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Geoecosystem-related dynamics of Acacia populations in the Israeli hyper-arid Arava Valley

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Similar to other Middle-Eastern and North-African drylands, Acacia populations across the hyper-arid Arava Valley of Israel have experienced dramatic phonological changes during the last few decades. These changes have been expressed with high mortality rates and low recruitment rates. Species of the Acacia trees across the region include the A. pachyceras, A. raddiana, and A. tortilis.

We studied the recruitment and decay rate of seedlings. Data obtained revealed that during a whole year after germination, overall survival rate of seedlings was 2%. Also, data showed that the main impediment to recruitment and survival of seedlings was insufficient access to soil-water, resulting in their mortality due to drying. Another, secondary impediment was imposed by erosional and depositional processes under heavy floods, resulting in the elimination or burial of seedlings. Modeling of results revealed that the drying of seedlings is defined with a constant mortality rate, which fits an exponential decay function. At the same time, seedling mortality due to fluvial processes is defined with a mortality rate that grows with time, which fits a Gaussian decay function.

Also, we investigated the effect of latitude, basin size, and microhabitat on vitality of existing trees. Results showed negative effect of latitude on tree mortality, fitting with the generally greater precipitation rates in the northern- than in the southern- Arava Valley. At the same time, no effect on tree mortality was recorded for basin size, proposing that in such extreme drylands, runoff ratio becomes more non-linear with increasing watershed size because of the greater dominance of ephemeral stream transmission losses, as well as due to the partial storm area coverage. Nor did the location in microhabitat across the valley floor affect tree mortality rate, highlighting the bimodal effect of greater access to flood water, potentially increasing survivability of old trees, but at the same time, imposing risks for young trees.

Additionally, we examined the impact of the type of channel's deposits on vitality and survivability of the Acacias. We found that compared to channels with a stony alluvium stratum, the mean tree density in channels incised in the red unit of the Early Pleistocene Zehiha Formation, characterized by hard layers of fine-grained reddish sediments, was 42% greater. Also, mean percentage of alive trees was significantly and 9% greater in these channels than that in the channels composed of stony alluvial stratum. The red unit was found to have a threefold greater available water capacity than that in the stony alluvium. It was concluded that once long-term droughts or climatic change occur in this hyper-arid region, the red unit deposit alleviates water stress for trees, increasing their vitality and survivability.