Notes on Geomorphology and STZ

steppe

The effects of climate on plants can be mediated both directly and indirectly by landforms, and directly by soils, across a range of scales (Giaccone et al. 2019, Moesland et al 2013, Swanson et al. 1988). Climate may be directly influenced by landforms which alter the local micro climate through phenomena such as cold pools (e.g. in Valleys) and micro-rain shadows (e.g. by mountains and ridges), resulting in variation in evapotranspiration demands and soil moisture availability (Pastore et al. 2022, Minder et al. 2008). Topographic slope and aspect control the amount of incipient solar radiation altering both soil temperatures and soil moisture, affecting both soil moisture and soil microbial composition and activity (Dearborn and Danby 2017). Topographic features have also been shown to influence the amount of soil water availability, at shallow depths, by altering the amount of overland, and subsurface, water flow leading to areas with either elevated or reduced amounts of water (McAuliffe 1994, Wondzell et al. 1996). The distribution of amount of coarse fragments in soil (Katra et al. 2008), as well as soil textural (English et al. 2005, Fernandez-Illescas et al. 2001, Singh et al. 1998), and chemical properties (e.g. carbonates, and soil organic carbon) (Duniway et al. 2010, Rawls et al. 2003). Collectively, these factors can lead to an apparent decoupling between the resolution of climate variables generated by spatial modelling and interpolation approaches, and the responses of plant populations. However this apparent discord in scale may be ameliorated by using two general approaches, both proactive and retroactive, the latter of which is also applicable to species lacking empirical seed transfer zones.

Section 1.

The direct effects of topography on climate are a well known phenomena and a variety of approaches for 'downscaling' gridded climate data from moderate resolutions (e.g. ~800m, ~1km) to fine resolutions have been developed (e.g. climateNA). Essentially these models … They can be used by analysts to develop high resolution surfaces, which can at least be used for extraction of covariates from raster surfaces, and help to most accurately capture local climate conditions. Indeed, this approach is already implemented by several researchers (cite; I think most the USGS folks use climateNA?). However, Given recent advances in computational power, predicting fit eSTZ models onto similarly high resolution surfaces is now an achievable task for most research groups. However, while these tools are more effective for modelling the variability in localized climate, they do not address the localized effects of geomorphology on precipitation which has reached the soil surface.

Inclusion of landform characteristics, such as topographic position, and topographic wetness indices, aspect and slope are achievable with data products such as… Given recent advances in remote sensing, in particular LiDAR, these products - especially the latter have great accuracy, and as covariates may help explain responses between populations; for example many populations from more arid portions of ranges may actually be located in refugial areas (e.g. northern facing toe's of slope) where they are buffered from the realized micro climate. These data sets have already been used in a study by (cite). Authors concluded …

High resolution soils data are available for a variety of physical and chemical components, however in our experience these data are less accurate than the aforementioned topographic data sets due to a lack of equatable remote sensing approaches.

Finally, maternal effects may manifest in common gardens …. These may be captured and better controlled for by incorporation of these variables under certain modelling frameworks (ASK FRANCIS!).

Section 2.

Restoration practitioners, when presented with multiple seed source options for a restoration and which have similar climate similarity to the site, have expressed interest in matching seeds using additional criteria. In scenarios where a practitioner has reason to believe that a population from a soil with more similar textural properties is desired spatially modelled products such as SoilGrids can be used to determine the similarity between major textural components. Under certain scenarios, the use of Ecological Site Descriptions (ESD's) will articulate the relationship between climate, geomorphology, and the response of vegetation to sites. The use of ESD's will not only lead to a match between geomorphology, but also foster the selection of seed lots where the focal species has been in a similar vegetation context to it's desired outcome, i.e. the population will have been exposed to other species likely to recruit at the site, or to be seeded. However, the development of ESD's across Western North America has been a long process, and the status of their mapping is variable, and to date no gridded surfaces for them exist. A solution has been the development of Ecological Site Groups (ESG's), these data sets combine local expertise with geospatial modelling approaches and have been developed for at least one large geographic expanse. While this product does not offer the same resolution as ESD's, they provide a solution which reflect the interactions between climate and geomorphology, and may be used at least temporarily to express these relationships.