UNAM
UNIVERSITY OF NAMIBIA

FACULTY	**AGRICULTURE, ENGINEERING AND NATURAL SCIENCES**		
DEPARTMENT	**ENVIRONMENTAL SCIENCE**		
SUBJECT	**SPATIAL STATISTICS**		
SUBJECT CODE	**GGS3611**		
DATE	**May/June 2022**		
DURATION	**3 HOURS**	**MARKS**	**100**

SPECIAL/SUPLEMENTARY EXAMINATION

Examiner: **E Hamunyela (PhD)**
External Moderator: **Prof. T. Dube, University of the Western Cape**

INSTRUCTIONS

1. Work in an orderly manner and present your work as neatly as possible.
2. While most of the marks will be awarded for content, candidates must bear in mind the importance of presentation, i.e. insight and critical thinking.
3. Number your questions correctly and clearly.
4. This paper consists of two (2) pages (excluding this front page).
5. Answer all questions in Sections A, B and C .

SECTION A: Total marks: 15

1. **Define** the following terms
   (a) Complete spatial randomness [3]
   (b) Inhomogeneous spatial poisson process [3]
   (c) Spatial intensity [3]
   (d) Spatial interpolation [3]
   (e) Spatial autocorrelation [3]

SECTION B: Total marks: 42

1. Suppose a crop farmer requested Maria to analyse spatial distribution of soil nitrogen content in his 10 000 ha farm. Maria collected and analysed nitrogen content at 8 samples as shown in Table 1, which she then gave to the farmer as a final product.
   (a) Calculate the **spatial mean** for soil nitrogen in the farm. Show all your work [4]
   (b) Suppose Maria did not use a systematic or random sampling approach in selecting the sampling locations in the farm. **Critique** her approach. [8]
   (c) If you were the crop farmer, **critique** the final product provided to you by Maria. [8]

Table 1: The x-and-y coordinates and soil nitrogen measured at each sample point in the crop farm by Maria

Sample	X	Y	Nitrogen (mg/kg)
A	17.5	22.5	50
B	17.8	22.1	70
C	18.2	22.3	65
D	17.3	22.6	79
E	17.6	22.2	89
F	16.9	22.3	125
G	17.4	22.4	130
8	17.5	22.2	28

   (d) Suppose the crop farmer realised that there was a specific location, **W**, that he really wanted to know the nitrogen content but Maria did not measure nitrogen at such location. Table 2 shows the distance in meters between location **W** and the sample locations collected by Maria. Suppose Maria decided to use inverse weighted distance approach to estimate soil nitrogen content at location **W.**
      i. **Rank** the samples in Table 2 from highest to lowest in terms of their contribution to the estimate of nitrogen at location **W.** [5]
      ii. **Justify** your ranking of the samples [5]
      iii. Use inverse weighted distance approach to estimate nitrogen content at location **W. Show** all your calculation. [12]

Table 2: Distance between sample points and location **W**

Sample	Distance from **W** (in meters)
A	33
B	160
C	200
D	29
E	45
F	127
G	7
H	14

SECTION C: **Total marks: 43**

1. Differentiate between the following terms
   (a) Isotropy and anisotropy **[4]**
   (b) Semivariance and semivariogram **[4]**
   (c) Nugget and sill **[4]**

2. What are the **major differences** between inverse weighted distance interpolation and ordinary kriging?
   [4]

3. Table 3 below shows the distance (in meters) between the pairs of sample locations where Maria measured the soil nitrogen in the crop farmer. Note, these are the same sample points as presented in Table 1 under Section B. For example, the distance between A sample point and B sample point is 14 meters.

   (a) **Compute** the semivariance of the soil nitrogen for each pair of points. **[8]**
   (b) Using distance interval of 25 meters, **create** distance bins and **calculate** average semivariance at each bin. **[8]**
   (c) **Create** a semivariogram after binning by distance. **[6]**
   (d) **Intepret** your semivariogram in the context of spatial dependence. **[5]**

Table 3: Distances (in meters) between the pairs of sample locations where Maria measured soil nitrogen in the crop farm

	A	B	C	D	E	F	G	H
A	0	14	25	21	6	50	136	68
B		0	45	25	125	85	56	25
C			0	43	127	21	57	54
D				0	52	34	50	43
E					0	56	125	35
F						0	65	83
G							0	68
H								0

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