles to be included in each different relief kit, taking into account the different necessities for children, women and older adults.

Kit´s name	Kit A	Kit B	Kit C	Kit D	Kit E	Kit F	Kit G	Kit H	Kit I
Age range	0 - 2 years	3 - 5 years	6 - 10 years	11 - 15 years - Men	11 - 15 years - Women	16 - 60 years - Men	16 - 60 years - Women	61 - 80 years	81 and more
Shampoo	X	X	X	X	X	X	X	X	X
Baby diapers	X								
Baby wet towel	X								
Antibacterial gel	X	X	X	X	X	X	X	X	X
Toilet soap		X	X	X	X	X	X	X	X
Toothpaste		X	X	X	X	X	X	X	X
Infantil toothbrush		X							
Toothbrush			X	X	X	X		X	X
Nail clipper				X	X	X	X	X	X
Hair comb				X	X	X	X	X	X
Sanitary towels					X		X		
Deodorant				X	X	X	X	X	X
Toilet paper		X	X	X	X	X	X	X	X
Coloring book		X							
Activity book			X						
Crayons		X	X						
Adult diapers									X

Table 4. Kits descriptions

Then the cost was calculated to obtain the variable "*c*" for the Newsboy Model. The costs are as follow in Table 5.

Kit´s name	Age range	Cost
Kit A	0 - 2 years	$ 231
Kit B	3 - 5 years	$ 176
Kit C	6 . 10 years	$ 176
Kit D	11 - 15 years - Men	$ 158
Kit E	11 - 15 years - Women	$ 178
Kit F	16 - 60 years - Men	$ 158
Kit G	16 - 60 years - Women	$ 178
Kit H	61 - 80 years	$ 158
Kit I	81 and more	$ 228

Table 5. Kit cost separated by age range and gender

The total amount of damaged reported by the CENAPRED affected the State of Puebla during 15 years from (2000 to 2015) was calculated to obtaine the variable *p*. We only consider the losses for hydrometeorological phenomena. The total damage reported sums 5,033 million MXN, the annual average is 335.5 million MXN, and the affected population was 254,959. Calculating the relationship between the losses and the affected people, we obtained 1,316 MXN per person. In Figure 9 is shown the total damages caused by hydrometeorological emergencies.

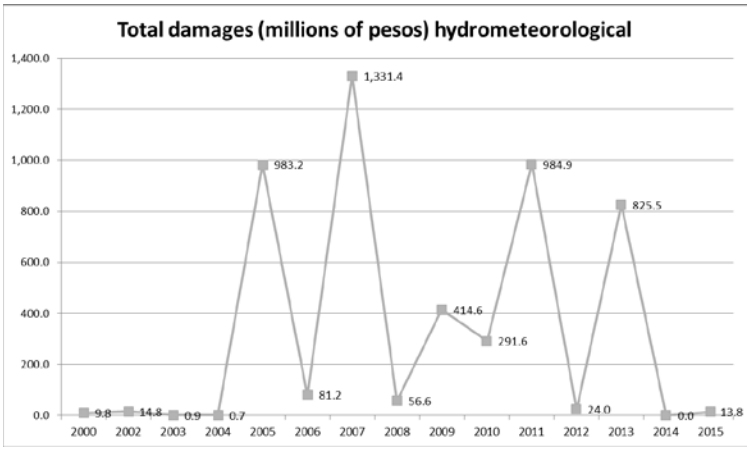


Figure 9. Total damages caused by hydrometeorological emergencies

5. Results and Discussion

Once the necessary data was obtained, we solve the newspaper model. The results were total relief kits of 277,602 pieces, that represent 48,225,830.00 MXN. Is suggested that this amount of relief kits can be held in August, September, and October, and be prepared before the disasters happen. The quantity calculated for each proposed kit is shown in Table 6 shows and table 7 shows the inventory cost for each proposed kit.

	0 - 2 years	3 - 5 years	6 - 10 years	11 - 15 years - Men	11 - 15 years - Women	16 - 60 years - Men	16 - 60 years - Women	61 - 80 years	81 and more	Total
	Q*	Q*	Q*	Q*	Q*	Q*	Q*	Q*	Q*	Q*
Total	**17,420**	**18,637**	**33,026**	**15,882**	**15,553**	**72,746**	**81,879**	**19,395**	**3,064**	**277,602**
Tlatlauquitepec	1,211	1,304	2,223	1,112	1,058	5,258	5,960	1,530	246	19,902
Huauchinango	2,315	2,462	4,280	1,978	1,953	9,900	11,594	2,354	339	37,175
Xicotepec	1,855	1,922	3,331	1,692	1,626	7,697	8,752	2,036	307	29,218
Guadalupe Victoria	407	450	824	394	389	1,604	1,774	462	98	6,402
Zautla	498	537	906	442	411	1,875	2,129	574	109	7,481
Chalchicomula de Sesma	950	1,037	1,838	891	906	4,603	5,139	1,332	243	16,939
Tlaola	513	548	1,063	520	496	1,911	2,082	468	66	7,667
Zaragoza	348	353	630	314	317	1,584	1,946	405	74	5,971
Cuetzalan del Progreso	1,113	1,240	2,229	1,070	1,051	4,772	5,214	1,476	181	18,346
Acateno	176	203	369	189	168	945	972	373	58	3,453
Tetela de Ocampo	598	599	1,064	550	567	2,633	2,917	875	175	9,978
Esperanza	321	344	613	279	306	1,416	1,574	392	89	5,334
Chiconcuautla	482	499	975	433	397	1,361	1,520	369	50	6,086
Zacapoaxtla	1,261	1,395	2,466	1,182	1,173	5,328	6,108	1,426	222	20,561
Tenampulco	117	134	253	137	120	705	772	332	49	2,619
Chignautla	825	931	1,545	688	675	3,045	3,333	556	90	11,688
Tecamachalco	1,738	1,852	3,334	1,499	1,510	7,378	8,361	1,386	257	27,315
Ayotoxco de Guerrero	181	196	334	195	181	867	934	230	37	3,155
Tlapacoya	156	152	310	176	182	629	679	176	22	2,482
Jopala	307	326	607	338	326	1,248	1,398	432	48	5,030
Huehuetla	372	406	739	354	337	1,500	1,678	617	64	6,067
Hueyapan	334	346	562	279	267	1,203	1,290	276	36	4,593
Hueytamalco	623	635	1,178	580	549	2,793	3,019	824	122	10,323
Atempan	719	766	1,353	590	588	2,491	2,734	494	82	9,817

Table 6. Total inventory kits by age range

	0 - 2 years	3 - 5 years	6 - 10 years	11 - 15 years - Men	11 - 15 years - Women	16 - 60 years - Men	16 - 60 years - Women	61 - 80 years	81 and more	Total
	$	$	$	$	$	$	$	$	$	$
Total	**4,024,020**	**3,280,112**	**5,812,576**	**2,509,356**	**2,768,434**	**11,493,868**	**14,574,462**	**3,064,410**	**698,592**	**48,225,830**
Tlatlauquitepec	279,741	229,504	391,248	175,696	188,324	830,764	1,060,880	241,740	56,088	3,453,985
Huauchinango	534,765	433,312	753,280	312,524	347,634	1,564,200	2,063,732	371,932	77,292	6,458,671
Xicotepec	428,505	338,272	586,256	267,336	289,428	1,216,126	1,557,856	321,688	69,996	5,075,463
Guadalupe Victoria	94,017	79,200	145,024	62,252	69,242	253,432	315,772	72,996	22,344	1,114,279
Zautla	115,038	94,512	159,456	69,836	73,158	296,250	378,962	90,692	24,852	1,302,756
Chalchicomula de Sesma	219,450	182,512	323,488	140,778	161,268	727,274	914,742	210,456	55,404	2,935,372
Tlaola	118,503	96,448	187,088	82,160	88,288	301,938	370,596	73,944	15,048	1,334,013
Zaragoza	80,388	62,128	110,880	49,612	56,426	250,272	346,388	63,990	16,872	1,036,956
Cuetzalan del Progreso	257,103	218,240	392,304	169,060	187,078	753,976	928,092	233,208	41,268	3,180,329
Acateno	40,656	35,728	64,944	29,862	29,904	149,310	173,016	58,934	13,224	595,578
Tetela de Ocampo	138,138	105,424	187,264	86,900	100,926	416,014	519,226	138,250	39,900	1,732,042
Esperanza	74,151	60,544	107,888	44,082	54,468	223,728	280,172	61,936	20,292	927,261
Chiconcuautla	111,342	87,824	171,600	68,414	70,666	215,038	270,560	58,302	11,400	1,065,146
Zacapoaxtla	291,291	245,520	434,016	186,756	208,794	841,824	1,087,224	225,308	50,616	3,571,349
Tenampulco	27,027	23,584	44,528	21,646	21,360	111,390	137,416	52,456	11,172	450,579
Chignautla	190,575	163,856	271,920	108,704	120,150	481,110	593,274	87,848	20,520	2,037,957
Tecamachalco	401,478	325,952	586,784	236,842	268,780	1,165,724	1,488,258	218,988	58,596	4,751,402
Ayotoxco de Guerrero	41,811	34,496	58,784	30,810	32,218	136,986	166,252	36,340	8,436	546,133
Tlapacoya	36,036	26,752	54,560	27,808	32,396	99,382	120,862	27,808	5,016	430,620
Jopala	70,917	57,376	106,832	53,404	58,028	197,184	248,844	68,256	10,944	871,785
Huehuetla	85,932	71,456	130,064	55,932	59,986	237,000	298,684	97,486	14,592	1,051,132
Hueyapan	77,154	60,896	98,912	44,082	47,526	190,074	229,620	43,608	8,208	800,080
Hueytamalco	143,913	111,760	207,328	91,640	97,722	441,294	537,382	130,192	27,816	1,789,047
Atempan	166,089	134,816	238,128	93,220	104,664	393,578	486,652	78,052	18,696	1,713,895

Table 7. Total inventory cost by age range

6. Conclusions and Future Research

The paper is based on proposing to have enough inventory levels of relief kits to help the largest possible population in the rainy season. The statistical data shows that the municipalities are affected during the summer.

It is important to emphasize that the Northern zone of the State of Puebla is in poverty and the social vulnerability is high, this is why the study considered the fact that people receive help from the government of Mexico. Remember that children, women, and the elderly are the most vulnerable in cases of disasters, so the study suggests focussing on a special relief kit for them. For example, some of the items include in the children´s kit are colors and a book, these items will help them to forget the critical situation.

As future research, using location-allocation models can be identified the best place to suggest having a distribution center with sufficient capacity to hold the inventory determined in this study and thus bring the aid closer to the endpoint. Also, this can safeguard the relief kits in safe places and afterward to distribute them to the affected people.

Additionally, an optimal route can be analyzed to take away this aid to the municipalities above. This route should minimize costs and maximize the delivery of relief kits through an appropriate routing model.

References

Axsäter, S. (2015) *Inventory Control*. Third Edit. Springer. doi: 10.1007/978-3-319-15729-0.

Canyon, D. V (2017) 'Military Provision of Humanitarian Assistance and Disaster Relief in Non-Confllict Crises', *Journal of Homeland Security and Emergency Management*, pp. 1–5. doi: 10.1515/jhsem-2017-0045.

CENAPRED (2015) *Mexico´s National Center for Prevention of Disasters*, *Resiliencia y Prevención en Protección Civil*. Available at: https://www.gob.mx/cenapred.

Chase, R. B. (University of S. C., Jacobs, F. R. (Indiana U. and Aquilano, N. J. (University of A. (2009) *Administración de Operaciones, Producción y Cadena de Suministro*. Twelfth ed. McGRAW-HILL / INTERAMERICANA EDITORES, S.A. DE C.V.

CONAGUA (2018) *CONAGUA*. Available at: http://smn.cna.gob.mx/es/climatologia/temperaturas-y-lluvias/resumenes-mensuales-de-temperaturas-y-lluvias.

CONEVAL (2017) 'Contenido'. Available at: https://www.coneval.org.mx/Medicion/MP/Paginas/Pobreza_2016.aspx.

Hillier, F. U. and Lieberman, G. J. (Late of S. U. (2001) *Introduction to Operations Research*. Seventh Ed, *Book*. Seventh Ed. McGraw-Hill. doi: 10.1016/0305-0548(93)90042-H.

Ilhan, A. (2011) 'The humanitarian relief chain', *South East European Journal of Economics and Business*, 6(2), pp. 45–54. doi: 10.2478/v10033-011-0015-x.

INEGI (2016) 'Anuario estadístico y geográfico de Puebla 2017'. Available at: http://internet.contenidos.inegi.org.mx/contenidos/Productos/prod_serv/contenidos/espanol/bvinegi/productos/nueva_estruc/anuarios_2015/702825077174.pdf.

Moore, M. *et al.* (2009) 'Learning from Exemplary Practices in International Disaster Management : A Fresh Avenue to Inform U . S . Policy ? Learning from Exemplary Practices in International Disaster Management : A Fresh Avenue to Inform U . S . Policy ?', *Journal of Homeland Security and Emergency Management*, 6(1), p. 40. doi: 10.2202/1547-7355.1515.

ONU (2013) *United Nations and humanitarian relief, Los Desastres Naturales*. Available at: http://www.un.org/es/humanitarian/overview/disaster.shtml.

Pan American Health Organization (1999) 'Asistencia humanitaria en caso de desastres: guía para proveer ayuda eficaz'. Available at: http://books.google.com/books?hl=en&lr=&id=j6GY6cVoyjcC&oi=fnd&pg=PP3&dq=Asistencia+humanitaria+en+caso+de+desastres+Guía+para+proveer+ayuda+eficaz&ots=tRlBjSK8y4&sig=rrObmNbHPelZrqIkz1cHthob_ao.

PNUD, P. de N. U. para el D. (2014) 'Informe sobre Desarrollo Humano 2014 Equipo del Informe sobre Desarrollo Director y autor principal', p. 19.

Da Silva Stefano, G. *et al.* (2017) 'Identifying Constraints to Increase the Resilience of Cities : A Case Study of the City of Porto Alegre', *Journal of Homeland Security and Emergency Management*, pp. 1–24. doi: 10.1515/jhsem-2016-0057.

Taha, H. A. (2012) *Investigación de Operaciones*. Ninth Edit. PEARSON EDUCACIÓN.

Thomas, A. (2005) 'Humanitarian Logistics : Enabling Disaster Response', *Fritz Institute*, pp. 1–17. Available at: http://www.fritzinstitute.org/pdfs/whitepaper/enablingdisasterresponse.pdf.

UNICEF (2009) *UNICEF Primera Infancia, Situaciones de emergencia*. Available at: https://www.unicef.org/spanish/earlychildhood/index_40745.html.

UNICEF (2017) *UNICEF México, 535 millones de niños son afectados por desastres en el mundo: UNICEF*. Available at: https://www.unicef.org/mexico/spanish/noticias_36267.html%0A.

UNISDR (2012) 'Cómo desarrollar ciudades más resilientes Un Manual para líderes de los gobiernos locales', p. 103.

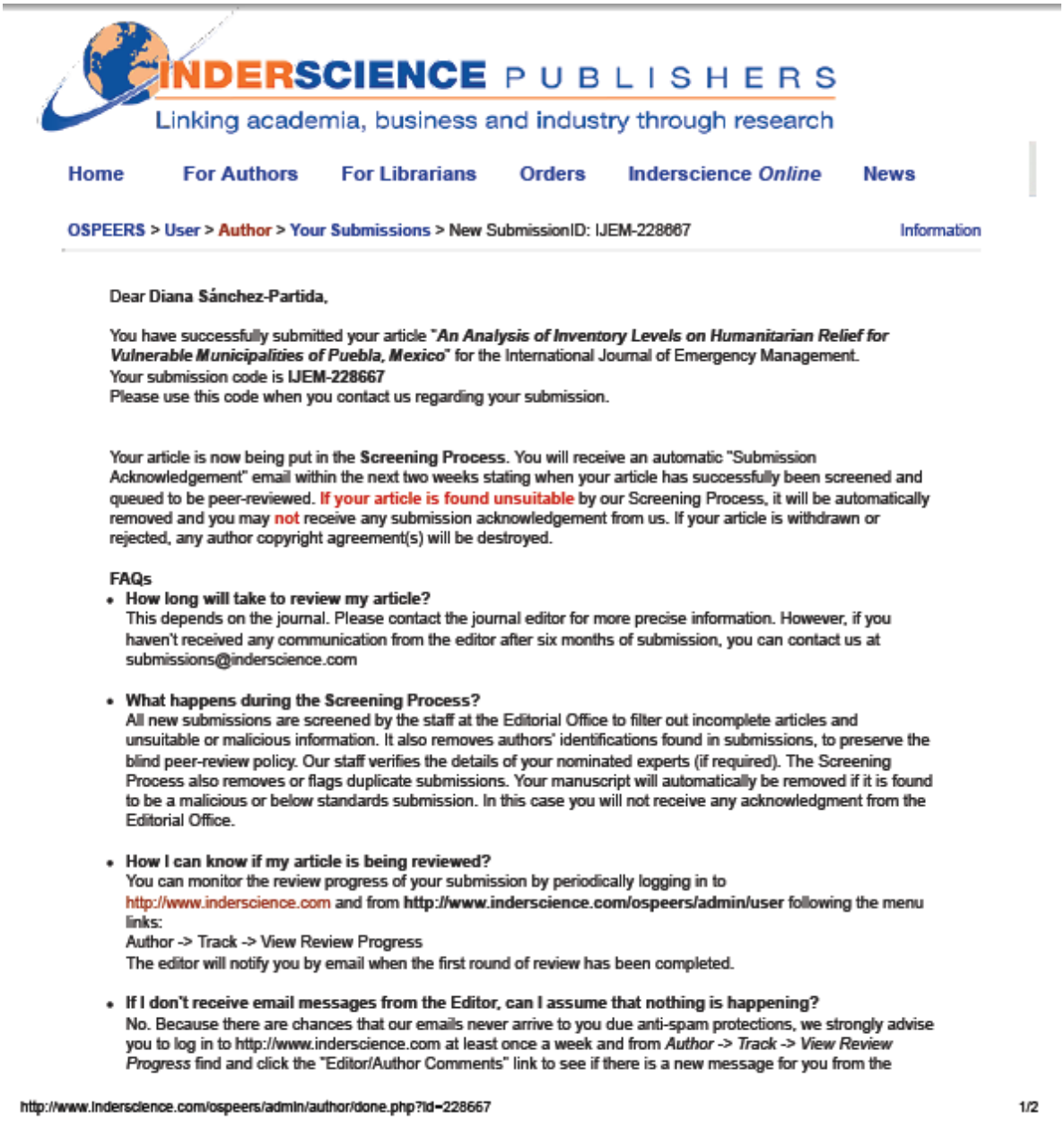
UNISDR (2013) 'Impacto de los Desastres en América Latina y el Caribe', pp. 1990–2013.

Capítulo III. Conclusiones

La investigación del artículo presentado en este documento puede extenderse a cualquier parte de la República Mexicana siguiendo el método propuesto.

La Logística Humanitaria tiene como fin el ayudar, y siempre habrá situaciones de riesgo en las que se pueden aplicar métodos logísticos para hacer llegar la ayuda de forma eficiente a poblaciones afectadas. Debemos seguir esforzándonos en ayudar y estar prevenidos, el bienestar de las personas y evitar pérdidas humanas siempre debe ser el principal objetivo.

Anexos



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