Geo-information for Integrated Water Resources Management (IWRM)

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Outline

- Introduction: IWRM and Geo Information
- Current In –Country Use of Geo-Information in IWRM
- Future Insight
Outline

• Introduction: IWRM and Geo Information
• Current In-Country Use of Geo-Information in IWRM
• Future Insight
Integrated Water Resources Management (IWRM)

- A process which
  - promotes the coordinated development and management of water, land and related resources
  - to maximise the resultant economic and social welfare in an equitable manner
  - without compromising the sustainability of vital ecosystems"
……builds on river basin management

- from both water quantity and water quality perspective
Integrated River Basin Management (IRBM)

- IRBM
  - *coordinated management of resources in natural environment (air, water, land, flora, fauna) based on river basin as a geographical unit*
  - *balancing man's need with necessity of conserving resources to ensure their own sustainability”*

- Integral part of IWRM
  - river basins constitute the management unit
    - IWRM provides the generic and common policy
  - Each river basin or sub-basin is unique
    - may have different focus
      - Agriculture, commercial/industries, eco-tourism, etc
Ground-water

Transboundary

Global

National

Drainage Basin

/river basin

Lake
River Basin
A geographical physical unit

Sungai Kelang River Basin
8 Local Authorities
Location of Langat and Klang River Basin

Klang River Basin

Langat River Basin
189 River Basins Management Units (RBMU) in Malaysia
Figure 1.1
Langat River Basin
Administrative and Management Boundaries
We all live in a river basin
● As the country, developed, geo-information assist us, in identifying the extend of build up areas that have replaced the natural environment

● These foot prints, buildings, roads and other paved areas
  ○ All within each specific river basin
  ○ All can impact on overland flow, in terms of both quality and quantity as it traverse the land to reach the rivers – the lowest point in the river basin
• As the country developed, geo-information assist us, in identifying the extend of build up areas that have replaced the natural environment

• These foot prints, buildings, roads and other paved areas
  • All within each specific river basin
  • All can impact on overland flow, in terms of both quality and quantity as it traverse the land to reach the rivers – the lowest point in the river basin
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- Introduction: IWRM and Geo Information
- Current In-Country Use of Geo-Information in IWRM
- Future Insight
Current use

- Basic information
  - Topography, delineation of river basin boundaries
  - Flow path of rivers and tributaries

- Analytical
  - Developing DEM
  - Identifying flood zones
  - Identifying other strategic/critical features and processes
    - Structures and challenges
Current use

- **Basic information**
  - Topography, delineation of river basin boundaries
  - Flow path of rivers and tributaries

- **Analytical**
  - Developing DEM
  - Identifying flood zones
  - Identifying other strategic/critical features and processes
    - Structures and challenges
Origins of rivers

- Head waters of rivers are from the highlands.
- Rivers and tributaries are the result of water finding its own levels, flowing to the coast from the highlands.
- Water in rivers/tributaries flows from the whole area of each basin/sub-basin.
- The central forest spine (CFS) is the origin of many major rivers in Peninsula Malaysia.
Digital Elevation Model of Semenanjung with RBMU boundaries (JICA, 1980) and major river systems
Digital Elevation Model with State, RBMU (JICA, 1980) Boundaries and Rivers for Negeri Perak
Digital Elevation Model with State, RBMU (JICA, 1980) Boundaries and Rivers for Negeri Pahang
Current use

- Basic information
  - Topography, delineation of river basin boundaries
  - Flow path of rivers and tributaries

- Analytical
  - Developing DEM
  - Identifying other strategic/critical features and processes
    - Structures and Water Resources challenges
River Basin
Has a limited carrying capacity, a function of hydrological and hydrodynamics

**Hydrological**: rainfall/runoff relationship within each river basin
**Hydrodynamic**: change in flow condition, will affect all initial environmental condition
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
- Climate Change
- Coastal Processes
- River Basin Planning
Water Resources Challenges

- Floods
- Water Quality
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- Forest Fires
- Climate Change
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- River Basin Planning
Flooding at the North-South Highway near Bumbung Lima (Muda River, 26 August 1997)
Kajian NAHRIM
Flood plain modeling
Ramalan kawasan banjir

Mula – 0 jam

Selepas 20 jam

Selepas 40 jam

Selepas 60 jam
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
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Coastal Resource Risk Index (CORRI)

Focus: the level of sensitivity of coastal resources towards water pollution
Sg Perai
Sg Perlis
Result: Pollutant Loading

- **Biochemical Oxygen Demand (BOD)**
  - Sg Perlis: 70 kg/day
  - Sg Kedah: 199 kg/day
  - Sg Perai: 74 kg/day

- **Chemical Oxygen Demand (COD)**
  - Sg Perlis: 910 kg/day
  - Sg Kedah: 2727 kg/day
  - Sg Perai: 1413 kg/day

- **Suspended Solids (SS)**
  - Sg Perlis: 27957 kg/day
  - Sg Kedah: 10276 kg/day
  - Sg Perai: 16060 kg/day
Kajian Tasik Negara, 2005

A Study on the Status of Eutrophication of Lakes in Malaysia commissioned by NAHRIM to UTM

Tasik Biru, Sarawak

Reservoirs, Sg Perak
From TNB
Classification of 90 Lakes Studied

- Medium (Mesotrophic): 62% (56 lakes)
- Bad (Eutrophic): 38% (34 lakes)
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
- Climate Change
- Coastal Processes
- River Basin Planning
Forest Fires

- Forest fires and haze now have a common recurrent of 3-4 years in Malaysia and Indonesia
- Major threats causing the loss of peat swamp forests

Firemen battle peat fires
Flooded hollows and basins provide ideal growing conditions of reeds and sedges and in humid tropical climate, indigenous shrubs and rain forests trees

Key to Formation of Peat Bog

[Diagram of peat formation]

[Recommended link: http://www.nics.gov.uk/doe envi/leaflet5.htm]
Peat Swamp Location in Langat River Basin

North Langat Peat Swamp

South Langat Peat Swamp
MAP 3: GENERALISED SOIL MAP

Dominant Soil Types
- Red Yellow and Some White Podzolics
- Shallow Red-Yellow Podzolics & Skeletal Soils
- Organic Peat and Some Alluvial Clay
- Spot Height
Peat water management in the Kinderdykes, the Netherlands

Peat water management in Malaysia

Tg Bijat, Sri Aman, Sarawak

Pontian, Johore
• Annual Subsidence (cm)

Soil Temp (°C)

Subsidence Rate

Regional Surface Winds and Observed Smoke Haze/Hot Spots over Cloud-free Areas

Issued at 7:10 pm on 11 March 2002

Haze and Weather Features
Hot spots with smoke/haze and plumes were detected in central Sumatra. Cloudy with showers over most parts of Kalimantan.

Issued by Meteorological Service Singapore
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
- Climate Change
- Coastal Processes
- River Basin Planning
Oceans may rise to danger level by 2100, says researcher

Wettest town going dry

Climate change – everyone’s in one boat

All of us are adding to global warming, so each of us should do something to curb it. Sonia Randhava has the task list.
Global Warming – Circulation change

- Anthropogenic forcing has likely contributed to Global Warming

- Climate change is affecting storm tracks, winds and temperature patterns
# Observed Climate Change

<table>
<thead>
<tr>
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<th>GLOBAL*</th>
<th>MALAYSIA</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1906-2005</td>
<td>1968-2002</td>
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<tr>
<td>Surface temperature</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>(°C)</td>
<td></td>
<td>0.49 – 0.91 (MMD)**</td>
</tr>
<tr>
<td>Sea level rise</td>
<td>1.8</td>
<td>3.1</td>
</tr>
<tr>
<td>(mm/yr)</td>
<td></td>
<td>1.25 (DID @ Tg Piai)***</td>
</tr>
</tbody>
</table>

* IPCC 4TH ASSESSMENT REPORT (AR4), 2007
** INITIAL NATIONAL COMMUNICATION, 2000
*** NATIONAL COASTAL VULNERABILITY INDEX STUDY,DID, 2007
Climate Change will affect basic elements of life
- Access to water, food production, health and environment

Adaptation
- Poorest countries are most vulnerable to climate change
- ...climate change be fully integrated in development policies ...
- ...international funding should support improved regional information on climate change impact … (ie identify vulnerabilities)
Figure 3.2. Examples of current vulnerabilities of freshwater resources and their management; in the background, a water stress map based on Alcamo et al. (2003a). See text for relation to climate change.

From IPCC AR4 WG2
Figure 1. (Reproduced from Figure 5.16 of Bindoff et al. (2007) Geographic distribution of long-term linear trends in mean sea level (mm yr$^{-1}$) for 1955 to 2003 based on the past sea level reconstruction with tide gauges and altimetry data (updated from Church et al., 2004)
NATIONAL HYDRAULIC RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)

From IPCC AR4 WG2

Forest production in North Asia is likely to benefit from carbon fertilization. But the combined effects of climate change, extreme weather events, and human activities are likely to increase the forest fire frequency. [10.4.4.1]

The Lena delta has been retreating at an annual rate of 3.6-4.5 m due to thermokarst processes which are likely to be influenced by projected rise in temperature. [10.6.1]

Net primary productivity of grassland in colder regions of Asia is projected to decline and shift northward due to climate change. The limited herbaceous production, heat stress from higher temperature and poor water intake due to declining rainfall could lead to reduced milk yields and increased incidence of diseases in animals. [10.4.1.3]

Cereal yields could decrease up to 30% by 2050 even in South Asia. In West Asia, climate change is likely to cause severe water stress in 21st century. [10.4.1.1]

In East Asia, for 1°C rise in surface air temperature expected by 2020, water demand for agricultural irrigation would increase by 6%--10% or more.

The gross per capita water availability in India will decline from ~1820 m³ yr⁻¹ in 2001 to as low as ~1140 m³ yr⁻¹ in 2050. [10.4.2.3]

Increase in coastal water temperatures would exacerbate the abundance and/or toxicity of cholera in South Asia. [10.4.5]

Rice yield is projected to decrease up to 40% in irrigated lowland areas of central and southern Japan under doubled atmospheric CO₂ [10.4.1.1]

The projected relative sea level rise, including that due to thermal expansion, ice sheet gravitational response, and the trends of rising river water level are 70-90, 50-70, and 40-60 cm in the Huanghe, Changjiang and in the Zhejiang Delta respectively by the year 2050. [10.4.3.1]

With a 1 m rise in sea level, 2,500 km² of mangroves in Asia are likely to be lost. Bangladesh would be worst affected by the sea level rise in terms of loss of land. Approximately 1,000 km² of cultivated land and sea product cultivating area is likely to become salt marsh, and 5,000 km² of Red River delta, and 15,000–20,000 km² of Mekong River delta are projected to be flooded. [10.4.3.2]

Increases in endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected in East, South and South-East Asia. [10.2.4.6]

Around 30% of Asia’s coral reefs are likely to be lost in the next 30 years due to multiple stresses and climate change. [10.4.3.2]

Figure 10.4. Hotspots of key future climate impacts and vulnerabilities in Asia.

From IPCC AR4 WG2
Data grid of CGCM1 that were used in the RegHCM-PM. The ocean grids which are used in the RegHCM-PM are shown as blue. The land grids which are used in the RegHCM-PM are shown as green.
The grid layout for the outer domain (1st Domain, 26x28 grids, 81 km resolution) of the RegHCM-PM under Mercator projection.
Figure 17 - Nested grids of the inner and the outer domains of RegHCM-PM under Mercator projection. The boundaries of the Peninsular Malaysia and nearby islands are overlaid on the grids.
Get your Longitudes and Latitudes through the Map provided

<table>
<thead>
<tr>
<th>Data Retrieval</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Query Criteria</td>
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<td>Longitude</td>
<td>Latitude</td>
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<tr>
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<tr>
<td>To</td>
<td></td>
</tr>
<tr>
<td>From Date</td>
<td>Jan</td>
</tr>
</tbody>
</table>

- Each grid (not pixel) has been made interactive with longitude and latitude values.

Min Latitude: 1.5 | Max Latitude: 7 | Min Longitude: 100.0 | Max Longitude: 104.5

*Important Notice: This map is just an approximate guide for Peninsular Malaysia.*
## Climate Change Projection

<table>
<thead>
<tr>
<th></th>
<th>GLOBAL*</th>
<th>MALAYSIA**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2050</td>
<td>2100</td>
</tr>
<tr>
<td>Surface temperature (°C)</td>
<td>1.6</td>
<td>2.8</td>
</tr>
<tr>
<td>(Emission Scenario SRES*** A1B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea level rise (m)</td>
<td>0.21-0.48</td>
<td></td>
</tr>
<tr>
<td>(Emission Scenario SRES*** A1B)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Rainfall (mm)</td>
<td>+10% (Kelantan, Terengganu &amp; Pahang)</td>
<td>-5% (Selangor &amp; Johor)</td>
</tr>
<tr>
<td>River Flows (m3/s)</td>
<td>+11% to +43% (Flood Flows)</td>
<td>-31% to 93% (Low Flows)</td>
</tr>
</tbody>
</table>

* IPCC WG1 4TH ASSESSMENT REPORT (AR4), 2007  
** STUDY ON IMPACT OF CLIMATE CHANGE ON HYDROLOGIC REGIME AND WATER RESOURCES OF P MALAYSIA, NAHRIM, 2006  
*** SRES = Special Report on Emission Scenarios
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
- Climate Change
- Coastal Processes
- River Basin Planning
Erosion – Peninsula Malaysia

Data From DID Malaysia
Erosion – Sabah & Sarawak

Data From DID Malaysia

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Shoreline Management Problems

- Silted Floating Mosque
- Silted Marina
- Water Quality/ silted site
Shoreline Management Problems

Silted Marina (Merang)
SUNGAI PAHANG, PEKAN PAHANG
dari google earth
Permodelan Hidraulik Sungai Pahang, Pekan
Perbandingan Perubahan kelajuan air sebelum dan selepas Pembuangan Delta di Muara Sungai Pahang, Pekan.

Kelajuan Arus Berkurang
Kajian Hidrodinamik
Cadangan Lapangan Terbang Baru Pulau Tioman
CADANGAN PROJEK LAPANGAN TERBANG

Penambakan laut dari Kg. Paya ke Tg. Genting:
- 2 km panjang Landasan
- 800 m keluar Lautan China Selatan
IMPAK KEKAL HASIL PROJEK LAPANGAN TERBANG KE ATAS PULAU TIOMAN

Kg Paya

Tg Genting

Kg. Genting

pantai yang cetek

pantai yang ditambak

Landasan Kapal Terbang – Kerja penambakan

pantai yang terhakis
Pergerakan sedimen

Tapak Cadangan Asal

Pantai Timur Pulau Tioman

Pantai Selatan Pulau Tioman

Area of sediment plume impact: 12km

Area of sediment plume impact: 17.5km

Area of sediment plume impact: 89m

Di Pantai Barat Pulau Tioman
Asian Tsunami – “Ring of Fire”

Malaysia Shoreline surrounded by Active Earthquake Plates
Pusat Gempa Bumi yang berbeda
impak akan berlainan

Case 1
24Dec2004

Case 2

Case 3

Case 4

Case 5

01/01/2005 01:00:00
Case 1: 24 Dec 2004

Kuala Muda, Kedah

Pulau Pinang

Pulau Langkawi
Case 3

Kuala Muda, Kedah

Pulau Langkawi

Pulau Pinang

Surface Elevation (meter)
- Above 1.6
- 1.4 - 1.6
- 1 - 1.4
- 0.6 - 1
- 0.2 - 0.6
- -0.2 - 0.2
- -0.6 - 0.2
- -1 - 0.6
- -1.4 - -1
- -1.6 - -1.4
- Below -1.6
Case 4

Pantai Barat, Sabah

Pusat Gempa Bumi

Sarawak

Surface Elevation (meter)
- Above 1.6
- 1.4 - 1.6
- 1 - 1.4
- 0.6 - 1
- 0.2 - 0.6
- -0.2 - 0.2
- -0.6 - 0.2
- -1 - 0.6
- -1.4 - 1
- -1.6 - 1.4
- Below -1.6

01/01/2006 04:28:00

01/01/2006 06:47:00
Case 5

Pantai Timur, Sabah
Water Resources Challenges

- Floods
- Water Quality
- Coastal Processes
- Forest Fires
- Climate Change
- Coastal Processes
- River Basin Planning
Example, Malaysia:
*Putrajaya Lake Management*

- Created Federal Administrative Capital
- 70% of the catchment is within the Putrajaya area
- 30% located outside Putrajaya area shared by other stakeholders i.e. UPM, MARDI, IOI, UNITEN, Sg. Merab Malay Reserve and Cyberjaya
- Catchment lies within the jurisdiction of Majlis Perbandaran Sepang (MPSp), Majlis Perbandaran Subang Jaya (MPSJ) and Perbadanan Putrajaya (PPj)

From: Perbadanan Putrajaya
Putrajaya Catchment, Sg Chuau Catchment, is a tributary of Langat River System

From: Perbadanan Putrajaya
From: Perbadanan Putrajaya
What has been done elsewhere

- Floods
- River Basin Planning
What has been done elsewhere

- Floods
- River Basin Planning
Location Map, Year 2007
Major floods reported by news services and satellite data observation
Updated November 2, 2007
Base image from NASA/JPL.

2007 - Global Flood Archive - Dartmouth Flood Observatory

Flooding Underway
Week ending November 2, 2007
NATIONAL HYDRAULIC RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)

Tropical Cyclone Nagris landing in Myanmar (2^{nd} May, 2008)

Details of NAGRIS
Occurred: April 26\textsuperscript{th} to 3\textsuperscript{rd} May
Radius: ~250 miles
Max wind speed: ~ 130 mph
Max peak surge: ~ 22 feet

Tropical Cyclone Nagris landing in Myanmar (2^{nd} May, 2008)
Modeling

- Automatic river basin and channel network modeling
  Use of digital elevation data

GTOPO30 (USGS HP)

DEM data

DEM data → River basin → River channel network
Advanced Land Observing Satellite (ALOS)

- **Launch:** 24 January, 2006.
- **Objectives:**
  - Cartography
  - Regional observation
  - **Disaster monitoring**
  - Resource surveying
What has been done elsewhere

- Floods
- River Basin Planning
Singapore River and Kallang Basin

- The catchment covers a fifth of the land area of Singapore.
The Greatest Catchment

The Marina Reservoir will play a key role in enhancing Singapore’s water supply from local catchment. It will have the biggest catchment among the 15 reservoirs, some 10,000 hectares (ha) in size or about one-sixth of Singapore’s land area.
SINGAPORE: PUBLIC SPACE & URBAN WATERFRONT master plan

LEGEND
- parks & open space
- interim green
- monuments
- promenade, pedestrian mall & plaza
- covered public space
- interim uses
- location where public spaces are encouraged

자료: URA (2004), Our City Centre Proposals
Downtown@Marina bay: Beyond Year 2025

URA (2004), International Design Consultancy for The Waterfront
River Rhine

- **Introduction**
  - length: about 1,100 km
  - Catchment Area: 196,100 sq km
  - Headwaters originate from eastern Switzerland and flow through Austria, Liechtenstein, Germany, France, Luxembourg and the Netherlands.
  - Is connected to the major rivers of Western Europe.
  - An important and busy waterway in Europe
River Rhine, Results

- Recreational facilities for sailing, fishing, and swimming established
- Clean drinking water
- Better Habitat for fish and aquatic life
- Sustainable Power Resource
- Water for agricultural and irrigation
- **Increase trade, factories and businesses**
- Reduced dissolve mineral by 90% since the 70s
- Develop close working relationship with all stakeholders to ensure the successful rehabilitation of the Rhine
New York City: Greenway Plan

Manhattan Waterfront Greenway Map

Existing Greenway
Greenway Connector
Planned Greenway
Proposed Greenway

NYC DCP (2004), Greenway Plan
NEW YORK: RIVERSIDE SOUTH PROJECT
Miller highway relocation

Existing

Proposed

Hudson River

Proposed Created Waterfront Park

Hudson River
CITY OF VANCOUVER: Greenways Network

- Stanley Park (118만평)
- Pacific Spirit Park (243만평)
- Queen Elizabeth Park (16만평)

게시자: City of Vancouver (2004), City Greenways
CITY OF VANCOUVER: English Bay
Shanghai, China
What next for Malaysia?
Sg Kelang - 2050?

Yodogawa – up stream of Osaka
Klang River Basin - 3-D

KUALA LUMPUR

SHAH ALAM
Udang Galah @ Brickfields? in 2050?
Vision for National Framework for WRM (NFWRM)

- Water Resources Management fully integrated throughout the country from the head waters to the coastal areas
  - Equity distribution of water between the sectors
    - Water supply for industry, housing and agriculture, integrated and well coordinated
  - Clean and vibrant rivers and water bodies
  - Malaysia’s biodiversity and gene bank, recognised, protected, thriving and contributing to the country’s economy
  - Floods, erosion, land slides and other land & water related challenges, well managed and under control
The NFWRM

- Focuses on Water resources governance
  - Incorporate land and water, together with other related resources, weaved in a matrix that
    - Complement one another
    - Workable, and developing incrementally, if necessary
    - Supported, monitored, assisted and enforced by all stakeholders
  - Ensure sustainable economic growth and pristine environment
  - Support, nurture and develop related water services turning them into successful businesses; beyond the shores of the nation
  - Must have action plans with targeted milestones
Suggested Milestones NFWRM

- **Immediate Term**
  - 6 months to 2 years: secure financial support to develop the framework - as directed by the NWRC and chaired by the YAB PM

- **Short Term**
  - 2-3 years: Develop the framework, together with more detail milestones and prioritize action plans

- **Medium Term**
  - 3-10 years: implement prioritized areas of actions such as
    - over-arching IRWM legislations to fit-in (adapt, adopt, amend) existing water related laws and proposed water related laws, which lies within a connected and contiguous single environmental system or units
    - setting up river basin organizations (189 of them) to manage development within each basin
    - managed impact of global warming on climate changes and water resources

- **Visionary Term**
  - Over 2 planning horizons or more, each of 25 to 30 years
    - Achieve Clean Water in lakes, rivers, ground water resources and coastal waters
    - The water sector developed to include development of related businesses providing service provisions beyond our shores
  - May need to be packaged to anticipate/dovetail election schedules, not only to ensure compliance but to monitor impacts
“A vision without action is just a dream;
An action without vision just passes time;
A vision with an action changes the world.”

......World Lake Vision (2003), Mandela?
Thank you