

QUALITY MANAGEMENT OF A GEOINFORMATION UTILITY: THE USERS' PERSPECTIVE

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ABSTRACT

Inquiry and analysis on the quality management of a GeoInformation Utility (GIU) on volcanic hazard assessment is discussed in this research paper. An assessment of how well the Philippine Institute of Volcanology and Seismology (PHIVOLCS) is performing its mandatory tasks to its users is examined. A representative group of organizations and non-organizational entities that use and need the geoinformation (GI) products of the GIU on volcanic hazards were interviewed. There are also literature materials, maps, and documents used to gather the necessary data. Information on PHIVOLCS itself is obtained through interviews with high-ranking personnel and from research materials and/or documents. The synthesis and analysis of the quality management procedure of the GIU is based on the users' requirements resulting from the interviews. Focusing on the results of interviews with the users of its GI, a conceptual framework on the quality management of a GIU on volcanic hazards has been identified. The analysis of the quality management of the GIU is then based on these identified users' requirements, such that, there are existing problems and constraints which prevent or hamper the GIU from providing better services. An integration of data quality and organizational/institutional quality parameters has been identified based on the users' requirements. Thus, it is concluded that the quality management of a GIU on volcanic hazards could well be analyzed based on the requirements of its GI users.

1 INTRODUCTION

"Successful information systems require good management practices. Management direction and control is necessary to ensure that information systems meet their objectives in terms of cost and quality and to ensure that the process of systems development is completed within a reasonable time-frame" [Modern Management and Information Systems for Public Administration in Developing Countries, 1985].

The best way to gauge the management of information system is to ensure that the resulting system is effective. Being effective means that the information system 1) promotes the objectives of the organization, 2) meets the users' needs, and 3) manages to comply with the existing and binding constraints.

The main issues - technical, institutional, economic - and the sub-issues - social, political, managerial, legal and educational - on managing an information system should be well-defined and understood in order to formulate solutions to them. In every organization, the issues are interdependent which require distinct methods of analysis and solutions. Some areas that may be considered in the analysis of the management issues are: 1) the effective use of resources; 2) planning of future activities; 3) improvement of the organization's overall effectiveness; and 4) identifying and evaluating the effects of external factors [Cassettari, 1993].

1.1 Framework of Quality Management

The synthesis and analysis of the quality management procedure of a GeoInformation Utility (GIU)¹ is mainly based on the users' requirements resulting from interviews conducted in 1996. Several categories or dimensions of the data quality of the GeoInformation² (GI) products³ on volcanic hazard assessment⁴ of the Philippine Institute of Volcanology and Seismology (PHIVOLCS) were identified from the interviews. These data quality parameters (or the lack of them) point to underlying factors that PHIVOLCS needs to resolve. PHIVOLCS is the government organization in the Philippines responsible for volcanological and seismological monitoring and research activities. The Institute generates geoinformation and provides this to various users as input for decision-making and disaster-mitigation activities, research studies, socioeconomic requirements (e.g., hazard assessment on *lahar*⁵-prone areas for bank mortgage), among other things.

Identification of the necessary actions by the GIU in response to the users' requirements then leads to a formulation of a better quality management procedure as a GIU on volcanic hazard assessment. The general categories or dimensions of the data quality of its GI products are as follows: 1) easily understood by the users; 2) additional information (and services as well) aside from what is currently available; 3) timeliness and promptness; 4) accessibility; 5) actuality; 6) accuracy; 7) effectiveness; 8) availability; and 9) legality/believability. In a study by Wang and Strong, a hierarchical framework for organizing data quality dimensions was developed which captures the aspects of data quality that are important to data consumers. The four dimensions of data quality that are important to data consumers are as follows:

- 1) **intrinsic** data quality which denotes that data have quality in their own right;
- 2) **contextual** data quality which highlights the requirement that data quality must be considered within the context at hand;
- 3) **representational** data quality which includes aspects related to the format of the data and meaning of data; and
- 4) **accessibility** data quality that answers the question on the extent to which data is available or obtainable.

Categories or dimensions relating to the organizational or institutional structure, procedure, and set-up of the GIU also point to its overall quality management scheme. These are 1) establishment of communication protocol; 2) use of indigenous warning signals; 3) commercialization of products and services; and 4) proper management and maintenance of the Geographic Information System (GIS) Laboratory. These categories or dimensions can be grouped under organizational/institutional quality. Hence, the framework on categorizing the quality management of a GIU on volcanic hazard assessment is illustrated in Figure 1.

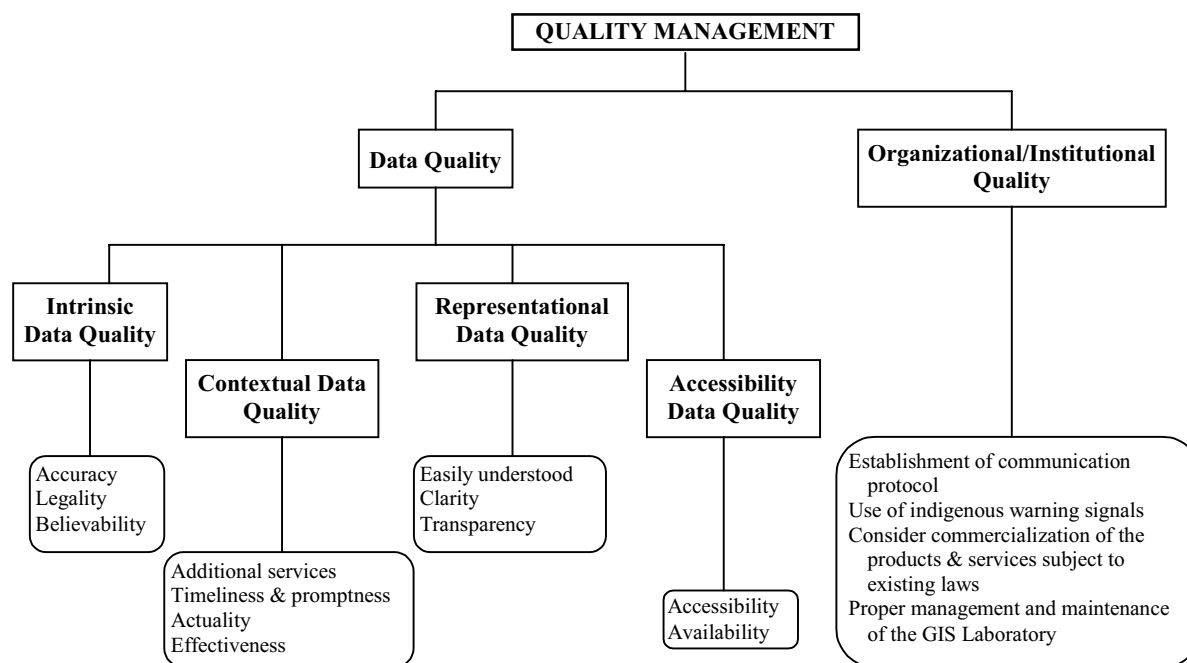


Figure 1. A Conceptual Framework of Quality Management for a Geoinformation Utility (GIU) on Volcanic Hazard Assessment

There are certain characteristics of a GIU to perform well in terms of 1) adhering to the objectives, mandates, duties and responsibilities, 2) its users' requirements, and 3) the existing issues and constraints that are binding to the utility. Particularly for PHIVOLCS, the characteristics listed below are applicable and necessary for it to function and perform well:

- 1) widely available, such that the GIU should have field stations covering the entire Philippine archipelago;
- 2) accessible which means that the field stations could be reached by people;
- 3) flexible, meaning that the GIU should be able to adapt to the kind of service required from it;

- 4) acceptable (or accepted) and reliable, such that the users and the general public believe and adhere to what the GIU is saying;
- 5) equipped with the necessary funding to support the needs for instruments, machinery, tools, supplies, etc. and manpower;
- 6) composed of enough, competent and well-trained work force, technical and non-technical;
- 7) supports system integration and interoperability which means that between divisions in the GIU, the gathering, processing and production of geoinformation should be manageable;
- 8) supported by a reliable communication network, such that information from the Main/Central Office should be easily transmitted to the provincial stations; and
- 9) has a working and effective quality management procedure.

Essentially, all of the first eight characteristics are fundamental components of a GIU leading towards a better quality management procedure.

2 METHODOLOGY

Data is primarily gathered through interviews with the various users of the GI products of PHIVOLCS. Two field volcanic stations of PHIVOLCS are considered as case studies. First is the Mount Pinatubo Volcano field station (Pinatubo Volcano Observatory in Clark Field, Pampanga) and second is the Mayon Volcano field station (Ligñon Hill Observatory in Legaspi, Albay). For the Pinatubo area, information was gathered on the users of GI from PHIVOLCS specifically from the loan organizations and the owners of land properties in the area (non-organization entities, NOEs; and the HDMF-PRO) and from a co-member from the Mount Pinatubo Commission, the NEDA-RO3. For the Mayon Volcano area, users of GI from PHIVOLCS concerned with disaster prevention (OCD-Region 5 and the PDMO-Albay), housing and land use (HLRB-Region 5) and technical aspect (MGB-Region 5) were interviewed. A group of users is selected on the basis of 1) the frequency which they use, need and request the GI products of PHIVOLCS, and 2) membership of the users and PHIVOLCS together in a bigger umbrella organization such that they deal with common objectives like disaster mitigation (the NDCC) and geographic information (IATFGI). Some of the users selected to be interviewed are asking for the Lahar Certifications and the latest Lahar Hazard Map from PHIVOLCS at a rate of five (5) requests per day if it is not *lahar* season, i.e., summer time. During *lahar* season (rainy months in the Mount Pinatubo area), the number of requests ranges from 10 to 15 per day. The other users that were interviewed are institutional clients of PHIVOLCS such that they are required to be given the GI by PHIVOLCS in virtue of the membership of both organizations to the same umbrella organization. The list of organizations and NOEs that comprise the representative group interviewed is shown in Table 1.

CENTRAL/MAIN OFFICES	OFFICES AND NOEs IN THE MOUNT PINATUBO AREA	OFFICES IN THE MAYON VOLCANO AREA
1) National Mapping and Resource Information Authority, Information Management Department (NAMRIA-IMD) 2) Department of Social Welfare and Development, Disaster Response Operation Monitoring and Information Center (DSWD-DROMIC) 3) Department of Public Works and Highways, Mount Pinatubo Rehabilitation Project Management Office (DPWH-MPRPMO) 4) Inter-Agency Task Force on Geographic Information (IATFGI) 5) National Disaster Coordinating Council (NDCC)	1) Home Development Mutual Fund, Pampanga Regional Office (HDMF-PRO) 2) National Economic Development Authority, Regional Office 3 (NEDA-RO3) 3) Certification-seekers (NOEs)	1) Office of Civil Defense, Region 5 (OCD-R5) 2) Provincial Disaster Management Office, Albay (PDMO-Albay) 3) Housing and Land Use Regulatory Board, Region 5 (HLRB-R5) 4) Mines and Geosciences Bureau, Region 5 (MGB-R5)

Table 1. List of Organizations and Non-Organizational Entities (NOEs) Interviewed

3 RESULTS AND ANALYSIS

Synthesizing the interviews, the geoinformation products of the GIU on volcanic hazards need to follow certain requirements as illustrated in Figure 2. Based on the response of these users to the questionnaires, the performance of PHIVOLCS as a GIU on volcanic hazard assessment can be evaluated. The user requirements are indicated in their response to the questionnaires. Specifically, these user requirements connote the problems and constraints that the utility needs to answer in order for it to become a better GIU on volcanic hazard assessment. In other words, these user requirements are indications of the problems and constraints that hinder or hamper the utility in performing its functions and duties as a GIU on volcanic hazard assessment. Given that this group is a representative selection out of all the

users, the results of the evaluation are of significant importance. Without passing any judgement on PHIVOLCS as a scientific (research-oriented) organization, the result of this research focuses on its service-oriented roles.

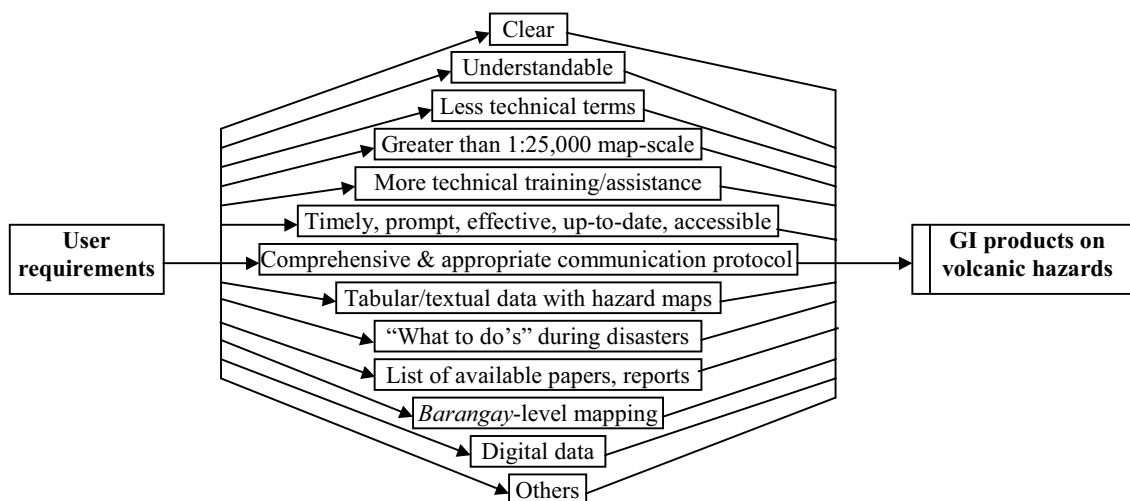


Figure 2. User Requirements on the GI Products in Volcanic Hazards

According to the user requirements, the problems and constraints that hinder or hamper PHIVOLCS in performing its functions and duties as a GIU on volcanic hazard assessment are as follows:

- 1) GI on volcanic hazards are too technical and beyond the understanding of the user community for which it is intended.
- 2) Current services on volcanic hazard assessment are not enough; interviewed users need more services.
- 3) GI products on volcanic hazards are not timely, not issued out promptly, not accessible, not accurate enough and not too effective.
- 4) There is no established, definite and acknowledged communication system or protocol between the GIU and some of the interviewed users.
- 5) Public information campaign of the utility is after the disaster has occurred.
- 6) The use of indigenous warning signals as a monitored parameter for volcanic eruption together with other scientific tools is not considered by the GIU; local residents recognize such indigenous signs.
- 7) Unavailability of
 - a) data which do not need real- or near real-time dissemination;
 - b) list of data, papers, reports on volcanoes and its hazards which are relevant to the users; and
 - c) updated volcanic hazard maps (at least for Mount Pinatubo and Mayon Volcano).
- 8) Lack of effective information-dissemination campaign.
- 9) There are individuals (or groups) that question the legality of the utility's statements which has implications on its institutional mandates as a GIU.

Analysis of user requirement results into the identification of the root causes for these problems. The identified reasons behind these constraints are the following:

- 1) PHIVOLCS is performing a dualistic role - as a scientific and as a service-oriented organization - which creates conflicting problems to a certain degree in the perception of some users, and officially, in setting priorities.
- 2) There is an Institute-wide lack of capable personnel to handle the map-updating job and the GIS Laboratory in the utility.
- 3) The GIS Laboratory needs proper management in terms of
 - a) the requirements of the users;
 - b) allocation of manpower and resources; and
 - c) establishment of duties and responsibilities to other divisions and as a service-arm of PHIVOLCS.
- 4) The institutional mandates of the GIU is not clearly understood by the public, especially those in the

provinces, prompting them to question the validity of PHIVOLCS' statements and even to ignore the warnings on danger zones.

- 5) In the evaluation of priorities, it may emerge that the GIU is suffering from budgetary constraints in implementing its function to provide the required GI products to the users.

These reasons behind the problems and constraints as required by the users need to be addressed and resolved in order for PHIVOLCS to improve its functions as a GIU on volcanic hazard assessment. Once these five basic problems are answered, the underlying constraints (1-9 above) will eventually be resolved not necessarily at once but one after the other.

4 CONCLUSIONS AND RECOMMENDATIONS

A GeoInformation Utility, such as the Philippine Institute of Volcanology and Seismology, should be able to provide better service if, first and foremost, the requirements by the users of its GI products will be satisfied. The basis for the performance of a GIU and its quality management is on the users' end, which this research paper focused on. On this context, there is a need for the utility to satisfy the requirements of the users of its GI products in order for it to function as a better GIU.

The quality management of PHIVOLCS as a GIU on volcanic hazard assessment encompasses issues ranging from technical, institutional, social, economic, legal, political, managerial, and educational. These issues are all relevant to the quality of the information from PHIVOLCS, to the quality of the processes which these information are obtained and produced, to the quality of the way all the procedures involved in PHIVOLCS are handled and to the overall quality of PHIVOLCS as a service-institute, as a group of people. Problems to these issues should be well identified and resolved. The GI users of the GIU concerned identified all the foundation of the issues discussed. The assessment of PHIVOLCS' quality management in terms of the requirements by the users provides a solid basis on how well PHIVOLCS is doing its mandated tasks. Based on the analysis of the results of the research, it is highly recommended for PHIVOLCS to consider the identified constraints and problems to its present production process. It should take the necessary actions in response to these problems and constraints which hamper its performance towards becoming a better GIU on volcanic hazard assessment.

Hence, it is concluded that user requirements are valid issues needed to be responded positively towards a better quality management of a GIU. The utility needs to respond positively to the identified inadequacies towards a better quality management as a GIU on volcanic hazard assessment.

Summarizing the analysis and referring to the dimensions of data quality, the following recommendations could be made for improvements in the respective dimensions:

Intrinsic quality

- use of the same format, type and style of GI products, either during calamity or not
- the GIU could be authorized to make Volcanic Warnings as lawful and permissible documents which the general public should abide
- responsibilities and liabilities related to the GIU's products should be clarified in its statutes
- incorporate indigenous warning signals of local residents in the scientific parameters being used to monitor volcanic eruptions

Contextual quality

- include in the Volcanic Updates the information needed by the users
- include statements about the consequence of the present volcanic situation so long as the users are well-informed on the correct meaning of the statement
- regular checks of the GIU on the dissemination and transmittal of GI to the users
- function as a public-oriented organization should be practiced with consistency; in order to be able to do so, the lack of manpower problem should be solved
- issuance of Volcanic Updates and Bulletins on a regular basis, preferably daily, and with explanation of consequences of the hazards mentioned in these GI at all times and not only during calamity-time; publication of the daily volcanic update in the local newspapers and broadcasting over the local radio could be considered
- set-up of on-line response systems
- systematize the map production line by going digital
- improve maintenance and management of GIS laboratory to refine actuality of data
- distribution of GI at the *barangay* [see endnote 3] level
- spatial display of the extent of the hazard map should be accompanied by textual data

- hazard maps need to be adjusted to the lowest possible level of mapping, preferably at the *barangay* level
- on-going evaluation of users' requirements by the GIU

Representational quality

- textual GI should be put in a language that target users can understand and comprehend, preferably in dialects or languages of local residents
- increase the level of knowledge of the people on volcanoes and its hazards starting from early childhood education; could be done by including topic of volcanoes in grade school, for example
- organization of community-based volcano lectures, seminars and the like
- maps created in the digital environment using computer technology could be enhanced to better suit the level of understanding of the users

Accessibility quality

- request to use direct telephone lines from the main station to the field stations
- employment of additional capable personnel
- set-up of on-line response systems
- improved communication procedures between the GIU and the users, and between users and their library
- improving data exchange in cooperation with the Inter-Agency Task Force on Geographic Information
- printing of maps in cooperation with the disaster management office, which in turn would distribute these to the community

Organizational/Institutional

- accommodate the production of hazard maps according to the requirements of its users by allocating additional funds to this activity; more sources of funds are needed; could submit more projects on hazard mapping for approval of the national budget
- tap assistance for locally funded projects and other funding requests
- assign a group of technical personnel to handle the GIS laboratory; this group should acquire additional hard/software
- incorporate data from all Divisions of the GIU to serve as the working and basic database system
- continuous training for additional input of knowledge in GIS
- emphasize and activate more Community-Based Volcano Monitoring System; this would increase more participation of local residents
- utilization of clearinghouse on volcanic hazards in order to inform users better which information is available and accessible where
- strictly observing that the official spokesperson of the GIU should be the one interviewed by the media people
- institutionalization of use of indigenous warning signals being observed by local residents as an additional aid for volcano monitoring and hazard assessment activities
- consider commercialization of the products and services of the GIU subject to existing laws in the Philippines
- establish further relations with other volcanic hazards' GIU abroad, keeping in mind and taking into account the social and cultural differences

Although the users that are considered in this research compose a representative group, it would still be relevant to consider additional organizations and non-organizational entities in the future for statistical purposes. It would also be beneficial to consider the other active volcanic areas in gathering information from the concerned users other than the two case studies in the paper - Mount Pinatubo and Mayon Volcano.

Finally, it is further recommended that research on the Philippine GeoInformation Infrastructure (GII)⁶ be considered. PHIVOLCS is just but a small contributing part that plays a role in the whole Philippine GII focusing in GI on volcanoes and earthquakes. It would be appropriate to conduct research on Philippine GII since the creation of a coordinating body on GI in the Philippines is still in its initial stage, the Inter-Agency Task Force on Geographic Information (IATFGI). Figure 3 illustrates the flow diagram of the Philippine GII development cycle.

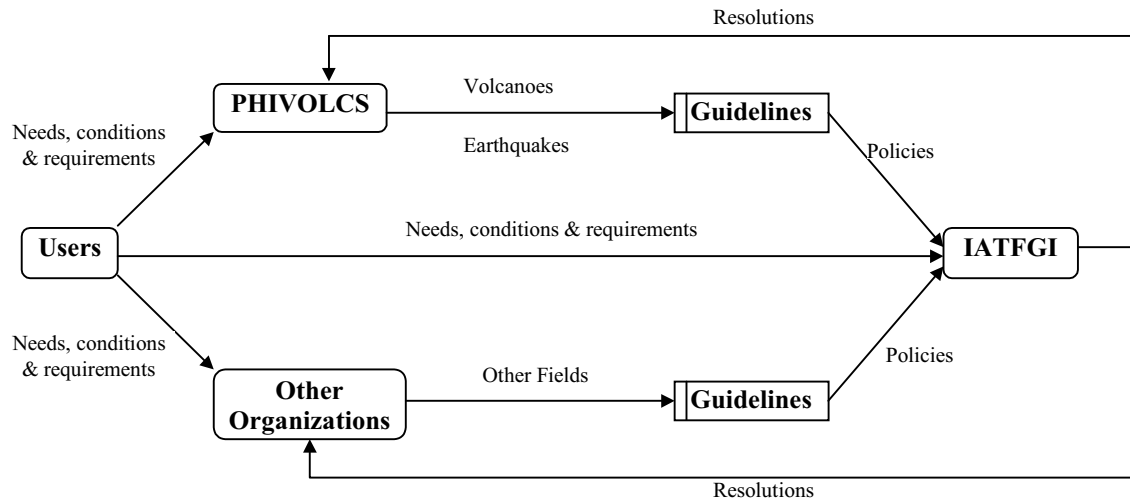


Figure 3. Development Cycle of a Philippine GeoInformation Infrastructure

ENDNOTES

¹A public utility is an organization supplying water, gas, electricity, etc, and regarded as a public service. The service that an organization provides could be on geoinformation, in which case, it then becomes a **geoinformation utility or GIU**. A definition of a GIU is given as "an infrastructure set up for the efficient distribution of data/information to enhance its availability, accessibility and use at an affordable cost" [Addai, 1995.] PHIVOLCS can, thus, be considered as a GIU on volcanic hazard assessment because it provides geoinformation on volcanic hazards to the public in the form of volcanic updates, certifications, hazard maps, among other products.

²Geoinformation is a contracted word coming from "geographic" (or "geologic") and "information." **Geographic information** is defined by the International Standard Organization (ISO) as "knowledge obtained as a result of the synthesis, analysis, or integration of geographic data" [ISO/TC211] while **geographic data** is defined as "a representation of phenomena referenced to locations relative to the earth" [ISO/TC211.]

³The geoinformation products of PHIVOLCS on volcanic hazard assessment are as follows:

- 1) Hazard Maps of various volcanic products, i.e., *lahar*, pyroclastic, lava, ashfall, etc.;
- 2) Volcanic Updates also known and called as Volcanic Daily Bulletins and Warnings;
- 3) Volcanic Hazard Assessments on properties or Certifications;
- 4) list of threatened *barangays*, the smallest unit of government in the Philippines;
- 5) publications, brochures, posters and manuals, including safety precautions before, during and after a volcanic activity; and
- 6) Operation Plan Maps.

⁴Hazard assessment of a volcano involves knowing what will happen with certain accuracy and reliability if the volcano suddenly becomes active or starts to erupt. The volcanic hazards that will result after an eruption are quantified in terms of the extent of its devastation usually depicted in the spatial context. Hence, the primary output of an assessment is a map showing up to where the hazard will go and the places that will be affected by the hazard.

⁵**Lahar** is an Indonesian term for rapidly flowing mixtures of volcanic materials and water.

⁶**Geographic Information Infrastructure (GII)** has been taken to include various software, hardware human resources, the actual spatial data, policies, agreements, standards, administrations, management, the knowledge and the technology to make all of these elements to work together in the pursuit of the objectives of the design. It serves the purpose of facilitating the efficient access and responsible use of geoinformation at an affordable cost. It enables the capability of transporting large quantity of data at high speed.

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