



***“Investing in Africa’s future”***

**COLLEGE OF HEALTH, AGRICULTURE & NATURAL SCIENCES**

**NANE 403: MANAGEMENT OF DRAINAGE BASINS AND WATER RESOURCES**

**FIRST SEMESTER FINAL EXAMINATIONS SESSION**

**NOVEMBER 2021**

**LECTURER: MR. W. ZENDERA**

**DURATION: 5 HRS**

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**INSTRUCTIONS**

- 1) Answer ANY ONE question.
- 2) ALL questions carry 100 marks
- 3) Clearly show all your calculations.

## NANE 403: MANAGEMENT OF DRAINAGE BASINS AND WATER RESOURCES

### Question 1

- a) A lake has an area of  $10 \text{ km}^2$ . During a specific month the lake evaporation was 90 mm. During the same month the inflow to the lake from a river was on average  $1.2 \text{ m}^3/\text{s}$  and the outflow from the lake via another river was on average  $1.1 \text{ m}^3/\text{s}$ . Also, for the same month a water level increase of 100 mm for the lake was observed.
- Calculate the precipitation in mm during that month. [5 marks]
  - State any assumptions you made in solving a). [3 marks]
  - The concentration of phosphorus in inflow river water was  $1.0 \text{ mg/L}$  and outflow river water  $0.8 \text{ mg/L}$  during the month. What was the change of stored phosphorus (kg) in the lake during the month? [5 marks]
- b) The diagram in figure 1 shows part of a basin drainage system

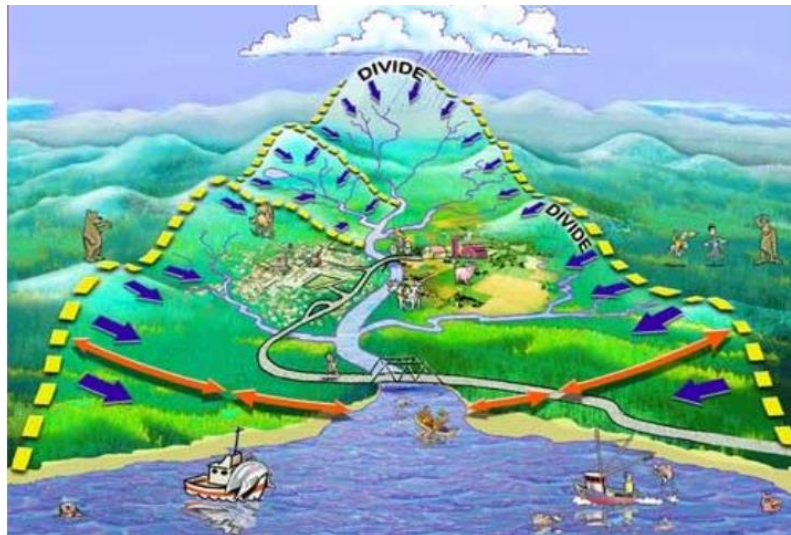


Figure 1: Basin drainage system

- Understanding the upstream and downstream linkages in hydrological processes is essential for water resource planning. Explain how human activities can influence the downstream and upstream hydrological processes. [20 marks]

- ii. Explain the likely possible causes of conflict emanating from a river basin. [7 marks]
- iii. Suggest the key elements of a well-functioning river basin management system. [10 marks]

c) **Case study: *Environmental Flows: Managing Water Allocation and Trade-Offs in the Water-Food-Energy Nexus***

An environmental flow is the water provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated. 'Environmental flows' is a tool for allocating water among multiple, competing uses in a watershed or river basin and building consensus on allocation decisions. Adoption and implementation requires that environmental flows are incorporated into water policies and laws. These should include the need for a negotiated consensus on flow allocation among all stakeholders. Environmental flows provide the means for integrated management of river flows to meet the needs of people, agriculture, industry, energy and ecosystems within the limits of available supply and under a changing climate. Environmental flows is thus a practical tool for managing allocation in the water-food-energy nexus.

- i. As the catchment manager tasked with implementing environmental flow recommendations in a catchment, present with sufficient detail the distinct features likely to lead to a successful implementation. [10 marks]
  - ii. Discuss the current and future challenges likely to hinder the implementation of environmental flows. [20 marks]
- d) Discuss the institutions, policies and regulations that govern water resource management in Zimbabwe. [20 marks]

## Question 2

- a) During a certain month a lake received an average inflow of  $6.0 \text{ m}^3/\text{sec}$  from the surface runoff sources. In the same period the outflow from the lake had an average value of  $6.50 \text{ m}^3/\text{sec}$ . Further in that month, the lake received a rainfall of 145 mm and the evaporation of the lake surface was estimated as 61 mm. The surface area of the lake is 5 000 ha.
- Write the water budget equation for the lake. [2 marks]
  - Calculate the change in water depth of the lake at the end of the month and state if the level increased or decreased. [8 marks]

Assume that there is no contribution to and from ground water storage.

- b) **The evolution and adoption of integrated water resource management (IWRM) in Ghana.** (*Extracted from: Agyenim B.J. and Gupta J., (2012): IWRM and Developing Countries: Implementation Challenges in Ghana. Physics and Chemistry of The Earth 47-48:46-57*)

The development of water management regimes has evolved over the years from pre-colonial times to the present attempt at IWRM. In pre-colonial times, comprehensive customary local approaches with taboos and prohibitions backed by sanctioning systems played a key role. Customary laws and practices covered water conservation, pollution control, protection of catchments and protection of fisheries. For example, there were rules that prohibited (a) people from farming close to river banks which were considered the abode of river gods and (b) human activities in certain sacred forest and groves. Water in all its forms was regarded in pre-colonial Ghana as common property not subject to an individual claim or ownership under customary law (Sarpong, 2008). Thus, private ownership of water resources was not allowed; hence an individual use or appropriation of water could not translate into ownership. The individual had only usufructuary rights to water. Water was a free common good - everyone was entitled to its use as a community good.

In colonial times, national sectoral policy was developed. The government deemed it appropriate to exercise control over water use in the public interest. Hence, a different water regime was introduced - written/ codified laws although the un-codified customary did not cease to operate (Sarpong, 2008). Thus, from the early 1900s Ghana began to experience a plural legislative framework for water management. However,

the colonial water laws and the customary law were applied to different instances dictated by statutory norms in response to socio-economic and political changes.

In the post-colonial period, national sectoral policy approaches continued; however, there was no single ministry or department responsible for water management and various ministries and commissions managed and protected water resources as they related to their operation and interests. The fragmentation in the water sector gave rise to discrete institutions, which emerged to promote sub-sector development in isolation. There was therefore no single coherent home for the water sector, neither was there one ministry responsible for water in Ghana.

- i. Discuss the weaknesses of the water management policies and practices during the pre-colonial and colonial periods in Ghana. [10 marks]
- ii. “The fragmentation in the water sector gave rise to discrete institutions, which emerged to promote sub-sector development in isolation” Discuss the challenges likely to emanate from this system. [10 marks]
- iii. As a manager for a catchment basin in a Ghanaian catchment area present six key issues you are likely to consider in order to ensure a successful implementation of IWRM. [30 marks]
- iv. Discuss the reasons for the need for planning and management of water resources. [20 marks]
- c) Discuss the merits and demerits of relying on ground water as a water source. [10 marks]
- d) Explain the need for stakeholder participation in a successful Integrated Water Resource Management. [20 marks]

### Question 3

- a) A catchment has a size of 100 km<sup>2</sup>. In its original condition, the average annual total runoff from the catchment is 1.1 m<sup>3</sup>/s. The average annual rainfall is 800 mm/year. In an average year, 50 % of the rainfall infiltrates and 12.5 % of the rainfall reaches the groundwater. Tests have turned out that the average annual evapotranspiration from the unsaturated zone (being the sum of the transpiration and bare soil evaporation) amounts to 340 mm/year. Assuming that storage effects are small. Compute the water in mm/year which:
- i. Reaches the root zone through the capillary rise in an average year. [5 marks]
  - ii. Seeps out from the groundwater to the surface water. [5 marks]
  - iii. Evaporated directly from interception. [5 marks]
  - iv. Evapotranspires in the catchment. [5 marks]

**b) Nabutola, W. (2010). The Mau Forest: Kenya's largest water tower: a perfect model for a sustainable development project? *Climate Change and Environmental Threats*.**

Mau forest is Kenya's largest water tower - it stores rain during the wet seasons and pumps it out during the dry months. It used to cover 400 thousand hectares, but 100 thousand of these have been expropriated. The Mau Forest Task Force identified the period between 1996 and 2005 as the worst decade for the forest cover in the country. But during the past 15 years, more than 100,000 hectares - one quarter of the protected forest reserve - have been settled and cleared. Tearing out the trees at the heart of Kenya has triggered a cascade of drought and despair in the surrounding hills and valleys.

"The plunder of Kenya's forests has continued over the years despite pleas to conserve them because of mismanagement, irresponsible and corrupt behaviour of politicians and government officials. This destruction has manifested itself in the form of deforestation, the shamba system, human settlements, cultivation, charcoal production and grazing. In addition to the Mau forests complex, all the

other four water towers namely; Mt Kenya, Aberdare Ranges, Mt Elgon, and Cherengani Hills have receded alarmingly.” *Nobel Laureate Prof Wangari Maathai. Sept 2009*

- i. Highlight some of the human activities mentioned above that has led to the destruction of Mau Forest in Kenya. [5 marks]
  - ii. In an effort to defend his constituency an MP who quoted saying that “rain does not come from forests, but from the skies” Give an explanation of the likely effects of this belief. [10 marks]
  - iii. State the five ecological services provided by the Mau Forest complex. [5 marks]
  - iv. State four economic sectors likely to be affecting by the destruction of the Mau Forest complex. [5 marks]
  - v. Should the government resettle people staying in the Mau Forest or resettle the affected downstream? Discuss. [15 marks]
- c) Giving examples, explain the significant function of wetlands. [20 marks]
- d) Explain the Technical, Institutional, Economic and financial aspects of water resources planning and management [20 marks]