CLIMATE CHANGE ADAPTATION AND THE WATER SECTOR : MALAYSIA'S EXPERIENCE

ZAINAB HASHIM
Research Officer

Ministry Of Natural Resources And Environment (NRE)

OUTLINE OF PRESENTATION

- **Climate Change**
- **Impacts on Water Resources**
- **Vulnerabilibity**
- **Adaptation**
- **The Future**

Glacier ice melting from global warming

ONE EARTH

A UNDP-IMPLEMENTED PROJECT

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 Randhawa* has the task list.

habitats at risk

Wettest town going dry

Climate Change - an integrated framework

Oceans may rise to danger level by 2100, says researcher

CLIMATE CHANGE & WATER

"Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems".

Intergovernmental Panel on Climate Change (IPCC)
Technical Paper VI: Climate Change and Water
June 2008

Climate Change Implication

- **Immediate impact with respect to water resources**
  - Extreme events of floods and droughts, affecting:
    - Water supply
    - Water quality
    - Agricultural production
    - Bio-diversity, etc

CLIMATE CHANGE AND ITS IMPACT ON WATER RESOURCES

Increases in temperature and reduced rainfall

- Reduced inflows to water storages (dams/reservoirs)
- Reduced streamflows
- Reduced water available for rainfed agriculture
- Reduced recharge of groundwater
- Threatened water supplies to cities and towns, agricultural, industrial, environmental
- Severe droughts

CLIMATE CHANGE AND ITS IMPACT ON WATER RESOURCES

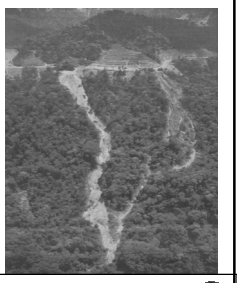
Increases in temperature and increased rainfall

- Increased inflows to water storages
- Increased pressure on water storage infrastructure
- Increased availability of water for rainfed agriculture
- Increased risk of flood damage
- Possible changes to ecosystems

CLIMATE CHANGE AND ITS IMPACT ON WATER RESOURCES

Altered frequency of extreme weather events

- Increased flooding
- Increased erosion
- More sediment and nutrients in streams



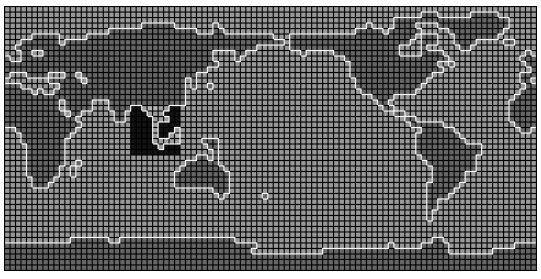
Where do we go from here?

NAHRIM Regional Hydroclimate Model of Peninsular Malaysia (RegHCM-PM)

- **Study Objectives**
  - Develop a regional hydrologic- atmospheric model to take into account climate change in Peninsular Malaysia and validate the model by historic hydrologic-atmospheric data
  - Evaluate the impact of climate change on the hydrologic regime and water resources of Peninsular Malaysia by means of the developed regional hydroclimate model (RegHCM-PM)
- Regional Hydroclimate Model of Peninsular Malaysia (RegHCM-PM) was developed by downscaling global climate change simulation data (Canadian GCM1 current and future climate data) that are at very coarse resolution (~ 410km) , to Peninsular Malaysia at fine spatial resolution (~9km).
- Able to quantify the impact of the complex topographical and land surface features of Peninsular Malaysia on its climate conditions.

10

Data grid of CGCM1 that were used in the RegHCM-PM..



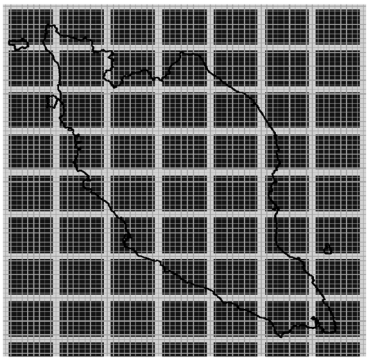


Figure 17 - Nested grids of the inner and the outer domains of RegHCM-PM under Mercator projection. The boundaries of the Peninsular Malaysia and nearby islands are overlaid on the grids.

FINDINGS

- In annual rainfall:
  10% increase for Kelantan, Terengganu and Pahang
  5% decrease for Selangor and Johor
- Temperature rise 2^0 C
- More droughts ie dry years (from modelling output: 2028, 2029, 2034, 2042 and 2044)
- More extreme hydrological conditions may be expected (higher high flows, and lower low flows)for Kelantan, Pahang, Terengganu and Kedah watersheds

National Communication 2 (NC2)
[2007-2009]

- Preparation of NC2
  - Chaired by Ministry of Natural Resources & Environment
  - to further integrate climate change issues and impacts into the national and local strategic, development and action plans.
- 3 Working Groups (WG) under NC2, and chairs:
  - WG 1 - Greenhouse Gases (GHGs) Inventory - FRIM
  - **WG 2 - Vulnerability & Adaptation (V&A) - NAHRIM**
  - WG 3 – Mitigation - PTM

NC2: WG2 - Vulnerability and Adaptation

- To undertake an assessment of potential impacts of climate change on several vulnerable sectors
- To formulate corresponding adaptation measures
  - 7 vulnerable sectors (and sub-committees):
    - Agriculture (MARDI)
    - Forestry (FDPM)
    - Biodiversity (FRIM)
    - Water resources (NAHRIM)
    - Coastal and marine resources (DID)
    - Public health (MOH)
    - Energy (PTM)

NC2: WG2 - Vulnerability and Adaptation

- 2 support groups under WG2
  - Climate Projections (NAHRIM) - looks at climate projections studies carried out in Malaysia, based on available climate models and data
  - Socio-Economic Impacts and Responses (LESTARI, UKM) - looks at socio-economic impact and responses from global warming and climate changes as well as adaptation measures

What Next ?

- Identifying Vulnerable Sectors
- Needed Actions to cope and adapt to the Climate Change
  - Incorporate in current development programs
    - Water Supply, Flood Mitigations and other infrastructure installations – will there be any design or O & M changes/requirements to infrastructures?
    - Re-look at planned development, incorporate planning of water needs/environmental impacts from project visualisation
    - Agriculture – cropping practices need to be accommodated to changing rainfall patterns and increase temperature

Vulnerability

STUDY AREAS

Preliminary assessment of the climate change impact on irrigation and water supply scenario of the following selected study areas:

1. Muda Irrigation Scheme
2. Kemubu Irrigation Scheme
3. Barat Laut Selangor Irrigation Scheme
4. Water supply in Klang Valley

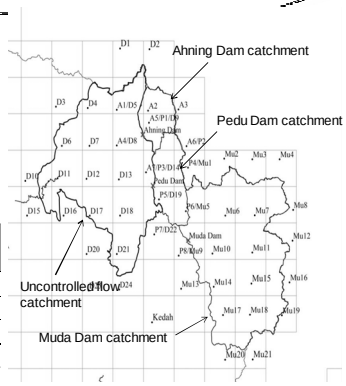
APPROACH & METHODOLOGY

- Estimate the water demands for irrigation and domestic/industrial (D&I) water supply in the Study Areas due to the projected climate change.
- Estimate water availability (catchment yields at dam and downstream) for irrigation and D&I water supply in the Study Areas using the projected climate data.
- Preliminary assessment of the climate change impact on water demand-availability scenario for the Study Areas corresponding to the periods of 2025-2034 and 2041-2050.

Monthly rainfall and temperature (NAHRIM 2006 projected data) were abstracted from respective grids.

The catchments weighted RF and Temp was input to the TM Model to derive the Total Runoff from the catchments.

Catchment	Number of Grids	Catchment Area (km²)
Ahning Dam	7	122
Pedu Dam	8	171
Muda Dam	21	984
Downstream	24	985

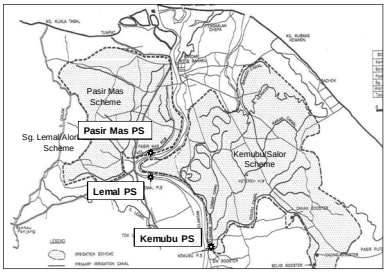


Kemubu Irrigation Scheme

Irrigation sources –
> Direct run-of-river flows from Sg. Kelantan
> Effective rainfall

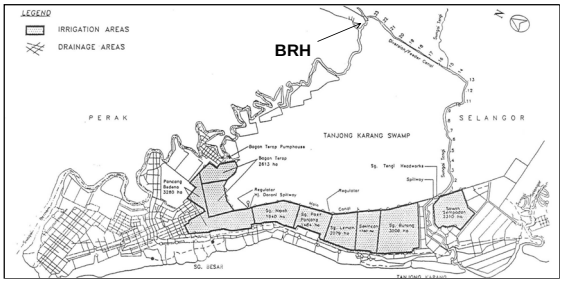
Irrigation Supply is pumped from Sg. Kelantan at the following intake points:

-Kemubu PS
-Lemal PS
-Pasir Mas PS



Barat Laut Selangor Irrigation Scheme

Covers an irrigation area of about 19,696 ha, and is located within the Northwest Selangor IADP area. Irrigation Supply is mainly diverted from Sg. Bernam at Bernam River Headworks (BRH)

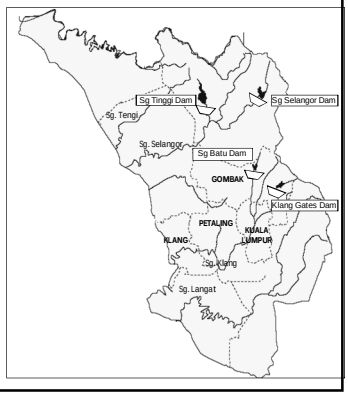


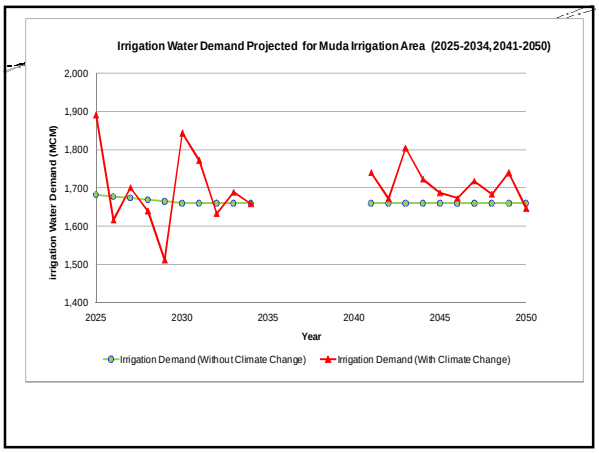
Klang Valley Water Availability

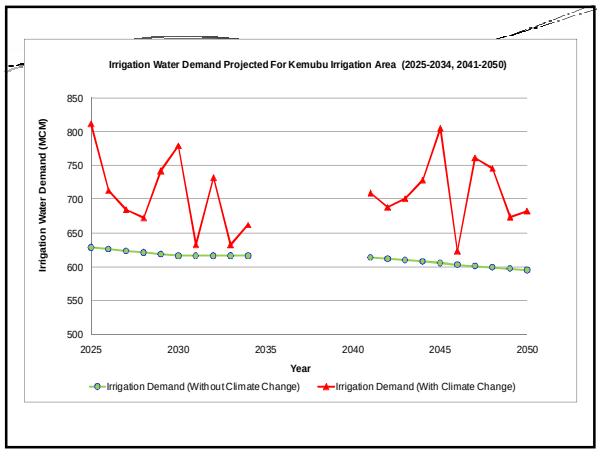
Water Supply System in Klang Valley:

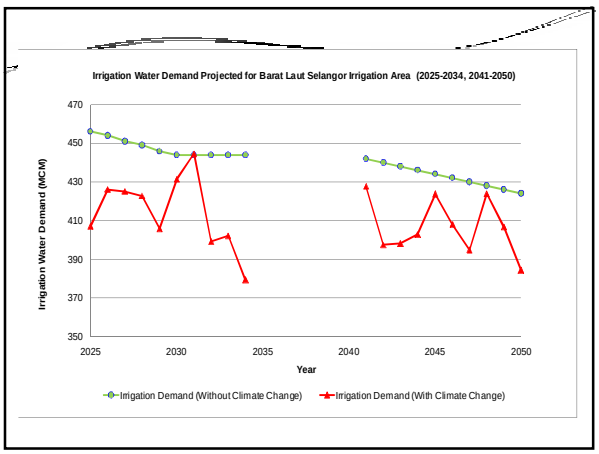
-Two storage dams (Klang Gates and Batu Dams)

- Sg Selangor Scheme comprises run-of-river & two storage dams (Sg Tinggi and Sg Selangor Dams).









Water Demand-Availability for Muda Irrigation Scheme with Dam Storage

- For water demand-availability assessment, it shows that 46 months of water deficit (19%) and 194 months of water surplus (81%) over the 240 months projection period.
- Deficit mainly occurs in Mar to July in 2027-2029 and 2048-2050
- 4 out of 20 planting seasons facing water deficits for the first 10-years, and 4 out of 20 for the second 10-year periods, most off-season crops
- Water deficit is mainly due to:
  - lower RF esp during 1st 10-year period.
  - Large variability in the monthly RF distribution
  - High Monsoonal evaporation

Water Demand-Availability for Kemubu Irrigation Scheme

- Water surplus ranges from the lowest 324 MCM (Aug 2028) to the highest 5,438 MCM (Dec 2033) is projected under climate change scenario.
- For 1 in 5 year low flow condition, water surplus ranges from the lowest 395 MCM (Jul 2031) to the highest 2,481 MCM (Dec 2033).
- The water surplus condition is mainly attributed to the large catchment size of Sg. Kelantan which provides abundant water resources.

Water Demand-Availability for BLS Irrigation Scheme

- 8 months of water deficit (3 %) under climate change scenario and 22 months deficit (9 %) for climate change scenario of 1 in 5 year condition.
- The water deficit is more frequent for the 2nd 10-year period especially for January & March.
- The water deficit is due to:
  - Lower future RF and hence lower water availability at BRH intake point at Sg. Bernam (transposed from Sg. Selangor @ Rantau Panjang) for the 2 future periods

Water Demand-Availability for Klang Valley Water Supply

- Water deficit is projected to occur for 194 out of 240 months (81 %) under climate change scenario.
- The water deficit is mainly due to:
  - Inadequate water availability from the dam and downstream catchments caused by the lower rainfall.
  - Dam storage not considered in this study.
  - Inter-state transfer is not considered – existing water sources are insufficient to meet the future water demand.
- Of the 240 months, 99 months (41%) having monthly rainfall higher than historical mean while 141 months (59%) having rainfall lower than the historical mean.

Possible Climate Change Implications

- From water demand-availability assessment, it is observed that the impact of climate change is both in the form of water deficit as well as water excess.
- Muda Irrigation Scheme largest monthly deficit in Mar 2048 amounts to -194 MCM. (Muda dam storage capacity 154 MCM).
- During the main-season, 3 to 4 months of consecutive irrigation water deficit occurred at 2026, 2034, 2042 and 2047.
- Prolonged irrigation water deficit may warrant cancellation of entire planting seasons.

Possible Climate Change Implications

- Muda Irrigation Scheme have large water excess in October 2046 and October 2048 as high as 487 MCM and 551 MCM respectively.
- Serious flooding of paddy fields will be likely to happen and will cause paddy crop damage as well.

Possible Climate Change Implications

- Kemubu Irrigation Scheme, water deficit is not a problem due to the large catchment area of Sg. Kelantan river basin.
- However, there is a problem of numerous months of excess water. The largest water excess is in December 2033 with 5,438 MCM/month.
- There are no flood mitigation dams to manage such serious flood impacts of climate change in the Kemubu Irrigation Scheme.

Possible Climate Change Implications

- The impact of climate change on the Barat Laut Selangor Irrigation Scheme is less severe.
- The largest deficit is in the month of January 2048 at -27 MCM/month (demand 28.5 MCM/month).
- The largest water excess is in May 2030 amounting to +260 MCM/month.
- There are no dams to manage excess water due to climate change.

Possible Climate Change Implications

- In Klang Valley, water rationing would have to be imposed like the past droughts due to the very prolong consecutive months of the water deficit.
- The most severe drought occurs in July 2044 with a peak deficit of -179 MCM/month.

Adaptation

The affected groups

Though they might not have called this, many already have long experience of "adaptation", for example

- People in flood-prone areas: houses on stilts
- Farmers in drought-prone areas:
  - ➢diversify their sources of income,
  - ➢cultivating more resilient crops,
  - ➢optimizing the use of scarce water,
  - ➢migrating temporarily in search for work elsewhere, etc.

The challenge is to assess and build on such traditional wisdom – helping people to protect their livelihoods and reduce their vulnerability.

Adaptation Strategies in Water Resources

- Enlarging reservoir capacity
- Flood Mitigation programme (SMART project)
- Improving hydrological forecasting
- Promoting widespread use of groundwater
- Changing land use practices
- Buffer zone for agriculture and forestry industries to minimize erosion and sedimentation

Possible Management Measures

In a situation of water stress:

- **Seasonal water rationing during times of shortage;**
- **Adapt industrial and agricultural production to reduce water wastage;**
- **Increase capture and storage of surface runoff;**
- **Better use of groundwater resources (risk: siltation)**
- **Rainwater harvesting**

Conclusion

- Global warming and climate change are real and that whatever mitigation measures currently taken, it is no longer possible to prevent the climate change that will take place over the next 2 to 3 decades
- There is a need to increase information for population in dealing with uncertainties and risks through the development of forecasting and scenarios
- Adaptation is the way forward

The Future

Needed Actions

- Paradigm shift/Mind set Change
  - What is our perception of water supply/WRM
    - can we reduce litres/pax/day? – therefore reduce stress on water resources development
      - Singapore is below 170 litres/pax/day
      - Malaysia, 270-450 litres/pax/day
    - What is our **overall objective in water supply services**
      - Supply all that is needed by each individual or
      - Do we have a conscientious supply policy to ***ensure sustainable economic development***
    - **Agriculture** – can we have precision farming and less water wastage
  - Can we treat all our waste water before discharging into the drains and river systems
    - More recycle instead of basin transfers
      - Bonus – Clean river, healthy living

NAHRIM, as an R&D Institution

- Will Continue with Hydroclimate Projection at finer scale, where necessary
- Will concurrently steer in the direction of R&D for Adaptation to Climate Change, specific to Water Resources
  - Approval of the 4th National Water Resources Council (NWRC) 20th August 2008
- Networking at Regional level
  - Water Knowledge Hub (WKH) for Climate Change Adaptation
  - AguaJaring/CapNet – IWRM Capacity Building

43

THANK YOU

NATIONAL HYDRAULIC RESEARCH INSTITUTE OF MALAYSIA (NAHRIM)