

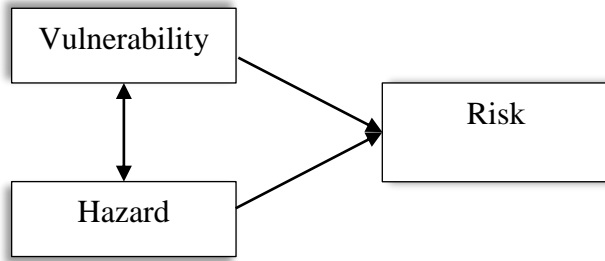
CODEBOOK

SOCIAL RESILIENCE TO NUCLEAR WINTER: AN ANALYSIS OF THE A.D. 536
ATMOSPHERIC EVENT

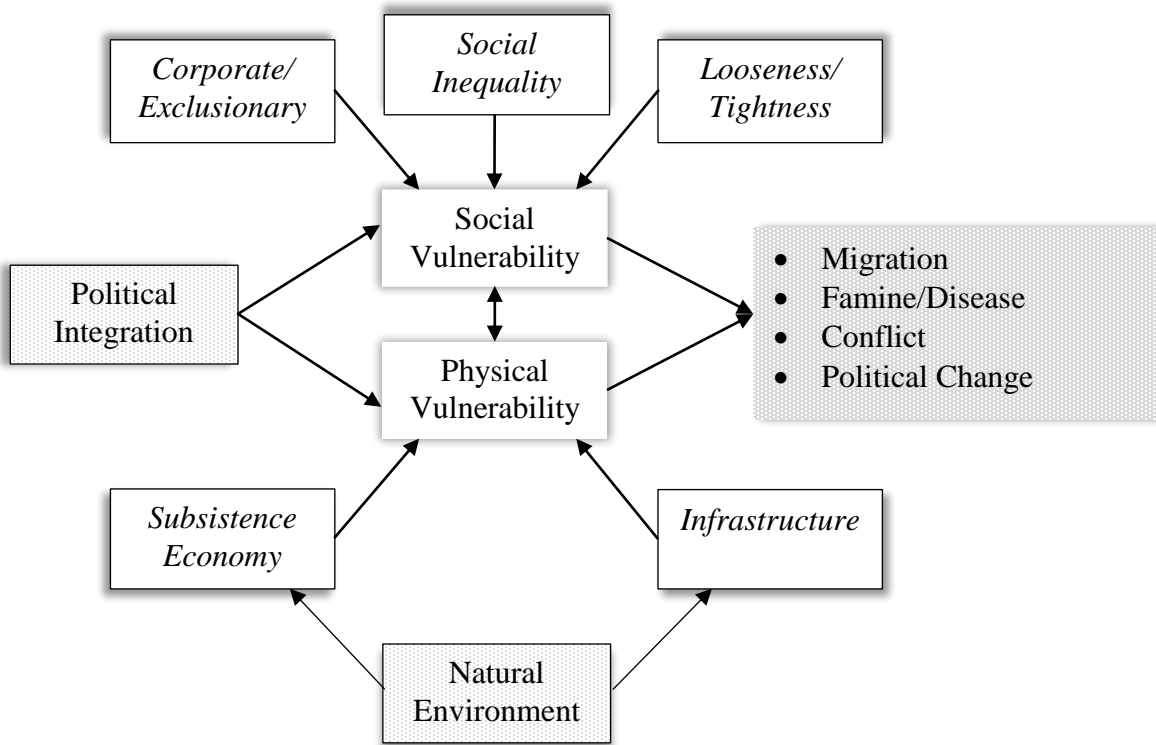
VERSION 5

NOVEMBER, 2017

General Model of Disaster Impact



ARO Model of Disaster Impact



ARO Variables

Control Variables

1. Political Integration
2. Natural Environment

Independent Variables

Social Vulnerability

1. Social Inequality
2. Looseness/Tightness Index
3. Corporate/Exclusionary Index

Physical Vulnerability

4. Subsistence Economy
5. Infrastructural Investment

Dependent Variables

1. Migration
2. Famine or Disease
3. Conflict
4. Political change

CONTROL VARIABLES

CV-1 Political Integration. (Murdock, George P., and Caterina Provost. 1971. "The Measurement of Cultural Complexity," *Ethnology*12:379-392.) [AR-TL-8]

0 = Autonomous local communities
1 = 1 level above community
2 = 2 levels above community
3 = 3 levels above community
88 = conflicting information
99 = missing

Data Quality:

1 = Good
2 = Poor
3 = Inferred answer
99 = Missing

CV-2. Natural Environment. Measured through several different GIS based data sets:

CV-2-1. Biome

CV-2-1-1. Olson's ecoregions

Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettengel, P. Hedao, and K.R. Kassem.
Terrestrial ecoregions of the world: A new map of life on earth
BioScience 51:933-938.
<https://databasin.org/datasets/68635d7c77f1475f9b6c1d1dbe0a4c4c>

CV-2-1-2. Holdridge life zones

Leemans, Rik. 1990. Global data sets collected and compiled by the Biosphere Project, Working Paper, IIASA-Laxenburg, Austria.
<http://www.fao.org/geonetwork/srv/en/metadata.show?currTab=simple&id=1006>

CV-2-1-3. Bailey's ecoregions

Bailey, Robert G. 1989. Ecoregions Map of the Continents *Environmental Conservation* 16(4).
<http://downloads.wdpa.org/ArcGIS/rest/services/Bailey/Bailey/MapServer>

CV-2-1-4. Freshwater ecoregions.

Robin Abell, Michele L. Thieme, Carmen Revenga, Mark Bryer, Maurice Kottelat, Nina Bogutskaya, Brian Coad, Nick Mandrak, Salvador Contreras Balderas, William Bussing, Melanie L. J. Stiassny, Paul Skelton, Gerald R. Allen, Peter Unmack, Alexander Naseka, Rebecca Ng, Nikolai Sindorf, James Robertson, Eric Armijo,

Jonathan V. Higgins, Thomas J. Heibel, Eric Wikramanayake, David Olson, Hugo L. López, Roberto E. Reis, John G. Lundberg, Mark H. Sabaj Pérez, and Paulo Petry. 2008. Freshwater Ecoregions of the World: A New Map of Biogeographic Units for Freshwater Biodiversity Conservation. *BioScience*. Vol. 58 No. 5: 403-414.
<https://databasin.org/datasets/0b6963be65074bca9306b1b6f05149d2>

CV-2-2. Agricultural Potential

CV-2-2-1. Problem agricultural lands.

FAO-UN. 2012. Dominant Type of Problem Lands. Rome, Italy: FAO.
<http://data.fao.org/ref/5534ec8b-0e09-4911-a249-9f4a97117377.html?version=1.0>

CV-2-2-2. Soil fertility constraints

FAO-UN. 2012. Global soil fertility constraints. Rome, Italy: FAO.
<http://data.fao.org/ref/c3b03760-88fd-11da-a88f-000d939bc5d8.html?version=1.0>

CV-2-2-3. Length of growing period

IIASA-FAO 2012. *Global Agro-Ecological Zones (GAEZ v3.0)*.
<http://www.fao.org/nr/gaez/about-data-portal/en/>.
<http://www.fao.org/geonetwork/srv/en/metadata.show?id=30582&currTab=distribution>

CV-2-3. Primary Productivity Constraints

CV-2-3-1. Sunlight constraints.

Churkina, G. and Running, S. 1998. Contrasting Climate Controls on the Estimated Productivity of Global Terrestrial Biomes. *Ecosystems* 1:206-215.
<https://databasin.org/datasets/6fcba40c990c483484a1d51dacf57d3c>

CV-2-3-2. Temperature constraints

Churkina, G. and Running, S. 1998. Contrasting Climate Controls on the Estimated Productivity of Global Terrestrial Biomes. *Ecosystems* 1:206-215.
<https://databasin.org/datasets/0b13ef1088b645a29ee49f8aaaaabb44>

CV-2-3-3. Water constraints

Churkina, G. and Running, S. 1998. Contrasting Climate Controls on the Estimated Productivity of Global Terrestrial Biomes. *Ecosystems* 1:206-215.
<https://databasin.org/datasets/321550b8dfef459ca5856508621bb1bc>

CV-2-4. Biodiversity

CV-2-4-1. Number of mammal species

World Wildlife Fund (WWF). 2006. Mammal species richness by ecoregion. *WildFinder: Database of Species Distributions*, ver. Jan-06. www.gis.wwf.org.
<https://databasin.org/datasets/863c20b7776d41d68612fa181b50e10a>

CV-2-4-2. Number of bird species

World Wildlife Fund (WWF). 2006. Bird species richness by ecoregion. *WildFinder: Database of Species Distributions*, ver. Jan-06. www.gis.wwf.org.
<https://databasin.org/datasets/798de47afddb48df9458338b04c995a4>

CV-2-4-3. Number of plant species

Kier, G., J. Mutke, E. Dinerstein, T. H. Ricketts, W. Ku, H. Kreft, and W. Barthlott. 2005. Global patterns of plant diversity and floristic knowledge. *Journal of Biogeography* 32: 1107-1116.
<https://databasin.org/datasets/43478f840ac84173979b22631c2ed672>

CV-2-4-4. Number of freshwater fish species

Abell, R., M.L. Thieme, C. Revenga, M. Bryer, M. Kottelat, N. Bogutskaya, B. Coad, N. Mandrak, S. Contreras Balderas, W. Bussing, M.L.J. Stiassny, P. Skelton, G. R. Allen, P. Unmack, A. Naseka, R. Ng, N. Sindorf, J. Robertson, E. Armijo, J.V. Higgins, T.J. Heibel, E. Wikramanayake, D. Olson, H.L. Lpez, R.E. Reis, J.G. Lundberg, M.H. Sabaj Pérez, and P. Petry. 2008. Freshwater ecoregions of the world: A new map of biogeographic units for freshwater biodiversity conservation. *BioScience* 58: 403-414.
<https://databasin.org/datasets/4f8f2f8e3ace42dca7141ca7781c0e4f>

INDEPENDENT VARIABLES

Components of Social Vulnerability

IV-1 Social Inequality.

IV-1-1. Variation in burials and burial goods. Sum of the following variables.

- IV-1-1-1. Burials in tombs or mausoleums
- IV-1-1-2. Burials with utilitarian goods (ceramics, tools, etc.)
- IV-1-1-3. Burials with personal ornaments
- IV-1-1-4. Burials with ritual objects
- IV-1-1-5. Burials with wealth objects (fineware ceramics, gold/silver objects, etc.)
- IV-1-1-6. Burials with exotic goods (rare or foreign materials and objects)
- IV-1-1-7. Burials with sumptuary goods (symbols of power or authority)
- IV-1-1-8. Burials with animal sacrifices
- IV-1-1-9. Burials with human sacrifices

IV-1-2. Variation in housing or house compounds. Sum of the following variables.

- IV-1-2-1. Houses with specialized craft production facilities
- IV-1-2-2. Houses with specialized storage facilities
- IV-1-2-3. Houses with multiple public or gathering areas
- IV-1-2-4. Houses with accommodations for servants
- IV-1-2-5. Houses with accommodations for guests
- IV-1-2-6. Houses with permanent external decoration
- IV-1-2-7. Houses with permanent internal decoration
- IV-1-2-8. Houses with multiple wings, atriums, patios.

Codes:

- 0 = Absent
- 1 = Rare
- 2 = Common
- 99 = Missing data

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-2. Looseness-Tightness Index. The index is the sum of the standardized scores on the variables below.

IV-2-1 Community integration, sum of scores [AR-TL-5] (based on Murdock and Wilson 1972)

- IV-2-1-1 Community integration by common residence
- IV-2-1-2 Community integration by common identity, dialect, subculture
- IV-2-1-3 Community integration by overlapping kin ties
- IV-2-1-4 Community integration by common social or economic status
- IV-2-1-5 Community integration by common political ties
- IV-2-1-6 Community integration by common religious ties

Codes:

- 0 = Absent
- 1 = Present
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-2-2 Prominent community ceremonials, sum of scores [AR-TL-6] (based on Murdock and Wilson 1972)

- IV-2-2-1 Rites of passage (including birth, marriage, and death ceremonies)
- IV-2-2-2 Calendrical ceremonies
- IV-2-2-3 Magical or religious ceremonies
- IV-2-2-4 Individual sponsored and communally attended ceremonies (e.g., moka, potlatch)

Codes:

- 0 = Absent
- 1 = Present
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

Standardization scores are determined by the following protocol:

- “unstandardized” implies that the range of variation extends far beyond a basic set of forms or types;
- “moderately unstandardized” implies that while most items follow a basic set of forms or types, they are also routinely altered or personalized to create a relatively large range of variation within those basic forms or types;
- “moderately standardized” implies that basic forms or types are generally followed, albeit with variation due to individual manufacture or preference;
- “standardized” implies strong adherence to basic forms or types with relatively little variation.

IV-2-3 To what extent are “fineware” ceramics standardized? [AR-TL-15]

- 0 = no fineware ceramics
- 1 = Unstandardized
- 2 = Moderately unstandardized
- 3 = Moderately standardized
- 4 = Standardized

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-2-4 To what extent are living dwellings standardized versus architecturally diverse? [AR-TL-19]

- 0 = no living dwellings
- 1 = Unstandardized
- 2 = Moderately unstandardized
- 3 = Moderately standardized
- 4 = Standardized

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-2-5 To what extent are public structures (including bureaucratic or palace structures, defensive structures, marketplaces, etc.) standardized versus architecturally diverse?

[AR-TL-20]

- 0 = no public structures
- 1 = Unstandardized
- 2 = Moderately unstandardized
- 3 = Moderately standardized
- 4 = Standardized

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-2-6 To what extent are ritual structures (including mounds, temples, enclosures, etc.) standardized versus architecturally diverse? [AR-TL-21]

- 0 = no ritual structures
- 1 = Unstandardized
- 2 = Moderately unstandardized
- 3 = Moderately standardized
- 4 = Standardized

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-3. Corporate-Exclusionary Index. The index is the sum of the standardized scores on the variables that follow. These variables are coded following coding details given in Peregrine (2012).

IV-3-1 Differentiation among leaders and followers [AR-PE-15]

- 0=egalitarian/no formal leaders
- 1=none
- 2=leaders have some privileges and/or access to resources others do not
- 3=leaders have extensive privileges and access to resources others do not, including special housing and sumptuary goods
- 4=leaders have exclusive privileges and exclusive access to special housing, resources, and sumptuary goods

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-3-2 Leader identification [AR-PE-16]

- 0=egalitarian/no formal leaders
- 1=none
- 2=leaders are identified by treatment or appearance
- 3=leaders are identified by recognized symbols of power or special behaviors
- 4=individual aggrandizement and/or cult of leaders

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-3-3 Sharing of authority [AR-PE-17]

- 0=egalitarian/no formal leaders
- 1=leaders share power extensively with others
- 2=leaders share power with a large cadre of other leaders
- 3=leaders share power with a few other leaders
- 4=leaders exercise exclusive power

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

IV-3-4 Emphasis of authority [AR-PE-18]

0=egalitarian/no formal leaders

1=emphasis placed on group solidarity and group survival

2=emphasis shared between group and leader, with greatest importance given to group survival

3=emphasis shared between group and leader, with greatest importance given to leader survival

4=emphasis placed on leaders as the embodiment of the group

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

IV-3-5 External contacts (excluding warfare) [AR-PE-19]

0=egalitarian/no formal leaders

1=few or unimportant

2=external contacts are part of leaders' authority, but not exclusive

3=external contacts are key to leaders' authority, but not exclusive

4=external contacts are exclusively controlled by leaders

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

Components of Physical Vulnerability

IV-4 Subsistence Economy

IV-4-1. Food Storage. Sum of the following variables (adopted from Seshat codebook).

- IV-4-1-1 Food preservation techniques
- IV-4-1-2 Containers for food storage
- IV-4-1-3 Household food storage facilities
- IV-4-1-4 Village food storage facilities
- IV-4-1-5 Supra-village food facilities

Codes:

0 = Absent

1 = Present

99 = Missing

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

IV-4-2. Agricultural Diversity [AR-SV-3; AR-SV-5]. Sum of the following variables

- IV-4-2-1 Crops: Cereals (Order: *Poales*)
- IV-4-2-2 Crops: Legumes (Order: *Fabales*)
- IV-4-2-3 Crops: Vegetables (Order: *Solanales*)
- IV-4-2-4 Crops: Squashes (Order: *Curcubitales*)
- IV-4-2-5 Crops: Regionally important subsistence plants (e.g. yam [Order: *Dioscoreales*]; taro [Order: *Alismatales*]; cassava [Order: *Malpighiales*]; amaranth [Order: *Caryophyllales*]; banana [Order: *Zingiberales*]; coconut [Order: *Arecales*])
- IV-4-2-6 Animals: Sheep, cattle, pig, llama, camel (Order: *Artiodactyla*)
- IV-4-2-7 Animals: Horse, donkey (Order: *Perissodactyla*)
- IV-4-2-8 Animals: Small mammals (Order: *Rodentia*; *Lagomorpha*)
- IV-4-2-9 Animals: Birds (Orders: *Galliformes*; *Anseriformes*)
- IV-4-2-10 Polyculture (Seshat). The practice of growing a number of different crops in a field such that they are planted or harvested at approximately the same time. It can take the form of companion planting (sometimes used in gardening and intensive cultivation of vegetables and fruits), and intercropping (where an additional crop is planted in the spaces available between the main crop).
- IV-4-2-11 Multicropping (Seshat). Multicropping is defined as "the practice of growing two or more crops in the same space during a single year, with substantial temporal separation in the planting times of different crops." The

crops can be the same type, or different types. It can commonly take the form of double-cropping (in which a second crop is planted after the first has been harvested), or relay cropping (in which the second crop is started amidst the first crop before it has been harvested).

IV-4-2-12 Fertilizers (Seshat)

Codes:

0 = Absent

1 = Present

99 = Missing

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

IV-4-3. Alternative Food Sources. [AR-SV-7] [AR-SV-9] [AR-SV-11] Sum of the following variables (corrected for biome (IV-4-4) if necessary).

IV-4-3-1 Fish: Mollusks (Classes: *Bivalvia*; *Gastropodia*)

IV-4-3-2 Fish: Shellfish (Class: *Malacostraca*)

IV-4-3-3 Fish: Marine reptiles (Class: *Raptilia*)

IV-4-3-4 Fish: Freshwater fish (Class: *Osteichthyes*)

IV-4-3-5 Fish: Saltwater fish (Classes: *Chondrichthyes*; *Osteichthyes*)

IV-4-3-6 Fish: Aquatic mammals (Orders: *Pinnipedia*; *Cetacea*)

IV-4-3-7 Animals Hunted: Small game (e.g. Orders *Rodentia*, *Lagomorpha*)

IV-4-3-8 Animals Hunted: Large game (e.g. Orders *Proboscidea*; *Perissodactyla*; *Artiodactyla*)

IV-4-3-9 Animals Hunted: Birds and Waterfowl (e.g. Orders: *Galliformes*; *Anseriformes*)

IV-4-3-10 Gathered Foods: Insects, grubs, honey

IV-4-3-11 Gathered Foods: Wild herbs, leaves, blossoms

IV-4-3-12 Gathered Foods: Tree pith, e.g., sago

IV-4-3-13 Gathered Foods: Wild roots or tubers

IV-4-3-14 Gathered Foods: Wild fruit, seeds, nuts, berries

Codes:

0 = Absent

1 = Present

99 = Missing

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

IV-5. Infrastructural investment. Sum of the following variables (adopted from Seshat codebook).

IV-5-1. Irrigation systems

IV-5-2. Agricultural terracing

IV-5-3. Drinking water supply systems

IV-5-4. Sewage management systems

IV-5-5. Food storage facilities

IV-5-6. Roads

IV-5-7. Fortifications.

Codes:

0 = Absent

1 = Present

99 = Missing

Data Quality:

1 = Good

2 = Poor

3 = Inferred answer

99 = Missing

DEPENDENT VARIABLES

DV-1. Migration. Proxied using AR-ST-1: Change in Population

- 1 = Dramatic decrease
- 2 = Decrease
- 3 = Stable
- 4 = Increase
- 5 = Dramatic increase
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

Archaeological indicators (adapted from Seshat codebook):

Change in settlement size. Indicate the nature of the change.

Development of new settlements. Explain the type of settlements, their locations, and their size.

Biodistance or genetic changes. Describe the evidence as completely as possible.

Changes in material culture. Describe as fully as possible.

DV-2. Famine and Disease. Proxied using AR-ST-2: Change in Health or Nutrition

- 1 = Dramatic decrease
- 2 = Decrease
- 3 = Stable
- 4 = Increase
- 5 = Dramatic increase
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

Archaeological indicators (adapted from Seshat codebook):

Skeletal evidence of disease or malnutrition. Indicate frequency, if known, and explain the nature of evidence.

Mass burials. Explain the nature of evidence (e.g., temporally discrete and unlike regular burials; no evidence of violent death).

Pictorial evidence of disease of famine. Provide details and explain the nature of the evidence.

DV-3. Conflict. Proxied by AR-ST-3: Change in Conflict

- 1 = Dramatic decrease
- 2 = Decrease
- 3 = Stable
- 4 = Increase
- 5 = Dramatic increase
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

Archaeological indicators: (adapted from Seshat codebook)

Skeletal evidence of violence Indicate frequency, if known. Explain the nature of evidence (e.g., arrow points embedded in bones).

Mass burials. In the explanatory paragraph explain the nature of evidence (e.g., high proportion of skeletons show evidence of violent death).

Settlement destruction In the explanatory paragraph explain the nature of evidence (e.g., evidence of burning, followed by abandonment).

Pictorial evidence of warfare Code absent/present. In the explanatory paragraph provide details and explain the nature of evidence (e.g., battles, attack on settlements, ritualized execution of prisoners, etc).

DV-4. Political change. Sum of standardized scores of the variables below.

DV-4-1. Change in Community Scale and Complexity [AR-ST-6]

- 1 = Community organization collapses.
- 2 = Size and/or organizational complexity of community decreases.
- 3 = Size and/or organizational complexity of community remains stable.
- 4 = Size and/or organizational complexity of community increases.
- 5 = Radical increase in the size and/or organizational complexity of communities
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

DV-4-2 Change in Regional Scale and Complexity [AR-ST-7]

- 1 = Regional system collapses.
- 2 = Size and/or organizational complexity of region system decreases.
- 3 = Size and/or organizational complexity of regional system remains stable.
- 4 = Size and/or organizational complexity of regional system increases.
- 5 = Radical increase in the size and/or organizational complexity of regional system.
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

DV-4-3 Change in Communal Ritual [AR-ST-8]

- 1 = Communal ritual ceases.
- 2 = Scale and/or organizational complexity of ritual decreases.
- 3 = Scale and/or organizational complexity of ritual remains stable.
- 4 = Scale and/or organizational complexity of ritual increases.
- 5 = Radical increase in the size and/or organizational complexity of ritual.
- 88 = Conflicting information
- 99 = Missing

Data Quality:

- 1 = Good
- 2 = Poor
- 3 = Inferred answer
- 99 = Missing

Initial cases to be coded

North America

- ARO-1. Point Peninsula Complex (Ontario Peninsula IBSS) 300 BCE-700 CE
- ARO-2. Mund Phase (Cahokia NGA/IBSS) 450 CE-600 CE
- ARO-3. Pioneer/Formative Phase (Gila River IBSS)
- ARO-4. Monte Alban IIIB and IV (Oaxaca NGA) 500 CE-900 CE
- ARO-5. Early Classic (Tikal IBSS) 250 CE-600 CE

Europe

- ARO-6. Early Merovingian (Paris Basin NGA) 486 CE-543 CE
- ARO-7. Ostrogothic Kingdom (Latium NGA) 489 CE-554 CE
- ARO-8. Migration Period (Southern Jutland ARO) 500CE – 700CE
- ARO-9. Brega (Ireland ARO) Reign of Túathal Máelgarb 533 CE-544 CE
- ARO-10. Toledo (Central Spain ARO) Reign of Theudis 531 CE-548 CE

Eastern Asia

- ARO-11. Rouran Khaganate (Orkhon Valley NGA) 300 CE-555 CE [Mongolia]
- ARO-12. Hephthalites (Sogdiana NGA) 408 CE-561 CE [Central Asia]
- ARO-13. Kofun (Kansai NGA) 250 CE-710 CE [Japan]
- ARO-14. Early Imperial Period (Middle Yellow River NGA) 200 BCE-900 CE
- ARO-15. Liang (Lower Yangtze River Valley ARO) Emperor Wu, 502-549 CE

Southern Asia

- ARO-16. Sasania Period (Susiana NGA) 224 CE-642 CE
- ARO-17. Kadamba Empire (Deccan NGA) 354 CE-540 CE
- ARO-18. Gupta Empire (Ganges ARO) Kumaragupta III ca. 530-540 CE

Northern Africa

ARO-19. Byzantine Empire (Upper Egypt NGA) 395 CE-631 CE

ARO-20. Jenne-jeno III (Lower Niger River NGA) 400 CE- 900 CE (dummy case?)