CLIMATE, CORRELATION, AND CAUSATION IN NORSE GREENLAND

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This paper is dedicated to the memory of the late Dr. Richard Jordan, a good friend and fellow Greenland-farer whose acerbic comments on this and other papers will be sorely missed.

Abstract. Since the early 1960s, archaeologists working in the North have given the collection of paleoecological data an increasingly high priority, and have regularly relied upon paleoclimatic reconstructions for both the description of ancient resource base and the explanation of changing prehistoric population size, settlement patterns, and technology. Recently, senior northern scholars identified with climatic explanations have modified or rejected earlier conclusions (Fitzhugh and Lamb 1985; McGhee 1981), now stressing the role of nonclimatic variables. The experience of economic historians interested in climate impact further suggests the need for a cautious and self-conscious approach by archaeologists. This paper examines the case of the extinction of Norse Greenland in light of these perspectives.

Correlation and Explanation: Some Problems

The collapse and extinction of the Scandinavian colony of West Greenland has long been taken as a textbook example of the impact of climatic change on human society. Even before the evidence provided by modern climatology and the remarkable accomplishments of the Greenland Ice Sheet Project, scholars investigating this lost colony were generally convinced that cooling climate must have played a determining role in the death of Norse Greenland (Bruun 1918, Nansen 1911, Nørlund 1924, 1936). While early positions on the role of climate as executioner differ, they can be fairly summarized by the statement: "it got cold and they died."

Variations on this statement have been seen in other contexts in other parts of the Arctic, as well as in warmer regions (for an excellent critical review see McGhee 1981), often providing both a neat final solution to knotty problems of archaeological explanation and a fine justification for the collection of all those animal bones, sediment samples, pollen cores, and macrofloral specimens now routinely brought back from the field. As the precision and resolution of an ever-expanding battery of paleoclimatic indicators provide a progressively more realistic view of at least the nearer past, and as our contacts with like-minded natural scientists also expand, there is a natural tendency to use the harder paleoclimatic data sets to prop up our own wobblier descriptions of ancient societies.

As many have noted, description has a recurrent tendency to become explanation in the consciousness of the unwary. This process, plus the sheer amount of work involved in subsistence reconstruction, often leads us to feel that by the time we have put together a model of a settlement/subsistence system and set it beside a current paleoclimatic model our explanatory duties are just about complete, and if we can correlate some sort of

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archaeologically visible cultural shift with a period of climatic change our description can magically become explanation. Any number of prehistorians' studies have indeed stopped here, with concluding statements about culture change that boil down to "it got cold/hot/dry/wet and they died/floresced/ migrated/intensified."

For decades, archaeologists working on historic sites have attempted to justify their grants by noting the potential role of later periods as a testing ground for concepts and methods popular with prehistorians. The richness and suspected precision of historic data sets are thus supposed to provide both illustrative set pieces and a sort of check on the work of colleagues dealing with more interesting or significant, but unfortunately less well documented cases. If investigation of the medieval-early modern period in the North Atlantic can play such an advisory role, then perhaps some cautionary signals should be hoisted regarding the efficacy of climatic correlation as explanation.

Climate and History Research

One major source of clear and rigorous thinking on the topic of climatic impact in historic times is the growing number of economic historians interested in the ecology of medieval/early modern agriculture in Europe. Often highly aware of advances in environmental science, this community has been much more receptive to climatic-change arguments than was an older generation scarred by Huntingtonian excesses (Huntington 1917). The documentation of significant shifts in mean temperatures between the "Little Climatic Optimum" or the "Early Medieval Warm Period" and the "Little Ice Age" or "Late Medieval Cold Period" by Brooks (1949) and Le Roy Ladurie (1972) and more memorably by H. H. Lamb (1977) and Bryson and Murray (1977) has resulted in a host of well-structured investigations of probable historical impacts throughout Europe and parts of North America. A recent series of edited volumes dealing with climate and history (Wigley et al. 1981; Smith and Parry 1981; Rotberg and Rabb 1980; Parry 1985, cf. Bigelow 1991) conveniently provide a survey of results.

If it is possible to distill a unified message from these varied conference volumes, it is that unambiguous cases of climatic impact are not easy to demonstrate in the historical record, and that arguments based on simple correlation are unconvincing. An extremely thorough and heavily quantitative study by de Vries (1980) of transport data; grain, butter, and fuel prices; burial statistics; and weather data for seventeenth to nineteenth century Holland concluded that variations in weather, even in the midst of the Little Ice Age, seemed to have little if any discernible impact in this particularly well documented case. A study of late eighteenth century Brittany by Sutherland (1981) likewise stressed the success of social buffering in smoothing medium-term climatic stresses. Comments by de Vries on the often referenced studies by Post (1977) and Pfister (1975, 1981) and Post's (1980: 721) rejoinder are all well worth consulting.

These negative or mixed results of climate-impact investigation in the world's most intensively studied historical region have led to some very cautious statements by historians and geographers still deeply committed to environmental history and climate study:

> . . . I am so far from regarding climatic change as of supreme importance to agricultural change that I consider it altogether subordinate to other factors [in particular to social and economic factors for change (Parry 1978)] and I thus hope that I shall not be taxed with embracing a notion which I look upon not merely as false, but as preposterous and absurd (Martin Parry 1981:16).

> . . . we conclude that the complex interrelationships between various parts of society make the detection of climatic impact extremely difficult, while in many historical situations climatic factors may be dismissed as of negligible importance (Wigley et al. 1981:3).

However, the very mercantile activities which provide so much of the rich documentary record for Holland, France, and England during these centuries may be themselves a symptom of what Bowden et al. (1981) describe as a "shedding" mechanism, whereby core states under stress shed the cost of climatic impact onto distant peripheries. The relatively developed nature of these core polities of the Wallersteinian World System (Wallerstein 1974) certainly provided Dutch burghers ready access to North Atlantic cod, Baltic grain, and tropical spices and beef by the local worst of the Little Ice Age around 1690. So if we see no clear climatic impact in these temperate zone centers of political and economic development, perhaps this is due to complex economic webs touching many distant markets. It might thus seem more productive to look at smaller, simpler societies closer to the climatic and social margins.

Northern Cases

If we turn to the Arctic and Subarctic, and particularly to the Eastern Arctic-North Atlantic region, there is no shortage of studies documenting the constraining effects of a cold and changeable climate on marine and terrestrial ecosystems exploited by local humans. Correlation of climatic change and culture change is commonplace in the literature, and has been used to explain changes in house form (Pedersen 1974; Schledermann 1976), local settlement expansion and contraction (Thorarinsson 1956, 1961; Parry 1978), and large scale movements of cultures and peoples (McGhee 1969/70, 1972;

Dekin 1972; Fitzhugh 1972; Stanford 1976; McGovern 1980/81).

There can be no question that relatively minor shifts in northern hemisphere temperatures can have marked impact in these latitudes, and few would imagine that phenomena like the presence or absence of summer pack ice would pass unnoticed by ancient residents. However, even in this region there has been a definite shift away from simple climatic correlation explanations in recent years. In part, this reorientation has sprung from the archaeological documentation of the range of adaptive strategies actually practiced in this supposedly restrictive zone. In part it is based upon growing sophistication in the use and interpretation of available climatic indicators. In the early 1970s it was less widely recognized that a paleoenvironmental indicator whose finest scale of resolution may be measured in centuries tells us little directly about human adaptive strategies played out on a scale of decades. As in other regions (cf. Gunn and Crumley 1986), far more attention is now being paid to matching of temporal and geographic scales.

As in climate history, there has also been a growing dissatisfaction in the North American Arctic with the notion of correlation as explanation, significantly felt most strongly by some of the very scholars whose early work most directly linked environmental and cultural change. Both McGhee (1981) and even more explicitly Fitzhugh (Fitzhugh and Lamb 1985) have questioned the deterministic assumptions of early models:

> These relations merely enhanced the possibility for culturally induced change across a very broad ecological and cultural frontier. As we learn more about the archaeology of Labrador, it appears that social and economic factors must be given a larger role in interpretations of cultural and territorial change (Fitzhugh and Lamb 1985:367).

In the North Atlantic, critics also have attacked early models which saw human settlement as a wholly dependent variable dominated by an admittedly overbearing climate. In Iceland, recent research has shown that the documentary data bases underlying sea-ice models like Koch's (1945) often-cited study are wholly unsound (Bell and Ogilvie 1978; Ogilvie 1981b). At the same time, the Icelandic scholar Gisli Gunnarson has strongly attacked both the theoretical and methodological underpinnings of climate history as applied to the Icelandic case (Gunnarson 1980). Astrid Ogilvie takes a more hopeful view of long-range possibilities—if correlation as explanation can be abandoned and a far more critical and rigorous approach to the historical sources adopted (Ogilvie 1981a, 1985, 1991; see also Durrenburger and Palsson 1989; Bigelow 1984, 1989, 1991; Sveinbjarnardottir et al. 1981, 1982, 1983).

Thus, the news from both the well-documented core and the northern peripheries is not particularly favorable to the notion that one can reliably predict human response from a knowledge of climatic variables alone, or that arguments from simple correlation can explain any such reaction, in prehistoric or in recent contexts. Thus statements like "it got cold and they died" are just not very useful, even if literally true.

Approaches to Linkage

Since it still seems instinctively reasonable that climate change and culture change *must* be connected somehow, many scholars in both climate history and northern archaeology have been searching for more rigorous ways of establishing linkage between climatic event and human economy.

The geographer Martin Parry has long championed a "retrodictive strategy" which involves the analysis of:

(1) the relationship between time, scale, and causality in climate-farming interactions;
(2) analogous crop-climate processes in the present;
(3) the relationship between weather variability and farming decisions; and
(4) changes in agro-climate (Parry 1981:6).

His work on farm abandonment in the Lammermuir region of the Scottish borders (esp. Parry and Carter 1985) provides an excellent example of the way in which modern crop tolerance data and documented climatic change on a yearly to decadal scale can be mapped onto a specific local topography, where predictions of chronic crop failure and eventual farm abandonment can be tested through rent records and field survey. In effect, this approach calls for the creation of a model of expectation based on current weather and resource data, allowing the researcher to "retrodict" periods and specific locations likely to experience hard times under certain clearly-specified situations. With such well-defined expectations of what would be likely to impact whom where and to what degree, we are certainly in a far better position to take a harder and more productive look at correlations between climatic and cultural change.

However, such models of expectation are no end in themselves, and they gain power and respectability only through regular contact with well-developed case studies supported by multiple, logically independent data sets. While case studies are not a substitute for general theory (Gunn and Crumley 1986), they are a vital necessity if debate on climate impact and social response is to progress beyond vague generalization. More information on climate response is desperately needed from a range of areas and periods, as we now are far from certain when and if small, isolated societies are more vulnerable to adverse impact than large and complex ones. This would appear to involve just the sort of conjunctive, environmental archaeology popularized in the 1960s–1970s, combined with the currently more fashionable concern for boundaries, long-range interactions, and politics.

The Case of Norse Greenland

For the past ten years, our team has been working on the problem of the Scandinavian colonization of the North Atlantic, with a special focus on Norse Greenland. This work has followed in the footsteps of a number of Scandinavian scholars, drawing on Greenlandic archaeological work dating to the end of the last century (Bruun 1896, 1917, 1918; Degerbøl 1929, 1934, 1936, 1941, 1943; Nørlund 1924, 1930, 1936; Nørlund and Stenberger 1934; Roussell 1936, 1941) and coordinating with many modern workers (Albrethsen 1982; Albrethsen and Keller 1986; Andreasen 1980, 1981, 1982; Christensen 1991; Halldorsson 1978; Olsen 1982; Gad 1982; Keller 1991, n.d.; Meldgaard 1977, 1982; E. L. Andersen 1982; Fredskild 1973, 1982; Stoklund 1982; Vebaek 1956, 1958, 1962, 1964, 1965, 1982, 1991; Schledermann 1982; Gulløv 1982; Weidick 1982; Hatting 1982; J. Andersen 1982; Krogh 1982a, 1982b; Berglund 1973, 1982, 1986; Møhl 1982; Sørensen 1982; Ostergaard 1982; Kleivan 1982; Jansen 1972; Buckland, Sveinbjarnardottir et al. 1983; McGhee and Einarsson 1983; McGhee 1984).

This research has provided us with a reasonably complete pattern of Norse sites, a number of useful zooarchaeological collections, and what little documentary evidence we are ever likely to have from the lost colony. This material has been discussed at length elsewhere (McGovern 1981, 1985a, 1985b, 1990, n.d.; McGovern and Jordan 1982; McGovern and Bigelow 1984; McGovern, Buckland, et al. 1983), and will be swiftly summarized here before we approach the topic of climatic impact.

Settlement/Subsistence Patterns

Most of Greenland is barren rock and ice. What green spots there are can be found at the heads of a few of the deep fjords of the southwest, and these ecological pockets are the only parts of the great island suitable for imported European domestic animals. If European settlers were to maintain the general pattern of North Atlantic herding/farming, they would have to be permanently limited to these few regions.

Within the pockets, there is great variation in vegetation, with some patches which are quite lush. These pastures were claimed by Eirik the Red and the other *Landnamsmen* (pioneer settlers: chieftains). Outside these most favored steadings, things get grimmer rapidly, and the poorer farms' pastures are poor indeed. Nevertheless, our fairly complete survey data and a few radiocarbon dates indicate that even the most marginal sites in the inner fjord pockets were occupied, probably within a generation of *Landnam*, or first settlement (Keller n.d.; McGovern n.d.).

The limited pastures of the inner fjords were probably never enough for a fully Icelandic-style agriculture, so the Norse also exploited a range of seals and the local caribou. Available faunal evidence (summarized in McGovern 1985b) and recent survey work (McGovern and Jordan 1981, 1982; Christensen 1991) indicate that both the spring harp sealing and the autumn caribou hunts were highly communal in character, involving drives, caches, and fairly extensive interfarm exchange. The spring sealing must have been particularly critical, providing a supply of meat and fat sorely needed after the long winter, when stored meat and dairy produce must have regularly run short.

In addition to subsistence economy, the Norse collected a cash crop—walrus ivory and hide. This *Nordrsetur* hunt (discussed more fully in McGovern 1985a) required a long and hazardous trip far north of the Norse settlement areas, and probably contributed little directly to subsistence. We do find bits of walrus skull from around the tusk root on the home farms (especially the larger farms), and a few ivory chips left from tusk extraction, but the tusks themselves all went to Europe in exchange for imported items, mainly iron and wood. Distant as it was from European markets, the Norse colony was a part of interregional trade networks.

Social Hierarchy

The unequal nature of West Greenland's patchy vegetation would tend to make some farms persistently more productive and more resilient in the face of extreme weather conditions than others. We would have reason to suspect some inequality in Norse society on ecological grounds even if there were no other evidence for social hierarchy.

However, we do have abundant documentary evidence for clearly defined ranking at first settlement, and if events followed the better-documented Icelandic case, the century and a half following *Landnam* would have seen plenty of exploitation of paupers, widows, and orphans, subversion of levelling mechanisms, voiding of chiefly social contracts, and escalating warfare as ambitious chieftains sorted things out in a fully-settled environment with little potential for further colonization (Sveinsson 1953). In Iceland at least, more and more people got deeper and deeper in debt to fewer and fewer great families. Households slipping from freeholding to tenant status also lost the right to participate in the local or regional assemblies, and

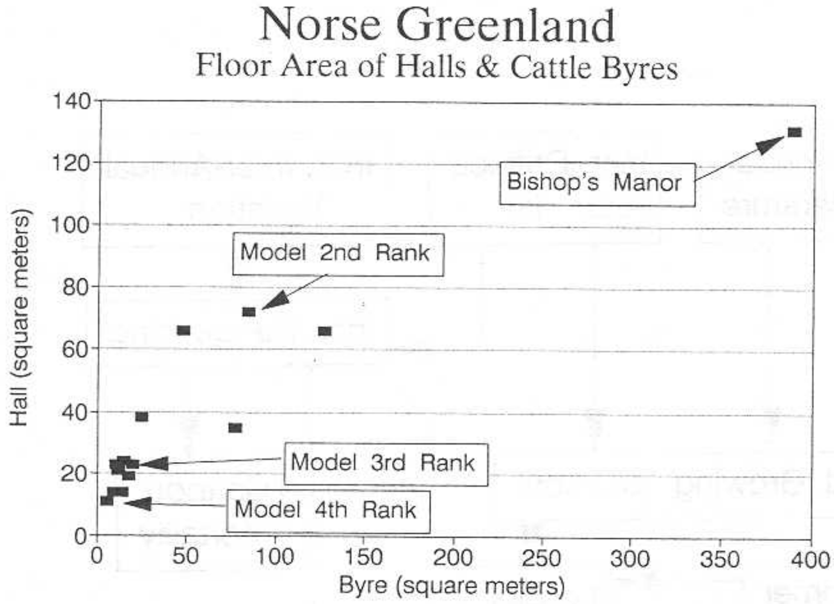

Figure 1. The interior floor area of excavated Norse ruins has been used as a measure of site rank. Hall area is a proxy measure for "human space," while cattle byre area is a proxy measure for "cattle space." The bishops' manor at Ø47 Gardar was far larger than any other Greenlandic site by all architectural measures.

to make any pretense of affecting the ways the settlements were run (Durrenberger 1985, 1991).

After 1264, both Iceland and Greenland became part of the Norwegian state, but perhaps more important was the establishment of a bishop (imported from Norway in exchange for a live polar bear, cf. Jones 1985) at Gardar in Greenland in 1127. Bishop Arnald and his successors (all Europeans direct from the continent rather than native sons) seem to have won the labor if not the hearts and minds of the Greenlanders in a spectacular fashion. The small turf churches of the early years were replaced by large stone ones, modeled directly on the latest continental designs and complete with imported stained glass, bronze church bells, and a horrific consumption of prime building lumber in this timber-poor landscape (Roussell 1941). To give an idea of relative scale, the cathedral of St. Nicholas at Gardar was nearly as large as either of the cathedrals of Iceland, nor was it the only major stone church in Greenland. By best estimates, Iceland's population was around 40,000–80,000 at this time, while Greenland's could never have been more than around 5000–6000 (McGovern 1981).

From a single surviving episcopal steward's account (Bardarsson in Gad 1970) we know that the church owned or controlled about two-thirds of the best land in Greenland by the mid-1300s (but also see Keller 1991 and Arneborg 1991, who argue for a more powerful role for secular chieftains). The bishop (or his secular backer) thus seems to have had both the mortgages and the souls of the majority of the Greenlanders in his keeping by the later phases of the Norse colony. Our archaeological floor area data certainly supports the economic and architectural importance of the bishop's manor by the later phases of the settlement (Fig. 1).

From our available documentary and archaeological evidence, we can thus model a small, but sharply hierarchical society supported partly by native and imported terrestrial species in the inner fjords, partly by marine resources of the fjords and open sea, and partly by a long-range hunt for arctic luxury goods and the transatlantic trade that hunt fueled. How did the transition from Little Climatic Optimum to Little Ice Age affect this small community and its tripartite economy? What portions of the Greenlandic Norse economy (and society) would have been most affected?

Expected Impact Models

It would be methodologically elegant if we had made up our model of expectation, generated some testable implications, and then systematically gathered zooarchaeological, locational, architectural, biogeographical and documentary data to carry out critical tests. However, our research followed no such neat progression, and most of the models that follow were *ad hoc* attempts to make sense of rich, but complex data sets collected under somewhat simplistic initial assumptions. Thus the integrating models presented here are a series of rough and unevenly quantified first attempts, which we are actively attempting to improve.

Following our analysis of the Norse economy and society, we thought it productive to investigate terrestrial and marine resource impacts separately, and to keep the hierarchical structure of medieval Norse society firmly in mind when investigating variation in farming strategy.

The impact of climatic change on Greenlandic biota has been much discussed for many years, as short-term fluctuations have had significant economic as well as ecological effects readily apparent to observers of all sorts (see Vibe 1967, 1978; Mat-

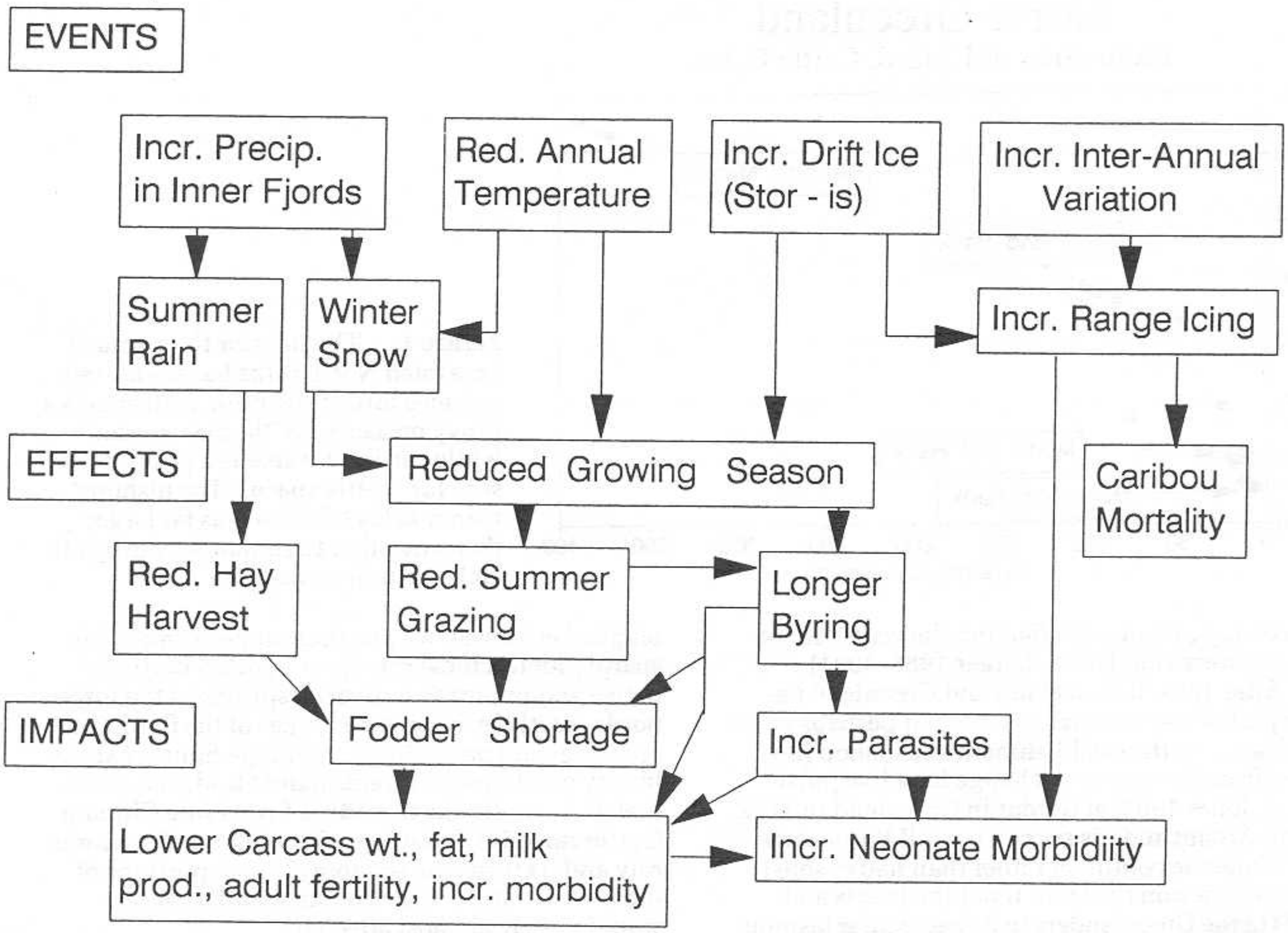

Figure 2. A simplified flow chart identifying the major linkages between climatic events, their effects on local resources, and their expected impact on components of the Norse economy.

tox 1973; M. Meldgaard 1986 for bibliography and review). Changes in overall Northern Hemisphere temperature translate, in Greenland, into shifts in ocean current circulation, which bring greater or lesser amounts of cold East Greenlandic water and ice up the west coast, and shifting air circulation patterns, which tend to reinforce or erode the distinction between continental inner fjords and oceanic coast (Böcher 1954). Shifts between equilibria are often rapid and abrupt. Different portions of the west coast are sometimes affected in concert by the same shifts, sometimes reactions are out of phase.

The two Norse settlement areas appear to have somewhat different controlling variables. The smaller, more northerly, Western Settlement is significantly more restricted to the continental inner fjords than the Eastern Settlement, which reaches well down several of the complex fjord systems of Narssaq and Qornoq Districts. The contrast of maritime outer fjord and continental interior also appears more marked in the Western Settlement, while drift ice seldom reaches the region. The Eastern Settlement area by contrast is much more open to the sea and to the influence of drift ice from East Greenland (the modern *stor-is*). While we will tend to lump discussion of impact in the two settlements, it is well to remember that more detailed research is likely to reveal significant differences in both vulnerability and impact in the two communities.

Terrestrial Impact Models

Figure 2 presents an attempt to identify the kinds of Little Ice Age (LIA) short-to-medium term weather events which would have had direct or indirect effects on the terrestrial portion of the Norse economy as we now understand it. The figure indicates at least the major avenues of possible impact, and owes a great deal to the careful documentation of actual LIA impacts in Iceland carried out by Astrid Ogilvie (1981a, 1981b, 1991), studies by teams led by Paul Buckland, and Gúdrun Sveinbjarnardóttir (Buckland 1988; Buckland, Sveinbjarnardóttir, et al. 1983; Buckland and Perry 1989; Buckland et al. 1991; Dugmore and Buckland 1991) and by an Ice-