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# Mechanical Analysis of Khair Abad Village, Surskhrud District, Nangarhar Province, Afghanistan

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**ABSTRACT**

The article results of studies on the physiochemical properties of nine samples in Khair Abad, Nangarhar, Afghanistan. In this research, we collected dissimilar samples from each profile and transported them to the research laboratory. The main objective of this study is to select physiochemical limitations in diverse places of Khair Abad, Nangrahar for the earlier geological periods. This inquiry is therefore essential, because of no or scares previous studies, in these areas. From the analysis, we found the soil type is loam, silty loam and the pH of the soil is basic and in some places near to acidic. The amount of $CaCO_3$, EC, and pH parameters are dissimilar according to the locations, and the amount of EC and pH are normal at all points, as well as we can find organic materials in different amounts. The results obtained suggest that the soil parameters can be used efficiently for the application of soil parameters catchment of the Kabul basin and other basins in Afghanistan.

## 1. Introduction

Afghanistan is one of the countries that is located in the central part of Asia, the Area is 652000 km$^2$ (Banks et al., 2002). It has 34 provinces every province has special geological characteristics. The climate of Afghanistan is arid and simi-aride, as well as it is a mountainous country, in the central and northern high mountains, but in the southern part, Farah, and Herat provinces of Afghanistan are plain areas and deserts (Bohannon, 2005). Afghanistan is a country dominated by a dry climate, with most of the area Characterized by the effect of global climate change on hydrological systems, especially on mountain snow and glacier melting, which can modify the timing and amount of in mountain watersheds. Therefore, accurate stream flow simulation and the forecast is of great importance to water resources management and Planning (Rasouli et al., 2020).

The key watercourses drain at the snow melting times (from January to May), rainy periods (March to April) and occasionally through quick overflowing terms (May to August), the main elevations of snow cover are Parwan maintains series, Wardak, Loger, Baba, Spingher, Salang, Kohkurugh, Koha Safi, Hindu Kush mountains ranges in Afghanistan (Rasouli, 2019), as well as here is the certain cold province, for example, Bamyan, Wardak, Loger, Badakhshan, Pangesher, Parwan, some parts of Kabul, in these snow cover from September to November and it is storing used for water in Afghanistan (Rasouli, 2020b).

Likewise, in the north sides of Afghanistan, there are specific glaciers Pamir Badakhshan, Mymai Badakhshan, and Panjsher mountains range belonging to the Hindu Kush mountains series in Afghanistan. Those are the main sources for Panjsher, Helmand, and Koner Rivers. In the particular province, we use rivers meant for irrigation and water supply (Drinking water), such as Bamyan, Panjsher, Wardak, Parwan, Helmand, and Kandahar, Kapesa, but in some sections of the specific province, for example, Wardak,

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Parwan, Panjsher spending from spring, and in several provinces for drinking and irrigation waters benefit from Kariz, and more other province using from a well (Rasouli, 2020b).

In these basins, all regolith and sediments are transported from different points of Loger, and Asmayey Mountains by sudden floods, and the Kabul River accumulated at different thicknesses in different locations of this basin. The Chelsaton Basin belongs to the Quaternary (Pleistocene) and Neogen geological periods, different sediments are deposited after one another and forms of morphology, which we can see at the different reliefs. Types of sediments in this basin directly belong to the kinds of rocks located in the surrounding mountains. In these sediments, we can see Garnete, Biotite, and Muscovite minerals particles. The surrounding mountains of this basin are formed from metamorphic rocks like Schist, Gneiss, and Slate it's called Crystalline (Rasouli et al., 2015).

Hydrogeological and geological studies are very important for these sedimentary basins, because all villages, health centers, and industries use groundwater from wells, Kariz, and springs. The Panjsher, Sanlang, Gurband, and Shetal Rivers are the main rivers that flow between these basins, and more groundwater recharge from the river bank and bed, especially in the snow-melting season. The aquifers of this sedimentary basin are located prolonging these rivers and their tributaries.

The aquifers are between different sizes of sediments (sands and gravel). The hydrogeology of Jalalabad Sedimentary Basins belongs to the different aquifers that are located in prolonged mountain ranges in the longitudinal valleys. The thickness and depth of aquifers are related to the slope and distance from the mountain range, generally, near mountain and slope areas there are gravels and angular materials but far from mountains are rounded and fine materials like bolder, cobbles, pebbles, granules, sands and silts.

Generally, for drinking, the water of shallow and deep wells benefited. More to the point, in some areas spring water originates from the fracture zones where pipe scam for gravity pumping systems and distributed install and benefited from the water in villages (Rasouli et al., 2021).

The Grade acidic belongs to the pH of the soil, and the formation of acids belongs to the chemical characteristics of soils. Also, related to the elements and components that are located at the air and after rains washing the air and infiltrating the soil. Activities of some animals and different plants also will be acidification of soils. In addition, the mutual effect of biochemical, solution particles of rocks and minerals that are located between soils and its absorption by colloids done some reactions of Cation Exchange Capacity and basic exchange capacity in some parts of soils mass.

The groundwater moves from aquifer layers at different speeds and washes soluble materials from different layers. Some soluble load from parent materials produced different elements and components. Industrial activities, for example, burning coal and oil in the predictable materials factory, vehicles, and permanent melting of plastics and metals result in a greater number of different gases going to the atmosphere with different types of precipitations again come down to the earth's surface and product different toxic elements between soils. For many years wars we can't do much research work and one of this research is soil, air, and water pollution (Rasouli, 2022a).

The basins can be described as valley-fill basins, which are filled with Quaternary and Tertiary sediments, gravels, and sedimentary rocks. Quaternary sediments are typically less than 80 m thick in the valleys. The underlying Tertiary sediments have been estimated to be as much as 1000 m thick in the valley Center. The gravel and sand were deposited mainly in the river channels. Describe the Lataband Formation as Quaternary terrace sediments younger Pleistocene age overlying conglomerates. The surrounding mountains are primarily composed of Paleoproterozoic gneiss and Late Permian through Late Triassic sedimentary rocks.

The inter-basin ridges, composed of metamorphic complex rocks, are Paleoproterozoic gneiss. The Khengal and basement rocks are overthrust by schist mélange, which has been called the Cottagay Series, in the northern Kohe Safi range. The sediments of the Khengal series started from the Jurassic and it is belonging to the Thythes Ocean in Afghanistan (Rasouli, 2022b).

Triassic clays and Paleozoic schist form the impermeable substratum of this aquifer. These carbonate formations burrow under the Mio-Plio-Quaternary cover in the basins, which forms a deep confined aquifer. The depth of the Miocene Marls forming the impermeable roof of this aquifer is about 1500 m in the contact with Prerif Ridges at the drilling point. The fracture rocks constitute the groundwater reservoirs. The main parameters for the migration of fluids in fractured rocks are the main geological characteristics of the fracturing, drainage, topography, and rainfall.

The hydrogeological context of different regional structures implies the existence of groundwater tables. E1 Hajeb–Ifrane Tabular is a free water table circulating in the Limestones and Dolomites. It is supplied directly by precipitation (Rasouli, 2022b).

## 2. Methods and Materials

In this research, we analyze the sample in two ways: one is field analysis and the second is laboratory analysis, it's consists of electro conductivity (EC), temperature, $CaCO_3$, and mechanical analysis of soil in Khair Abad Nangrahar.

### *2.1. Study Area*

Khair Abad village belongs to the Nangrahar Province and is one the agricultural villages. The soil type of this village is loam. The thickness of soil in this village belongs to the morphology and relief of area. In these places, the slope of area the thickness of soil is lower, but at those places the plain areas the thickness of soil is more. In those places the fare from mountains the sizes of sediments are smaller, but those places near to the slopes and at plain areas the sizes of sediments are bigger (Fig. 1).

### *2.2. Field Works*

The field works instruments that are used in this research were summarized in Table 1.

### *2.3. Sampling*

In this research we get the following procedure:

- The samples we get from those places, there are not any fertilizers or chemicals animal, as well as no ruminants of animals,
- From the bottom of the walls, we cannot get samples,
- In the time of sampling, we cannot use instruments that not having iron oxide, fertilizers, and not having any others diesis,
- As well as we must be having one sheet of paper for the notebook with samples,
- That places we get samples their not haves clay,
- Before we get a sample from one place the surface of the earth we must clean from surface materials and
- We cannot foot samples at the fertilizers used plastics.

### *2.4. The Types of Samples*

Generally, in soil science, we have four types of samples, and they consist of the following:

- Simple samples: every sample that we used generally it's called a simple sample,
- Complex samples: if we have several samples mixed it's called a complex sample,
- Undisturbed samples: when we get one sample in the natural condition it's called an undisturbed sample and
- Disturbed samples: when one sample changes the natural conditions, it's called a disturbed sample.

### *2.5. The Instruments*

The instruments we used in this research consist of:

- In this research, we used the instrument the shovel (spade) for gets samples and
- Cylinders for gets sample to the laboratory.

### *2.6. The Features of Samples*

This research for sampling consists of the following:

- Locations of Sampling,
- The depth of sampling,
- The types of usage from lands,
- The owner of the land and
- The person who gets the sample.

### *2.7. Laboratory Works*

When we get the sample from the field we transported it to the laboratory and out of plastic, we stay for 24 h in the free air to dry.

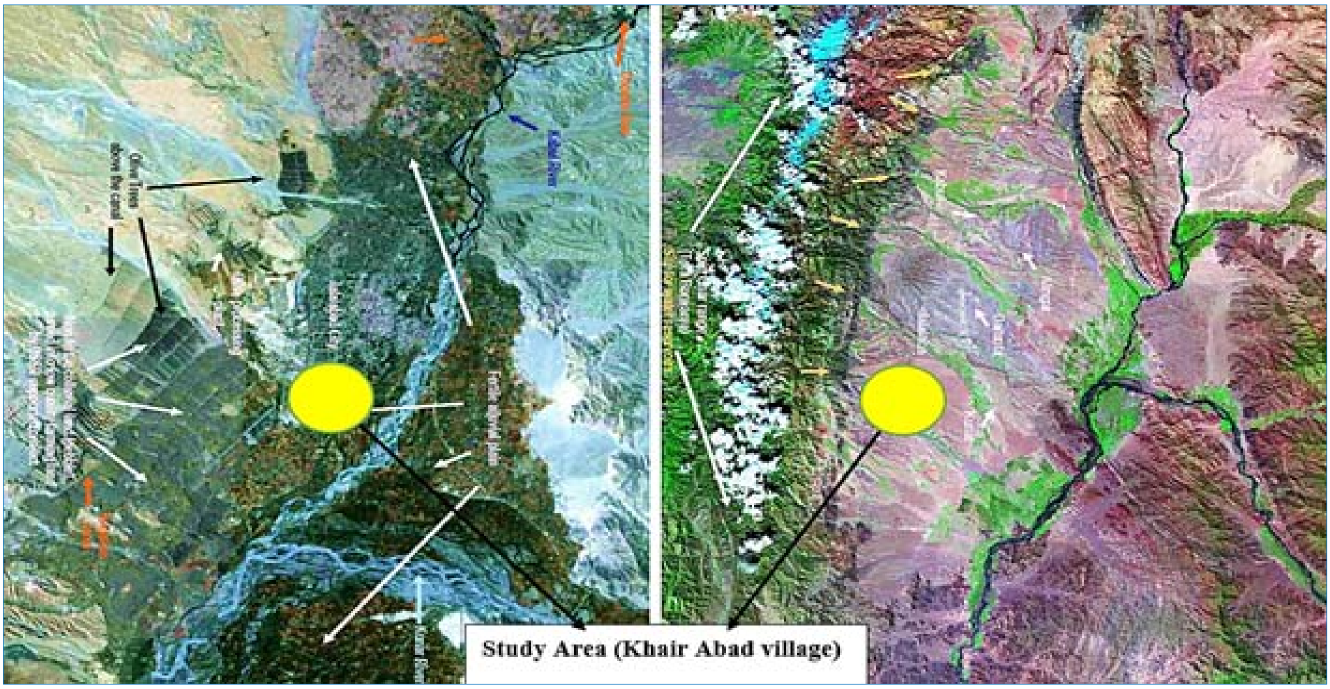


Table 1. The field works instruments that are used in this research

| No | Parameter | Unit | Device of measurement | Type of test |
|---|---|---|---|---|
| 1 | EC | µm/cm | pH - meter | Field |
| 2 | pH | - | pH - meter | Field |

For the first work, we have done in this research, for the separation of different sizes we used the sieving analysis method. Generally, in this method, we separated the sizes of fine materials (sand, silt, clay), but first of all this method we did we must clean all from other materials, and after we had done this research. The pH of the soil belongs to the acidic

($H^+$), and basic ($OH^-$), as well as when the acid and basic equal it's called the neutral condition of the soil. As well as the basic condition of the soil belongs to some other components also it consists of $CO_3$, $HCO_3$, and acidic salts.

Generally, the neutral condition of soils is 6.6 -7.4, from 4.6-6.6 is acidic, 2.2 - 4.6 are strongly acidic, 7.4-8.4 its basic, and more than 8.4 is strongly basic. The pH of the soil belongs to the regions, generally, in wet regions, the pH of the soil is 4 - 7, and when the pH of the soil is lower it belongs to the dry regions. The electro conductivity (EC) of soil shows the electricity of salt in the soil at the unit of µmohs/cm. the EC belongs to the existence of ions, in those soil, the number of ions increased the EC also increased. The buffer solution of EC is at the different proportions 1:10, 1:5, and 1:2, and in this research, we measure the pH and EC with pH-meter.

***2.8. Orography of Afghanistan***

Generally, the Orography of Afghanistan is divided into four types:

- High mountain regions,
- Medium mountain regions,
- Low mountain regions and
- Plains.

Afghanistan is one the mountains form countries, the high mountains located northeast of Afghanistan it's belonging to the Mustage which is Wakhan, central and east Hundukush, and Hinduraj, Wakhan located east to west and is 6505 m in height, the east Hindu Kush is north to northeast its height is between 5500 - 6000 m height but in some part is 7000 m height and the total length is 350 km (Bohannon and Turner, 2007), the Hinduraj little prolong in Afghanistan only 130 km and it's from northeast to southwest. The medium mountain regions consisting of ParaPamizus, Turband Turkistan, its height increasing to the southeast, the Para Pamizus height is 3000-3500 m and its total length is 550 km, Turban Turkistan is more than 4000 m height (Avouac and Burov, 1996). The low mountain regions it's consisting of the west of Badakhshan to Polykhomri River the main mountains of this consist of Rustaq, Simi Turband Turkistan, and the mean height is 700-900m (Böckh, 1971).

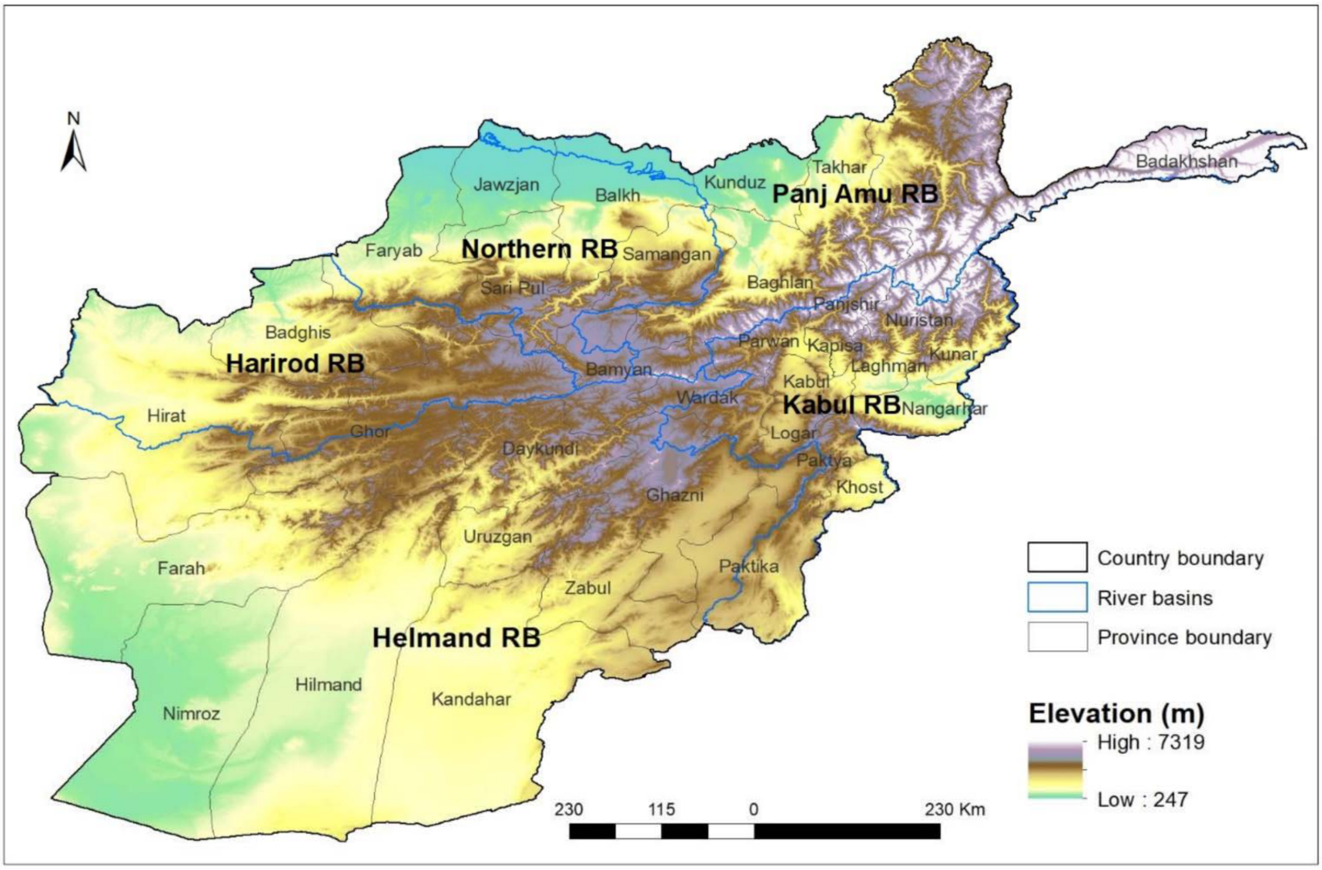


Fig. 2. Showing of the elevations of Afghanistan in mater (Najmuddin et al., 2022)

The Plains areas consist of the lateral of Amu River, the southeast, and northwest the 300-350 m height. The mountains near the Iran border's generally plain areas and deserts, Afghanistan about 75% belonging to the mountains, it's located from northeast to southwest, generally, in the northeast, the height of the mounts continues to little and wider and it's at the form of fan (Broshears et al., 2005), but the more height mountains located at the Parwan, Qatghan, Wakhan, and Nuristan and it's the skeleton of Hundukush mountains in Afghanistan, it is watershed between Amu Indus River. This series of mountains continues to Tajikistan, China, and India. The total length of the Hindu Kush Mountains is 800 km and by valley, systems separated by the east Hindu Kush, central Hindu Kush, and the west Hindu

Kush, at the west and southwest of Hindu Kush are located the middle mountains of Afghanistan, and its located east to west, but in the north and south is middle height mountains ParaPamizus (Abdullah et al., 1997), Turband Turkistan and Hazara Jat Mountains.

In the Southeast of Afghanistan is located Suleiman mount range and it's from east to west (Hamdard et al., 2022). In addition, in the south, north, and west of Afghanistan we can find plain areas and deserts (Fig. 2).

### *2.8. Climate*

The climate of Afghanistan is aride to simi aride, with a cold winter season, and a continental climate of extreme temperatures. Annual rainfall ranges from 100 mm to 400 mm. Accumulated winter snow from the high mountains sustains agriculture. The changing conditions down the snow-fed river valleys create agricultural conditions and thus cropping possibilities (JICA, 2007). In this research valleys are steep, rivers fast flowing and the valleys floors are narrow. Winter is cold, but summers are mild with short but abundant growing conditions. Lower down, as they move out of the foothills, the valley floors broaden into the flat plain with slow-flowing rivers. Here, winters are milder and summers, and the growing seasons are longer (Molnar, 1990).

### *2.9. Watersheds*

Since rivers play such an important role in determining land use, another important criterion to classify the territory from the point of view of agriculture is watersheds. The thousands of streams coming down from the Hindu Kush define a large number of watersheds comprising five major basins or more current river systems (Torge et al., 2003). Only one of the river systems the so-called Indus basin dominated by the Kabul River does ultimately to the Indium Ocean by way of the Indus River (Table 2). All the other systems drain into the deserts and arid plains around Afghanistan, with no sea outlet (Summerfield and Hulton, 1994).

Table 2. River Basin in Afghanistan

| River basin | Area % | Water % | Rivers |
|---|---|---|---|
| Amu Darya | 14 | 57 | Amu Darya, Panj, Wakhan, Kunduz |
| Hari Rod Murghab | 12 | 4 | Hari Rod, Murghab, Koshk |
| Helmand | 41 | 11 | Helmand, Arghandab, Tarnak, Ghazni, Farah, Loger |
| Kabul (Indus) | 11 | 26 | Kabul, Konar, Panjshir, Ghorband, Alinigar, Logar |
| Northern | 11 | 2 | Balkh, Sar-ipul, Khulm |
| Non-drainage area | 10 | | |

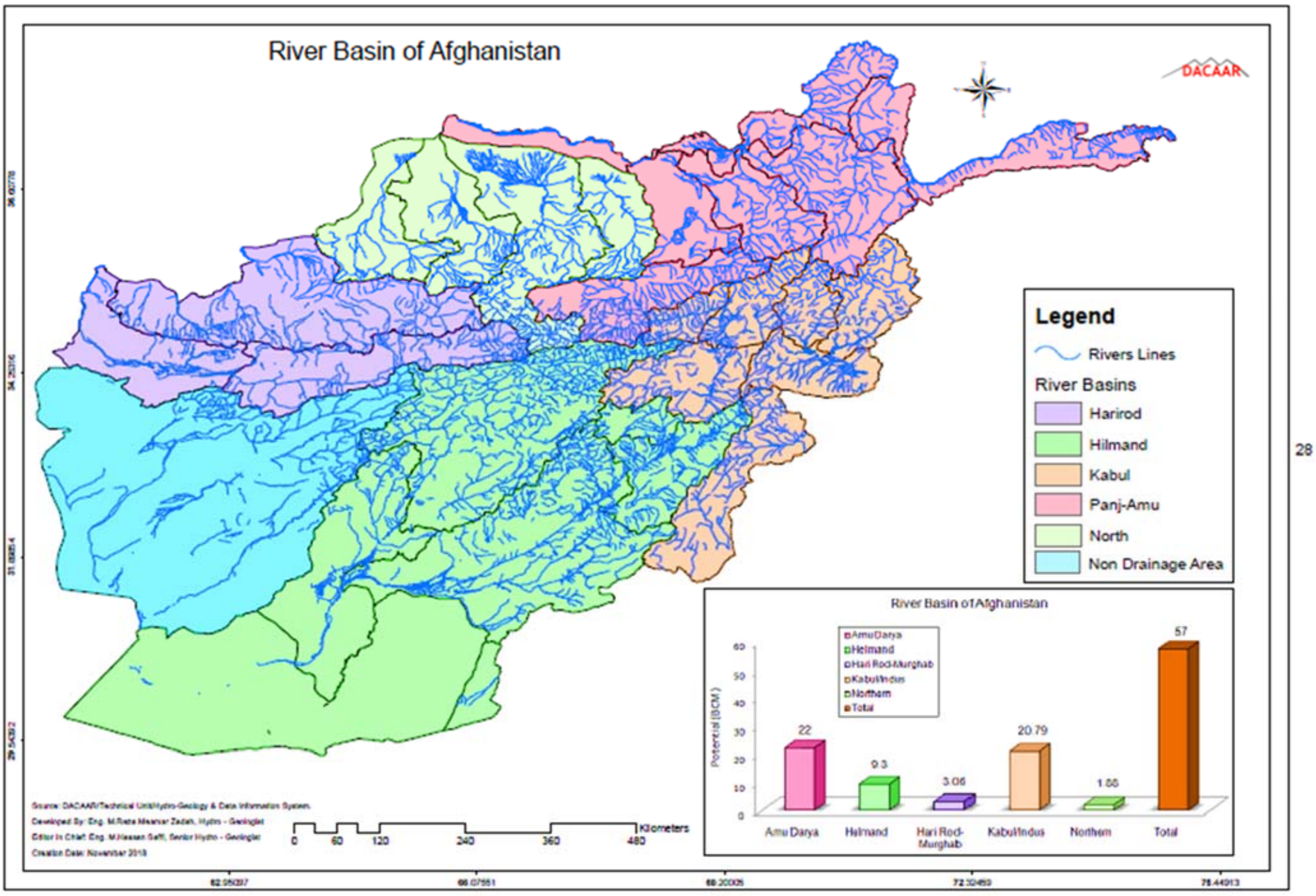


Fig. 2. The main river basin in Afghanistan (DACAAR, 2017)

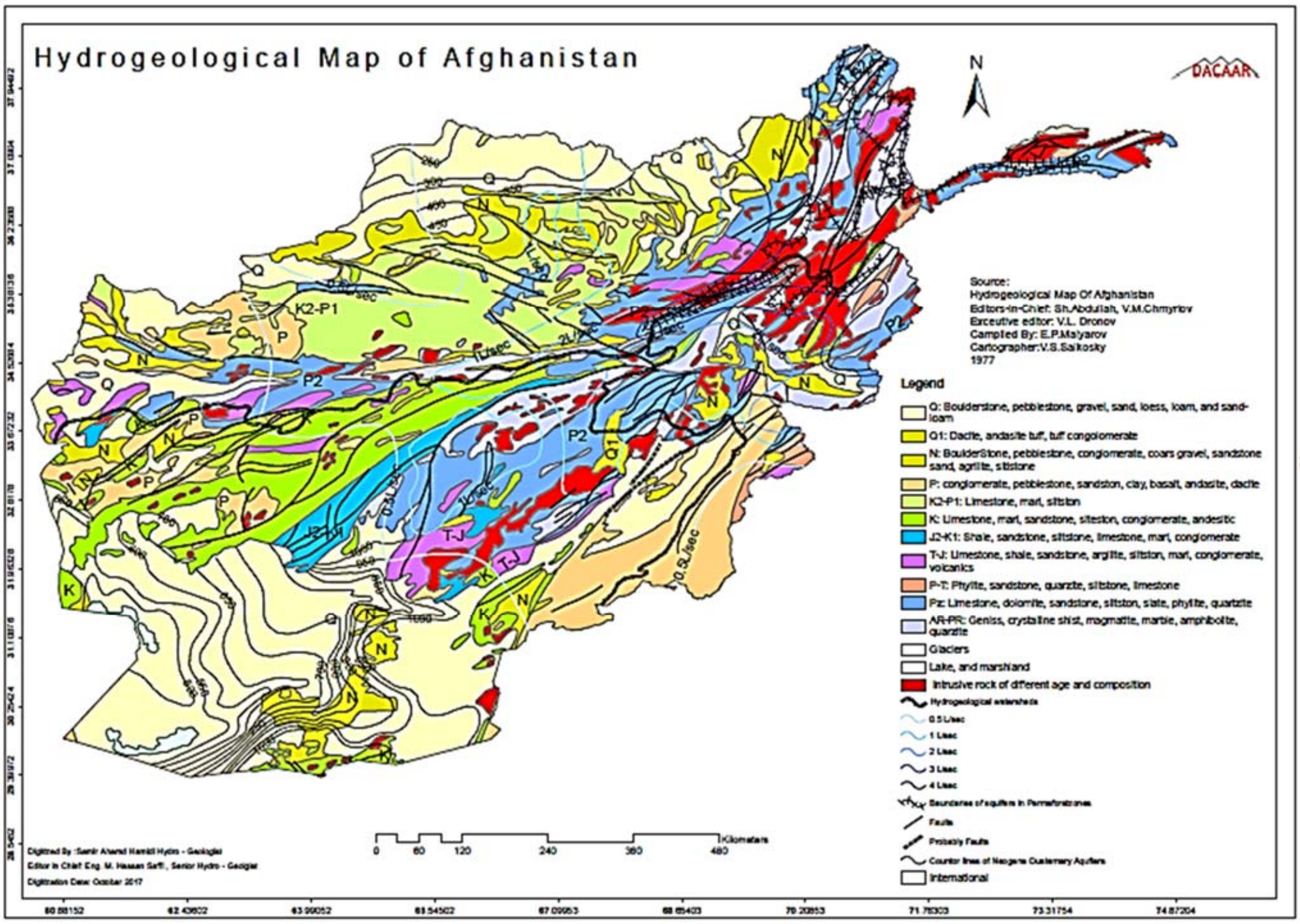


Fig. 3. Location map of hydrogeological basins of Afghanistan (DACAAR, 2017)

***2.11. The Hydrology of Afghanistan***

In Afghanistan, three rivers flow for 12 months, such as Helmand, Panjsher, and Koner, but particular rivers related to snow-melting seasons and rainy periods for example Kabul, Paghman, and Loger Rivers (Fig. 3). The third rivers are related to the flooding seasons, it's involving of some valleys and mountains areas. As the result of 20 years of climate change and drought in Afghanistan, the irrigation and drinking water used from groundwater storages (wells, Kariz, and springs), is percolated from surface waters, during snow-melting periods. In Afghanistan, for one year stored 75 million meters of cubic fresh water, from these waters are 57 million meters cubic consists of surface water, and from these only 18 million meter cubic involved groundwater. Meant from 100 % of Afghanistan 76 % of water consists of surface water and 24 % of water consists of groundwater (Rasouli, 2022a).

Each major river system is further composed of several specific watersheds and a total of 27 meso watersheds are identified within the five major river systems.

***2.12. Hydrogeological Basins of Afghanistan***

Hydrogeological Basins of Afghanistan are as follows:

- Southern Afghanistan Artesian Basins,
- North Afghanistan Artesian Basins,
- Central and North-Eastern Afghanistan folded Area (Karst or Fractured area)
- Intermountain closed by inter-mountainous basin

The Southern Afghanistan Artesian Basins extend from the southeast to the west for more than 1000 km (Rasouli and Safi, 2021). In the north, these basins border with the central Afghanistan folded area, in the northwest, it is limited by the Aab-e-Istada and the Moqure Tarnak faults in the west, it extends towards Iran and in the south and east it extends up to Baluchistan (Arian et al., 2015).

***2.13. Southern Afghanistan Artesian Basins***

Southern Afghanistan Artesian Basins include:

- Artesian Basins
- Basins with fracture - karst water

***2.14. Artesian Basins***

Artesian Basins include:

- Kata waz
- Lower Helmand
- Registan

***2.15. Basins with Fracture- Karsts- Water***

Basins with fracture- Karsts- water include:

- Tarnak
- Chaghayiay

***2.16. Northern Afghanistan Artesian Basins***

The North Afghan Platform has a pre-Jurassic Basement of pre-Carboniferous to Triassic rocks unconformable overlain by Jurassic to Recent sedimentary rock (Rasouli, 2020b). The pre-Jurassic basement is exposed mostly along the southern and eastern margins of the platform in the ParaPamizus and Hindu Kush ranges. Northwards and westwards, it outcrops only in a few tectonic inliers, like the Banda Turkistan uplift. Along the southern edge and eastern edge of the platform, the basement is cut by an Early Mesozoic magmatic arc, which extends north-westwards (mostly obscured by the younger sediments) along the southern edge of the Amu Darya basin, and through the central Caspian Sea as far as the Crimea (Rasouli, 2020b).

It can also be traced through the North Pamir and into the Hindu Kush (Rasouli, 2021). The North Afghan Platform, unlike areas to the west and east, is presently in static equilibrium (Rasouli, 2019). Along its northern and western edges, the Platform drops beneath the Quaternary cover of the Tajik and Murghab basin. These basins separate the North Afghan Platform from the Turan platform to the Pre-Jurassic basement.

The pre-Jurassic basement of the platform is exposed in the Parapamisus, Bande Turkistan, and Hindu Kush Pamir mountains, where it consists of pre-Carboniferous to Triassic rocks deformed and intruded at the end of the Triassic, and again during younger Mesozoic-Cenozoic times. These reasonably well-studied mountains form the edge of the Jurassic and younger North Afghanistan Platform (Shamal and Rasouli, 2018). The Parapamisus, north of the Harirud Fault is the exposed southern edge of the north Afghan platform, though cut by several strike-slip faults. The Banda Turkistan is a part of the platform exposed along the oblique-slip Banda Turkistan Fault. The Hindu Kush and north Pamir are thrust over the platform along the Ishkamish-Khohon and Darvaz Fault Zones and are tectonically complex due to Neogen deformation during the formation of the Pamir (Rasouli, 2020b). The deformation associated with the collision of India with Asia has obscured much original structural and stratigraphic relationship close to the Harirud and related fault zones (Rasouli et al., 2015).

### *2.17. North Afghan Platform Cover*

The North Afghan platform cover consists of Mid-Mesozoic to Neogen sediments covering Paleozoic –Triassic rocks and structures. The platform has four main areas separated by major faults the Herat Trough, the Qualia Now, Maimana, and Sherbergnan blocks. However, the dominantly Right-Lateral Neogen faults do not significantly offset any structures in the pre-Jurassic basement and have little effect on Mesozoic-Recent Facies belts. To the north, the platform is faulted against the Tajik basin, while to the northwest it passes gradually into the Murghab Basin (Rasouli et al., 2021).

### *2.18. Tajik and Murghab Basins*

The North Afghan platform drops north and northwest into two basins filled with thick Jurassic to Recent deposits and separated by a broad sill. The Tajik basin is separated by a major subsurface fault from the Sherbergnan platform area, while the Murghab Basin lies northwest of, and is transitional to the North Afghan platform. The Tajik Basin is a typical south-eastward-facing passive margin basin involved in the younger continental collision (Rasouli, 2022a). The oceanic lithosphere is still descending beneath the Hindu Kush as shown by deep-focus earthquakes down to 200 km (Rasouli, 2022b). The Murghab basin is less well known but has a section similar to the North Afghan platform. Both basins have rift-type Triassic bimodal basic acid. Extrusive interbed with continental deposits at their bases, on deformed Paleozoic rocks, were exposed at the basin margins (Kortekaas and Dawson, 2007).

### *2.19. Northern Afghanistan Artesian Basins*

Northern Afghanistan Artesian Basins include:

- Artesian Basins
- Basins with Fracture- Karst Water
- Hydro-geological massive

### *2.20. Artesian Basins*

Artesian basins are included:

- Amu Darya
- Kunduz
- Kulab- Kokcha
- Sheberghan
- Koshk

### *2.21. Basin with fracture- Karst Water*

Basin with fracture- karst water includes:

- Murghab
- Maimana
- Shashan

### *2.22. Hydro-geological Massif*

Hydro-geological massif includes:

- Band-e-Turkistan
- Surkha

### *2.23. Central and North-Eastern Afghanistan Folded Area (Karst or Fractured Area)*

From the southeast, it is separated by the Tarnak-Moqoor fault and from the north by North Artesian Basins along the major Harirud Fault. Also, from east and northeast, it is separated by Hindu Kush Badakhshan Massive from North Afghanistan Basin.

In the southwest, it is separated by the boundaries of hydro-geological basins. It forms from South Artesian Basin in the area of Dasht-e-Markoh and Sistan and from the west border with Iran and the north border with Tajikistan, and the east it forms the border with Pakistan (Elliontt, 2001). Central Afghanistan Hydro- geological folded area included:

- Hydrogeological massif
- Basin with fracture-karst water
- Sub Artesian basins
- Basin in superimposed formation

### *2.24. Hydro-Geological Massif*

Hydro-geological massif included:

- Hindu Kush- Badakhshan and Pamirian Nuristan,
- Harirud,
- Upper Helmand- Srobi,
- Arghandab,

### 2.25. Basin with Fracture-Karst Water

Basin with Fracture-Karst Water included:

- Middle Helmand,
- Tyrin,

### 2.26. Sub-Artesian Basins

**Sub-Artesian Basins included:**

Upper Harirod,

- Aruzgan,

### 2.27. Basins in Super Imposed Formation

Basins in Super Imposed Formation included:

- Adraskan,
- Dasht-e-Nawor,
- Farahrod.

### 2.28. Intermountain Closed by Inter-Mountainous Basin

The intermountain closed through includes Kabul, Jalal Abad, Aynak, and Wakhan. Herat, Baghlan, Balkh, Obe-Istada, and Katawaz. The geology of areas is composed of bedrock at the bottom (with various geological formations and ages) underlying a Neogen and Quaternary sediments sequence. The groundwater flow is controlled from the groundwater recharge areas (foothills of mountains) ranges towards discharge areas in the mid to lower reaches of rivers valleys.

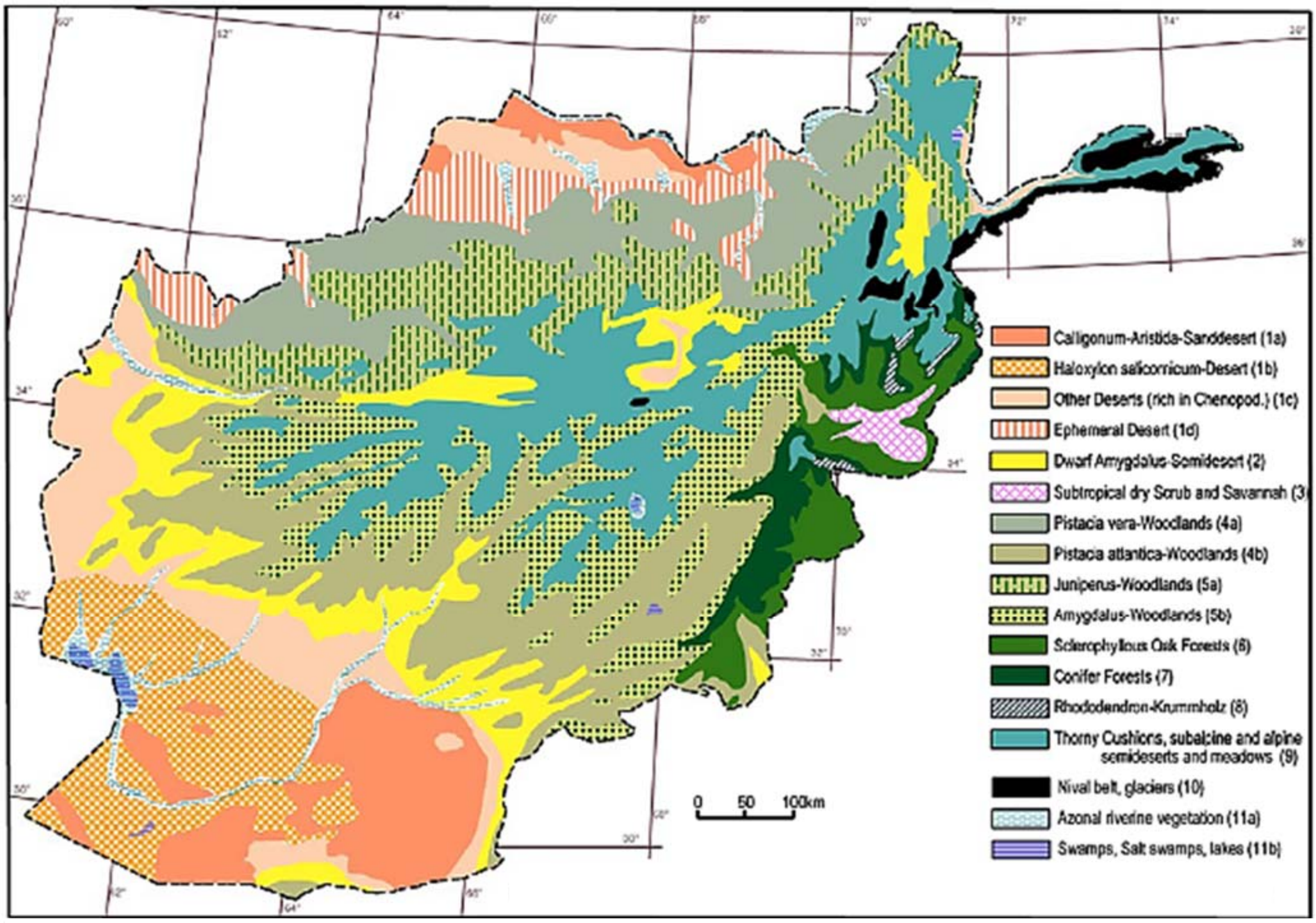


Fig. 4. Showing of the Agriculture systems in Afghanistan (Breckle, 2007; Pittroff, 2011)

The Quaternary aquifers are likely to be recharged in foothills by rivers and streams coming from the high mountains and infiltrating into course-grained and fine-grained alluvial sediments. The recharge is likely to be highest during the snowmelt season. Thus groundwater recharge is highly dependent on quantities of winter snowfall and rainfall. Further away from the mountains, the recharge to the Neogen and Quaternary aquifer is likely to take place by infiltration of water through to the bed of perennial and seasonal Rivers and streams (Fig. 3). In the irrigated areas substantial recharge is likely to occur via leakage from irrigation channels ditches and canals (Tünnemeier et al., 2005).

### 2.29. Geography and Land Use

Afghanistan has a total of 647,500 km$^2$ of land area, and reportedly 248,187 ha of water bodies (2,482 km$^2$, some 1.0% of total land area). Its area is composed of mountains and desert areas where the Iranian Plateau borders the mountains of central Asia (Koons, 1989).

The Hindu Kush mountains range splits Afghanistan from east to west. The steeped high peaks of the Wakhan corridor are in the east, at 5,500-7,500 meters' altitude. In the east-central and central part, the mountains broaden into wide spurs fanning to the north and south at 3,000- 4,000 meters' elevation. In the west, the mountains end in the Sefed Koh

Range, north of Herat and close to the northwestern border, where the altitude is around 1,100 m (Lave1 and Avouac, 2001).

### 2.30. Status of Agricultural Sections

The Agriculture sector has suffered from varying degrees of degradation for almost 25 years. A combination of war civil conflict, exploration, and enforced neglect have combined to leave a legacy of degraded natural resources, especially forests and rangeland, damaged infrastructures, and fragmented rural institutions.

Although population pressures are increasing, Afghanistan can mobilize over 7.5 milion hectares (Mha) of cultivated land, of which 60% would be irrigated and 20% would be double croped (Montgomery, 1994).

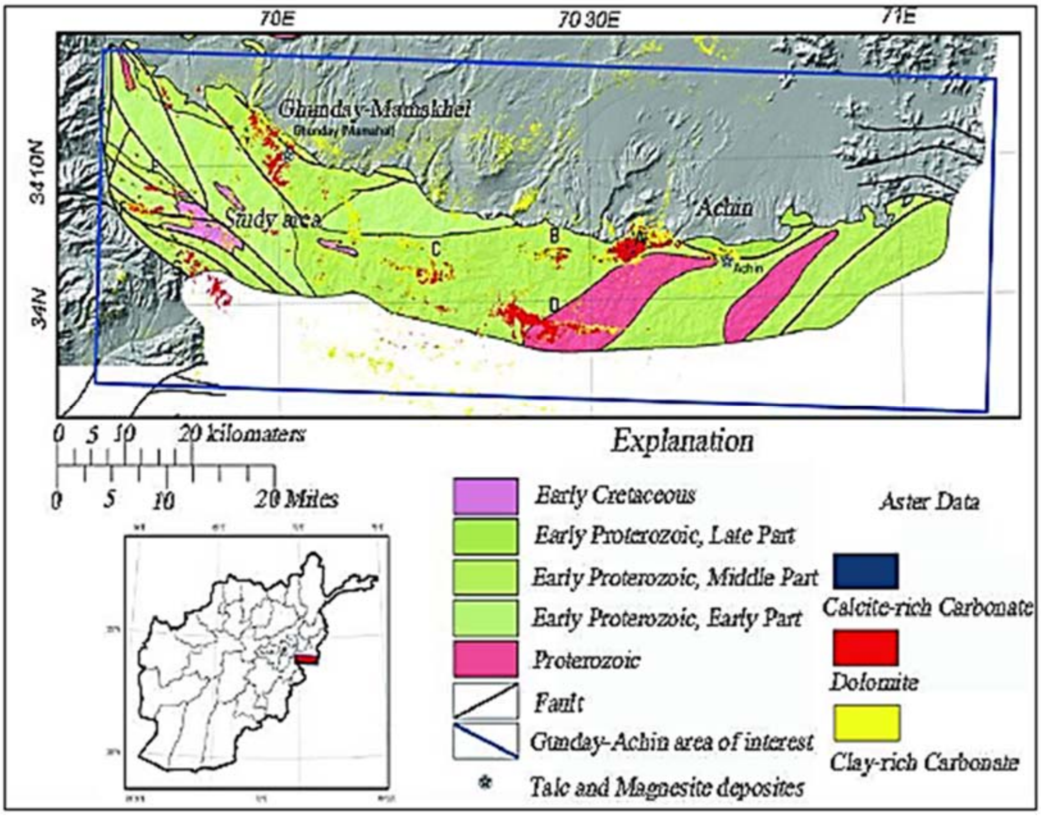


Fig. 5. Showing of the geological map of Nangrahar province (DACAAR, 2017)

This degree of land and water use amount to about 0.35 ha per capita, a relatively generous ratio in a regional context. In addition, the country has about 29 Mha of rangeland for use by livestock. If productivity can be restored to levels similar to those of the rest of the region, then Afghanistan should be able to resolve medium to longer term food security concerns.

As determined by the mountain system described above, Afghanistan is usually divided into 4 geographic regions:

- Northern plain,
- Central mountains,
- Eastern and southern hills and foothills and
- Southern and westhern lowlands.

Only some 12% of Afghanistan land is arable. Use of Afghanistan land is: arable land, 12% permanat crops, 0% permanent pastures, 46% forsts and woodland, 3% other 39. Irrigated land 30,000 km$^2$ (Munsell, 1999). Most of the country has an arid to simi arid climate with rainfall ranging from 100 to 400 mm. The climate is typically continental with temperatures varying from -10C° in winter to 34 °C in summar. Precipitation is erratic and eften occurs as violent storms. Over half the country receives less than 300 mm of rain and snow. About half the annual precipitation occurs in winter (between January and March), except for the southeastern mountains, which catch the western edge of the summer monsoon, most precipitation falls as snow in the central mountains. About 30% of precipitation falls as rain in the spring between April and June (Paetzold et al., 2005).

### 2.30. Agroecological Zones

Topography is the factor of greatest influence in agriculture, and results in an extreame diversity of agriculture. Major agroecological production zones have been catagorized differently. Effective croping involves many valleys, all of them with a different conditions.

However, the identification and demension of agroecological zones in Afghanistan is rather defficult. The country has avery varied geography, with literally thounsanths of microclimates and micro watersheds, and frequentely conditions change from one valley to the next, within a fairly short distance.

The main instrument for analysing agroecological zones is the Afghanistan Land Cover Atlas. As land use has somewhat changed over the intervening years, and normally varies from one year to the next according to rainfall and climate conditions, even that very significant work has some drawback. FAO is now preparing to update the Land Cover Atalis, using recent satellite imagery and ground data, but no such update is available at the movement on a general basis.

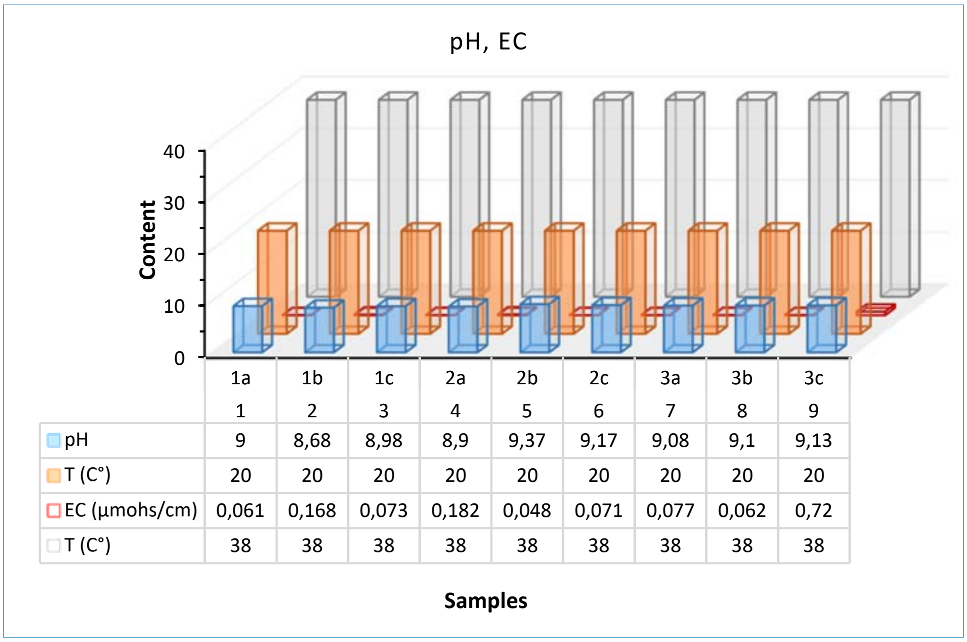


Fig. 6. The pH and EC and belongs temperature in Nangrahar

Table 3. Showing of the pH and EC of soil in Nangrahar

| No | Label of sample | pH | T (C°) | EC (µmohs/cm) | T (C°) |
|---|---|---|---|---|---|
| 1 | 1a | 9.00 | 20 | 0.061 | 38 |
| 2 | 1b | 8.68 | 20 | 0.168 | 38 |
| 3 | 1c | 8.98 | 20 | 0.073 | 38 |
| 4 | 2a | 8.90 | 20 | 0.182 | 38 |
| 5 | 2b | 9.37 | 20 | 0.048 | 38 |
| 6 | 2c | 9.17 | 20 | 0.071 | 38 |
| 7 | 3a | 9.08 | 20 | 0.077 | 38 |
| 8 | 3b | 9.10 | 20 | 0.062 | 38 |
| 9 | 3c | 9.13 | 20 | 0.72 | 38 |

Only a small part of Afghanistan land 12% of country, mostly in scattered valleys, is suitable for for farming, and most of this requires irrigation. However, less than 1/3 of the arable land is irrigated, primarily due to water shortage. Water from apring and river is ditributed through surface dtches and underground channels (Nakata, 1972).

Agroecological zones and watersheds are the most significant criteria for zoning if the purpose is survying agriculture. Agriculre is possible only in specific patches or strips of land in the numerous mountains valleys and the thousands of more or less contiguuous and relatively extensive agriculture areas on exist in some part of the territory (such as the Turistan plains or the Northern foothills) where flat or gently undulating land prevails, but even there the actual conditions of the terrain and the capricious nature of water supply impose at the best of times only a patchwork of cultivable and uncultivable and rather than a contiues pattern of cultivation.

Thus, the zones may be considered to break down into a number of specific agricultural areas located in different provinces and didtricts, belonging to different watersheds and existing at different elevations. These zones reflect basic ecological properties of land and climate, plus some supplementary creteria about accessibility and agricutural activity.

These local variants of the zones have their own agricultural specificity, and thus conclusions about one of the broad agro ecological zones (Fig. 4). Generally, there are eight Agro climatic zones in Afghanistan (Ruleman et al., 2007).

- Badakhshan Mountains Zone,
- Central Mountains Zone,
- Eastern Mountains Zone,
- Southern Mountains zone,
- Northern Mountains Zone,
- Turkistan Plains zone,
- Heart Farah Low Land Zone,
- Helmand River Valley Zone.

***2.31. Irrigated and Rainfed Area***

In Afghanistan, we have only 8 million hectares (Mha) of Afghanistan is 63 million ha, are arable. Arable land is scattered throughout the country mostly in valleys along rivers and other water sources. Nearly 50% of the arable land is irrigated in some manner ¾ of it located north of the Hindu Kush Mountains. The more land of about 77% of all wheat and 85% of all food and industrial crops come from irrigated lands.

Some 2.5 million ha are irrigated annually. Total irrigable area is about 5.3 Mha, of which half is irrigated each year, while the other half lies fallow. Only 1.4 Mha of irrigated land had sufficient water throughout the year to allow double cropping. Another 1.4 million ha is cultivated as rainfed land, so some 4 million ha of land were cultivated annually before 1978 by some 1.2 million farm families. Currently, a large part (30% up) of the irrigation systems have been damaged or destroyed by the war. Because of abandonment, neglect and lack of maintenance, another 15-20% of the land area is probably not in in sufficient condition to support further agricultural development. Actual irrigated land probably amounts to about 1.2-1.3% Mha, and is decreasing every year (Souriau et al., 1988).

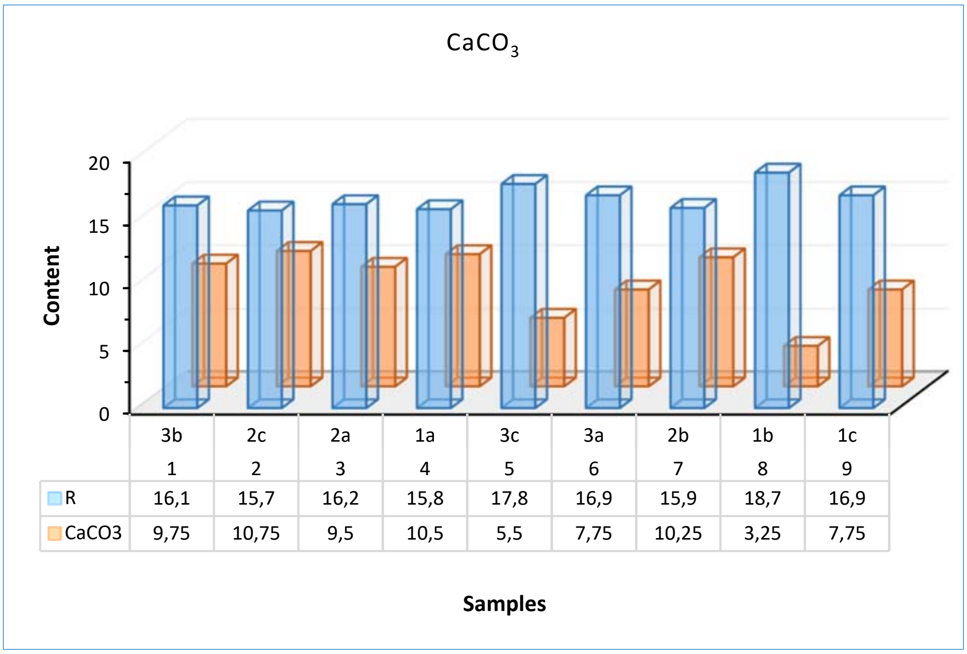


Fig. 7. The amount of $CaCO_3$ in Nangrahar

Table 4. Showing of the amount of $CaCO_3$ in Nangrahar soil

| No | Number of samples | R1- R2 | R | $CaCO_3$ |
|---|---|---|---|---|
| 1 | 3b | 0-16.1 | 16.1 | 9.75 |
| 2 | 2c | 16.1 - 31.8 | 15.7 | 10.75 |
| 3 | 2a | 0 -16.2 | 16.2 | 9.5 |
| 4 | 1a | 16.2 - 32.00 | 15.8 | 10.5 |
| 5 | 3c | 0 - 17.8 | 17.8 | 5.5 |
| 6 | 3a | 0-16.9 | 16.9 | 7.75 |
| 7 | 2b | 16.9-32.8 | 15.9 | 10.25 |
| 8 | 1b | 0-18.7 | 18.7 | 3.25 |
| 9 | 1c | 18.7-35.6 | 16.9 | 7.75 |

***2.32. Farming Systems***

Agricultural production is basically small holding with irrigated cropping, supplemented by livestock. Cropping intensity depends on availability of irrigation water and the length of the growing season. Crop rotation is well understood by farmers. As possible, legumes, animal manure, and chemical fertilizers are used. Sloane lists 7 farming systems which represent a combination of agro ecological zones and the factors which limit production.

These apply to 95% of irrigated and 85% of Rainfed agriculture. In these areas, agriculture consists of small pockets in an arid landscape. Also, not covered are the nomadic livestock people (Kutchi) who make up some 7-10% of the population, and are the principal users of the semi-arid lands (Wheeler et al., 2005).

***2.33. Location of Nangrahar***

The Nangrahar province located at the east side of Afghanistan at the 70° 30′ east of longitude, and 33° 56′ north of latitude, and its 599 m.a.s.l, it's about 7916 km². From west side of this province is Kabul and Loger, from south side Pactika and Khaiber Pashtonsha, from east and south east with downrange line. The average temperature of at the summer season is 45 °C and at the winter is 2 °C. The climate of this season is Mediterranean, and the precipitation of this province is about 242-390 mm. In this province we having only having rainfall but in some place we have snowfall such as Khogyani, Hasarak, Spingher, and Kashmand Mountains. The climate in these places is temperate, but in others places is warm. This province surrounded by mountains ranges, at north side of this province is Hindu Kush mountains ranges, the Spingher mountains is at south side of this province, the Turger mountains is located at the west sides, and from east side from surrounded by Baba mountains ranges. The Spingher mountain are one of the very important mountains of this province, and it is one of the very long series and it's about 84 km long, and it's started from Peshawar to west of Loger province (Rasouli and Safi, 2021). The average height of this mountains is 3500 m and at the all seasons of year is filled by snow cover.

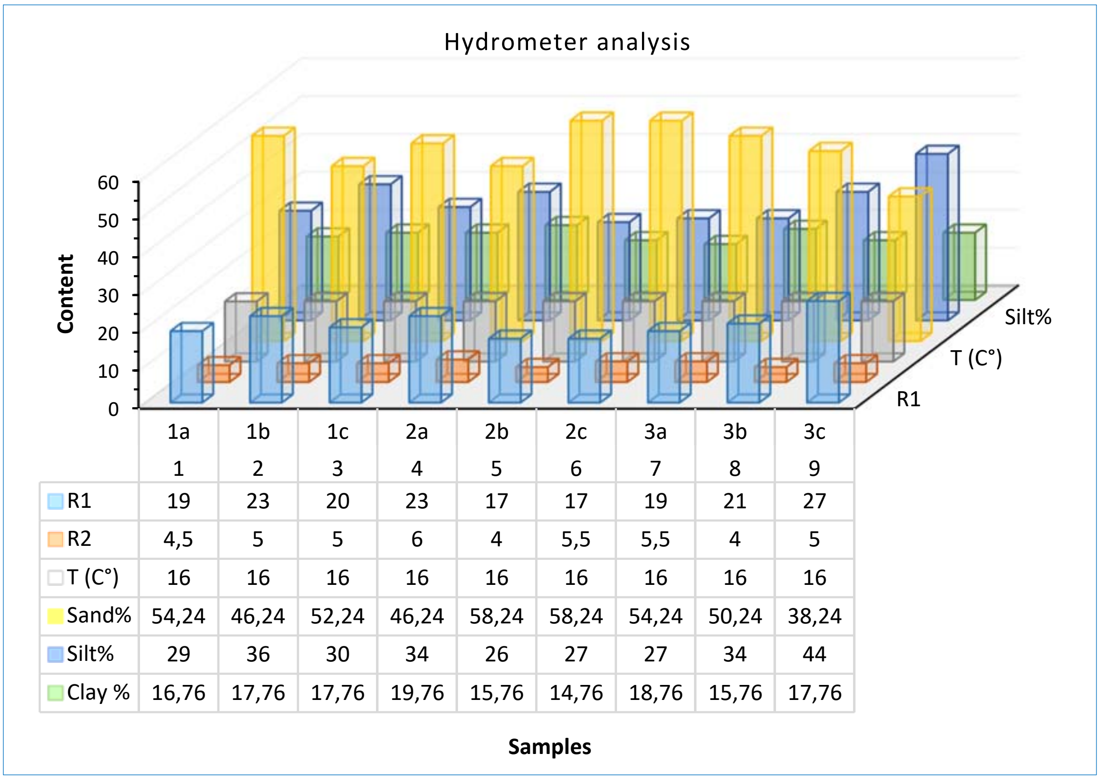


Fig. 8. The soil mechanical analysis in Nangrahar

Table 5. Mechanical analysis of soil in Nangrahar

| No | Number of sample | R1 | R2 | T (C°) | Sand % | Silt % | Clay % | Types of soil |
|---|---|---|---|---|---|---|---|---|
| 1 | 1a | 19 | 4.5 | 16 | 54.24 | 29 | 16.76 | Sandy loam |
| 2 | 1b | 23 | 5 | 16 | 46.24 | 36 | 17.76 | Loam |
| 3 | 1c | 20 | 5 | 16 | 52.24 | 30 | 17.76 | Loam |
| 4 | 2a | 23 | 6 | 16 | 46.24 | 34 | 19.76 | Loam |
| 5 | 2b | 17 | 4 | 16 | 58.24 | 26 | 15.76 | Sandy clay loam |
| 6 | 2c | 17 | 5.5 | 16 | 58.24 | 27 | 14.76 | Sandy clay loam |
| 7 | 3a | 19 | 5.5 | 16 | 54.24 | 27 | 18.76 | Sandy loam |
| 8 | 3b | 21 | 4 | 16 | 50.24 | 34 | 15.76 | loam |
| 9 | 3c | 27 | 5 | 16 | 38.24 | 44 | 17.76 | loam |

### *2.34. Geology of Nangrahar*

The Nangrahar zone is part of the depth of the former Cimmerian folding, it deposes in the zone and is located above the folding and ridges of the former Cimmerian that forms the foundation of the geosyncline. These folding outcropped to the surface of the earth in the mountains (Shamal and Rasouli, 2018). In the eastern part of the zone and in the southeastern part of the Nangrahar City, on the left bank of the Kabul River and on the banks of the Kunar River, the upper Paleozoic and lower Mesozoic sediments are visible in the surface. The central part of the zone is covered by Neogen sediments (Rasouli, 2020b).

The rocks and sediments of the Nangrahar ranging from Archaean- Proterozoic to Quaternary in age (Fig. 5). The Archaean- Proterozoic formations composed of various gneisses, Quarsite, Amphibolite's, and Crystalline, Schist's, which containing the beds layers of the white –grayish marble. The thickness of the marble beds and layer inside the gneisses varies from 300-600 m (Rasouli, 2019).

The Paleozoic formations are relatively extensive in the Nangrahar Zone, which includes the Ordovician, Silurian, Devonian, and Carboniferous formations. These formations are composed of Quarsite, Schist's, sandstones, argillites, and limestone. The contact relationship between these formations is not clear in some places. The sediments, and composed of conglomerates, sandstone, and clays. Quaternary sediments have filled the rivers valleys and their thickness is not very high (Rasouli, 2021).

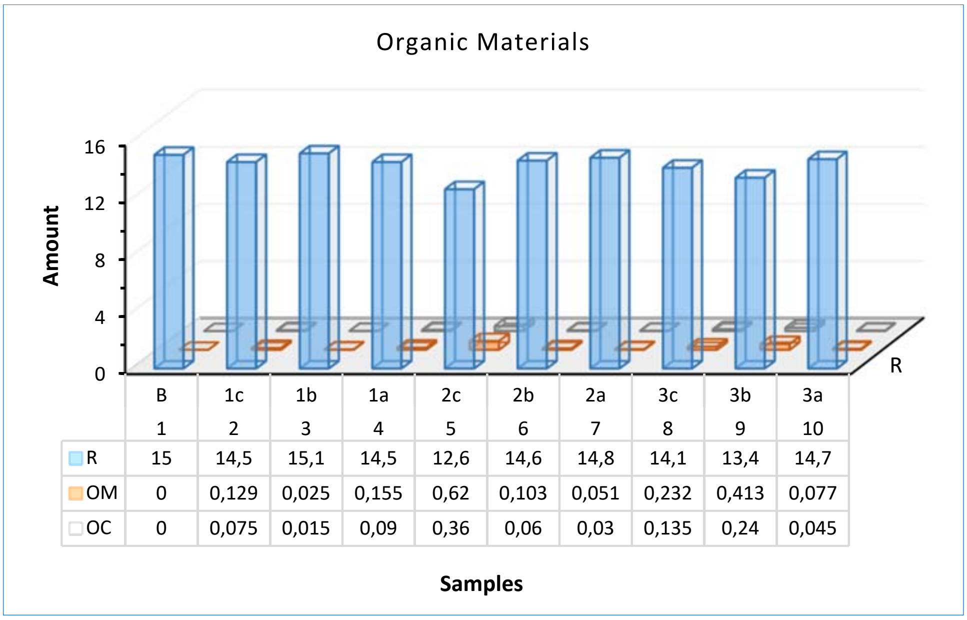


Fig. 9. The soil OM analysis in Nangrahar

Table 6. OM of Nangrahar soil

| No. | Number of samples | B - R | R | OM | OC |
|---|---|---|---|---|---|
| 1 | B | 0 – 15 | 15 | 0 | 0 |
| 2 | 1c | 15 – 29.5 | 14.5 | 0.129 | 0.075 |
| 3 | 1b | 29.5 – 44.6 | 15.1 | 0.025 | 0.015 |
| 4 | 1a | 0 – 14.5 | 14.5 | 0.155 | 0.09 |
| 5 | 2c | 14.5 – 27 | 12.6 | 0.620 | 0.36 |
| 6 | 2b | 27 – 41.6 | 14.6 | 0.103 | 0.06 |
| 7 | 2a | 0 – 14.8 | 14.8 | 0.051 | 0.03 |
| 8 | 3c | 14.8 – 28.9 | 14.1 | 0.232 | 0.135 |
| 9 | 3b | 28.9 – 42.3 | 13.4 | 0.413 | 0.24 |
| 10 | 3a | 0 – 14.7 | 14.7 | 0.077 | 0.045 |

## 3. Results and Discussion

### *3.1. The Instruments for Measurement of pH and EC*

In this research for measurement pH and EC we used the following instruments:

- Electrical Balance,
- 10gr soil,
- Plastic Boatel (50 ml), its 25ml for pH, and 25ml for EC,
- Potable water (50 ml),
- Shaker.

### *3.2. Procedure*

First of all, we balanced 10 gr soil sample, and after that we put at the plastic boatel, and mixed with 25 ml potable water. After that we put at the Shaker machine to good mixed together for 30 min, the mechanism of this machine is its shaking for 180 time, the sample in water. After this the sample exit from shaker and we measure the pH and EC of soil. The results of this test are showing in the Fig. 6 and Table 3.

### *3.3. Soil $CaCO_3$*

Shows the amount of lime in the soil of this soil, if the amount of $CaCO_3$ more than 25% in soil it shows the more amount of lime and genesis of mother lime rocks. When this condition occur in this case in soil cannot growing plants.

### *3.4. Materials for Determination $CaCO_3$*

In this research for determination $CaCO_3$ the following:

- Soil (20 gr),
- HCL (20 ml),
- Lamp
- Phenol Phataline (3-5 drops),
- Biorite instrument and
- Solution of NaOH.

### *3.5. Preparation Solution of $CaCO_3$*

- Phenol Phataline (0.5 gr) put in 100 ml Etanile,
- HCL (37%) at the concentration of (82.8 ml) and it adds on one li water and we mixed together,
- NaOH (40 gr) and by solution of titration and magitite in one-liter water solutes.

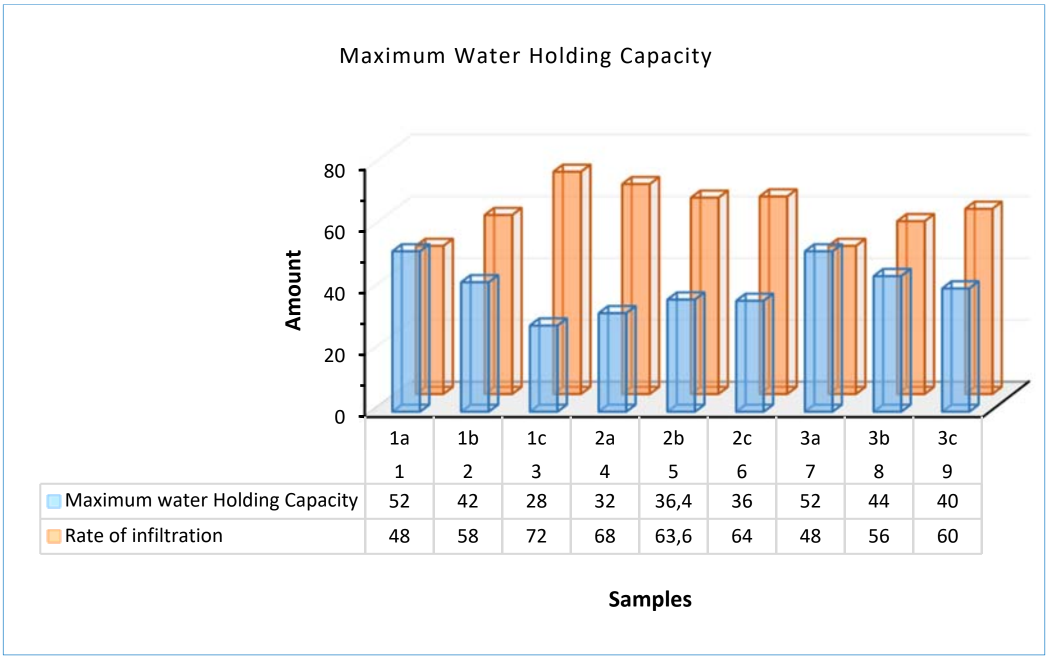


Fig. 10. The soil maximum water holding capacity (MWHC) in Nangrahar

Table 7. The maximum water holding capacity (MWHC) in Nangrahar soil

| No | Number of Sample | Maximum water Holding Capacity | Rate of infiltration |
|---|---|---|---|
| 1 | 1a | 52 | 48 |
| 2 | 1b | 42 | 58 |
| 3 | 1c | 28 | 72 |
| 4 | 2a | 32 | 68 |
| 5 | 2b | 36.4 | 63.6 |
| 6 | 2c | 36 | 64 |
| 7 | 3a | 52 | 48 |
| 8 | 3b | 44 | 56 |
| 9 | 3c | 40 | 60 |

### *3.6. Procedure*

We prepared 2 gr soil and its put in 20 ml HCL, after we give 50 C° temperature of stove, and cooling for several minutes and after (3-5drop) of chemical solution of phenol Phataline, and after by titration of NaOH.

We can have calculated by the following formulas (Fig. 7 and Table 4):

$CaCO_3\% = HCL - NaOH\ (0.05)100 \div 2$

$CaCO_3\% = 20 - 16.1(0.05)50$

$CaCO_3\% = 9.75$

### *3.7. Soil Textures*

In this method we selected types and sizes of soil, for selected this we used the following instruments:

- 40 gr Sodium Hexa Metaphaphat,
- 10 gr Sodium Carbonates,
- Stirrer tool,
- Magnate,
- Potable waters,
- Flask 1000 ml,
- 50 gr soil sample and
- Sylander 1000 ml,

### *3.8. Preparation of Solution*

For this research we used 40 gr Sodium Hexa Metaphaphat, 10 gr Sodium Carbonates, by Stirrer and Magnate and we solute at the 10 gr potable water and after we foot at the Flask 1000 ml and we resaved to the volume of 1lit, and at the result we find the texture of soil.

### *3.9. Procedure*

In this research we 50 gr sample wight, and after prepared solution at 1000 ml Sylander, we add 50 ml on soil sample, and we add 100 ml potable water, and we closed by Paraffin films, and shaker for 40 secs, and after 4 h we studied, the second study by Tm and the temperature we determine, and after calculate we can find the percentage of clay, silt, and sand, and we find by Soil Textural Triangle (STT), and the types of soil we can find.

### *3.10. Calculations*

Silt+clay= R1+(F-67) 0.2
Silt+clay = 27+ (86.4 – 67)0.2
Silt+clay = 30.88÷ 50(100)
Silt+clay = 61.76 %
Clay = R2 + (F-67) 0.2
Clay = 5+ (86.4-67) 0.2
Clay = 8.88 ÷ 50 (100)
Clay = 17.76%
Sand = 100 – silt + clay

F = 9 ÷ 5 (C + 32)
F = 1.8 (16 + 32)
F = 86.4

Silt = Silt + Clay -Clay
Silt = 61.76 – 17.76
Silt = 44 %

Sand = 100 – 61.76
Sand = 38.24%
(Sand+silt+clay)% = (38.24% + 44 % + 17.76%) = 100 %

From that we can find the calculation of sand, silt and clay equal to 100 and this method is correct. When we done this analysis from percentage of fine material (clay, silt, clay), at the Khair Abad Village, Surskhrud District, Nangrahar Province, Afghanistan by hydrometer the types of soil are loam (Fig. 8 and Table 5).

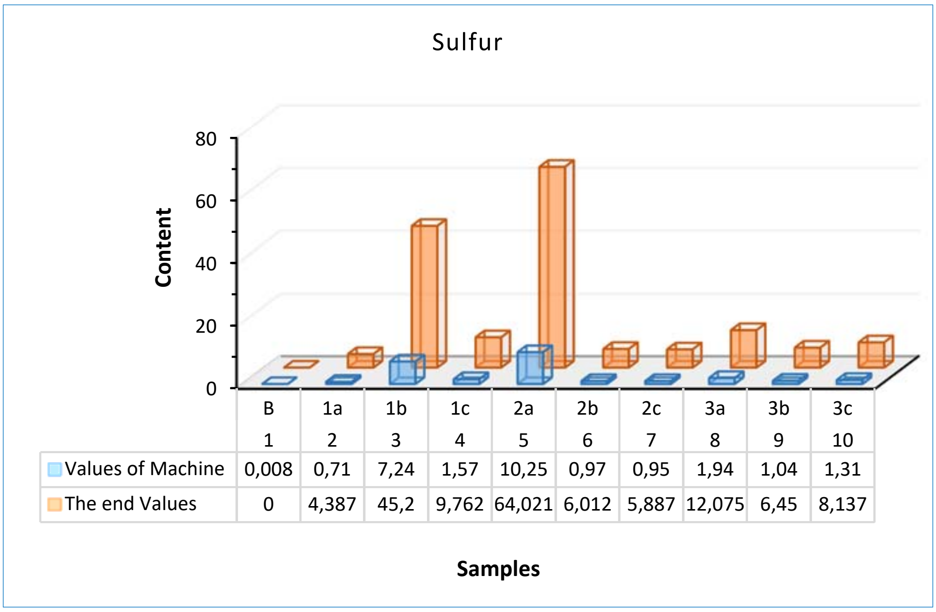


Fig. 11. The soil Sulfur analysis in Nangrahar

Table 8. The amount of S of Nangrahar soil

| No | Number of samples | Values of machine | The end values |
|---|---|---|---|
| 1 | B | 0.008 | 0 |
| 2 | 1a | 0.71 | 4.387 |
| 3 | 1b | 7.24 | 45.2 |
| 4 | 1c | 1.57 | 9.762 |
| 5 | 2a | 10.25 | 64.021 |
| 6 | 2b | 0.97 | 6.012 |
| 7 | 2c | 0.95 | 5.887 |
| 8 | 3a | 1.94 | 12.075 |
| 9 | 3b | 1.04 | 6.45 |
| 10 | 3c | 1.31 | 8.137 |

### *3.11. Organic Material (OM) Analysis*

Generally, the OM we can find in soil, and the amount of this materials belong to the vegetation covers. The OM is one of the very important parts of soil, and the existence of these materials very good nutrient for animals and plants.

The origin of OM is the remnants of plants and animals. At the first when the OM occurred in soils in this case it occurs under decomposition of soil edaphon (soil flura and fauna), and in this case more changing its structures at soil. Two phenomenon is very important at the OM, one is mineralization and other one is humification. From erosion, the soil which is benefited for transportation in Afghanistan contain most of the OM in its nature. After the tenths decade most of the soils in Afghanistan contains microorganism in its nature. The OMs are very important for agriculture in soil, the OMs are very important like heart and blood in human body. For finding OM we can find the following:

- 1gr soil,
- Potassium dichromate,
- Sulfuric acids 98%,
- Arto sulfuric acids,
- Furious Ammonium sulfites,
- Di phenol Amid,
- Potable water,
- Biorite device,
- Stirrer and magnate,

### *3.12. Preparation of Solution*

- 196.1 gr furious ammonium sulfites in 1 L, water solved,
- 49.4 gr potassium dichromate, in 1 L water solved,
- 0.5gr Di phenol Amide, solved in $H_2SO_4$100 ml.

### *3.13. Procedure*

First of all, we balanced 1gr soil, and after we input in Biker 500 ml. Afterward, by Barite automate 20 ml $H_2SO_4$ we constricted, after 10ml solution of Potassium di chromite, after that for 30 min stay to very good solutes. After that we add potable water, and we add 10 ml Arto phosphoric acid, and after we adds 10-15 drops of Di phenol Amid, and after under the device of biorite, and self biorite by furious aluminum sulfite, to zero degree filled and add magnetite and Stirrer and shaking and stay to change the color of solution to the green, and after the drops of furious aluminum sulfite we calculated after the changes we calculated and the every numbers we noted, and we deferential one another's (Fig. 9 and Table 6), and at the end the relatively numbers calculated the following formulas:

- OC=(B-R) 0.03 × 0.05 × 100 ÷1
- OC= (15-14.4) 0.15× 100 ÷1
- OC= 0.09
- OM= OC×1.724
- OM= 0.09×1.724
- OM= 0.155

### *3.14. Maximum Water Holding Capacity*

In this research we used the following instruments:

- 100 ml Sylander,
- 100 gr soil,
- 100 ml potable water,
- Cone and
- Filter

### *3.15. Procedure*

First of all, we get 100 ml Sylander, and we used cone and filter in the upper part of Sylander, and after we add the 100ml soil in cone and add 100ml water on soil, and after we stay for one day and night to water infiltrate from soil (water pass from filter, and soil). After we note the all-infiltrated water from filter (Fig. 10 and Table 7).

### *3.16. Sulfur Analysis*

In this research for Sulfur analysis the following instruments:

- 5 gr soil,
- Solution of CaCl,
- The solution of Gimeashika,
- Astic Acid,
- Solution of BaCl,
- Machine of Shaker,
- Filter paper and
- Spectra photometer Machine.

### *3.17. Preparation of Solution*

- In this research we 0.5434 gr add in 1li potable water,
- 1.5 gr CaCl in 1li potable water solved and
- 0.25 gr gemisheaka solved in 100 ml potable waters.

### *3.18. Procedure*

In this research we weighted 5gr soil, and added at 50ml Biker, after we make the 25 ml solution of CaCl and after shocked by Shaker to very good solved for 30 min to very good solved to gathers, and after we done the filtration procedure.

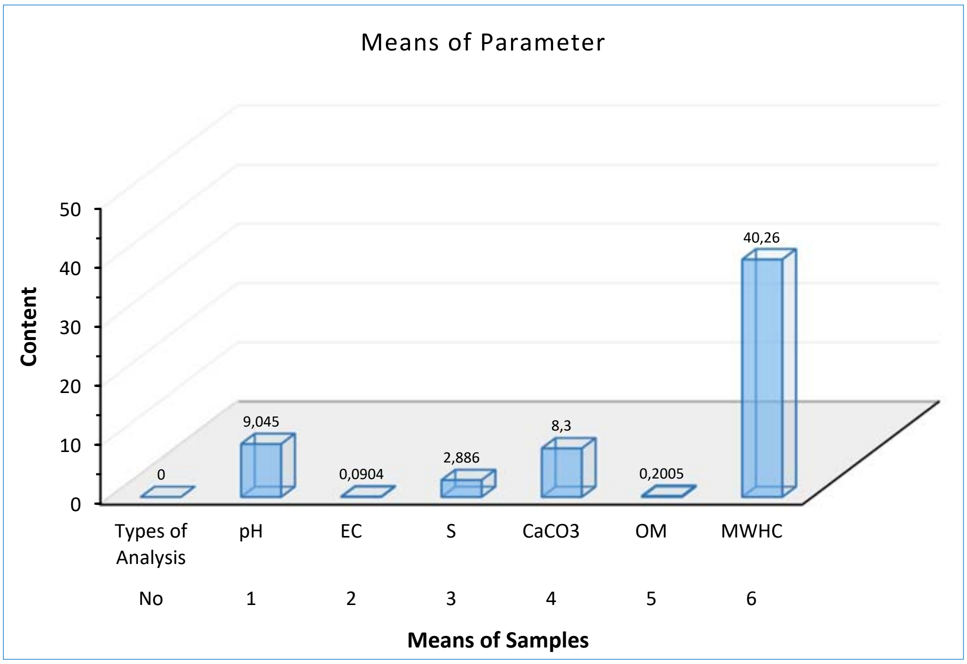


Fig. 12. The mean of soil parameters in Nangrahar

Table 9. The mean of parameters in Nangrahar soil

| No | Types of analysis | Total mean | | | |
|---|---|---|---|---|---|
| 1 | pH | 9.045 | | | |
| 2 | EC | 0.0904 | | | |
| 3 | S | 2.886 | | | |
| 4 | $CaCO_3$ | 8.3 | | | |
| 5 | OM | 0.2005 | | | |
| 6 | MWHC | 40.26 | | | |
| 7 | T | Sand% | Silt% | Clay% | Type of Soil |
| | | 50.906 | 31.8 | 17.204 | Loam |

After that we add 1ml the solution of Gemisheaka, 1ml Acetic acid, and after we made solution in one Flask at the volume of 25 ml (Fig. 11 and Table 8), and after that all solution we added at the Spectra photometer and we equal the range of machine on 470 nm and after we read this sample, but first of all we must the following points:

- First of all, me must equilibrium the device (CaCl 5 ml, BrCl, 1.5 gr, gemisheaka, 25 ml, acetic acid 4 ml), after we read the samples.
- Blank: as we said already blank also as another samples, but the different is only that there we cannot add soils.

Generally, we can calculate by the following formula:
$A\times S= (R-B)\ 25\div 20\times 5$
In this formula;
A= available (Amount),
S= sulfur,
R= reading,
B=blank,
25= amount of $CaCO_3$,
20= the amount of sample after passing filter,
5= the wight of soil.
$A\times S= 0.97-0.008\times 25\div 4$
$A\times S= 0.962(6.25)$
$A\times S= 6.0125$

In this research, we collected the samples from different horizons. In this research, we get the mean of all parameter such as pH, EC, sulfur, $CaCO_3$, OM and MWHC. These all parameter have the good result and we can use for all agriculture and growing plants (Fig. 12, and Table 9).

## 4. Conclusion and Discussion

The soil mechanical analysis is used to measure Soil parameters such as pH, EC, $CaCO_3$, soil fractions and OM in the Khair Abad village, Surskhrud District, Nangrahar Province in Afghanistan. The pH is upper from 7, and its basic, the EC is good and normal. $CaCO_3$ is lower from international criteria's (25%) and its 8-11 and its good for growing plants, the texture of soil is loam and its good for growing plants. The number of OM 0.5 is more and its good from point of view OM is good. As the S in soil is according to international criterion 5 and is more from 5, for lowering this we can low the acidic conditions and it is good for the soil fertile. The means of physical and chemical parameters values of soil parameter are pH 9.045, EC 0.0904, S 2.886, $CaCO_3$ 8.3, OM 0.2005, MWHC 40.26, the soil type is loam respectively. The soil samples and Parameters shows good results with national and international standards, and values differences, close to one other. The results obtained suggest that the Soil research can be used efficiently in the other district of the Kabul Province and others provinces in Afghanistan.

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## Conflicts of Interest

The authors declare no conflicts of in interest regarding the publication of this paper.

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