Water – climate change – disaster – (food and energy) nexus: the emerging Indonesian economy perspective

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Hotel Santika, Jakarta
1-2 April, 2013
Water management issues

Water use
- Municipal clean and drinking water supply
- Agricultural and fishery use
- Industrial use
- Energy production
- Natural ecosystem function and climatic regulation
- Cultural use
- Waste disposal
Global water shortage
(Kummu et al., 2010)

The water crowding index, i.e. Falkenmark water stress indicator, was used to identify water shortage in 284 sub-basins.

- A few areas moderate shortage: 2%
- 9%
- 35%
- 1800 (1000-1700 m3/capita/year)
- 1900 (<1000 m3/capita/year)
- 1960
- 2005

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Water reform and food security in Asia

The population in Asia is projected to increase by 1.5 billion people by 2050.

International Water Management Institute (IWWI) and the United Nations Food and Agriculture Organization (FAO):

- many Asian nations "face the politically risky prospect of having to import more than a quarter of the rice, wheat and maize they will need by 2050,"

Colin Chartres (IWWI)

- "Asia's food and feed demand is expected to double by 2050.
- Relying on trade to meet a large part of this demand will impose a huge and politically untenable burden on the economies of many developing countries,"
- "The best bet for Asia lies in revitalizing its vast irrigation systems, which account for 70 per cent of the world's total irrigated land,"
Walk This Way: Making the right choices to reduce your water footprint

**Rise & Shine**
- **Toilet**: 6 gallons/flush
- **Low-flow Toilet**: 1.3 gallons/flush

**Breakfast**
- **Coffee**: 3.7 gallons
- **Tea**: 9 gallons

**Lunch**
- **Soda**: 55 gallons
- **Water**: 11.3 gallons
- **Beef**: 15,000 gallons

**Dinner**
- **Wine**: 1.87 gallons
- **Chicken**: 0.95 pounds
- **Beer**: 1.97 gallons

**Cleaning Up**
- **Washing Machine**: 22 gallons
- **Dish Washing**: 20 gallons

**Energy**
- **Solar**: 24.5 gallons/week

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**Total Saved**: 2,270.75 Gallons
Water – climate change – spatial change – disaster – (food & energy) nexus
Talk agenda

1. Asia and Indonesia on the rise
2. Water resources and footprints in Indonesia
4. Future studies
Asia has the highest population per continent in the world. The current estimated population is over 4 billion people. That is close to 60% of the WORLD’s population!

**Estimated Population Densities**

http://seep.s.ufl.edu/student/goods/1377/e-portfolio/20130429/520e2520map.pdf

NCGIA, UNEP/Gрид

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Asia’s share of world trade and world GDP is increasing.

Sources: IMF, World Economic Outlook database; Direction of Trade Statistics; and IMF staff calculations.
Asian Rivers Top WWF Risk List From Pollution, Climate Change

by William French
Geneva (AFP) Mar 20, 2007

Five rivers in Asia serving over 870 million people are among the most threatened in the world, as dams, water extraction and climate change all take their toll, the World Wide Fund for Nature (WWF) said on Tuesday.

The Yangtze, Salween-Nu, Indus, Ganges and Mekong-Lancang rivers make up half of the WWF’s "top ten" most threatened river basins, which "either already suffer most grievously under the weight of these threats or are bracing for the heaviest impacts," the organisation said.
Sedimentation and major river basins in Asia
Changes in the sediment loads of rivers

- Wide ranging environmental and social and economic consequences.

Longer term sediment loads

- Climate change is increasingly seen as a cause
- Human impact is generally recognized to be the key cause.

The key drivers of increasing changes due to:

- Land clearance, land-use activities and other forms of catchment disturbance

Decreasing changes due to:

- Sediment trapping by dams, soil conservation and sediment control programmes, and sand extraction from river channels.
Figure 1: Population extinctions in Singapore and Southeast Asia. Green and blue bars represent recorded and inferred extinctions in Singapore, respectively. Yellow and red bars represent minimum and maximum projected extinctions in Southeast Asia, respectively.
**Indonesia today ...**

- 16th-largest economy in the world
- 45 million members of the consuming class
- 53% of the population in cities, producing 74% of GDP
- 55 million skilled workers in the Indonesian economy
- $0.5 trillion market opportunity in consumer services, agriculture and fisheries, resources, and education

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**... and in 2030**

- 7th-largest economy in the world
- 135 million members of the consuming class
- 71% of the population in cities, producing 86% of GDP
- 113 million skilled workers needed
- $1.8 trillion market opportunity in consumer services, agriculture and fisheries, resources, and education
Bonus Demografi ini harus dimanfaatkan secara maksimal di saat negara lain menghadapi situasi “aging population”.
INDONESIA TENGAH MENGALAMI PROSES URBANISASI YANG SANGAT PESAT

Kelas Menengah 2030: 135 juta

- 53% penduduk Indonesia tinggal di kawasan perkotaan. Di tahun 2025 jumlah tersebut akan lebih dari 65%. Kawasan-kawasan perkotaan akan sangat membutuhkan pembangunan infrastruktur yang besar-besaran untuk bisa mendorong daya saing perekonomian nasional.
The growing effluent society in Indonesia

An estimated 90 million Indonesians could join the consuming class by 2030

Million people

- Below consuming class: 240 in 2010, 195 in 2020, 280 in 2030 in 5–6% GDP scenario, 280 in 2030 in 7% GDP scenario
- Consuming class: 45 in 2010, 85 in 2020, 145 in 2030 in 5–6% GDP scenario, 110 in 2030 in 7% GDP scenario

Additional people in the consuming class: 40 in 5–6% GDP scenario, 90 in 7% GDP scenario, 125 in 7% GDP scenario

1 Rounded to the nearest five million.
2 Consuming class defined as individuals with an annual net income of above $3,600 at 2005 purchasing power parity (PPP).
3 Based on annual GDP growth of between 5 and 6 percent.

SOURCE: McKinsey Consumer and Shopper Insight (CSI Indonesia 2011); 2010 Population Census, Indonesia’s Central Bureau of Statistics; Canback Global Income Distribution Database (C-GIDD); McKinsey Global Growth Model; McKinsey Global Institute Cityscope 2.0; McKinsey Global Institute analysis
2. WATER RESOURCES AND FINGERPRINTS IN INDONESIA
Inland water resources in Indonesia

- 13.85 millions ha of rivers, lakes and ponds
- 5,590 major rivers with 65,017 tributaries in Indonesia
- 12.0 millions ha rivers and floodplains
- 1.8 millions ha of natural lakes
- 0.05 millions ha of reservoirs
- The total length of major rivers 94,573 km
- 1,512,466 km² catchment areas

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Inland water resources in Indonesia

840 lakes, 735 ponds and 162 reservoirs in Indonesia

- Lake Toba is the largest (110,260 ha)
- Lake Matano is the deepest (600 m)
- Lake Sentarum (West Kalimantan) → unique wetland (10 months wet and 2 months dry)

- Covering and area of 126,000 ha
- The volume is 13 billions m3 fresh water
- Buffering 266 freshwater fish species
- 18 species are endemic
Potential Water Availability and Water per capita per year

1.008 x 10^9 m^3
98.800 m^3/k/thn

247 x 10^9 m^3
18.300 m^3/k/thn

981 x 10^9 m^3
251.500 m^3/k/thn

738 x 10^9 m^3
18.400 m^3/k/thn

187 x 10^9 m^3
1.600 m^3/k/thn

60 x 10^9 m^3
5.500 m^3/k/thn

Global average
1.200 m^3/k/yr
Water Supply – Demand Ratio

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Virtual water import per province
(net virtual flows between island group, only the largest flows, > 10^9 m^3/year) (Bulsink et al., 2010)
### Gross virtual water flows (10^6 m^3/year) between provinces (2000 – 2004) (Bulsink et al., 2010)

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Water footprints of Indonesian provinces per capita related to crop products (2000 – 2004) (Bulsink et al., 2010)
Virtual water trade balance and water footprint for Indonesia and the island of Java (Bulsink et al., 2010)

Indonesia

- Re-export of virtual water: 0
- Water use for export products: 43.7
- Virtual water export: 43.7
- External water footprint: 5.8
- Internal water footprint: 227.4
- Water footprint: 233.2
- Virtual water import: 5.8
- Water use within Indonesia: 271.1
- Virtual water budget of Indonesia: 276.9

Java

- Re-export of virtual water: 0
- Water use for export products: 1.6
- Virtual water export: 1.6
- External water footprint: 15.6
- Internal water footprint: 98.8
- Water footprint: 114.4
- Virtual water import: 15.6
- Water use within Java: 100.4
- Virtual water budget of Indonesia: 116.0

The numbers refer to water volumes in $10^9$ m$^3$/yr. The water use refers to the production for food only.
Top 4 Economies in Asia for 2010

(Excluding South Asia and Oceania)

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP ($US)</th>
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<tbody>
<tr>
<td>China</td>
<td>5,878,629,246,677</td>
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<td>Japan</td>
<td>5,497,812,568,086</td>
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<td>Korea, South</td>
<td>1,014,483,158,314</td>
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<tr>
<td>Indonesia</td>
<td>706,558,240,892</td>
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</table>

Source: World Bank (National Accounts Data and OECD National Accounts Data)

http://energyinasiablog.com/2011/10/11/how-dependent-are-asias-top-4-economies-on-foreign-oil/

Top Five Coal Exporters, 2009

<table>
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<tr>
<th>Country</th>
<th>Million Short Tons</th>
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<tr>
<td>Australia</td>
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<td>Indonesia</td>
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<td>South Africa</td>
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<td>United States</td>
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Source: EIA International Energy Statistics

http://www.eia.gov/emeu/cabs/indonesia/images/Coal_Exp.gif

Future hazard for inland waters in Indonesia?

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Indonesia Primary Energy Mix 2010 and 2030
(Data Source: Indonesia Energy Outlook 2009, Ministry of EMR)

**Year 2010**
- Hydro: 2.7%
- Geothermal: 1.6%
- Coal: 18.8%
- Gas: 28.6%
- Oil: 48.4%

Annual Energy Demand: 1100 Million BOE.
Oil only: 1.4 Million BOPD.

**Year 2030 – Scenario Climate #2**
- Gas: 25.6%
- Coal: 30.5%
- Oil: 30.4%
- Hydro: 3.9%
- Biofuel: 4.9%
- Geothermal: 2.5%
- Biomass: 1.9%
- Nuclear: 0.3%
- Solar & Wind: 0.055%

Annual Energy Demand: 3500 Million BOE.
Oil only: 2.5 Million BOPD.
3. WATER – CLIMATE CHANGE – DISASTER – (FOOD AND ENERGY) NEXUS
3 major climate engines in the Indonesian Region

IOZM
Cyclicity
15 months
3-4 years

ENSO
Cyclicity
5-7 years
Tendency
4 years
Temperature trend in 100 years

**January**
- Medan: 1.98°C
- Palembang: 2.5°C
- Majene: -0.3°C
- Manado: -0.03°C
- P.Pinang: 1.7°C
- Jakarta: 1.04°C
- Cilacap: 3.38°C
- Makasar: 2.8°C
- Bone: 1.8°C
- Surabaya: 1.46°C
- Denpasar: -0.6°C

**July**
- Medan: 1.55°C
- Palembang: 4.6°C
- Majene: 0.0°C
- Manado: -0.76°C
- P.Pinang: 0.9°C
- Jakarta: 1.4°C
- Cilacap: 3.41°C
- Makasar: 1.8°C
- Bone: 3.0°C
- Surabaya: 3.29°C
- Denpasar: -2.2°C
Has the climate been changed in Indonesia?
Has the climate been changed in Indonesia?
AVERAGE WATER SUPPLY IN RIVER BASIN REGIONS IN INDONESIA

Legend:
- < 2.00 mm/hari
- 2.01 - 3.00 mm/hari
- 3.01 - 4.00 mm/hari
- 4.01 - 5.00 mm/hari
- 5.01 - 6.00 mm/hari
- > 6.01 mm/hari
VULNERABLE LAKES TO CLIMATE CHANGE BY WATER DEFICIT DURING DRY SEASON IN THE NEAR FUTURE (2015 – 2039) PERIOD

[Map of Southeast Asia with labeled vulnerable lakes and water deficit values]

©Jan GRADS: COLA/UNES 2009-08-12-17:11
VULNERABLE LAKES TO CLIMATE CHANGE BY WATER DEFICIT DURING DRY SEASON IN THE LONG FUTURE (2075 - 2099) PERIOD

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INDEX MAP OF POTENTIAL FLOOD THREAT IN INDONESIA
Disaster frequency and death toll in Indonesia (1815 – 2012)

Sebaran Kejadian Bencana dan Korban Meninggal per Jenis Kejadian Bencana 1815 – 2012

1 April 2013
ASEAN Foresight Focus Group
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Flood frequency and death toll by province (1822 – 2011)

Jumlah Kejadian Bencana Banjir dan Korban Meninggal
Per Provinsi 1822 - 2011

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Impact of global warming on sea level
Possible average sea level rise (low – high emission GHG scenarios, 2080)

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<th>Estimated Lost of land</th>
<th>of total land area of the above map</th>
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<td>Maximum</td>
<td>5.71 %</td>
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<td>Best guess</td>
<td>0.75 %</td>
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Global temperature
Average Sea level rise

©Jan Sopaheluwakan, 2013
Observed Sea level rise at several cities in Java (source: Subandono)
Coastal inundation risk area SLR 20 year later (16Cm), Pekalongan City Courtesy of Ministry of Research & Technology, Dr. Subandono, Prof. A Fauzi
Coastal inundation risk area SLR 60 year later (48Cm), Pekalongan City
Courtesy of Ministry of Research & Technology, Dr. Subandono, Prof. A Fauzi
Coastal inundation risk area SLR 100 year later (80Cm), Pekalongan City Courtesy of Ministry of Research & Technology, Dr. Subandono, Prof. A Fauzi
4. FUTURE STUDIES

➔ URBANIZED AREAS/ISLAND
➔ INLAND WATERS
Towards 2100: water – climate change – disaster – food (and energy) nexus

- Flash floods will be more frequent and more severe droughts in (West and East) Java and Jakarta
  - Less rice producing fields in northern coastal plain, threatening the food security
  - Higher water footprints due to food imports
  - Hydropower will be in higher vulnerability for less water
- South Sulawesi will suffer from less water, and thus less rice production and export to Java and elsewhere
- Severe water deficit in lakes and dams in Java
- More floods in coastal plain of East Kalimantan, North Sumatra and Eastern Sumatra
- Degrading ecosystem and less fess water supply on about 5% of inundated coastal plain and small islands by sea level rise and water scarcity will be one of the consequence
  - Southern Papua, Eastern coast of Sumatra, East and South Kalimantan, Northern coast of Java, and hundreds of small islands will suffer most
Uneven water shortage in Indonesia (attn. Java)

The effects of changes in population and urbanised areas on water shortage

- roughly several times more important than changes in water availability as a result of long-term climatic change.

Major trends in adaptation measures to cope with reduced water resources per capita, such as

- irrigated area,
- reservoir storage,
- groundwater abstraction, and
- global trade of agricultural products,
- closely follow the recent increase in global water shortage

Urban adaptive life style on water efficient food consumption, climate proof and disaster friendly living environment and settlement

- Blue – green urban landscapes in flood vulnerable areas
- Low carbon and affordable green technology
- Low water fingerprints diet and life style
The future of inland waters in Indonesia (Haryani, 2012)

Indonesia will suffer from 2 to 3% annual rainfall increase (Ratag (2001) in Susandhi (2007))

Shorter rainy season with increasing rain intensity

- Increasing surface runoff on rivers and lakes

Longer dry seasons will reduce water volume and the surficial coverage

- Increasing temperature will increase the evaporation and threaten the water supply (lakes, dams, swamps/wetland)

Ecological changes in inland waters due to siltation and increasing sedimentation
Climate change impact to lake ecosystem and inland waters (Haryani, 2012)

Physical impact
- Basin and catchment integrity \(\rightarrow\) lake connectivity
- Water budget
- Temperature and stratification

Chemical impact
- Increasing contaminant and lake sedimentation
- Water retention, phosphor accumulation and eutrophication
- Nutrient enrichment, stratification and anoxic condition

Biological impact
- Increasing risk to species extinction
- Multiscale changes: structure, and ecosystem dynamics up to physiological changes
- Geographical shift of some taxa

Carbon storage and sink
- Lake ecosystem as a carbon storage and sink
- 37 millions ha of wetland \(\rightarrow\) 20 millions ha peatland
THANK YOU ...