DISASTERS: A SIMPLIFIED SYSTEMIC SCALE (SSS) FOR CLASSIFYING MAGNITUDES OF HURRICANES AND EARTHQUAKES.

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Abstract

Disasters are themes of growing concern. The number and magnitude of disasters is increasing with time and there are different ways for quantifying the magnitude of the natural phenomena that detonate them.

In this paper it is proposed a method for classifying the magnitude of these phenomena in a simpler, systemic and systematic way, which may help to classify the type and speed of the answer to face the menace of a disaster.

The actual methods for classifying the magnitude of hurricanes and earthquakes are analyzed and a new Simplified Systemic Scale of only three levels is proposed. It is concluded that the same simplified systemic scale may be used for other natural phenomena that produce disasters.

Keywords: Disasters, Simplified Systemic Scale magnitudes classification, hurricanes, earthquakes.

Introduction

Disasters are themes of great actuality because they happen quite frequently, with bigger intensity, and causing more impacts on society, in terms of fatalities and material losses. Magnitude of disasters depends on vulnerability of the community and on agressivity of the natural phenomena that generates them.

The intensity of the natural phenomena (hurricane, seism, etc.) may be reported with great accuracy, but in a way not comprehensible for the majority of the population. On the contrary, the magnitude of the phenomena could be reported in a simpler and comprehensible way, even if it is not too exact.

The main objective of this paper is to propose a simpler way or reporting the magnitudes of the natural phenomena, in order that the populations understand quickly the importance of the risk that the phenomena represent, and the measures or actions to be taken, so that the disaster could be avoided or mitigated.

In North America, when the alert system detects that a hurricane of a great magnitude is coming to a city, the population is alerted and the prepared contingency plan is

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implemented immediately. The authors think that a similar method that is actually used with the scale Saffir-Simpson for hurricanes, with five different magnitudes, could be used for seism, tsunamis, floods, volcanic eruptions, and droughts, which actually represent the majority of phenomena that detonate disasters.

The different scales usually utilized for hurricanes and earthquakes are analyzed in this paper, and from them, a new scale, with only three levels, is proposed. With a simpler and shorter scale, it is expected that people could understand better how to react in a simpler and opportune way, when a natural phenomenon appears, in order to avoid or to reduce the magnitude of the disaster that could be generated if not preventive actions are taken.

Knowing the level of magnitude of the phenomenon that is approaching, should be enough to decide what action to take. It is not necessary to know exactly how many kilometers/hour is the velocity of the winds of a hurricane to decide what to do. The same could be said about earthquakes. It is not necessary to know exactly what the amplitude of the seism is, to do something about it. It is enough to know that the order of magnitude is 1, 2 or 3, in order to make something appropriate and opportune.

A scale of only three levels of magnitude permits to make a rapid decision about what to do when a natural phenomenon appears. For instance, when a hurricane appears with less than 150 km/hr, it means in the new Simplified Systemic Scale (SSS), that it is a hurricane level 1, and that only minor precaution are to be taken. But if the hurricane has a velocity of more than 200 km/hr, then it is a hurricane level 3 in the proposed SSS, which is the most dangerous possible, and this means that probably the population should evacuate the city, accordingly to a previously prepared contingency plan (see table 3).

The equivalences among the new Simplified Systemic Scale and the previous scales for hurricanes and earthquakes are explained in their respective chapters.

Disasters, a systemic point of view

A community is considered in a disaster situation, when its usual way of functioning is out of order, and it is not possible for the community to come to a normal situation, in a rapid way, without the external aid of other communities.

Disasters are the result of aggressive natural phenomena acting on a vulnerable community. This is showed graphically in fig. 1.

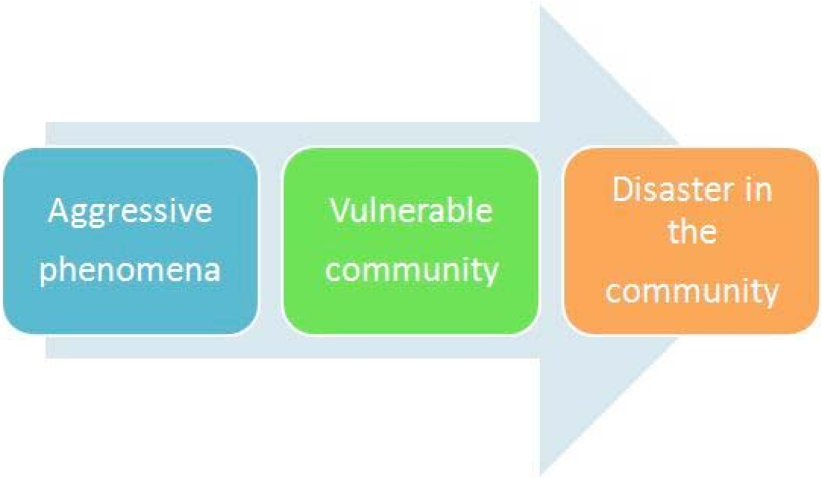

Fig. 1- Disasters are the result of aggressive phenomena acting on vulnerable communities.

It is needed that both factors (aggressive phenomena and vulnerable community) interact in order to produce a disaster. A very aggressive phenomenon, like hurricane Katrine would not have produced a great disaster, (more than 1800 dead persons and a material loss of more than 75 billion dollars) if New Orleans would not be so vulnerable, at that time.

Why a three levels scale?

It is well known that almost every body remembers at least three aspects of any situation, and this knowledge is used in many usual problems solutions. For instance, the **semaphore** is used with only three color lights, green, yellow and red to control traffic of vehicles and pedestrians in a busy intersection of streets, where green means that the driver or the pedestrian may continue driving or walking; yellow is a signal of alert, meaning that red color is coming soon; and red light means that it is not allowed to continue driving or walking. This **semaphore** with three lights is a very well known system for controlling the traffic of cars and pedestrians in crowed streets.

Fig. 2- Semaphore

Triage is a medical practice for selecting the patients to help first, among many injured, in order to optimize scarce resources. This is a very common method used in a war or in a catastrophic situation. The first patients to be helped by doctors and nurses are those that have curable wounds, which, if not attended rapidly, may become fatal. The second priority is patients who have slight injuries, probably curable by themselves, and all they need is some advice from the nurse or doctor, so that the patients may walk out the hospital rapidly, by themselves. Third priority is those patients that have very grave, fatal wounds, and all that can be done is to help them to well dying. With this ***triage*** practice, resources are optimized in an ethical way.

In many usual situations, it is very common to use a **three levels classification system**. For instance, for indicating the level of experience, there are beginners, medium and advanced workers or researchers. For planning purposes, it is used the short, medium and long term or period. For educational purposes, there are elementary, high school, and professional colleges. For financial purposes, an investment may have a bass, medium or high interest rate. For defining the age of persons, one may be young, adult or old. And so on.

So the authors think that a **system of three levels** for classifying the aggressiveness of natural phenomena would be useful for defining what type of reaction should be taken to face it. ***Level 1*** means that some minimal precaution should be taken, for instance, people should not go outside home, in case of hurricanes. ***Level 2*** means that more precautions are to be taken, for instance, protecting windows and other fragile items, besides not going outside. ***Level 3*** means that evacuation is probably needed, because the danger of remaining home is too high. But the appropriate reaction should be defined by each community, depending on their past experiences and good judgment. Fig. 3 shows the usual options in case of danger.

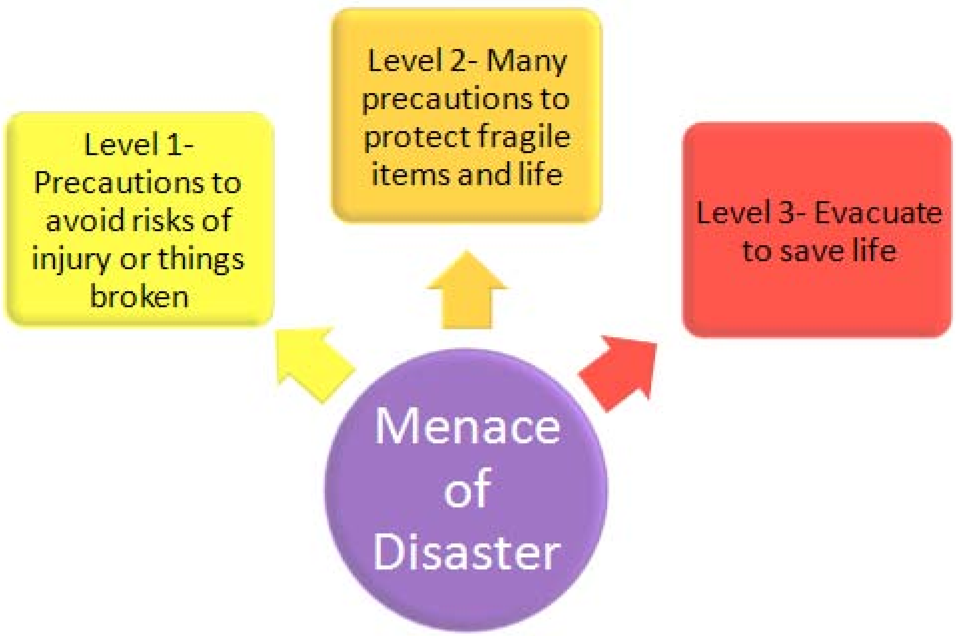

Fig. 3- Three options to face menaces of disasters

Hurricanes

Hurricanes are meteorological phenomena, with winds at high velocity and a very dense rain that produce many fatalities and material looses in the communities that are not prepared to face them.

There are several ways to determine the magnitude of hurricanes. The most known are the Beaufort and the Saffir-Simpson scales. In the following tables their characteristics are indicated.

Table 1- Beaufort scale

Note that wave heights in the scale are for conditions in the open ocean, not along shore.

Beaufort number	**Wind speed**				**Mean wind speed (kt / km/h / mph)**	**Description**	**Wave height**		**Sea conditions**	**Land conditions**
	kt	**km/h**	**mph**	**m/s**			**m**	**ft**		
0	0	0	0	0-0.2	0 / 0 / 0	Calm	0	0	Flat.	Calm. Smoke rises vertically.
1	1-3	1-6	1-3	0.3-1.5	2 / 4 / 2	Light air	0.1	0.33	Ripples without crests.	Wind motion visible in smoke.
2	4-6	7-11	4-7	1.6-3.3	5 / 9 / 6	Light breeze	0.2	0.66	Small wavelets. Crests of glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle.
3	7-10	12-19	8-12	3.4-5.4	9 / 17 / 11	Gentle breeze	0.6	2	Large wavelets. Crests	Leaves and smaller twigs in

									begin to break; scattered whitecaps	constant motion.
4	11-16	20-29	13-18	5.5-7.9	13 / 24 / 15	Moderate breeze	1	3.3	Small waves.	Dust and loose paper raised. Small branches begin to move.
5	17-21	30-39	19-24	8.0-10.7	19 / 35 / 22	Fresh breeze	2	6.6	Moderate (1.2 m) longer waves. Some foam and spray.	Smaller trees sway.
6	22-27	40-50	25-31	10.8-13.8	24 / 44 / 27	Strong breeze	3	9.9	Large waves with foam crests and some spray.	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult.
7	28-33	51-62	32-38	13.9-17.1	30 / 56 / 35	Near gale	4	13.1	Sea heaps up and foam begins to streak.	Whole trees in motion. Effort needed to walk against the wind.
8	34-40	63-75	39-46	17.2-20.7	37 / 68 / 42	Gale	5.5	18	Moderately high waves	Twigs broken from trees.

									with breaking crests forming spindrift. Streaks of foam.	Cars veer on road.
9	41-47	76-87	47-54	20.8-24.4	44 / 81 / 50	Strong gale	7	23	High waves (2.75 m) with dense foam. Wave crests start to roll over. Considerable spray.	Light structure damage.
10	48-55	88-102	55-63	24.5-28.4	52 / 96 / 60	Storm	9	29.5	Very high waves. The sea surface is white and there is considerable tumbling. Visibility is reduced.	Trees uprooted. Considerable structural damage.
11	56-63	103-119	64-73	28.5-32.6	60 / 112 / 70	Violent storm	11.5	37.7	Exceptionally high waves.	Widespread structural damage.
12	64-80	120	74-95	32.7-40.8	73 / 148 / 90	Hurricane	14+	46+	Huge waves. Air filled with foam and spray. Sea completel	Considerable and widespread damage to structures.

									y white with driving spray. Visibility greatly reduced.	

Table 2 - The Saffir-Simpson scale

The five categories are, in order of increasing intensity:

Category 	**Sustained winds**	33–42 m/s	74–95 mph	64–82 kt	119–153 km/h
	Storm surge	4–5 ft		1.2–1.5 m	
	Central pressure	28.94 in Hg		980 mbar	
	Potential damage	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage[			
	Example storms	Bess (1974) – Jerry (1989) – Ismael (1995) – Danny (1997) – Gaston (2004)			
Category 	**Sustained winds**	43–49 m/s	96–110 mph	83–95 kt	154–177 km/h
	Storm surge	6–8 ft		1.8–2.4 m	
	Central Pressure	28.50–28.91 inHg		965–979 mbar	
	Potential damage	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected anchorages may break their moorings.[5]			

	Example storms	Carol (1954) – Diana (1990) – Erin (1995) – Marty (2003) – Juan (2003)			
Category 3	**Sustained winds**	50–58 m/s	111–130 mph	96–113 kt	178–209 km/h
	Storm surge	9–12 ft		2.7–3.7 m	
	Central pressure	27.91–28.47 in Hg		945–964 mbar	
	Potential damage	Some structural damage to small residences and utility buildings, with a minor amount of curtain wall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain may be flooded well inland.[5]			
	Example storms	Alma (1966) – Alicia (1983) – Roxanne (1995) – Fran (1996) – Isidore (2002)			
Category 4	**Sustained winds**	59–69 m/s	131–155 mph	114–135 kt	210–249 km/h
	Storm surge	13–18 ft		4.0–5.5 m	
	Central pressure	27.17–27.88 in Hg		920–944 mbar	
	Potential damage	More extensive curtain wall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.[5]			
	Example storms	"Galveston" (1900) – Hazel (1954) – Iniki (1992) – Iris (2001) – Charley (2004)			
Category 5	**Sustained winds**	≥70 m/s	≥156 mph	≥136 kt	≥250 km/h
	Storm surge	≥19 ft		≥5.5 m	
	Central pressure	<27.17 in Hg		<920 mbar	

	Potential damage	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.[5]
	Example storms	"Labor Day" (1935) – "Mexico" (1959) – Camille (1969) – Gilbert (1988) – Andrew (1992) – Katrina (2005)

The approximated equivalences between the proposed Simplified Systemic Scale and the Beaufort and Saffir-Simpson scales are showed in table 3.

Table 3 – The Simplified Systemic Scale for Hurricanes and approximated equivalences with the Beaufort and the Saffir-Simpson scales

(SSS) Simplified Systemic Scale	Wind Speed Km/hr	Beaufort Scale	Saffir-Simpson Scale	Meaning
1 **Yellow Alert**	Less than 149	1 – 4	1	Few Risks (stay inside)
2 **Orange Alert**	150 – 199	5 – 8	2 – 3	Dangerous (Protect fragile parts of dwellings)
3 **Red Alarm**	Bigger than 200	9 – 12	4 – 5	Very dangerous (evacuate)

The reactions to be taken to face a hurricane that is approaching will depend on the previous contingency plan for each community. Usually at level 3 (SSS), people should evacuate the city, and with level 1 (SSS) the community should take some precautions, as not going outside, meanwhile that with level 2 (SSS) people should protect windows and other fragile parts of the dwelling (see fig. 3).

Earthquakes

Earthquakes are violent movements of earth surface. Seism of great magnitude produces many fatalities and material losses. They are originated by the inner movement of the earth tectonic plates. There are several dangerous zones well known around the world, where Japan and Mexico have been severely affected by earthquakes in recent years (Mexico1985, Kobe 1995)

The magnitude of earthquakes may be measured by several scales, being the most known the Mercalli and the Richter scales which are showed at the following tables 4 and 5 respectively.

Table 4- The Mercalli scale.

I. Instrumental	Not felt except by a very few und favorable conditions.
II. Feeble	Felt only by a few persons at re: on upper floors of buildings suspended objects may swing.
III. Slight	Felt quite noticeably by perso especially on the upper floors o Many do not recognize it as an Standing motor cars may ro Vibration similar to the passing Duration estimated.
IV. Moderate	Felt indoors by many, outdoors b the day. At night, some awake windows, doors disturbed; cracking sound. Sensation like striking building. Standing motor noticeably. Dishes and win alarmingly.
V. Rather Strong	Felt by nearly everyone; many Some dishes and windows brok objects overturned. Clocks may s
VI. Strong	Felt by all; many frightened and r walk unsteadily. Windows, dishe broken; books off shelves; s furniture moved or overturn instances of fallen plaster. Damag
VII. Very Strong	Difficult to stand; furniture brol negligible in building of good construction; slight to moderate ordinary structures; considerabl poorly built or badly designed some chimneys broken. Noticed

	driving motor cars.
VIII. Destructive	Damage slight in speciall structures; considerable i substantial buildings with part Damage great in poorly built str of chimneys, factory stack monuments, walls. Heavy furnitu
IX. Ruinous	General panic; damage cons specially designed structures, w frame structures thrown out Damage great in substantial bu partial collapse. Buildings foundations.
X. Disastrous	Some well built wooden structur most masonry and frame structu with foundation. Rails bent.
XI. Very Disastro	Few, if any masonry structu standing. Bridges destroyed. greatly.
XII. Catastrophic	Total damage - Almost ev destroyed. Lines of sight and le Objects thrown into the air. moves in waves or ripples. Larg rock may move.

Table 5 – The Richter scale

Description	**Richter Magnitudes**	**Earthquake Effects**	**Frequency of Occurrence**
Micro	Less than 2.0	Micro earthquakes, not felt.	About 8,000 per day
Very minor	2.0-2.9	Generally not felt, but recorded.	About 1,000 per day
Minor	3.0-3.9	Often felt, but rarely causes damage.	49,000 per year

Light	4.0-4.9	Noticeable shaking of indoor items, rattling noises. Significant damage unlikely.	6,200 per year
Moderate	5.0-5.9	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings.	800 per year
Strong	6.0-6.9	Can be destructive in areas up to about 100 miles across in populated areas.	120 per year
Major	7.0-7.9	Can cause serious damage over larger areas.	18 per year
Great	8.0-8.9	Can cause serious damage in areas several hundred miles across.	1 per year
Rarely, great	9.0-9.9	Devastating in areas several thousand miles across.	1 per 20 years
Meteoric	10.0+	Never recorded.	Unknown

The new Simplified Systemic Scale (SSS) proposed for the earthquakes and its approximate equivalence with the Mercalli and the Richter scales are showed in table 6.

Table 6 – The Simplified Systemic Scale (SSS) for earthquakes and its approximate equivalence with the Mercalli and the Richter scales

(SSS) Simplified Systemic Scale	**Recorded Amplitude cm**	**Mercalli scale**	**Richter Scale**	**Meaning**
1 **Yellow Alert**	Less than 1	1 – 4	Less than 5	Few Risks (Protect fragile parts of dwellings)

2 **Orange Alert**	1-9	5 – 8	5 to 7	Dangerous (Stay near a secure structure, and away of windows)
3 **Red Alarm**	Bigger than 10	9 - 12	Bigger than 7	Very dangerous (evacuate)

With this Simplified Systemic Scale is relatively easier to make a decision and to proceed to do something about the phenomenon that is approaching a community. If this proposed Simplified Systemic Scale is adopted for the community and if a preparation plan is implemented, the vulnerability of the community will be lessened and the risk of major disasters will be minimized.

Conclusion

Inspired by the Saffir-Simpson scale of five levels for classifying the magnitude of Hurricanes, with the intention of developing a scale simpler and easier to understand by anybody, and with the purpose of facilitating the reaction in face of natural menaces (hurricanes and earthquakes) approaching a community, it is proposed in this paper a new Simplified Systemic Scale (SSS) of three levels, which, hopefully, will be adopted and probably adapted to the circumstances of each community. With this SSS, and with a contingency plan prepared and implemented by each community, the risks of disasters by hurricanes and earthquakes will be reduced to a minimum.

A similar Simplified Systemic Scale can be proposed also for other phenomena that might detonate disasters, such as floods, droughts, volcanic eruptions, tsunamis, etc. Probably we will work on these themes in future papers.

This Simplified Systemic Scale is part of a strategy for generating a culture of prevention and mitigation of disasters in all the communities subject to the menace of phenomena that provoke disasters.

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Webgraphy

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