Data Integration and Analysis System (DIAS)

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The University of Tokyo

GEO Alliances and Harmonization Workshop
Washington DC, USA, 11-12 November, 2009
Earth Observation and Ocean Exploration System

Objectives
The system contributes to national security in a broad sense by coping with global environmental and energy problems such as:
- monitoring of global warming and natural disasters
- exploration of energy resources

Components of the System

Satellite Observation & Monitoring System
Advanced Ocean Exploration Technology
Data Integration and Analysis System (DIAS)
The Mission of DIAS

• to coordinate the cutting-edge information science and technology and the various research fields addressing the earth environment;
• to construct data infrastructure that can integrate earth observation data, numerical model outputs, and socio-economic data effectively;
• to create knowledge enabling us to solve the earth environment problems; and
• to generate socio-economic benefits.
Computational Modeling in Two Stages: Driving Evolution & Enabling Revolution

- **2001**: Homogeneous Cluster
- **2005**: Interactive physics, biology, chemistry; assimilation of satellite data
- **2010**: .25° x .25° resolution; hurricanes, storm fronts
- **2015**: .25° x .25° resolution; add cloud, chemistry, & radiation effects
- **2020**: Fully interactive (biology, chemistry, physics) ensemble simulations in an operational mode

Data Size, Bytes

- **GigaFLOPS**
- **TeraFLOPS**
- **PetaFLOPS**
- **ExaFLOPS**

Evolutionary

Revolutionary

Real Demonstrated Performance doing useful Science
DIAS, tackling a large increase in volume of the earth observation data

DIAS is developing a core system for data integration and analysis that includes the supporting functions of life cycle data management, data search, information exploration, scientific analysis, and partial data down-loading.
Global Earth Observation System of Systems

A Prototype of Data Integration and Analysis

Application Layer
- User Apps.
- Common Software
  - Visualizer (w display wall)
  - Discovery Work Flow Assist
  - Data Quality Manager
  - Data Transformer
  - Data Crawler
  - ETL
  - Data Manager
  - Data Navigator
  - Meta Data Manager

Data Management Layer • DBMS

File System Layer
- Storage Management System
- Power management System

Storage Layer
- Disk Array
Where is data? How to access?

Technical Terms among Different Disciplines

Quality? Reliability?
DIAS, tackling a large increase in diversity of the earth observation data

For improving data interoperability, DIAS is developing a system for identifying the relationship between data by using ontology on technical terms and ideas, and geography. DIAS also is acquiring data base information from various sources by developing a cross-sectoral search engine for various data bases.
Making Connection among Disciplines through Ontology

Dictionary to Ontology

Geographical Ontology
### A Prototype of Data Integration and Analysis

**Application Layer**
- Climate
- Water
- Disaster
- Agriculture
- Biodiversity
- Oceanography
- Fishery

**Common Software Layer**
- Visualizer (w display wall)
- Discovery Workflow Assist
- Data Quality Manager
- Data Transformer
- ETL
- Data Crawler
- Data Manager
- Data Navigator
- Meta Data Manager

**Data Management Layer**
- DBMS
- Storage Management System
- Power Management System

**File System Layer**
- PB Scale Logical File

**Storage Layer**
- Disk Array

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**Reverse Dictionary**

**GIS**
- Civil Engineering etc.

**Technical Term Dictionary**
- Remote Sensing

**Data Model Searching System**
- UML Metadata
- XML Schema

**Hierarchical Diagram**

**Extra Diversity and Complex Relativity of Data and Information**

**Data Related Information Archive System**

**Geographical Dictionary**

**OWL Association/Link Knowledge**

**Database Across Searching System**

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**Extra-Large Volume data from various data and information source**

- In situ Observation
- Citizen Observation
- Oceanographic Observation
- Satellite Observation
- Weather and Climate Model
- Operational Observation
- Operational Information
DIAS develops an information system for agricultural production management by integrating the real-time monitoring data of farmland, the growing condition of each crop cultivar, meteorological data, numerical weather predictions, and climate model predictions. This system will be usable by the farming community, enabling them to make improved management decisions especially in regions which are susceptible to global warming impacts.
DIAS compiles data bases of a number of important indices of biodiversity, including invasive alien species and endangered species through participatory monitoring programs, integrates to analyze the data with other earth observation data, and disseminates the products in a form to be easily used for decision making related to biodiversity conservation.
Applications

Ocean Circulation and Fishery Resources Management

DIAS provides usable information for a sustainable fishery resources management by constructing an oceanography- fishery cooperative platform that enables resource managers to investigate relationships between fluctuations in the fishery resources and the seasonal to decadal ocean variations derived from an ocean re-analysis based on the data assimilation by applying the four dimensional variational assimilation methods.
The Asian countries cooperatively integrate data from earth observation satellites and in-situ networks with other types of data, including numerical weather prediction model outputs, geographical information, and socio-economic data, to generate information for making sound water resources management decisions.
Drought and Water Scarcity

Flooding and Land Slides

Water Pollution and Ecosystem Degradation

Climate Change Impacts on Water Cycle
GEOSS
Asian Water Cycle Initiative (AWCI)

To promote integrated water resources management by making usable information from GEOSS, for addressing the common water-related problems in Asia.

Uniqueness

- A River Basin of Each Country
- Observation Convergence
- Interoperability Arrangement
- Data Integration
- Open Data & Source Policies
- Capacity Building
- Early Achievements
GEOSS Asian Water Cycle Initiative (AWCI)

19 Member Countries
"Recent Signs of Water-related Disasters"

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<th>ID</th>
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</table>
GEOSS Asian Water Cycle Initiative (AWCI)

19 Member Countries

18 River Basins for Initial Demonstration

Countries:
- Myanmar
- Malaysia
- China
- Mongolia
- Korea
- Japan
- Pakistan
- Nepal
- Bhutan
- India
- Bangladesh
- Myanmar
- Laos
- Thailand
- Cambodia
- Philippines
- Sri Lanka
- Thailand
- Cambodia
- Malaysia
- Indonesia
Web-based Data Archiving & Integration System

Data Integration and Analysis System (DA-09-02a)

- Search IF
- Data Download
- Document Generator
- Visualization System

• Search with Metadata
• Data Download
• Document Generation from Meta Data
• Data Visualization

User
Data status as of 2009/04/10

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<tr>
<th>Country</th>
<th>Basin Name</th>
<th>Basic Info.</th>
<th>Raw Data Upload</th>
<th>Quality Control</th>
<th>Metadata Initial Registration</th>
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YY/MM/DD: Handling Date

- Completely Finished
- Full Data provided by offline
- Partial Data provided by offline
- Partially Finished
GEOSS Asian Water Cycle Initiative (AWCI)

19 Member Countries

18 River Basins for Initial Demonstration

Countries:
- Myanmar
- Malaysia
- China
- Mongolia
- Korea
- Japan
- Pakistan
- Nepal
- Bhutan
- India
- Bangladesh
- Vietnam
- Uzbekistan
- Nepal
- Laos
- Thailand
- Malaysia
- Indonesia
- Sri Lanka
- Philippines
- Cambodia
- Tibet
GEOSS/AWCI Flood Evacuation Instruction System in Vietnam

Topography and River Channel Network

Land-use

Atmospheric and Land Surface Water Observation

Heavy Rainfall Prediction Coupled with Satellite Data Assimilation

Numerical Weather Prediction

Heavy Rainfall Prediction

Operational Data

Flood Prediction

Prediction of the inundation Area and Depth

Numerical Weather Prediction

Evacuation Instruction

Heavy Rainfall Prediction

Atmospheric and Land Surface Water Observation

Topography and River Channel Network

Land-use

Socio-Economic Data

Evacuation Instruction

November 2004

Heavy Rainfall Prediction

Operational Data

Atmospheric and Land Surface Water Observation

Topography and River Channel Network

Land-use

Socio-Economic Data

Evacuation Instruction
The outflow from *LaoCai* is taken as inflow from its upper region.
Global Rainfall Map in near-real-time (GSMaP_NRT)

- GSMaP (Global Satellite Mapping for Precipitation) is originally funded by JST/CREST during 2002-2007.
  - Development of reliable MWR algorithm consistent with TRMM/PR and precipitation physical model developed by using PR (Aonashi et al., 2009).
  - Combination of microwave radiometer retrievals with GEO IR by the moving vector (like CMORPH) and new Kalman filtering method (Ushio et al., 2009).
- JAXA/EORC began to provide near-real-time version data of GSMaP (GSMaP_NRT) about 4-hour after observation via password protected ftp site since October 2008.
- Hourly browse images, kmz files for GoogleEarth, and 24-hour movies are also available from Web server.

Ben Ngoc is in the 1 km downstream of the Hoa Binh reservoir.
Glacier Lake Outburst Floods (GLOFs)

Lake area expansion
Water and energy budget distributed hydrological model (WEB-DHM) coupled with climate models

Lake area expansion
Daichi/PALSAR Synthetic aperture Radar for identifying water surface

Moraine topography
Daichi/PRISM: three independent optical systems for digital elevation data

Source: Google Earth
Climate Change Impacts on Heavy Rainfall in Indonesia

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<th>B1</th>
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<tr>
<td></td>
<td>2046-2065</td>
<td>2081-2100</td>
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<tr>
<td>Number of models which show more severe distribution than now</td>
<td>82%</td>
<td>94%</td>
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<td>14(/17)</td>
<td>16(/17)</td>
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<td>100-year probable rainfall</td>
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</table>

*Note: The values in bold are the ones of interest.*
**Design Rainfall**

- Current Design Rainfall
- Future Design Rainfall under Climate Change

**Design Hydrograph**

- Discharge (m^3/s)
  - Current Climate
  - Climate Change

Hydrological Model
Climate Change Impacts on Flood Control Plan in Indonesia

Probable flood (10year)
- Current Climate

Probable flood (10year)
- 50 years later
End to End Approach on Climate Change Adaptation

- **Scientific approach**
  - Quantifying uncertainty
  - Multi-model ensemble (MME)
  - Down-scaling
  - Basin-scale prediction of quantity & quality

- **Engineering approach**
  - Water quantity and quality prediction
    - flood
    - ordinary water
    - ground water
    - drought
  - Current facility, plan, management
  - Inform ation
  - Flood control system
  - Storage
  - Treatm ent
  - Logic model
  - Filed survey
  - Inter-industry analysis
  - Flood Disaster potential

- **Socio-economical approach**
  - Adaptation options
    - Early warning
    - Innovative technology
    - Flood control
    - Quality control
    - Allocation policy
    - Land use
    - etc.
  - Impact assessment
  - Decision making
  - Monitoring evaluation

- System Generalization through Intercomparison Studies