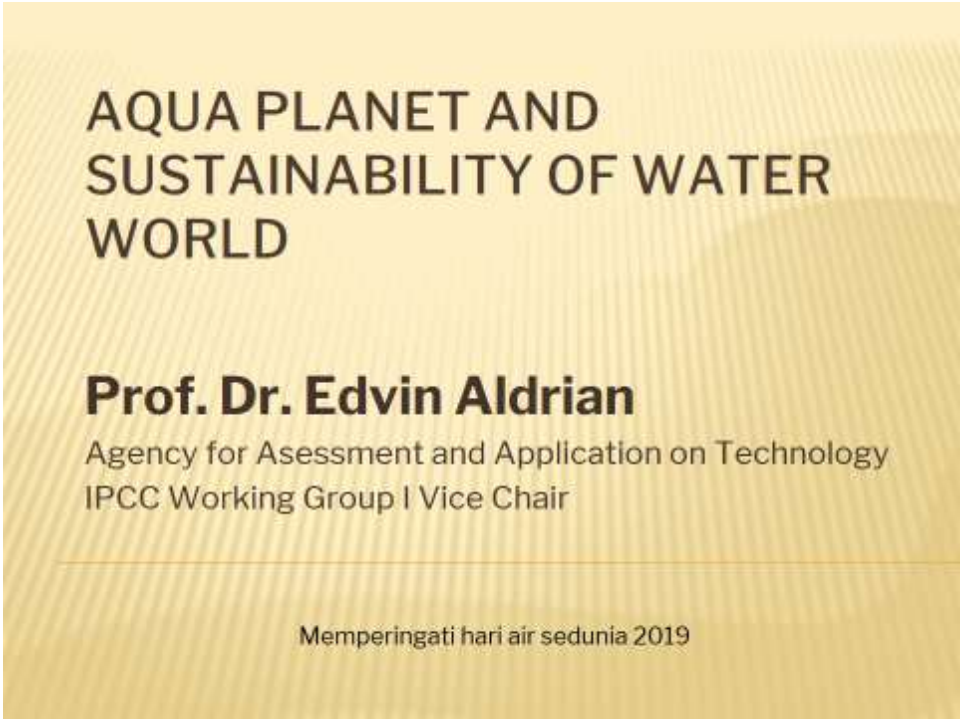
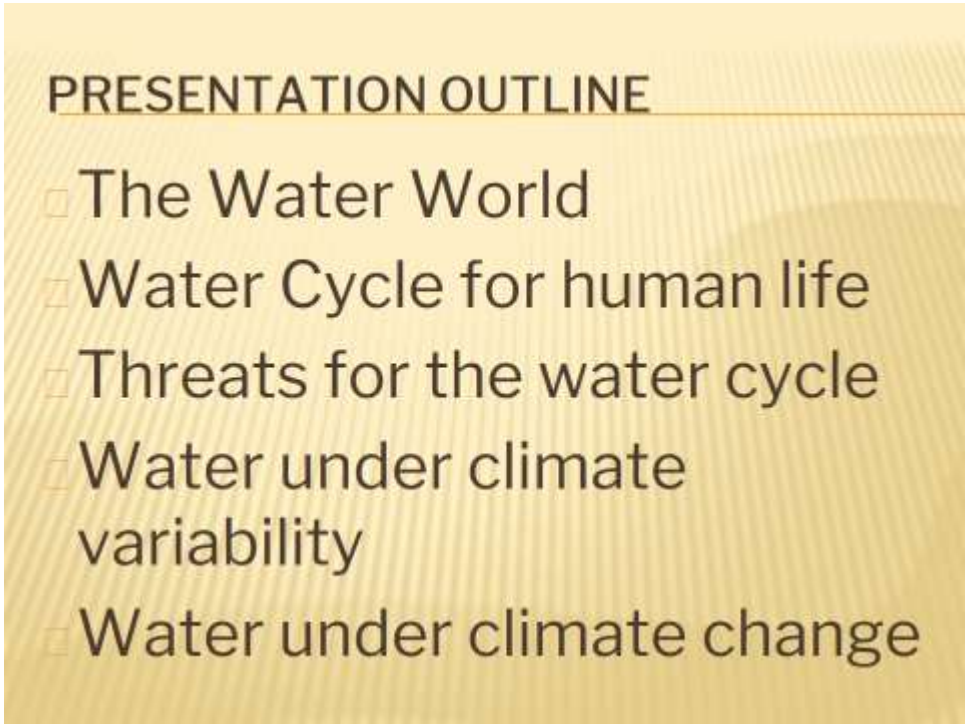
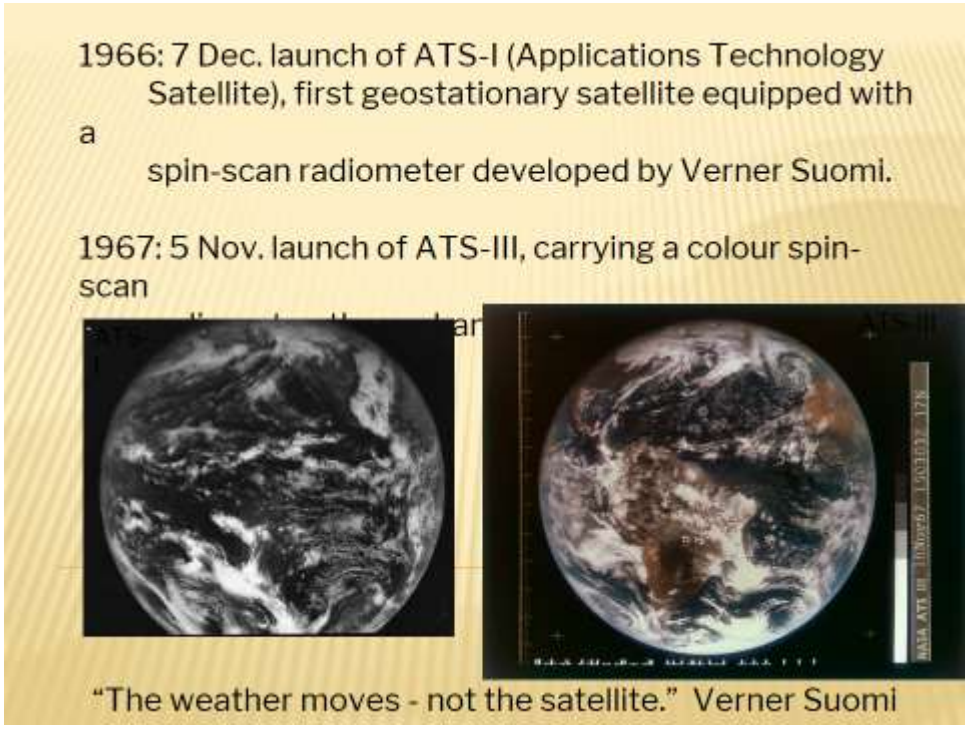

AQUA PLANET AND SUSTAINABILITY OF WATER WORLD
Prof. Dr. Edvin Aldrian
Agency for Asessment and Application on Technology
IPCC Working Group I Vice Chair
Memperingati hari air sedunia 2019


PRESENTATION OUTLINE
The Water World
Water Cycle for human life
Threats for the water cycle
Water under climate variability
Water under climate change


OUR WATERY WORLD


1966: 7 Dec. launch of ATS-I (Applications Technology Satellite), first geostationary satellite equipped with a spin-scan radiometer developed by Verner Suomi.
1967: 5 Nov. launch of ATS-III, carrying a colour spin-scan
"The weather moves - not the satellite." Verner Suomi

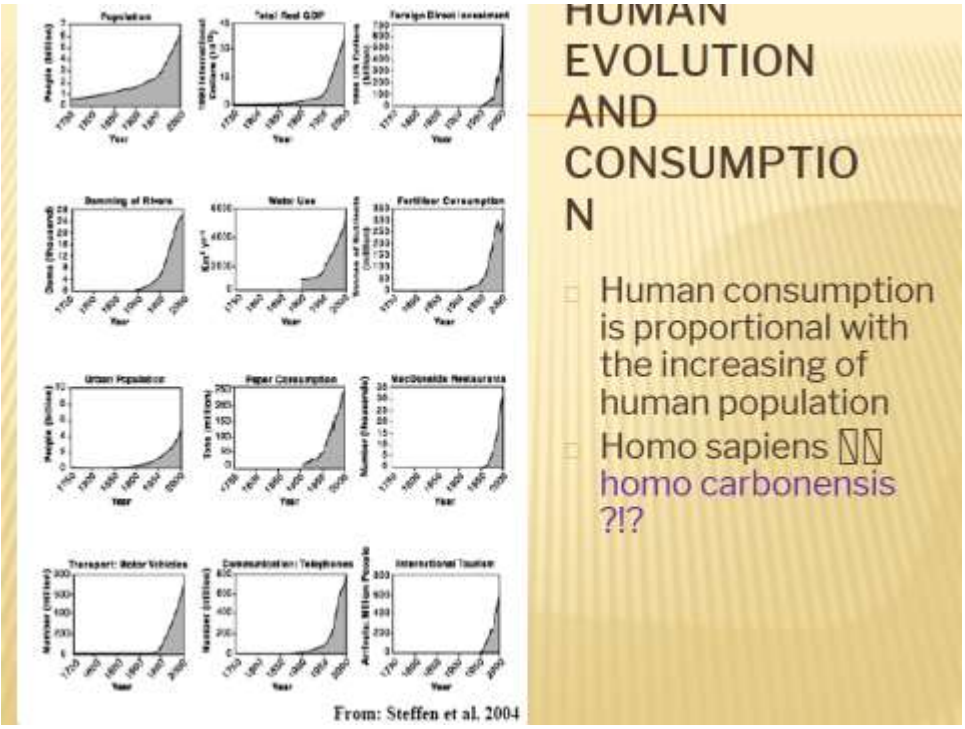
THE WATER WORLD

- Planet earth is the only watery planet that human can life comfortably
- The closest planet with the same watery condition needs several time of life span to go
- Planet earth maintain the comfort temperature to sustain watery world
- Water on planet earth comprises of liquid, gas and solid formations and they are interchange with water cycle
- Only around 4% of water is useable and they are part of water cycle

THE WATER WORLD

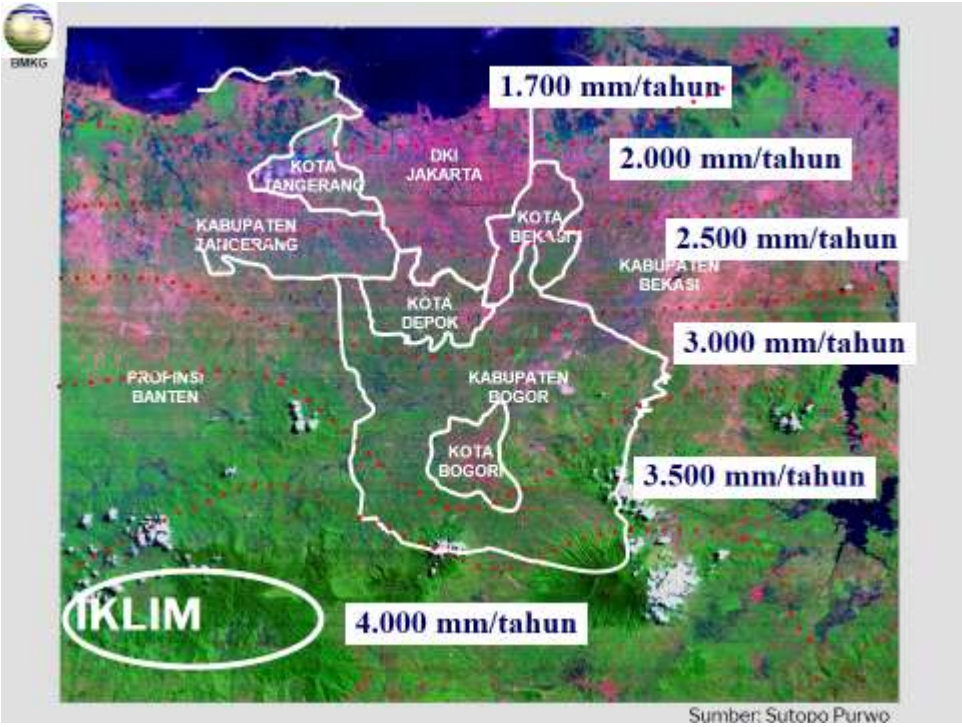
- Ocean comprises 79% of the earth surface
- The watery climate is quite diverse with humid tropical, dry sub tropical, high latitude tundra and glacier pole region.
- Water in the atmosphere is the main engine of warming planet. If there is no water vapour in the atmosphere, the temperature will be -18°C on average, although this is not the main cause of the warming planet
- Water, indeed is the damping impact to the climate and hold the retention of heat release during the warming planet

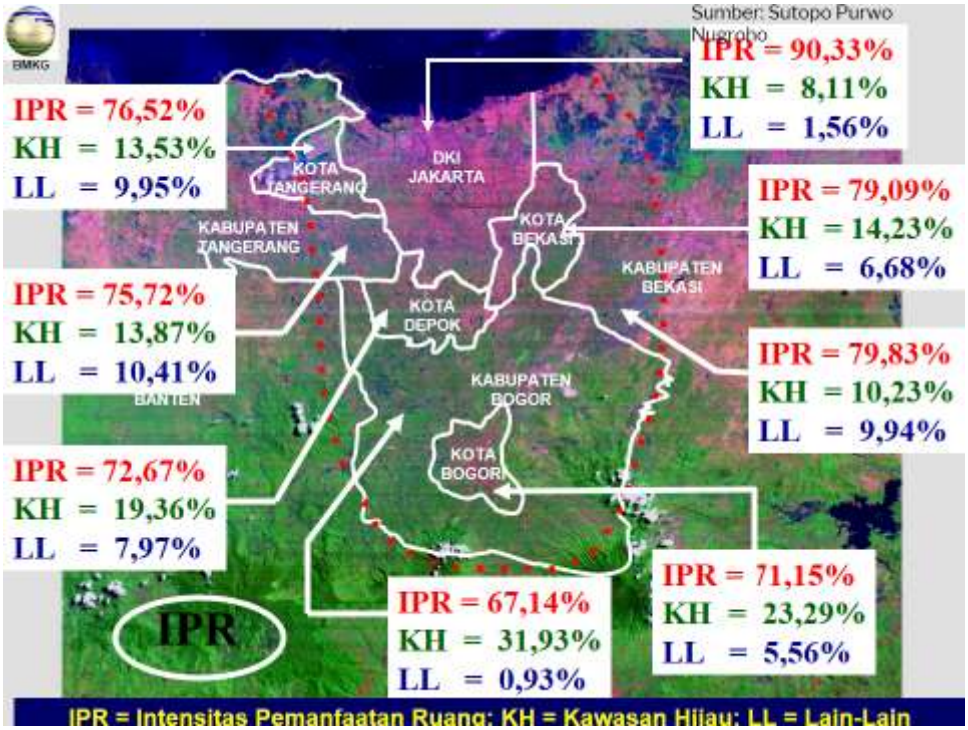

LATAR BELAKANG PEMANASAN GLOBAL
(INTERAKSI ENERGI DAN AIR DI MUKA BUMI)
Perubahan di Atmosfer :
Komposisi, Sirkulasi
Perubahan dalam
Siklus Hidrologi
Perubahan
Input
Matahari
Atmosfer
Awan
N_2, O_2, Ar,
H_2O, CO_2, CH_4, N_2O, O_3, etc.
Aerosol
Aktivitas Gunung Berapi
Interaksi
Atmosfer-Biosfer
Presipitasi
Evaporasi
Radiasi
Terestrial
Pengaruh
Aktivitas Manusia
Pertukaran
Panas
Tekanan
Angin
Gletser
Lapisan
Es
Biosfer
Interaksi
Daratan-
Atmosfer
Es Laut
Hidrosfer :
Laut
Interaksi
Tanah-Biosfer
Permukaan Daratan
Interaksi es - laut
Hidrosfer :
Sungai dan Danau
Perubahan Cryosphere :
Salju,Tanah Beku, Es Laut, Lapisan Es, Gletser
Perubahan di Laut :
Sirkulasi, Muka Laut, Biogeokima
Perubahan Permukaan Lahan :
Orografik, Penggunaan Lahan, Vegetasi, Ekosistem
IPCC 2007

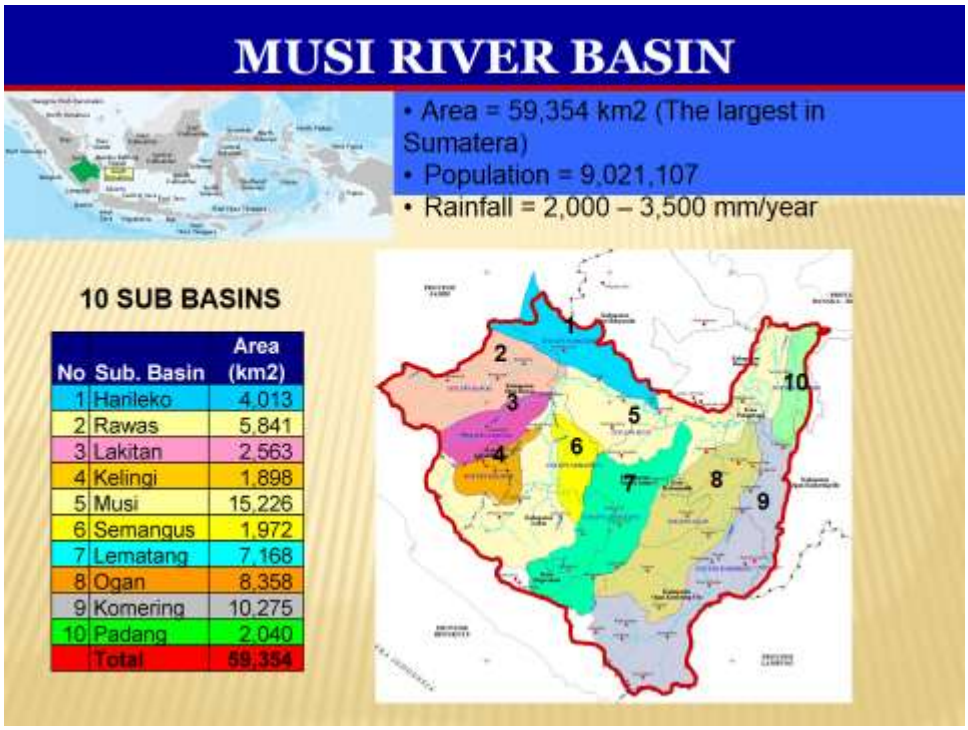

HUMAN
EVOLUTION
AND
CONSUMPTIO
N
Human consumption is proportional with the increasing of human population
Homo sapiens homo carbonensis ?!?
From: Steffen et al. 2004

PWEUBAHAN TATA GUNA LAHAN TERHADAP ALIRAN SUNGAI

- Kisah DAS Ciliwung
- Kisah DAS Musi


BMKG
1.700 mm/tahun
2.000 mm/tahun
2.500 mm/tahun
3.000 mm/tahun
3.500 mm/tahun
4.000 mm/tahun
KOTA TANGERANG
DKI JAKARTA
KABUPATEN TANGERANG
KOTA BEKASI
KABUPATEN BEKASI
KOTA DEPOK
PROFINSI BANTEN
KABUPATEN BOGOR
KOTA BOGOR
IKLIM
Sumber: Sutopo Purwo


Sumber: Sutopo Purwo Nugroho
BMKG
IPR = 90,33%
KH = 8,11%
LL = 1,56%
IPR = 76,52%
KH = 13,53%
LL = 9,95%
IPR = 79,09%
KH = 14,23%
LL = 6,68%
IPR = 75,72%
KH = 13,87%
LL = 10,41%
IPR = 79,83%
KH = 10,23%
LL = 9,94%
IPR = 72,67%
KH = 19,36%
LL = 7,97%
IPR = 67,14%
KH = 31,93%
LL = 0,93%
IPR = 71,15%
KH = 23,29%
LL = 5,56%
IPR
KOTA TANGERANG
DKI JAKARTA
KABUPATEN TANGERANG
KOTA BEKASI
KABUPATEN BEKASI
KOTA DEPOK
KABUPATEN BOGOR
KOTA BOGOR
IPR = Intensitas Pemanfaatan Ruang; KH = Kawasan Hijau; LL = Lain-Lain


MUSI RIVER BASIN
• Area = 59,354 km2 (The largest in Sumatera)
• Population = 9,021,107
• Rainfall = 2,000 – 3,500 mm/year
10 SUB BASINS
No Sub. Basin Area (km2)
1 Hanleko 4,013
2 Rawas 5,841
3 Lakitan 2,563
4 Kelingi 1,898
5 Musi 15,226
6 Semangus 1,972
7 Lematang 7,168
8 Ogan 8,358
9 Komering 10,275
10 Padang 2,040
Total 59,354
1
2
3
4
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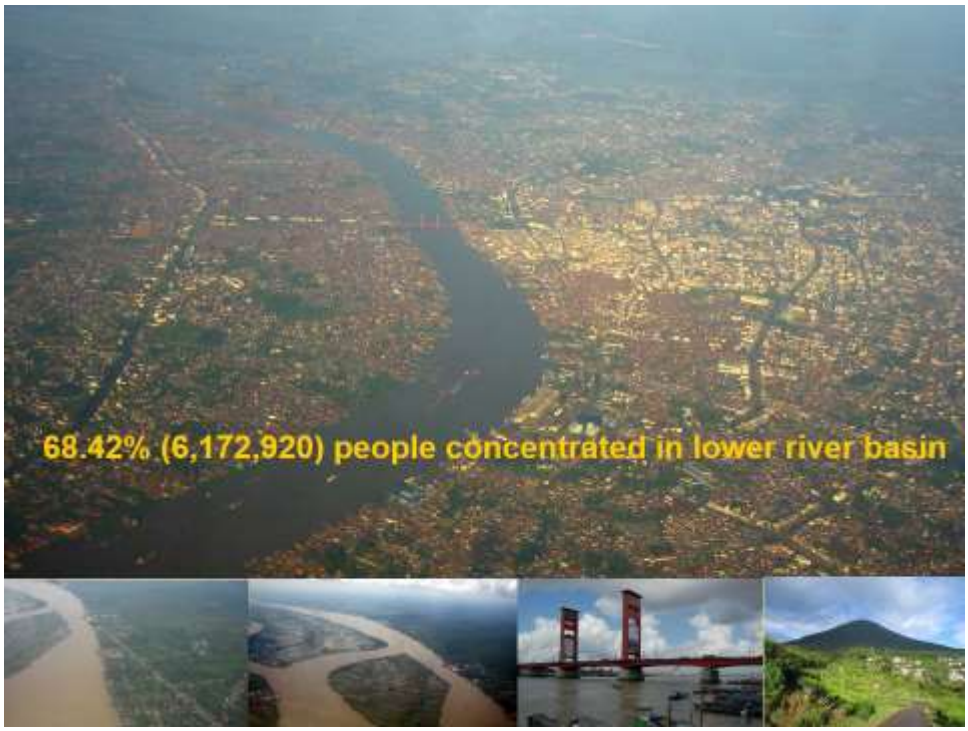
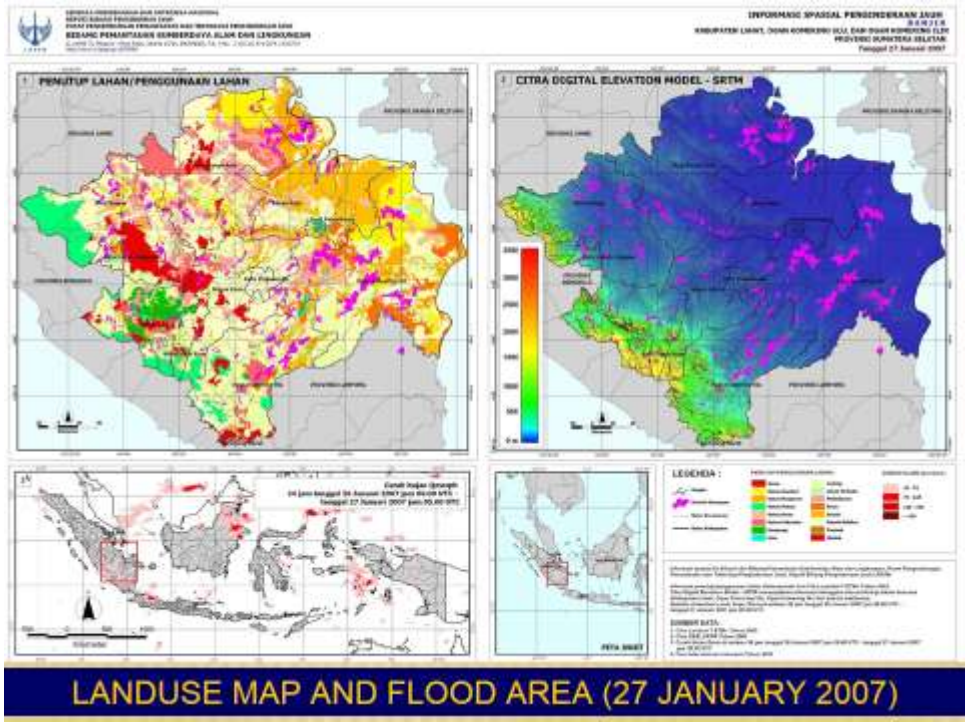
9
10

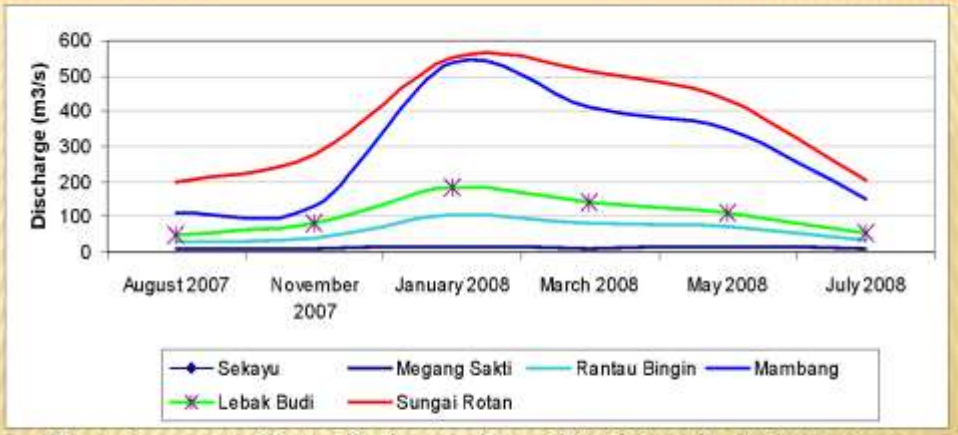

68.42% (6,172,920) people concentrated in lower river basin


CONDITIONS OF MUSI RIVER BASIN
Harileko river
Musi river
Musi river
Kelingi river
Musi river
Lematang river
Ogan River
Komering River

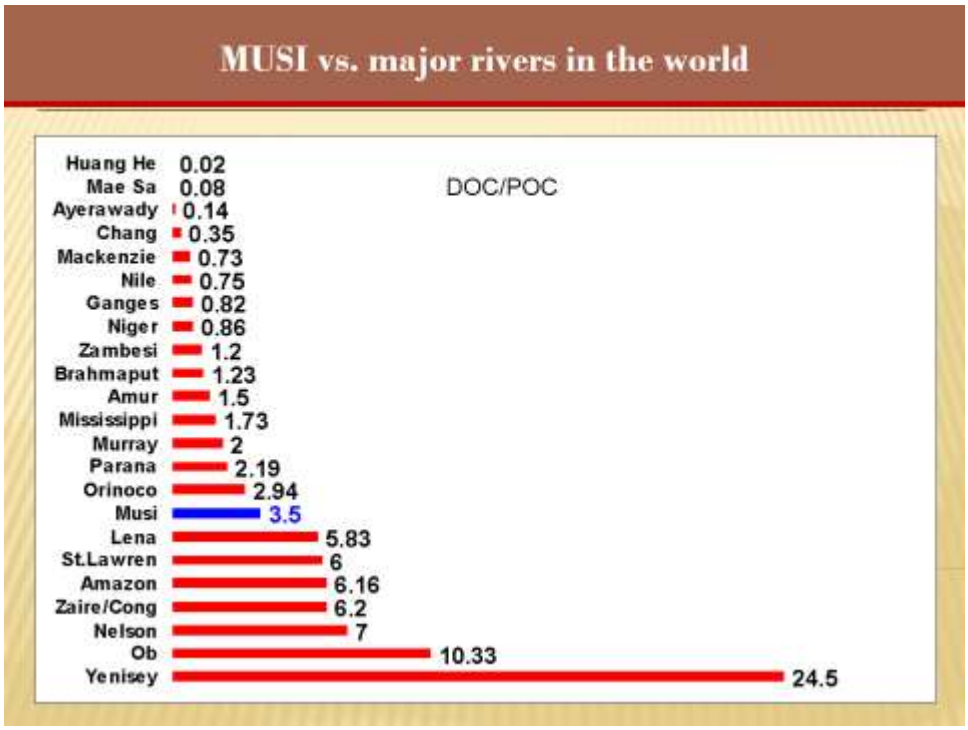

PENUTUP LAHAN/PENGGUNAAN LAHAN
CITRA DIGITAL ELEVATION MODEL - SRTM
LEGENDA :
LANDUSE MAP AND FLOOD AREA (27 JANUARY 2007)

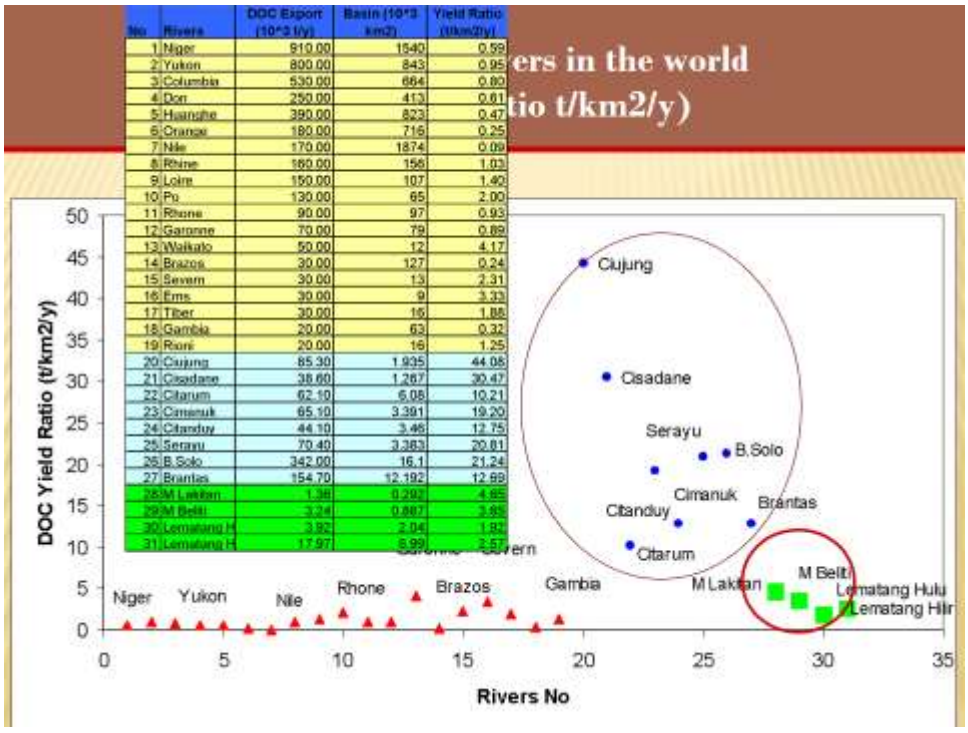
DISTRIBUTIONS OF HYDROMETRY STATIONS IN MUSI RIVER BASIN

DISCHARGE



- **There is seasonality in discharge data of Musi river basin but not as extreme contrast as in Java rivers**
- **Baseflow retentions of Musi river is large, during dry season baseflows from ground water are still flowing, different from Java rivers**
- **Coefficient of river regime (Qmax/Qmin<50), good condition, better than rivers in Java.**



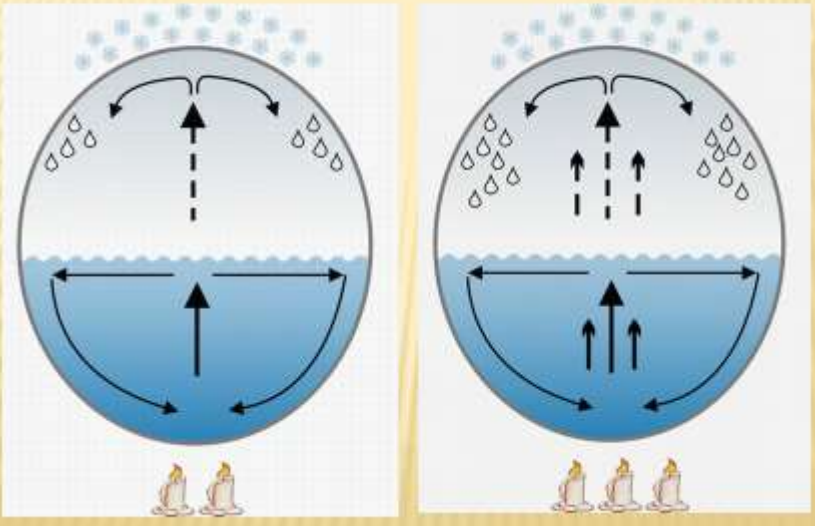


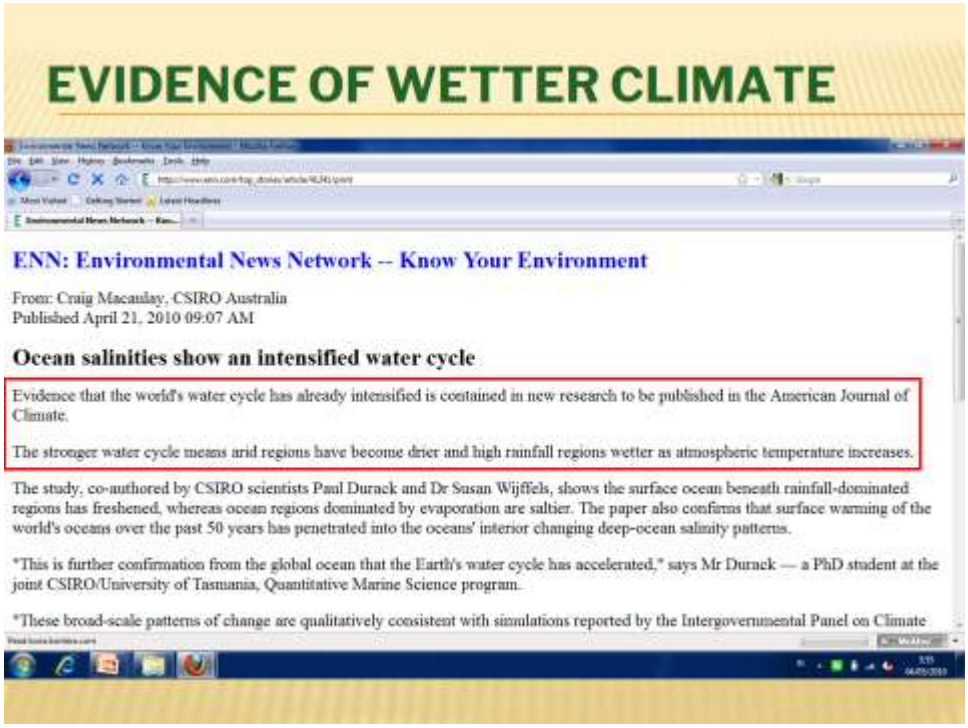
No	Rivers	DOC Export (10^3 t/y)	Basin (10^3 km2)	Yield Ratio (t/km2/y)
1	Niger	910.00	1540	0.59
2	Yukon	800.00	843	0.95
3	Columbia	530.00	664	0.80
4	Don	250.00	413	0.61
5	Huanghe	390.00	823	0.47
6	Oranje	180.00	716	0.25
7	Nile	170.00	1874	0.09
8	Rhine	160.00	156	1.03
9	Loire	150.00	107	1.40
10	Po	130.00	65	2.00
11	Rhone	90.00	97	0.93
12	Garonne	70.00	79	0.89
13	Waikato	50.00	12	4.17
14	Brazos	30.00	127	0.24
15	Severn	30.00	13	2.31
16	Ems	30.00	9	3.33
17	Tiber	30.00	16	1.88
18	Gambia	20.00	63	0.32
19	Rioni	20.00	16	1.25
20	Ciujung	85.30	1.935	44.08
21	Cisadane	38.60	1.267	30.47
22	Citarum	62.10	6.08	10.21
23	Cimanuk	65.10	3.391	19.20
24	Citanduy	44.10	3.46	12.75
25	Serayu	70.40	3.383	20.81
26	B.Solo	342.00	16.1	21.24
27	Brantas	154.70	12.192	12.69
28	M Lakitan	1.38	0.292	4.85
29	M Belit	3.24	0.887	3.65
30	Lematang H	3.92	2.04	1.92
31	Lematang H	17.97	8.99	2.57

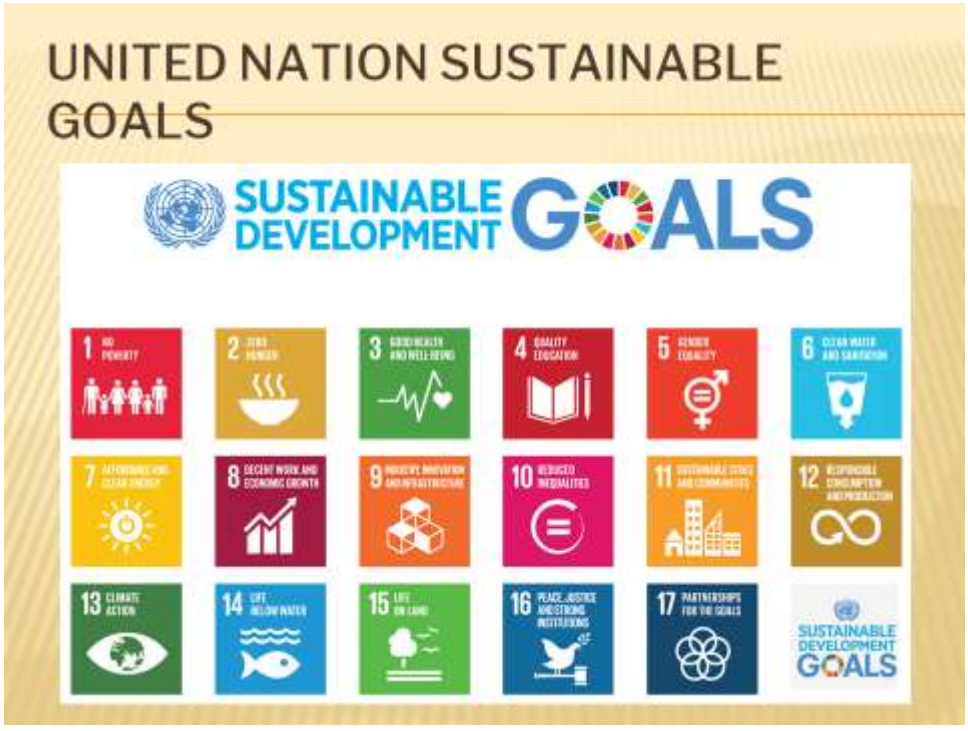
THREAT FOR WATER CYCLE

- Water pollution
- Water quality
- Water cycle acceleration
- Water consumption
- Sustainability of water supply

IMPACT OF GLOBAL WARMING ON WATER CYCLE (EXTENSION OF TROPICAL REGION, NEW TROPICAL AREA)




EVIDENCE OF WETTER CLIMATE
ENN: Environmental News Network -- Know Your Environment
From: Craig Macaulay, CSIRO Australia
Published April 21, 2010 09:07 AM
Ocean salinities show an intensified water cycle
Evidence that the world's water cycle has already intensified is contained in new research to be published in the American Journal of Climate.
The stronger water cycle means arid regions have become drier and high rainfall regions wetter as atmospheric temperature increases.
The study, co-authored by CSIRO scientists Paul Durack and Dr Susan Wijffels, shows the surface ocean beneath rainfall-dominated regions has freshened, whereas ocean regions dominated by evaporation are saltier. The paper also confirms that surface warming of the world's oceans over the past 50 years has penetrated into the oceans' interior changing deep-ocean salinity patterns.
"This is further confirmation from the global ocean that the Earth's water cycle has accelerated," says Mr Durack — a PhD student at the joint CSIRO/University of Tasmania, Quantitative Marine Science program.
"These broad-scale patterns of change are qualitatively consistent with simulations reported by the Intergovernmental Panel on Climate


UNITED NATION SUSTAINABLE GOALS
SUSTAINABLE DEVELOPMENT GOALS
1
2
3
4
5
6
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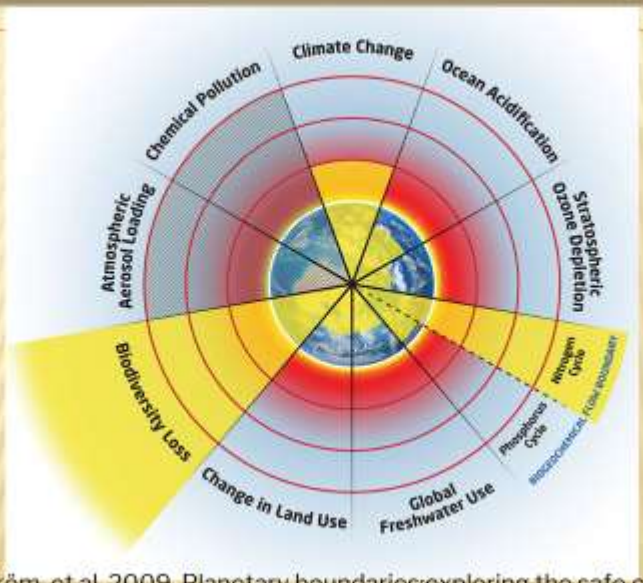
10
11
12
13
14
15
16
17
SUSTAINABLE DEVELOPMENT GOALS

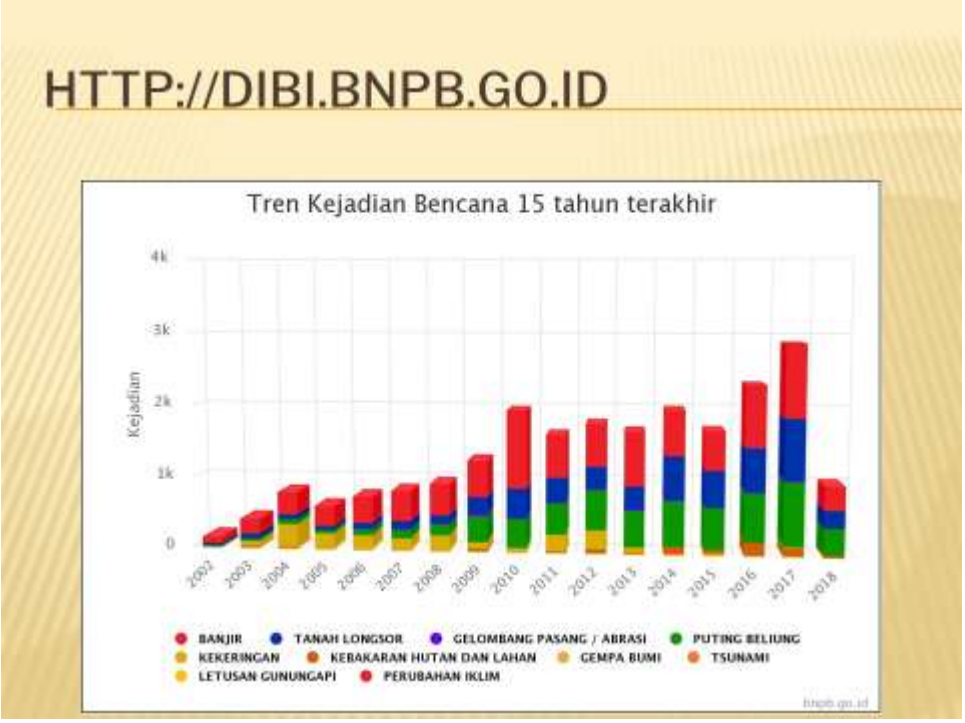
LIMIT OF EARTH CARRYING CAPACITY



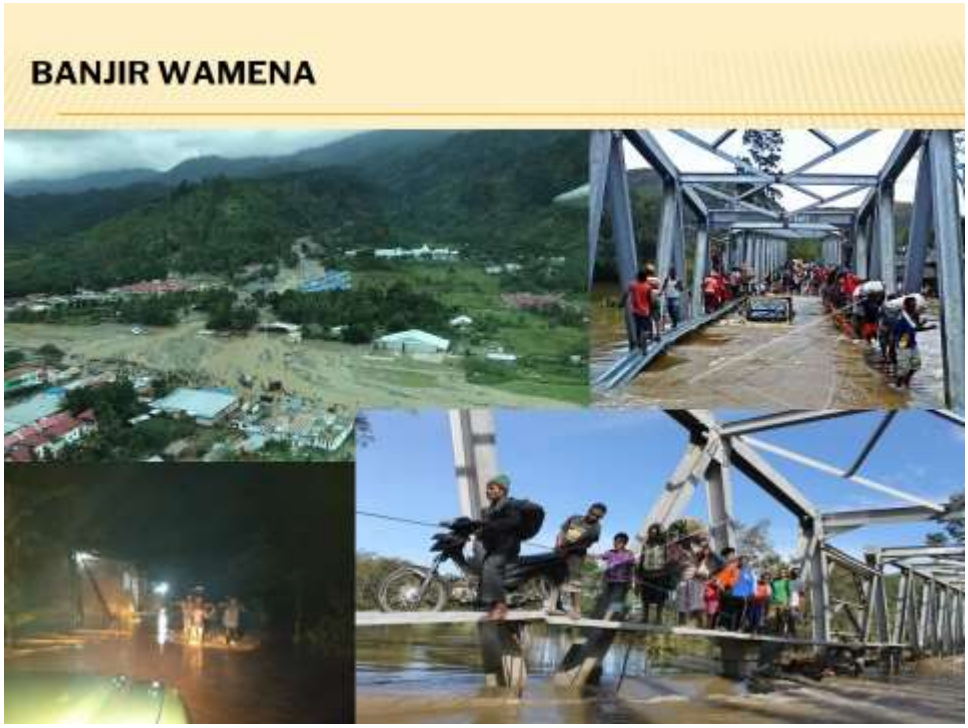
Rockström, et al. 2009. Planetary boundaries:exploring the safe operating space for humanity. *Ecology and Society* **14**(2): 32

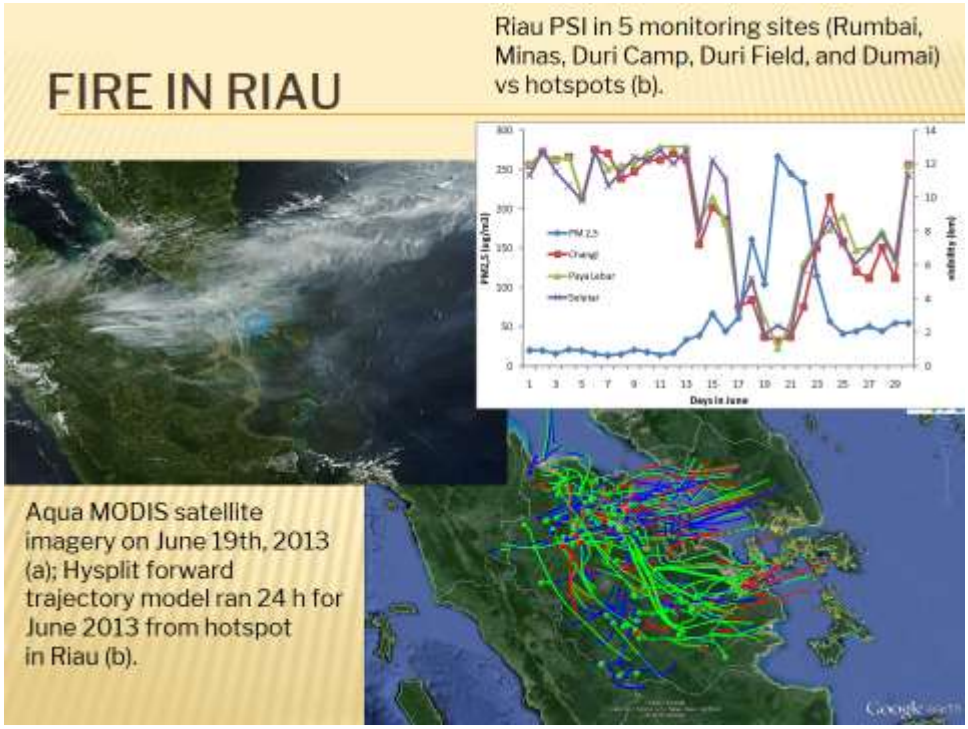
BENCANA HYDROMETEOROLOGIS

- Banjir
- Kekeringan
- Puting beliung
- Tanah longsor
- Kebakaran hutan
- Badai tropis
- Hujan es

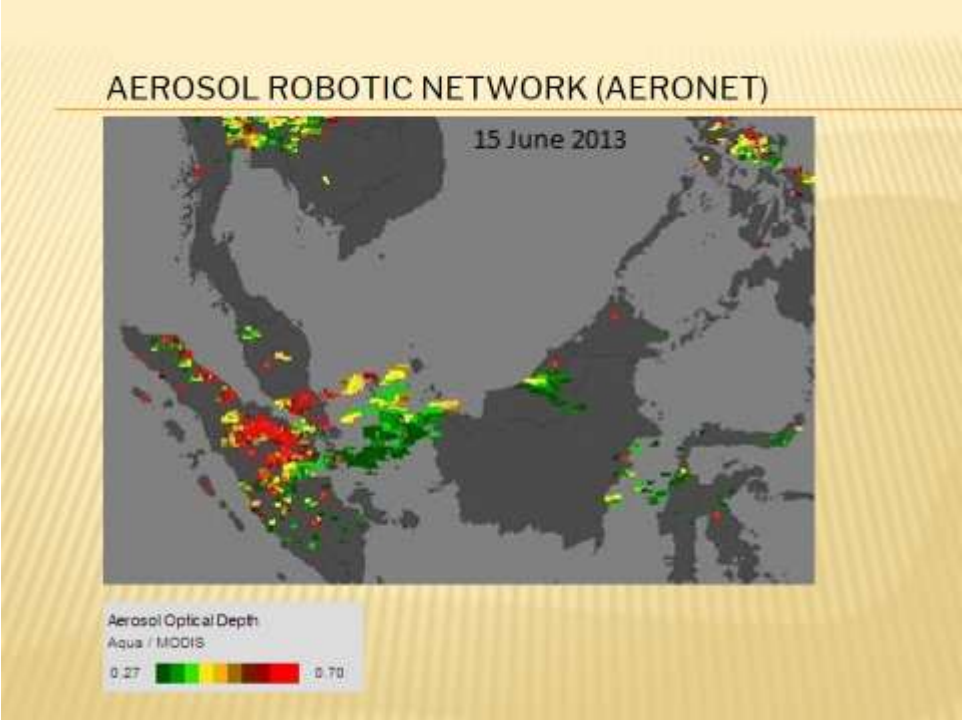

HTTP://DIBI.BNPB.GO.ID
Tren Kejadian Bencana 15 tahun terakhir
Kejadian
4k
3k
2k
1k
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
BANJIR
TANAH LONGSOR
GELOMBANG PASANG / ABRASI
PUTING BELIUNG
KEKERINGAN
KEBAKARAN HUTAN DAN LAHAN
GEMPA BUMI
TSUNAMI
LETUSAN GUNUNGAPI
PERUBAHAN IKLIM

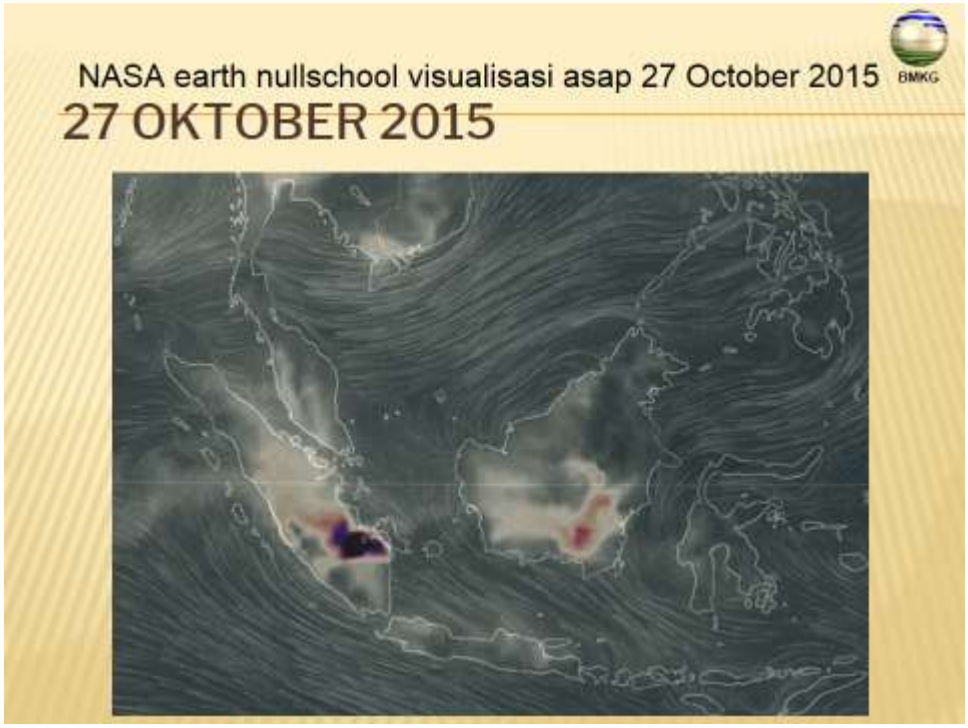

BANDUNG HUJAN ES (FENOMENA GLOBAL WARMING BARU)


BANJIR WAMENA


FIRE IN RIAU
Riau PSI in 5 monitoring sites (Rumbai, Minas, Duri Camp, Duri Field, and Dumai) vs hotspots (b).
Aqua MODIS satellite imagery on June 19th, 2013 (a); Hysplit forward trajectory model ran 24 h for June 2013 from hotspot in Riau (b).


FOREST FIRE IN JAMBI PROVINCE
SUMATERA
HOTSPOT IN SUMATERA 1 OCTOBER 2014
Jambi City


AEROSOL ROBOTIC NETWORK (AERONET)
15 June 2013
Aerosol Optical Depth
Aqua / MODIS
0.27
0.70


NASA earth nullschool visualisasi asap 27 October 2015
27 OKTOBER 2015


Ketidaksetimban Air
(sifatnya temporer)
Ketidaksetimban Air
(sifatnya permanen)
Ulah alam
Ulah manusia
Kekeringan
Kegersangan
Kering
Kekurangan Air
Penggurunan

DEFINISI KEKERINGAN (VLACHOS (1980)

- **Kegersangan** (aridity): kondisi alam permanen dan gambaran iklim yang stabil di sesuatu wilayah
- **Kekeringan** (drought): gambaran sementara dari iklim atau kebiasaan dari penyimpangan iklim yang dapat diduga
- **Kekurangan air** (water deficit): akibat dari ulah manusia yang berlebihan sehingga menimbulkan kekurangan air di suatu wilayah yang sifatnya sementara
- **Penggurunan** (desertification): bagian dari proses rezim ekologi yang terganggu oleh aktivitas manusia sehingga menimbulkan kegersangan atau kekeringan sampai pada tahap tertentu.

KEKERINGAN BERHUBUNGAN DENGAN

- Curah hujan atau kelembaban udara yang rendah
- Terjadi akibat proses alami
- Kelembaban tanah berkurang
- Berlangsung dalam jangka waktu yang lama tergantung dari rata-rata lamanya perioda kering atau didasarkan pada tingkat kekeringan relatif terhadap tingkat kekeringan normal.
- Serangan kekeringan berlangsung lambat
- Didaerah yang rata-rata curah hujannya rendah, kekeringan datang secara berkala

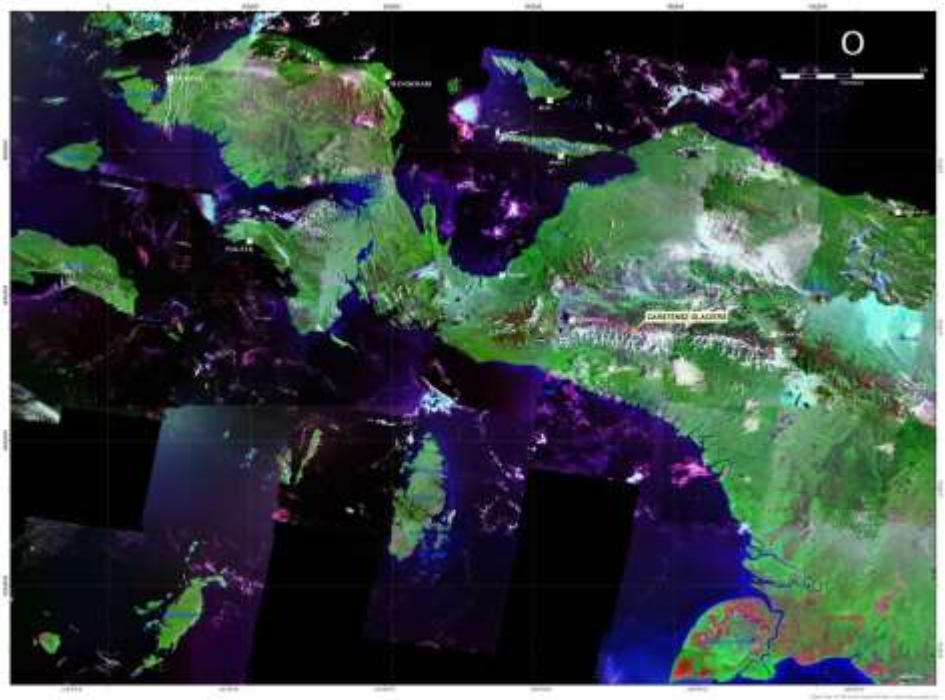
DAMPAK KEKERINGAN

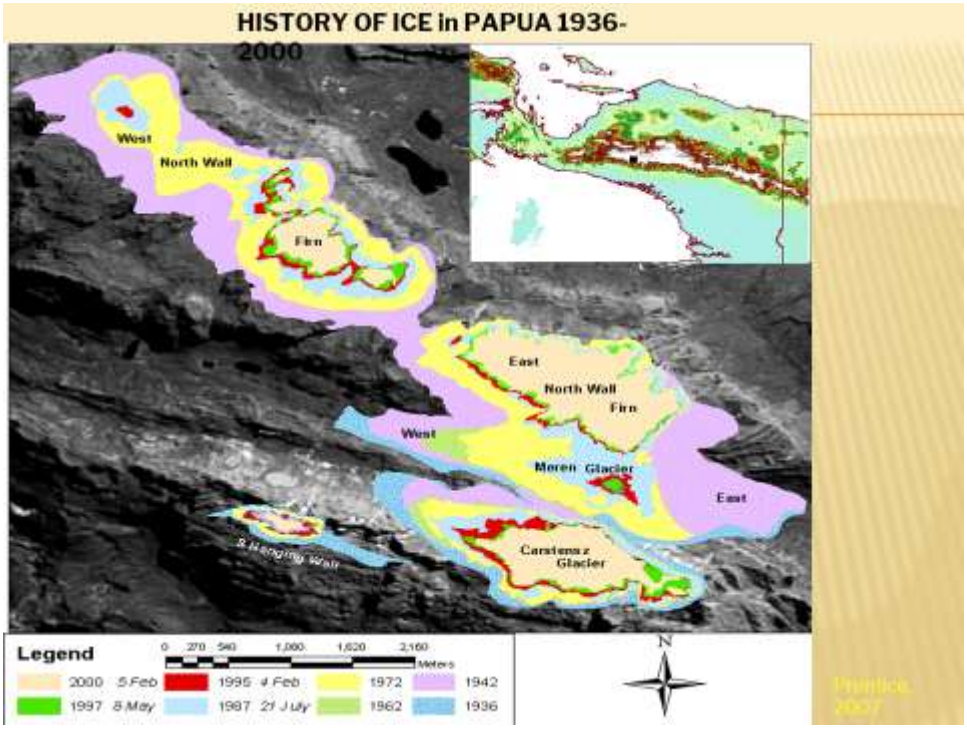
SUMBER: DITLIN DEPTAN

Tahun	Luas Tanam	Luas Banjir		Luas Kekeringan		Total (Banjir+Kekeringan)		Persentase (puso)
		Terkena	Puso	Terkena	Puso	Terkena	Puso	
1997	10.105.913	58.197	13.953	517.614	87.099	575.811	101.052	1
1998	13.435.646	143.344	33.152	180.701	32.557	324.045	65.709	0.49
1999	11.965.539	190.466	42.275	104.539	12.631	295.005	54.906	0.46
2000	11.382.739	243.931	58.651	91.105	5.116	335.036	63.767	0.56
2001	11.348.427	196.164	32.765	151.39	12.434	347.554	45.199	0.4
2002	10.655.578	219.58	63.459	348.512	41.69	568.092	105.149	0.99
2003	12.364.653	263.181	66.838	568.619	117.006	831.8	183.844	1.49
2004	11.520.080	311.246	84.588	163.923	26.384	475.169	110.972	0.96
2005	12.425.805	245.504	80.384	283.66	44.829	529.164	125.213	1.01
2006	10.889.565	329.826	138.227	338.261	73.045	668.087	211.272	1.94
2007	12.755.019	329.475	99.039	454.059	58.641	783.534	157.68	1.23
2008*	9.339.965	187.138	66.618	194.508	21.284	381.646	87.902	0.94

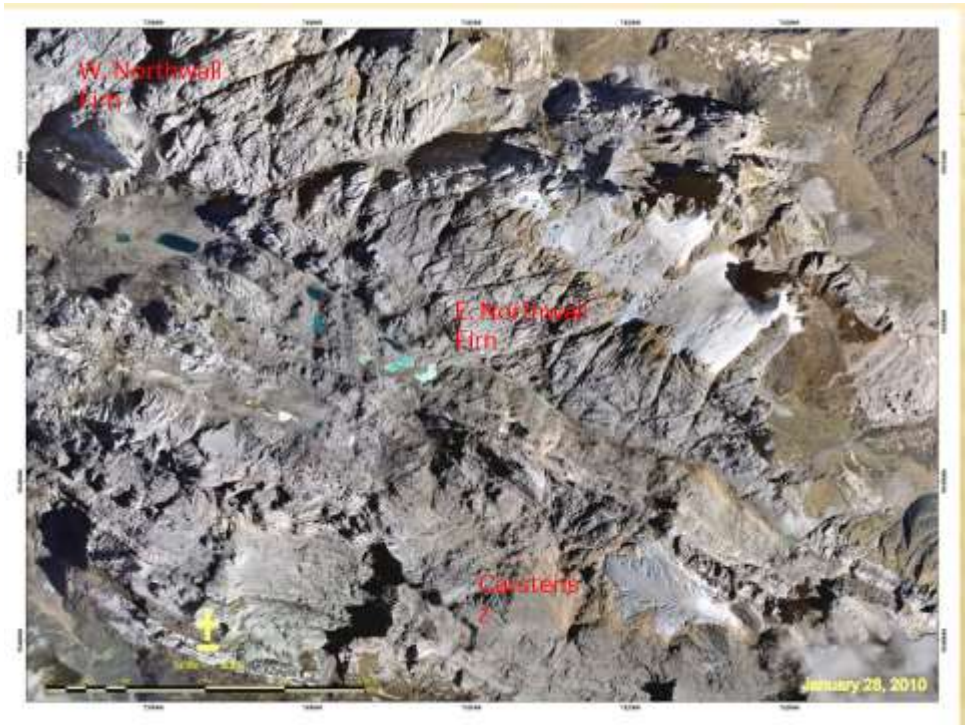
BERKURANGNYA LAPISAN ES JAYAWIJAYA

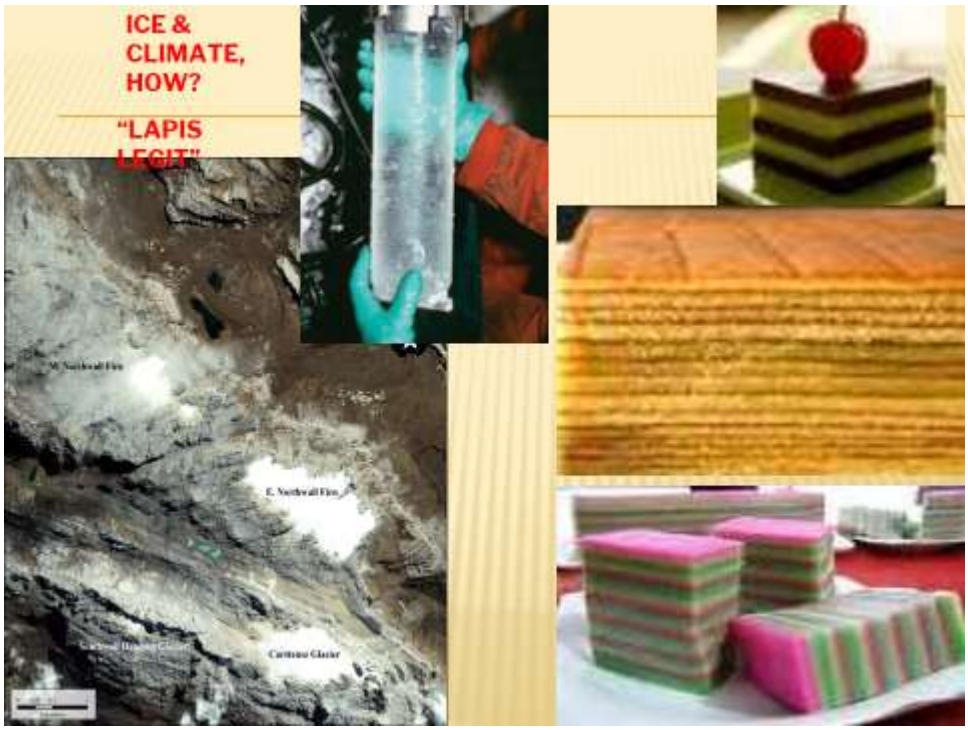
- Sebagai implikasi pemanasan global terjadinya menurunan lapisan es di muka bumi yang membahayakan tingkat kenaikan muka air laut dan ancaman suplai ketersediaan air di muka bumi
- Di khawatirkan beberapa wilayah muka bumi akan terganggu ketersediaan suplai air dan keberlangsungan ekologis
- Indonesia adalah salah satu hot spot dari salju abadi tropis selain Kilimanjaro dan pegunungan Andes di Peru

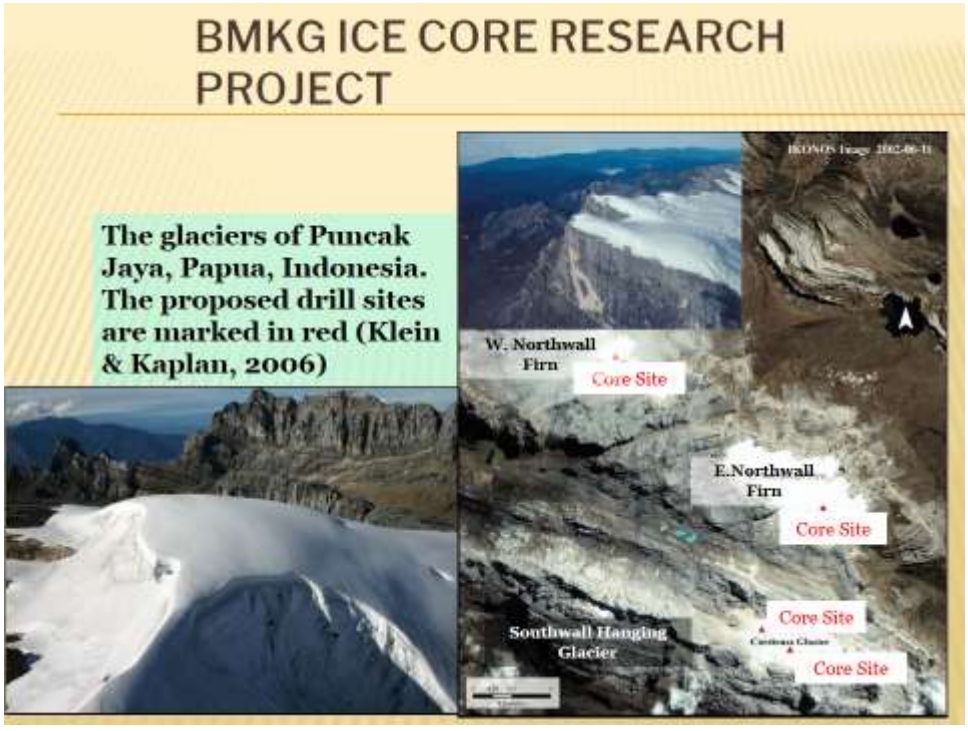


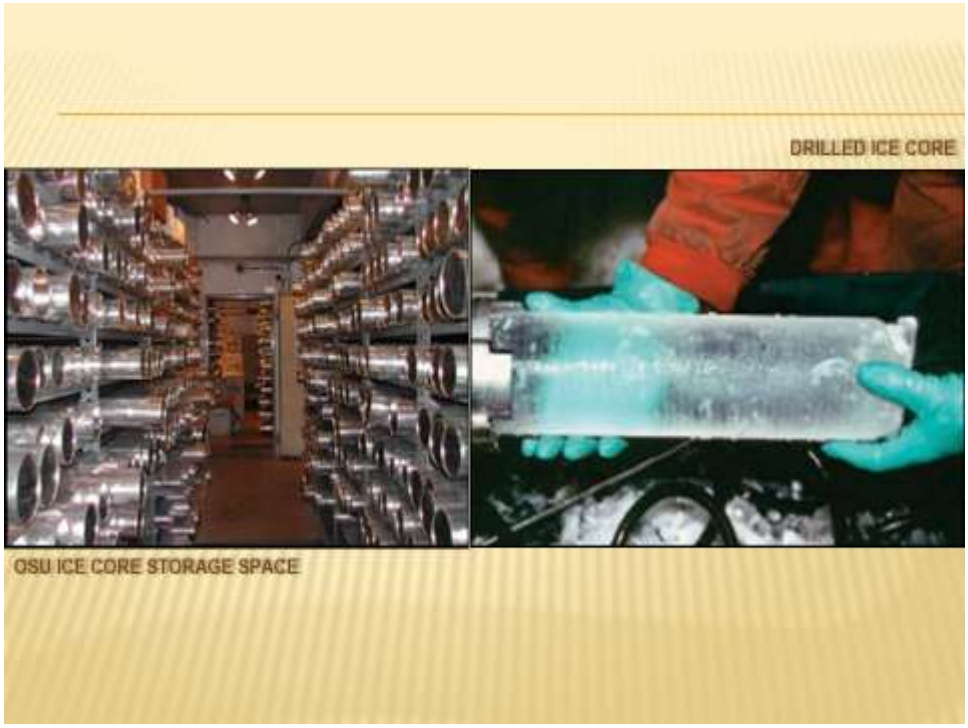

HISTORY OF ICE in PAPUA 1936-2000
West
North Wall
Firn
East
North Wall
Firn
West
Moren Glacier
East
Carstensz Glacier
Legend
2000 5 Feb
1995 4 Feb
1972
1942
1997 8 May
1987 21 July
1962
1936
N


PUNCAK
JAYA
1936
1991
2001
2009
May 15, 2010


W. Northwall
Firn
E. Northwall
Firn
Carstens
2
January 28, 2010


ICE &
CLIMATE,
HOW?
"LAPIS
LEGIT"


BMKG ICE CORE RESEARCH
PROJECT
The glaciers of Puncak Jaya, Papua, Indonesia. The proposed drill sites are marked in red (Klein & Kaplan, 2006)
W. Northwall Firn
Core Site
E.Northwall Firn
Core Site
Core Site
Southwall Hanging Glacier
Core Site


DRILLED ICE CORE
OSU ICE CORE STORAGE SPACE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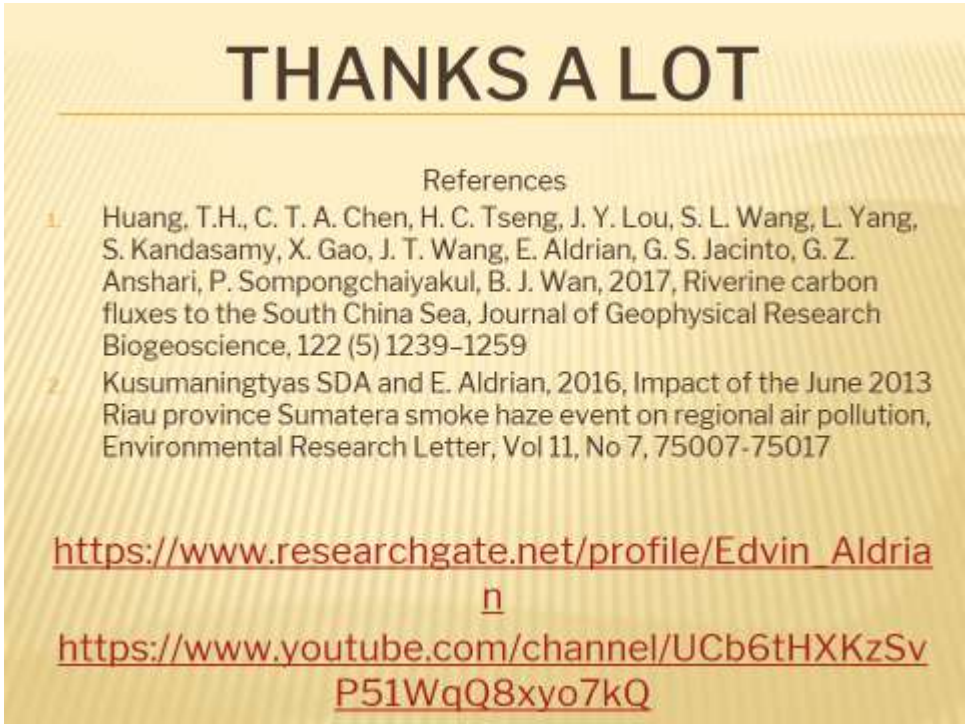
CONCLUSIONS

1. Indonesia dianugerahi kecukupan air dengan intensitas hujan yang relatif tinggi dari rata rata 2000 hingga 13000 mm pertahun.
2. Permasalahan adalah terjadinya distribusi temporal yang tidak merata dan sungai-sungai yang pendek akibat bentuk pulau
3. Polusi perairan darat adalah masalah utama yang perlu mendapatkan perhatian khusus
4. Dalam menghadapi perubahan iklim telah terjadi percepatan laju siklus air, juga pemanasan yang terjadi banyak diserap oleh badan air. Selain itu pemanasan global terbukti menurunkan lapisan es di muka bumi seperti lapisan es di Jayawijaya.


THANKS A LOT
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