The Applications of GPS CORS in Indonesia: Status, Prospect and Limitation

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GPS CORS In Indonesia

◉ **Government Agencies**
   → Bakosurtanal CORS (IPGSN)
   → BPN CORS (SRIKANDI network)
   → LIPI CORS (SUGAR network)
◉ **University**
   → ITB (with GSI, ERI Tokyo Univ and Bakosurtanal)
   → UGM
   → UI
◉ **Private Sector**

Abidin et al. (2010)

IPGSN : National GPS CORS of Indonesia

- The Indonesian Permanent GPS Station Network (IPGSN)
- Maintained and opertaed by Bakosurtanal (the National Coordinating Agency for Surveys and Mapping)
- All stations of IPGSN use the high precision L1/L2 geodetic type GPS receivers (i.e. Ashtech UZ-12, Leica GRX1200 family, Topcon GB-1000 and Net G3, and Septrentio PolarX2) with choke ring antennas and radomes.
- Most of the GPS receivers equipped with meteorological (temperature, pressure and humidity) sensors.
- Besides GPS receiver, the station also equipped with a radio or VPN-IP modem for data communication, sufficient batteries and solar panels to charge the batteries.
- GPS data is recorded at 1Hz rate and streamed in real time or near real time of 1 hour latency to the data processing center at Bakosurtanal office in Cibinong, West Java.
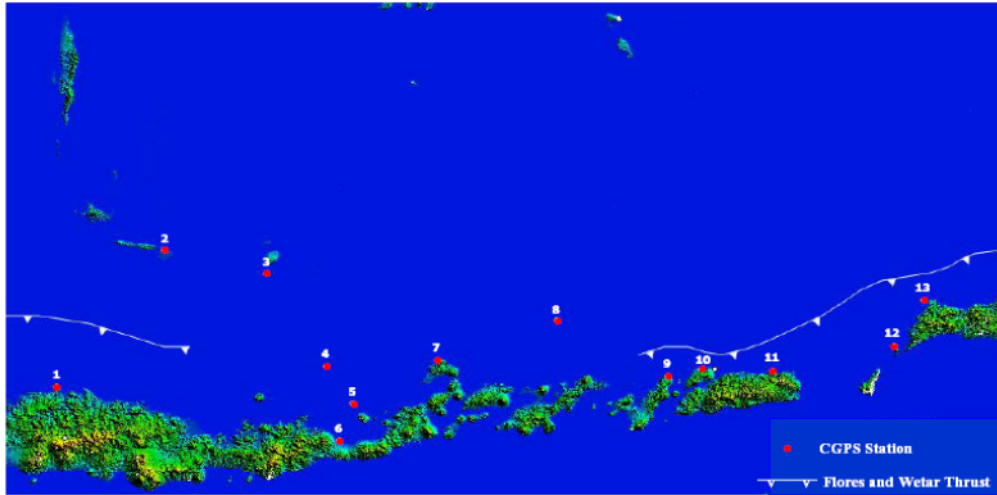
Abidin et al. (2010)
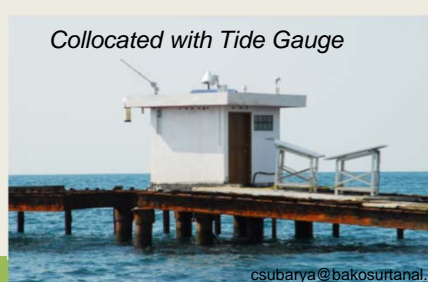
Current Status of IPGSN (61 stations)

Example :
IPGSN in West Java

Example : IPGSN in Bali region
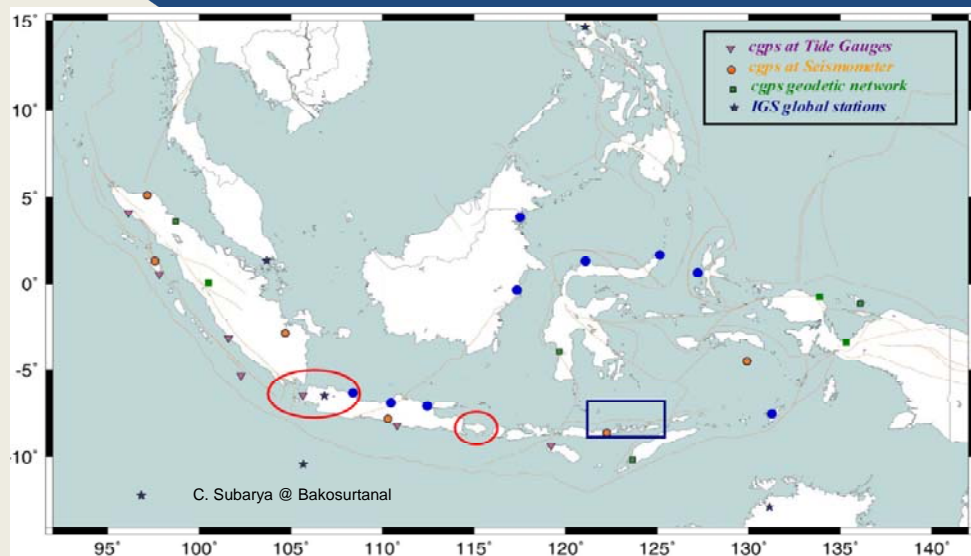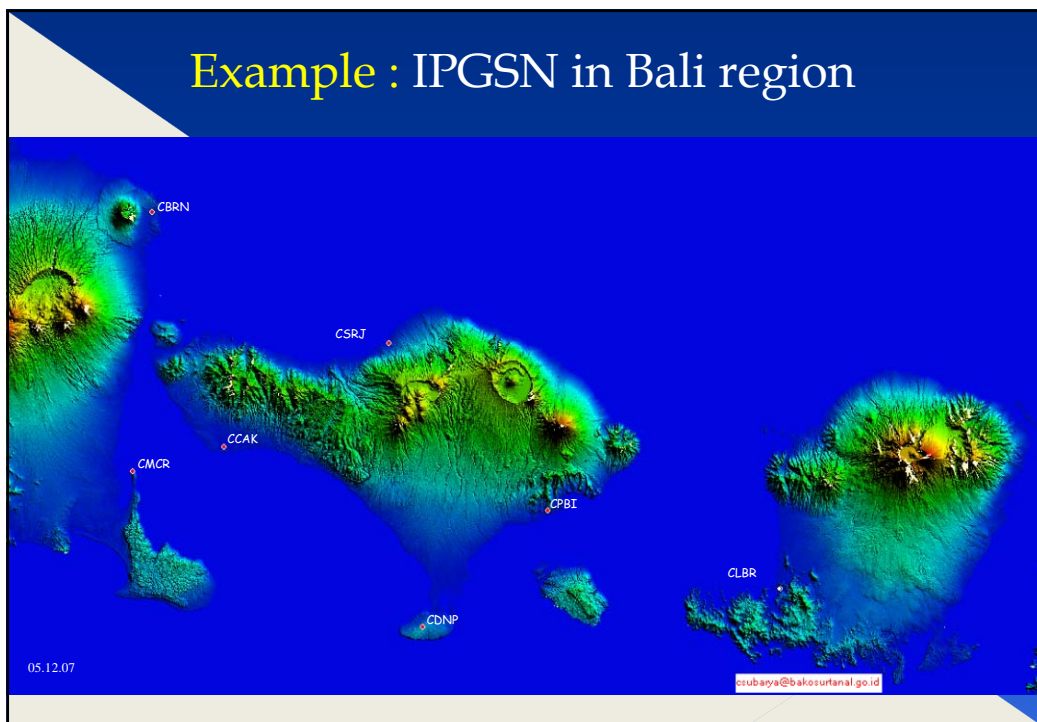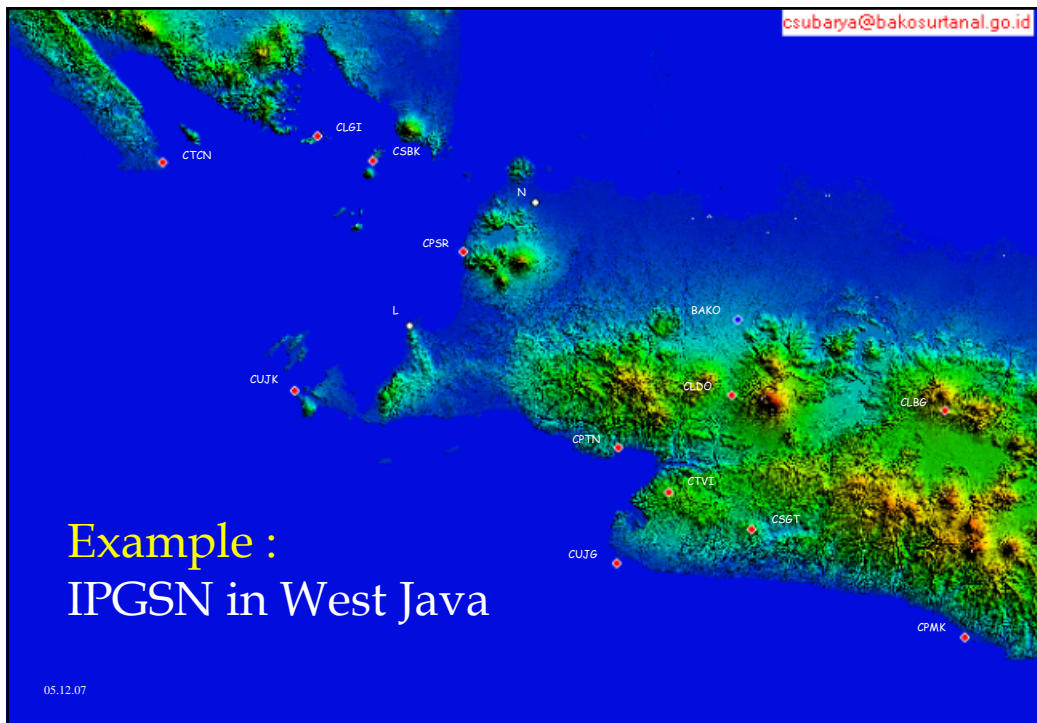
Example : IPGSN in Flores region

FLORES Continuous GPS High Rate Real Time Network

IPGSN Station Types

Collocated with Tide Gauge

IPGSN Instrumentation

Sensor
meteo

Receiver
GPS

Radio
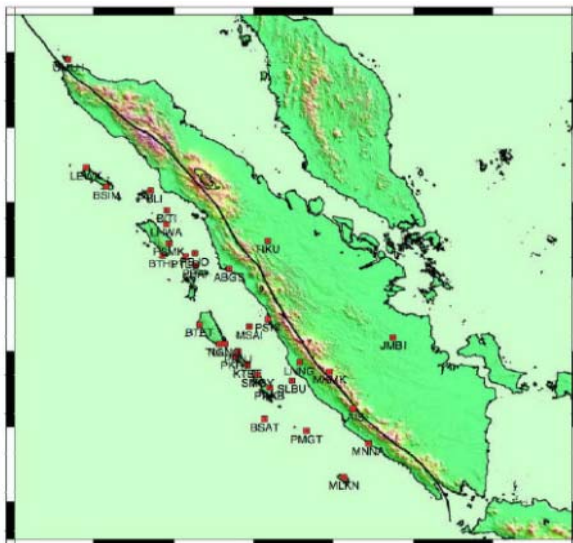
Telemetry
buffer

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➢

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GPS CORS of LIPI (SUGAR Network)

Station: ABGS

Station: NGNG

Photos from *Caltech DGPS* (2010)

Abidin et al. (2010)

GPS CORS of BPN (National Land Agency)

- To speed up the land administration process in Indonesia.
- GPS CORS of BPN consisting of Class-A and Class-B type stations.
- The Class-A type stations will be established on the ground and have specification and performance comparable to the IPGSN stations
- The Class-B type stations will usually installed on the building, preferably in the land office building in the corresponding areas

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GPS CORS of BPN (National Land Agency)

Tangerang   Bogor   Bekasi

- All stations of BPN GPS CORS will be equipped with dual-frequency geodetic-type GPS receivers.
- 3 stations around the capital city of Jakarta, i.e. Tangerang, Bekasi and Bogor, have been established and tested.
- In 2010, other 33 CORS stations will be established in Java and Bali and other strategic areas outside Java and Bali.

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GPS CORS managed by Geodesy ITB

West Java — Location of GPS CORS

Papandayan, Ciremai
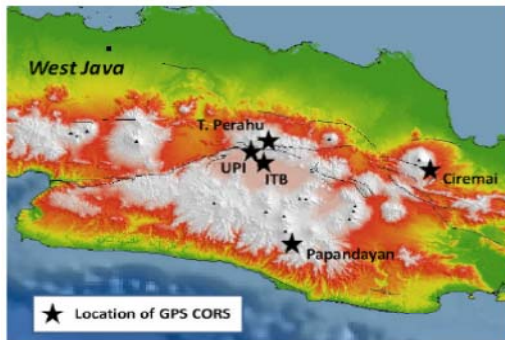
In cooperation with
GSI Japan, ERI University of Tokyo,
and Bakosurtanal.

- At present : 5 GPS CORS stations as shown in the Figure.
- The main aim of this CORS network is to study the inter-seismic deformation of active faults in West Java, e.g. Cimandiri, Lembang and Baribis faults

Abidin et al. (2010)

Existing and Potential Applications of GPS CORS in Indonesia

Utilization and Function of GPS CORS	
Real-time mode	**Post-processing mode**
Early warning system for various natural hazards in Indonesia.	The coordinate reference frame for various positioning, surveying and mapping applications in Indonesia.
The Network-RTK system for surveying and mapping applications.	The coordinate reference frame for monitoring and studying natural hazard phenomena in Indonesia
The reference stations for supporting various navigation and transportation applications (land, marine, air).	The monitoring network for geodynamics and tectonic studies in Indonesian region.
Integration, checking and validation for various coordination reference systems	Studying and mapping the characteristics of troposphere and ionosphere above Indonesian territory.

The existence of GPS CORS networks will be very useful for Indonesia, a vast archipelago consisting of more than 17.000 islands and has population of more than 200 millions.

Abidin et al. (2010)

Example : GPS CORS and Earthquake Study in Indonesia

Inter-Seismic   **Co-Seismic**   **Post-Seismic**

Reference : Subarya (2009)
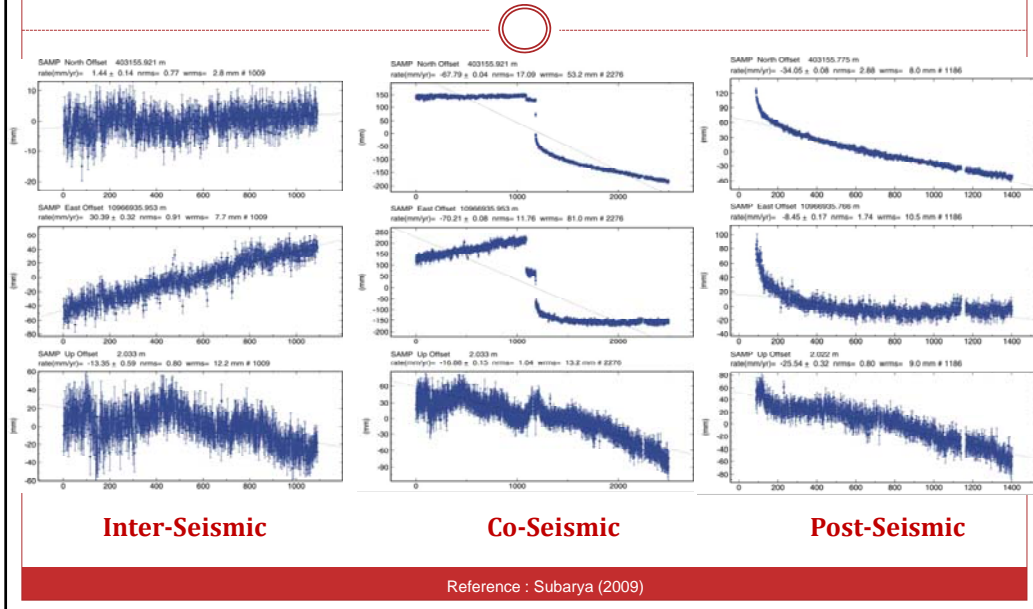
CGPS and Earthquake Analysis
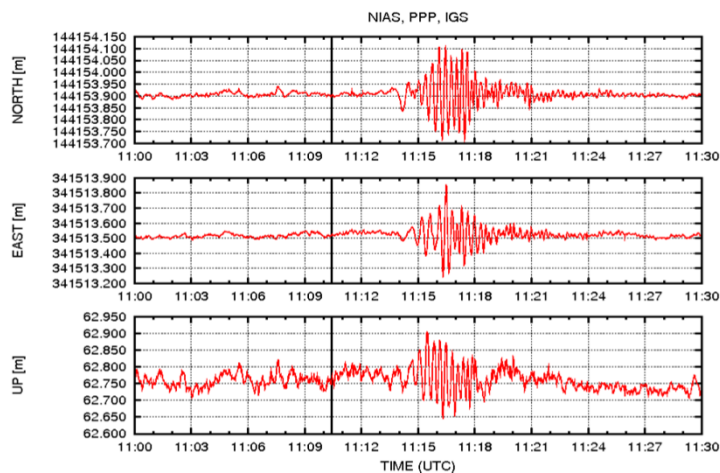
- *Bengkulu earthquake (2007-09-12 11:10:25, magnitudes 8.0).*
- *Precise Point Positioning for station NIAS using final IGS orbits and satellite clocks*

Reference : Subarya (2009)

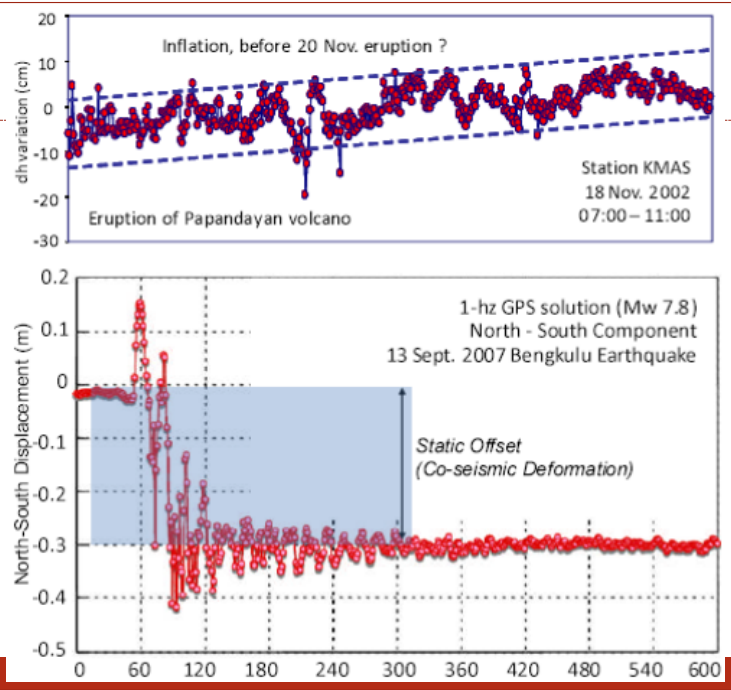The potential applications of GPS CORS data for studying the characteristics of deformation related to the eruption of Papandayan volcano on 20 Nov. 2002 (above) and the 13 Sept. 2002 Bengkulu earthquake (below)

References :
[*Abidin et al.,* 2005],
[*Meilano et al.,* 2009]

Inflation, before 20 Nov. eruption ?

Station KMAS
18 Nov. 2002
07:00 – 11:00

Eruption of Papandayan volcano

1-hz GPS solution (Mw 7.8)
North - South Component
13 Sept. 2007 Bengkulu Earthquake

Static Offset
(Co-seismic Deformation)

Example of Monthly TEC Model for Indonesia from GPS Continuous Data

Reference:
[*Muslim,* 2009]

March 2000

March 2003

March 2004

March 2007
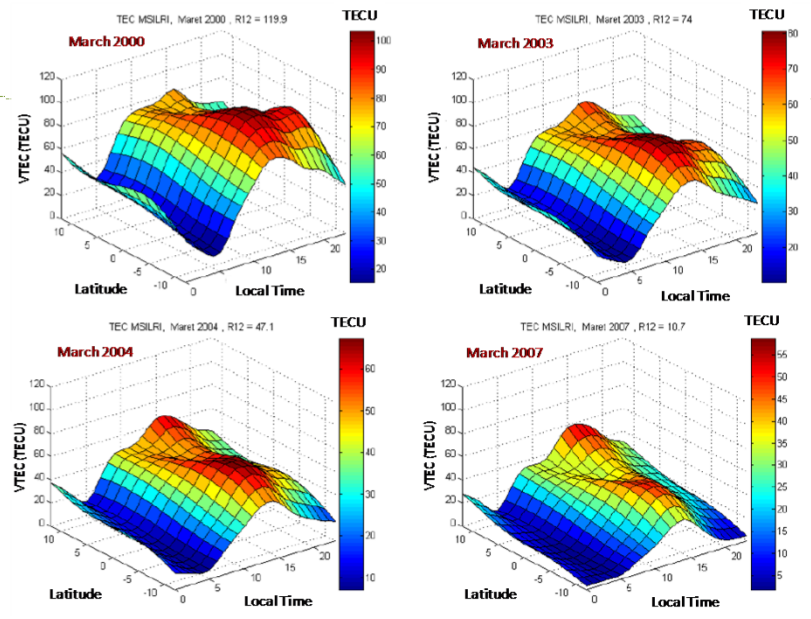
CGPS derived Ionospheric TEC anomalies prior to the 26 December 2004 Earthquake

Reference : [*Muslim*, 2009]

ITEWS

http://www.gitews.org/

Several Indonesian GPS CORS (IPGSN) stations can also become part of the Indonesian Tsunami Early Warning System (ITEWS)

ITEWS
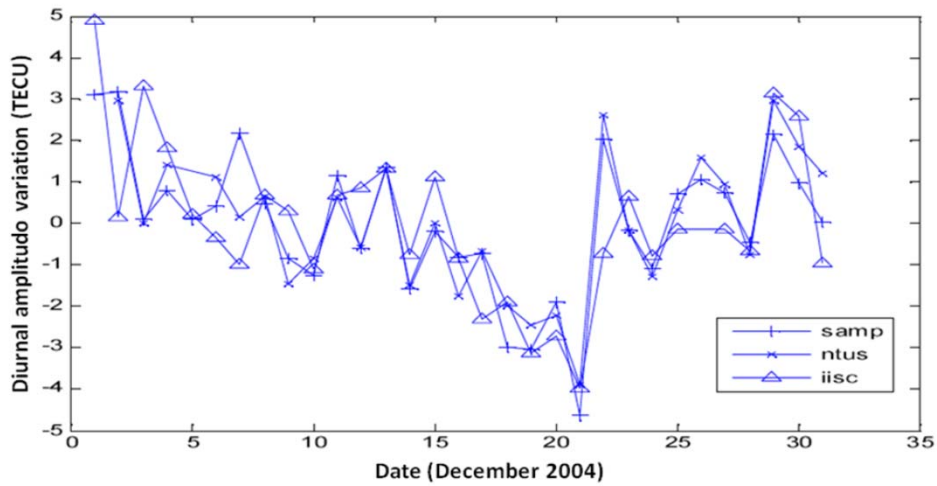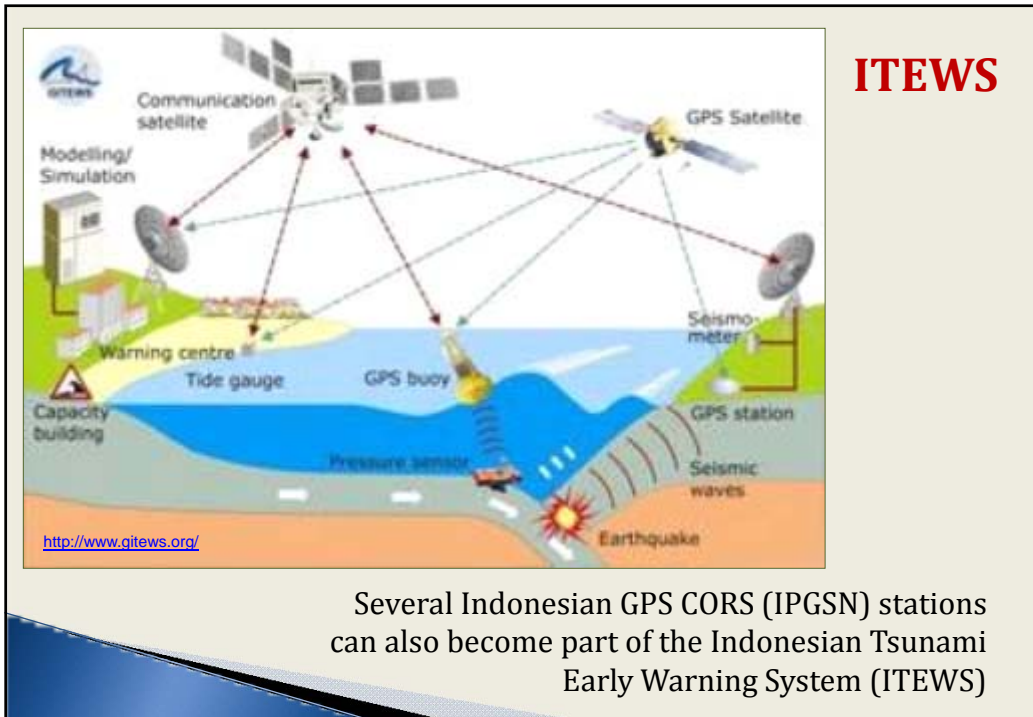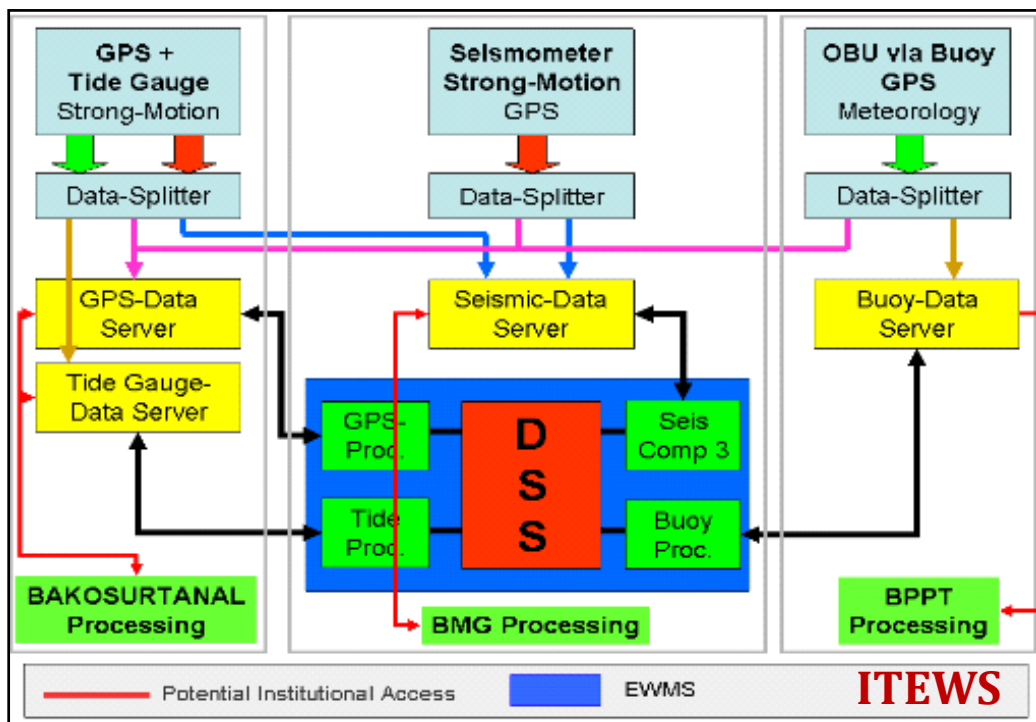
GPS CORS in Indonesia :
Challenges and Limitations (1)

Communication Link and Infrastructure

1. The reliability of the GPS CORS will strongly depend on good and reliable communication links between the continuous GPS stations and its data processing centre. In the case of IPGSN which is maintained by Bakosurtanal, its locations are located all over Indonesia, and the data processing centre at Bakosurtanal, Cibinong in West Java. Considering the vast area being cover, the archipelagic nature of Indonesia, relatively high spatial divide in the communication infrastructure inside the Indonesian region, and the remoteness of most of continuous GPS stations, the internet and satellite-based communication link seem to be the most effective solution for IPGSN. However, this mode of communication is relatively expensive; and in the case of internet connection, the 100% integrity and reliability cannot always be achieved, even in Java island region which has a relatively best communication infrastructure.

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GPS CORS in Indonesia : Challenges and Limitations (2)

Continuous Support for Maintenance and Operation

2. In order to have good, reliable and continuous mode of operation, all remote continuous GPS stations will also require proper and continuous maintenance and caring. Each station will therefore need proper resources all year long, e.g. electrical power supply, related hardware and software resources, and human resources for checking and taking care the station site and equipments. The difficulty in operating and maintaining the GPS CORS station in Indonesia will vary and usually getting more difficult when its location getting farther away from Java island and/or from the urban areas. The financial support for the daily operation and maintenance of GPS CORS stations therefore should always be considered, preferably in the long term basis. In the case of national GPS CORS such as IPGSN, the political will and continuous support from the central government is indeed necessary.

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GPS CORS in Indonesia : Challenges and Limitations (3)

Working Culture & Human Capital

3. Maintenance and operation of the relatively large scale GPS CORS networks in Indonesia, such as those presently maintained by Bakosurtanal and in future also by BPN; will require also conducive and professional working culture, and also good support from dedicated and professional human resources. This human capital, is not needed just to operate and maintain the whole system, but also to process the collected data and analyze the obtain results for various applications and interests. At present times, the working culture in the government offices are not always compatible and suitable with the working culture needed for maintaining and operating the good and reliable GPS CORS networks. The number of qualified and dedicated persons for maintaining and operating GPS CORS should also be increased and provided with proper reward and remuneration. In this case, outsourcing part of the operational and maintenance activities of GPS CORS network to the private company may also be considered.

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GPS CORS in Indonesia :
Challenges and Limitations (4)

Capacity Building and Human Resource Development

4. Since the large scale GPS CORS network covering Indonesian region will require substantial amount of qualified human capital, the related human resource development program should also be systematically planned by the related institutions (e.g. Bakosurtanal and BPN). In terms of high learning institutions, at present times in Indonesia there are four state universities (ITB Bandung, UGM Yogyakarta, ITS Surabaya, and Undip Semarang) and three private universities (Itenas Bandung, ITN Malang, University of Pakuan Bogor) that have study programs on surveying, geodesy and/or geomatics engineering. In the context of GPS CORS related capacity building in related institution, those high learning institutions, besides supplying their graduates can also offer various Continuing Education Programs (CEP) for enhancing the competency of human resources belonging to various agencies related to the GPS CORS programs.

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GPS CORS in Indonesia :
Challenges and Limitations (5)

Multi Purpose Utilization

5. Since the development of good and reliable national GPS CORS network (e.g. IPGSN) will absorb a lot of money and efforts, the use of the system is preferably not just only for supporting one specific sector such as positioning, surveying and mapping. Instead it should also support other national needs and interests, such as natural hazard mitigation and intelligent support system. Since each application usually will have their own specification on data requirement and management, then the GPS CORS system should be adaptively designed and operated to fully support those various applications.

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Closing Remarks (1)

1. World-wide development of GPS CORS is increasing rapidly, due to increasing availability, accuracy, reliability and integrity of GPS systems; and also to advancements in electronics, instrumentation and control fields. The applications of GPS CORS in Indonesia has also steadily growing and has good opportunity to serve various national, regional and local needs and interests.

The existence of good and reliable GPS CORS network covering the Indonesian archipelago would greatly increase our ability of observing the Earth system dynamics and phenomena in the region; and at the same time increasing the accuracy and reability of the national spatial (geodetic) reference system for supporting various applications and needs related to positioning, navigation, surveying and mapping in the Indonesian region.

Closing Remarks (2)

2. The advancements of GPS CORS networks in Indonesia should also be supported by proper legal infrastructures and qualified human resources. The support and endorsements from central government, parliament, related governmental agencies and high learning institutions will therefore also be important for suistainable development of GPS CORS in Indonesia.

3. Finally, it should be emphasized that some of GPS CORS applications in Indonesia (e.g. positioning, surveying and mapping and also intelligent transportation systems), if professionally managed can generate a substantial amount of revenue for government and also private sector. Therefore if is considered suitable, the business prospects and plan of the national GPS CORS system of Indonesia should also be taken into consideration and systematically be prepared.

Thank you very much for your attention