Sustainability of Water Resources: Improving Resilience to Climate Change Impacts

Sustainable Safe Water Innovation For Laguna and Quezon

Susan M. Gallardo, Dr. Eng'g.
CESDR – De la Salle University

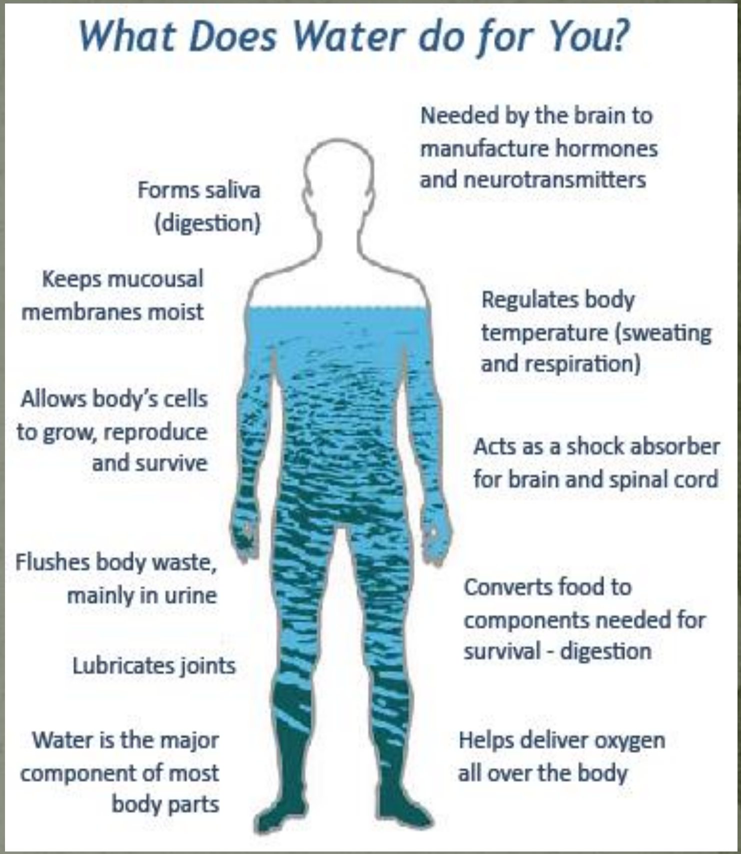
REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF SCIENCE AND TECHNOLOGY

10th Philippine National Health Research System (PNHRS) Week (PNHRS)
Puerto Princesa , Palawan

WATER

- **Renewable Resource**
- **Naturally Recycled**
- **Water is needed for LIFE**
- **Water Consumption**
  - Population
    - A person needs to drink 2-4L per day;

      For cooking, bathing and cleaning, the average is 20-50L per day
  - economic status
  - climate
- **Abundant but not clean or safe in some cases**



How safe is "Safe Water"?

- Standards set by law
- Philippine National Standards for Drinking Water 2007
- DAO 2016-08 (DENR)

Table 3. Water Quality Guidelines for Primary Parameters

Parameter	Unit	Water Body Classification								
		AA	A	B	C	D	SA	SB	SC	
BOD	mg/L	1	3	5	7	15	n/a	n/a	n/a	
Chloride	mg/L	250	250	250	350	400	n/a	n/a	n/a	
Color	TCU	5	50	50	75	150	5	50	75	
Dissolved Oxygen[a] (Minimum)	mg/L	5	5	5	5	2	6	6	5	
Fecal Coliform	MPN/100mL	<1.1	<1.1	100	200	400	<1.1	100	200	
Nitrate as NO_3-N	mg/L	7	7	7	7	15	10	10	10	
pH (Range)		6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.0	6.0-9.0	7.0-8.5	7.0-8.5	6.5-8.5	6.
Phosphate	mg/L	<0.003	0.5	0.5	0.5	5	0.1	0.5	0.5	
Temperature[b]	°C	26-30	26-30	26-30	25-31	25-32	26-30	26-30	25-31	2
Total Suspended Solids	mg/L	25	50	65	80	110	25	50	80	

Notes:
MPN/100mL – Most Probable Number per 100 milliliter
n/a – Not Applicable
TCU – True Color Unit
(a) Samples shall be taken from 9:00 AM to 4:00 PM.
(b) The natural background temperature as determined by EMB shall prevail if the temperature is lower or higher tha
WQG; provided that the maximum increase is only up to 10 percent and that it will not cause any risk to human h
and the environment.

Table 4. Water Quality Guidelines for Secondary Parameters-Inorganics

Parameter	Unit	Water Body Classification							
		AA	A	B	C	D	SA	SB	SC
Ammonia as NH_3-N	mg/L	0.05	0.05	0.05	0.05	0.75	0.04	0.05	0.05
Boron	mg/L	0.5	0.5	0.5	0.75	3	0.5	0.5	5
Fluoride	mg/L	1	1	1	1	2	1.5	1.5	1.5
Selenium	mg/L	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.1
Sulfate	mg/L	250	250	250	275	500	250	250	275

Table 5. Water Quality Guidelines for Secondary Parameters-Metals[c]

Parameter	Unit	Water Body Classification							
		AA	A	B	C	D	SA	SB	SC
Arsenic	mg/L	0.01	0.01	0.01	0.02	0.04	0.01	0.01	0.02
Barium	mg/L	0.7	0.7	0.7	3	4	0.1	0.7	1
Cadmium	mg/L	0.003	0.003	0.003	0.005	0.01	0.003	0.003	0.00
Chromium as Hexavalent Chromium (Cr^{6+})	mg/L	0.01	0.01	0.01	0.01	0.02	0.05	0.05	0.05
Copper as Dissolved Copper	mg/L	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.02
Iron	mg/L	1	1	1	1.5	7.5	1.5	1.5	1.5
Lead	mg/L	0.01	0.01	0.01	0.05	0.1	0.01	0.01	0.05
Manganese	mg/L	0.2	0.2	0.2	0.2	2	0.4	0.4	0.4
Mercury	mg/L	0.001	0.001	0.001	0.002	0.004	0.001	0.001	0.00
Nickel	mg/L	0.02	0.02	0.04	0.2	1	0.02	0.04	0.06
Zinc	mg/L	2	2	2	2	4	0.04	0.05	0.8

Note:

(c) Unless otherwise specified, the above parameters are expressed as total metals.

Table 6. Water Quality Guidelines for Secondary Parameters-Organics

Parameter	Unit	Water Body Classification							
		AA	A	B	C	D	SA	SB	SC
Benzo(a)pyrene	µg/L	0.7	0.7	0.7	1.5	3	0.7	0.7	1.5
BTEX									
Benzene	mg/L	0.01	0.01	0.01	0.05	0.5	0.01	0.01	0.05
Toluene	mg/L	0.7	0.7	1	4	5	1	1	4
Ethylbenzene	mg/L	0.3	0.3	0.3	1.5	2	0.2	0.2	1.5
Xylenes	mg/L	0.5	0.5	0.5	1.5	1.8	0.5	0.5	1.5
Cyanide as Free Cyanide	mg/L	0.07	0.07	0.07	0.1	0.2	0.02	0.02	0.1
Organophosphate as Malathion	µg/L	1	1	1	3	6	1	1	3
Oil and Grease	mg/L	<1	1	1	2	5	1	2	3
Polychlorinated Biphenyls[d]	µg/L	<0.1	<0.1	0.2	0.5	1	0.3	0.3	0.5
Phenol & Phenolic Substances[e]	mg/L	<0.001	<0.001	<0.001	0.05	0.5	<0.001	<0.001	0.05
Surfactants (MBAS)	mg/L	<0.025	0.2	0.3	1.5	3	0.3	0.3	1.5
Trichloroethylene	mg/L	0.07	0.07	0.07	0.9	2	0.07	0.07	0.9
Total Organochlorine Pesticides[f]	µg/L	n/a	n/a	50	50	50	50	50	50
Aldrin	µg/L	0.03	0.03	n/a	n/a	n/a	n/a	n/a	n/a
Chlordane	µg/L	0.2	0.2	n/a	n/a	n/a	n/a	n/a	n/a
Dichlorodiphenyltrichloroethane (DDT)	µg/L	1	1	n/a	n/a	n/a	n/a	n/a	n/a
Dieldrin	µg/L	0.03	0.03	n/a	n/a	n/a	n/a	n/a	n/a
Endrin	µg/L	0.6	0.6	n/a	n/a	n/a	n/a	n/a	n/a
Heptachlor	µg/L	0.03	0.03	n/a	n/a	n/a	n/a	n/a	n/a
Lindane	µg/L	2	2	n/a	n/a	n/a	n/a	n/a	n/a
Methoxychlor	µg/L	50	50	n/a	n/a	n/a	n/a	n/a	n/a
Toxaphene	µg/L	4	4	n/a	n/a	n/a	n/a	n/a	n/a

6.2 Guidelines for Groundwater Quality. Groundwater shall be maintain at a quality consistent with its intended beneficial usage. For purposes preserving and protecting groundwater quality, the WQG set forth in Table shall be maintained.

Table 7. Groundwater Quality Guidelines

Intended Beneficial Use	Groundwater Quality Guidelines
Source of Potable Water and Other Domestic Use	Adopt Class A WQG (except BOD and Dissolved Oxygen)
Bathing and Other Primary Contact Recreation	Adopt Class B WQG (except BOD and Dissolved Oxygen)
Irrigation, Fish Culture, Livestock Watering	Adopt Class C WQG (except BOD, Dissolved Oxygen, and Total Suspended Solids)

6.3 Important Considerations. The WQG are set regardless of t assimilative capacity of water bodies, and to ensure that assimilati capacities are not exceeded, the WQG set forth in Tables 3-6 are:

a) Annual average of at least 10 data sets for primary parameters exce for fecal coliform.

b) Annual average of at least 4 data sets for secondary inorgar parameters.

c) Geometric mean of at least three data sets per quarter for fec coliform. Further, maximum allowable limit for fecal coliform is twi the WQG per sample.

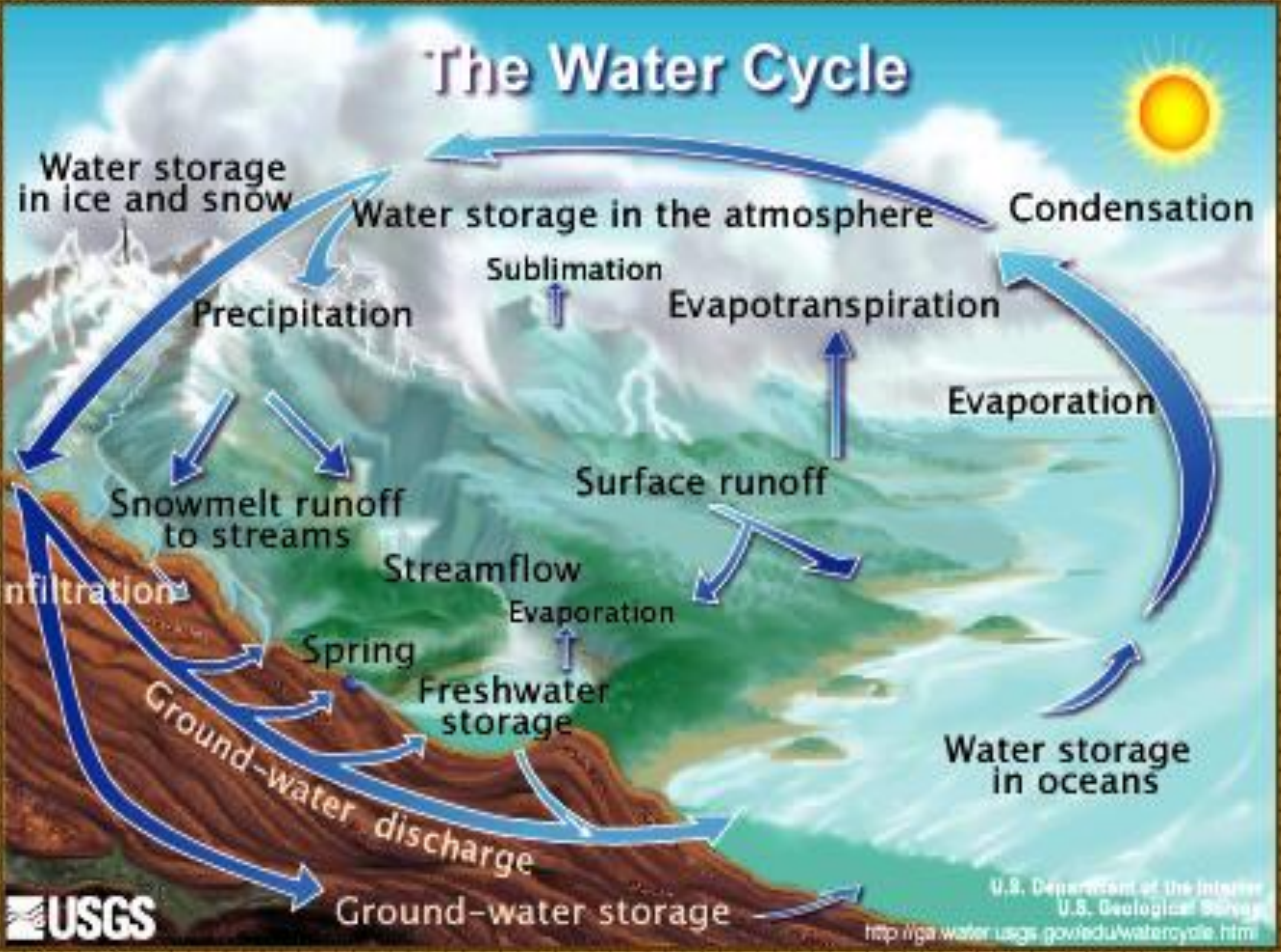
d) Maximum allowable limit for secondary metals and organi parameters.

e) For water quality parameters that are naturally occurring in t Philippines, the natural background concentration as determined EMB shall prevail if the concentration is higher that the WQ provided that the maximum increase is only up to 10 percent a that it will not cause any risk to human health and the environme

SECTION 7.0 General Effluent Standards. Discharges from any point sour shall at all times meet the effluent standards set forth in Tables 2-3 to maintain t required water quality per water body classification. The GES shall be us regardless of the industry category.

Effluent used for irrigation and other agricultural purposes shall conform he Department of Agriculture Administrative Order 2007-26 or the Guidelines he Procedures and Technical Standards for the Issuance of a Certification Allowi or the Safe Re-use of Wastewater for the Purposes of Irrigation and Oth Agricultural Uses.

Effluent quality monitoring procedures (i.e. effluent quality monitoring pla sampling, QA, QC, etc.) shall be in accordance with the Effluent Quality Monitori Manual issued through EMB Memorandum Circular 2008-008.


The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Surface runoff
Snowmelt runoff to streams
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS
U.S. Department of the Interior
U.S. Geological Survey
http://ga.water.usgs.gov/edu/watercycle.html

Water Distribution

Reservoir	**Volume of water (10^6 km³)**	**Percent of total**
Oceans	1370	97.25
Ice caps & glaciers	29	2.05
Groundwater	9.5	0.68
Lakes	0.125	0.01
Soil moisture	0.065	0.005
Atmosphere	0.013	0.001
Streams & rivers	0.0017	0.0001
Biosphere	0.0006	0.00004

How long does water stays in the reservoirs?

Reservoir	**Average residence time**
Oceans	3,200 years
Glaciers	20 to 100 years
Seasonal snow cover	2 to 6 months
Soil moisture	1 to 2 months
Groundwater: shallow	100 to 200 years
Groundwater: deep	10,000 years
Lakes	50 to 100 years
Rivers	2 to 6 months
Atmosphere	9 days

Water Resources Region	Groundwater Potential	Surface Water Potential	Total Water Resources Potential
X Northern Mindanao	2,116	29,000	31,116
XII Southern Mindanao	1,758	18,700	20,458
VI Western Visayas	1,144	14,200	15,344
XI Southeastern Mindanao	2,375	11,300	13,675
IX Western Mindanao	1,082	12,100	13,182
VIII Eastern Visayas	2,557	9,350	11,907
II Cagayan Valley	2,825	8,510	11,335
III Central Luzon	1,721	7,890	9,611
IV Southern Tagalog	1,410	6,370	7,780
I Ilocos	1,248	3,250	4,498
V Bicol	1,085	3,060	4,145
VII Central Visayas	879	2,060	2,939
TOTAL	20,200	125,790	145,990

Table 1. Water availability, in MCM

(Source: Philippines Environment Monitor 2003)

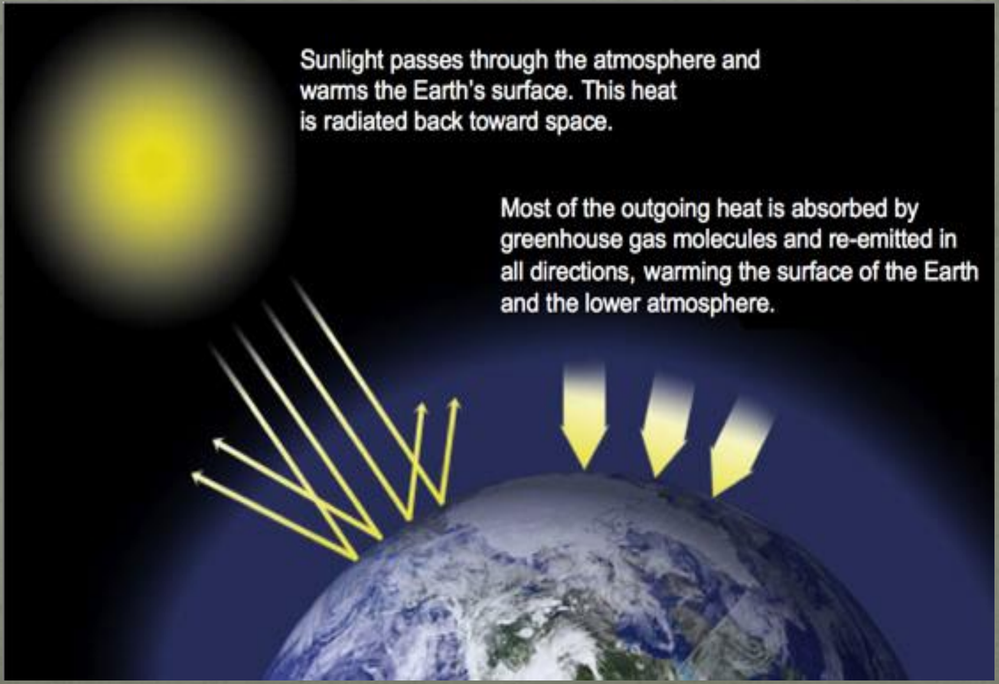
Classification	Number
Class AA Waters intended as public water supply requiring only approved disinfection to meet the PNSDW	**5**
Class A Waters suitable as water supply requiring conventional treatment to meet the PNSDW	**203**
Class B Waters intended for primary contact recreation (e.g. bathing, swimming, skin diving, etc.)	**149**
Class C Waters for fishery, recreation/boating, and supply for manufacturing processes after treatment	**231**
Class D Waters intended for agriculture, irrigation, livestock watering, etc.	**23**

Table 2. Number of classified inland surface water bodies

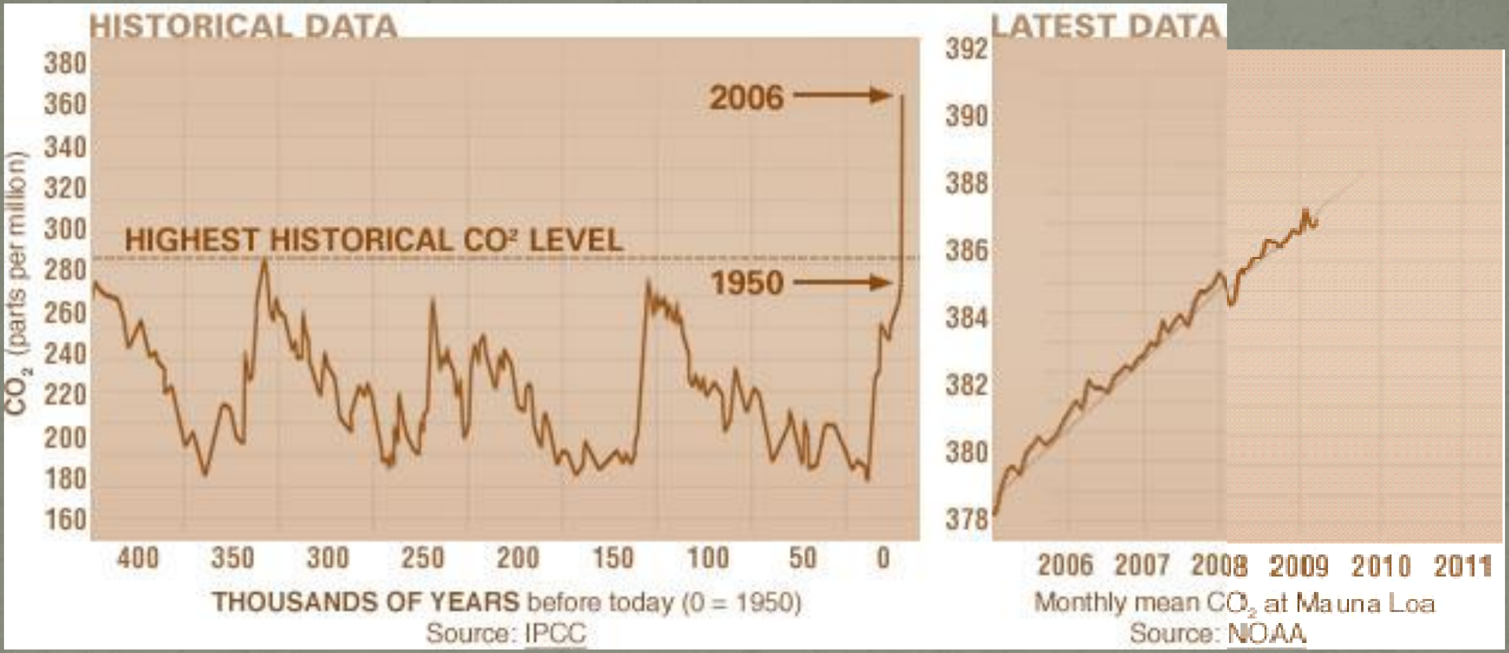
(Source: EMB National Water Quality Status Report, 2006)

What happens when there is climate change?

- Climate is the pattern or cycle of weather conditions such as temperature, wind, rain, snowfall, humidity, clouds including extreme or occasional ones over a large area, averaged over many years
- Climate change is caused by Greenhouse gases
- Greenhouse gases like CO_2, CH_4, NO, and others (CFCs)

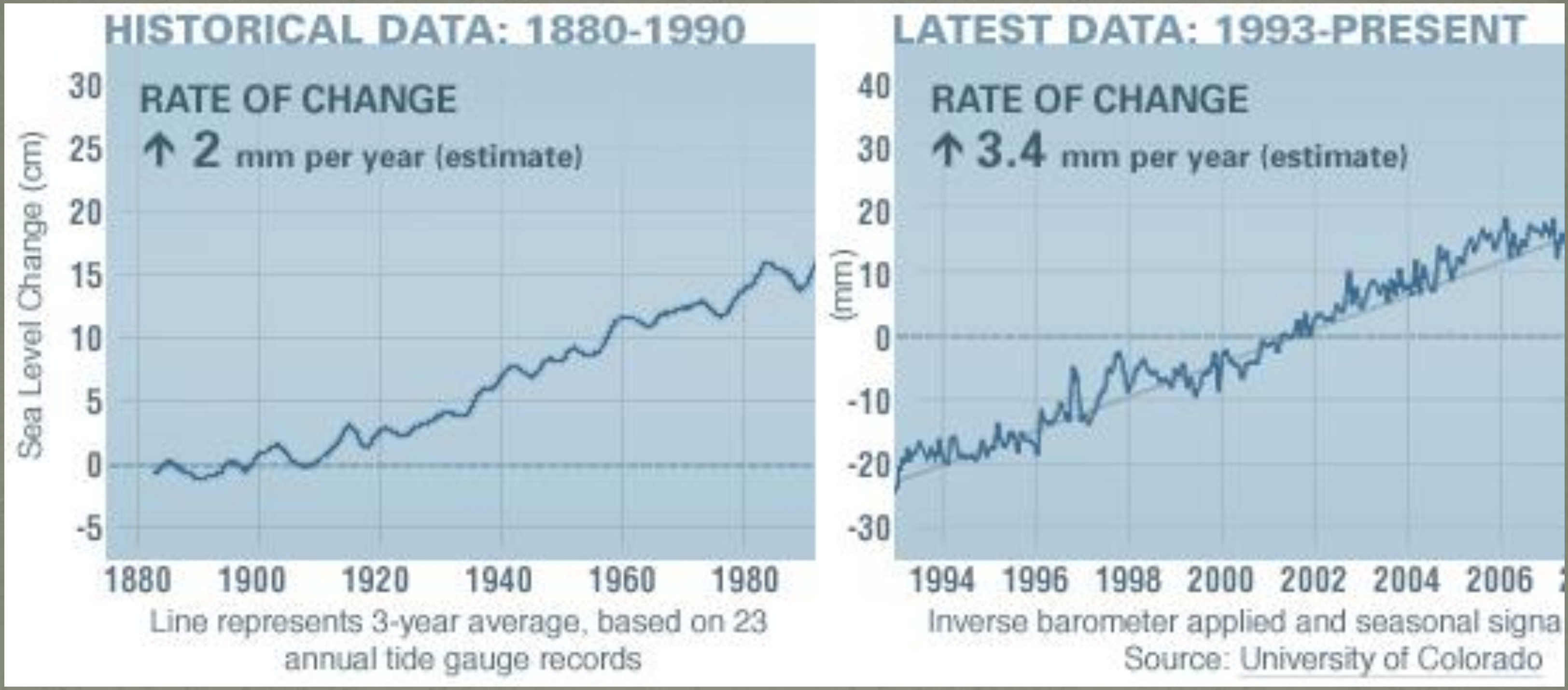


Carbon Dioxide Concentration



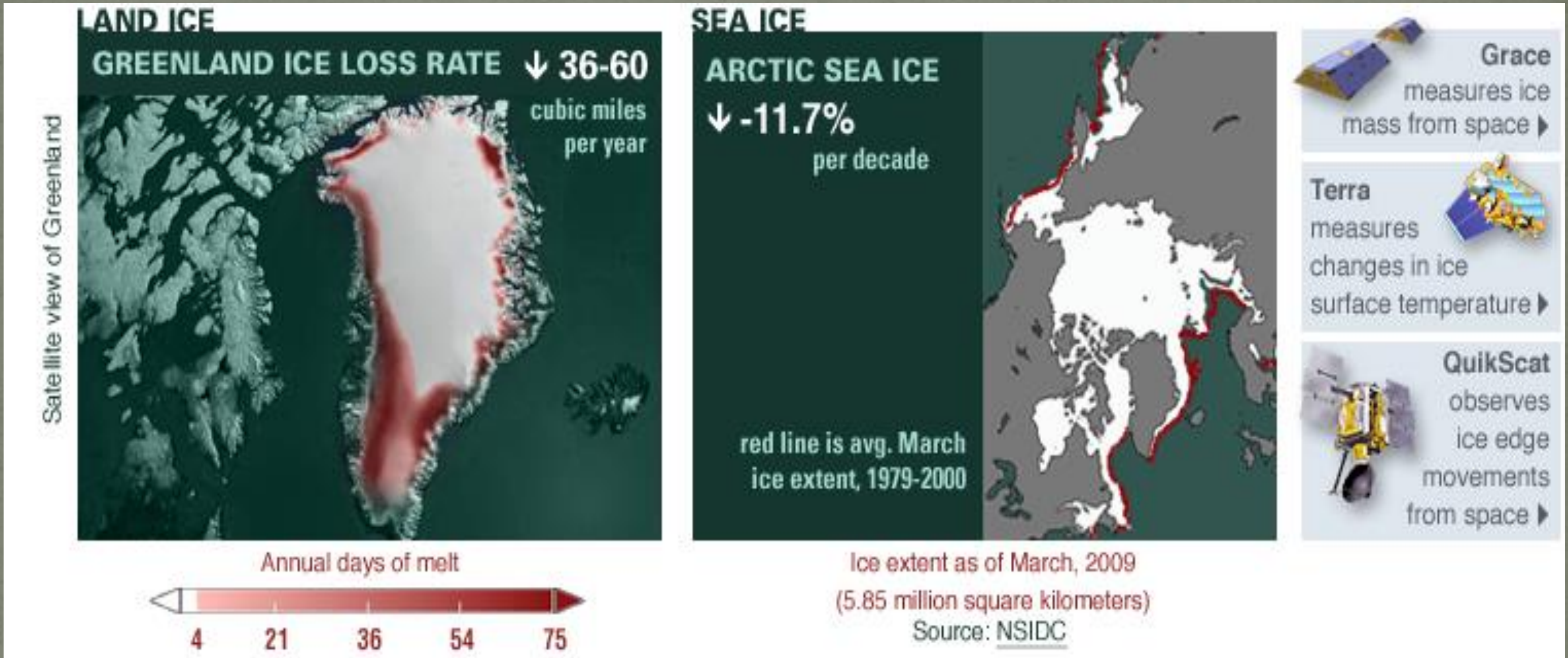
Carbon dioxide (CO2) is an important greenhouse gas released through natural processes such as respiration and volcano eruptions and through human activities such as deforestation and burning fossil fuels. The chart on the left shows the historical levels of CO2 in the Earth's atmosphere. The chart on the right shows CO2 levels in recent years (corrected for average seasonal cycles).

SEA LEVEL



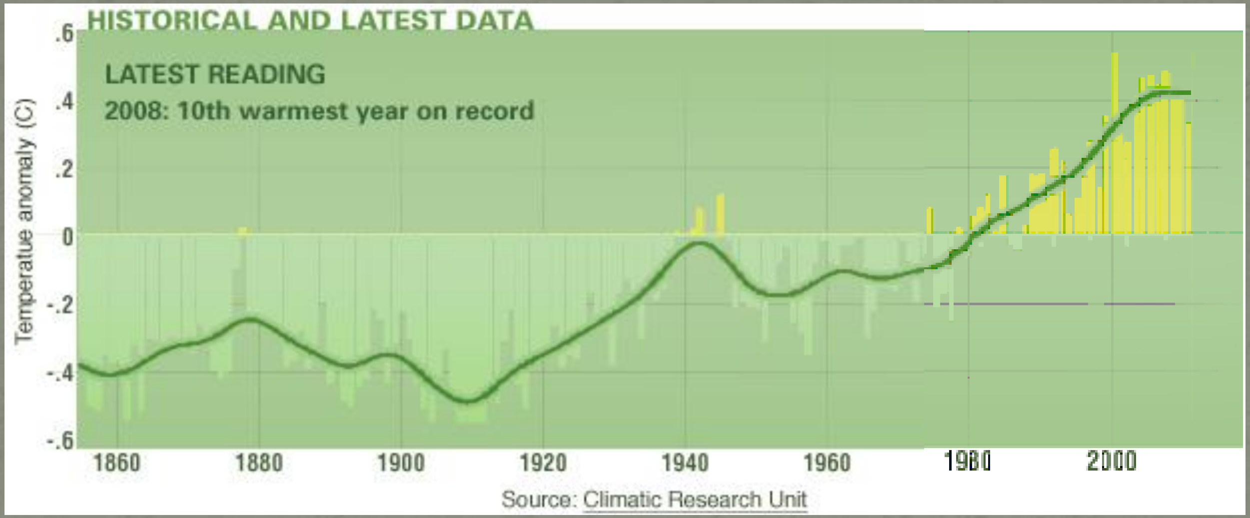
The chart on the left shows historical sea level data derived from 23 tide-gauge measurements. The chart on the right shows the average sea level since 1993 derived from global satellite measurements. Sea level rise is associated with the thermal expansion of sea water due to climate warming and widespread melting of land ice.

MELTING OF ICE



This illustration on the left shows areas where ice melt occurred for more than three days over Greenland during 2007. Areas in which melt occurred for longer time periods are shown in a darker red while those areas melted for fewer days are shown in lighter red

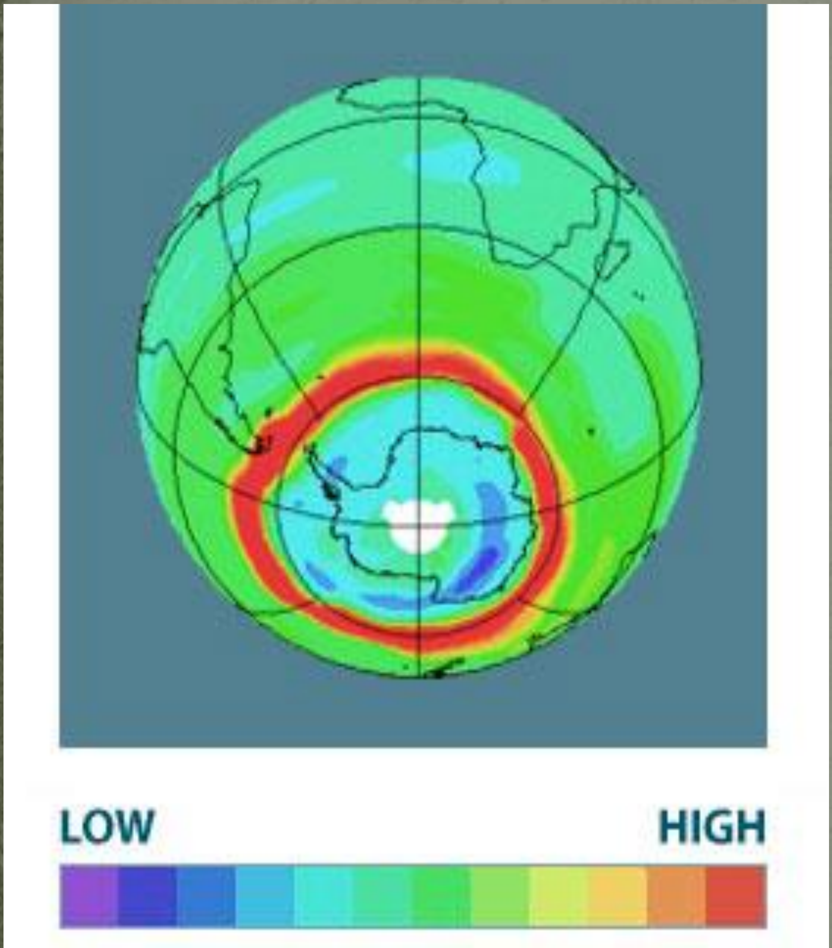
GLOBAL AVERAGE TEMPERATURE



The time series shows the combined global land and marine surface temperature record from 1850 to 2007. The year 2007 was eighth warmest on record, exceeded by 1998, 2005, 2003, 2002, 2004, 2006 and 2001.

OZONE HOLE

Latest size: 27 million square km (10.4 million square miles)
Record size: 27.4 million square km (10.6 million square miles)
(Sept. 7-Oct. 13 average)



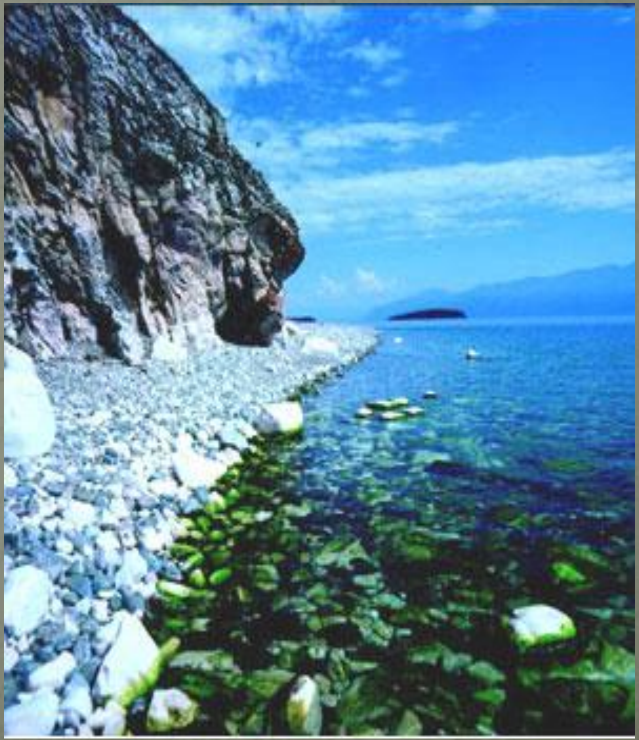
The "ozone hole" is a severe depletion of the ozone layer high above Antarctica. It is primarily caused by human-produced compounds that release chlorine and bromine gases in the stratosphere. The ozone layer acts to protect life on Earth by blocking harmful ultraviolet rays from the sun.

The image at left is a view of the most recent Antarctic ozone hole, derived from satellite measurements that monitor the ozone layer. The blue and purple colors are where there is the least ozone, and the greens, yellows, and reds are where more ozone is present.

There are signs that ozone depletion is slowing in response to the 1987 Montreal Protocol, which resulted in a significant reduction in global emissions of ozone-depleting chemicals. However, climate change may cause the ozone hole to expand further.

What are the impacts on health and water resources?

- Increase in water
- Decrease in water
- Increase in water temperature



Increase in water

- Precipitation Changes
- Flooding

Public Health Issues associated with Precipitation

Extreme Precipitation

Sewage overflows

Increased runoff: sediment, contaminants, nitrate, etc.

Contamination of surface and groundwater

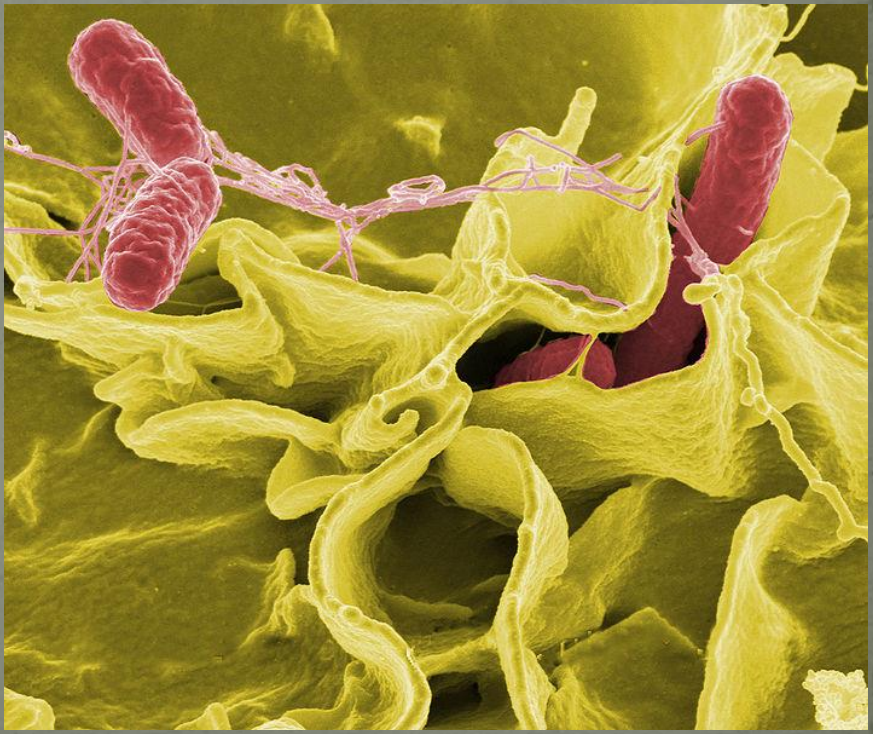
Physical injuries and destruction of property

Waterborne disease outbreaks from drinking water or recreational contact (beachgoers): Giardiasis, E coli, Cryptosporidium

Public Health Issues associated with Flooding

- Foodborne illnesses (e.g. *Salmonellosis)*
  - Increased risk from contamination of certain food crops with feces from nearby livestock or wild animals following heavy rain and flooding

  (Ebi et al, 2008; CCSP, 2008)



- Waterborne illnesses
  - Caused by pathogens (e.g. *Cryptosporidium* and *Giardia*) which may increase following downpours
  - Can also be transmitted in drinking water and through recreational use

  (Ebi et al, 2008; CCSP, 2008)

Decrease in water

- Drought
- Lower water levels

Strong El Niño threatens water supply
By Janvic Mateo (The Philippine Star) | Updated August 2, 2015 - 12:00am

Public Health Issues – Drought & Lower Water Levels

- Reduced soil moisture reserves, groundwater supplies, lake and wetland levels, and stream flows
- Potential concentration of pollutants
- Decreasing water supply for drinking water and agriculture
- Agriculture: adversely affects crop progress and soil moisture and therefore food supply
- Psychological effects

Increase in water temperature

- Changes in fish populations & mercury
- Algal blooms
- Reduced dissolved oxygen
- Incomplete mixing
- Increased vectors
- Invasive species/ northern expansion of organisms

SUMMARY AND POLICY IMPLICATIONS VISION 2030

THE RESILIENCE OF WATER SUPPLY AND SANITATION IN THE FACE OF CLIMATE CHANGE

- WHO DFID
- FIVE KEY CONCLUSIONS OF THE VISION 2030 STUDY
  - 1. Climate change is widely perceived as a threat rather than an opportunity. There may be significant overall benefits to health and development in adapting to climate change.
  - 2. Major changes in policy and planning are needed if ongoing and future investments are not to be wasted.
  - 3. Potential adaptive capacity is high but rarely achieved. Resilience needs to be integrated into drinking-water and sanitation management to cope with present climate variability. It will be critical in controlling adverse impacts of future variability.
  - 4. Although some of the climate trends at regional level are uncertain, there is sufficient knowledge to inform urgent and prudent changes in policy and planning in most regions.
  - 5. There are important gaps in our knowledge that already or soon will impede effective action. Targeted research is urgently needed to fill gaps in technology and basic information, to develop simple tools, and to provide regional information on climate change.

Climate resilience strategies for water resources

- Green infrastructure
- Grey infrastructure
  - Rainwater storage
- Emergency Preparedness
  - Disaster risk and reduction management
- Individual Strategies
  - Water treatment and reuse
  - Water conservation
  - Desalination

Green subdivision

Mangrove plantation

Safe water innovation for Laguna and Quezon

NOVEL NATURAL WATER FILTERS
FOR
NAGCARLAN, PHILIPPINES

Funded by United States Environmental Protection Agency
under the People, Prosperity, Planet (P3) Program

Project Leaders:
Dr. James Patrick Abulencia…………Manhattan College
Dr. Susan Gallardo…………………..De La Salle University
Co-Proponents:
Anne Caraccio……………………….Manhattan College
Nithin Abraham…………………….Manhattan College
Nicholas Ruffini……………………. Manhattan College
Shannon O'Brien……………………Manhattan College
Francis Narvin Tañala……………….De La Salle University
Katrina Pulutan……………………...De La Salle University

Water Condition in Nagcarlan

- Six water springs along the slope of Mt. Banahaw
- Uncontrolled application of pesticides
- Houses and piggeries with poorly constructed septic tanks
- Pipelines are 50 years old or more

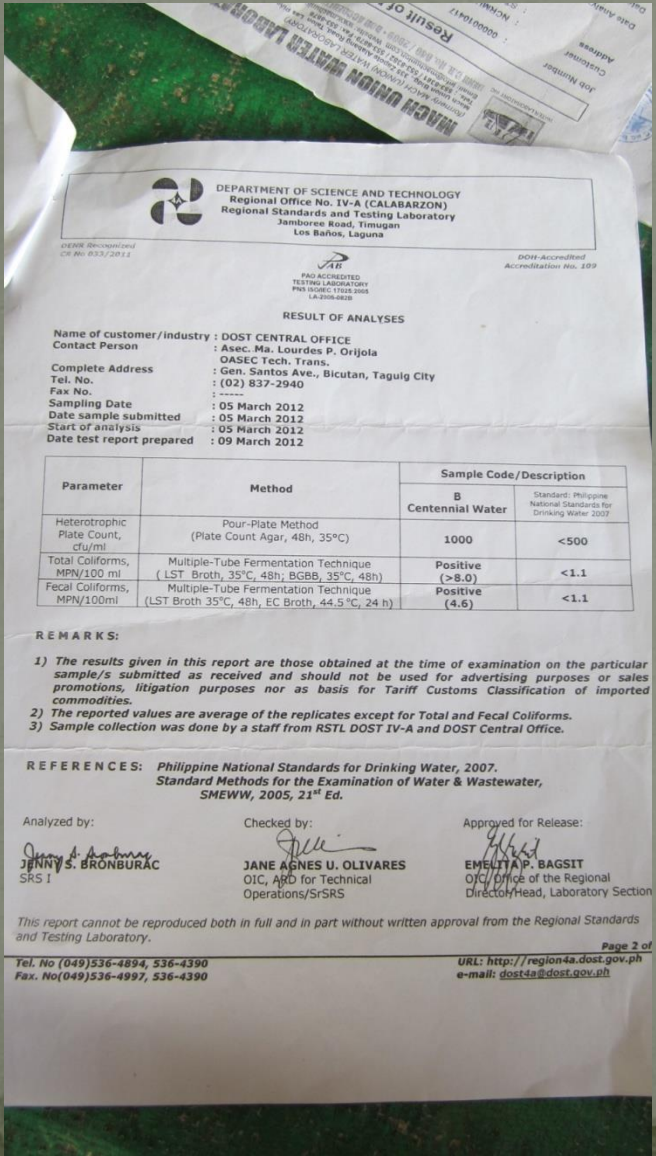
Calauan Laguna in 2012

In Rizal Laguna

Storage for water coming from 3 springs

Mulanay Quezon

Assessment of water quality



DEPARTMENT OF SCIENCE AND TECHNOLOGY
Regional Office No. IV-A (CALABARZON)
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Jamboree Road, Timugan
Los Baños, Laguna

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CR No 033/2011

DOH-Accredited
Accreditation No. 109

PAO ACCREDITED
TESTING LABORATORY
PNS ISO/IEC 17025:2005
LA-2006-082B

RESULT OF ANALYSES

Name of customer/industry : DOST CENTRAL OFFICE
Contact Person : Asec. Ma. Lourdes P. Orijola
OASEC Tech. Trans.
Complete Address : Gen. Santos Ave., Bicutan, Taguig City
Tel. No. : (02) 837-2940
Fax No. : -----
Sampling Date : 05 March 2012
Date sample submitted : 05 March 2012
Start of analysis : 05 March 2012
Date test report prepared : 09 March 2012

Parameter	Method	Sample Code/Description	
		B Centennial Water	Standard: Philippine National Standards for Drinking Water 2007
Heterotrophic Plate Count, cfu/ml	Pour-Plate Method (Plate Count Agar, 48h, 35°C)	1000	<500
Total Coliforms, MPN/100 ml	Multiple-Tube Fermentation Technique (LST Broth, 35°C, 48h; BGBB, 35°C, 48h)	Positive (>8.0)	<1.1
Fecal Coliforms, MPN/100ml	Multiple-Tube Fermentation Technique (LST Broth 35°C, 48h, EC Broth, 44.5 °C, 24 h)	Positive (4.6)	<1.1

REMARKS:

1) *The results given in this report are those obtained at the time of examination on the particular sample/s submitted as received and should not be used for advertising purposes or sales promotions, litigation purposes nor as basis for Tariff Customs Classification of imported commodities.*
2) *The reported values are average of the replicates except for Total and Fecal Coliforms.*
3) *Sample collection was done by a staff from RSTL DOST IV-A and DOST Central Office.*

REFERENCES: *Philippine National Standards for Drinking Water, 2007.*
Standard Methods for the Examination of Water & Wastewater, SMEWW, 2005, 21st Ed.

Analyzed by:
JENNY S. BRONBURAC
SRS I

Checked by:
JANE AGNES U. OLIVARES
OIC, ARD for Technical Operations/SrSRS

Approved for Release:
EMELITA P. BAGSIT
OIC, Office of the Regional Director/Head, Laboratory Section

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Page 2 of

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Fax. No(049)536-4997, 536-4390
URL: http://region4a.dost.gov.ph
e-mail: dost4a@dost.gov.ph

- Positive for total coliform and fecal coliform

PROJECT DESCRIPTION

The project aimed to create a personal water purification solution for the citizens of Nagcarlan, Philippines that effectively treats The main objective of the filter is to help decrease the incidence of waterborne illness in Nagcarlan through the design and manufacture a robust, patentable personal water purification device constructed from indigenous natural resources.

The filter contains activated carbon and citricidal extract to remove the following contaminants:

- Heavy metals
- Pesticides
- E.coli and other bacteria

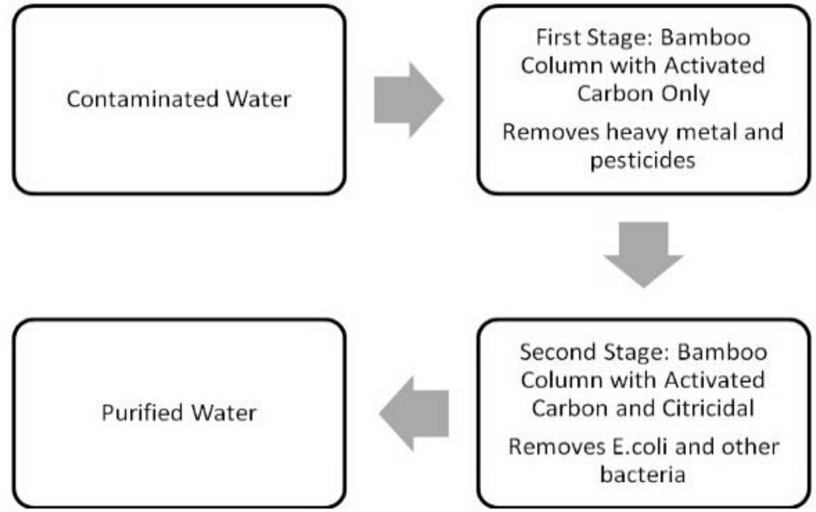
IN RELATION TO PEOPLE, PROSPERITY, AND PLANET

People:
The proposed water quality solution for the town would benefit the people of Nagcarlan by decreasing the number of waterborne pathogens and increasing the overall quality of life for the community.

Prosperity:
The proposed water filter will help put an end to further excavation projects to dig individual wells or springs, or construction of expensive water treatment facilities. A cradle-to-cradle environmental life cycle approach can be implemented by using gasification to regenerate spent activated carbon.

Planet:
The proposed water filter is 100% recyclable and biodegradable, which will mitigate the release harmful toxins, particulates, and greenhouse gases produced by incineration. The filter waste will be available for biodegradable refuse, recyclable projects, or simply reused. The need to buy bottled water will drastically decrease and

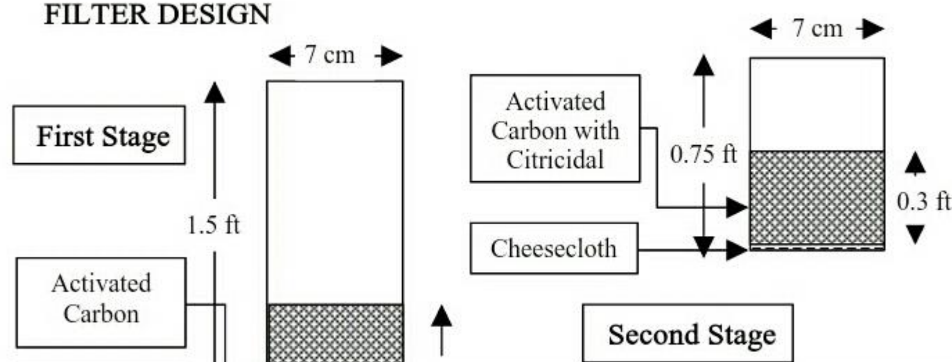
SCHEMATIC DIAGRAM



MATERIALS AND SUPPLIES

1. **Activated Carbon** – used as the primary material for the filter.
2. **Citricidal Extract** – used for the disinfection of water against E.coli and other bacteria.
3. **Bamboo** – used to house the filtering medium
4. **Cheesecloth** – used to filter activated carbon particles from treated water

FILTER DESIGN




MANHATTAN
COLLEGE
IT BAG

Concluding remarks

- Climate change is a real threat
- Impacts on water, food and health are already felt in country
- Climate adaptation and resilience are needed
- Water treatment technologies are available but safe water innovation is needed for disaster preparedness

Thank you for listening

susan.gallardo@dlsu.edu.ph