**Title**

How is accessibility to cities affecting biodiversity change?

**Introduction**

Globally, humans have modified 50% of terrestrial land cover, leading to major pressures on the biosphere and its inhabitants (IPBES, 2020). Increasing human population and the growth of cities and road networks, which predicate the equity agenda of the UN by advancing accessibility (UN, 2015), are expected to cause additional pressures on the natural environment. Urbanisation and roads have greatly altered habitats and connectivity of those, leading to disturbances in ecological communities. Abundance, richness and composition of ecological communities are changing globally in complex ways (Blowes et al., 2019; Eriksson and Hillebrand, 2019; Magurran et al., 2019; Dornelas et al., 2019). Current rates of changes of ecological communities are beyond what ecological theory predicts (Gotelli, 2017). The consequences for ecosystem processes, such as their temporal and spatial resilience are not fully understood, their link has been identified though. Understanding drivers of global biodiversity change to establish effective conservation programs without compromising human development towards better equality, is a key topic on the agenda of decision makers all over the world.We currently only have a limited understanding of how accessibility to cities, such as the presence of cities and roads, as a global change driver, is altering the assemblages of communities.

Given the sheer extent of human impact on the natural environment, it is common convention that biodiversity is declining on a large scale. However, studies reveal a more complex picture that is very dependent on the scales and biodiversity metrices used (McGill et al., 2015). While local alpha diversity seems to show no decrease in species richness, global biodiversity seems to decline. At the same time, local communities show high species turnover (changes in the composition of ecological communities), potentially indicating a different type of biodiversity change; large scale reorganization of communities leading to homogenization across space (Blowes et al., 2019). This homogeneity leads to a decrease in biodiversity over larger scales and has serious implications on the ability of species communities to adapt to future environmental changes (Eriksson and Hillebrand, 2019).

Changes to the environment caused by the enhancement of accessibility, such as cities and roads, might lead to a different species filter which favour more similar species across scales. Local immigration of species can be enhanced by both changing environmental conditions and favouring species that prefer urban environments as well as through transportation and human traffic as trade roads have led to homogenization (McKinney, 2006). Both ways are indirect effects of enhancing accessibility.

Recent global scale datasets of roads and accessibility to cities provide a new opportunity to measure this aspect of human development at a global scale. By integrating the dataset with X amount of biodiversity records, my analysis provides unprecedented insight into the influence of accessibility to cities as a global change driver of biodiversity change.

*Take home message? How is this work relevant to the scientific community?*

**Objectives and research questions**I aim to investigate the effect of accessibility of cities on compositional biodiversity changes globally addressing the following research questions:

1. Do locations with higher accessibility to cities lead to higher turnover within sites than locations with lower accessibility (temporal turnover)?
2. Do locations with higher accessibility to cities lead to higher biodiversity homogenization across sites than locations with lower accessibility (spatial turnover)?
3. (How does each taxon respond to high/low accessibility?)
4. Is there an interactive affect of population density and accessibility on biodiversity homogenization? / How is spatial/ temporal turnover/homogenization (general and taxa-specific) influenced by population density?

**Research hypotheses**My hypotheses are that there will be a positive relationship between high accessibility scores and turnover and biodiversity homogenization and between population density and biodiversity homogenization. When analysing taxa’s responses, I hypothesize that taxa will have different relationships with accessibility scores and population density, with both positive and negative interactions present. Those hypotheses will be tested against the null hypotheses of no relationship between accessibility and turnover and biodiversity homogenization and population density and homogenization, respectively.

**Predictions**I predict that globally, areas with high accessibility will display higher turnover and drive more biotic homogenization than areas with lower accessibility, as human disturbances and connections such as roads tend to select similar winners (Blowes et al., 2019). Based on differences in ecological characteristics among the taxa analysed, I predict that they will respond to accessibility individualistically. SOMETHING WITH MOBILITY. I predict that the relationship between population density and turnover/homogenization will also be ??.

If the results agree with my null hypotheses, this will indicate that accessibility is not a global driver of turnover and biodiversity homogenization, thus other global drivers need to be identified and analysed. If the results support my alternative hypothesis, this will question business-as-usual extension of cities and roads as a human development goal.

**Methods**In my analysis I ask how the magnitude of accessibility to cities affects the time series of ecological assemblages (turnover) and biotic homogenization. I assess variation in rates of biodiversity change (turnover) and homogenization across [list taxas]. To quantitively test the ecological consequences of accessibility to cities, I will use two global databases.

**Databases***Accessibility to cities 2015 data*I will derive accessibility to cities scores for the nominal year 2015 for ~ 100km² cells (matching the grid cells of the BioTIME database) around the location of each population in the BioTIME database from the Accessibility to Cities 2015 (Weiss *et al.*, 2018) database using the Google Earth Engine. This database calculates least-cost-path land-based travel time to the nearest densely populated area (between 85 degrees north and 60 degrees south) at a 30 arc seconds X and Y resolution. Areas with >1,500 inhabitants/km² or a majority of built-up land cover types coincident with a population centre of at least 50,000 inhabitants are defined as densely populated areas. I will bound the scores extracted between zero and one, where zero is not accessible and one is very accessible.

*BioTIME Database – biodiversity time series data*I will use data from the currently largest (and open-source) database of community/ecological assemblage time series, BioTIME data base (Dornelas *et al.*, 2018). These data include XXX records of abundance and number of species in XXX different communities monitored between XX and XX. Consistency of methods used? Units? How to standardise cell sizes/communities/overlapping data? To calculate turnover, I will only include data with two or more datapoints between the years 2005-2015.

I will quantify temporal changes in community composition within sites, as the turnover component of beta diversity (species replacement rather than abundance) at the last data point available relative to the first observation data point within the time period outlined above (or rolling basis?). I will bound the scores of turnovers between zero and one, where zero is no change in community composition and one indicates that all of the original species have been replaced.

From the community composition over time model, I will extract the means for composition change (turnover) for each time series, which will then become the response variable in the following stage of my analysis where I will test turnover against accessibility.

I will quantify changes in community composition among sites (measure of biological homogenization) by doing pairwise comparisons of dissimilarity scores. NEED TO FIND OUT MORE.

*Population density dataset*NEED TO FIND OUT MORE.

**Statistical analysis**All models will be fitted in a Bayesian framework using hierarchical linear models. Include biome/regions as random effects? Distribution of models? NEED TO FIND OUT MORE

RQ1:  
Turnover ~ accessibility (binomial?) + latitude + duration observation

Random: year, biome, study ID

RQ3:  
Turnover ~ accessibility (binomial?) + latitude + duration observation + taxa + accessibility:taxa

Random: year, biome, study ID

Data checks

* Data points from BioTIME which don’t have accessibility score?
* Distribution Histrogram
* Center latitude and year data?
* Sites coincidence with protected areas
* Spatial extent of studies
* Is there effect of amount of data points in time series on outcomes?
* Duration of same accessibility score? How to handle data that changed from low a -> high a

Ideas for sensitivity analysis of models

* Sensitivity to cell size
* Reaction rare species vs common species
* Differences in latitude (eg tropics)
* Taxonomic differences (if not included as research question)
* Preference of urban-adapted species?
* Choice of biodiversity metric?

Anticipated results and their importance

Example graphs

**Risk mitigation**

Anticipated problems and their minimisation

Challenges

**Proposed timetable of activities**

Gantt chart