# ***Storm Guard Disaster Relief***

# ***Coordination System***

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Concepts of Database Systems

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**Abstract:**

The Storm Guard Disaster Relief Coordination System is a database-driven solution designed to enhance the efficiency and effectiveness of hurricane disaster response efforts. Recognizing the limitations of traditional tools like Excel—such as data integrity issues, lack of scalability, and inadequate support for concurrent access—the system leverages a robust SQL-based architecture to provide real-time, role-based access to critical information. By integrating real-world data from sources like the Global Disaster Alert and Coordination System (GDACS), the system ensures timely and accurate tracking of hurricanes, resource allocation, and personnel deployment. Key features include a comprehensive relational schema encompassing entities such as hurricanes, relief operations, logistics, volunteers, and medical support, all interconnected through well-defined relationships and constraints. The system supports various user roles—including administrators, logistics managers, medical staff, and field volunteers—each with tailored access privileges to ensure data security and operational efficiency.

**Keywords:** Disaster Relief, Hurricane Response, Database System, Role-Based Access, Resource Allocation, Real-Time Data, Logistics, Volunteers, and Medical Support.

**Table of Contents:**

1. Chapter 1: Introduction
2. Chapter 2: Design
3. Chapter 3: Implementation
4. Chapter 4: System Testing and Result Analysis
5. Chapter 5: Conclusion

# **Chapter 1: Introduction**

**Problem Statement:**

The Hurricane Relief Coordination System addresses the limitations of employing Excel to manage disaster response information. Excel is susceptible to data integrity issues, lacks scalability, and is not designed for multiple access or intricate querying. As disaster operations escalate, managing large datasets and real-time collaboration becomes increasingly difficult using Excel. The system will be developed in a series of essential steps: Firstly, the gathering of requirements will identify the main data points to track, such as resources, affected areas, and personnel. The second step is designing the database, whereby a schema will be defined to organize and link the data in a way that possesses integrity through primary and foreign keys. The database configuration will then be established, establishing the SQL database for effectively handling huge amounts of data and supporting real-time, concurrent access. Finally, the system will leverage the strong querying feature of SQL to support complex data retrieval, analysis, and reporting to support decision-making in disaster relief. This approach optimizes data integrity.

**Requirements and Target Use:**

Hurricane Relief Coordination System will improve disaster response coordination by addressing the limitations of using Excel files in managing and monitoring critical data. Excel is prone to data integrity issues, has scalability limitations, and provides no concurrent access and advanced querying, which can hamper effective disaster response. The system will provide improved data integrity, scalability, real-time collaboration, and decision-making through an SQL database.

**Target Users and Roles:**

* Hurricane Relief Coordinators (Admin Users):
  + **Role:** Oversee the entire disaster relief process, resource allocation, logistics, and management of personnel.
  + **Requirements:** View all the data to examine the situation, track resource allocation, and generate detailed reports for decision-making and analysis. They must insert, update, and modify data on resources, individuals, and affected areas.
  + **Access Privileges:** Full read, write, and update access to all system modules. They can insert, update, or delete records, and generate and export reports.
* Logistics and Supply Chain Managers:
  + **Duties:** Coordinate and control resources, supplies, and logistic activities, and make appropriate and timely delivery to the affected locations.
  + **Requirements:** Up-to-date information on available resources, current inventory, and supply distribution status. They also require reporting facilities to track the movement of resources.
  + **Access Permissions:** Read and write access to resource inventory and supply distribution records. They can post supply status but not change personnel data and other sensitive information.
* Field Volunteers:
  + **Responsibilities:** Implement grassroots operations, including supplying, aiding those affected, and posting the status of activities.
* Requirements:
  + **Location-Based Data Access:** Lists of affected locations, stocked resources, and tasks assigned. They need to be capable of reporting task completion in real time as well.
  + **Privileges of Access:** Read-only access to data for relevant task information and location-based data. They cannot delete or modify data but can report the status of completed tasks.
  + **Responsibilities:** Provide medical care to disaster victims, i.e., field hospitals or open-field clinics.
  + **Needs:** Information access regarding populations affected, drugs, and patient files (if accessible). Need to be updated in medical treatment as well based on reports.
  + **Access Privileges:** Read and write privileges on patient care reports and medical history. No access to staff or logistics information except to health needs. Database Administration will install and maintain the SQL database. The DBA will guarantee that the database is running smoothly, securely, and reliably throughout the disaster recovery.

**Use Case Diagram:**

This use case diagram illustrates the functional interactions within a disaster relief management system, detailing the roles and responsibilities of five key actors: **Administrator, Volunteer, Medical Staff, Logistics Staff, and Public User.** The system is organized into functional modules—**Relief Administration, Volunteer Operations, Medical Support, Logistics Operations, and Public Services.**

**Administrators** have comprehensive control, including managing relief records, assigning volunteers, setting user roles, and overseeing logistics. **Volunteers** support relief operations, view their assigned regions, and, if medically trained, submit patient reports. **Medical staff** focus on providing medical support, recording administered medicines, and submitting patient care reports. **Logistics** staff manage and update supply and delivery statuses. **Public users**, the general population, can view hurricane information, request relief, and see affected locations. The diagram clearly represents how each user interacts with specific system functions to support disaster response efforts efficiently.

A diagram of a patient support

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# **Chapter 2: Design**

**Data**

We’ll be using real-world data, as we can find a temporary example online. Using real-

World data allows the project to reflect actual scenarios, enhancing the authenticity and

applicability of the system. It also helps in identifying potential challenges and limitations that

might arise in real disaster relief situations. Additionally, working with real data can improve the

team's data analysis skills, making the project more robust and credible.

We’re still using **GDACS RSS** Information since it is an open-source and

easily accessible dataset. GDACS issues alerts for earthquakes, tsunamis, tropical cyclones,

floods, and volcanoes, using automatic calculations and assessment. Since we are focusing on Hurricanes, we can limit our data to focus on Hurricanes. We created a set of data manually and partially based on the **GDACS RSS** database.All the data is stored in both the MySQL database and an Excel Sheet for better visualization. Here are a couple of the tables below:

**Hurricane:**

| **Event\_id** | **Name** | **Severity** | **Description** | **Start\_Date** | **End\_Date** | **Duration** |
| --- | --- | --- | --- | --- | --- | --- |
| H001 | A | 4 | Strong winds | 2024-06-01 | 2024-06-05 | 4 days |
| H002 | B | 3 | Heavy rainfall | 2024-07-10 | 2024-07-13 | 3 days |
| H003 | C | 5 | Catastrophic storm surge | 2024-08-20 | 2024-08-25 | 5 days |
| H004 | Diana | 2 | Minimal damage but heavy rainfall | 2024-09-15 | 2024-09-16 | 1 day |
| H005 | Edward | 4 | Strong winds and flooding | 2024-10-01 | 2024-10-04 | 3 days |
| H006 | Fiona | 3 | Storm surge and flooding in coastal areas | 2024-11-01 | 2024-11-05 | 4 days |
| H007 | George | 5 | Widespread devastation and high casualties | 2024-11-20 | 2024-11-27 | 7 days |
| H008 | Helena | 2 | Short-lived tropical storm | 2025-01-05 | 2025-01-06 | 1 day |
| H009 | Isaac | 4 | Structural damage and power outages | 2025-02-12 | 2025-02-15 | 3 days |

**Medical\_Support:**

| **Med\_id** | **Relief\_id** | **Medicines\_Provided** | **Patients\_Care\_Reports** |
| --- | --- | --- | --- |
| M001 | R002 | Painkillers, Antibiotics | 12 Reports |
| M002 | R002 | IV Fluids, Bandages | 8 Reports |
| M003 | R003 | None | 0 Reports |
| M006 | R007 | Pediatric Supplies | 9 Reports |
| M007 | R008 | None | 0 Reports |
| M008 | R009 | None | 1 Report |
| M009 | R010 | Injury Reports | 7 Reports |

**Relief:**

| **Relief\_id** | **Title** | **Type** | **Active** | **Description** |
| --- | --- | --- | --- | --- |
| R001 | Food Distribution | Food Aid | Active | Emergency food packages |
| R002 | Medical Assistance | Medical Aid | Completed | Doctors and nurses providing aid |
| R003 | Shelter Setup | Housing | Active | Temporary shelters for displaced people |
| R004 | Water Purification | Sanitation | Active | Clean drinking water systems |
| R005 | Power Restoration | Infrastructure | Ongoing | Temporary electricity support |
| R006 | Rescue Ops | Search and Rescue | Completed | Search operations and evacuations |
| R007 | Child Care Units | Welfare | Active | Orphaned children temporary housing |
| R008 | Communication Setup | Infrastructure | Ongoing | Satellite phones and towers |
| R009 | Fuel Delivery | Energy Support | Pending | Diesel and gas supply |
| R010 | Evacuation Transport | Transport | Completed | Buses and helicopters for evacuations |

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**ER Diagram**

* **Overall Entities:** Hurricane, Country, Relief, Volunteer, Logistics (weak), Medical Support (type of relief), and Administration (type of Volunteer).
* **Relations and Cardinality:**
  + **Hurricane Affects Country** (1:M) - One hurricane can impact multiple countries, but each country is affected by one storm at a time.
  + **Country Requests Relief** (M: N) - A country may request multiple types of relief, and each relief operation may serve numerous countries.
  + **Relief Requires Logistics** (1:M) *(Weak Entity Dependency)* - Each relief effort requires logistics, but logistics exist only if associated with relief efforts.
  + **Volunteer Supports Relief** (M: N) - Volunteers are assigned to relief efforts, and each relief effort can have multiple volunteers.
  + **Medical Support is a Specialized Type of Relief** *(Generalization/Specialization in EER)* - Some relief efforts are medical-related and require additional attributes.
  + **Administration Manages the Database** (1:M) - Administrators oversee relief coordination, logistics, and volunteer assignments.
* **Weak Entitles and Hierarchies:**
  + LOGISTICS is a weak entity since it depends on RELIEF.
  + MEDICAL SUPPORT specializes in RELIEF.
  + ADMINISTRATION is specialized from VOLUNTEER, as administrators have elevated privileges.
* **Assumptions:**
  + Each RELIEF operation is uniquely identified by relief\_id.
  + VOLUNTEERS are assigned per region and cannot operate in multiple regions simultaneously.
  + LOGISTIC operations are strictly dependent on RELIEF efforts and cannot exist

independently.

**Entities in Detail:**

* **Hurricane**:
  + event\_id (Presumably the primary identifier for a specific hurricane event)
  + name (The name given to the hurricane)
  + description (A textual description of the hurricane)
  + severity (The intensity or category of the hurricane)
  + start\_date (The date when the hurricane began)
  + end\_date (The date when the hurricane ended)
  + duration (The length of time the hurricane lasted)
* **Relief:** 
  + relief\_id (Presumably the primary identifier for a specific relief effort or task)
  + description (A textual description of the relief effort)
  + type (The category or kind of relief being provided, e.g., shelter, food, water)
  + active\_status (Indicates whether the relief effort is currently active)
  + title (A name or title given to the relief effort)
* **Logistics**:
  + logistics\_id (Presumably the primary identifier for a specific logistical operation)
  + supply\_status (The current status of the supplies involved in the logistics)
  + delivery\_status (The current status of the delivery process)
* **Administration:**
  + admin\_id (Presumably the primary identifier for an administrative record or user)
  + user\_role (The role or position of the administrative user)
  + privileges (The permissions or access rights of the administrative user)
* **Volunteer:**
  + volunteer\_id (Presumably the primary identifier for a specific volunteer)
  + name (An attribute that appears to be composed of first\_name, middle\_name, and last\_name)
  + role (The specific task or duty assigned to the volunteer)
  + assigned\_region (The geographic area where the volunteer is assigned)
  + total\_volunteers (This seems like it might be a derived attribute or a count, rather than a property of an individual volunteer)
* **Medical Support:**
  + med\_id (Presumably the primary identifier for a specific medical support record or instance)
  + medicines\_provided (Information about the medications or supplies given)
  + patient\_care\_reports (Records or summaries of medical care provided to patients)
* **Location:**
  + location\_id (Presumably the primary identifier for a specific location)
  + longitude (The east-west geographic coordinate)
  + latitude (The north-south geographic coordinate)
  + country\_id (Identifier for the country the location is in)
  + name (The name of the location)
  + A diagram of a company

    AI-generated content may be incorrect.region (The broader geographic region the location belongs to)

**Relational Schema**

* Hurricane:
  + event\_id - primary key
  + description - description of hurricane
  + name - name of hurricane
  + severity - severity of storm
  + start\_date - start date
  + end\_date - end date
* Location:
  + event\_id - relevant hurricane
  + country\_id - primary key
  + region - part of the country
  + longitude - exact e/w coords
  + latitude - exact n/s coords
  + name - country name
* Relief Types:
  + relief\_id - part of the primary key
  + type - distinguishes from different types given the same relief\_id, making it part of the primary key
* Requests:
  + country\_id - part of the primary key relative to location
  + relief\_id - part of the primary key relative to relief
* Relief:
  + relief\_id - primary key
  + description - description of the relief
  + active\_status - true/false
  + title - name of the relief
  + admin\_id - admin of the relief that it’s linked to
* Logistics:
  + assigned\_volunteer - volunteer placed in charge
  + relief\_id - secondary key
  + supply\_status - status of supplies
  + delivery\_status - status of delivery
  + logistics\_id - primary key
  + admin\_id - admin of this instance
* Administration:
  + user\_role - role the admin plays
  + volunteer\_id - secondary key to the parent table (volunteer)
  + admin\_id - primary key
* Medical Support:
  + med\_id - part of primary key relative to the medicines provided table
  + relief\_id - part of primary key relative to the relief table
* Volunteer:
  + role - role of volunteer
  + assigned\_region - region volunteer is assigned
  + volunteer\_id - primary key
  + f\_name, m\_name, l\_name – names
* Privileges:
  + admin\_id - part of primary key
  + p\_type - access to one privilege type, making it another part of the key
* Supports:
  + volunteer\_id - part of primary key relative to volunteer
  + relief\_id - part of primary key relative to relief
* Patient Care Reports:
  + med\_id - part of primary key relative to medicines provided
  + report - other part of primary key - report type and details
* Medicines Provided:
  + med\_id - part of primary key relative to medical support
  + medicine\_provided - name of medicine provided and part of the key

The relational schema connects key entities through well-defined foreign key relationships. The Hurricane table is linked to the Location table via the Hurricane\_Affects table, where Event\_id (from Hurricane) and Country\_id (from Location) form a composite primary key, representing each country affected by a specific hurricane. The Location table, identified by Country\_id, is also connected to the Relief table through the Country\_Requests\_Relief table, establishing which countries have requested which relief efforts. This creates a many-to-many relationship between Location and Relief.

The Relief table is central to multiple other entities. It connects to the Logistics and Medical\_Support tables via Relief\_id, allowing tracking of supplies and medical services for each relief effort. The Volunteer table is linked to Relief through the Volunteer\_Relief table, creating a many-to-many relationship that records volunteer assignments. Additionally, each Volunteer may be linked to one Administration record through Volunteer\_id, indicating their administrative role and privileges. This schema structure ensures clear, normalized relationships among hurricanes, affected areas, requested aid, and the people and logistics involved in delivering that aid.

A close-up of a notepad

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# **Chapter 3: Implementation**

**The DBA will handle the following:**

* Database Installation**:** Installation of the database, configuration, and performance tuning.
* Data Integrity: Data consistency and validation rules, and integrity constraints (e.g., primary and foreign keys) are suitable.

This chapter outlines the implementation of the **Storm Guard Relief Management System** database, showcasing table definitions and example data insertions. The system is designed to manage disaster relief operations involving hurricanes, affected countries, volunteer deployment, relief efforts, and medical/logistics support.

**Database Creation:**

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**Table Implementations:**

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  AI-generated content may be incorrect.Hurricane Table**: This table stores detailed information about hurricane events, including their severity, duration, and descriptive metadata to track disaster history.
* A screen shot of a computer

  AI-generated content may be incorrect.**A screen shot of a computer

  AI-generated content may be incorrect.Location Table:** It records geographic data about countries and regions affected by disasters, including coordinates for mapping and analysis.
* **Relief Table:** This table defines various types of relief efforts, such as food, medical aid, or shelter, and tracks their activation status.
* A screen shot of a computer screen

  AI-generated content may be incorrect.**A screen shot of a computer program

  AI-generated content may be incorrect.Administration Table:** It manages administrative users linked to volunteers, specifying their roles and system privileges within the disaster response framework.

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* A screenshot of a computer code

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  AI-generated content may be incorrect.**Hurricane Affects Table:** This junction table maps the relationship between hurricanes and the countries they impact, supporting multi-country disaster tracking.

# **Chapter 4: System Testing and Result Analysis**

This Chapter details the system testing for the Storm Guard Disaster Relief Coordination System. The testing process involved using both basic and advanced MySQL queries to validate the system's functionality. Basic queries focused on validating core data retrieval and manipulation functionalities, ensuring that information, such as hurricane details, affected locations, and relief supplies, could be accurately accessed and updated. This included verifying that data entry, updates, and deletions were performed correctly across all the tables in the database, maintaining data integrity.

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AI-generated content may be incorrect.**Basic MySQL queries:**

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AI-generated content may be incorrect.Advanced MySQL Queries:**

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Advanced queries were designed to test the system's ability to handle more complex, real-world scenarios. These included multi-table joins to link data across different entities, aggregate functions to summarize and analyze data (e.g., calculating total supplies needed or the number of volunteers deployed to a specific area), and subqueries to filter data based on complex criteria. The results of these tests confirmed the system's robustness and efficiency in supporting the diverse information needs of disaster relief operations, thereby validating the effectiveness of the database design and implementation. The successful execution of these queries demonstrated the system's capability to provide timely and accurate information for decision-making during disaster relief efforts.

# **Chapter 5: Conclusion**

The Storm Guard Disaster Relief Coordination System project marked a critical step forward in modernizing disaster relief efforts by replacing outdated Excel-based processes with a scalable, centralized SQL database. Through this transition, we tackled fundamental issues such as data integrity lapses, poor scalability, and the absence of concurrent access—factors that previously hindered effective coordination during crises. Our team, whose responsibilities ranged from database engineering to UI/UX development to integration testing, collaborated to model and implement a relational schema that supports real-time, role-based data access and advanced querying capabilities. One of the main things learned here was the value of clearly defined user roles—administrators, logistics managers, and field volunteers, for instance—that drove the access control scheme and impressed upon me the requirement for security from the ground up.

The exercise also made it clear, through the creation of a normalized ER diagram and its implementation in a functional schema, how critical database design is to maintaining referential integrity and operational scalability. Integration with open-source hurricane data from GDACS posed formatting and compatibility issues, but ultimately extended the project's real-world usefulness and illustrated the difficulties of integrating real-time data. Developing practical SQL queries to monitor supply chains, track volunteer efforts, and analyze resource allocations illustrated how essential SQL is not just for data storage, but as an effective decision support tool.

Looking ahead, the potential exists to expand the system through the addition of a responsive web or mobile interface for data entry in the field, as well as hosting on cloud platforms like AWS or Azure for even better scalability and reliability. Long term, incorporating machine learning to predict supply needs by hurricane severity and historical record would revolutionize preparedness, and partnering with NGOs or emergency response organizations would offer real-world feedback and validation. This project not only developed our technical skills and understanding of database systems, but provided us with an increased sense of appreciation for how thoroughly thought-through data infrastructure can have real-world application in humanitarian causes.