The effects of different types of land - use on the soil

by

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Abstract

The purpose of this literature review is to outline the effects that different land - uses can have on the soil. Soil health is defined as the capacity of the soil to function as a vital ecosystem that is able to sustain plants, animals, and humans. The fir st section of this review covers the soil's ability to support all these ecological functions thanks to its fundamental constituents such as its organic content, chemical nutrients, physical characteristics, moisture, microbial diversity and cation exchang e capacity. The second and third sections discuss the use of the land for agriculture and forests respectively. The type of agriculture featured in the second section is industrial agriculture and its negative effects on the soil are thanks to monocropping and pesticides are discussed. The third section covers the naturally occurring growth of forests and what kind of effects that can have on the soil which are for the most part ecologically positive(Supports carbon fixation, biodiversity, and prevents eros ion).

0.0 Literature review methodology .

The initial databases chosen for the literature cited in this review were obtainable thanks to the SUNY Purchase library which enables students to search and acquire reputable journals, books, and articles from credible sources. From the SUNY Purchase library's tools, literature pertaining to soil health, agricultural soil effects, forest soil effects, and soil degradation consequences were obtained. Via the SUNY Purchase library search functions the primary databases that were used were Environment complete, JSTOR, EBSCOhost, Science direct, and biological abstracts. From these initial databases and articles that were read and cited from there were also further sources within their reference sections which allowed for additional databases and citable sources that could be used within this review. These additional sources included university presses(such as the University of California and Oxford university press), university extensions that included Cornell and Ohio State Universities, as well as other online databases that provided free PDFs which included Worldcat, Researchgate, Nature.com, and Hindawi. Lastly, both the initial databases from the Purchase library and the additional databases obtained from further research yielded other independent scholarly works that also allowed for more data relevant to the topic of soil components, agricultural/forest land use, and or soil degradation. These independent works included the following books and journals: Soil Taxonomy: a Basic System of Soil Classification for Making and Interpreting Soil Surveys, Plant Ecology, and Horse Pasture Management. Overall, the literature ranged from the dates of 1981 to 2020. These works were all chosen for their comprehensive knowledge on the subject matter of soils, numerous citations from other scholarly works which landed them credibility, as well as the ease in which they were able to be obtained as they all did not require payment to be viewed.

The way that the data obtained from these articles is organized is based on the sections of the paper for which they were able to provide the most information for. The paper's four primary sections(Fundamental Soil components, Agriculture effects, forest effects, and soil degradation) are all built around the literature relevant to their subject. While each section features numerous sources, there is a select core of literature that provides the bulk of the information featured per section. Within each section of the paper, the literature chosen is further discussed in terms of its contents such as the methods used, how old the data is, or if there have been any further amendments made to correct previous misunderstandings.

1.0 Fundamental soil components: INTRODUCTION .

All the literature examined agreed that there were multiple components of the soil that allowed it to be a fertile medium for terrestrial plant life and a supportive part of an ecosystem. Some sources also stated the importance of soil for not only its ability to grow plants but also its ability to ecologically support the earth by filtering water and recycling pollutants from the ground(Mancl, Karen. 2016). On top of this, *"Soil Taxonomy..."* provides the detai l that soil provides food, fibers, and drugs to support the economic functions of human society(USDA, 2002). The soil components that are discussed are chronologically ordered as follows; 1) organic matter content, 2) physical characteristics, 3) chemi cal components, 4) microbial life, and 5) cation exchange capacity. These essential qualities of the soil that enable it to foster life are detailed in the next subsection.

1.1 Fundamental soil components .

1. *"The Health of Our Soils: toward Sustainable Agriculture in Canada"* and *"Soil respiration and the global carbon cycle* " provided most of the source literature on organic matter. The information both works provided was built on earlier data and research done before by other researchers. The data provided while decades old is still accurate in regards to information on organic matter. Organic matter refers to the detritus that can be found both above and below ground. Organic matter can be derived from a variety of sources such as decaying animals, plants, and even waste(animal dung, urine, and even human feces). The quality, composition, and quantity of this organic matter and detritus can influence many dynamics such as plant growth, forest productivity, and even rate of decay of surface materials (Schlesinger and Andrews, 2000). Both "Soil respiration and the global carbon cycle" and "The Health of our soils" cite that the loss of organic matter in soils appears to have a negative effect on the land's ability to grow plants. The age of both works despite being over a decade old, is still relevant and the information they give on organic soil content has yet to be disputed. Not only does the presence of organic matter in the soil affect its ability to support plant life but it can also influence microbial life forms(which are essential for both biodiversity and plant vitality) as an active population of microorganisms in the soil requires a suitable supply of compostable material (Acton, D. F., et al. 1995).
2. Physical characteristics, while not an official definition, refers to the soil's non - chemical and structural features and they are a second quality that can severely affect its health. Physical characteristics are simply a catch - all term used only in this review for the information on soil physicalities found in the literature. These physical characteristics

consisted of two main components, a) texture and b) structure. The literature that provided the most information on the soil's physical characteristics were: 1) "*Quantifying the ability of environmental parameters to predict soil texture fractions using regression - tree model with GIS and LIDAR data: the case study of Denmark.*", 2) "*Soil Taxonomy: a Basic System of Soil Classification for Making and Interpreting Soil Surveys*", and 3) "*Soil Mapping and Process Modeling for Sustainable Land Use Management*". All three sources provided information on the importance of soil texture but *"Soil Taxonomy"* was able to provide the most information pertaining to soil structure. In "*Quantifying the ability of environmental parameters..."* Geographic Information Systems (GIS) and regression - tree modeling were both used to detect the relationships with soil textures and the environment(Elevation, slope gradient, and curvature) to provide information on how the land's effects on soil textures can influence land productivity. The methods of "*Soil Taxonomy..."* featured extensive use of pedons or 3- dimensional soil samples to properly show soil texture but did not explain in too much detail the effects it could have on the soil's productivity. *"Soil Mapping..."* had the most relevant data on physical soil characteristics in it's 7th chapter; "*Modeling Agricultural Suitability Along Soil Transects Under Current Conditions and Improved Scenario of Soil Factors"*. The chapter featured research done in Northern Spain where land transects were investigated and the soil's ability to support growth was observed against characteristics such as its texture and structure.

a. Soil texture refers to the relative percentage of sand, silt, and clay particles within a soil layer. The texture of different grain sizes/texture can range from small grains that yield a smooth poorly drained soil type known as clay, to rough easily permeable large grain soils that are known as sandy. The texture of the soil can heavily influence its aeration, its ability to hold water, and its capability to resist erosion(USDA, 2002)(Lyles, Leon & Tatarko, John. (1986). Soil aeration or porosity refers to the ability for resources such as oxygen and water to pass through the soil(USDA, 2002). The soil's ability to hold water is important as having enough water in the soil is essential to foster life however too little or too much can have drastic consequences on the soil's capacity to sustain any organisms(Acton, D. F., et al. 1995). The third and final point on the ability of soil to resist erosion is important for the purposes of protecting the land from serious changes in the biosphere that can occur such as landscape transformation(Sameh K. et al, 2017). Soil texture is an important soil property that supports crop production which the researchers of "Quantifying the ability of environmental parameters to predict soil texture fractions using regression-tree model with GIS and LIDAR data: the case study of Denmark." were able to find when the percentages of sand, silt, and clay in the soil affected its vulnerability to being affected by precipitation which tied back to the soils ability to remain suitable for growing plants (Greve et al., 2012). Soil particles may be either mineral or organic but in most soils, the largest proportions of particles are mineral and these soils are therefore referred to as "mineral soils"(Sameh K. et al, 2017).

b. Soil structure differs from soil texture in that soil structure refers to the arrangement of individual particles within the soil rather than their specific abundance. They are similar however in that both structure and texture can affect the soil's ability to hold nutrients and be permeable enough for water to reach plant roots. The structure of the soil is classified in "Soil Taxonomy'' by 6 principle types 1) granular, 2)plated, 3)prismatic, 4)blocky, 5)aggregated, and 6) massive. Granular and aggregated soil structure is the most permeable of the soil structure types and found mostly near the surface(USDA, 2002) and its importance lies in its ability to allow for permeability for ease of water and nutrient transports. An overabundance of plated and massive soil structure near the surface(Both of which have very low permeability) can result in poor flow of nutrients and water through the soil which can cut off access to water from plant roots.

3. The chemical composition of the soil is also vital for its health, and in turn the health of the ecosystem. The primary chemical components of the soil that are to be discussed are: a) pH, b) nitrogen, c) oxygen, and d) soil moisture. *"Elements of the Nature and Proper ties of Soils", "Metal Speciation and Contamination of Soil",* " *Soil erosion and agricultural sustainability"* and " *Structure formation and its consequences for gas and water transport in unsaturated arable and forest soils"* where the primary literary source s for information on chemical composition featured in this review. The data found in these sources was all compounded information from a multitude of other research obtained from other works and there was no real field data collection done by the authors a t all. However this does not discredit the validity of their information which was not only comprehensive but had little gaps in knowledge and while all these sources are from the early 2000's their results have not been disputed in any way.

   a. **pH.** The pH of the soil is a measure of its acidity or alkalinity. The acidity or alkalinity of the soil will heavily affect its solubility to nutrients and minerals (U. Förstner, 1995). It is considered beneficial to have a soil pH measuring from 6 to 7, as too low (too acidic) a pH will allow for an excess of soluble metals(like Aluminium and Cadmium) that are toxic to plant growth while too high/too alkaline a soil pH will prevent the soil from having any availability of precious nutrients and minerals (H. B. Bradl, 2004).

b. **Nitrogen** .The technique where Nitrogen can even arrive at plants is the Nitrogen cycle. Deficiencies in Nitrogen within the soil can be detrimental to plant growth. One consequence is that trees can have a decreased photosynthetic ability and leaf Nitrogen content(Tang, J., Sun, B., Cheng, R. et al. 2019). The nitrogen cycle is a pattern of procedures during which nitrogen travels through both living and nonliving things: the air, soil, water, plants, creatures and Bacteria(Brady, N., & Weil, R. 2010). In the air, nitrogen exists as a gas (N_2) which is unusable by plants in its gaseous state. Yet in the ground it can exist as nitrogen oxide(NO), nitrogen dioxide(NO_2), and Nitrate(NH_3) which can be readily absorbed by plants via their roots in the soil.

c. **Oxygen** . Like the chemical element of Nitrogen, Oxygen content of the soil is an important element for plant growth. One method in which Oxygen is able to be taken into the soil is via the oxidation of H2O in the soil. Another way Oxygen is able to enter the soil is via diffusion from the air which is dominant. Reduced concentration of oxygen in the soil affects plant physiological processes such as nutrient and water uptake as well as respiration, and redox potential of soil elements. Plants grown in soils that lack Oxygen in a lab setting are shown to have lesser total plant biomass, particularly seen in their roots(Chérif, M.,et al, 1997). The main mechanism of oxygen transport in the soil is by diffusion, a dynamic process greatly influenced by soil physical properties such as texture and pore size distribution,(Neira, Jose et al, 2015). Wider and bigger pores in the soil will allow more diffusion of gases into and out of it than smaller pores will(Horn, R., and A. Smucker. 2005). Soil texture refers to its particle sizes and their distribution within it. The organization of the particles and their size is thus another factor affecting the rate at which oxygen is able to diffuse into the soil. Soils with higher concentrations of smaller particles result in poor gas transport and greater gas retention . This can be the result of soil compaction and have the unfavorable effect of decreased levels of plant growth(Czyz, E.A. 2004).

d. Soil moisture or Hydrologic regime refers to the water found in the soil and it is significant for it gives the soil the capacity to support life (Paul Voroney, 2019), however it likewise serves to tie and secure the physical particles in the soil structure and is the medium by which elements and nutrients are absorbed by plants(Brady, N., and Weil, R. 2010.). Without water, plants cannot develop and all plants need some water. Many agricultural plants require higher amounts of water(such as rice and sugarcane), and need more extensive irrigation on top of other normal wellsprings of water obtained from the hydrological cycle such as rain.

4. The literary source that provided the most information on microbial life was *“Ecosystem services provided by the soil biota”*. While many other works featured in this review do mention soil microbes such as *“The Health of Our Soils: toward Sustainable Agriculture in Canada" and “Elements of the Nature and Properties of Soils",* Brussaard’s article

"Ecosystem services provided by the soil biota" was by far the most comprehensive in regards to soil microbiology. As well as being relatively new(<10 years old), Brussard's article is very well suited for those seeking information solely on soil microbes as it does not discuss in detail other aspects of soil health such as texture or structure. The article, like many other sources featured in this review, combi ned data obtained from other researchers. What was found is that there are actually many types of bacteria and fungi that are in the soil, performing various tasks that are vital to its health. The types of organisms that can be found include bacteria, fun gi, and protozoa. These organisms are primary decomposers of organic matter, but they do other things, such as provide nitrogen through fixation, detoxify harmful chemicals, suppress disease, and produce products that might stimulate plant growth(Brussaard L. 2012).

5. Cation exchange capacity (CEC) is the total capacity of a soil to hold exchangeable cations/positive ions. The two literary sources that were found to be the most comprehensive on CEC were *"Interpreting Soil Test Results: What Do All The Number s Mean " and " Cation Exchange Capacity (CEC). Agronomy Fact Sheet Series # 22". "Interpreting Soil Test Results"* was actually a full book of which only the section that featured cation exchange was reviewed. "(*CEC). Agronomy Fact Sheet Series # 22"* was a brief but dense article released by the Cornell University Cooperative Extension. Both sources were very detailed in the importance of the soil's lesser known ability to exchange cations. It is a very important soil property influencing soil structure st ability, nutrient availability, soil pH and the soil's reaction to fertilisers and other ameliorants (Hazleton and Murphy 2007). Clay soil particles and organic matter components of soil have negatively charged sites on their surfaces which hold positively

charged ions (cations) by electrostatic force. This electrical charge is critical to the supply of nutrients to plants because many nutrients exist as cations (Such as Mg and K). In general terms, soils with large quantities of negative charge are more fertile because they retain more cations (McKenzie et al. 2004). The main ions associated with CEC in soils are the exchangeable cations calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}) and potassium (K^{+}) (Rayment and Higginson 1992). Soils with a low CEC are more likely to develop deficiencies in potassium (K^{+}), magnesium (Mg^{2+}) and other cations while high CEC soils are less susceptible to leaching of these cations (CUCE 2007).

1.2 SUMMARY .

Organic content, physical characteristics, chemical components, microbial life, and cation exchange capacity were the five main soil features that the literature of this section universally agreed to be important to the productivity of the soil. Any lack in quality of these five features can cause the soil's ability to support life to deteriorate.

2.0 Agriculture: INTRODUCTION .

The literature that provided the most comprehensive information on the effects of industrial agriculture on soils were as follows: " *A study of the effects of land use changes on soil physical properties and organic matter", "Dirt: The Erosion of Civilizations", "Soil health in agricultural systems" and "The European Atlas of Soil Biodiversity* . Most of these sources all used the same technique to acquire their data on agriculture's effects on the land. Their methodology involved compiling a wide variety of data from sources such as the USDA and the UNEC E, providing information on the ways agriculture in parts of the world such as the US and EU can affect the soil. In the case of *"Dirt: The Erosion of Civilizations";* historical data on an international scale was the primary method used to summarize their findings. Communities in the Amazon, Tibet, Indonesia, and Guatemala were all areas that were examined for signs of soil deterioration due to land use, which included use for agricultural purposes. Industrial agriculture was found to be detrimental and result in the soil's essential components(such as its organic matter, physical stability, nutrient availability, etc) to decline(Haghighi F. et al, 2010). The data in al l sources indicated that industrial agriculture was also responsible for immense losses in soil biodiversity and the soil's resistance to erosion.

2.1 Agriculture: Soil effects .

Most of the agricultu ral output in first world countries is derived from industrial agriculture(USDA, 2020) which is the kind of agriculture that was examined in this literature review. Industrial agriculture entails the heavy usage of pesticides, heavy - duty vehicles, and exte nsive usage of the same land over and over again(Haghighi F. et al, 2010)(Al - Kaisi, Mahdi 2004). In addition, Industrial Agriculture requires extensive resources in order to be productive, these resources being primarily water, fertilizer, and fuel, which in turn require their own resources and energy to be procured in their own right(D. R. Montgomery, 2012). As such, the effects of industrial agriculture on soils examined in all the literature reviewed can be summed up in 3 major parts: 1) erosion, 2) nutr ient depletion, and 3) loss of biodiversity.

1. Erosion in agriculture occurs when the soil is irrigated and tilled(Haghighi F. et al, 2010). Industrial agriculture in turn requires intensive irrigation and tilling most often done by machinery which can multi ply the effects of erosion to the point where soil production is

vastly outpaced by soil erosion(D. R. Montgomery, 2007). Around the world, topsoil layers are being eroded away at much faster rates than they are replenished. And according to David Montgomery, a geologist from the University of Washington, at least one percent of American top soils are being lost each year due to erosion with the primary cause of this being agriculture (D. R. Montgomery, 2012). The results of the soil being eroded from agricultural practices is multifaceted. The topsoil can become so loose that it can be easy enough for it to be carried away by run-off water or even the wind (R. Montgomery, 2007). This can also occur when agricultural practices leave the soil without any sort of adequate plant cover which can have the consequence of exposing more soil to surface runoff and wind (Singer, M. J. & Munns, 2006)

2. Nutrient depletion in the soil can happen from farming and its effects can be compounded with erosion that can be derived from excessive farming practices. Multiple sources cite how monocropping is one Industrial agricultural practice that can heavily deplete the soil of essential nutrients such as nitrogen, phosphorus, and potassium (Sustainable Agriculture Research & Education, 2012). Depletion of Nutrients and usage of more artificial fertilizers also has the added consequence of lowering the soil's microbiological diversity(Paungfoo-Lonhienne, Chanyarat et al. 2015) as some fertilizers may favor certain pathological strains due to different nitrogen, phosphorus, or potassium levels which can different than the soil's native nutrient composition(Zhou, Jing et al.2017)
3. Biodiversity loss in the soil is another consequence of agricultural land usage. Biodiversity of the soil refers to the variety of organisms that live within the soil as well as the range of ecological relationships that they are a part of. It is estimated that nearly ¼ to ⅓ of the world's entire

biodiversity is found within the soil (Jeffery S et al, 2010). Most of the biodiversity of the soil can be grouped into five major categories: Bacteria, actinomycetes, fungi, and protozoa, with their differences being both in size and function. The most significant source of biodiversity loss from agriculture is from erosion(Orgiazzi, A. & Panagos, P, 2018) as erosion can expose the lower levels of the soil where microbial life resides. Other agricultural techniques that can deteriorate soil biodiversity include monocultures, excess pesticide application, and compaction of the soil due to heavy machinery (Wachira P. M. et al, 2014).

2.2 SUMMARY .

Land used for industrial agriculture was ultimately observed to be very detrimental to soil health in all literary sources on the subject matter. The effects of erosion, nutrient depletion, and biodiversity loss from industrial agriculture all appeared to be getting worse as industrial agricultural practices often involve using the land over and over again without paying too much heed to the state of the soil(Kibblewhite, M G et al. 2008).

3.0 Forests: INTRODUCTION .

This section covers forest land-use of which there were two primary sub-types; undisturbed and disturbed. The purpose of this division is to properly highlight how all lands that are considered “forests” are not always equal in terms of their soil quality thanks to human activity. In contrast to the land used for industrial agriculture, land-use for the purpose of undisturbed forest growth was observed across many literary sources such as reports released by the UNECE, UNESCO, and EPA, to have bountiful benefits on the soil. These ranged from enhancing its ability to resist erosion to allowing the soil to harbor greater diversities of microbial life and higher levels of organic content. These sources were selected for this section not only for their credibility but also because when compiled together, they provide a global view on the relationship between forest soils and human activity. The literature covers temperate forests across Western Europe and North America, tropical forests in eastern Nepal, and warm forests in Argentina. The fact that the literature was able to show similar relationships between human disturbance, forest growth, and soil health despite how geographically far apart the data was in each source allows for an excellent insight on how soil science is an international field not limited by man-made borders. Undisturbed forest growths were overall observed to have positive effects on soil health in all the literature reviewed. Contrary to this were disturbed forest growths which experienced extensive human activity and displayed less healthier soils. The literature for undisturbed forest growths also made great mention of disturbed forests and in all sources, it was universally revealed that disturbed forests soils that were more vulnerable to negative outcomes such as erosion and biodiversity loss. This section contrasts disturbed and undisturbed forest soils on 4 criteria: 1) nutrient cycling, 2) microbial diversity, 3) carbon storage, and 4) vulnerability to erosion and runoff.

3.1 Forest: Soil effects .

Forest growths are subdivided into two main groups in this paper, natural undisturbed forests and disturbed forests, and their different effects on the soil were investigated. Undisturbed forests comprise the world's woodland that do not experience extensive direct human interaction such as woodfelling and land-clearing for the purpose of farming. For this paper the definition of undisturbed woodlands shall be that of the Economic Commission for Europe of the United Nations' also known as the UNECE. The UNECE states that undisturbed forests must display natural dynamics such as dead wood occurrence and natural regeneration along with having no significant human intervention or to have recovered from any previous human disturbance and being able to display natural dynamics again(UNECE, 2000).

Disturbed forests on the other hand comprise global woodlands that experience human interactions and as such tend to be in a far more fragile state due to extensive lumbering and land clearing. Disturbed forests fail to meet UNESCO's definition of a natural forest as disturbed forests often display poor ecological dynamics(Such as nutrient recycling and carbon storage) and frequent human interaction. In this paper, disturbed forests are defined as forests that are currently experiencing or have experienced any sort of extensive anthropologic activity which can include tree-felling and clearing land for the purpose of farming or settlement construction.

The main ways in which these two forest sub-categories affect the soil differently are as follows

1. Nutrient cycling
2. Microbial diversity
3. Carbon storage
4. Erosion and Runoff

1. Nutrient cycling refers to the system where matter is converted and transferred among organisms in a forest. A large part of the nutrient cycle occurs with the aid of the soil, and it is important for not only plant life within the forest but for animals as well. Without a proper nutrient cycle, grazing animals would find little amounts of edible plant matter as

these plants that grazers rely on, are in turn heavily reliant on a proper nutrient cycle to grow (I. C. Meier, C. Leuschner, and D. Hertel, 2005). The sources for this section all summarily concluded that disturbed forests tended to have far fewer nutrients(nitrogen, potassium, and phosphorus) stored in its soil which in turn led to a decrease in nutrients in the forest foliage (T. P. Gautam and T. N. Mandal, 2016;) (Mou, Pu, et al. 1993). However undisturbed forests

2. Microbial diversity within disturbed and undisturbed forests refers to the vast array of microorganisms living in the soil. These microbes are the aforementioned bacteria, actinomycetes, fungi, algae and protozoa. These tiny creatures are essential to the survival of a forest for multiple reasons, them being mainly the act of water dynamics, nutrient cycling, and disease suppression. However disturbances within a forest can have detrimental effects on its soil and in turn the microbial organisms within it. Without these microbes, forests would be unable to perform vital natural transactions such as nitrogen fixation, decomposition of materials, and the storage of groundwater. Research showed that disturbances within forests such as clear cutting for agricultural purposes caused a decrease in the diversity of microbes within the soil by almost half (Marta Cabello & Angélica Arambarri, 2002).
3. Carbon storage in forests is the process where forests became massive reservoirs of natural carbon where gaseous carbon is taken in and solid carbon in the form of biomass(both living and dead) is stored. While soils can already become significant pools of Carbon as discussed previously, forests can intensify the concentration of carbon stored in the soil thanks to debris/organic material from the canopy and plants. Most forests keep their solid Carbon storage within the soil which in turn can be utilized to foster life, which is more often than not plant

growth. For example, in 2016 the EPA found that across 48 states and southern Alaska(excluding Hawaii and north Alaska), forests had the majority of their carbon stored in their soil(almost 52 percent), while the rest was made up of mostly above ground biomass(EPA, 2018). While in undisturbed forests,Carbon storage capacities are relatively unhindered, the act of human disturbance such as logging and clear- cutting can severely hinder the forest and in turn the soil's ability to hold carbon. This loss in forest carbon stores can often be linked to human activities such as logging, understory fires, habitat fragmentation, as well as overhunting(Parrotta J. A. et al, 2012).

3.2 SUMMARY .

Between the two forest subdivisions(disturbed and undisturbed), the results found in the literature confirmed that undisturbed forests provide many benefits to soils which included superior nutrient cycling, microbial diversity, carbon storage, and resistance to erosion. Disturbed forests however demonstrated inferior aspects in all four of these categories. The literature supports that human activity can be detrimental to forest soil health via activities such as clear- cutting(disturbance).

4.0 Conclusion .

The soil's multiple components are what allow it to be a healthy medium to foster plant and animal life. These fundamental components include soil composition and properties such as moisture and physical traits. Land used for agricultural and forest growth can alter the soil's previously aforementioned qualities which in turn can have subsequent consequences on biodiversity and ecosystem health. Natural land usages for the purpose of forest growth can benefit soil health such as improving soil stability(Making it less vulnerable to erosion due to tree and plant roots[SOURCE]), retaining water and nutrients, as well as providing decomposable material that can be readily used by soil microbes in the form dead flora(Ziemer, Robert R. 1981). However the extensive human usage of land for Industrial agriculture has been shown to cause detrimental effects on soil quality, plant life and animal life. The negative effects on the soil derived from land abuse can have lasting effects that are altogether detrimental for the future quality of life on not just animals and plants but human society as well. We do not need to look too far back into our history to see how land deterioration can spell disaster for humanity with examples such as the dust bowl of the early 1900's which could happen even today despite our modern technology.

Works cited

1. Acton, D. F., et al. The Health of Our Soils: toward Sustainable Agriculture in Canada. Supply and Services Canada., 1995.
2. Al- Kaisi, Mahdi, and Iowa State University. "Frequent Tillage and Its Impact on Soil Quality." Frequent Tillage and Its Impact on Soil Quality | Integrated Crop Management, Iowa State University Extension and Outreach, 28 June 2004, crops.extension.iastate.edu/encyclopedia/frequent-tillage-and-its-impact-soil-quality.
3. Bechtold W.A., Patterson P.L.. The enhanced Forest Inventory and Analysis Program – National Sampling Design and Estimation Procedures, 2005U.S. Department of Agriculture Forest Service General Technical Report SRS-80 Southern Research Station. p. 85

4. Brady, N., and Weil, R. 2010. "Nutrient cycles and soil fertility," in Elements of the Nature and Properties of Soils, 3rd Edn, ed V. R. Anthony (Upper Saddle River, NJ: Pearson Education Inc.), 396–420.
5. Brussaard L. Ecosystem services provided by the soil biota. In: Wall DH. (ed.) Soil Ecology and Ecosystem Services. Oxford: Oxford University Press, 2012, 45–58
6. C. E. Pankhurst, "Evaluation of soil biological properties as potential bioindicators of soil health," Australian Journal of Experimental Agriculture, vol. 35, no. 7, pp. 1015–1028, 1995.
7. Chérif, M., Tirilly, Y. & Bélanger, R.R. Effect of oxygen concentration on plant growth, lipid peroxidation, and receptivity of tomato roots to Pythium F under hydroponic conditions. European Journal of Plant Pathology 103, 255–264 (1997).
8. Cornell University Cooperative Extension (CUCE) (2007) Cation Exchange Capacity (CEC). Agronomy Fact Sheet Series # 22. Department of Crop and Soil Sciences, College of Agriculture and Life Sciences, Cornell University.
9. Czyz, E.A. 2004. Effects of traffic on soil aeration, bulk density and growth of spring barley. Soil and Tillage Research 79:153-166.
10. D. R. Montgomery, Dirt: The Erosion of Civilizations, 2nd Ed. (University of California Press, 2012).
11. D. R. Montgomery, "Soil Erosion and Agricultural Sustainability," Proc. Nat. Acad. Sci. (USA) **104**, 133268 (2007)
12. Economic Commission for Europe of the United Nations (UNECE)/ Food and Agriculture Organization of the United Nations (FAO), Terms and Definitions, "Temperate and Boreal Forest Resources Assessment 2000", United Nations, July 1997

13. Environmental Protection Agency (2018). Carbon Storage in Forests. US: https://www.epa.gov/ro
14. Greve, Mogens & Kheir, Rania & Greve, Mette & Bøcher, Peder. (2012). Quantifying the ability of environmental parameters to predict soil texture fractions using a regression-tree model with GIS and LIDAR data: The case study of Denmark. Ecological Indicators - ECOL INDIC. 18. 10.1016/j.ecolind.2011.10.006.
15. Haghighi Fashi, Fereshte & Gorji, Manouchehr & Shorafa, M.. (2010). A study of the effects of land use changes on soil physical properties and organic matter. Land Degradation & Development. 21. 496 - 502. 10.1002/ldr.999.
16. Hazelton PA, Murphy BW (2007) Interpreting Soil Test Results: What Do All The Numbers Mean?. CSIRO Publishing: Melbourne.
17. H. B. Bradl, "Adsorption of heavy metal ions on soils and soils constituents," Journal of Colloid and Interface Science, vol. 277, no. 1, pp. 1–18, 2004.
18. Hillel, D. Out of the Earth: Civilization and the Life of the Soil; University of California Press: Berkeley, CA, USA, 1991
19. Horn, R., and A. Smucker. 2005. Structure formation and its consequences for gas and water transport in unsaturated arable and forest soils. Soil and Tillage Research 82:5- 1
20. I. C. Meier, C. Leuschner, and D. Hertel, "Nutrient return with leaf litter falls in Fagus sylvatica forests across a soil fertility gradient," Plant Ecology, vol. 177, no. 1, pp. 99–112, 2005.
21. Jeffery S, Gardi C, Jones A, Montanarella L, Marmo L, Miko L, Ritz K Peres G, Römbke, J & Van der Putten W. (2010). European Atlas of Soil Biodiversity. Publications Office of the European Union.

22. Kibblewhite, M G et al. "Soil health in agricultural systems." Philosophical transactions of the Royal Society of London. Series B, Biological sciences vol. 363,1492 (2008): 685-701. doi:10.1098/rstb.2007.2178

23. Lyles, Leon & Tatarko, John. (1986). Wind erosion effects on soil texture and organic matter. Journal of Soil and Water Conservation. 41.

24. Mancl, Karen. "Using Soil to Remove Pollutants From Wastewater." Using Soil to Remove Pollutants From Wastewater, 25 Feb. 2016, ohioline.osu.edu/factsheet/aex-745.

25. Marta Cabello, Angélica Arambarri, Diversity in soil fungi from undisturbed and disturbed Celtis tala and Scutia buxifolia forests in the eastern Buenos Aires province (Argentina), Microbiological Research, Volume 157, Issue 2, 2002, Pages 115-125, ISSN 0944-5013, (http://www.sciencedirect.com/science/article/pii/S0944501304700671)

26. McKenzie NJ, Jacquier DJ, Isbell RF, Brown KL (2004) 'Australian Soils and Landscapes An Illustrated Compendium' CSIRO Publishing: Collingwood, Victoria.

27. Mou, Pu, et al. "Effects of Soil Disturbance on Vegetation Recovery and Nutrient Accumulation Following Whole-Tree Harvest of a Northern Hardwood Ecosystem." Journal of Applied Ecology, vol. 30, no. 4, 1993, pp. 661–675. JSTOR, www.jstor.org/stable/2404245. Accessed 2 May 2020.

28. "Natural Resources Conservation Service." Food Web & Soil Health NRCS Soils, www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/health/biology/?cid=nrcs142p2_053865.

29. Neira, Jose & Ortiz, Mauricio & Morales-Salinas, Luis & Acevedo, Edmundo. (2015). Oxygen diffusion in soils: Understanding the factors

and processes needed for modeling. Chilean journal of agricultural research. 75. 35-44.

30. Orgiazzi, A.; Panagos, P. Soil biodiversity and soil erosion: It is time to get married. Adding an earthworm factor to soil erosion modeling. Glob. Ecol. Biogeogr. 2018, 27, 1155–1167.
31. Paul Voroney, Chapter 4 - Soils for Horse Pasture Management, Editor(s): Paul Sharpe, Horse Pasture Management, Academic Press, 2019, Pages 65-79, ISBN 9780128129197,
32. Paungfoo-Lonhienne, Chanyarat et al. "Nitrogen fertilizer dose alters fungal communities in sugarcane soil and rhizosphere." Science Reports, 5(8678) (March 2, 2015). Retrieved May, 8 2019, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5155403/
33. Parrotta JA, Wildburger C, Mansourian S (2012) Understanding relationships between biodiversity, carbon, forests and people : the key to achieving REDD+ objectives. A Global Assessment Report., Vol. 31. International Union of Forest Research Organizations (IUFRO), Vienna, Austria.
34. Sameh K. Abd-Elmabod, Antonio Jordán, Luuk Fleskens, Jonathan D. Phillips, Miriam Muñoz-Rojas, Martine van der Ploeg, María Anaya-Romero, Soad El-Ashry, Diego de la Rosa, Chapter 7 - Modeling Agricultural Suitability Along Soil Transects Under Current Conditions and Improved Scenario of Soil Factors, Editor(s): Paulo Pereira, Eric C. Brevik, Miriam Muñoz-Rojas, Bradley A. Miller, Soil Mapping and Process Modeling for Sustainable Land Use Management, Elsevier, 2017, Pages 193-219,
35. Sassenrath, Gretchen F. "Soil Health Is Important for the Water Cycle." High Plains Journal, 9 Jan. 2018, m.hpj.com/crops/soil-health-is-

important-for-the-water-cycle/article_33711037-31e0-5d38-8a77-083a03d01659.html.

36. Schlesinger and Andrews, 2000 W.H. Schlesinger, J.A. Andrews Soil respiration and the global carbon cycle Biogeochemistry, 48 (2000), pp. 7-20

37. Singer, M. J. & Munns, D. N. Soils: An Introduction, 6th ed. Pearson Education Inc., 2006.

38. Soil Taxonomy: a Basic System of Soil Classification for Making and Interpreting Soil Surveys. Soil Conservation Service, U.S. Dept. of Agriculture, 2nd edition, 2002.

39. Sustainable Agriculture Research & Education. "Rotations and Soil Organic Matter Levels." SARE, (n.d.) Retrieved April 23, 2020, from https://www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Crop-Rotations/Rotations-and-Soil-Organic-Matter-Levels

40. Tang, J., Sun, B., Cheng, R. et al. Effects of soil nitrogen (N) deficiency on photosynthetic N-use efficiency in N-fixing and non-N-fixing tree seedlings in subtropical China. Sci Rep 9, 4604 (2019). https://doi.org/10.1038/s41598-019-41035-1

41. T. P. Gautam and T. N. Mandal, "Effect of disturbance on biomass, production and carbon dynamics in moist tropical forest of eastern Nepal," Forest Ecosystems, vol. 3, no. 11, pp. 10–10, 2016.

42. U. Förstner, "Land contamination by metals—global scope and magnitude of problem," in Metal Speciation and Contamination of Soil, H. E. Allen, C. P. Huang, G. W. Bailey, and A. R. Bowers, Eds., pp. 1–33, CRC Press, Inc., Boca Raton, FL, USA, 1995.

43.USDA."Farms and Farm Income," https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/farming-and-farm-income/ Accessed May, 8th, 2020

44. Wachira PM, Kimenju JW, Okoth SA, Kiarie JW. 2014. Conservation and Sustainable Management of Soil Biodiversity for Agricultural Productivity . Sustainable Living with Environmental Risks., Japan: Springer

45. Ziemer, Robert R. 1981. The role of vegetation in the stability of forested slopes. Proceedings of the International Union of Forestry Research Organizations, XVII World Congress, 6-17 September 1981, Kyoto, Japan. vol. I: 297-308.

46. Zhou, Jing et al. "Consistent effects of nitrogen fertilization on soil bacterial communities in black soils for two crop seasons in China." Scientific Reports 7, 3267 (2017). Retrieved May,8 2020, from https://www.nature.com/articles/s41598-017-03539-6