Content description and contact information

This repository contains all R-scripts and respective model output data needed to reproduce the methods, results and figures of the manuscript *Browsing herbivores improve the state and functioning of savannas – a model assessment of alternative land use strategies* by Katja Irob, Niels Blaum, Selina Baldauf, Leon Kerger, Ben Strohbach, Angelina Kanduvarisa, Dirk Lohmann and Britta Tietjen. For any questions regarding content in this repository please contact Katja Irob.

R-Scripts

R-Scripts to reproduce all figures and statistical procedures are provided in the folder *Analysis* and the corresponding data in the *Data* folder. Scripts for the evaluation of the sensitivity analysis output and plant species parameterisation are in the folder *Sensitivity*, corresponding sensitivity output data in the folder *Input*. If you want to reproduce the results please download the repository and run the code with R (most conveniently in R-Studio). For any questions regarding the R-Scripts please contact Katja Irob.

Script	Description
Analysis/Coverplots.R	Script to visualise and analyse the meta-PFT cover time series for the land use scenarios used in the main part of the manuscript
Analysis/Coverplots_appendix.R	Script to create the meta-PFT cover time series for all other land use scenarios presented in the appendix
Analysis/Composition_plots.R	Script to visualise and analyse the strategy-type composition of the last 20 years of simulation for each scenario used in the main part of the manuscript
Analysis/Composition_appendix.R	Script to visualise the strategy-type composition of the last 20 years of simulation for additional scenarios presented in the appendix
Analysis/Richness_evenness.R	Generation of richness and evenness values, visualisation and analysation of the data of the last 20 years of simulation for each scenario used in the main part of the manuscript
Analysis/Richness_evenness_appendix.R	Generation of richness and evenness values and visualisation of the data of the last 20 years of simulation for additional scenarios presented in the appendix
Analysis/EFA.R	Exploratory factor analysis to determine clusters depending on plant strategies. Additional calculation of functional dispersion (FDis) and visualisation of PFT clusters including individual abundance and distance to centroid for the main scenarios
Analysis/Waterplots.R	Calculation of T/ET, visualisation of T/ET and soil moisture and statistical evaluation for the main scenarios
Analysis/Waterplots_appendix.R	Calculation of T/ET, visualisation of T/ET and soil moisture for all additional scenarios
Sensitivity/Parameterisation_sensitivity_browse.R	Merging sensitivity output for all parameters and climate repetitions, determining parameter value at desired cover change based on linear regression analysis, visualisation of output for browsing scenarios

Script	Description
Sensitivity/Parameterisation_sensitivity_graze.R	Merging sensitivity output for all parameters and climate repetitions, determining parameter value at desired cover change based on linear regression analysis, visualisation of output for grazing scenarios

Folder /Data

Folder /Results

This folder contains model output files for grazing and browsing scenarios for the stocking rates 20 ha/LSU and 40 ha/LSU. The filename e.g. *"EH_100years_yearly_EH_SR20browse_climrep-1.txt"* refers to the site "Etosha Heights" (EH), 100 years simulation time and yearly output, the stocking rate (SR) 20 ha/LSU of browsers and the climate repetition 1 (of 30). The files contain the complete model output and are condensed to the variables of interest using the R scripts in */Analysis*. Only the output variables used in this study are explained below.

File	Description
EH_100years_yearly_EH_SR20/40browse/ - graze_climrep-x.txt	EcoHyD simulation output for 100 years based on environmental conditions at Etosha Heights, Namibia.

Year: year from 0-99 **meanGcover_x**: mean perennial grass cover of strategy types 0-9 [-] **meanScover_x**: mean shrub cover of strategy types 0-11 [-] **meanAcover_x**: mean annual grass cover of base-type [-] **meanGtotalcover**: total perennial grass cover [-] **meanStotalcover**: total shrub cover [-] **meanAtotalcover**: total annual grass cover [-] **Annualevaporation**: total annual evaporation [Vol%] **AnnualtranspirationL1**: total annual plant transpiration of layer 1 [Vol%] **ML1**: soil moisture in layer 1 during rainy season [Vol%] |

Folder Methods_Paramerization_Calibration

File	Description
Diploschistes_data_Pintado.txt	Light curves of net photosynthesis for *Diploschistes diacapsis* at optimum water content digitized from Pintado et al. (2005): **CO2_flux**: net photosythesis (µmol m-2s-1) **rad**: photosynthetic photon fluence rate (µmol m-2s-1) **T_surf**: Temperature (°C) **population**: sun or shade population
reflectance_chamizo_et_al_2012.txt	Reflectance in El Cautivo curved digitized from Chamizo et al. (2012): **crust_type**: crust type measured (one of cyanobacterial, lichen, lichen-moss and moss), **wavelength**: wavelength at which reflectance was measured (nm), **reflectance**: reflectance (%)
Temp_NP_diploschistes_Pintado_2005.txt	Net photosynthesis of *D. diacapsis* measured at different temperatures (digitized from Pintado et al. (2005)): **temp**: temperature (°C) **np**: net photosynthesis (µmol m-2s-1) **population**: sun or shade population

File	Description
Temp_Resp_diploschistes_Pintado_2005.txt	Dark respiration of *D. diacapsis* measured at different temperatures (digitized from Pintado et al. (2005)): **temp**: temperature (°C) **respiration**: dark respiration (µmol m-2s-1) **population**: sun or shade population
waterCurve_Pintado_2005.txt	Water curve of net photosynthesis (digitized from Pintado et al. (2005)) **SAT**: Thallus water saturation (%) **rel_netPS**: net photosynthesis relative to the maximum (%) **population**: sun or shade population
waterPotential_scheidegger_pintado.txt	Water potential dependent on thallus saturation digitized from Pintado et al. (2002) and Scheidegger et al. (1995): **potential_measured**: thallus water potential (MPa) **saturation**: thallus water saturation (%) **species**: species measured (one of ramalina, teloschistes, Ramalina_capitata) **reference**: data reference (one of scheidegger and Pintado)

Folder Results_Model_Output

Folder	Description
Experiment1_ElCautivo/	Folder with modeling results for all climate sensitivity scenarios in El Cautivo. Folders are named with the variables that were changed and the atmosperic CO2 concentration used for the respective simulation (e.g. folder rain_tair5_rhum25_850ppm is the scenario in which rainfall was decreased, air temperature increased by 5°C, relative humidity reduced by 25% and atmospheric CO 2 increased to 850 ppm (RCP 6.0)). In each folder there is a folder output_fluxes with one file for each model output variable. Output is for 1 year in hourly resolution after 900 years of simulation (steady state)
Experiment2_Aranjuez	Folder with modeling results for the climate change scenarios in Aranjuez. The folders correspond to the 5 different scenarios that were conducted and contain output for the last year of a 900 year simulation in hourly resolution for different variables
ElCautivo_differentHydrophobicity/	Folder with modeling results for a model version without hydrophobicity (folder noHydrophobicity) and a different parameterization of hydrophobicity (hyd_001_001). Naming of the folders identical to Experiment1_ElCautivo.Output is for 1 year in hourly resolution after 900 years of simulation without hydrophobicity and 200 years for different parameterization of hydrophobicity
Measured_Data/activityTabernas.txt	Measured activity data of *Diploschistes diacapsis* in El Cautivo (Raggio et al. (2017)):**Y**: photosynthetic Yield (II) = Fv/fm **Temp**: thallus surface tempeature (°C) **sample**: sample ID **Date_Time**: date and time of measurement

Folder	Description
lichenCover_Aranjuez.txt	Measured lichen cover at the climate manipulation experiment in Aranjuez: **Crust**: 1 = initial Crust cover > 75%, 0 = initial crust cover < 25% **OTC**: warming with open top chamber (1 = yes, 0 = no) **Rain**: rainfall exclusion (1 = yes, 0 = no) **DESIGN**: treatment id (1 = control, 2 = rainfall exclusion, 3 = warming, 4 = both) **2008.6 ... 2018.7**: lichen cover values in the respective years (%) (decimal places represent the month in which measurements were taken)