"SIMCLONE – GAME SIMULATOR FOR CYCLONE DISASTER MANAGEMENT"

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ABSTRACT

Disaster has a perspective connotation; there is nothing called as disaster in the absolute sense. Any event which occurs in the time domain, the effect of which if felt in a negative way is characterized as a disaster. In the world disasters occur either due to natural reasons or artificial reasons. In such cases what is required is to improvise a scheme for analyzing such natural disasters in respect of type, geographical location, intensity, impact and other allied consequences and arriving at methodologies for mitigating the effects. During the past few decades the international community has become increasingly concerned with cyclone disasters, which have tended to cast more annihilating consequences on larger concentrations of population. The opportunities for gaining experience in pre - disaster preparedness and planning, and in disaster rescue and relief is very limited in actual situations. It is impractical to provide appropriate real experience; but a simulated exercise is a practical alternative. SIMCLONE, *Computer Simulation Model for Cyclone Disaster Management* has been designed to fulfill this need.

The objective of the present simulation exercise is to provide with a realistic situation on which the problems and techniques of resource management during pre - cyclone and post - cyclone disaster can be judiciously experimented. In other words this simulator facilitates the understanding of the nuances of pro - active planning vis - a - vis reactive planning in the light of highly volatile dynamic situations and leads ultimately to the objective assessment of the consistency and dexterity with which "impromptu" decisions are made by the appropriate authorities. This macro model has a global touch with this applicability to a wide variety of situations.

A working prototype of the system has been developed using VB / PowerBuilder which can run from a laptop to any upward compatible system in Windows environment. The design and development of the prototype model was strictly followed in accordance with the ISO 9000 standards followed within the organisation.

1. INTRODUCTION

Disaster has a perspective connotation; there is nothing called as disaster in the absolute sense. Any event which occurs in the time domain, the effect of which if felt in a negative way is characterized as a disaster. But in the empirical sense it refers to a damage sequence which is the concomitant of the intensity of source event.

In the world disasters occur either due to natural reasons or artificial reasons. While the later ones are carefully detected and totally avoided, the former ones are sometimes beyond human control and strategy. In such cases what is required is to improvise a scheme for analyzing such natural disasters in respect of type, geographical location, intensity, impact and other allied consequences and arriving at methodologies for mitigating the effects. In other words instead of making a re - active planning after the incidence of the disaster to restore normalcy, it is highly desirable to have pro - active planning by developing tangible methods for preparedness to meet such challenges.

In this context, a prototype is developed to illustrate the Disaster Management System pertaining to cyclones.

2. MOTIVATION

During the past few decades the international community has become increasingly concerned with cyclone disasters, which have tended to cast more annihilating consequences on larger concentrations of population. It is now realized, with the actual and potential threats of disasters which assume global significance, that much emphasis will have to be bestowed on Disaster Management.

The opportunities for gaining experience in pre - disaster preparedness and planning, and in disaster rescue and relief is very limited in actual situations. It is impractical to provide appropriate real experience; but a simulated exercise is a practical alternative. SIMCLONE, *Computer Simulation Model for Cyclone Disaster Management* has been designed to fulfill this need. The objective of the present simulation exercise is to provide with a realistic situation on which the problems and techniques of resource management during pre - cyclone and post - cyclone disaster can be judiciously experimented. In other words this simulator facilitates the understanding of the nuances of pro - active planning vis - a - vis reactive planning in the light of highly volatile dynamic situations and leads ultimately to the objective assessment of the consistency and dexterity with which "impromptu" decisions are made by the appropriate authorities.

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Cyclone being a natural disasters cannot be prevented. Hence, cyclone preparedness is a pragmatic way of ensuring cost effective means of mitigating the effects of cyclone.

3. DISASTER REPRESENTATION

Disasters fall under different types. However, the magnitude of disaster size (intensity of cyclone) varies with any specific types. When a tropical cyclone approaches a country, risk of serious loss or damage arises from the following damaging factors : winds, rainfall, river floods and storm surge. The operational forecaster encounters the following issues :

- The uncertainty of the storm's best track or trajectory.
- The deterrents that arise due to forecast errors when reliability is paramount.
- The inter annual variability of annual average errors for any warning center.

The National Oceanic and Atmospheric Administration has performed studies to determine the "return interval" of varying magnitude events. The results are as follows:

Type of Storm	Wind Velocities	Return Interval
Betsy	upto 210 Km/hr	15 - 75 years
Carmille	upto 270 Km/hr	every 200 years

But often tropical cyclones of various intensities strike different areas or regions. The following nomenclature is followed for different systems:

Name	Wind (actual or inferred Km/hr)
Low pressure zone	upto 30
Depression	between 31 and 55
Deep Depression	between 56 and 61
Cyclone storm	between 62 and 87
Severe cyclone storm with a core of hurricane winds	between 88 and 115

4. PHASES IN SIMCLONE

The system is conceived as consisting of three major phases such as :

- Pre - disaster Phase
- During disaster Phase
- Post - disaster Phase

As mentioned in the introduction, this is a didactic tool to make the Decision Makers participate in the process in the artificial ambience so that at later point of time similar situations can be handled in reality with utmost preparedness and alacrity.

During the pre - disaster period which is defined in terms of the time gap between the disaster source and the striking destination, the decision makers after anticipating the disaster trajectory embarks on allocating resources to various regions (Sub - Districts) based on resources availability. During disaster, decisions are exclusively confined to the previous status reports and the impending new cyclone position. During the post disaster period damage and deprivation reports are generated after the cyclone, and the quality of the decisions taken during all these three phases is being implicitly reflected in the reports.

5. FUNCTIONAL MODULES

These three phases expand into the following seven major functional modules :

- Resource Allocation Module
- Transportation Module
- Evacuation Module
- Shelter Supplies Module
- Disaster Effects Module
- Scientific Game Module
- Deprivation Module

The modules are synergistically integrated to constitute a decision support system.

Since this is a didactic tool to be interacted with, by the Decision Makers the information exchange among the modules is carried out with a set of three Decision Forms corresponding to the respective three phases. Figure 1 shows the functional diagram of the system.

Resource Allocation : The allocation of resources such as basic supplies, equipment, transport, rescue teams, repair and medical teams is indicated through the Decision Form - I to each district and sub - district. The inventory of resource in each district / sub - district is continually updated. Another function of this module is to calculate the cost effective allocation to each sub - district.

Transport Module : The incremental flow of information passes from the resource allocation module to transport module. The primary function of the transport module is to allocate the different types of vehicles to various consignments.

Evacuation Module : The function of the evacuation module is (1) to evacuate the people from vulnerable areas to shelters or safer regions, when the disaster threatens and (2) to rescue people and safeguard their property when the disaster strikes. The input information to this module comes from transport module in the form of number of trips of available vehicles to evacuate people forcibly and from resource allocation module in the form of budget allocated for voluntary evacuation.

Shelter Supplies Module : The incremental flow of information passes from the resource allocation module and transport module to the shelter supplies module. The primary function of this module is that of determining the resource consumption or utility by deploying the allocated resources to various shelters.

Disaster Effects Module : The major function of the disaster effects module is determination of disaster effects in terms of post - disaster effects. The disaster effects module establishes the initial conditions of the cyclone disaster, which represents the disaster areas and their status (12 hours after cyclone crossing the coast). The disaster effects module computes and categorizes the damages.

Scientific Game Module : The incremental flow of information passes from resource allocation module and disaster effects module to scientific game module. The primary function of scientific game module is that of determining the resource requirements for each sub - district. The secondary function is that of estimating further damages due to shortage of resources after the post - disaster effects. The computations in this module initially examine the effective allocations of resources made by decision - makers. This gives the availability of resource in each sub - district. Then the shortages of resources in each sub - district are calculated after making scientific calculations for resource requirements.

Deprivation Module : This module is concerned with evaluating the success or failure of the life support systems in a sub - district. Using shortage matrix, number of people deprived of food, likely to be infected, dead, and recovered from injury is computed.

6. EVALUATION

The system gives the following feedback in the form of reports and graphs:

- Allocation Cost: This shows the total cost incurred for allocation of resources by the Decision Maker.
- Residual Inventory: This report gives the position of resources after each allocation.
- Shelter Allocation: This report gives forcible movement of people from residential areas to shelters.
- Transport Availability: This report gives the number of trips required by the trucks, tankers, and buses to move essential items, water/kerosene and people from one place to another.
- Damages: This report shows the detail damage assessment in terms of number of people/livestock affected, dead/injured, damages in terms of buildings etc. The damage factors are computed by statistical equations based on the historic damage reports. As a representative example, the computation of the damage factors in respect of the affected population with the established logistic equations is shown in the Appendix.
- Requirement/Shortage: This report gives the actual requirement and the shortage and the reasons thereof.

Any evaluation process is accomplished by the feedback. Different decisions in respect of allocation of resources made during the disaster are captured in the form of negative and positive feedback from the system. As elucidated earlier, the cardinal idea in this experimental or artificial game is to attune the decisions to minimize the loss in terms of human and livestock. In this way, the feedback will throw light on the quality and the appropriateness of decisions even under such uncertain and stochastic conditions. The following table gives one representation reflecting implicitly the attitudinal responses of the Decision Makers.

Disaster Effects

Windspeed	Population Affected	Homeless	Dead	Injured
50	5400	3	2	10
60	8000	5	10	24
80	10600	70	30	50
100	14600	1000	60	1230
150	26600	1300	1000	2000
200	40000	17000	2000	5000

A working prototype of the system has been developed using VB / PowerBuilder which can run from a laptop to any upward compatible system in Windows environment. The design and development of the prototype model was strictly followed in accordance with the ISO 9000 standards followed within the organisation.

7. CONCLUSION

The main features of the system:

- Helps the Decision Makers to train themselves to make decisions more in a pro - active way than in reactive way.
- Acts as a didactic took for facilitating Decisions Makers to be better prepared in handling the anticipated effects of cyclones.

- Helps the Decisions Makers in prioritizing the resources during future contingency planning.
- Acts as a Decision Support System in planning for rehabilitation after the disaster.
- Uses extensive data, namely topographic, demographic, logistic support structures and information close to reality.
- Runs on stand alone from a lap-top to any upward compatible system, in Windows environment.

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CYCLONE DISASTER MANAGEMENT SIMULATOR

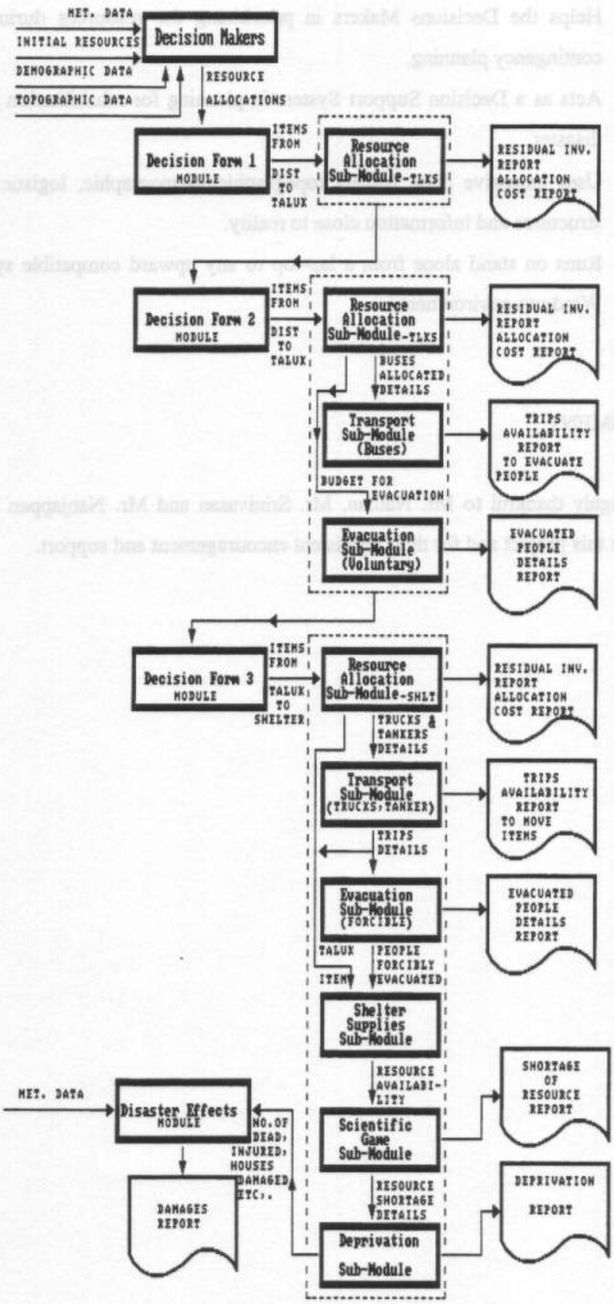

Figure 1

APPENDIX

Method - 1

The Damage Factor in the absence of exact data in respect of people affected (either due to wind alone or other inadventious factors) is assumed to be following the Power law in the first instance.

(i.e., Damage Factor = a * Windspeed ^ b)

This has been exemplified by having a probing look into the available meteorological historic data, and logical connectivity between the wind speed and the damage factor is inferred. The following table represents the Damage Factor in percentage corresponding to the windspeeds (Based on Damage Reports of the previous years).

TABLE - 1

Wind Speed	Wind Speed(Log)	Damage Factor(%)	Damage Factor (Log)
50	1.70	2%	.35
60	1.80	5%	.70
100	2	10%	1
150	2.2	20%	1.3
200	2.3	40%	1.6

When these values are plotted on logarithmic scale with damage factor on the Y axis and windspeed on the X axis. It shows a good rectilinear fit. Based on this fit the values of the intercept 'a' and the exponent 'b' of the power law are obtained. The equation is now represented as

DF(W i) = .0055 W ^ 3/2

Method - 2a

Since if a system is subject to multifarious events the damage factor cannot be computed in isolation of one another. It is always preferable to superimpose a lump parameter which can be called as 'U'.

Hence simple formula can be modified taking into account the intangible factors (such as flooding characteristics, ecological collapse, nutritional factors, paucity of medical support and random occurrences).

$$\text{Where } U_i = DF(W_i) \;/\; \sum DF(W_i)$$

$$TDF(W_i) = DF(W_i) + U_i$$

'U' is a lump parameter accounting for all the intangibles which is a random variable following uniform distribution with its dependents on wind velocities. The approximate or tentative 'U' parameters corresponding to wind velocities as follows :

TABLE - 2

Wind Speed	Using .0055 * W ^ 3/2	'U'	TDF(Wi)
50	.020	.05	.070
60	.030	.075	.105
80	.040	.100	.140
100	.055	.140	.195
150	.100	.250	.350
200	.150	.400	.550

These values are arrived at by taking percent on the average of damage values corresponding to the wind velocities as if 'U' factors do not exist. This is one of the methods of apportioning the lump parameter based on the statistical reasoning with a view to map or superimpose the intangibles as well.

Method - 2b

Most of the disaster effects can be judged with reference to certain physical laws which has a function of type involving the multiplication of 1/3rd. For example if the damage factor without the consideration of intangibles is X, the additive damage factor is X * 1/3.In other words X + X/3 determines the total damage factor.

$$\text{Where } U\,i \;=\; DF\,(W\,i)\;/\;3$$

$$TDF\,i = DF\,(W\,i) + U\,I$$

In this particular case the damage factors for windspeed are given below.

TABLE - 3

Wind Speed	Using .0055 * W ^ 3/2	(0055 * W ^ 3/2)/3	TDF(Wi)
50	.020	.007	.027
60	.030	.010	.040
80	.040	.013	.053
100	.055	.018	.073
150	.100	.033	.133
200	.150	.050	.200

Both the methods hold significance as the depth of havoc, that these intangibles produce falls into a intensity spectrum.The depth of havoc can be considered as falling into three levels Low, Medium & High.The appropriate use of Method 2a & Method 2b revolves on demographic, topographic and other relevant data which have implicit influence on these three levels. If demographic and topographic data are well defined and which are in a favorable state Method 2b can be safely adopted; on the other hand if the depth of havoc is crucial and high then Method 2a could be used.