Data Repository Item 1

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1. Precise Trench Locations.

Table DR1. Trench locations referenced to NAD83 (North America Datum of 1983) from GPS surveys in 2002 (Rio Puerco) and 2000 (Chaco). Left and Right indicate the endpoints of the cross sections. Latitude and longitude are given in decimal degrees.

Trench	Position	Longitude	Latitude
Chaco	Left	107.96869	36.06149
	Right	107.96710	36.06324
	Thalweg	107.96797	36.06233
Hwy 6	Left (BM)	106.98557	34.78183
	Right (BM)	106.98788	34.77991
	Thalweg	106.98765	34.78000
Belen	Left	106.88822	34.68463
	Right (BM)	106.89059	34.68473
	Thalweg	106.88822	34.68463
Bernardo	Left	106.85870	34.41756
	Right	106.85992	34.41713
	Thalweg	106.85990	34.41714

2. Spatial and Temporal Coverage. Dates, resolution and sources of aerial imagery are shown in Table DR2. The 1935, 1950s, and 2005 imagery and the 2005 LiDAR DTMs cover the entire segment from Hwy 6 (vk 0) to the old Highway 85 bridge at vk 54.9. The bridge is 110 m downstream from the USGS streamflow-gaging station Rio Puerco near Bernardo, NM (at vk 54.8). The 1970s imagery covers 95.4% of the study segment, with a gap from vk 2.7 to 5.0. GPS survey data from April 2002 cover vk 0-54.9 and include a channel thalweg profile and arroyo cross sections at trench sites. GPS survey data from January 2007 cover vk 0-9.3 and include a channel thalweg profile, selected flood-plain points, and channel and arroyo cross sections. The GPS data from April 2010 cover vk 0-31.8 and include channel and arroyo cross sections and flood-plain profiles.

Table DR2. Sources of aerial imagery

Year	Image type	Source	Acquisition Date(s)	Original Photo scale	Rectified Image pixel size (m)
1935	Aerial photographs	US Department of Agriculture	1935	1:31,680+	1.28
1950s	Aerial photographs	Army Map Service, Corps of Engineers	11-1953, 1-1954, 02-1954,	1:54,000	1.35 2.28
		Farm Service Agency	06-1955	1:20,000	0.92
1970s	Aerial photographs	Unknown	08-1975 05-1979	1:39,100 1:12,000	1.70 0.55
2005	Digital imagery*	Aerial LiDAR survey,	04- and 07-2005	NA	0.20

+Scale obtained from Miller (1999).
*Standard Imagery LiDAR Composite (SILC)
NA = not applicable for digital images

3. Resolution and Rectification. The 2005 Standard Imagery LiDAR Composite (SILC) images were delivered geo-referenced to the UTM coordinate system, Zone 13, NAD 83 by Spectrum Mapping LLC (unpublished report, 2005). Differential rectification on a pixel-by-pixel basis produced highly-accurate, ortho-photographically correct images. Horizontal and vertical accuracies of the 2005 LiDAR DTMs and imagery are less than 0.3 m root-mean-square-error (RMS error). Pixel size for the SILC imagery is 0.20 m x 0.20 m, whereas the DTMs have 2.0 m x 2.0 m cell size. Prior to receiving the 2005 imagery, the scanned 1935, 1950s, and 1970s images were registered to the same coordinate system and horizontal datum using 1996 U.S. Geological Survey Digital Orthophoto Quarter-Quads (DOQQs) derived from 1996 National Aerial Photography Program (NAPP) imagery. The DOQQs have a 1-m pixel size and meet the National Map Accuracy Standards (NMAS) at 1:12,000 scale, which specifies that well-defined points must fall within 1/30 inch (33.3 feet; 10.2 m). In areas with limited relief (e.g., the pre-arroyo valley floor and the arroyo bottom), observed horizontal errors are on the order of 3 m or less. The method used to map the tops and bottoms of the arroyo walls, described in the next section, limited the effects of registration errors in the pre-2005 imagery in mapping arroyo features. Photographs were registered, then rectified using a six-parameter affine transformation that uniformly rotates, scales, and translates the image (ESRI, ArcDoc version 9.2).

4. Aerial Photograph Registration Accuracy. Geomorphic changes within the arroyo can be determined only when the amount of change in position of a linear feature, for example the arroyo wall, is greater than the error in image registration (Mount et al., 2003). RMS errors from the registration of nine 1935 photographs averaged 1.88 m, with a maximum value of 3.5 m. Average pixel size for the rectified images is 1.28 m (Table DR2). These results from registration using a limited number of identifiable points (4 to 6, with an average of 5) suggest much greater accuracy than was achieved over the entire images. In order to obtain a better assessment of the accuracy of the registrations, sets of more than 50 points identifying features common to the 1935, 1950s, 1970s and 2005 images were selected and coordinates for these points obtained from the appropriate images. The 2005 SILC imagery has the highest accuracy (less than 0.30 m RMS error; Table DR3) and image quality. Therefore, these images provided the reference base for comparison of corresponding point locations in the 1935, 1950s, and 1970s images. Linear distances between the coordinates obtained from the 2005 SILC images and the coordinates for the same points in the earlier rectified images were computed (Table DR3). Maximum point location errors from the 1935, 1950s, and 1970s images were 13.9 m, 13.1 m, and 14.2 m, respectively. The data show that the registered images and features mapped from these images meet the NMAS specification for 1:24,000-scale maps of no more than 10 percent of identifiable points have errors greater than 1/50th inch (12.2 m).

Table DR3. Comparison of average registration errors and average deviation of test points from reference point locations.

				Test point error statistics:			
Photo Year(s)	Pixel size (m)	Number of images	Average registration error (m)	Average error (m)	Std Dev (m)	n	% of points with > 12.2 m error
2005	0.20	16	< 0.30	reference points			
1979	0.55	8	1.963	5.64	3.16	51	4
1975	1.70	4	1.726				
1953, 1954	1.34	5	3.077	6.21	3.65	56	7
1954	2.28	2	2.702				
1955	0.92	1	2.705				
1935	1.28	9	1.880	4.76	3.55	59	3

5. Historic Arroyo Depth Data. Arroyo depth measurements listed by Bryan (1928) were at locations referenced to the Public Land Survey System (PLSS), enabling reasonably accurate estimates of location relative to the 2005 arroyo. The data within the study reach include a single point from J. W. Garretson's 1855 survey of the New Mexico Principal Meridian, 9 points from G. H. Pradt's 1898 survey (vk 3.3 to 19.1), and 10 points from Post's 1927 survey (vk 1.3 to 44.7). Trench chrono-stratigraphy provides additional data on historic arroyo depths at the three sites, and Bryan's 1936 surveyed arroyo cross section at vk 0.76 (Elliott et al., 1999) also provides a depth point. A survey headpin on the pre-arroyo valley floor at the Bryan cross section allowed vertical adjustment of the 1936 cross section data to the NAVD 88 datum. Arroyo depth in 2005 as a function of distance down-valley is shown in Figure 9a. These values were used to calculate arroyo volume in 2005.

6. Registration of 1927 Arroyo Width Data. Arroyo top width in 1927 was obtained from a graph provided by Bryan and Post (1927) showing arroyo width as a function of distance upstream from the mouth. Distance up-valley from the mouth in relation to the 2005 arroyo can be determined relatively accurately for only a few specific points (e.g., the location of the Bryan cross section) that can be used to convert distance up-valley to distance down-valley along our identified arroyo centerline. In addition, the relation between Bryan and Post's 1927 distance up-valley from the mouth and the 2005 distance down-valley from Hwy 6 along the arroyo centerline is not constant. Rapid channel migration indicated by the large increases in arroyo width between 1927 and 1935 suggest the arroyo centerline position may have moved between 1927 and 2005, changing the distance along that path. Distances to known points, such as the Bryan cross section, were used to estimate the initial conversion. Minor adjustments to down-valley distance were then applied to improve the agreement between locations of wide arroyo segments in 1927 and 1935. The resulting distance conversions are:

1) For down-valley distance 0 to 30 vk,
   distance down-valley (vk) = 58.200 – distance up-valley (km)
2) For down-valley distance 30 to 55 vk,
   distance down-valley (vk) = 58.573 – distance up-valley (km)

Arroyo width features and their measurement are illustrated in Figure DR1.

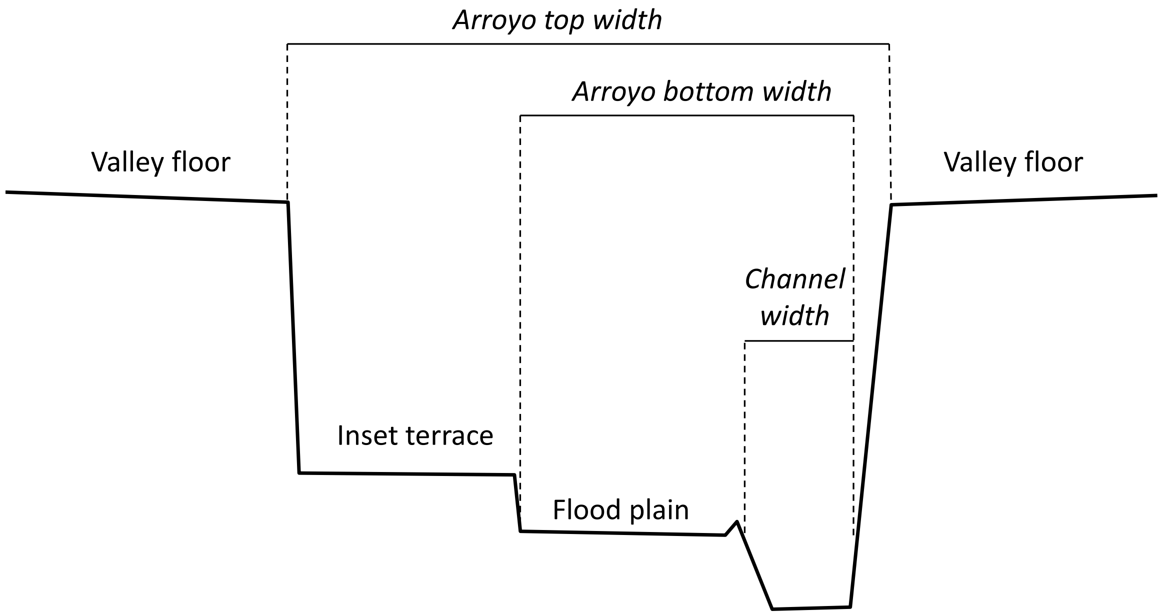

Figure DR1. Illustration of arroyo width features and their measurement.

7. Calculation of Changes in Arroyo Volume. We estimated arroyo volumes in 1927, 1935, 1950s and 1970s for each 0.5-km interval by calculating changes relative to 2005 in depth and in planimetric top and bottom areas. We assumed that the change in arroyo volume was the difference between the increase in volume resulting from arroyo widening and the decrease in volume resulting from arroyo filling. The increase in volume resulting from arroyo widening was calculated as the increase in arroyo planimetric area within the interval multiplied by the average height of the valley floor above the 2005 flood plain. The decrease in volume resulting from arroyo filling was calculated as the change in arroyo bottom elevation multiplied by the planimetric area of the arroyo bottom at the beginning of the time period. Since the 1950s, channel area has changed little and has been small relative to arroyo area. Therefore, between 1955 and 2005, we neglected changes in channel area. In 1935, aerial photography shows that the channel was wide at both Bernardo and Highway 6. For Highway 6 we assumed that the arroyo-bottom elevation in 1935 was the average arroyo bottom elevation at the nearby monumented cross section surveyed by Kirk Bryan in 1936 (Elliott et al., 1999). At Bernardo, aerial photographs show that almost all of the arroyo bottom traversed by the trench was channel bed in 1936; we used the elevation of this channel bed as determined by trench chronostratigraphy as an estimate of arroyo bottom elevation in 1935. The mean value of 2005 average arroyo depth from the 42 DTM cross sections is 6.24 m and the standard deviation is 1.84 m (29.5% of the average arroyo depth). The sparse depth data available for the 1930s and 1950s limit the estimated accuracy of the computed change in arroyo volume relative to that in 2005 to within about 30%. We calculated arroyo volume in 1927 from width and depth data surveyed by Bryan and Post (1927). The average difference in 2005 arroyo depth at adjacent cross sections was 0.60 m, and the estimated potential error in interpolated 0.5-km arroyo depth is one-half that difference, 0.30 m, or 4.8% of the average arroyo depth. The maximum error in arroyo planimetric area also is estimated to be no more than 5% based on the accuracy of linear feature mapping (Vincent et al., 2009) and image registration errors (DRI 1). Therefore, the maximum error in calculated 2005 arroyo volume is expected to be less than 10%.

8. References

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