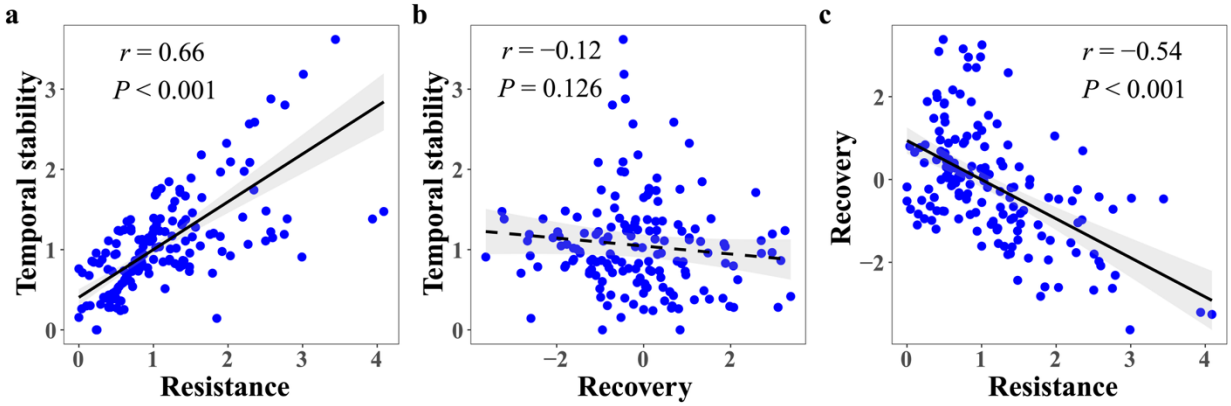
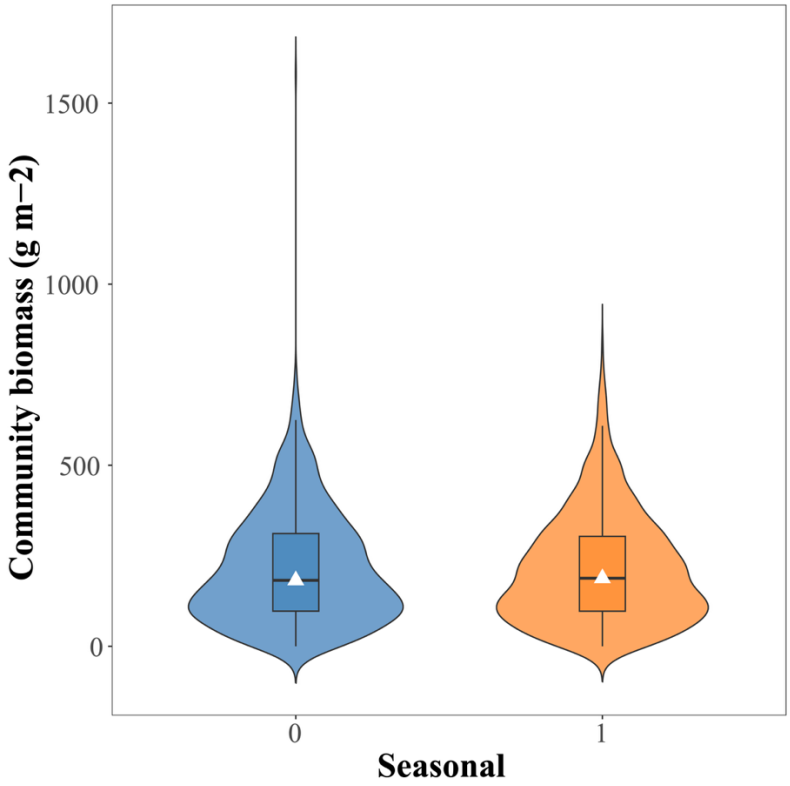
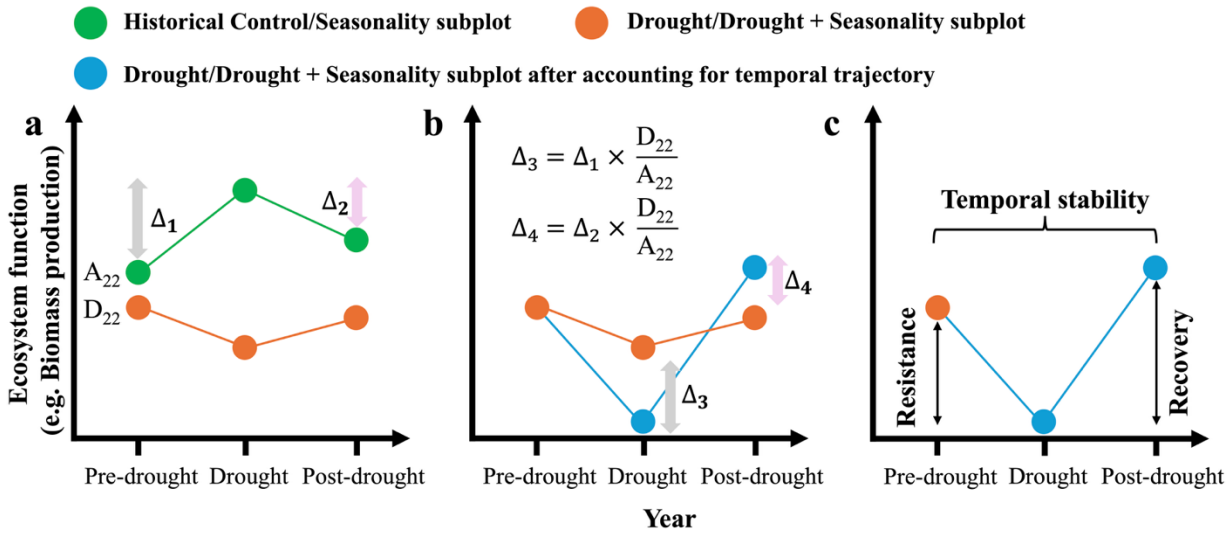
EXTENDED DATA FIGURES



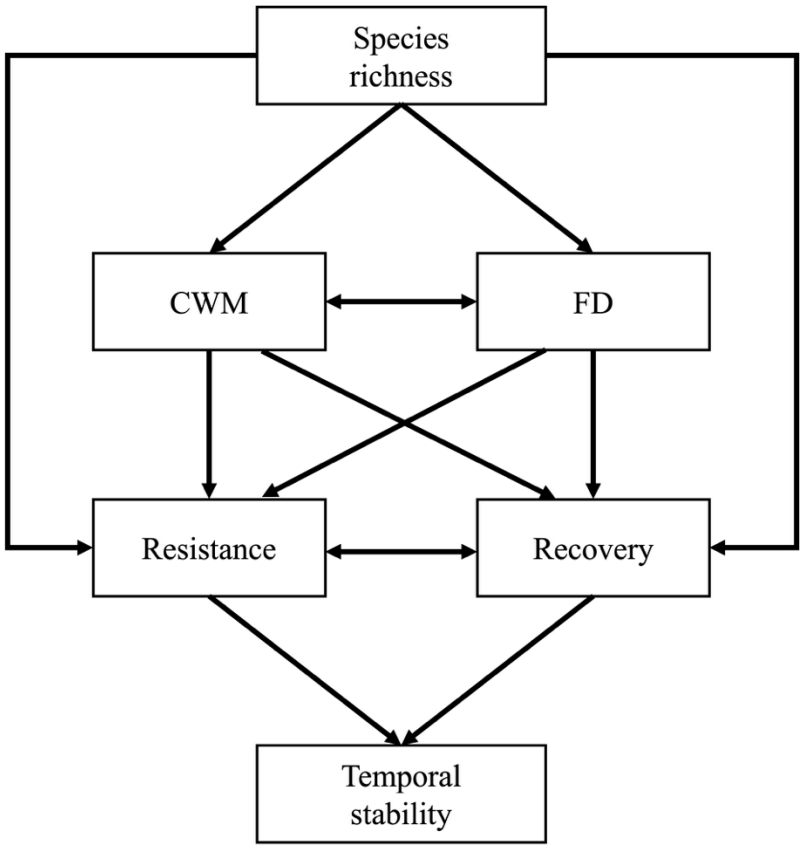
Extended Data Figure 1 | Relationships between different dimensions of ecosystem stability. (**a**) Temporal stability and resistance, (**b**) temporal stability and recovery, (**c**) resistance and recovery. Temporal stability, resistance, and recovery are log-transformed. Lines show mixed-effects model fits (solid for $P < 0.05$; dotted for $P \geq 0.05$). Shaded areas represent 95% confidence intervals. Correlation coefficient (r) are shown in each panel. Sample size (N) equals to 159 in all panels.



Extended Data Figure 2 | Community biomass (g m^{-2}) under different Seasonality precipitation treatments, illustrating the effects of seasonality precipitation treatment on biomass production. Sample size (N) equals to 2430.



Extended Data Figure 3 | Conceptual framework for calculating ecosystem stability after accounting for natural interannual variation. (**a**) how ecosystem function (e.g., biomass production) fluctuates over time under historical control/Seasonality conditions, (**b**) how the design separates the effects of drought from interannual variability, and (**c**) the three dimensions of ecological stability examined in this study. Under Historical control/Seasonality conditions, ecosystem function exhibits natural year-to-year fluctuations. Under Drought/Drought + Seasonality, ecosystem function is expected to vary proportionally across years relative to the ambient pattern.



Extended Data Figure 4 | Hypothesized causal model linking biodiversity, functional traits and ecosystem stability. Conceptual diagram illustrating the predicted direct and indirect effects of species richness, community-weighted mean (CWM) traits, and functional diversity (FD) on resistance, recovery and ultimately temporal stability, based on existing literature and our a priori hypotheses.

EXTENDED DATA TABLES

Extended Data Table 1. Summary of hypotheses relating biodiversity to three dimensions of ecosystem stability. "Conservative" indicates expectations for communities composed of more conservative species.

Biodiversity	Ecosystem stability	Hypothesized effect	Ecological Rationale
Species richness	Temporal stability	(+)	More diverse communities have a higher chance of including a species that will increase its performance and compensate for other species in response to perturbation[35].
	Resistance	(+)	
	Recovery	(+)	
Community-weighted mean traits (CWM)	Temporal stability	Conservative (+)	Conservative species are characterized by low relative growth rates, conservative resource acquisition and processing, and long lifespans. These traits enable them to better withstand environmental fluctuations, but may also constrain their capacity for rapid regrowth[25].
	Resistance	Conservative (+)	
	Recovery	Conservative (-)	
Functional diversity (FD)	Temporal stability	(+)	Greater trait dissimilarity among species within a community increases the likelihood that species will respond asynchronously to environmental fluctuations[29].
	Resistance	(+)	
	Recovery	(+)	

Extended Data Table 2. Variance structures selected for each bivariate relationship between biodiversity and ecosystem stability, based on *AICc* comparisons and likelihood-ratio (χ^2) tests.

Biodiversity	Stability	Variance Structure
Species richness	Resistance	NULL
	Recovery	varPower
	Temporal stability	NULL
CWM-SLA	Resistance	varPower
	Recovery	varExp
	Temporal stability	varConstPower
CWM-LDMC	Resistance	varPower
	Recovery	NULL
	Temporal stability	varPower
FD-SLA	Resistance	NULL
	Recovery	NULL
	Temporal stability	NULL
FD-LDMC	Resistance	NULL
	Recovery	NULL
	Temporal stability	NULL

Extended Data Table 3. Variance structures selected for each bivariate relationship between different dimensions of ecosystem stability, based on *AICc* comparisons and likelihood-ratio (χ^2) tests.

Stability dimension 1	Stability dimension 2	Variance Structure
Temporal stability	Resistance	varConstPower
Temporal stability	Recovery	varPower
Resistance	Recovery	NULL