MONITORING ACACIA TREES IN THE NEGEV AND ARAVA

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ABSTRACT

This academic paper reviews monitoring efforts related to acacia trees in the Negev and Arava regions. The studies explore challenges in seedling establishment, climate change impacts, and human-induced factors affecting acacia populations. Additionally, the paper highlights the interdependence between acacias and local biodiversity, emphasizing the need for conservation strategies. The findings underscore the importance of monitoring acacia trees for ecosystem preservation and sustainable management in these unique desert habitats.

***K*eywords** Acacia Monitoring · ML

1 Introduction

The Negev and Arava regions in Israel are home to a remarkable ecological system that thrives in one of the most challenging environments on Earth - the desert. Within this arid landscape, the acacia trees stand tall as resilient sentinels, crucial to the delicate balance of this unique ecosystem. As environmental awareness grows, so does the need to understand and protect these invaluable acacia populations. This introduction sheds light on the significance of monitoring acacia trees in the Negev and Arava. These monitoring efforts are essential for safeguarding the well-being of both the trees and the myriad of flora and fauna that depend on them for survival. Understanding the challenges faced by acacia seedlings, tracking changes in climate, and assessing the impacts of human activities are vital steps in preserving the ecological integrity of the region. Over the past few decades, acacia populations have faced new challenges due to climate change and human interventions, resulting in a decline that warrants immediate attention. In response, dedicated researchers and environmentalists have initiated long-term monitoring projects to comprehensively assess the health and status of acacia trees throughout the region. Through this monitoring, we gain critical insights into the factors affecting acacia regeneration, the resilience of mature trees, and the overall stability of the desert ecosystem. Armed with such knowledge, conservationists and policymakers can implement informed strategies to protect these majestic trees and ensure the survival of countless interconnected species that rely on their existence. This paper explores the methodologies employed in monitoring acacia trees, the data gathered, and the implications it holds for maintaining the delicate balance of the Negev and Arava's arid habitat. By understanding the ecological intricacies of this unique region, we can foster a greater appreciation for the vital role played by the acacia trees and work collaboratively towards a sustainable and harmonious coexistence with nature.

2 Related Work

The monitoring of acacia trees in the Negev and Arava regions has garnered significant attention from researchers, environmentalists, and policymakers alike. As these unique ecosystems face growing threats from climate change, urbanization, and human activities, numerous studies have been conducted to understand the dynamics of acacia populations and their vital role in maintaining ecological balance. In this section, we review the key findings and methodologies of existing research related to monitoring acacia trees in this arid region.

2.1 Assessment of Acacia Regeneration

Researchers have investigated the challenges acacia seedlings encounter during their early growth stages. Studies by Gersani and Kadmon [1] and Ginott-Lahav et al.[2] shed light on the impact of competition from native and invasive plants, as well as natural grazers on seedling survival rates. These works emphasize the importance of understanding seedling establishment to ensure the long-term sustainability of acacia populations.

2.2 Climate Change and Acacia Resilience

Monitoring efforts have explored the effects of climate change on acacia trees. Ginat et al.[3] presented a comprehensive analysis of the rising average air temperature in the Arava region and its potential consequences on acacia health. Long-term meteorological data from the southern Arava were used to identify trends and patterns in temperature fluctuations, providing crucial insights into climate-related challenges faced by acacia populations.

2.3 Human Impact and Conservation Strategies

Several studies have assessed the impact of human activities on acacia trees. Schick and Novak-BenDavid[4] examined the consequences of urban development and infrastructure projects on water availability for acacia trees. Similarly, Zvuloni-Armoza et al. [5] explored the effects of excessive pumping on aquifers, affecting the natural water supply for the trees. Understanding these human-induced challenges is vital for devising effective conservation strategies.

2.4 Long-Term Monitoring Initiatives

Notable long-term monitoring projects have been established to track the health and dynamics of acacia populations in the Negev and Arava. Groner and Hov [6] conducted extensive monitoring at multiple sites in the southern Arava, capturing data on tree population sizes, seedling survival rates, and environmental variables. Perelberg, Ron, and Ramon contributed to this knowledge by extending the monitoring to a broader region, providing valuable insights into acacia distribution and abundance.

2.5 Biodiversity Dependence on Acacia Trees

The interdependence between acacia trees and various local flora and fauna has been a subject of interest in numerous studies. Perelberg et al.[7] investigated the relationship between acacia trees and diverse wildlife species, emphasizing the keystone role of acacias in sustaining biodiversity in the Negev and Arava.

2.6 Ecological Restoration and Conservation

In response to the decline of acacia populations, researchers have explored restoration practices to enhance seedling establishment and ensure ecological stability. Stavi[8] proposed water harvesting techniques to mitigate water scarcity for acacia seedlings, while Brandt [9] examined the importance of considering individual trees in restoration efforts. The related work discussed above illustrates the diverse and comprehensive efforts made to monitor and understand acacia trees in the Negev and Arava. The findings of these studies contribute significantly to our knowledge of the intricate relationships between these iconic trees and their surrounding ecosystem. By synthesizing the insights from existing research, this paper aims to contribute further to the ongoing efforts of preserving and conserving the invaluable acacia populations in this unique desert habitat.

3 Method

3.1 Data Collection

The monitoring of the Acacias extends over the entire Arava, and is conducted by two teams of Desert and Dead Sea R&D personnel in the Eilot branch and in the Masada branch. The Eilot team monitors sites from Nahal Shlomo in the south to Nahal Seif in the Middle Arava, and the Dead Sea team monitors channels in Ashlim and Tzalim projects. Monitoring is conducted according to the protocol outlined in the report "Uniform Plan for Monitoring Boats in the Arava" (Gruner et al., 2017). As of 2019, the nature of sampling in Nahal has been changed at the request of the Nature and Parks Authority, to only sample a third of the streams (or once every three years monitoring Nahal). In light of the fact that this is an extremely important monitoring, we have decided to continue to partially monitor the streams of the Nature and Parks Authority so that one third of the streams are fully monitored.

A partial monitoring fot Acacias consists of: Date, site, plot, channel, GPS, tree number, species, trunk circumference (measurement tape/mechanical/electronic dendrometer), livenes (live, dead, dry), mortality, foliage, flowering, pods (Bani index - evaluation between 1-5), hernog, trunk circumference and taking an RGB photo from the phone.

Full monitoring for Acacias consists of: Along with all the parameters taken in the partial monitoring, the following parameters are also measured: east-west canopy length, north-south canopy length, tree height, grazing line, bottom leaf, and RGB photography.

3.2 Model Training and Evaluation

We utilized five distinct classification models to predict acacia tree foliage based on the collected dataset. The models employed were as follows:

- **Decision Tree**
- **Random Forest**
- **Gradient Boosting**
- **Support Vector Classifier**
- **K-Nearest Neighbors**

In this project, our objective was to predict the future foliage of trees based from last observations . To facilitate this prediction, we categorized the foliage scores into three distinct levels: 'Low' with scores of 0 and 1, 'Medium' with scores of 2 and 3, and 'High' with scores of 4 and 5. Alongside this predictive task, we also aimed to explore the potential influence of the stream on the foliage of the trees. Furthermore, we conducted an investigation into the impact of the specific site on the foliage.

Each model was trained on the preprocessed dataset, with features engineered from the field observations collected between 2016-2021. The training process involved optimizing the internal parameters of each model to achieve the best possible performance on the training data. Hyperparameters such as learning rate, maximum tree depth, and regularization parameters were adjusted during the training process.

After training, the models were evaluated using four key evaluation metrics: accuracy, recall, precision, and F1-score. These metrics provide a comprehensive view of the models' performance in different aspects of classification.

- **Accuracy**: The proportion of correctly classified instances to the total number of instances. It provides an overall measure of model performance.
- **Recall (Sensitivity)**: The proportion of true positive instances (correctly predicted positive cases) to the total number of actual positive instances. It indicates the model's ability to capture positive cases.
- **Precision**: The proportion of true positive instances to the total number of predicted positive instances. It measures the model's accuracy when it predicts positive cases.
- **F1-score**: The harmonic mean of precision and recall. It provides a balanced measure of the model's performance in capturing both positive cases and minimizing false positives.

4 Results

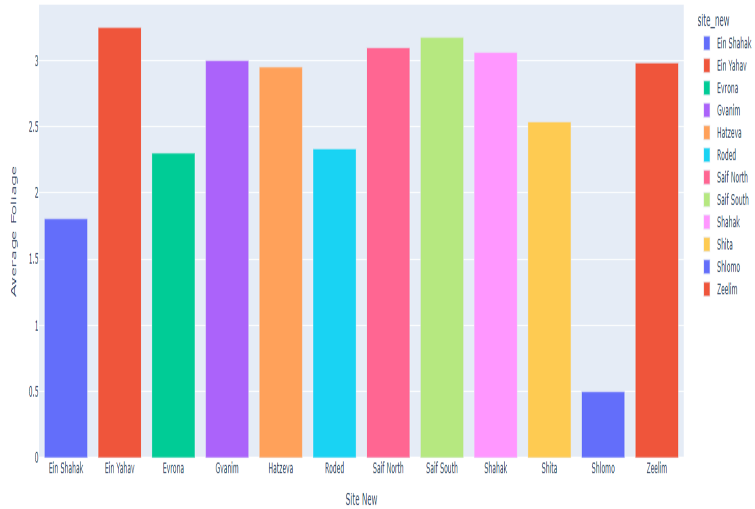

Figure 1: Average Foliage by Site

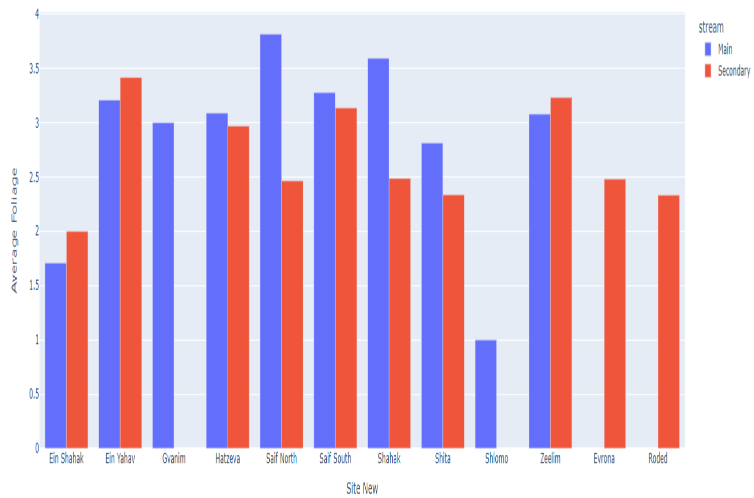

Figure 2: Average Foliage by Sites according stream

In our initial analysis, our focus was directed toward evaluating the mean foliage levels of trees across different sites, as illustrated in (Figure 1). Furthermore, we investigate potential connections between tree stream within the primary or secondary site and their corresponding foliage levels (Figure 2).

Our findings reveal that Site Ein Yahav with the highest average foliage level among the trees , while Site Shlomo harbors a relatively lower average foliage level among the trees . Notably, a compelling trend emerges: in the majority of cases, trees within the main sites exhibit a higher degree of foliage humility compared to those situated in the secondary sites. This pattern is especially pronounced, except for the Zeelim site, where trees within the secondary location manifest a higher average foliage humility than their main site counterparts.

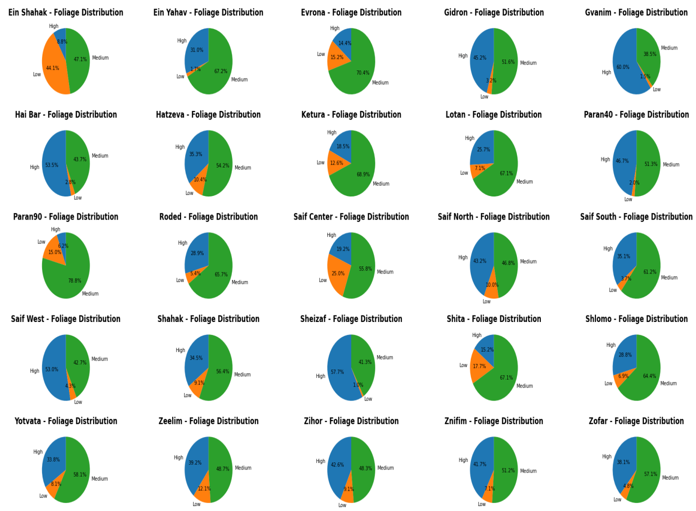

Figure 3: Foliage Distribution

In this (Figure 3), we transitioned the foliage scores into categorical labels of Low, Medium and High. We examine the distribution of tree foliage levels across different sites. Our primary goal was to determine the percentage of trees classified by their foliage levels within each distinct site. This exploration aimed to uncover variations in foliage levels among different sites. A clear trend became evident: at Site Sheizaf, there was a notably high prevalence of trees displaying High foliage, outshining the other sites. In contrast, Site Ein Shahak showcased the least occurrence of trees with Low foliage when compared to all the other sites

Table 1: Model Comparison Using Evaluation Metrics

Model	Accuracy	Precision	Recall	F1 Score
Decision tree	0.623	0.623	0.626	0.624
Random Forest	0.725	0.725	0.725	0.721
Gradient Boosting	0.69	0.69	0.686	0.679
Support Vector Classifier	0.687	0.687	0.703	0.659
K-Nearest Neighbors	0.642	0.642	0.639	0.64

Upon completion of preprocessing the dataset, we partitioned it into Train and Test. The outcomes reveal that the Random Forest model achieved the most promising results, attaining an accuracy score of 0.725. Conversely, the Decision tree model exhibited comparatively inferior performance, recording an accuracy score of 0.623.

5 Discussion

In this section, our analysis focused on foliage levels and their interplay with site characteristics and predictive modeling. We observed a consistent trend of higher foliage abundance in primary sites compared to secondary ones, with an intriguing exception in the Zeelim site. Transitioning to categorical labels, we found that Site Sheizaf stood out for housing a significant proportion of trees with High foliage, while Site Ein Shahak had fewer trees with Low foliage.

Furthermore, it's essential to acknowledge the relatively modest accuracy scores obtained in our predictive models. This outcome can be attributed to the inherent complexity of predicting tree foliage classifications in subsequent tests, which is influenced by multifaceted factors. This difficulty arises from several factors. Firstly, the inconsistency of the testing intervals across different times of the year can affect the accuracy, as the foliage state of a tree can vary seasonally. Moreover, the assessment process itself might not be consistent since it could involve different individuals measuring the trees, potentially leading to variability in results.

6 Conclusion

In conclusion, our study has shed light on the critical role that monitoring acacia trees plays in the preservation of the unique desert ecosystem in the Negev and Arava regions. The arid environment presents a challenging backdrop for these resilient trees, making their monitoring essential for both their survival and the interconnected web of life that depends on them. Our findings have revealed insightful patterns in foliage distribution across different sites, with primary sites often exhibiting higher foliage levels. Notably, the Zeelim site deviated from this trend, showcasing the intricacies of local ecological dynamics.

While predictive models demonstrated promise in capturing foliage trends, their relatively modest accuracy scores underscore the intricate nature of predicting humble tree classifications. These difficulties arise from multiple factors, including variations in testing intervals and the potential influence of different individuals conducting assessments.

Our research contributes to the ongoing efforts to conserve acacia populations by offering insights into their health, regeneration, and resilience. By understanding the relationships between these iconic trees and their surroundings, we pave the way for informed conservation strategies that safeguard the delicate balance of the Negev and Arava ecosystem. Ultimately, our study emphasizes the importance of continued monitoring, research, and collaboration to ensure the sustainable coexistence of humanity and the remarkable desert flora that enriches our world.

Acknowledgments

We would like to thank Nitzan Segev for his assistance and response to all of our questions.

References

[1] S Lahav-Ginott, R Kadmon, and M Gersani. Evaluating the viability of acacia populations in the negev desert: a remote sensing approach. *Biological Conservation*, 98(2):127–137, 2001.

[2] David Saltz, David Ward, Immanuel Kapofi, and Japhet Karamata. Population estimation and harvesting potential for game in arid namibia. *South African Journal of Wildlife Research-24-month delayed open access*, 34(2):153–161, 2004.

[3] Hanan Ginat, Yanai Shlomi, Sawsa Batarseh, and Justin Vogel. Reduction in precipitation levels in the arava valley (southern israel and jordan), 1949–2009. *J Dead-Sea Arava Res*, 1:1–7, 2011.

[4] BRIAN W van Wilgen, DM Richardson, DC Le Maitre, C Marais, and D Magadlela. The economic consequences of alien plant invasions: examples of impacts and approaches to sustainable management in south africa. *Environment, development and sustainability*, 3:145–168, 2001.

[5] Mario Sophocleous. From safe yield to sustainable development of water resources—the kansas experience. *Journal of hydrology*, 235(1-2):27–43, 2000.

[6] S Isaacson, JE Ephrath, S Rachmilevitch, S Maman, H Ginat, and DG Blumberg. Long and short term population dynamics of acacia trees via remote sensing and spatial analysis: Case study in the southern negev desert. *Remote Sensing of Environment*, 198:95–104, 2017.

[7] Shai Einbinder, Amir Perelberg, Oded Ben-Shaprut, Marie H Foucart, and Nadav Shashar. Effects of artificial reefs on fish grazing in their vicinity: Evidence from algae presentation experiments. *Marine environmental research*, 61(1):110–119, 2006.

[8] I Stavi and E Argaman. Soil quality and aggregation in runoff water harvesting forestry systems in the semi-arid israeli negev. *Catena*, 146:88–93, 2016.

[9] Sarah J Sapsford, Angela J Brandt, Kimberley T Davis, Guadalupe Peralta, Ian A Dickie, Robert D Gibson, Joanna L Green, Philip E Hulme, Martin A Nuñez, Kate H Orwin, et al. Towards a framework for understanding the context dependence of impacts of non-native tree species. *Functional Ecology*, 34(5):944–955, 2020.

Appendix

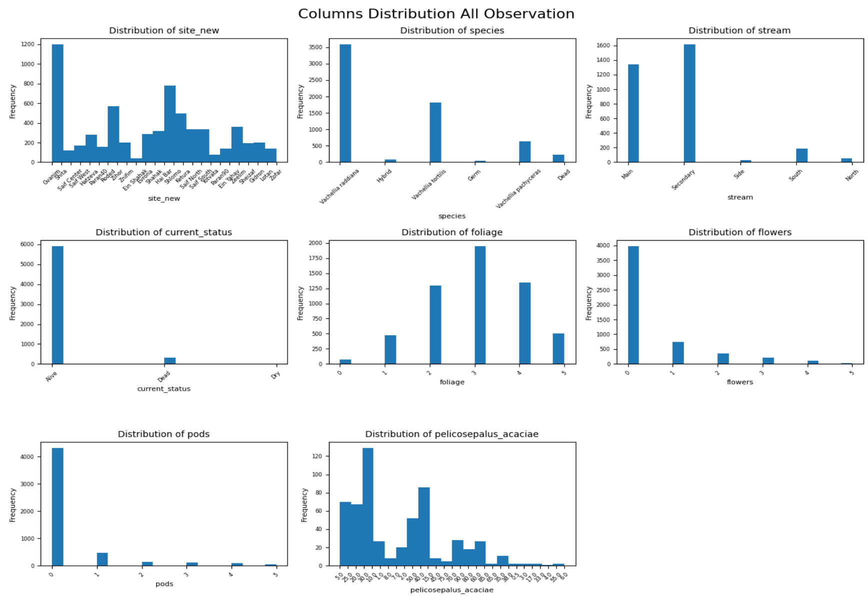

Figure 4: Distribution columns

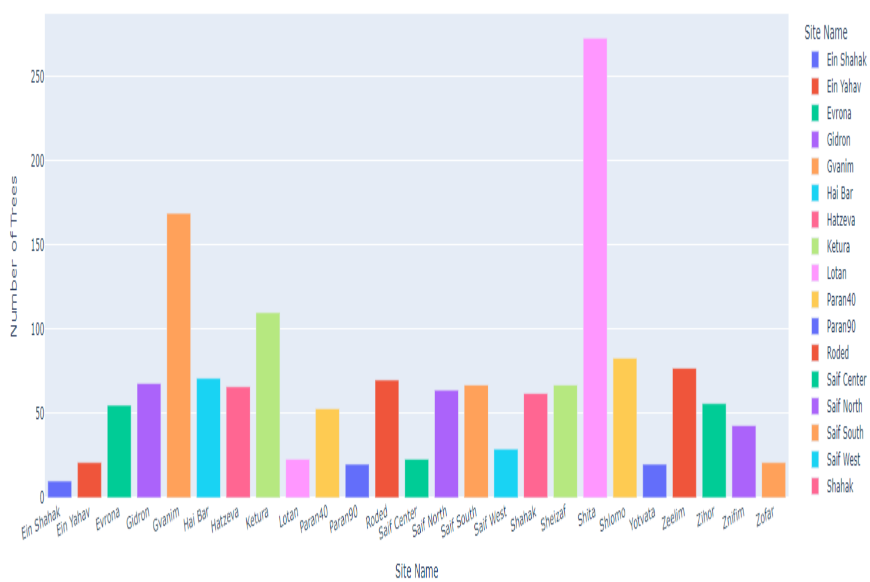

Figure 5: Number of trees per Site

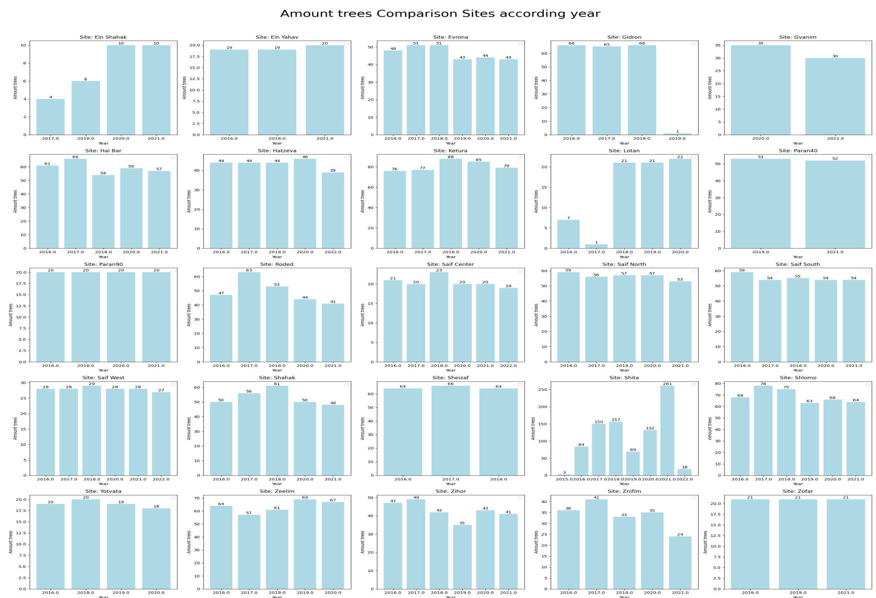

Figure 6: Amount trees per Sites according year

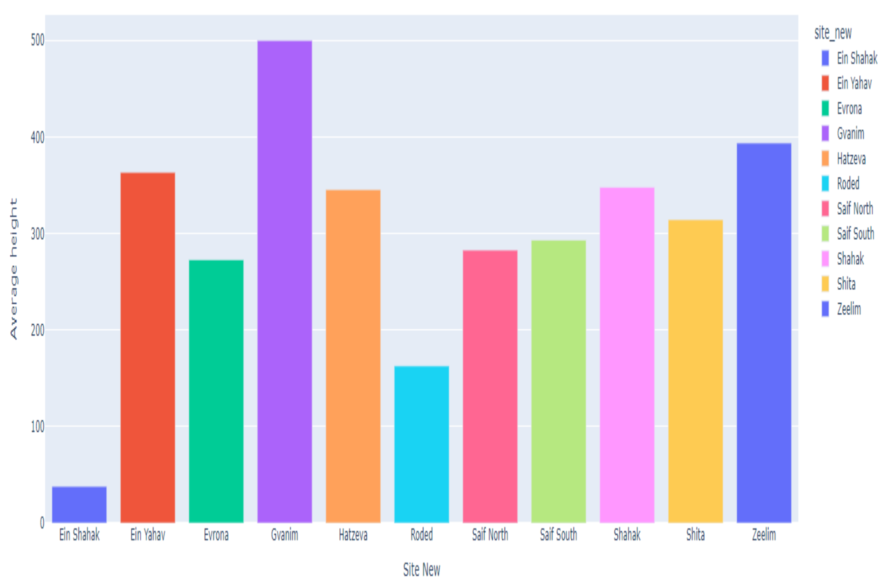

Figure 7: Average height by sites

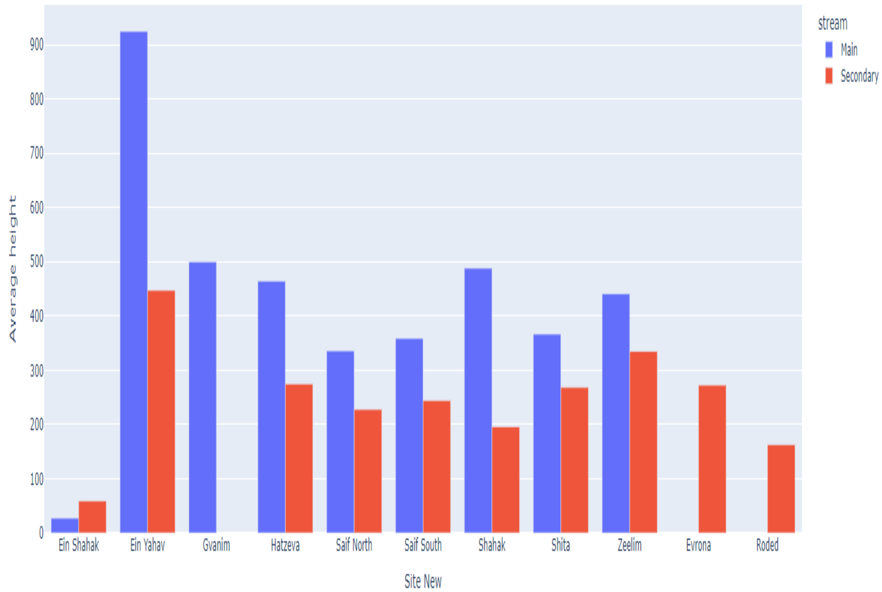

Figure 8: Average height by sites according stream

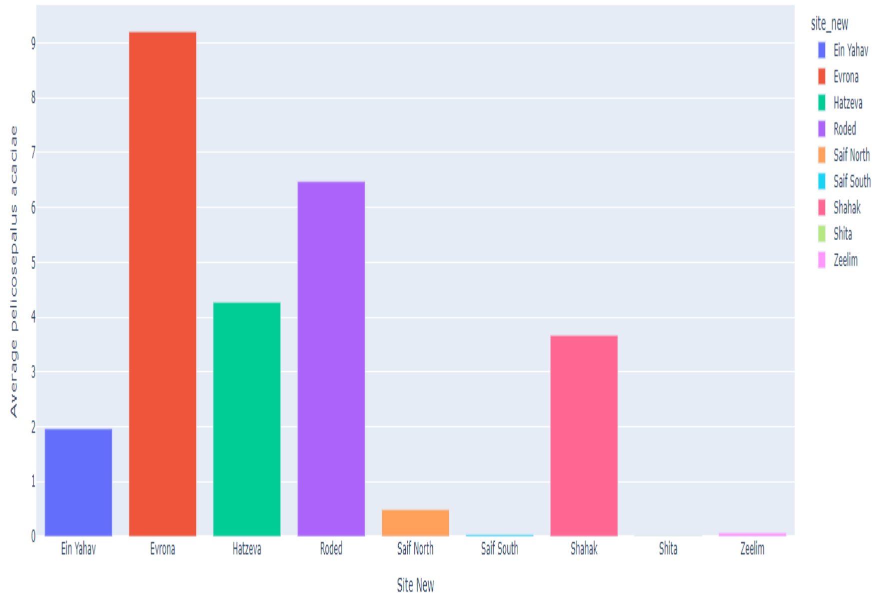

Figure 9: Average pelicosepalus acaciae by sites

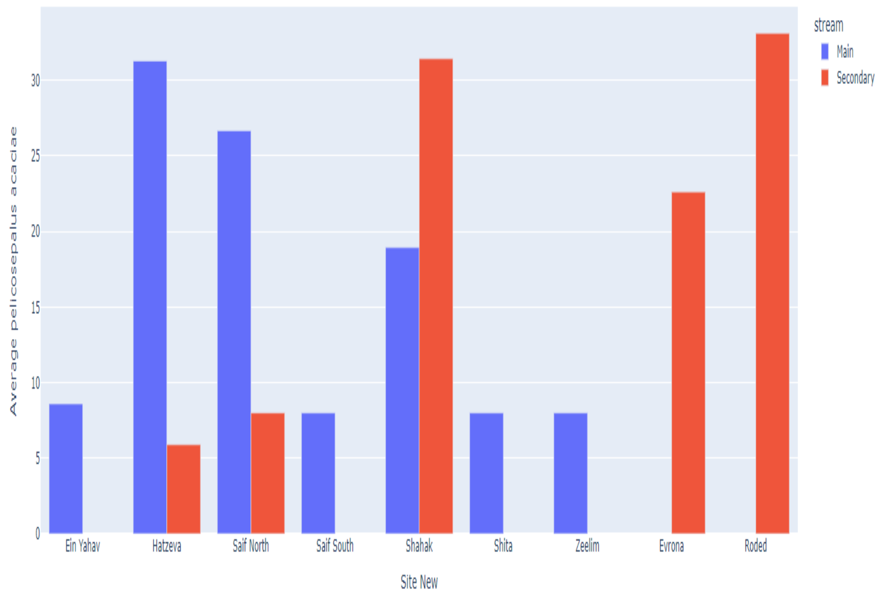

Figure 10: Average pelicosepalus acaciae by sites according stream

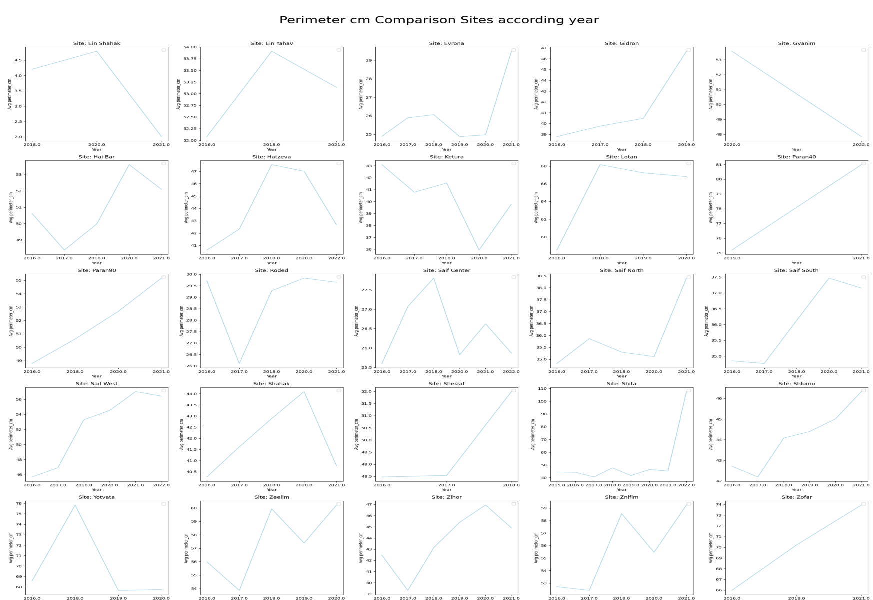

Figure 11: Perimeter cm Comparison Sites according year

Figure 12: Ratio Status trees per Sites according year

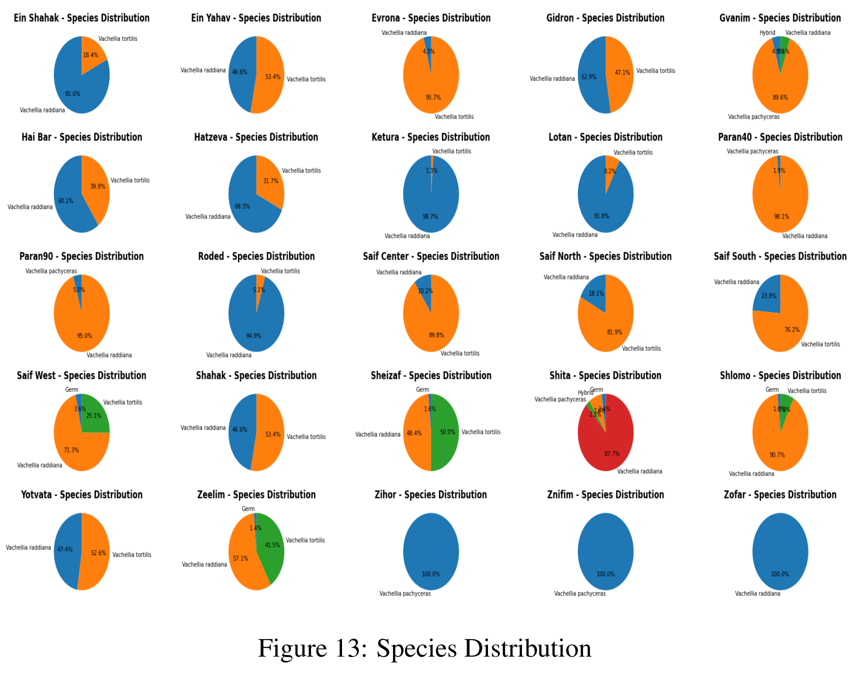

Figure 13: Species Distribution