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HANDOUT #4

GRAD/SCI221 ENVIRONMENTAL SCIENCE **Saturday**
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1. Hydrologic or Water Cycle

It represents the pathways where water travels as it circulates throughout global systems by various processes. The visible components of this cycle are Precipitation and Runoff. Other components such as evaporation, infiltration, transpiration, percolation groundwater recharge, interflow, and groundwater discharge. Water is available in the atmosphere, the oceans, on land and within the soil and rocks of the earth's crust. Water molecules from one location to another are driven by the solar energy. Moisture circulates from the earth into the atmosphere through evaporation and then back into the earth as precipitation (rainfall/rainwater). Hydrologic or water cycle describes the continuous movement of water on, above and below the earth surface. This cycle involves the following key processes:

(a) *Precipitation (P)*: condensed water vapour that falls to the earth surface. Some precipitations forms are rain, snow, hail, sleet, drizzle, etc.
(b) *Runoff or Surface runoff (Q)*: variety of ways by which water moves across the land which includes both surface and channel runoff.
(c) *Infiltration or subsurface runoff/flow (Qc)*: the flow of water from the ground surface into the ground, consequently becomes soil moisture or ground water. Subsurface runoff when the flow of water underground, in the vadoze zone and aquifers which returns to the surface as springs or seep into the oceans and seas, or land surface at lower elevation due to gravity.
(d) *Evaporation and transpiration:* (e.1) *Evaporation* is the process of liquid converting into water vapour (gas), through wind action and solar radiation and returning to the atmosphere; (e.2) *Transpiration* is the process by which water molecules leaves the body of a living pant and escapes to the atmosphere; (e.3) *Evapo-transpiration* includes all evaporation from water and land surfaces, as well as transpiration from plants.

The estimated volumes of water held at the earth's surface as shown below. It can be observed that most of the earth's water is in the oceans and fresh water is only a small proportion of the total water (2.5%) mainly stored in the ice.

	Volume (×10³ km³)	***% of total***	***% of fresh water***
Oceans and seas	1,338,000	96.54	-
Ice caps and glaciers	24,064	1.74	69.6
Groundwater	23,400	1.69	30.1
Permafrost	300	0.022	-
Lakes	176	0.013	0.3
Soil	16.5	0.001	0.05
Atmosphere	12.9	0.0009	0.04
Marsh/wetlands	11.5	0.0008	0.03
Rivers/Streams	2.12	0.00015	0.006
Biota	1.12	0.00008	0.003
Total	**1,385,984**	**100.00**	
Freshwater	**35,029**	**2.5**	**100.00**

Source: Dawei Han (2010), Concise Hydrology; Tim Davie (2002), Fundamentals of Hydrology

2. Importance and Utilization of Water

Knowledge of hydrology is basis for the development of water supply systems. Salinity problems in agriculture also evidence of the lack of hydrologic principles of water management; locations of costly developments in flood plains of large river systems. Better understanding of hydrology, can help determine how and to what extent the cycle can be modified by human activity in practical way. For example large-scale irrigation systems increase soil water content, evaporation, and crop use of water. A practical knowledge of hydrology will help the decision-maker and general public understand the overall effect of human's influences on the hydrologic cycle and the side effects of projects on other people, their activities and the environment. Thus, informed decision-maker will be able to weigh the advantages of each proposed change in the hydrologic cycle against the disadvantages.

- Water is essential for life. The use of water by man, plants, and animals is universal. Without water can be no life.
- Man can live nearly two months without food, but can live only three or four days without water. Man himself is 80 percent water.
- Water is essential for the maintenance and improvement of health and sanitation of the community.
- Water is a principal raw material for food production and metabolic processes.
- Water provides man with some means of recreation, such as boating, hunting, swimming and fishing.
- Water protects life and property against fire.
- Water is employed in various industrial processes, power generation and also for navigation and transportation of goods and people.
- Water plays an important role in balancing the ecological system - the relationship between living things and the environment in which they live.

Water conservation and sanitation are important. The use of water is rapidly increasing due to growing population and urbanization. Shortage of both surface and groundwater is some areas in the country. Illegal and unregulated construction of deep wells also contributed in land sinking, consequently caused the lowering of water table. The lowering of fresh water (lakes, rivers) levels cause salt intrusion or salt water in the some coastal areas which ruined wells. In addition, uncontrolled pollution and contamination of the river systems and underground sources have greatly impaired the water quality. Thus, depletion of water supply is inevitable which requires better means of replenishing its supply to meet the increasing demand.

Major Purposes/Uses of Water

- Domestic/residential: for household needs such as drinking, food preparation, bathing, washing clothes and dishes, flushing of toilets, watering of plants (gardens and lawns).
- Commercial: for hotels/motels, restaurants, office buildings, other commercial facilities and institutions.
- Irrigation: artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf courses.
- Industrial: for industrial purposes such as fabrication, processing, washing, and cooling.
- Livestock: for livestock watering, feed lots, dairy operations, fish farming, and other on-farm feeds.
- Mining: for extraction of minerals occurring naturally and associated with quarrying, well operation, milling, and other preparations at the mine site.
- Public: for the public purposes such as firefighting, street washing, municipal/town parks, and swimming pools.
- Rural: for suburban or farm areas for domestic and livestock needs and this is generally self-supplied type.
- Thermoelectric power: for the process of the generation of power.

Classification of fresh surface water (rivers, lakes, reservoirs)

Classification	Beneficial Use
Class AA	Public water supply class I. This class is intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines
Class A	Public Water Supply Class II. For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration, and disinfection) in order to meet the NSDW.
Class B	Recreational Water Class. For primary contact recreation such as bathing, swimming, ski diving, etc. (particularly those designated for tourism purposes).
Class C	(1) Fishery Water for the propagation and growth of fish and other aquatic resources; (2) Recreational Water Class II (boating, etc.); and (3) Industrial Water Supply Class I (for manufacturing processes after treatment).
CLASS D	Navigable waters

Sources of Water

a. Rain or Atmospheric water – this is the most common form of precipitation
b. Surface water – a mixture of surface runoff and groundwater such as rivers, streams, ponds, lakes, seas, oceans, impounding reservoirs
c. Groundwater – a portion of rainwater which percolated into the earth to form underground deposits called aquifers. Examples are springs, wells, and infiltration galleries

Properties of Water

a. Physical properties – turbidity, color, odor, taste
b. Chemical properties – hardness, alkalinity and acidity (pH), carbon dioxide, dissolved oxygen, chemical oxygen demand, iron and manganese, toxic substances phenolic compounds
c. Bacteriological characteristics – pathogens, coliform (fecal) organisms or bacteria, E-coli

Relevant Laws and Regulations

a. Commonwealth Act #383 – punishment in dumping into rivers of refuse waste matter or substances
b. Republic Act #3931 – Creation of the National Water and Air Pollution Control Commission
c. Presidential Decree #1067 – Instituting the water code governing ownership, appropriation, utilization, exploitation development, conservation and protection of water resources
d. DENR Administrative Order #34 – Revised water usage and classification/water quality criteria
e. DENR Administrative Order #35 – Revised effluent regulations, which provides effluent standards for toxic and other deleterious substances and other pollutants in the various categories of protected waters.
f. Republic Act 9275 – Philippine Clean Water Act of 2004 which provides mechanisms for the sustainable use, protection and preservation of the water resources in the country.
g. Presidential Decree 856 – Code of Sanitation of the Philippines, Chapter II- Water Supply
h. Presidential Decree 522 – Implementing rules and regulation for the water supply provisions covering standards and their bacteriological and chemical examinations, including the evaluation of results
i. Department of Health (DOH) Administrative Order #447-F of 1991 – Updated of the 1978 National Standards for Drinking Water.
j. DOH Administrative Order #31 – Requirements for the accreditation of water analysis laboratories.

k. DOH Administrative Order #18-A – Standards of quality and requirements for the processing, packaging, and labeling of bottled drinking water.
l. DOH Administrative Order #2007-0012 – Philippine National Standards for Drinking Water 2007
m. DOH Administrative Order #26-A – Philippine National Standards for Drinking Water 1993

3. SUGGESTED READING RESOURCES:

1 Vesilind P.A, Morgan, S.M., and Heine, L.G. (2013). *Introduction to Environmental Engineering*, 1st Philippine reprint, Singapore: Cengage Learning Asia Pte Ltd.
2 Mihelcic, J.R. and Zimmerman, J.B. (2010). *Environmental Engineering Fundamentals, Sustainability, Design*, Singapore: John Wiley & Sons Singapore Pte, Ltd.
3 Davis, M. L. And Masten, S.J. (2004). *Principles of Environmental Engineering and Science*, International Edition, New York: McGraw-Hill Education (Asia), New York.
4 Henry, J.G. and Heinke, G.W. (2000). *Environmental Science and Engineering*, Singapore: Pearson Education Asia Pte., Ltd.,Singapore.
5 Speight, J.G. and Lee S. (2000). *Environmental Technology Handbook*, 2nd Edition, USA: Taylor & Francis, USA.