International Union of Geophysics and Geodesy

Indonesian National Committee

Country Report

IUGG General Assembly

Sapporo, Japan

June 30 – July 11, 2003

Introduction

Joenil Kahar,
President of The Indonesian National Committe for IUGG

The Country Report for the IUGG General Assembly XXIII at Sapporo, Japan prepared by the Indonesian National Committee for IUGG consists of reports for the associations: IAG, IAGA, IAHS, IAMAS, IASPEI and IAVCEI.

Country Report for IAG consists of three parts:

1. Geodetic Activities in the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL)
2. Report of the National Gravity Commission
3. Research Activities conducted by the Institute of Technology in Bandung, they are about:
    a. GPS Survey for Natural Hazard Mitigation
    b. Tectonics Motions of Sulawesi Region
    c. Geoid Study of the Indonesiaan Archipelago

Country Report for IAGA describes about:

1. Geomagnetic Activity of Indonesia conducted by the National Agency for Geophysical and Meteorological Agency
2. Activities Related to Geomagnetic Research in Indonesia conducted by National Institute of Aeronautics and Space

Country Report for IAHS presents "*Towards a new paradigm for integrated water resources management and development in Indonesia*" which discuss about:

1. Present Conditions
2. Institutional Issues
3. Reformation Water Resources Policy
4. Vision and Mission of Water Resources Management
5. Local Authority Implementation in Water Resources Management

Country Report for IAMAS will about:

1. Climate and Atmospheric Science Activities In Indonesia
2. Activities Related to Ionospheric Research in Indonesia
3. Activities Related to Middle and Upper Atmospheric Research in Indonesia

Country Report for IASPEI will report on Seismic Monitoring and Research Directions in seismology and physics of the Earth's interior

Country Report for IAVCEI describes about Related Activities with IAVCEI in Indonesia:

1. Explosive Volcanism
2. Cities and Volcanoes

3. Subduction Zone Magmatism
4. Mitigation of Volcanic Disasters
5. World Organization of Volcano Observatories (WOVO)
6. Chemistry of Volcanic Gases
7. Volcanogenic Sediments
8. Large Volume Basaltic Province
9. Volcanism aand the Earth's Atmosphere
10. Granites
11. Volcanic Lakes
12. IASPEI/IAVCEI Joint Commission on Volcano Seismology
13. Expectation to the future

THE INDONESIAN NATIONAL COMMITTEE FOR IUGG (INC-IUGG)

Adhering Organization: Indonesian Institute of Sciences (LIPI)
Jl. Jend. Gatot Subroto No. 10
Jakarta 12710, Indonesia

President	: Joenil Kahar	Dept. of Geodetic Engineering, Institute of Technology of Bandung, Jl. Ganesa 10, Bandung 40132 Indonesia Phone: 022 – 2534286 Fax: 021 – 2534286 Mphone: 0811 – 230837 E-mail: joenil@indo.net.id
Vice President	: Klaas J. Villanueva	National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) Jl. Raya Jakarta Bogor KM 46 Cibinong 16911, Indonesia Phone: 021 – 8753066 Fax: 021 – 8757635 Mphone: 0811 – 230837 E-mail: klaas@indosat.net.id
Secretary	: Hery Harjono	Research Center for Geotechnology (Puslit Geoteknologi LIPI) Kompleks LIPI, Jl. Sangkuriang Bandung 40135, Indonesia Phone: 022 – 250364 Fax:: 022 – 2504593 E-mail: hharjono@geotek.lipi.go.id
Incoming President	R.W. Matindas	National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) Jl. Raya Jakarta Bogor KM 46 Cibinong 16911, Indonesia Phone: 021 – 8753067,8754592 Fax: 021 – 8752064 Mphone: 0812 – 8024137 E-mail: secr@indo.net.id

NATIONAL CORRESPONDENTS OF ASSOCIATIONS

IAG	: Hasanuddin Z. Abidin	Dept. of Geodetic Engineering, Institute of Technology of Bandung, Jl. Ganesa 10, Bandung 40132 Indonesia Phone: 022 – 2534286 Fax: 021 – 2534286 Mphone: 0811 – 247265 E-mail: hzabidin@gd.itb.ac.id
IASPEI	: Sri Widiyantoro	Dept. of Geophysics and Meteorology Institute of Technology of Bandung, Jl. Ganesa 10, Bandung 40132 Indonesia Phone: 022 – 2500494 Fax: 022 – 2534139 Mphone: 0812 - 2381962 E-mail: sriwid@geoph.itb.ac.id
IAVCEI	: Wimpy S. Tjetjep	Directorate General of Geology and Mineral Resources, Ministry of Energy and Mineral Resources Jl. Prof. Dr. Soepomo SH No 10 Jakarta 12810, Indonesia Phone: 021 – 8280773 Fax:: 021 – 8297642 Mphone: 0811 - 908424 E-mail: wimpys@rad.net.id
IAGA	: Hendar Gunawan	Tangerang Geophysics Station Jl. Meteorologi No. 5, Tanah Tinggi Tangerang, Indonesia Phone: 021 – 5577 1822 Fax: 021 – 8701625 Mphone: 0811 – 204212 and 0811 – 908424 E-mail: hendargunawan@hotmail.com

NATIONAL CORRESPONDENTS OF ASSOCIATIONS (Cont'd)

IAMAS	: Hery Herjanto	Meteorological and Geophysical Agency (BMG) Jl. Angkasa I No. 2, Kemayoran Jakarta 10620, Indonesia Phone : 021 – 6540158 Fax : 021 – 6540158 Mhone: 0816 – 1842302 E-mail : hery_h@bmg.go.id
IAHS	: Joesron Loebis	Research Institute for Water Resources Jl. Juanda No. 193, PO Box 51 Bandung 40135, Indonesia Phone: 022 – 2501533, and 022 – 2501544 Fax : 022 – 2500163 Mphone: E-mail: joesron@melsa.net.id
IAPSO	: Safwan Hadi	Dept. of Geophysics and Meteorology Institute of Technology of Bandung Jl. Ganesa 10, Bandung 40132 Indonesia Phone: 022 – 2500494 Fax : 022 – 2534139 Mphone: E-mail: safwan@geoph.itb.ac.id

Geodetic Activities in the National Coordinating Agency for Surveys and Mapping (Bakosurtanal)

Prepared by Matindas R.W., B. Sapto Pratomosunu, Subarya C., Manurung P., Sutisna S.
National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL)
e-mail : pgg@bakosurtanal.go.id

Introduction

The National Coordinating Agency for Surveys and Mapping of Indonesia is responsible for providing the national spatial data and information of land and water within the territory. The area of land cover about 2 millions km2, and water or sea about 3 millions km2. The spatial data of accuracy equivalent to a map scale of one to a million has covered the entire land area. A better accuracy of the spatial data equivalent to the scale of one to fifty thousands is under progress for completion. The area of which lacking the data is in the region of eastern part of Indonesia. The national long term development planning has been launched by the government since past three decades, until to date, the urgent need of the spatial data is increasing. In line with the demand increase for local development planning over the region (provinces and district area), a national programme which is focussed on generating spatial data and information is introduced. The programme was implemented since in the mid-nineteen eighty for developing the national spatial data base and information.

This spatial database is essential for project planning, land monitoring and evaluation over the national territory. Following the action for generating the spatial data, a surveys operation also conducted to gather data or information of natural resources. The method of acquisition of spatial data and information of natural resource potential will be described in this report.

Geodetic data is one of the fundamental data in the Spatial Data Infrastructure, and resulted from geodetic activities which, is funded by government in the frame work of the national programme. This report presents current activities implemented by the Agency.

Development of the Geodetic Activities in Indonesia

Development of establishment the geodetic control surveys using a modern technology such as Doppler Satellite System was conducted in Indonesia in the early nineten seventy for providing spatial data and information within the frame work for development of national spatial data and information infrastructure. The application of The Satellite Transit Doppler as space-based positioning system (using US satellite, NWL-9-D) was intended for establishment the geodetic control networks as the reference of the spatial data and for various activities. The Doppler positioning system was also utilised for developing the new Indonesian Datum 1974 for the national base mapping of Indonesia. As compared to the traditional geodetic survey of the optical system, the satellite Doppler system provides great advantages in term of improve accuracy, more convenient in the field operation and time saving.

Further use of the satellite transit Doppler observations were applied for mapping control and for fixing boundary markers. International border survey and demarcation between Indonesia and Papua New Guinea had been carried out since 1983. There are 52 Doppler points were fixed on the Indonesian parts, and similar number on Papua New Guinea parts. Doppler control points were also used for fixing Provincial administrative boundaries in Sumatra and Kalimantan. By the end of 1990, the total number of Doppler points have been established in Indonesia were 1258 and 90 points, these points were used for the integration of urban mapping coordinate system into the national geodetic system based on the Indonesian Datum 1974 (ID-74).

The recent development on geodetic survey in Indonesia was implemented using Global Positioning System (GPS), and this GPS survey activities were started in the early nineties. The application of the GPS positioning technique has brought new definition on Indonesian Datum 1995 (ID-95) which was introduced in 1996, and presently used in Indonesia. This geodetic reference system is referring to the ellipsoidal of World Geodetic System 1984 (WGS'84).

Detailed report on activities carried out using the GPS technology is described as follows :
The Zero order GPS geodetic measurements were established to provide precise unified national horizontal network in 1992 with inter-station distances of more than 100km. The coordinate data set resulted from the adjustment is in International Terrestrial Reference Frame (ITRF) 1991 system, and is transformed to WGS-84 and to the Indonesian Datum 1974 (ID-74) systems for practical use.

The first order GPS network is further established to densify the Zero Order stations which were developed in stages island by island, and at present time these points consists of more than 500 stations distributed over the entire country, with inter-station distances varying from 15 to 300 km. Based on the observation derived from the two orders of these GPS network, a new Indonesian datum was determined and declared as Indonesia Datum 1995 (ID-95).

GPS Permanent Tracking Station is operated by the Agency on a number of permanent tracking stations located in Medan, Cibinong, Pare-pare,

Kupang and Biak. These stations are also part of the Asia Pacific permanent GPS tracking network for the GIS infrastructure in the Asia and the Pacific region.

GPS Application for Administrative and International Boundaries. The National border surveys programme for administrative demarcation between neighboring provinces in the country have established some 101 reference markers positions using GPS. For the International land border survey program, some 93 reference markers have been established and fixed, they are 52 for the Indonesia and Malaysia border, and 41 for the Indonesia and Papua New Guinea border. Recent development on the International border survey cover the region along the border of Indonesia and Democratic Republic of Timor Leste. The International sea boundary, a number of baseline points consisting of more 200 points were determined with GPS in the Digital Marine Resource Project conducted from 1998 to 2000. These points were aimed at defining the jurisdiction state boundary and its continental self, as well as for the EEZ (Economic Exclusive Zone) of Indonesia, in connection with the implementation of the UNCLOS ratification made by the Government of the Indonesia in 1982.

GPS Application for Geodynamic study was initiated with an investigation of oblique plate convergence in Sumatra. The first GPS field campaign took place in August-September 1989 with survey design in such way allowing to measure horizontal strain rates, both along the Sumatra fault system and across the fault. The second epoch of field campaign took place in June-July 1990. During this period the first epoch of mainland stations were re-observed, but none of the station in the fore arc islands. The third epoch of GPS campaign took place in June-July 1991. During the campaign, an earthquake coincidently occurred in the surroundings field observation with a magnitude of 4.6 on the Richter scale. The following observations were repeated in 1992 and 1993. The results show the existence of the fault deformation and its characteristics that consistence from year to year during the 5 years continuously monitoring.

Geodynamics study using GPS measurement in Irian Jaya was carried out in order to understand the deformation pattern of Irian Jaya fault system. From 1991 to 1993 there were three epochs of GPS observation had been carried out and 6 reference markers in the vicinity of the Irian Jaya fault system were measured.

Geodynamic investigation on Toba Lake deformation has been carried out by utilizing GPS relative positioning method to measure a transect at the southern end of Toba Lake. Thirteen transect points were occupied twice, i.e. in September 1993 and September 1994 and the preliminary result suggest that a various displacement exist due to tectonic activities in the area.

On December 12, 1992 at 05:30 GMT or 13:50 local time, a 7.5 Ms earthquake struck the north central coast of Flores Island, Indonesia, and generated a major and destructive tsunami. After the earthquake, in period of 1st-5th of January 1993, GPS measurements were conducted to reoccupy eight points measured in July-August 1992 by Bakosurtanal as part of geodetic network.

GPS campaign for crustal deformation monitoring in West Java Under the program of the International Decade for Natural Disaster Reduction (IDNDR), the Disaster Prevention Research Institute (DPRI), Kyoto University established research cooperation with Research and Development Center for Geotechnology, the Indonesian Institute of Sciences. This research cooperation is associated by the Department of Geodetic Engineering, Institute of Technology Bandung. The main objective of the project is to detect crustal motion which associated with tectonic and volcanic activities in West Java, Indonesia. The investigation was focused on the evolution of Cimandiri and Lembang faults, which are two of some tectonic features in West Java caused by the subduction of the Indo-Australian plate into the Eurasian plate. To monitor crustal motions along the faults, 17 GPS stations were occupied during 1992 and 1993 campaign.

GPS measurement across the Java trench subduction. A joint venture project study on Java Trench subduction was carried out between Bakosurtanal (National Coordination Agency for Surveying and Mapping, Indonesia), School of Surveying UNSW (The University of New South Wales, Australia), ITB (Institute of Technology Bandung, Indonesia), and SIO (Scripps Institution of Oceanography, San Diego, USA). From the first GSP measurement, a relative subduction rate across the Java trench between Christmas Island and Cibinong (West Java) has been determined. The three dimensional vector between these sites has been measured annually commencing in September 1989 using GPS. The Subduction rate was found to be 71 mm/year ±9mm.

GPS measurement in Sulawesi triple junction. GPS application for geodynamic studies were also carried out in Sulawesi to monitor the triple junction deformation in Central Sulawesi. Three repeated GPS measurement had been carried out.

GPS Application for Volcano Monitoring. GPS application for monitoring active volcanoes in Indonesia has been started since 1996. There are two volcanoes are intensively monitored using GPS technique of observation, namely: mount Merapi in Yogyakarta and mount Guntur in West Java. These works are carried out under research cooperation between Indonesia and German and Japan scientists.

International Co-operation on Geodetic Activities

Geodetic activities implemented in the framework of the co-operation among Regional and International countries are described in the following section :

1. Geodynamic study of South-East Asian Region (GEODYSSEA). In 1993 an agreement to carry out a joint research on geodynamic study in South-east Asian (SEA) region was agreed by the European Union (EU) Commission and the members of the South-East Asian Nation (ASEAN), called the Geodyssea project. The project was designed to investigate the regional characteristics of crustal deformation in the South-East Asian (SEA) region, utilizing GPS. The first campaign took place from

November 28 up to December 3, 1994 with 25 of 44 points were occupied in Indonesian region.

2. Asia and the Pacific Space Geodynamics (APSG) Programme. A number of Asia-Pacific geo-scientists led by China proposed a programme to establish the Asia Pacific Space Geodynamics to the IAG in its meeting in Boulder Colorado, 1996. The main objective of the APSG is to unite all relevant activities in the region into a cooperative research project in plate tectonic, crustal motion and deformation, and sea-level change in the area. The primary objectives of study are to measure and monitor, using space techniques, the relative motion between the Eurasian, Pacific, Philippine, and Indo-Australian plates including the plate tectonic motion along the boundaries, as well as local crustal deformation. Further study is focused on the evolution and dynamics of the crustal motion of the island arc system in the Western Pacific boundary zone and the mountain-building zones of the Tibetian Plateau and Southeast Asia;measure and monitor sea-level change in the Asia and Pacific region using space techniques including altimetry and tide gauge data to study the characteristics and causes of the fluctuations in global sea surface. The similar study is aimed to investigate the dynamics of the Earth as a whole (Earth rotation, gravity changes, etc.) and the mass motions within each layer and their dynamic relations. Later, Investigation on natural hazards (earthquakes, volcanic eruptions, sea immersion, etc.) in the region is included as well as their relation with various Earth motions, and provide basic information for the prediction of natural disasters.

3. The Asia Pacific Regional Geodetic Network. Indonesia has actively participated in the Working Group on Regional Geodetic Network for Asia and the Pacific, a working group formed by the UN Permanent Committee on GIS Infrastructure for Asia and the Pacific. Since the availability of a reliable geodetic network is one of the fundamental data sets of the element of GIS infrastructure, the countries in the Asia and Pacific Area agree to establish a regional network as part of a global network. Two regional campaigns n two consecutive years have been launched successfully using a combination of space observation technology i.e.: GPS, satellite DORIS, Very Long Baseline Interferometry (VLBI) and Satellite Laser Ranging (SLR)

Geodetic Activities in Support of Study for Development of Earth Sciences

The National Coordinating Agency is also conducting research in relation to the Earth Sciences, the following section describes a number geodetic activities in support of the research.

1. GPS Application for Height Determination and Datum Unification Vertical datum connection is one of primary issues in Indonesia.

Some studies had been carried out to possibly solve this problem by integrating the existing leveling, gravity, tide gauges, satellite altimetry and GPS data available in the country. The main problem on this study was reported that good gravity data in the country is rarely available leading to the resulted orthometric GPS leveling accuracy is still inadequate to achieve the accuracy level of spirit leveling.

2. GPS Meteorology and Ionospheric Studies. Research on the application GPS for meteorology has been initialized since 1998 with funding provided by the Indonesian National Research Council and Government. The water vapor content can be extracted from GPS signal delay in its propagation from the satellite in space to a receiver.

3. GPS study is also carried out to investigate total electronic content in the ionosphere in Indonesian region that has tropical characteristics.

4. A long-term joint research between Frontier Observational Research System for Global Change (FORSGC) Japan and its Indonesian counterparts namely BPPT, BMG and Bakosurtanal on GPS meteorology is also carried out, started in April 2001 and expected to be operational for about 15 years. The main objective of the research is to investigate weather local variation of west to East coast of Sumatra using two GPS permanent tracking stations, established as part of the research.

5. GPS at Tide Gauge for Sea Level Variation Monitoring. GPS application for sea-level variation monitoring in Indonesia will play an important role, not only to provide basic data for the unification of vertical datum of tide gauge bench marks, but also to be used as a tool to measure : (i) tide gauge position and elevation with respect to geocenter, (ii) mean sea-level variation itself relative to the close by benchmark or direct to an absolute geodetic datum, and (iii) some sea-level dynamic parameters, such as Indonesian sea through flow (ARLINDO), sea current, ocean wave, etc. For these applications, since last year Bakosurtanal has started to carry out some GPS measurement for the determination of position and elevation of the Indonesian tide gauge stations. An ongoing programme carried out by the International GPS Service (IGS) to perform GPS observation at or close to the tide gauges around the globe. Indonesia take initiative to participate on this programme by establishing GPS station near more than 8 tidal stations.

6. DGPS Application for ECDIS and VTS. The application of ECDIS covering Indonesian main sea waters and the establishment of VTS in the three international passages through the archipelago are parts of the continuation of the Digital Marine Resource Mapping (DMRM) Project, terminated on July 1998. The initial area of study for the ECDIS and VTS were designed in the Malacca strait. Therefore, the existing 6 DGPS stations and 4 permanent tracking stations will play an important role in providing differential corrections.

Bibliography

BAKOSURTANAL., 2003 "The 7Th Meeting of The Sub-Committee on Space Technology and Space Application (SCOSA)", National Report.

BAKOSURTANAL., 2002 "Laporan Tahun Dinas 2002, Pusat Geodesi & Geodinamika" Internal report.

BAKOSURTANAL., 2001 "Laporan Tahun Dinas 2002, Pusat Geodesi & Geodinamika" Internal report.

Subarya C., 2002 "Laporan Dalam Rangka Menghadiri SCAR Antartic Geodesy Symposium (AGS02) dan PCGIAP Workshop on Regional Geodesy" Internal report.

THE INDONESIAN GRAVITY COMMISSION (IGC)

A Short Note on Gravity Survey Activities in Indonesia

Aris Susilo[1], Parluhutan Manurung[2], Juniar P. Hutagaol[3] and M. Untung[4]
[1] Geological Research and Development Centre
[2] National Coordinating Agency for Surveys and Mapping
[3] Marine Geological Institute
[4] Ex Geological Research and Development Centre

The historical work of Vening Meinesz conducting pendulum survey along the Java Trench in the years 1923 up to 1934 can be claimed as a milestone of gravity survey in the Indonesian Archipelago. It was found that regional isostatic anomalies occupying the trenches along the outer arc belt are in the order of about –250 mGal. With reference to the global tectonic hypothesis, the anomalies are interpreted as subduction of the oceanic crust of which the accretion zones are actively developed within this belt. After the historical work, gravity surveys for oil search and gas were actively conducted. At the early stage, the surveys were conducted using torsion balance and later in the fifties modern gravimeters such as Worden and LaCoste & Romberg were then used. The surveys result in a large number of gravity data scattered in many government institutions and companies. Most of the oil bearing structures in Indonesia were discovered by the gravity method. However, the gravity data are referred to different datum and efforts have been made to compile the data using a common standard procedure allowing the data more meaningful and useful.

The Indonesian Gravity Commission (IGC) or KGN (Komisi Gayaberat Nasional) which was established in 1989 is obliged to actively taking part to carry out this important compilation work. Members of the commission are those institutions involved with gravity related works namely, the National Coordinating Agency for Surveys and Mapping (BAKOSURTANAL) which takes part as the coordinating body, the Geological Research and Development Centre (GRDC), the Marine Geological Institute (MGI), the Bureau of Meteorology and Geophysics (BMG), PERTAMINA (the National Oil and Gas Company), the Oil and Gas Research Centre and Universities. The Commission consistently publishes Year Book, containing gravity work in the country and results of surveys and researches.

The GRDC has been conducting systematic gravity surveys over the whole archipelago since the year 1969. The survey using LaCoste and Romberg gravimeters is aimed at producing gravity sheet maps at the scale of 1:100 000 for Java and 1:250 000 for outside Java. The topographic sheet maps of 1: 50 000 in the island of Java and 1:250 000 in the islands outside Java are used as field base maps, when available aerial photos were also used. At present about 70 % of the whole land

area is covered by gravity measurements. (Figs. 1 & 2). Areas which are not covered are those inaccessible by land vehicles. It is strongly recommended that the areas would be surveyed using either airborne or helicopter platform. Gravity surveys applying a cell method were conducted in Papua from 1979 to 1981 using helicopter as transport. The surveys show an excellent technique for rugged areas. A topographic sheet map at the scale of 1:250 000 was divided into six cells with a cell center at the middle of a cell. The idea of a cell method is to keep a uniform station distribution in the area of investigation, (Untung, 1987).

The main base station in the country is DG-0 that stands for Directorate Geology Zero is located in the main building of the Geological Survey of Indonesia in Bandung. Its value is relative to the absolute gravity values in Sydney, Darwin, Tokyo and Singapore. All of the gravity measurements in the country should be based on the DG-0 value so that all of the values are on the same datum. At present all of the gravity values are reduced to the WGS84. The establishment of the base point and its derivative, classified as first order network, consisting of 61 stations were conducted under the cooperation of GRDC and the University New England Australia in 1976 and 1977, (Adkins, et al. 1978). However, most of the buildings where the gravity points were situated, have been renovated or modified leading to no longer available to be reoccupied for gravity control measurements.

BAKOSURTANAL established a comprehensive gravity network consisting of three categories, i.e. first, second and third orders. The first order network, in addition to the former network established by GRDC, consisting of 105 stations is located at commercial airports all over the country as shown in Figure 3. The second order stations are of 1807 stations located along roads in Java and Bali, 2429 stations in Sumatra, 896 stations in Sulawesi, 103 stations in Lombok, 220 stations in West Timor, 50 stations in Maluku and 104 stations in Seram. All of the stations are situated at such sites easy to be reoccupied Figure 4. BAKOSURTANAL also established two calibration lines each located in Java and Sumatra Islands with gravity interval of more than 200 mGal, (Manurung and Bahri, 2001).

A joint project of IGC and GETECH (Geophysical Technology) of the University of Leeds, UK, to establish a national gravity data base was initiated in 1993 up to 1996, (GETECH, 1995). The project resulted in an updating of all gravity data base in the country and the data are stored in the database at the GRDC computer center. This contains principal facts namely, stations position, elevation and observed gravity. Figure 5 shows an image map of Indonesia derived from data observed from the field and also from a data compilation of old data collected by oil companies in the fourties and also from satellite data in the sea areas. Some free air maps were also produced. Researches and exploration companies use the maps as a basic reference for exploration and studies. Gravity maps of Indonesia consisting of Free Air, Bouguer, and Digital Terrain Maps were produced and related papers were published in many international journals and conference proceedings.

The Marine Geological Institute (MGI) has been conducted marine gravity surveys on near-shore and coastal areas since the year of 1994.

The areas of coverage are as follows, Banten, Lada and Cirebon Bay, and Indramayu Waters in West Java, Jepara and Semarang Waters in Central Java, Gresik Waters and Bluto Bay in East Java and also in the waters of South Lampung, (Figures 6 and 7). Some gravity ties to the surveyed areas were carried out from the Indonesian Gravity Network main base station DG.0 located in Bandung and to the MGI Base Stations in Cilacap Sea Harbour (Central Java) and Pangkal Balam Sea Harbour in Bangka Island (South Sumatra). The surveys were run under the MGI's Project, that is, the Systematic Marine Geological Project. Except the areas of Jepara Waters in Central Java, Gresik waters in East Java as shown in Figure 6 and Berau Bay in the Bird Head of Irian Jaya or Papua as shown in Figure 8. Some technical assistance was also provided by MGI to PERTAMINA and private exploration companies such as Geoservices, Gecoprakla and Amerada Hess. At present, the MGI has covered areas of 11,384 sq. km, consisting of 341 stations in the coastal areas and 1,515 stations near shore. Comprehensive marine surveys were also conducted by foreign scientific institutions such as Woods Hole and California Institute of Technology and also some from Europe, (MGI, 2001)

The aims of the marine gravity surveys are to collect gravity data of near shore and coastal areas and to produce Free Air gravity anomaly maps at the scale of 1:100.000 and occasionally Bouguer anomaly maps. The near shore areas were surveyed using an underwater gravitymeter of LaCoste & Romberg model U26/G964 whereas the coastal areas by a land gravitymeter of LaCoste & Romberg model G-862. The GPS Trimble and Garmin navigation system were used to determine the site locations. Depths of the sea bottom were determined using echo sounders SIMRAD or Raytheon. Since the underwater gravitymeter is equipped with a pressure gauge, in some cases, this was also used to determine the sea bottom depths. The depth values obtained by the underwater gravitymeter are much similar to those obtained with SIMRAD echosounder. Transit and leveling equipments were used to determine accurate positions and elevations of the base stations. Tidal observations were conducted to determine the mean sea level and also to correct the depths of the sea floor. The survey line interval of the near-shore is of 3 to 5 km and 1 to 2 km in the coastal areas. The GRS67 and the crustal density of 2.67 g/cm^3 were used to calculate the anomalies, whereas Surfer Software version 16.0 and Map Info version 6.0 were used for contouring. The value of free air anomaly ranges from 20 to 90 mGal.

Research on geoid determination is carried out by universities and Bakosurtanal whereas the application of gravity for mineral, hydrocarbon exploration and geodynamic are by universities and research institutes. Intensive studies on local gravity phenomena and volcanic eruptions have also been made by the Gajah Mada University in Yogyakarta, (UGM, 2001). There are about 660 gravity observation stations carried out around the Merapi and Merbabu volcanoes. The surveys result contributes a better understanding on the mechanism of magma flow along the eruption channel. Further research on this problem has still to be made.

The Bureau of Meteorology and Geophysics (BMG) maintains seismic stations all over the country to record seismic events such as

earthquakes and tremors. In addition to recording the seismological phenomena, gravity measurements were also conducted on the same site and these are also part of the national gravity network, (BMG, 2001). These stations in total of 28 are marked permanently by pillars of half a meter of height.

A database on oil and gas data is established by Patra Nusa Data, a private company assigned by the Directorate General of Oil and Gas of the Department of Energy and Mineral Resources to monitor and record all oil and gas exploration as well as production. The database bears a name of Indonesian Metadata base (INAMETA), (Patra Nusa Data, 2001). As far as gravity data stored in INAMETA, there are 456 reports and 1,256 gravity maps. These data will not of any value if a thorough and serious study not to be made.

Some private exploration companies also made gravity measurements for locating economic potential deposits such oil and gas and also minerals. Such activities are usually in the form of a contract work, (Geoservices, 2001).

References

Adkins, J., Sukardi, S., Said, H. and Untung, M., 1978, *A Gravity base Station Network for Indonesia,* Geol. Surv. Of Indonesia, Technical Publication.

Bureau of Meteorology and Geophysics, 2001, *Activity of Surveys and Gravity Mapping,* Proceedings, IGC, 2001.

GRDC, 2001, *Status of Gravity Mapping*, Proceedings, IGC, 2001.

Geoservices, P.T., 2001, *Activity of Gravity Section,* Proceedings, IGC, 2001.

GETECH, 1995, *South East Asia Gravity Project Technical Report, Indonesia,* GETECH, Department of Earth Sciences, University of Leeds.

Manurung, P. and Bahri, E.S., 2001, *Fifteen Years Gravity Survey Activity within Bakosurtanal,* Proceedings, IGC, 2001.

MGI, Marine Geological Institute, 2001, *Mapping and Gravity Survey Activity,* Proceedings, IGC, 2001.

Patra Nusa Data, P.T., 2001, *The IGC Activity within Patra Nusa Data in the period 2000-2001,* Proceedings, IGC, 2001.

UGM, Gajah Mada University, 2001, *The UGM Activity on Gravity*, Proceedings, IGC, 2001.

Untung, M., 1987, *The Isostatic State of the Crust in the Western Portion of Irian Jaya*, Sixth Regional Congress on Geology, Mineral and Energy Resources, Jakarta, 6-12 July, 1987.

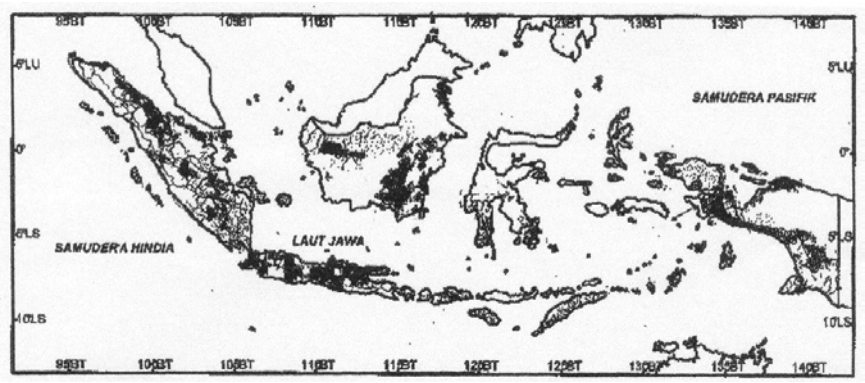


Figure 1. Distribution of Land Gravity Observation stations in Indonesia. Status at the end of 2001. Blank area is not accessible by land vehicles. Airborne gravity is recommended.

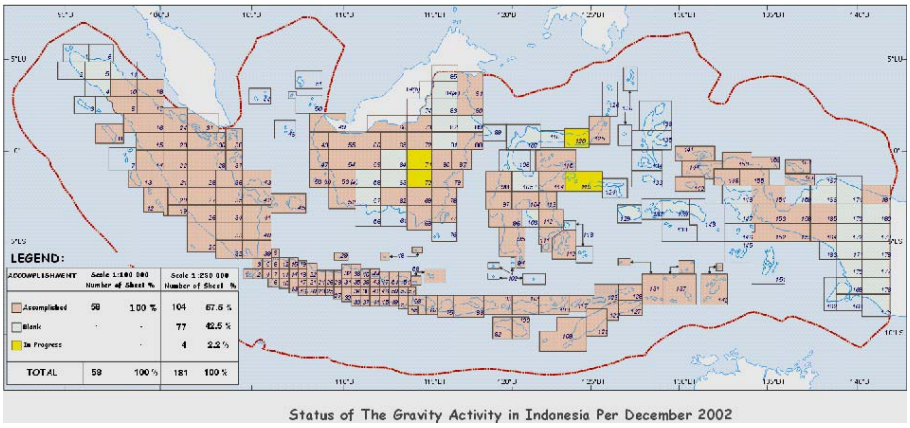


Figure 2: Status of systematic gravity mapping at the end of 2002. Station spacing in Java of about 2 km, outside Java 5 – 10 km. Product: Gravity sheet map of 1:100,000 for Java and gravity sheet map of 1:250,000 for outside Java.

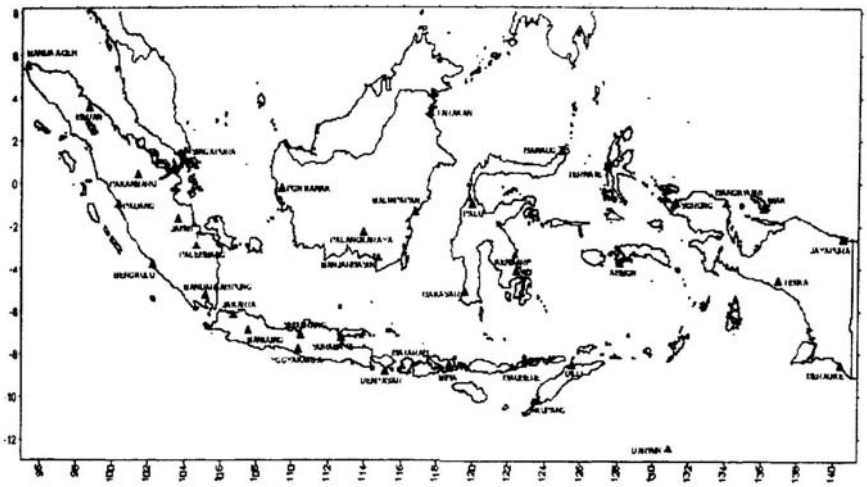


Figure 3. Distribution of First Order of the National Gravity Network

Figure 4. Distribution of Second Order of the National Gravity Network

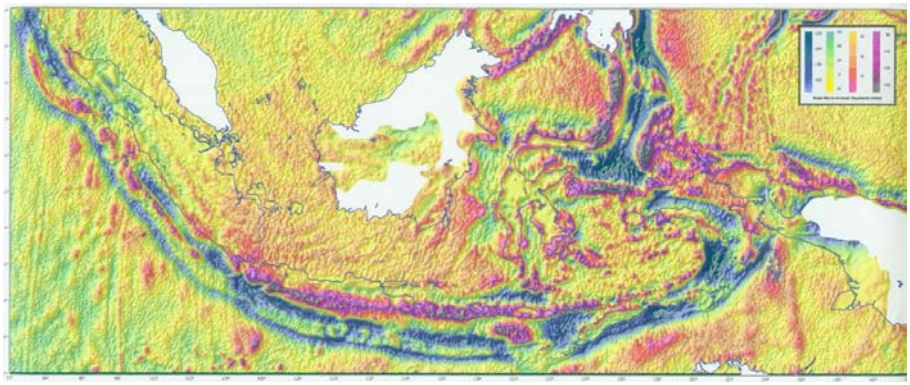


Figure 5. Gravity Anomaly Indonesia 1:5.000.000 compiled from land Bougeur values and Free-air in the marine area. The Bouguer reduction uses the WGS84, where as the Free-air anomaly is obtained from the altimetry satellite. There are 203,129 stations for the Bourgeur reduction and 741,602 for the Free-air. Grid spacing is 2′ x 2′.

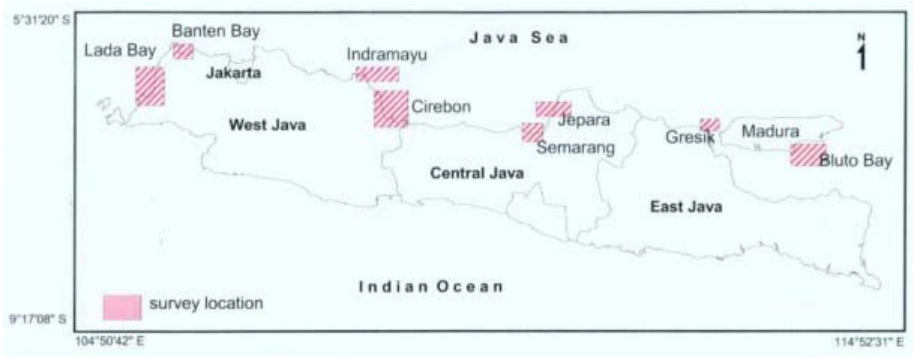


Figure 7. Gravity Mapping in Java from data observed from the field and also from a data compilation of old data collected and also from satellite data in the sea areas

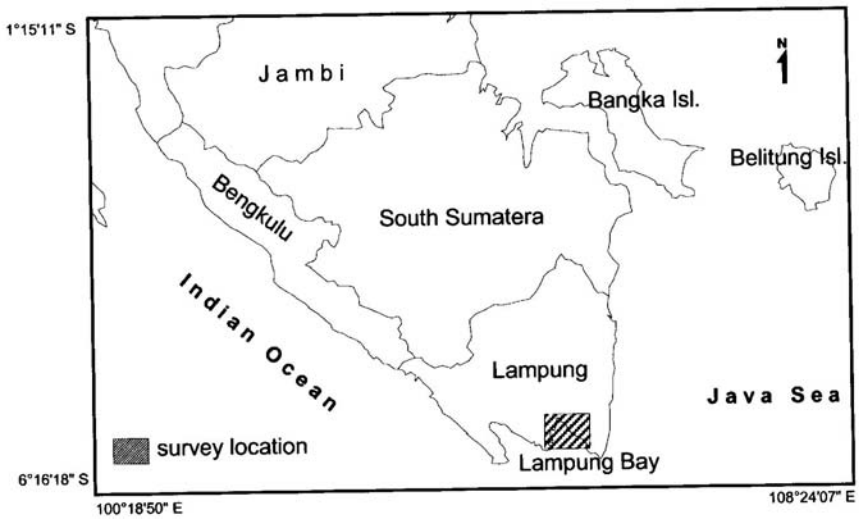


Figure 7. Gravity Mapping in Sumatra from data observed from the field and also from a data compilation of old data collected and also from satellite data in the sea areas

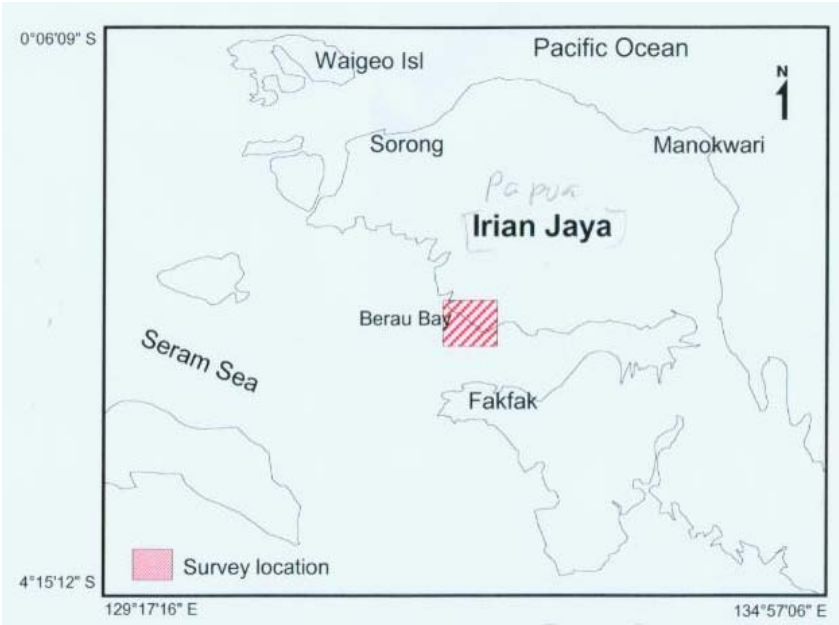


Figure 8. Gravity Mapping in Irian Jaya (Papua) from data observed from the field and also from a data compilation of old data collected and also from satellite data in the sea areas.

GPS Survey for Natural Hazard Mitigation in Indonesia

Dr. Hasanuddin Z. Abidin
Dept. of Geodetic Engineering, Institute of Technology Bandung
Jl. Ganesha 10 Bandung 40132 INDONESIA
e-mail : hzabidin@gd.itb.ac.id

Introduction

Indonesia are prone to several natural hazards, such as arthquakes, volcanic eruptions, landslides, landsubsidence, droughts, floods, forest fires, windstorms, and tsunamis.
Many geodetic techniques have been used for studying and monitoring such natural hazard mitigation. This section will describe in general the use of GPS survey technique for volcano deformation, landsubsidence, and land slide studies in Indonesia.

GPS Surveys for Volcano Deformation Monitoring

Monitoring volcano deformation have been conducted at several volcanoes in Indonesia. Departement of Geodetic Engineering, Institute of Technology Bandung in cooperation with Directorate of Vulcanology and Geological Hazard Mitigation has conducted GPS surveys in Guntur, Papandayan, Galunggung, Tangkubanperahu, Kelut, Bromo, Ijen dan Batur volcanoes. Location of these volcanoes can be seen in the following Figure 1.

Up to June 2003, the number of campaigns that have been conducted on those volcanoes are 12 times for Guntur, 7 times for Papandayan, 3 times for Galunggung, once for Tangkubanperahu, 3 times for Kelut, 2 times for Bromo, once for Ijen dan 3 times for Batur volcanoes. Geodetic dual-frequency GPS receivers are used for observation, and a Bernesse 4.2 GPS software is used for data processing.

The results of those GPS-based volcano deformation monitoring studies can be seen in *Abidin et al.* (1997, 1998a, 1998b, 1998c), *Abidin* (1998), *Abidin et al.* (2001a, 2002) dan *Abidin* (2001). The studies have provided not only the deformation characteristics of the corresponding volcanoes, but also the understanding on strengths and weaknesses of GPS survey technique for volcano deformation study and monitoring.

Figure 1. Location of major volcanoes in Indonesia.

GPS Surveys for Land Subsidence Monitoring

Land subsidence is not a new phenomenon for Jakarta. It has been reported for many years that several places in Jakarta are subsiding at different rates. According to the Local Mines Agency of Jakarta, over the period of 1982 to 1997, subsidence ranging from 20 cm to 200 cm is evident in several places in Jakarta. The occurrence of land subsidence in Jakarta was realized for the first time in 1926.

According to hydro-geologists there are four different types of land subsidence that can be expected to occur in the Jakarta basin, namely: subsidence due to groundwater extraction, subsidence induced by the load of constructions (i.e. settlement of high compressibility soil), subsidence caused by natural consolidation of alluvium soil, and geotectonic subsidence. From those types of subsidence, the main spectrum of land subsidence in Jakarta is thought to be caused by groundwater extraction.

Since the early 1980's, the land subsidence in several places of Jakarta has been measured using several measurement techniques, e.g. leveling surveys, extensometer measurements, ground water level observations, and GPS (Global Positioning System) surveys.

For studying land subsidence phenomena in Jakarta, seven GPS surveys have been conducted so far, starting in Dec. 1997. The GPS subsidence monitoring network being used is shown in Figure 2, consisting of about 20 points. The surveys were conducted by the Departement of Geodetic Engineering, Institute of Technology Bandung in cooperation with Directorate of Vulcanology and Geological Hazard Mitigation. Geodetic dual-frequency GPS receivers are used for observation, and a Bernesse 4.2 GPS software is used for data processing.

The results obtained by this study can be seen in *Abidin et al.* (1998d, 2000, 2001b) and *Yulaikhah et al.* (2001).

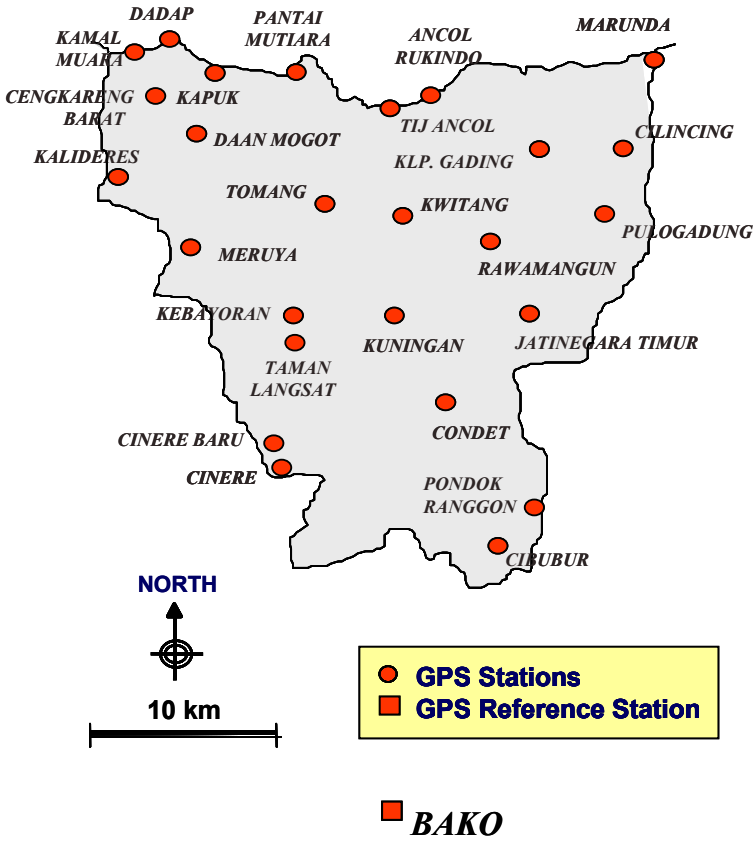


Figure 2. GPS subsidence monitoring network in Jakarta.

GPS surveys have also been conducted to study land subsidence phenomena in Bandung basin, West Java. Four GPS surveys have been carried out, namely in Feb. 2000, Nov. 2001, July 2002 and June 2003. The GPS subsidence monitoring network being used is shown in Figure 3. The surveys were conducted by the Departement of Geodetic Engineering, Institute of Technology Bandung in cooperation with Directorate of Vulcanology and Geological Hazard Mitigation. Geodetic dual-frequency GPS receivers are used for observation, and a Bernesse 4.2 GPS software is used for data processing. The results obtained by this study can be seen in *Abidin et al.* (2000, 2002).

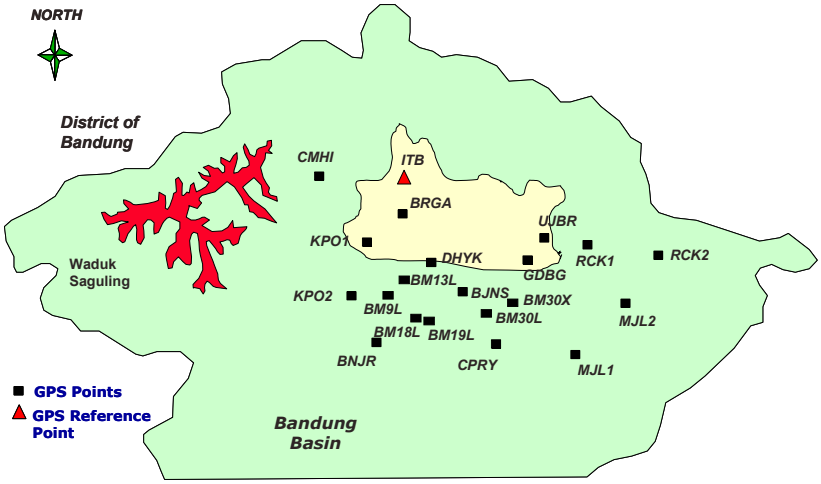


Figure 3. GPS subsidence monitoring network in Bandung basin.

GPS Surveys for Landslide Study

GPS surveys have also been conducted to study land slide phenomena in two landslide prone areas in West Java, namely Ciloto and Megamendung. Three GPS surveys have been carried out in Ciloto, and two surveys in Megamendung. The GPS landslide monitoring network being used in Ciloto and Megamendung are shown in Figures 4 and 5. The surveys were conducted by the Departement of Geodetic Engineering, Institute of Technology Bandung in cooperation with Directorate of Vulcanology and Geological Hazard Mitigation. Geodetic dual-frequency GPS receivers are used for observation, and a Bernesse 4.2 GPS software is used for data processing. The results obtained by this study have not been published yet.

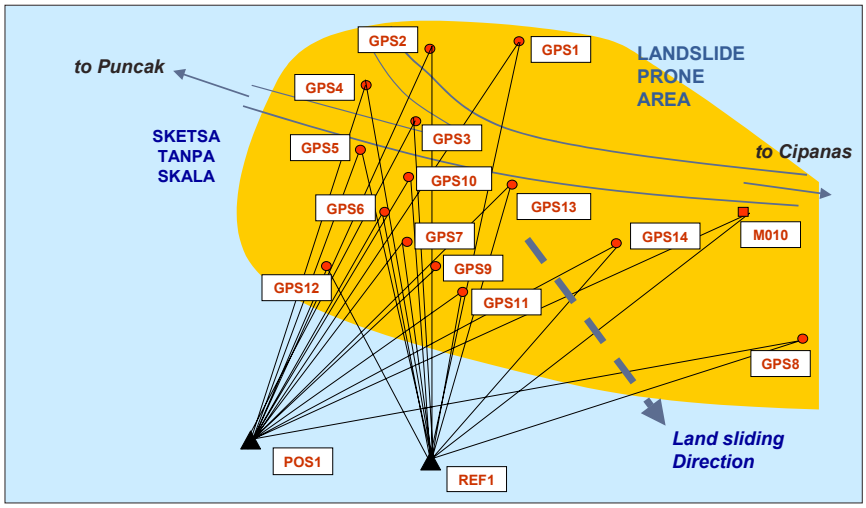


Figure 4. GPS landslide monitoring network in Megamendung area.

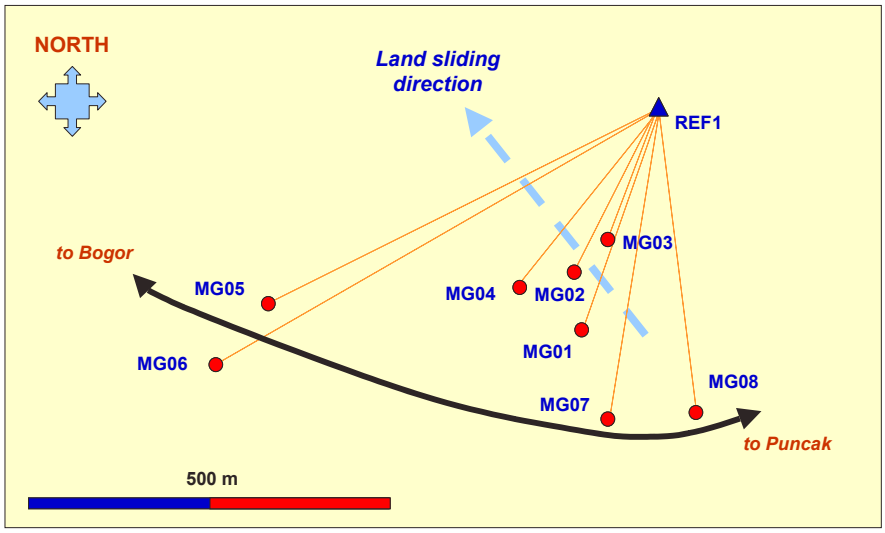


Figure 5. GPS landslide monitoring network in Megamendung area.

Bibliography

Abidin,H.Z., O.K. Suganda, M.A. Kusuma, I. Meilano, B. Setyadji, D. Muhardi, R. Sukhyar, J. Kahar, T. Tanaka (1997). "Monitoring the Deformation of Guntur Volcano (West Java, Indonesia) Using GPS Survey Method: Status and Future Plan." Proceedings of International Symposium on Natural Disaster Prediction and Mitigation, Kyoto, December 1-5, pp. 81 – 88.

Abidin,H.Z., I. Meilano, O.K. Suganda, M.A. Kusuma, D. Muhardi, O. Yolanda, B. Setyadji, R. Sukhyar, J. Kahar, T. Tanaka (1998a). "Monitoring the Deformation of Guntur Volcano Using Repeated GPS Survey Method" Proceedings of the XXI International Congress of FIG, Commission 5 : Positioning and Measurements, Brighton, U.K., 19 – 25 July, pp. 153 - 169.

Abidin,H.Z., O.K. Suganda, I. Meilano, M.A. Kusuma, B. Setyadji, R. Sukhyar, J. Kahar, T. Ta-naka, C. Rizos (1998b). "Deformation Monitoring of Indonesian Volcanoes Using Re-peated GPS Survey Method: Status and Plan." Proceedings of Symposium on Japan-Indonesia IDNDR Project Volcanology, tectonics, Flood, and Sediment Hazards, Band-ung, 21-23 September, pp. 39 – 50.

Abidin,H.Z., I. Meilano, O.K. Suganda, M.A. Kusuma, O. Yolanda, D. Muhardi, B. Setyadji, R. Sukhyar, J. Kahar, T. Tanaka (1998c). "Some Aspects of Volcano Deformation Monitoring Using Repeated GPS Surveys." Proceedings of Spatial Information Science, Technology and Its Applications, Wuhan, China, 13-16 December, pp. 92 - 109.

Abidin, H.Z., M.A. Kusuma, I. Meilano, M. Arief Nurdin, Dudi Darmawan, Agus Bintoro, J. Kahar (1998) "Pemantauan penurunan tanah di wilayah Jakarta dengan metode survei GPS." *S&P, Majalah Survey*

dan Pemetaan, Majalah Ikatan Surveyor Indonesia, ISSN : 0125-9466, Vol. XII, No.3, Juni, pp. 45 - 56.

Abidin,H.Z. (1998). " Monitoring the deformation of volcanoes in Indonesia using repeated GPS survey method: status, results and future plan." Proceedings of the International Workshop on Advances in GPS Deformation Monitoring, ISBN : 1-86308-073-2, Curtin University, Perth, 24-25 September, Paper no. 18.

Abidin,H.Z., I. Meilano, R. Djaja, D. Darmawan, R. Songsang, I. Meilano, M.A. Kusuma, Sumarwan, H. Rajiyowiryono, C. Subarya (2000). "Studi Penurunan Tanah di Jakarta dan Bandung Dengan Metode Survei GPS." *Proceedings of the 29th Annual Convention of Indonesian Association of Geologists,* Vol. 3 : Environmental Geology and Geological Hazard, Bandung, 21-22 November, pp. 53 - 64.

Abidin, H.Z. (2001). "The Use of GPS for Natural Hazard Mitigation in Indonesia." Proceedings of Workshop on the Use of GNSS, Jointly organized by UN/USA/Malaysia, Kuala Lum-pur, 20-24 Agustus, Session IV, Paper 3.

Abidin, H.Z., M.A. Kusuma, O.K. Suganda, F. Kimata, A. Tanaka, S. Kobayashi, N. Fujii (2001a). "Studying the deformation of Indonesian volcanoes by GPS and INSAR tech-niques." Proceedings of 1st ALOS PI Workshop, Earth Observation Research Center (EORC) NASDA, Tokyo, 28-30 March, pp. 157 - 159.

Abidin, H. Z., R. Djaja, D. Darmawan, S. Hadi, A. Akbar, H. Rajiyowiryono, Y. Sudibyo, I. Meilano, M. A. Kusuma, J. Kahar, C. Subarya (2001b). "Land Subsidence of Jakarta (Indonesia) and its Geodetic-Based Monitoring System." *Natural Hazards*. Journal of the International Society of the Preventation and Mitigation of Natural Hazards, Vol. 23, No. 2/3, March, pp. 365 - 387.

Abidin, H.Z., M. Hendrasto, H. Andreas, M. Gamal, F. Kimata, O.K. Suganda, M.A. Kusuma, M.A. Purbawinata (2002). " Studying the Deformation of Bromo Volcano by Using GPS and EDM Surveys". Program and abstracts of International Symposium on Geodesy in Kanazawa and 98th Meeting of the Geodetic Society of Japan, Kanazawa, 28-30 October, Paper I10, pp. 19-20.

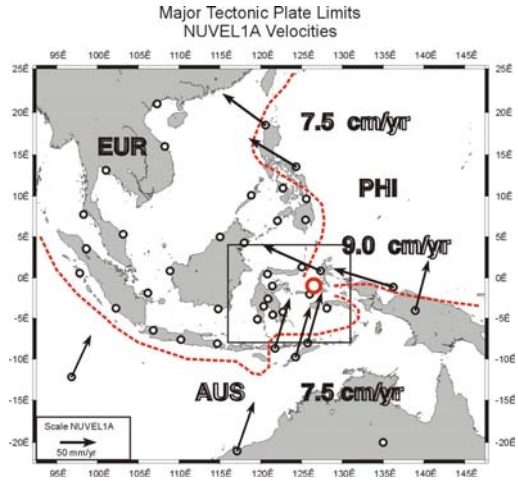
Abidin, H.Z., R. Djaja, H. Andreas, M. Gamal, D. Murdohardono, H. Rajiyowiryono (2002) "Penurunan Tanah di Cekungan Bandung Pada Periode (2000 – 2002) Hasil Estimasi Metode Survei GPS." *Majalah Geologi Indonesia*, , ISSN : 0216-1061, Vol. 17, No. 3, Desember, pp. 55 - 72.

Yulaikhah, H.Z. Abidin, and D. Murdohardono (2001) "Model Perkiraan Penurunan Muka Tanah Wilayah DKI Jakarta." *Majalah Geologi Indonesia*, , ISSN : 0216-1061, Vol. 16, No. 1, April, pp. 55 - 72.

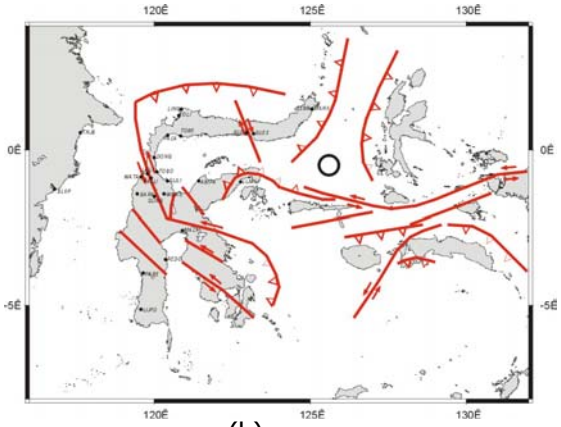
Tectonics Motions of Sulawesi Region

D..A Sarsito & J. Kahar
Department of Geodetic Engineering
Institute of Technology in Bandung

Studying of the geodynamics of Eastern Indonesia has been conducted since 1997, under cooperation of DEOS (Delft Institute for Earth Oriented Space Research) and the Department of Geodetic Engineering, the Institute of Technology, Bandung (ITB). Every year, since 1997. a dense geodestic network in Sulawesi, Indonesia was re-measured. The network is situated in a tectonic complex region near the triple junction of the Eurasian, the Philippine and the Indo-Australian tectonic plates (figure 1). The campaign included a re-measurement of a Palu-Koro fault transect in Sulawesi. The campaign coordinate solutions were computed and mapped in the ITRF 1997. using a regional IGS site approach.



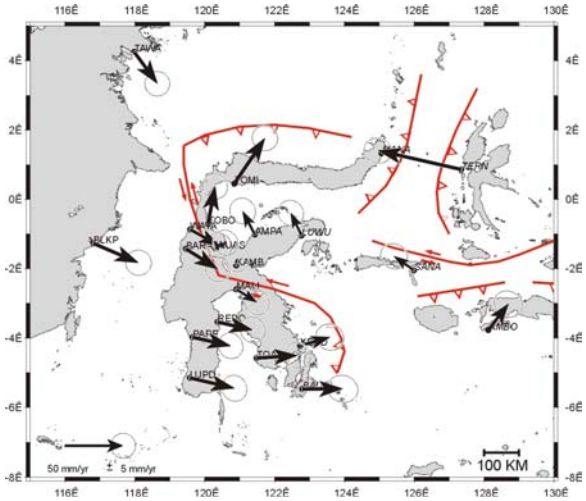
(a)



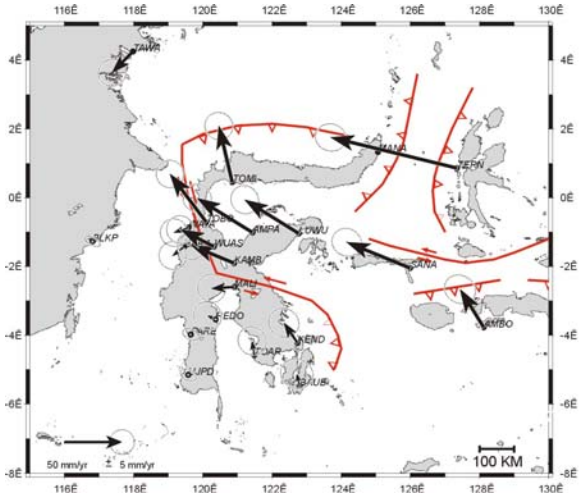
(b)

Figure 1: (a) Sulawesi in Major tectonic Plates;
(b) Main tectonics in Sulawesi

Preliminary result of GPS Sulawesi Campaign are shown in figures 2 and 3

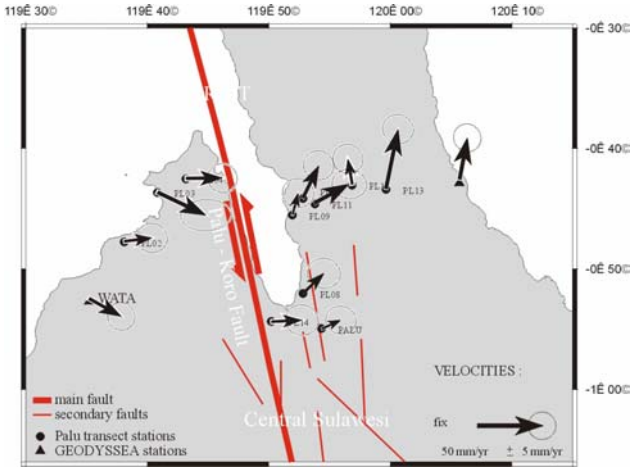


(a)

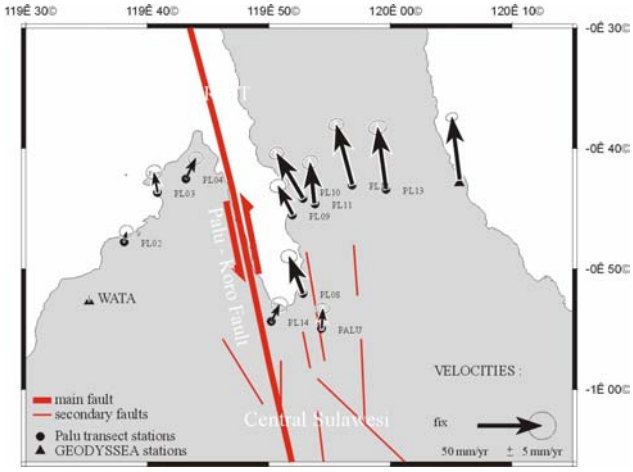


(b)

Figure 2: Horizontal velocities (a) in ITRF, (b) w.r.t Sundaland



(a)



(b)

Figure 3: Result of Palu-Koro transect: (a) ITRF97, wrt Sundaland

More explanation about this investigation might be foud in some oublications such as Sarsito, et al [2000], Sarsito, et al [2002] and Simons, et al [1999].

References

Sarsito, D.A., W.J.F. Simons, B.A.C. Ambrosius [2002]: Studying the Dynamics of Sulawesi Using Geodetic Approach: The Preliminary Results . Presented at the Annual Meeting of the Indonesia Gephycisists Union, Bandung, October 2000

Sarsito, D.A., W.J.F. Simons. B.A.C. Ambrosius, H.Z. Abidin,. J.Kahar [2002]: Tectonic Motions of Sulawesi Region: Preliminary Results of the Sulawesi 2000 GPS Campaign. Presented at the International Workshop on Tsunami Risk and its Reduction in the Asia Pacific Region, Bandung, Indonesia 18 – 19 Mei 2002.

Simons, W.J.F, D. van Loon, A. Walpersdorf, B.A.C Ambrosius, J. Kahar, H.Z. Abidin, D.A. Sarsito, C. Vigny, S.H. Abu, P. Morgan: Geeodynamics of S.E. Asia: First Results of the Sulawesi 1998 GPS Campaign: in Geodesy Beyond 2000 (ed: K.P Schwarz), IAG Symposia vol. 121, Springer-Verlag, Berlin, pp. 271- 277

Geoid Study of the Indonesian Archipelago

Prijatna, K and J. Kahar
Department of Geodetic Engineering
Institute of Technolgy in Bandung

Determination of the geoid of the Indonesia Archipelego is started by Kahar [1981] by accuracy is about ± 4 m on land region. According to Khafid [1997], a precise geoid in the Indonesian Archipelgo might be obtained by considering the following facts:

1. Pysical terrain or bathimetric characteristics, e.g. moiuntainous terrain, complex tectonics and type archipelago-type geography;
2. establishment of a high resolution mean free air gravity anomaly data base covering the entire area of Indonesia and its of its surrounding;
3. need for a Digital Terrain Model (DTM) in order to correct for the terrain effects
4. unified national vertical datum;
5. insight into the oceanographic and tidal setting in the Indonesian waters for tide gauges and satellite altimetry.

Considering the above facts Prijatna [1998] a strategy for geoid determination in the Indonesian Archipelago. To implement the strategic plan, some studies and investigations were conducted by Prijatna & Haagmans [2000,2002].

References

Kahar, J. [1981]: Analysis of geoid in Indonesian Region. PhD Dissertation, Institut teknologi Bandung.

Khafid [1997]: On the unification of Indonesian Local Height System, PhD Dissertation. Institut fur Astronomische und Physikalische Geodaesie , Technisse Universitaet Muenchen, Germany.

Prijatna, K. [1998]: A strategy for geoid determination in the Indonesian Archipelago. DEOS Progress Letter (Ed: Roland Klees0, no. 98.1, pp. 101-122.

Prijatna, K. and R. Haagmans [2000]: Investigation on a geoid computation procedure for the Indonesian Archipelgo: A Simulation. Poster presentation at IAG Meeting, Banff, Canada.

Prijatna, K. and R. Haagmans [2002]: Combination of a global geopotential model, gradiometry and gravity data in regional geoid determination. Poster presentation at IAG Meeting Budapest, Hungary.

Geomagnetic Activity of Indonesia

Executive Summary

Dr. Hendar Gunawan
Tangerang Geophysical Station
Jl. Meteorologi No. 5 Tanah Tinggi Tangerang, INDONESIA
e-mail : hendargunawan@hotmail.com

Network of Observation and Improvement.

Permanent Observatory

Indonesia Geomagnetic Observatory has been operated since 1959 by Meteorological and Geophysical Agency (BMG), Department of Communication. Three Permanent Geomagnetic Observatories maintain by government of Indonesia are Tangerang Geomagnetic Observatory, Banten Province, since 1959, and Tuntungan , Medan , North of Sumatra Province since 1974 and Tondano , Manado Geomagnetic Observatory, North of Sulawesi Province since 1990. All of these stations started with analog instruments.

There are two kind of standard observations are Absolute Observation and Relative Observation sistem. Absolute Obserevation by using classical instrumentation based on the observation of magnet in a changing magnetic field. The classic absolute measurement of Horizontal Intensity H using Quartz Horizotal Magnetometer (QHM), Balance Magnetic Zero (BMZ), and Declination Inclination Magnetometer (DIM). Relative Observation in classical system variometer were used torsion magnetometers with suspended and balance magnets for continuous recording of the field variations. The variations were recorded in analog form on photopaper. All of the Absolute and Relative classical Observations still in good operations and product geomagnetic data such as Horizontal Intensity, Geomagnetic Declination, Vertical Intensity and Total Intensity and others geomagnetic component.

The main problem should become for next year or next two years are difficulties for photographics paper for continuous variograph. Because of magnetic observation are intended to operate over long term, for ten or hundred years is short time, the main problem is development of environment due to artificial magnetic disturbance. For instant at Tangerang Geomagnetic Observatory showed height electromagnetic noise from New electrical railway and local activity (central market, houses of villages near side observations and others. Effect of artificial magnetic disturbance such as instability of base line absolute data, not clear of suddent magnetic storm etc.

Improvement to modern standard instrument with digital computer base geomagnetic observatory and operations have been improved at two stations. Tangerang Geomagnetic Observatory since 1999 and Tondano, North of Sulawesi Province since 2000. These instruments are Digital Variometer Instrument, Computer Data Acquisition System, and Computer Data Processing and Absolute instrument. Tuntungan Geomagnetic Observatory still in classical operations and tried to improve this year in cooperation with Belgium.

Repeat Stations Network.

Fifty-three magnetic repeat Stations also maintained by Meteorological and Geophysical Agency since 1960's, with the network to covered all of Indonesia region. The time observation done every five years, describes five magnetic element reduce to the five year magnetic EPOCH. Magnetic repeat stations network located mainly at Aerodrome Airport, Meteorological Stations and Geophysical Stations and others. The last Magnetic EPOCH 2000 has be done and already published.

The main problem are loses of point repeat station observations because of airstrip extension and development of airport building. Technical problem are non simultaneously time observations and worse data reduce to EPOCH station correction.

Monitoring Remark.

Brief on monitoring remarks for geomagnetic data is : Try to maintained continuity observational and long time operational. Improvement of Geomagnetic instrumentations using digital adoption and upgrade geomagnetic instrument. Inter exchange geomagnetic data and do maintained or supervision for developing country. The need of training and asistance for continuitas operational with IAGA standard.

Improvement of digital instrumentation observation system will improve data quantity, and quality of geomagnetic data in Equatorial area, especcially in Indonesia. Forinstant monitoring of magnetic storm activity such as a storm suddent commencement (SSC), suddent impuls (SI) etc. are very clear.

Activities Related to Ionospheric Research in Indonesia

Dr. Sarmoko Saroso
National Institute of Aeronautic and Space (LAPAN)
The Atmospheric Science and Climate Application Center
Address: Jl. Dr. Djundjunan 133 Bandung, 40173 Indonesia
fax. no. : +62 22 6037443

Ionospheric Vertical Sounding Observations and Research

The ionospheric vertical sounding network in Indonesia consist of six digital ionosondes located at Pameungpeuk (7.64°S, 107.69°E), Biak (1.10°S, 136.05°E), Pontianak (0.03°S, 109.33°E), Sumedang (6.90°S, 107.50°E), Manado (1.48°N, 120.85°E), and Kupang (10.17°S, 123.98°E). The digital ionosondes data provided every 15 minutes with high time resolution digital ionograms will be come available. These high time resolution ionograms will provide useful information on the behavior of ionospheric layer and also for HF radio communication over Indonesia. The ionospheric vertical sounding observations covers about one solar cycle is used to develop a model of HF radio communication prediction. Through collaboration between Indonesia and Australia, the accuracy of frequency prediction has been improved using real-time frequency management. The activity is supported by oblique sounding system between Manado - Sumedang, Manado - Darwin and Manado - Derby.

The spread F phenomenon observed as diffuse echoes on the ionograms, is a well known feature occuring during nighttime. According to their diffusion characteristics on the ionogram, Spread F echoes are usually classified into two types: frequency Spread F and range Spread F. By using the spread F data obtained at ionosonde network in Indonesia during the period from 1982 to 2002, the seasonal and solar cycle variations of frequency and range type Spread F at the equatorial anomaly region were investigated in detail. Indonesia is presently participating in Western Pacific project to develop a forecasting capability fot the occurance and severity of Equatorial Spread F (ESF) on a day-to-day time scale. The goal of the Western Pacific project is to obtain a comprehensive set of measurements include the electric field and the plasma density distribution along a magnetic meridian plane (120°E longitude), in both hemisphere.

Ionospheric Total Electron Content Observations and Research

Total electron content and scintillation observations are carried out at Sumedang, Bandung, Pontianak and Parepare in collaboration with DSTO (Defence Science and Technology Organisation) Australia, to study the effect of the ionosphere on the reception of signals from satellites.

Total electron content and scintillation data deduced from GPS satellites, with applications to the physical modelling of total electron content and of scintillation effects. The signals from GPS satellites are being used to provide group delay and differential phase information as well as the total electron content and scintillation. A daily plot of diurnal variations of total electron content and scintillation are produced for each day.

Towards a new paradigm for integrated water resources management and development in Indonesia

Joesron Loebis
Research Institute for Water Resources
Jl. Ir.H.Juanda 193, Bandung 40135, INDONESIA
joesron@melsa.net.id

Abstract

Indonesia is currently decentralizing water resources management to regional governments. In order to achieve the objectives of an efficient and effective water supply to all stakeholders, the implementation of a policy of "one river basin, one plan and one integrated water resources management and development" is urgently needed. This policy focuses on establishing a proper institutional framework, exploring self-financing system management strategies, as well as legal aspects and water rights for development and management. In this paper, establishing an institutional framework is the main issue which is very complex because of the interacting domains of economy, society, law, culture, science and technology. An interdisciplinary analysis of all the above factors are thus very important. The paper also addresses the modification of existing aspects of water resources related to the present law and regulations, establishing a networking of hydrological data collection, providing decision support systems, analyses of the conjunctive use of surface water and groundwater at the local scale, water quality control and role sharing between central and regional governments.

Key words: Water Resources Management

Introduction

In 1999, Indonesia has entered a new era by issuing and implementing Law 22 on the Regional Governments. The spirit of the new law is to decentralize authority and responsibility from the central to the regional governments in order to distribute welfare more uniformly across the nation. Regional governments are now acquiring substantial authority and responsibility to manage all domestic resources. This covers all sectors, including water resources. Focusing on the water resources sector, this paper will concentrate on its management and development aspects in relation to the strategic issues mentioned above. The following table compares the present paradigm with the new one that is proposed in this paper.

No	Obsolete	New Pradigm
1	Water is considered a public good.	Water is considered an economic good.
2	Water supply is a welfare activity.	Water supply is an economic activity
3	Decision making is centralized in government offices (Minister of Public Work).	Water allocation is a decentralized activity
4	Administrative regulation of water supply	Water is considered an economic instrument
5	Bureaucratic allocation of water to users	Stakeholders participate in the allocation of water.
6	A proliferation of agencies to administer water.	There is one single transparent agency at the national level, for controlling.
7	Water licenses granted in isolation	Conjunctive use of groundwater and surface water.
8	Unclear and inefficient organizational structure.	Water administration fully accountable to public.
9	Water developments for single use only.	Integrated development for multiple uses.
10	Water administration based on political subdivisions of country.	Water administration based on river basin units.
11	Water distribution is heavily subsidized and is a heavy burden on the national budget.	The user pays, thus releasing government funds for other purpose

Present Conditions

Problems with managing the water resources in Indonesia have been a serious warning and encouragement for the government to establish a policy that involves all related parties (stake holders) including all government institutions, related sectors, professional organization, and non-governmental organization. Although water is a renewable resource, following its hydrologic cycle irrespective of administration or political boundary, its use and sustainability are heavily influenced by the politic, social, and economic conditions of the society in the water resources area. Therefore a solution is needed that integrates the natural system (both quantitative and qualitative) with the societal system of the resource users. However, these two system integrations alone will not be sufficient, inter-sector interaction involving all related parties (stake holders) need also be taken care of. Specifically, three fields are involved: watershed management, water resources management, and environmental management. Three institutions will perform these three activities with different responsibilities, although they are related to each other. Therefore, these fields need to be managed simultaneously within one policy framework of integrated management approved by all related institutions involving all stakeholders (see Fig. 1). The critical levels of

water resources availability to support the environment can be described as follows:

1. Total size of critical river catchments has increased from 13.1 × 10^6 to 18.5 × 10^6 ha as a result of forest development. Therefore, the number of management areas has increased from 22 to 59. As a result of a decrease in catchment storage capacity, stream flow may become more variable, enhancing soil erosion and sedimentation.
2. Extended dry season related to global climate fluctuations influencing food production significantly.
3. Dramatic decrease in streamwater quality as a result of pollution, which may lead to an increase of water supply processing costs, negative impacts on public sanitation and an endangerment of water biota.
4. Degradation of river beds as a result of sand and rock mining in many rivers, causing structural, functional and infrastructure damage alongside the rivers.
5. Increase in sedimentation as a result of erosion in upstream catchment areas, household garbage in urban areas, tailing, and land development which has already caused river morphology changes. Decreasing river channel capacities resulting in ecosystem damage and a threat of flood disaster.
6. Groundwater mining exceeding the natural availability which may cause land subsidence and seawater intrusion in several rural and urban areas.

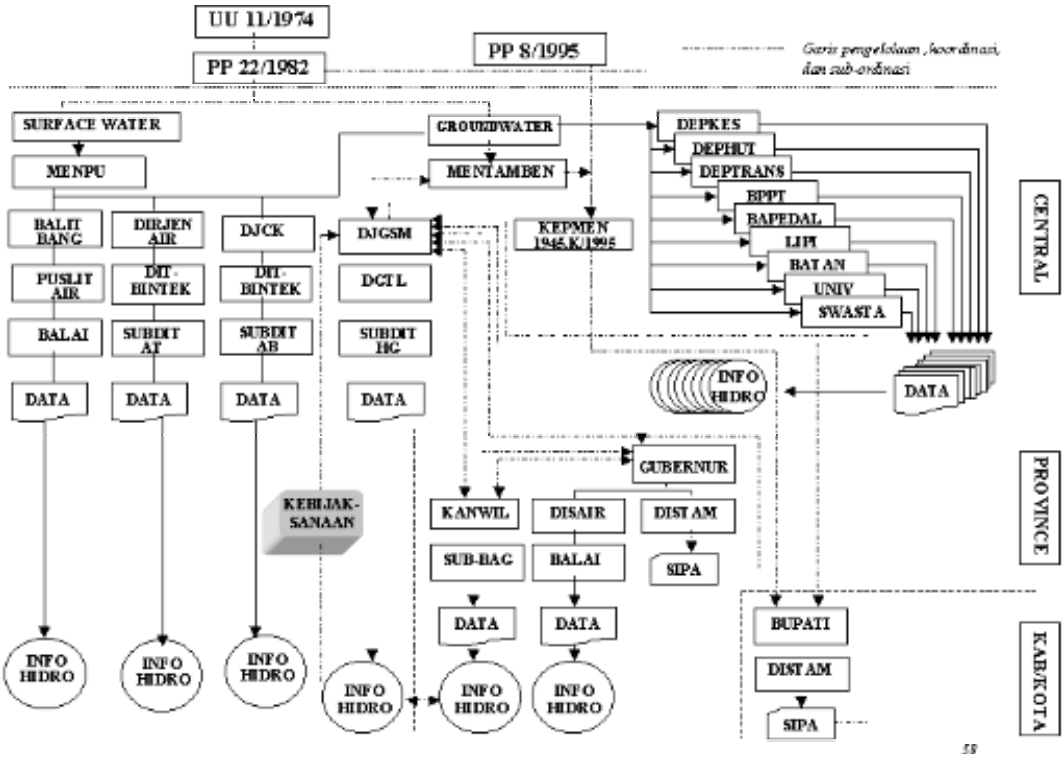


Figure 1. Present condition.

The water resources sector is also facing the problem of long term investments and the increasing challenge and complexity in management

which may hamper economic development and food supply stability. Such problems may be caused by negative impacts of population growth, urbanization and industrialization. Among the main problems are the following:

1. Local scarcity of water allocation in various sectors as a result of increasing non-irrigation sector demand.
2. Insufficient clean water supply if the infrastructure and clean water management institutions are not able to meet the fast growing demand.
3. Water pollution from urban, industrial and mining waste causing negative impacts and reducing the availability of water in sufficient quality.
4. Limitations on the operation funds and the maintenance for existing infrastructures as well as on investments to extend infrastructures in response to the growing demand for water.

The investments mentioned above require high investment costs. Therefore, an improved institutional frame work, involving planning and management as well increased participation of stake holders, is essential.

Institutional Issues

Among the multidimensional institutional constraints are the following:

1. Insufficiency of existing law and regulations.
2. Unimplemented regulations for irrigation water fees (Bulk Irrigation Water Supply) and fees for urban and industrial waste.
3. Weakness of sector institutions in establishing an integrated water resources policy, investment planning, governance, water resources strategic allocation management and waste control.
4. Insufficient coordination among government institutions in problem solving require integrated action and cooperation among institutions.
5. "Development project administration culture" based on economic incentives and penalties.
6. Suspending the maintenance cycle may require early rehabilitation associated with high costs.
7. Complexity of human resources transfer from the central government to local governments along with the decentralization programme.
8. Unavailable mechanisms in stakeholder consultation and representation in sector decision making.

Reformation Water Resources Policy

The reformation needs include changes in the principles of government administration and a change in paradigm of water requirements. Here the focus is on three main reformation policies:

1. Characteristics of most substantial water resources problems.
2. Sustainable needs for food stability and development, and use of sustainable irrigation.
3. Solving institutional problems.

Referring to Keputusan Presiden No.123, Year 2001, a coordinating team of water resources management has been established lead by Menko Bidang Perekonomian with Ketua Harian Menteri Kimpraswil. The task of the team is to formulate the national water resources policy and other policies in the water resources field as required. Furthermore, Keputusan Menko Bidang Perekonomian No. Kep. 15/M.Ekon/12/ 2001, Year 2001 on the establishment of a Secretary of the Water Resources Management Coordinating Team consists of the Directive Team, Execution Team and Working Team. The Secretary is responsible for supporting the work and the functioning of Tim Koordinasi Pengelolaan Sumber Daya Air referred to as the water resources national policy directive as mentioned in Keputusan Menko Bidang Perekonomian No. Kep. 14/M.Ekon/12/2001 Year 2001 of the National Policy Directive for Water Resources. Keputusan Presiden No. 123 Tahun 2001 provides directives and guidelines for the national policy establishment to the Water Resources Management Coordinating Team as follows:

1. The objectives of water resources development are to create synergy and to avoid inter-sector, inter-region and intergeneration conflicts, in order to strengthen national unity.
2. Facilitate integrated water resources management both between sectors and at inter-regional, central, province, river basin, and kabupaten/kota levels by improving development regulations in water resources and form a coordination forum for executives at central, regional and river basin levels.
3. Balance conservation efforts and utilization of water resources thus gaining sustainable benefits from water resources for this and the coming generations.
4. Balance social and economic functions to ensure the main needs of each individual. Utilize water resources as economic resources that provide an optimum value to the public with attention on maintenance and conservation efforts.
5. Governance of water resources management to operate in harmony, integrating the aspects of supply and demand of surface and groundwater (conjunctive use) and the institutions for water resources management.
6. Improvement and recovery of water availability and quality along with maintenance and recovery of water resources support capacity to ensure sustainable benefit.
7. Control of water related disasters, and improved preparedness and public participation in the context of flood disaster and other water related disasters in order to secure food production, protect housing areas, and mitigate ecosystem damage caused by water related disasters.
8. Use of water resources by giving priority to the public and other strategic purposes decided by the central government, regional government and the public.
9. Improvement of initiatives and public and private participation in water resources development and establishment of government institutions to assist in a more decentralized and democratic water resources use, and to create synergies and solve conflicts in water management.

10. Improving the availability, accuracy and timeliness of data and information, so that water resources development becomes a transparent process to the public at all stages.

Moreover, the specific objectives of the water resources policy reformation are as follows:

1. Formation of a governmental and private inter-institution forum at a central level for the water resources organizational framework.
2. Adoption and implementation of a national water policy to give directives to planning, programming, financial, management and sector regulations.
3. Formation of institutions and procedures to involve stakeholders and users in establishing policy and decision making.
4. System improvement, national water resources management information network and decision support system.
5. Development of integrated management and river area water resources regulations.
6. Formation of effective management organizations within strategic river areas.
7. Application of a system of water rights to ensure efficient and fair water allocations.
8. Formation of institutional framework to establish law and justice regarding pollution matters.
9. Restoration of the functioning of transparent farmer organizations with authority for organizing and financing irrigation management.
10. Ensuring the financial sustainability of operational, maintenance and irrigation rehabilitation networks.
11. Re-organization of the irrigation service administration.

Vision and Mission of Water Resources Managenent

The vision of water resources management is to achieve optimum resources utilization for the benefit of all people of the Republic of Indonesia, based on the mission implementation as follows:

1. Water resources conservation.
2. Water resources utilization including management, supply, conservation, development, and manufacturing.
3. Water disasters control and prevention.
4. Public participation and privatization.
5. Improvement of the availability and transparency of water resources data and information including the infrastructure and facility system.

Principles of water resources management

The water resources management methods are implemented based on several principles as follows:

1. Principle of "one river basin, one plan and one integrated water resources management and development" by using a river catchment area as the main management entity.

2. Sustainable water resources, implying water resources utilization with adequate conservation efforts.
3. Establishment of master plans through broad participation of all stakeholders.
4. Democratic process of making operational water resources policies by involvement of all types of stakeholders through representatives in a coordination forum based on a balance between social function and economic value, public benefit, conservation, fairness, synergy, independence, transparency and public accountability.
5. Policy implementation executed by independent, professional and accountable institutions.
6. Involvement of all societal and stakeholder elements in all stages of the planning, decision making and development.
7. Sharing the cost of water resources among all users, through implementation of the "water user pays" and "polluters pays" principles, based on a cross-subsidizing system referring to the general norm.

Local Authority Implementation in Water Resources Management

As a result of Law No. 22/99, local authorities are taking over the responsibility of water resources management, thereby reducing the distance between the provider and user, so the water resources may receive more attention and may be easier to manage. Local governments are also required to perceive water not merely as an economic commodity but also to respect its social function as a public property. Every water resources policy established by any particular local authority may not harm other local interests. With a better understanding of the sustainable management principle it is expected that every local government will raise their awareness of the importance of consolidating the cooperation with other regions, due to the mutual benefit principle. Therefore, water resources may contribute to uniting the nation.

In this context, there are at least four potential conflict areas: First, water resources utilization in any particular administrative area may diminish the utilization prospects for downstream administrative areas. Second, water storage in any particular administrative area may cause flood disasters or reduce land use benefits in adjacent administrative areas. Third, water pollution in any particular administrative area may cause social, economic and environmental costs for downstream administrative areas. Fourth, any particular upstream administrative area is the guardian and buffer of water resources conservation but the benefit goes to the downstream administrative area. Land use changes in upstream areas may cause flood disasters in downstream areas.

To facilitate agreement on the sharing of responsibilities, including the sharing of water resources benefits and costs, a coordination system and a conflict solving mechanism are needed. These are provided through the Forum of Koordinasi Dewan Daerah Wilayah Sungai which is at the inter kabupaten-kota or provincial level. Hence, efforts are required to empower the existing law:

1. Law reformation to empower law related to water pollution and deterioration of the river basin environment.
2. Implementation of the "user pays" and "polluter pays" principles as tools for enhancing water use efficiencies and water quality, and also indirectly providing more income to the regional government.
3. General policy for domestic, urban, industrial and farming waste disposal.
4. Improved coordination among related institutions in law enforcement.
5. Establishment of a water quality and waste control network at the river basin level.

From the perspective of human resources, financing and technical issues, the following efforts are needed:

1. Campaigns on the importance of water resources conservation with audience targets including government institutions, related sectors, user representatives, NGOs, and the general public.
2. Empowerment of gender for water efficiency enhancement and a sanitary water resources environment.
3. Managing water quality through improvement and maintenance of water resources ecosystems.
4. Encourage emerging local technologies for development and water quality control.
5. Encouragement of public participation in controlling functions and community service centres.
6. Applying an incentive and penalty system for industry to encourage water resources conservation.
7. Encouragement of development efforts and water pollution treatment installations.
8. Encouragement of the issuance of regional governments on water resources including its quality control.
9. Prohibition of trash disposal into any water resources.
10. Providing an information system on the water resources potential.

Conclusion

1. Water as a renewable resource and our main living resource is a fragile resource and clearly limited in time and space.
2. For water resources management a holistic approach should be adopted, supported by a strong institutional system involving all stake holders.
3. Decentralization of water resources management is important for bringing public service functions closer to the public and also for strengthening the control system of water utilization and environmental damage by society.
4. In water resources management, local governments should not perceive water merely as an economic commodity but also distribute it according to its social functions.

5. All types of stakeholder should be involved at all stages of the decision making related to water resources management, from the planning to its use.
6. Users should bear the cost through the implementation of the "user pays" and "polluter pays" principle based on a cross subsidization system according to the general norm.
7. The current water resources policy reformation is expected to be able to become an effective foundation for integrating and synchronizing sustainable water resources management in the context of local authorities having acquired more responsibilities.
8. The success of the water resources policy reformation depends on the government, political will and public participation that require consistency in its implementation.

References

Cahyono, M., Suryadi, A., Soekarno, I. & Syahril, M. (1999) *Prosiding Seminar Nasional Desentralisasi Pengelolaan Sumber Daya Air di Indonesia.* Kajian mengenai perundang-undangan, kelembagaan dan pengusahaannya, Bandung, September 1999, Jurusan Tehnik Sipil. ISSN:0853-6457.

Gany, H. A. & Mutreja, K. (2000) *Inter-agency Coordination Between Water-Related Agencies.* Academic Paper no.1, Cisarua, Bogor, Indonesia.

Government of Republic Indonesia (1974) *Law no.11, 1974 on Water Resources Development* (English translation). Bureau of Legal Affairs, Secretariat General, Ministry of Public Works, Supplement of Government Gazette of the Republic of Indonesia no.3046.

Government of Republic of Indonesia (1982) *Government Regulation of the Republic of Indonesia no. 22 of 1982 on Water Management Regulation* (English translation). Government Gazette, Supplement no.3225.

Soetrisno, S. (1998) Groundwater Management Problems, Jakarta and Bandung, Indonesia, comparative case studies. Posted on Internet on 1 September 1998, www.geocities.com/Eureka/Gold-/1557/gw_manage.html.

Climate and Atmospheric Science Activities In Indonesia

Dr. Sri Kaloka
National Institute of Aeronautic and Space (LAPAN)
The Atmospheric Science and Climate Application Center
Address: Jl. Dr. Djundjunan 133 Bandung, 40173 Indonesia
fax. no. : +62 22 6037443

Climate Modelling

Investigation of climate by computer which is called by Climate Modeling is the most useful tool to investigate future climate. In a climate model, the various physical laws that determine the climate such as conservation of energy, conservation of mass, and the gas law are expressed as mathematical equation that specify the relationship between different variables such as temperature, air pressure, wind and precipitation. By specifying the various climate forcing, iti is possible to calculate the climate. LAPAN has installed a climate modeling facilities which include: atmospheric and ocean GCM and Limited Area Models (LAM) developed by CSIRO, Australia.

The limited area model (LAM) is to be used to study climate impact of varying several properties of vegetation and land cover change and this facilities are being continuously improved in order to produce the reliable climate and weather prediction.

To understand atmospheric fenomena over equatorial region, LAPAN and Kyoto University of Japan has been operating meteorological instruments in Kototabang, West Sumatra (0.20^{o} S; 100.32^{O} E) which is called Equatorial Atmosphere Radar. The operational of this radar is inaugurated on June 26, 2001. At present there are 10 instruments installed in Radar site and in operation, they are :

1. Equatorial Atmosphere Radar to measure of zonal, meridional and vertical wind from 1.5 to 120 km
2. Radio Acoustique Sounding System to measure of temperature, pressure and humidity from 2 to 14 km
3. X – Band Rain Radar to measure of precipitation
1. 4. Ceilometer to measure of the base clouds altitude
4. Radiometer to measure of water paper content from surface to 10 km
5. Microbarograf to measure of surface pressure
6. Micro Rain Radar to measure of drop size distribution
7. Optical Rain Gauge to measure of rains fall intensity
8. Meteor Wind Radar to measure of wind velocity and direction from 90 – 120 km.
9. Air glow meter to measure of gravity wave

Ozone, Green House Gases and Air Pollution Dispersion

Ozone

International issues on ozone depletion have been one of LAPAN's scientist concern. They analyze and investigate of :

1. The trend of total Ozone over Jakarta
2. Total Ozone over Indonesia
3. Ozone modelling for Indonesia
4. Monitoring of ozone profile in Watukosek, East Jawa every week under collaboration between LAPAN and NASDA.

Green House Gases and Air Pollution Dispersion

- Monitoring of air quality in Indonesia has been focused in several big cities such as Jakarta, Bandung, Surabaya etc. Data obtained are used as an input in TAPM (The Atmospheric Pollution Model) software to asses its distribution in certain area. Aerosol profile which showed by Backscattering Coefficient has been also monitored by Lidar in Bandung under collaboration between LAPAN and Meteorological Research Institute and Communication Research Laboratory of Japan.
- Monitoring of acid rain in Bandung as an effect of air pollution

Scientific Meeting

LAPAN has held a National Seminar on Climate Prediction 2002, on July 31, 2002 at Bandung with topics discussion :

- Technical prediction based on physical models (General Circulation Model, Limited Area Model)
- Statistical Time Series (ARIMA etc.)
- Time series model based on neural network, wavelet transformation, non linier dynamic analysis.
- Hybrid model
- Application include climate prediction
- ENSO prediction's for 2003

Activities Related to Middle and Upper Atmospheric Research in Indonesia

Dr. Sarmoko Saroso
National Institute of Aeronautic and Space (LAPAN)
The Atmospheric Science and Climate Application Center
Address: Jl. Dr. Djundjunan 133 Bandung, 40173 Indonesia
fax. no. : +62 22 6037443

Middle/Upper Atmosphere Observations and Research

Recent studies have revealed that the behavior of the equatorial atmosphere in the Indonesian region is very important for the understanding of the global structure of atmosphere dynamics. Through collaboration between Indonesia, Japan and Australia, an MF radar has been established at Pontianak (0.03°S, 109.33°E) since November 1995 for measurements of atmosphere dynamics in the equatorial mesosphere and lower thermosphere. It will be also be used to examine planetary scale oscillations as well as gravity waves. The radar which operates at 1.98 MHz provides wind velocities in the altitude range 60 - 100 km during daytime and 70 - 100 km during night, with a height resolution of 2 km and a time resolution of 2 min.

An observatory with a wind profiling radar called Equatorial Atmosphere Radar (EAR) has been established at Koto Tabang (0.2°S, 100.32°E) Indonesia through collaboration between Indonesia and Japan, and it is expected to be a regional center for equatorial atmosphere research in South East Asian Countries.

Airglow Observations and Research

A wide field CCD imager system for OH airglow obserbation was set up in Indonesia and started observation in September 21, 2000 through collaboration between Indonesia and Japan. The system was located at Sumedang (6.90°S, 107.50°E). This imager has sensitivity at the wave length between 680 and 1000 nm. The field of view is 80 deg in north–south and east-west directions, which cover about 190 km in horizontal space at the altitude of 87 km which is a typical height of airglow. The observation has been carried out every night except for the time of moon shine, which is about 25 days in a month. During the first 3 months (from September 21 to December 5), clear sky images have been collected for 15 days out of 59 days observations. The wave periods, horizontal wavelengths and horizontal phase velocities were distributed 5 min – 12 min, around 30 km and 40 – 80 m/s, respectively. A clear tendency of southward propagation was found for the southern hemisphere spring and winter.

Activities Related to Geomagnetic Research in Indonesia

Magnetic Micropulsations Observations and Research

The network of geomagnetic observations consist of three fluxgate magnetometers has been established in Indonesia to routinely monitor variations in the geomagnetic pulsations for investigations of varying phenomena such as the effects of geomagnetic storms and magnetic micropulsations on the ionosphere. The geomagnetic components of H, D and Z are derived from a fluxgate magnetometer at one minute interval. A set of induction magnetometer has been used to observe the phenomena of geomagnetic micropulsations. Indonesia is presently participating in the Circum-pan Pacific Magnetometer Network (CPMN) along 210 degree magnetic latitudes. The magnetic observations have been made simultaneously at about 20 stations. Simultaneous ground-based observations are useful to study the global nature of penetration mechanism of ionospheric electric fields from the polar into the equatorial region and to clarify the coupling mechanism between the solar wind and the Earth's ionosphere for the space weather study.

IASPEI Country Report (Indonesia–2003)

Sri Widiyantoro Ph.D
Dept. of Geophysics and Meteorology, Institute of Technology Bandung
Jl. Ganesha 10 Bandung 40135, INDONESIA
e-mail : sriwid@geoph.itb.ac.id

The IASPEI country report, Indonesia – 2003, includes several major topics such as: (i) seismic monitoring mainly conducted by the Meteorological and Geophysical Agency (MGA) of Indonesia; (ii) research directions in seismology and physics of the Earth's interior; and (iii) selected publications.

Seismic monitoring

MGA of Indonesia is a governmental agency whose task in seismology is to monitor seismic activities in the Indonesian region. MGA now operates 58 short-period seismographs, which consist of 28 digital stations and 30 analog stations. The network is divided into 5 regional seismological centers (RSC) and 1 national seismological center (NSC) located in Jakarta. Each center has its own system for processing the real-time data of telemetry stations and non real-time data of analog staffed seismic stations. NSC receives the real time data from telemetry stations forwarded by RSC and the phase data from staffed seismic stations through a communication system in a non real time basis. In case of large earthquake in Indonesia, MGA is responsible to announce the hypocenter and the impact as quickly as possible to the public. In 1996, MGA installed the tsunami warning system based on 1 seismic station namely TREMORS (Tsunami Risk Evaluation through seismic MOment from a Real-time System) in Tretes, East Java. The system had been working until the end of 2000. At present, the real time system does not work anymore in NSC because of communication problems between the station and MGA new office.

MGA also operates 22 JISNET (Japan-Indonesian Seismic NETwork) Broadband stations in cooperation with NIED of Japan, 2 OHP (Ocean Hemisphere Project) Broadband stations in cooperation with ERI (Earthquake Research Institute, The University of Tokyo, Japan), and 1 GSN of IRIS station. The cooperation between MGA and CTBTO coordinated by the Indonesian Department of Foreign Affairs plans to utilize 6 seismographic stations to be the auxiliary stations of CTBTO in Indonesia.

A new monitoring system will be developed in a three-year project starting this year to integrate and update the hardware and software. The project is focused on the utilization of broadband data, real time

monitoring, automatic processing and warning system for tsunamigenic events. The updated system will not be successful without a new cooperation with a country that has a developed monitoring system.

Research directions in seismology and physics of the Earth's interior

Directions of research in seismology and physics of the Earth's interior in Indonesia have been particularly focused on the following subjects:

(i) Investigation of complex subduction zone structure beneath the Indonesian archipelago through non-linear seismic tomographic imaging (Contact person: S. Widiyantoro, Bandung Institute of Technology, E-mail: sriwid@geoph.itb.ac.id);

(ii) Comprehensive studies on active faults, in particular regarding the great Sumatran fault (Contact person: D. Natawidjaja, Geoteknologi, Lembaga Ilmu Pengetahuan Indonesia, Bandung, E-mail: danny@gps.caltech.edu);

(iii) Tsunami zoning (Contact person: N. T. Puspito, Bandung Institute of Technology, E-mail: puspito@geoph.itb.ac.id);

(iv) Seismic anisotropy studies for structure beneath Lake Toba, North Sumatra (Contact person: S. Winardhi, Bandung Institute of Technology, E-mail: winardhi@geoph.itb.ac.id);

(v) Long-term earthquake forecast: A search of reliable methods for Indonesia (Contact person: W. Triyoso, Bandung Institute of Technology, E-mail: triyoso@geoph.itb.ac.id);

(vi) Volcano seismology (Contact person: Surono and G. Suantika, Volcanological Survey of Indonesia, Bandung, E-mail: gede@VSI.esdm.go.id); and

(vii) Geodetic studies for geophysical / seismological problems (Contact person: H. Z. Abidin, Bandung Institute of Technology, E-mail: hzabidin@gd.itb.ac.id).

Publications (Selected)

Most of the following publications were prepared through close research cooperation with foreign scientists:

1. Fauzi, McCaffrey, R., Wark, D., Sunaryo, PrihHaryadi, P. Y., Lateral variation in slab orientation beneath Toba caldera, northern Sumatra. **Geophys. Res. Lett**., 23, 443-446, 1996.
2. Prawirodirdjo, L. et al., Geodetic observations of interseismic strain segmentation at the Sumatra subduction zone. **Geophys. Res. Lett**., 24, 2601-2604, 1997.
3. Prawirodirdjo, L., Bock, Y., Genrich, J., Puntodewo, S. S. O., Rais, J., Surbaya, C., Sutisna, S., One century of tectonics deformation along the Sumatra fault from triangulation and GPS surveys, **J. geophys. Res**., 105, 2000.
4. Sieh, K., Natawidjaja, D., Neotectonics of the Sumatran fault, Indonesia. **J. geophys. Res**., 105, 28295-28326, 2000.

5. Tandon, K., Lorenzo, J.M., Widiyantoro, S., O'Brien, G.W., Variations in inelastic failure of subducting continental lithosphere and tectonic development: Australia - Banda arc convergence. **Plate Boundary Zones – AGU Monograph**, Geodynamics Series 30, 341-357, 2002.
6. Widiyantoro, S., van der Hilst, R.D., Structure and evolution of lithospheric slab beneath the Sunda arc, Indonesia. **Science**, 271, 1566-1570, 1996.
7. Widiyantoro, S., van der Hilst, R.D., Mantle structure beneath Indonesia inferred from high-resolution tomographic imaging. **Geophys. J. Int**., 130, 167-182, 1997.
8. Widiyantoro, S., Complex morphology of subducted lithosphere in the mantle below the Molucca collision zone from non-linear seismic tomographiy. **Engineering Science, Proceedings ITB**, Bandung, 2003 (*in press*).
9. Widiwijayanti, C., Deverchere, J., Louat, R., Harjono, H., Diament, M., Hidayat, D., Analysis of the aftershock sequence of the Mw 6.8 Liwa earthquake, Indonesia. **Geophys. Res. Lett**., 23, 3051-3054, 1996.

Activities Related with IAVCEI in Indonesia: A Country Report From Indonesia

Dr. Wimpie S. Tjetjep and Dr. Djumarma A. Wirakusumah
Directorate General of Geology and Mineral Resources
Jl. Prof. Dr. Soepomo SH No. 10 Jakarta, INDONESIA
Telp : +62 21 8280773 Fax : +62 21 8297642

Introduction

Aim

We would like to know how far our activities we have done and those what we can do in the near future related with the International Association of Volcanology and Chemistry of Earth Interior (IAVCEI) program in Indonesia. In other wards we would like to know how far the Indonesian and the international scientists understand about the IAVCEI and its program.

Background

Indonesia is the richest country concerning volcanoes in the world and is also a member country in organizations of IAVCEI, WOVO etc. Many kinds of knowledge can be involved in or related with Volcanology, because the volcanology is a very wide knowledge. Many scientists especially volcanologists are interested to do study or research in volcanological science or volcanological aspects in Indonesia. Many scientists intend to contribute their research products by discussion or presentation or publish them among the scientists themselves. That is why, it would be a task for all Indonesian scientists who understand about IAVCEI in Indonesia to promote the IAVCEI program to all scientists, institutions, and Scientific Associations in Indonesia who are related with the IAVCEI. We know that the IAVCEI is consisted of 15 commissions. However many contributions of Indonesian scientists concerning volcanoes or in chemistry of Earth Interior or things related with the IAVCEI program done in Indonesia or beyond Indonesia have not been registered if they are close related with the IAVCEI program through their commissions.

Strategy

Continuous promotion on the IAVCEI in Indonesia is very important. The promotion can be carried out through holding meetings, seminars,

symposiums, workshops or anything related with the IAVCEI program in Indonesia, also attending and involving some seminars, workshops, or symposiums in Indonesia and abroad. A join cooperation work or activities between or among some institutions in Indonesia and abroad can also support this promotion. Contribution to the IAVCEI can be carried out by giving contribution all the above activities by means writing and publishing papers, involving some educations, and some collaborations. Reporting these through the related existing IAVCEI commissions is very important as it will be promoting and developing IAVCEI program both in the Indonesia and in the world.

IAVCEI activities in Indonesia

According to their commissions, the IAVCEI has 15 scientific commissions which are more concerned with more specialist aspects of volcanology:

- Commission of Explosive Volcanism.
- Commission of Cities and Volcanoes
- Commission of Subduction Zone Magmatism.
- Commission of Volcanic Disasters
- Commission of World Organization of Volcano Observatories
- Commission of Chemistry of Volcanic Gases
- Commission of Volcanic Sediments
- Commission of Large-Volume Basaltic Provinces
- Commission of Volcanism and Earth's Atmosphere
- Commission of Remote Sensing
- Commission of Granites
- Commission of Volcanic Lakes
- Commission of IASPEI/IAVCEI Joint Commission on Volcano Seismology
- Commission of IASPEI/IAVCEI Inter-Association Commission on Physical and Chemical Properties of Materials of the Earth's Interior
- Commission of Working Group on Volcano Acoustics

All activities done in Indonesia or by Indonesian scientists related with the IAVCEI program before and within the last three years will be reported on the basis of the existed IAVCEI commissions as follows.

Explosive Volcanism.

IAVCEI General Assembly 2000 Bali, Indonesia.

Our appreciation was delivered to the IAVCEI who has chosen Indonesia as a host to have an opportunity in holding the IAVCEI General Assembly at Bali, Indonesia in July 18-22, 2000. The Organizing Committee has chosen the theme of the symposium so called "Exploring Volcanoes : Utilization of their resources and Mitigation of their hazards".

The IAVCEI General Assembly 2000 was attended by 490 participants from 39 countries including Indonesia as the host country. 170

participants of 15 countries representing the Europe Continent, 191 participants of 11 countries representing the Asian Continent, 110 participants of 10 countries representing American Continent, 11 participants representing the Australian Continent, 3 participants representing African Continent, and 6 participants representing New Zealand. Total of 498 abstracts have been accepted and have been classified in to twelve topics of the symposium.

Relation with the IAVCEI commission, "Explosive Volcanism", 93 abstracts have been presented in the IAVCEI General Assembly 2000 in July 18-22 at Bali, Indonesia. The abstracts told involving many volcanoes in the world. All of the abstracts were collected and were written in the book of "Abstract and Addresses" IAVCEI General Assembly 2000.

Two addition field trip programs in the IAVCEI General Assembly 2000, Bali, Indonesia which are related with the commission of "Explosive Volcanism" have been done. They were :

- Pre IAVCEI symposium field trip to Bromo, Semeru, and Lamongan volcanoes, East Java (July 12-17, 2000) involving 30 participants. Participants discussed about deposits of caldera products to interpreted about the catastrophic eruption or explosive volcanism of Bromo and Semeru..
- Post IAVCEI Symposium field trip to Krakatau volcano (July 23-28, 2000) involving 55 participants added by a guide book of Krakatau volcano gave also contribution to this commission. The participants dicussed about all deposit products of explosive eruptions of Krakatau.

The IAVCEI General Assembly 2000 Bali, Indonesia and the abstracts and the field-trips were able to contribute directly to the IAVCEI commission especially the Explosive Volcanism and IUGG in general and to related scientists in the world.

Cooperation between Japan and Indonesia.

The cooperation has been carried out through Directorate of Volcanology and Geological Hazard Mitigation (Indonesia) and Geological Survey of Japan since 1996 in Geology of Volcanoes. The objects are Indonesian Volcanoes which produced calderas. The volcanoes that have been studied were Tambora (Sumbawa island), Rinjani (Lombok island), and Bromo (East Java). The study focused explosive volcanoes related with their released energy. The result of the study were contributed and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

Attending the Symposium of "Montague Pelee 1902-2002".

5 abstracts made by Indonesian scientists were submitted to the Symposium hosted by Institute de Physique du Globe de Paris-IAVCEI under the Research Ministry, France located at Saint-Piere, Martinique, France in May 12-16, 2002 with the theme of "Explosive volcanism in subduction zone". Three of the five abstracts were dealing with volcanology and volcanological mitigation, while the other two were dealing with volcano seismology. Four Indonesian scientists attended the symposium. The symposium was held to commemorate after a century

of the catastrophic eruption of Mt Pele of May 8, 1902. The symposium was fully supported by IAVCEI and WOVO since the symposium gave a developing value in science to find methods for volcanic monitoring and understanding of volcanic explosive eruption with the purpose of improving our ability in volcanic eruption prediction.

Cities and Volcanoes.

Merapi Workshop 1995.

The workshop was held at Yogyakarta during the period of July 1995 involving about 60 participants. The participant consisted of experts in volcanology from all over the world and some from local authorities who talked about the effect and anticipation activities if Merapi volcano erupts to some area at Magelang Region. Local Region also made some region regulations concerning people life or people activity related with Merapi activity. The volcano is about 30 km away to the north from the big city of Yogyakarta.

Monitoring of Merapi volcano by using many kinds of method was the main topic to be discussed in the workshop. Merapi is a famous active volcano with the Merapi eruption type. Many active volcanoes in the world showed their eruption with the eruption type so-called Merapi eruption type. Comparison in monitoring volcanoes which have characteristic similar as that of Merapi was very important especially to save people from volcano disaster.

Merapi Workshop 1997.

The workshop was held at Yogyakarta during the period of July 1997 involving about 80 participants. The participant consisted of experts in volcanology from all over the world and some from local authorities who talked about the effect and anticipation activities if Merapi volcano erupts to some area at Magelang, Sleman, Klaten, and Boyolali Regions. Local Region also made some region regulations concerning people life or people activity related with Merapi activity.

Study about lava dome growth at Merapi by using many method such as seismic, deformation, chemistry, geophysics was one of the main object have to be done by any expert especially by Merapi group who has opportunity to work at Merapi volcano.

City of Volcano 3 at Hawaii, USA 2003.

The City of Volcano 3 (COV3) will be held at Hawaii in July 14-16, 2003 involving many experts in volcanology and some local authority to talk monitoring volcanoes, volcanic eruption, and their effect to cities around. Two Indonesian experts in volcanology will be participated in the COV3 during the period of time to present the volcanic hazard mitigation system in Indonesia. Comparison among the mitigation methods applied at many countries will be one of the main object to discuss in the COV3 at Hawaii.

Subduction Zone Magmatism.

Second Snellius Expedition 1984.

The expedition was carried out in 50 years of commemorating the First Snellius Expedition in 1929. The expedition composed very wide geological knowledge. A part of them was volcanological side. Four Netherlands experts in volcanology and five Indonesian experts in volcanology took part to have survey mainly in petrochemistry, some water and gas chemistry on 14 volcanoes (as volcanic islands) along Inner Banda Arc, Eastern part of Indonesia, and seismic study of Banda api volcano during the period of July 1984. According to the magmatic compositions, the volcanoes vary from andesitic to high potassium ones. The petrochemistry analyses showed some evidences of subduction zone at this area and gave some clues concerning magmatism of subduction zone of this area. The results were reported in the Second Snellius Seminar at Amsterdam in 1985. Some results of the analyses produced some papers published in some international journals. The expedition on volcanological part also gave contribution to this IAVCEI commission, "Subduction Zone Magmatism" and that to IAVCEI in general.

Cooperation between DGGMR (Indonesia) and UU (the Netherlands).

MOU for the cooperation between Directorate General of Geology and Mineral Resources (DGGMR) through Directorate of Volcanology and Geological Hazard Mitigation (DVGHM) of Indonesia and Utrecht University (UU)of the Netherlands with the Netherlands as the donor country. The first five years period of the cooperation was signed in 1995 up to 2000.

Some institution beyond DVGHM such as the Indonesian Science Institute (LIPI), Institute of Bandung Institute of Technology (ITB), and Geological Research and Development Center in Bandung were accompanied to work with Utrecht University with the aim was to develop the understanding of volcanic geochemistry. The priority object of volcanoes are those in North Sulawesi, Java, West Nusa Tenggara, and East Nusa Tenggara.

Join research between Indonesian and Netherlands scientists on geochemistry of Indonesian volcanoes have been done. 2 Indonesian Master degree graduated from Utrecht University, the Netherlands in 1998 were produced through this collaboration. One Indonesian PhD degree in geochemistry who studied about chemical pollution dealing with some volcanoes at West Java, Indonesia was graduated from Utrecht University in 1998 through joint research in the Second Snellius Expedition and also the Cooperation between Indonesia and the Netherlands. An other one Indonesian PhD student is on going at Utrecht University to study about geochemistry of Ijen volcano, East Java, Indonesia.

One of the Indonesian Master Degrees was studying dealing with magma genesis of Ambang volcano, North Sulawesi. An other one studied about water chemistry related with an active volcano at Java. Some other papers written by scientists from both countries as one of

the products of this collaboration were published in some international journals. Unfortunately the MOU of the cooperation between DGGMR and Utrecht University had difficulty to extend due to project priority in the Netherlands since the year of 2000.

IAVCEI General Assembly 2000 Bali, Indonesia.

24 abstracts dealing with Subductin Zone Magmatism of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected and presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

IAGI Scientific Meeting.

Many papers dealing with the IAVCEI Commission, "Subduction Zone Magmatism" were collected and were presented in the Indonesian Geologists Association (IAGI) Scientific Meeting. The IAGI Scientific Meeting is done once a year in Indonesia. At lease 4 papers dealing with this IAVCEI Commission at Indonesian volcanoes were always involved in this Scientific Meeting.

Mitigation of Volcanic Disasters.

IAGI and HAGI Scientific Meting.

Many papers dealing with the IAVCEI Commission, "Mitigation of Volcanic Disasters" were collected and presented in the Indonesian Geologists Association (IAGI) the Indonesian Geophysisists Association (HAGI) Scientific Meetings. The IAGI and HAGI Scientific Meetings are done once a year in Indonesia. At lease 4 papers dealing with this IAVCEI Commission at Indonesian volcanoes were always involved in this Scientific Meeting every year respectively.

Merapi Workshops of 1995 and 1997.

Monitoring Merapi volcano by using many kinds of method was the main topic to be discussed in the Merapi Workshop of 1995. Merapi is a famous active volcano with the Merapi eruption type. Many active volcanoes in the world showed their eruption with the eruption type so-called Merapi eruption type. Comparison in monitoring volcanoes which have characteristic similar as that as Merapi was very important especially in predicting volcanic eruption. Abstracts about this were collected in the Proceeding of Merapi Workshop of 1995 and were presented during the workshop.

In the Workshop of 1997, study about volcanic monitoring method and lava dome growth at Merapi by using many method such as seismic, deformation, chemistry, geophysics was one of the main object have to be done by any expert especially by Merapi group who has opportunity to work at Merapi volcano. Abstracts about this were collected in the Proceeding of Merapi Workshop of 1997 and were presented during the Workshop of 1997.

IAVCEI General Assembly 2000 Bali, Indonesia.

85 abstracts dealing with the IAVCEI commission, "Mitigation of Volcanic Disasters" of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected in the "Abstract and Addresses IAVCEI General Assembly 2000 and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

Cooperation between Indonesia and Japan.

The formal cooperation in volcanology between Indonesia through the Directorate General of Geology and Mineral Resources (DGGMR) through the Directorate of Volcanology and Geological Hazard Mitigation (DVGHM) or the previous name of the Volcanological Survey of Indonesia (VSI) and the Disaster Prevention Research Institute (DPRI), Kyoto University (Japan) through the Sakurajima Volcano Research Center (SVRC) has been carried out since the last 10 years.
MOU for the first five year period cooperation was signed in 1993, and the second five years period cooperation was signed in 1998 which will be finished in June 2003 and it will be proposed to be extended through the new five years period cooperation.

All of the cooperation are dealing with investigating active volcanoes and their disaster mitigations. The aim of the cooperation were :

- Carrying out some research activities dealing with volcanic eruption and tectonic in Indonesia.
- Experts and technician exchange and manpower improving.
- Holding an international meeting to evaluate the result of the cooperation.
- According to the result of the 1998-2003 period of cooperation, periodic or continuous volcanic monitoring of some active volcanoes which are Guntur, Papandayan, and Merapi volcanoes have been carried out using :
- Seismic method (5 seismometer, 3 components at 5 permanent locations) at Guntur volcano.
- Tilting by using tiltmeter, water tube tiltmeter at Guntur volcano.
- Geodetic method by using leveling, EDM and GPS methods at Guntur, Papandayan and Merapi volcanoes.

According to "man power improving" part during the period of 1998-2003 (until now), 6 Indonesian scientists have been attended some training courses especially in volcanology at Japan; 4 scientists have finished their MSc degree at Japan with an other one Indonesian scientist is still on the way to finish her MSc; one Indonesian person is now doing his PhD in volcanology at Japan. Their thesis and their papers dealing in Mitigation of Volcanic Disasters have been finished and were published in some international journals, and were presented in some national and international symposium.

At the end of the 1993-1998 period of the cooperation, "an international symposium on Japan-Indonesia IDNDR Project-Volcanology, Tectonics, Flood, and Sediment Hazards" was held at Bandung in September 21-23 1998. 200 Indonesian and Japanese scientists participated this

symposium with 51 papers have been presented during the symposium. The result of the symposium was held for evaluating the cooperation between two countries and also for evaluating if the following five years cooperation was necessary to be extended or not.

Similar symposium with the aim of to evaluate the cooperation between the two countries the end of the 1998-2003 period of the cooperation which was held in June 18-20, 2003 at Bandung, Indonesia. Up to now (when this report was written), more than 30 papers would be presented and some points related to the mitigation of volcanic disasters will be discussed in the symposium.

This cooperation and the symposium are certainly give contribution to all related associations under the IUGG especially IAVCEI and to related scientists in the world. This is also close related especially with "predicting volcanic eruptions", one of the topics which will be discussed or issued in the IUGG meeting at Sapporo in 2003.

Cooperation between Indonesia and Germany MOU for the cooperation between DGGMR through Directorate of Volcanology and Geological Hazard Mitigation (DVGHM) of Indonesia and Geo Forschung Zentrum (GFZ) of Germany was signed in 1997 for the period of five years (1997-2002) with Germany as the donor country. The title of the cooperation activity was "Merapi volcano : Mechanism Evaluation, Risk Assessment, Prediction Improvement".

The aim of the cooperation was to understand and to improve knowledge dealing with volcanic mechanism and processes. From the result, it was expected that some contribution would be able to overcome in mitigating volcanic hazard especially in prediction or early warning capability. The cooperation was also done for sharing and transfer of technology between two countries. The scope of activity was investigation on geophysics, such as seismology, deformation, magnetoteluric, electromagnet, resistivity, gravity, geochemistry, and geology.

All of the recorded data in the sensors installed in the field were mostly telemetered to the Center Office of Merapi in Yogyakarta. The result of the cooperation activities can be explained as follows.

- Building a volcanic monitoring network by using seismic broadband at 5 field stations.
- Deformation monitoring by using multi-parameter (tilt meter, GPS, climate and soil temperature measurements, radon-meter) scattered at 4 separated locations.
- Sensors of gas and temperature were installed at Merapi summit.
- Radar (one station) for monitoring rain, velocity and volume of lava avalance and pyroclastic.
- Self-potential volcanic monitoring system was installed at Merapi summit.
- All of experiments especially using telemetry system gave several advantages that can be implemented for volcanic monitoring purposes in Indonesia.

A workshop on seismic data processing with the title of the workshop was "Of poles and Zeroes" was held in March 7 –14, 2002 at Yogyakarta. The aim of workshop holding was exchange of knowledge and to understand the basic concept and processing techniques of seismic digital data by using modern technique approach. 14 participants involved in this workshop.

Exchange of visiting staff of both sides were done within the period of time of cooperation. Two Indonesian scientists were participated to have short training courses respectively in Germany within the last two years. One Indonesian staff is now doing his MSc degree in electronic instruments in Germany.

The MOU of cooperation unfortunately could not be extended for the following five years period after 2002 due to problems of the research budget priority and strengthening of research project numbers in Germany. However, this collaboration has given some contributions in volcanological science (through their papers published in some international journals and were presented in some international and national seminars) especially to the IAVCEI commission, Mitigation of Volcanic Disasters" and that to some associations under the IUGG, and the activities are matched with all related IAVCEI scientific topics which will be issued or discussed in the IUGG Scientific Meeting at Sapporo in 2003.

Cooperation between Indonesia and France.

MOU for the cooperation between DGGMR through Directorate of Volcanology and Geological Hazard Mitigation (DVGHM) of Indonesia and Delegaton Aux Risques Majeurs, DRM part of the Ministry of Environtment of France. The first five years period of cooperation between both countries was signed in 1986. The last five years period of the cooperation was extended and was signed in France in October 2001.

The title of the cooperation activity is "Collaboration between Indonesia and France in volcanology" with France as the donor country.
The aim of the cooperation are :

- To find new technique in volcanic monitoring.
- To help and improve the capability of Indonesian scientists
- To understand much deeper and wider of Indonesian volcanoes (andesitic composition) for comparison study with the existing similar volcanoes in France.
- Join research and equipments installation which were done at Merapi consists of :
- Installing of magnetic monitoring station at 4 location on Merapi flanks.
- ACQ Program is used for recording digitalize seismic activities at Merapi volcano. This method is applicable at any other volcano.
- Seismic antenna system is utilized for seismic monitoring especially to know the arrival direction of a seismic event.
- GPS are used for geodetic survey in monitoring of lava dome growth at Merapi.
- Tilt monitoring using pendulum tilt-meter.

- Through this cooperation some improving of scientists capability were done such as :
- 10 Indonesian PhD in volcanology were produced through this cooperation using France government budget. At the moment, 2 PhD Indonesian students in volcanology are still on going in France.
- Scientists exchange to France and to Indonesia have also been done for writing paper together with France scientists.

Thesis and papers made through the research and join research were published in some international and national journals and presented in some international and national seminars such as IAVCEI scientific meeting and IAGI or HAGI scientific meetings.

All activities in the collaboration between the two countries has given some contributions in volcanological science to all association under the IUGG, and the activities are matched with all related IAVCEI topics which will be issued or discussed in the IUGG meeting at Sapporo in 2003.

Attending some international seminars.

An Indonesian volcanologist attended the IAVCEI General Assembly 1993 at Canberra, Australia presenting a precursor features on 1983 Colo volcano eruption (Central Sulawesi, Indonesia). The presentation has given contribution especially to IAVCEI and to IUGG in general.

During the Fourth Colima meeting at Mexico in January 1994 and during the fifth Colima meeting in January 1996 an Indonesian volcanologist respectively gave a contribution to make a presentation dealing with precursor of volcanic eruption for some volcanoes in Indonesia. This certainly gave also contribution to this commission, "Mitigation of Volcanic Disasters", and IUGG in general.

On the other hand a paper with the title of "Earth Observation and in situ measurements for volcanoes : Indonesian perspective" made by and was presented Indonesian volcanologist and discussed in the International Global Observation Strategy (IGOS) Geohazard Workshop which was held in Frascati, Italy in March 4-6, 2003. The workshop was organized by the IGOS Geohazard Ad-Hoc working group hosted the European Space Agency. The objective of the IGOS was to set up a coherent strategy to ensure that geospatial data can be made available to respond to the needs for environmental information from policy and decision makers and to support scientific and operational environmental programmes. The proposal IGOS Geohazards theme provides an integrated geological/geophysical IGOS theme that address geo-spatial information needs for volcanoes, earthquake and ground Instability Hazards. The objective of the workshop was to bring together representatives from the users and scientific communities, to identify the major issues on Geohazards information needs which were :

- capture the needs from scientific research and from the operational users.
- Discuss state of the art methodologies, technical and scientific solutions, geosphysical models, geospatial data handling.

- Review the geohazards theme proposal that will be submitted to the IGOS Partnership and to build a general consensus around the theme proposal.

This workshop was close relation with the program of IAVCEI commission, "Mitigation of Volcanic Disasters" and also give contributions to all association under the IUGG in general.

A number of 12 abstracts written by scientist on volcanology have been submitted to the Organizing Committee of the IUGG General Assembly 2003 Sapporo, Japan. Most of the abstracts are dealing with the IAVCEI commission of "Mitigation of Volcanic Disaster". Nine of the 12 Indonesian scientists will attend and will present their paper at the IUGG General Assembly 2003 Sapporo, Japan in July 2003.

World Organization of Volcano Observatories (WOVO).

Indonesian Volcano Observatories.

Indonesia has 129 active volcanoes where 79 among them have to be monitored. Up to now, observatory buildings have been built on 69 Indonesian volcanoes. Installing some kinds of equipments such as seismographs, equipments for visual observation, radio communication. In some certain volcanoes (such as Merapi, Guntur, Lokon volcanoes), many kinds of methods for volcanic monitoring are installed.

There are three categories in volcanic monitoring on the basis of relationship between the Observatory Building and the number of volcanoes to be monitored from. All of them are organized by the DVGHM.

Firstly, local volcanic monitoring system where a single active volcano is monitored from an Volcano Observatory building by using radio telemetry system. Most volcanoes are monitored by this way.

Secondly, regional center volcanic monitoring system where some active volcanoes located close by to each other technically are monitored from one Volcano Observatory Building by using radio telemetry system. There will be 7 regional center volcanic monitoring system can be applied in Indonesia. This kind of method has been applied at three of the 7 locations sinc the last three years. They are at West Java province involving Guntur, Papandayan, and Galunggung volcanoes; At Bali province involving Batur and Agung volcanoes; at North Sulawesi province involving Soputan, Lokon, and Mahawu volcanoes. In the next near future, a regional center volcanic monitoring system will be applied at East Java province involving Bromo, Semeru, and Lamongan volcanoes.

Thirdly, global volcanic monitoring system where some remote active volcanoes are monitored from the center office at Bandung, Indonesia by using Argos or satellite system since the last 6 years. This system was used using join cooperation between Indonesia and France governments. Thus the data is also transmitted to Paris, France.

All of these methods are used for experiments and for volcanic monitoring purposes in Indonesia.

Meetings related with Observatory Activity.

A volcano observers International short course was held in Indonesia in 1986 at Yogyakarta. The number of participants consisted of 20 volcano observers coming from Indonesia, Philippines, Papua New Guinia, Russia, and Columbia. The course was held through a collaboration in organizing committee between the Volcanological Survey of Indonesia and UNESCO. The teachers were invited from some other countries such as France, Italy, Australia, USA, and Indonesia. The aim of this course is to give a main similar way in volcanic monitoring work, to give some modern basic knowledge in volcanic monitoring jobs, and to compare some additional volcanic monitoring ways at any country. The Observers are tool to obtain volcanic information to let us know in what level of activity the volcano is. This is certainly a contribution for the IAVCEI commission, "WOVO" and IAVCEI in general.

Simulation of evacuation practices.

A simulation for evacuation practice was carried out in the field at Kemusuk village (Merapi volcano west flank), Central Java, Indonesia held in 1984. The simulation was organized by the local government of Central Java Province involving local citizen at the area. All participants were acted as the chief of region government, as governor, as journalists, as volcano observers, and as really community. This simulation gave a very simple technique for the people to know how and when people should run if the volcano was increase in activity. In other ward, this technique is a strategy to make people understand the guidance how they should run when the volcano is in active.

A volcano observers short course was held at Yogyakarta in second week of January 2003 during the period of 4 days. The participants were involved volcano observers, technician, and some staffs of local government from many cities, regions, and provinces. The final activity of the course was simulation of decision in the increasing of activity at any volcano involving all participants who acted as volcano observers, as journalists, as chief of region, as governor, as NGO, as local citizen etc. This activity was actually a simple understanding and a simple practice what people should do when people are facing a volcano in active or in eruption.

Chemistry of Volcanic Gases.

The Fifth Field Volcanic Gases Workshop in Indonesian volcanoes.

The workshop was held in collaboration between the Directorate General of Geology and Mineral resources (DGGMR) through the Volcanological Survey of Indonesia (VSI) and UNESCO in 1993. The aim of the workshop was to find methods in volcanic gas sampling technique, analyses them, and its relationship with volcanic monitoring method on the basis of volcanic gases.

The field workshop was opened formally in Bandung, with the field of volcano objects were Tangkuban parahu (West Java), Kamojang (West Java), Papandayan (west Java), Dieng (Central Java), and Merapi (Central Java). Groups of participants consisted of USA, France, Italy, Rusia, Belgium, Canada, Philippines, Japan, South Korea, New Zealand,

and Indonesia with the total number of participants of about 40. All of the groups brought their own equipments with them and they brought the gas sample to their own country to be analyzed. The workshop was closed formally in Yogyakarta.

Extended abstracts made by the group were collected in the book of Abstract and Addresses and were presented during the workshop. All participants were very happy with the workshop result as every participant gave contribution in knowledge and equipments, thus they got understanding much wider about the knowledge and many kinds of the equipments.

IAVCEI General Assembly 2000 Bali, Indonesia.

48 abstracts dealing with the IAVCEI commission, "Chemistry of Volcanic Gases" of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected in the "Abstract and Addresses IAVCEI General Assembly 2000 and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

Cooperation between Indonesia and Germany

The aim of the cooperation was to understand and to improve knowledge dealing with volcanic mechanism and processes. One of the scopes of activity was investigation on geochemistry, and geology.

The recorded data in the sensors installed in the field were telemetered to the Center Office of Merapi in Yogyakarta. One of the result of the cooperation activities was.

- Deformation monitoring by using multi-parameter (tilt meter, GPS, climate and soil temperature measurements, radon-meter) scattered at 4 separated locations.
- Sensors of gas and temperature were installed at Merapi summit.

All of experiments especially using telemetry system gave several benefits that can be implemented for volcanic monitoring purposes.

Volcanogenic Sediments.

IAVCEI General Assembly 2000 Bali, Indonesia.

17 abstracts dealing with the IAVCEI commission, "Volcanogenic Sediments" of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected in the "Abstract and Addresses IAVCEI General Assembly 2000 and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

IAGI Scientific Meeting.

Many papers which are related with the IAVCEI Commission, "Volcanogenic Sediments" were collected and presented in the Indonesian Geologists Association (IAGI) Scientific Meeting. The IAGI

Scientific Meeting is carried out once a year in Indonesia. At lease 2 papers dealing with this IAVCEI Commission on Indonesian volcanoes were always involved in this Scientific Meeting.

PhD thesis at Utrecht University.

A PhD thesis with the title of "Volcanogenic Polution : Element accumulation and dispersal around Patuha Volcano and Ciwidey River, West Java, Indonesia" was made by Indonesian scientist at Utrecht University, the Netherlands in 1998. Some scientific papers made by the same writer were also published in some international and national scientific journals. This thesis was also a good contribution to this commission, "Volcanogenic Sediments", IAVCEI, and IUGG in general.

Another PhD thesis is now still on going which is being done by another Indonesian scientist at Utrecht University. The thesis is about Volcano pollution at The Ijen Volcano, East Java, Indonesia. This thesis is expected that will also be a good contribution this commission, "Volcanogenic Sediments", IAVCEI and IUGG in general.

Large Volume Basaltic Province.

A PhD thesis made by an Indonesian scientist at Cantebury University, New Zealand with the title of "Geology of Galunggung, West Java, Indonesia" partly explained about a basaltic magma produced by the Last process of the Galunggung volcano (West Java) eruption in 1982-1983. An abstract dealing with this part was also submitted in the IAVCEI General Meeting at New Mexico, USA in 1989. This paper and thesis are good contribution to this commission, the IAVCEI and IUGG in general.

Volcanism and the Earth's Atmosphere.

Every volcanic activity (including eruption) occurred in Indonesia is always reported to the Smithsonian magazine by Indonesian government through the Directorate of Volcanology and Geological Hazard Mitigation. There are at lease three Indonesian volcanoes increased in activity within one month are reported in this magazine. The report consists of name, location of the volcano, condition of volcanic activity, with some volcanic information technically.

The same report with a certain format was also sent quickly to Darwin, Australia for aviation safety purposes. Indonesian archipelago is an International air traffic between Asia-Europe and Australia. A meeting dealing with the aviation safety has ever been done in Darwin, Australia in 1995 to evaluate if everything can be done well.

Remote Sensing.

Aerial and space images contain a detailed record of features on the ground at the time of data acquisition. Images interpretation is made as

to the physical nature of objects and phenomena appearing in the images. Dealing with the volcano, a conventional and digital images interpretation with the aid of computer has been applied. This information is then compiled, generally in the form of hardcopy maps and as a computer files that can be merged with other layers of information in geographical information system (GIS). Much of the work undertaken by remote sensing mission, which is focused on hazard and risk assessment as part of mitigation of volcanic disaster are:

1. Geomorphological mapping of the volcano to identify the area, which have affected and might be affected by volcanic eruption products dealing with producing volcanic prone zone map,
2. Landuse mapping to identify elements at risk in the volcanic prone zone.

Many of Remote Sensing and GIS activities have been done by Indonesian Earth Geoscientists through carrying out and attending national and International seminar, such as :

- Geological mapping of the volcano to identify the type of volcanic deposits,
- 2th Annual Meeting of Indonesian Remote Sensing and Geographic Information System Forum, 2002, with one of topic of Hazard Mitigation and Disaster Management,
- The role of geomorphology in volcanic hazard mitigation, presented on International Symposium on Application of Remote Sensing and Geographic Information System to Disaster Reduction, 1998, Tsukuba, Japan,
- Application of remote sensing for volcano tourism development, presented on 10th Annual Meeting of Remote Sensing Society of Indonesia, Mataram, 2001.
- Remote sensing methods were applied for geothermal exploration at Mataloko Geothermal Field, Flores island, Indonesia in 1999. This method help a lot in geothermal exploration purposes.

An international corporative programme has been carried out to monitor the Indonesian volcanoes. SATTIN (SAtellite Technology Transfer in INdonesia), a joint project between French-Indonesian governments to monitor Indonesia's volcanoes with prototype Argos Platform. The project leaders are the BPPT, the Indonesian Agency for the Assessment and Application of Technology. SATTIN has set up two types of sensors and early warning system equipments on 20 volcanoes. Measurements are processed locally and the results are sent back by Argos to monitor the volcanoes. The direct receiver station at Directorate of Volcanology and Geological Hazard Mitigation's (DVGHM) facility retrieves messages alternately from four NOAA satellites, which receive data from the Argos transmitters and relay them in real time. Data on each volcano are therefore received over 12 times a day. The DVGHM's team and French experts have worked together to set up the transmitters and interpret results.

In case of Remote Sensing and GIS application, two Indonesian scientists have graduated from International Institute for Aerospace Survey and Earth Geosciences, The Netherlands, a university concerned to remote

sensing and geographical information system. During their study, they produced two thesis dealing with hazard and risk assessment of volcanic eruption, namely:

1. Geomorphological approach to volcanic hazard zonation using remote sensing images.
2. GIS Modelling for Pyroclastic Flows Hazard and Risk Assessment, a case study of Merapi Volcano, Central Java, Indonesia

In participating in the earth geosciences society dealing with mitigation of volcanic disaster, many earth geoscientists wrote paper and presented in the national and international seminars, such as :

- **Simulation for Eruption Lahar of Mt. Galunggung: An estimation to the future**, presented on 27th Annual Convention of the Indonesian Association of Geologist Vol. III, December 1998 and IAVCEI-General Assembly 2000, Bali-Indonesia,
- **Volcanic Hazard and Mapping in Indonesia,** presented on Ninth Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia-GEOSEA 1998,
- **Earth Observation and in-situ measurements for volcanoes: the Indonesia perspective**, presented on Geohazards Workshop, March 2002, Frascati, Italy.
- **The role of geomorphology in volcanic hazard mitigation**, presented on International Symposium on Application of Remote Sensing and Geographic Information System to Disaster Reduction, 1998, Tsukuba, Japan.

Granites.

IAGI Scientific Meeting.

Many papers which are related with the IAVCEI Commission, "granites" were collected and presented in the Indonesian Geologists Association (IAGI) Scientific Meeting. The IAGI Scientific Meeting is carried out once a year in Indonesia. At lease 4 papers dealing with this IAVCEI Commission on Indonesian volcanoes were always involved in the IAGI Scientific Meeting.

Volcanic Lakes

IAVCEI General Assembly 2000 Bali, Indonesia.

21 abstracts dealing with the IAVCEI commission, "Volcanic Lakes" of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected in the "Abstract and Addresses IAVCEI General Assembly 2000 and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia".

On the other hand, a group of Volcanic Lakes pre-symposium field-trip to three volcanoes (Dieng, Kelut, and Ijen volcanoes) on Java, Indonesia was carried out during five days (July 12-17, 2000). About 30 participants were involved in this field-trip. Guide-book of each volcano

was made separately. The participants who interested in the field-trip were mostly geochemists. Discussion among guides and participants on all about volcanic lakes of the three volcanoes were also taken part at each volcano field respectively.

A leaking process of Ijen crater-lake water within Ijen caldera through Banyu Putih River flowing towards the north until North coast of East Java at Asem Bagus village, Situbondo, East Java, Indonesia. The water Ph is less than 0.5 in the crater lake and is 3.5 at Asem Bagus village (45 km away to the north from the crater lake). The Banyu Putih River is the only river flows from the crater lake through the caldera wall at the North and that reach to the Asem Bagus village and the North Coast of East Java. Due to this condition, the low Ph river water of Banyu Putih has penetrated to many wells belong to people used for their daily life. The Ph of the river water tends to decrease gradually. The fluor content in the well water at Asem Bagus vary between 1.5 and 3.5 ppm which is higher than the normal value according to WHO standard for people heath.

Investigation dealing with this problem is being done as a research for a PhD program at Utrecht University by an Indonesian scientist. On the other side, we need to do some investigation upon this problem to safe people life at Asem Bagus and some areas or villages where is passed through by the Banyu Putih River. Some efforts to neutralize the Ph of the river water is required. Some data and information dealing with this effort by adding some limestone into the water to produced gypsum and the higher Ph water has been done in the laboratory many times. Furthermore some experiment effort by adding some other elements then some aluminum and iron with the water Ph becoming higher. This work has been done by Directorate of Vulcanology and Geological Hazard Mitigation of Indonesia. This is an environment problem (it is not alny a volcanological problem) where the prevention effort requires multi-disciplines to be involved and that requires long-term program to solve them totally and that requires a big total budget to solve them involving the whole job from up-stream job until down-stream.
At this opportunity, it needs to have a cooperation or partnership between Indonesia and some other countries to solve this problem.

IASPEI/IAVCEI Joint Commission on Volcano Seismology.

IAVCEI General Assembly 2000 Bali, Indonesia.

24 abstracts dealing with the IAVCEI commission, "IASPEI/IAVCEI Joint Commission on Volcano Seismology" of many volcanoes from all over the world written by many scientists from all over the world respectively (including Indonesia) were collected in the "Abstract and Addresses IAVCEI General Assembly 2000 and were presented in the IAVCEI General Assembly 2000 Bali, Indonesia.

IAGI and HAGI Scientific Meting.

Many papers dealing with the IAVCEI Commission, "IASPEI/IAVCEI Joint Commission on Volcano Seismology" were collected and presented in the

Indonesian Geologists Association (IAGI) the Indonesian Geophysicists Association (HAGI) Scientific Meetings. The IAGI and HAGI Scientific Meetings are carried out once a year in Indonesia respectively. At lease 4 papers dealing with this IAVCEI Commission at Indonesian volcanoes were always involved in this Scientific Meeting respectively.

MSc thesis at Bandung Institute of Technology, Indonesia.

Two MSc thesis at ITB and one PhD thesis at France dealing with this commission, "Joint Commission on Volcano Seismology" are :

- MSc thesis with the title of Seismic Tomography at Guntur Volcano, West Java, Indonesia (in 2002) to study subsurface structure on the basis of volcanic earthquakes occurred at Guntur Volcano.
- MSc thesis about understanding micro-earthquakes related with hydraulic fracture processes due to water injection at geothermal field of Kamojang, West Java, Indonesia was done in 2001.

IASPEI-IAVCEI Inter-Association Commission on Physical and Chemical Properties of Materials of the Earth Interior.

A PhD thesis with the title of "some studies on volcanology, petrology, and structure of Mt. Kelut, East Java, Indonesia" was done at Victoria University of Wellington, New Zealand in 1991. The thesis studied about petrogenesis of Kelut volcano, and that about structure of Kelut and its surrounding area.

Working Group on Volcano Acoustics.

Three kinds of wave of frequency were usued for acoustic pressure study in the Crater lake of Kelut Volcano, East Java, Indonesia.

- **Band 1**, low frequency was used to detect earthquakes at Kelut area.
- **Band 2,** moderate frequency was used for audio detection due to gus bubble.
- **Band 3,** high frequency was used to detect under ground pressure increasing recorded before volcanic earthquake event or before volcanic eruption event.

The pressure acoustic monitoring was accompanied by monitoring of temperature of crater lake water at the bottom and temperature of water at the middle deep of the crater lake of Kelut Volcano. The pressure acoustic data monitoring of pre February 10, 1990 showed a very good increasing significantly, indicating features until a few seconds before eruption event of February 10, 1990. Before the 1990 Kelut eruption, the data transmition was done by using Argos system.

A PhD thesis with the title of "Pressure acoustic monitoring system at Crater lake of Kelut Volcano, East Java, Indonesia" was done by an Indonesian scientist at France in 1995.

All of the acoustic equipment were ruined by the 1990 Kelut eruption. The new equipment for pressure acoustic were re-installed in 2001 for monitoring pressure acoustic, temperature of crater lake water at the

bottom, that at the middle deep of the lake, and that at the air above the crater lake of Kelut Volcano. The data transmition is done by using Imarsat satellite system. The average quiescence period for Kelut volcano is 15 years.

Expectation to the Future

Related with the IAVCEI activity or program in Indonesia, there are several points that are expected in the near future :

- Investigation and development continuously to find good methods and strategy for mitigation of Volcanic Disaster through holding volcanological seminars or workshops in Indonesia or participate seminars or workshop dealing with volcanology somewhere abroad.
- Regional Center Volcanic Monitoring System at 7 areas all over Indonesia can be applied. This requires equipments provide such as seismographs, deformation equipments, personal computer; requires educated staffs or educated volcano observers.
- Integrated study on the leaking of the Ijen crater lake water including volcanic mitigation and overcoming the acid water problem at down-stream area at the North Coast of East Java, Indonesia can be carried out to prevent the community health become worst in the future. Partnerships are expected to work together with Indonesian scientists in doing all of these.
- Cooperation work between Indonesia and developed countries in volcanological aspects and in volcanic hazard or disaster mitigation purposes in Indonesia are expected to be continued as they are worthwhile for Indonesia.