# Smart Monitoring System For Weather and Tsunami Detection (SMSWTD)

## System Mission

The mission of the SMSWTD is minimize loss of life and property by enhanced cutting edge solutions of disaster prediction, resilience and response.

Objectives:

* + Provide real-time, actionable insights to authorities
  + Monitor weather condition using advanced sensor technologies
  + Predict severe weather events and tsunamis with state-of-the-art algorithms
  + Mitigate natural disaster by spreading accurate and timely information

## Vision

To be initiative technology to save lives at the risk of severe weather conditions by leveraging real-time, cutting-edge advanced solutions.

## Values

* + **Accuracy**: Ensures precise data flow through whole processes.
  + **Safety**: Prioritize saving lives and protection of properties.
  + **Collaboration**: Involve all stakeholders to reach better outcomes.
  + **Accessibility**: Facilitate information availability without limitation.
  + **Stability**: Maintaining consistent and resilient actions in real-time
  + **Flexibility**: Integrate multiple layers technologies to adapt new situations.

## Contradiction

* + **Accuracy versus Speed:** Prioritizing accuracy over speed in delivering real-time insights, it possible to lead to inaccurate information being provided to authorities, which could cause panic lead to misguided decisions or delay of proper action. Moreover, this could contradict to the objective of mitigating natural disaster by spreading accurate and timely information.
  + **Cost Efficiency versus Cutting-Edge Technology:** To monitor weather conditions and predict disasters, the system might face a budget constraint. Cutting-edge technology (such as advanced sensors or sophisticated algorithms) is often expensive. If the system is forced to compromise on technology in favor of cost-efficiency, the prediction accuracy and real-time monitoring capability could be reduced, leading to inaccurate disaster forecasting or slower response times. This could hinder the mission of minimizing the loss of life and property, as poorly functioning equipment may fail to provide accurate, actionable insights.
  + **Predictive Accuracy versus Public Interpretation:** The system might invest heavily in predictive algorithms to forecast weather events accurately, but if it focuses too much on predictive accuracy, it may fail to create public awareness campaigns that help people interpret the information. Without proper education on how to understand the predictions and warnings, the public may either underreact or overreact to alerts. For example, if a tsunami is predicted with low certainty, the public may ignore the warning, or in the case of an overly conservative prediction, they might evacuate unnecessarily. This lack of understanding about predictions and warnings could reduce the effectiveness of the system in saving lives.

## Negative impact

The SMSWTD could have several negative impacts directly and indirectly.

**5.1. Inaccurate or Delayed Predictions**

* **Impact**: While the system aims to predict weather events and tsunamis, the predictive algorithms may not always be accurate, especially in complex or rapidly changing situations. Uncertainty in predictions could lead to either overreaction or underreaction.
* **Consequences**: Authorities and communities may **overreact** on predictions that turn out to be false or exaggerated, leading to economic losses, or social disruption. In contrary, **Underreaction** of the predictions downplay the severity of an event. It could result in inadequate preparation or response, leading to unprepared communities and higher losses of life and property.
  1. **Data privacy and Security**
     + - **Impact:** The system's advanced technology might create a false sense of security among both authorities and the public. People may assume that technology will always predict disasters accurately and that timely alerts will always be provided, leading them to underestimate risks or reduce preparedness.
       - **Consequences:** Communities and authorities might not take proactive steps to prepare for disasters relying too much on the technology for alerts. If a disaster strikes unexpectedly (e.g., due to unforeseen variables not captured by the system), the false sense of security could result in poorly coordinated or delayed response efforts.
  2. **Social Inequality**
     + - **Impact:** The system may not be designed to adequately address social inequalities. Vulnerable populations, such as those with limited access to technology, low literacy levels, or living in remote areas, might not benefit from real-time alerts or disaster predictions. These groups could be left behind or fail to receive critical warnings, which could exacerbate existing social inequalities.
       - **Consequences:** Increased vulnerability of marginalized groups during disasters. Social conflict if some populations such as low-income communities, elderly people, or those without access to modern communication technology, feel excluded or underserved by the system’s response.
  3. **Complexity and Inflexibility**
     + - **Impact:** The system could become highly complex as it integrates multiple layers of technology, data sources and prediction models. This complexity might make the system difficult to operate in changing conditions.
       - **Consequences:** Response could be slow due to complex decision-making structures within system. Adjusting unpredictable disaster scenarios possible to awake difficulty. Moreover, System cost increase due to system complexity and operation difficulty.

## System Context and Operating Environment

The SMSWTD involves a multitude of stakeholders, technological infrastructures, and external factors that all interact with each other. The system's success hinges on its ability to predict severe weather events and tsunamis accurately, provide timely information to authorities and the public, and integrate data from diverse sources effectively. At the same time, the system must navigate various challenges, such as ensuring reliable communication, dealing with diverse geographical conditions, maintaining public trust, and securing adequate funding. A well-coordinated approach and adaptable design will be necessary to overcome these challenges and effectively minimize loss of life and property during natural disasters.

**Stakeholders:**

* **Government Authorities:** National, regional, and local government agencies (e.g., emergency management, disaster relief authorities) are key recipients of real-time data. These authorities use the system's insights for decision-making regarding public safety, evacuation plans, and resource allocation.
  + - * **Meteorologists & Scientists:** Experts in weather prediction and seismic activity are central to the development and continuous improvement of the prediction algorithms and sensor technologies that drive the system.

**Operating Environments:**

* **Sensor Networks and Data Integration:** SMSWTD depends on advanced sensor technologies, including air-craft based sensors (wind speed, direction, and type and amount of precipitation), underwater sensors, and satellite systems. The integration of data from these sensors is crucial for accurate monitoring and prediction.
* **Cloud Computing and Advanced Computing Models:** The system requires powerful cloud infrastructure for real-time data processing and storage. Advanced computing models enable the system to analyze vast amounts of data from sensors, satellites, and other sources to detect patterns and make predictions. Machine learning and AI models improve prediction accuracy and offer actionable insights to authorities.
* **Data Communication Systems:** To reach all stakeholders effectively, the system must use reliable communication channels. These include mobile apps, SMS alerts, social media notifications, and radio broadcasts. In some regions with limited internet access, offline applications or broadcast radio may be used for communicating alerts.

**A computer screen shot of a diagram

Description automatically generated**

## System Requirements

In terms of whole system, the system requirements divided into four sections, weather monitoring and tracking, tsunami detection and monitoring, risk analysis and integration, and public notification and alert system.

* 1. **Weather Monitoring and Tracking**
     1. **Storm Detection and Tracking:** It shall use satellite imagery and aircraft-based sensors to monitor and track storms in real time. To track storm, it is required to detect different types of storms. Those are tropical storm, cyclones.
        1. **Storm Detection and Classification**

*Tropical storm detection*: Once the wind speeds exceed 39 mph (63 km/h) and reach 74 mph (119 km/h), the system is upgraded to a tropical storm.

*Cyclones storm detection:* The storm is closely followed by both satellite imagery and radar, and international organizations, such as the National Hurricane Center (NHC), issue advisories, watches, and warnings for affected regions. If wind speeds increase above 74 mph (119 km/h), the tropical storm becomes a hurricane (Atlantic and Eastern Pacific), typhoon (Western Pacific), or cyclone (Indian Ocean and South Pacific).

*Lighting detection:* Storms often produce lightning, which can be detected to identify active storm cells and gauge their intensity. These systems track lightning strikes, providing insight into the storm's strength.

*Coastal storm:* In coastal regions, ocean buoys monitor sea conditions such as wave height, sea surface temperature, and ocean currents, which are important for detecting and predicting storms, including hurricanes and typhoons.

* + - 1. **Storm Tracking**

Machine learning models can be trained on historical storm data to predict storm behavior more accurately. By analyzing past storms, AI can identify patterns that may indicate intensifying or weakening systems and improve prediction accuracy over time.

* + - 1. **Parameters:**

Latitude

* + - * Longitude
      * Altitude
      * Diameter
      * Wind Speed
      * Direction
      * Type of precipitation
      * Amount of precipitation
      * Temperature
      * Humidity
      * Cloud formation
  1. **Real-Time Updates:** Continuous analysis of weather information and generation of real-time weather updates enabling meteorologist and authorities to monitor storm tracking and prediction.
     1. **Weather Monitoring**

Centralized dashboard that displays real-time data from all sensors, providing a complete view of current weather condition. The dashboard visualizes temperature, wind speed, wind direction, rainfall rates, severe weather events. System provides charts, maps, graphs on weather update, predict storm impact zone, storm tracking.

**7.2.2. Data Acquisition Satellite**

The Data Acquisition Satellite shall store geostationary satellite sensor data.

**7.2.3. Data Acquisition Drone**

The Data Acquisition Aircraft shall store two drones data.

* 1. **Tsunami Detection and Monitoring**
  2. **Risk Analysis and Integration**
  3. **Public Notification and Alert System**