APPENDIX 3. Quantitative study of inequalities using Lorenz curves and Gini coefficients

The choice of variables

The level of wealth distribution between individuals, social groups, or entire societies can be represented by Lorenz curves from which Gini coefficients are derived (Kohler and Smith 2018). Many types of inequalities within community can be considered: wealth, prestige, health or access to resources (Peterson and Drennan 2018). Access to resources, mainly access to arable land, was not limited in the rainfed agricultural system we studied, since it did not rely on specific labor-costly landscape modifications related to water concentration or irrigation practices. Some indicators of social status (funeral ornaments, architectural features) do not necessarily constitute valid measures of wealth inequality but rather reflect differentiations of prestige (Peterson and Drennan 2018). Our observations do not reveal differences in architectural features or funeral assemblages within or among the settlements of the study area, thus ruling out notable inequalities in prestige.

Housing and storage unit areas are common indicators in studies of economic wealth in past societies. This choice can, however, be debated: some consider that the housing space reflects the size of the family more than its wealth (Cutting 2006) and that the size of the storage units is relevant if and only if, no part of the agricultural production is directly exported without the need for immediate storage. A direct export of agricultural products without storage seems unlikely in the Intersalar given the ease of grain conservation and the great isolation of the study sites within this pre-desert region. We therefore considered an analysis of the major inequalities within this society based on data on housing space and storage capacity to be justified.

Gini coefficient calculation

Beyond the analysis of the total housing space (THS) and the total storage capacity (TSA) per household unit, we seek to aggregate these variables m in order to give a synthetic account of household wealth. Two approaches were followed.

On the one hand, following Bogaard et al. (2018), we calculated a variable W for each household using a function similar to the Cobb-Douglas production function from economics. The aggregate variable calculated for each household unit is W_i:

$$W_i = THS_i^{\alpha}.TSA_i^{(1-\alpha)}$$

where THS_i is the housing space of the i-th household and TSA_i the storage area of the same household with α being the relative importance of housing compared to farming wealth as a determinant of one's living standard ($0 \leq \alpha \leq 1$). As proposed by Bogaard et al. (2018), we used two plausible values for α, 0.25 and 0.5, leading to the two Gini coefficients CD02 and CD05. All coefficient calculations used bootstrap resampling techniques with a number of resamples equal to 1000 (Dixon et al. 1987, Peterson and Drennan 2018).

On the other hand, we used a composite coefficient that considered, for each site, the geometric mean of the two previous coefficients into a single coefficient based on the calculation of the Human Development Index (HDI) as an alternative to single-variable Gini coefficient (UNDP 2010). This calculation assumes that increasing the number of variables increases the accuracy and precision of the coefficient aggregated. Applied to archaeology, Oka et al. (27) call such a coefficient the composite archaeological index (CAI) whose main advantages lie in the analysis of its temporal evolution within the societies studied and in the facilitation of comparative studies. We thus calculate a composite Gini as:

$$CAI\text{-}W = (Gini\_THS)^{0.5}.(Gini\_TSA)^{0.5}$$

Fig. A3.1. Lorenz curves for CD02 (—), CD05 (—), total housing space (THS - - -), and total storage area (TSA - - -) on a household basis at the 12 sites.

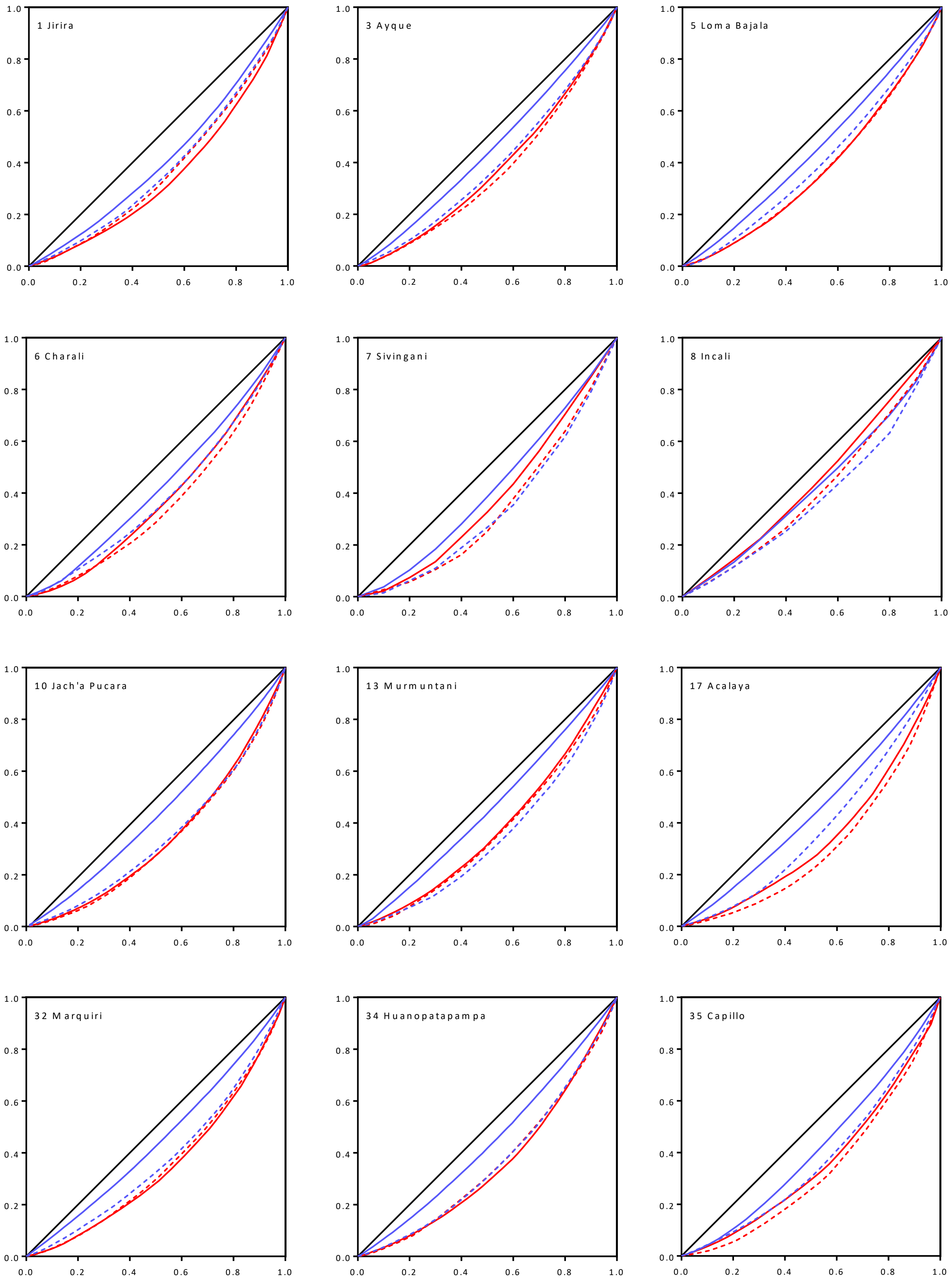

Fig. A3.2. Gini coefficients for the Intersalar region during the 13th-15th centuries (data points A and B) compared to 369 different sites across the world and different types of adaptation and 370 political scales. (After Figs. 2 and 3 in Kohler et al. 2017).

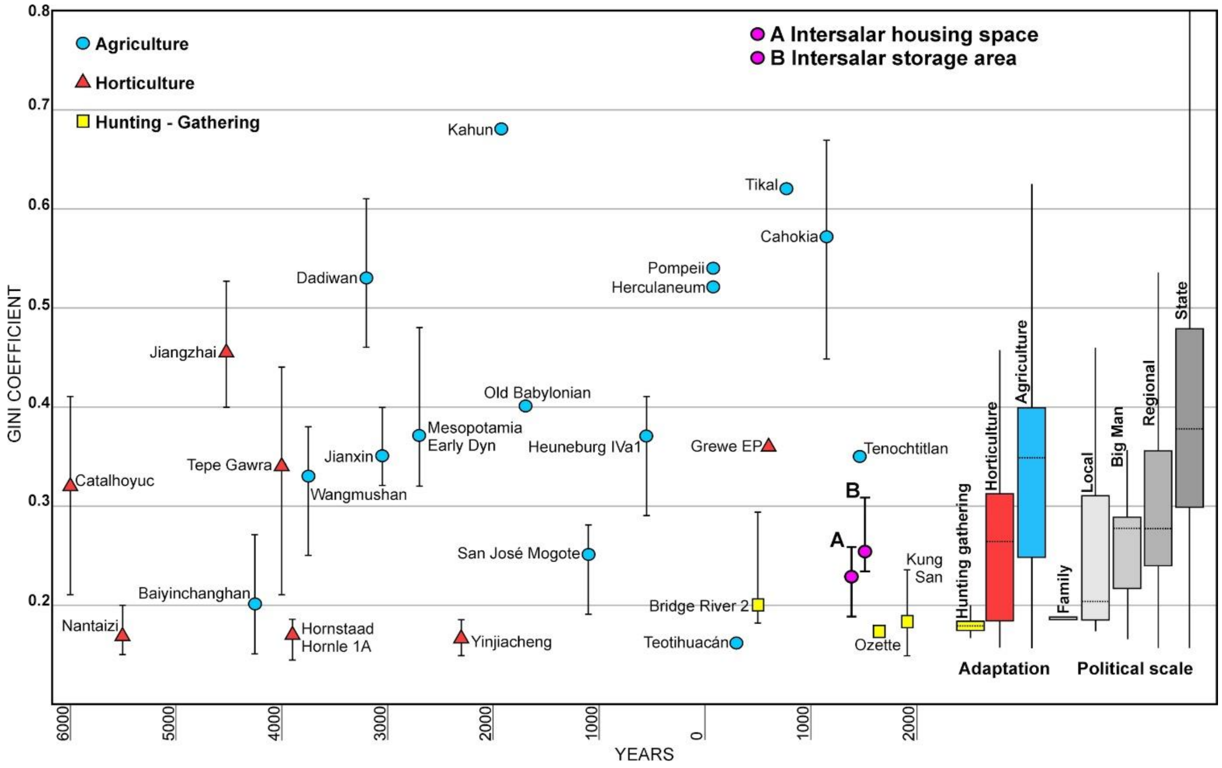

Table A3.1. Mean values for the Gini coefficients and their bootstrapped error ranges for 10-90 percent confidence based on 1000 resamples. THS: Gini coefficient for total housing space; TSA: Gini coefficient for total storage area; CD02 and CD05: Gini coefficients using the Cobb-Douglas production function for α = 0.25 and 0.5 respectively; CAI-W: composite archaeological index. (see Appendix 3 for complete definitions).

	Site n°	**Household number**	**THS**			**TSA**		
			Mean	10%	90%	Mean	10%	90%
Jirira	1	37	0.216	0.190	0.241	0.228	0.197	0.260
Ayque	3	40	0.192	0.168	0.215	0.251	0.221	0.281
Loma Bajala	5	56	0.183	0.158	0.210	0.236	0.211	0.262
Charali	6	22	0.211	0.175	0.249	0.271	0.228	0.314
Sivingani	7	10	0.248	0.175	0.325	0.254	0.186	0.319
Incali	8	10	0.152	0.089	0.205	0.130	0.098	0.159
Jach'a Pucara	10	86	0.286	0.262	0.309	0.315	0.284	0.345
Murmuntani	13	35	0.275	0.238	0.311	0.244	0.203	0.285
Acalaya	17	42	0.235	0.202	0.269	0.364	0.326	0.400
Marquiri	32	41	0.227	0.201	0.254	0.261	0.225	0.298
Huanopatapampa	34	52	0.250	0.225	0.275	0.255	0.222	0.289
Capillo	35	28	0.231	0.203	0.258	0.305	0.256	0.353
		Mean	0.226			0.259		
		CV (%)	16.92			21.70		

	Site n°	**Household number**	**CD 02**			**CD05**		
			Mean	10%	90%	Mean	10%	90%
Jirira	1	37	0.210	0.182	0.240	0.200	0.174	0.228
Ayque	3	40	0.219	0.192	0.245	0.205	0.177	0.231
Loma Bajala	5	56	0.211	0.189	0.232	0.189	0.165	0.213
Charali	6	22	0.231	0.193	0.274	0.211	0.173	0.251
Sivingani	7	10	0.242	0.173	0.303	0.243	0.177	0.308
Incali	8	10	0.100	0.063	0.133	0.097	0.059	0.132
Jach'a Pucara	10	86	0.291	0.266	0.315	0.277	0.255	0.299
Murmuntani	13	35	0.234	0.192	0.277	0.238	0.193	0.282
Acalaya	17	42	0.317	0.2842	0.351	0.276	0.245	0.305
Marquiri	32	41	0.233	0.198	0.270	0.217	0.184	0.250
Huanopatapampa	34	52	0.228	0.199	0.256	0.216	0.190	0.241
Capillo	35	28	0.272	0.223	0.319	0.251	0.210	0.290
		Mean	0.232			0.218		
		CV (%)	22.84			21.81		

(continued)

(continued)

	Site n°	Household number	CAI-W		
			Mean	10%	90%
Jirira	1	37	0.222	0.201	0.242
Ayque	3	40	0.219	0.199	0.239
Loma Bajala	5	56	0.207	0.188	0.226
Charali	6	22	0.238	0.210	0.267
Sivingani	7	10	0.248	0.195	0.298
Incali	8	10	0.138	0.104	0.170
Jach'a Pucara	10	86	0.300	0.279	0.318
Murmuntani	13	35	0.258	0.230	0.285
Acalaya	17	42	0.292	0.2669	0.317
Marquiri	32	41	0.243	0.222	0.265
Huanopatapampa	34	52	0.252	0.231	0.273
Capillo	35	28	0.265	0.239	0.292
		Mean	0.240		
		CV (%)	17.62		

Table A3.2. Pearson correlation coefficients (r) between site features and Gini coefficients in the 12 study sites. THS: Gini coefficient for total housing space; TSA: Gini coefficient for total storage area; CD02 and CD05: Gini coefficients using the Cobb-Douglas production function with α = 0.25 and 0.5 respectively; CAI-W: composite archaeological index. (see Appendix 3 for complete definitions). For n = 12 (df = 10), the critical value of Pearson correlation coefficient (r) at P = 0.05 is 0.576.

Gini index	**TSA**	**THS**	**CD02**	**CD05**	**CAI-W**
Site surface	0.61 *	0.31 ns	0.59 *	0.51 ns	0.55 ns
Site elevation	-0.23 ns	-0.26 ns	-0.32 ns	-0.36 ns	-0.27 ns
Number of household	0.45 ns	0.45 ns	0.47 ns	0.45 ns	0.52 ns
Mean strorage area per household	-0.12 ns	0.11 ns	-0.071 ns	-0.025 ns	-0.023 ns
Mean housing space per household	0.12 ns	0.11 ns	0.17 ns	0.19 ns	0.15 ns

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