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Effect Of Salt Concentration and PH on Soil, Its Impact In North Kabul

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Abstract:

The main point of this paper refer to assessment of Hydrogen Ions concentration which call in abbreviation as pH in Northern Kabul city. The PH control and assessment is very important issue, because its variation could be bring many problems such as water and soil contamination and serious structure damages at fundaments.

The hypothesis of this article is the assessment effect and finding relation between salt concentration and its pH. The main goal is understanding factors and comprehension of function mechanism of negative effects of PH on Soil and water in studies area. Methods of assessment based on library report investigations of different National and International organization such as USGS, JICA Water Quality Assessments between 2009-2018 years in Kabul city and around region and Author field investigation (2018-2020).

According to long term investigation and analyzing data and its correlation found that the usage of Agricultural fertilizers such as Ammonium Phosphate and Potassium Phosphate and sulfur reduce pH, vs adding Sodium Nitrate, Calcium Nitrate and also animal's fertilizers increase Soil PH. Moreover, pH amount increased with fertilizer usage and depth of soil profile. Shear strength of granular soil increase with increase of pH value (Motiur, 2015).

Keywords: PH, Soil contamination, salt concentration, Ion exchange Capacity, soil reaction. Shear strength, Concrete damage.

Introduction:

Concerning to the past studies of the term must be mentioned, that a large number or studies had been dedicated around the world to relation between salt concentration and pH such as (Schwab, 1991), (Satar,2009),(USGS, 2009), (Don, 2014), (Motiur,2015). Without any doubt that is clear, But my study focus on impact of this phenomenon at soil contamination/ degradation due to PH increases and also destruction of concrete aggregate at fundaments structures. Soil properties are closely associated with soil-forming/environmental forcing factors, such as

topography, climate, and parent material. The relationship between soil properties and soil-forming factors is an issue that has been studied all over the world. Soil pH is a measurement of soil acidity and alkalinity thereby representing the H^+ concentration in the soil solution. Soil pH is a key index of soil properties, which was considered as one of the main variables influencing other soil properties. Studies have shown that soil pH can influence crop yields, soil nutrient release, and soil microbial activity to a large extent. If farmland soil is too acidic or too alkaline, then land production will be limited. Soil pH is an important regulator of soil and is inevitably controlled by different soil-forming factors. Previous studies have reported that factors associated with the variations in soil pH differ with locations and scales. At the global scale, soils collected from different climates have distinct soil pH. Soils from arid climates are commonly alkaline with a high soil pH. By contrast, soils from humid climates are commonly acidic with a low soil pH. Precipitation and potential evapotranspiration control soil pH variations at the global scale. Additionally, the effects of climate factors on soil pH variations are observed at regional scales. Soil pH is a measure of the acidity (low pH) or alkalinity (high pH) of the soil. Generally accepted pH value for corn production is between the ranges of 6.0 to 6.5. High pH problems typically begin at pH 7.8 or higher and are often accompanied by saline soils, sodic soils, or saline-sodic soils (Trego, M., Peric N. (2005).Soils can be naturally acid or alkaline, and this can be measured by testing their pH value. Having the correct pH is important for the safety of constructions fundaments and also healthy plant growth. Being aware of the long-term effects of different soil management practices on soil pH is also important.

Research has demonstrated that some agricultural practices significantly alter soil pH. The variation of PH value due to concentration of solid minerals tends to degradation of soil and also might be damaged fundament of construction especially concrete aggregates (Motiur R., Tansim. T. N, 2015). In this study, not only clearly mentioned the way of controlling pH varieties in soil (too much High or too much low pH), but also evaluated it economic importance on social life.

Materials and methods

The Study Area

Afghanistan is a mountainous and dry country located in the arid sub-tropics in south-Asia. It has an arid and semi-arid continental climate with cold winters and hot summers. The study area Coordinate: (34º,30' N – 34º,40' N and 69º,10'E-69º,20'E) is located in northern Kabul city the capital of Afghanistan. The elevation of region varies between 1800 to 2000 m. The climate of the study area is hot at summer and cold during winter. The mean annual temperature of about 22^0 C and mean precipitation of about 400mm/year [1]. The population consist from different

ethnic group, mostly speaking at Persian language. About (40) years ago the region was covered mostly by Lagoon Water with different herbs and grasses, but during recent four decades due to Drought and climate warming the water body went –off, and People started construct houses and also cultivation. Despite at spreading salt soil and Salty Water (mostly Sulphatic content) people grow some plants and cultivated in small scale. In many places in the surface in the region could seen salty soil at white color with thickness variation about (5 – 20) cm.

Geology of Region

The study area historically belongs to Lacustrine Quaternary modern deposition .i.e. long before at tertiary period it was a lake ,then as result of Endogenic and geotectonic process and also climatic change, water body evaporated and gradually the old lake filled with mentioned above depositions. From Lithological view the area composed of Loam, fine sand, clay and sandy-clay with different thickness layers. The whole region occupied about 35 km, but myself due to limited possibility and lack of laboratory equipment for necessary analyzing only studied a small region about 8 km^2. The Lacustrine deposition located directly over the alluvial sediment with a medium thickness about 25m [17]. The ground water depth different from (30 to 60m).The water debt also changed from (0.4 to 3)lit/sec. The hardness of water well from (0.8 up to13,8) mg-eq. The recharge of water-bearing horizon obtained from atmospherics precipitations and also from lower lacustrine layers deposition. Due to arid climate and Drought in region, most of water body because of Capillarity phenomenon evaporated and the salt which bringing from depths as a result of evaporation process remained on surface which made the soil salty. The Schematic look and maps of area shows in (Fig 6, 7).



Fig 1: A look from study area (Source: Author)

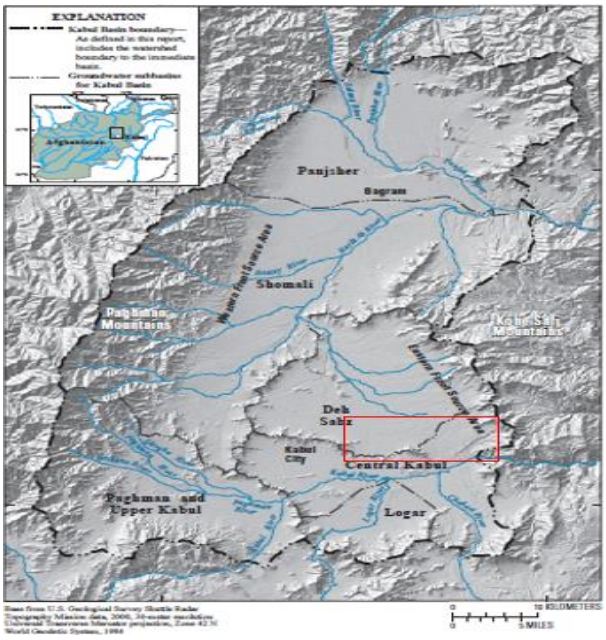


Fig 2: Satellite map of study Area[9]

Theory

The acidity or alkalinity of a substance is measured in pH units, a scale running from 0 to 14. A pH of 7 is neutral. As numbers decrease from 7, the acidity gets higher. As numbers increase from 7 so does the alkalinity. Soils generally range from an extremely acidic pH of 3 to a very alkaline pH of 10. This range is a result of many factors, including a soil's parent material and the amount of yearly rainfall an area receives. Most cultivated plants enjoy slightly acidic conditions with a pH of about 6.5. Pin oak, gardenia, blueberry, azalea, and rhododendron are among the plants that demand a very acidic pH of 4.5 to 5.5. Soil pH has indirect yet far-reaching effects on plants. Plant nutrients become available or unavailable according to the soil's pH level (chart, right). Yellowing between the veins of young leaves indicates an iron deficiency, a condition arising not from a lack of iron in the soil but from insufficient soil acidity to put iron into a form that a plant can absorb. Most plants thrive in slightly acidic soil because that pH affords them good access to all nutrients. Soil pH also influences soil-dwelling organisms, whose well-being, in turn, affects soil conditions and plant health. The slightly acidic conditions enjoyed by most plants are also what earthworms like, as do microorganisms that convert nitrogen into forms that plants can use. More material is needed to change the pH level of a clay soil than for a sandy soil because the charged surfaces of clays make them more resistant to pH changes than the uncharged surfaces of sand particles. Generally, limestone is used to raise a pH level, and sulfur is used to lower it [16].

Maintaining the correct pH level for soil is an important task. Naturally alkaline soils will keep shifting up the pH scale because of the rock minerals from which they were formed. It's important not only for avoiding of degradation of soil and Vorst environmental condition but also for Construction fundament safety. Problems with soil pH (too high or too low) might be cause some problems for plants such as: Inadequate pH levels can result in certain nutrients becoming tightly bound to the soil or precipitating as solid materials ,making them unavailable to the plant, while other nutrients can become increasingly available ,resulting in toxic levels in the plant. For example ,calcium availability can be substantially reduced and manganese can become toxic at low pH [15].

Management options for high pH soils: When it comes to high pH soils, it may be more difficult to lower the pH than to manage the availability of soil nutrients. This is because high pH is often caused by the parent material of the soil, which will continue to break down over time and buffer any attempts to acidify the soil. Soils that contain free carbonates are the most difficult to alter in terms of pH:

•Grow crops that are more tolerant to alkaline soils.

•Improve plant-available nutrients by adding fertilizers or chelates tothe soil. A heavier reliance on starter fertilizers may be needed.

•If the soil does not contain free carbonates, adding elemental sulfur ,which is turned into sulfuric acid by bacteria in the soil, or directly adding sulfuric acid may help to acidify the soil over time; however ,this is usually uneconomical for large acres as the amount required to lower the pH may be exceptionally high..

•Adding organic matter in the form of manures or crop residue can lower the pH over time as the breakdown of organic matter releases acids while also providing essential nutrients, including micronutrients. Soil microbes convert Sulfur into sulfuric acid as Follows:

$$S + 1/2\ O_2 + CO_2 + 2\ H_2O \rightarrow H_2SO_4 + C\ H2O \quad (1)$$

In this reaction H_2SO_4 dissolve calcium carbonate and makes gypsum, conversion to sulfuric acid Takes time: several weeks (faster in warm weather)(Pierzynski, et all, 2000).

Soil Salinity, Sodicity, and High Soil pH relation

Soil salinity is the content of soluble salts in the soil, which can readily dissolve in the soil water solution and be taken up by plants. These ions include sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), calcium (Ca^{2+}) chloride (Cl^-), sulfate (SO_4^{-2}), Carbonate (CO_3^{-2}), bicarbonate (HCO_3^-), and nitrate (NO_3). Soil sodicity is the concentration of exchangeable sodium ions in the soil Sodic soils have high levels of sodium and low levels of other salts. Sodic-soils can have structural issues because the sodium ions weaken soil aggregates, resulting in a collapse of the soil structure. This is especially common in sodic soils with high clay or silt content. Sodic soils often have a high pH, often greater than 8.4. Some soils may have both high saline and high sodium levels; these are termed saline-sodic soils. When salts build up in the soil, the following issues can occur in plants: High levels of salts in the soil water solution can cause osmotic stress to the plant. This is because water will move from a less salty solution (generally the soil) to a more salty solution (generally the plant cell). The potential for water to move into plant cells is reduced when the soil water solution also has a high salt concentration. Thus, the plant cannot absorb water as efficiently (Fan Z, Ma YJ. 2001).

•The deterioration of the physical soil structure in sodic soils can result in restricted water and air movement through the soil, which can cause difficulties with water penetration into the soil, soil crusting, and waterlogging .Soil salinity and sodicity issues can occur anywhere, but are most common in areas with limited rainfall and high evapotranspiration, such as in arid and semi-arid growing regions, where the solutes are less likely to be leached through the soil profile and collect in the root zone. Irrigation water that contains high levels of solutes and high water tables that carry the solutes to the surface can also contribute to soil salinity and sodicity problems. Inadequate pH levels can influence the activity of herbicides and

other chemical reactions, as well as microbial activity. For example ,low pH decreases the activity of nitrifying bacteria that convert ammonium to nitrate, the predominant form used by plants. High levels of salts in the soil may also cause nutrient deficiencies .For high pH soils, the sodium absorption ratio (SAR) or exchangeable sodium and percentage (ESP) should also be calculated, as the two conditions are often linked [13].

Factors affecting variation of soil in different region

Soil pH is a key factor that controls soil nutrient availability, soil microbial activities, and crop growth and development. However, studies on the soil pH variations of cultivated lands in different horizons at the regional scale remain limited. In this work, about 45 soil samples were collected from three soil horizons (A, B, and C) from study area. The relative importance of the studied variables to soil pH differed with the horizons. Generally, pH value showed increases with concentration of mineralization specially with increasing the amount of Co_3^- radical anions (Fig 3 and 4).

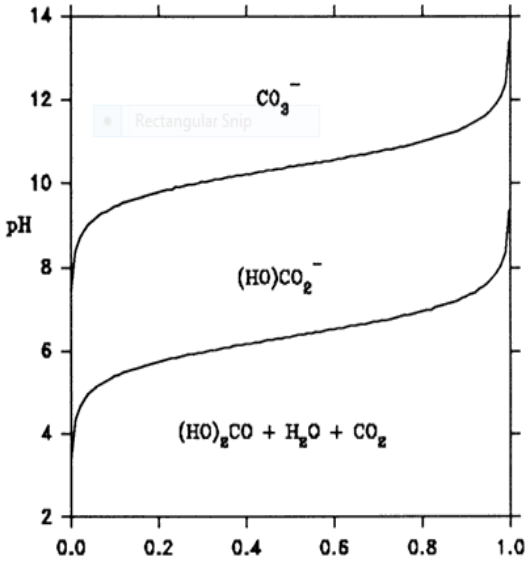


Fig 3: Relation between pH and Carbonate ions[20]

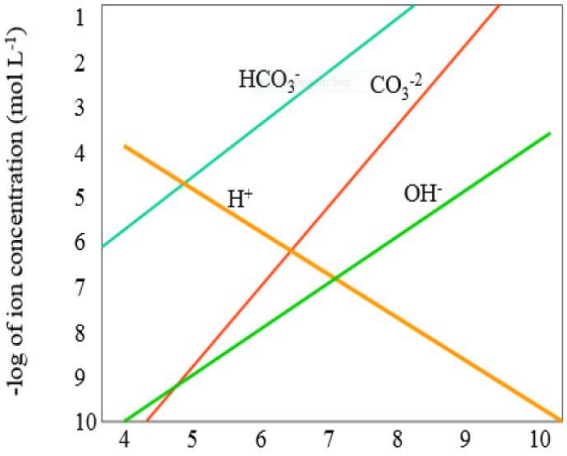


Fig 4: pH Relation ion concentration with pH value[6]

Material and method of research Work

For determination of Soil pH, done following steps:

1. Sampling soils from different points and also water wells of studying area,
2. Measuring pH value by field pH-meter,
3. Measuring water pH in water wells at study area.
4. Analyzing data by correlation with salt concentration in soil,
5. Studying of scientific Journal, books published since 2009 up-to 2020 related to it.

For research activities due to limited possibilities, used the equipment as follows:

1. Pocket pH-meter,
2. Electro Conduct ivy-meter for measuring TDS,
3. Knife to dug earth for sampling soil,
4. Plastic bag,
5. Bottle for taking water from well.
6. Cylinder for measurement.

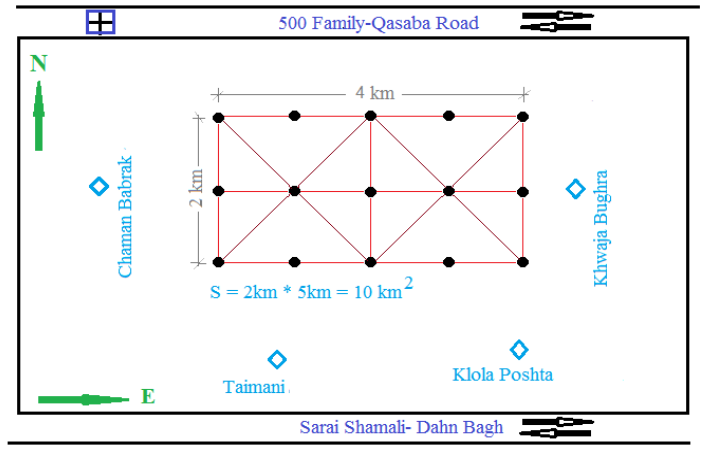


Fig 8. The Research studying Field In Northen Kabul city.(Sourse, by Authur,2020).

Legends:

region

Soil sampling point

Square

From each point token (3) samples: from soil surface, from (15) cm and (40) cm depth and then tested pH soil after preparing soil slurry.

Tab 1: pH value variation at water well in studying area.

Well No	TDS (g/lit)	PH
131	0.40	7.57
132	0.41	7.2
133	0.5	7.4
147	0.56	7.75
148	0.92	7.64
149	0.86	7.75
150	0.7	7.44
151	1.4	7.85
152	0.9	7.55
153	3.7	8.25
154	3.72	8.25
155	1.04	7.93
156	1.05	7.95
157	2.82	7.5
Domestic well	14,8	8.4

Results and Discussion

The soil sample token from surface, (15 cm) and (40cm) at (15) points in studying area shows the pH increasing from surface to depth. The soil pH Maximum Value about 8.3 in Chaman Babrak (11^{th} district), and Minimum value about 6.1 in Char-Qala(Wazir-Abad, 4^{th}district). Besides, soil samples also token from water well at different depths (20 –140) m. The measuring pH value and TDS from (14) well in studying area written in Tab 1. As from Table 1 data correlation between TDS and PH value seen, the relation between them is linear i.e. at point 153 with increasing TDS value to 3.7 g/lit, the pH value going Up until 8.25, but in some cases (partly) such as point 131 and 133 we can see versus ratio. Comparison between Ground water pH in different water wells depth with surface soils shows, that the salt concentration in water higher than soil, which refer to past historic of region as old lack depression deposits. The explanation for this phenomena is that at low pH, H^{+} competes with the Cu^{++} for complications with the organic matter. As the pH increases, more of the Cu can be completed with the organic matter and less is therefore adsorbed by the clay. This phenomena has important implications with regards to the practice of liming acid soils to raise the pH increasing metal retention. In soils with significant levels of dissolved organic matter increasing soil pH may actually mobilize metal due to complex formation. The usage of different agricultural fertilizer in soil without doubt bring some abnormality and varieties at soil PH. Actually a number of fertilizer such as Ammonium phosphate, sulfate, chlorine, potassium, Super phosphate and Sulfur decrease soil PH, meanwhile some other fertilizer such cyanide, Sodium Nitrate, Calcium Nitrate and animal's fertilizer decrease it. The effect of Micro-organism action during Humusation of remaining organism particles also could make change at Soil PH, because the final or in other words out-coming decay soil material has specific PH value, which differ from others.

The owing (up and downing soil layer) agriculture action also might be bring change at soil PH, because the owing action and afterward watering field (earth) obtain soil washing phenomenon, which Cause the migration of salt from top layers to deep soil layers .Finally, one region with similar soil, might be the differences of PH between agricultural soils and non-agricultural (derelict) soils. That needs for more measurement and investigation, who might be done by next followers. Finally, the outcome of research shows:

- The decay of Organic materials cause pH reduction.
- The usage of Ammonium Nitrate and Sulfate Nitrate also could cause soil acidity.
- Adding Iron Sulfate reduce soil pH.
- PH value variation has seasonal characteristic.

- The pH amount increased with increasing depth of soil.
- In general, maximum retention of cationic metals occurs at pH>7 and maximum retention of anionic metals occurs at pH<7.
- pH value of soil is decreasing day by day by acid - rain, industrial residue, fertilizer, insecticides etc.
- The Chapman Babrak (in center of depression) has very high pH than other place. The area known as Alkali NE's soils.
- The salty soil at surface in research area contained more SO_4 radical in form of $MgSO_4$ and Na_2 SO_4.

Experimental result shown that the shear strength increase with increase of pH values of soil. Shear strength of granular soil is increase with increase of pH value. So if we want to increase shear strength of acidic soil we have to increase pH value. Neutral mixing water is desirable for concrete in any case. A concrete with pore solution with a pH less than 6 can quickly corrode down steel reinforcement and also corrode the concrete mix. It makes the concrete excessively porous with the passage of time and the increase in porosity speeds up the corrosion process. The most common amendment to increase soil pH is lime (CaCO3 or MgCO3).

Conclusions

The pH of the soil is very important parameter, because it has influence on adsorption/desorption, precipitation/dissolution, and also oxidation-reduction reactions. Without any doubt the climate, topography, and parent material have varied influence on soil pH in different horizons. The relationships between soil pH and the soil-forming factors in different horizons different in north Kabul depression. The results of testing indicated that the values of soil pH increased along the horizon gradient from the A to C horizons. Different soil-forming factors played different roles in the three horizons. The Chaman Babrak as center of Kabul North region Depression known as Alkaline Soil with very High pH and High CO_3 Ions. The pH amount increased with the usage of fertilizer and depth of soil profile. Shear strength of granular soil is increase with increase of pH value. The most common amendment to increase soil pH is lime (CaCO3 or MgCO3).

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