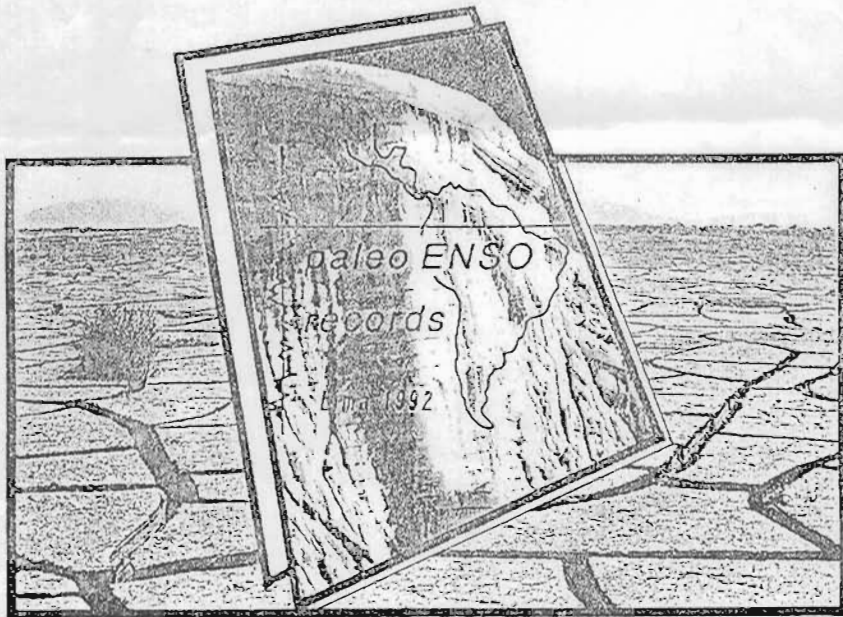


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HISTORICAL RECORD OF EL NIÑO EVENTS IN PERU (XVI-XVIIIth CENTURIES): THE QUINN ET AL. (1987) CHRONOLOGY REVISITED

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El registro histórico de eventos El Niño en Perú: un reexamen de la cronología propuesta por Quinn et al. (1987) para el período s.XVI-s.XVIII.

Una cronología de eventos El Niño en el transcurso de los últimos 450 años ha sido elaborada por Quinn et al. (1987). Este registro, basado en una amplia compilación de textos históricos referentes a anomalías climáticas en el Perú, es de suma importancia para los estudios de periodicidad y de variaciones de intensidad del fenómeno El Niño, y empieza a ser ampliamente utilizado por numerosos investigadores del sistema ENSO (El Niño-Oscilación Austral). El presente trabajo consiste en revisar la cronología propuesta por Quinn et al., en base a los mismos textos referenciados por los autores (y agregando unos pocos), para el período s.XVI-s.XVIII. Este nuevo análisis crítico de textos nos lleva a confirmar la validez de la mayoría de los eventos propuestos en aquella cronología. En algunos casos, sin embargo, consideramos que los elementos disponibles no permiten determinar, con buena probabilidad la ocurrencia de un evento El Niño. En otros casos, por ejemplo cuando sólo se tiene una información aislada sobre una lluvia en Lima, o una crecida del río Rimac, consideramos que se requeriría datos adicionales antes de poder afirmar que estas anomalías corresponden a un evento El Niño. Por otro lado, la determinación de la intensidad de los eventos pasados El Niño sigue siendo un problema difícil de resolver, sobre todo cuando se tiene información parcial y geográficamente limitada.

INTRODUCTION

Quinn et al. (1987) developed a chronological series of the major El Niño events that might have occurred in the last 450 years. This was done through a compilation of historical sources, most of them concerning evidence of meteorological anomalies in Peru. The Quinn et al. (1987) study (further referred to as QNA) included estimates of event intensity, as well as a confidence rating in the evaluation of the event reconstruction. The QNA chronological reconstruction of the main ENSO events in the last few centuries is not the only one (see Hamilton & Garcia, 1986; Huertas, 1987), but it remains the most detailed and the most complete proposed so far. As such, it has been accepted by numerous authors working on paleo-ENSO record. Some researchers even based part of their studies on this chronology (e.g. Enfield, 1988; Enfield & Cid, 1990; Fairbridge, 1990; Nicholls, 1990).

There is a tendency to use the QNA chronology without taking into account some of the uncertainties that Quinn et al. originally expressed (cases with confidence rating of

Years	QNA, 17 Strength Coastal	Major sources	Direct observ- ation	Geographical sites of the reported phenomena	Inven- tory posi- tion	And near- ness	Remarks
1525-60	S	3	Jerez, 1534 [1968:197]	-	Colombia coast	*	See H. A. O., 1990; O. A. H., 1991
1531	S	4	Jerez, 1534 [1968:200]	-	Piura	No	See H. A. O., 1990; O. A. H., 1991
1532			Phragm., 1892 [1955:240]	-	-	-	-
1530			Montesinos, 1642	-	Cuzco	*	Dry weather in the Altiplano (Cuzco)
1540	M/S	3	Montesinos, 1642	-	Cuzco - Lima	*	Storm and hail
			Arenas de Mayo (in QNA)	-	Lima (11.7.1540)	*	"Aguaz" and "red" tide
1541			Cobo, 1653 [1964:1.190]	-	Lima	?	Rain, water running in the streets
1552	S	4	Muro, in Usanas, 1806 [1815:38]	-	Lima (13.07.1552)	?	1 thunder-clap & 3 lightnings during winter storm
1567			Cobo, 1639	-	-	*	-
1568	S+	5	Portocarrero, 1926-84-85	-	Cuzco	*	Floods in all the Peruvian rivers (source of original information?)
			Olivas, 1631	-	Equatorial Pacific O.	*	Panama-Lima trip in 26 days (arrival in Lima on 25/3/1568)
			Portocarrero, 1926-84-85	-	Cuzco	*	Floods in all rivers, great damage (from which source?)
1574	S	4	García Rosell, 1963	-	Piura la vieja	M	Rain, (should be strong because not remembered in 1578)
			Huertarza, 1947	-	Lambayque, Trujillo	*	Rains during two months
1578	VS	5	Cabello Balboa [185 (1922-294)]	-	Trujillo	VS	Very strong event, never seen before
			Lobos (1956 on 240:14-15)	-	Chicama-Trujillo	*	-
			Arcus, 1590 [1554:82]	-	Trujillo	*	-
			Cobo, 1653 [1964:1.190]	-	Trujillo	*	-
			Cobo, 1639 [1964:2.311]	-	Lima	*	Rising flood
			García Rosell, 1963	-	Alto Piura	*	-
1591-2	S	2	Martínez y Vela, 1592	-	Piura	*	Dry weather in Bolivia
1593			Lidarraga, 1664:14-15	-	Trujillo	S	Storm ("torre"), not as strong as 1578 event
1594			Lidarraga, 1664:14-15	-	Trujillo	(M)	Storm and lightning, rains
1596			Orcos & Alvarez, 1669:38	-	Piura	M	Heavy rainfall in Piura area and formation of a pool on the table-top
1607	S	5	Cobo, 1639 [1964:1.212]	-	Lima (February)	*	Rising River flood, and destruction of a bridge at Lima
1608			Palma, 1894 [1964:41]	-	Lima	?	Rising River flood
1614	S	3	Cobo, 1653 [1964:1.190]	-	Chancay (Feb./March)	*	Rainstorm, rain from the Sierra according to Cobo
1618	S	4	Vaqueo de Espinosa, 1629	-	-	*	-
1619			Cobo, 1653 [1964:1.190]	-	Ba (June)	*	-
1624	S+	4	Cobo, 1653 [1964:1.190]	-	Zala, Trujillo	S	Lightning and strong storm like in 1552
1634	S	4	Suárez, 1634 [1936:15-15]	-	Lima (Feb./March)	*	River floods south of Lima, rainstorm in Lima, flood in Ayacucho
1652	S+	4	Cobo, 1653 [1964:1.190]	-	Lima (February)	*	Rainstorm, rain from the Sierra according to Cobo
1660	S	3	Portocarrero, 1926-84-85	-	Supe	?	Supe River flood [original information from which source?]
1671	S	3	Portocarrero, 1926-84-85	-	Supe, Rimac	?	Rimac and Supe river floods [source of original information?]
1681	S	3	Rocha, 1681	-	-	*	-
1686			Schöppmann m., 1985	-	Yapatera, Alto Piura	M	Continuous rains that cause destruction
1687	S+	4	Remy, 1931	-	Lima (2.12.1687)	?	Strong storm that causes destruction
1688			Melo, 1912; Taula, 1934	-	-	*	-
1696	S	3	Palma, 1894 [1964:42]	-	Lima (11.2.1696)	?	Rising River flood

1701	S	4	Freyro de Sosa, 1705 [1984:1-157] Bueno, 1703-1778 [1951:50] Usanero, 1876 [1815:28-39]	+ + +	Trujillo Trujillo Trujillo	3	Thunderstorm
1707	S	3	Cowke, 1712	-			
1708			Alonso y Jarama, 1745	-			
1714	S	4	Gentil, 1728 Portocarrero, 1926-84-85	- -	Arequipa	7	Chilo River flood
1715			Lahera, 1914	-			
1720	S	4	Rubiano y Andrade ms., 1782 Schuback, 1729 [1971:303] Freyro de Sosa, 1763 [1984:1-160-161] Bueno, 1763-1778 [1951:50-53] Palma, 1894 [1964-1151]	- + + + -	Zana Paña (March) Trujillo Zana and valleys Lima	3	Zana River flood, rain during at least two weeks Heavy fog "Not as strong as 1723" - important remark "Stronger than 1724" - see above Thunderstorm
1728	VS	5	Asensio, 1740 [1974:174] Juan A. Ulloa, 1748 [1978:27] Freyro de Sosa, 1763 [1984:1-157-166] Acosta 1780-89 [1987:3,3-344] Laguarda, 1791, ind. 169	+ + + + +	Piura Chosupe Trujillo Paña, Zana Piura	VS	Destruction of the port They made a confusion between 1728 and 1726, 40 days of rain Event stronger than 1729 Zana flood, damage in Piura Destruction in the city
1747	S	3	Freyro de Sosa, 1763 [1984:1-163] Munoz, in Usanero, 1806 [1815:38] Schuback ms., n.d.	- - -	Trujillo Lima Sanctor Alto Piura	3	Rain (2 days) in Trujillo and more to the north Thunderstorm Heavy rain
1748			Steinmann, 1825:177-178	-	Chosupe		Rain during 11 nights ("and no rain until 1812" - see to be treated?)
1761	S	3	Bueno, 1763-1778 [1951:39]	-	Santa	7	Santa River flood? was it related to EN conditions?
1775	S	4	Puente, 1885 Portocarrero, 1926-84-85	- -	Lima	7	Rimac River flood
1785			Lahera, 1914	-			
1786	S	4	Estrada Lima, 1977 Portocarrero, 1926-84-85	- -	Lima	7	Rimac River flood
1791	VS	3	Marciano Pizarro 7/6/1791 Newbury, 1834 Par Solis, 1862 Spratt, 1864:29 Tovar, in Egeuzen 1864:247-248	- + + + +	Lambayeque (March) Piura Piura	3	Lambayeque River flood In 1801 the low strong event remembered in the 1791 event

Table 1. Revised Quinn et al. (1987) chronology of El Niño events (XVI-XVIIIth centuries); see text for explanation, for bibliographical references see Quinn et al. (1987) and this abstract (shaded references)

2 and 3). Because of the importance of such a chronology, especially for studies on the recurrence of the phenomenon in a recent past, it is surprising that the QNA study did not foster more contradictory works. Actually we do not know of studies that pointed to adjustments of the QNA chronology, aside from the two short notes that we previously published (Hocquenghem & Ortlieb, 1990; Ortlieb & Hocquenghem, 1991). In these short papers, we first focused on the evidence concerning the years 1525-26 and 1531-32 and suggested to eliminate the first two events of the sequence of historical El Niños, and in the second one we expressed some doubts about the intensity determined by Quinn et al. for some events of the XVI-XVIIth centuries and about some criteria used in the determination of former occurrences of El Niño events in Peru. Here, we proceed with our critical re-examination of the sources mentioned by Quinn et al. for the period extending to the early XIXth century. Our analysis is presented in the form of a table where we discuss the validity of the sources, the localities where facts were reported, the possible occurrence of El Niño events and their potential intensity.

METHODOLOGICAL APPROACH

Our study aims to reinforce the QNA chronology through a new and independent evaluation of the main published historical sources. The emphasis is put on a critical reading of the texts that mention meteorological (or more exceptionally: oceanographical) anomalies possibly related to El Niño occurrences. For each El Niño event mentioned in the QNA chronology, we first intended to reconfirm the occurrence of the phenomenon, and also tried to evaluate the relative strength of the events. In a few instances, we appended new relevant data.

We basically used the sources cited by Quinn et al. (or took the original version in Spanish). In a few cases, we did not find the texts referred to by these authors (see asterisks in but last column, Table 1). Quinn et al. did not provide the precise location of the relevant information in the texts, but we considered useful to include in Table 1 the number of the pages (and year of edition) of most of the published sources. New references on evidence of events and new descriptions of impacts of former El Niño events include those of Suardo (1936), Lequanda (1793), Lizárraga (1968), Ocoña y Alvarez (1969), Huertas (1987), Schlüpmann (1988), and Stevenson (1925). For the issue concerning the 1525-26 and 1531-32 "events", we had previously referred to a series of texts, not mentioned by Quinn et al., that contradict their interpretation of former occurrence of the phenomenon; we shall not repeat here this discussion and the references herein (see: Hocquenghem & Ortlieb, 1990).

For the reconstruction of a paleo-ENSO chronology, we considered that direct eyewitnesses, or at least authors who wrote shortly after the occurrence of the concerned events, were necessarily more reliable than writers that lived one, two, or three, centuries later. Thus, we distinguished firsthand, from indirect, historical sources (respectively, "+" and "-" in Table 1). We considered as indirect sources those that repeated previous information, even if they did not acknowledge their own sources (in some cases these can be determined unambiguously, notably when the same words were used). We surmise that the mention of such secondhand references is of little help, if not misleading, and should be avoided for clarity-sake. As an example of multiple citations, we can cite the case of the 1720 event, for which it is clear that Petersen (1935) took his information from Remy (1931), who himself cited Unanue (1806), who himself referred to Feijoo de Sosa (1763). In such

cases, we decided to eliminate all the secondhand informants, and keep only those who provided truly original information (Table 1). The indirect writers that were retained in Table 1 are those who provide otherwise unreported data which we did not want to discard totally (until contradictory information is acquired). An asterisk, in the same column ("Direct observation"), simply means that we did not get access to the source referenced by Quinn et al.

We observe that many QNA El Niño events have not been documented by evidence from the northern Peruvian coast, and we are particularly concerned by the possibility that some stronger than usual "garua" rains falling on Lima may not indicate any El Niño event. When the reported rains or lightnings, occurred in winter (July), we wonder whether this information does not rather point to strengthened "anti-El Niño" (inappropriately called by some authors "La Niña") conditions. Furthermore, we hesitate to give much credit to the indication of any isolated rainstorm in Lima or in central Peru, as evidence of strong El Niño events.

Another commonly called for argument used by Quinn et al. is the mention of Rimac River floods. But the recent history of exceptional floods ("huaycos") of the Rimac River seems to exclude a direct correlation with El Niño conditions (Hamilton & García, 1986; Ibañez & Gomez, 1990). These floods, which may be catastrophic are related to storms that anomalously cross the high Andes east of Lima, and not to rainfalls linked to Pacific Ocean atmospheric circulation.

Thus, we scrutinized the cases for which available data concern exclusively the central coast of Peru (mainly Lima) from those which referred to the northern coast (Piura, Lambayeque, Trujillo), and also specified the date of the reported phenomena (Table 1).

The determination of former El Niño strengths, on the basis of historical sources, remains a major problem. Quinn et al. considered four categories of events: VS (very strong), S (strong), M (moderate), and W (weak), but recognized almost exclusively VS and S events for the period anterior to 1800 AD. In a few instances, they were able to distinguish S from S+ (slightly more than strong) events, and moderate events. By using essentially the same sources referred to by QNA, we have been more circumspect. Recent studies (Huertas, 1987) have shown that the intensity of the El Niño phenomenon varies geographically within the northern coast of Peru, in such a way that one event may be viewed as strong in Piura and weak in Trujillo, or vice-versa. Consequently, in the (most common) cases where the information is geographically limited, it is particularly uneasy to appraise the strength of former events.

We tend to infer that the moderate events only affected the northern coast of Peru, namely the Piura area, and that the strong and very strong events had noteworthy impacts in a wider geographical area, that encompasses the Lambayeque-Zaña and Trujillo areas. For obvious reasons, the strongest events are the best documented, and therefore are easier to characterize in terms of intensity. Actually, we tend to confirm the intensity evaluation for almost all the VS events defined in the QNA chronology, but are more reticent regarding the S events.

CONCLUSIONS

Two major problems arose from our critical analysis. One deals with the identification of former El Niño events on the basis of data concerning exclusively the central and southern coast of Peru, and the other one is the appraisal of the strength of former events. We expect that discussions in the Paleo-ENSO Records symposium will help to resolve, or at least bring new elements to solve, these two questions.

Practically, this re-examination of the QNA chronology tends to indicate that it is probably still untimely to use the sequence of paleo-El Niño events as a solid basis for recurrence studies of the phenomenon. We interpret that some of the El Niño events included in the QNA chronology probably did not occur, and that some others were possibly less strong than as determined by Quinn et al..

From our analysis (including our previous studies), it seems well established that no major rainfalls occurred between 1531 (inclusively) and 1574-78 in the Piura region (we reassess here that no El Niño event occurred in 1531-32). Therefore, we interpret that the first well-identified, strong or very strong, El Niño event is the one of 1578. At the end of the XVIIth century, there are several indications of rains and storms in northern Peru, but it would be unrealistic to consider that several successive (1591-1596) years could be El Niño years (Table 1).

For the XVIIIth century, we did not find unambiguous indication of strong or very strong El Niño event (while the QNA chronology includes 11 S or S+ events !). Only two El Niño events appear well documented: one (possibly strong) in 1624, and another one, previously unrecognized, in 1686 (which may have been only moderate ?).

In the XVIIIth century, a very strong event occurred in 1728, and four strong events were registered in 1701, 1720, 1747-48 and 1791. The 1747 event recognized by QNA probably encompassed 1748, according to new data. For the XVIIIth century, Quinn et al. had considered two VS events and 8 S or S+ events.

For future research, we strongly suggest to focus on unpublished manuscripts that concern Piura and Trujillo, like those transcribed by Huertas (1988) and Schlüpmann (1988). This type of previously unreleased information presents the highest potential for a better estimation of the strength of former El Niño events.

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