[Supplementary material]

Lidar reveals the entire kingdom of Izapa during the first millennium BC

Robert M. Rosenswig[1,*] & Ricardo López-Torrijos[1]

[1] *Department of Anthropology, University at Albany, State University of New York, Arts and Sciences 237, Albany, NY 12222, USA*

[*] *Author for correspondence (Email: rrosenswig@albany.edu)*

Materials and methods: lidar collection and processing

Basic methodology employed by the Izapa Regional Settlement Project (IRSP) have been published in some detail. Lidar data collection and processing as well as ground-truthing and ceramic phase designation methodology were published based on initial work on the piedmont survey zone around Izapa (Rosenswig *et al*. 2013). Comparisons of mound detection results were then comparatively assessed between different ground cover conditions and lidar collection campaigns in the piedmont and low hills zones (Rosenswig *et al*. 2015a). These Supplemental Materials consists of a review of lidar data parameters for the low hills zone (collected in 2010) the piedmont zone (collected in 2011) from the first campaign of data collection as well as results from the second data collection campaign carried out in 2015 that filled in the area between the two initial zones and extended the survey coverage south and west of the low hills zone (Figure S1). These data descriptions are intended to accompany the digital elevation model (DEM) mosaic that can be made available to interested researchers by the senior author.

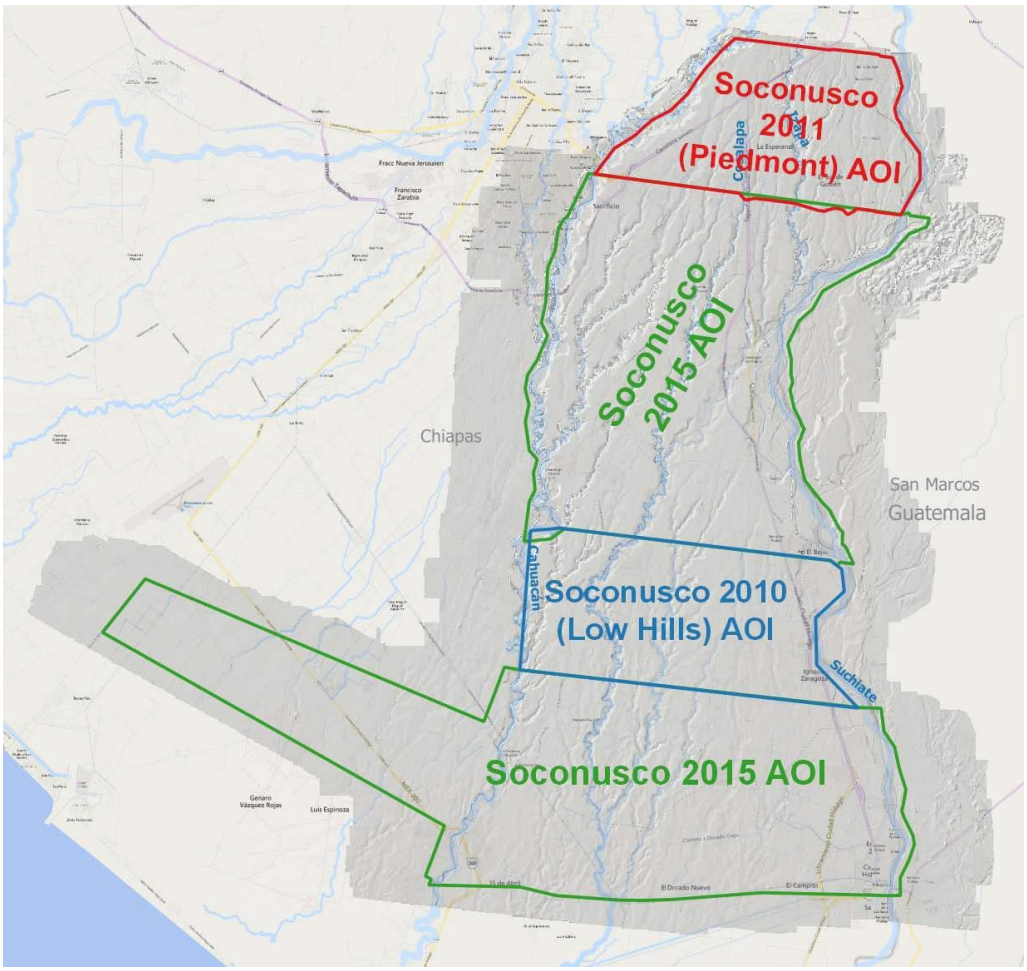

Figure S1. Location of three campaigns of lidar data collection. The area of interest (AOI) is between the Cahuacán and Suchiate Rivers where intensive pedestrian survey was undertaken.

Soconusco 2010–2015 lidar DEM mosaic

The DEM mosaic composed of the 609 individual DEM tiles derived from the Soconusco 2010, Soconusco 2011 and Soconusco 2015 lidar collections (Figure S2). DEM derived from airborne lidar data collected in part of the low hills and piedmont area of the Soconusco region archaeological survey zone. The primary area of interest (AOI) is located between the Cahuacán and Suchiate Rivers (Figures S1–S3). Lidar data was collected and delivered beyond both of these rivers, for a total of 584.8km^2 (228.4mi^2). Raster resolution of 1m, WGS84 datum, UTM zone 15 North projection. Note that the ground footprint of an individual DEM tile does not correspond to the footprint of a lidar tile: the lidar tiles included in the derivation of each DEM

tile can belong to any of the lidar collections that cover its footprint. It follows that the lidar ground point spacing for DEM tiles covered by multiple collections differ from the point density reported for individual collections. The mosaic is in GDAL virtual raster format, the component tiles in GeoTIFF raster file format with LZW compression. Total DEM tile size is 1.4GB. The temporal gap between data collection campaigns, use of different lidar sensors and residual difference in elevation for the same area (as measured by different sensors) did not adversely affect the suitability of this derived DEM for its intended purpose. Review of the data lineage is advised for other uses.

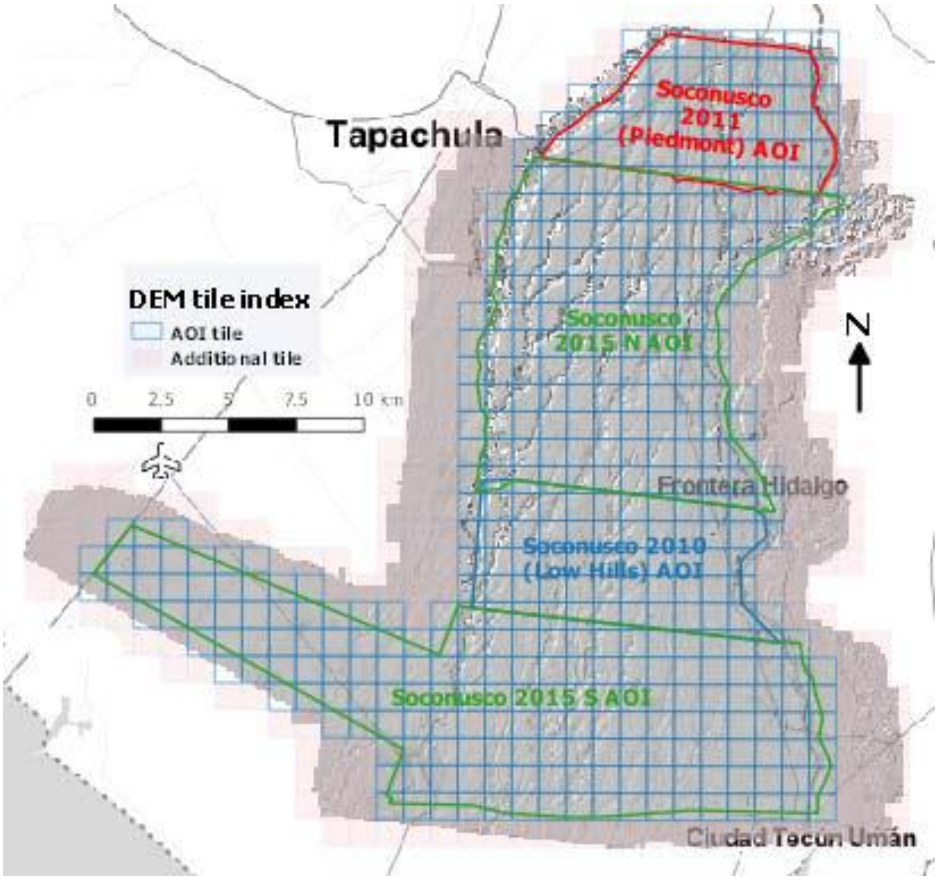

Figure S2. Soconusco 2010-2015 lidar collection area of interest and additional DEM tiles.

Ground point density varies depending on the land cover, the lidar systems settings for each of the collections, and, the overlap between two or more adjoining flight overpasses. The denser the vegetation covering the ground, as occurs along the major rivers corridors, the less the laser beam penetrates the canopy and the lower the ground point density. For any area, more frequent

laser pulses emitted from the system translates into more detected ground points. In general the flight/lidar settings used in the 2015 collection produced a higher ground point density. Finally, we used all detected ground points to interpolate the DEM, including flight passes that covered the same area up to five times in some cases. The overall, average ground point density used for the DEM interpolation ranged between 1.4 and 4.3 points per m^2 (Table S1) whereas in particular areas density was as high as 16 points/m^2 and along the edges lower than 1 point/m^2 (Figure S3).

	Mean	Median	Standard Deviation
Soconusco2010	1.7	1.4	1.4
Soconusco2011	1.4	1.1	1.2
Soconusco2015 North	2.9	2.8	1.9
Soconusco2015 South	3.4	2.9	2.3
2010x2015 overlap, 2010 AOI	3.7	3.6	1.9
2010x2015 overlap, 2015 S AOI	4.3	3.9	2.2
2010x2015 overlap, 2015 N AOI	3.4	3.1	2.0
2011x2015 overlap, 2011 AOI	3.1	2.9	2.0

Table S1. Overall ground point density for the area of interest (AOI) reported as points per sq m.

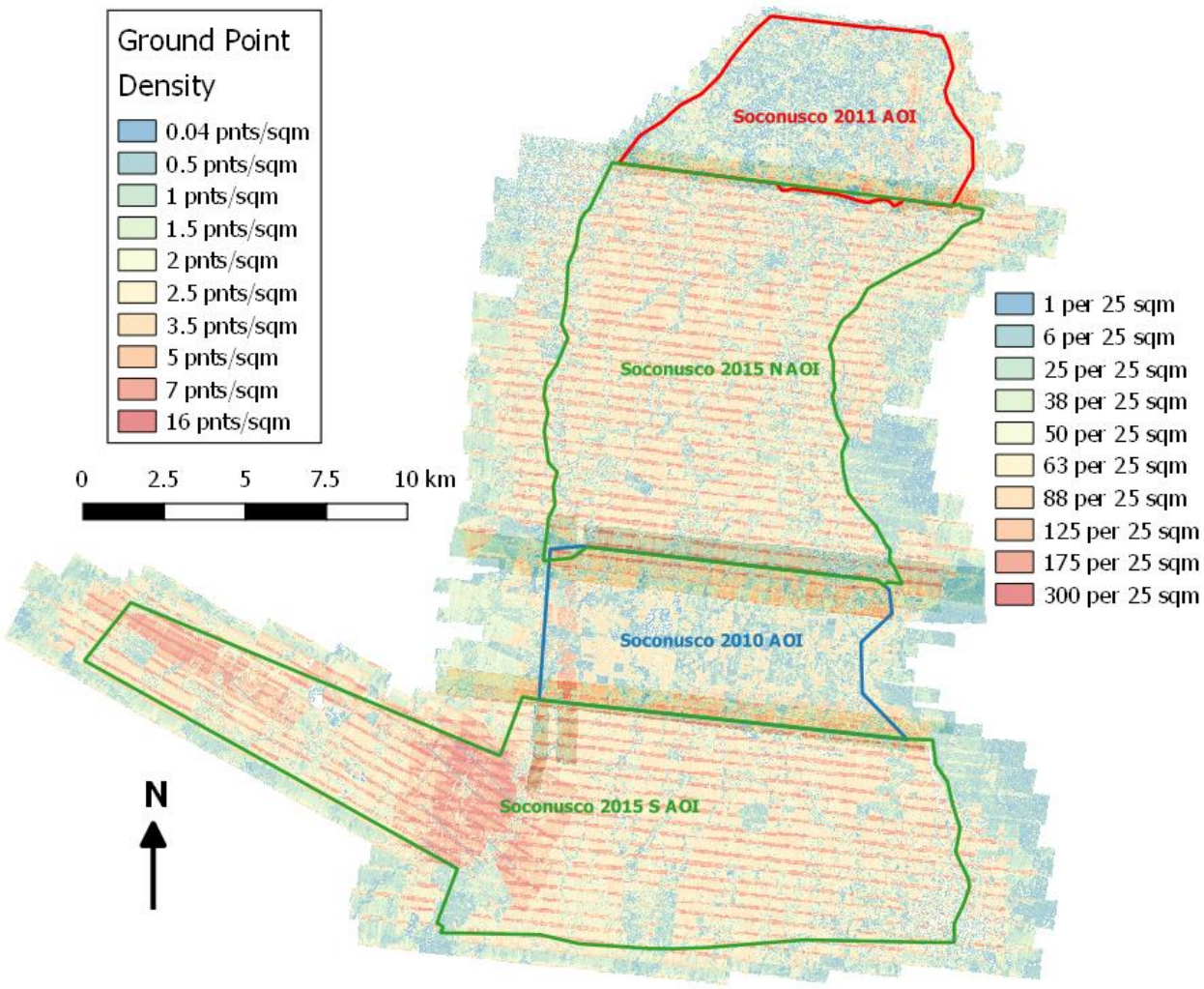

Figure S3. Ground point density of 584.8km^2 of lidar data collected by the IRSP.

These lidar data products were developed in support of the IRSP and processed to document regional history of the Izapa kingdom in the Soconusco region of Chiapas, Mexico. The IRSP used the lidar data to "see through" tropical vegetation and produce a fine-grained ground elevation map. This was used to identify pre-Hispanic mounds in both the Soconusco low hills and piedmont zones, as these are the only consistently observable indications of past occupation visible on the ground surface. Detection of mounds varying in size upwards from 3m x 3m and 0.5m height was sought.

Ground data derived from lidar were used to infer changes through time of regional settlement patterns and relative population levels in complementary environmental zones.

Inferring how such changes correspond to the political organisation is the primary goal of the IRSP (e.g., Rosenswig *et al*. 2013; Rosenswig *et al*. 2015a; Rosenswig and Mendelsohn 2016). Rosenswig *et al*. 2018). Other uses in hydrology, cartography, geomorphology and many other applications are possible.

Data quality and accuracy information

Logical consistency report: All grid cells are populated. No-data cells had no measurement carried out.

Horizontal accuracy report: Nominal horizontal accuracy of is of 0.3m (≈1.0'), 1 sigma.

Horizontal positional accuracy assessment: 1m nominal, as per flight sensor parameters.

Vertical accuracy report: No ground truth positions were collected to verify and align the vertical datum of any of the collections, therefore the vertical coordinate should be treated as relative to the WGS84 datum. The vertical coordinates of the Soconusco 2015 lidar collection were offset in the vertical by -8.4m to better align it with the 2010 and 2011 collections. Relative Vertical Accuracy of ≤ 60mm. Smooth surface repeatability ≤ 80mm RMSDz, ±0.16m maximum difference.

Vertical positional accuracy assessment: <0.1m nominal, as per flight sensor parameters.

Data Source and process information

Soconusco 2010 lidar – low hills zone

Airborne lidar data collected in part of the low hills zone between the Cahuacán and Suchiate Rivers in Chiapas, México. Lidar data was collected and delivered beyond both of these rivers, for a total of 87km^2, but in those flightline segments the lidar system collection parameters were beyond those specified for the project – e.g. the laser beam scanning angle might be beyond the [-20deg, +20deg] range. Therefore data quality parameters only apply to LAS tiles within the

49.5km^2 project specified area of interest (AOI), where ground truthing activities were carried out.

Airborne 1 Corporation, a private contractor based out of El Segundo, California, carried out five flights between August 20 and 23, 2010, using an Optech ALTM 100K (A1) scanner. The scanner was mounted on a single engine Cessna airplane. Flying height was approximately 1300m (4400ft) with a ground speed averaging 230km/h (144mi/h.) The laser scanner was operated with a scan frequency of 37kHz a scan angle of 20 degrees and up to 3 return per laser pulse. A total of 22 swaths of lidar data were collected, with a trajectory PDOP < 2. Twenty of the flight lines, spaced about 350m apart, were parallel to each other, and two were perpendicular to the rest.

Point cloud coordinates were processed to generate data in LAS version 1.2 format, in the WGS84 datum and UTM zone 15 projection. As no GPS ground truth points were collected to verify and align the vertical datum, it should be treated as relative. Later comparison with the vertical coordinates of the Soconusco 2015 lidar collection revealed this collection to have an average vertical offset of +8.4m with respect to the later.

Lidar data was post-processed with an automated lidar point classification routine to extract bare earth and isolated outlier points. Additional partial supervised classification improved the automated classification in areas of project interest. Vegetation misclassified as ground remains in areas of dense vegetation, along the main rivers, or dense crops. Average ground point density within the area of interest on the low hills is 1.7 points per m^2. Lidar written into LAS version 1.2 files, named with a sequential project 4-digit number, each covering a 1x1 km area; the project AOI from the low hills is covered by 69 tiles, while 50 tiles cover the additional collection area.

The delivered lidar product has a nominal vertical accuracy of 0.185m (≈0.6') at the 95% confidence interval. The nominal horizontal accuracy of is of 0.3m (≈1.0'), 1 sigma. The lidar yielded an average total collection point density of 3.2 points per m^2 and ranged from 0.7 to 5.9 points per m^2 (see Rosenswig *et al*. 2015a for more detail).

Soconusco 2011 lidar –Piedmont zone

Airborne lidar data collected in the piedmont zone on either side of the Izapa River between the Cahuacán and Suchiate Rivers. Lidar data was collected and delivered beyond both of these

rivers, for a total of 57.8km^2, but in those flight line segments the lidar system collection parameters were beyond those specified for the project – e.g. the laser beam scanning angle might be beyond the [-30deg, +30deg] range. Therefore data quality parameters only apply to LAS tiles within the 41.6km^2 project specified area of interest (AOI), where ground-truthing activities were carried out.

Airborne 1 Corporation, a private contractor based out of El Segundo, California, carried out two flights on April 29 and May 1, 2011 using a Reigl VQ 480 scanner. The scanner was mounted on a single engine Cessna airplane. Flying height was approximately 1220m (4000ft) with a ground speed averaging 240km/h (150mi/h.) The laser scanner was operated with a scan frequency of 100kHz and scan angle of 30 degrees and up to 6 return per laser pulse. A total of 5 swaths of lidar data were collected, with a trajectory PDOP < 2. Point cloud coordinates were processed to generate data in LAS version 1.2 format, in the WGS84 datum and UTM zone 15 projection. As no GPS ground truth points were collected to verify and align the vertical datum, it should be treated as relative. Later comparison with the vertical coordinates of the Soconusco 2015 lidar collection revealed this collection to have an average vertical offset of +8.4m with respect to the later.

Lidar data were post-processed by Airborne 1 Corporation to filter out vegetation and above-ground structure points. Vegetation misclassified as ground remains in areas of dense vegetation, along the main rivers. The average ground point density within the area of interest is 1.4 points per m^2. Lidar written into LAS version 1.2 files, named with a sequential project 4-digit number, each covering a 1x1km area; the project AOI is covered by 61 tiles, while 14 tiles cover the additional collection area.

The delivered lidar product has a nominal vertical accuracy of 0.185m (≈0.6') at the 95% confidence interval. The nominal horizontal accuracy of is of 0.3m (≈1.0'), 1 sigma. The lidar campaign provided approximately 210 million lidar measurements, yielding an average total collection point density of 3.2 points per m^2, ranging from 0.7 to 5.9 points per m^2 (see Rosenswig *et al*. 2013 for more detail).

Soconusco 2015 lidar

Airborne lidar collected in the low hills area of the Soconusco region archaeological survey zone, expanded the 2010 lidar collection area and connected it with that collected in 2011. The

bulk of the 239km^2 area of interest (AOI) is located between the Cahuacán and Suchiate Rivers in Chiapas, México. The remainder is a 37km^2 long trapezoid area that projects to the West-Northwest of the Cahuacán River (Figures S1-S3). Lidar data were collected and delivered beyond these boundaries, for a total of 440km^2, but the lidar system collection parameters were beyond those specified for the project – e.g. the laser beam scanning angle might be beyond the [-30deg, +30deg] range. Therefore data quality parameters only apply to LAS tiles within the 252.7km^2 project specified area of interest, where ground trueing activities were carried out. Merrick & Company, a private contractor based out of Greenwood Village, CO, carried out 5 flights between March 22 and March 28, 2015, using a Leica Geosystems SN53 ALS50 Phase 2+ scanner. The scanner was mounted on a Cessna 402C airplane. Flying height was 5500ft (1676m) on average, with an average ground speed of 140 knots (259km/hr.) A total of 70 swaths of lidar data were collected: 68 parallel to each other and 2 perpendicular to the rest for vertical alignment. Lidar acquisition was limited to periods when the PDOP (Positional Dilution of Precision) was less than 4.0. Nominal Ground Sample Distance 0.68 meters. Scan Angle 30 deg. Laser Pulse Rate 131,500Hz. Scan Rate 38Hz and detection of up to 4 returns per laser pulse.

Point cloud coordinates were processed to generate data in LAS version 1.2 format, in the WGS84 datum and UTM zone 15 projection. As no GPS ground truth points were collected to verify and align the vertical datum, it should be treated as relative. Comparison with the vertical coordinates of the Soconusco 2010 and Soconusco 2011 lidar collections revealed this collection to have an average vertical offset of -8.4m with respect to the previous ones. A +8.4m shift was applied to all the Z lidar point coordinates to compensate the offset and be able to compare the ground across collections. After application of the vertical offset, the average residual difference in elevation across the different collections is below 80mm in open terrain, with the largest individual residual elevation difference values, up to 0.3m, found along the overlap between the Northern tiles of the 2010 data (low hills zone) and this 2015 data. Relative Vertical Accuracy of ≤ 60mm. Smooth surface repeatability ≤ 80mm. RMSDz, ±0.16m maximum difference.

Lidar data were post-processed by Merrick & Company with an automated lidar point classification routine to extract bare earth and isolated outlier points. Note that, in contrast to the 2010 and 2011 collections, the overlap between adjoining swaths were used, resulting in a higher point density of 50- to 150m-wide bands along the lidar swath overlap areas. Also, end-of-scan

points were not trimmed out of each scan line. The IRSP carried out additional partial supervised classification to improve the automated classification in areas of project interest. Vegetation misclassified as ground remains in areas of dense vegetation, along the main rivers, or dense crops. The average ground point density within the 2015 area of interest is 2.9 points per m^2.

Lidar written into LAS version 1.2 files, named with a sequential project 4-digit number, each covering a 1x1km area; the project AOI is covered by 328 tiles, while 186 tiles cover the additional collection area. The mean total collection point density is of 5.3 points per m^2.

Processing Information

Step 1

Derived Binary floating point DEM tiles from the combination of all lidar LAS tiles produced and reviewed during the Soconusco 2010, Soconusco 2011 and Soconusco 2015 lidar collections. Note that the ground footprint of each DEM tile does not correspond to the footprint of a single LAS tile: each DEM tile is derived from several complete or partial LAS tiles. The LAS tiles included in the derivation can belong to any of the lidar collections that cover the DEM tile footprint. Refer to the DEM tile index and the LAS tile indices for the individual LAS collections to determine the LAS tiles involved in each DEM tile derivation.

The derivation parameters were as follows:

• Interpolation type: Raster regular gridded surface
• Interpolation method: triangular irregular network (TIN)
• Included LAS point classes 2 (ground), 17 (bridge) and 26 (Formative Period archaeological mound)
• NoData = -9999
• Grid spacing: 1m cells
• Raster parameter: elevation
• Raster type: binary floating point raster (FLT) with an accompanying header file
• Raster size: 1000 x 1000m tiles (a total of 609 tiles)
• Overall ground point density: 2.28 pnts/m^2
• Tile name: per Lower Left Corner coordinates, LowerLeftCornerX_LowerLeftCornerY_elev.flt

As a result of the use of all detected ground points in all collections to interpolate the DEM, the lidar average ground point density varies from that for each individual collection, as can be seen from the following statistics, limited to the collection's area of interest (AOI). Ground point density varies depending on the land cover, the lidar systems settings for each of the collections, and, the overlap between two or more adjoining flight overpasses. The denser the vegetation covering the ground (as occurs along the major rivers corridors), the less the laser beam penetrates the canopy and the lower the ground point density. For any area, more frequent laser pulses emitted from the system translates into more detected ground points. In general, the flight/lidar settings used in the 2015 collection produced a higher ground point density. Finally, we used all detected ground points to interpolate the DEM, including flight passes that covered the same area up to four times in some cases. As used for the DEM interpolation the lidar average ground point density ranged between 1.4 and 4.3 points per square meter (Table S1).

Step 2

The floating point binary raster DEM tiles was converted to GeoTIFF format, LZW compression, with GDAL's 'gdal_translate' utility. The reference system was set during the process to UTM zone 15 North projection, WGS 84 datum, meters. The process results in a total of 609 DEM tiles (*_elev.tif GeoTIFF files), each 2.9 MB (3.8MB uncompressed) and named as per its Lower Left Corner (X_Y) coordinates plus a '_elev' suffix. The total size for all the studied area is of 1.4GB (2.8GB uncompressed).

Step 3

To facilitate visualization, a mosaic of all the individual DEM tiles was created in GDAL's Virtual Dataset format, filename Soconusco2010-2015lidarDEMmosaic_v20160909.vrt

Lower-tier centres of the Izapa Kingdom

All images presented in these supplemental materials were generated from the combined 2010-2015 DEM (Figure S4). Red lines on each hillshaded DEM indicate the extent of mounds that date to the Middle and Late Formative period, primarily the Duende, Escalón, Frontera and Guillén phases. Some of these sites have surface remains from earlier (rarely) and later occupation (often Terminal Formative Itstapa and Jaritas phases) but the majority of remains we documented on the ground surface date to the Middle and Late Formative periods. To date, the only sites where excavations have been undertaken to evaluate the correspondence between surface indicators and subsurface deposits is at Izapa (Site 1; see Lowe *et al*. 1982, 2013; Rosenswig *et al*. 2018) and Don Hermelindo (Site 23; see Rosenswig *et al*. 2014) located in the low hills zone and discussed in more detail below. The resolution of the regional patterns provides a synchronic picture of the 600-year (700–100 BC) political organisation. This resolution is not as fine-grained as we have for Izapa but it will take many lifetimes to undertake sufficient excavation at each site to do so. The area over which mound are documented and the number of mounds at each monumental centre indicated in Figure S4 are presented in Table S2.

Formative Site #	**Settlement Tier**	**Area of Mounds (ha)**	**# of Mounds**	**Site Collection #**	**Site Name**
1	1	229.0	89	Iz	Izapa
2	3	1.5	4	Tp 2192	
3	3	2.5	8	Tp 2241	
4	4	0.6	4	Tp 1506	
5	3	1.4	4	Tp 1505	
6	3	2.9	6	Tp 1507	
7	3	1.8	5	Tp 1502	
8	3	0.7	5	Tp 1504	
9	3	1.5	5	Tp 1517	
10	3	2.6	11	Tp 1511	

11	3	3.0	11	Tp 1509	
12	3	3.6	4	Tp 1510	Cupertino
13	3	1.3	5	Tp 1512	
14	3	2.2	5	Tp 1513	
15	3	1.2	4	Tp 1515	
16	3	1.5	6	Tp 1514	
17	3	4.3	14	Tp 1516	
18	3	2.1	6	Tp 1518	
19	4	0.8	4	Tp 1522	
20	3	14.1	26	Tp 1521	El Carmen
21	3	4.5	9	Tp 1519	
22	3	4.7	14	Tp 1521	Tres Hermanos
23	3	5.5	13	Tp 1001	Don Hermelindo
24	3	1.1	4	Tp 1523	
25	3	3.6	7	Tp 1231	
26	3	0.9	4	Tp 1224	
27	3	8.7	21	Tp 1082	Juan Molinas
28	3	1.6	5	Tp 1367	
29	3	1.3	7	Tp 1270	
30	2	42.8	55	Tp 1530	Las Viudas
31	3	1.9	5	Tp 1525	
32	3	1.2	5	Tp 1527	
33	3	3.3	6	Tp 2013	
34	4	0.7	4	Tp 1501	
35	3	4.7	13	Tp 1508	
36	3	1.6	4	in Guatemala	
37	3	>4	>5	in Guatemala	
38	3	2.2	9	in Guatemala	
39	3	3.4	5	in Guatemala	El Jobo
--	2	~ 16	35	in Guatemala	El Jardin

40	--	11.3	14	Tp 1520	
41	--	4.3	8	--	
42	--	3.6	16	Tp 1528	
43	--			Tp 1524	
44	--	5.6	6	--	La Cabana

Table S2. Forty-four Formative-period monumental centres documented by the IRSP.

Piedmont – 2011 survey season

The piedmont zone was the first area that the IRSP employed lidar data to undertake pedestrian survey. It was here that the senior author learned to identify pre-Hispanic mounds with hillshaded DEMs derived from lidar, and this methodology along with preliminary results are described by Rosenswig *et al*. (2013). One month was spent systematically surface collecting every mound within Izapa and these results are used to document the site's occupation on a phase by phase basis for the Formative period and also recently presented for the Classic period (Rosenswig and Mendelshohn 2016). Another month of pedestrian survey was spent surface collecting each of the other mounds documented in the piedmont survey zone. During this field season we had not yet recognised the regularity of site planning and orientation outlined in this paper. The mounds that form Site 2, Site 3, Site 4 and Site 33 were each surface collected and, of course, each recognised as being part of a formal mound centre.

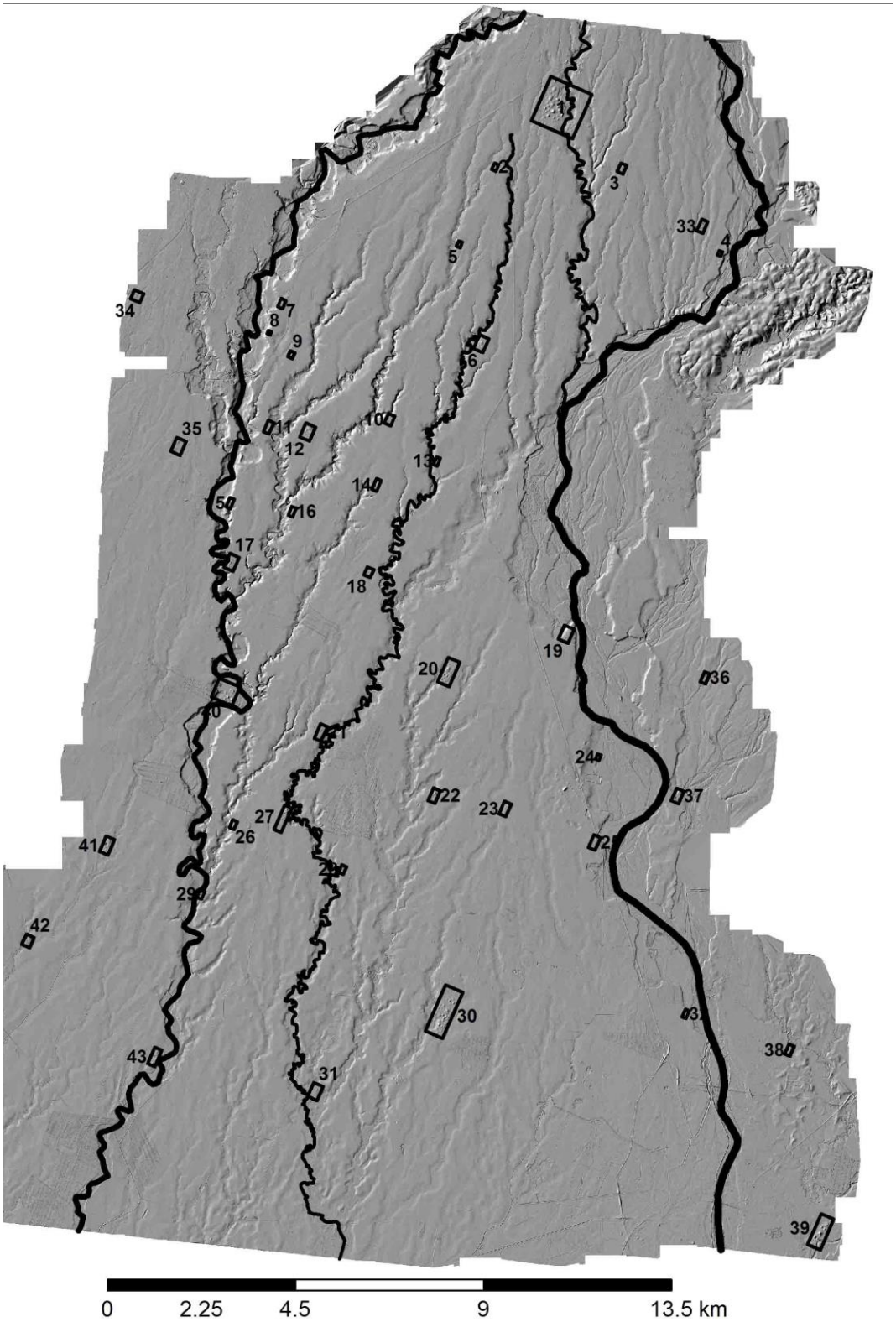

Figure S4. Hillshaded DEM with all IRSP Formative-period centres indicated.

Site 2 (Tp 2192)

This is a very small third-tier centre located on the west side of the headwaters of the Cosalapa River, less than 2km from the Izapa capital. A very low platform is discernible below the northern mound with a single architectural feature on the south edge of this platform (Figure S5). Mounds define the east and west sides of the site's single plaza and a very low mound defines its southern edge. Terminal Formative period ceramic remains were noted on the surface in addition to the majority that are from the Middle and Late Formative periods. The south three mounds were planted in cacao and the northern pyramid and platform had rambutan growing. An uncarved stone monument (recorded as Tp Mon. 4) was documented on the platform south of the main pyramid.

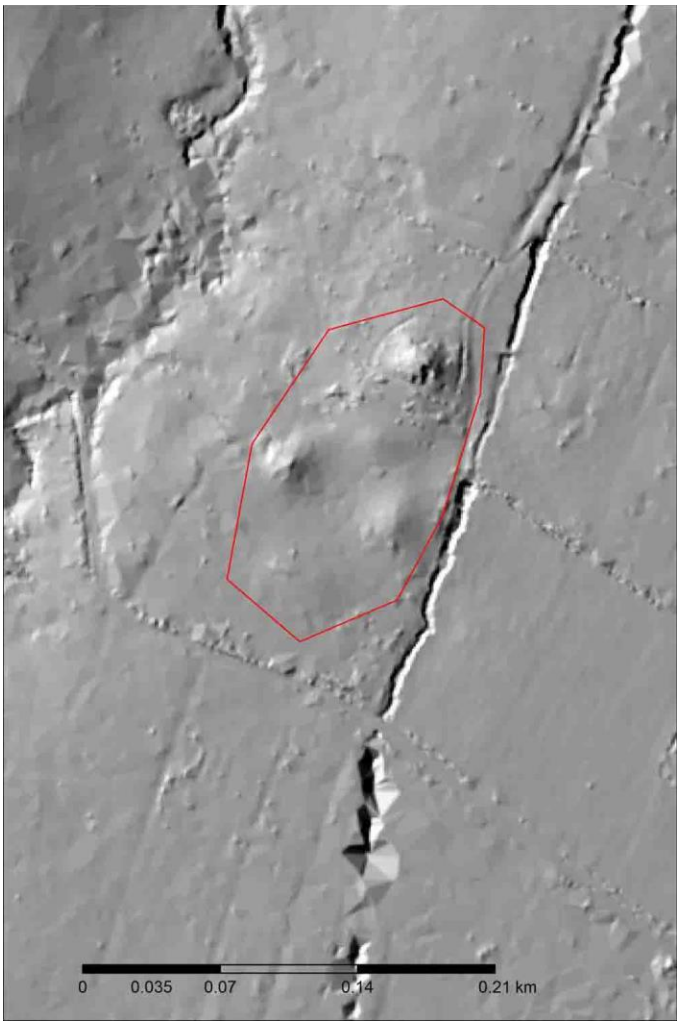

Figure S5. Hillshaded DEM image of Site 2, a Formative-period centre in the Izapa kingdom.

Site 3 (Tp 2241)

This third-tier centre is on the east side of a small stream that empties into the Izapa River and has sustained modern disturbance. The northern pyramid mound and the platform on its southern side are clearly visible (Figure S6). A low, square mound, with a "textured" pattern to the DEM due to thick vegetation growing on it, separate the site's two plazas. The first plaza us defined by a small mound on its west side and is open on the east side, with the plaza limits defined by a drop off to lower ground. On the low western mound (designated Tp 2243), we documented five uncarved stela and two uncarved altars. The second plaza, further south from the main mound, is not currently defined by a mound on its southern side but a modern foot path and other disturbance may have obliterated surface indications of the mound. Terminal Formative remains were noted on the surface in addition to the majority that are from the Middle and Late Formative periods.

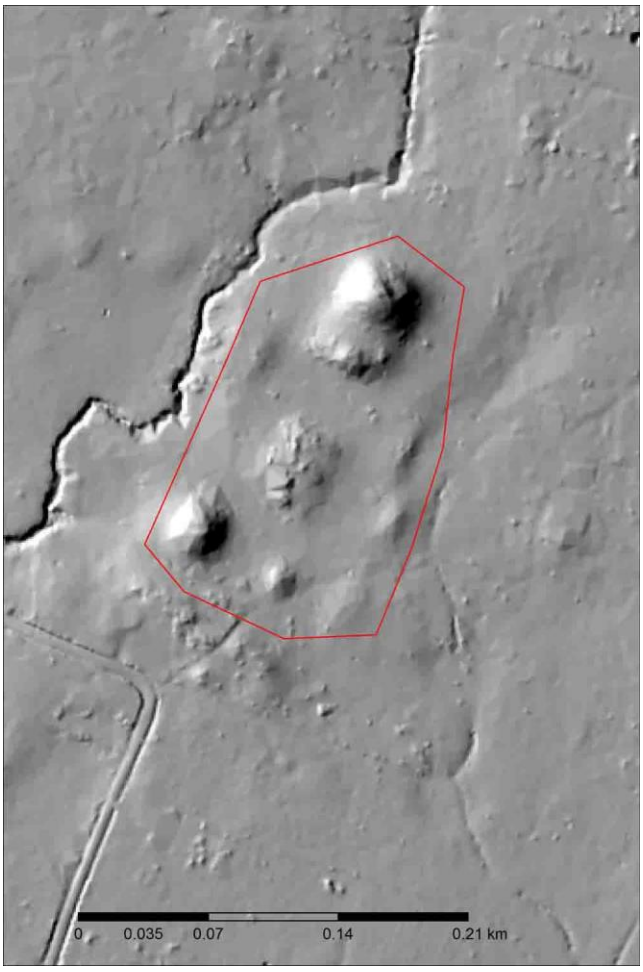

Figure S6. Hillshaded DEM image of Site 3, a Formative-period centre in the Izapa kingdom.

Site 4 (Tp 1506)

There are two components to this site on the west bank of the Suchiate River at the top of a sheer rise that provide a majestic view (Figure S7). The southern mounds date to the Classic period and are covered in Plumbate sherds and other contemporaneous types. The northern four mounds form a fourth-tier centre in the regional hierarchy and is laid out in Izapa pattern. The largest mound is to the north just like higher order centres but there is no platform supporting it. Therefore, there is no formalised stage at the north side of the plaza. Rituals could well have been carried out at the base of the northern mound, and so, still been framed by the mound in the foreground and volcanoes in the background. Four mounds are the minimum that allows for all activities in this plaza to be defined as cultural space by earthen mounds. Form and orientation of the largest northern mound provides the link between a small site like this and larger sites that are higher up in the settlement hierarchy. This site was planted in cacao and we first documented in in 2011 when we designated the northern mound Tp 2009.

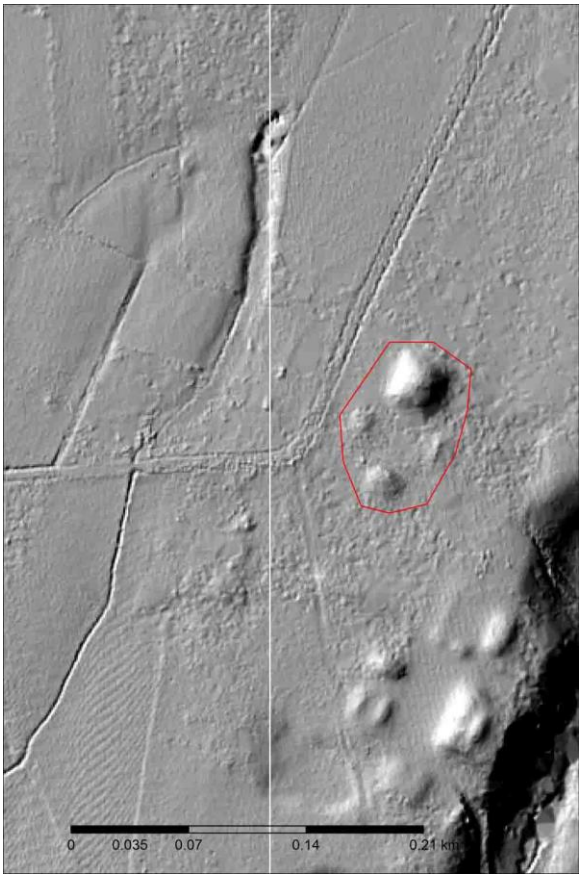

Figure S7. Hillshaded DEM image of Site 4, a Formative-period centre in the Izapa kingdom.

Site 33 (Tp 2013)

This third-tier centre is located between two small streams that both empty into the Suchiate River and is 4.5km from the Izapa capital. Modern earthmoving has created a ridge around the site's northern mound and seems to have disturbed the site's platform (Figure S8). However, the three small architectural features on the platform "stage" are still discernible. The site's single plaza is defined by mounds on four sides but is more elongated north-south than most other centres. This makes the plaza more rectangular (or oval) than square as is the norm. The site was in pasture when visited in 2011 with little ground surface visibility or recent disturbance so ceramic sherd collection samples were minimal.

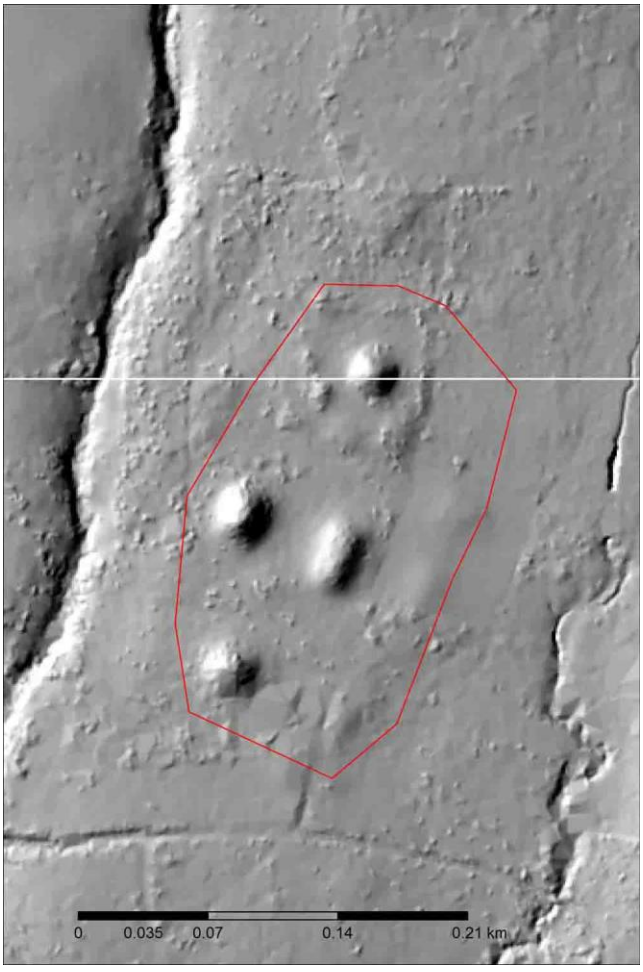

Figure S8. Hillshaded DEM image of Site 33, a Formative-period centre in the Izapa kingdom.

<u>Low Hills – 2012 survey season</u>

The nine Formative-period monumental centres documented in the low hills survey zone during the 2012 field season is what led the senior author to recognise an Izapa-pattern site layout (Rosenswig *et al*. 2015). The recognition of the consistent north-south arrangement of sites with multiple plaza groups is also what pushed the senior author the developmental history of the architectural construction at Izapa itself. It was long recognised that Group A was built only during the Guillén phase (Lowe *et al*. 1982: 133). Less appreciated is what this means for the size and shape of the Middle Formative period occupation of Izapa as consisting of three plazas spread south of Mound 30a. This realisation prompted excavations of the mounds both north and south of Mound 30a on this alignment (Rosenswig *et al*. 2018). Analysis of the nine Formative-period monumental centres in the low hills survey zone also resulted in documenting the consistency of their orientation to Tacaná and Tajumulco volcanoes (Blake *et al*. 2015).

Site numbering systems were different during different field seasons. During the 2012 low hills survey season, every mound documented with lidar was given an individual Tp (indicating Tapachula) number and surface collected as Tp 1001 through Tp 1432 (Rosenswig *et al*. 2012). This was done as every mound was visited regardless of whether it was part of a mound cluster or a solidary mound in order to document every mound in the survey zone. During the 2015 season, Izapa pattern monumental centres were given a single number for the entire site and mounds differentiated within sites by mound numbers. In all cases, the Mound 1 was assigned to the northern conical pyramid. Sites in the low hills zone that were first documented in 2012 are referred to by the number originally assigned to the northern pyramid in order to avoid confusion of decided which of the mound numbers to use. In some cases, sites were first documented in 2012 and then revisited in 2015 resulting in being assigned two site numbers, this is noted where relevant.

Site 21 (Rubidelia Bautista, Tp 1519)

This third-tier centre is located west of a bend in the Cosalapa River south of the town of Guadalupe Victoria. The main mound on a platform with three small architectural features as well as one plaza to the south are clearly visible with the DEM (Figure S9). There could be no more typical third-tier centre than this. In addition to these typical characteristics, one small mound north of the main mound and another small mound south of the plaza all align on a single axis, giving the entire site a common orientation. Further, three small mounds distributed along the eastern side of the site pair with the northern-most mound, the southern-most mound as well as with the east mound of the plaza. These three mounds extend the architecture right up to the Cosalapa River. This site was first identified and surface collected during the summer of 2012 and the northern conical pyramid recorded as Tp 1191 (Rosenswig *et al*. 2014).

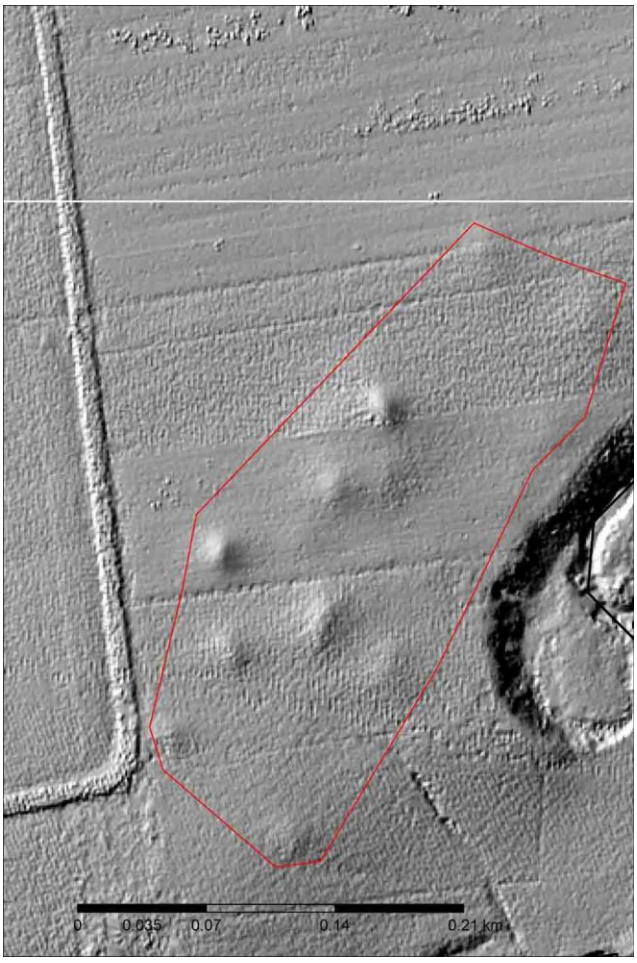

Figure S9. Hillshaded DEM image of Site 21, a Formative-period centre in the Izapa kingdom.

Site 22 (Tres Hermanos, Tp 1021)

This third-tier centre is south and east of low, swampy ground that drains into a small stream and has a property fence-line running through its centre. Nevertheless, a northern main pyramid mound on a platform with three small features on its southern "stage" are clearly visible both and the lidar hillshaded DEM (Figure S10) and when we visited the site (Figure S11). Also discernible on the DEM are the site's two plazas extending to the south, although mound defining the eastern side of the southern-most plaza is somewhat obscured due to thick vegetation and the fence. Like Site 21, there is an additional small mound south of the southern plaza on the main site axis. Further, there are more small mounds east of the main architecture that seem to also be on the site's axis.

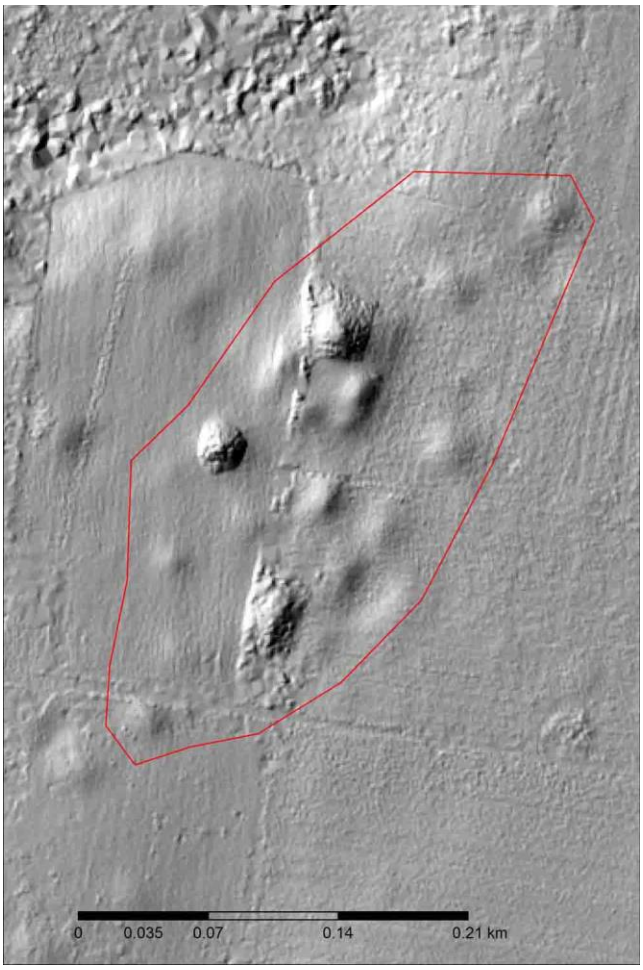

Figure S10. Hillshaded DEM image of Site 22, a Formative-period centre in the Izapa kingdom.

Figure S11. Photograph of Tres Hermanos (Site 22) facing north-northeast towards the main platform and northern pyramid mound.

Site 23 (Don Hermelindo, Tp 1001)

This third-tier centre is located east of inundated low ground that drains into a small stream. The site has a 7m-high northern main pyramid mound (Mound 1), a platform with three features on it and one plaza to the south (Figure S12). There are also two small mounds to the south on the main site alignment. In addition, there are also three small mounds east of the main site alignment that are each paired with a mound on the main axis. West of the main site alignment there are two more mounds—one paired with the main northern pyramid and the other with the southern mound that closes the south end of the plaza—that create two additional plazas on either side of the second largest mound at the site (i.e., Mound 2) that follow the main alignment.

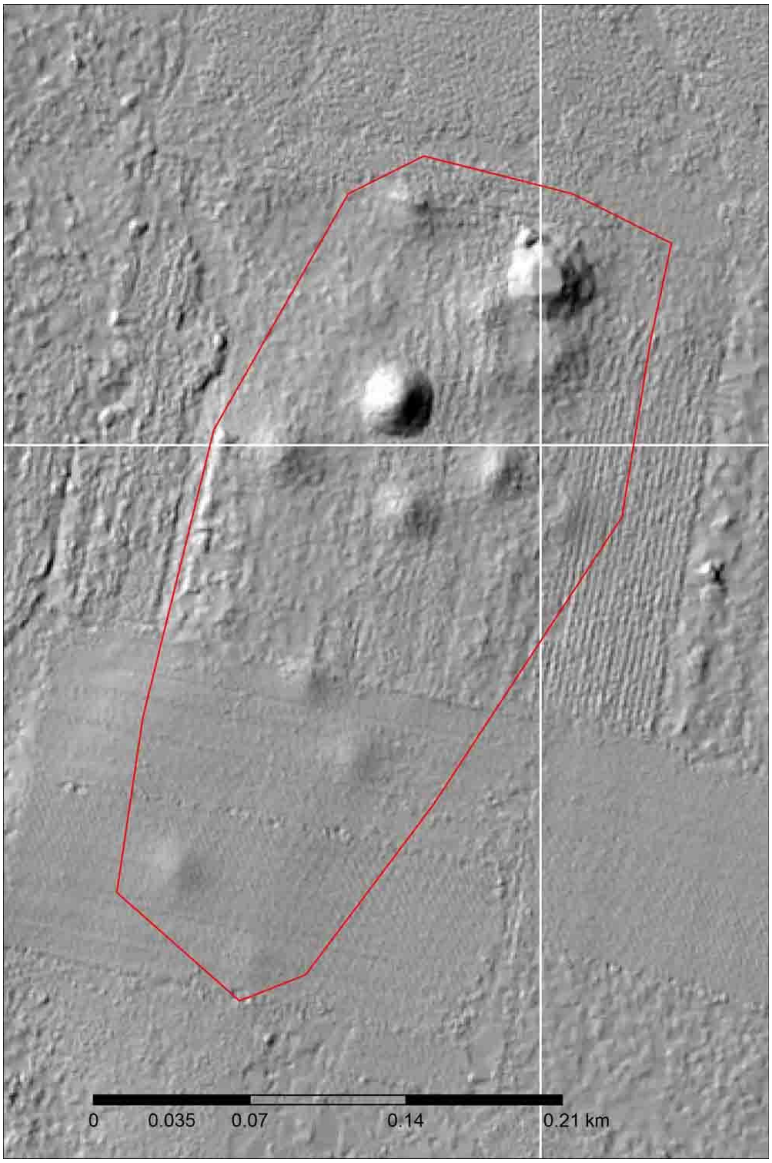

Figure S12. Hillshaded DEM image of Site 23, a Formative-period centre in the Izapa kingdom.

Based on the knowledge acquired during excavations at the site in 2012 (Rosenswig *et al*. 2012), we documented two additional very low mounds east of the red polygon indicated on Figure S12. These two mounds are directly east of the northern mound and platform but not visible on the lidar. The occupied area of the site was therefore larger than can be detected by lidar alone. As a result, the size of the pre-Hispanic community was larger than the site we report. However, for the sake of regional consistency, we report only what is visible using lidar derived hillshaded DEM projections. Similarly, seven other small domestic mounds were

documented within the red polygon but are also not discernible on the lidar. Therefore, both site area estimates and total number of mounds are minimal estimates.

Don Hermelindo (Site 23) is the only lower-order centre within the Izapa kingdom where excavations have been undertaken. Seven 1x3m test trenches probed the platform's southern edge and excavated into three of the site's mounds (Rosenswig *et al*. 2014). These excavations document a substantial Conchas-phase occupation at the site and so demonstrate that this community in the low hills zone survived the collapse of the La Blanca polity and was incorporated into the subsequent Izapa kingdom. Excavation, ceramic analysis and radiocarbon dating further document that Don Hermelindo was occupied during the Duende through Guillen phases (700–100 BC) just like Izapa. A photograph of Don Hermelindo (Figure S13) illustrates how different vegetation on the site's mounds impacts how they appear on the lidar. The northern pyramid is covered in trees and thick underbrush and as a result appears fuzzy and irregular (see Figure S12). In contrast, the site's second largest mound that defines the west side of the plaza, is kept clean of underbrush and only a few trees are allowed to grow on it. As a result, it is clearer and more distinctly depicted in Figure S12.

Figure S13. Photograph of Don Hermelindo facing north, taken during excavations in 2012. Mound 2 (on the left with no underbrush on it) and the main northern pyramid (Mound 1) covered in trees on the right.

Site 24 (Tp 1523)

This is a small third-tier centre (Figure S14) and is located above the west edge of the Suchiate river flood zone. The northern pyramid sits on a low platform with two (of the usual three) features clearly visible on the south and east edge of the "stage". The feature we would expect on the west edge of the platform was obscured by the road cut that runs over the platform immediately south of the main pyramid (see Figure S14). A single plaza is formed by distinct east and west mounds, whereas the southern mound that closes this culturally-defined space is less distinct on the DEM as it has been ploughed down over the years. Site 24 is as small as a third-tier centre can be with the fewest mounds and least effort expended in earthmoving yet still containing all of the essential characteristics of our typology. This site was not recognised as an Izapa-pattern centre during the 2012 survey season on subsequent analysis and therefore was not included in the discussion published by Rosenswig *et al*. (2015) who discuss eight rather than nine lower order centres.

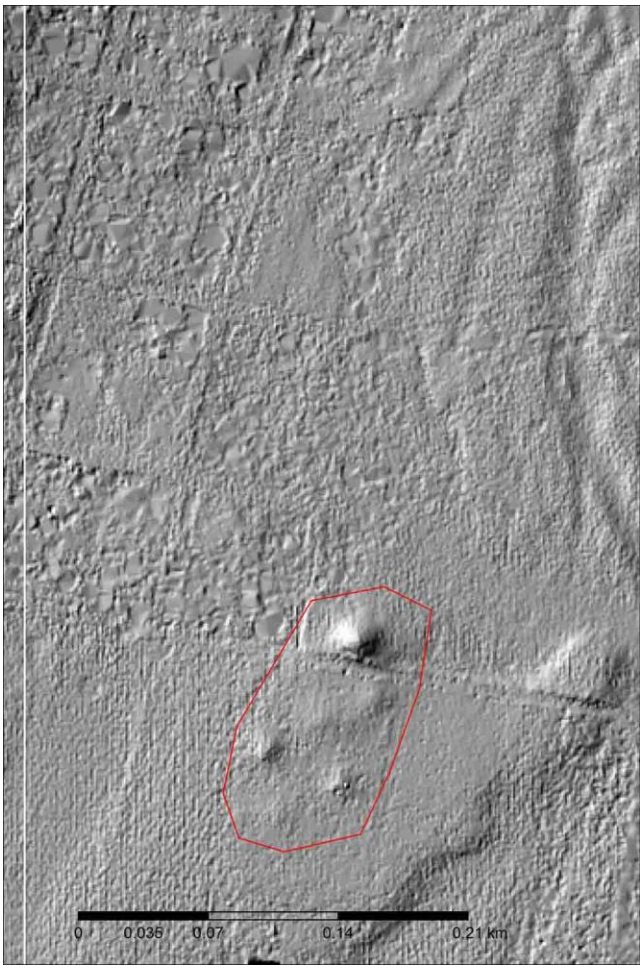

Figure S13. Hillshaded DEM image of Site 24, a Formative-period centre in the Izapa kingdom.

Site 25 (Teresa Rodriguez, Tp 1231)

This is a third-tier centre that has been significantly impacted by the highway that leads south to Ciudad Hidalgo. The site is located just south of the Frontera Hidalgo gas station at the south end of the Cross site which was the largest Late Classic period centre in the region (Rosenswig & Mendelsohn 2016). When vegetation is cut low, mounds are visible on the west side of the road to those driving by.

The highway construction destroyed much of the site's platform and the entire northern pyramid (Figure S15). Despite this damage, the lidar DEM allows the site to be recognised due to its alignment, the plaza formed by unimpacted mounds as well as other mounds further south that are also on the same alignment. Middle and Late Formative sherds were collected from these mounds in addition to the large number of Classic-period remains that are present due to the

proximity of the Cross site (Rosenswig *et al.* 2014). As discussed in Rosenswig and Mendelsohn (2016), numerous Classic-period centres in the region were located near earlier Formative-period centres. All Classic-period centres, like Group F at Izapa, were built north of the earlier centres except for Site 25. The reversed placement of Site 25 and the Cross site is likely the result of the former being up against the edge of the Suchiate River flood zone as well as the latter being the largest known Classic-period centre in the Soconusco.

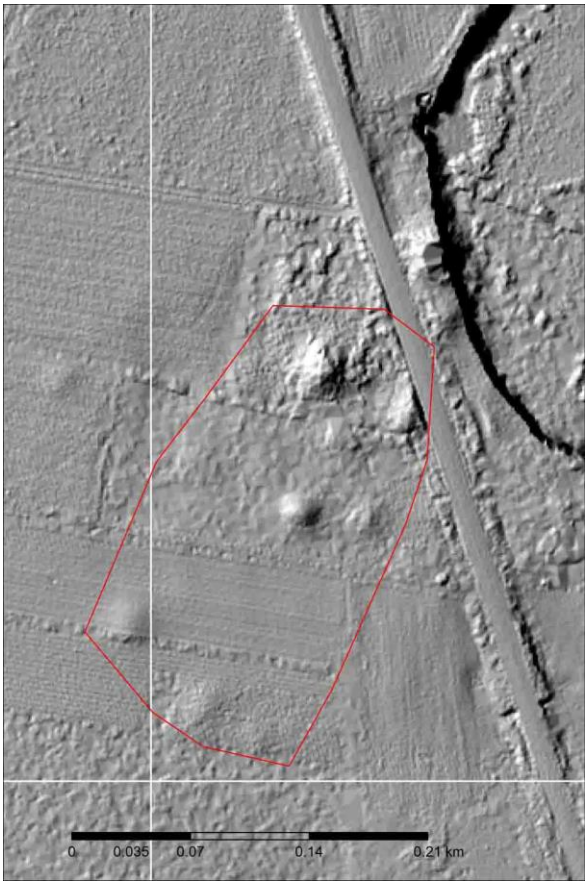

Figure S15. Hillshaded DEM image of Site 25, a Formative-period centre in the Izapa kingdom.

Site 26 (Guadalupe Jacinto, Tp 1224)

This small fourth-tier centre is located on the east shore of a stream just before it empties into the Cahuacán River. The northern pyramid is small and no platform is discernible on the DEM (Fig. S16). However, two of the architectural features in approximately the correct position are visible as are two mound that define the east and west sides of the plaza to the south. This site was not initially recognised as an Izapa pattern centre (Rosenswig *et al.* 2013) and only identified as such once we determined how ubiquitous and consistently organized the lower-

order centres are in the Izapa kingdom. This grouping of mounds contained Duende through Guillén phase ceramics making them coeval with the kingdom. Without ground-truthing and surface collecting such a small centre could not have been conclusively linked to the Izapa kingdom settlement system.

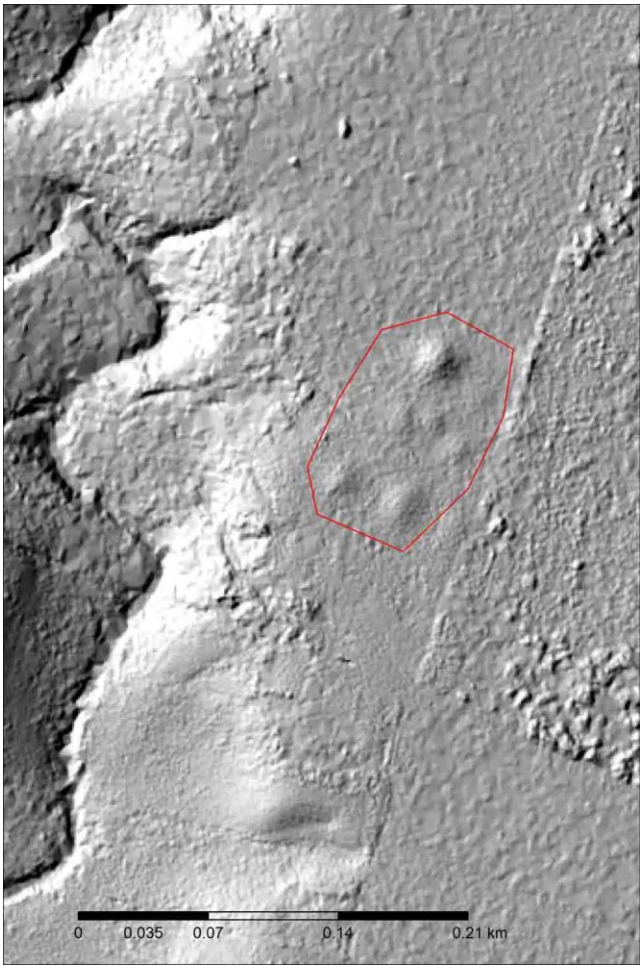

Figure S16. Hillshaded DEM image of Site 26, a Formative-period centre in the Izapa kingdom.

Site 27 (Juan Molina, Tp 1082)

This site is located on the west shore of the Cosalapa River and is one of the largest third-tier centres we have documented. It is not classified as a second-tier centre because it does not have a ball court or an E-Group (see Table 1). Three plazas south are defined on all side by large, well-preserved mounds that extend south-southeast of the main pyramid and platform (Figure S17).

The platform at this site is square with three architectural features clearly visible and the main pyramid on the platform's north edge. The platform closes the north side of the northern-most plaza. The mound to the far south is not on axis of the rest of the site but was covered with Middle and Late Formative ceramics so was occupied while this was an Izapa kingdom centre. The construction of this centre directly west of a river is reminiscent of the placement of Izapa.

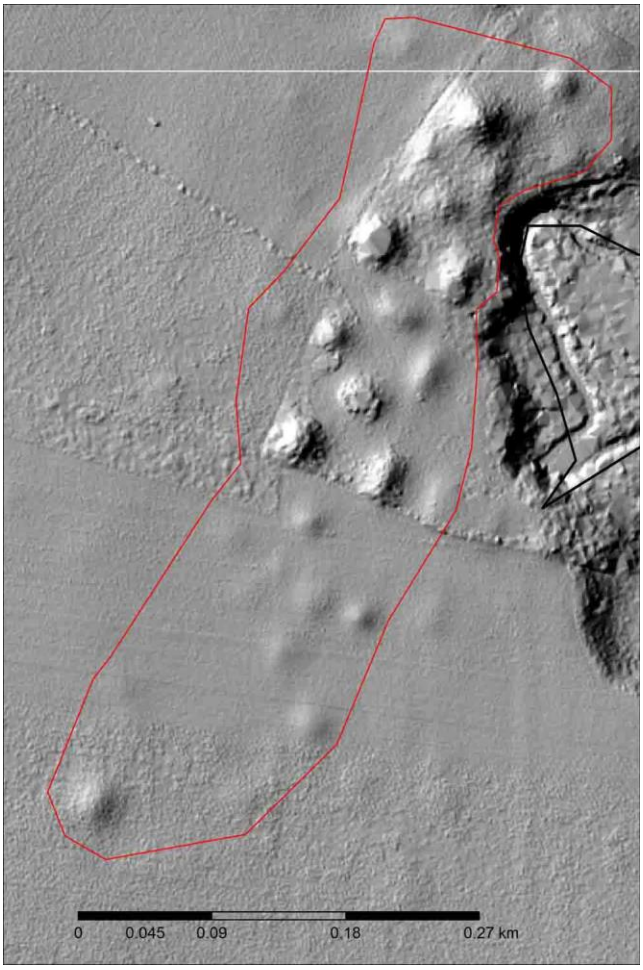

Figure S17. Hillshaded DEM image of Site 27, a Formative-period centre in the Izapa kingdom.

The land use of the Juan Molina site shown in Figure S18 illustrates grass-covered pasture in the foreground, a row of low bushes along the property line with trees in the background covering the site's larger mounds. Low mounds are documented in the pasture (Figure S17). This distinction in land use on different sized mounds is common in the region where large mounds are generally left to grow over as they are not cultivated whereas low

mounds are treated in the same way as flat ground. Comparing Figures S17 and S18 also highlights how lidar records mounds: tree cover obscures mounds to the eye but does not impede lidar recording them whereas mounds are visible in long grass but this land cover degrades the clarity of lidar depiction of them. This latter degradation is the result of post-processing algorithms that discard many ground points in the process of removing low-lying vegetation to produce a bare earth model of an area.

Figure S18. Photograph of Juan Molina (Site 27) showing a property line that separate different types of land cover.

Site 28 (Roberto Carlos, Tp 1367)

This small third-tier centre is located south of the large Agromod plantation and is on the west shore of a small stream meander (Figure S19). The site is as small as a third-tier centre can be and was likely not significantly different in extents or population from a fourth-tier centre. The site consists of a northern pyramid on a low platform with three small architectural features visible. Two larger mounds define the west and east sides of the site's single plaza. The plaza is

closed on the south side by a small mound that has been ploughed down along two sides, and the plough furrows are visible on the lidar. Approximately one third of the northern pyramid has been excavated away and a water tank built on its top. In spite of the site's small size and all of the disturbance, the Izapa pattern layout remains clearly discernible.

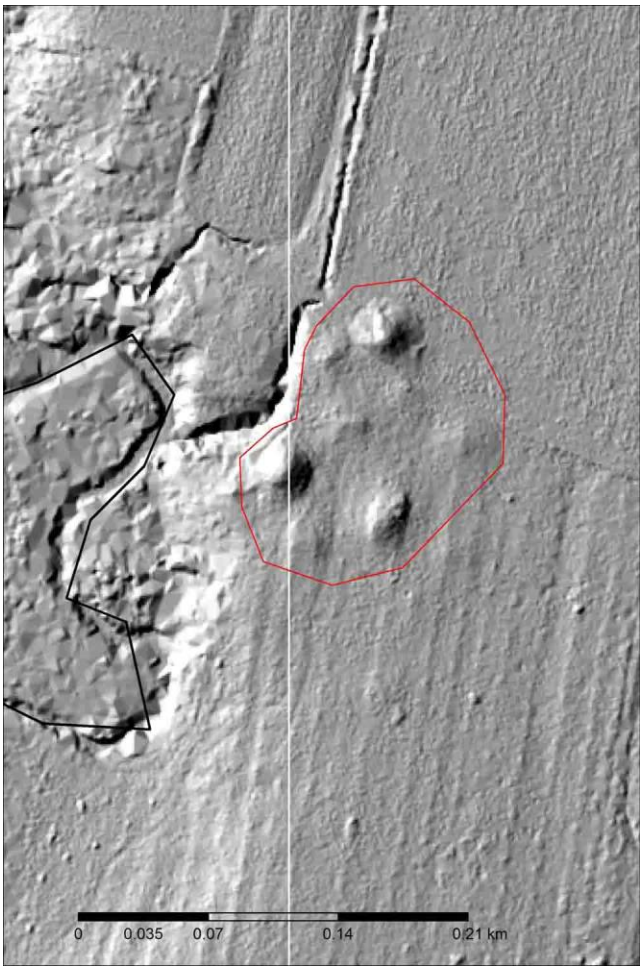

Figure S19. Hillshaded DEM image of Site 28, a Formative-period centre in the Izapa kingdom.

Site 29 (La Esperanza, Tp 1270)

This third-tier centre is located on the east shore of the Cahuacán River. It is on the high ground on the "safe side" of this large river that floods to the west at the bend pictured in Figure S20. The site's northern pyramid is clearly visible whereas the platform is harder to see from the lidar. The platform is discernible if you know what to look for and the southern architectural feature also shows up clearly. This architectural feature on the platform also serves to close the

northern side of the plaza that is also clearly defined by mounds on its west and east sides. A very low mound defines the plazas' south side but again, if you know what to look for it is quite clear. Two other mounds are visible to the south following the same overall site axis: one south from the plazas' west mound and the other in line with the main pyramid and south mound of the plaza but it is a bit obscured as a modern path runs over it.

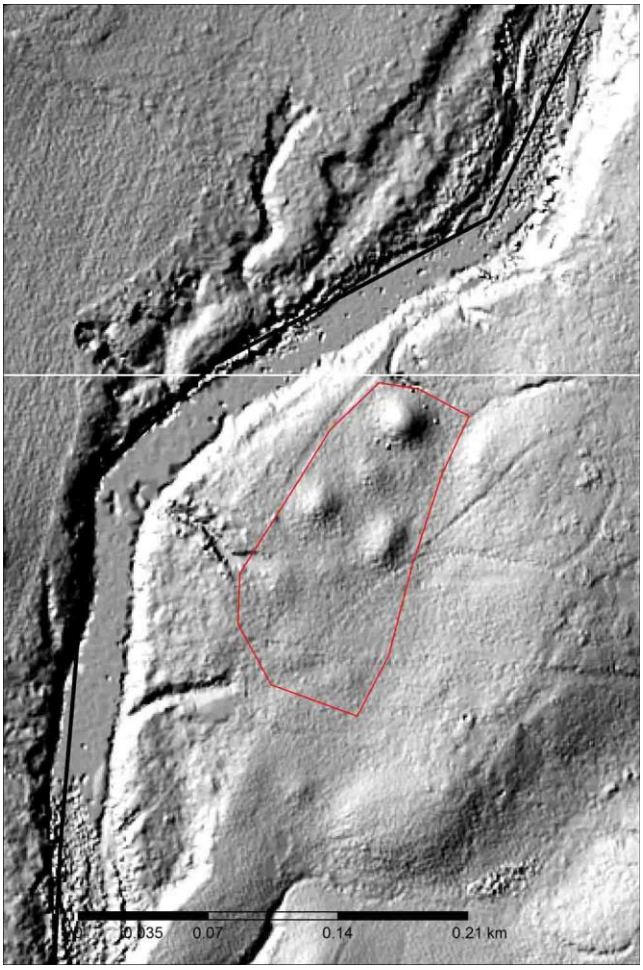

Figure S20. Hillshaded DEM image of Site 29, a Formative-period centre in the Izapa kingdom.

Second lidar campaign: 2015 Survey Season

In 2015, twenty-two new monumental centres within the Formative-period Izapa kingdom were identified by the IRSP between the Suchiate and Cahuacán Rivers. Architectural features visible from the lidar were ground-truthed and temporally diagnostic artefacts were

collected. Unlike the piedmont and low hills, we did not visit and surface-collect every mound visible from the lidar derived hillshaded DEM imagery. Instead, we visited every mound centre and pragmatically surface collected as many mounds as we could so as to date their main period of occupation. Another four sites were identified as having the Izapa patterns but are in Guatemala (Sites # 36, 37, 38 and 39) so were not visited. In addition, another five mound centres (Sites # 40, 41, 42, 43, 44) were identified west of the Cahuacán River as having an Izapa-pattern like arrangement. Each of these five centres were visited in 2015, surface collected and determined to have been occupied during the Middle and Late Formative periods. However, due to differences in site layout and placement (discussed in the printed text and below), they are interpreted as not having been a part of the Izapa kingdom.

Sites in Mexico

Site 5 (Tp 1505)

This is a small third-tier centre with a clear Izapa-pattern layout on the east site of a small stream that empties into the Cosalapa River (Figure S21). The site's large mound and platform were in pasture when we visited it and we recovered a good sample of sherds from the south side of the platform as an arroyo ran by and lots of sherds were eroding out. The northern pyramid is clearly visible on the lidar imagery as is the site's platform on which it sits. Less clear are the platform's architectural features. The feature on the east side of the platform is discernible as a bulge on the platform edge and the feature on the south edge is disturbed but visible if one knows to look for it. The west edge of the platform is difficult to make out from the lidar as is an architectural feature on this side. The site's plaza is visible on a raised terrace next to the small stream with mounds defining its east and west sides where expected. The mound defining the plaza's south side appears a little off of the expected alignment but this is due to some modern disturbance on the mound's west side. Given our current knowledge of the consistency of Izapa-pattern centres and the information we gathered by ground-truthing this site, this site clearly fits all expectations.

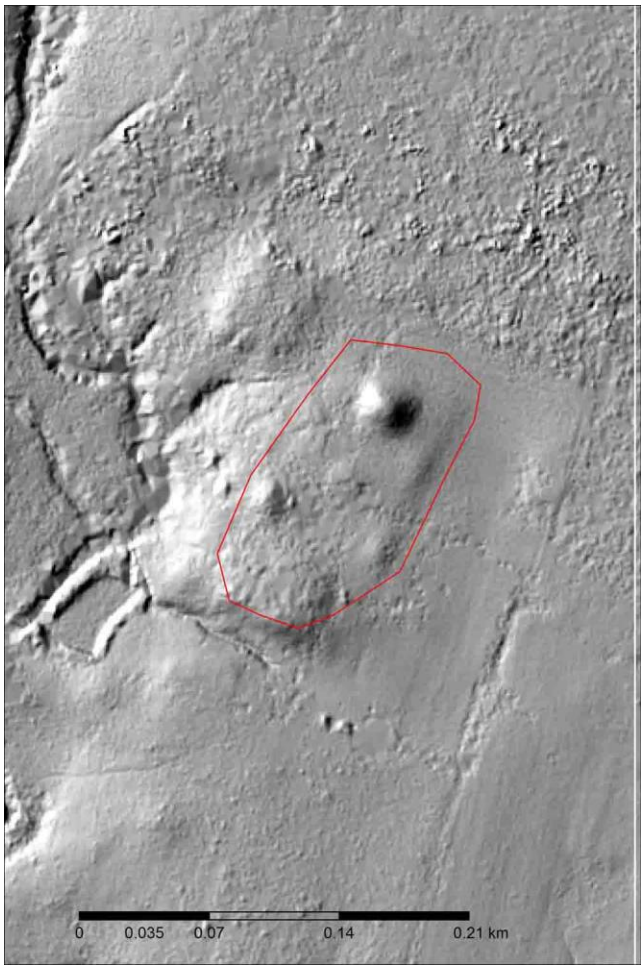

Figure S21. Hillshaded DEM image of Site 5, a Formative-period centre in the Izapa kingdom.

Site 6 (Tp 1507)

This third-tier centre is located between a newly paved road that leads from the Ciudad Hidalgo highway towards Vicente Guerrero town and the Cosalapa River to the west. It is a clear Izapa-pattern site with a northern pyramid mound and a distinct platform with three features on it (Figure S22). Three mounds form a plaza south of this: the west mound is conical and the east mound is slightly linear (together they are reminiscent of an E-Group). The mound that defines the southern side of the plaza is on axis and only appears to be too far to the east because the western mound is actually farther west that is generally the case in Izapa-patterns centres (see Figure S22). Three more small mounds are located to the south. Site 6 is planted in mangos and so clear of vegetation under the trees. The large northern pyramid mound has a trench cut

through it that would be worth cleaning and profiling. Due to this disturbance sherd collection was abundant.

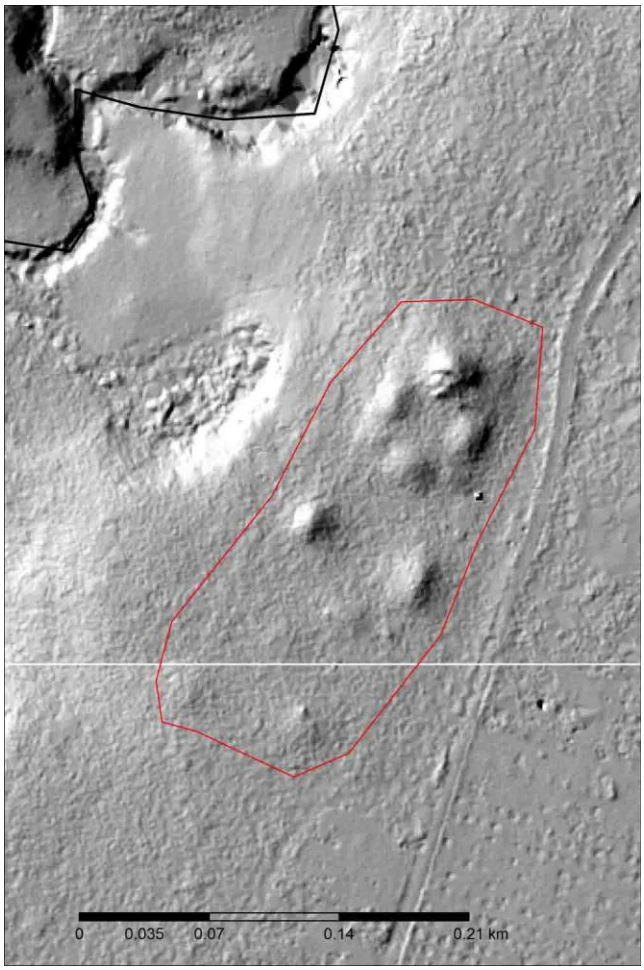

Figure S22. Hillshaded DEM image of Site 6, a Formative-period centre in the Izapa kingdom.

Site 7 (Tp 1502)

This is a well-preserved third-tier centre on the northwest side of the Tapachula southern bypass (on the right-hand side when going into town from the coast). The highway is clearly depicted on the west side of Figure S23. This is an Izapa-pattern centre with a platform and one plaza. The one thing that does not appear "correct" about this site is that the platform is oval rather than square and the northern pyramid does not appear to be as large as is generally the case. Further, the features on the platform are not arranged symmetrically and the west one is too far north. The large square feature on the south edge of the platform created a plaza to the south with west, east

and south mounds clearly visible. The west mound is conical and the east mound linear in a manner reminiscent of an E-Group. The site is currently in pasture and visible from the road. Standing in the site's plaza one can clearly see the mounds aligned towards Tacaná. There is a large, stone basin at the southern side of the main mound centred on the site alignment. Middle and Late Formative ceramic sherds were collected from the surface of this site. Therefore, we interpret the unexpected shape of the platform, and locations of features on it, as being due to subsequent disturbance. However, the round shape of the platform is also found at nearby Site 13 (see Figure S28) so it is possible that there was an idiosyncratic reason why these two sites were distinctive. Excavations could determine which of these scenarios was the case.

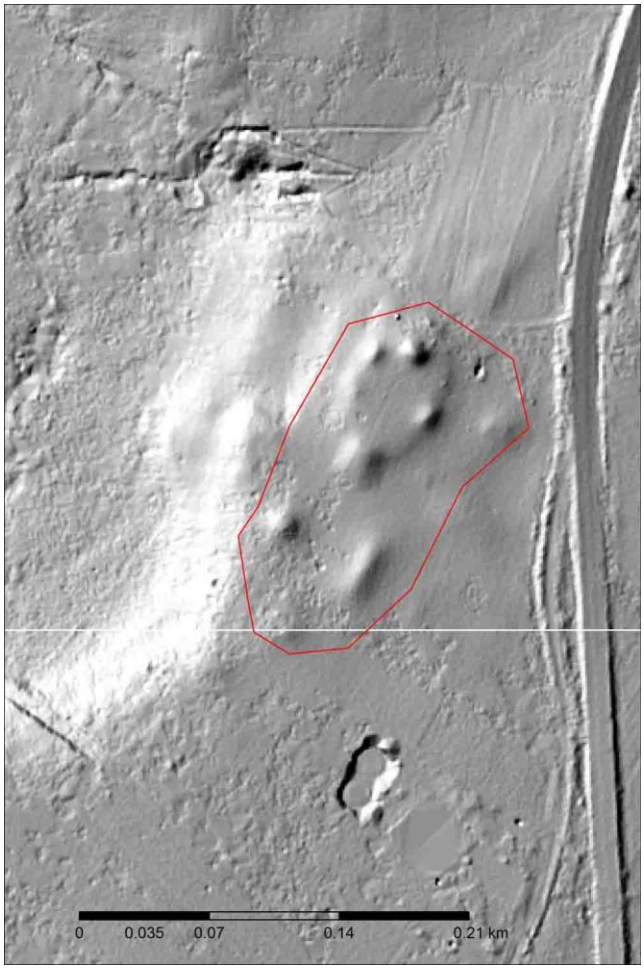

Figure S23. Hillshaded DEM image of Site 7, a Formative-period centre in the Izapa kingdom. Down-hill at the ranch house they had recently dug a fish pond when we visited in 2015 and Conchas and Duende phase sherds were collected from the back dirt. This modern feature is visible at the top of Figure S23. The area was thus occupied prior to the establishment of the

Izapa kingdom and one of the few locations that Rosenswig is aware of with Conchas-phase remains on the piedmont besides the site of Izapa itself.

Site 8 (Tp 1504)

This is a small third-tier centre located between the Tapachula southern bypass highway and overlooking the Cahuacán River's east shore. There are more mounds visible on the ground than can be made out with the lidar DEM (Figure S24). After ground-truthing, we recognised that the site consists of a small platform with three architectural features and two mounds defining the east and west sides of a plaza to the south. Even with the accuracy of the lidar derived imagery, ground-truthing is essential to achieve complete results.

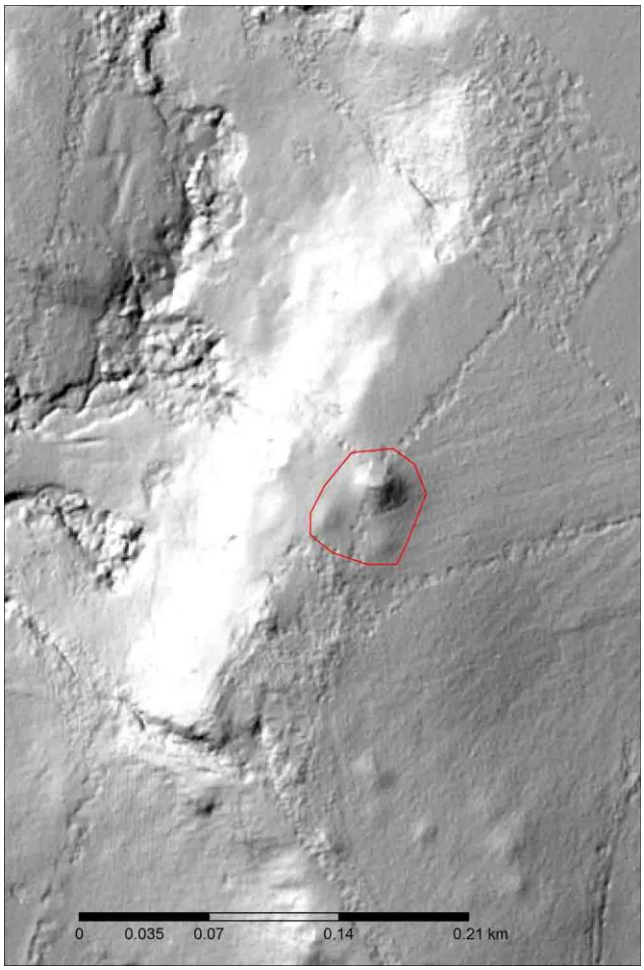

Figure S24. Hillshaded DEM imagery of Site 8, a Formative-period centre in the Izapa kingdom.

Site 10 (Tp 1511)

This is a third-tier Izapa-pattern centre on the southeast shore of a small stream that eventually empties into the Cahuacán River (Figure S4). A natural terrace along the river was used to help create the platform and keep site's residents above the river's flood zone (Figure S25). Thick grass growing under the milpa planted on the site made surface collection challenging and somewhat obscured smaller mounds. The northern pyramid is clearly visible as is the platform and the three architectural features on each side of the platform. The site has two plazas extending south of the platform. The northern of the two plazas is formed by the platform on its northern side and two relatively large mounds defining its west and east sides. The west of these mounds is conical and the east is linear, which is reminiscent of an E-Group. The mound that defines the south side of this plaza is small and serves double-duty by defining the northern side of the second plaza. The other three mounds that define the second plaza are also small and, as they were covered in high grass, less distinct on the lidar-derived DEM.

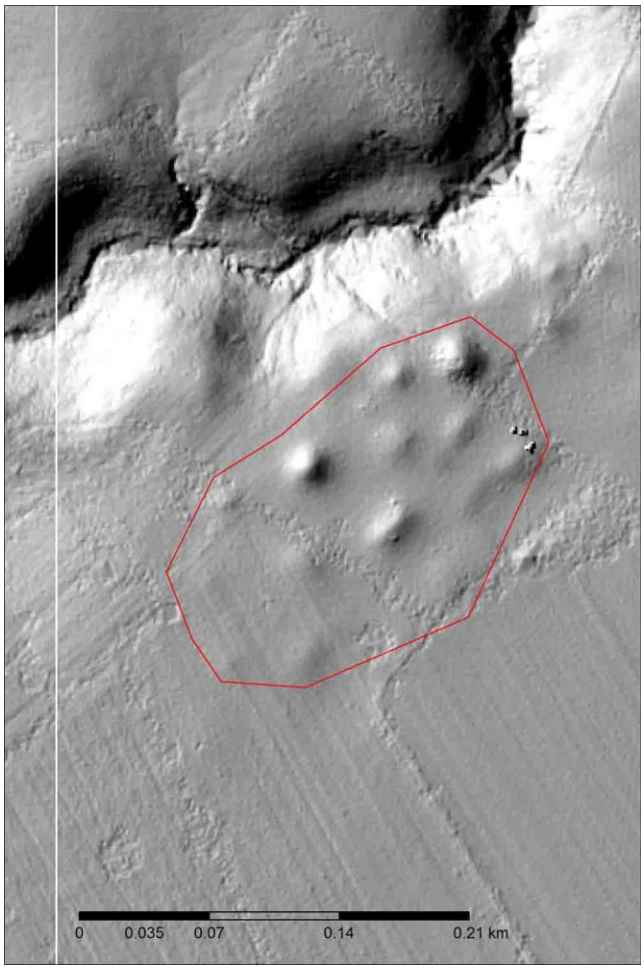

Figure S25. Hillshaded DEM image of Site 10, a Formative-period centre in the Izapa kingdom.

Site 11 (Tp 1509)

This is another third-tier centre that we accessed off of the Tapachula southern bypass highway. It is an Izapa-pattern site with two plazas south of the northern pyramid and platform located on the west shore of a tributary that empties into the Cahuacán River (Figure S26). All of the land was in pasture when we visited with low grass and poor sherd visibility. The northern pyramid mound is distinct as is the square platform that's northern and eastern sides descend down to the river's flood zone. The placement of this platform thus gives the impression that is it higher that what was created with construction. The three architectural features on the platform are clearly visible. As at other sites, like Don Hermelindo (Site 23) and Tres Hermanos (Site 22), the mound that defines the west side of the first plaza is very large. The southern plaza is formed by small, yet very distinct mounds and two more mounds are visible farther south.

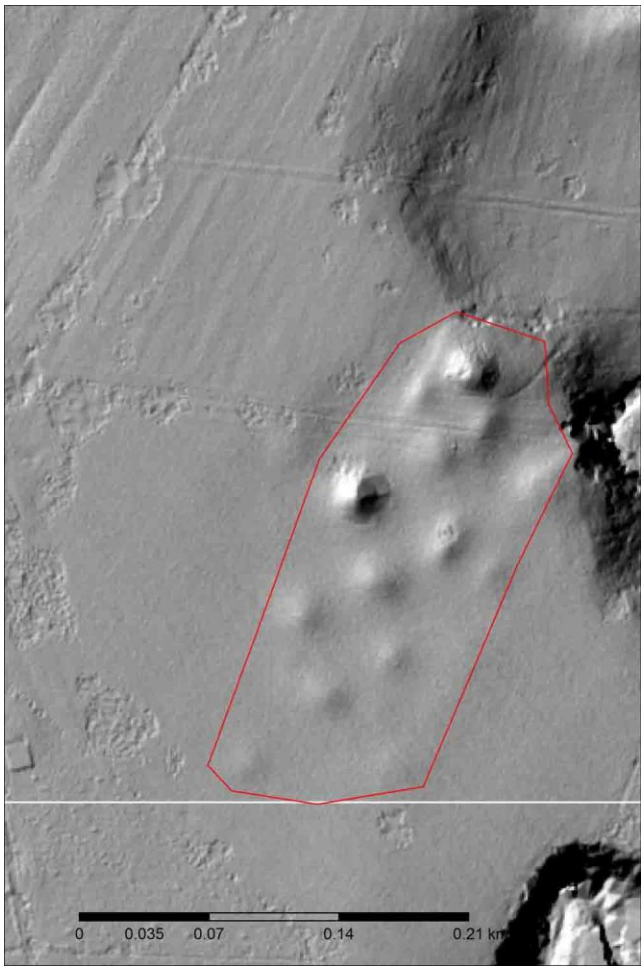

Figure S26. Hillshaded DEM image of Site 11, a Formative-period centre in the Izapa kingdom.

Site 12 (Cupertino, Tp 1510)

This site is located off of the Tapachula southern bypass on the road to Amoa. The entire site is in pasture and belongs to a single landowner named Don Cupertino. The pyramid mound is conical and very visible from the road. As a result, most local residents are aware of it and while surveying in the area we were repeatedly told about it. This was an Izapa-pattern site that seems to have been later significantly altered after the Formative period. The square platform is very large and high with steep sides and three architectural features. The plaza to the south is formed by a conical mound on the west side and a linear mound on the east side (again reminiscent of an E-Group. Middle and Late Formative period ceramic sherds were recovered from these mounds but Rosenswig suspects that they may have been altered after this. The plaza

is closed on the south side by a small mound ~150m away. Rosenswig further suspects that there may have been originally been two plazas at the site when it operated as part of the Izapa kingdom. There is a small ballcourt at the south end of the site that is definitely not Formative-period in date and some Postclassic sherds were recovered from it. Future excavation will be required to determine the extent and form of post-Formative alterations to the architecture at this site.

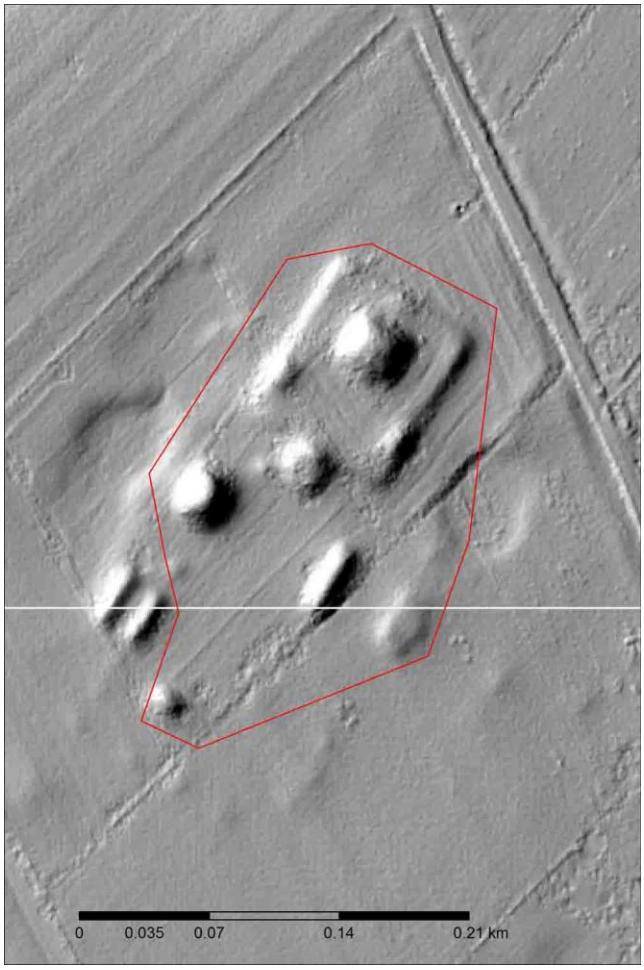

Figure S27. Hillshaded DEM image of Site 12, a Formative-period centre in the Izapa kingdom.

Site 13 (Tp 1512)

This site is a third-tier centre located on the edge of the Cosalapa River, directly west of Matapa down the paved road with a large sports complex at the turn-off. This is a clear Izapa-pattern site that was planted in milpa when we visited but the large mound was unplanted and the

grass on it cut short. Good ceramic sherd samples were collected from a few of the mounds and from the erosion of the terrace descending to the river with water run-off channels providing effective collection contexts. The northern pyramid is clearly visible, as is the platform on which it sits and the three architectural features (Figure S28). However, unlike the majority of the lower-order centres, this site's platform is round rather than square, and so, similar in this aspect to Site 7 depicted in Figure S23 (the two sites are only 5km apart). One plaza is clearly discernible south of the platform. The east mound is less clear that the west due to thick and high grass coverage. A small mound closes the south side of the plaza and then another mound (that shows up more clearly on the DEM imagery) is 30m further south on the site's primary axis.

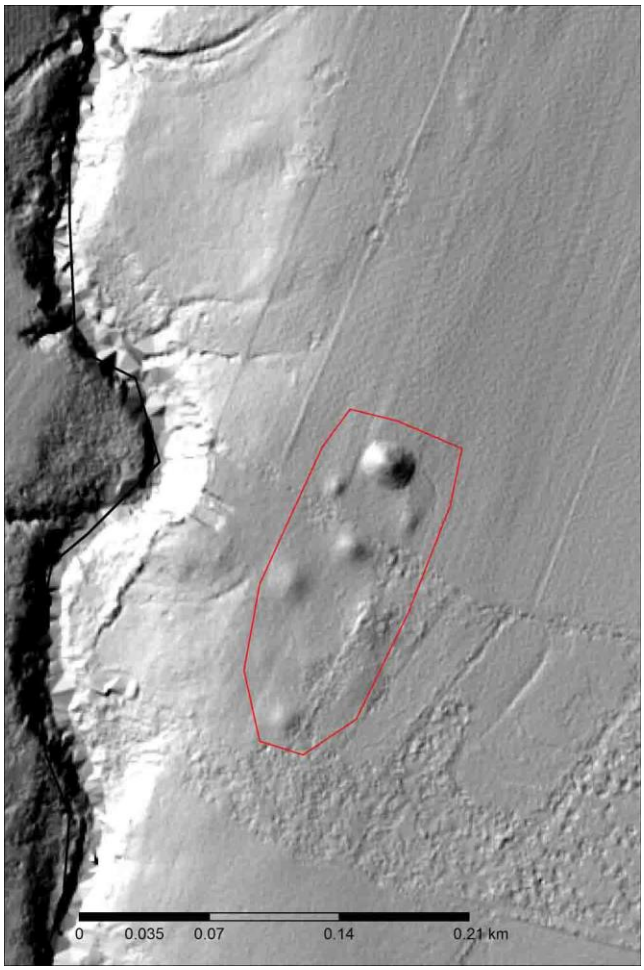

Figure S28. Hillshaded DEM image of Site 13, a Formative-period centre in the Izapa kingdom.

Site 14 (Tp 1513)

We accessed Site 14 from the road across from Metapa but could have easily done so from the Tapachula southern bypass highway. The site is a third-tier centre and was planted in milpa so recovery of sherds was good. This is a clear Izapa-pattern centre with a northern pyramid on a platform with three architectural features (Figure S29). The only strange thing was the shape of the mound defining the west side of the plaza, as it appeared flat on its west edge. Ground-truthing revealed that the mound had been cut with repeated use of a disk plough on its west and east edges—cut straight on the west side whereas ploughing following the rounded contour of the mound on the east side. This mound on the west side of the plaza is the highest at the site which is not typical. The mound defining the east side of the plaza is relatively low and linear so that together, the two mounds are reminiscent of an E-Group. The plaza is open on its southern side but there is, however, another mound to the south.

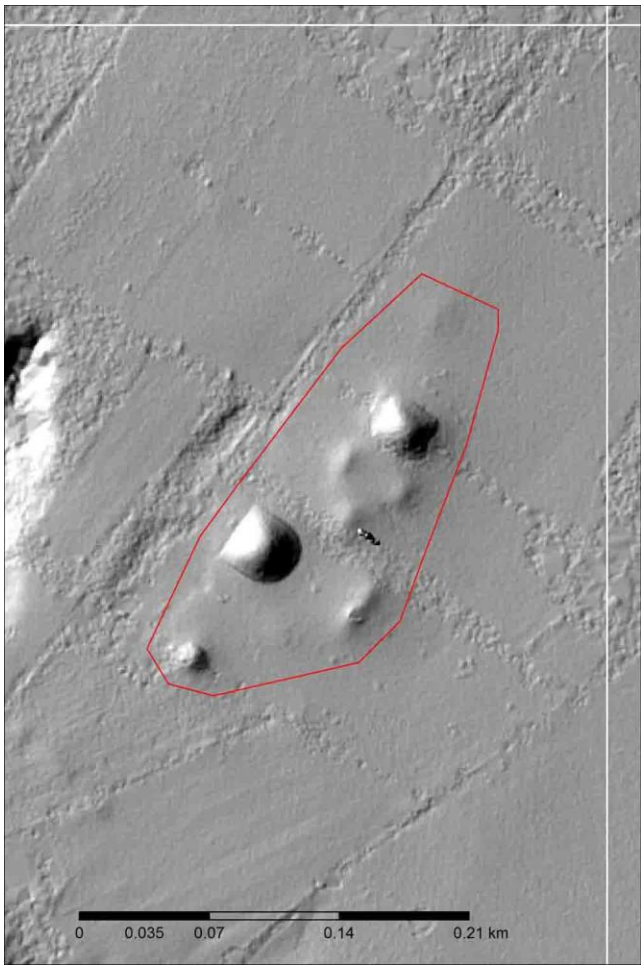

Figure S29. Hillshaded DEM image of Site 14, a Formative-period centre in the Izapa kingdom.

Site 15 (Tp 1515)

This third-tier center is located north of the town of Guadalupe Victoria on the east shore of the Cahuacán River at a small cluster of houses. The site was in pasture when we visited it and behind a small church. Due to grass cover we had trouble collecting many sherds and those we did find were mostly eroding down the slope towards the river. The site is a small Izapa-patterns centre with one plaza and a platform with small features on is southern edge (Figure S30). However, the site was reoccupied during the Classic period and resulted in the site being covered in Plumbate ceramic sherds. This later construction resulted in small mounds being built on the northern side of the Formative-period conical pyramid that created a circle of Classic-period mounds. The construction of an enclosed plaza made of many small mounds as well as the construction of such plazas north of Formative-period centres is characteristic of Classic-period

construction practices in the area and is discussed further by Rosenswig and Mendelsohn (2016).The Formative-period plaza to the south is defined on the west side by a mound that is clearly depicted on the DEM whereas the mound defining the east side is less clear as it was built on the edge of a steep stream bank. The plaza is open to the south. The site is oriented to between the Tacaná and Tajumulco volcanoes.

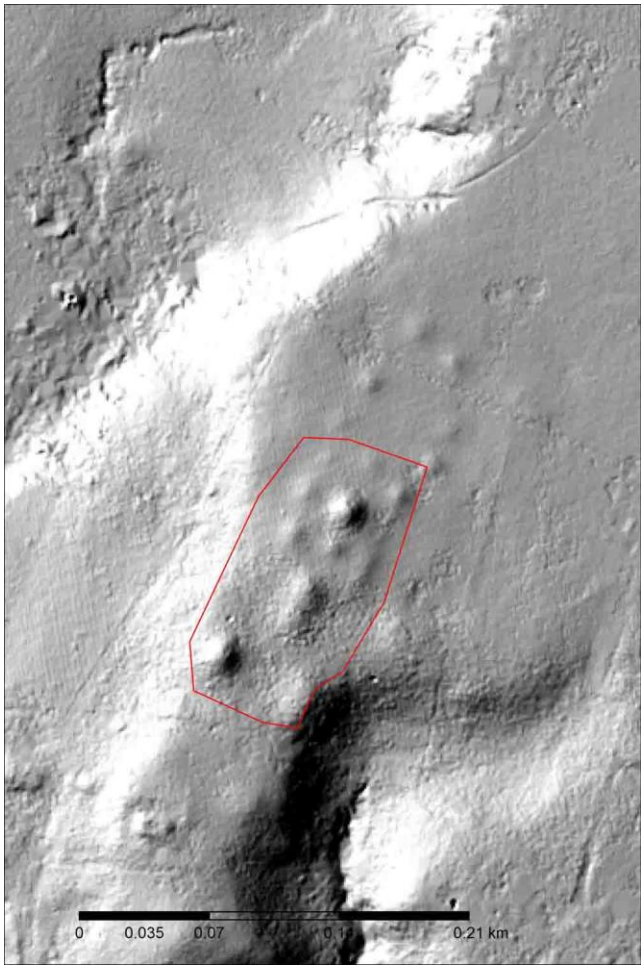

Figure S30. Hillshaded DEM image of Site 15, a Formative-period centre in the Izapa kingdom.

Site 16 (Tp 1514)

This site is located ~2km north of Guadalupe Victoria over-looking the Solis River a few kilometres before it empties into the Cahuacán River. This third-tier Izapa-pattern centre has a northern pyramid on a square platform that has three small architectural features on its southern edge (Figure S31). There is one plaza to the south of the platform that is formed by four small

mounds of roughly equivalent size. Unlike many lower-order centres, the plaza is therefore not defined on its northern edge by the platform. Further, a single low, broad mound was built to the north of the platform. The alignment of this centre appears to be towards the southern flank of the Tacaná volcano.

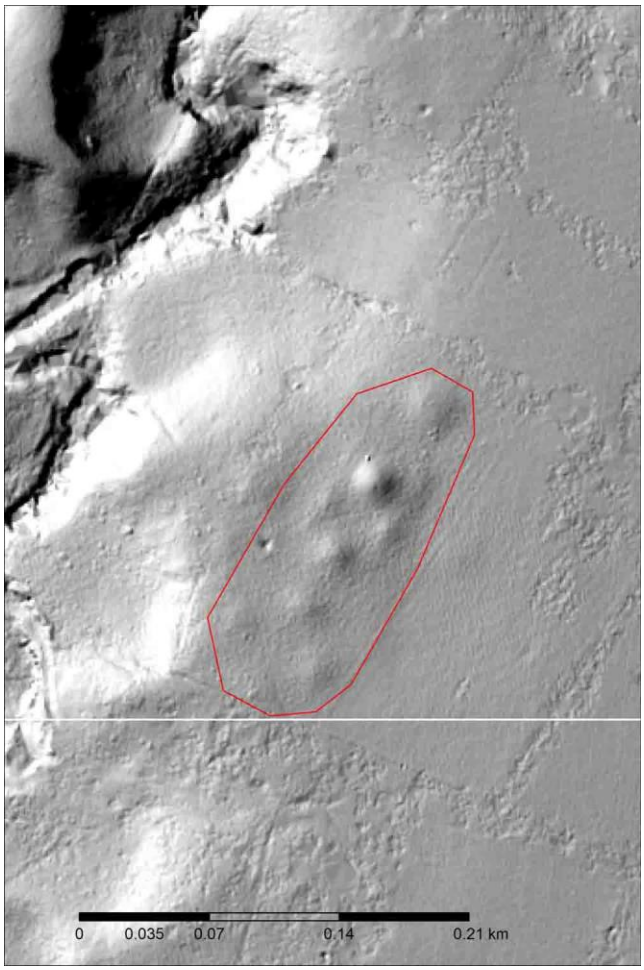

Figure S31. Hillshaded DEM image of Site 16, a Formative-period centre in the Izapa kingdom.

Site 9 (Tp 1517)

This Izapa-pattern site is located right next to Guadalupe Victoria's cemetery and was planted in milpa when we visited. Access was easy and visibility good so we collected an ample sample of sherds. Obsidian density was extremely high and we make large collections.

Site 17 (Tp 1516)

This is a relatively large third-tier centre located on the eastern shore of the Cahuacán River south of Site 15 (see Figure S4), and so closer to the town of Guadalupe Victoria. This is a nice Izapa-pattern site and more complex than many other 3rd tier centres (Figure S32). There is a square platform with three architectural features and a conical pyramid. There are two plazas to the south. The first is formed by large mounds and closed on the northern side by the site's platform whereas the southern plaza is formed by smaller mounds. The west mound of the first plaza is conical and the east mound linear and therefore reminiscent of an E-Group. East of the platform and first plaza there are three mound arrange on the same alignment and forming two more small plazas. In fact, another small mound closes off the south side of this eastern plaza and also creates yet another plaza with the southern-most plaza's north and east mounds as well as the first plaza's linear, eastern mound. To the north of the site's platform is another plaza formed by three small mounds and the north edge of the platform itself. Only the largest centres in the Izapa kingdom (Izapa, Las Viudas and El Carmen) seem to have this northern plaza and at Izapa it was built during the Terminal Formative period after AD 100 (33). The main mound and terrace were in thick secondary vegetation when we visited but mounds to the south were in milpa and we recovered large sherd samples.

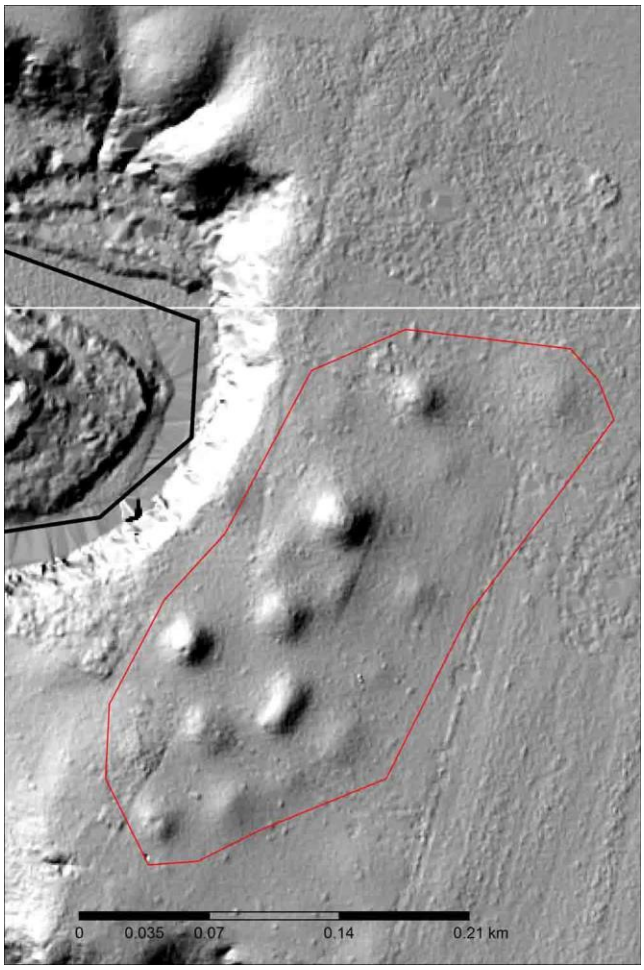

Figure S32. Hillshaded DEM image of Site 17, a Formative-period centre in the Izapa kingdom.

Site 18 (Tp 1518)

This site is located west of the city of Metapa and close to the Cosalapa River. We took the road in from the Matapa sports complex but on the way out exited on the paved road that goes to Agromod. We were able to drive right into the site and the fields had just been ploughed. In spite of good visibility, surface visibility of sherds was lower than expected and the large mound was covered in thick vegetation. This is a small, third-tier centre and from the ground it is evident it aligns to somewhere between Tacaná and Tajumulco. The northern pyramid is clearly depicted in the DEM (Figure S33). There is a low platform with the expected three architectural features visible. A single plaza south of the platform is framed by three mounds, the eastern being linear so reminiscent of the E-Group configuration. The only other mound at the site is 70m to the west of the south end of the site's plaza.

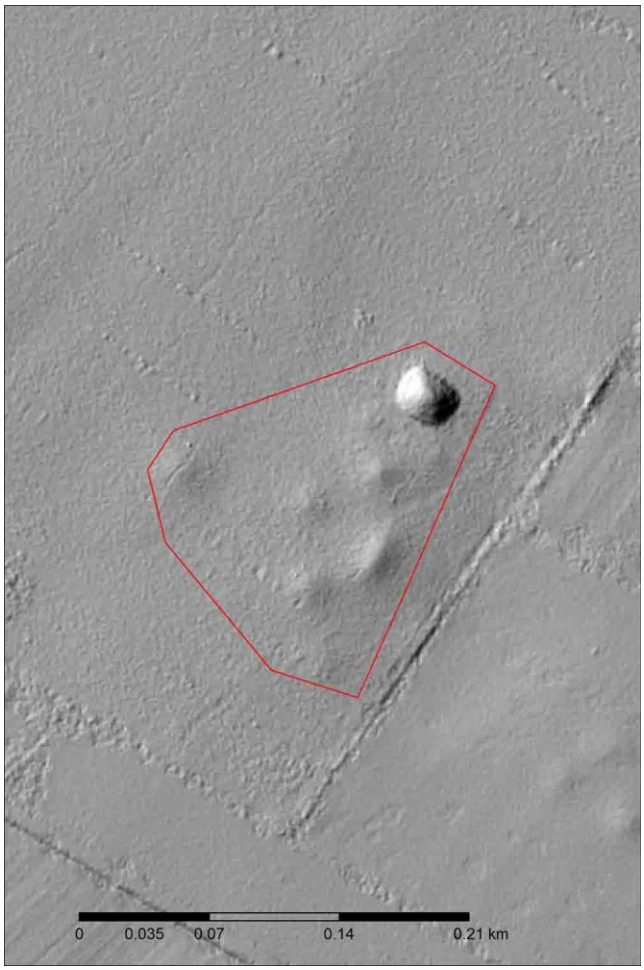

Figure S33. Hillshaded DEM image of Site 18, a Formative-period centre in the Izapa kingdom.

Site 19 (Tp 1522)

This site is in pasture, all on the same property and contains two components (Figure S34). The northern component consists of four mounds that form a fourth-tier centre in the Izapa kingdom. The southern component is a Classic-period site with small mounds forming a round plaza with a large mound in the centre (see Rosenswig and Mendlesohn [2016] for further discussion of these sites). The northern side of the larger northern conical mound had been dug into of earth when we visited in 2015. This disturbance resulted in some decent collection samples of Middle and Late Formative period ceramic sherds from a site that was otherwise lacking of sherds on the ground surface.

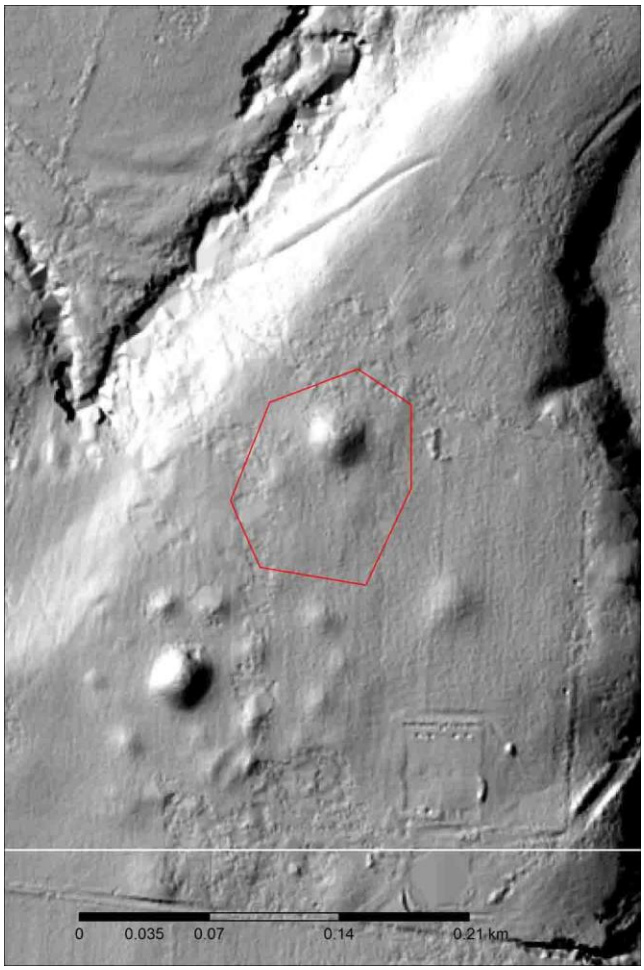

Figure S34. Hillshaded DEM image of Site 19, a Formative-period centre in the Izapa kingdom.

Site 20 (El Carmen, Tp 1521)

This is the third largest Izapa-pattern site between the Cahuacán and Suchiate Rivers (after Izapa and Las Viudas) and should be considered a second-tier centre. The site is located on the east side of a small stream (Fig. S35) and named El Carmen after the Canton in which it is located (in the Municipio of Frontera Hidalgo). The site has two landowners with the property line roughly in the middle of the site. To get there, one follows the paved road west, towards Guadalupe Victoria from the Ciudad Hidalgo highway at Frontera Hidalgo. It is the second road north (passed the Navy base and across a stream) between two large tree along an unpaved road. Less than 1 km north up this dirt road the site is on the left-hand side of the road.

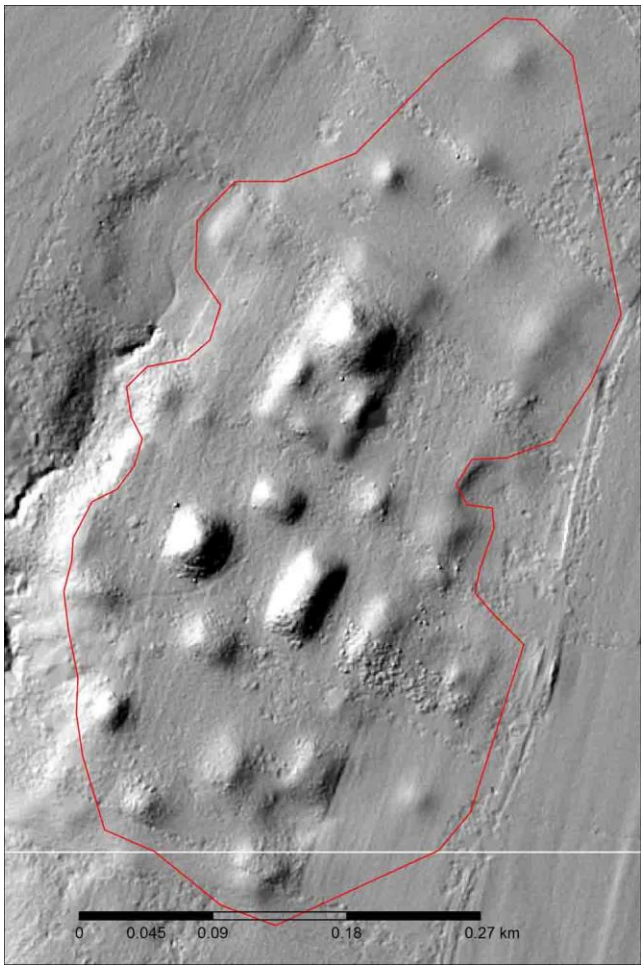

Figure S35. Hillshaded DEM image of Site 20, a Formative-period centre in the Izapa kingdom.

El Carmen has a rectangular platform with a conical northern pyramid and three architectural features on the south side of the platform (Figure S35). There are two plazas to the south with east and west mounds of the first plaza being much larger than the others (see Figure 36) and, as they are conical and linear, resemble an E-Group. The large, linear mound also has a paired linear mound to the east that is much lower and forms a ballcourt. A paired E-Group/ballcourt is also documented at Las Viudas (see Figure S37). Numerous other mounds arranged around the east side of the southern part of El Carmen form another 4 plazas.

North of El Carmen's platform is an additional plaza that is a bit off of the sites main axis (slightly too far to the east). We suspect that this plaza was built during the Terminal Formative period as is also suspected for equivalently placed plazas at Site 17 (Figure S32) and Las Viudas (see Figure S37) as well as Izapa. All four of these sites have rectangular (rather than square

platforms) platforms and at Izapa we have documented that the extension of the platform north dates to the Itstapa and Jaritas phases when the Mound 30a platform was doubled in size (Rosenswig *et al.* 2018). There is another mound further north at El Carmen that is on axis (so likely dates to the Middle and Late Formative period) and is equivalent to Mound 10 at Izapa. A number of the largest centre of the Izapa kingdom thus seem to have been occupied longer than the smaller centres.

Figure S36. Photo of El Carmen (Site 20) taken from the southern mound of the second plaza looking north. Trees in distance are growing on the northern pyramid and platform.

Site 30 (Las Viudas, Tp 1530)

Las Viudas is the second largest centre within the Izapa kingdom, consists of 86 mounds and extends over more than 42ha and stretches 1km from north to south (Figure S37). This is a second-tier centre located 22km from the Izapa capital and another 22km from the Pacific Ocean (see Figures 2 & 4). Las Viudas defines the southern edge of the Izapa kingdom and there is virtually no Middle of Late Formative occupation between this secondary centre and the estuary (Figure 2) (Rosenswig 2008). However, there was significant occupation in the estuary itself at this time with evidence of substantial salt production (Neff *et al.* 2018). Located ~20km from salt processing locales, Las Viudas would have been in an ideal location to administer the distribution of salt to residents of the Izapa kingdom.

Las Viudas has a northern pyramid mound on a platform with five architectural features, although the two on the east side not clearly visible on the DEM (Figure S37) as the others due to thick secondary growth whereas the other three are planted in milpa. There are four plazas south of the platform and all are all oriented towards the Tacaná volcano. The single largest mound at Las Viudas is located at the south end of the site, is conical and measure 18m in height (Figure S38). This mound is the west, conical feature of the site's E-Group that is formed with a linear mound to the east. The linear mound on the east side of the E-Group is paired with another low, linear mound farther east that together form a ballcourt. This joined E-Group and ballcourt is also documented at El Carmen (Figure S35) and possibly El Jardín (Figure S47).

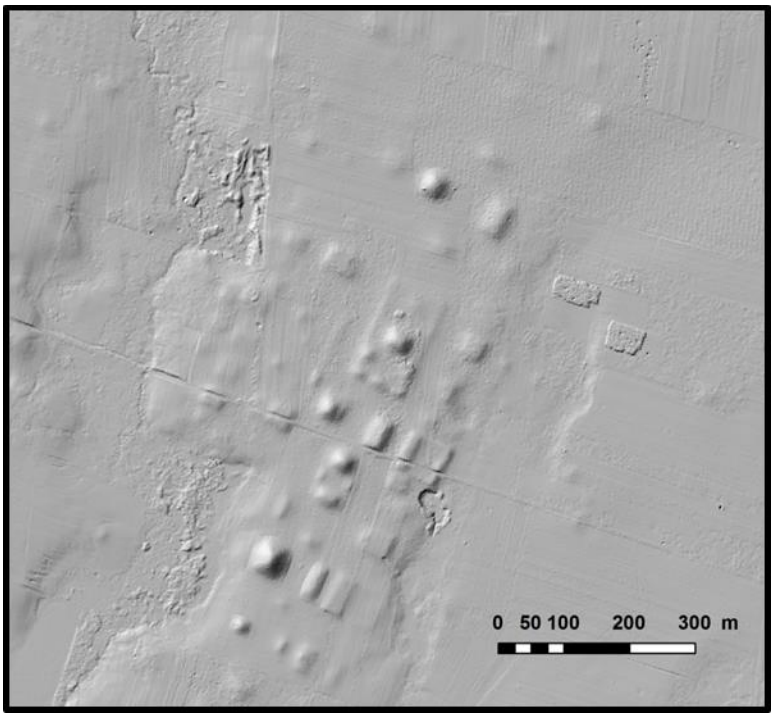

Figure S37. Hillshaded DEM image of Site 30 (Las Viudas), a Formative-period centre in the Izapa kingdom.

Las Viudas is one of only four sites (the others being Izapa, El Carmen and Site 17) where a rectangular northern platform is documented. Based on recent excavations at Izapa (Rosenswig *et al.* 2018), Rosenswig interprets the northern half of the platform as being a Terminal Formative period (AD 100–400) extension. Las Viudas has an additional plaza group north of the platform (see Figure S37) that probably also dates to the Terminal Formative period.

Another feature that Rosenswig also suspects was built during the Terminal Formative period is the compact, raised plaza group immediately south of the modern road that cuts through the centre of the site. The raised plaza group is smaller than would be expected and was also built on a different orientation from the rest of the site.

Figure S38. Photograph of the largest mound at Las Viudas (18m high), the conical mound of the site's E-Group. Photo faces south and the edge of the linear mound of the E-Group is visible on the left side of the image.

Site 31 (Tp 1525)

This small third-tier centre is on the east side of a small stream and located directly southwest of Las Viudas (Site 30) if you continue west along the paved road north of las Viudas. The conical mound at the north of the site and three small features on the platform are clearly visible as are the three mounds that form the site's single plaza (Figure S39). The alignment of the site is also visible from the site and falls somewhere between the Tacaná and Tajumulco volcanoes. When we visited in 2015, there were lots of sherds eroding out of the ploughed fields around all mounds and at least 500m beyond them in all directions. The clear visibility of ceramic sherds well beyond the extents of mounded architecture at this site emphasised how a survey methodology focused on mounds is likely underestimating the population.

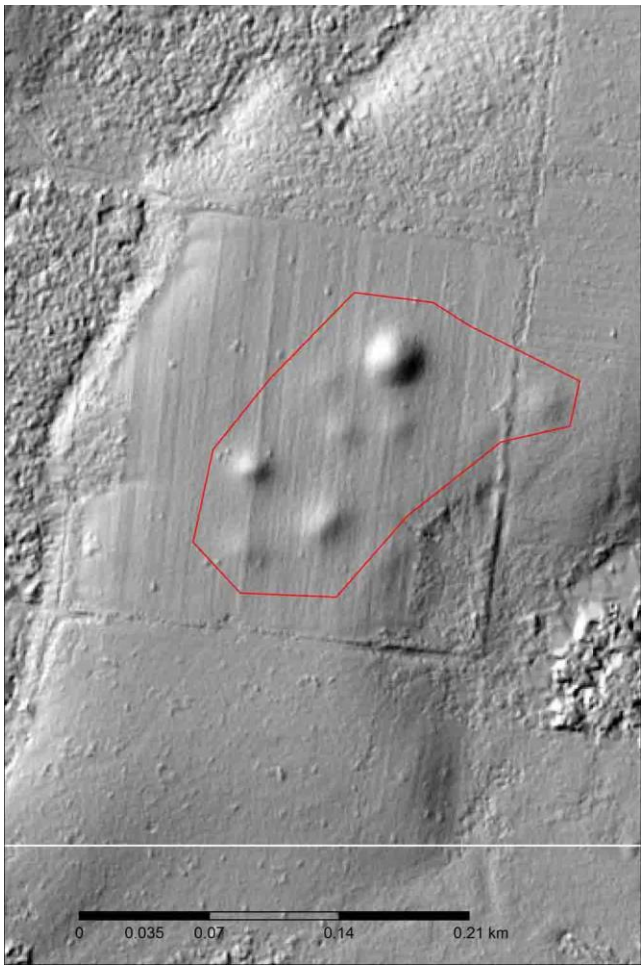

Figure S39. Hillshaded DEM image of Site 31, a Formative-period centre in the Izapa kingdom.

Site 32 (Tp 1527)

This small third-tier centre is located on the west bank of the Suchiate River and just north of the Ciudad Hidalgo highway bypass as well as the international border crossing to Guatemala (Figure S4). This is an Izapa-pattern site but the southern side of the site's platform has been excavated away so it is not possible to know if small architectural features were present (Figure S40). There are mounds south of this but due to modern disturbance plazas are not clearly distinguishable. The land is pasture and the grass was high and thick which made sherd collection difficult but we have enough to confirm the site's Formative-period occupation.

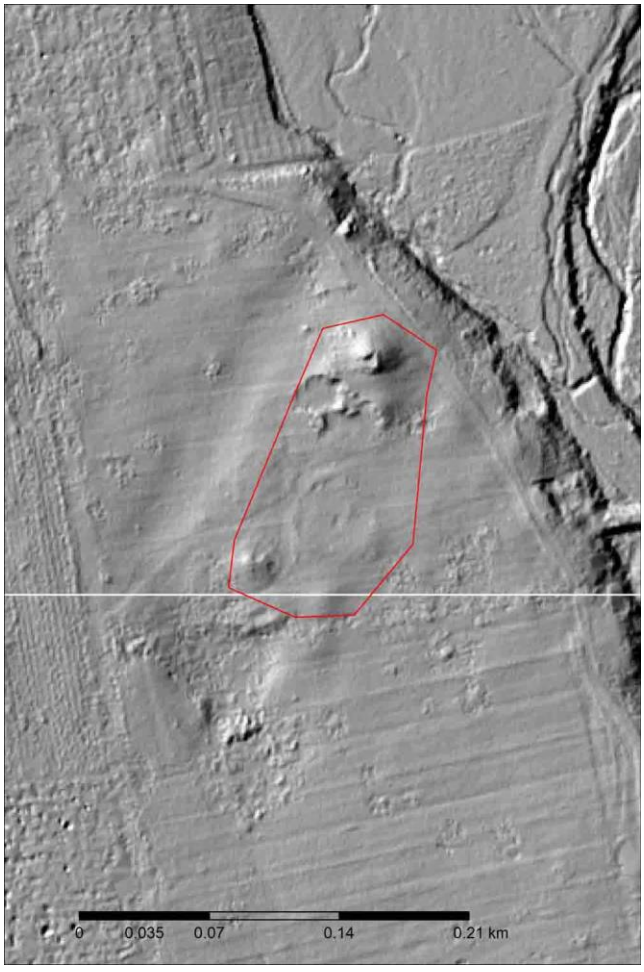

Figure S40. Hillshaded DEM image of Site 32, a Formative-period centre in the Izapa kingdom.

Site 34 (Tp 1501)

This small fourth-tier centre is located at the west edge of the lidar collection area and 3 km west of the Cahuacán River. The site is just east of the Tapachula Walmart parking lot with encroaching Tapachula suburbs on all sides of the field in which the four mounds were documented (Figure S41). This site will very shortly not exist and in 2015 the northern mound was already heavily impacted. This small site is located on the western side of the Cahuacán River but interpreted as being part of the Izapa kingdom as it is less than 10km north of Site 35 which is also interpreted as being part of the kingdom (see below)

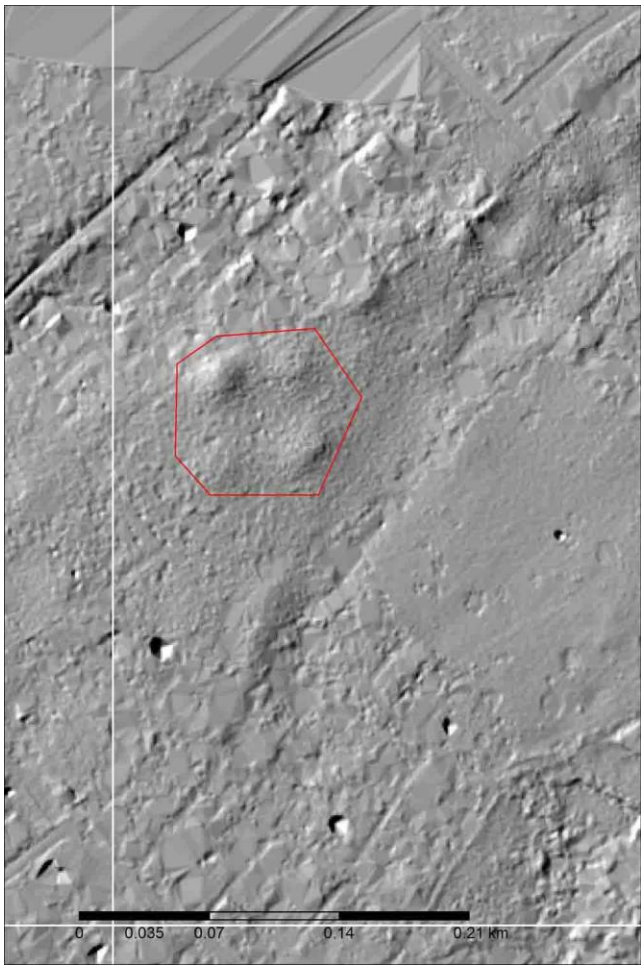

Figure S41. Hillshaded DEM image of Site 34, a Formative-period centre in the Izapa kingdom.

Site 35 (Tp 1508)

This is a third-tier centre in the Izapa kingdom. Two key mounds that form the south and east sides of the first plaza, as well as the platform itself, were not clearly visible in the lidar DEM due to foot paths that run over them. However, ground-truthing confirmed the existence of each of these mounds and established this as a good size, Izapa-patterns centre with three plazas spread south of the conical mound and platform (Figure S42). The second plaza has a large and distinct conical mound defining its west side. The mound defining the east side of this plaza is low and linear so together the two mounds form an E-Group. The third plaza is formed by particularly small mounds on its west and east sides with the largest, most distinct mound of the plaza being on its' the north side, and also defining the south side of the second plaza. This mound centre is organised and oriented like all of those in the kingdom and located only 13km

from the Izapa capital city, and so, interpreted as being part of the kingdom unlike other mound centres (i.e., Sites 40-44) west of the Cahuacán River that are discussed below. Site planning and proximity to the centre of power therefore establish Site 35 as being part of the Izapa kingdom.

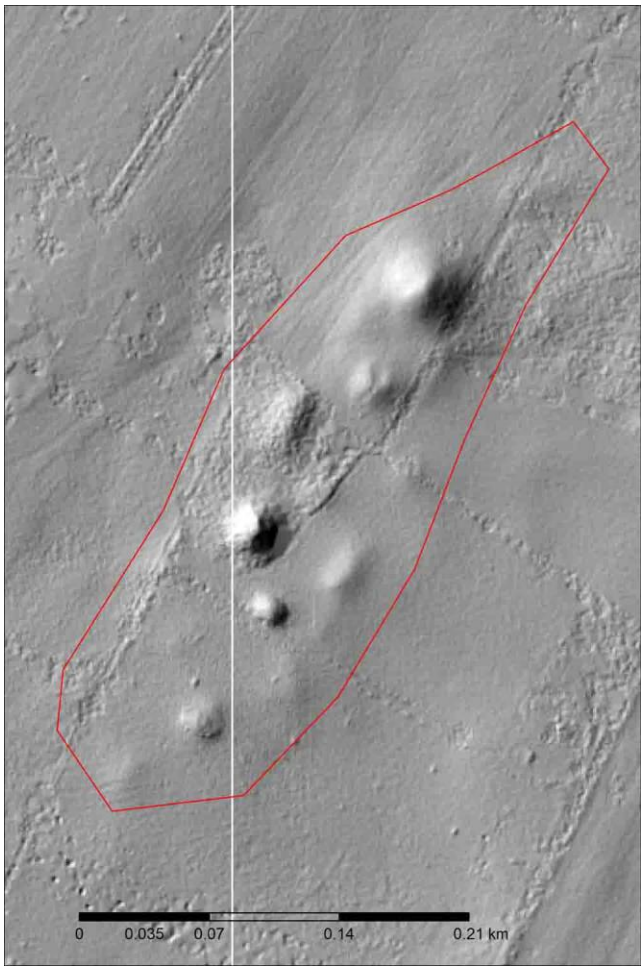

Figure S42. Hillshaded DEM image of Site 35, a Formative-period centre in the Izapa kingdom.

Guatemalan Sites

Although the IRSP did not purposely target Guatemalan sites for documentation with lidar, data was collected up to 3 km east of the Suchiate River (see Figures S1-S4). Four Izapa-pattern centres were documented in Guatemalan but, as they have not been ground-truthed, we cannot confirm that they definitely date to the Formative period. However, based on our experience on the Mexican side of the border, we strongly suspect they are coeval and thus part

of the Izapa kingdom. Each of these mound centres (Sites 36-39) were assigned a Formative centre number on the regional map (Figure S4) but we do not have site collection numbers. In addition, we include two larger centres – El Sitio and El Jardín – that were reported by Shook (1965) and that we then visited in 2015 and confirmed that there are Middle and Late Formative period ceramic sherds on the ground surface.

Site 36

This third-tier centre is located between two small streams that empty into the Suchiate River. The site's northern platform has three small architectural features on its south side and a pyramid that are clearly visible on the DEM (Figure S43). The site's single plaza is formed by four mounds, the west one being conical and the east one linear and thus forming an E-Group.

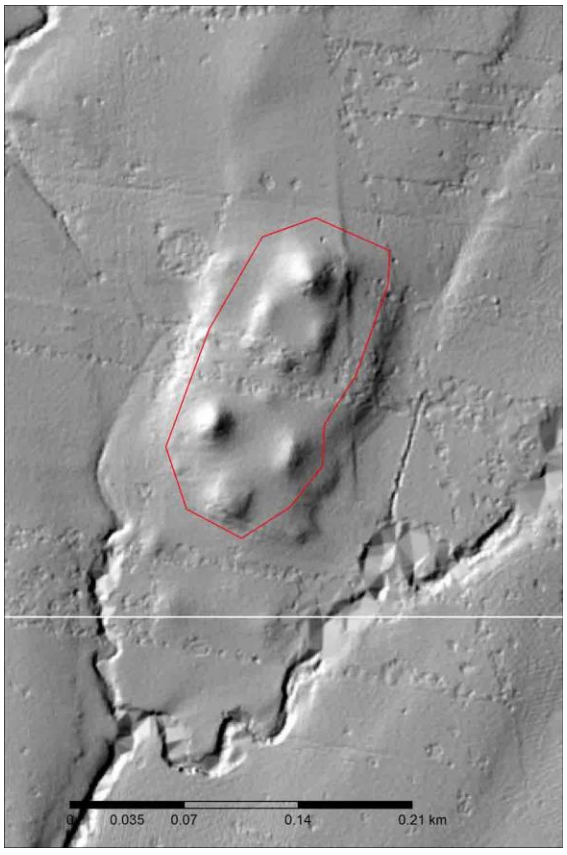

Figure S43. Hillshaded DEM image of Site 36 in Guatemala, a Formative-period centre in the Izapa kingdom.

Site 37

This site is located south of a small stream that empties into the Suchiate River. It appears to be a fairly large, third-tier centre that is heavily impacted by modern development and is at the very edge of the lidar (Figure S44). The northern pyramid appears to be intact but the platform on which it sits is destroyed on its western side by a low circular feature (possibly a modern water tank) and on the southern side by modern construction. The platform's western architectural feature is eroded but still discernible but the southern feature (and entire south edge of the platform) has been lost. The platform's eastern feature seems to be intact. The modern construction (which seems to be a rectangular compound with structures) has destroyed the first plaza group entirely. A modern road runs through the southwest corner of the second plaza to the compound. The second plaza is defined by a large conical mound on its western side and a linear mound on its eastern side that together form an E-Group. The southern mound of this second plaza is clearly visible as is another low, linear mound that may form a ballcourt on the east side of the E-Group as is also the case at El Carmen (Figure S35) and Las Viudas (Figure S37). The angular nature of the southern part of Figure S44 is the result of too few data points at the edge of the DEM, and so, if the site continues to the south with another plaza (or two) to the south, the lidar data did not capture it.

Figure S44. Hillshaded DEM image of Site 37 in Guatemala, a Formative-period centre in the Izapa kingdom.

Site 38

This third-tier centre is located south and west of a small stream. The entire area of the DEM has a "rough" look and it would be informative to ground-truth the area to see what land use results in this pock-marked texture (Figure S45). The site has a northern conical mound and an oval platform reminiscent of Site 13 (Figure S28) and Site 7 (Figure S23). The west and east architectural features on the south side of the platform are visible but the expected southern feature is not. There are two plazas to the south. The first is formed by larger mounds than the second. The west mound of the first plaza is conical and the eastern mound is slightly linear, so together are reminiscent of an E-Group. Two mounds east of the first plaza form a third plaza at this mound centre

.

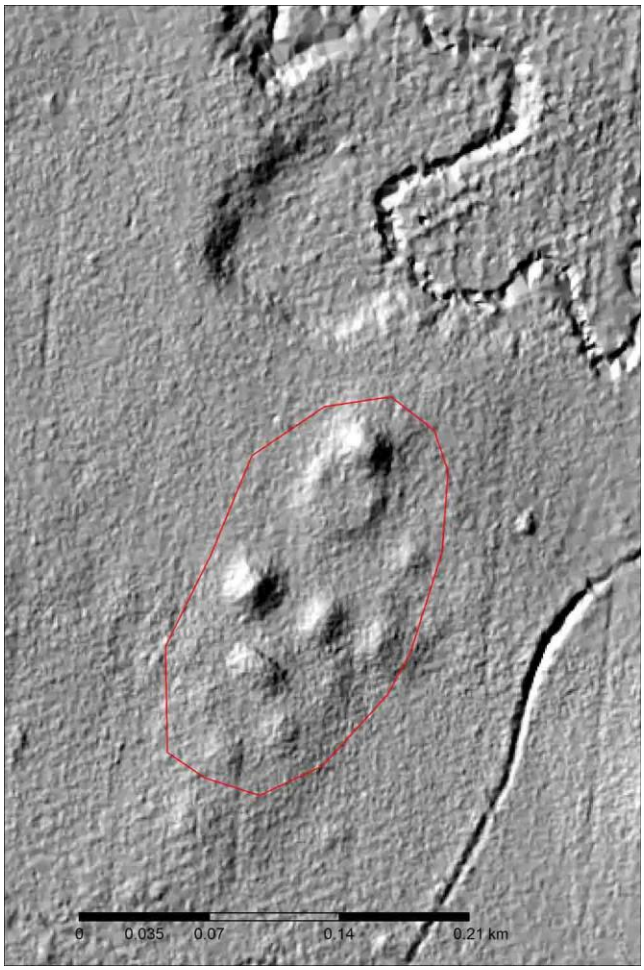

Figure S45. Hillshaded DEM image of Site 38 in Guatemala, a Formative-period centre in the Izapa kingdom.

Site 39 (El Jobo)

During the summer of 2015, we visited the site of El Jobo that is reported by Shook (1965) as having a carved Izapa-style stela. We had a bit of trouble finding the site but now know that it is located directly west of Tecun Uman (across the border from Ciudad Hidalgo) toward the south end of town. It is east of the railway line that goes south to the coast and south of the railway line that runs more or less east-west along the coast. The site is on the west shore of the Melendrez River that joins the Naranjo River a few kilometres to the south. The site we visited looks like a dike had been built parallel to the river and it took us some time to figure out that there were still intact mound present. Later, when looking at photos of the stela published by

Shook (1965), Rosenswig noticed that these features were visible in the background thus confirming that is where the stela was recovered and that if these features are modern they were built before the 1940s. The site reminds Rosenswig of the site of Los Toros (near the Tapachula airport) in that it consists of a scatter of relatively large mounds along the edge of a river with no particular organisation. Another similarly organised (or not organised) cluster of large mounds documented by the IRSP lidar is Site 43 on the west side of the Cahuacán River (Figure S52). This may be the Terminal Formative (aka Proto-Classic) architectural pattern that succeeded the formal organisation of the Izapa kingdom. If this is so, then the stela documented by Shook was likely brought to El Jobo from Izapa after its collapse. The IRSP lidar had the coverage of Guatemala cropped out for the 2015 Chiapas field season so we did not have access to this DEM when we visited the site.

Upon examining the entire lidar block and plotting out the GPS points for the mounds we visited at El Jobo when back in Albany, we found that they were just off of the edge of our coverage but to the south there are mounds that seem to form an Izapa-pattern centre (Figure S46). The large mounds at the south likely date to the Terminal Formative period and part of the same occupation as the mounds we visited to the north of the finca's main access road that is depicted in the DEM running across the top of Figure S46. The site we identify as a Formative-period centre by the red polygon in Figure S46 has not been ground-truthed so we cannot report the age of the ceramics that cover it. If we are correct, and in was an Izapa kingdom centre, then the northern platform and pyramid are largely destroyed with just the footprint of the platform remaining. One plaza is preserved and has the elements of an E-Group with a conical mound on the west and a linear mound on the east. There may have been another plaza group (or even two) to the south but if so they are under what Rosenswig assumes is later Terminal Formative period construction. This is all supposition that could be partially cleared up by visiting the site and documenting the age of ceramic sherds on the surface. However, excavation trenches will be required to conclusively document the construction history of this component of the site.

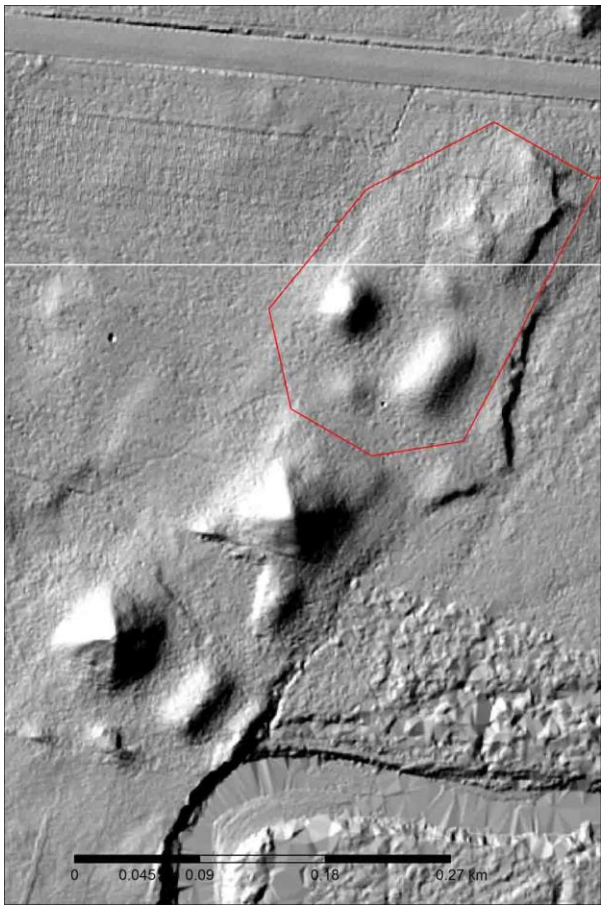

Figure S46. Hillshaded DEM projected from lidar of Izapa-pattern centre below the site of El Jobo (Site 39) reported by Shook (1965).

El Sitio

This site in Guatemala is under the modern town of the same name located on the east side of the Melendrez River. The highway defines the east side of the site and the main road through town (heading west from the highway) defines its northern limit. The archaeological site then extends south and west on either side of an unpaved road that runs parallel to the highway. Walking south along this unpaved road, the northern pyramid mound is evident on the left hand (east) side of the road under houses and their yards. Continuing south along this unpaved road, it was evident when it drops down off of the southern edge of the platform and then a few mounds are evident that form a plaza to the south. Following the unpaved road further south leads to more large mounds and a few uncarved stone monuments. Given the "unorganised" arrangement of these mounds, this part of the site likely dates to the Terminal Formative period. The part of the site in town was clearly a major centre within the Middle and Late Formative period Izapa

kingdom and enough of this site remains that with lidar the Izapa-pattern will be discernible. Shook never mapped this site, likely because it was already under the town when he visited it. This is also the find spot for the 'El Sitio Axe' that depicts a maize cob growing from the cleft in an Olmec-style individual's head.

El Jardín

This site is in Guatemala on the west side of the highway from Mexico just south of the town of Catarina. In Shook's unpublished field notes dated to 1943, this site is easily recognised from his sketch map as what we are now calling an Izapa-pattern centre (Figure S47). According to his sketch, the site measures ~600m north to south is oriented 15 degrees east of north. This second-tier centre has a pyramid mound at the north end of the site which sits on a platform that has three architectural features. The sketch depicts four plazas extending to the south. The first and third plazas each have a conical mound defining their west sides and a linear mound on their east sides (especially the third plazas), reminiscent of E-Groups. Shook records 35 mounds at El Jardín which is less than half the number depicted by lidar at Las Viudas (and they are also spread out over less than half the area. However, El Jardín does not have any obvious Terminal Formative period alterations so it is possible that the centers were closer in size during the emergence and apogee of the kingdom.

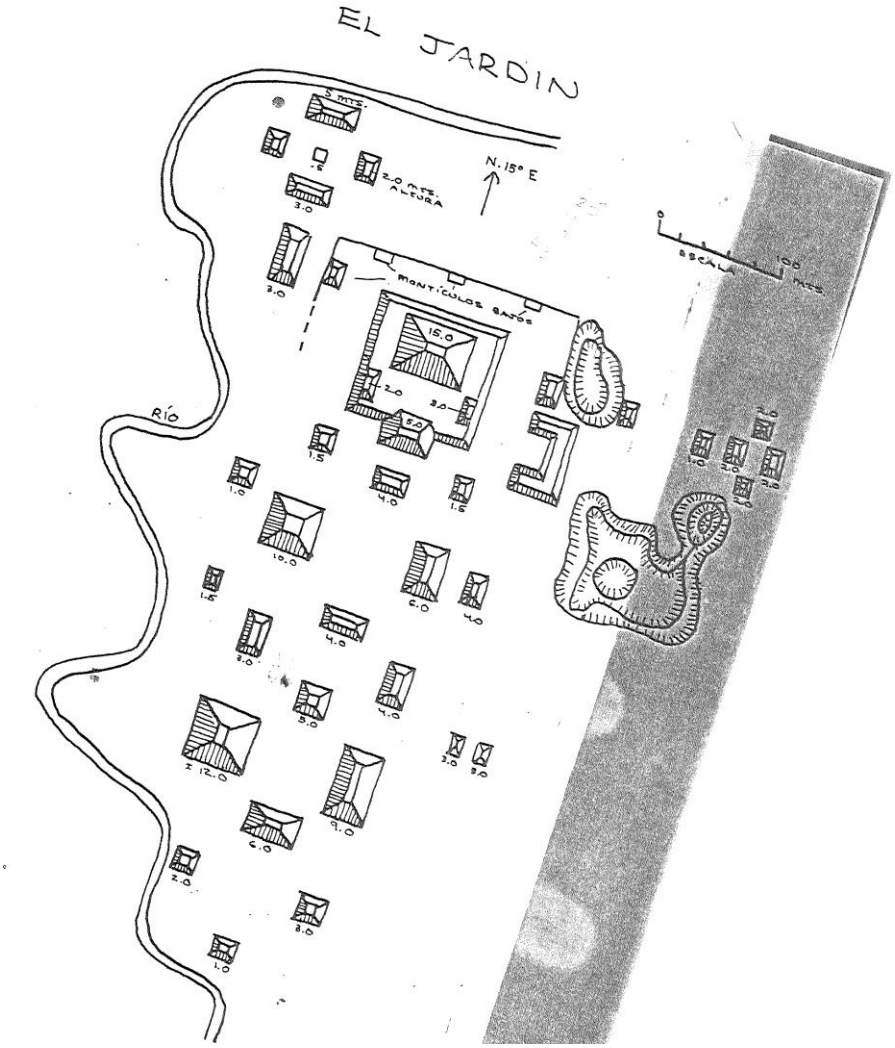

Figure S47. Sketch map of El Jardín made by Edwin Shook in his 1943 unpublished notes.

In 2015, we visited the main mound and platform that were in milpa (Figure S48). The plaza groups that extend south were clearly visible as there was little surface vegetation under the mature stand of African palm that covers them in the plantation to the south. We did not visit the mounds in the palm plantation but all seem to be well preserved. We confirmed the age of this site as there are recognisable Middle and Late Formative sherds visible on the ground surface from the area in milpa pictured in Figure S48. This is currently the third largest site known from the Izapa kingdom (after Izapa itself and Las Viudas), defining its' eastern extent and positioned directly between the Izapa capital and the neighbouring capital of El Ujuxte (see Figure 4).

Figure S48. Photograph of El Jardín platform and northern pyramid mound, taken from the highway looking west.

Non-Izapa pattern sites west of the Cahucan River

Site 40 (Tp 1520)

This site is located west of the Cahuacán River just north of a large banana plantation called Rancho Grande (marked on the 1:50 000 topographical maps) after passing through the town of El Manzano. The site is down in the river's floodplain with some mounds in pasture and some planted in mangos behind the quarry and dump used by Rancho Grande. The pyramid mound and platform are way off axis to the west as well as being too far from the other mounds to conform with the Izapa pattern (Figure 4B). As discussed in the main text, and in relation to Sites 41, 42 and 44, we interpret such sites on the west side of the Cahuacán River as not being part of the Izapa kingdom but the centres of contemporaneous, neighbouring peoples. Surface collections indicate that the site was occupied during the Middle and Late Formative period; so was built and used at the same time as the Izapa kingdom centres. There are elements of the Izapa kingdom pattern present at Site 40 such as the existence of a platform with a mound on it, an E-Group formed by two large mounds and smaller mound defining the north and south ends of the plaza as well as multiple other plazas. However, given the consistency in form and layout of the more than three dozen centres documented with lidar on the other side of the Cahuacán River, the divergences at Site 40 (as well as Sites 41, 42 and 44 discussed below) are interpreted as being culturally and political meaningful.

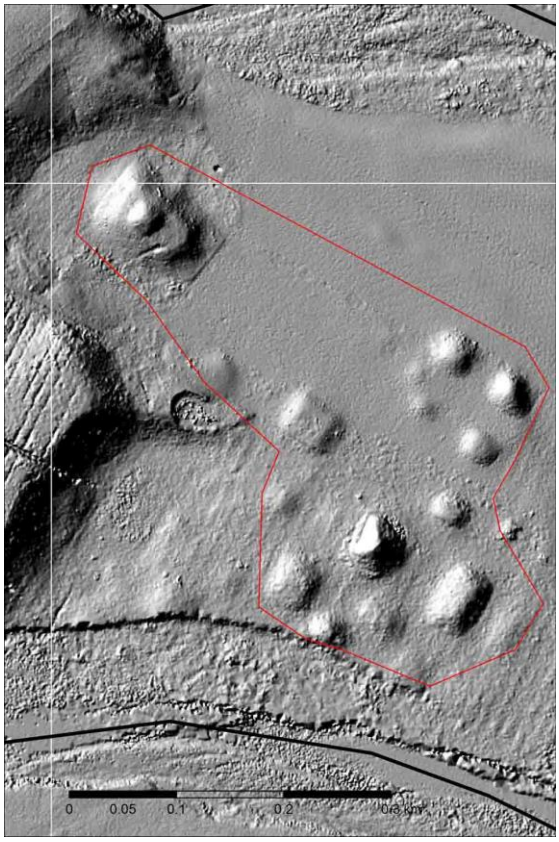

Figure S49. Hillshaded DEM image of Site 40, a Formative period centre.

Site 41

This group of mounds is located near the edge of the lidar data and was cropped from the DEM imagery that we employed during the 2015 field season. As a result, we did not visit the site, so gave it no field number and did we did no collect a sample of ceramic sherds. However, Site's 36, 37 and 38 in Guatemala were similarly not visited yet, based on the architectural form and organization alone, it is evident that they conform to the standards documented with the three dozen Izapa kingdom centres recorded between the Cahuacán and Suchiate Rivers (Fig. S4). This site is thus grouped with the larger Sites 40, 42 and 44 and also interpreted as being a contemporary settlement beyond the Izapa kingdom's western border.

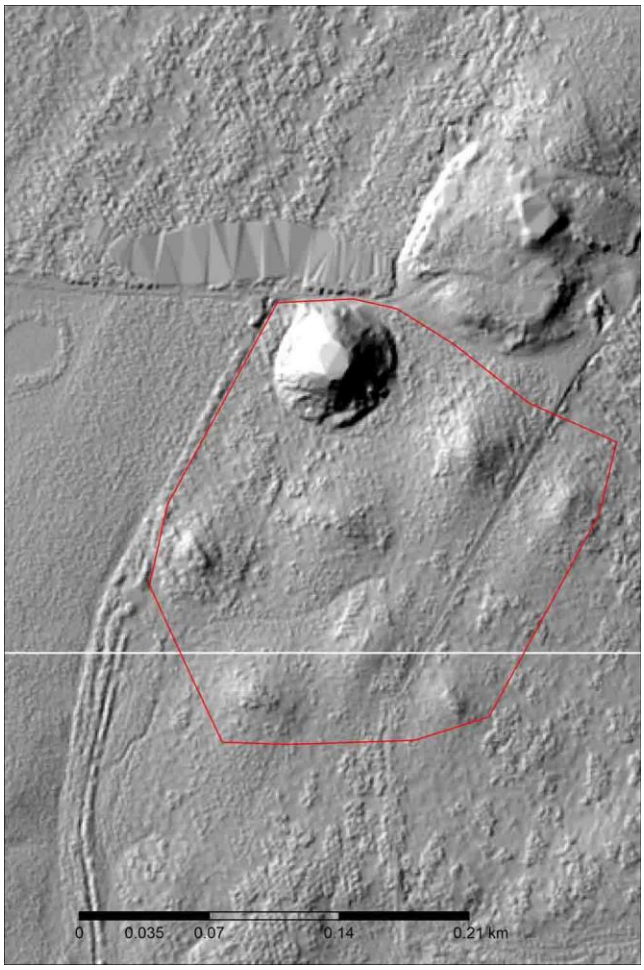

Figure S50. Hillshaded DEM image of Site 41, a Formative period centre.

Site 42 (Tp 1528)

This site is located west of the Cahuacán River, up a road to the north from the Ciudad Hidalgo-Tapachula Airport highway at sign for Canton Bodegas. The site is located near a landing strip used for crop dusters and we had a bit of difficulty accessing it as no roads go close and there is a stream on either side (Figure S51). The land was in pasture but with lots of cows on it and the resulting erosion allowed for good surface collections. The site was occupied during the Middle and Late Formative periods but not arranged like those east of the Cahuacán River. There is a northern pyramid mound but it does not align with the plazas to the south as it does at all the Izapa-pattern centres. There is no evidence of a platform but two possible architectural features are visible where they would be expected. Four distinct mounds form the first plazas oriented toward the west side of the northern pyramid. A second plaza is formed by three mound

and open on the south side at the bottom of the area defined by the red polygon. If this is a plaza, it does not align with either the other plaza or with the northern pyramid, as is the case with centres in the Izapa kingdom. The "correct" elements are present but not put together in the right way.

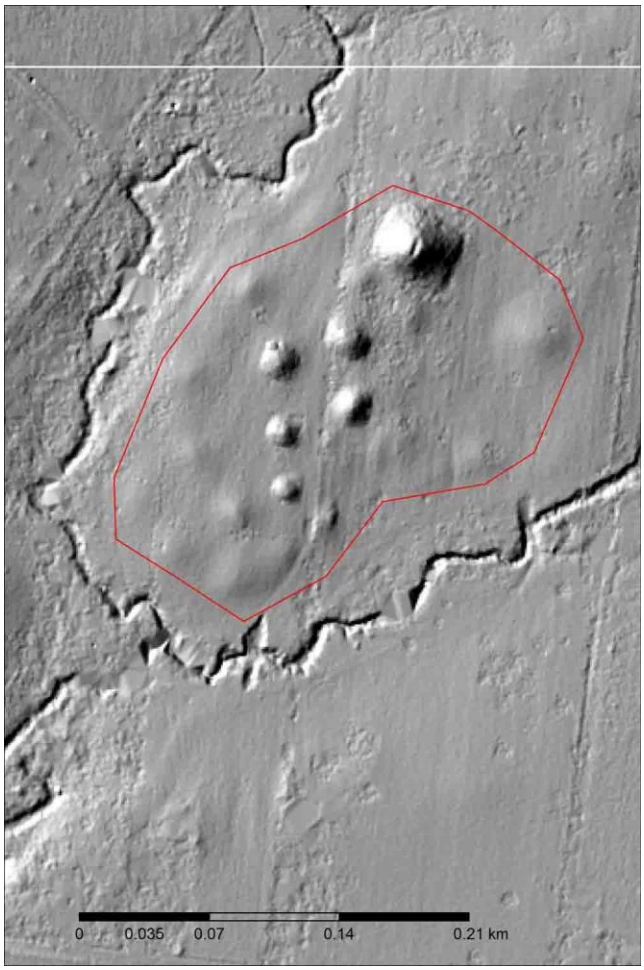

Figure S51. Hillshaded DEM image of Site 42, a Formative-period centre.

Site 43 (Tp 1524)

This site is located on the west side of the Cahuacán River and ~2 km north of the highway that runs from Ciudad Hidalgo to the Tapachula airport. There are some large mounds running along the edge of the river and one had a road cut through it and another has been excavated away on one edge. There is also some major erosion occurring on the river side of the site. Large numbers of ceramic sherds were recovered from this erosion, many were Middle and

Late Formative but more dated to the Terminal Formative period. The site does not have an Izapa-pattern layout or any appearance they the site's builders were trying to imitate it as at other sites on the west side of the Cahuacán River. Site 43 is instead set up like other Terminal Formative centres like Los Toros (north of the Tapachula airport) and El Jobo in Guatemala (discussed above). So, while not a mound centre contemporaneous with the Izapa kingdom, the erosion at this site reveals that is was the location of peoples who did not build mounds at this time. For this reason it would be an interesting place at which to pursue excavations in the future.

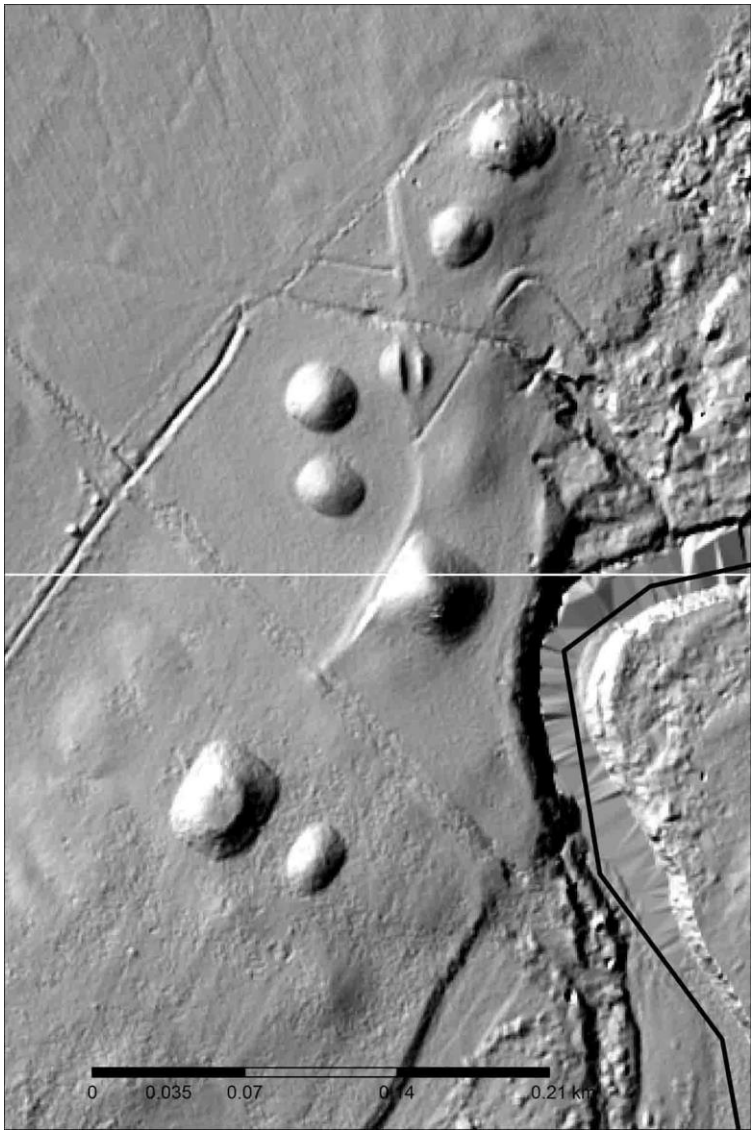

Figure S52. Hillshaded DEM image of Site 43, a mound centre west of the Cahuacán River.

Site 44 (La Cabaña)

This site is recorded by the NWAF as La Cabaña but Rosenswig (2011) has referred to it as Las Tinajas as this is the name of the town in which it is located. The site has been visited on multiple occasions and Middle Formative period ceramic sherds documented throughout the area defined by the red polygon (Figure S53). The northern pyramid has a platform on its south side that extends to close to the eastern mound that defines the site's single plaza. The platform has been ploughed down over the years. The plaza's east mound is linear and the mound defining the west side of the plaza is conical so reminiscent of an E-Group. None of the three smaller mounds at the south part of the site are in the "correct" position (i.e. bilaterally symmetrical) to close the plaza. Again, like other mound centres west of the Cahuacán River, this site contains similar elements to those built within the Izapa kingdom but that are no put together in the "right way." In addition to the occupation contemporary with the Izapa kingdom, Terminal Formative sherds have been recovered from around a modern house built on the lower mound visible on the top part of the west side of the DEM (Figure S53).

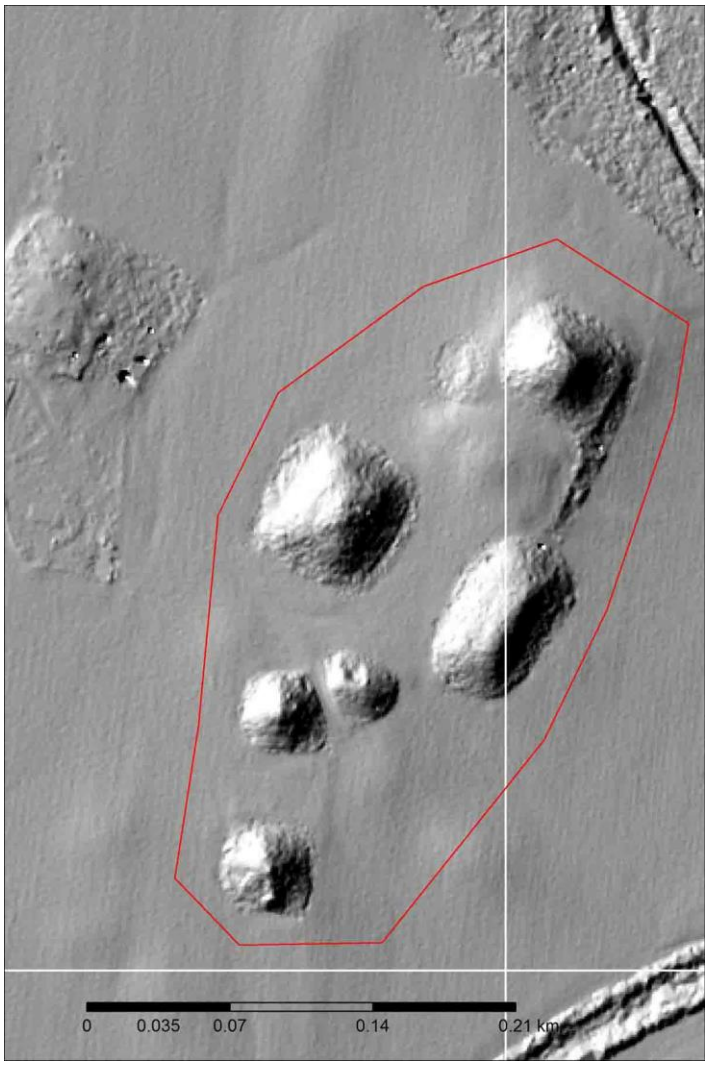

Figure S53. Hillshaded DEM image of Site 44, a mound centre west of the Cahuacán River.

References

BLAKE, M., R.M. ROSENSWIG & N. WABER. 2015. Izapa's hinterland: the use of lidar mapping to examine the layout and spatial orientation of secondary centers in the Soconusco Region, Chiapas, Mexico. Paper presented at the 80th Annual SAA, San Francisco.

LOWE, G.W., T.A. LEE JR. & E.M. ESPINOZA. 1982. *Izapa: an introduction to the ruins and monuments.* Provo (UT): Brigham Young University.

NEFF, H., P.H. BURGER, B.J. CULLETON, D.J. KENNETT & J.G. JONES. 2018. Izapa's industrial hinterland: the eastern Soconusco mangrove zone during Archaic and Formative times. *Ancient Mesoamerica* 29 (2): in press.

ROSENSWIG, R.M. 2008. Prehispanic settlement in the Cuauhtémoc region of the Soconusco, Chiapas, Mexico. *Journal of Field Archaeology* 33(4): 389–411. https://doi.org/10.1179/009346908791071178

–2011. An early Mesoamerican archipelago of complexity: as seen from changing population and human depictions at Cuauhtémoc, in R. Lesure (ed.) *Sociopolitical transformation in early Mesoamerica: Archaic to Formative in the Soconusco Region*: 242–71. Berkeley: University of California Press.

ROSENSWIG, R.M. & R.R. MENDELSOHN. 2016. Izapa and the Soconusco region, Mexico, in the first millennium AD. *Latin American Antiquity* 27(3): 357–77. https://doi.org/10.1017/S1045663500015789

ROSENSWIG, R.M., J. GASCO, C. ANTONELLI, R. MENDELSOHN, M. NAVARRO CASTILLO AND C. VIDAL-GUZMAN. 2012. Proyecto de Reconocimiento Regional de Izapa 2011: Informe Técnicos Parciales. Mexico City: Consejo de Arqueología, INAH.

ROSENSWIG, R.M., R. LÓPEZ-TORRIJOS, C.E. ANTONELLI & R.R. MENDELSOHN. 2013. Lidar mapping and surface survey of the Izapa state on the tropical piedmont of Chiapas, Mexico. *Journal of Archaeological Science* 40(3): 1493–1507. https://doi.org/10.1016/j.jas.2012.10.034

ROSENSWIG, R.M., R.R MENDELSOHN, C. ANTONELLI, R. LIESKE, Y. NÚÑEZ CORTÉS. 2014. Proyecto de Reconocimiento Regional de Izapa 2012. Report to Consejo de Arqueología, INAH, Mexico City.

ROSENSWIG, R.M., A.M. VANDERWARKER, B. J. CULLETON & D.J. KENNETT. 2015. Is it agriculture yet? Intensified maize-use at 1000 cal BC in the Soconusco and Mesoamerica. *Journal of Anthropological Archaeology* 40: 89–108. https://doi.org/10.1016/j.jaa.2015.06.002

ROSENSWIG, R.M., B.J. CULLETON, D.J. KENNETT, R. LIESKE, R.R MENDELSOHN & YAHAIRA NUNEZ-CORTES. 2018. The early occupation of Izapa: recent excavations, new Middle Formative dating and ceramic analyses. *Ancient Mesoamerica* 29 (2), in press.

SHOOK, E.M. 1965. Archaeological survey of the Pacific coast of Guatemala, in G.R. Willy (ed.) *Archaeology of southern Mesoamerica:* 180–94. Austin: University Texas Press.