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An investigation of sediments grain size in the coastal area of Nour

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Abstract

Nowadays, marine studies and researches are considered inevitable for various purposes such as economic, security, political, military, and environment. An all-encompassing and comprehensive view of the field of marine studies is obvious, and it goes without saying that conducting such studies will result in significant achievements and results. In this research, the amount of marine sediments in the eastern part of the city of Nour, Mazandaran Province, and their different types were sampled and studied through sea expeditions in six turns throughout a year. Sampling stations were selected at a distance of four kilometers and an approximate width of 230m. Study area selection was based on the history of research and the existence of ports in the past. To study the sediments of the seabed zone of the research area, three stations were selected. Sediments were sampled in three stations, with a distance of two kilometers from each other, and twelve sections at a distance of 20m from each other (with the exception of the first section, located at a distance of 10m from the coastline). The amount of sediments and their types were determined in the research area during the intervals of every two months over a year and in the laboratory by screeners and vibrators. The results indicated that the predominant sediment types of the seabed in the area are respectively very fine sand with an average of 90.594%, coarse sand (3.701%), medium sand (2.871%), medium gravel (2.256%), and mud (0.582%).

Keywords: Sea sediments; Sediments type; Sediments grain size; Nour Coasts; Caspian Sea.

1. Introduction

Nowadays, marine studies and investigations are considered inevitable for various purposes such as economic, security, political, military, and environmental. All-encompassing and comprehensive view of the field of marine studies is obvious, and it goes without saying that conducting such studies will result in significant achievements and results (Al-

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Ramazan *et al*., 2001; Sohrabi, 2005). Some of these achievements are the quantitative and qualitative improvement of technical knowledge, methods and technologies, modeling and presentation of research patterns, the benefits of water and underwater reservoirs, all of which will have tangible and intangible effects on everyday life (Shafieefar and Taghizadeh, 2000; Pourmand, 2001; Haj Babaei, 2003). The optimal use of major marine resources, in addition to its economic advantages, is also important from the point of view of military and defense issues (Banazadeh Mahanie *et al*., 2005).

Sedimentary particles have very diverse sizes. The particles are classified based on their highest diameter, which was presented for the first time by Udden and Wentworth. Udden-Wentworth scale is a logarithmic scale in which the limit of every degree is twice as large as the limit of the next smaller degree (Karami Khaniki and Chaychi-Tehrani, 2005). There is a logarithmic scale stemming from the mentioned scale conversion for the segmentation of the particles diameter which is calledφ.

$$\phi = -\log_2(D) \quad (1)$$

$$D = 2^{-\phi} \quad (2)$$

1.1. Methods for measuring the particles diameter

Granometry or particle diameter measurement is the density measurement of the particles in different diameters. The measurement methods are different for the particles with different diameters (Maleki Tabrizi, 2005; Vassel Ali, 2006). The accuracy of the operation is inversely related to the particle, diameter so that the smaller the particles, the more accurate the measurement will be.

1.2. Measuring the coarse particles diameter

The diameter of coarse particles (gravel) can be directly measured by special tools such as caliper (Yari and Taj Firooz, 2000). There is another way to measure the particles diameter in the plain, shooting the samples, but the problem with this method is that the second dimension is not clear and the actual volume of the particles cannot be calculated.

1.3. Measuring the sand-sized particles diameter

1.3.1 Sifting method

The particles diameter is obtained in different ways. The most common method is screening the samples. In this method, at first the sample is weighted and then the excess material is washed and after re-weighing, the sample is dried in an oven at 40 °C. Then some of the sediments are weighted and placed on the highest sieve. The sieves are placed on each other in a way that the smaller pores are at the bottom (Herbich, 2000).

The sieves are shaken for 15 minutes by a machine. After the machine has stopped, the amount of the remaining sediments is accurately weighed in each sieve. In this method, each sieve has a certain diameter and the particles remained at the surface of each sieve have a larger diameter than the sieve, but they have a smaller diameter than the upper sieve. Thus, the particles diameter is calculated in this way.

1.3.2 Microscopic sections

This method uses microscopic sections to measure the particles. The measurements obtained in this method are not useful for statistical calculations, because, crossing the stone in different directions creates different sizes.

1.3.3 Measuring the silt and clay-sized particles diameter

Granulated particles such as silt and clay are measured by pipette and hydrometers. Because the small particles of clay and silt are very sticky, sieving cannot be used for granulation of these particles. To measure the diameter of these particles, first it is necessary to dissolve their organic matters by dilute chloride-acid and remove them from the environment. To reduce the amount of adhesion between the particles, suspending materials are added to the mixture of water and sediment. Then, the particle size is calculated based on the velocity of a particle falling in the fluid (using the Stokes's Law).

The force of viscosity (Stokes's Law) :

Stokes's law is based on the effect of concentration on the fall of particles in the water, which is the method for calculating the fine particle size. When the particle is deposited at a constant velocity, this speed is called the velocity of fall. In this case, the resistance force introduced by the water onto the particle preventing its precipitation is equal to the gravity force acting in the opposite direction. Therefore, the particle starts falling from its initial speed with a constant speed. The particle diameter can be calculated according to this law and the velocity of falling particles. In fact, the velocity of a falling particle depends on the diameter of the particle, its density, and the density of the liquid. The larger the diameter of the particle and the higher its density is, the faster it will fall.

1.4. Nomination of sediments based on the particles sizes

In 1954, Folke presented two triangular diagrams for nominating sediments based on the size of the constituent particles and sedimentary rocks. The first triangle is used to designate coarse-particle sediments, constituted of gravel (particles larger than 2 mm), sand (particles between 0.0625 to 2 mm) and mud (particles smaller than 0.0625 mm). In this triangle, according to the frequency ratio of the particles mentioned in the sediments, 15 main tissue groups have been identified. The name of the deposit in this triangle is determined by two factors: the amount of gravel in the sediment, and the sand-to-mud ratio.

To nominate the finer particle sediments that lack any gravel, another triangle is used constituted of sand, silt, and clay. There are ten ranges in this triangle based on different proportions of sand, clay and silt. And each of these ranges belongs to the sediment with a certain ratio of these particles. For example, if 90% of the particles are composed of sand, the sediment is called sand, or if the sediment contains 50% sand, 16%, silt and 32% clay, it is called clay-sand.

1.5. Investigation of particles size

Investigation of the sediments distribution is of high importance for comparing different samples, because the various properties of the sediments and the factors affecting their formation can be found out. The sediment particles are mostly transported and driven by air and gradually precipitate by decreasing the air flow (Soulsby, 1997; Coastal Engineering Manual, 2002). The size of the particles in the sediments actually represents the energy of the transportation. If a mass contains lots of sediments with large particles (gravel), this frequency can indicate the maximum flow velocity during sedimentation (Soulsby and Demgaard, 2005).

Moreover, the distance traveled by these sediments is short since if the transport distance increases, the energy factor decreases and the coarser particles deposit, and these coarse particles are broken and crumbled due to collisions with each other or with the sea bottom. Actually, by specifying the amount of gravel, sand and mud particles, we can interpret and analyze the energy of the environment. A series of statistical terms are used to better understand the distribution of the particles in sediments.

Statistically analysis and particles study is done through several methods one of which is drawing the curve and doing the calculations in a graphical method. The curves drawn for this purpose are histograms as well as normal and aggregate distributions, in each of which, the x-axis represents the particle size and the y-axis represents the percentage of sediment frequency.

2. Materials and methods

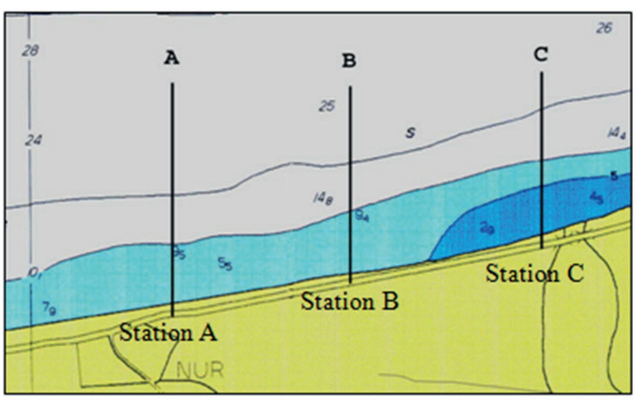
The study stations were selected through a marine region located at the east of the city of Nour, Mazandaran Province (Alizadeh, 2001), with a length of four kilometers and a width of approximately 220m. The area selection is based on the history of research and the existence of ports in the past.

2.1. Location of the measuring stations

According to the research area (Figure1), the geographic location of the selected stations adjacent to the coast is as follows. The geographical location of the stations was determined by the GPS.

2.2. Selection of stations for sampling

Sediment sampling was carried out in three stations at a distance of two kilometers from each other, and three sections (in three different depths) at each station at a distance of 10, 110 and 210 meters from the coastline (Figure 2), and sampling was done in the research area at



Station A	36° 34' 58" N 52° 01' 18" E
Station B	36° 35' 08" N 52° 02' 40" E
Station C	36° 35' 21" N 52° 04' 02" E

Figure 1. The location of the stations in the research area coasts

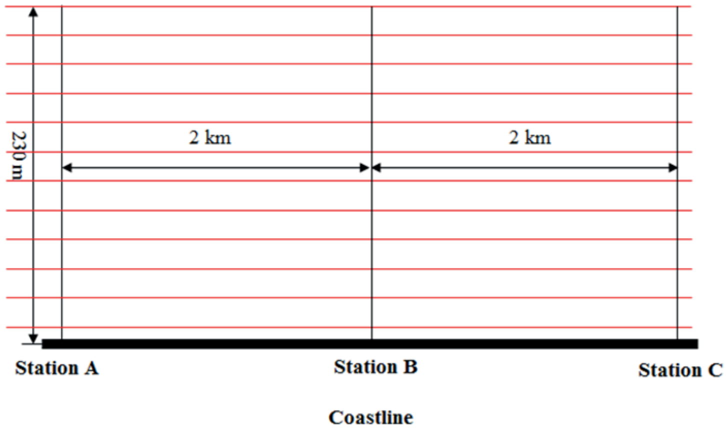


Figure 2. A scheme of the stations and the longitudinal and transverse distances of the research area

Figure 3. Sediment sampler

Table 1. Times of sampling and measurements over a year

Turn	1	2	3	4	5	6
Time	June 2006	August 2006	October 2006	December 2006	February 2007	April 2007

intervals of two months over a year (Table 1), by sediment sampler (Figure 3). The sediment samples were transmitted to the soil laboratory of the Faculty of Natural Resources and Marine Sciences of Tarbiat Modares University to determine the type and size of the particles. It should be noted that sampling was carried out in appropriate weather and sea conditions, and mostly at an average wave height of less than 25 centimeters.

2.3. Seabed sediments type and percentage

To determine the type and percentage of the seabed sediments from a sample, some of the sea bed sediment should be put into a 500 or 1000cc cylindrical container and some amount of hydrogen peroxide should be added to it to eliminate the organic material. Then, the container should be placed inside an oven at 70

Figure 4. Oven

Figure 5. A sample sieve

Figure 6. The sieve shaker

° C for 48 hours to be dried up (Figure 4). Next, the precipitate should be weighed and put inside the sieves (Figure 5) with the mesh numbers of 18-30-35-230-400, which respectively represent the sediments sizes from medium gravel to coarse sand, medium sand, very fine sand, and mud. Next, the sieves should be placed on one another from top to the bottom over the shaker for 15 minutes (Figure 6). After that, the sieves should be removed from the shaker and the residual sediments in each sieve should be weighed to finally determine the sediments type and percentage.

3. Results and Discussion

In order to determine the type and amount of sediment of the seabed in the research area, after conducting the sampling in the sea and measurements in the laboratory and calculating the percentage of each type of sediment, the following results have been obtained:

Table 2. The average of different types of sea-bed sediments in Station A at different sampling times

	1	2	3	4	5	6
Medium gravel	0.602	2.884	5.233	0.848	0.420	6.534
Coarse sand	1.994	4.847	7.280	0.955	0.674	10.237
Medium sand	1.984	6.023	6.617	0.627	0.412	3.923
Very fine sand	95.598	86.205	80.766	96.463	97.287	79.436
Mud	0.266	0.228	0.104	0.671	1.027	0.037

Table 3. The average of different types of sea-bed sediments in Station B at different sampling times

	1	2	3	4	5	6
Medium gravel	1.562	1.417	2.113	0.861	0.612	2.400
Coarse sand	2.823	3.370	2.567	0.359	0.514	7.607
Medium sand	2.026	2.190	3.587	0.319	0.313	7.707
Very fine sand	92.940	91.631	89.452	97.788	97.795	83.203
Mud	0.829	1.575	2.281	0.586	0.433	0.083

Table 4. The average of different types of sea-bed sediments in Station C at different sampling times

	1	2	3	4	5	6
Medium gravel	1.953	3.349	5.090	0.776	0.855	3.098
Coarse sand	2.872	6.032	8.570	0.421	0.471	5.024
Medium sand	2.017	4.646	4.999	0.721	0.394	3.345
Very fine sand	92.739	85.982	81.198	97.933	97.758	88.314
Mud	0.510	0.115	0.350	0.650	0.511	0.219

According to the Tables 2 to 4, the minimum and maximum amounts of the different types of seabed sediments in the sampling stations are as follows (Table 5):

Station A & Station B

A) The highest amounts of medium gravel and coarse sand are in spring and their lowest amounts are in winter.

B) The highest amount of medium sand is in fall and its lowest amount is in winter.

C) The highest amounts of very fine sand and mud are in winter and their lowest amounts are in spring.

Station C

A) The highest amounts of medium gravel, coarse sand, and medium sand are in late summer and their lowest amounts are in winter.

B) The highest amount of very fine sand is in winter and its lowest amount is in fall.

C) The highest amount of mud was in winter and its lowest was in summer.

The annual mean of the amount of seabed sediments determined in the research area and is presented in Table 6.

According to Table 6, the dominant sediments of the seabed in the research area are respectively very fine sand, coarse sand, medium sand, medium gravel, and mud with the highest rates. The dominant sediment variations in the seabed

Table 5. The minimum and maximum annual mean values of the sea-bed sediments

	Minimum	Maximum
Medium gravel	Station B (1.494%)	Station A (2.754%)
Coarse sand	Station B (2.873%)	Station A (4.331%)
Medium sand	Station C (2.687%)	Station A (3.264%)
Very fine sand	Station A (89.293%)	Station B (92.135%)
Mud	Station A (0.389%)	Station B (0.965%)

Table 6. Annual mean of the amount of seabed sediments in the research area

Sediment type	Medium gravel	Coarse sand	Medium sand	Very fine sand	Mud
Percentage	2.256	3.701	2.871	90.594	0.582

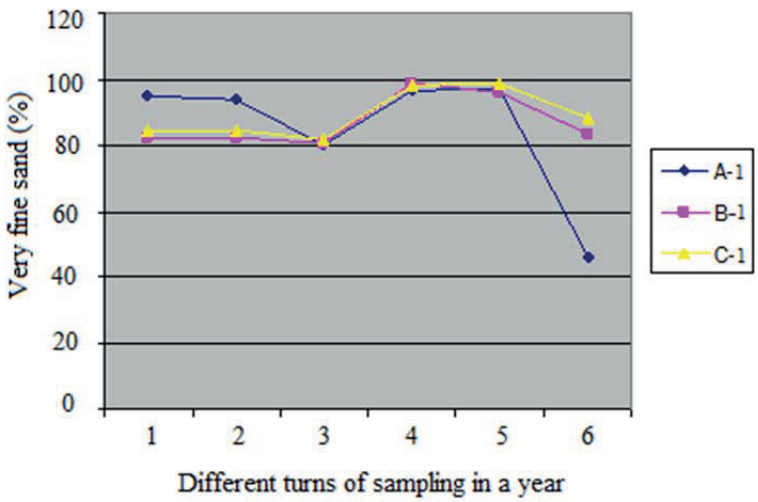


Figure 7. The percentage of very fine sand in the first section of the three stations in the research area during the study period

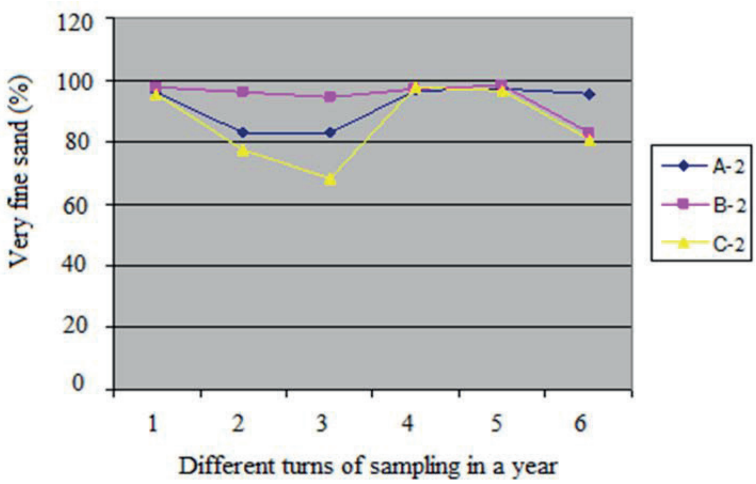


Figure 8. The percentage of very fine sand in the second section of the three stations in the research area during the study period

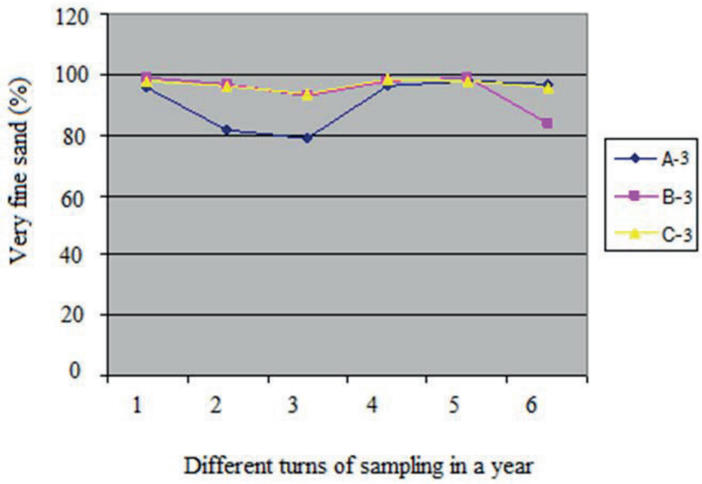


Figure 9. The percentage of very fine sand in the third section of the three stations in the research area during the study period

at the joint sections of the research area stations are shown in Figures 7 to 9.

According to the objective observations of the waves (Mansouri and Torabi Azad, 2004), the breaking of the waves can be achieved near the coasts of the research area through the identification of the sediments types. The sandy sediments of the seabed indicate a mild slope of the surf zone, confirming the turbulent breaking of the waves in this region due to the depth of the area and its mild slope.

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