2 December 2022

Feature Dataset: ARCCVA

Aquatic-Riparian Climate Change Vulnerability Assessment
USDA Forest Service Southwestern Region

Introduction and Background:

Land managers are considering ongoing and potential effects of climate and drought on natural resources to coordinate responses for the protection of ecosystems and their water supply, aquatic and riparian biodiversity, and other ecosystem services (Smith and Friggens 2017). Though climate vulnerability of these systems remains understudied (Mott Lacroix et al. 2017), the Rocky Mountain Research Station (RMRS) of the USDA Forest Service, The Nature Conservancy (TNC), and other organizations have developed assessments, tools, and methods for evaluating specific localities or the vulnerability for key ecosystem components. The Aquatic-Riparian Climate Change Vulnerability Assessment (ARCCVA) complements prior work with a regionwide vulnerability assessment of sufficient thematic detail to support natural resource policy and management prioritization, watershed assessment, monitoring systems, and to support effects analyses of landscape-scale projects. This work builds on an approach established by Smith and Friggens (2017) and adds additional indicators and spatial extent. by The ARCCVA satisfies some requirements of the Forest Service Climate Scorecard and partially fulfills the vulnerability assessment requirement of the agency's Climate Adaptation Framework used to support the subsequent step of building an adaptation strategy. The ARCCVA includes subwatershed-scale reporting (HUC12) for all lands of Arizona and New Mexico along with watersheds that include Forest Service lands in the Oklahoma and Texas panhandles. The assessment was supported by existing data sources on over two dozen intrinsic and climate-related indicators associated with watershed condition, riparian and aquatic habitat, and the presence of warm- and cold-water fish.

List of feature classes in this feature dataset:

- ARCCVA *Polygon*

<u>Aquatic-Riparian Climate Change Vulnerability Assessment (</u>ARCCVA).

Data Dictionary

Field Name	*Field Type*	*Description/Domain*
OBJECTID	OID	System generated field and value.
HUC_12	Text 12	6th field hydrologic unit code (HUC12). Source data are NHD.
HU_12_NAME	Text 120	6th field hydrologic unit name. Source data are NHD.
UplandCCVA	Text 50	Upland Climate Change Vulnerability Assessment (CCVA) rating for the HUC12 unit, either Low, Moderate, High, and Very High. Values also include <Null> and 'No CCVA'. Source data are from Triepke

Field Name	*Field Type*	*Description/Domain*
		et al. (2019) for subwatersheds in AZ and NM. For the subwatersheds in OK and TX where the National Grasslands occur the NatureServe Habitat Climate Change Vulnerability Index (Comer et al. 2019) was used and rescaled to match the upland CCVA scoring. Metric, climate expressed (future climate) - EXPOSURE + SENSITIVITY (IMPACT) Low, Moderate, High, Very High, No CCVA, <Null>
SummFlowChange	Double	Change in Summer Stream Flow score for each HUC12 unit was based on Western U.S. Stream Flow Metrics data and determined by first computing miles of stream and then calculating the percent of the watershed stream miles to exceed rating thresholds (calculated with perennial segments only; Appendix B), before rescaling values on a 0-1 scale. Some <Null> values present. Western U.S. Stream Flow Metrics is an online dataset of modeled flow metrics for streams in major river basins of the Western US for historical and future climate change scenarios. Source data represent a 2030-2059 climate forecast and were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml Metric, climate change – EXPOSURE 0 to 1, <Null>
AnnFlowChange	Double	Change in Annual Stream Flow score for each HUC12 unit with change in flow volume based on Western US Stream Flow Metrics data and determined by first computing miles of stream and then calculating the percent of the watershed stream miles to exceed rating thresholds (calculated with perennial segments only; Appendix B), before rescaling values on a 0-1 scale. Some <Null> values present. Western U.S. Stream Flow Metrics is an online dataset of modeled flow metrics for streams in major river basins of the Western US for historical and future climate change scenarios. Source data represent a 2030-2059 climate forecast and were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml

Field Name	*Field Type*	*Description/Domain*
		Metric, climate change – EXPOSURE 0 to 1, <Null>
ColdTempFishPct	Double	Change in Stream Temperature Suitable to Coldwater Fish Habitat score for each HUC12 unit is determined by first computing miles of stream and then calculating the percent of the watershed stream miles to exceed rating thresholds (calculated with perennial segments only; Appendix B), before rescaling values on a 0-1 scale. Source data represent a 2030-2059 climate forecast and were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml Metric, climate change – EXPOSURE 0 to 1, <Null>
WarmFishTempPct	Double	Change in Stream Temperature Suitable to Warmwater Fish Habitat score for each HUC12 unit determined by first computing miles of stream and then calculating the percent of the watershed stream miles to exceed rating thresholds (calculated with perennial segments only; Appendix B), before rescaling the results as 0-1. Source data represent a 2030-2059 climate forecast and were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml Metric, climate change – EXPOSURE 0 to 1, <Null>
UpCCVANum	Double	Upland Climate Change Vulnerability Assessment (CCVA) score for overall upland vulnerability in the HUC12 unit. Watersheds were assigned scores of 0 (low), 0.33 (moderate), 0.66 (high), 1 (very high), or <Null> (no assignment). Source data are from Triepke et al. (2019) for subwatersheds in AZ and NM. For the subwatersheds in OK and TX where the National Grasslands occur the NatureServe Habitat Climate Change Vulnerability Index (Comer et al. 2019) was used and rescaled to match the upland CCVA scoring.

Field Name	*Field Type*	*Description/Domain*
		Metric, climate change – EXPOSURE + SENSITIVITY 0 to 1, <Null>
FlowTimingChange	Double	Change in Stream Flow Timing score for each HUC12 unit with values rescaled 0-1 indicating the amount the center of flow mass timing has changed. This metric was based on Western US Stream Flow Metrics data where stream segments with the center of mass flow timing changed by greater than or equal to 14 days were identified as having a significant flow change. Total miles of perennial stream segments exceeding this significant flow change threshold were calculated for each watershed (Appendix B). Values were calculated as a percentage of total perennial stream segments within a watershed before rescaling values on a 0-1 scale. Some <Null> values present. Western US Stream Flow Metrics is an online dataset of modeled flow metrics for streams in major river basins of the Western US for historical and future climate change scenarios. Source data represent a 2030-2059 climate forecast and were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml Metric, climate change – EXPOSURE 0 to 1, <Null>
RoadCrossingDensity	Double	Road Crossing Density score on perennial stream segments for each HUC12 unit. Density values represent the number of road crossings per square kilometer in the watershed, rescaled from 0 to 1, where 1 represents the maximum density. Source data were taken from USGS TIGER roads database (https://www.census.gov/programs-surveys/geography/guidance/tiger-data-products-guide.html) and NHD stream flow lines. Metric, intrinsic – EXPOSURE 0 to 1, <Null>
DiversionDensity	Double	Diversion Density score indicating the relative density of diversions (canals) in each HUC12 unit. Density values were calculated based on the total number of canals per square kilometer in a

Field Name	*Field Type*	*Description/Domain*
		watershed and then rescaled as a range of 0-1. Source data are NHD at individual basin scale, count per square kilometer. Metric, intrinsic – EXPOSURE 0 to 1, <Null>
WildfireRisk	Double	Wildfire Risk score based on percentage of each HUC12 unit with either high or very high wildfire hazard potential and then rescaled to a range of 0-1. Source data were from 2018 wildfire hazard ratings, https://www.firelab.org/project/wildfire-hazard-potential Metric, intrinsic – EXPOSURE 0 to 1, <Null>
TEColdwaterFish	Long Integer	T&E Coldwater Fish Presence in the HUC12 unit. Species included *Oncorhynchus apache* & *Oncorhynchus gilae*. Note: this metric is not rescaled since doing so would dilute the "value" of watersheds with just 1 species despite their importance. However, this makes this attribute inherently weighted heavier than other metrics. Values are either '1' or '<Null>'. Source data are from Forest Service aquatic biologists. Metric, intrinsic – SENSITIVITY <Null> (no), 1 (yes)
ContWaterTemp	Double	Contemporary Water Temperature score indicating perennial water segments in each HUC12 unit where current temperatures are below 9 degrees C. These segments represent areas where warming temperatures may still provide potential future refugia for coldwater spawning habitat. Values were summarized to include percent perennial streams below 9 degrees C and then rescaled from 0 to -1. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Source data were taken from https://www.fs.usda.gov/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml Metric, intrinsic - ADAPTIVE CAPACITY

Field Name	*Field Type*	*Description/Domain*
		-1 to 0, <Null>
SpringGDEscaled	Double	Relative Number of Springs and GDEs in each HUC12 unit. Calculations included tallying total spring counts based on NHD point layers, and then rescaling values on a negative 0-1 scale where -1 represents the maximum count of GDEs found in any of the watersheds. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Metric, intrinsic - ADAPTIVE CAPACITY -1 to 0, <Null>
PctKarst	Double	Percent Karst or Pseudokarst in each HUC12 unit with results rescaled from 0 to -1 where -1 represents the maximum percent karst. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Source data from 'Karst in the United States: A digital map compilation and database' (Weary and Doctor, Open-File Report 2014–1156) using sandstone, evaporites, piping, volcanics, and carbonites. Metric, intrinsic - ADAPTIVE CAPACITY -1 to 0, <Null>
BeaverDamCapacity	Double	Beaver Dam Capacity metric based on the amount of stream segments within a HUC12 unit that are suitable for beaver dams according to segment slope, mapped riparian vegetation potential, and management conflicts. Values were rescaled from 0 to -1, where -1 represents the watershed with the most length of beaver dam suitable stream segments. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Derived data source based perennial segments (NHD) buffered, calculated slope for riparian ERUs. For herb-dominated hydrology was based on EDW subbasins, LANDFIRE vegetation data (EVT, ReMap) and potential management conflict (EVT_PHYS) including Developed-High Intensity, Developed-Low Intensity, Developed-Medium Intensity, Developed-Roads, and Quarries-Strip Mines-Gravel Pits-Well and Wind Pads

Field Name	*Field Type*	*Description/Domain*
		Metric, intrinsic - ADAPTIVE CAPACITY -1 to 0, <Null>
HProLandinCatchPct	Double	Percent Protected Lands of each HUC12 unit with highly protected status, USGS GAP values of 1 or 2. Actual value represents percent of the watershed not of protected lands. The resulting values were rescaled from 0 to -1, where -1 represents the watershed with the most length of beaver dam suitable stream segments. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Source data were taken from USGS PADUS (https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/introduction-pad-us-viewer?qt-science_center_objects=0#qt-science_center_objects). Metric, intrinsic - ADAPTIVE CAPACITY -1 to 0, <Null>
WellDensityScaled	Double	Well Density within each HUC12 unit rescaled to a range of 0-1 to represent the relative well density. Metric, intrinsic – EXPOSURE 0 to 1, <Null>
DamsScaled	Double	Dam Density for each HUC12 unit representing the relative density of major dams, rescaled from 0 to 1 where 1 representing the watershed with the highest number of major dams present. Source data is Nationwide USGS https://nationalmap.gov/small_scale/mld/dams00x.html (shapefile of major dams in the United States). Metric, intrinsic – EXPOSURE 0 to 1, <Null>
TE_Riparian	Short Integer	Presence of Riparian or Aquatic T&E Species based on the intersection of critical habitat or range with each HUC12 unit, where a value of 1 indicates one or more species and 0 indicating none. Source data are from FWS web pages for individual species (e.g., https://ecos.fws.gov/ecp/species/3536).

Field Name	*Field Type*	*Description/Domain*
		Metric, intrinsic – SENSITIVITY 1 or <Null>
TE_WarmFish	Double	Presence of Warmwater T&E Fish based on the intersection of critical habitat or range with each HUC12 unit, where a value of 1 indicates one or more species and 0 indicating none. Source data are from FWS web pages for individual species (e.g., https://ecos.fws.gov/ecp/species/3536). Metric, intrinsic – SENSITIVITY 1 or <Null>
WatershedNaturalCover	Double	Percent Natural Cover of vegetation within each HUC12 unit, where values are rescaled from -1 to 0, where -1 represents the highest natural cover. As with all adaptive capacity scoring, a negative scale is used as an opposing factor to impact. Natural cover data were taken from LANDFIRE EVT. Metric, intrinsic - ADAPTIVE CAPACITY -1 to 0, <Null>
IntExposure	Double	Intrinsic Exposure intermediate score based on the addition of the values for the relevant metrics for the class. For coldwater and intermediate classes, the metrics are 1) Road Crossing Density, 2) Diversion Density, and 3) Wildfire Risk. For warmwater classes, the metrics are 1) Well Density Scaled, 2) Dam Density Scaled, and 3) Wildfire Risk. <Null> values are ignored in intermediate and overall scoring and act as zeros. Intermediate Score, Intrinsic – EXPOSURE 0 to 1.60
ClimateChangeExposure	Double	Climate Change Exposure intermediate score for future climate exposure based on a composite of the relevant metrics for the class.

Field Name	*Field Type*	*Description/Domain*
		For coldwater, the metrics are 1) Change in Annual Stream Flow, 2) Change in Summer Stream Flow, 3) Change in Stream Temperature Suitable for Coldwater Fish, and 4) Upland Climate Change Vulnerability Assessment (CCVA) numerical ratings. For warmwater perennial classes, the metrics are 1) Change in Annual Stream Flow, 2) Change in Summer Stream Flow, 3) Change in Stream Flow Timing, 4) Change in Stream Temperature Suitable to Warmwater Fish, and 5) the Upland Climate Change Vulnerability Assessment rating (CCVA). <Null> values are ignored in intermediate and overall scoring and act as zeros. Intermediate Score, Climate – EXPOSURE 0 to 4.0
IntSensitivity	Double	Intrinsic Sensitivity intermediate score based on a composite of the relevant metrics for the class. For coldwater and intermediate classes, the metrics are 1) Presence of T&E Riparian and Aquatic Species and 2) Presences of T&E Coldwater Fish. For warmwater classes, the metrics are 1) Presence of T&E Riparian and Aquatic Species and 2) Presences of T&E Warmwater Fish. Intermediate Score – Intrinsic SENSITIVITY 0,1,2
IntAdaptCapacity	Double	Intrinsic Adaptive Capacity intermediate score based on a composite of based on a composite of the relevant metrics for the class. For coldwater and intermediate classes, the metrics are 1) Contemporary Water Temperature, 2) Relative Number of Springs and GDEs, 3) Percent Karst or Pseudokarst, 4) Beaver Dam Capacity, and 5) Percent Protected Lands.

Field Name	*Field Type*	*Description/Domain*
		For warmwater classes, the metrics are 1) Relative Number of Springs and GDEs, 2) Percent Karst or Pseudokarst, 3) Percent Natural Cover, and 4) Percent Protected Lands. <Null> values are ignored in intermediate and overall scoring and act as zeros. Intermediate Score, Intrinsic - ADAPTIVE CAPACITY -3.78 to 0
ImpactScore	Double	Impact intermediate score based on the addition of three intermediate exposure and sensitivity scores including 1) Climate Change Exposure, 2) Intrinsic Exposure, and 3) Intrinsic Sensitivity. <Null> values are ignored in intermediate and overall scoring and act as zeros. Intermediate Score, Impact - EXPOSURE + SENSITIVITY 0 to 5.82
CombinedScore	Double	Vulnerability Score based on the addition of 1) Intrinsic Adaptive Capacity intermediate score and the 2) Impact overall score. Vulnerability Score, exposure + sensitivity + adaptive capacity – VULNERABILITY -3.00 to 4.76
VulnCategory	Text 50	Vulnerability Category Rating of low, moderate, or high based on the combination of 1) Intrinsic Adaptive Capacity intermediate score and the 2) Impact overall score. Vulnerability Score, exposure + sensitivity + adaptive capacity – VULNERABILITY Low, Moderate, High
ClimateChangeVulnerability	Text 50	Climate Change Vulnerability intermediate rating based on climate change exposure metrics. Perennial watersheds – Rated low if all of the flow and temperature metrics are rated low and the

Field Name	*Field Type*	*Description/Domain*
		upland CCVA rating is low or moderate. Watersheds are rated high if one or more of the flow or temperature metrics are rated as high or if flow and temperature metrics are intermediate, but upland CCVA rating is high. All other watersheds are rated as moderate. For non-perennial subwatersheds the upland CCVA ratings are used as a proxy for overall climate change exposure in the absence of the full suite of climate indicators. Since the upland CCVA did not include the National Grasslands, some subwatersheds receive no rating ('Not Analyzed') for the climate change vulnerability. Summary Climate Rating - All Climate Exposure, 21st-Century climate trends EXPOSURE Low, Moderate, High, Not Analyzed
Class	Text 50	Temperature and perennial/non-perennial stratification: Coldwater, intermediate, or warmwater class combined with perennial status, Filter Coldwater – Perennial, Intermediate - Non-perennial, Warmwater – Perennial, Warmwater - Non-perennial
SHAPE AREA	Double	Area in Meters
SHAPE LEN	Double	Length in Meters

References

Comer, P.J., J.C. Hak, M.S. Reid, S.L. Auer, K.A. Schulz, H.H. Hamilton, R.L. Smyth, and M.M. King. 2019. Habitat Climate Change Vulnerability Index Applied to Major Vegetation Types of the Western Interior United States. Land 8(7), 108. https://doi.org/10.3390/land8070108.

Isaak, D.J., S.J. Wenger, E.E. Peterson, E.E., J.M. Ver Hoef, S.W. Hostetler, C.H. Luce, J.B. Dunham, J.L. Kershner, B.B. Roper, D.E Nagel, G.L Chandler, S.P. Wollrab, S.L. Parkes, D.L. Horan. 2016. NorWeST modeled summer stream temperature scenarios for the western U.S. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2016-0033.

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Smith, D.M., and M.M. Friggens. 2017. A spatially explicit and quantitative vulnerability assessment of coldwater fish habitat and riparian corridors in the intermountain West. USDA Forest Service technical report available online <https://srlcc.databasin.org/>. Rocky Mountain Research Station, Fort Collins CO. 185 pp.

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