FINAL REPORT for APN PROJECT

Project Reference Number: CBA2013-CBA2013-05NSY-Sutrisno

The Implementation of Multi Sensors Remote Sensing Technology for Sustainable Disaster Management

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Final Report submitted to APN

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

The world is facing global change impact due to the climate change and nature phenomenon. Remote sensing technology is able to observe the changes, predict the possible disaster through forecasting and contribute the ways to lower the damage, up to the recovery and mitigation processes. Therefore, an international capacity building workshop is strongly needed to enhance sharing knowledge, experiences and exchanging idea for developing new technologies in remote sensing sciences among leading scientists and early careers especially those from the developing countries that are most vulnerable to the disaster related to climate change and nature variability. The support from APN will provide the opportunity for about 26 aspiring young scientists from Asia - Pacific region to participate in this workshop

Keywords

Remote sensing, Multi sensors, Disaster

Objectives

The main object of this activity is to increase the scientific capabilities and environment awareness of regional scientists and early careers in the application of remote sensing technology for disaster management in order to protect and restore the health and integrity of the Earth's ecosystem within their own region. Experiences and technology form leading countries such as Japan, Singapore and Switzerland will be obtained through the workshop

Amount received and number years supported

The Grant awarded to this project was US$ 38,000 for Year basis

Activity undertaken

Year	Date	Major Activities	Place
2013	31th May	Project Planning Meeting	Jakarta
	31th May	Criteria for the financial support selection, time schedule and other administrative preparation	Jakarta
	May, 28th – July 2013	Call for participation: abstract submission and travel request	Jakarta
	29 July – 4 August	Selection of the granted support candidates	Jakarta
	5 August 2013	Notification of granted support to the successful candidates	Jakarta
	6 August – 1 September 2013	Preparing the administrative of the successful candidates to attend the workshop, travel and visas	Jakarta
	22 September 2013	Kick off Meeting of RS new Technology Preparedness	Bogor
	July – September	Data, software and method, questionnaire preparation	Jakarta

	20 October 2013	Workshop 1: a. Registration, b. Sharing sessions c. Fundamental technology ALOS-2 data For global change and disaster management d. Technical training of ALOS-2 data for climate change and disaster management e. Introducing GEOSS for future management network	Bali
	21 October 2013	Workshop 2: a. Sharing knowledge session b. Technical training Of high Resolution images, d. Panel discussion e. Participant closing note	Bali
	21 - 24 October 2013	Joint other ACRS event	Bali
	23 October 2013	Field Work and Technical excursion	Bali
	27 October 2013	Post Workshop meeting	Werdhapura hotel, Bali
2014	29 – 30 March 2014 and 5 – 6 April 2014	Post Workshop training (5 – 6 April 2014 only): Training of multi sensor remote sensing technology for disaster management: Remote sensing Analysis	Ibn Khaldun University Campus, Bogor
	September – February 2014	Final report and project recommendations/dissemination	Jakarta
	March - April 2014	APN project & financial reporting	Jakarta

Results

a) Enhance the scientific and technical capabilities for 26 early careers/ young scientists in regional Asia Pacific Countries in remote sensing technology for disaster management
b) Raise awareness and socialize the technology to protect and restore the health and integrity of the earth's ecosystem in their own countries.
c) Alert the youth of global change issue that may cause catastrophe within Asia Pacific region and transferred their knowledge in their home countries
d) Acknowledge the development of remote sensing technology from the 34th ACRS conference
e) Develop network and cooperation from all participants
f) Publish their research result to broaden the scientific capabilities and sharing knowledge to others

Relevance to the APN Goals, Science Agenda and to Policy Processes

The project is line with APN's third strategic Plan agenda as it encompasses the remote sensing technology for observing, monitoring, projecting and managing the environmental changes within pre and post disaster, either by nature or climate change factors within the Asia Pacific region. The project will enhance scientific capacity in developing countries to improve decision ‑ making relating to issues that are directly linked to their sustainable development. Indeed, the project will employ a two - track process of capacity enhancement for experienced leading scientists and capacity development for early - career scientists. Beside that, the project is also collaborated to strengthen appropriate interactions among scientists and policy - makers, which are some are the participants of the workshop and ACRS 2013. The lecturers indeed provide scientific input to policy decision - making and scientific knowledge either through the workshop or the whole ACRS 2013 events.

Self evaluation

This project was initiated to enhance, share, transfer, cooperate and develop network for the young scientist and early careers in Asia Pacific region in the field of Remote sensing and its application in global change issues, especially relating to the disaster. The new technology develop by Japan in the active remote sensing sensor and the launched of new satellite was designed to anticipate the disaster caused by either climate change or natural. Indeed, the development of high resolution image that was captured by UAV and its technical method to make it as maps, will encourage the young scientists and early careers to define the method in recovery and mitigation program.

Both passive and active remote sensing provide for support humanitarian action and plan to manage the disaster in sustainable mitigation and rehabilitation processes. Passive remote sensing, such as ALOS-2, enables to track the movement of the earth's crust, dangerous oceanic pattern as an input for mitigation processes (Osawa, 2011). Meanwhile, high resolution optical remote sensing sensors on vehicle such as UAVs, provide autonomous remote operation, and able to monitor the catastrophe such as volcanic event, tsunami, Hurricane, flooding and major Storm, earthquake-triggered (Bendea et all, 2008).

Either satellite borne or UAVs are being taught in the workshop and post workshop training. However, the need to have a small ground practice after the workshop has been hindered by security clearances. Therefore, the post workshop training for local students and early careers seems has also should be done as the continuation of the workshop. The workshop was held in accordance with 34th Asian Conference on Remote Sensing (34th ACRS) that was attended by about 1500 participants from all around the world, even though the majority are Asians. New method, technology, data and tools were being shared, informed, transferred and possibly cooperate during this conference that will advance the knowledge and the network of the early careers and young scientist as well. So, we though either workshops or conference are beneficial to all of them for bridging their future career toward the world harmony and the sustainable world.

Potential for further work

The potential further works are the training using both new image and new technology. The preparation should be done properly due to the security problems

Publications (please write the complete citation)

Workshop report will be disseminated to all of the collaborators and participants' organization. Meanwhile tutorial material, the model of data that derived from remote sensing assessment for the purpose of disaster management will be published through APN, ISRS website.

References

1. Bandea, H., P. Boccardo, S. Dequel, F.Tonolo, D. Marenchino, F. Piras. Low cost UAVs For Post Disaster Management. 2008. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B8. Beijing 2008
2. Osawa, Yuji. 2011. A New satellite to Battle Large-scale Natural Disaster., http://www.jaxa.jp/article/special/antidisaster /osawa_e.html

Acknowledgments

Asia Pacific Network For Global Change research (APN) is the major funding source of the workshop, without whose financial support our activities would not have been impossible. We are very grateful for their support to run the program. We are also grateful for the support provided by the 34th Asian Conference On remote Sensing (ACRS) committee for facilitating our project. A special thanks to the leading scientist from ETH Zurich, ETH Singapore, RESTEC – Japan and national ministry of Indonesia, without their support, technically and financially, the activities would be impossible.

TECHNICAL REPORT

Preface

Realizing the resistance of Asia Pacific region to many disaster, either by nature or human pressure, the need to share into insight technology that capable to manage the earth in sustainable manners are definitely needed. Therefore, the workshop of Multi sensors remote sensing technology for disaster management was held in accordance with 34th Asian Conference on Remote Sensing (ACRS) in Bali at 20th to 21st October 2013. Many young scientists and early careers are participated in this event, that with the leading scientist have shared the new remote sensing technology to be implemented in their hometown in the near future.

We would like to convey our gratitude to Asia Pacific Network (APN) For global change research that have make this event a success. Our gratefulness also goes 34th ACRS committee, the leading scientist and the workshop participants that has contribute to the success of this event.

We hope that the technology that obtain either from the workshop or the whole 34th ACRS will give benefit to all participants and will increase the awareness of the needed to maintain the sustainable nature related to disaster issues. We also hope that other capacity building will be carried out to be more improve the awareness and the knowledge of the scientists from all around the world relating to the remote sensing technology and the global change issues.

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Appendices

1.0 Introduction

The need to acquire fast and responsive information regarding the catastrophe in Asia Pacific region has been filled by the advance of remote sensing technology. Precaution management up to the mitigation information can be provided by this technology. Therefore, in accordance with the 34th Asian Conference on Remote Sensing (ACRS) that held in Bali, 20 to 24 October 2013, a capacity building workshop which involve early careers from Asia Pacific region to discuss and learn this issue has been held.

The issue of "Sustainable Asia" from the 34th Asian Conference on Remote Sensing (ACRS) is also inspiring the workshop. Because of the frequent catastrophe occurs in Asia Pacific countries that may be caused by climate change, human driving force or nature phenomenon. Climate change may cause storm surges, high wave, sea level rise, drought, heavy rainfall within the region. Meanwhile, flooding or landslide are the disaster both caused by climate change and human induced factors that quite often occur in Asia Pacific countries. Tsunami is other catastrophe by nature which hits Asia Pacific region lately. The workshop will focus on disaster management as one of the global change model because the disaster will degrade the Asia Pacific environment if the sustainable management for precautionary or mitigation management is not take into account. For this reason, a remote sensing technology is needed to observe, monitor and asses the world nature phenomenon in order to forecast, mitigate and manage the disaster parameters.

Realizing that many methods, techniques and data have been developed by leading scientists worldwide, especially for obtaining and analysing the disaster, a model of sharing knowledge, technology transfer, exchange ideas of research and experiences of disaster, typology of disaster become the idea for this workshop. Therefore, this workshop may encourage early careers and experienced leading scientists to attend the workshop and communicate in two ways approach.

The aim of the project is to

a) Enhance the scientific and technical capabilities for early careers in regional Asia Pacific Countries in remote sensing technology for disaster management

b) Raise awareness to protect and restore the health and integrity of the earth's ecosystem within region.

c) Alert the youth of global change issue that may cause catastrophe within Asia Pacific region

d) Provide the recommendation about internationally - based "state of knowledge" to the relevant decision makers.

e) Publish the result to broaden the scientific capabilities.

2.0 Methodology

The project was consists of; meetings, workshop, excursion and training (see the figure below). Meanwhile, the methods for each are:

a. Meetings: kick off and post workshop meeting were carried out at this project with the discussion method approach.

b. Workshop: the teaching method in two way approach was being employed at this event. The leading scientists provided the data and the material for lecturer, that consist of background theory, Method and data of the lecture

c. Excursion: the excursion or field trip aims to learn the in site source of natural disaster (volcano). The participants learnt the background of characteristics of disaster in the volcano museum and compare it in the field site. The leading scientists are also prepared the image data from this in situ site in order to give knowledge for participants to compare the image with the real feature on earth. Besides that, the cultural experience was also learnt from the local temple to see the perspective of the local wisdom relating to the disaster.

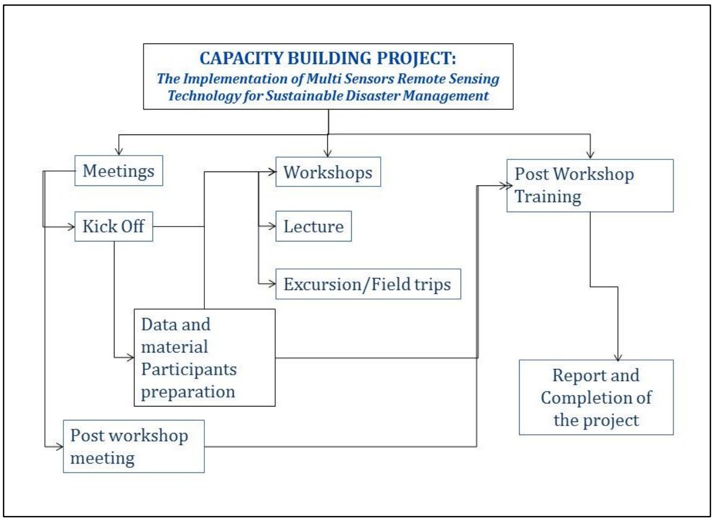


Figure 1. Method diagram

d. Post workshop Training: the teaching method in two way approach was being employed at this event. The leading tutor provide the data and the material for lecturer, that consist of background theory, Method and data of the lecture

3.0 Results & Discussion

A. Preparation

The preparation aims to manage the workshop and the financial support for selected participants. The meeting preparation was held prior the project to determine the date of kick off meeting, the criteria for funded participants and the post meetings. Based on the meeting discussion, the kick off meeting was better held on 20th September 2011 instead of 10th September 2011 due to the peak session of the proposed hotel.

The criteria for grantee candidate can be determined as follow

a. The applicants should submitted paper through ACRS 2013 website. The topic has to be related to the theme of workshop (hazards or natural resources topics)
b. The applicants should be registered in the Workshop of “The Implementation of multi sensors Remote Sensing Technology for Sustainable Disaster Management” and should apply for financial support (will be developed in ACRS 2013 website if the project is approved)
c. The applicants should agree to submit closing note regarding the outcome of their attendance to the workshop and the ACRS scientific conference (the guideline will be developed in ACRS 2013 website if the project is approved)
d. The applicants papers should be accepted either as oral or poster
e. The age of the participants should be less than 30 at the time of application. Limited financial support will also provide for those whose ages are less than 40.

f. The country of the origin should be vary depend on the number of each countries applicants.
g. If there is possible to do so, we try to invite more people by maximizing the travel allowance, that under certain circumstances for the applicants that age are more than 30 will have the half financial support such as airfare only or accommodation only.
h. Successful applicants will get the financial support for the workshop and the whole event of ACRS 2013.

Meanwhile the schedule for inviting the grantee or financial support candidates are:

	Project Activities	**Date**	**Objective**	**Output**
1	Criteria for the financial support selection, time schedule and other administrative preparation	End of May	Deriving criteria for selection, timeline for selection process of candidates and administrative arrangement	Matrix of granted support criteria, travel administrator arrangement
2	Call for participation: abstract submission and travel request	End of May _ 28 July 2013	Inviting applicants	List of applicants/ countries
3	Selection of the financial support candidates	29 July – 4 August	Selecting the best candidates for attending the workshop according to the criteria which will represent countries among Asia Pacific region	List about 20s successful candidates
4	Notification of successful candidates	5 August 2013	Announcing the result of selection to the successful candidates	Letter of announcement to the successful candidates
5	Preparing the administration of the successful candidates to attend the workshop, travel and visas	6 August – 1 September 2013	Preparing the travel arrangement to the successful candidates	Ticket, accommodation and visa support for successful candidates
6	Participants attending the workshops and 34TH ACRS	20 – 24 October 2013		

B. Kick Off Meeting

A kick off meeting has been held in Bogor Permai at 20 September 2013 as the preparation for running a workshop. The result of the kick off meeting indicates the need to transfer the new technology of:

a) ALOS-2

ALOS-2 will be carried a L-band Synthetic Aperture Radar (SAR) named "PALSAR-2". SAR has characteristics of observation under the day-night and bad weather condition. Because of this, it is very powerful tool for monitoring disasters.
Former Japanese earth observation satellite "ALOS-1" has contributed to many disasters in the world. And it acquired a lot of information of global change and climate change not only disasters but only environmental issues. *Jaxa* (Japan aerospace exploration agency) state that they has been conducting research and development activities to improve wide and high-resolution observation technologies developed for DAICHI in order to further fulfill social needs. These social needs include: 1) Disaster monitoring of damage areas, both in considerable detail, and when these areas may be large 2) Continuous updating of data archives related to national land and infrastructure information 3) Effective monitoring of cultivated areas 4) Global monitoring of tropical rain forests to identify carbon sinks. These issues seem can be the need of the workshop.

The next workshop will introduce examples of disasters from earthquake, volcano, flood, and landslides fields. And lecturer will introduce examples of forest monitoring to understand global change because it related to RISK of disaster at the least.

b) UAVs (Unmanned Aerial Vehicle)

According to the UVS International definition, a UAV is a generic aircraft design to operate with no human pilot on board. Meanwhile, the definition of disaster may content at any situation natural or manmade that poses a threat to life, property or the environment (Brewer, 2010). Therefore the key issues of using UAVs for disaster management may include its ability to

- ✓ Match the sensor and airframe to the “event.”
- ✓ Provide autonomous or “remote operation”
- ✓ capabilities to sensor.
- ✓ Provide capabilities for data telemetry.
- ✓ Examine data compression if required to telemeter
- ✓ large data volumes.
- ✓ Capabilities for data handling on ground.
- ✓ Information distribution to community.

During any disaster the priorities for emergency responders and managers remain the same, i.e ; protect lives, property, environment and indeed recovery processes. This can be fulfilled by UAVs. The workshop will introduced data acquisition using UAVs, and the photogrammetric data processing pipeline, Real-time, on-line and off-line processing, Emphasis is on the processing of UAV images.

c) Introduction to GEOSS

Introducing GEOSS (Global Earth Observation System) to learn the future network about remote sensing data and any disaster method. Information from GEOSS website: “*This ‘system of systems’ will proactively link together existing and planned observing systems around the world and support the development of new systems where gaps currently exist. It will promote common technical standards so that data from the thousands of different instruments can be combined into coherent data sets. The ‘GEOPortal’ offers a single Internet access point for users seeking data, imagery and analytical software packages relevant to all parts of the globe. It connects users to existing data* *bases and portals and provides reliable, up-to-date and user friendly information – vital for the work of decision makers, planners and emergency managers. For users with limited or no access to the Internet, similar information is available via the 'GEONETCast' network of telecommunication satellites"*

GEOSS is the best solution for accessing the earth observation satellite sata. Global change research may use the data for their study, especially dealing with disaster issues. However, high resolution data seems become a problem for more accurate and detail information

The result of Kick off meeting are:

1. Need to study the capability of the ALOS-2 for disaster management
2. Need to study the capability of UAVs in managing the disaster.
3. Due to the limitation of time, The GEOSS introduction will be explained at the post workshop meeting
4. Regional experience in disaster will be explained during the excursion, taking the Mount Batur as the example. The UAVs practise will also held if all of the clearance regulation has been successfully approved. Participants will also learn the volcano disaster characteristic in Mount Batur museum supporting by the Alos-2 image.

Completeness of the kick off meeting materials can be seen in *Appendix 1.*

C. Grantee Processes

The selection process resulted in 26 participants, they are:

NO	NAME	County Of Origin
1	Mr. Anugrag Aeron	India
2	Ms. Anjillyn Mae Cruz Perez	Philippines
3	Ms. Ati Rahadiati	Indonesia
4	Mr. Bui QuangThanh	Vietnam
5	Ms. Christmas de Guzman	Philippines
6	Mr. Dadan Ramdhani	Indonesia
7	Ms. Hang Nguyen thiThuy	Vietnam
8	Mr. Heru Sulistyo	Indonesia
9	Mr. Hua Su	China
10	Ms. Intareeya Sutthivanich	Thailand
11	Mr. Junyi Huang	Hongkong China
12	Mr. Krisna Prasad Bhandari	Nepal
13	Ms. Le Van Anh	Vietnam
14	Mr. Md. Raffi Uddin	Bangladesh
15	Mr. Muhammad Ikhwan Bin Jamaluddin	Malaysia
16	Mr. Nguyen Kim Anh	Vietnam
17	Mr. Pawan Kumar	India
18	Mr. Reiza Muhammad Ariansyah	Indonesia
19	Mr. RongJun Qin	Singapore
20	Mr. Ryoichi Furuta	Japan
21	Mr. Tam TzeHuy	Malaysia
22	Ms. Vandana	India
23	Ms. Virany SENGTIANTHR	Lao
24	Mr. Xiaoping Du	China

NO	NAME	County Of Origin
25	Ms. Habibeh Valizadeh Avan*)	Iran
26	Mr. Sherzod Zaitov *)	Uzbekistan
1	Prof Armin Gruen	Switzerland
	Committee	
1	Ms. Alinda T. Zain	Indonesia
2	Mr. Asep Darmawan	Indonesia
3	Mr. Bambang Surya	Indonesia
4	Mr. Muh.Evri	Indonesia
5	Ms. anthy T. Hidayat	Indonesia

**) Do not show up at the event. Ms.Habibeh Valizadeh Avan did not show up because she has to migrate to Canada at the day of the workshop, Mr.Sherzod Zaitov did not show up for no reasons.*

D. Capacity Building Workshop "The Implementation of Multi Sensors Remote Sensing Technology for Sustainable Disaster Management"

The workshop was held on 20 to 21 October 2013 at Discovery Kartika Plaza hotel – Kuta, Bali. Attended by More than 60 people, the 2 days workshop was held with the following agenda

Sunday, 20 October 2013
Venue: Arjuna Room, Discovery Kartika Plaza Hotel, Bali

Time	Program	Person in Charge
08.00 - 09.00	Registration	Committee
09.00 - 09.10	Opening The workshop	Dr. Dewayany Sutrisno
09.10 - 09.40	Sharing Knowledge	Dr. Dewayany Sutrisno
09.40 - 10.00	Coffee break	Committee
10.00 - 11.00	Introduction of Japanese new earth observing satellite "ALOS-2". management	Dr. Ryoichi Furuta**)
11.00 - 12.00	Utilization for management of global change	Dr. Ryoichi Furuta**)
12.00 - 13.00	Lunch	Committee
13.00 - 15.00	Utilization for management of disaster due to climate change	Dr. Ryoichi Furuta**)
15.00 - 15.15	Coffee break	
15.15 - 16.15	Fundamental-1: Data acquisition in Photogrammetry – concepts and systems Satellite, standard aerial, UAV and terrestrial approaches	Prof.Armyn Gruen
16.15 - 17.30	Fundamental-2: The photogrammetric data processing pipeline Real-time, on-line and off-line processing Emphasis is on the processing of UAV images	Prof.ArmynGruen

***) Dr. Ryoichi Furuta was represented Dr.Eisuke Koizumi, because he has other duties outside of RESTEC*

Monday, 21 October 2013
Venue: Arjuna Room, Discovery Kartika Plaza Hotel, Bali

Time	Program	Person in Charge
09.00 – 12.00	Attending The opening Ceremony of ACRS 2013 and keynote speeches from international experts	Committee
12.00 – 13.00	Lunch	Committee
13.00 - 16.00	Technical training Of high Resolution images: Automated triangulation, DSM generation, Ortho-image generation	Rongjun Qin
16.00 - 17.00	Panel discussion	Prof.ArmynGruen/ qin
17.00 - 18.00	Participants closing note	Dr. DewayanySutrisno

Wednesday, 23 October 2013

09.00 - 16.00	Field Work and Technical excursion - Welcome performance - visit the Mount Batur volcanology museum - site visit to "Mount Batur" - Local culture knowledge	Committee Committee Committee Committee Committee

(a) Result of the Workshop

Sunday, 20 October 2013

The participants learnt the role of new technology satellite for disaster management. The new technology was launched due to the Japanese nature condition that is vulnerable to natural disaster such as earth quake, tsunami and volcanoes eruption. Japan and Indonesia are the two countries that have grieve experience regarding the tsunami. Therefore, this new technology hopefully will assist us in managing the precaution, emergency response and recovery base on their tsunami infliction.

Other Asia Pacific countries that have sea, island and coast are possibly affected by tsunami, such as the condition when Aceh tsunami outspread everywhere to the countries locate within the indian Ocean. And so did the Japanese tsunami that also threaten the coastal and archipelagic state along the Pacific Ocean. Besides that, the disaster such as landslide, flood, forest fire, global and climate change and other human and nature disaster are needed to be mitigated and managed using any new satellite technology. Therefore, this technology gives opportunity to the participants to explore the capability of any new technology to manage their problem dealing with disaster. The leading scientist shared with them:

- ✓ *Overview, Improvement from and Expectations of new satellite technology*
  Leading scientist explained that JAXA has conducted research and development activities to improve wide and high-resolution observation technologies for further fulfil social needs. This new technology has the capability:
  - Disaster monitoring:
    - To contribute to the nation’s disaster prevention activities through fast access to damaged areas during serious disasters in Japan, Asia and so on, as well as continuous monitoring of subsequent disasters and/or recovery/reconstruction status over the areas.
    - To contribute to improving disaster prediction accuracy, etc. by providing disaster-related organizations with InSAR data necessary for deformation forecast/monitoring.

- Global forest monitoring:
  - To contribute to solving global warming issues by providing related organizations with data derived from global monitoring of tropical rain forests to identify carbon sinks.

And other land monitoring, agricultural monitoring and natural resources exploration .

The leading scientist also explained that, the imageries of new technology is able to :

a) contribute the scientific approach to the disaster management activities as part of the social infrastructure by providing wide and high-resolution observation data during large-scale natural disasters in Japan and foreign countries. It will be based upon technology developed for ALOS, and feedback gained through its use.
b) promote data utilization for needs including land and infrastructure management and resource management (Jaxa, 2012). In the future, this new technology hopefully will monitor, prevent and mitigate the disaster impact and assist any effort regarding the emergency respond and post disaster management

✓ *Tutorial of new satellite technology*

The leading scientists shared with the participants, the implementation of the imageries of this new technology in handling the disaster, especially in its utilization for management of global change, such as de-forestation/re-forestation monitoring, volcanic activities and earthquake monitoring, and its utilization for management of disaster due to climate change such as flood monitoring and landslides monitoring.

✓ *Overview of the Data acquisition in Photogrammetry – concepts and systems Satellite, standard aerial, UAVs and terrestrial approaches*

The leading scientist shared the acquisition of high resolution images and remote sensing for disaster management. The platform may be vary from satellite, space borne, stratospheric, aerial, UAVs (helicopter, airplanes) and terrestrial platform and he shares each images derived from sensor' in each platform capability in analysing the disaster, such as for earthquake, tsunami, flooding and other global and climate change issues. These issues must be dealing with the resolution of each images, i.e:

- Satellite images < 5 m
- Aerial images < 20 cm
- UAVs image < 10 cm
- Terrestrial image < 1 cm

These images should attain the response planning that able to:

1. Development of damage simulation model
2. Method to rapidly assess damage
3. Models to allocate limited resources in an optimal way

The leading scientist believed that the above model and method can be accomplished by high resolution images on board of UAVs platform due to its ability to obtain detail information of remotely or hazardous area that impossible to be visited by human. The model derived from this images can support emergency response and recovery management.

<u>Monday, 21 October 2013</u>

✓ Opening ceremony of 34th ACRS 2014

The participants attend the opening ceremony of 34th ACRS 2013

- ✓ Current issues of remote sensing technology speeches by world/international experts/leading scientist. The participants may improve their knowledge by attending this session which offer the delegate with the new development of remote sensing technology

- ✓ *Training of automated triangulation, DSM generation and Ortho-image generation*

  The leading scientists shared how to obtain earth information using UAVs and how the imageries derived from UAVs was being processes for further utilization. The technique to make the image ready were including generate DSM, triangulation and ortho-images. The leading scientist believed that UAV is flexible for the disaster reaction, Safe to the pilot and Low cost way to obtain information. Some problems can be found in implementing this platform such as small UAV can only map small area, sometimes not easy for applying permissions, sometime the battery problem are existed, risk of fail and signal interferences sometime happened.

  The detail information of overview, tutorial and training can be seen in *Appendix 2*

- ✓ *Sharing Knowledge*
  In this session, the participants expressed their benefit in attending the workshop and their future hope in implementing their knowledge that was obtained from their workshop and the whole ACRS event.

  The detail of participants expression were described in the following closing note in *Appendix C*.

<u>Wednesday, 23 October 2013</u>

- ✓ *Field Work and Technical excursion*

Mount Batur was selected as the excursion destination to give participants more better understanding about the characteristic of an active volcano, its hazardous, and how to spatially manage and monitor its activities. After Mount Agung, Mount Batur is one of the most sacred mountain and an active volcano in Bali. On September 20, 2012 UNESCO has made Mount Batur Caldera a part of the Global Geopark Network.

Participants were learned the history mount Batur eruption in the Mount Batur Museum (Museum Gunung Batur). The museum was established to educate the public on both the dangers of volcanoes as well as the positive contribution they make to mankind. The characteristics of the Mount Batur, its eruption pattern, comparing with other volcanoes, are exhibited in this museum. Even, the simulation of the after Christ eruption of Mount Batur and the video of the Mount Batur eruption were also played in the museum.

Figure 2. Mount Batur Museum

Participants were also have a site visit to Mount Batur and studied its characteristic using the ALOS-2 images hand out

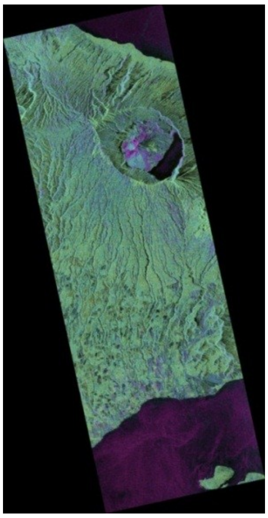


Figure 3. Mount Batur (Alos Palsar, 2013)

Figure 4. Mount Batur, Bali

<u>*Information:*</u>

(GunungBatur) is an active volcano located at the center of two concentric calderas north west of Mount Agung, Bali, Indonesia. The south east side of the larger 10×13 km caldera contains a caldera lake. The inner 7.5-kilometer-wide caldera, which was formed during emplacement of the Bali (or Ubud) ignimbrite, has been dated at about 23,670 and 28,500 years ago (Sutawidjaja et al. 1992)

The southeast wall of the inner caldera lies beneath Lake Batur; Batur cone has been constructed within the inner caldera to a height above the outer caldera rim. The Batur strato volcano has produced vents over much of the inner caldera, but a NE-SW fissure system has localized the Batur I, II, and III craters along the summit ridge. Historical eruptions have been characterized by mild-to-moderate explosive activity sometimes accompanied by lava emission. Basaltic lava flows from both summit and flank vents have reached the caldera floor and the shores of Lake Batur in historical time. The caldera contains an active, 700-metre-tall strato volcano rising above the surface of Lake Batur. The first historically documented eruption of Batur was in 1804, and it has been frequently active since then. The substantial lava field from the 1968 eruption is visible today when viewed from Kintamani, a town that straddles the southwest ridge of the greater caldera (Sutawidjaja et al. 1992)

The caldera is populated and includes the two main villages of Kedisan and Toya Bungkah. The locals largely rely on agriculture for income but tourism has become increasingly popular due to the relatively straightforward trek to the summit of the central crater (Langston-able, 2007)

The lake, Danau Batur, is the largest crater lake on the island of Bali and is a good source of fish.

E. Post Workshop Meeting

<u>Sunday, 27 October 2013</u>

✓ Post workshop Meeting:

Post- workshop meeting was held in Werdhapura hotel Sanur – Bali at 10.00 am to 15.00 pm in accordance with 34th ACRS summer school host by Udayana University and Indonesian Society for

Remote Sensing. The topic of discussion was dealing with :

a) Evaluation of the workshop
b) Evaluation the whole implementation of the project
c) The propose capacity building in Indonesia following the implementation of the workshop.

The result of the meeting was:

1. The workshop has been successfully held and the objective of the workshop has been achieved, i.e
   a. The participants have been aware about the development of the remote sensing technology to manage the disaster and global change issue (expressed in the participants' closing note)
   b. Sharing, transferring and networking about the new technology and the disaster/global change issue has also been done within the workshop and the whole ACRS event (expressed in the participants' closing note).
   c. The workshop has been awaken the awareness of the scientists and the early career regarding the catastrophe that lurking the Asia pacific region
   d. Cooperation among participants has been established by proposing research cooperation, training invitation to participants and other conference, seminar and workshops invitation are being offered to all participants
   e. The participants thinks about the implementation of the theories and technique of remote sensing in their home countries (expressed in the participants' closing note)
   f. The need of more practical training of both technology was also proposed by participants after the failure to held the short field exercise due to the security and operation obstacles.
2. As the countries that face many disasters, Indonesia agree to implement the high resolution satellite technology for monitor, mitigate, emergency responses and recovery management of multi disasters
3. The next activities should been done following the workshop
4. Post workshop training was being proposed in this meeting such as
   a. Remote sensing for global change issues, with study case of its impact in west java or Jakarta due to seasonal flooding and sea level rise
   b. Remote sensing for global change issues , with the issues of coastal and marine approach
   c. Remote sensing for monitor, emergency response and recovery management of natural disaster such as volcanoes eruption. This issue was taken into account due to the raising activity o some volcanoes in Indonesia, such as Sinabung, merapi and anak Krakatau.
   d. Advance remote sensing training using other sensor or imageries
5. Regarding no (4), the meeting participants agree to held the post workshop training in West Java under certain circumstances:
   a. The training will be an advance remote sensing application for the impact of global climate change, such as flooding
   b. Using other Remote sensing imageries
   c. Should be done in the university that has limited facilities in remote sensing laboratory or practise.

e. Post Workshop Training: Multi sensor remote sensing for disaster management : A Remote Sensing Analysis

<u>Saturday, 5 – 6 April 2014</u>

Post workshop training was held at Ibnu Khaldun University (UIKA) , bogor in 5 – 6 April 2014. The training is the second session of the whole training that was held on 29 to 30 March 2013 and 5 – 6 April 2014. The issue of the training was taken into account to develop the skill of the students in some of the university in west java regarding the flooding that hit java island recently as the impact of environment change and the climate change issues. Here, the students learn to monitor, mitigate and modelling the emergency or recovery management by implementing the remote sensing technology. Ciliwong River was taken as the study area since landslide, annual flooding, flash flood are quite often occur along the river bank and the lowland area such as Jakarta. Flood disasters are shown to account for about a third of all natural disasters with the trend of worrying upward and be responsible for over half the death (Knight and Shamseldin, 2006). A hydrological or catchment area modelling may assist to mitigate the impact of flooding (Flemming, 2002). In this occasion, the trainee learnt the model by using remote sensing data, such surface hydrological modelling and terrain analysis.

Based on the remote sensing data, the trainee is also learnt to map the technical planning to manage the disaster such as emergency, mitigate and recovery (DDR Indonesia, 2012). Field check was also employed to obtain the accuracy of the assessment in the second day (fourth day of total training).

The agenda of the training can be described as follow:

Saturday, 29 March 2014

Training of Information system by Ibn Khaldun University (UIKA)

Sunday, 30 March 2014

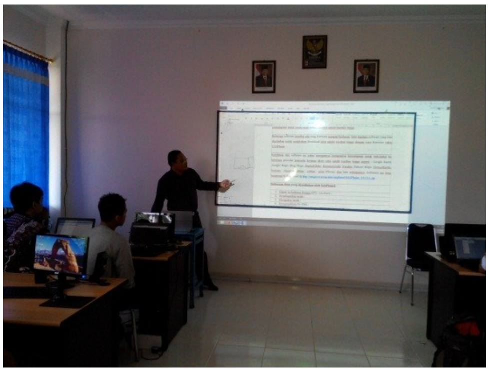
Other field observation by UIKA

Saturday, 5 April 2014

Training of multi sensor remote sensing technology for disaster management: a remote sensing analysis

Date, Time	Activities	Representative
08.00 – 09.00	Registration	Committee
09.00 – 10.00	Forewords and introduction from The dean of the technical sciences faculty, President of ISRS and Waindo Spectera	Committee
10.00- 10.15	Coffee break	
10.15 – 12.00	Applied Remote sensing 1	Mr Antonius K.
12.00 – 13.00	Lunch	
13.00 – 16.00	Applied Remote sensing 2	Ms.Antonius K
16.00 – 16.15	Coffee break	
16.15 – 17.00	GIS application based on Remote sensing	ISRS and integrasia
Sunday, 6 April 2014		
08. 00 – 14.00	Field observation	Committee
14.00 – 15.00	back to campus	Committee
15.00 – 18.00	Re-interpreted and spatial report	Committee
18.00 – 18.30	Break	
18.30 – 20.00	Dinner and Closing	Committee

The result of the training is able to improve the skill of the students in Remote sensing, especially in managing the river flooding.



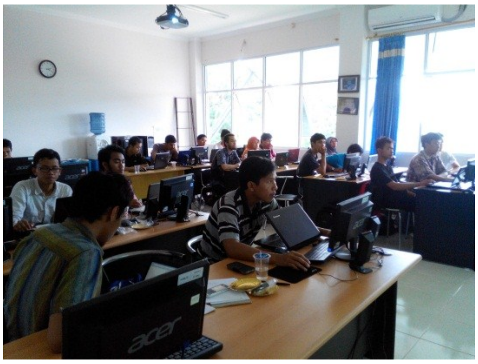


Figure 5. Post Workshop Training: Multi sensor remote sensing for disaster management : A Remote Sensing Analysis. Bogor, 5 April 2014

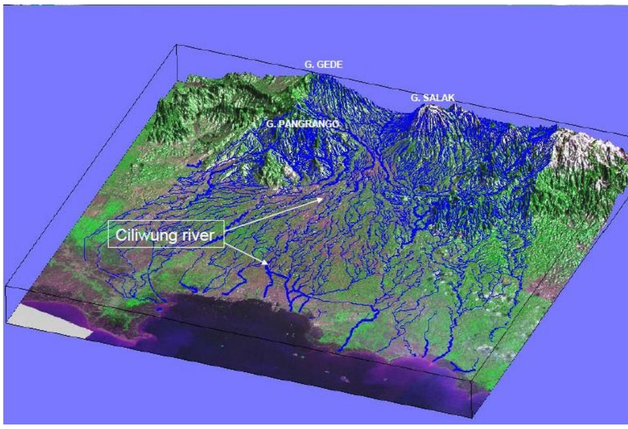


Figure 6. Surface Hydrological modeling (Radityo, 2010)

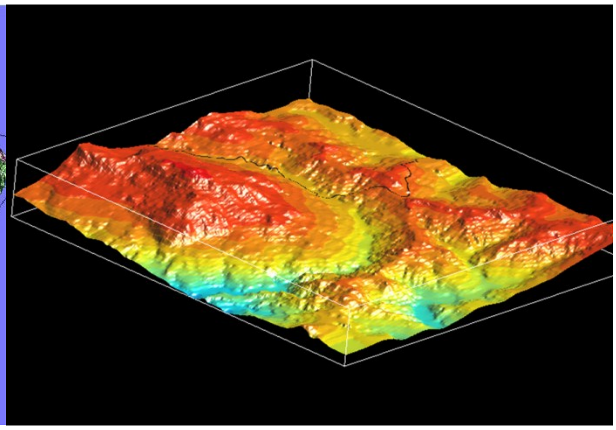


Figure 7. Terrain analysis

4.0 Conclusions

The workshop of Multi sensor remote sensing technology for disaster management has indicated the need for this technology for earth observation management related to either disaster or any global change issues. The early warning system can be provided for precaution and saving the nature and human life, and so does for emergency response, monitor the damage area, recovery and any post disaster management processes.

The utilization of ALOS-2 are able to manage and give information any disaster related to the earth quake, global change and climate change issues that definitely needed for manage the sustainable earth. Meanwhile, the utilization of UAVs are importance for monitoring the damage area, rescue, recovery and managing the post disaster.

Participants are happy to share and accept these new technologies of remote sensing, that that will able to advance this knowledge and implemented for their own countries not for a distance future.

However, we really regret that due to the security clearance, the UAVs practises cannot be employed. Indeed, the limitation of time become the obstacle to employ the UAVs practise as well.

Indeed, due to the limitation of time, the announcement of financial support cannot be pronounced earlier that make the numbers of applicants were less that we are expected.

5.0 Future Directions

Remote sensing has many platform, sensors and resolution that have their own characteristics, advantages and disadvantages. In the workshop, the participants have learned two types of Remote sensing technology to assist them cope with any global change issues as so did the disaster. However, this two days workshop has limitation in more detail practises in the implementation of both technology, ALOS and UAVs. In the future, other capacity building such as summer school or training is definitely needed to improve the skill of the early careers and the young scientists, especially in the utilization of any Remote sensing technology for global change issues.

Besides that, project cooperation is also need for the implementation of the workshops among Asia Pacific countries. The project should involve the developing and developed countries. The emphasis of this project should be able to increase the capacity of early careers and young scientist to solve the global change problems

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Appendices

APPENDIX 1. Kick off meeting: RS new Technology Preparedness

Bogor Permai, 22 September 2013

Summary:

Global change has become the right issues for the welfare of the mankind. It may cause catastrophe to the humanity and bring earth to naturally decrease. Human and nature are both affect the global change issues. Human induced factors may cause flood, landslide, land subsidence and even the climate change. The nature disaster such as earth quake, tsunami, volcanoes, indeed storm, heavy rain that seemingly cause by nature but related to climate change are other factors that support di degradation of the earth surface in the short term but sometime give advantages in the near future. All of those earth phenomenon are easily monitored and managed by remote sensing technology. Relating with the advancing remote sensing technology up to the highest and detail capability to monitor any earth objects characteristics, a workshop has to be held in order to increase the capacity of the youth in coping with the world catastrophes. The kick off meeting was held to introduce the right issues of remote sensing technology dealing with disaster. Whether the remote sensing new technology such as ALOS and UAVs will meet the need of rapid information for monitor, early warning, emergency response and recovery management of any disaster and global change issues, should be discuss in this kick off meeting.

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Agenda/Programme

MAPIN/ISRS

APN
Asia-Pacific Network for Global Change Research

KICK OFF MEETING RS NEW TECHNOLOGY PREPAREDNESS
20 September 2013- Wisma Bogor Permai – Indonesia

08.30 – 09.30	:	Registration
09.30 – 10.00	:	Opening Ceremony Dr. Mahmud Raimadoya (ISRS advisory board)
10.00 – 10.15	:	Coffee Break
10.15 – 11.45	:	A brief Introduction to The Implementation of multi sensors remote sensing technology for disaster management project Dr. Dewayany Sutrisno
11.45 – 12.15	:	The Global Change issues and Remote Sensing Dr. Mulyanto Darmawan
12.15 - 13.30	:	Break and lunch
13. 30 – 14.00	:	The advance remote sensing technology for disaster management Dr. Dewayany Sutrisno
14.00 – 14.30	:	Introduction to GEOSS Dr. Nani Hendiarti
14.30 – 15.00	:	Coffee Break
15.00 – 16.00	:	Group Discussion and brain storming
16.00 – 16.30	:	Resume of The kick off meeting
16.30 – 17.00	:	Closing speech

Funding sources outside the APN

Organization	*Type of support*	*Amount*
1. Indonesian Society For Remote Sensing	*Meeting material, administrative staff*	
2. Geospatial information Agency	*Meeting staff honoraria,*	*USD 1000*

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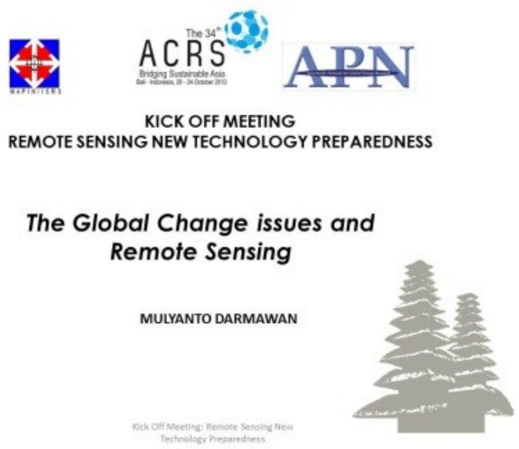
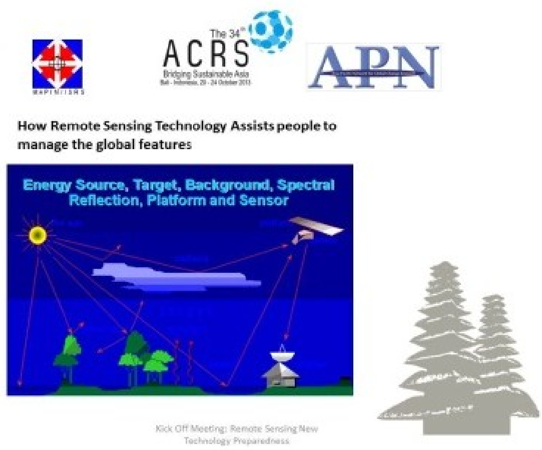
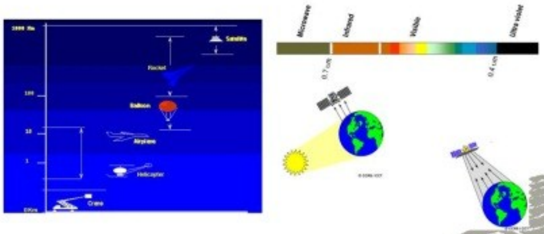
Presentation

a. The Global Change issues and Remote Sensing: Dr.Mulyanto Darmawan







Kick Off Meeting: Remote Sensing New Technology Preparedness

WHAT IS THE GLOBAL CHANGE ISSUES:

1. Climate change impact
   - numerous effects on earth features: storm, rain, drought, sea level rise etc
2. Population increased
   - Effects land conversion for food, dwellers and others
3. Land conversion
   - Less primary forest for urban, rural and agricultural development

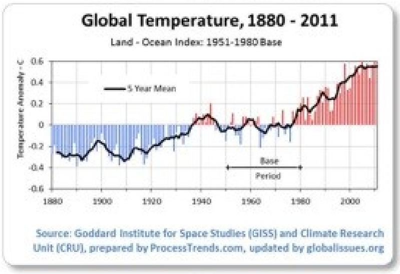
Kick Off Meeting: Remote Sensing New Technology Preparedness

Many are agreed that climate change may be one of the greatest threats facing the planet.

Recent years show **increasing temperatures** in various regions, and/or increasing extremities in **weather patterns**.

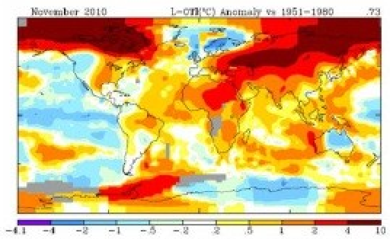
Kick Off Meeting: Remote Sensing New Technology Preparedness

Increasing Temperature



Kick Off Meeting: Remote Sensing New Technology Preparedness

GLOBAL TEMPERATURE CHANGE ANALYSIS FOR REMOTE SENSING DATA



Source: GISS Surface Temperature Analysis, NASA Goddard Institute for Space Studies, accessed January 30, 2011

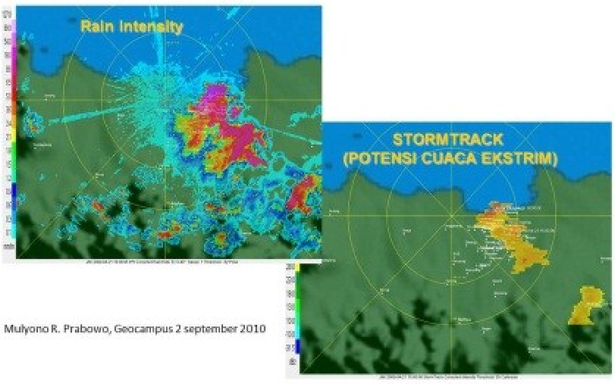
Kick Off Meeting: Remote Sensing New Technology Preparedness

INCREASING EXTREMITIES IN WEATHER PATTERNS BY REMOTE SENSING DATA

Geostationary satellites of the Japan Meteorological Agency (MTSat 2) and EUMETSAT (Meteosat-7) captured the extraordinary size of typhoon Hiayan as it approached the Philippines. Source. © 2013 JMA/EUMETSAT.

Kick Off Meeting: Remote Sensing New Technology Preparedness

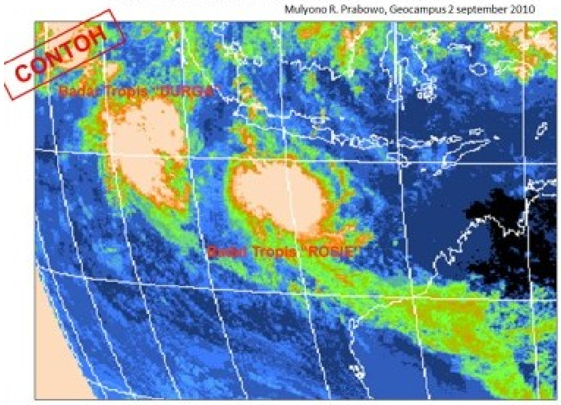
Example of Microwave remote sensing for extreme wheather



Mulyono R. Prabowo, Geocampus 2 september 2010

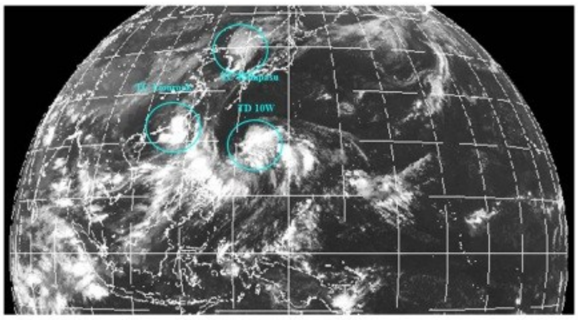
Climate satellite 23 April 2008 – 07.00 WIB

Mulyono R. Prabowo, Geocampus 2 september 2010



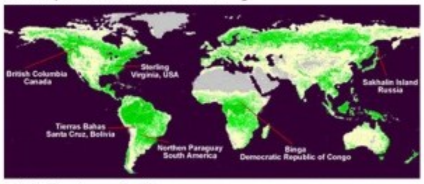
Mulyono R. Prabowo, Geocampus 2 september 2010

Tropical cyclone analysis
02 September 2010, 00 UTC



- Gambar: Citra Satelit 02 September 2010 pukul 00.00 UTC **TC Kompasu, TC Lionrock, TD 10W**

Land cover change is increasingly affecting the biophysics, biogeochemistry, and biogeography of the Earth's surface and atmosphere, with far-reaching consequences to human well-being.



Global land cover facilities,
http://glcf.umd.edu/services/landcoverchange/landcover.shtml

Kick Off Meeting: Remote Sensing New Technology Preparedness

LAND CONVERSION THROUH REMOTE SENSING

Rhondonia Brazil deforestation using Modis Data
http://www.bu.edu/lcsc/research/global-land-cover/

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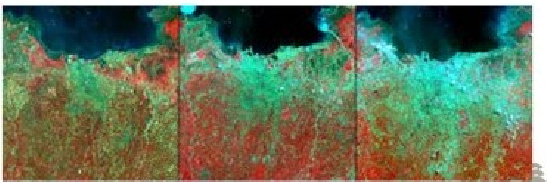
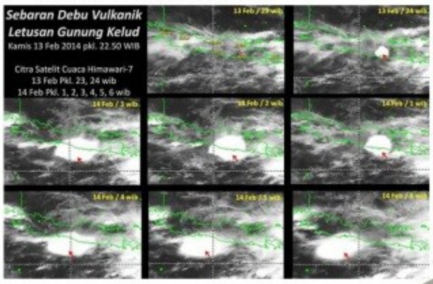


URBANG GROWTH IN JAKARTA
Landsat MSS and TM data

Kick Off Meeting: Remote Sensing New Technology Preparedness

The spreading of volcanic ash



Kick Off Meeting: Remote Sensing New Technology Preparedness

Forest Fire analysis

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OTHER IMPACT ON GLOBAL CLIMATE CHANGE

1. Rapid changes in global temperature
2. Small average global temperature change can have a big impact
3. Extreme Weather Patterns
    1. Super-storms
    2. Extreme weather events on the increase
4. Ecosystem Impacts
5. Rising Sea Levels
6. Increasing ocean acidification
7. Increase in Pests and Disease
8. Failing Agricultural Output; Increase in World Hunger
9. Agriculture and livelihoods are already being affected
10. Women face brunt of climate change impacts

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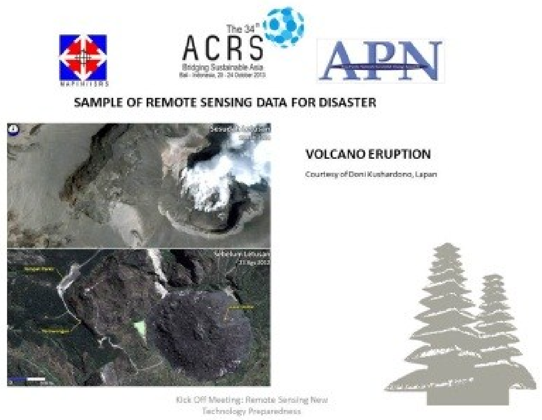
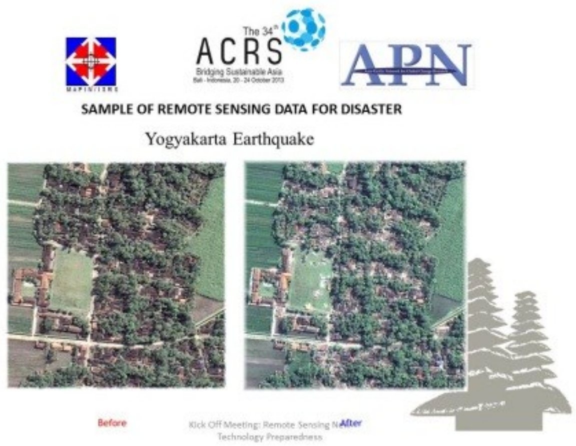
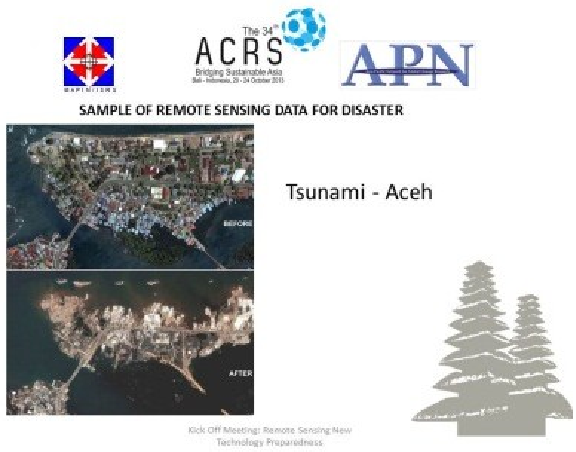
THANK YOU VERY MUCH FOR YOUR ATTENTION

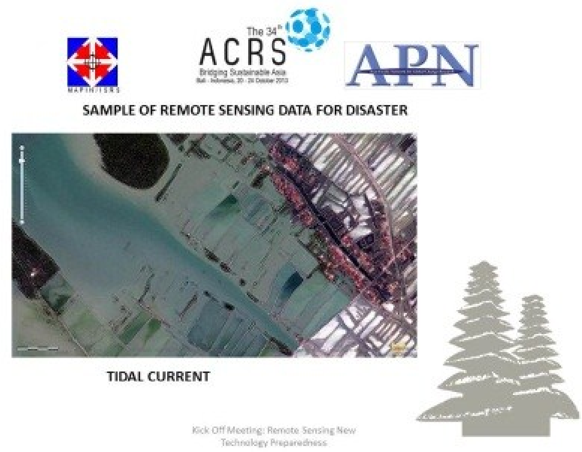
Kick Off Meeting: Remote Sensing New Technology Preparedness

f. The advance remote sensing technology for disaster management: Dr.Dewayany Sutrisno









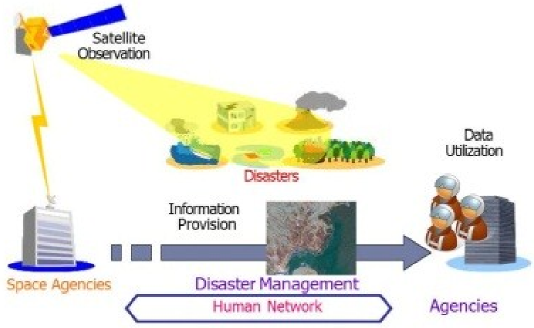
SAMPLE OF REMOTE SENSING DATA FOR DISASTER

TIDAL CURRENT

Kick Off Meeting: Remote Sensing New Technology Preparedness

Sentinel Asia

Source:
Dr. Masahiko Nagai
Asian Institute of Technology (AIT)
Geoinformaticss Center



PROPOSED REMOTE SENSING TECHNOLOGY FOR THE WORKSHOP

1. The planning for ALOS-2 launched, provide better image for disaster and any global change issues
2. Unman Aerial Vehicle, Provide better technology for detail disaster management issues

Kick Off Meeting: Remote Sensing New Technology Preparedness

ALOS-2 mission objectives are to:

1. Disaster Monitoring (including the solid earth research)
2. Environmental monitoring for sustainable Earth in Forestry, Cryospheric, and sea Ice
3. Natural Resources (Agriculture, Ocean monitoring, and resources)
4. Technology Development for the Future Earth Remote sensing (satellite and sensor)

Jaxa 2012, The 4th ALOS Research Announcement for ALOS-2

Kick Off Meeting: Remote Sensing New Technology Preparedness

Examples of utilization research

- ✓ **Land use and land cover change monitoring**
- ✓ Forecasting of sea-state conditions and seas ice for off-shore applications
- ✓ Ship traffic monitoring and fishery management in coastal waters
- ✓ Agriculture and forestry management (planting status, agricultural productivity estimation, vegetation changes, etc.)
- ✓ **Natural disasters (forest fires, flooding, landslide, earthquakes, etc.)**
- ✓ Pollution monitoring (oil spill, red tide, etc.)
- ✓ Geology and natural resources exploration
- ✓ Applications related to SAR interferometry (digital elevation models, crustal movements, vegetation distribution, etc.)
- ✓ Development of the Geographic Information System (GIS) database at national land
- ✓ **Educational use**

Jaxa 2012, The 4th ALOS Research Announcement for ALOS-2

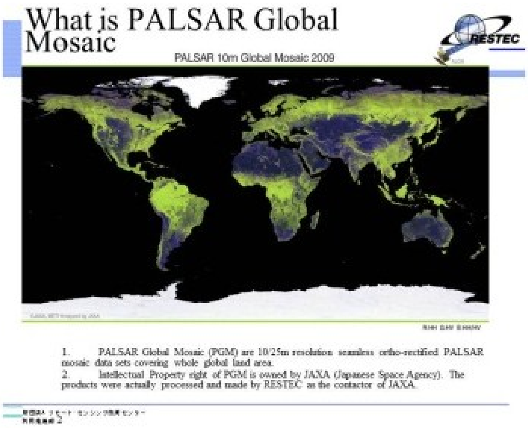
Kick Off Meeting: Remote Sensing New Technology Preparedness

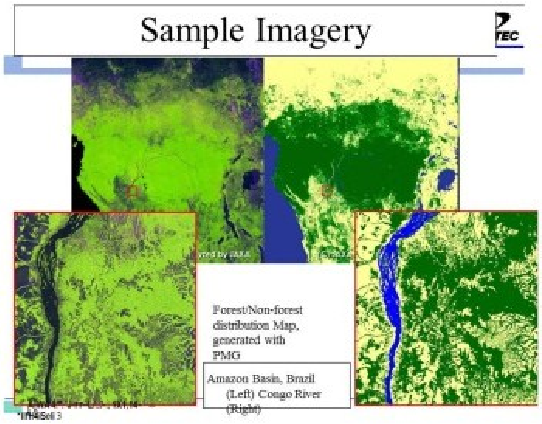
Examples of major objectives

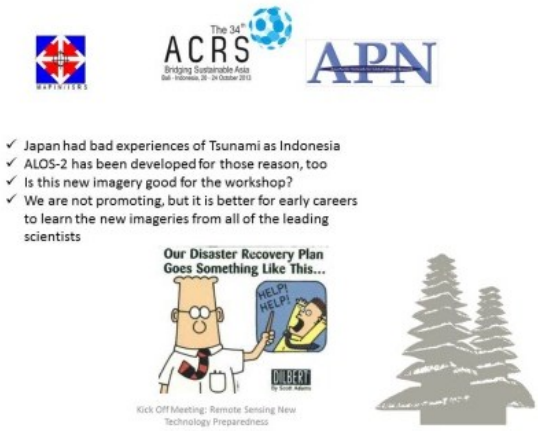
- ✓ **Land use and land cover change**
- ✓ Topography and geology
- ✓ Terrestrial ecosystem, agriculture and forestry
- ✓ **Climate system, hydrological processes, and water resource related research**
- ✓ Oceanography and coastal zone related research
- ✓ Process studies for microwave scattering and SAR interferometry
- ✓ Basic studies for measuring accuracy by optical sensors with fine spatial resolution
- ✓ Microwave scattering, SAR interferometry, and the Polarimetric SAR researches

Jaxa 2012, The 4th ALOS Research Announcement for ALOS-2

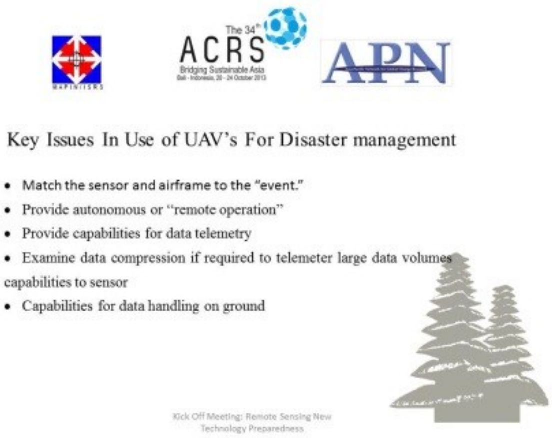
Kick Off Meeting: Remote Sensing New Technology Preparedness

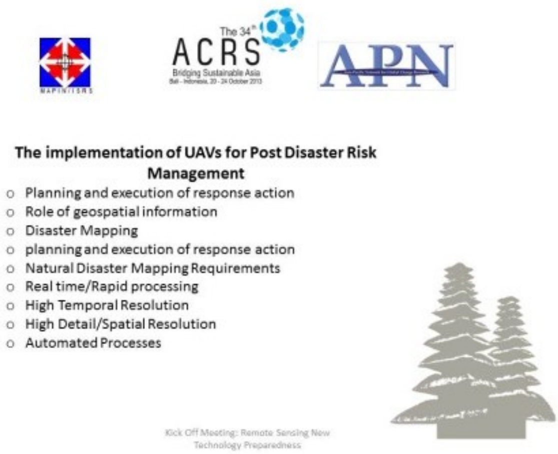

What is PALSAR Global Mosaic
PALSAR 10m Global Mosaic 2009
1. PALSAR Global Mosaic (PGM) are 10/25m resolution seamless ortho-rectified PALSAR mosaic data sets covering whole global land area.
2. Intellectual Property right of PGM is owned by JAXA (Japanese Space Agency). The products were actually processed and made by RESTEC as the contactor of JAXA.

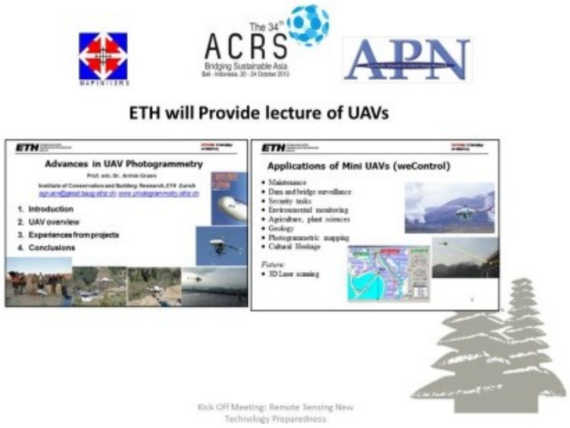

Sample Imagery
Forest/Non-forest distribution Map, generated with PMG
Amazon Basin, Brazil (Left) Congo River (Right)

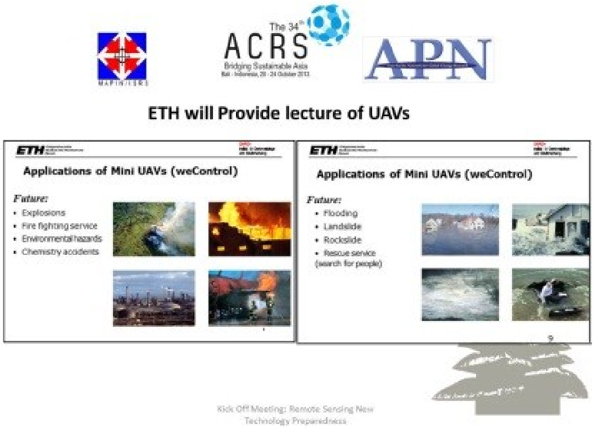

The 34th ACRS
Bridging Sustainable Asia
APN
Japan had bad experiences of Tsunami as Indonesia
ALOS-2 has been developed for those reason, too
Is this new imagery good for the workshop?
We are not promoting, but it is better for early careers to learn the new imageries from all of the leading scientists
Our Disaster Recovery Plan Goes Something Like This...
HELP! HELP!
DILBERT
Kick Off Meeting: Remote Sensing New Technology Preparedness


The 34th ACRS
Bridging Sustainable Asia
APN
PROPOSED REMOTE SENSING TECHNOLOGY FOR THE WORKSHOP
UNMAD AERIALVEHICLE (UAVs) For Disaster Management
UAV-base System
Disasters monitoring
Ubiquitous Sensor network system
City monitoring
Vehicle-based system
Kick Off Meeting: Remote Sensing New Technology Preparedness


The 34th ACRS
Bridging Sustainable Asia
APN
Key Issues In Use of UAV's For Disaster management
Match the sensor and airframe to the "event."
Provide autonomous or "remote operation"
Provide capabilities for data telemetry
Examine data compression if required to telemeter large data volumes capabilities to sensor
Capabilities for data handling on ground
Kick Off Meeting: Remote Sensing New Technology Preparedness


The 34th ACRS
Bridging Sustainable Asia
APN
The implementation of UAVs for Post Disaster Risk Management
Planning and execution of response action
Role of geospatial information
Disaster Mapping
planning and execution of response action
Natural Disaster Mapping Requirements
Real time/Rapid processing
High Temporal Resolution
High Detail/Spatial Resolution
Automated Processes
Kick Off Meeting: Remote Sensing New Technology Preparedness


The 34th ACRS
Bridging Sustainable Asia
APN
ETH will Provide lecture of UAVs
Advances in UAV Photogrammetry
1. Introduction
2. UAV overview
3. Experiences from projects
4. Conclusions
Applications of Mini UAVs (weControl)
Kick Off Meeting: Remote Sensing New Technology Preparedness

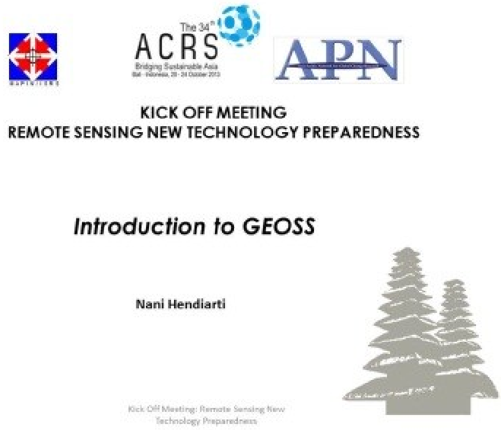

The 34th ACRS
Bridging Sustainable Asia
APN
ETH will Provide lecture of UAVs
Applications of Mini UAVs (weControl)
Future:
• Explosions
• Fire fighting service
• Environmental hazards
• Chemistry accidents
Applications of Mini UAVs (weControl)
Future:
• Flooding
• Landslide
• Rockslide
• Rescue service (search for people)
Kick Off Meeting: Remote Sensing New Technology Preparedness

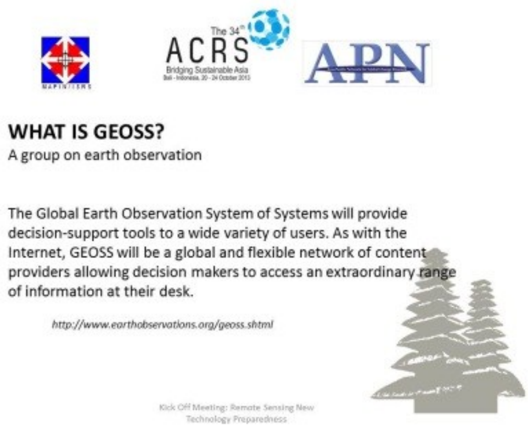

Example of Flood Monitoring using UAVs
Source:
Dr. Masahiko Nagai
Asian Institute of Technology (AIT)
Geoinformaticss Center

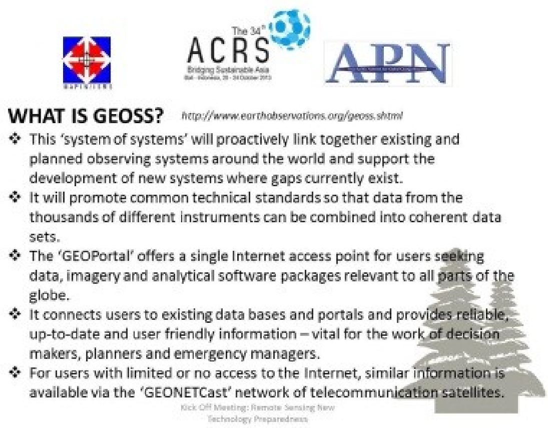

The 34th ACRS
Bridging Sustainable Asia
APN
GPS Camera
Kick Off Meeting: Remote Sensing New Technology Preparedness

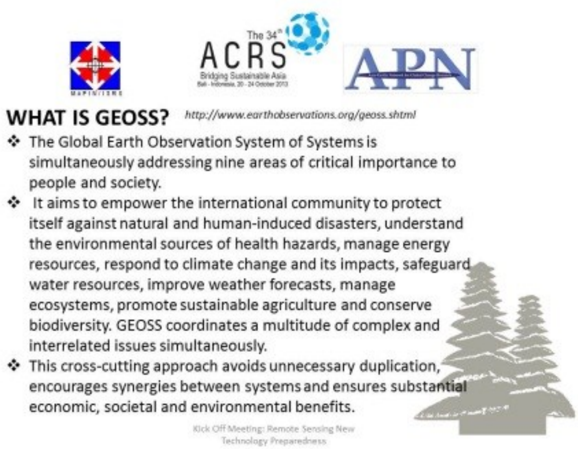

The 34th ACRS
Bridging Sustainable Asia
APN
PLEASE SUBMIT YOUR COMMENT
THANK YOU VERY MUCH
FOR YOUR ATTENTION
Kick Off Meeting: Remote Sensing New Technology Preparedness

g. Introduction to GEOSS: Dr.Nani Hendiarti









The GEOSS Data Sharing Principles

One of the first accomplishments of the Group on Earth Observations was the acceptance of a set of high level Data Sharing Principles as a foundation for GEOSS. Ensuring that these principles are implemented in an effective yet flexible manner remains a major challenge. The **10-Year Implementation Plan** says "The societal benefits of Earth observations cannot be achieved without data sharing" and sets out the **GEOSS Data Sharing Principles**:

- There will be **full and open exchange** of data, metadata and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation;
- All shared data, metadata and products will be made available with minimum time delay and at minimum cost;
- All shared data, metadata and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

http://www.earthobservations.org/geoss.shtml

Kick Off Meeting: Remote Sensing New Technology Preparedness

http://www.earthobservations.org/geoss.shtml

Kick Off Meeting: Remote Sensing New Technology Preparedness

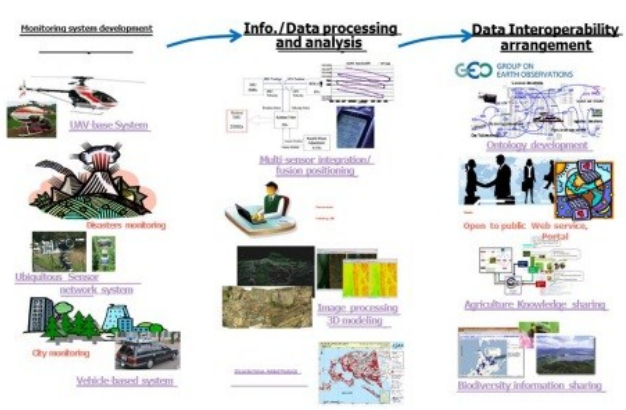
Global Earth Observation System of Systems (GEOSS)

Earth Observation Data Interoperability Arrangement

Global Earth Observation System of Systems (GEOSS)

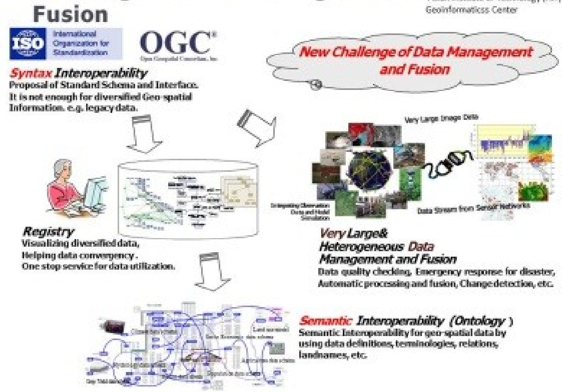
Research Flow for Mapping Technology

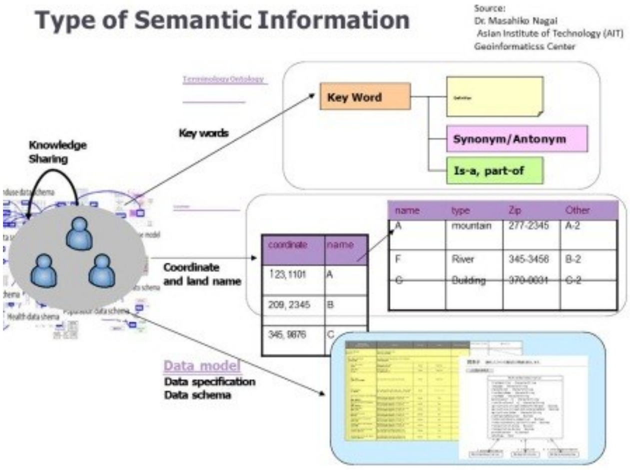
Source:
Dr. Masahiko Nagai
Asian Institute of Technology (AIT)
Geoinformaticss Center

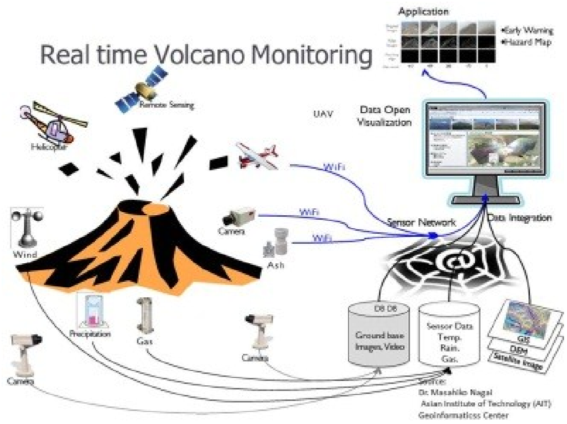


Challenge for Data Management & Fusion

Source:
Dr. Masahiko Nagai
Asian Institute of Technology (AIT)
Geoinformaticss Center







THANK YOU VERY MUCH
FOR YOUR ATTENTION

Kick Off Meeting: Remote
Sensing New Technology

APPENDIX 2. WORKSHOP The Implementation Of Multi Sensors Remote Sensing Technology For Sustainable Disaster Management

Summary

The advance of remote sensing technology may provide the world to observe, analysis and manage the nature of the earth easily, especially dealing with the global change issues. Many sensors on board of satellite, aircraft, mobile and others platforms relating to the spatial and temporal resolution offer varied detail of information to be implemented in various sciences need. The development of remote sensing technology has been discussed, disseminated, shared, transferred and cooperated via an annual remote sensing conference such as Asian Conference on Remote Sensing (ACRS). The 34th ACRS in Bali that was attended by 1500 participants also offer this change to all of the world scientist and all of the remote sensing stakeholders, whereas early careers and young scientists are also part of it. Therefore, the workshop was held at 20- 21 October 2013 that introduced the new remote sensing image that will be launched at the new satellite platform, i.e Alos-2 and so does the new methodology of rapid mapping using UAVs. 31 participants are funded by APN from Bangladesh, China, Hongkong-china, India, Indonesia, Japan, Kenya, Lao, Malaysia, Nepal, Philippines, Singapore, Switzerland, Thailand, Vietnam, Uzbekistan and Iran. The last two countries' participants did not show up. The participants from Switzerland, Singapore, and Japan were leading scientist that shared their knowledge and technology to others. The result of the workshops and ACRS 2013 will improve the scientific and technical capabilities for early careers or scientists in regional Asia Pacific Countries and increasing the awareness on global change issues to achieve world sustainable environment and livelihood.

<u>List of Participants</u>

1 **Mr.Anugrag Aeron**

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PT Smart Tbk

43 **FX Prastya Juniarta**

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55 **Mr.Muh.Evri**

Agency for the Assessment and Application of Technology

56 **Mr.Asep Darmawan**

Indonesian Society For Remote Sensing

Agenda

WORKSHOP The Implementation Of Multi Sensors Remote Sensing Technology For Sustainable Disaster Management
20 - 21 October 2013 - Discovery Kartika Plaza Hotel, Bali – Indonesia

Sunday, 20 October 2013
Arjuna Room, Discovery Kartika Plaza Hotel - Bali

Time	Program	Person in Charge
08.00 - 09.00	Registration	Committee
09.00 - 09.10	Opening The workshop	Dr. Dewayany Sutrisno
09.10 - 09.40	Sharing Knowledge	Dr. Dewayany Sutrisno
09.40 - 10.00	Coffee break	Committee
10.00 - 11.00	Introduction of Japanese new earth observing satellite "ALOS-2". management	Dr. Ryoichi Furuta**)
11.00 - 12.00	Utilization for management of global change	Dr. Ryoichi Furuta**)
12.00 - 13.00	Lunch	Committee
13.00 - 15.00	Utilization for management of disaster due to climate change	Dr. Ryoichi Furuta**)
15.00 - 15.15	Coffee break	
15.15 - 16.15	Fundamental-1: Data acquisition in Photogrammetry – concepts and systems Satellite, standard aerial, UAV and terrestrial approaches	Prof.Armyn Gruen
16.15 - 17.30	Fundamental-2: The photogrammetric data processing pipeline Real-time, on-line and off-line processing Emphasis is on the processing of UAV images	Prof.Armyn Gruen

WORKSHOP The Implementation Of Multi Sensors Remote Sensing Technology For Sustainable Disaster Management
20 - 21 October 2013 - Discovery Kartika Plaza Hotel, Bali – Indonesia

Monday, 21 October 2013
Arjuna Room, Discovery Kartika Plaza Hotel - Bali

Time	Program	Person in Charge
09.00 – 12.00	Attending The opening Ceremony of ACRS 2013 and keynote speeches from international experts	Committee
12.00 – 13.00	Lunch	Committee
13.00 - 16.00	Technical training Of high Resolution images: Automated triangulation, DSM generation, Ortho-image generation	Rongjun Qin
16.00 - 17.00	Panel discussion	Prof.Armyn Gruen / qin
17.00 - 18.00	Participants closing note	Dr. Dewayany Sutrisno

Wednesday, 23 October 2013
Kintamani, Bangli Regency

09.00 - 16.00	Field Work and Technical excursion - Welcome performance - visit the Mount Batur volcanology museum - site visit to "Mount Batur" - Local culture knowledge	Committee Committee Committee Committee Committee

Funding sources outside the APN

Organization	*Type of support*	*Amount*
Indonesian Society For Remote Sensing	○ Material & method tutorial, ○ workshop equipment, ○ 2nd day venue, meals and coffee break, ○ technical & administrative assistance, ○ workshop goodies bags ○ dinner ○ Funded participants	*USD 19,800*
ETH_ Singapore & Zuriech	data, software, tools, technology and tutorial	
Restec-Japan	data, technology, method, tutorial and in kind of workshops' venue	

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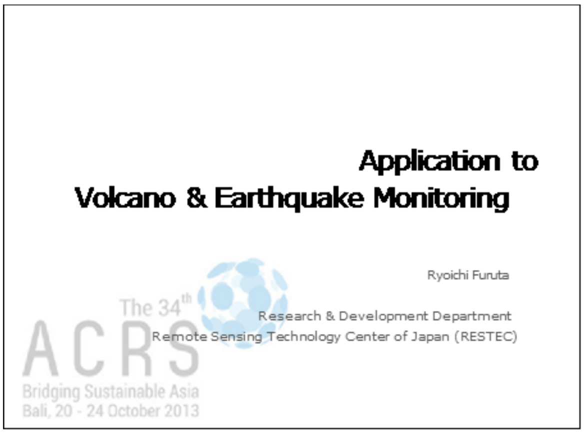
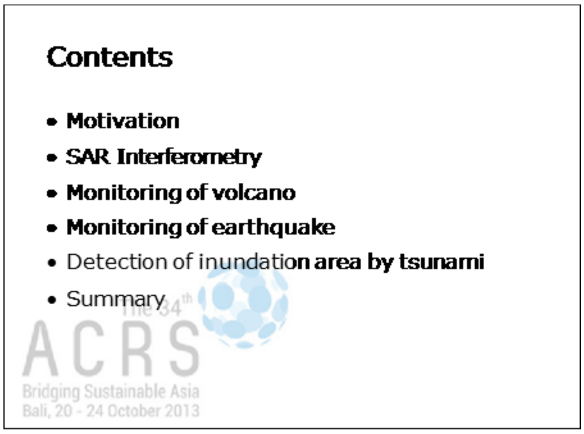
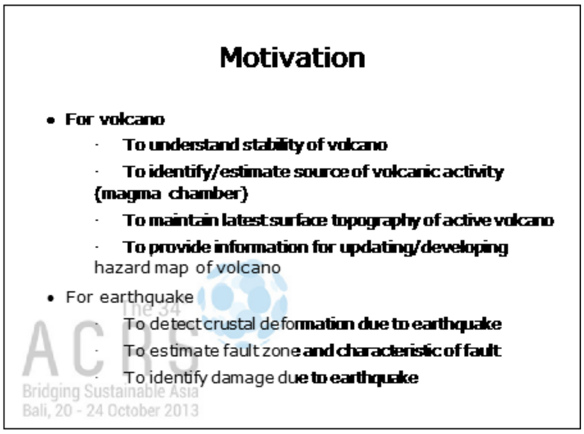
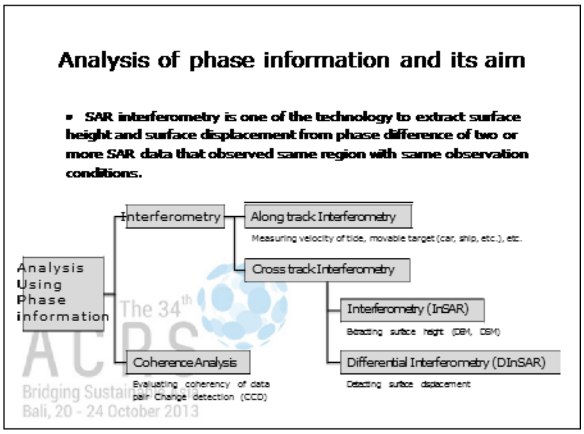
Presentation

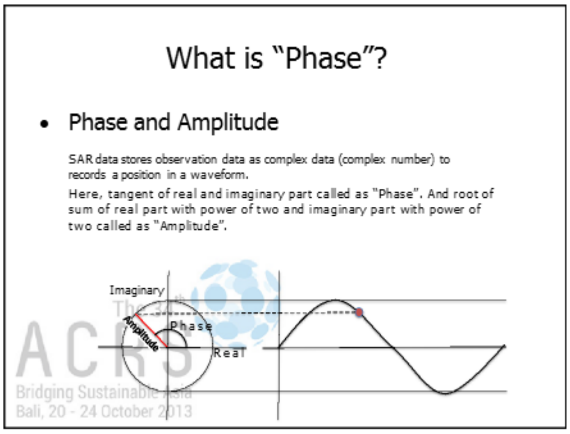
a. Japanese new earth observing satellite "ALOS-2": Dr. Ryoichi Furuta

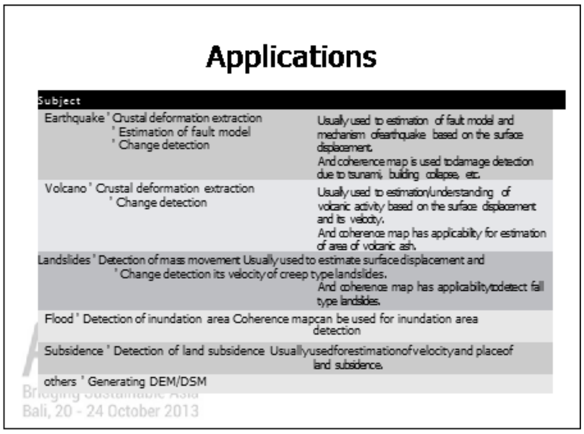


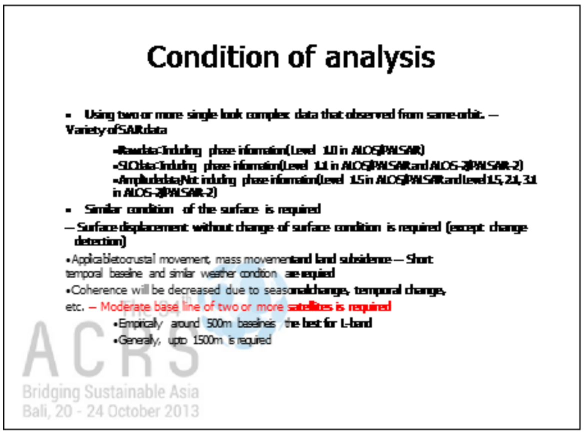







What is "Phase"?
Phase and Amplitude
SAR data stores observation data as complex data (complex number) to records a position in a waveform.
Here, tangent of real and imaginary part called as "Phase". And root of sum of real part with power of two and imaginary part with power of two called as "Amplitude".
Imaginary
Phase
Amplitude
Real
Bridging Sustainable Asia
Bali, 20 - 24 October 2013


Applications
Subject
Earthquake ' Crustal deformation extraction ' Estimation of fault model ' Change detection
Usually used to estimation of fault model and mechanism of earthquake based on the surface displacement.
And coherence map is used to damage detection due to tsunami, building collapse, etc.
Volcano ' Crustal deformation extraction ' Change detection
Usually used to estimation/understanding of volcanic activity based on the surface displacement and its velocity.
And coherence map has applicability for estimation of area of volcanic ash.
Landslides ' Detection of mass movement ' Change detection
Usually used to estimate surface displacement and its velocity of creep type landslides.
And coherence map has applicability to detect fall type landslides.
Flood ' Detection of inundation area
Coherence map can be used for inundation area detection
Subsidence ' Detection of land subsidence
Usually used for estimation of velocity and place of land subsidence.
others ' Generating DEM/DSM
Bali, 20 - 24 October 2013


Condition of analysis
Using two or more single look complex data that observed from same orbit. – Variety of SAR data
Raw data: Including phase information (Level 1.0 in ALOS/PALSAR)
SLC data: Including phase information (Level 1.1 in ALOS/PALSAR and ALOS-2/PALSAR-2)
Amplitude data: Not including phase information (Level 1.5 in ALOS/PALSAR and Level 1.5, 2.1, 3.1 in ALOS-2/PALSAR-2)
Similar condition of the surface is required
– Surface displacement without change of surface condition is required (except change detection)
Applicable to crustal movement, mass movement and land subsidence – Short temporal baseline and similar weather condition are required
Coherence will be decreased due to seasonal change, temporal change, etc. – Moderate base line of two or more satellites is required
Empirically around 500m baselines the best for L-band
Generally, up to 1500m is required
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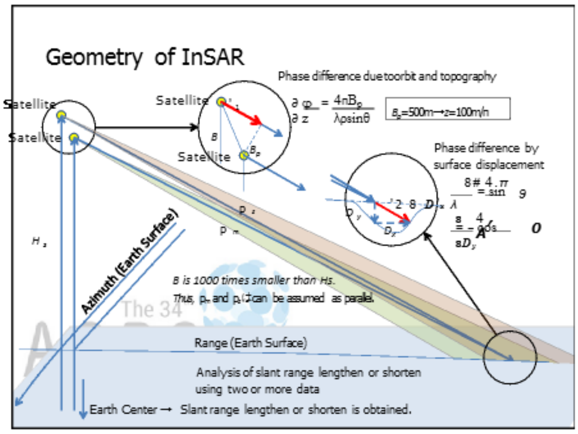
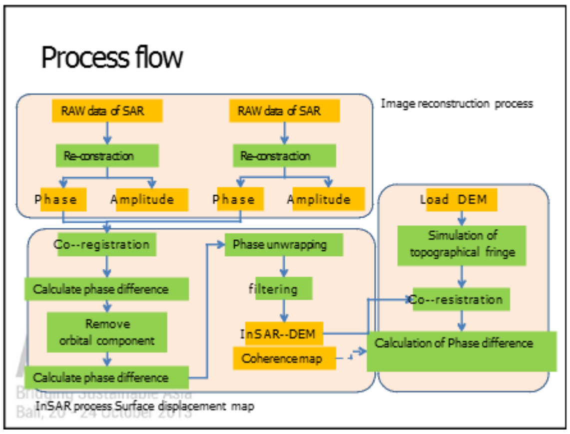
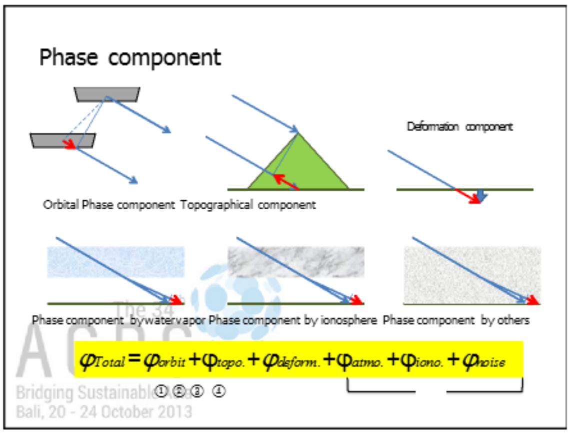

Geometry of InSAR
Phase difference due to orbit and topography
Satellite
Satellite
Satellite
Satellite
Phase difference by surface displacement
Azimuth (Earth Surface)
B is 1000 times smaller than Hs.
Thus, ρ_1 and ρ_2 can be assumed as parallel.
Range (Earth Surface)
Analysis of slant range lengthen or shorten using two or more data
Earth Center → Slant range lengthen or shorten is obtained.


Process flow
RAW data of SAR
RAW data of SAR
Image reconstruction process
Re-constraction
Re-constraction
Phase
Amplitude
Phase
Amplitude
Load DEM
Co-registration
Phase unwrapping
Simulation of topographical fringe
Calculate phase difference
filtering
Co-resistration
Remove orbital component
InSAR-DEM
Coherence map
Calculation of Phase difference
Calculate phase difference
InSAR process Surface displacement map


Phase component
Deformation component
Orbital Phase component
Topographical component
Phase component by water vapor
Phase component by ionosphere
Phase component by others
$\varphi_{Total} = \varphi_{orbit} + \varphi_{topo.} + \varphi_{deform.} + \varphi_{atmo.} + \varphi_{iono.} + \varphi_{noise}$
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Each component and its equations

Total phase component

Orbital fringe

$$\frac{d\varphi}{d\rho} = \frac{4\pi}{\lambda}\frac{B_p}{\rho_1 \tan\theta}$$

Deformation fringe (Horizontal)

$$\frac{\partial\varphi}{\partial D_x} = \frac{4\pi}{\lambda}\sin\theta$$

$$d\phi = \frac{\partial\varphi}{\partial\rho}d\rho + \frac{\partial\varphi}{\partial z}dz + \frac{\partial\varphi}{\partial D_x}dD_x + \frac{\partial\varphi}{\partial D_z}dD_z$$

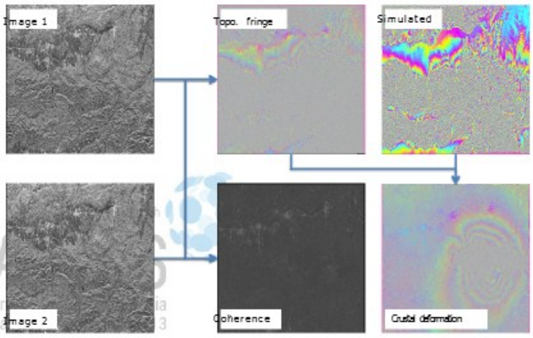
$$\frac{\partial\varphi}{\partial z} = \frac{4\pi}{\lambda}\frac{B_p}{\rho \sin\theta}$$

Topographical fringe

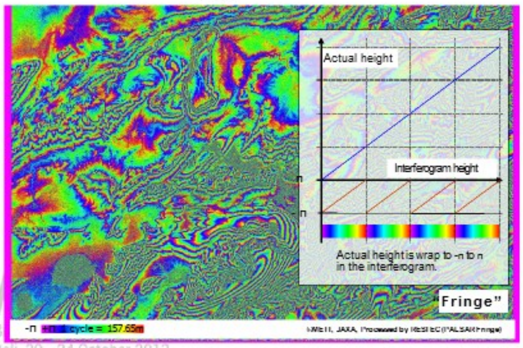
$$\frac{\partial\varphi}{\partial D_z} = \frac{4\pi}{\lambda}\cos\theta$$

Deformation fringe (Vertical)

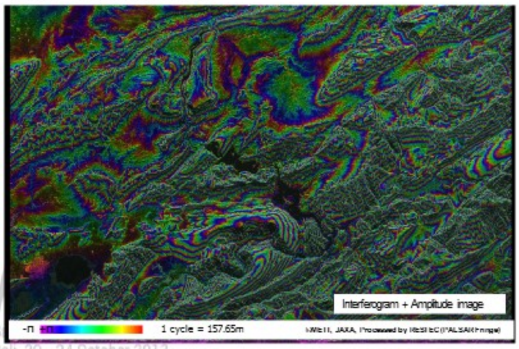
Schematic diagram



Result of InSAR (1)



Result of InSAR (2)



Effective use of coherence map

Coherence map is index of similarity of two or more observation data. Availability of InSAR analysis.

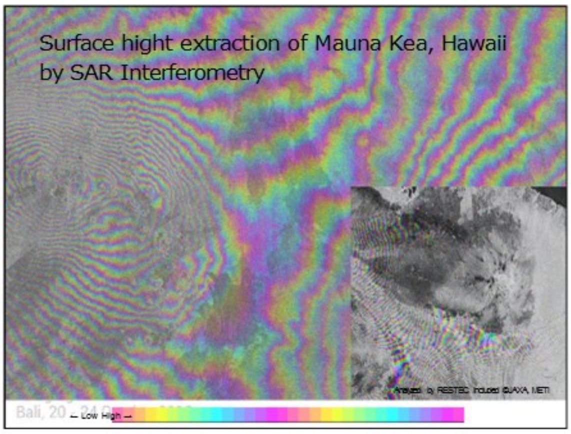
$$\gamma = \frac{E(c_1 c_2^*)}{[\ldots]^{1/2}}$$

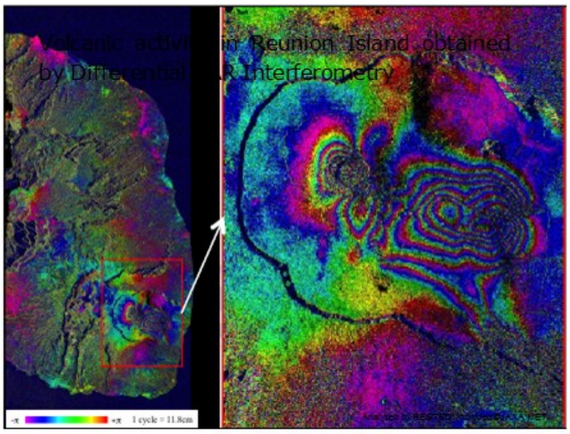
C1, C2 : SLC data of Master and Slave
* : Complex conjugate

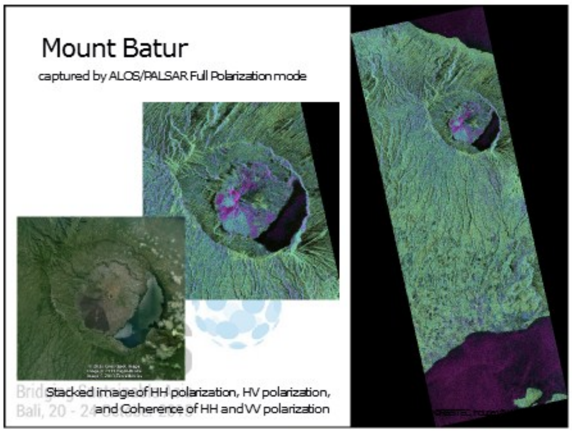
0 1

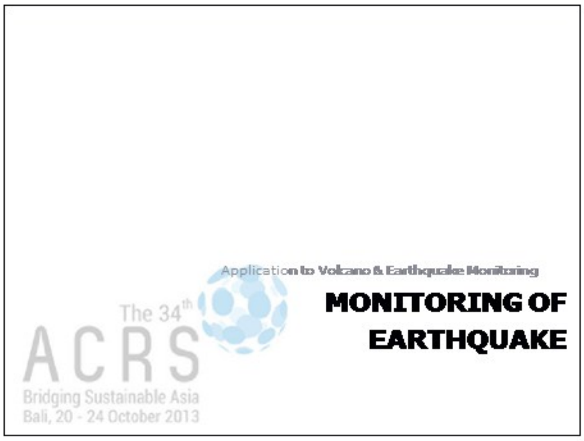
Application to Volcano & Earthquake Monitoring

MONITORING OF VOLCANO


Surface hight extraction of Mauna Kea, Hawaii
by SAR Interferometry
← Low High →


Volcanic activity in Reunion Island obtained
by Differential SAR Interferometry
1 cycle = 11.8cm


Mount Batur
captured by ALOS/PALSAR Full Polarization mode
Stacked image of HH polarization, HV polarization,
and Coherence of HH and VV polarization


Application to Volcano & Earthquake Monitoring
MONITORING OF
EARTHQUAKE
The 34th
ACRS
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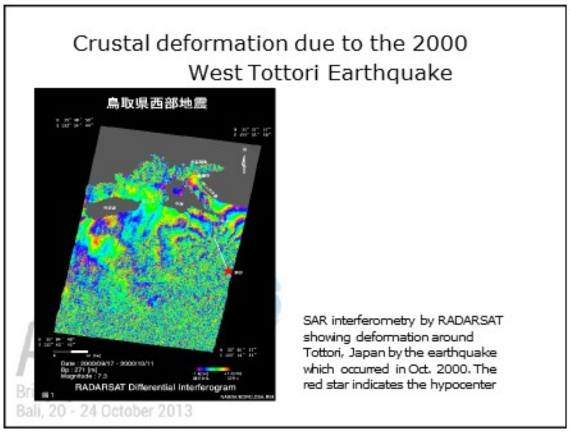
Crustal deformation due to the 2000
West Tottori Earthquake
鳥取県西部地震
RADARSAT Differential Interferogram
SAR interferometry by RADARSAT
showing deformation around
Tottori, Japan by the earthquake
which occurred in Oct. 2000. The
red star indicates the hypocenter
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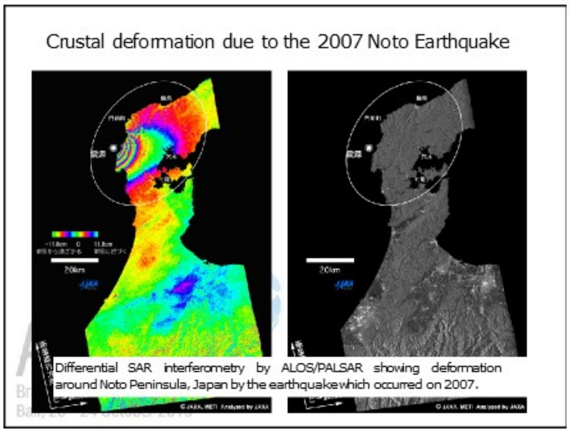
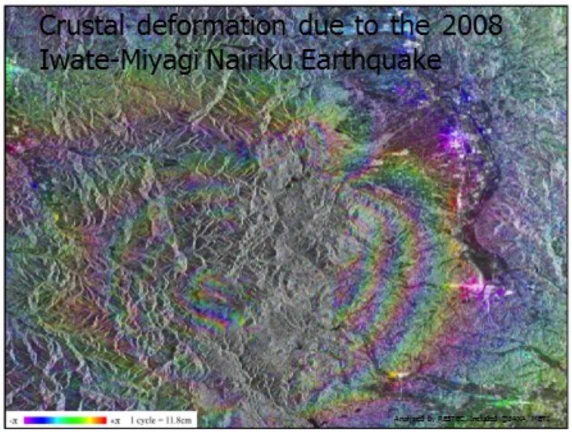
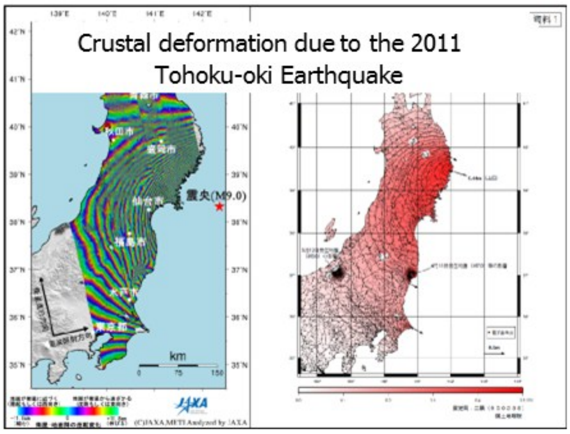

Crustal deformation due to the 2007 Noto Earthquake
20km
Differential SAR interferometry by ALOS/PALSAR showing deformation
around Noto Peninsula, Japan by the earthquake which occurred on 2007.





Application to Volcano & Earthquake Monitoring

DETECTION OF INUNDATION AREA BY TSUNAMI

A new approach for inundation area estimation

- **Combination use of Hyper-Spectral Sensor and Synthetic Aperture Radar**
  - To understand right threshold of water body of SAR
  - To use high classification capacity of hyper-spectral sensor
- **SAR imagery has classified based on the analysis of Hyper-Spectral imagery**
- Proposed method has **availability of improvement** of SAR image classification **accuracy**

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Analytical condition

- **Satellite and Sensor**
  - ALOS/PALSAR FBS
  - EO-1/Hyperion (220ch, 30m resolution)
- **Observation date**
  - ALOS/PALSAR: 2011/03/13 – EO-1/Hyperion: 2011/03/13

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Methodology

- Classification by EO-1/Hyperion data
  - Remove deficit and noisy bands from original data
  - Make AOI for analysis
  - Apply principal component analysis (PCA)
  - Classification
    - 20 classes classified using 5th order principal component
- Comparison with NRCS of SAR imagery
- SAR image classification

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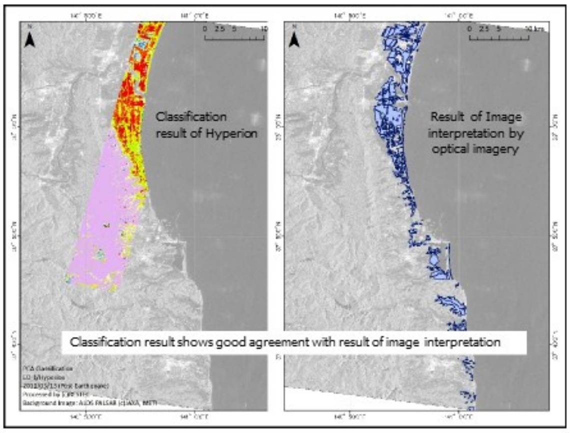


Relationship of class derived from Hyperion and NRCS of PALSAR

Hyperion_CLASS	PALSAR_MIN	PALSAR_MAX	PALSAR_MEAN	PALSAR_MAJORITY	PALSAR_MINORITY	PALSAR_MEDIAN
1	-21.311	11.648	-12.261	-13.078	-21.311	-12.558
2	-21.113	13.329	-11.0702	-12.252	-21.113	-11.658
5	-19.653	13.329	-8.84963	-11.483	-19.653	-9.603
18	-19.092	13.329	-8.58539	-10.813	-18.486	-9.4
8	-19.568	13.329	-6.06959	-9.863	-19.568	-6.603
9	-19.377	13.329	-8.13742	-9.661	-19.377	-8.686
15	-16.912	13.276	-6.88887	-7.066	-16.912	-7.335
7	-19.234	13.329	-6.6029	-6.611	-19.234	-7.279
6	-18.779	13.329	-6.0044	-5.987	-18.779	-6.619

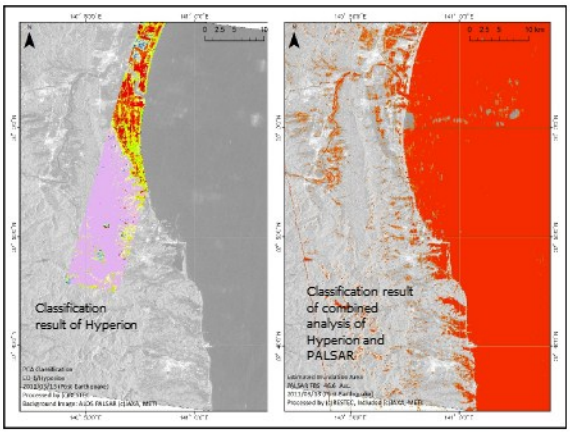
Threshold has obtained from average of majority of neighborclass

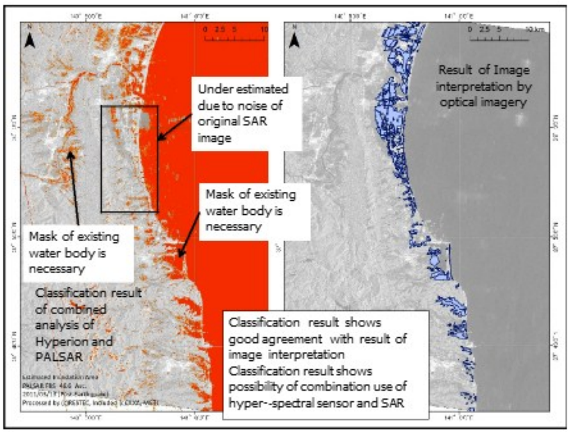
Class1 : --12.6650 dB
Class2 : --11.8675 dB
Class3 : --11.1480 dB
Class4 : --10.3380 dB
Class5 : -- 9.7620 dB
Class6 : -- 8.3635 dB
Class7 : -- 6.8385 dB
Class8 : - 6.2990 dB

Inundation area

Not inundation area

Apply to PALSAR image observed on 13 March 2011





Application to Volcano & Earthquake Monitoring

SUMMARY

SAR is one of the powerful tool for monitoring volcano and earthquake

- **Interferometry and Differential SAR interferometry provides surface height information and its changes due to volcanic activity or earthquake**
- **Crustal deformation of historical earthquake in Japan was obtained by DInSAR analysis**
- **ALOS-2/PALSAR-2 increased opportunity of InSAR by precise orbit control for InSAR application**
- Behavior of earth crust will **be obtained more clearly**
- A new approach, combined **analysis of Hyperion and ALOS/** PALSAR, shows expectable res**ult for combination use of ALOS-**-2 and ALOS--3.

Applica'on to Flood Monitoring

Ryoichi Furuta

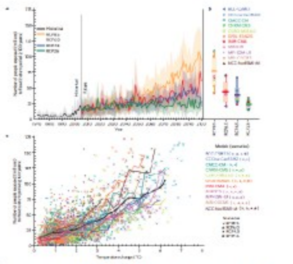
Research & Development Department
Remote Sensing Technology Center of Japan (RESTEC)

Contents

Applica'on to Flood Monitoring

MOTIVATION

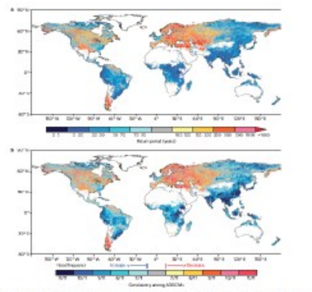
Flood event (1)



- Flood is the common disaster in the world.
- Number of people exposed to flood increased in the future is es'mated.
- Number of people exposed to flood increased by global warming is es'mated.

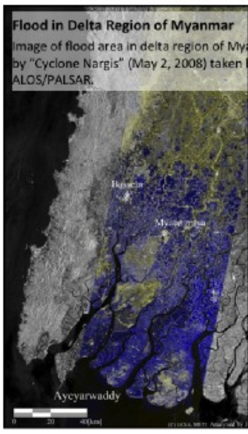
Source: Yukiko Hirabayashi et al., Global flood risk under climate change, Nature Climate Change, Published online 9 June 2013.

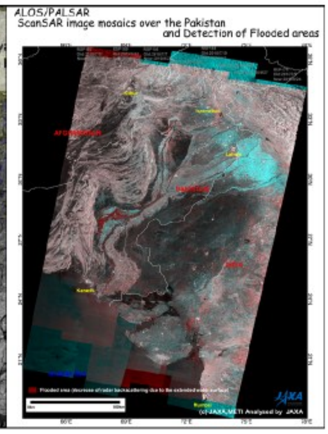
Flood event (2)

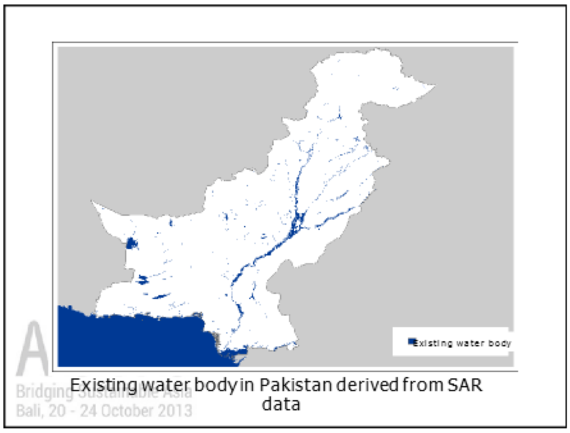


- Increasing of flood event in Eurasia, south America and central Africa is es'mated.
- Broad area and effec've monitoring system is needed.

Source: Yukiko Hirabayashi et al., Global flood risk under climate change, Nature Climate Change, Published online 9 June 2013.






Existing water body
Existing water body in Pakistan derived from SAR data
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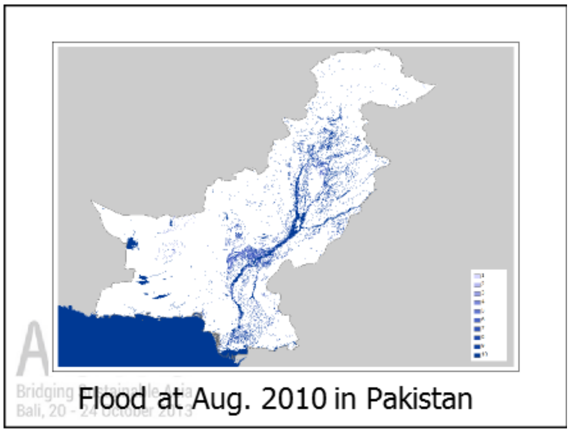
Flood at Aug. 2010 in Pakistan
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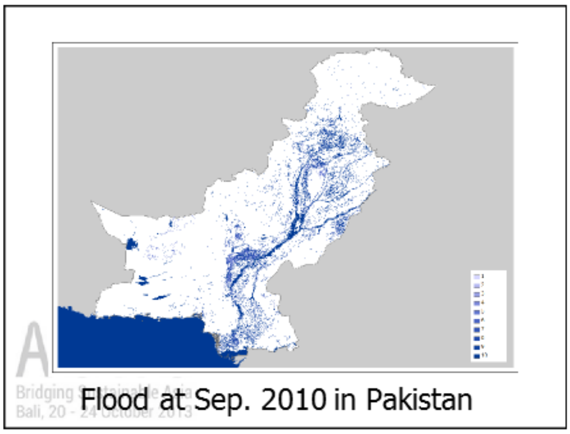
Flood at Sep. 2010 in Pakistan
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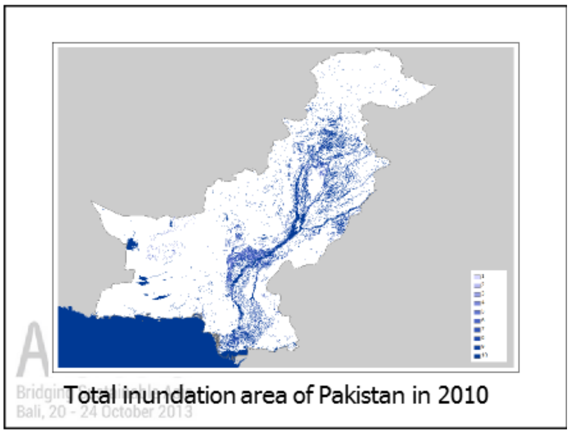
Total inundation area of Pakistan in 2010
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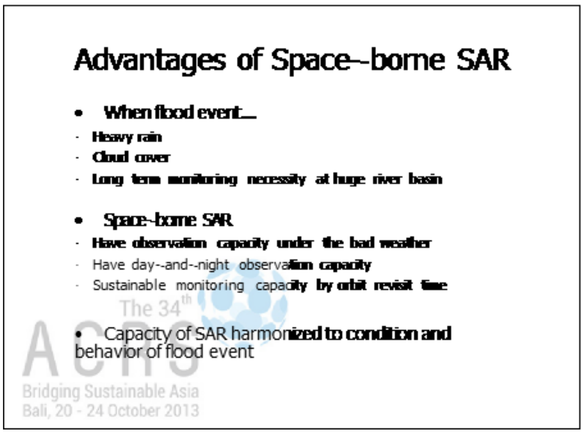
Advantages of Space--borne SAR
• When flood event…
- Heavy rain
- Cloud cover
- Long term monitoring necessity at huge river basin
• Space-borne SAR
- Have observation capacity under the bad weather
- Have day--and--night observation capacity
- Sustainable monitoring capacity by orbit revisit time
• Capacity of SAR harmonized to condition and behavior of flood event
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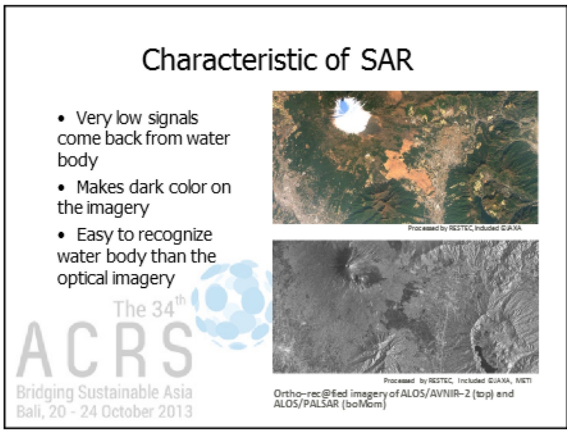
Characteristic of SAR
• Very low signals come back from water body
• Makes dark color on the imagery
• Easy to recognize water body than the optical imagery
Processed by RESTEC, Included ©JAXA
Processed by RESTEC, Included ©JAXA, METI
Ortho-rectified imagery of ALOS/AVNIR-2 (top) and ALOS/PALSAR (bottom)
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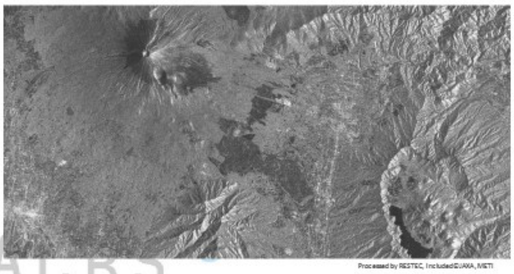
Application to Flood Monitoring

DETECTION OF WATER BODY FROM SAR IMAGERY

Shade of SAR imagery (1)



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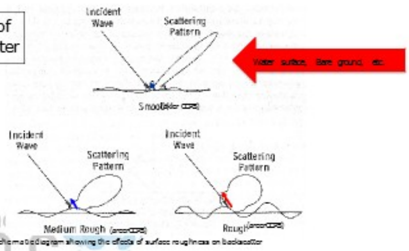
Shade of SAR imagery (2)

Mechanism of surface scatter

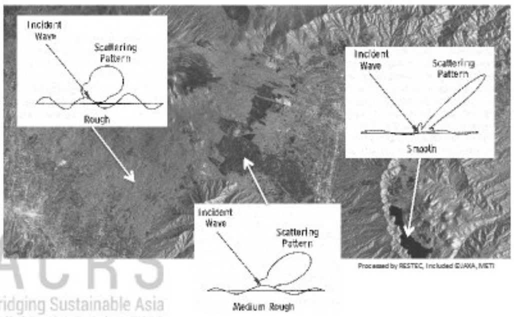


Rayleigh criterion

Smooth: h > λ/ 8 cosθ
Rough : h < λ/ 8 cosθ

(h : the mean height of surface variations λ: the radar wavelength θ: the incidence angle)

Shade of SAR imagery (3)



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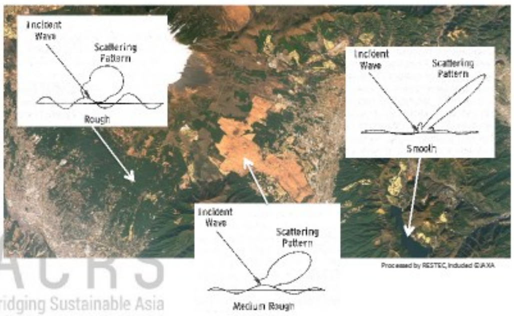
Shade of SAR imagery (3)



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Principle for Flooded Area Detection

- Physical basis for flooded area detection

	Flooding	
	Non--flooded	Flooded
Land cover	Non-water surface	Water Surface
Roughness	Rough	Smooth
Scattering type	Diffused	Specular
Backscatter	High	Low

- Therefore SAR backscattering intensity generally changes to be lower according to the land cover change from non--water surface to water surface by flooding.

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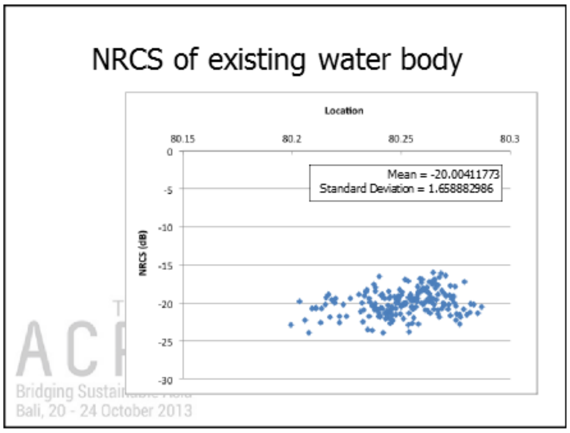

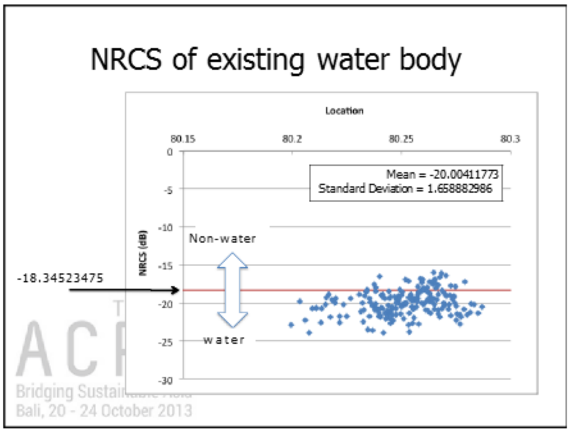

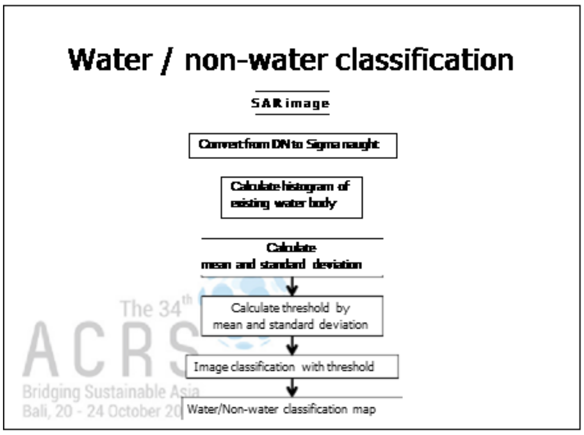

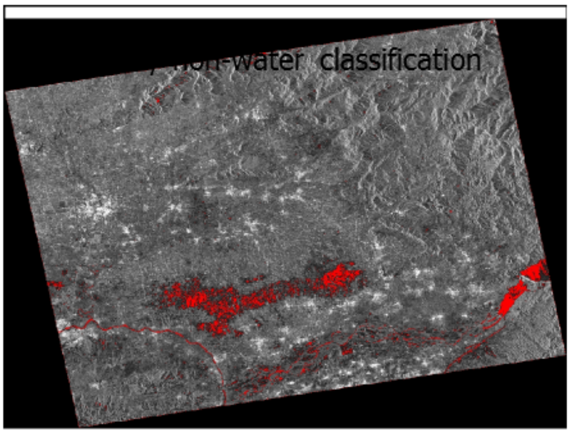

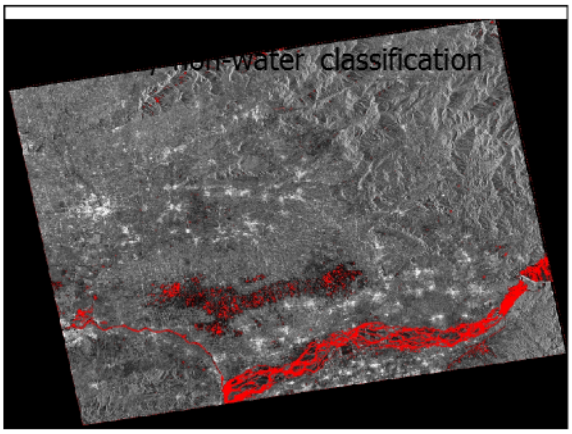

Problems and solutions

Problem	Solution
Radar shadow shows similar back scatter value of water body	Correct (Mask out) by slope of Digital Elevation Model (DEM) Subtracting before and after images
Desert shows similar back scatter value of water body	Correct (Mask out) by land use land cover classification map derived from other sources Subtracting before and after images
Flat building roof shows similar back scatter value of water body	Correct (Mask out) by digital map or overlay digital map Subtracting before and after images
Road shows similar back scatter value of water body	Correcting is difficult. Overlay digital map.
Bare ground shows similar back scatter value of water body	Correct (Mask out) by digital map Subtracting before and after images
Paddy field and farm land shows similar back scatter value of water body at before planting or planting stage	Correct (Mask out) by digital map Subtracting before and after images

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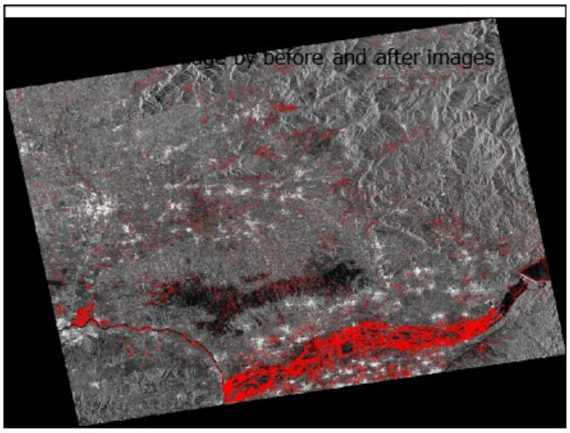
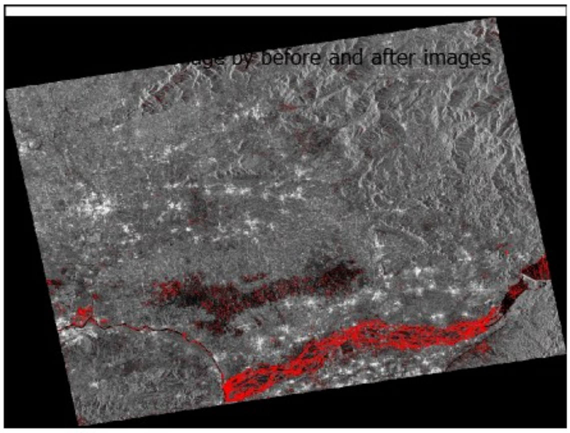
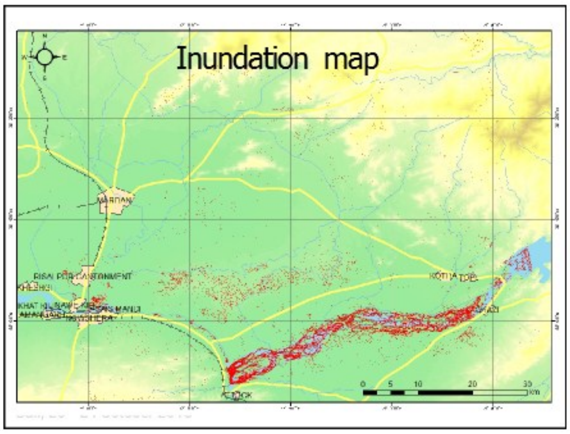

by before and after images


by before and after images


Inundation map
MARDAN
RISAL PUR CANTONMENT
KOTLA
NOWSHERA
0 5 10 20 30


Application to Flood Monitoring
CASE STUDY OF
DEVELOPMENT OF RIVER MONITORING SYSTEM
IN MEKONG RIVER
The 34th
ACRS
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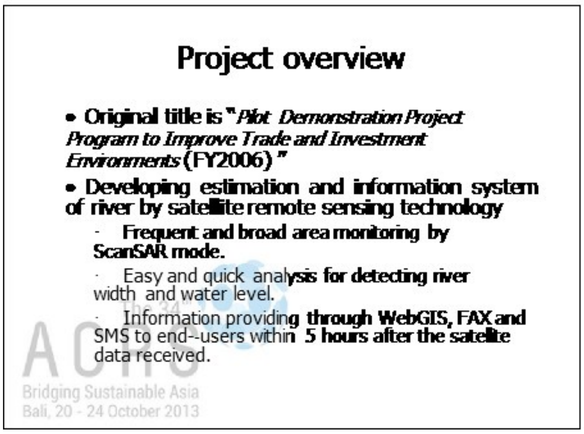
Project overview
• Original title is "Pilot Demonstration Project Program to Improve Trade and Investment Environments (FY2006)"
• Developing estimation and information system of river by satellite remote sensing technology
- Frequent and broad area monitoring by ScanSAR mode.
- Easy and quick analysis for detecting river width and water level.
- Information providing through WebGIS, FAX and SMS to end--users within 5 hours after the satellite data received.
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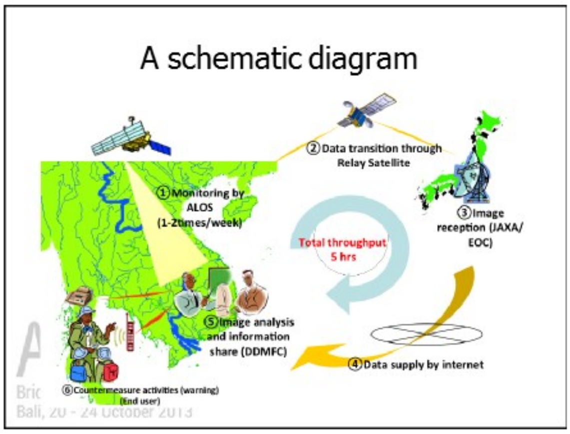
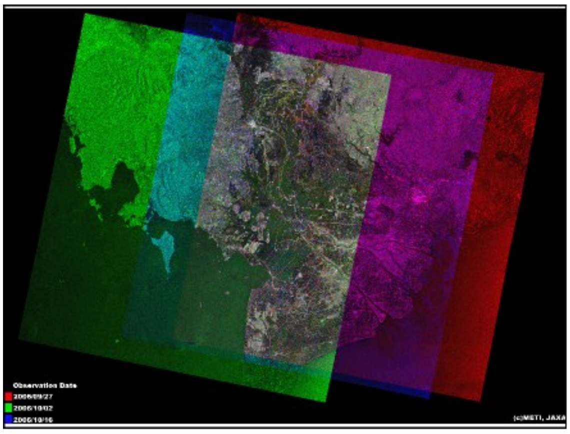
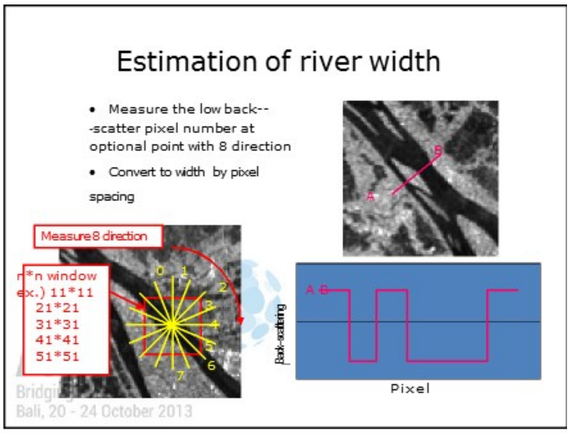
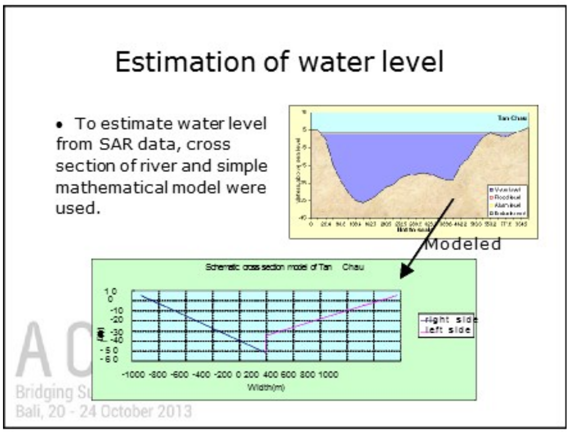
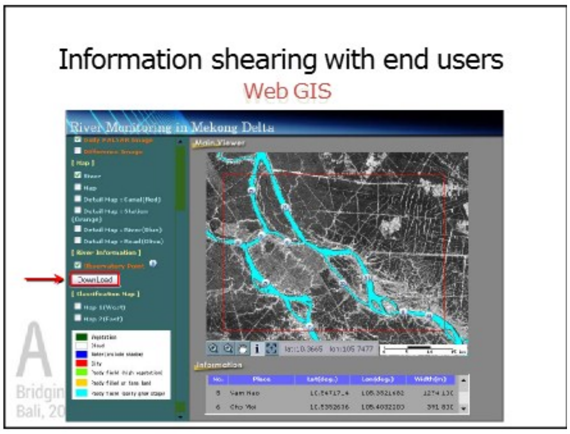
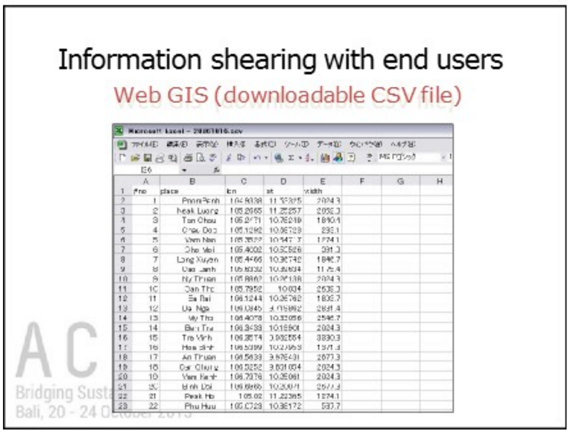

A schematic diagram
②Data transition through Relay Satellite
①Monitoring by ALOS (1-2times/week)
③Image reception (JAXA/ EOC)
Total throughput 5 hrs
⑤Image analysis and information share (DDMFC)
④Data supply by internet
⑥Countermeasure activities (warning) (End user)

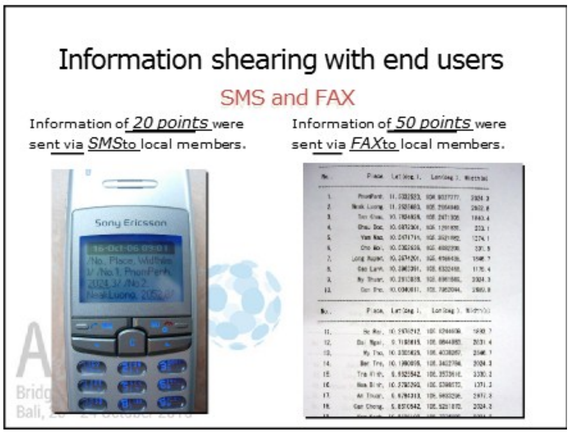

Observation Date
2006/09/27
2006/10/02
2006/10/16
(c)METI, JAXA


Estimation of river width
• Measure the low back--
-scatter pixel number at
optional point with 8 direction
• Convert to width by pixel
spacing
Measure 8 direction
n*n window
ex.) 11*11
21*21
31*31
41*41
51*51
Back-scattering
Pixel
Bali, 20 - 24 October 2013

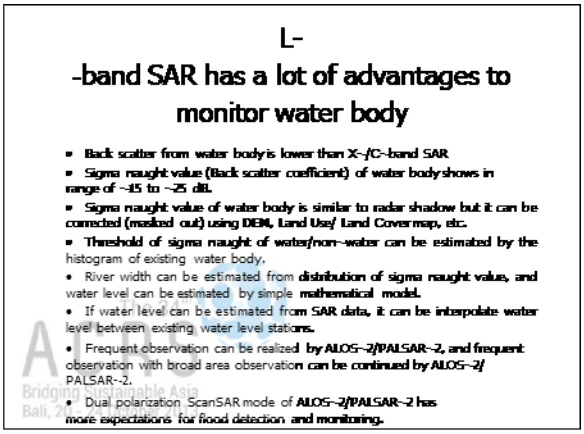

Estimation of water level
• To estimate water level from SAR data, cross section of river and simple mathematical model were used.
Tan Chau
Modeled
Schematic cross section model of Tan Chau
Right side
Left side
-1000 -800 -600 -400 -200 0 200 400 600 800 1000
Width(m)
Bridging Su
Bali, 20 - 24 October 2013


Information shearing with end users
Web GIS
River Monitoring in Mekong Delta
Main Viewer
Download
Information


Information shearing with end users
Web GIS (downloadable CSV file)
Bridging Sust
Bali, 20 - 24 October 2013


Information shearing with end users
SMS and FAX
Information of 20 points were sent via SMS to local members.
Information of 50 points were sent via FAX to local members.
Sony Ericsson


Application to Flood Monitoring
SUMMARY
The 34th
ACRS
Bridging Sustainable Asia
Bali, 20 - 24 October 2013


L-
-band SAR has a lot of advantages to monitor water body
Back scatter from water body is lower than X-/C-band SAR
Sigma naught value (Back scatter coefficient) of water body shows in range of -15 to -25 dB.
Sigma naught value of water body is similar to radar shadow but it can be corrected (masked out) using DEM, Land Use/ Land Cover map, etc.
Threshold of sigma naught of water/non-water can be estimated by the histogram of existing water body.
River width can be estimated from distribution of sigma naught value, and water level can be estimated by simple mathematical model.
If water level can be estimated from SAR data, it can be interpolate water level between existing water level stations.
Frequent observation can be realized by ALOS-2/PALSAR-2, and frequent observation with broad area observation can be continued by ALOS-2/ PALSAR-2.
Dual polarization ScanSAR mode of ALOS-2/PALSAR-2 has more expectations for flood detection and monitoring.

Application to Landslides Monitoring

Ryoichi Furuta

Research & Development Department
Remote Sensing Technology Center of Japan (RESTEC)

Contents

- Motivation
- SAR Interferometry
- Monitoring of mass movement
- Recognition of fall type landslides
- Recognition of both creep and fall type landslides

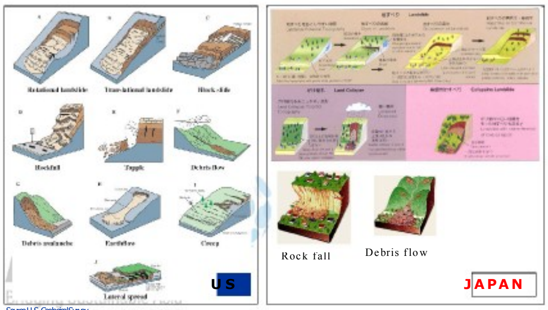
Application to Landslides Monitoring

MOTIVATION

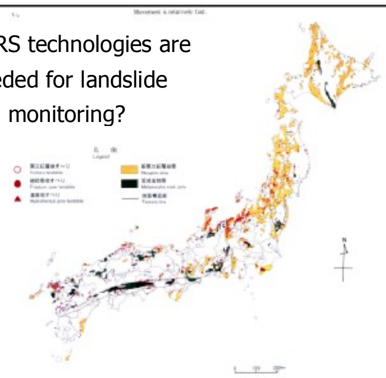
What is Landslide?

- Natural disaster due to the movement of soils or rocks
- Landslide: Debris flow, Mass movement, Mud and Rock slide, etc.
- Trigger: Earthquake, Heavy rain, Freeze-thaw, Water-logging, Erosion, Weathering, etc.
- Debris flow

Type of landslide

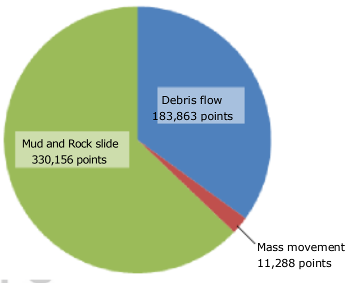


Why RS technologies are needed for landslide monitoring?



Landslide map of Japan (after Landslide of Japan, MLIT)

Number of Landslide hazard area in Japan



Necessity of consideration of landslide type when utilizing RS technology

	Creep type	Fall type
Geology	Usually it occur at the place of specified geology and geological structure	No relation to geology
Soil texture	Active at the border of clayey layer as slide surface	Sandy soil, Rock
Topography	Occurred at slope with 5~20 degrees, landslide topography	Steep slope with more than 20 degrees, top of valleys
Activity situation	Time dependency, re-activity, continuity	Low time dependency, spontaneous
Velocity of movement	Very slow velocity with 0.01~10mm/day	Very fast velocity with more than 10mm/day
Clod	Mostly, clod is undisturbed	Disturbed condition
Trigger	High relation to ground water behavior	Hard rainfall, high relation to precipitation intensity
Size	Very big, wide	Very small, narrow
Symptom (sign)	Clack, subsidence, uplift, ground water change, etc.	No symptom

By consideration of characteristic of landslide, DInSAR is the best way to monitor creep type landslide and optical and SAR imagery would be useful to monitor collapse type landslide.

Possibility of SAR data for landslide monitoring

Type of landslide	Scatter situation	Image analysis based on Intensity	DInSAR analysis
A. Rotational landslide	Change	O	△(O)
A. Translational landslide	Change	O	△
A. Rockfail	Drastically change	△	×
A. Topple	Drastically change	△(×)	×
A. Debris flow	Change	△	△
A. Debris avalanche	Change	O	△
A. Earthflow	Change a little		
A. Creep	No change	×	O
A. Lateral spread	Change	△	△

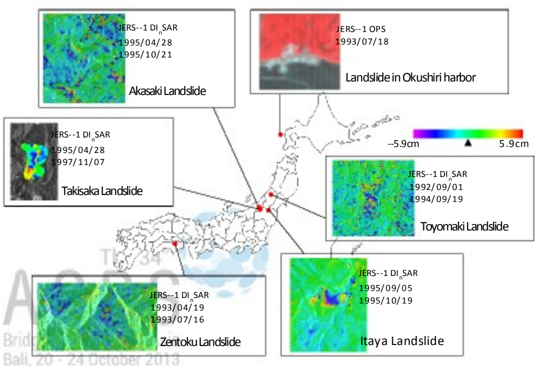
Possibility is accumulated by area of landslide.
- It is preferable that collapse width in each direction has more than 30 times of resolution.
Possibility of DInSAR depends on the surface condition and velocity of movement. - If surface condition is drastically change, DInSAR analysis cannot be applied.

Applicability of satellite remote sensing for landslide investigation

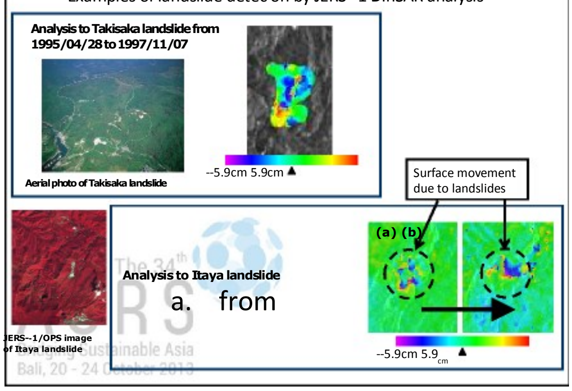
Menu of investigation	Purpose	Method	Applicability of satellite remote sensing technology
Topographic interpretation Field investigation	Find a landslide	Interpretation of aerial photo and/or topographic-map Field investigation	Image interpretation by Optical image, SAR intensity image, DEM
Landslide size estimation	Estimation of 3-D structure and size of landslide	Estimation of depth of slide surface Field investigation	Can be estimated by the result of interpretation and/or DInSAR
Boring and core-sampling	Understanding of stiffness of the ground and 3-D ground structure of landslide	Elastic wave exploration 2-D resistivity measurement	Impossible
Deformation measurement	Understanding of landslide behavior	Strain gage Borehole inclinometer Multi-layer deformation gage	Can be done by DInSAR
Sliding surface evaluation	Understanding of hazard level of landslide	Numerical analysis Hazard assessment by simple analysis	Can be done by combination use of DInSAR and numerical analysis

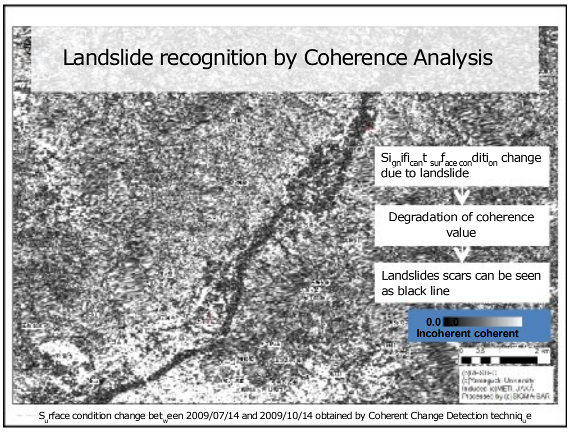
Applicability of SAR data is higher than optical data

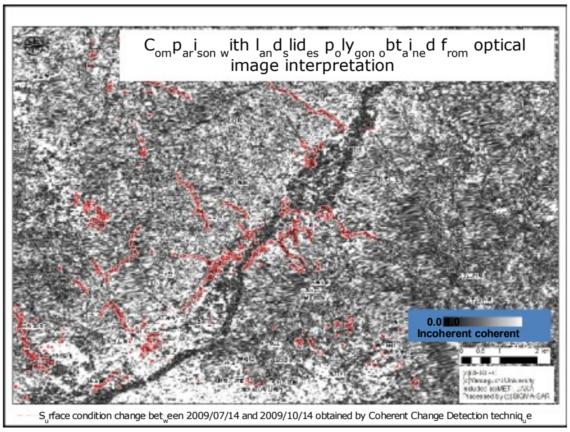
Examples of landslides detection by JERS-1 DInSAR analysis



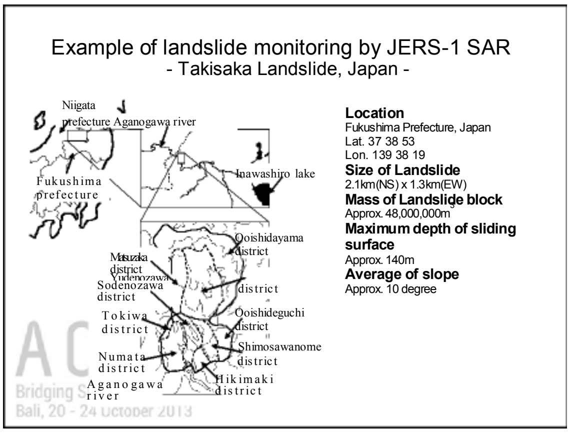
Examples of landslide detection by JERS-1 DInSAR analysis

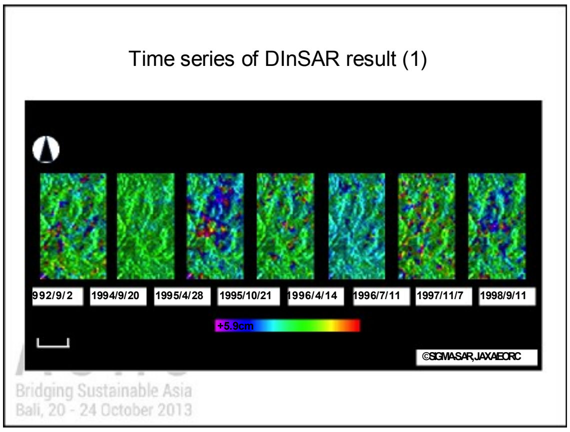


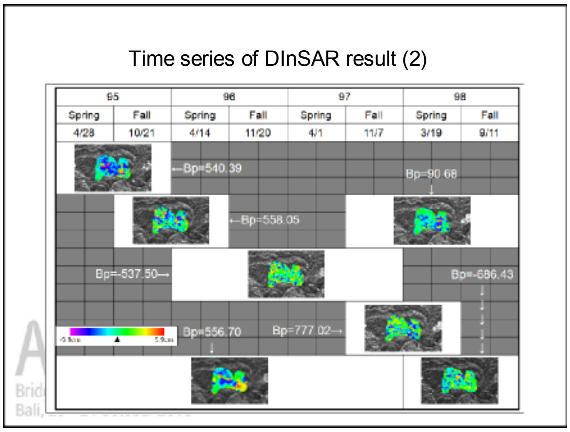

Landslide recognition by Coherence Analysis
Significant surface condition change due to landslide
Degradation of coherence value
Landslides scars can be seen as black line
0.0 1.0
Incoherent coherent
Surface condition change between 2009/07/14 and 2009/10/14 obtained by Coherent Change Detection technique


Comparison with landslides polygon obtained from optical image interpretation
0.0 1.0
Incoherent coherent
Surface condition change between 2009/07/14 and 2009/10/14 obtained by Coherent Change Detection technique

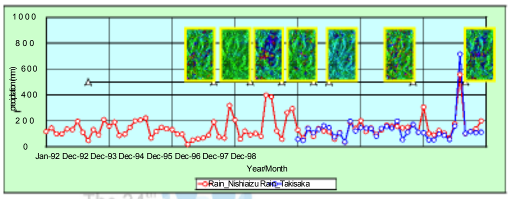

Application to Landslides Monitoring
MONITORING OF MASS MOVEMENT
The 34th ACRS
Bridging Sustainable Asia
Bali, 20 - 24 October 2013


Example of landslide monitoring by JERS-1 SAR
- Takisaka Landslide, Japan -
Niigata prefecture
Aganogawa river
Fukushima prefecture
Inawashiro lake
Ooishidayama district
Matsuzaka district
Yudenozawa district
Sodenozawa district
Tokiwa district
Ooishideguchi district
Shimosawanome district
Numata district
Aganogawa river
Hikimaki district
Location
Fukushima Prefecture, Japan
Lat. 37 38 53
Lon. 139 38 19
Size of Landslide
2.1km(NS) x 1.3km(EW)
Mass of Landslide block
Approx. 48,000,000m
Maximum depth of sliding surface
Approx. 140m
Average of slope
Approx. 10 degree


Time series of DInSAR result (1)
1992/9/2
1994/9/20
1995/4/28
1995/10/21
1996/4/14
1996/7/11
1997/11/7
1998/9/11
©SIGMASAR,JAXAEORC
Bridging Sustainable Asia
Bali, 20 - 24 October 2013

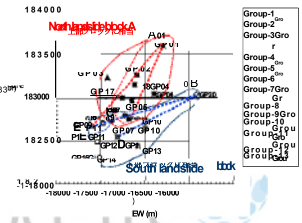

Time series of DInSAR result (2)
95
96
97
98
Spring
Fall
4/28
10/21
4/14
11/20
4/1
11/7
3/19
9/11
Bp=540.39
Bp=90.68
Bp=558.05
Bp=-537.50
Bp=-686.43
Bp=556.70
Bp=777.02

Comparison to precipitation



v Occurrence of landslide movement coincide to the term of high precipitation in this case v Precipitation as one of the reason of landslide was confirmed v More than 400mm/month precipitation as a criteria of this landslide was estimated

A challenging of hazard estimation using DInSAR result (1)



Estimation of the depth of slide surface by empirical equation (Maruyama et. al, 1994)

d=0.105+0.084×L

d:the depth of slide surface at center of landslide block (m)

L:length of landslide block (m)

Estimated slide surface depth

RMS over 0.9 between 2 points A-C : 77.92 (m)

B-D : 85.39 (m)

RMS over 0.7 between 2 points A-E : 102.66 (m)

B-E : 103.67 (m)

v Landslide blocks were estimated by DInSAR result based on the cross correlation of deformation v Estimated landslide blocks were coincide to landslide block estimated by ground survey v The depth of slide surface was estimated from DInSAR result and empirical equation v Estimated depth of slide surface at the center of landslide block was almost coincide to depth of landslide block estimated by ground survey

A challenging of hazard estimation using DInSAR result (2)

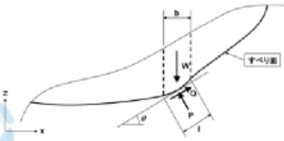
Calculation of safety factor

Moment that resist slipping

$$F_s = \frac{\sum [(W \tan\varphi + cb)/m]}{\sum W \tan\theta}$$

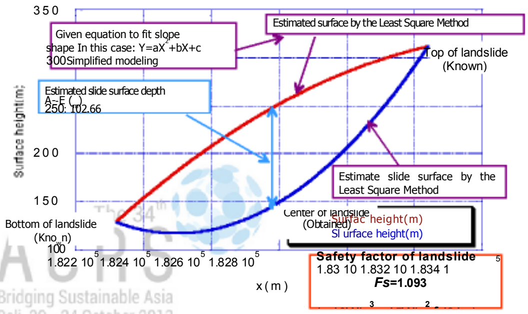
Moment that occurring slipping

$$m = \left(1 + \frac{\tan\varphi \tan\theta}{F_s}\right) \cos\theta$$



Fs<1.0: Safe, Fs≧1.0: Unsafe

A challenging of hazard estimation using DInSAR result (3)



Application to Landslides Monitoring

RECOGNITION OF FALL TYPE LANDSLIDES

Objectives

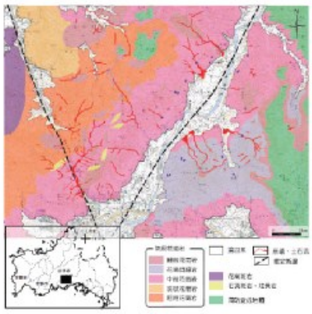
- To develop landslides recognition technique using dual/quad polarization SAR data
- To confirm best combination of polarization for application of landslides recognition
- To confirm effectiveness of use of dual/quad polarization SAR data for

Methods are use in this study

- Two kinds of method are applied to two case studies
- Polarimetric Interferometry is applied to landslide in Japan
- Difference of two topographical fringes obtained from different polarization is calculated to extract landslides.

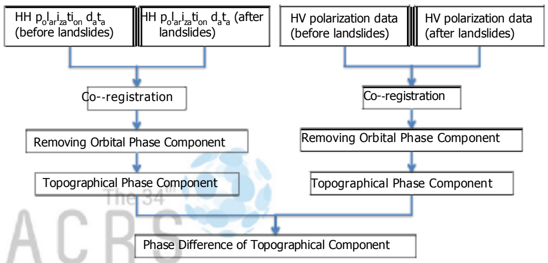
Summary of the Hofu Landslides

- Location : Hofu city, Yamaguchi Prefecture,



(H. Fukuoka et. al., 2010)

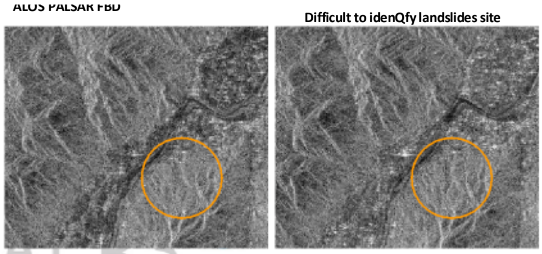
Schematic diagram of polarimetric InSAR analysis for dual polarization data



Comparison of HH polarization imagery

ALOS PALSAR FBD

Difficult to idenQfy landslides site



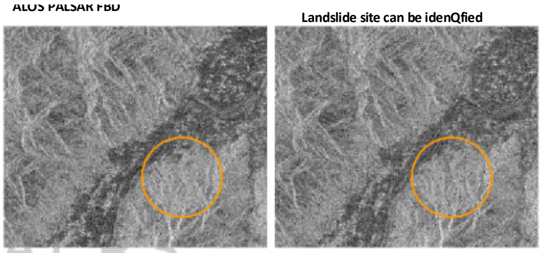
HH_2009/07/14 HH_2009/08/29

©RESTEC Included ©JAXA, METI

Comparison of HV polarization imagery

ALOS PALSAR FBD

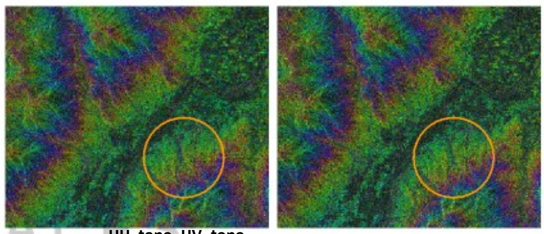
Landslide site can be idenQfied



HV_2009/07/14 HV_2009/08/29

©RESTEC Included ©JAXA, METI

Comparison of topographical fringe of HH and HV polarization

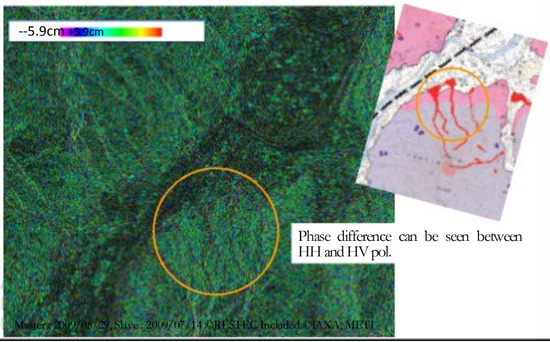


HH_topo. HV_topo.

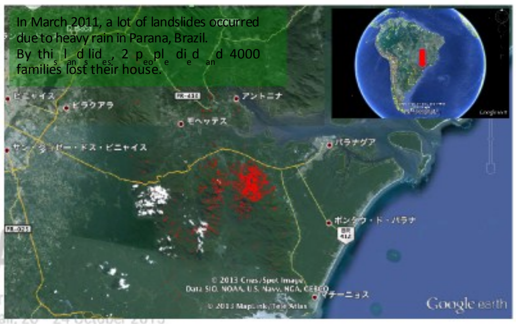
Master:2009/08/29, Slave : 2009/07/14, Bperp= approx. 325m

©RESTEC Included ©JAXA, METI

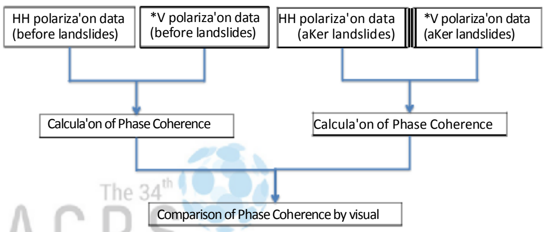
Phase difference of HH and HV polariza'on



Test site in Paranagua, Brazil

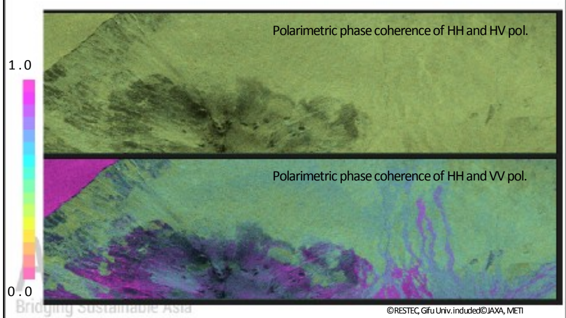


Schema'c diagram of polarimetric phase coherence analysis for quad polariza'on data



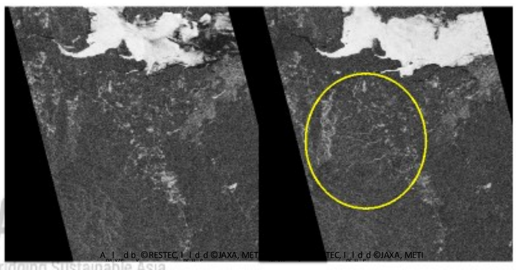
*V HV or VV polariza'on

Comparison of Polarimetric Phase Coherence with different combina'on of polariza'on

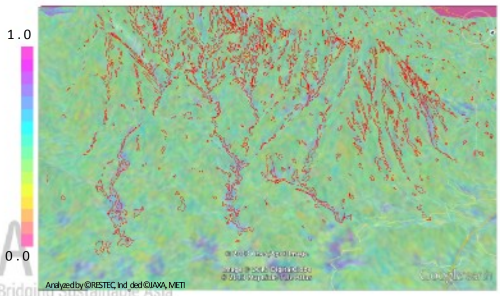


Comparison of Polarimetric Phase Coherence of before and aKer landslides

Before AKer



Compared with polygons



Application to Landslides Monitoring

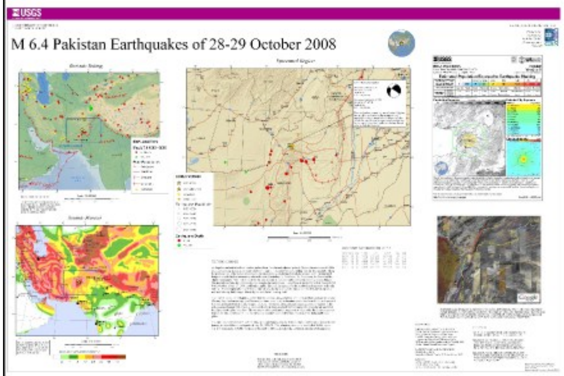
RECOGNITION OF BOTH CREEP AND FALL TYPE LANDSLIDES

The 34th ACRS Bridging Sustainable Asia Bali, 20 - 24 October 2013

Details of The 2008 Pakistan Earthquake

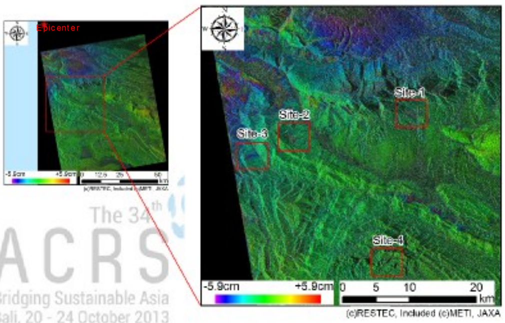
Magnitude	6.4
Date-Time	**Tuesday, October 28, 2008 at 23:09:58 UTC** Wednesday, October 29, 2008 at 04:09:58 AM at epicenter Time of Earthquake in other Time Zones
Location	30.656°N, 67.361°E
Depth	15 km (9.3 miles) set by location program
Region	PAKISTAN
Distances	60 km (35 miles) NE of **Quetta, Pakistan** 190 km (120 miles) SE of **Kandahar, Afghanistan** 195 km (120 miles) NNE of **Kalat, Pakistan** 640 km (400 miles) WSW of **ISLAMABAD, Pakistan**
Location Uncertainty	horizontal +/- 4.8 km (3.0 miles); depth fixed by location program
Parameters	NST=166, Nph=166, Dmin=459.3 km, Rmss=1.11 sec, Gp= 25°, M-type=regional moment magnitude (Mw), Version=A
Source	USGS NEIC (WDCS-D)
Event ID	us2008yscs

Source: hbp://earthquake.usgs.gov/earthquakes/recenteqsww/Quakes/us2008yscs.php



Location

Test sites for comparison of each analysis



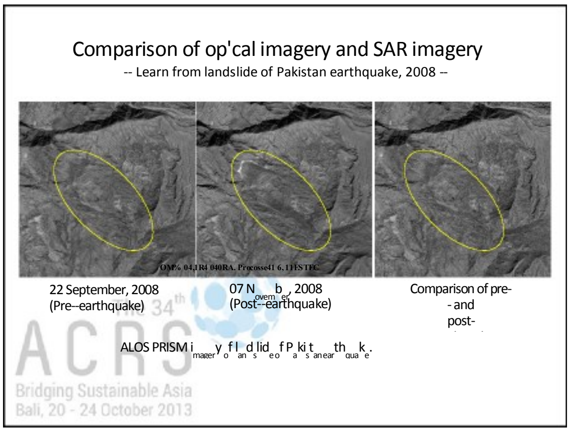
Comparison of optical imagery and SAR imagery

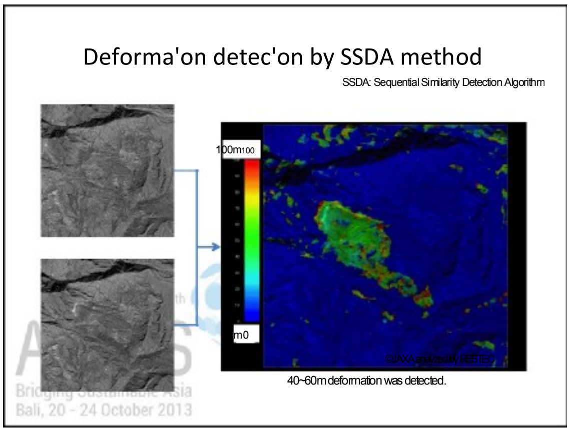
-- Learn from landslide of Pakistan earthquake, 2008 --

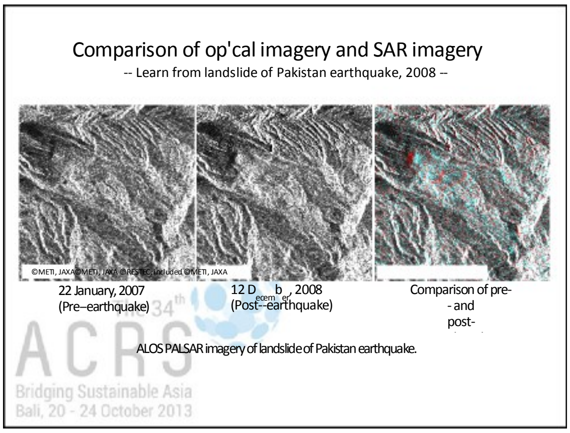
22 September, 2008 (Pre-earthquake)

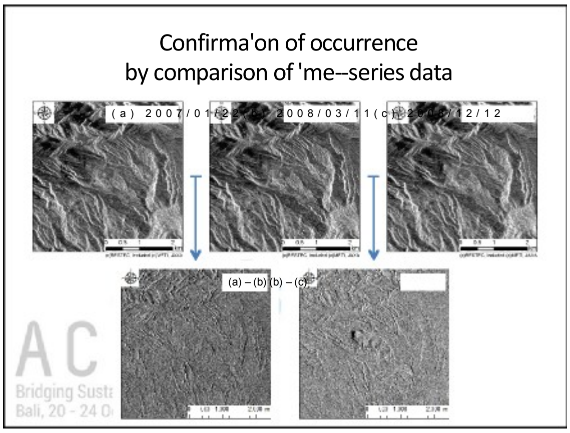
07 November, 2008 (Post-earthquake)

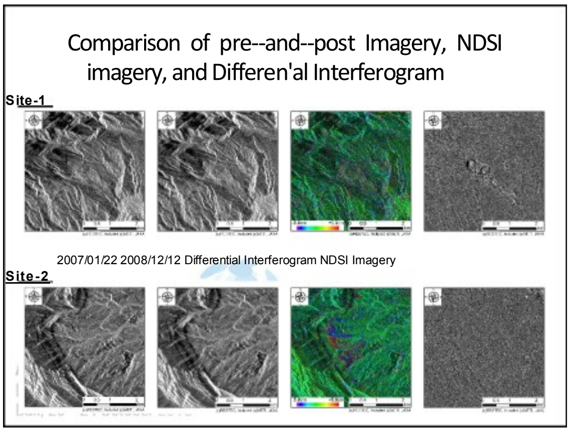
ALOS AVNIR-2 imagery of landslide of Pakistan earthquake.

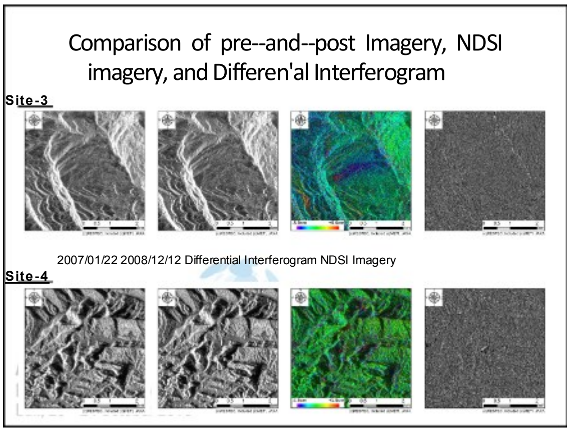

Comparison of op'cal imagery and SAR imagery
-- Learn from landslide of Pakistan earthquake, 2008 --
22 September, 2008
(Pre--earthquake)
(Post--earthquake)
Comparison of pre-
- and
post-


Deforma'on detec'on by SSDA method
SSDA: Sequential Similarity Detection Algorithm
40~60m deformation was detected.


Comparison of op'cal imagery and SAR imagery
-- Learn from landslide of Pakistan earthquake, 2008 --
22 January, 2007
(Pre--earthquake)
(Post--earthquake)
Comparison of pre-
- and
post-
ALOS PALSAR imagery of landslide of Pakistan earthquake.


Confirma'on of occurrence
by comparison of 'me--series data


Comparison of pre--and--post Imagery, NDSI
imagery, and Differen'al Interferogram
Site-1
2007/01/22 2008/12/12 Differential Interferogram NDSI Imagery
Site-2


Comparison of pre--and--post Imagery, NDSI
imagery, and Differen'al Interferogram
Site-3
2007/01/22 2008/12/12 Differential Interferogram NDSI Imagery
Site-4

Application to Landslides Monitoring

SUMMARY

To observe all type of landslides, combination of several analysis is necessary

- SAR interferometry perform to monitor creep type (very slow) landslides.
- SAR interferometry cannot be used to monitor fall type (very fast) landslides.
- Coherence analysis can be detecting fall type landslides.

b. Fundamental-1: Data acquisition in Photogrammetry – concepts and systems Satellite, standard aerial, UAV and terrestrial approaches: Prof em Armin Gruen

ETH

Multi-sensor remote sensing technologies for disaster management

Prof. em. Dr. Armin Gruen
Institute of Conservation and Building Research, ETH Zürich
agruen@geod.baug.ethz.ch

ETH

Geospatial Technologies

Data acquisition : Many new platforms and sensors (space, aerial, terrestrial)

Data processing : Powerful computing devices („cloud processing"), fast/automated processing (on-line, real-time results)

Data administration & analysis: SIS technology

Data representation: Visualization (3D cartography), VR, animation

Data access and dissemination: Web-based technologies

Applications: Beyond mapping: Cultural Heritage, LBS, environmental monitoring, hazards, security, risk, business, tourism, simulation, animation (geogames, movies, TV), etc.

2

ETH

New (or revitalized) data acquisition systems and techniques for photogrammetry

+ Oblique aerials, multi-camera systems (e.g. Pictometry)
+ Multi-head frame aerials (DMC, UltraCam, Rollei, etc)
+ Linear Array aerials (ADS60, StarImager, etc.)
+ Panoramic imagers: Fisheye, Linear Array (CycloMedia, PanCam, et al.)
+ Diverse LiDAR systems
+ Multiple LiDAR systems (Optech Lynx Mobile Mapper)
+ Very highres satellite imagers with multiple chips focal planes (WorldView-1, etc.)
+ UAVs (Stratospheric platforms (future), airplanes, helicopters, etc.)
+ Integrated/hybrid systems

3

ETH

Comparison

Image data <=> Laser data

High resolution Medium resolution

Good X,Y- accuracy Good Z- accuracy

sigma X,Y = 0.5-1 pi x mb 0.2 - 1.0 m

sigma Z = 0.01-0.02 % hg 0.1 - 0.15 m

Models edges Models smooth surfaces

Texture, context info Implicit object description

Better to scale (hg, lens) Fixed sampling increment

Complementary Data

4

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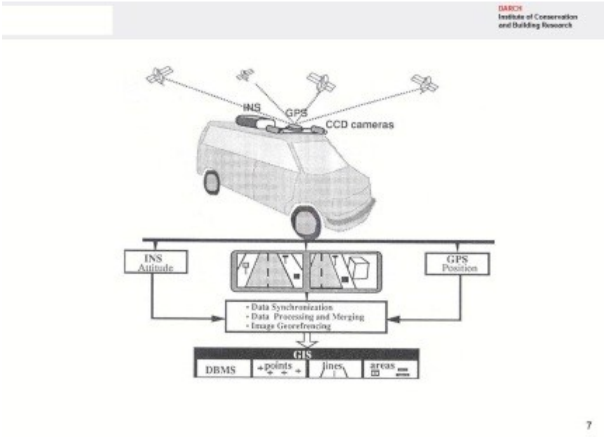
Need for terrestrial sensing

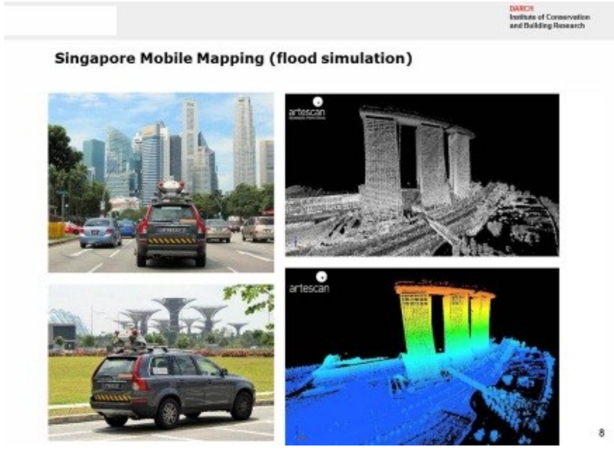
ETH

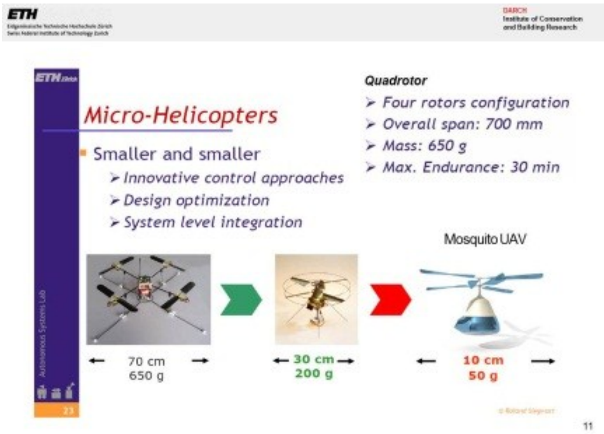
VisionCruiser™, Wuhan University, China

VisionCruiser™ has been used on over 220,000 km of roads in China.

6







ETH

Disaster response planning

1. Development of damage simulation model
2. Methods (models) to rapidly assess damage
3. Models to allocate limited resources in an optimal way

Remote sensing techniques contribute to 1, 2 and (3)

For 2.: Multi-tiered procedure

- Regional damage assessment by satellite imagery (optical, radar) (Future: Stratospheric platforms, geostationary)
- Local assessment from aerial platforms (images, LiDAR, helicopters, UAVs)
- Detailed analysis from terrestrial platforms (Mobile Mapping systems, flying "mosquito" robots)

═ Many tools available, but: data processing methods not always ready

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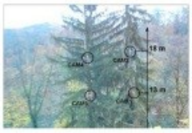
Modeling: generic /mixed / reality–based

Goal: Better understanding of event-triggering parameters and consequences

a. Simulation of events, risk analysis ▶ boursai

a. Analysis of events, prevention ▶ TRAMM



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DARCH Institute of Conservation and Building Research

Generic Decision Theoretical Framework for Earthquake Risk Management

Uncertainty Modeling for Decision Analysis

Risk analyses are subject to uncertainty or incompleteness.
Variables are subject to several sources of uncertainty:

- Inherent or natural variability of the phenomenon itself (aleatoric uncertainty)
- Modeling uncertainty:

i. uncertainty as to whether all factors that influence the model are included, and

i. uncertainty in how the model describes the relationship between these factors (epistemic uncertainty)

- Statistical uncertainty (epistemic uncertainty)

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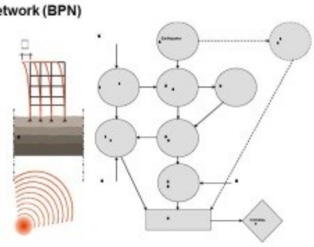
Generic Decision Theoretical Framework for Earthquake Risk Management

Inference by Baysian Probabilistic Network (BPN)

i. Formulation of causal interrelations of events leading to one of the events of interest (consequences)

i. Assignment of probability structures describing the conditional state probabilities for each node

i. Assignment of the consequences corresponding to the events in the BPN.



Exemplary Baysian Network (BPN)

15

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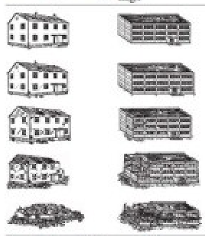
Interpretation key for visual damage assessment
EMS ... European Macroseismic Scale



Masonry buildings	Reinforced buildings	Classification of damages
		Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)
		Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)
		Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)
		Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)
		Grade 5: Destruction (very heavy structural damage)

Fig. 1 Classification of damage to masonry and reinforced buildings (EMS, 1998).

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Visual interpretation of vertical aerials (experiences)

Ogawa et al, 2000: 1995 Kobe earthquake, comparison with ground survey

- Effective for „collapsed" and „severely damaged" buildings
- Stereo better than mono
- Excellent shape and location determination

Problems with vertical aerials:
- Detection of minor damages, damages to side walls and columns difficult

But: Oblique frame array images available
Three-line Scanner (TLS) and multi-line scanner images

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Kobe, 1995, after

18

Why image-based? - Wealth of information

Example DTM - Methods of data acquisition

a. Photogrammetry
b. Digitization of analogue contours
c. Laserscanning (LIDAR)
d. Interferometric or stereo radar
e. Tachymetry
f. Dynamic GPS

Photogrammetry (images) with bonus information:

Ortho-image, model texture, material, use of object (land-use), object extraction (buildings, roads), etc.

Valuable, multi-use data !

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Photogrammetry and Remote Sensing:

Turning images into n-dim models (+ semantic info)

Variable scales: From Mars mapping to nanotechnology

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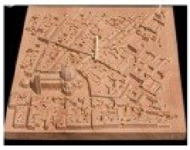
Photogrammetry and Remote Sensing

Turning images into n-dim models (+ semantic info) plus change detection (in 3D)

Example: Firenze



21

Photogrammetric principles/priorities

* Sophisticated sensor models, network competence
* Refined algorithms (→ precision)
* Redundant data (→ reliability)
* Self-diagnosis
* System design for general applicability
* Engineering approach: Testing, verification, robustification

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Image-based products (stages of value adding)

- Raw images
- Geo-located images
- Geo-referenced images
- Ortho-images, -maps
- Line maps
- 3D/4D models
  + Geometry
  + Texture
  + Semantics/Attributes

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«Highresolution» (definition)

Satellite images: < 5m

Aerial images (standard): < 20cm

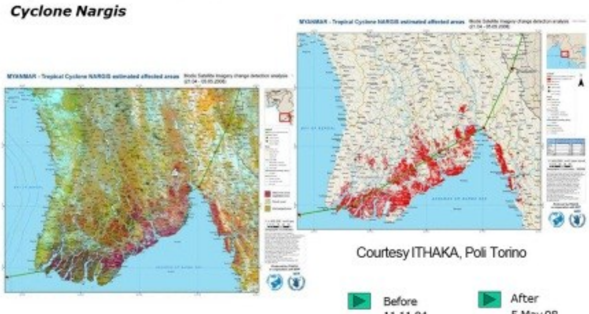
UAV images: < 10cm

Terrstrial images: < 1cm

24

Miyanmar – before and after

Cyclone Nargis



Courtesy ITHAKA, Poli Torino

Before 11.11.04

After 5 May 08

25

Natural disaster monitoring – Haiti, 1.2010

Haiti, DG images

26

Natural disaster monitoring – Qinhai, 5.2010

Yushu, Quickbird 15 April

27

Tornado, Devastations in Oklahoma

Terminology: Integration vs. Fusion

Fusion : The process or result of joining two or more things together to form a single entity.

Integration *(Latin „integer"):* Combining parts so that they work together or form a whole.

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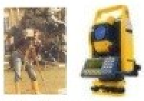
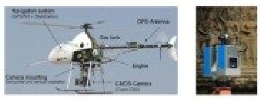
Integration Levels

- ***Sensor***



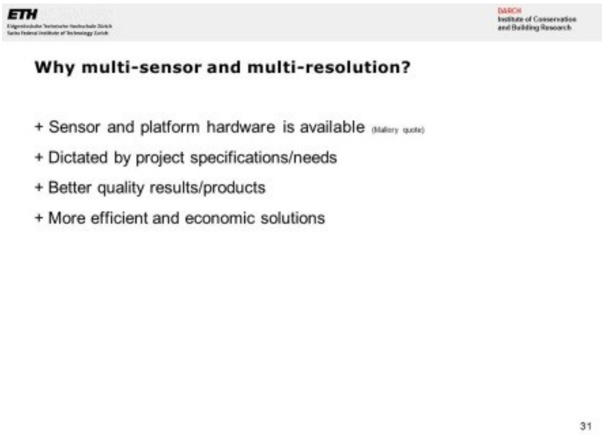
Or: Insert in focal plane of Linear Array camera photodiodes for laserscanning

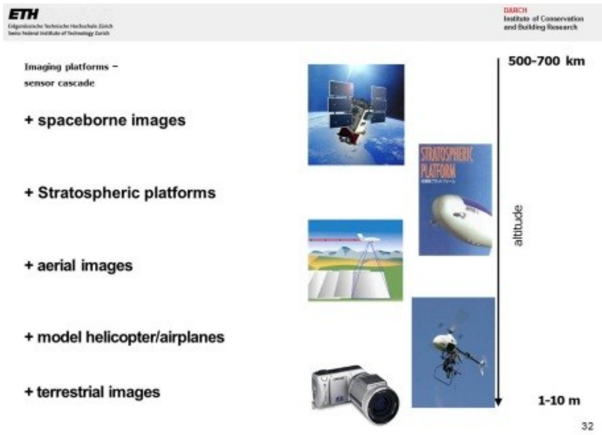
- ***Acquisition System***

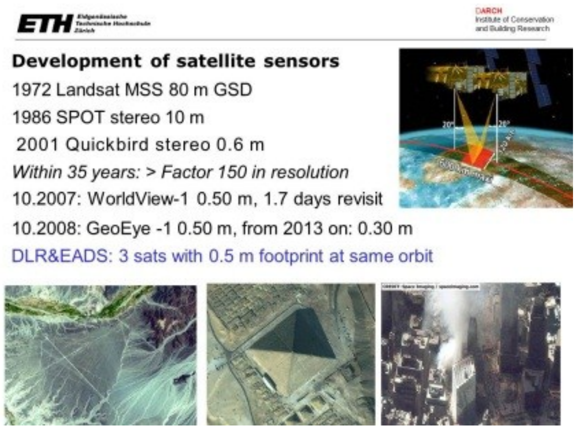


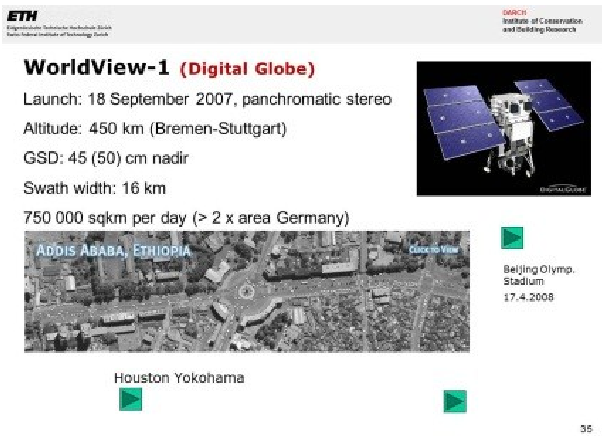
- ***Data processing***
- ***Result***

30









CBA2013-05NSY-Sutrisno-FINAL REPORT

High spatial resolution satellites (HRSI)

- Ground Sampling Distance (GSD) down to 0.5 m
- Almost all with stereo capability
- High geometric accuracy potential
  Georeferencing: 1 pi planimetry and height and better
  DSM: 1-5 pi height (Factors: terrain, landuse, image texture, image quality)

But,
- Availability not good.
  Hopes for improved availability with more such systems planned
  (e.g. DLR with 3 sensors simult. in orbit with 0.5 m footprint)
- High costs. Hopes for lower costs with increasing competition (ALOS/PRISM)
- Low image quality (calibration problems, timing, weather, atmospheric effects, clouds)
- Lack of good and transparent commercial software packages (matching)

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Radiometric Quality

Aerial Zurich PRISM Zurich

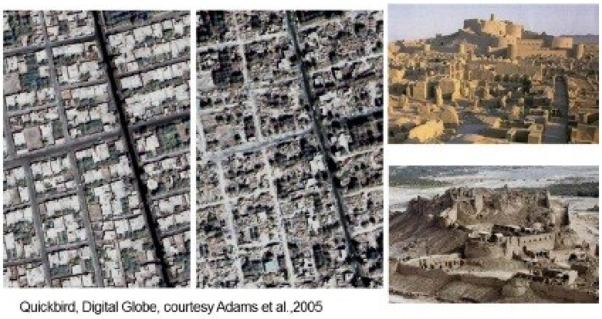
38

Spaceborne systems – QUICKBIRD

Bam, Iran: before and after the earthquake

39

Destructions by Bam earthquake

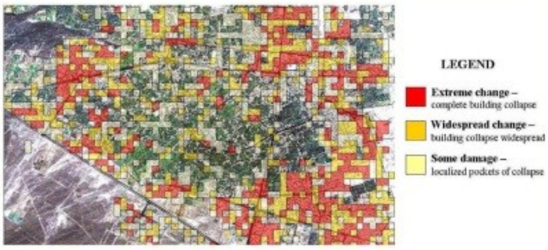


Quickbird, Digital Globe, courtesy Adams et al.,2005

40

Destructions by Bam earthquake

VIEWS (Visualizing the Impacts of Earthquakes using Remote Sensing Images) system (Adams et al., 2005):



VIEWS damage assessment: Texture-based change detection

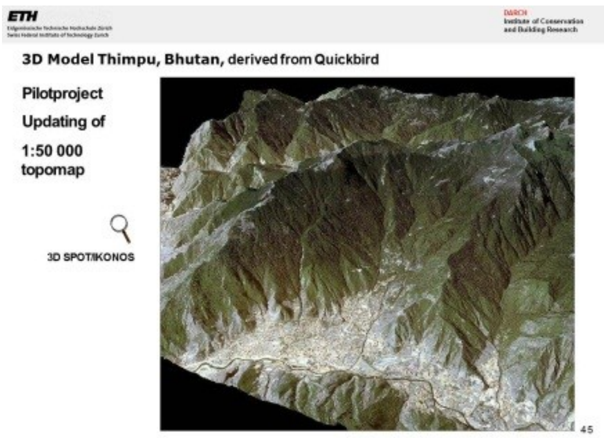
41

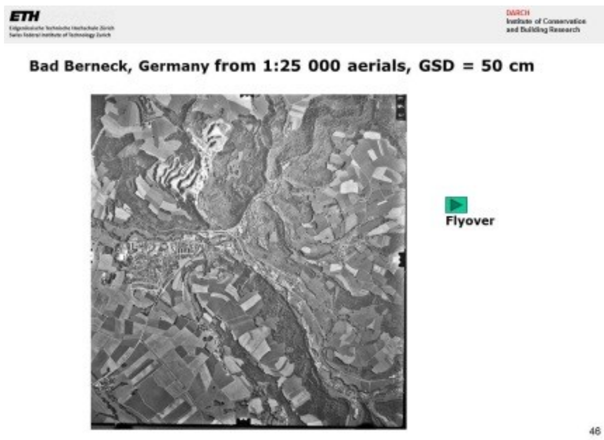
Example SPOT application

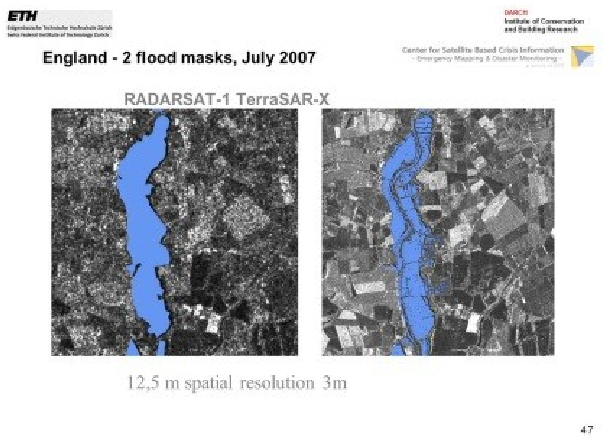
Monsoon 2000: Mekong flooding, Cambodia-Vietnam border

September 25 - Beginning of the drop in level of the water.
The plain is completely flooded. Rice pods are under water.

42







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DARCH
Institute of Conservation and Building Research
Singapore – HRSI stereos
WV-2 Punggol IKONOS Little India, Geelong
49


ETH
DARCH
Institute of Conservation and Building Research
Building Model – Little India
50


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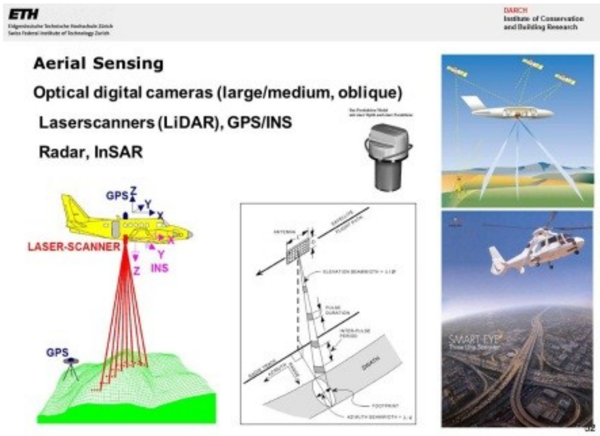
DARCH
Institute of Conservation and Building Research
Punggol 3D


ETH
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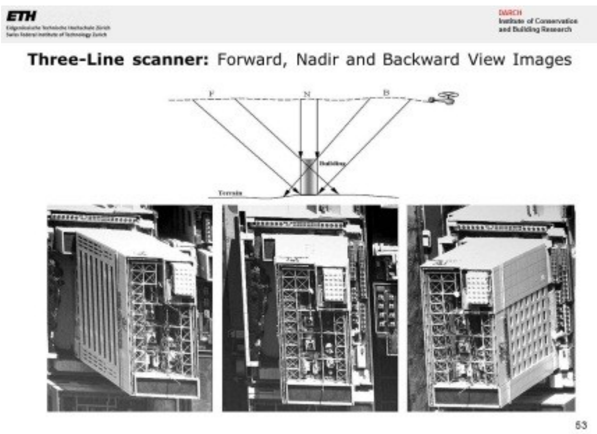
Aerial Sensing
Optical digital cameras (large/medium, oblique)
Laserscanners (LiDAR), GPS/INS
Radar, InSAR
GPS
LASER-SCANNER
INS
GPS
SMART-EYE
52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Three-Line scanner: Forward, Nadir and Backward View Images
F
N
B
Building
Terrain
53


ETH
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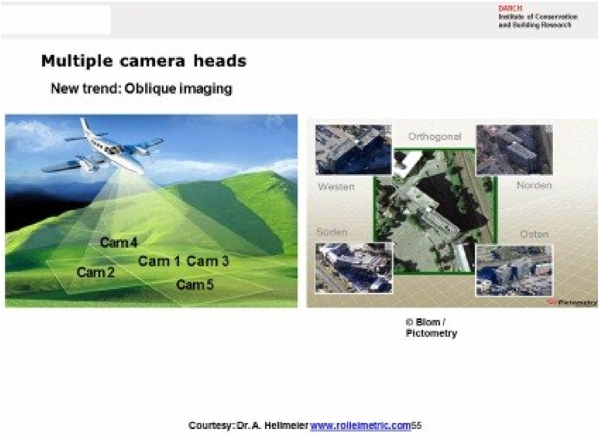
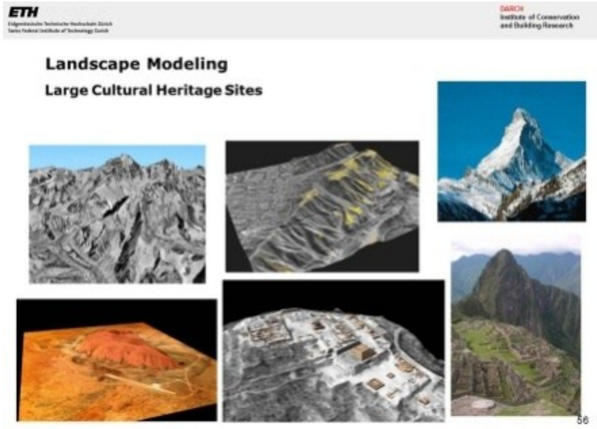
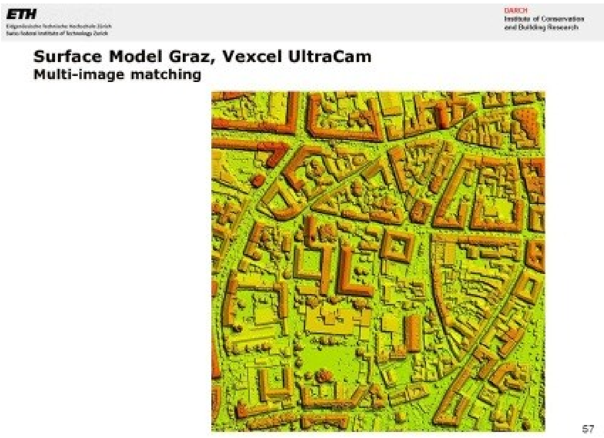
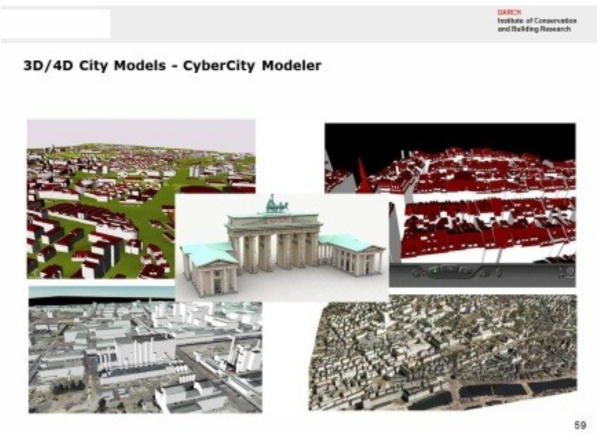
Side-looking view image
23
Tokyo Shibuya area, Oblique angle 23degree
54

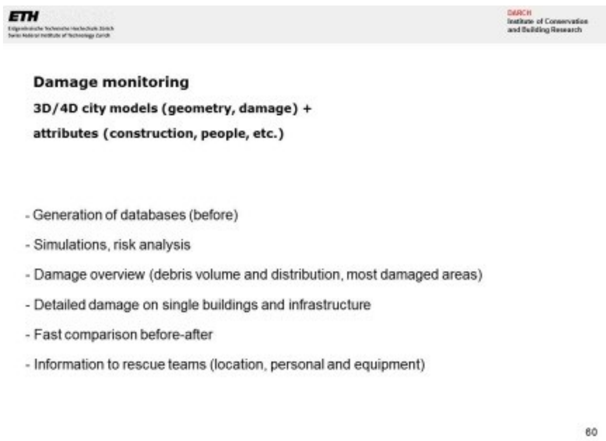

Multiple camera heads
New trend: Oblique imaging
Cam 4
Cam 2
Cam 1 Cam 3
Cam 5
Orthogonal
Westen
Norden
Süden
Osten
© Blom / Pictometry
Courtesy: Dr. A. Hellmeier www.rollelmetric.com
55


ETH
Landscape Modeling
Large Cultural Heritage Sites
56


ETH
Surface Model Graz, Vexcel UltraCam
Multi-image matching
57


ETH
Canopy tree model from aerials
Multi-image matching
58

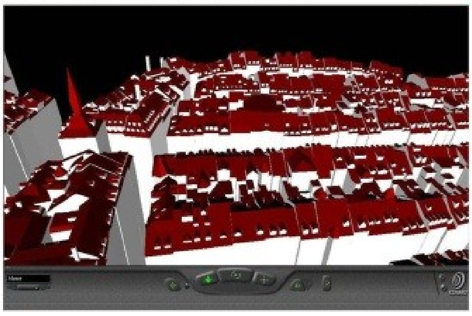

3D/4D City Models - CyberCity Modeler
59


ETH
Damage monitoring
3D/4D city models (geometry, damage) +
attributes (construction, people, etc.)
- Generation of databases (before)
- Simulations, risk analysis
- Damage overview (debris volume and distribution, most damaged areas)
- Detailed damage on single buildings and infrastructure
- Fast comparison before-after
- Information to rescue teams (location, personal and equipment)
60

Semi-automated object reconstruction/modeling

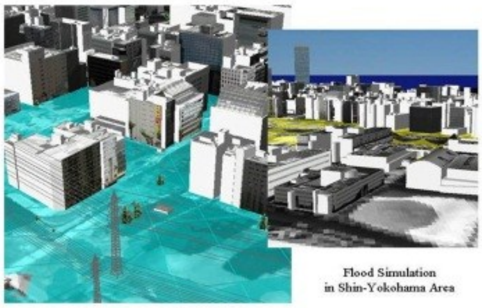
3D city modeling (buildings, etc.): CC-Modeler

(Cooperation IGP, ETHZ & Cybercity AG) Salzburg



61

City 3D Modeling assisted with CC Modeler



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BIM – Building Information Models

For individual buildings, but also for whole cities

Contain - geometry

- topology
- semantics
- appearance

Used for

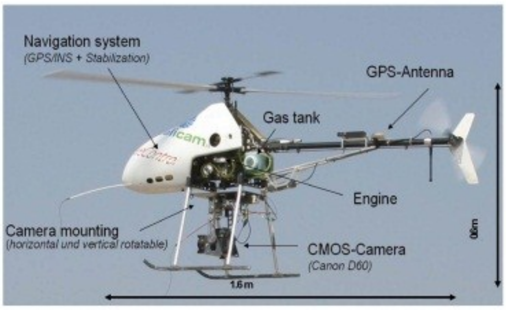
Analysis of lifecycles of building stocks and flows:

Determining "flows": 4D city models, updating, processes

UAV photogrammetry

64

UAV photogrammetry (Helicam, weControl)



65

Development of close-range sensors

Low cost cameras

Panoramic cameras

Laserscanners, structured light

3D CCD/CMOS chips

Hybrid systems

Ladybug2

6 CCDs

30 FPS

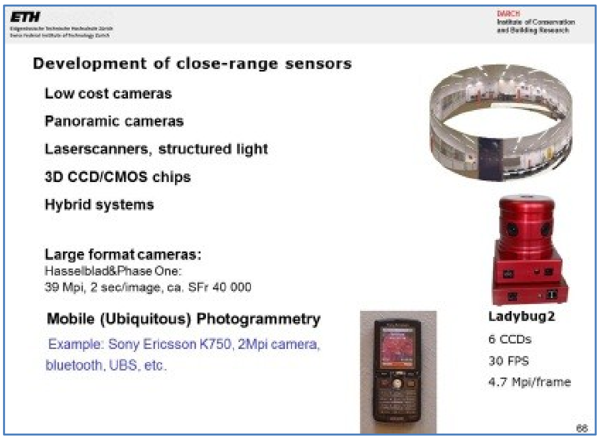
4.7 Mpi/frame

Large format cameras:
Hasselblad&Phase One:
39 Mpi, 2 sec/image, ca. SFr 40 000

Mobile (Ubiquitous) Photogrammetry

Example: Sony Ericsson K750, 2Mpi camera, bluetooth, UBS, etc.

66


DARCH
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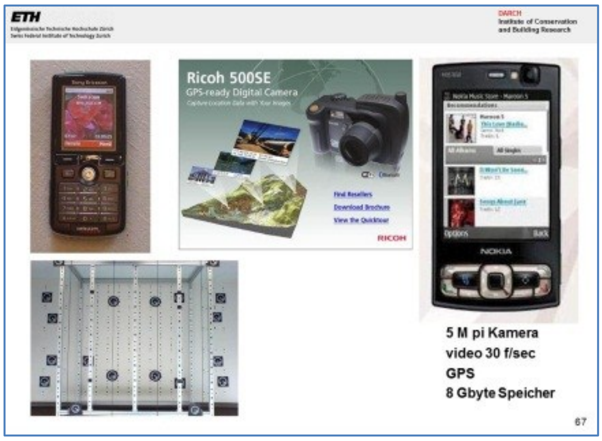
Development of close-range sensors
Low cost cameras
Panoramic cameras
Laserscanners, structured light
3D CCD/CMOS chips
Hybrid systems
Large format cameras:
Hasselblad&Phase One:
39 Mpi, 2 sec/image, ca. SFr 40 000
Mobile (Ubiquitous) Photogrammetry
Example: Sony Ericsson K750, 2Mpi camera, bluetooth, UBS, etc.
Ladybug2
6 CCDs
30 FPS
4.7 Mpi/frame
66


DARCH
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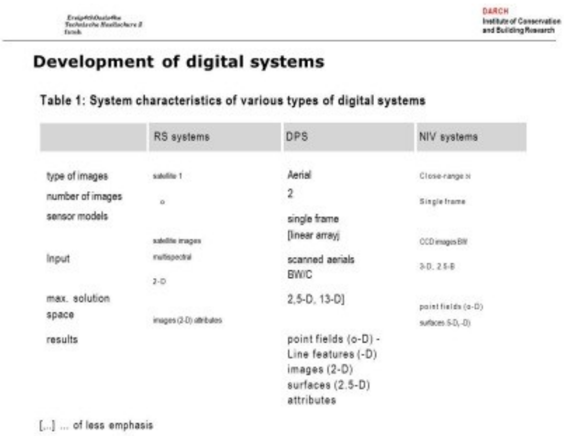
Ricoh 500SE
GPS-ready Digital Camera
5 M pi Kamera
video 30 f/sec
GPS
8 Gbyte Speicher
67


DARCH
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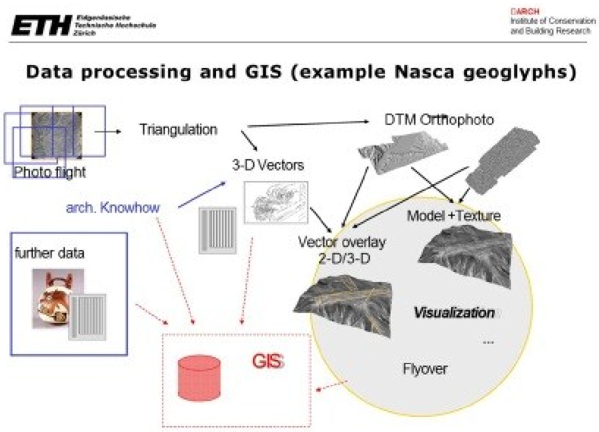
Development of digital systems
Table 1: System characteristics of various types of digital systems
RS systems
DPS
NIV systems
type of images
number of images
sensor models
Input
max. solution
space
results
Aerial
2
single frame
[linear array]
scanned aerials
BW/C
2,5-D, 13-D]
point fields (o-D) -
Line features (-D)
images (2-D)
surfaces (2.5-D)
attributes
[...] ... of less emphasis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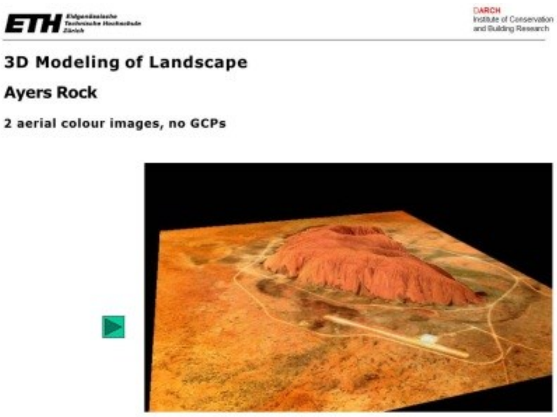
Data processing and GIS (example Nasca geoglyphs)
Triangulation
DTM Orthophoto
Photo flight
3-D Vectors
arch. Knowhow
Model +Texture
further data
Vector overlay
2-D/3-D
Visualization
GIS
Flyover


ETH Eidgenössische Technische Hochschule Zürich
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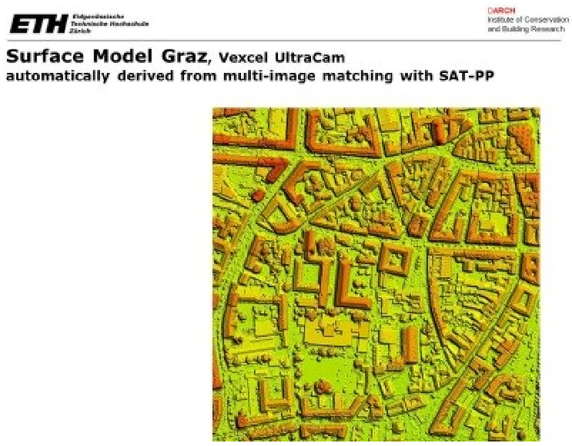
3D Modeling of Landscape
Ayers Rock
2 aerial colour images, no GCPs


ETH Eidgenössische Technische Hochschule Zürich
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Surface Model Graz, Vexcel UltraCam
automatically derived from multi-image matching with SAT-PP

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Surface Model (Street Factory)

automatically derived from vertical and oblique images

Courtesy: ASTRIUM

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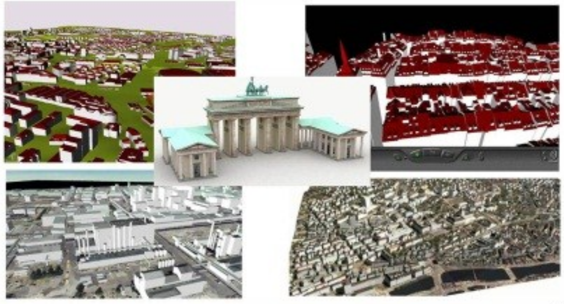
3D/4D City Models - CyberCity Modeler



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Problems with automated building reconstruction

+ Image interpretation
+ Automated control of level of detail
+ Correct topology

Currently: No progress in automated image interpretation
Way out: Multi sensor/data concept

Therefore: Development of semi-automated approaches

Major problem: Quality control !!!

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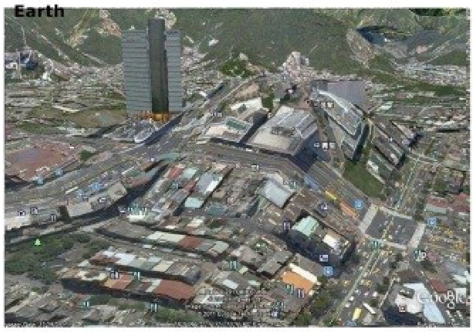
Quality control

Taipei – reality based modeling on Google Earth



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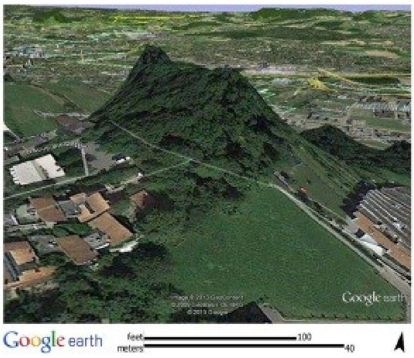

Zurich
Gockhausen
in Google Earth

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"Assessment of earthquake damages by image-based techniques"
Dissertation by M. Rezaeian, 2010, ETH Zurich

"Classification of collapsed buildings during earthquakes from stereo aerial photographs using multiple features"

M. Rezaeian , A. Gruen
GeoRisk Journal, 2010

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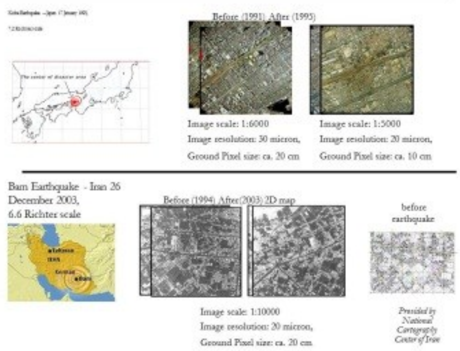

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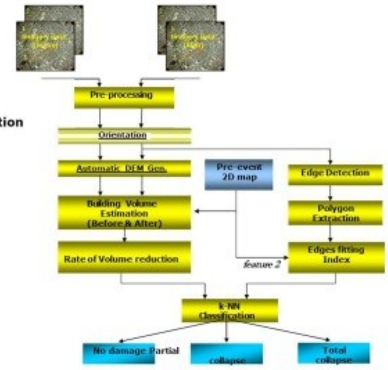
Damage classification flowchart



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Conclusions of the MERCI Workshop:
Management of Earthquake Risks
August 28-29, 2006, ETH Zürich

Which are the big issues in earthquake risk management?
Stakeholders: academia, industry, rescue teams, victims

+ General consensus: Uncertainties in earthquake risk management should be reduced !
  Substantial research at Universities and industry research groups;
  However: difficulties in communication between researchers and other stakeholders.

+ University researchers often fail to appreciate the context and needs of the industry and thus
  focus on very specific areas, which for the large picture might be of less significance.

+ **Presently most applied risk management is performed by "black box" tools mainly developed**
  by the industry with very little input from academia.
+ Presently no clear knowledge on how uncertainty reduction is most efficiently achieved.

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Photogrammetry today:

+ From point positioning and 2.5D mapping to an integrated, unified nD technology, encompassing satellite, aerial and terrestrial sensor platforms
+ From single sensor/multiple processing instruments to multiple sensors/single processing platform technique

1. *Technologies are converging (satellite, aerial, terrestrial)*
   Processing (almost) platform-independent
1. *Image understanding is a hard problem*
   Full automation only possible for highly structured images or unstructured products
   Remedy: Multi (hybrid)-data approach (?)

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Conclusions

+ Variety of digital sensors available with on-line and real-time capabilities
+ *Problems*
  - development of automated and fast methods for data processing and information extraction
  - logistics and organization of data acquisition, processing and communication
  - suitable data for the "before status" not available

+ Fast damage assessment on regional and local scale is realistic for the near future
  But: Detailed damage analysis?

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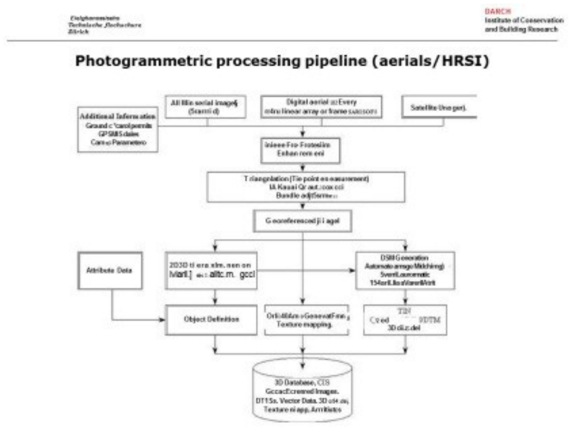
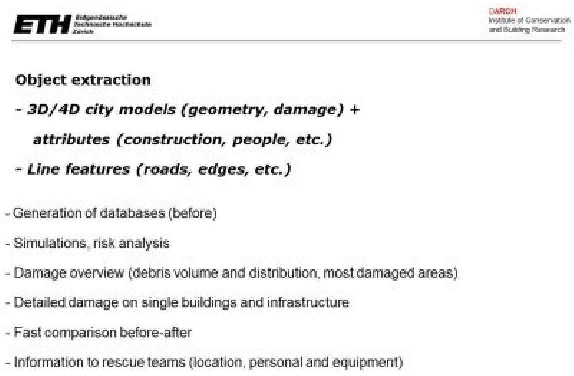
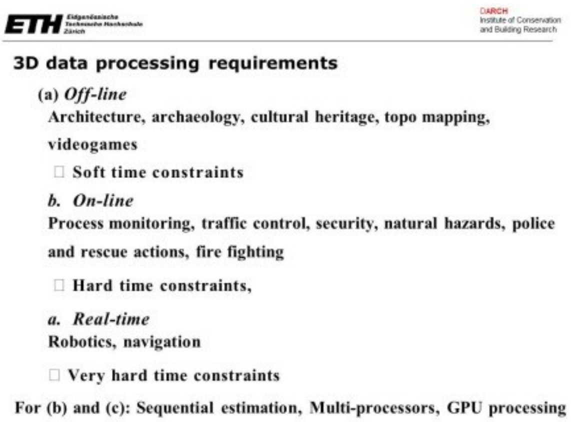
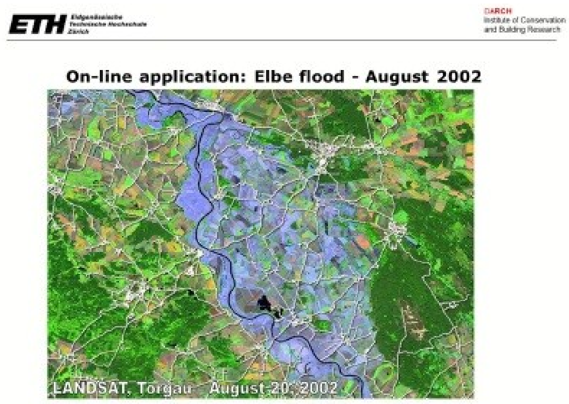
c. Fundamental-2: The photogrammetric data processing pipeline Real-time, on-line and off-line processing Emphasis is on the processing of UAV images: Prof Armin Gruen









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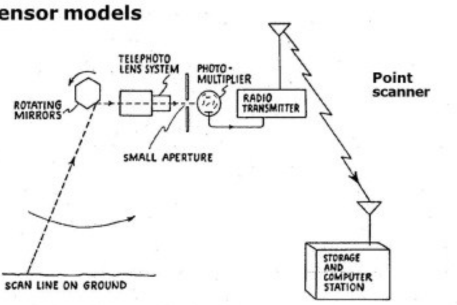
Sensor models



Point scanner

Spot-scan photomultiplier method for electronic photogrammetry, used by the FRA TSS

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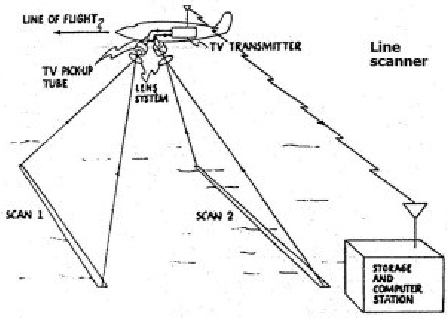

Line scanner

Single-line-scan television method

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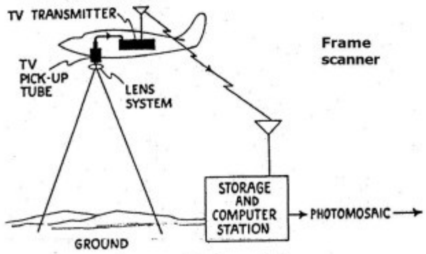

Frame scanner

Television method

Scanning Principles for P. Rosenberg's „Fully Automated Photomap"

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Bundle Adjustment

Mathematical Model of single frame sensor
Central Projection

- Simultaneous determination of orientation parameters and object coordinates
- No separation into relative and absolute orientation
- Interior orientation can be included in the unknown parameters of the adjustment
- **Solution**: Combination of forward intersection and resection
- **Basis**: Collinearity equations

D (ω, f, k) = orthogonal rotation matrix ($D^{-1} = D^T$)

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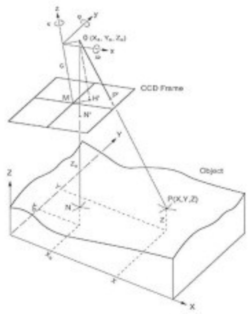
Components (eliminating the scale factor □):

Or, for j=1...m images:

$$x_{ij} = -c_j f_{ij}^x + x_{0j}$$
$$y_{ij} = -c_j f_{ij}^y + y_{0j}$$



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Mathematical Model

- **Observations: image coordinates (x_{ij}, y_{ij})**
- **Unknowns: X_i, Y_i, Z_i, X_{0j}, Y_{0j}, Z_{0j}, w_j, f_j, k_j, (x_{0j}, y_{0j})** — *i points, j images*
- **Functional Model is non-linear:**

$x_{ij} = F^x_{ij}$ (X_i, Y_i, Z_i, X_{0j}, Y_{0j}, Z_{0j}, w_j, f_j, k_j, x_{0j}, y_{0j}) $y_{ij} = F^y_{ij}$ (X_i, Y_i, Z_i, X_{0j}, Y_{0j}, Z_{0j}, w_j, f_j, k_j, x_{0j}, y_{0j})

- **Linearization with Taylor**

dX_i + dY_i + dZ_i + dX_{0j} + ... + F

=> Approximations for the unknown parameters (very important in close-range)

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After the linearization (*example*):

$a_1 x + b_1 y + c_1 = 0$
$a_2 x + b_2 y + c_2 = 0$
...
$a_n x + b_n y + c_n = 0$

$\mathbf{A} = \begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \\ \dots & \dots \\ a_n & b_n \end{bmatrix}$ $\mathbf{x} = \begin{bmatrix} x \\ y \end{bmatrix}$ $\mathbf{l} = \begin{bmatrix} c_1 \\ c_2 \\ \dots \\ c_n \end{bmatrix}$

Design matrix

Unknown vector: X_i, Y_i, Z_i, X_{0j}, Y_{0j}, Z_{0j}, x_{0j}, y_{0j}, w_j, f_j, k_j

Observation vector: x_{ij} y_{ij}

$\mathbf{Ax} - \mathbf{l} = \mathbf{0}$

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Solution (Least Squares Estimation):

$l = f(x)$. — x = unknown vector of the parameters l = constant vector

$l - e = Ax$, P — e = error vector for observations

$\hat{x} = \left(A^T P A\right)^{-1} A^T P l$, — A = design matrix (*no.obs* x *no.unkn*, obs>>unkn)

$v = A\hat{x} - l$,

$\hat{\sigma}_0^2 = \frac{v^T P v}{r}$, $r = n - u$.

x = solution vector
P = weight matrix for the constant vector l
v = residuals
s_0 = std dev a posteriori of unit weight
r = redundancy

At least 7 informations for the ***DATUM DEFINITION*** necessary:

a. 7 Parameters of the EO or
b. 7 coordinates of object points (GCP) or
c. free network solution (inner constraints)

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Table 1: Photogrammetric orientation and point positioning procedures as special cases of
the general bundle method

Procedure	Given Parameters	Unknown Pararneliers
General bundle		(X, Y, Z)i; I-0j;EOM
Metric camera bundle	I0j	(X, 3', Z)i; .E0i
Spatial resection (a)	I0s; (X, Y, Z)i	E0j
(b)	(X, Z)i	IO; E0i
Spatial IntersecLion (Stereo or multirrame)	I0j; *EO*	(X, Y,

. Interior orientation, *EO*.. . Exterior orientation

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Precision and reliability of the bundle solution

- Covariance matrix
- Theoretical precision
- Empirical precision

— Statistical quality of the recovered vector x (unknown parameters)

Precision of the solution vector □ **COVARIANCE MATRIX** [no.unkn x no.unkn] $C_{xx} = \hat{\sigma}_0^2 \left(A^T P A\right)^{-1}$

Q_{xx} = cofactor matrix

$s_{x_i} = \hat{s}_0 \sqrt{q_{xx}}$ — Standard deviation of the unknown x_i
s_0 = std dev. a posteriori of unit weight
q_{xx} = i-th element of the diag. of the cofactor matrix

$s_X = \sqrt{\frac{\sum s_X^2}{n_X}}$ — Average precision of the object coordinates X

- Reliability — Related to SYSTEMATIC ERRORS
  BLUNDERS
  WEIGHT ERRORS

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Lens distortion - Examples

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Bundle adjustment with additional parameters (APs)

- **Method:**
Extend the mathematical model (collinearity equations) of the adjustment with additional parameters

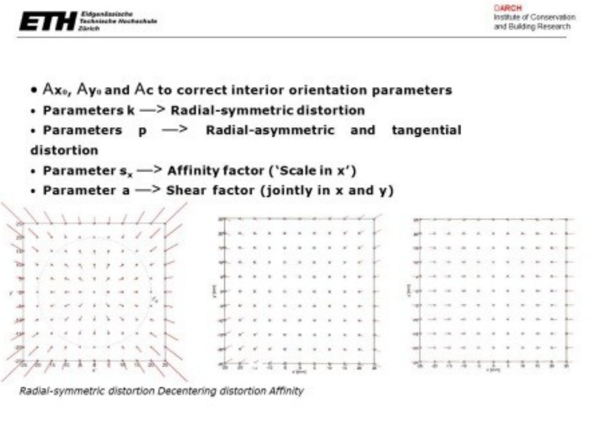
APs:

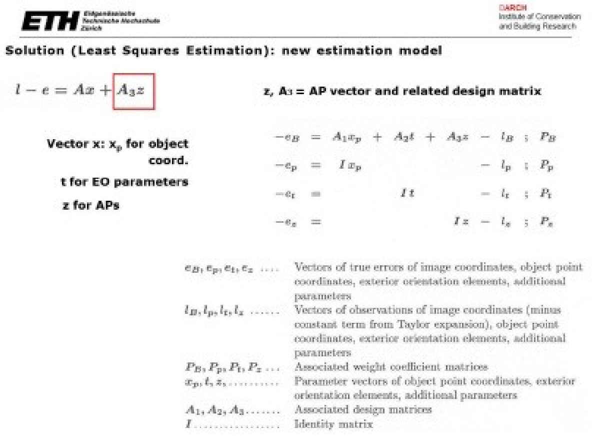
$$x_{ij} = -c_j f_{ij}^x + x_{0j} + \Delta x_{ij}$$
$$y_{ij} = -c_j f_{ij}^y + y_{0j} + \Delta y_{ij}$$

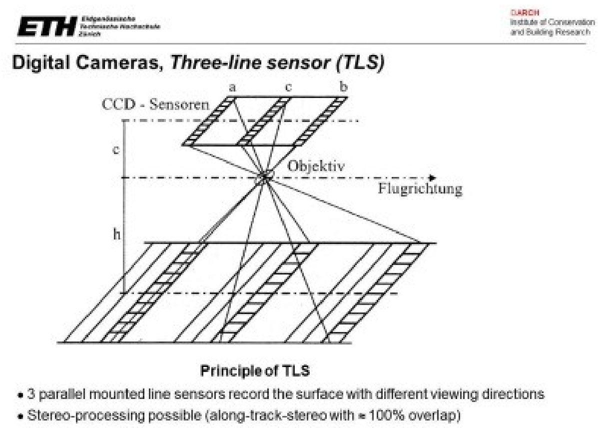
$$\Delta x = -\Delta x_0 + \frac{\bar{x}}{c}\Delta c + \bar{x} s_x + \bar{y} a + \bar{x} r^2 k_1 + \bar{x} r^4 k_2 + \bar{x} r^6 k_3 + \left(r^2 + 2\bar{x}^2\right) p_1 + 2\bar{x}\bar{y} p_2$$
$$\Delta y = -\Delta y_0 + \frac{\bar{y}}{c}\Delta c + 0 + \bar{x} a + \bar{y} r^2 k_1 + \bar{y} r^4 k_2 + \bar{y} r^6 k_3 + 2\bar{x}\bar{y} p_1 + \left(r^2 + 2\bar{y}^2\right) p_2$$

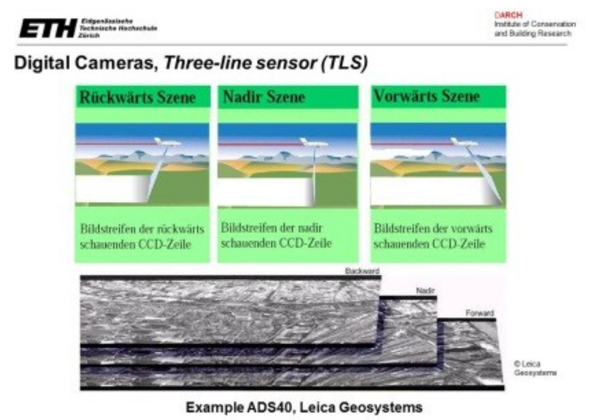
with $\bar{x} = x - x_0$, $\bar{y} = y - y_0$, $r^2 = \bar{x}^2 + \bar{y}^2$

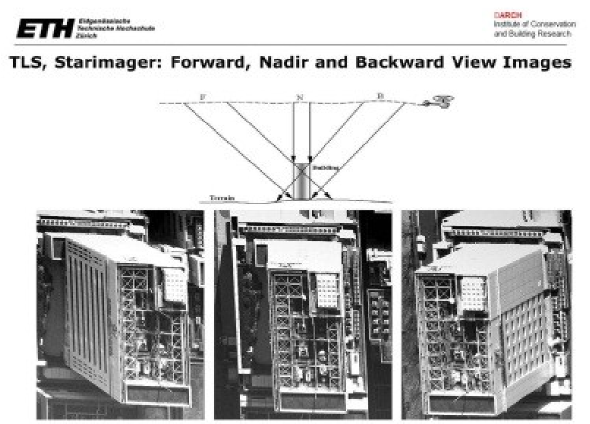
(Brown/Beyer model)











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Side-looking view image

Tokyo Shibuya area, Oblique angle 23degree

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Advantages of TLS technique

- **More pixels per frame (larger area coverage)**
- **Triple or more overlap (redundancy)**
- **Orthogonal in flight direction (min. of occlusions, true orthos)**
- **PAN and MS simultaneously**
- **Building facades better visible (impact on geometry and texture)**
- **Radiometric depth (16 bit)**

> Aerial TLS technology allows for new processing paradigms

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Orientation

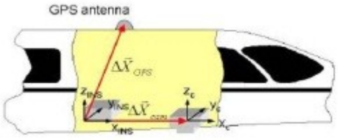
Direct Georeferencing: Integration of INS/GPS can lead to good absolute accuracy.

GPS (differential phase observations with rover-master receiver separation below 30 km): 10 cm or better

High quality INS: 20 arc sec (?)

Translational offsets between GPS, INS and camera

Rotational offset between axes of INS and camera



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Georeferencing. Image Orientation

3 methods, used with satellite images :

a. **Parametric, physical sensor models („strict models“)**
b. Non-parametric models
c. Combinations (e.g. phys. model with self-calibration)

Usefulness of a particular model depends on various factors, as:
+ Geometrical resolution (footprint)
+ Type of sensor (Linear Array, Matrix Array, field of view, etc.)
+ Accuracy requirements
+ Availability of a priori informations (attitude and position values from navigation, GCPs, etc.)

Physical models

Modeling of the physical imaging properties of the sensor geometrically (functionally and stochastically).

A priori a constant number of parameters, which are not data dependent.

Strict model, but: In-depth knowledge of exterior and interior orientation required!

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Non-parametric sensor models

- **Rational Functions** A polynomial-based approach connecting image space and object space coordinates via an 80 parameter transformation
  RF Coefficients derived by the image provider via a rigorous model using navigation data - not via ground control (GCPs)
- **Affine Projection Model** Affine model recognises that as the field of view becomes small, parallel projection is approached
  A promising practical approach needing modest no. of GCPs, but sensor motion must be linear
- **Direct Linear Transformation** Uses projective equations between image space (2D) and object space (3D) coordinates
  An empirical approach needing a minimum of 6 GCPs (instable - generally not recommended)

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Rational functions for HRSI

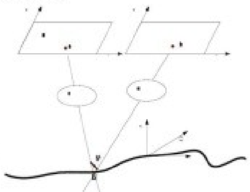
Object-to-image space RPC transformation is from offset normalised latitude, longitude & height to offset normalized line & sample coordinates

$$l_n = \frac{l - LineOffset}{LineScale} \qquad U = \frac{\phi - LatitudeOffset}{LatitudeScale}$$

$$s_n = \frac{s - SampleOffset}{SampleScale} \qquad V = \frac{\lambda - LongitudeOffset}{LongitudeScale}$$

$$W = \frac{h - HeightOffset}{HeightScale}$$

(l, s) are measured line, sample coordinates
(ϕ, λ, h) are geographical coordinates of the ground point



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Rational functions for HRSI

RPCs comprise 80 coefficients, with 10 extra scale and offset terms

$$F_1 = l_n = \frac{Num_L(U,V,W)}{Den_L(U,V,W)}$$

$$F_2 = s_n = \frac{Num_S(U,V,W)}{Den_S(U,V,W)}$$

$$Num_L(U,V,W)_j = a_1 + a_2V + a_3U + a_4W + a_5VU + a_6VW + a_7UW + a_8V^2 + a_9U^2 + a_{10}W^2 + a_{11}UVW + a_{12}V^3 + a_{13}VU^2 + a_{14}VW^2 + a_{15}V^2U + a_{16}U^3 + a_{17}UW^2 + a_{18}V^2W + a_{19}U^2W + a_{20}W^3$$

$$Den_L(U,V,W)_j = b_1 + b_2V + \dots + b_{19}U^2W + b_{20}W^3$$

$$Num_S(U,V,W)_j = c_1 + c_2V + \dots + c_{19}U^2W + c_{20}W^3$$

$$Den_S(U,V,W)_j = d_1 + d_2V + \dots + d_{19}U^2W + d_{20}W^3$$

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Bias - compensated RPFs

x = RPFx(X,Y,Z) + a + bx + cy

y = RPFy(X,Y,Z) + d + ex + fy

Reasoning: Relative orientation with RPCs usually good, but absolut position/orientation insufficient.

Affine transformation corrects for this problem.

6 parameters > 3 GCPs required !

Often sufficient: Shifts in x and y (2 parameters a and d)

Then only 1 GCP required !

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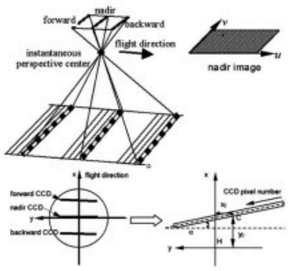
Physical camera model

(time-dependent central perspective)



$$u = f_s t$$

$$\begin{cases} x' = x_0 + (v - Midv) \times ps \times \sin\alpha \\ y' = y_0 + (v - Midv) \times ps \times \cos\alpha \end{cases}$$

$$\begin{cases} x = x' + \Delta r \times x'/r = I_x(v) \\ y = y' + \Delta r \times y'/r = I_y(v) \end{cases}$$

$$and \quad \Delta r = a_1 r + a_3 r^3 + a_5 r^5$$

$$r = \sqrt{x'^2 + y'^2}$$

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} X_0 \\ Y_0 \\ Z_0 \end{bmatrix}_N + \lambda R(\omega,\varphi,\kappa)_N \begin{bmatrix} x \\ y \\ -c \end{bmatrix}$$

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LA collinearity equations

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} X_{GPS}(t) \\ Y_{GPS}(t) \\ Z_{GPS}(t) \end{bmatrix} + R\begin{pmatrix} \Omega(t) \\ \Phi(t) \\ K(t) \end{pmatrix} \begin{bmatrix} T_X \\ T_Y \\ T_Z \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ s \end{bmatrix} + \lambda R \begin{pmatrix} \omega_{INS} + \omega_0 + \omega_1 t \\ \varphi_{INS} + \varphi_0 + \varphi_1 t \\ \kappa_{INS} + \kappa_0 + \kappa_1 t \end{pmatrix} \begin{bmatrix} x \\ y \\ -c \end{bmatrix}$$

$$Where \quad t = \frac{u}{f_s}; \quad \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} I_x(v) \\ I_y(v) \end{bmatrix}$$

These equations are used together with all trajectory models DGR, PPM and LIM

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Linear Array sensor and trajectory modeling for orientation and triangulation

Imaging & trajectory models

Imaging model: Pushbroom

Trajectory models:

DGR... Adjustment with stochastic EO

PPM (n)... Piecewise Polynomial Modeling with n segments

LIM(n)... Lagrange Interpolation with n orientation fixes

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Georeferencing by Photogrammetric Triangulation

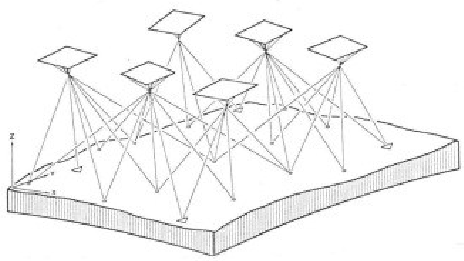
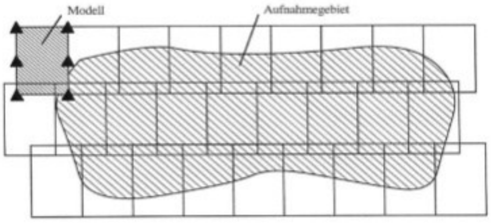


Image Block



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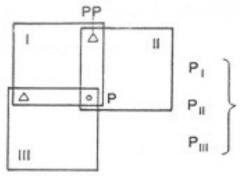
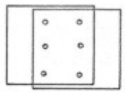
Tie points

Used to connect image coordinate systems





Minimum of 5 points per model, but usually > 6

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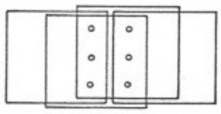
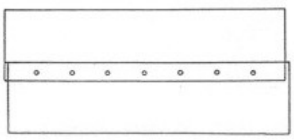


Tie points in strip direction



Tie points across strip direction

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Blocktriangulation with bundle method

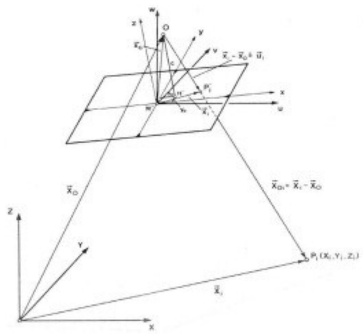
Mathematical model:

Central projection

Collinearity condition:

$$\bar{X}_i - \bar{X}_0 = \lambda_i R(\bar{x}_i - \bar{x}_0)$$

$$u_i = R(\bar{x}_i - \bar{x}_0)$$



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Object point — **Object coordinate system**

Projection center

Image point — **Image coordinate system**

$\bar{x}_i$; $\bar{x}_0$ **Principal point**

Rotation matrix

λ_i... **Scale factor**

Indices: i = 1, 2,. . . , n Object points

j = 1, 2, . . ., m Images

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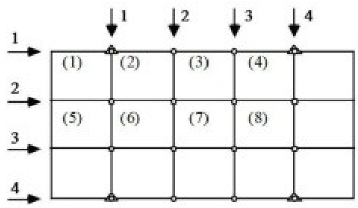
Matrix structures and computational problems

Example: 2 strips with 4 images each (60% overlap in both directions)



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(1) ... (8) Images
11 ... 44 Points

$4 \cdot 4 = 16$ Points => $3 \cdot 16 = 48$
$2 \cdot 4 = 8$ Images => $6 \cdot 8 = \underline{48}$
96 Unknowns

4 central images => $2 \cdot 9 \cdot 4 = 72$
4 perimeter images => $2 \cdot 6\ 4 = \underline{48}$
120 Observations

4 Full GCPs => $3 \cdot 4 = \underline{12}$
Total 132 Observations

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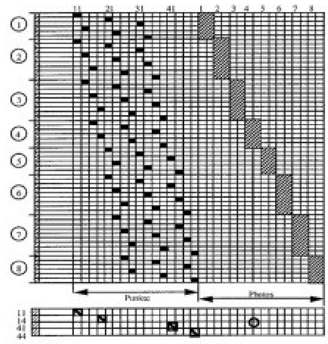
Least Squares Design matrix A



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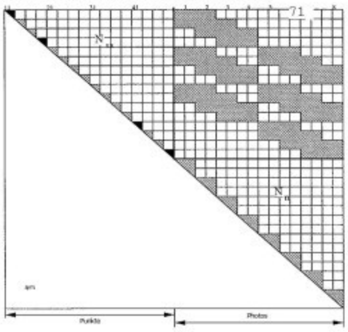
Least Squares Normal Equations (without right hand side)



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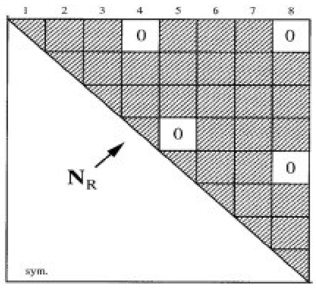
Pre-reduced Normal Equations system :



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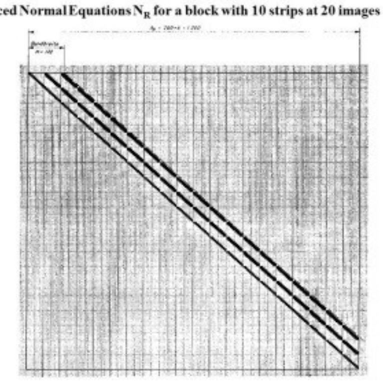
Pre-reduced Normal Equations N_R for a block with 10 strips at 20 images each



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GCP distributions (numbers and locations)

Planimetry: Only perimeter points (Fig. 1)

Height:

q = 20 % GCP chains across strip direction with distance i baselengths (Fig.2)

q = 60 % squared GCP raster with meshwidth i (Fig.3)

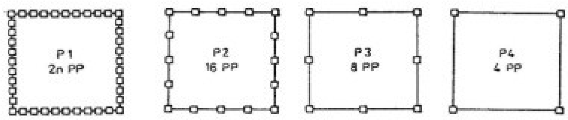

Fig. 1: Planimetric GCPs for q = 20 % and q = 60 %

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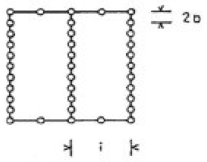

Fig. 2: Height GCP distribution for q = 20 %

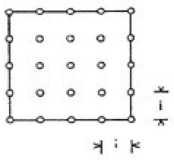

Fig. 3: Height GCP distribution for q = 60 %

pix4D triangulation results

Accuracy of triangulation (depends on quality of tie points, GCPs, overlap, c, image quality, image content, etc.): 0.5-2 pixels

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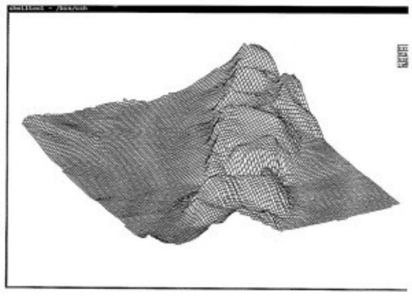
Digital Terrain Model (DTM), Digital Surface Model (DSM)

Classical DTM: z = z(x,y), 2.5D representation, single-valued function



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Primary data

a. Point data (x,y,z), representing only geometrical height information
b. Point data including additional information (geomorphological, structural, topological), as
 + prominent single points (depressions, hilltops, saddle points, etc.)
 + lines of steepest slope
 + contour lines
 + breaklines (surface singularities, first and second deriv. not defined)
 + structure lines (non-singular transition between differently sloped surface patches, large curvature perpendicular to the structure line)
 + ridge and valley lines (special cases of breaklines or structure lines)

- Acquisition of terrain data in conventional way (tachymetric or with photogrammetry) is based on (b)-type data
- Most modern approaches of image matching are only capable of generating (a)-type.

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Terrain representation

Most relevant discrete terrain representations:

a. ***Regular grid (Rastermodel)***
Data is given on a square or rectangular grid with constant grid width. Structure information is lost.

a. ***Triangular meshes (TIN)***
The structure is obtained via Delauney-Triangulation. Points on breaklines are included in the triangulation and this structure information is maintained.

a. ***Contours***
Traditional representation originating from analogue maps. Structure information is implicitly included.

a. ***Profiles***
Normally in form of parallel profiles with varying point density along the profiles. Structure information is lost but point selection is adapted to structural conditions.

a. ***Unstructured irregular point cloud***

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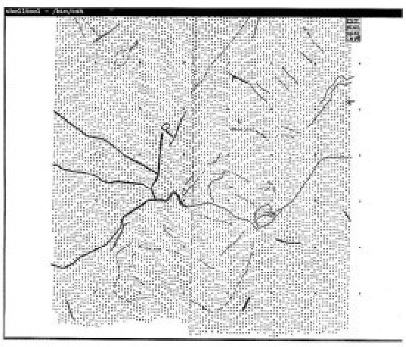
DTM forms of representation

Profiles & Breaklines



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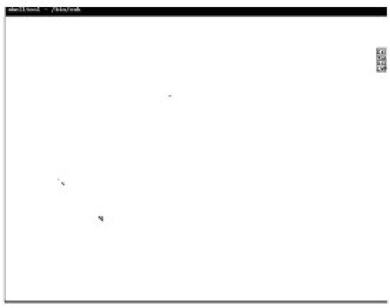
Rastermodell („Wireframe,



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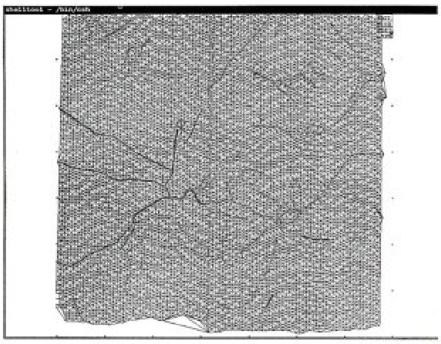
TIN ... Triangulated Irregular Network



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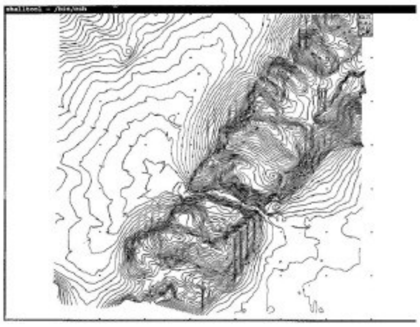
Contour representation



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Methods of data acquisition

a. **Photogrammetry**
b. **Digitization of analogue contours**
c. **Laserscanning (LIDAR)**
d. **Interferometric or stereo radar**
e. **Tachymetry**
f. **Dynamic GPS**

Nationwide datasets are nowadays available in many countries, partly of very high accuracy, as derived from aerial laser-scanning or from maps.

E.g. swisstopo data (www.swisstopo.ch):

+ DOM on 2m grid, sigma(Z) = 0.5 – 1.5 m

+ DHM25 on 25m grid (scanned 1:25 000 topomap), sigma(Z) = 1.5 – 7m

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Photogrammetric DTM generation

a. Manual measurements
   On Analytical Plotters or Digital Stations in stereo mode
a. Automated generation by image matching
   On Digital Stations. Substantial post-editing (correction of blunders)

Sampling Modes
- selective
- homogeneous
- random
- mixed forms

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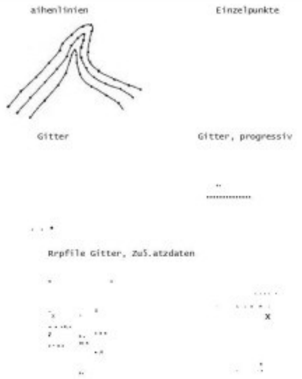

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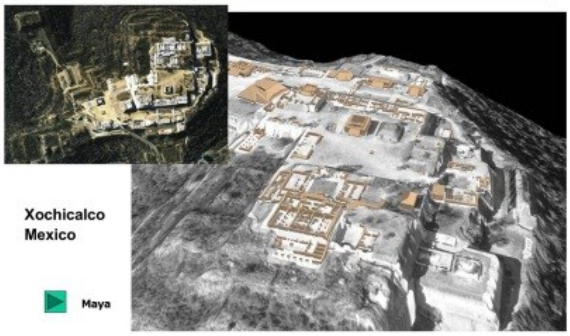

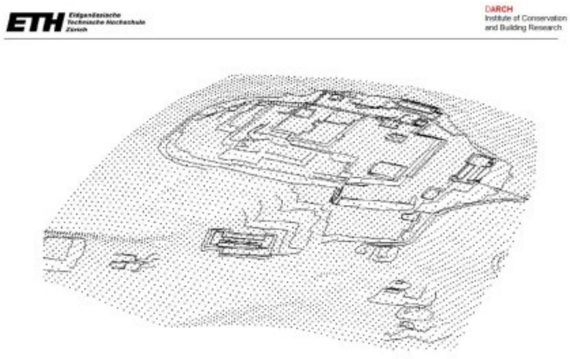
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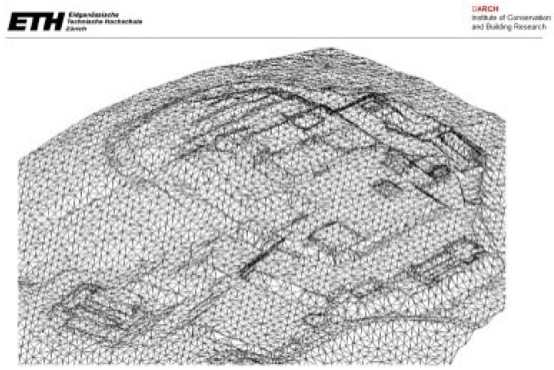
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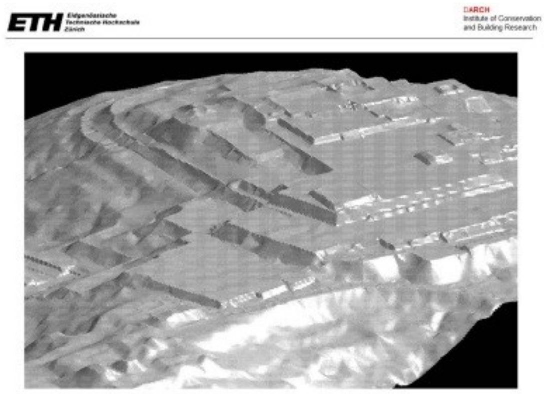
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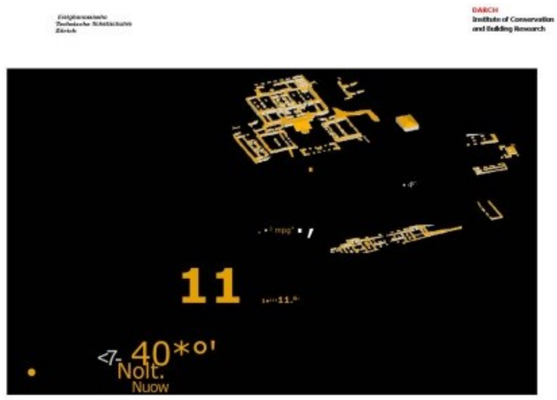
DARCH
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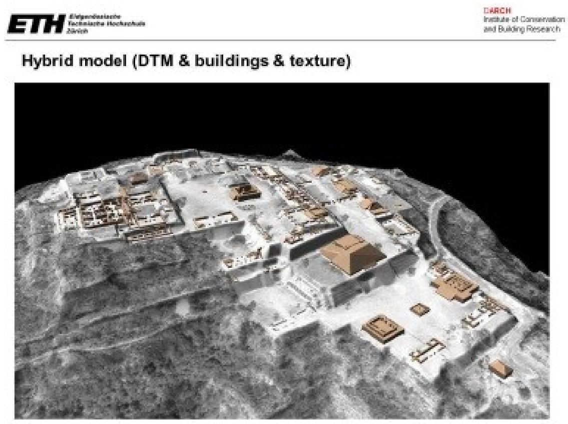
and Building Research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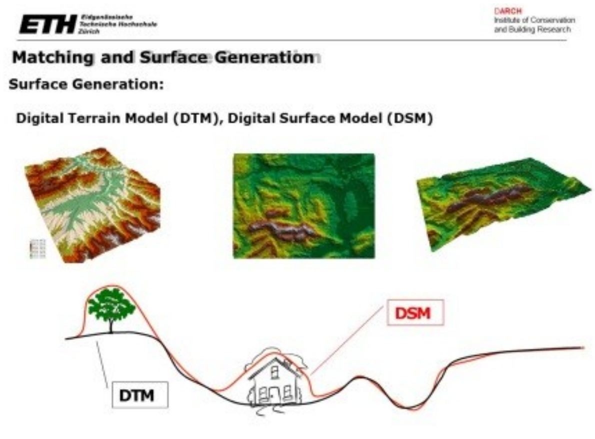
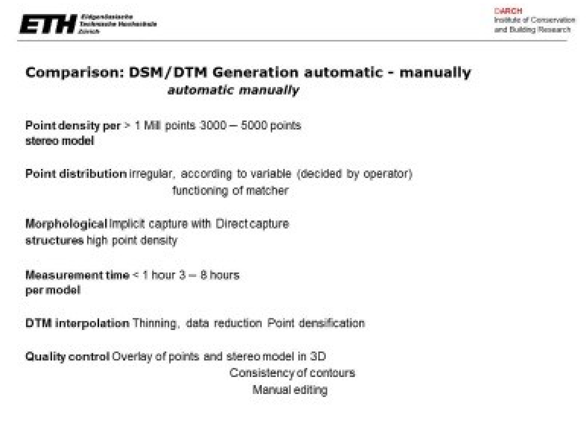
Hybrid model (DTM & buildings & texture)


Matching and Surface Generation
Surface Generation:
Digital Terrain Model (DTM), Digital Surface Model (DSM)
DSM
DTM


Comparison: DSM/DTM Generation automatic - manually
automatic manually
Point density per stereo model > 1 Mill points 3000 – 5000 points
Point distribution irregular, according to functioning of matcher variable (decided by operator)
Morphological structures Implicit capture with high point density Direct capture
Measurement time per model < 1 hour 3 – 8 hours
DTM interpolation Thinning, data reduction Point densification
Quality control Overlay of points and stereo model in 3D
Consistency of contours
Manual editing

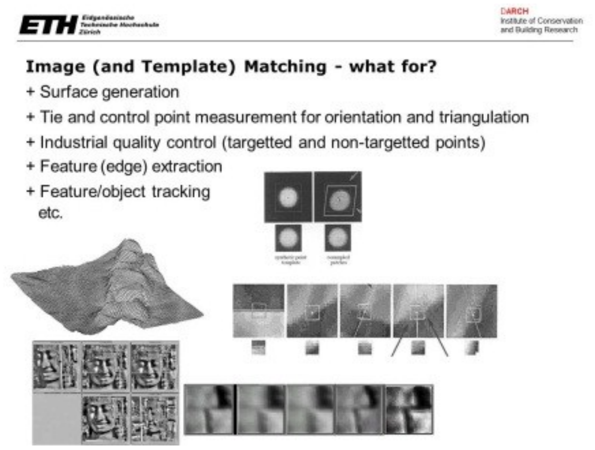
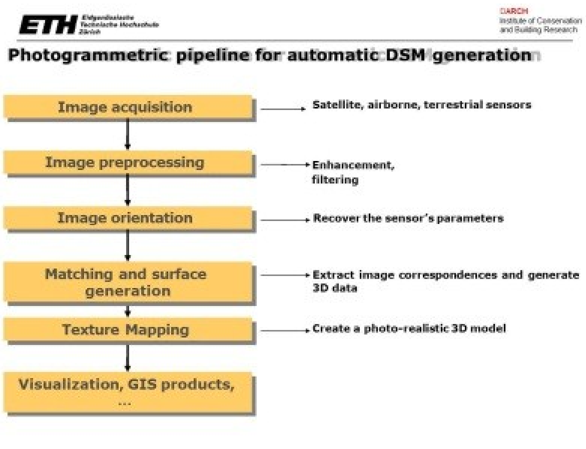
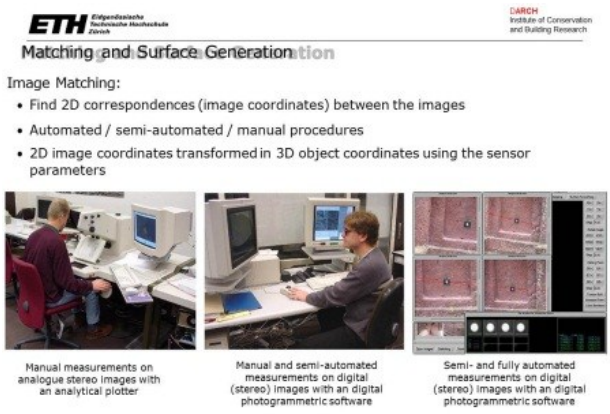
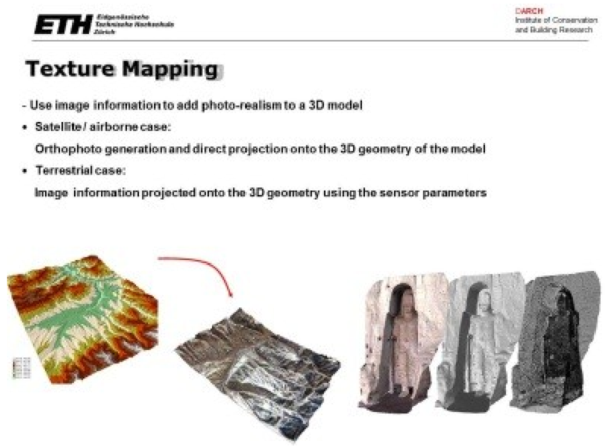


Image (and Template) Matching - what for?
+ Surface generation
+ Tie and control point measurement for orientation and triangulation
+ Industrial quality control (targetted and non-targetted points)
+ Feature (edge) extraction
+ Feature/object tracking
etc.

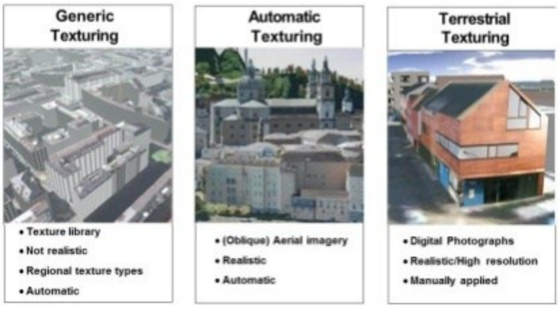

Photogrammetric pipeline for automatic DSM generation
Image acquisition
Satellite, airborne, terrestrial sensors
Image preprocessing
Enhancement, filtering
Image orientation
Recover the sensor's parameters
Matching and surface generation
Extract image correspondences and generate 3D data
Texture Mapping
Create a photo-realistic 3D model
Visualization, GIS products, ...


Matching and Surface Generation
Image Matching:
• Find 2D correspondences (image coordinates) between the images
• Automated / semi-automated / manual procedures
• 2D image coordinates transformed in 3D object coordinates using the sensor parameters
Manual measurements on analogue stereo images with an analytical plotter
Manual and semi-automated measurements on digital (stereo) images with an digital photogrammetric software
Semi- and fully automated measurements on digital (stereo) images with an digital photogrammetric software


Texture Mapping
- Use image information to add photo-realism to a 3D model
• Satellite / airborne case:
Orthophoto generation and direct projection onto the 3D geometry of the model
• Terrestrial case:
Image information projected onto the 3D geometry using the sensor parameters

Attribute: Texture

Levels of texture



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DSM generation by image matching

Major research issue in computer vision and digital photogrammetry for many years. Many different approaches have evolved.
Still not fully solved.
Three basic techniques:

a. Intensity-based
b. Feature-based
c. Relational

Intensity-based matching: Image data is used in form of grey values. Most prominent methods are cross-correlation and least squares matching (LS-matching). Also called "area-based" matching. Give subpixel accuracy, in extreme cases 1/10 pixel and better.
LS-matching is a highly non-linear process and requires therefore very good approximate values.

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Feature-based matching: Requires the extraction of basic image features, like blobs, corners, junctions, edges, etc. first. Matching is performed between these features. Features are sometimes more stable with regard to reflectance characteristics. Problem: Information which is lost during the feature extraction phase cannot be recovered any more.
Some methods provide for subpixel accuracy, but not at the level of the intensity-based methods.

Relational matching: Uses geometrical or other relations between features and structures (combination of features). Correspondence is established by tree-search techniques. These methods are not very accurate but usually robust. They do not require good approximations. Use in digital photogrammetry for DTM generation is rather scarce.
Descriptions of these various techniques in Lemmens,1988, Baltsavias,1991.

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The early approaches

Image Matching by cross-correlation
First- and second-order derivative matching
Relaxation methods
Segmentation and graph structure matching
Transform ('Hough transform') matching
Feature (edge) matching, etc.

Critical analysis by
Rosenfeld, A.,1984: Image analysis: problems, progress and prospects.
Pattern Recognition 17(1):3-12

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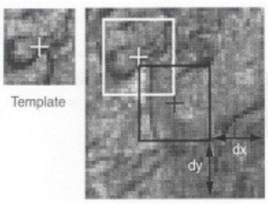
Crosscorrelation



Search window. The template is shifted over the window (black square). White square: location of best correspondence

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Crosscorrelation

[illegible]

with patch dimensions 2N +1, 2M+1
f, g ... greyvalues of template f and patch g
f, g ... related mean values of template f and patch g
x', y', x, y ... pixel coordinates of template and patch center in the original images

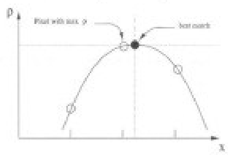

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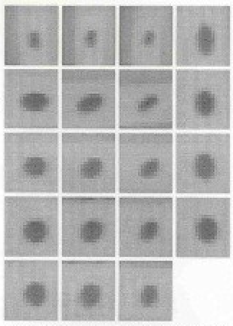
Image Matching by cross-correlation
The need of image re-shaping

Zheltov, S., Sibiryakov, A., 1997: Adaptive sub-pixel cross-correlation in a point correspondence problem.
Extension of cross-correlation by including image re-shaping (affine transformation)



Areas of the 19 images of target 1517 (second lowest target of rightmost rod).

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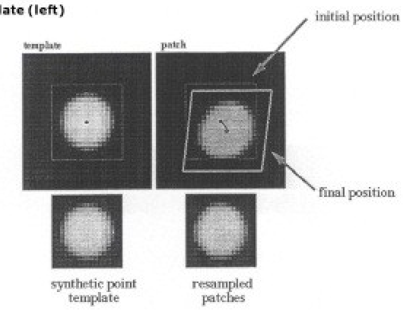
Least Squares Matching
5-parameter transformation of an image patch (right) to a disk-shaped synthetic template (left)



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The mathematical model of stereo-LSM

Observation equations:

f(x,y) -e(x,y) = g(x,y)

f(x,y)...template
image functions
g(x,y)...picture

Linearized:

-e(x,y) = $g_x AT_x$ + $g_x xAS_x$ + $g_x yAR_x$ + $g_y AT_y$ + $g_y xAR_y$ + $g_y yAS_y$ + $g^\circ(x,y)$ - f(x,y)

with g_x = 8g°(x,y) / 8x

63/ " = 6g°(x,y) I by

-e = Ax - **1** ;

e N(0, ^{Got} P^{-1}) ; **P** diagonal

Normal equations:

(A^TPA)2 - ATM = 0

Solution: = (A^TPAY^1ATP1

Covariance KXX = $_0$2(ATpA)-1

--> Iteration (Initial values!)

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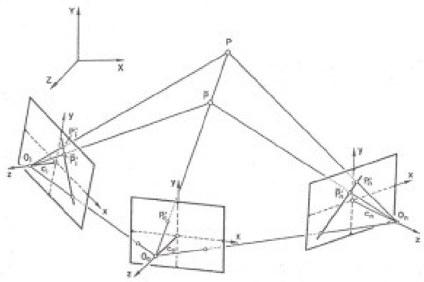
LS Multi-image matching – collinearity constraints

Template: Patch Po'

Pi' (i = 1,...,n) are found under consideration of the collinearity conditions



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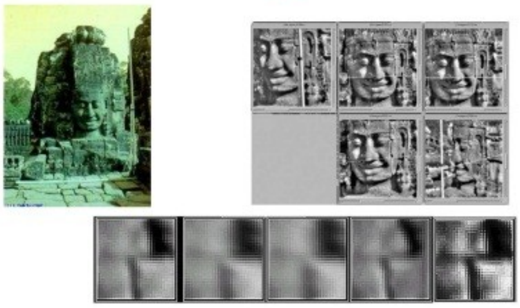
LS Multi-image matching
Example Bayon



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Problems in DTM generation

a. Little or no texture
b. Distinct object discontinuities
c. Local object patch is no planar face in sufficient approxim.
d. Repetitive objects, incl. vegetation
e. Occlusions
f. Moving objects, incl. shadows
g. Multi-layered and transparent objects
h. Radiometric artifacts, like specular reflections and others
i. Reduction from DSM to DTM

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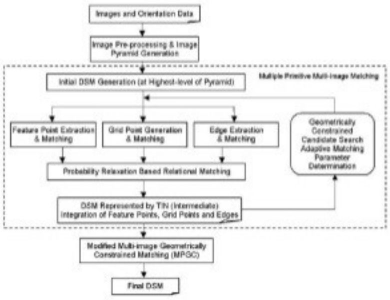
Solutions

Zhang, L., 2005. Automatic Digital Surface Model (DSM) Generation from Linear Array Images. PhD Dissertation, Report No. 88, IGP, ETH Zurich, Switzerland.



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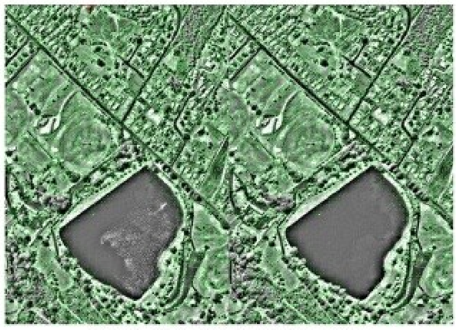
Example: Matched feature points



IKONOS Geo; Hobart, Australia; GSD: 1.0 m

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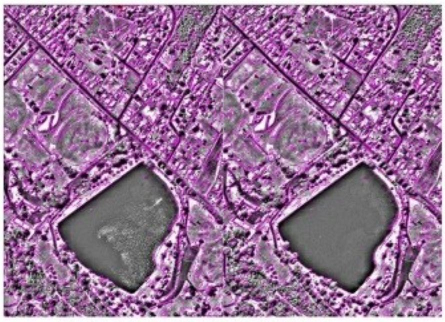
Example: Matched edgels



IKONOS Geo; Hobart, Australia; GSD: 1.0 m

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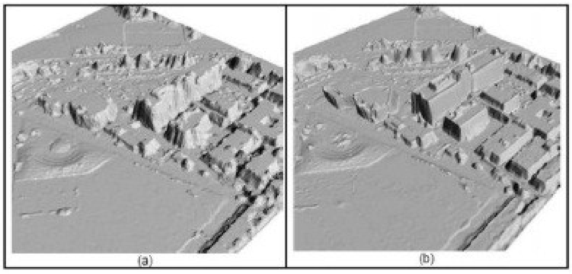
Image Matching –
With and without edges

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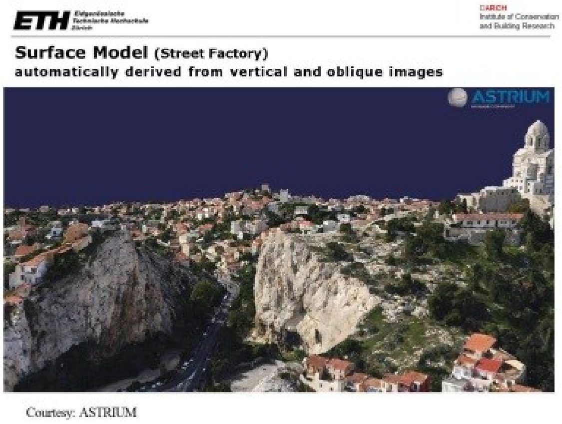
Points Edges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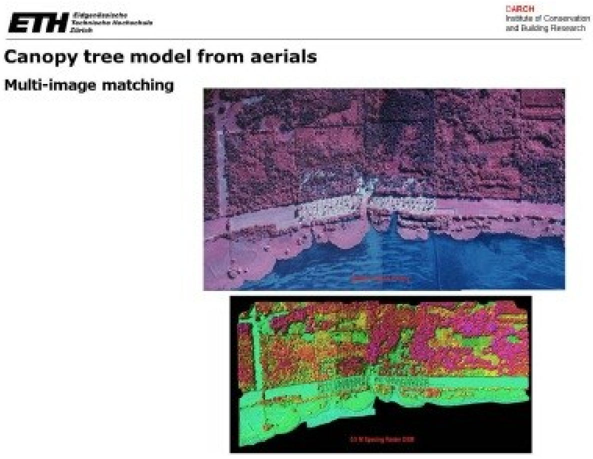
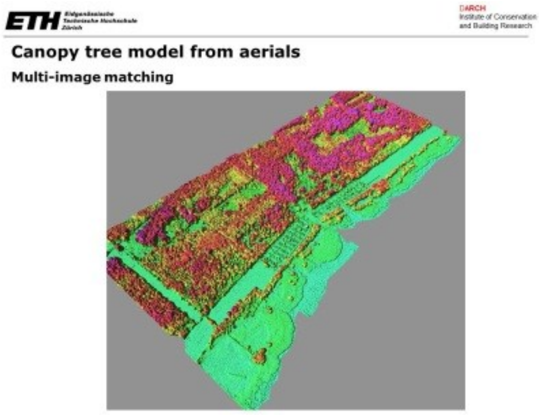
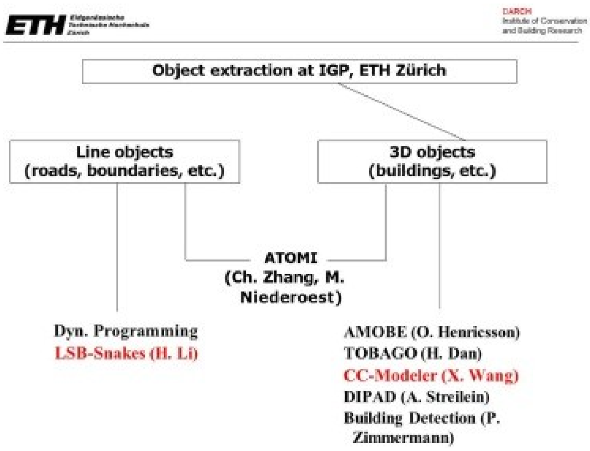
Surface Model (Street Factory)
automatically derived from vertical and oblique images
ASTRIUM
Courtesy: ASTRIUM


ETH
Canopy tree model from aerials
Multi-image matching


ETH
Canopy tree model from aerials
Multi-image matching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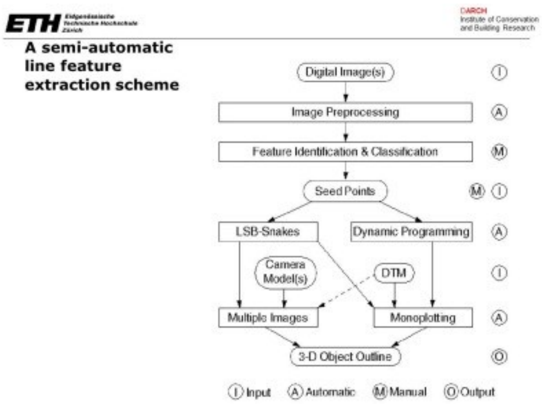
Object extraction at IGP, ETH Zürich
Line objects (roads, boundaries, etc.)
3D objects (buildings, etc.)
ATOMI (Ch. Zhang, M. Niederoest)
Dyn. Programming
LSB-Snakes (H. Li)
AMOBE (O. Henricsson)
TOBAGO (H. Dan)
CC-Modeler (X. Wang)
DIPAD (A. Streilein)
Building Detection (P. Zimmermann)


ETH
A semi-automatic line feature extraction scheme
Digital Image(s)
Image Preprocessing
Feature Identification & Classification
Seed Points
LSB-Snakes
Dynamic Programming
Camera Model(s)
DTM
Multiple Images
Monoplotting
3-D Object Outline
I Input
A Automatic
M Manual
O Output

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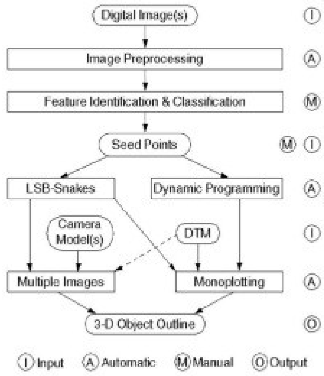
A semi-automatic line feature extraction scheme



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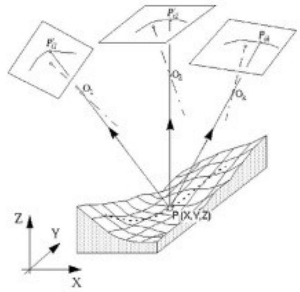

Multiple images arrangement for 3-D LSB-Snakes. The line feature is represented by 3D B-splines in object space and a sequence of points in the images.

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The Concept of LSB-Snakes

- B-spline representation for the Snakes
- Least squares estimation with
  - + Photometric observations (imaging model)
  - + Geometric observations (expected geometry of curve)
  - + Observations for boundary conditions (e.g. seed points)

==> Estimation of spline parameters for object description (3D space)
Including internal quality control (Covariance matrix)

Traditional Snakes formulated as a variational problem

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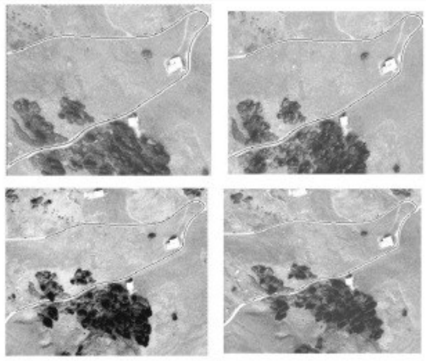

Extracted road centre line

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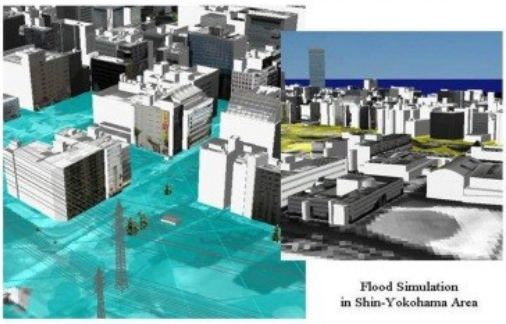
City 3D Modeling assisted with CC Modeler



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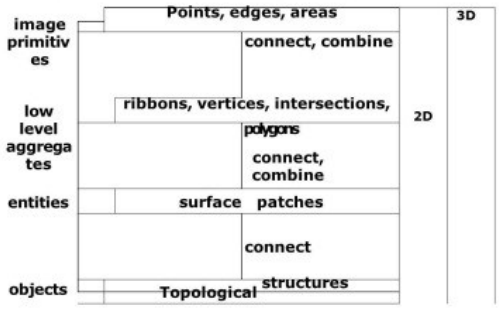
Object extraction: Processing strategies



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Problems with automated building reconstruction

+ Image interpretation
+ Automated control of level of detail
+ Correct topology

Currently: No progress in automated image interpretation
Way out: Multi sensor/data concept

Therefore: Development of semi-automated approaches

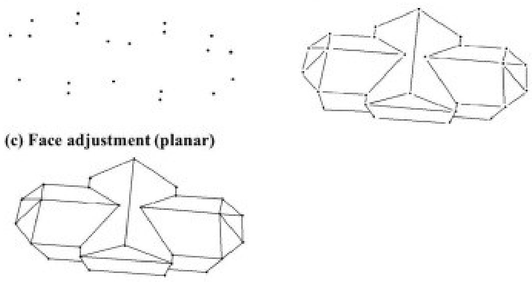
Major problem: Quality control !!!

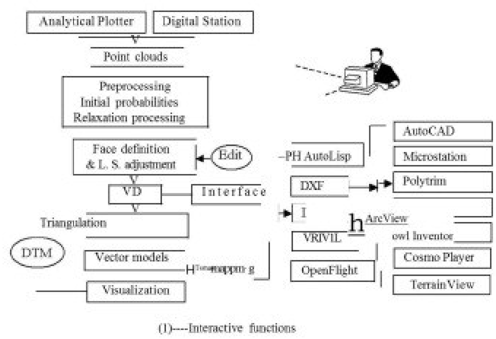
3D City Modeling

CyberCity Modeler (CC-Modeler), *Gruen, Wang, 1998*
- semi-automated
- images (satellite, aerial, terrestrial)
- polyhedral world (buildings, roads, waterways, bridges, trees, DTM)
  Commercial software (CyberCity AG, Zurich, Los Angeles, Lingtu)
  > 2 000 000 buildings, worldwide
- Main applications: City planning, environmental modeling, facility management, car navigation, archaeology, cultural heritage, Google Earth, etc.

Pointcloud Structured and adjusted roof faces

a) 3-D Pointcloud (b) Face assignment (non-planar)





CC-Modeler: ETH Zurich, Main Campus

Planning

Flyover

Industrial plant

CBA2013-05NSY-Sutrisno-FINAL REPORT

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Hamburg, Google Earth (courtesy: CyberCity AG)

Google Earth, Hamburg

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Florence, Italy

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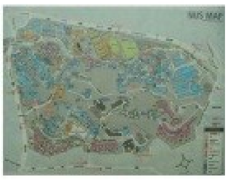
SEC-FCL project – UAV over NUS campus

Singapore – ETH Centre for Global Environmental Sustainability

Future Cities Laboratory (Simulation Platform)



2.2 km2

109

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SEC-FCL UAV NUS campus flight

Take-off and landing stations

CREATE take-off

Falcon roof landing

Education Resource Centre CREATE Tower

110

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4x4 image block University Hall

4x4 block

P-Centres total block

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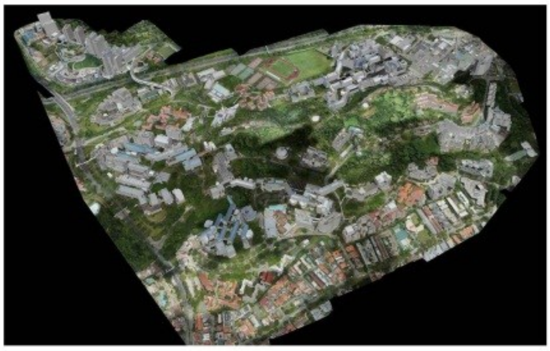
NUS model - overview



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CREATE building

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NUS Campus — Flyover geometry

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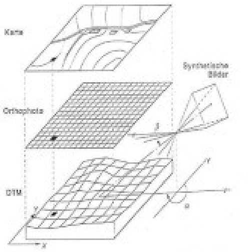
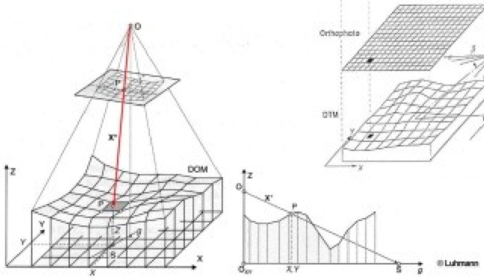
Ortho-image, differential rectification





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Procedures

Given: Orientation original image
DTM

Pixeltransformation:
a. Orthophoto > DTM > Original image
(Raster) (Raster) (Raster)

a. Original image > DTM > Orthophoto
(Raster) (arbitrary) (arbitrary > Raster)

Ad (b): Time consuming
1. Intersection imaging ray x DTM
2. Unsorted field of orthophoto pixels > pixelraster must be interpolated

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Ad (a): More elegant

1. DTM Interpolation for position of orthophoto pixel location
2. Backtransformation into original image
3. Greyvalue must be computed (interpolated) in the original image

(a) Perspective Pixeltransformation

Every single pixel is transformed

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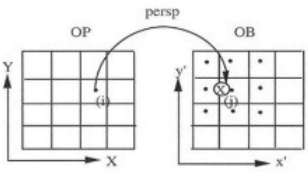
Pixeltransformation



For each pixel a new grey value must be interpolated, e.g. by affine, bilinear, projective interpolation, using the surrounding 4 supporting points

Algorithm can be parallelized !

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Accuracy of ortho-images

- Good conditions: Better than 1 pixel
- Orthoimage resolution □ not more than resolution of original image
- Important error sources: DTM, orientation

Orthoimage from DTM Orthoimage from erroneous DSM

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Accuracy of ortho-images: Non-DTM objects

- Buildings, bridges, trees, etc. are radially displaced
- Reduction of errors: Long c, use only central portion of image
- Post-correction □ Result is "True Orthophoto"

Orthoimage – image perimeter area True Orthoimage True Orthoimage – overlay with vectors

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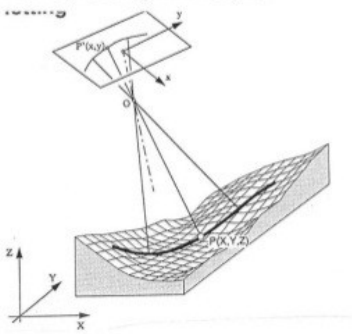
Monoplotting: Principle



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Monoplotting

Applications: Whenever not high accuracies are requested and a simple method is preferred. Also, when only a single image is available.

Principle:

Combination of single image and DTM

a. Measurement of objects in the singe image (□ x,y)
   + Manually
   + Semi-automatically
a. On-line computation of object coordinates (□ X,Y,Z)

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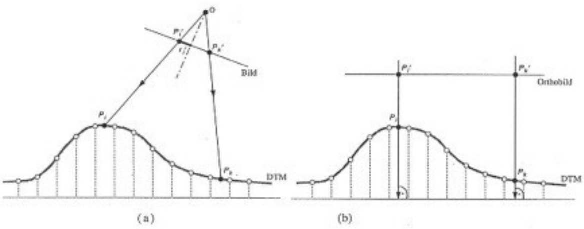
Monoplotting: Principle



a. Combination original image /DTM
b. Combination ortho-image/DTM

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In case (b) (ortho-image) the computation of P_i is very simple. The ortho-image delivers implicitely for every image point akready the object coordinates X_i , Y_i. Only the corresponding height Z_i must be extracted from the DTM. This is done by interpolation.

There are several options for the interpolation formulae. Recommended is a bilinear interpolation, because it is a good compromise between quality of approximation and computing time.

It is a surface of second order (hyperbolic paraboloid), whose generating elements are straight lines.

Normally only the j = 1, ...,4 adjacent DTM supporting points are used. Are those on a regular grid, the computation is particularly simple and fast.

In case (a) however the projecting ray OP_i' must be intersected with the DTM. There are 2 possibilities:

1. Local modeling of the DTM by analytical functions (e.g. by a polynomial). Analytical computation of the intersecting point. Dependent on the quality of the first approximation this procedure must be iterated.
1. Iteration in the discrete DTM

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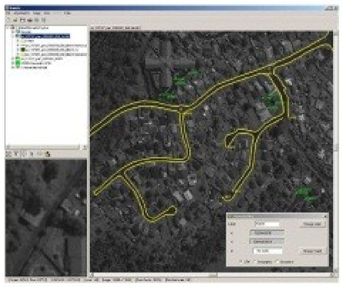
Monoplotting: 3D mapping of points and linear features



Measure single points in monoplotting mode using one image in combination with DTM

Measure polylines/closed polyline in monoplotting mode

 3D mapping of points and linear features

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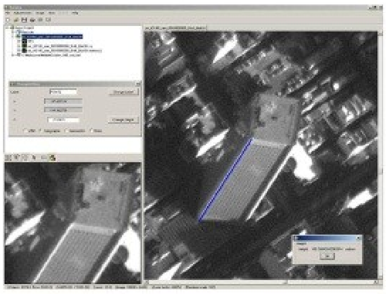
Height measurement of buildings by monoplotting



Measure ground point using one image in combination with a DTM
 XYZ

Measure roof point
 Z from intersecting projection line and XY

 Height ΔH

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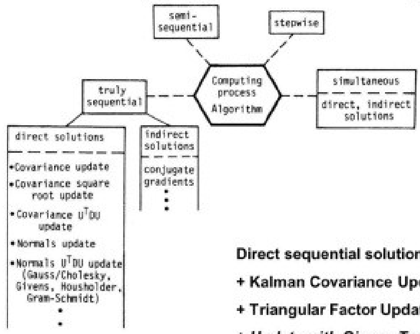
Options for the computing process in On-Line Triangulation



Direct sequential solutions

+ Kalman Covariance Update

+ Triangular Factor Update (TFU)

+ Update with Givens Transformations

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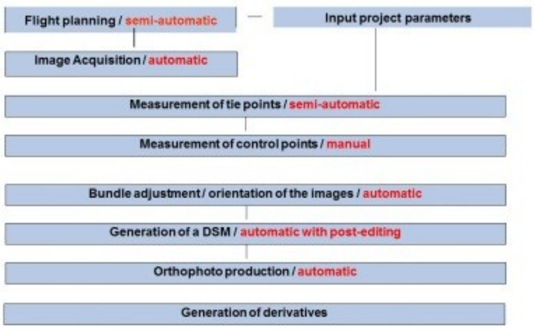
Current photogrammetric workflow



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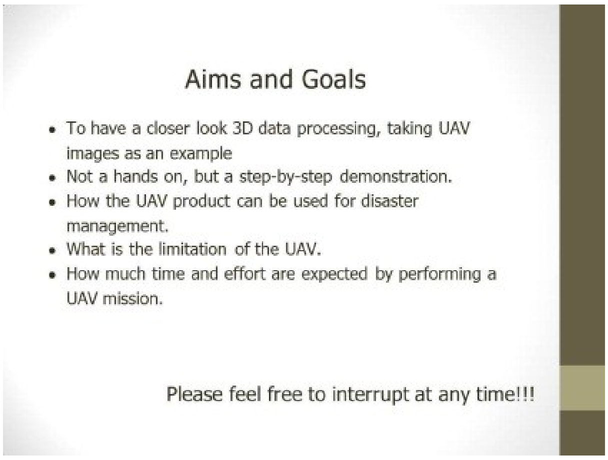
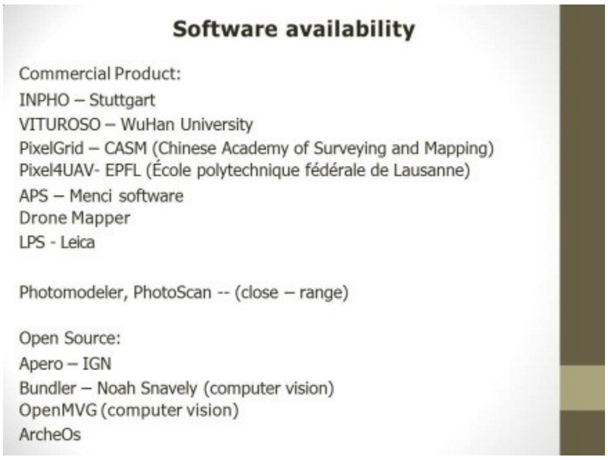
Conclusions

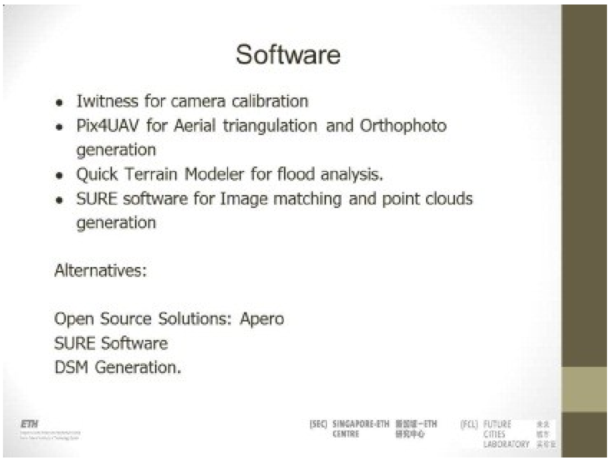
+ Variety of digital sensors available with on-line and real-time capabilities
+ *Problems*
  - development of automated and fast methods for data processing and information extraction
  - logistics and organization of data acquisition, processing and communication
  - **suitable data for the "before status" not available**

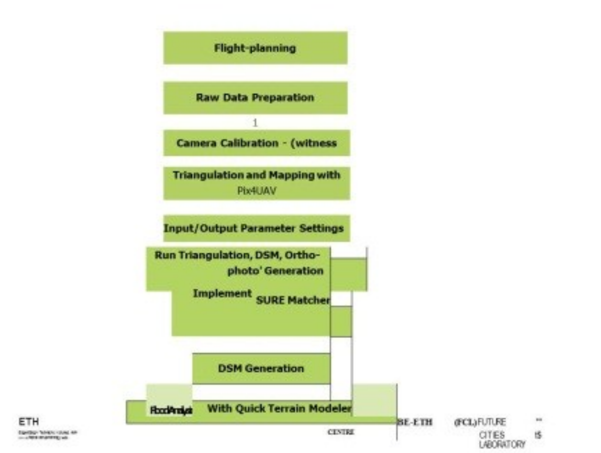
+ Fast damage assessment on regional and local scale is realistic for the near future
  But: Detailed damage analysis?

h. Technical training Of high Resolution images: Automated triangulation, DSM generation, Ortho-image generation: Rongjun Qin

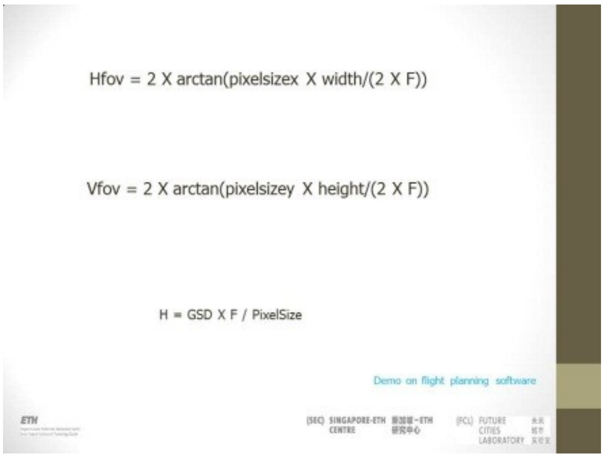


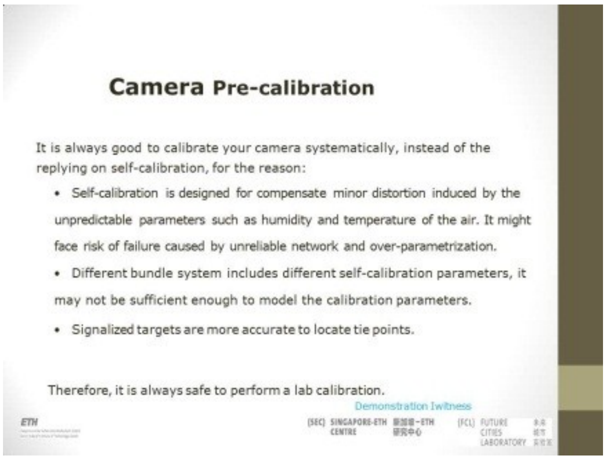


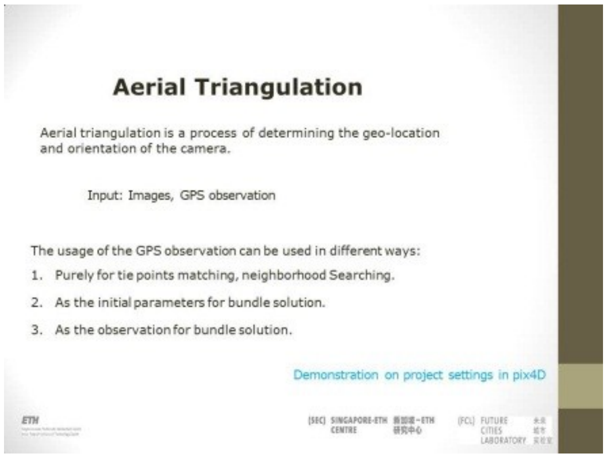


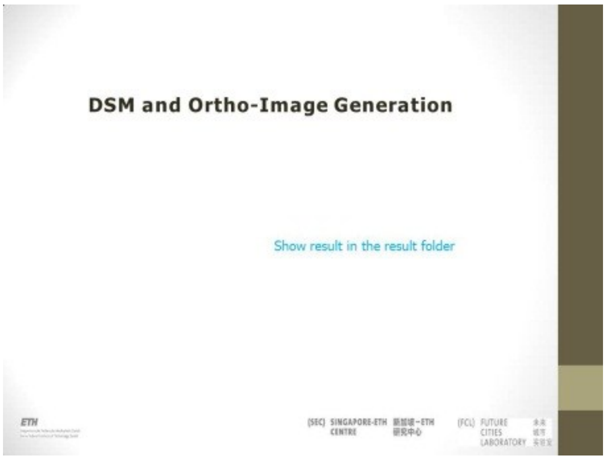


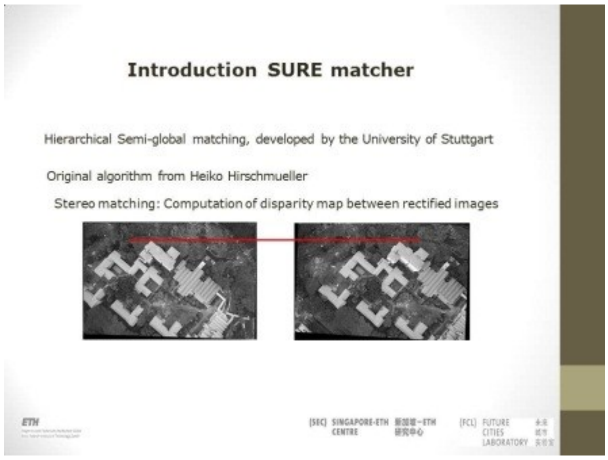

Flight Planning – parameters
• Focal length
• Pixel size
• Flying height
• GSD (Ground Sampling Distance)
• Overlap


Hfov = 2 X arctan(pixelsizex X width/(2 X F))
Vfov = 2 X arctan(pixelsizey X height/(2 X F))
H = GSD X F / PixelSize
Demo on flight planning software


Camera Pre-calibration
It is always good to calibrate your camera systematically, instead of the replying on self-calibration, for the reason:
• Self-calibration is designed for compensate minor distortion induced by the unpredictable parameters such as humidity and temperature of the air. It might face risk of failure caused by unreliable network and over-parametrization.
• Different bundle system includes different self-calibration parameters, it may not be sufficient enough to model the calibration parameters.
• Signalized targets are more accurate to locate tie points.
Therefore, it is always safe to perform a lab calibration.
Demonstration Iwitness


Aerial Triangulation
Aerial triangulation is a process of determining the geo-location and orientation of the camera.
Input: Images, GPS observation
The usage of the GPS observation can be used in different ways:
1. Purely for tie points matching, neighborhood Searching.
2. As the initial parameters for bundle solution.
3. As the observation for bundle solution.
Demonstration on project settings in pix4D


DSM and Ortho-Image Generation
Show result in the result folder


Introduction SURE matcher
Hierarchical Semi-global matching, developed by the University of Stuttgart
Original algorithm from Heiko Hirschmueller
Stereo matching: Computation of disparity map between rectified images

$C\, p, D_p = Lp - (R) - D_p(l)$)

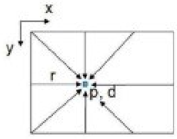
Pixel-wise matching is not unique. Therefore add additional cost (penalty) on the disparity steps (discontinuity):

$E(D) = \sum EC\, p, D_p + {}_{ae(p)EPT}\, D_p \# D_s(2)$ [ ]

Semi Global Matching

Optimization of Equation (2) NP-hard

Semi-global strategy: as an extension of dynamic programming, it reduces 2D global optimization into multiple 1D directional dynamic programming.



$E = E_r$

Image is adopted from Heiko Hirschmüller's presentation

Hierarchical Semi-global Matching

Traditional Semi-Global matching: require large memory storage, computation time on normal computer. For UAV images, the disparity level easily goes up to more than 1000, which require memory for M X N X D for computation.

Wenzel et al: Perform it hierarchically, from a coarse level to a finer level, the disparity searching ranges comes from the former level.

It is a stereo-matching algorithm, point clouds are generated for every stereo model, the result of the multiple models are fused as a post step.

SURE Demonstration

Resample point clouds into grid raster

DTSMSample Demonstration

Application of UAV product

- Geometry analysis
-Simulations, risk analysis
-Detail inspection on single buildings
-information to rescue teams.

Demonstration: Quick Terrain modeler

3D polygonal models of individual buildings

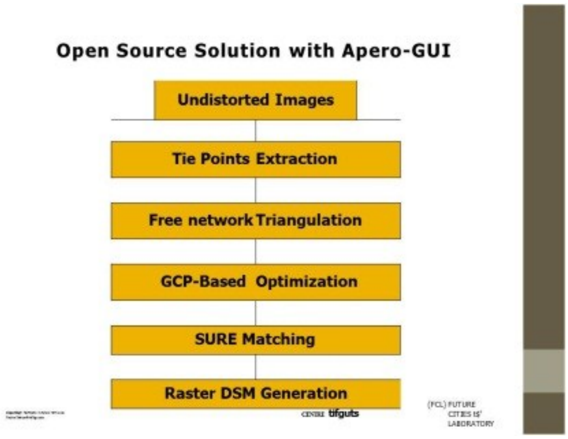
Stereo – measurement of key points (stereo analyst of Erdas)

CC-modeler for modeling, CC-edit and 3D max. for post-editing

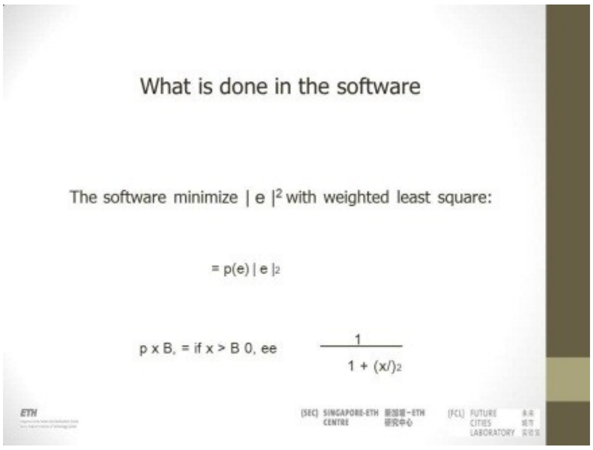
Automatic Texture mapping, post-editing for trees.

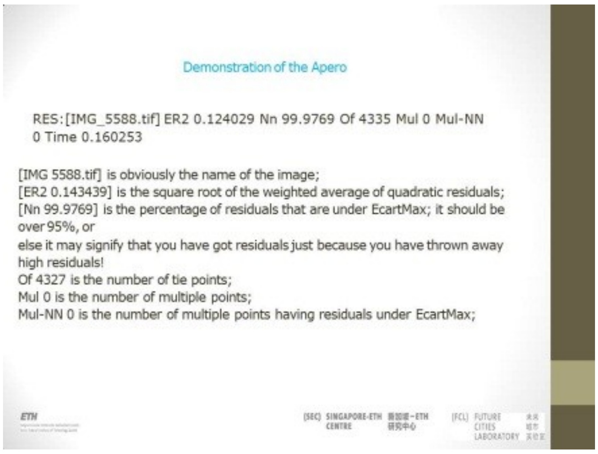
3D Models of NUS Campus


An Alternative solution – Open source
Apero software – Aérotriangulation Photogrammétrique Expérimentale Relativement Opérationnelle
Windows, Linux, MacOS

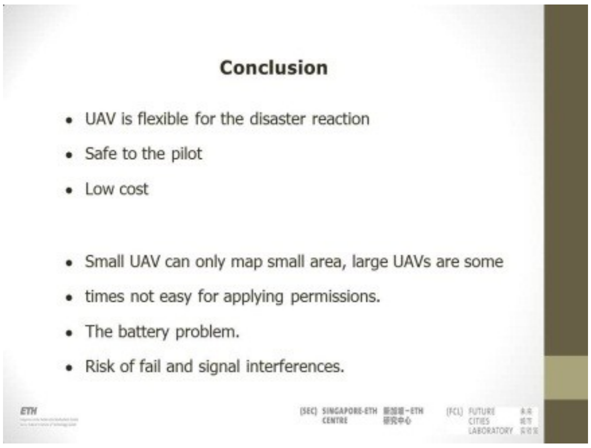

Open Source Solution with Apero-GUI
Undistorted Images
Tie Points Extraction
Free network Triangulation
GCP-Based Optimization
SURE Matching
Raster DSM Generation


Tie point extraction
GPS information is purely used for pair-wise tie points matching.
1. Automatic determination of the pair-wise matching –
3 times average neighboring distance are used for searching neighborhood.
1. Line based extraction mode
2. Multi-scale based exhaustive search.


What is done in the software
The software minimize | e |2 with weighted least square:
= p(e) | e |2
p x B, = if x > B 0, ee
1
1 + (x/)2


Demonstration of the Apero
RES:[IMG_5588.tif] ER2 0.124029 Nn 99.9769 Of 4335 Mul 0 Mul-NN 0 Time 0.160253
[IMG 5588.tif] is obviously the name of the image;
[ER2 0.143439] is the square root of the weighted average of quadratic residuals;
[Nn 99.9769] is the percentage of residuals that are under EcartMax; it should be over 95%, or
else it may signify that you have got residuals just because you have thrown away high residuals!
Of 4327 is the number of tie points;
Mul 0 is the number of multiple points;
Mul-NN 0 is the number of multiple points having residuals under EcartMax;


Demonstration of inspection on buildings in 3D (create building)


Conclusion
• UAV is flexible for the disaster reaction
• Safe to the pilot
• Low cost
• Small UAV can only map small area, large UAVs are some
• times not easy for applying permissions.
• The battery problem.
• Risk of fail and signal interferences.
ETH
(SEC) SINGAPORE-ETH CENTRE
(FCL) FUTURE CITIES LABORATORY

e. Financial support Participants Closing Notes

1. Mr.Anugrag Aeron
Research Student
Center of Excellence in Disaster Mitigation and Management,
Indian Institute of Technology Roorkee,
INDIA

Firstly, I am extremely thankful to the APN and ACRS for providing me funding and opportunity to be a part of the most respected and highly recognized Asian Remote Sensing Conference. I got chance to meet several people to discuss about their research work and also their culture. It is a giant platform to share the knowledge.

On the very first day, Dr. Ryoichi Furuta gave the introduction to Japanese new Earth observing satellite ALOS-2. He explained the Advance Land Observing Satellite (ALOS) and Panchromatic Remote Sensing Instrument for Stereo Mapping (PRISM), their properties and comparisons with Advanced Visible Near-Infra Red Radiometer AVNIR-2, Phased Array L-band Synthetic Aperture Radar (PALSAR). ALOS project is used mainly for Disaster Monitoring, Land Monitoring, Agriculture Monitoring, Natural Data Exploration and Global Forest Monitoring. PALSAR-2 will provide a very high resolution of upto 3 m. These satellites have tremendous potential for developing disaster management projects. Forestry monitoring, global warming are the hot topics among disaster managers. There is also a discussion about L-band NRLS which is mainly used for monitoring oceanic plantation cycle. The new method of combining Hyperspectral and SAR images was discussed.

All these remote sensing technologies are highly useful in disaster mitigation and management. I hope that these high resolution imaginaries will provide more and more accurate predictions for future disasters. The merging of different technologies will provide new dimensions to the research and projects for disaster mitigation.

Especially the flood trend will increases in the future because of global warming. There are flood analysis methods but there are little methods for preventing the flood. A web GIS for Mekong delta may be a good example. The landslide monitoring and prediction is also very difficult. India is a big country, so there are all types of natural disaster happening every year. Earthquake, landslide, flood, forest fire, volcanic activity, cyclone, high wind etc. are common in India. India needs a very high level of preparation for mitigating these types of disasters. Effective planning and implementation of strategies are required from top to bottom level. The remote sensing and GIS technologies will provide great solutions to the disaster managers.

Prof. Armyn Gruen discussed the photogrammetry, multisensor technology, UAV, real-time processing, DTM/DSM generation etc. A discussion for disaster response planning, damage monitoring, UAV photogrammetry and 3D modeling was done. He also showed the project which used the UAV photogrammetry and discussed the results for damage assessment. Mr.RongJunqin presented the demo of this project. It is a new method and also very difficult to implement but the results are more accurate for disaster management and planning. I hope it will be very beneficial if the project will become economically viable.

I may assure you that the research going in the field of disaster mitigation and management will definitely be beneficial for the people and the world. The remote sensing and GIS are the key tools for monitoring the earth climate. The new and high resolution satellite images will give more accurate results and the new methods will facilitate to mitigate the disaster.

Again I am very thankful to APN and ISRS/MAPIN for providing me such a great opportunity to be a part of the ACRS family.

Thank you, With regards
Anurag Aeron
Research Student
Center of Excellence in Disaster Mitigation and Management,
Indian Institute of Technology Roorkee,INDIA

2. Ms.Anjillyn Mae Cruz Perez
Department of Geodetic Engineering
University of the Philippines, Diliman
PHILIPPINES

It has been a great honor for me to be chosen as one of the participants in the Multi-sensor Remote Sensing Technology for Sustainable Disaster Management Workshop, not only because of the ACRS 2013 full-funding support that came with it, but mostly because of the excellent learning experience that I have attained from the speakers, Dr. Ryoichi Furuta and Prof. Em. Armin Gruen.

The things that I have learned from Dr.Furuta about SAR technology and Dr.Gruen about LiDAR and

photogrammetry applications for disaster management will be very helpful first, in our disaster mitigation projects handled by the University of the Philippines and the Department of Science and Technology. The Disaster Risk Exposure Assessment and Mitigation (DREAM) project is basically an integration of LiDAR and photogrammetry to derive 3D maps of the 18 river basins in the country. The use of SAR data will also be incorporated to better map the regions since radar can pass through clouds and can be used even in adverse weather. The knowledge shared to us by the speakers gave me more insight on the project.

Another benefit that I got from the workshop is related to my teaching profession. Being an Assistant Professor from the University of the Philippines, I can transfer and share the knowledge that I obtained from the speakers for them to better understand and appreciate the topics on Photogrammetry as well as LiDAR and Radar Remote Sensing.

I hope that the workshop will still be offered in the succeeding ACRS so that the participants can learn more about the different technologies beneficial not only in disaster mitigation, but in other applications as well.

With this, I am very much thankful to the Workshop's Organizing Committee headed by Dr.DewayaniSutrisno, as well as the Asia Pacific Network (APN) for allowing me to participate in the workshop, and also to Dr.Furuta and Prof. Em. Gruen, for the invaluable knowledge that you have imparted to all of us.

Regard
Anjillyn Mae C. Perez, MSc.
Department of Geodetic Engineering
University of the Philippines, Diliman

3. Ms.Ati Rahadiati
PhD Student
Faculty of fisheries and marine sciences –
Bogor Agricultural University,
INDONESIA

It is really a great honor for me to attend "Multi-sensors Remote Sensing Technology for Sustainable Disaster Management" workshop in Bali. I thank to all of the committee that give me change to attend this workshop and the 34th Asian Conference on Remote Sensing.

I do believed, the content of the workshop is very worthwhile for me, either for my study or for my jobs. I work as the earth science scientists in Indonesia that will always be need the remote sensing technology. Nowadays, the need for more detail data is urgently needed for me to get the accurate information. Fundamental introduction and tutorial demonstration that I have gotten from this workshop are very useful in my day to day work and study. Especially when the rapid mapping is urgently needed for my countries that has lot of disasters. This technology will assist not only me but also our countries dealing with those disaster problems. So, we can manage, observe and protect our nations in such as way that will mostly save our people.

Thank you very much for giving me a change to attend this workshop and the whole 34th ACRS events

Regard
Ati Rahadiati
Faculty of fisheries and marine sciences –
Bogor Agricultural University, Indonesia

4. Mr. Bui Quang Thanh

VNU University of Science, Viet Nam National University
Ha Noi
Viet Nam

The Workshop entitled "Multi-sensors Remote Sensing Technology for Sustainable Disaster Management" that covered the Japanese new Earth Observation Satellite program and applications of AlOS family products for Global Change Management, Climate Change induced Disaster Monitoring. The second part focussed on Data acquisition in Photogrammetry, data processing and applications of UAV in 3D modelling.

It was one of the best workshops I have been to. Fundamental introduction and tutorial demonstration were useful in my day to day work and I can use the skills in my job. The instructors were friendly and approachable trainers, and it was great to hear practical experiences and examples. They were very knowledgeable on the subject matter and I enjoyed the discussion sessions. This was an excellent opportunity to obtain knowledge about multi-sensors remote sensing. Each participant, represents a different discipline, and it is the actors themselves, directly involved in the daily discussion, who are best qualified to determine, in practice, the best path to be followed

*It can be reaffirmed that, shared by all participants of the discussion moments, the ALOS radar products and UAVs would be useful in Disaster management and*rapid response to disaster, which can be used as decision support devices for urgent rescues.

Having worked in the research and teaching institution with main focuses on application of spatial technology for sustainable use of natural resources, I am deeply aware of comprehensive skills that are required to guide students and to conduct relevant research projects, in particularly, the uses of coming AlOS data and high resolution images from UAVs. I will firstly use what I learn from the training course to lead the lectures with theories and new practices and to seek for cooperation with local training institutions for further wide spreading of the learnt knowledge. Second thing I will seek for international and local fund to conduct researches in provinces which are most vulnerable to Disasters. Of all mentioned activities I will definitely try to involve participation of local communities to final decision of issues relating to climate change induced natural disasters.

Bui, QuangThanh
VNU University of Science, Viet Nam
Email: qthanh.bui@gmail.com

5. Ms. Christmas de Guzman

Asia-Pacific Network for Global Change Research; UPLB
East Building, 4F
1-5-2 Wakinohama Kaigan Dori
Chuo-ku, Kobe 651-0073
JAPAN

6. Mr.Dadan Ramdhani

Msc Stundents
Bandung Institute of Technology
Jln Ganesha- Bandung
INDONESIA

Having worked in the research and as the student with main focuses on application of spatial technology, I am deeply aware of comprehensive skills that are required to guide me and to conduct relevant research projects. In particularly, the uses of high resolution images from, either from Alos-2 or UAVs. I hope the theories from the training course will lead me to the new practices to advance my research in the development the rapid survey equipment, the research that I has been worked on.

Thank you very much for giving me a change to attend this workshop and the whole 34th ACRS events

Regard
DadanRamdhani

Bandung Institute of Technology
JlnGanesha- Bandung

7. Ms. Hang Nguyen thi Thuy
VNU University of Science, Vietnam National University
Hanoi
VIETNAM

Fundamental technology ALOS-2 data for global change and disaster management: Interesting. I like the video of ALOS activities much. Lots of information for ones who do not know yet about ALOS. For someone who use ALOS already, the tutorial part is more attentive.

Tutorial: This is the part I love most about the lecture. There is a lot of information and experience. I hope I can use radar data in my research in the future

Multi-sensor remote sensing technologies for disaster management: Quite a lot of information. I love the demo videos about hazard models. Very promising. It gives me many ideas for preparing lecture for student

Data acquisition in Photogrammetry- concept and systems satellites, standard aerial,UAV, and terrestrial approach: Very informative. However, I think the lecture focused much on technical issues of photogrammetry, there are many equations, formula that made the lecture seem like for a long course study. If possible, detail equation of georeferencing and the like could be shorter and more sharing knowledge of application

The photogrammetric data processing pipeline: Very interesting. The idea of UAV is not new to me but I never have experienced the processing of UAV images. I will research more about the UAV

My general comments:

I would like to express my great gratitude to the APN, the IASS, the AARS, and our lecturers, Dr. Ryoichi Furuta, Prof. em Armin Gruen and Mr. Qin Rongjun for providing us a very precious opportunity to attend the workshop and gain a lot of knowledge about remote sensing, particularly, multi-sensor image processing.

The lectures and presentations are very interesting and I love it much. However, I think perhaps we should have a fixed agenda and if possible next time, the lecturers may have sent participants several questions about their knowledge, experience, expectations of the topics so that in the workshop we would have more interactive environment among participants and lecturers. If possible, it would be great if participants were introduced to some literatures (articles, books, project, etc) related to the workshop topic.

For my own objects as a lecturers, I think I could derive new understanding and knowledge to share with my students.

Thank you very much,

Hang Nguyen thiThuy
VNU University of Science, Vietnam National University, Hanoi

8. Mr.Heru Sulistyo
Student of Informatics management university
Bina Sarana Informatika
INDONESIA

As a student that work in technology management and as an staff in the air force, the theories and lecture that I've gotten from this workshop are very worthwhile to support my jobs and my study

I do realize the importance of the lecture in this workshop to support me in emergency respond and recovery processes if any disaster occur. I do learnt the location of disaster damage and the level of dangerous of the area if any disaster occur. I do hope more field practises and how to digitally process the lab will be train to me in the next future.

Beside that, meeting the remote sensing stakeholders and the leading scientists from all over the world are really a great opportunity for me, so I can make a network with them and so does the workshop participants for future cooperation

Thank you very much for the change to attend the workshop and 34th ACRS 2013. Hope I will have a change to participate of the training or workshop.

Regard
HeruSulistyo
Informatics management university- Indonesia

9. Mr.Hua Su
Xiamen University
CHINA

Thanks very much for your great efforts on the ACRS2013, it should be a successful conference. I feel quite glad and honour to come here as a APN awardee, and feel so happy and exciting to attend the workshop and the excursion. This is my first time I attend ACRS, and also the first time I come to Indonesia Bali. The conference and the workshop are really nice, and Bali is actually amazing island, the beautiful scenes and the warm and courteous people here attracted me deeply, I like here so much.

From the conference and the workshop, I get more informations about the multi sensors remote sensing technology, and aslo learn how to use the RS technology for sustainable disaster management, such as ALOS-2 satellite applications and DTM/DSM generations. In addition, I also meet and make lots of friends from different Asian countries through the meeting and presentation, talking and communication with them are unforgetable experiences, we learn from each other, not only the knowledge but also the special cultures from different regions and respective country, that's so interesting.

At last, I sincerely wish you a very successful conference! Thank you very much for your efforts and the finance support.

Best wishes,
Hua Su
Xiamen University – China

10. Ms.Intareeya Sutthivanich
Suranaree University of Technology
Nakhon Ratchasima
THAILAND

It is a great pleasure for me to write this closing note for the multi sensors remote sensing technology for sustainable disaster management workshop that held on 20-24 October 2013 in the 34th ACRS, Bali, Indonesia.

The workshop focused on disaster management in order to mitigate the disasters that will degrade the Asia Pacific environment by applying remote sensing new technologies such as high resolution images, SAR, GEOSS, and etc. The lectures and case studies have enhanced my background knowledge very much. This workshop was very fruitful not only personal point of view but also from a professional point of view. I believe participates have gained the knowledge and new experiences from sharing this participation. I really appreciate the lecture that full of good foundation of theories. I wish we will have this kind of workshop again in the next ACRS conference since it provides, enhances and alerts awareness to protect and restore the health of our environment by using remote sensing technology tools.

I would like to express my deep gratitude to APN, all lecturers (e.g. Dr.Eisuke Koizumi, Prof. em. Armin Gruen) and also special thank to Dr.Dewayany Sutrisno and Ati Rahadiati for hospitality in Bali. The workshop and technical excursion will be one of my best memorable times in Bali, Indonesia always.

Best regards,
Intareeya Sutthivanich
Suranaree University of Technology
Nakhon Ratchasima, Thailand.

11. Mr.Junyi Huang
Department of Geography, Hong Kong Baptist University
HONGKONG CHINA

I'm particular gratitude to the Asian-Pacific Network for Global Change Research (APN) and Indonesian Society for Remote Sensing (MAPIN/ISRS) for providing funding support for me, to attend this extraordinary workshop and the ACRS 2013.

The participants span a wide geographical origin that makes this event diverse, I know many of them in the workshop and we talked about our own project topics. We all have similar research interest, using remote sensing technique to address the natural disaster or environmental problem and enjoy the scholarly idea exchange.

The arrangement of workshop is also very successful. The content not only include lecture that deliver the fundamental knowledge, but also the tutorial sessions that provides many amazing demos.

As a master student with a background of geography, I received fruitful training in the past 1.5 days, including the training of image processing from the photogrammetry perspective, and the building of 3D model in the city. Also, the introduction of ALOS-2 satellite by JAXA also brought me new knowledge of earth observation technique. These training are of particular benefit to my thesis project, using remote sensing data to map the landslide susceptibility.

Thanks again to the organizations, committee, organizing persons and lecturers.

Regards,
Junyi Huang
Department of Geography, Hong Kong Baptist University

12. Mr.Krisna Prasad Bhandari

Institute of Engineering, Tribhuvan University
NEPAL

I would like to thank the ACRS organizing committee and APN for the arrangement and providing fund for the participants in ACRS conference and Multi sensors Remote Sensing Technology for Sustainable Disaster Management.

I feel that it is my honor to get chance to learn and share about the multi sensor remote sensing application in disaster management and ACRS scientific conference application of remote sensing and GIS in multidisciplinary aspect. The lectures from the professor were good and useful for my organization and research. I got the three benefits and outcome of the workshop.

1. Knowledge gain

I got the valuable knowledge regarding the connection of multisensory remote sensing application to the disaster management. Knowledge gain from workshop about the multi sensor data from satellite is applicable because of the disaster vulnerability in my country such as land slide, flooding, forest fire. This workshop knowledge is important for prepared to safe before the disaster and rescue and development after the disaster. Knowledge share by the participants from the different countries and expert knowledge was useful for my teaching and research work. I learn from the Kintamani field trip in Bali about the disaster of the volcano. It was knew knowledge for me.

2. Knowledge transfer

I will transfer knowledge about the application of remote sensing to disaster management to teach the university student and in GO, NGO work on disaster management. Material from the resource person is very important to teach student. This knowledge is important to share in the development organization GO, NGO and INGO. I am working as advisor in GO, NGO and INGO which are working on disaster management. I could share and apply the knowledge gain from workshop in the practical field as well as academic field.

3. Networking

During the workshop it was very nice opportunity to make friendship, share the experience and future collaboration to work among the Asia pacific region scientist, professor and students. This workshop will be help in the development of the remote sensing work on disaster and ACRS scientific conference will help in the other multidisciplinary application.

Regard
Krisna Prasad Bhandari
Institute of Engineering, Tribhuvan University , Nepal

13. Ms. Le Van Anh

VNU University of Science, Vietnam National University
Hanoi
VIETNAM

Dear Sir/Madam

I am Le Van Anh from Vietnam, who is one of the participant of the workshop of Multi Sensors Remote Sensing Technology for Sustainable Disaster Management under APN's funding support.

Currently, I am working as a young researcher in Department of Environmental Information Study and Analysis, Institute of Geography. My work is much related to researches and projects of disaster management using Remote Sensing and Geographic Information System technology. I really want to improve my knowledge in this field and find out experiences from different countries as well. That's why I registered to participate this workshop to study and share experiences about disaster risk management and mitigation.

The workshop gave us the overview about sensors which can be applied in study of disaster management especially when global climate change recently has been leading amount of natural disasters in all over the world. The Dr. Ryoichi Furuta's lecture of introduction of ALOS data illustrated that many types of disasters such as forestation, volcano and earthquake, flood and landslides can be monitored effectively by using ALOS PALSAR which is one kind of high resolution weather-unaffected active sensors. We look forward to being able to study and apply new improvement ALOS-2 data in disaster management in the near future. Additionally, Prof. ArmynGruen and his colleague gave us an impressive presentation about different types of sensors which can be used to stimulate the scenario of disasters. It's really significantly helpful when we can process data in real time for quick respond of disaster case.

Finally, I very highly appreciate your organizing this workshop and conference for those who are interested in as well as our disaster-happening countries. Furthermore, your financial support and careful arrangement for entire ACRS 2013 conference has created a valuable chance for us to be able to present our research as well as attend many worth presentations in various topics of leading scientists coming from different Asian countries. I strongly believe the knowledge achieved from this workshop and conference would considerably assist disaster management in our country in particular and Asia Pacific environment in general.

Regard
Le Van Anh
VNU University of Science, Vietnam National University- Hanoi

14. Mr. Md. Raffi Uddin
Bangladesh University of Engineering and Technology
BANGLADESH

I would like to thanks Indonesian Society for Remote Sensing and Asia Pacific Network for Global Change Research for financial support. I would also like to thanks all other supporting organizations. I would also like to thanks to organizing committee for arranging such a very big workshops and conference by sacrificing their endless physical and mental efforts.

The Multi Sensors Remote Sensing Technology for Sustainable Disaster Management and 34th Asian Conference on Remote Sensing (ACRS-2013) help me to lot of ways. The world renowned scientists gave their valuable talk regarding the use of remote sensing data and how to use it for disaster management for Bringing Sustainable Asia. Since research on remote sensing in Bangladesh is inadequate despite of lot of disasters. This Workshop and conference are extremely helpful to understand the use of remote sensing technology for disaster management. So, I am able to understand the development and progress of use of remote sensing technology for disaster management in different countries in the world from the workshop and conference.

In the postgraduate level (e.g. M. Phil and Ph. D) our university offer courses related to Remote Sensing. Therefore, upon returning to my home country, as a teacher I will be able to pass on the acquired knowledge to our students who are enrolled Remote Sensing related courses. In addition, I am supervising thesis works related to Meteorology and Climate Change, so this interaction with world renowned scientists will also be helped me to gather new idea and to know new development of research in these fields. Certainly upon return to my home country the acquired knowledge and ideas will be shared to my students who are using remote sensing data for their research work. So ultimately the students of our laboratory will be benefited and hence our country will be benefited.

In addition to this, interaction with different participants from different countries all over the world also helps to know the multicultural aspect of different countries

Regard
Md. RaffiUddin
Bangladesh University of Engineering and Technology

15. Mr. Muhammad Ikhwan Bin Jamaluddin

MSc in Civil Engineering by Research (GIS &Remote sensing)
UniversitiTeknologi PETRONAS, Tronoh - Perak
MALAYSIA

First of all I would like to thanks for this opportunity which for me is huge, and a very good experience to me especially as a student to expose to this huge Asia event. Thanks you very much.

Secondly, i would like to thanks the all the committees for ACRS 2013, Bali because organising the conference and also a big applause to Ibu Dr.Dewayany Sutrisno and also Ibu Ati Rahadiati for the smooth process of accommodation, food, logging, travelling, field trip and everything for my 7 days staying in Bali, Indonesia. It a very unique experience.

ACRS 2013 give me great opportunities in of knowledge, education, and experience and off course networking. I met a lot of expert in the same area of study, and also many importance people in remote sensing

For the workshop Multi-sensors Technology for Sustainable Disaster Management, the talk done by Dr. Ryoichi Furata is so beneficial to me, as to know on how the ALOS-2 satellite development is been done. Is a valuable session for me to see how the development of the satellite was done and the improvement do they put in the ALOS-2. These give me the knowledge on how to choose an image for my next research especially in monitoring deforestation and landslides for my country, Malaysia. In addition, Dr. Ryoichi Furata is so friendly in person and gain a lot of knowledge in different perspective in remote sensing, even though he is the most respected person in this field.

The second speaker, Prof. Dr.ArmynGruen have given input to me on how the UAV operating from A – Z. This new technology for disaster monitoring and how the backstage process in processing the image, georeferencing, DTM and etc have put me in different point of view, on how to manage to improve more in my research stage to using UAV technology to capture image.

Last but not least, i must say that is conference is one of the respectful events done every year for remote sensing. And as a student this will beneficial me a lot in my research. A lot of thank to the organizing committee and of course for Indonesian indirectly for great experience in Bali

Regard

Muhammad Ikhwan bin Jamaludin
MSc in Civil Engineering by Research (GIS &Remote sensing)
UniversitiTeknologi PETRONAS, Tronoh, Perak, Malaysia

16. Mr. Nguyen Kim Anh

Department of Environmental Information Studies and Analysis
Institute of Geography, Vietnam Academy of Science and Technology
18 Hoang Quoc Viet Rd., CauGiay, Hanoi
VIETNAM

Dear committee members,

I am Nguyen Kim Anh and I have been working for Vietnam Academy of Science and Technology for more than 6 year. My interest research on the field of using remote sensing and GIS for oil spill detection and building GIS database for oil pollution study. Additionally, forest and biomass inventory are monitoring in the period of time from 2012 to 2026. It has been acknowledged that radar images are beneficial in estimated carbon stock and biomass as well as oil detection. Consequently, have strong motivation in using radar images such ALOS PALSAR and ENVISAT ASAR or RADARSAT to monitoring marine surface and forest monitoring.

Presently, I am going to study at PhD level and i would focus on the topic of Using remote sensing, GIS and AHP to assess environmental quality. It is widely known that nowadays we are in time of fast development and population grown at alarmingly degree. Many natural resources has been exploited and used to supply the industries in the world which has devastating impact to the environment and created massive issues to the people. Therefore, it is necessary to identify and give an assessment to the problems which caused to the environment. Remote sensing and GIS play an vital role in solving these problems.

In order to enhance skills and knowledge in such field, I especially would like to attend this workshop and in limited time lecturers has provided basic and necessary concept which are solid background for students develop research studies. Lecturers are so professional and flexible. Services and equipment of the room was good, however, if students are provided laptop or bring own laptop then would be practicable. Lecturers could prepare data, setting up software and steps for student perform flowing lecturers like image processing and 3D modeling or LIDAR measurement. So as to ensure all of students can catch step by step flowing lecturers, assistance lecturers should be required.

Outlined above is some notes , through this closing note i would like to express my sincere thank to the ACRS conference and APN has support for attendants especially gratitude thank to local organizers, the way they organize hospitably make we feel warm when we are far away from home.

Kindest regards
Nguyen Kim Anh (Ms)
Department of Environmental Information Studies and Analysis
Institute of Geography, Vietnam Academy of Science and Technology
18 Hoang Quoc Viet Rd., CauGiay, Hanoi, Vietnam, Tel: (84-4)37562417, Mobile: (84-4)936593737,

17. Mr.Pawan Kumar

Banasthali University
INDIA

Firstly, I would like to note that it was an incredible experience for me to attend this Asian Conference on Remote Sensing at Bali, Indonesia. The whole experience of this was very good with great exposure. On the occasion of this conference new ideas and work was exchanged in an effective way that it was worth. I am very great full to you for facilitating me with the funds and all the help and support. Meeting the people from all over the world was an amazing experience and it would always be a memorable experience in my life. Sharing my research work in the field of Remote Sensing in front of all the dignitaries from all over the world was so good and it feels great when people appreciated my work as i was awarded first prize in the Innovation Paper Presentation.

At the end i just want to thank you for all the help and support and I look forward to see youon future occasions and i hope next ACRS-2014 will again support me.

Best wishes
Pawan Kumar
Banasthali University

18. Mr.Reiza Muhammad Ariansyah
ISRS INDONESIA

As the fresh employee, the knowledge that I obtain form the workshop is very valuable. At school, I only learn the standard remote sensing technology and only heard and read from the magazine or seminars about the development of this technology,

Having access to the data and method is really broaden my knowledge about the useful of remote sensing and makes me more aware that the earth is continually changes due to the human activities.

I really need other opportunities to advance my skill in remote sensing because I saw from the exhibition and from many speakers that are the leading scientists from all over the world, that remote sensing technology do not stop revolving and continue to be more advanced.

By having this new knowledge, I believed will support my job in the remote sensing organization . Because, I have to meet the experts that if I do not know any will be left behind

Thank you very much for all of the lecturers and the committee.

Regard
Reiza Muhammad Ariansyah
Indonesian society for Remote sensing / ISRS
T/F: +62 21 8790 6041
Email: Reiza.dina@gmail.com

19. Mr.RongJun Qin

Students
Singapore ETH Center, Future Cities Laboratory.
SINGAPORE

20. Mr. Ryoichi Furuta
Deputy Senior Research Scientist,
Research & Development Department,
Remote Sensing Technology Center of Japan (RESTEC)
3-17-1 Toranomon, Minatoku, Tokyo
Japan

Dear all,

I would like to say my great appreciation to APN, ACRS2013 committee and participants. And also to Dr. Sutrisno Dewayany, Prof. Armin Gruen, and Mr. Rounjin Qin. Thank you for gave me an opportunity to made lecture and workshop in ACRS2013. It was very nice workshop that was covered utilization of satellite and UAV as latest technology to disaster management. Both technologies has a lot of possibilities for monitoring disasters but also has a lot of problems to applying practical work. I think this was clear from this workshop. I was introduced some best practices in my presentation but more practices are necessary for practical use. I hope a lot of participants, including myself, will make there best practices and improve current situation based on our lectures to make more safe world. Again, thank you for gave me an opportunity to made lecture in ACRS2013, and thank you for your participation to our lecture. Anytime your contact is welcome.

Best regards,
Dr. Ryoichi Furuta
Deputy Senior Research Scientist,
Research & Development Department,
Remote Sensing Technology Center of Japan (RESTEC)
3-17-1 Toranomon, Minatoku, Tokyo, Japan
Phone: +81-3-6435-6735
E-mail: furuta_ryoichi@restec.or.jp

21. Mr. Tam Tze Huy

Institute of Geospatial Science and Technology
Universiti Teknologi Malaysia
MALAYSIA

First of all, I would like to thanks APN to sponsor me to attend ACRS 2013 held in Bali.

I felt great after attended two days of multisensor workshop. Besides, I also met some new friends during the workshop. Anyway, I gained much knowledge from the speakers as well as the participants. It is very to good to me and also my research work.

Best wishes
Tam TzeHuy
Institute of Geospatial Science and Technology, Universiti Teknologi Malaysia

22. Ms. Vandana

Banasthali University
India

Thanks to the ACRS2013 and APN who provided us with the funding and environment to gain the geospatial knowledge and provision of reflection of applicative approach. The ACRS conference was ultimate exposure of knowledge and interaction among different countries brainstorms. It was nice experience to see the applicative approach of different remote sensing techniques for the social improvement and new geospatial activities of different people gave new and innovative ideas to do some pioneering in this field. It provided the directional way for inventive and novel thinking. This was a common platform for all the researchers, scientists and students which helped in sharing knowledge among different people from different areas. There were different workshops in which the seniors gave the ideas to apply the studies into real world. Their deliberation by showing results encouraged to think new and pioneering.

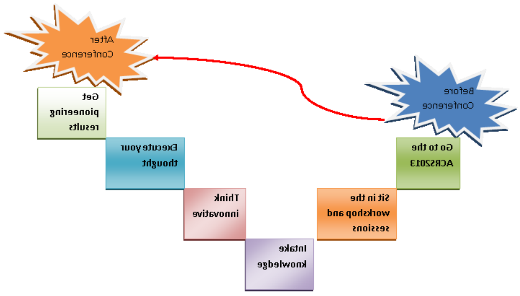
The different sessions were conducted for presentations in which we can chose and attend of our choice. These sessions broadens our thought to the different fields. The management was admirable in which everything about the conference was very clear. All the directions have been put on. The staff was very cooperating and clear such that even the different languages also crossed the barrier of communication between people from different countries.

We have been provided with a free excursion tour which was full of entertainment and knowledge too. The volcanic site, rice fields and temple shows the culture which is good addition of knowledge to everyone's diary. There is smile on everyone's face in Indonesia which gives a home feeling in other country too.

The award ceremony was good in which different people were given awards for their work. This encourages all of us to do something innovative and pioneering.

In total The ACRS2013 conference is eventually successful by which students like us being provided by a platform in which we can think, execute and get something innovative. IF I will get the chance in every ACRS conference, it will be the great opportunity for me.

Here I am making a simple picture for the process we have been through in the conference.



Namastey (Greetings) and Dhnywad (Thank you) to ACRS conference and APN

Regard
Vandana
Banasthali University, India

23. Ms.Virany SENGTIANTHR

Remote Sensing Center (RSC), Natural Resources and Environment Institute (NREI), Ministry of Natural Resources and Environment (MONRE)
Patouxay Road, PO. Box: 7864, Vientiane
LAO PDR

Dear ACRS committee,

On behalf of Lao PDR participant, I would like to take the opportunity to appreciated the ACRS committee and APN for the full support. I am really learned in dept on the “Multi sensors RS Technology for Sustainable Disaster Management Workshop”. This workshop has accorded me a unique opportunity to learned on photogrammetry for management of disaster such as flood monitoring, landslide monitoring and related to global climate change. I know more information on ALOS-2 for disaster and climate change. I am very interest to generate 3D data using high resolution of satellite (areal Zurich, QUICKBIRD, PRISM and IKONOS) to monitor the flood in urban area. And I have great opportunity to make a network between ACRS members and sharing experience and culture.

I am very grateful to Prof. Armyn Gruen and Dr. Ryoichi Furuta for lecture during the workshop. Special thanks for the local host.

May, I would like to have the suggestion: I would like to have more time to practice the 3D modeling. Lao PDR still lack of knowledge on Remote Sensing and GIS technology for disaster management. I would like to have capacity building .and I will also continue to support the RS-GIS activities for natural resources monitoring and disaster reduction.

Sincerely,
Virany SENGTIANTHR (Ms)
Remote Sensing Center (RSC), Natural Resources and Environment Institute (NREI), Ministry of Natural Resources and Environment (MONRE)
Patouxay Road, PO. Box: 7864, Vientiane, Lao PDR, Telephone: (856-21) 217650 E-mail: svirany@yahoo.com, viranys@hotmail.com

24. Mr. Xiaoping Du

Key Laboratory of Digital Earth
Institute of Remote Sensing and Digital Earth (RADI),
Chinese Academy of Sciences
No.9 Dengzhuang South Road, Haidian District
CHINA

Dear Dr. Dewayany,

I am Xiaoping Du, from Institute of Remote Sensing and Digital Earth (RADI), Chinese Academy of Sciences (CAS), Beijing.

I am very glad to meet you in Bali and thank you for your kind and friendly host. Also thanks for you and the ACRS2012 committee's efforts to organize this valuable workshop which benefits me a lot.

Firstly, it's the best opportunity for me to learn and absorb new knowledge and skills about remote sensing technology for disaster management. I have learned the ALOS2's improvement features and their new missions. The global change monitoring using remote sensing is an important technique for understanding the large scale disasters risk in the world. UVA images acquisition and 3D reconstruction are impressed me a lot, especially the results applied in flood simulation. These new technique sessions are quite attractive for me!

Secondly, the famous and outstanding lecturers in the workshop have great explored my potential, and got inspired to improve myself.

Finally, I have introduced my research progress to the workshop participants who give me many encouragements and invaluable advice.

Above all, I am so happy to attend this workshop and have got a lot of knowledge and friendships from this event!

Dear Dewayany, again, I wish to express my sincere appreciation to you and the organizers for the funding to support me attending the conference in the beautiful island, Bali!

Best wishes,
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http://www.radi.ac.cn/
86-10-8217 8073
xpdu@ceode.ac.cn

25. Prof Armin Gruen

ETH Zuerich, ETH Singapore Future City Laboratory
Zurich
Switzerland

APPENDIX 3. Post Workshop Meeting : importance of technical ability in the field of remote sensing

Werdhapura hotel- Bali, 27 October 2013

Summary

Post workshop meeting was held to (1) evaluate the implementation of the workshop of multi sensor remote sensing technology for disaster management, (2) to discuss the whole implementation of the project and (3) to discuss the propose activities following the workshop in regional view. The resume of the meeting indicate that the workshop has been successfully held and the target of the project has been achieved eventhough 2 of the funded participants did not show up. Other activities should be done following the workshop, i.e post workshop training because the participants felt the need to have the more practical training. The post workshop training will be held in West Java , focus on the remote sensing digital image processing for the impact of climate change issues such as flooding. The training propose to be done in the local university that has limited facility in remote sensing laboratory.

Agenda:

1. Evaluation of the multi sensor remote sensing technology for disaster management workshop
2. Evaluation of the whole project
3. The proposed activities following the workshop

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Funding sources outside the APN

Organization	*Type of support*	*Amount*
1. Indonesian Society For Remote Sensing Regional Bali	*Meeting material, administrative staff, venue,*	*USD 1000*
2. Indonesian Society For Remote Sensing	*Meeting staff honoraria,*	*USD 1000*

APPENDIX 4. Post Workshop Training: Training of multi sensor remote sensing technology for disaster management: a remote sensing analysis

Ibnu Khaldun University, 5 – 6 April 2014

Summary:

Regarding many catastrophes that have been occur in Indonesia and the relation with the workshop in Bali, a training was held in Ibnu Khaldun University in Bogor. This training was aimed to improve the skill of the students in of local universities to manage the disaster issue by using remote sensing technology. The training consisted of the basic method in analyzing the disaster using remote sensing data, such as the flooding and landslide in Ciliwung river, and how the emergency response and recovery progress should be managed. A ground checking was also employed to check the accuracy of the remote sensing data analysis result, either in the input of early warning, possible destruction area, emergency response and recovery program.

Agenda

Date, time	Programs	Representative
Saturday, 29 March 2014	Other training by UIKA	Ibn Khaldun University (UIKA)
Sunday, 30 March 2014	Other field observation by UIKA	Ibn Khaldun University (UIKA)
Saturday, 5 April 2014		
	Training of multi sensor remote sensing technology for disaster management: a remote sensing analysis	
08.00 – 09.00	Registration	Committee
09.00 – 10.00	Forewords and introduction from The dean of the technical sciences faculty, President of ISRS and Waindo Spectera	Committee
10.00- 10.15	Coffee break	
10.15 – 12.00	Applied Remote sensing 1	Ms Anton
12.00 – 13.00	Lunch	
13.00 – 16.00	Applied Remote sensing 2	Ms. Putri
16.00 – 16.15	Coffee break	

16.15 – 17.00	GIS application based on Remote sensing	ISRS and integrasia
Sunday, 6 April 2014		
08. 00 – 16.00	Field observation	Committee
Monday, 7 April 2014		
08.00 – 12.00	Re-interpreted and spatial report	Committee

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Funding sources outside the APN

Organization	*Type of support*	*Amount*
1. Ibnu Khaldun University	1st, 2nd, and 3rd day of training	
2. Indonesian Society For Remote Sensing	Meeting staff honoraria,	*USD 1000*
3. Waindo Spectera	Material, data, method and lecturers	
4. Integrasia	Computers and software	

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<u>Presentation</u>

a. Applied Remote Sensing-1: Mr. Antonius K.

Definition

Ilmu dan seni untuk memperoleh informasi tentang obyek, daerah, atau gejala dengan jalan menganalisis data yang diperoleh menggunakan suatu alat tanpa kontak langsung terhadap obyek, daerah atau gejala yang dikaji (Lillesand & Kiefer, 1994).

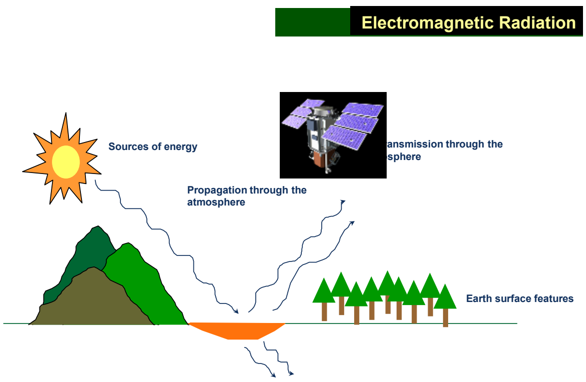
- Istilah Penginderaan Jauh = Inderaja
  Remote Sensing; Teledetection; Perception Remota; Fernerkundung
- **Tanpa kontak langsung :** harus ada energi sebagai media
  - Energi Cahaya
  - Pancaran Energi Termal
  - Energi Gelombang Mikro
  - Energi Sonar

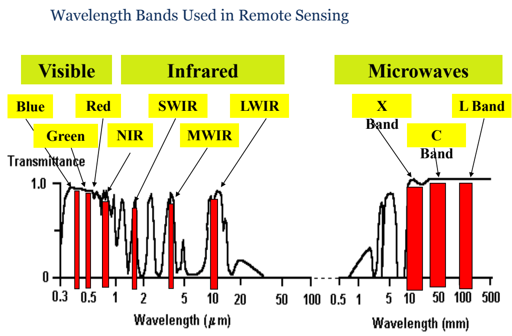
Sistem Penginderaan Jauh

> **Berdasarkan Wahana (*Platform*):**
- Airborne : pesawat, balon udara, burung merpati
- Spaceborne : satelit, pesawat ulang-alik, pesawat ruang angkasa

> **Berdasarkan Sumber Tenaga Elektromagnetik :**
- Sistem pasif : Sinar Matahari
- Sistem aktif : sumber buatan - RADAR

Remote Sensing Concept





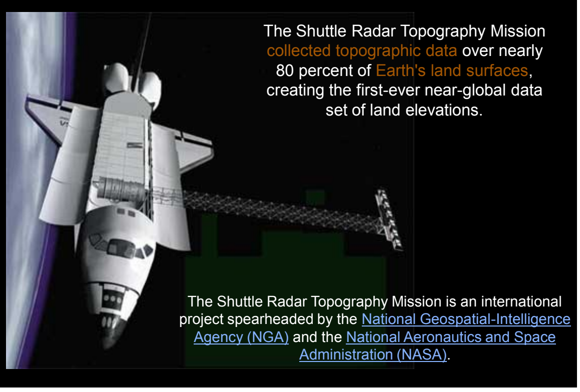
Sensor Citra Satelit

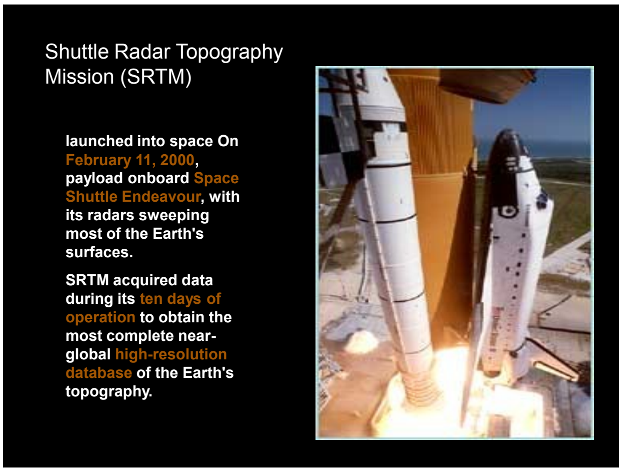
Sensor Pasif
- Energi elektromagnetik dari matahari
- Panjang Gelombang Visible dan Inframerah

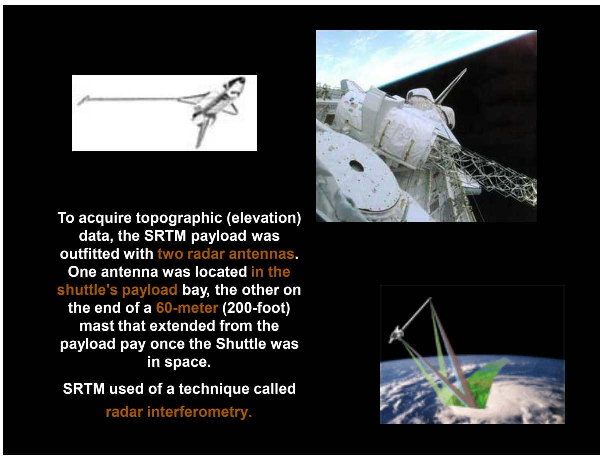
Sensor Aktif
- Energi dari satelit
- Gelombang Mikro/SAR

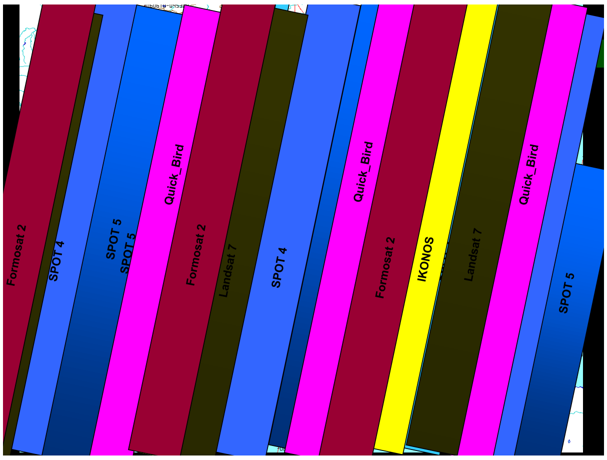
7

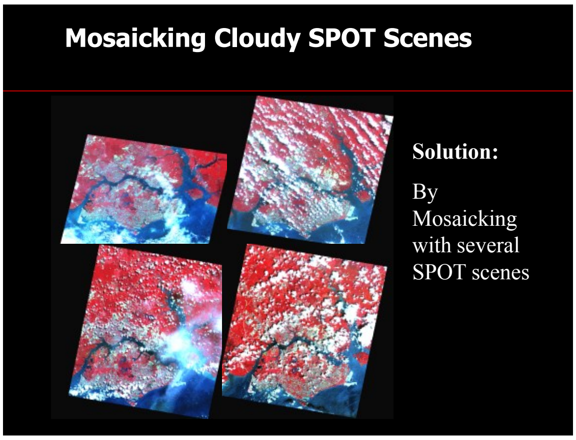
Space Shuttle Remote Sensing

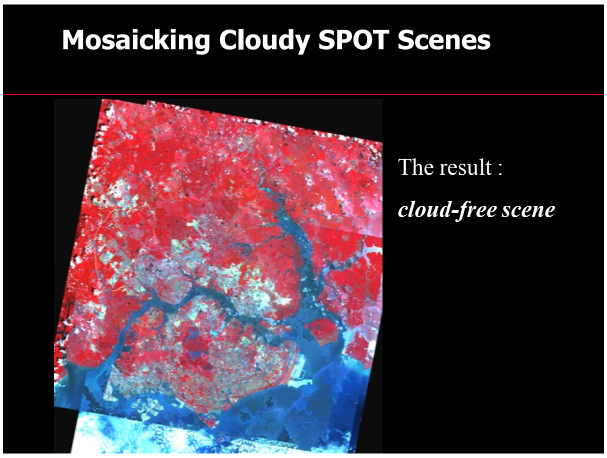


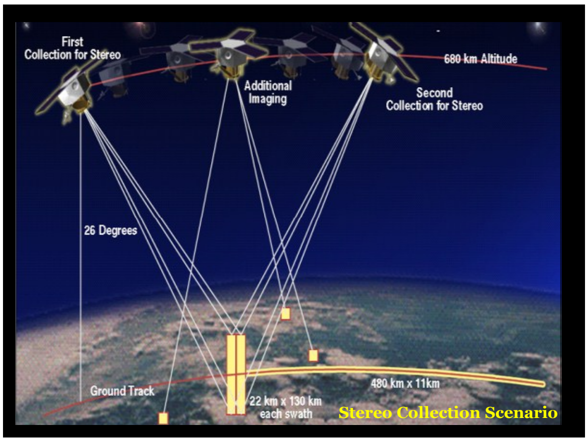

Shuttle Radar Topography Mission (SRTM)
launched into space On February 11, 2000, payload onboard Space Shuttle Endeavour, with its radars sweeping most of the Earth's surfaces.
SRTM acquired data during its ten days of operation to obtain the most complete near-global high-resolution database of the Earth's topography.

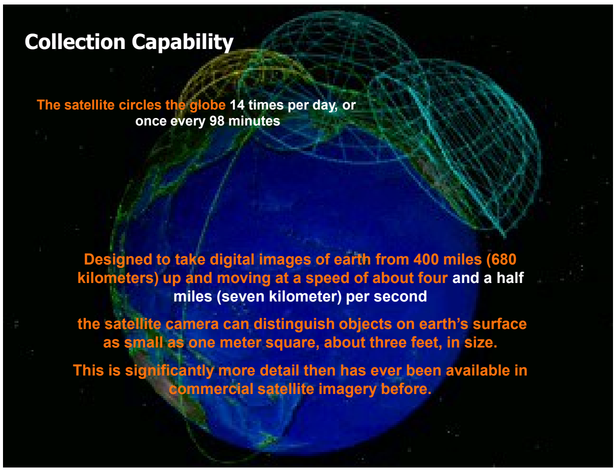

To acquire topographic (elevation) data, the SRTM payload was outfitted with two radar antennas. One antenna was located in the shuttle's payload bay, the other on the end of a 60-meter (200-foot) mast that extended from the payload pay once the Shuttle was in space.
SRTM used of a technique called radar interferometry.

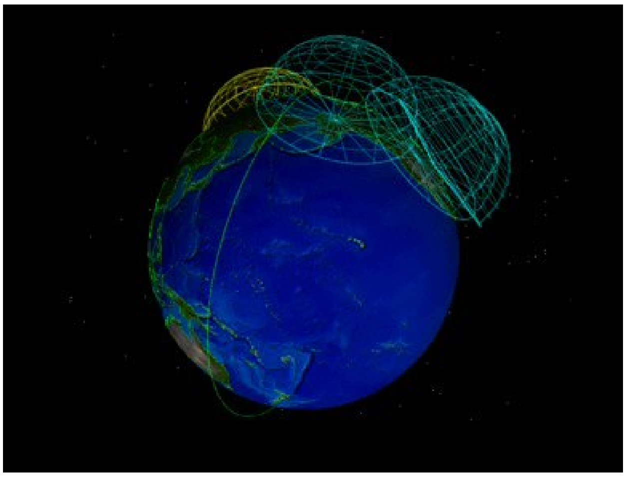

Formosat 2
SPOT 4
SPOT 5
SPOT 5
Quick_Bird
Formosat 2
Landsat 7
SPOT 4
Quick_Bird
Formosat 2
IKONOS
Landsat 7
Quick_Bird
SPOT 5

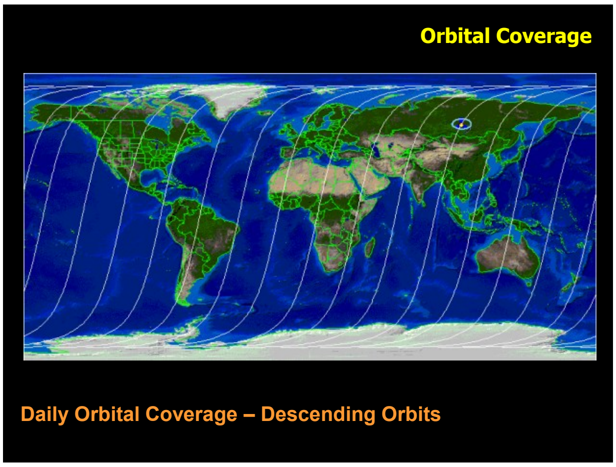

Mosaicking Cloudy SPOT Scenes
Solution:
By Mosaicking with several SPOT scenes


Mosaicking Cloudy SPOT Scenes
The result :
cloud-free scene


First Collection for Stereo
680 km Altitude
Additional Imaging
Second Collection for Stereo
26 Degrees
Ground Track
22 km x 130 km each swath
480 km x 11km
Stereo Collection Scenario

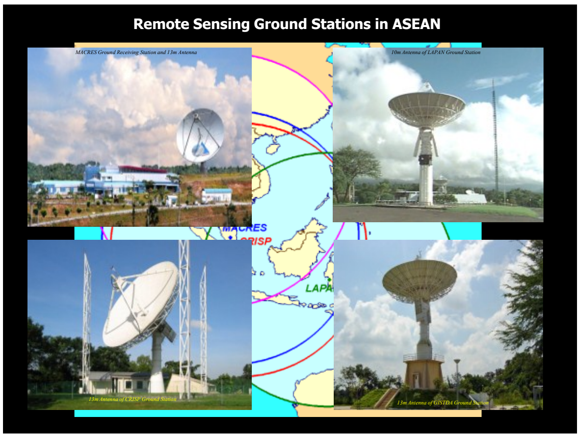

Collection Capability
The satellite circles the globe 14 times per day, or once every 98 minutes
Designed to take digital images of earth from 400 miles (680 kilometers) up and moving at a speed of about four and a half miles (seven kilometer) per second
the satellite camera can distinguish objects on earth's surface as small as one meter square, about three feet, in size.
This is significantly more detail then has ever been available in commercial satellite imagery before.

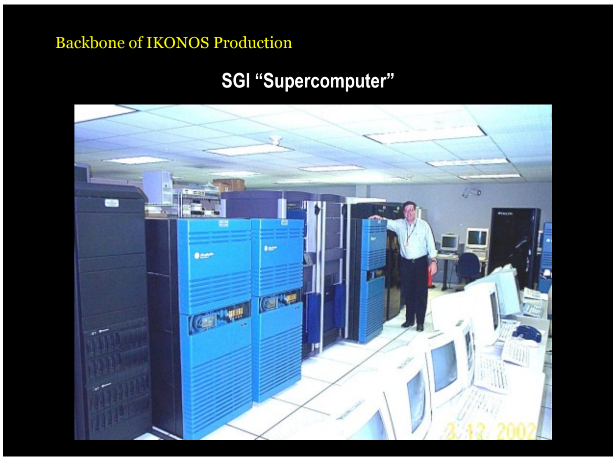



Orbital Coverage
Daily Orbital Coverage – Descending Orbits

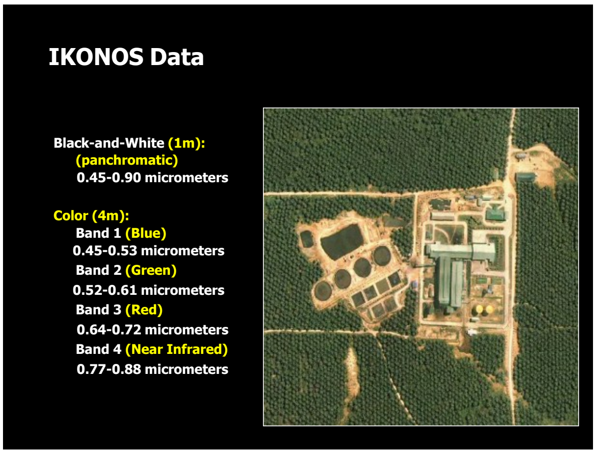

9.1 Meter Ground Station Antenna

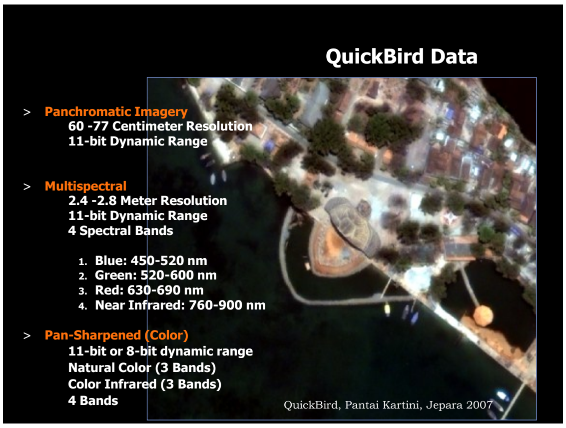

Interim Ground Station Middle East

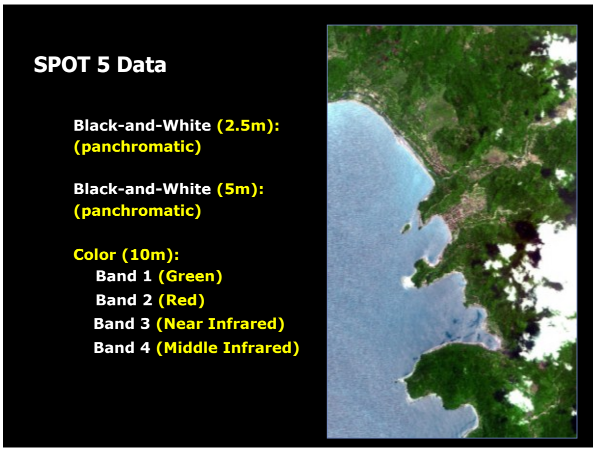

Remote Sensing Ground Stations in ASEAN
MACRES


Backbone of IKONOS Production
SGI "Supercomputer"
3.12.2002

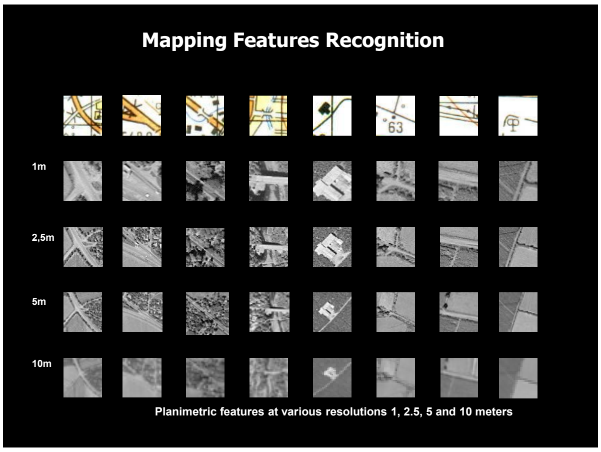

Resolusi Citra Satelit
> Resolusi Spasial (Ukuran Pixel)
> Resolusi Spektral (Jumlah Band)
> Resolusi Temporal (Perekaman Ulang)
24


IKONOS Data
Black-and-White (1m):
(panchromatic)
0.45-0.90 micrometers
Color (4m):
Band 1 (Blue)
0.45-0.53 micrometers
Band 2 (Green)
0.52-0.61 micrometers
Band 3 (Red)
0.64-0.72 micrometers
Band 4 (Near Infrared)
0.77-0.88 micrometers


QuickBird Data
> Panchromatic Imagery
60 -77 Centimeter Resolution
11-bit Dynamic Range
> Multispectral
2.4 -2.8 Meter Resolution
11-bit Dynamic Range
4 Spectral Bands
1. Blue: 450-520 nm
2. Green: 520-600 nm
3. Red: 630-690 nm
4. Near Infrared: 760-900 nm
> Pan-Sharpened (Color)
11-bit or 8-bit dynamic range
Natural Color (3 Bands)
Color Infrared (3 Bands)
4 Bands
QuickBird, Pantai Kartini, Jepara 2007

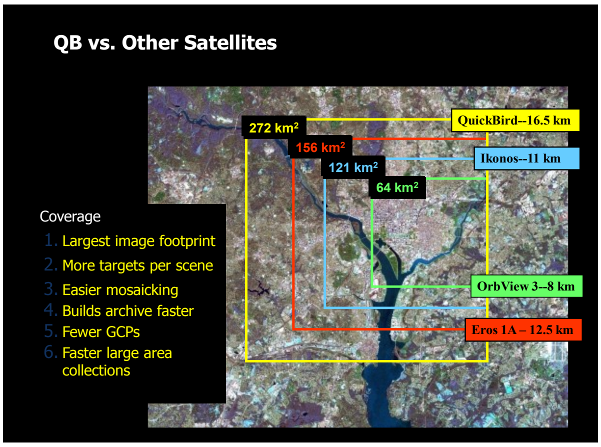

SPOT 5 Data
Black-and-White (2.5m):
(panchromatic)
Black-and-White (5m):
(panchromatic)
Color (10m):
Band 1 (Green)
Band 2 (Red)
Band 3 (Near Infrared)
Band 4 (Middle Infrared)

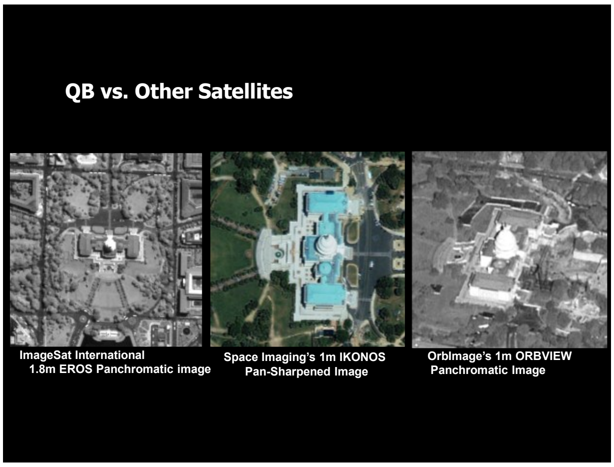

Height Resolution Satellite for
Detail Ecosystem Mapping
SPOT5-2,5m, Kota Padang,
West Sumatera, 2006

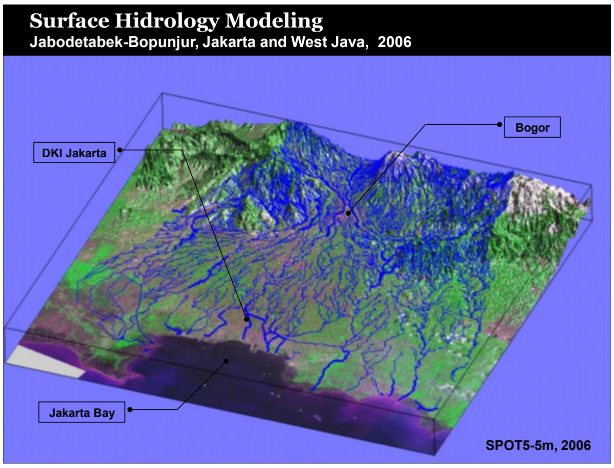


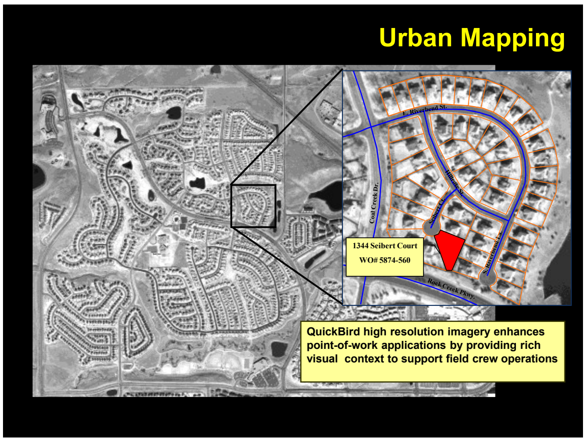
SCALES vs Cartographic Maps & Satellite Imagery

Cartographic Map Scales	Satellite Imagery	Basic Accuracy	Accuracy
1:100K	30m resolution	200m	50m
1:50K	20m resolution	300m	25m
1:25K	10m resolution	30m	12.5m
1:10K	2.5m resolution	30m	10m
1:5K	1m resolution	12-15m	2.5m
1:3K	0.61m resolution	12-15m	1.5m
1:2.5K	0.5m resolution be to launch		1m

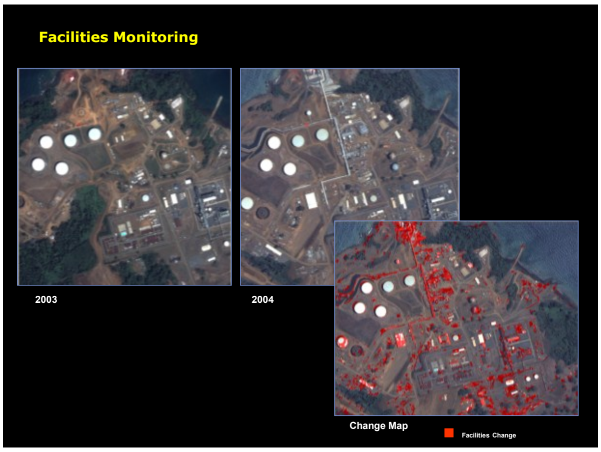


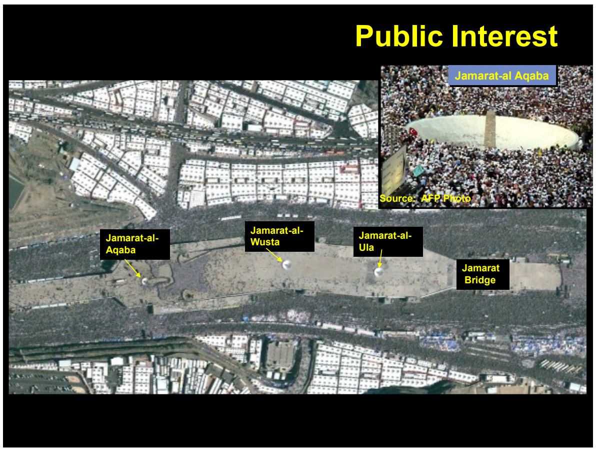



Surface Hidrology Modeling
Jabodetabek-Bopunjur, Jakarta and West Java, 2006
DKI Jakarta
Bogor
Jakarta Bay
SPOT5-5m, 2006

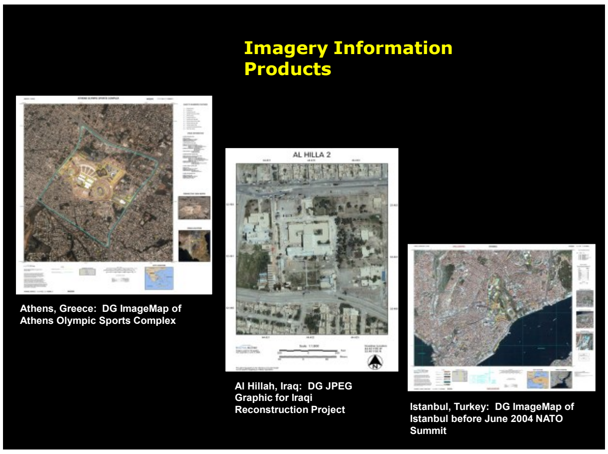

Urban Mapping
1344 Seibert Court
WO# 5874-560
QuickBird high resolution imagery enhances point-of-work applications by providing rich visual context to support field crew operations


Urban Growth: Parcel Mapping


Facilities Monitoring
2003
2004
Change Map
Facilities Change


Public Interest
Jamarat-al Aqaba
Source: AFP Photo
Jamarat-al-Aqaba
Jamarat-al-Wusta
Jamarat-al-Ula
Jamarat Bridge


Media/News Applications


Imagery Information
Products
AL HILLA 2
Athens, Greece: DG ImageMap of
Athens Olympic Sports Complex
Al Hillah, Iraq: DG JPEG
Graphic for Iraqi
Reconstruction Project
Istanbul, Turkey: DG ImageMap of
Istanbul before June 2004 NATO
Summit


Terima Kasih
42

b. Applied Remote Sensing-2: Mr. Antonius K.

ERDAS ER Mapper

Antonius K.

PT. Waindo SpecTerra

Official partner of:

ER Mapper pertama kali launching oleh Earth Resources Mapping Pty Ltd tahun 1989 Di Australia

Menggunakan interface wizard base untuk memudahkan pengguna

Mengembangkan teknologi kompresi yang disebut *Enhanced Compress Wavelet*

Mengembangkan produk aplikasi enterprise untuk melayani penyebarluasan data raster melalui Internet. Nama Produk **Image Web Server**

LEICA (Anak perusahaan dari HEXAGON) memiliki divisi software Image Processing dengan nama LGGI (Leica Geosystem Geospatial Imaging)

Memiliki produk ERDAS Imagine yang merupakan pesaing dari ER Mapper

Tahun 2007 LGGI mengakuisisi ERM dan memasukkan produk ER Mapper dan IWS kedalam jajaran produk baru LGGI

LGGI juga mengakuisisi perusahaan yang memiliki produk Red Spider dengan kemampuan menampilkan data vektor dan raster melalui web dengan menggunakan standard service dari Open Geospatial Consortium (OGC)

LGGI memiliki jaringan pasar di Asia Pasific, Eropa dan Amerika

Hexagon merupakan perusahaan dengan modal perusahaan lebih dari 2 Milyar US Dollar

Hexagon melihat LGGI mulai berkembang. Untuk mempercepat perkembangannya, dibentuk suatu anak perusahaan langsung di bawah HEXAGON dengan nama

Produk ERDAS

ERDAS ER Mapper
ERDAS Imagine
ERDAS Image Web Server
ERDAS TITAN

ER Mapper

- Pengolah Citra Digital
- ER Mapper ability
  - Optical Image Processing
  - Radar Image Processing
  - ECW: better compression with best result
  - Plugins for GIS Software: ArcView, MapInfo, AutoCAD & Microsoft Office

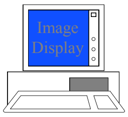
'Traditional' Image Processing

RASTER FILE 1 → Image processing operation → RASTER FILE 2

Hambatan:

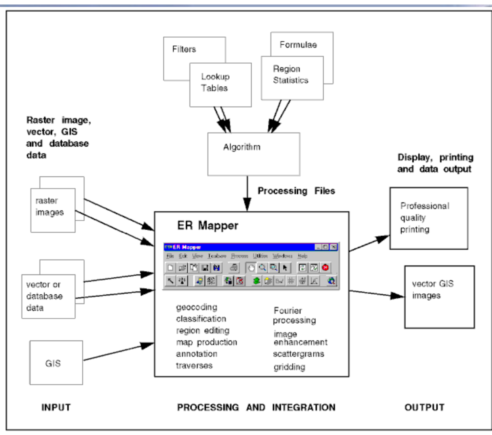
- Ukuran Hardisk yang terbatas
- Waktu Processing
- Multi-task operations require multiple files and processing
- Duplication required if the result is not what is required

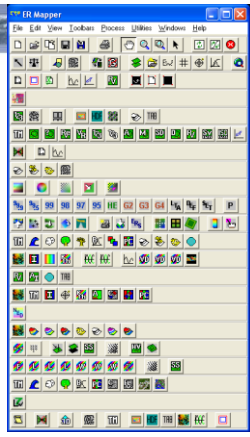
ER Mapper Image Processing

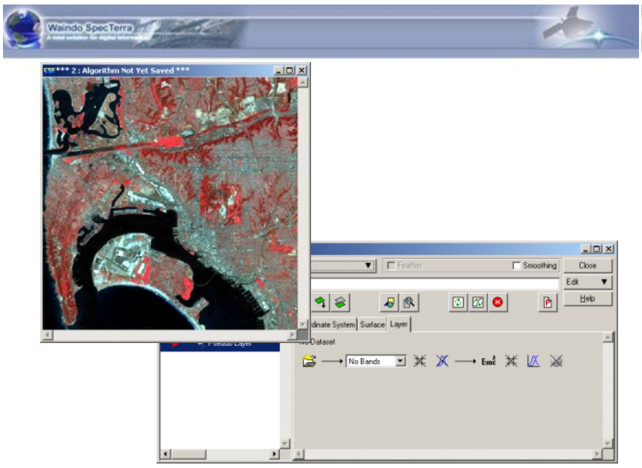
RASTER FILE → Processing Algorithm → 

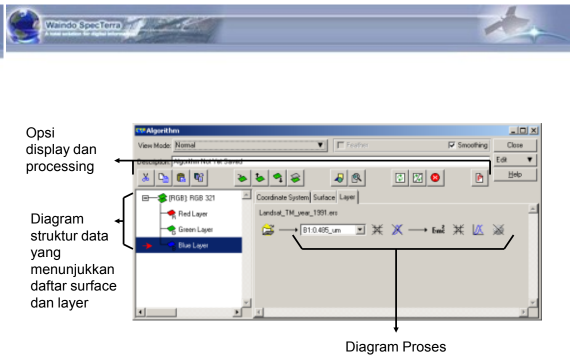
- Formulas (ratios, PC, etc.)
- Filters (smooth, sharpen, etc.)
- Contrast/brightness
- more...

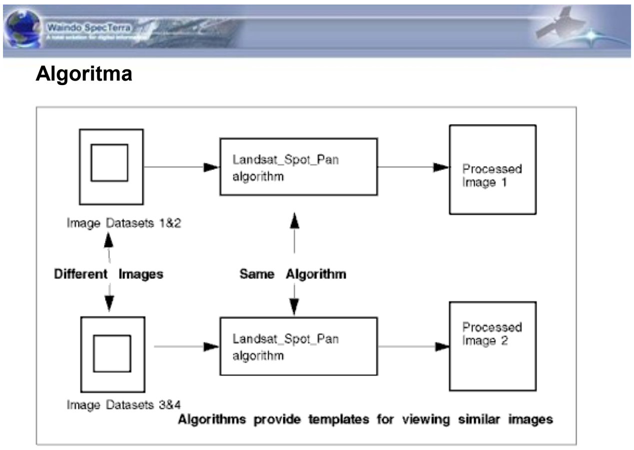
Save only processing algorithms

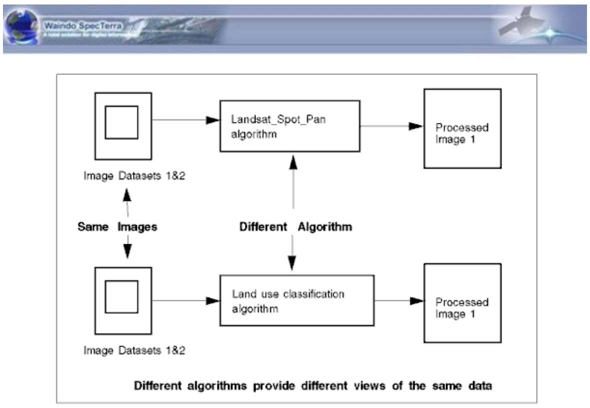






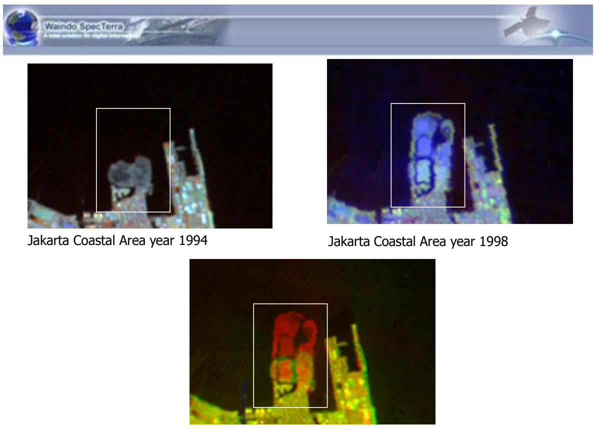






Dataset Characteristics

	Dataset	Virtual Dataset	Algorithm
Header file has Statistics	✓	✓	X
Header file has GCP data	✓	X	X
Algorithm Processing	✓	✓	✓
Cell Profiling	✓	X	X
Traversing	✓	X	X
Rectification	✓	X	X
Calculate Statistics	✓	✓	X
Raster Cell to Vector Polygon	✓	✓	X



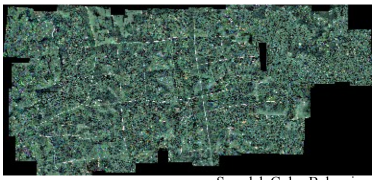
Jakarta Coastal Area year 1994

Jakarta Coastal Area year 1998

Changes of Jakarta Coastal Area 1994 - 1998

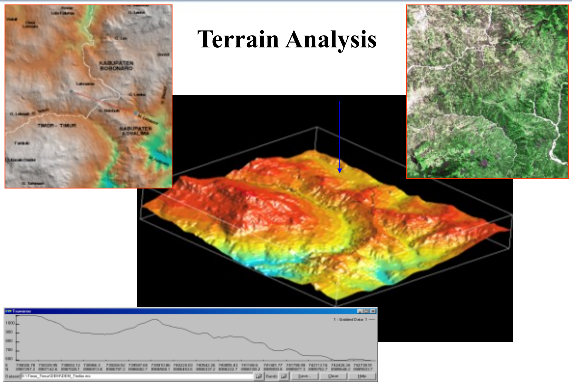
Mosaicking dan color balancing

Sebelum Color Balancing



Sesudah Color Balancing

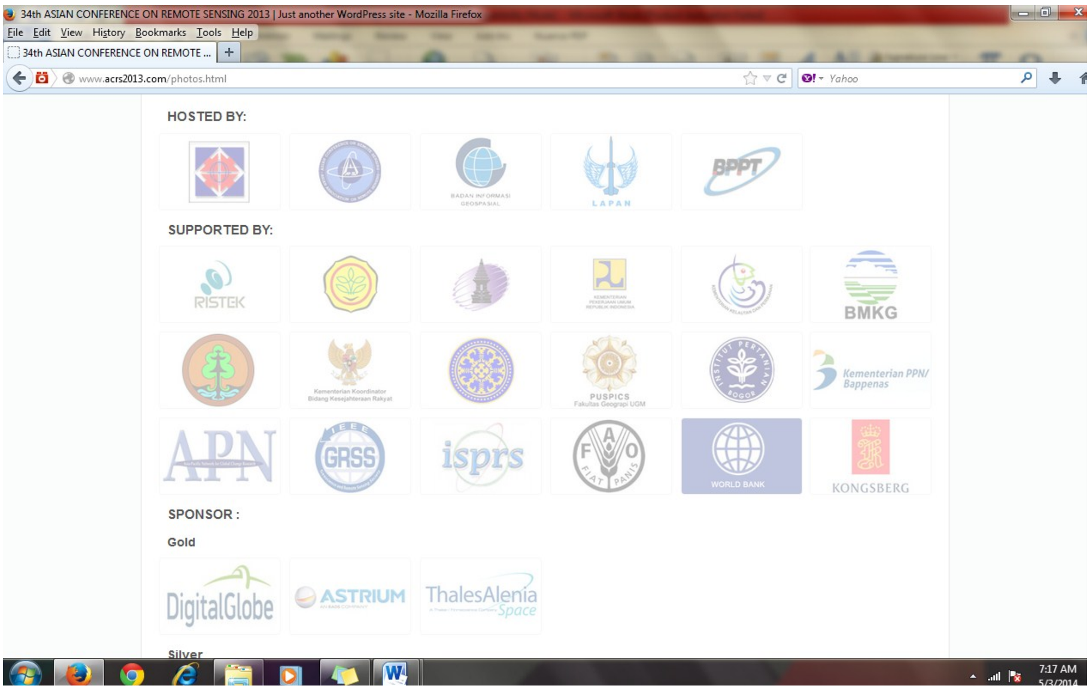
Terrain Analysis

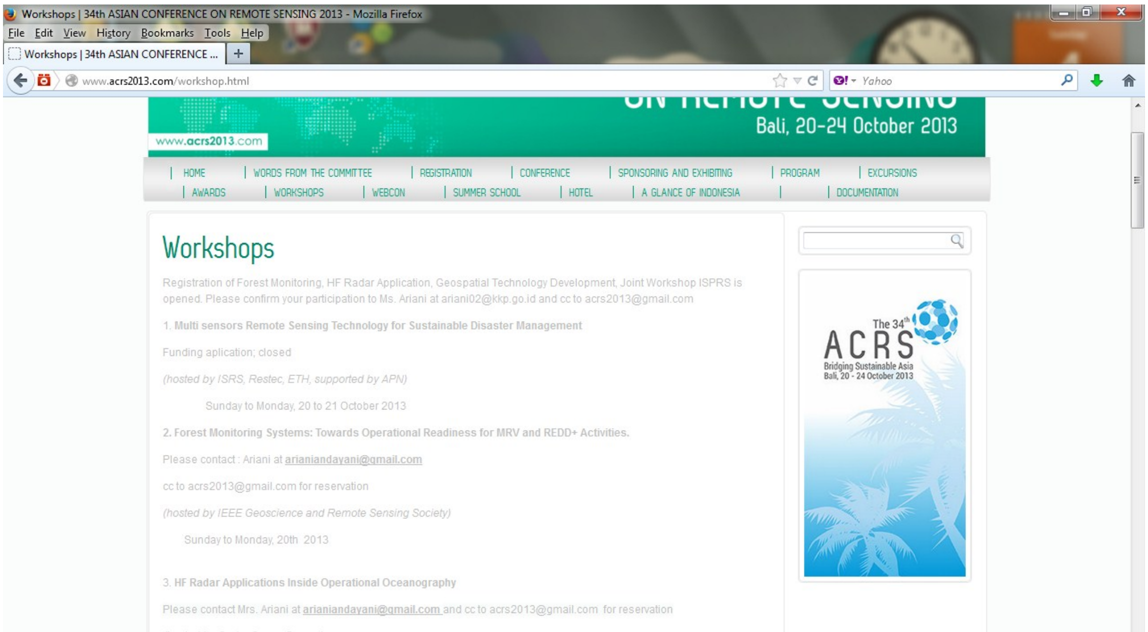


TERIMA KASIH

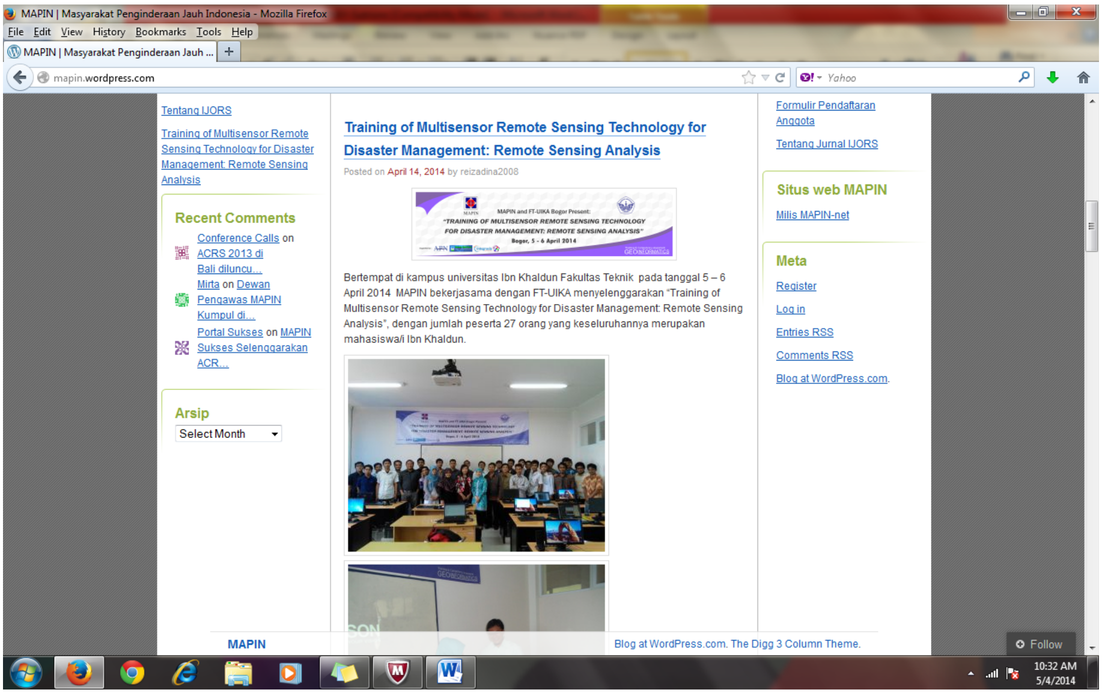
APPENDIX 5. Workshop Publication

a. www.acrs2013.com, can also be access via www.lapan.go.id, www.a-a-r-s.org/acrs, www.mapin.or.id, www.big.go.id,www.populationenvironmentresearch.org/whatsnew.jsp

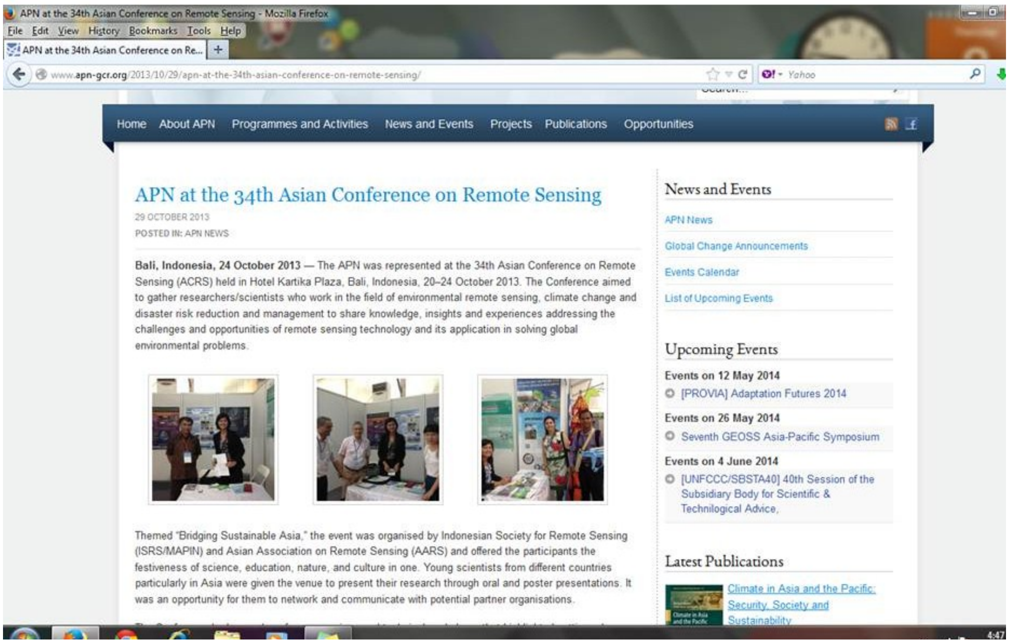




b. www.mapin.or.id



c. www.apn.org



d. Leaflet, Brochure (internationally distribute)