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Item 6 of the provisional agenda*

COUNTRY REPORT ON THE IMPLEMENTATION OF THE RESOLUTION OF THE FOURTEENTH UNITED NATIONS REGIONAL CARTOGRAPHIC CONFERENCE FOR ASIA AND THE PACIFIC

INDONESIA

* E/CONF.92/INF/1

KL00-0045

1. INTRODUCTION

This Country report is an update to the previous report presented at the Fourteenth United Nations Regional Cartographic Conference for Asia and the Pacific, held in Bangkok, Thailand, 3-7 February 1997. This report Covers the period from April 1997 to January 2000, and is prepared in line with the implementation of the resolutions as endorsed in the fourteenth United Nations Regional Cartographic Conference for Asia and the Pacific.

The progress in the field of survey, mapping, and charting, development of Indonesian National Spatial Data Infrastructure and Capacity Building is discussed in this country report.

2. GEODETIC ACTIVITIES

2.1 HORIZONTAL CONTROL

As already been reported in the last Fourteenth UNRCC meeting, Indonesia started to use GPS (Global Positioning System) technology to carry out National Geodetic Control network since 1989. GPS has proven its capability to provide very high accuracy of relative coordinate measurement between observed points. This potential has made GPS become an operational tool for monitoring crustal deformation world widely, including Indonesia.

A new high precision GPS control networks have been established to cover the Indonesian archipelagic region. By February 2000, the total numbers of National Geodetic GPS control stations of Zeroth and First orders specification is 487 points. These points are of Zeroth and First order standard. In addition, the National Land Agency (BPN) has carried out densification of those GPS control point for the purpose of cadastral surveying and mapping.

Up till March 2000 BPN has established some 16,124 GPS control points in some selected BPN project areas. These control points meet the standard of accuracy of second and third order class. These GPS control points constitute a national geodetic reference and control points and are adjusted in the new Indonesian Datum 1995 (ID-95) which adopt the WGS84 reference ellipsoid and also in the ITRF91 as well as ITRF94. Table 1 illustrates the distribution of the

GPS control points in major islands in Indonesia, see also Map 1 for the distribution of the Zeroth and First order GPS control points.

Other space geodetic techniques available are DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite), installed in 1992 at Bakosurtanal Cibinong in cooperation with IGN France.

GPS controls have also been fixed for boundary demarcation, administrative as well as for international boundary on land, either for positioning of base points and baselines for maritime boundary. Up to December 1999, some 233 base points have been fixed by GPS for maritime boundaries.

Table 1: Horizontal control points in Indonesia by GPS.

Island/ Isles	Area (Km²)	Number of points				
		Total	ZO	FO	SO	TO
Java Is.	133.970	11659	7	75	1584	9993
Sumatera Is.	450.870	2651	19	80	1508	1044
Kalimantan Is.	541.480	936	10	68	435	445
Sulawesi Is.	212.420	738	12	86	410	280
Lesser Sunda Isles.(Incl. Bali)	86.790	463	13	75	275	100
Mollucus Isles	74.500	75	8	42	25	-
West Papua	414.960	37	12	-	25	-
Total Indonesia GPS only	1,914990 (land)	16611	81	406	4262	11862

- Please note that ZO, FO, SO and TO are stand for zeroth, first, second and third order respectly.

2.1.1 GPS Permanent Tracking Station and DGPS

To provide a better service to GPS users in Indonesia, a program of establishing Indonesian Permanent GPS Station Network (IPGSN) and Relative Differential GPS (DGPS) system had been initiated since 1994/95. Four IPGSN stations, i.e. Cibinong (in Java), Parepare (in Sulawesi), Medan (in Sumatra) and Toli Toli (in Sulawesi) have been in operation since 1995, 1996, 1997 and 1999 respectly.

Six DGPS permanent stations for Digital Marine Resources Mapping (DMRM) project have been in operation since 1997. Their locations are in Medan, Jakarta, Denpasar, Kupang, Manado and Biak (see Map 2). In the year 2000, two

IPGSN sites are planned to be installed in Kupang (West Timor) and in Biak (West Papua).

2.2 VERTICAL CONTROL

Since the last report to the UNRCC (Bangkok, February 1997), a little progress for the second order leveling network has been done in Southeast Sulawesi and West of Seram island for a total of 185 benchmarks. Up till March 2000, the total of surveyed leveling line is 23.107 line-Km and 5855 benchmarks. Table 2 illustrates the status of vertical control network for Indonesia, see also Map 3 for its distribution.

For the provision of height datum, tide gauge observations were used to compute mean sea level. But Indonesia still adopts separate height datum for each of the island. A study to unify of height datum for Indonesia has been carried out by Kahar et.al., but due to the lack of required data, the study need to be continued.

Table 2: Vertical control network in Indonesia

Island/Isles	Area in (Km²)	Number of BM	Line-Km
Java Is.	133.970	1.536	4.625
Sumatera Is.	450.870	2.495	10.621
Kalimantan Is.	541.480	151	683
Sulawesi Is.	212.420	900	4.054
Irian Jaya	414.960	-	-
Others	161.290	773	3.124
Total Indonesia	1.914.990 (land)	5.855	23.107

2.3 GRAVITY SURVEYS AND GEOID STUDY

First order gravity base stations in Indonesia have been established since 1990 using relative gravimeter of La Coste & Romberg. Some 39 gravity base stations were connected to the IGSN-74 and absolute gravity base station. Each base station has two reference markers which were also connected to the main marker (base station). See Map 4, for the station distribution.

Second order gravity network was established at leveling benchmarks in Java, Sumatera, Sulawesi, Madura, Bali, Lombok, Timor, Ambon and Seram. A total of 21.723 line-kms and 5193 benchmarks observed from 1988-1996. Table 3 shows the statistics of gravity network implementation in Indonesia.

Table 3: Status of Gravity Network in Indonesia

Island/Isles	Area in (Km^2)	No. of BM	Line-Km
Java Is.	133.970	1.198	4.750
Sumatera Is.	450.870	2.429	10.621
Kalimantan Is.	541.480	-	-
Sulawesi Is.	212.420	798	3.272
Irian Jaya	414.960	-	-
Others	161.290	768	3.080
Total Indonesia	1.914.990	5.193	21.723

Besides gravity network implementation, a grided gravity data of 5'x5' for Indonesia have been compiled from various sources. Mapping of the Bouguer and Free-air anomaly have been completed on 1:5.000.000, 1:1.000.000 scales.

Geoid studies using the above mentioned data have been carried out more intensively by Bakosurtanal since 1994. Both the OSU91A and EGM-96 geopotential models have been used as the long wave length parameter in the remove and restore ring integration technique to compute a regional and local gravimetric geoid of Indonesia. The resulted geoid computation are reported by Sutisna and Kasenda, Khafid, et.al. in Bakosurtanal Document (1996 and 1999).

2.4 TIDEGAUGE STATION NETWORK

For the provisional of height datum of the leveling network in Indonesia, tidegauges were installed in the main islands. Due to the increase demand on providing sea level data for the study of sea level rise and tsunami early warning system, as well as for the definition of chart datum and sea boundary, more tidegauges have been installed by Bakosurtanal. Up till March 2000, the Bakosurtanal's tidegauge network consists of 53 tidegauge stations.

2.5 GPS GEODYNAMIC OBSERVATION NETWORK

For the purpose of plate tectonic deformation study in Indonesia, GPS technique has been chosen for the operation of plate tectonic monitoring. As being situated in the active region of tectonics and volcanic, Indonesia is prone to natural hazards, such as earthquakes, tsunami, volcanic eruption, landslide, etc. By using GPS Indonesia is heavily involve in the maintenance and cooperation of GPS monitoring for plate tectonic deformation study. Based on the nature and philosophy of the study some different methods of geodetic measurement for plate tectonic deformation study have been established in Indonesia. They are the ASEAN regional network, Sumatera network, Sunda subduction network, Flores network, Biak network, Irja network, Palu Koro network and Sunda strait network.

GPS observation campaigns for the geodynamics of South and Southeast Asia (Geodyssea) have include 25 points in Indonesia and were observed three times, i.e. 1994, 1996 and 1998. The plan for this year will be (i) to install two GPS permanent stations in Central Sulawesi in cooperation with Delft Technical University (TU Delft) the Netherlands and ENS Paris, France; (ii) to re-observe geodynamic monitoring point in Sulawesi triple junction; and (iii) to reconnaissance about ten sites in Sumatra for the establishment of GPS permanent stations of Sumatran fault.

2.6 DATUM GEODESI NASIONAL - 1995

In February 1996 BAKOSURTANAL as the National Coordinating Agency for Survey and Mapping adopted a new coordinate system for the Republic of Indonesia. This new system in a geocentric datum is known as the "Datum Geodesi Nasional 1995 (DGN95)" or in English : "Indonesian Datum 1995 (ID-95)". The Zeroth Order Geodetic Network consist of sixty stations covering the whole country were established. All the station of this network were included in a global solution which provided the geocentric coordinates based on ITRF 91 at epoch 1992.0, with an estimated accuracy of better than 0.1 parts per million. These coordinates form the definition of DGN95. For practical purposes, to express these coordinates in latitudes and longitudes the World Geodetic System 1984 (WGS84) ellipsoid is used. The move to a geocentric datum is essential to be able to define land and maritime boundaries with an accuracy that is compatible that of the coordinates reference system and the modern positioning technology.

2.7. Regional Geodetic Network

Indonesia participate actively in various international campaign to establish a regional geodetic network. Under the Asia Pacific Regional Geodetic Project (APRGP) of PCGIAP, Indonesia has participated in 3 campaign in 1997, 1998, and 1999, and processed the data as individual solution by using GAMIT.

Within the APSG Indonesia participate in the management board and working group of Western Pacific Studies and Working Group on sea level rise.

3. MAPPING ACTIVITIES

3.1. Aerial Photography

Aerial photographic survey for mapping purposes has created an invaluable time series database. Aerial photographic data since 1980 up to 1999 have been compiled at Bakosurtanal. They consist of B/W and FCIR types of photographs of scales 1:100.000, 1:60.000, 1:50.000, 1:30.000, 1:25.000 and 1:15.000. Table 4 shows the list of available aerial photos at Bakosurtanal, and Map 5 illustrates their coverage.

3.2 Digital Mapping of Java, Bali, the Lesser Sunda Islands and Southern Mollucas, at the scale of 1:25.000

This project is a cooperation project between Indonesia and Norway, covering ±1662 sheets at 1:25.000 scale, and is scheduled to be completed in year 2001. A Kinematic GPS aerial photography was completed in 1993-1994 together with the establishment of 150 ground GPS station and 200 height measurement points.

As of April 1, 2000 the following status of production is achieved :

- Stereo compilation (Database 0) : 1617 maps
- Cartographic editing (Database 1) : 1590 maps
- Filed compilation : 1430 maps
- Cartographic editing (Database 2) : 1240 maps
- Offset Printing : 931 maps

A special report on this project is presented in a CD-ROM accompanying this report.

Table 4. Coverage of Aerial Photography

NO	Area Coverage / dated	Scale & type	Purpose
1.	Sumatera, 1976	1 : 100 000, BW	Topographic Map scale 1 : 250.000, 1 : 50.000
2.	Kalimantan, Sulawesi, 1981/1982	1 : 100 000, BW	Topographic Map scale 1 : 50 000 & Photo Map
3.	Kalimantan Sulawesi, 1981/1982	1 : 60 000, FCIR	Natural Resource Mapping
4.	Jawa, Bali, Nusa Tenggara, 1981/1982	1 : 50 000, BW	Topographic Map scale 1 : 25 000
5.	Jawa, Bali, Nusa Tenggara, 1981/1982	1 : 30 000, FCIR	Natural Resource Mapping
6.	Sumatera, Kalimantan, Irian Jaya, 1986/1987	1 : 30 000 BW	Mosaic control for Transmigrasi feasibility study (SUAT –V)
7.	Kalimantan, 1986	1 : 50 000, BW	Topographic Map scale 1 : 50 000, filling the gap of REAP project.
8.	Sumatera, Kalimantan, Sulawesi, Irian Jaya & Maluku 1988	1 : 25 000, BW	Photo Map scale 1 : 25 000, Transmigrasi feasibility study (SSDP-Trans V)
9.	Gap Kalimantan,& Sulawesi, 1988	1 : 50 000, BW	Topographic Map scale 1 : 50 000, filling the gap of REAP Project.
10.	Jabotabek, 1989	1 : 15 000, BW	Research using GPS kinematics for mapping
11.	Sumatera, Sulawesi, Jawa, Bali NusaTenggara, 1991/92	1 : 25 000, BW	Photo map for land Resource Evaluation and Planning studi pengembangan wilayah
12.	Kalimantan Irian Jaya & Maluku, 1992/1993	1 : 25 000, BW	Photo map for land Resource Evaluation and Planning studi pengembangan wilayah
13.	Perbatasan RI-PNG, 1992/1993	1: 50 000, BW	State Boundaries between RI and PNG skala 1 : 50 000
14.	Bangka, Sulawesi Selatan, 1993/1994	1 : 25 000,BW	Coastal Environmental Mapping, scale 1 : 50 000, (coastal ecosystems)
15.	Lampung, 1993/1994	1 : 25 000, BW	Topographic Map scale 1 : 50 000
16.	Jawa, Bali, Nusa Tenggara, 1992/1994	1 : 50 000, BW	Digital mapping scale 1 : 25 000.
17.	Biak, Seram, Kalimantan Timur	1 : 25 000, BW	Coastal Environmental Mapping, scale 1 : 50 000, (coastal ecosystems)

3.3 Digital Marine Resource Mapping (DMRM)

The first phase of the Digital Marine Resource Mapping Project is scheduled for 1995-1998, to provide the country with Digital Bathymetric chart of the designated sea lanes, verification of the base points that form the Indonesian archipelagic base lines and the charting of the continental shelves, continental margins and Economic Exclusive Zone.

This project employs 3 hydrographic survey vessels, the Baruna Jaya I, II and III equipped with Simrad Multibeam Echosounders (EM 1000 and EM 12 D). A helicopterborne Hawkeye Laser System operates from another vessel to provide bathymetry of the coastal areas. This project is supported by 25 Tidal stations and six DGPS reference stations namely Jakarta, Medan, Den Pasar, Kupang, Manado and Biak.

This work is carried out among others to comply with the United Nations Convention of the Law of the Sea (UNCLOS) and according to the standards as set up by the International Hydrographic Office (IHO). (IHO special publication S-57 version 3.0)

In the first stage, this project produced positions of 233 base points, 45 sheets of designated sea lane charts at the scale of 1:100.000 and 1:200.000, 71 charts at scale 1:200.000 as well as 15 charts at the scale of 1:1.000.000 covering the territorial waters, Economic Exclusive Zone and the continental shelves.

The following stages of DMRM Project is directed toward charting of the modified Sea Lanes by using Baruna Jaya VIII, a survey vessel operated by the Indonesian Institute of Science. The new objective is to create a National Resources Marine Data Base.

A separate report on DMRM activities is given in attachment.

3.4. Cadastral Mapping

Under the World Bank loan no. 3792-IND, the National Land Agency implements the Land Administration Project for five years beginning in 1995 to 2000. Since 1995, the project has completed all systematic registration of 1.2 million parcels in ten districts in Java. In addition, the project is finalizing the development of the Land Laws and Regulations database and expected to be finished by the end of year 2000.

In 1999, to support cadastral surveys around the country, within a licenced Surveyor Program, the National Land Agency has issued licences for 97 cadastral surveyors and 96 assistant cadastral surveyors. This surveyors are distributed over 35 towns and districts in 10 provinces.

3.5. Satellite Image Map

A four years project (1996-2000) is now on going under the name of "Satellite Applications and Technology Transfer in Indonesia" (SATTIN) .

This is a Franco-Indonesian project focusing on Eastern Indonesia. One of the aims of this project is to map a part of Indonesia's Eastern Provinces : Halmahera, Seram, Ambon, Bandaneira, Aru, Jayapura, Memberamo, Biak, Manokwari, Fakfak, Sorong, Nabire, Timika, Merauke, at the scale of 1:50.000 by processing satellite imagery, and set up an image production line in Bakosurtanal.

After four years of production , the project has completed a number 218 sheet out of total 241 sheets (see Map 6).

3.6. Charting

The Navy's Hydro Oceanography Service (DISHIDROS) is responsible for the sea navigational chart production over the Indonesian seabody. DISHIDROS is equipped with conventional and modern charting equipments. The CARIS (Computer Aided Resources Information System) has been installed in 1994 to develop a digital charting system to produce the digital base maps for the production of Electronic Navigational Charts (ENC). At present, DISHIDROS already produces 618 charts including sea navigational, thematic and military purpose charts.

In modern way, the CARIS system produces 23 base maps and 5 ENCs covering seabodies of Jakarta, Semarang and Surabaya. The ENC production continues to map the Indonesian sea-lanes and international seaports.

The production of ENC of Malacca Straits and Singapore Straits involves a cooperation of four countries : Indonesia, Singapore, Malaysia and Japan. Since it was started in 1996 several activities has been executed. Joint surveys were carried out in 1996 and data clarification was implemented in Tokyo Japan in 1998.

The joint production of the ENC of Malacca Straits and Singapore Straits is still going on and DISHIDROS actively participate in the realization of these ENC. The new chart spheroid will be the WGS 84 spheroid.

3.7. Geological Mapping

Geological mapping activities in Indonesia is the responsibility of Geological and Geophysical Mapping Division, under the Directorate General of Geological Research and Development Center (GRDC).

The GRDC is responsible in carrying out geological systematic and thematic mapping. The systematic geological and geophysical maps with the scale of 1:100,000 for Java and Madura islands and 1:250,000 for other islands were completed in 1995.

The center is also assigned the task of compiling regional systematic and thematic maps at scales of 1:500,000, 1:1,000,000, 1:2,000,000 and 1:5,000,000.

3.8. Global Mapping

Since December 1999 Indonesia has participate in the Global Mapping Project. One candidate has successfully follow a training course on Global Mapping supported by JICA in Tsukuba, Japan.

Indonesia has prepared Land Cover Layer (1989) and in 2001 will make available the following layers :

- National administrative unit,
- Hydrography (generalized from 1 : 250.000 map), and
- Updating of land cover (based on TM, SPOT, Radar Images)

4. DEVELOPMENT OF INDONESIAN NATIONAL SPATIAL DATA INFRASTRUCTURE

At present, Indonesia is reformulating the approach toward the development of a National Spatial data Infrastructure (NSDI). In the past much emphasize were given toward identifying various data producer and user, institutional capacity building, acquiring and gathering spatial data and human resources development.

In the last annual meeting of the National Coordination Agency forum on GIS a consolidated approach toward development of Indonesian NSDI in line with that proposed by PCGIAP was agreed. The components of NSDI as well as their interrelation are shown in Figure-1.

For the future, by using this approach, the national effort will be focused on establishing, maintaining, and updating the various databases through several custodians and providing access to wider users.

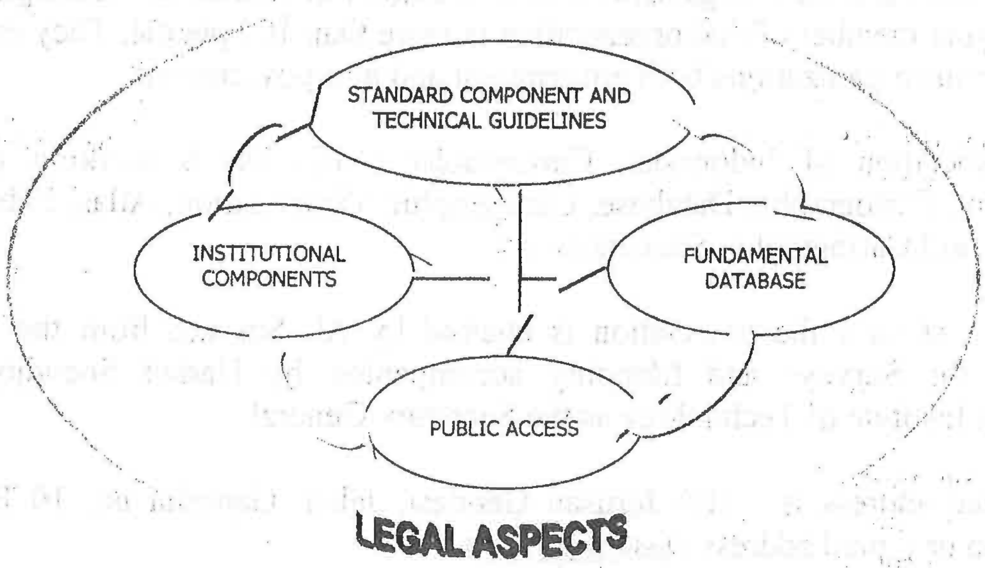

Figure-1 : Component of Indonesian NSDI

5. REORGANIZATION OF BAKOSURTANAL

In October 1998, a new Presidential Decree No. 87/1998 has renewing the mandate of Bakosurtanal responsibility in national policy in surveying and mapping as well as in the development of national geographic information system of the country.

The new organization of Bakosurtanal consist of the Head of Bakosurtanal assisted by two Deputies and a Secretary, and has six centers responsible for () Basic Surveys (ii) Survey for Natural Resources, (iii) National Atlases, (iv) Base Mapping and mapping for Spatial Planning, (v) Bathymetric Mapping and Aeronautical Charting, and (vi) Geographic data and information. The present head of Bakosurtanal is Prof. Dr. Joenil Kahar.

6. CAPACITY BUILDING

6.1. The Association of Indonesian Cartography (AIC)

On December 1, 1999 a number of cartographer and cartographic product user gathered and agreed to form a professional and organization in cartography. The name of that profession organization is Association of Indonesian Cartography. At this moment member of that organization is more than 100 people. They originated from various organizations both government and non-government.

The Association of Indonesian Cartography (AIC) has 6 working groups : Toponimy, Cartographic Database, Cartographic Visualization, Atlas, Public Map, Training and Cartographic Socialization.

For the first term the association is chaired by Al. Susanto from the National Agency for Surveys and Mapping accompanied by Hadwi Soendjojo from Bandung Institute of Technology as the Secretary General.

The office address is : ITB Jurusan Geodesi, Jalan. Ganesha no. 10 Bandung, Indonesia or e-mail address : hadwi@gd.itb.ac.id.

Several programs have been formulated and those programs will be the agenda for the next 3 years of AIC. One of the programs is the improvement of Atlas for Elementary School. For this matter AIC already held a workshop on 22 March 2000. AIC would like to communicate with similar international organization.

6.2. Geomatics Education and Training in Indonesia

Several universities and institutions have been providing education and training in the field of Geomatics. In order to anticipate the demand of human resources in the field of Geomatics, the education and training in this field should be nationally coordinated and integrated. The coordination and integration might be applied by standardization of curriculum, materials, guidance and mechanism.

On-the-job training in some institution is an effective and efficient alternative to educate new staffs in the field of Geomatics. This training could be used to motivate staff and to provide a forum to exchange knowledge among the staffs.

6.3. Education and Training Center activities in BAKOSURTANAL

The Education and Training Center of BAKOSURTANAL organizes several education and training program in the field of Surveys and Mapping for internal and external personnel.

In the 1999/2000 fiscal year the center has organized the education of 12 personnel in several universities and the training of 60 personnel in various training centers.

The Education and Training Center also successfully hosted the Integrated Use of Remote Sensing and GIS for Land Use Mapping Training Course, under the sponsorship of ESCAP-UNDP and the Government of Indonesia in 1999 and 2000. This training course was attended by a number of participants from several developing countries.

6.4. PUSPICS, Education Center for Satellite Image Interpretation

PUSPICS, stands for Pusat Pendidikan Interpretasi Citra Satelit or Education Center for Satellite Images Interpretation was established in 1983, and is situated at the Faculty of Geography University of Gajah Mada, Yogyakarta. The center has been actively involved in providing training and building cooperation with other institution nationally and internationally.

To date, PUSPICS has trained quite a number of people in form of :

- Regular training : 429 participants
- Training center for development countries : 92 participants
- Non-regular training : 628 participants

6.5. The Indonesian Surveyors Association (ISA)

The Indonesian Surveyor Association (ISA) was established in 1972 and at present has more than 1000 member all over Indonesia. ISA herself is also member of the Federation of International Surveyor (FIG), International Society of Photogrammetry and Remote Sensing (ISPRS) and The Asean Federation of Land Surveyors and Geomatics (FLAG).

In the last 3 years ISA has focused her effort to keep competence of Indonesian Surveyors to International Standard on : Surveying -- GIS and Remote Sensing.

Other than that ISA has also conducted several international and national seminars to provide her members with information on the development in various technology and application field of survey and mapping, GIS and Remote Sensing. An international seminar was successfully conducted in 1999 in cooperation with Technical Commission VI : Education and Communication of the ISPRS.

Furthermore, to support the government in the application of law no. 22, 1999 on Regional Autonomy ISA will in the near future extend the training center for Survey and Mapping to provinces outside Java.

The ISA contact person and address is Agus Hermawan Atmadilaga. Jl. Raya Jakarta-Bogor Km.46, Cibinong.16911 West Java, Indonesia. E-mail : isigeo@indo.net.id.

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Tantan Ruchiatan, Ir. P.T. Nusantara Agung Consultant

ATTACHMENT

MAP 1 : DISTRIBUTION OF NATIONAL GEODETIC FRAMEWORK AND CONTROL POINTS

MAP 2 : DISTRIBUTION OF GPS STATION NETWORK AND DGPS NETWORK

MAP 3 : DISTRIBUTION OF NATIONAL VERTICAL CONTROL NETWORK

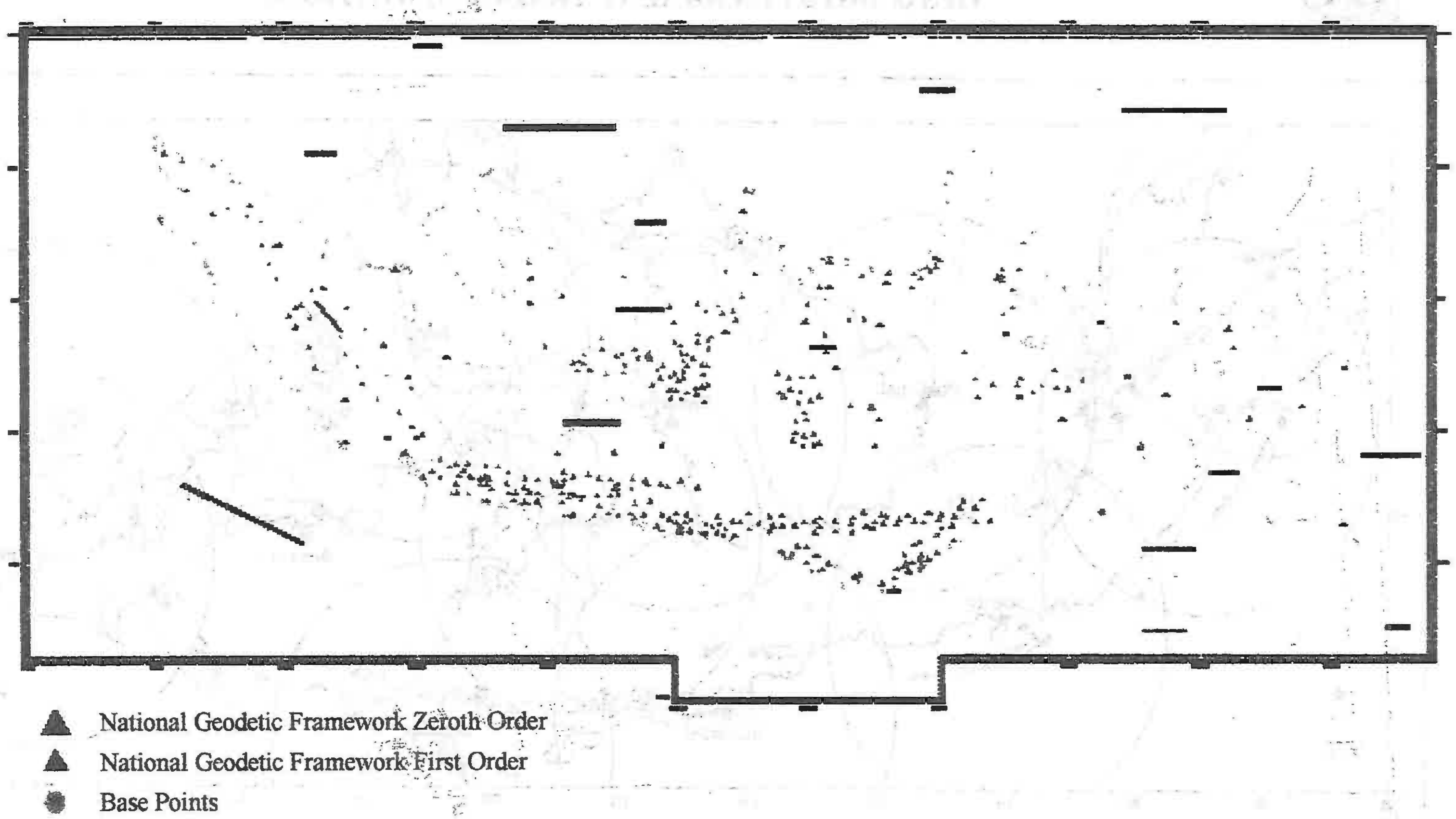
MAP 4 : DISTRIBUTION OF NATIONAL GRAVITY BASE STATION NETWORK

MAP 5 : AERIAL PHOTOGRAPHY COVERAGE 1980 – 1999

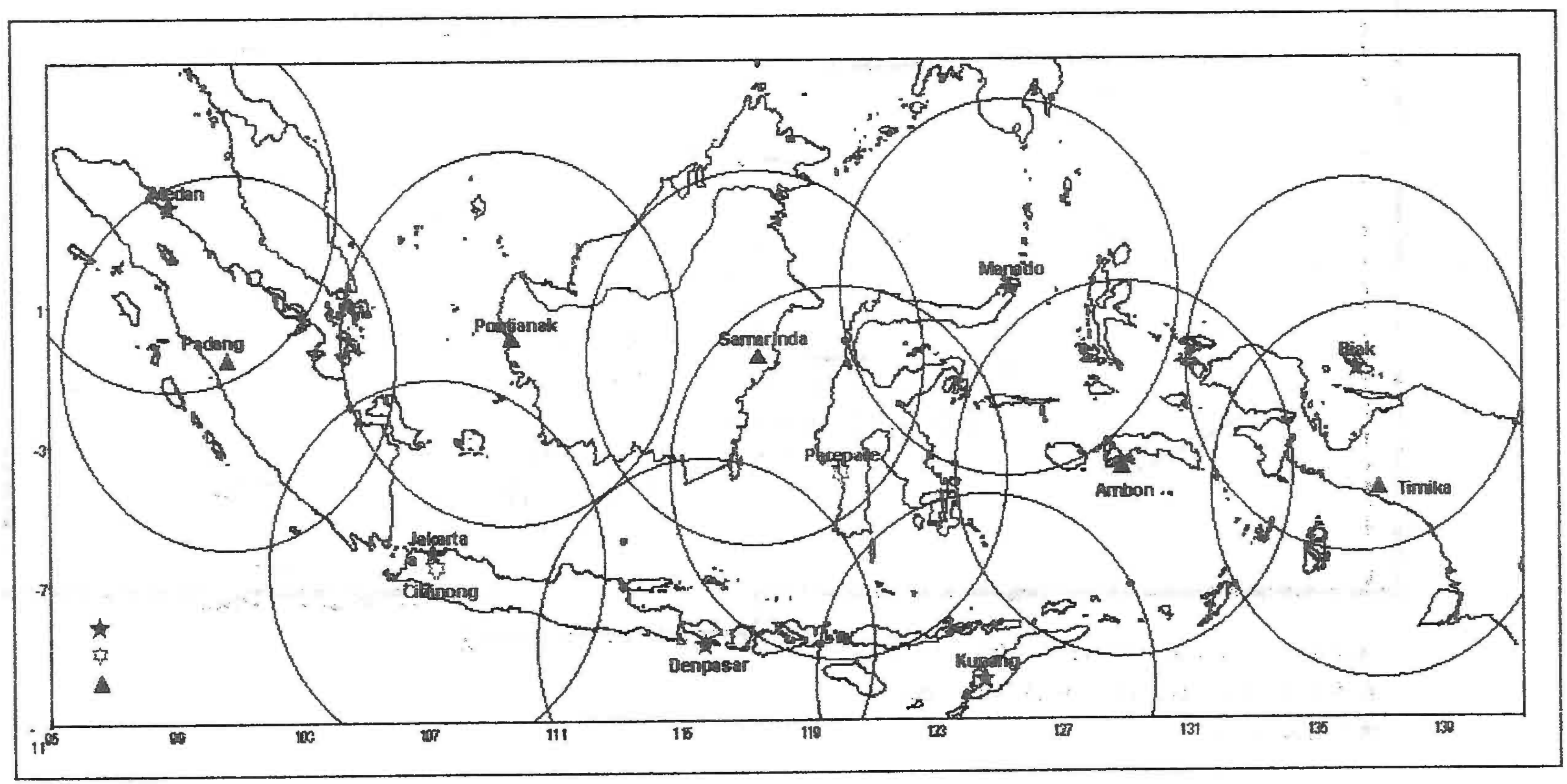
MAP 6 : STATUS OF SATELLITE IMAGE MAP PRODUCTION

PAPER : Overall Project Presentation , The Digital Marine Resource Mapping of Indonesian Waters

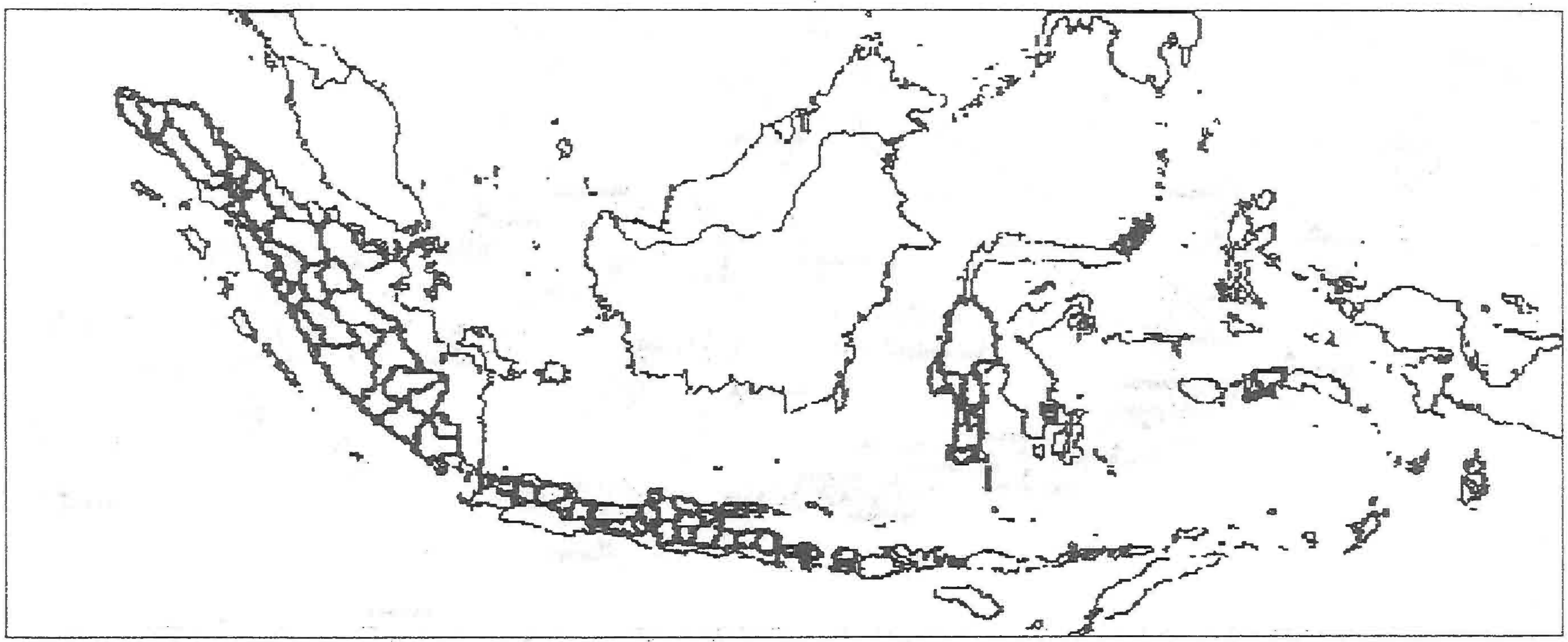
MAP 1 :
DISTRIBUTION OF THE ZEROTH AND FIRST ORDER GPS CONTROL POINTS



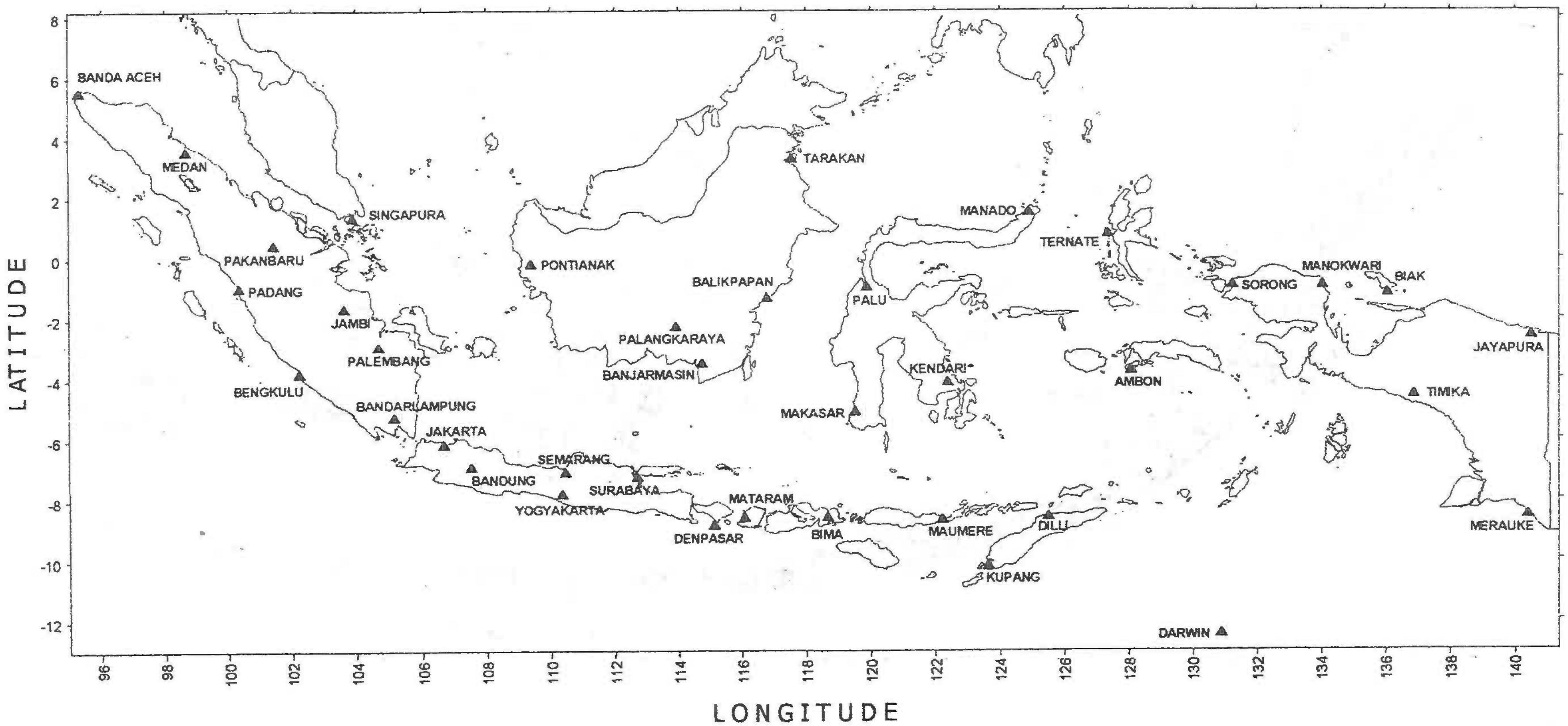
MAP 2:
GPS & DGPS PERMANENT TRACKING STATIONS



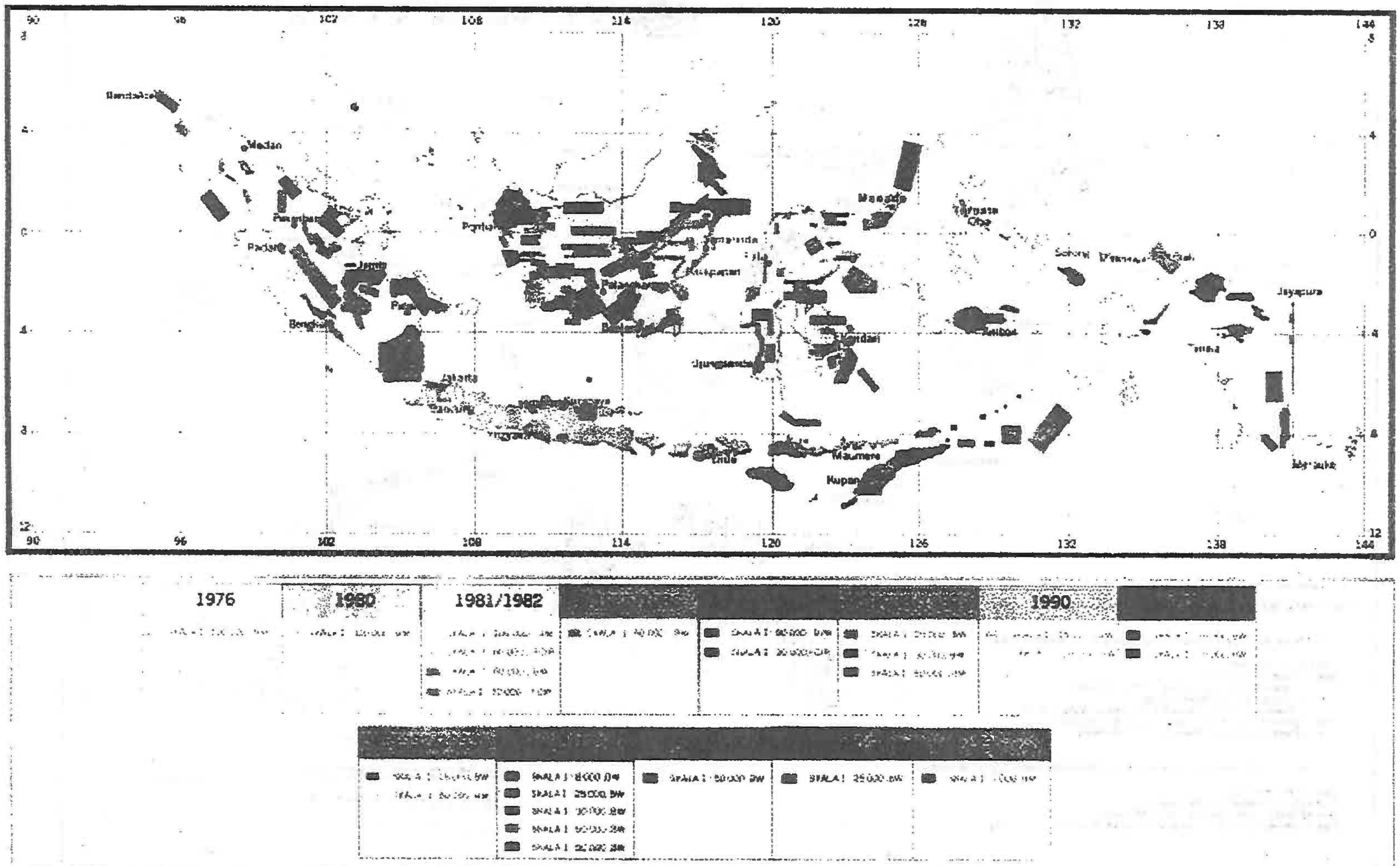
MAP 3 :
DISTRIBUTION OF VERTICAL CONTROL NETWORK



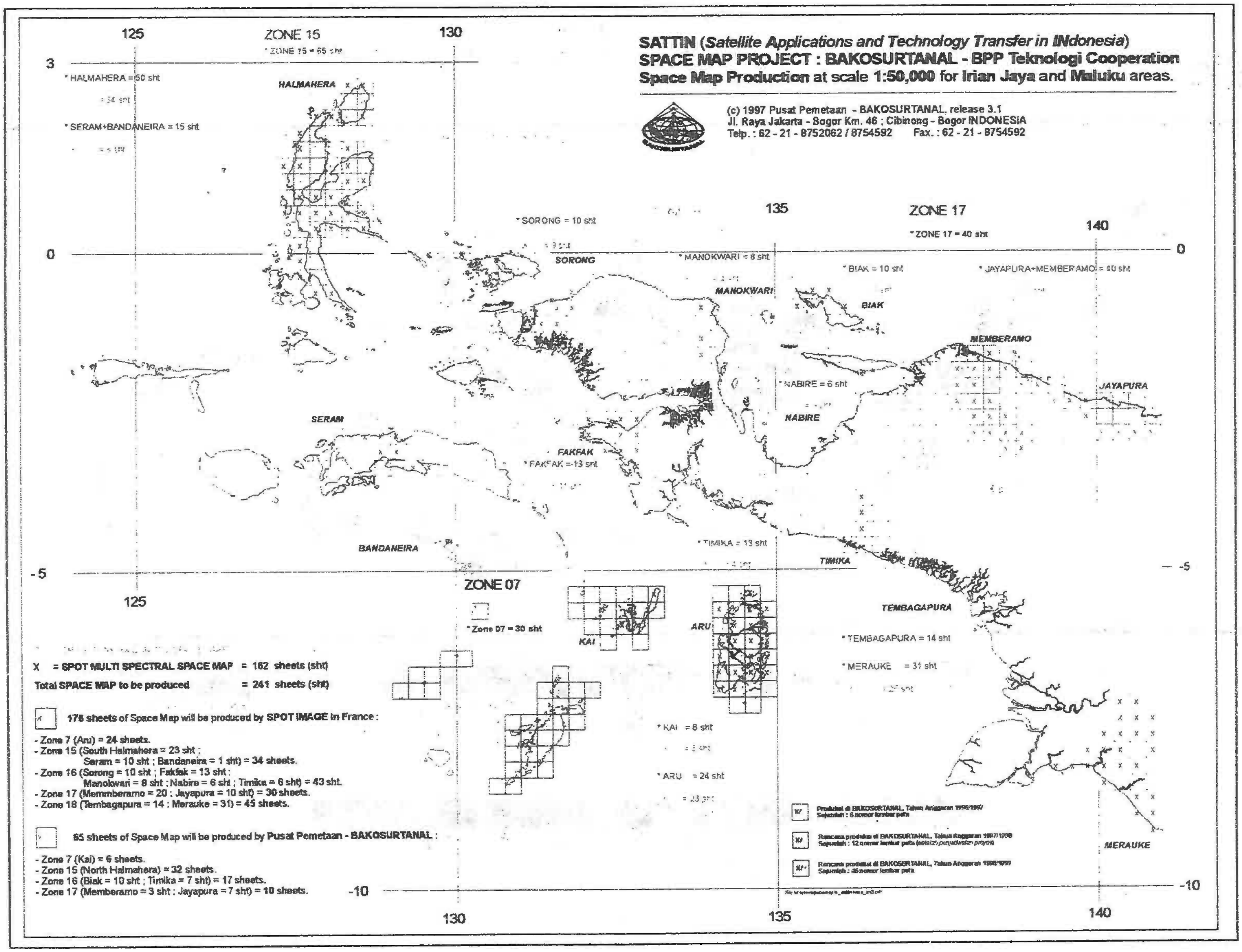
MAP 4 :
DISTRIBUTION OF NATIONAL GRAVITY BASE STATION NETWORK



MAP 5 :
AERIAL PHOTOGRAPHY COVERAGE



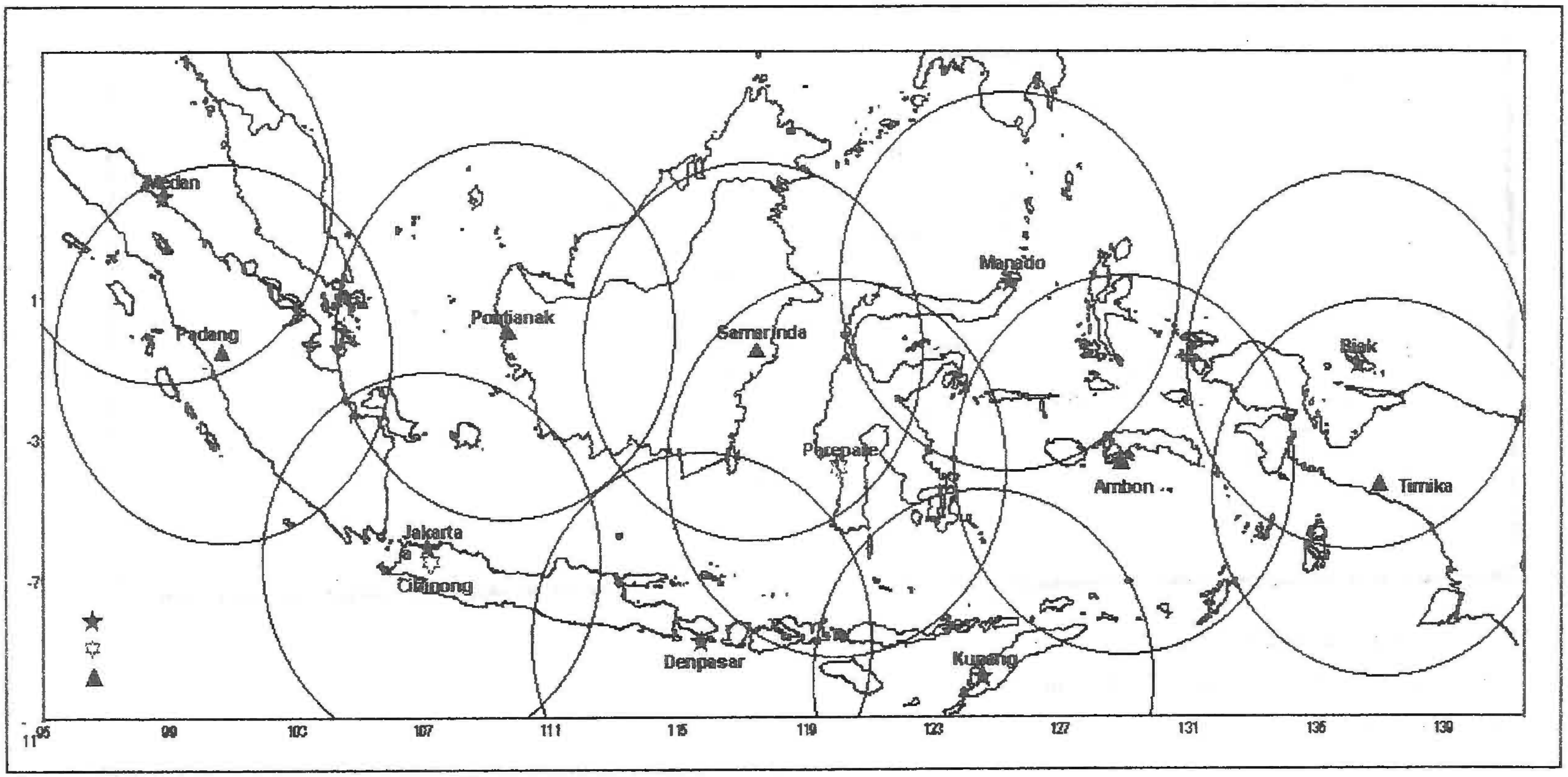
MAP 6 :
STATUS OF SATELLITE IMAGE MAP PRODUCTION



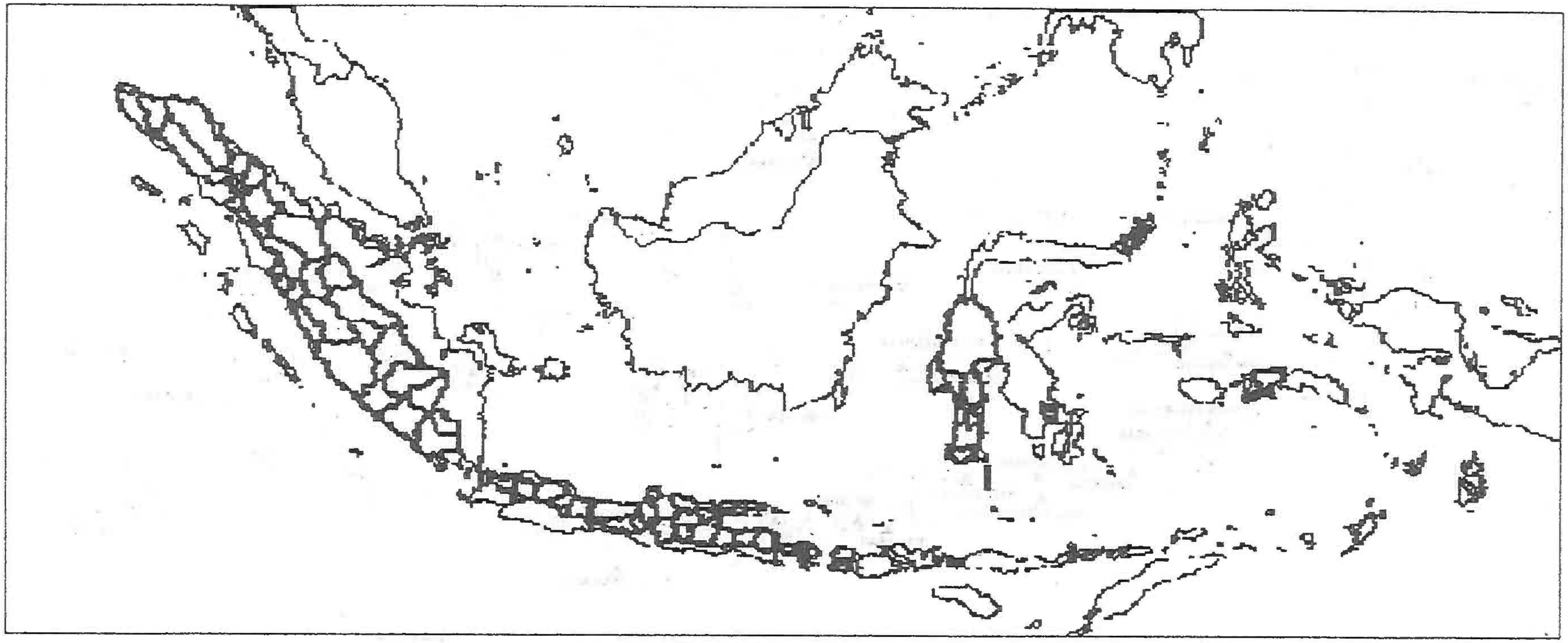
MAP 1 :
DISTRIBUTION OF THE ZEROTH AND FIRST ORDER GPS CONTROL POINTS

▲ National Geodetic Framework Zeroth Order
▲ National Geodetic Framework First Order
● Base Points

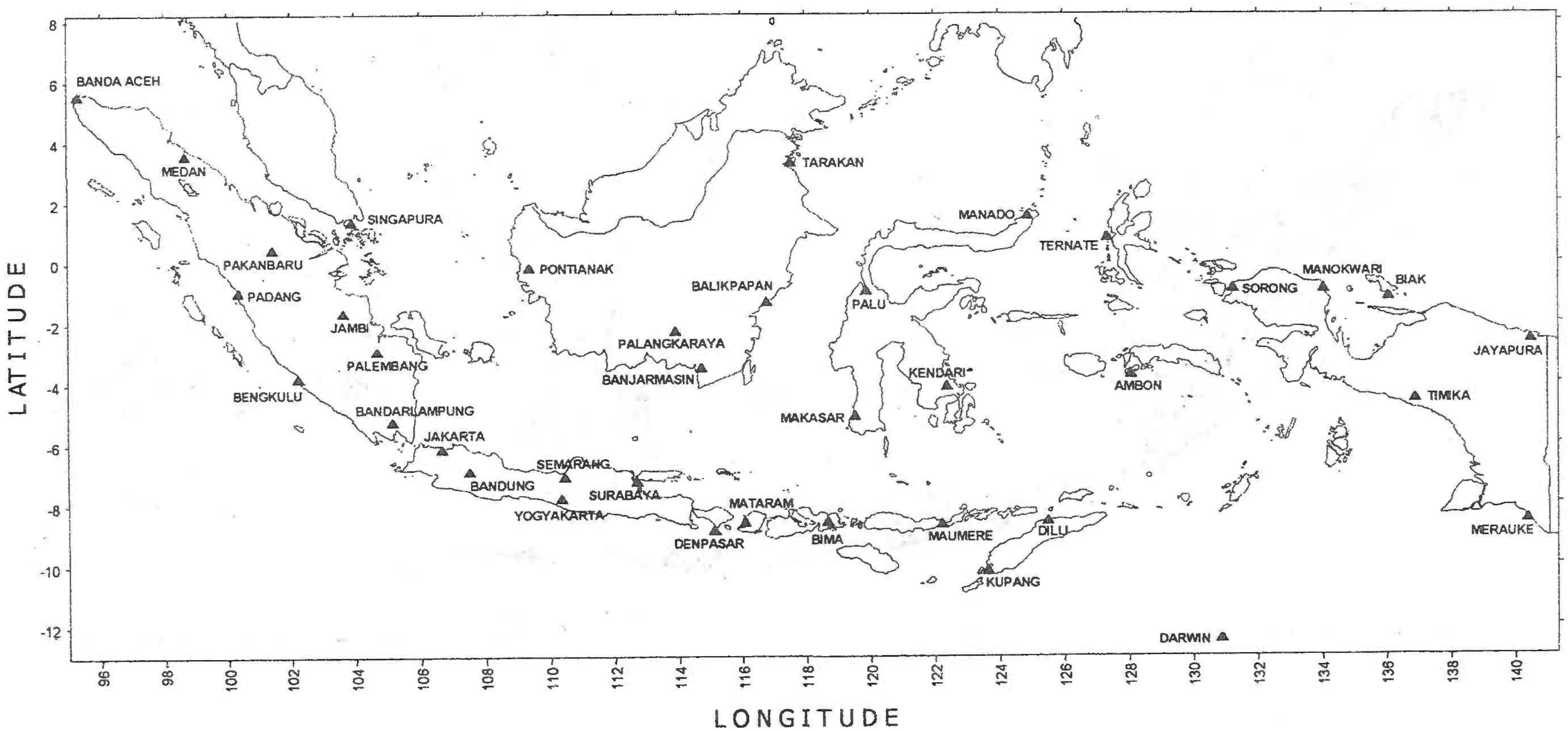
MAP 2 :
GPS & DGPS PERMANENT TRACKING STATIONS



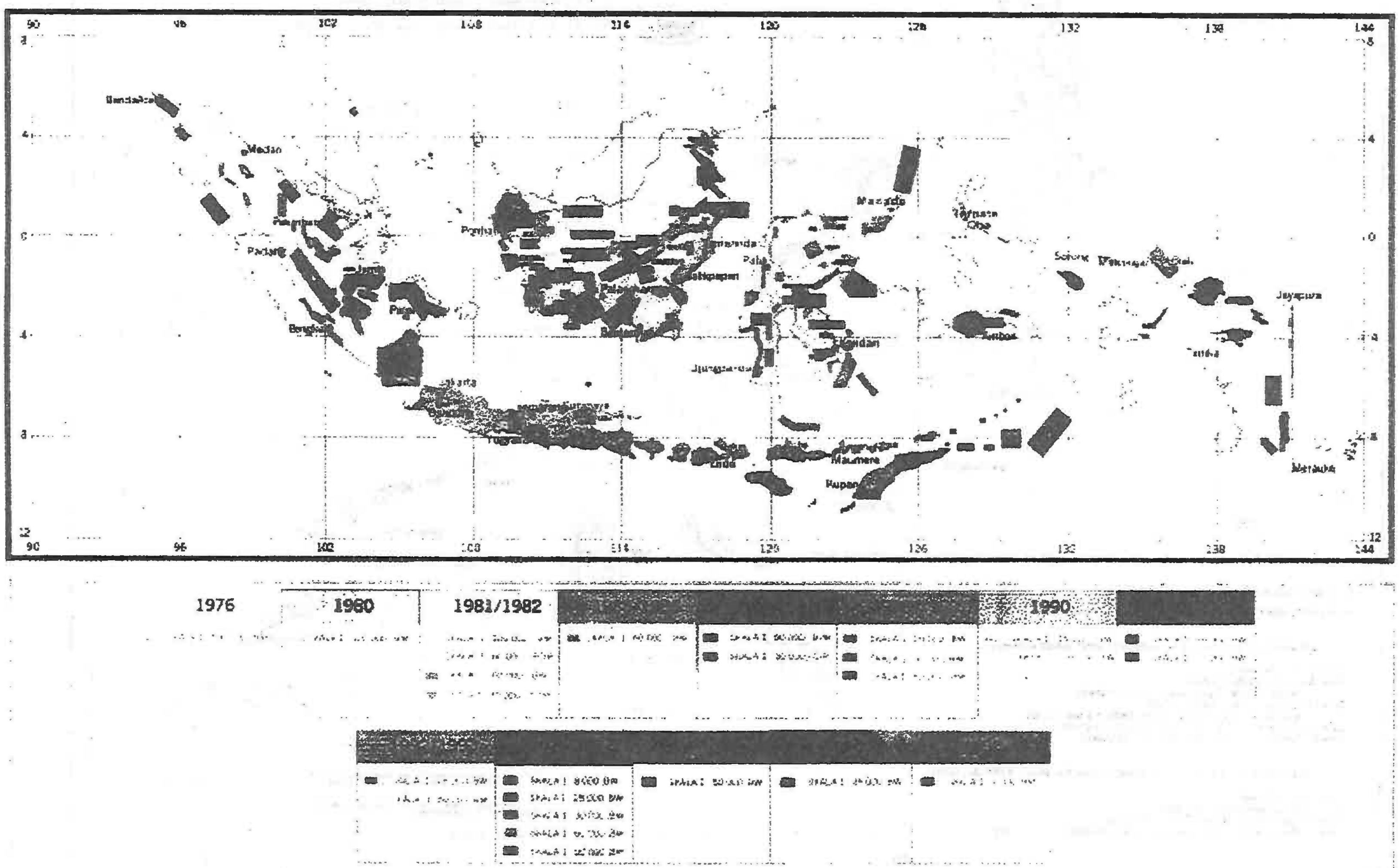
MAP 3 :
DISTRIBUTION OF VERTICAL CONTROL NETWORK



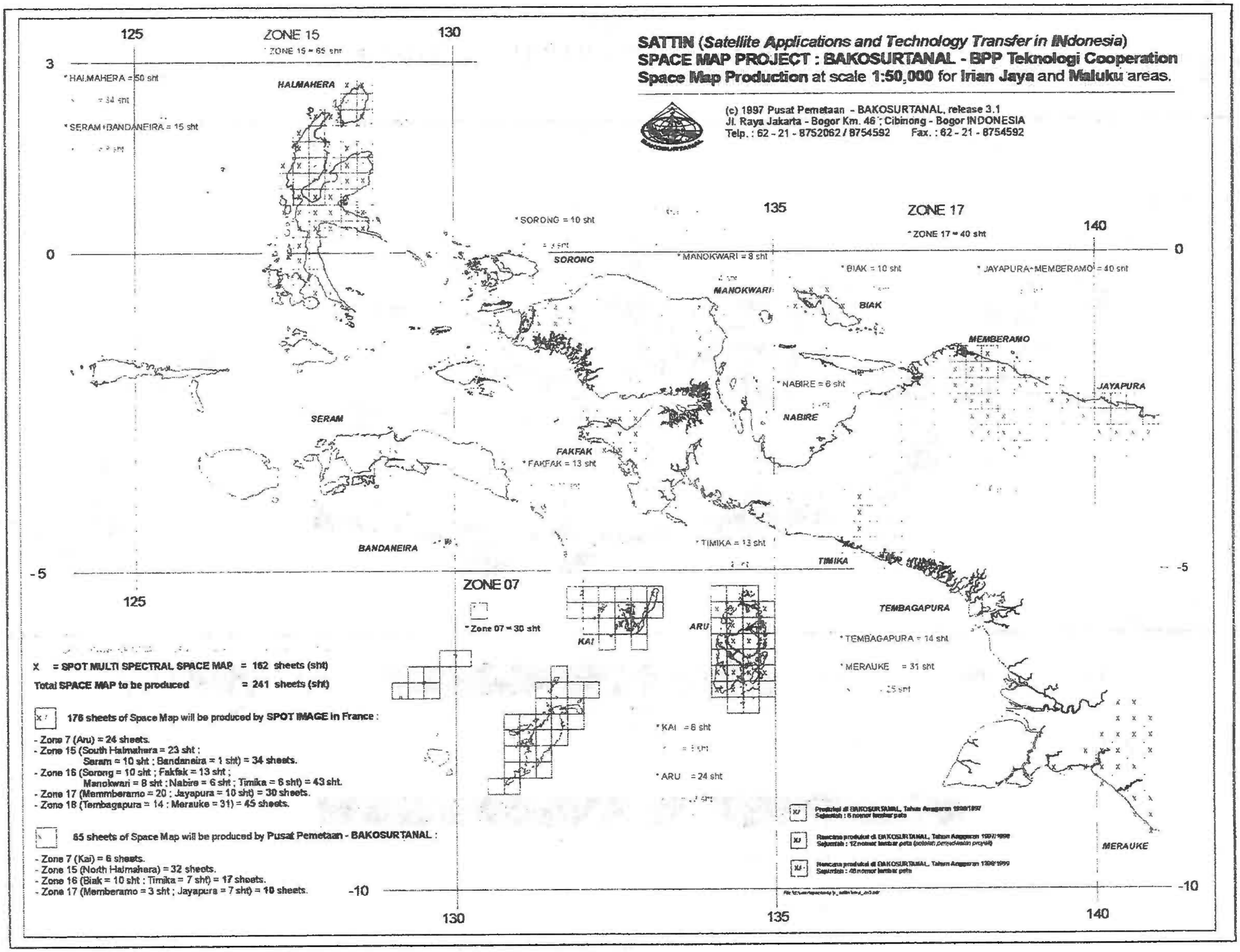
MAP 4 :
DISTRIBUTION OF NATIONAL GRAVITY BASE STATION NETWORK



MAP 5 :
AERIAL PHOTOGRAPHY COVERAGE



MAP 6 :
STATUS OF SATELLITE IMAGE MAP PRODUCTION



Overall Project Presentation
The Digital Marine Resource Mapping of Indonesian Waters[1]

by

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ABSTRACT

The United Nations Convention on the Law of the Sea 1982 (UNCLOS'82) came into force on 16 November 1994. By ratification of this convention (with Indonesian Law No. 17/1985) Indonesia has declared itself to be an Archipelagic State and therefore has the right to designate Sea Lanes for "continuous and expeditious" passage of foreign shipping through its waters and the adjacent Territorial Sea. As a result of this the State has an obligation to facilitate safe navigation by production and publication of appropriate and correct navigational charts.

BAKOSURTANAL - Badan Koordinasi Survey Dan Pemetaan Nasional (The National Coordinating Agency for Surveys and Mapping) was appointed as the executive Indonesian agency to carry out the Digital Marine Resource Mapping Project within Indonesian Waters. Thus the DMRM Project was born and has been carried out since the beginning of January 1996, jointly by Indonesia and Norway.

This vast undertaking called for production of many completely or partially updated charts in scales of, 1:1.000.000 for the EEZ, 1:200.000 for the Baselines and the Territorial Sea and 1:300.000 & 1:100.000 covering the Sea Lanes.

This in turn required massive survey operations and data gathering/correction to provide:

- Verification of a total of 233 Archipelagic Basepoints in accordance with internationally accepted guidelines as defined by IHO and as laid down in UNCLOS'82.
- Bathymetric data in pinpointed 'Critical Areas' of the Sea Lanes and Basepoint locations.
- Accurate coastline information

The most advanced technology and equipment available was used.

- A Network of 6 DGPS (Differential Global Positioning System) Reference Stations was established to produce Pseudo Range Corrections (PRC), to be used for differential position correction for the survey platforms.
- The Survey Vessels, three Ships and two Launches, were equipped with Simrad Multibeam echo sounders, DGPS navigation and satellite communication equipment.
- One vessel with flight hangar, carrying a Bell 212 helicopter mounting the Hawkeye Airborne Laser Bathymetry System for coastline and Basepoint measurements.
- A further vessel for the Basepoint Reference Monument Verification field team supported by Bulco helicopter and fast launch.
- 25 Standard Port tide recording stations were constructed.
- Approximately 81,000 Km of Indonesian Coastline was acquired and processed, by means of airborne laser, radar satellite imaging, aerial photography, existing digital data or digitizing of acceptable existing analogue data from maps or charts.
- Hardware and software, for a National Marine Resource Database and Chart Production was procured, designed and installed.
- A primary satellite based communication system between the vessels and the Project Production Center was established.

Execution of this Digital Marine Resource Mapping of Indonesian Waters Project is outlined by the following paper.

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[1] Paper presented at the seminar on Dissemination of Digital Marine Resource Mapping, March 28th 2000.

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the dmrm project

The DMRM Project (Digital Marine Resource Mapping of Indonesian Waters) was born from the Indonesian government's desire to adhere to internationally accepted standards while complying with **UNCLOS82** (the United Nations Convention on the Law of the Sea 1982). This allows a state to declare itself as an Archipelagic Nation providing certain criteria are met. It also recognizes a limit of the Territorial Sea of up to 12 nautical miles, and ratifies the concept of the EEZ (Exclusive Economic Zone). Under this concept, Archipelagic Nations possess sovereign rights to explore and exploit all the resources of the sea-bed, the subsoil and the water column out to a distance of 200 nautical miles from the Baselines, which determine the Territorial Sea, the EEZ, the Contiguous Zone and the Continental Shelf.

Moreover all such nations are obliged to facilitate safe and expeditious passage in designated Sea Lanes through its waters and to maintain environmental monitoring and control mechanisms. For Indonesia, which has a total marine area of some 5.8 million km^2, this was clearly a major undertaking. Blom Dantarsa Co, with its wealth of experience and technical resources, accepted the challenge in 1996 and has been helping to fulfill that obligation, beginning with Phase 1 of the DMRM project.

During this phase the **PPC (Project Production Center)** was established at Kemang Raya in Jakarta. It was staffed by 16 expatriates, each one an expert in his own field, and 61 Indonesian Counterparts and ancillary personnel.

All data processing and production of paper navigational charts and S-57 data, as well as preparation for production of **ENC's (Electronic Navigational Charts)** was done there, as was the development of the **NMRD (National Marine Resource Database)**. Moreover it was the hub of the computer network and all satellite communications, thus making it 'Mission Control' for survey operations and logistics. It also monitored the Project's tidal stations and reference stations, one of which was situated there. A further 74 expatriates and 15 Indonesians were employed on the project's survey vessels.

meeting the challenge

Swath Bathymetry surveys were performed by three vessels through the designated Sea Lanes and around the EEZ using state-of-the-art techniques. Multibeam Echosounders and Laser Bathymetry penetrate into every single part of the seabed topography thus presenting a complete coverage within the survey area. Using these swath scanning techniques, no obstacle or obstruction remains undetected.

The total length of the Indonesian **Coastline** is approximately 81,000 km. The coast of Java, Bali, Nusa Tenggara and South Moluku was derived from existing digital information. Up to 1000 accurate analog maps covering Sumatra, Eastern Kalimantan and Sulawesi, were digitized or retrieved in digital form where available. **Satellite Imagery** and airborne **Laser Bathymetry**, which maps the shoreline as well as depths with a high degree of accuracy, covered the remaining 46,000km. This was very important for the essential **Verification of Basepoints**, through which the Baselines were drawn. This operation was supported by a fourth vessel carrying a helicopter.

LAT (Lowest Astronomical Tide) is the established vertical datum for tidal reductions as recommended by the IHO. **Tide Gauges** now installed at 25 Standard Ports provide information for tidal analysis and data reduction.

WGS84, which is internationally accepted, and also recommended by the IHO, is the horizontal datum for all charts. Hence, six **DGPS Reference Stations** have been installed to establish a permanent DGPS (Differential Global Positioning System) network. These stations are referenced to the national WGS84 zero order control network and transmit DGPS corrections to users via satellite link.

The NMRD has been constructed to serve as Indonesia's national data hub for marine resource information. The S-57 object catalogue defined by the IHO is the basis for data modeling of all the relevant databases. This allows the automatic production and update of ENC's and facilitates the publication of **Paper Charts** requiring very little manual editing.
Vessel Traffic Surveillance will be installed during Phase II of the project in the most critical areas of the Sea Lanes; particularly in the Malacca Strait, the Singapore Strait, the Sunda Strait, the Lombok Strait and the Ombai Strait. These will monitor the movement of vessels in any particular area to ensure compliance with local traffic regulations and provide safer navigation. They will also aid in the protection of the local environment and provide a data network to authorities of any particular port or coastal region for administration, research and planning purposes.

lanes, zones and basepoints

SEA LANES

As an Archipelagic State, Indonesia has the right to designate Sea Lanes for "continuous and expeditious" passage of foreign shipping through its waters and the adjacent Territorial Sea. Consequently the State has an obligation to accurately survey such Sea Lanes and to facilitate safe navigation by publishing appropriate and correct navigational charts.

Sealane ALKI I starts in the South China Sea west of Kalimantan and goes southwards through the Java Sea and the Sunda Strait, into the Indian Ocean.

Sealane ALKI II starts eighty-nine nautical miles north of the equator between Kalimantan and Sulawesi. It heads southwards through the Java Sea and passes through the Lombok Strait before entering the Indian Ocean.

Sealane ALKI III is divided into three legs after the first common section, which starts in the Maluku Sea and heads southwards into the Banda Sea east of the Maluku Islands. From here it proceeds as follows:

A. Southwards through the Banda Sea towards Timor Island heading south-westwards into the Indian Ocean.

B. Southwards through the Banda Sea, east of Timor Island into the Timor Sea.

C. South-eastwards to the south of the Maluku Islands into the Arafuru Sea north of Australia.

Sealane Changes

It should be noted that towards the end of survey activities for Phase 1 various requests from other nations prompted several changes to the axis line coordinates of these Sea Lanes. As a result, some areas require further survey and this is a major part of the STOP GAP Project which will start early 2000.

EXCLUSIVE ECONOMIC ZONE

In accordance with UNCLOS 82 an Archipelagic State can extend an EEZ up to 200 nautical miles from Baselines drawn between Basepoints on its coastline. The State has jurisdiction over all installations and artificial islands, and sovereign rights to exploit the natural resources contained therein. It can also regulate marine scientific research and has responsibility for protecting and conserving the marine environment.

BASEPOINT VERIFICATION

A Basepoint is the outermost extent of land with an altitude of zero based on LAT. Its position is determined by range and bearing from a concrete Basepoint Monument using a Wild TC1700 Totalstation.

All Basepoint Monument positions have been verified by GPS (Global Positioning System) carrier phase measurement simultaneously with two predetermined zero order Geodetic Reference Monuments using Trimble 4000SSI GPS receivers to form a triangle of observable vectors.

There are now 192 Basepoint Reference Monuments, with a further 178 supplementary monuments supporting a total of 238 Basepoints around the exterior coastline of the Indonesian Archipelago. Many are in remote and inaccessible locations and the shore teams who carried out this operation spent many days camping in the bush. They were transported to most locations by either helicopter or small launch and they were supported by the helicopter carriers, KRI Dewa Kembar, and KRI Multatuli, which was also involved in the Laser Bathymetry operation.

tide gauge stations

Tides are caused by the gravitational influences of the moon and the sun, which create tidal waves. These waves have periods of about 12 and 24 hours. The water movements are affected by the Earth's rotation and the landmasses and are therefore different for each location.

One reason for monitoring tidal behavior is to establish vertical datum from which heights and depths for both hydrographic and land surveys are measured. It also facilitates accurate tidal predictions to allow safe navigation in harbors and shallow areas, and assists in planning coastal zone management.

The DMRM Project has established **Standard Port Tide Stations** at 25 locations throughout the Indonesian Archipelago. These stations are equipped with SM5075 logging hardware with a storage capacity of 10 days. Tidal records are stored at 10 minute intervals based on observations taken every 15 seconds. Barometric pressure observations are recorded hourly and a level switch is provided for quality control purposes. These data are automatically collected daily by the production center via telephone modem.

Moveable Tidegauges were deployed from the survey vessels in the area they were surveying. The WLR7 tidegauge used by the DMRM Project has a 3 month storage capacity and records tidal observations at 10 minute intervals. These data were complemented by barometric pressure observations made hourly onboard the vessels. The information was then transferred via the satellite link to the PPC for processing.

Tidal Analysis can be made using the data from the Standard Ports along with data from BAKOSURTANAL's existing network. The aim is to reproduce significant parameters to describe the tidal regime at the place of observation. These 'Tidal Constituents' are based on the assumption that the responses of the oceans and seas to tidal forces do not change with time. In Indonesia the 'Harmonic Analysis' method is used. Here the sum of a finite number of Harmonic Constituents, whose angular speeds and phases are determined from the astronomical arguments, is used to predict the tides. These are published in official tables containing high and low water times for Standard Ports and constants for adjustment to Secondary Ports. Moreover, LAT can be determined for chart datum and various tidal levels for different land survey projects.

the dgps reference network

The Reference Station Network Concept

The concept of DGPS is to reduce or eliminate the signal errors deliberately introduced into the GPS satellite navigation system by the US defense authorities. If no corrections are made the GPS system can give position errors of up to 300m. When using DGPS the error can be reduced to less than 3m, which was the accuracy specified for the DMRM Project.

Therefore the Project has established six DGPS reference stations evenly spread throughout the Indonesian Archipelago. These stations are referenced to the national WGS84 zero order control network.

Each station calculates its own position from the GPS signals it receives. It then compares this position with the correct one and calculates the range corrections to each individual satellite. These are sent, via a communication satellite link, to the HUB reference station, which performs a continuous monitoring of the quality of the complete network. The introduced error can be estimated by comparing the satellite range correction discrepancies recorded simultaneously at each station surrounding the survey area. Corrections can then be relayed to vessels every second, where a weighted correction contribution from each reference station is calculated.

Each reference station has satellite communication equipment, a PC with Searef software, a modem for remote control via telephone line and an UPS (Uninterruptable Power Supply). In addition the HUB reference station has Sealink and Seanet software.

satellite communications

Apart from Project related requirements, such a chain, with multi-user capability, is of great benefit to National Authorities and Research Institutions concerned with future mapping and charting. The system may be configured with selective access to ensure that it is blocked to unauthorized use. The chain is also expected to generate revenue when DGPS services are made available on a selective basis to commercial users. By upgrading the present equipment it is also possible to serve high accuracy land survey purposes such as long baseline static measurements and tectonic drift.

The DMRM Project depended mainly upon **Satellite Communication** to transfer needed information to and from the survey vessels and other locations. All communications went through the PALAPASAT 2BR geostationary satellite.

The HUB through which all satellite communications pass was located at the PPC in Jakarta. The equipment there consisted of a stationary 3.8m satellite antenna, satellite modems, modem protection switches and multiplexers.

The Survey Vessels' only means of communication in most cases was via a duplex satellite link of 32Kb per second capacity. After taking protocol-overhead into account that translated into approximately 9Mb per hour. DGPS reference signals transmitted from PPC every second, a telephone line, a fax line and data traffic were all multiplexed into the channel and shared the capacity. The first three items were given priority over data traffic on a dynamic basis. When one of these demanded bandwidth, it was allocated "on the fly" up to the maximum available. Whatever was not used by the high priority types was then made available for data traffic.

Each vessel's satellite communication equipment consists of a stabilized 2.05m satellite antenna, an antenna controller unit, a satellite modem and a multiplexer. The antenna is housed in a white dome mounted on the front deck making the vessels easily recognizable. The rest of satellite communication equipment is rack mounted in the vessel's online operations room.

The **DGPS Reference Stations** are connected to the HUB via a simplex satellite link of 9.6Kb per second capacity. The satellite communication equipment at each reference station consists of a stationary 1.8m satellite antenna and a satellite modem.

the survey vessels

Indonesia has owned three French built 'Baruna Jaya' research vessels since 1990. Their two diesel engines each deliver 825 horsepower, giving a maximum speed of 14 knots and a range 7500 nautical miles at 12 knots. With an overall length of 60.4m and a beam of 11.6m they can accommodate up to 50 persons including the 34 officers and crew.

The DMRM Project utilized these vessels for bathymetric surveys throughout the Indonesian Archipelago. Differential correction signals were received via dedicated satellite link and applied to GPS signals by 'Seadiff' to give DGPS positional accuracy of better than 5m. At the same time 'Seapath' used DGPS signals and data from other motion sensors to calculate the exact attitude of the vessel. All this information was fed into the 'Navipac' navigation system and applied to the bathymetric data.

Bathymetry was acquired using Simrad Multibeam Echosounders and was logged and quality controlled using dedicated Merlin and Mermaid software systems.

Baruna Jaya III was equipped with a Simrad EM12D Multibeam Echosounder for deep sea and reconnaissance surveys of the continental shelf to determine the limits of Indonesia's Exclusive Economic Zone.

Baruna Jaya I and II were both equipped with Simrad EM1000 Multibeam Echosounders for surveying the Indonesian Sea Lanes.

Baruna Jaya I and II also had a 9.0m **Survey Launch** each equipped with the Simrad EM950 Multibeam Echosounder. They were used for surveying critical nearshore and shallow areas in the Sea Lanes. Positional recording equipment was the same as the mother vessel from where the launch received DGPS correction signals via UHF radio link instead of satellite.

Each Blom Dantarsa survey team was lead by an 'Activity Coordinator' and was comprised of two Senior Hydrographic Surveyors, two Data Quality Controllers, a Navigation System Engineer and an Acoustic System Engineer. Two of the vessels also had a Hydrographic Surveyor manning the survey launch. Each member of the survey team had an Indonesian 'Counterpart' to enable the transfer of technology, which was an integral part of the Project.

laser bathymetry

The KRI Multatuli was also employed on the DMRM Project. Its single 5500 horsepower diesel engine gives a maximum speed of 18.5 knots and a range of 6000 nautical miles at 16 knots. It has an overall length of 111m, a beam of 16m and can accommodate up to 120 persons. Designed with a helideck, it was an ideal platform for the Project's Bell 212 helicopter, to which it transmitted DGPS signals via UHF radio as for the launches. The vessel was also used to support the Basepoint survey teams working in remote coastal locations. A Vessel Operation Coordinator headed the team comprising of one Senior Hydrographic Surveyor, a Senior Geodetic Surveyor, a Laser Bathymetry Operator, a Laser Bathymetry Engineer and a System Engineer.

SAAB Hawkeye is an airborne laser bathymetry system used for surveying shallow water and coastline. Housed in a pod mounted on a Bell 212 helicopter, it has the capacity to cover approximately 15km^2 per hour at high resolution. A rapid scanner fires laser generated optical pulses of two wavelengths, covering a swath at right angles to the line of flight. The infra red laser is reflected from the water surface while the green one penetrates the water column.

Depth is then derived from the elapsed time difference between the two reflections and the two pulses are polarized to discriminate water from land. The Normal Search Mode scans in front of the helicopter through an arc of 20° from the nadir point. For more detailed inspection High Resolution Mode is used. The aircraft's attitude is established using a laser gyro and the laser pulses are adjusted accordingly to maintain the planned coverage. The scan pattern is displayed real-time and approximately 1Gb of data per hour is logged onto tape via a UNIX Workstation. Each mission is also recorded on videotape for quality control.
All post processing was done onboard the helicopter carrier using dedicated software packages. Only accepted ASCII xyz-data was sent to the Project Production Center.

For the DMRM the use of RadarSat has also played a key role for the coastline survey in areas where the laser system proved inoperable. Coastline surveys are normally very time consuming and costly using traditional survey methods. A total of 136 images have been processed resulting in around 60,000 km of vectorized coastline being included into the Marine Resource Database and data processing.

the navigation system

Seatex Seadiff DGPS Positioning was installed on the three Baruna Jaya survey vessels. It extracts raw GPS pseudo-range signals from its built in Trimble GPS receiver from a maximum of 8 available satellites. Seadiff is able to decode DGPS data from up to 24 reference stations, and position fixes with data from up to 12 of these can be calculated simultaneously to provide the primary solution. An integrated solution can be derived by combining data from a set of reference stations. This provides increased accuracy and minimizes the effects of temporary errors from a single reference station.

The Seadiff software also provides an estimate of the quality of the final position solution by using redundant observations. All available satellite data together with external height information are utilized to generate a set of statistical parameters. Prior to position computation all pseudo-ranges are statistically tested for gross errors. Each observation is weighted with regard to the satellite's elevation, the age of the differential corrections, the distance from the reference stations and the rate of change of correction. Ionospheric and tropospheric models can be selected for enhanced performance over extended distances.

Seatex Seapath derives attitude, position, velocity and time information using data from its four GPS antennas mounted on a fixed cruciform bracket on a forward mast. It performs carrier phase measurements and calculates the vessel's movements about its' X, Y and Z axis (heave, roll and pitch). Differential signals are used to give a greater degree of accuracy. A **Motion Reference Unit** (MRU) also registers the vessel's heave, roll and pitch. At the same time a **Digital Gyro** uses the latitude from the Seadiff position to gain an accurate heading. Data from both Gyro and MRU are imported into the Seapath system for calibration and backup. The vessel's motion is then provided to both Navipac for positional calculations and to the Echosounder for beam array adjustment.

Eiva Navipac takes the final antenna position from Seadiff and transforms it to the center of the Echosounder transducer as a layback position using attitude information from Seapath. This 'Reference Position' is then output to the Echosounder itself.

technology in depth

Other inputs are constantly monitored on various Navipac pages to gain necessary information throughout the survey operation. Navipac shows positional data on the **Helmsman Display** mounted on the bridge. This provides the vessel's Helmsman with the necessary information for effective guidance along the survey lines. It is also used to create runlines as well as waypoints.

The Simrad EM1000 (Baruna Jaya I and II) is used for water depths down to 1,000m. The transducer is raised and lowered inside a trunk, located below the hull unit, by remote control from the online room where the operation console is located.

The Simrad EM950 (Survey Launches) is used for water depths down to 300m. The transducer is fix mounted under the keel of the launch, and all operations are done from the operation console.

The EM1000 and EM950 are both shallow water precision seafloor mapping systems. They have a wide range coverage with a normal operating angle of 150° covering 7.4 times the water depth. For nearshore surveys, river banks and channels, there is a special mode called 'Embankment Mode' where the outermost beams scan 5° above the horizontal. This makes it possible to survey to the water surface. The normal operating mode is EDBS where the 60 beams are spaced equidistant horizontally. It is also possible to use a swinging equiangle beam spacing of 1.25°, which results in 120 independent beams.

The Simrad EM12D (Baruna Jaya III) is used for water depths down to 11,500m. This system has two transducers (one transmitting and one receiving) fix mounted on either side of the keel, producing a total of 162 beams. In addition to the operating console, there is a console with monitors for both port and starboard systems
The EM12D is an ocean depth precision seabed mapping system. It has a wide range coverage and a maximum operating angle of 150° covering 7.4 times the water depth.

Simrad Mermaid is used for logging the data, which are also converted to the Simrad Survey Format files used by Merlin.

Simrad Merlin provides users with the means of real time inspection and quality control of data. The default main window shows survey lines recorded during the survey and can also show swath coverage. When logging is in process a moving color coded depth window is also available. The Grid Display module processes the rawdata and generates a color-coded image of gridcells. This is run offline, and is used for QC of coverage. In addition the Waterfall Display shows a 3D simulation of the seabed, giving an impression of any 'noise' in the data. Merlin also covers most of the needs for real time instrument inspection and calibration. Both packages run on UNIX workstations utilizing advanced visualization tools in the X/Motif environment.

data processing

Raw Survey Data gained from the different acquisition systems must be checked for spurious data like spikes in positions and depths. Depths must also be corrected for tides, so the final chart can be represented in the correct vertical datum. Two applications are used in the post processing, depending on data source.

Simrad Neptune is used for putting large amounts of raw survey data from the Multibeam Echosounders through a correction and cleaning process. **The Survey Control** module gives an overview of the survey data and organizes the processing. **Position Processing** is done using the PosProc module, which removes navigational spikes and smoothes the vessel's track. **Depth Processing** is done by means of the DepthProc module, which uses a parameter file to correct the depths for tides and other information recorded from various sensors. Finally **Statistical Cleaning and Filtering** are performed using the BinStat module, which grids the survey area into cells and filters it according to user defined parameters. Only position and depth are output as xyz-files for further processing.
IRAP (Interactive Reservoir Analysis Package) is the next stage in the processing. This imports and grids the randomly distributed xyz-data from Neptune and EB1 as 'Freepoints'. It then makes a **DTM** (Digital Terrain Model) by interpolating values for each grid node from the surrounding Freepoints. When this is complete it generates contours at the desired intervals by interpolating between these grid nodes.

SAAB EB1 is used to put Laser Bathymetry data through a similar process using dedicated software modules. Because the amount of data from this system was so great it was carried out onboard the helicopter vessel and only the accepted xyz-data was sent to PPC via satellite.

the nmrd

The National Marine Resource Database

There has been a major shift in relations between Hydrographic offices and their consumers. The presentation of geographic data by traditional means, such as paper charts, is entirely in the hands of the publishing authority, down to the smallest detail. Geographic information may now be distributed by any electronic media such as CD-ROM, Internet, dedicated satellite links, etc. This information may then be displayed and utilized by consumers in the format of their choice. For example an ECDIS user will visualize his ENC according to the internationally accepted S-52 Symbolization Standard.

The NMRD is designed. to meet these new demands and connect the different maritime organizations in Indonesia. It will be administered and updated centrally by BAKOSURTANAL, the controlling authority for mapping and surveying.

The database has been developed using the Informix Universal Server with spatial data option and integrated with the MapInfo SpatialWare software. This system is based on a spatial extension to the Informix database engine, for managing large volumes of complex geographic and related information in a seamless form. It is designed to integrate the best, specialized tools for geographic editing, quality control, data capture, processing, production, and data distribution.

Processed survey data output from IRAP can be directly imported into the NMRD. Other Source Material is needed to supplement the data gathered in the survey areas. Items such as existing navigational charts and lists of navigational aids are collected from the various authorities and scrutinized for their reliability.
Existing charts are scanned to raster format and digitized using a S-57 based digitizing software. The monitor screen is used as a digitizing tablet with the raster as a background. Data can then be digitized quickly and accurately using an integrated automatic line following routine and full topology is created during this process.

Because the complexities of the real world can not be fully represented and stored in digital form, a simplified data model is used. Object geometry is represented on one level, over which is the user configurable data model. This performs an interface with terms and rules in the real world by describing the structure, identity, attributes and operation of objects, and their relationship to others.

chart production

The database is configured according to version three of the IHO S-57 Standard for Transfer of Digital Hydrographic Data. Each object class defined in the user data model can be viewed and may have its attributes configured and revised individually to support any needed extensions to the original standard configuration.

Production of ENC's

Because data within the NMRD are collected and maintained according to S-57, ENC's can be exported from the database without the need for further editing or filtering. This so-called EN Cell can then be read directly into an ECDIS system. As all geographic objects in an ENC are defined by a unique identifier, updates may be performed automatically.

Paper Chart Production

The DMRM Project was required to produce approximately 113 paper Navigational Charts according to IHO standards.
The aim was to be able to produce paper charts directly from the NMRD with as little manual work as possible, using the attributes it contains to apply the correct symbology and produce color separations which could then be sent for printing. If a correct database is maintained a chart can be produced from it within two days.
Data is exported from the NMRD in an ASCII format that contains all the S-57 attributes and other special attributes that are used for automatic chart production. Prior to export the data has been checked in terms of attribute integrity and S-57 data structure so that the exported data is ready to be processed by the next stage.

ChartGen, BorderGen and SourceGen are modules developed to run inside MapInfo. They interpret the attributes in the exported data and apply the correct symbolization, using look-up tables, line styles and symbol fonts, again developed in PPC for this specific purpose.

Adobe Illustrator was used for mounting and color separation of the data processed and out put from MapInfo. At this stage all the other chart and cosmetic information is gathered together from various databases and assembled ready for final editing. All symbolization is present and color separation is already an integral part of the work. All that remains is for textual overwriting and general layout to be completed manually before the complete file is sent to the image setter for film and plate production.

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