https://doi.org/10.48047/AFJBS.6.2.2024.71-79

AfricanJournalofBiologicalSciences

Research Paper Open Access

Predicted Impacts of Climate and Land Use Changes on Plant Diversity

Dr Selvakumar V[1]*, Hurmat[2],DrRitu Gautam[3], DrAvinash Krishna Goswami[4], Ashish Kaushal[5],Othman Mahjoob Khalaf[6]

[1]Assistant ProfessorDepartment of Maths and Statistics, Bhavan's Vivekananda College of Science, Humanities and Commerce Hyderabad, Telangana. Mail id: vskselva79@gmail.com

[2]Department of Pharmaceutical Science, Swami Vivekanand college of Pharmacy, Chandigarh Banur(Ramnagar) Mail id:khurmat311@gmail.com

[3]Assistant Professor, School of Law, Sharda University, Mail Id: ritu.gautam@sharda.ac.in,Orcid Id-0000-0001-8207-9565

[4]Assistant Professor- LawInstitute - Sharda School of Law, Sharda University, Email id - dravinashgoswami@gmail.com,Orcid Id-0000-0002-8874-7947

[5]Jindal Global Business School, O P Jindal Global University, Sonipat, Haryana, Mail Id: ashishkiitdelhi@gmail.com

[6]College of Education, Al-Farahidi University, Baghdad, Iraq. Mail id: othmanothman@uoalfarahidi.edu.iq

Corresponding author (*):vskselva79@gmail.com

Article History
Volume 6,Issue2, Feb 2024
Received:17Dec 2023
Accepted : 08 Jan 2024
Published : 07 Feb 2024
doi: 10.48047/AFJBS.6.2.2024.71-79

Abstract

The land diversity has been increasingly endangered due to alterations in land use and climatic patterns. This study examines the anticipated effects of changes in climate and land usage on the variety of plants in the Tawang and Lower Subansiri districts of Arunachal Pradesh, India. The research region is characterized by an elevation range of 1900 to 5500 meters above sea level, and it is currently facing risks from the transformation of natural forests and insufficient land management. We collected field survey data from three villages in both districts for the years 2020 to 2022. Climate change consequences are evaluated by taking local knowledge and evaluating the experiences of various age cohorts. The findings indicate a decrease in the degree of forested areas and notable changes in the composition of tree, shrub, and herbaceous species within the examined regions. Local perspectives of climate change encompass observations of altered precipitation patterns, rising temperatures, variations in harvesting seasons, and modifications in water availability. It requires the implementation of location-specific strategies to effectively address the impacts of climate change, especially in remote areas and highlights the urgent requirement to adopt sustainable practices for the welfare of local communities.

Keywords: Climate Change, Plant Diversity, Land Usage Changes,

1. Introduction

The alteration of land use has significant consequences for the diversity of plants, which is an essential element of ecosystems on a global scale (Marques, et al., 2019).Human endeavors such as farming, urbanization, and infrastructure development cause major changes to the arrangement and distribution of plant species in ecosystems.The interaction between changes in land utilization and plant diversity gives rise to concerns over the loss of biodiversity, the segmentation of habitats, and the resilience of ecosystems.Comprehending the intricate

connections between agricultural patterns and plant groups is essential for implementing effective conservation measures and maintaining environmentally friendly land use (Prokopová, et al., 2019). Through the process of understanding and resolving these intricacies, we may enhance our knowledge to develop regulations and procedures that support the preservation of biodiversity and achieve a harmonious balance between human requirements and the protection of the diverse and complex range of plant life on the earth.

It is crucial to anticipate the consequences of climate change to efficiently deal with the difficulties that may arise.Scientific models and analysis offer vital insights into the possible implications of changing climate patterns on environments, economic growth, and society.Theanticipatedeffects of changing climate include greater temperatures, modified patterns of rainfall, and increased occurrence of huge climatic catastrophes.These modifications have extensive effects, including agriculture, water reserves, biodiversity, and human welfare (Mina, et al., 2021).

The combination of climate change and alterations in land use presents an important threat to the variety of plant species, which is crucial for maintaining environmental balance and human welfare.Anticipating the implications of climate change and land usage alterations on plant diversity is an essential academic activity that has effects on the preservation of biodiversity and sustainable utilization of land (Pellegrini, et al., 2021). The direct impact of climatic change on plant environments appears through variations in temperature, alterations in precipitation patterns, and the appearance of severe weather conditions (Díaz, et al., 2019).Meanwhile, human activities such as development and expansion of agriculture increase the pressure on plant ecosystems. This interaction can result in the loss of habitats, the splitting up of habitats into smaller parts, and the disturbance of the natural spread of plant varieties (Yan, et al., 2022). The anticipated effects of these two combined factors are varied and complicated. Due to climate change, plant species might have difficulties in adjusting or relocating to appropriate habitats, which could lead to the disappearance of these species in specific areas.Variations in precipitation patterns can influence the accessibility of water, therefore impacting the well-being of plants and the composition of different species (Harrison, et al., 2020).Furthermore, alterations in land utilization frequently result in the partitioning of habitats, which isolates plant populations and limits the exchange of genetic material, so presenting a greater threat to their ability to adapt and recover (Spicer, et al., 2022).This research aims to determine the effects of improved land usage on species diversity. Additionally, it aims to capture the local community's observations and opinions about climate change in the region.

Newbold, 2018 examined that both changes in land use and climate variability will pose serious risks to biodiversity, possibly even surpassing the consequences of changes in land use. Findings show the preservation of biodiversity and the operation of ecosystems are significantly affected by these discoveries. Peters, et al., 2019 examined ecological functioning and diversity as influenced by land use and weather. Increased land-use intensity leads to increased declines in species in arid rural areas, as well as shifts in animal, plant, and microbe ecosystems. In climate-wise hard areas, climate can alter these impacts, decreasing ecosystem tolerance to changes in land utilization. Velazco, et al., 2019 examined how land use and climate changes affect the geographic delivery of species of plants. The findings showed that the combination of land use and climate change will seriously harm plants, with the largest effects in areas with the highest plant diversity. Le Provost, et al., 2020 investigated crop diversity today and was still shaped by past changes in land use, emphasizing the

significance of taking land-use legacy consequences into account in management initiatives to preserve and replenish diversity. It was important because modifications to land use can slow down biodiversity reactions, emphasizing the necessity for all-encompassing efforts to protect it.

Hof, et al., 2018 examined the impact of climate change and land usage on global vertebrate species diversity. Results show the integrated consequences of changes in climate and land use change are most serious under the growth of bioenergy crops, meaning diversity will suffer in a manner similar to high-level emitting situations. Fonseca, et al., 2019analyzed the implications of potential climate and land use changes on fire incidence. "Fire relative probability (FRP)" variation was found to vary significantly over space, with October exhibiting the largest overall change. An increase was caused by the optimistic climatic land use estimate. The results are raised when both the "representative concentration pathway (RCP)" and sustainability situations are combined. Northrup, et al., 2019 examined the anticipated that alterations in land use and climate would be the main causes of the loss of diversity worldwide. An unusual time collection of excellent quality temperature and land-use data demonstrates how these forces interact to reduce the number of forest plants and birds. Bucak, et al., 2018 examined the structure and services of the ecosystem that are at risk due to agricultural practices and climate change. Land use patterns and changes in climate have an impact on freshwater lakes. Reduced hydraulic and nutritional loads, altered water levels, and a rise in phytoplankton abundance are anticipated future changes that could limit the availability of potable water.

Shrestha and Shrestha 2019 examined the possibility of natural invasion was increased by climate change, especially in areas where invasive alien species can thrive. Considering predicted climatic scenarios, the majority of “invasive alien plants (IAPs)” would spread, with high-elevation landscapes being the most susceptible. These possible effects on ecological services, biodiversity, and livelihoods should be taken into consideration by the administration. Wu, et al., 2019 investigated the production and diversity connections, which are important for forecasting how ecosystems would react to disturbances from humans and changes in the climate. The total primary productivity was shown to be positively correlated with the season of growth precipitation and negatively correlated with temperatures. Temporary fences did not change patterns of production. Marengo, et al., 2018 examined the changes in climate and patterns throughout the forest region, concentrating on local and remote causes. A "die back" in the event that temperature rises above a certain threshold was discussed, as well as effects on the duration of the dry season, fire danger, and forest resiliency. Strategies for management are essential to sustainability over the long term. Dwire, et al., 2018 examined land usage in three situations: businesses as normal, fast economic growth, and environmental preservation. It does this by using the Dyna-CLUE system and Multi-Objective Programming. The model illustrates the expansion of built-up land at the cost of environmental lands, with deterioration being mitigated by ELP measures.

2. Methodology

Study area

The Tawang district (region 1) of Arunachal Pradesh is located in the far northwest of the state. It has an altitude range of 1900 to above 5500 meters above sea level, with an overall geographical area of 2350 square kilometers. The Lower Subansiri(region 2) district in the state, spans an altitude range of 1635–2750 meters above sea level and has an area of 3500 square kilometers.The research area chosen for this research is depicted in Figure 1.

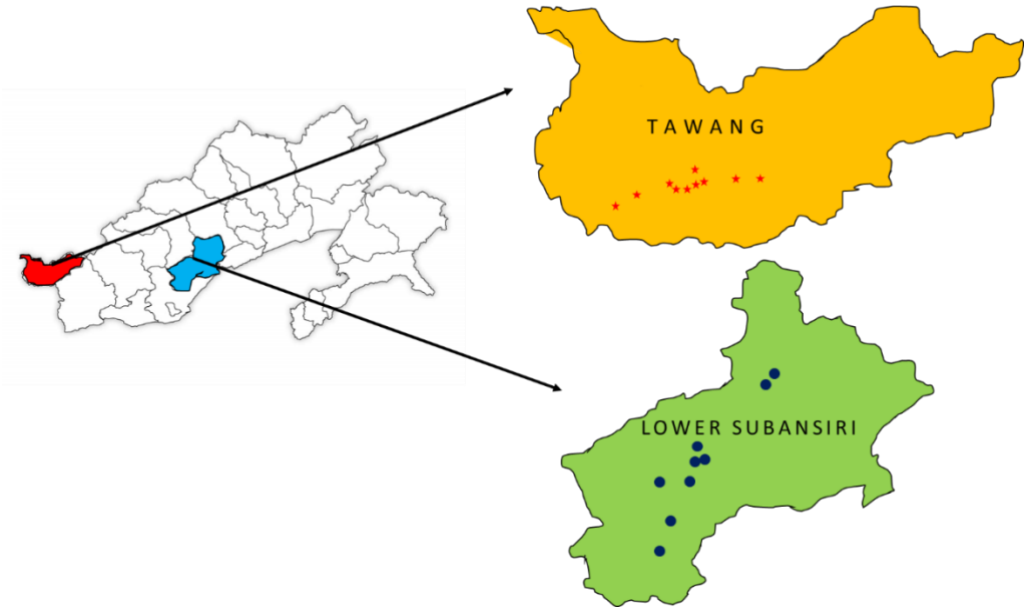

Figure 1: Study area (source: author)

The escalating process of transforming natural forests and insufficient management of land offer significant threats to the environment in the area. Most of the individuals in the state rely on forestry and agricultural resources. The area has experienced a decrease in forest cover of 285 km2 in comparison to the evaluation. The study locations were chosen in areas where natural forests are being converted into other modified land use categories, such as agricultural lands, and grazing lands etc., (Figure 2).

Figure 2: Natural forests (a) Agricultural land (b) Grazing land
(Source: (a) https://www.britannica.com/place/Arunachal-Pradesh/People
(b) https://kaziranganationalparkassam.in/arunachal-pradesh/)

The vision of climate change

Even though there is a lack of comprehensive climate change data for the area, tribes are typically the first to notice changes in weather patterns and their impact on natural resources, water supplies, crop yields, the accessibility of key plant species, and other environments. This study was carried out in three villages from both the Region 1 and Region 2 districts between 2020 and 2022. Data on climate change understanding was collected using individual interviews and standardized surveys. The respondents, both male and female, were classified into three age groups: 15–25 years, 26–45 years, and 46–70 years. A survey was conducted, administered to an overall of 150 responses from each village, regardless of their age class. The agricultural aspect of the survey included information regarding the family members, socioeconomic status, both primary and secondary revenue, and agricultural information such as ownership of land, position, water possibility, and availability of plants, etc. The crops in this research region consisted of rice, wheat, potato, and other varieties.

3. Result and discussion

Plant diversity

The forest study was conducted in the adjacent forest of the improved land usage categories. The area of Region 1 reported an entire of 6 tree species, 8 shrubs, and 8 herbaceous. The tree species was measured to be 17.50 square meters per hectare, as indicated in Figure 3. An overall of 6 trees, 6 shrubs, and 8 herbaceous have been identified in the Valley of the region 2. The tree population was measured at 590 stems per acre, while the shrub and sapling concentration was documented at 8960 individuals per acre. The herb and seedling density was found to be 13,980individuals per hectare. The tree species had a documented area of 19.50m2/ha, as shown in Figure4.

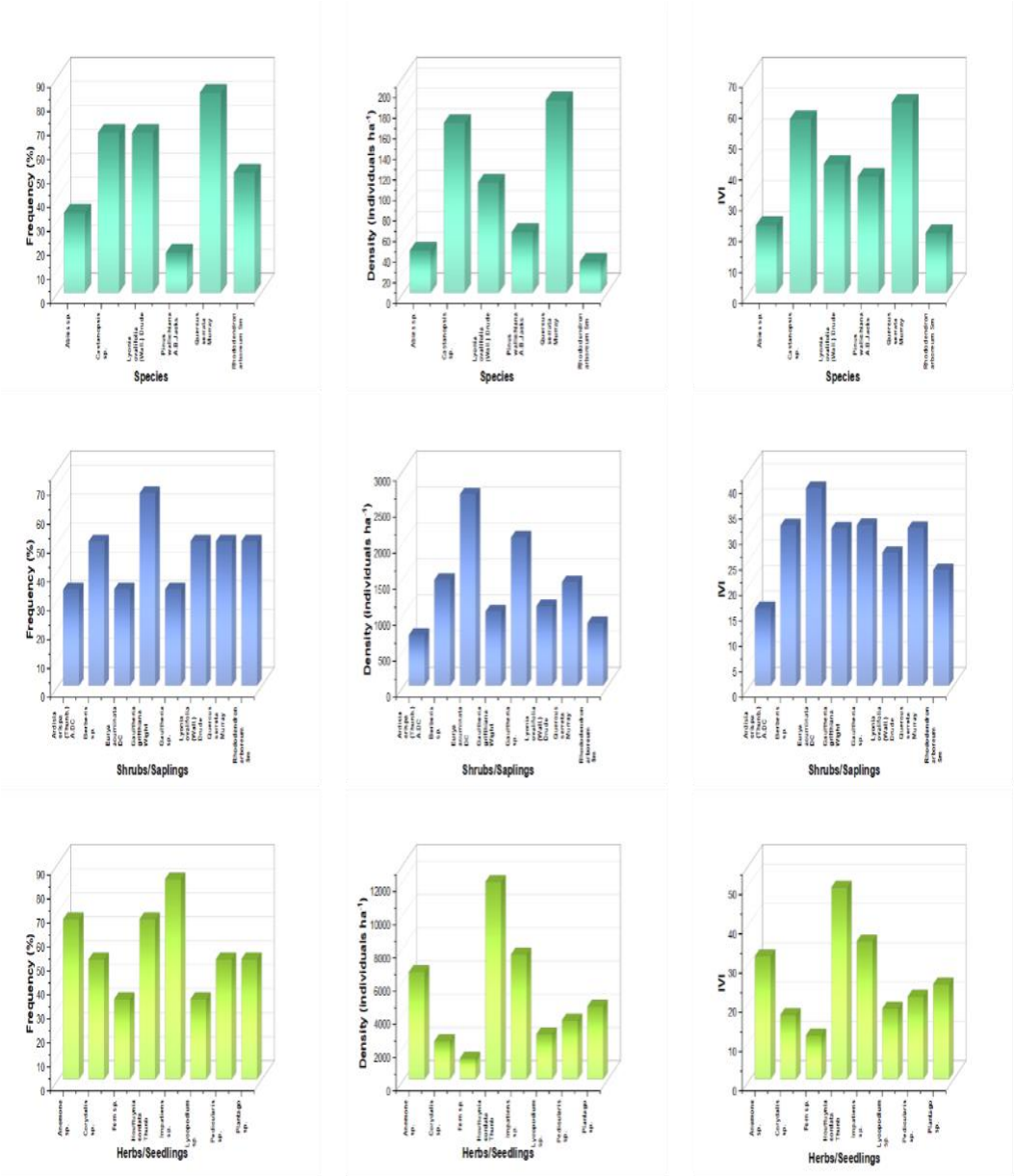

Figure 3: Species of region 1(source: author)

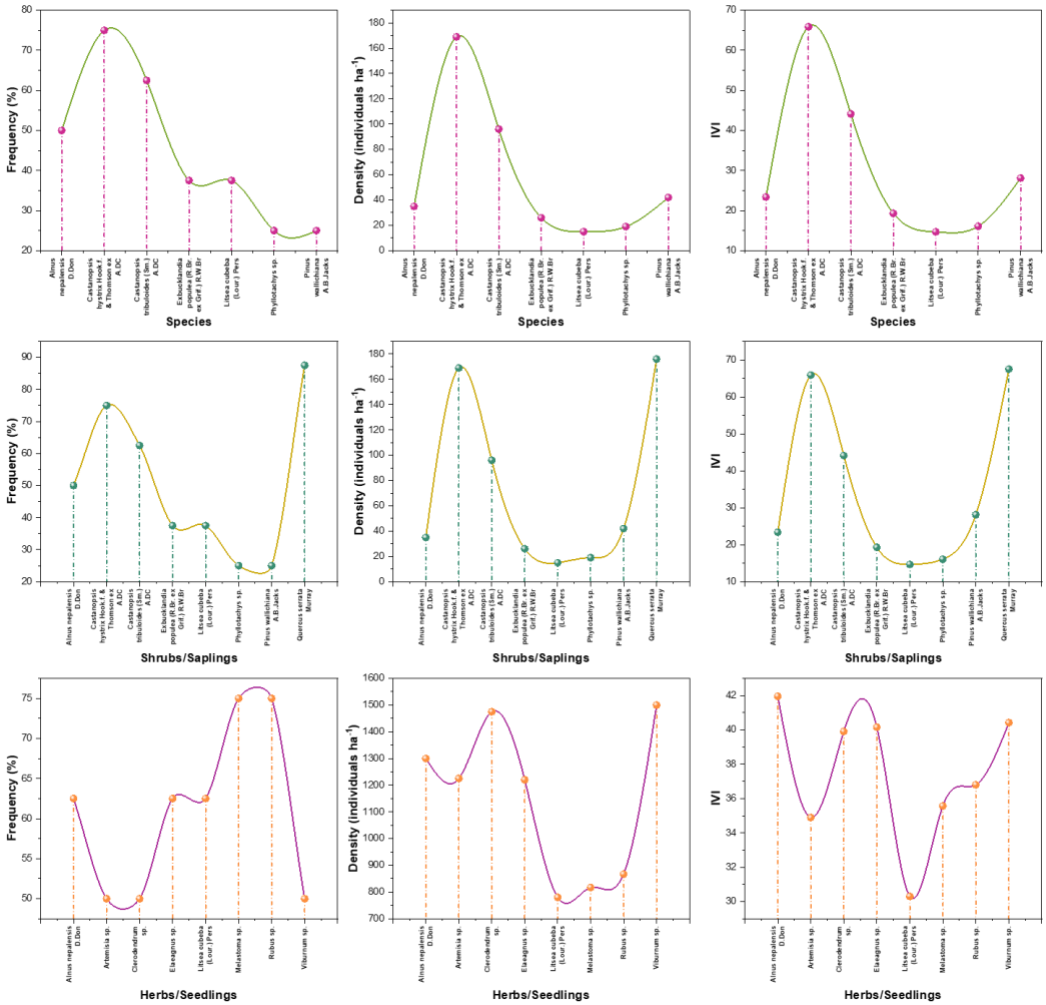

Figure 4: Species of region 2(source: author)

Research of graphical suggestions for climate change

It is an urgent global challenge that humanity is currently facing, which means that we have reached an important point in addressing it. The populations living in high-altitude areas are currently experiencing the effects of continuous climate change, including changes in the weather, rising sea levels, and temperature increases. It has been observed that there has been a shift in weather patterns, frequency of rainfall, and changes in the timing of seasons over the past 15-25 years.Significant variations in the individual reactions of age groups to various environmental variables. The majority of the participants in the older age group observed numerous climate change-related alterations and were willing to convey their opinions freely.In contrast, younger participants were not likely to have seen alterations in the weather and were afraid to share their views on the matter.

The climate change assessments they mentioned consisted of changes in precipitation patterns, rising temperatures, and agricultural tensions such as changes in harvesting time and results, the emergence of new crops, changes regarding water accessibility, and the decline of specific plants in forests nearby (Figure 5).The development of dominating woody species has declined, resulting in a limited distribution of "shrubs and herbaceous species", which have been restricted to certain locations. In addition, they emphasized the decline in the population of local wildlife in this area. We conducted a study on the "snow coverage of Gorichen Peak" in region 1. The research included a period of 35 years, from 1981 to 2022, and we analyzed the snowfall pattern using Landsat images taken every 10 years.

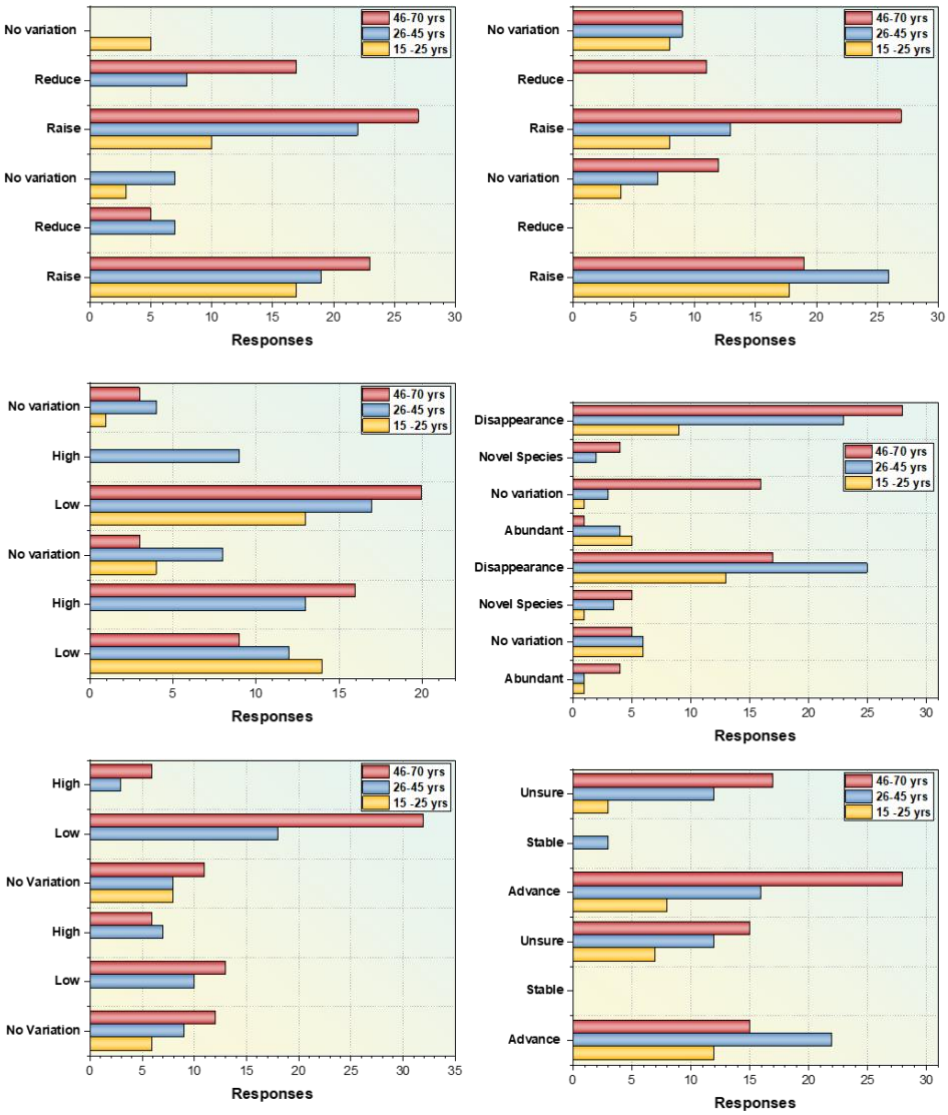

Figure 5: Outcome of Responses(source: author)

Discussion

Due to the amplified impact of human activities on the surroundings, there will be a corresponding negative impact on both the diversity of living organisms and the organization and operation of ecosystems. The reduced tree species densities in the neighboring forest areas of the current study may be attributed to the frequent and significant harvest by the villagers. The presence of a significant amount of human-induced pressure consistently hurts the framework of vegetation, whereas a small amount of pressure benefits both the structure and the operation of the ecosystem. The variation in biodiversity observed across different land uses reflects the extent to which human activities impact the properties of vegetation. Moreover, the chosen land uses have undergone agricultural operations, where farmers have employed the slash-and-burn farming practice, which entails the complete removal of vegetation through cutting.

The current study has observed that the villagers are encountering climate change; nevertheless, the majority of the individuals surveyed are unaware of this phenomenon. The responses confirm the specific observations made in a given time and place. They reflected on the anticipated old events and also noted that the climate circumstances were more favorable. The study found that responses were influenced by age, which supports the findings from the area known as the Arctic where older individuals reported experiencing greater reform compared to younger individuals. The responses to climate change varied, with advantages as

well as disadvantages observed.

4. Conclusion

The research examined the effects of improved land usage on surrounding forest areas and its effects on physico-chemical parameters.The results showed that the change in land usage has influenced the variety of species in the forest located close to the changed land area.The objective was also to emphasize the reactions of the locals living in the surrounding area to the changing climate conditions.Local responses demonstrated that the region has been undergoing persistent alterations in weather trends, including increased rainfall quantity, rising temperatures in the atmosphere, and a decrease in snowfall patterns, similar to other areas.Therefore, it is crucial to deal with the adaptation procedure and take appropriate, locally possible steps to reduce the effects of climate change as well as modify land use patterns for improved ecosystem function and structure to effectively tackle the effects of climate change at a regional level.Therefore, it was essential to implement locally attainable management techniques to ensure the long-term survival of rural populations, especially those living in distant places.

References

Bucak, T., Trolle, D., Tavşanoglu, U.N.,Çakıroğlu, A.I., Ozen, A., Jeppesen, E. and Beklioglu, M., (2018). Modeling the effects of climatic and land use changes on phytoplankton and water quality of the largest Turkish freshwater lake: Lake Beyşehir. *Science of the Total Environment,* **621,** pp.802-816.

Díaz, F.P., Latorre, C., Carrasco-Puga, G., Wood, J.R., Wilmshurst, J.M., Soto, D.C., Cole, T.L. and Gutiérrez, R.A., (2019). Multiscale climate change impacts on plant diversity in the Atacama Desert. *Global Change Biology*, **25(5)**, pp.1733-1745.

Dwire, K.A., Mellmann-Brown, S. and Gurrieri, J.T., (2018). Potential effects of climate change on riparian areas, wetlands, and groundwater-dependent ecosystems in the Blue Mountains, Oregon, USA. *Climate Services*,**10**, pp.44-52.

Fonseca, M.G., Alves, L.M., Aguiar, A.P.D., Arai, E., Anderson, L.O., Rosan, T.M., Shimabukuro, Y.E. and de Aragão, L.E.O.E.C., (2019). Effects of climate and land-use change scenarios on fire probability during the 21st century in the Brazilian Amazon. *Global change biology*, **25(9),**pp.2931-2946.

Harrison, S., Spasojevic, M.J. and Li, D., (2020). Climate and plant community diversity in space and time. *Proceedings of the National Academy of Sciences*, **117(9),**pp.4464-4470.

Hof, C., Voskamp, A., Biber, M.F., Böhning-Gaese, K., Engelhardt, E.K., Niamir, A., Willis, S.G. and Hickler, T., (2018). Bioenergy cropland expansion may offset positive effects of climate change mitigation for global vertebrate diversity. *Proceedings of the National Academy of Sciences*,**115(52)**, pp.13294-13299.

Le Provost, G., Badenhausser, I., Le Bagousse-Pinguet, Y., Clough, Y., Henckel, L., Violle, C., Bretagnolle, V., Roncoroni, M., Manning, P. and Gross, N., (2020). Land-use history impacts functional diversity across multiple trophic groups. *Proceedings of the National Academy of Sciences*,**117(3),**pp.1573-1579.

Marengo, J.A., Souza Jr, C.M., Thonicke, K., Burton, C., Halladay, K., Betts, R.A., Alves, L.M. and Soares, W.R., (2018). Changes in climate and land use over the Amazon region: current and future variability and trends. *Frontiers in Earth Science*,**6**, p.228.

Marques, A., Martins, I.S., Kastner, T., Plutzar, C., Theurl, M.C., Eisenmenger, N., Huijbregts, M.A., Wood, R., Stadler, K., Bruckner, M. and Canelas, J., (2019). Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth. *Nature Ecology & evolution*, **3(4),**pp.628-637.

Mina, U., Kumar, A., Chaturvedi, A.K. and Kumar, P., (2021). Climate change and plant diversity: Threats and opportunities. Climate Change and the Microbiome: *Sustenance of the Ecosphere*,

pp.369-396.

Newbold, T., (2018). Future effects of climate and land-use change on terrestrial vertebrate community diversity under different scenarios. *Proceedings of the Royal Society B*,**285(1881),**p.20180792.

Northrup, J.M., Rivers, J.W., Yang, Z. and Betts, M.G., (2019). Synergistic effects of climate and land-use change influence broad-scale avian population declines. *Global Change Biology*,**25(5),**pp.1561-1575.

Pellegrini, E., Buccheri, M., Martini, F. and Boscutti, F., (2021). Agricultural land use curbs exotic invasion but sustains native plant diversity at intermediate levels. *Scientific reports*, **11(1),**p.8385.

Peters, M.K., Hemp, A., Appelhans, T., Becker, J.N., Behler, C., Classen, A., Detsch, F., Ensslin, A., Ferger, S.W., Frederiksen, S.B. and Gebert, F., (2019). Climate–land-use interactions shape tropical mountain biodiversity and ecosystem functions. *Nature*,**568(7750),**pp.88-92.

Prokopová, M., Salvati, L., Egidi, G., Cudlín, O., Včeláková, R., Plch, R. and Cudlín, P., (2019). Envisioning present and future land-use change under varying ecological regimes and their influence on landscape stability. *Sustainability*, **11(17),**p.4654.

Shrestha, U.B. and Shrestha, B.B., (2019). Climate change amplifies plant invasion hotspots in Nepal. *Diversity and Distributions*,**25(10),**pp.1599-1612.

Spicer, M.E., Radhamoni, H.V.N., Duguid, M.C., Queenborough, S.A. and Comita, L.S., (2022). Herbaceous plant diversity in forest ecosystems: patterns, mechanisms, and threats. *Plant Ecology*, **223(2),**pp.117-129.

Velazco, S.J.E., Villalobos, F., Galvão, F. and De Marco Junior, P., (2019).A dark scenario for Cerrado plant species: Effects of future climate, land use and protected areas ineffectiveness. *Diversity and Distributions*, **25(4),**pp.660-673.

Wu, J., Li, M., Fiedler, S., Ma, W., Wang, X., Zhang, X. and Tietjen, B., (2019). Impacts of grazing exclusion on productivity partitioning along regional plant diversity and climatic gradients in Tibetan alpine grasslands. *Journal of Environmental Management*,**231,**pp.635-645.

Yan, Y., Jarvie, S., Liu, Q. and Zhang, Q., (2022). Effects of fragmentation on grassland plant diversity depend on the habitat specialization of species. *Biological Conservation*, **275**, p.109773.

Cite this article as: **DrSelvakumarV**Predicted Impacts of Climate and Land Use Changes on Plant Diversity, African Journal of Biological Sciences. 6(2), 71-79. doi:10.48047/AFJBS.6.2.2024. 71-79