'Landscape, people and climate are three factors which are inextricably linked, an understanding of the course of recent environmental change requires an analysis of not only the elements themselves, but also of the way in which each influences the other.' (M Bell and MJC Walker, 2005)

Discuss, with particular reference to early-mid Holocene prehistory and the Neolithic Revolution.

Studies of the Quaternary, or palaeoscience, is becoming increasingly viewed as a key component in the assessment, understanding and modelling of modern socio-ecological systems that trace the interaction of humans, landscape and climate; Simmons (1989) writes: 'the sequence of the Holocene provides a unique opportunity to understand episodes of human activity in the context of changes in landscape and environment[al instability]. In this sense the Neolithic revolution - the origins of agriculture (circa. 15,000-10,500 BP) - emerges as a critical juncture in the relations between Man (culture), landscape (the medium) and climate (nature). Several historical narratives (Roberts, 1989; Westropp, 1872) posit the Revolution as the definitive moment of rupture between humans and climate, the former (increasingly) affecting the latter (humans on climate: through (agricultural) alteration of atmosphere and land use) and the latter (decreasingly) affecting the former (climate on humans: through postglacial warming/amelioration in CO2 conditions.) These narratives reiterate a mantra of dualism between humans (culture) and environment (nature), wherein humans are seen as (i) pathological and disruptive of the natural order (ii) progressively transforming and 'producing nature(s)' (Marxism) (iii) ecologically dominant resulting in the enculturation of environments and (v) emergent out of the Neolithic.

Fundamentally, this essay critiques the binary suggesting that by setting people apart (rupture) from nature, there increases a tendency to explain environmental changes in either natural or anthropogenic terms. The impracticality, or myopia, of such praxis is however illustrated in the concept of equifinality: 'the impossibility of distinguishing between many possible histories from different possible initial conditions and different possible process mechanisms on the basis of the available evidence.' I thus argue that dualistic histories, whilst largely legitimate, interpret the Holocene in a deterministic way that forecloses other possibilities (in both interpretation of the past and implications for the future). I explore several, dominant western narratives of dualistic thinking on the Neolithic Revolution (i) environmental determinism (Oasis theory, population growth hypothesis, CO2 Limitation hypothesis) and (ii) humanism (the Ruddiman Hypothesis). I then propose an alternative, or more so an enhancing of these ideas to an inclusion of 'possibilities'. Rather than seeing people, landscape and climate as separate, or in duel, I suggest a praxis of coevolution, a dynamic ecology - cognisant of the interlinkings and the meshwork of actants (ANT) - wherein 'each may be responsible for modifying the other, giving rise to conditions of increasing interdependency' (Bell et. al, 2005).

I show how this model of co-evolution (multiple and diffuse agencies) was realised in the very rubric of Neolithic Revolution as a spatially heterogenous and emergent 'mode of production [with] no single point of origin' (Roberts, 1989). This diffuseness on one level reiterates the significance of climate (post-glacial amelioration) in effecting relatively abrupt and universal change in human (societal) behaviour. More subtly, however it presses on the French school of possibilism (as middle ground between environmental determinism & humanism) and the idea that human societies may respond in a variety of (localised) ways to the influences of the physical environment ('there are no necessities, but everywhere possibilities; and man, as master of the possibilities, is the judge of their use' (Febrve, 1932)). Borrowing from current discourse in Environmental Geography and the clamour to create a republican epistemology or, 'open society' (1984) wherein 'all knowledge claims - scientific and non-scientific, western and non-western - are integrated, I suggest that modes of possibilist thinking might offer new vistas in our understanding of human-landscape-climate interaction within the Quaternary. In this vein, 'fine high resolution studies of localised changes (I explore Denmark) are far more likely to advance our understanding of abrupt environmental influences on behavioural innovations than broad scale analyses of generalised behavioural change (Oasis theory) only causally linked to climate change through temporal coincidence' (Brown et. al, 2009).

Farming began independently in several parts of the world, Vavilov (1987) identifies seven 'centers of origin' of domesticated plants. Archaeological evidence has been uncovered to suggest very early experimentation with planting and harvesting from Egypt around 12,500 BC and from southeast Asia around 10,000 BC, before the appearance of numerous farming villages in many parts of South West Asia (Iraq, the Fertile Crescent) between 7000 and 5000BC where the major crops were wheat, barley and legumes. The invention of agricultural systems in the Americas - based on maize, beans, squashes and potatoes - is dated somewhat later between 5000 and 3000 BC. Colledge (2009) places these several independent 'centers of origins' within a timeframe that recognises climatic (glacial-interglacial) oscillations, positing: the 'coincidence of climatic amelioration (post-LGM) during the late Pleistocene-early Holocene (c.15,000 - 10,500 BP) with the origins of food procurement and production points to a global limitation for domestication.' One hypothesis (Sage, 1995) proposes that a rapid CO_2 increase from 180ppm to ~270ppm during deglaciation caused a significant increase in growth rates of wild crop progenitors, thereby removing a productivity barrier to successful domestication: 'this increased productivity would have reduced the risk of a failed harvest allowing increased exploitation of a limited number of wild species, and a move away from the generalised foraging of a broad spectrum of plant foods, thus enabling the development of agriculture' (Sage, 1995).

Wright and Thorpe (1999) apply the CO_2 limitation hypothesis to a finer temporal scale (c. 13,000 to 11,500 BP) between the Last Glacial Maximum and Younger Dryas (a brief period of climatic disruption marked by a return to colder, glacial conditions). They suggest that the improved climatic conditions (warming) before the Younger Dryas

Table 6.1. Some Theories of the Development of Agriculture

General Theories	*Summary*	*References*
	Environmental Change	
Oasis theory	Environmental changes at the end of the Pleistocene forced people into a close association with certain plants and animals, leading to their domestication in some instances	Childe 1936, 1942
Hilly flanks theory	Intensive exploitation of the native grasses along the hilly flanks of the Tigris-Euphrates river valley led to domestication of those species in some areas	Braidwood 1960
Marginal environment	Due to increasing need for efficiency, people living in marginal environments would have been forced to intensively manage their plants and animals, resulting in their domestication in some instances	Binford 1968; Flannery 1969
Food crisis	Due to the loss of Pleistocene species hunted by people, people were forced to manage their remaining animals more efficiently, leading to their domestication in some instances	Cohen 1977
Wet and stable	Dry and unstable environment prevented agriculture during the Pleistocene, but environment became wetter and stable afterwards, leading to plant intensification, domestication, and agriculture	Richerson et al. 2001
	Population Expansion	
Population growth	As populations began to expand and demand for food increased, the exploitation of certain species intensified and led to their domestication	Cohen 1977
	Changes in Organization and Management	
Efficient hunter-gatherers	A particular efficient group of hunter-gatherers increased the yield of a particular resource, perhaps to the point of increasing dependence and ultimate domestication of that resource	Winterhalder and Goland 1997
Scheduling changes	Changes in scheduling in the exploitation of wild resources created an overreliance on some resources, eventually leading to domestication	Flannery 1972

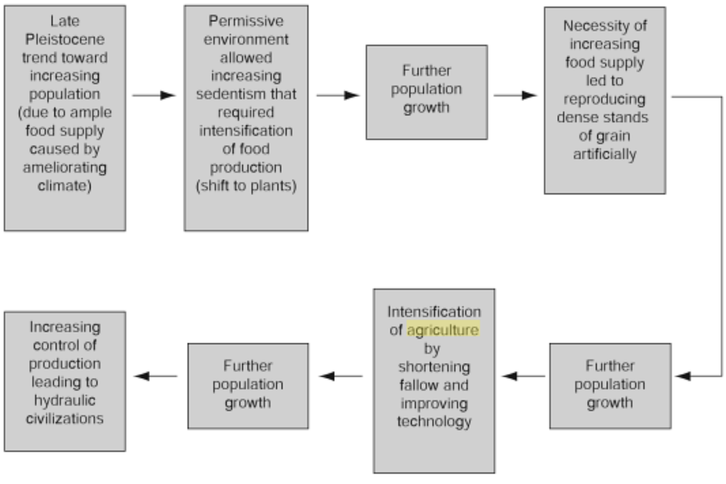
Theories of the Development of Agriculture (Sutton et. al, 2010)
Note the shift in emphasis from environmental determinism (top) to humanism (bottom)

episode facilitated population expansion before the Younger Dryas then forced these very populations to retreat into regions of refugia and to sustain the enlarged, sedentary population by cultivation of cropland. In the subsequent period after the Younger Dryas - marked by CO2 increase and the expansion of annual grasses - these communities flourished. Recent archaeological research in the Jordan Valley (Quintero et. al, 2003) supports the idea that drier conditions during the Younger Dyras forced populations to 'shrink and concentrate around permanent water sources (oases) [and] to sow crops they had previously harvested wild.'

This, along with the deterministic assumption that farming was natural and desired [by all hunter-gatherers] at first sniff of an opportunity' forms the basis of Childe's (1936) 'Oasis Theory'. It is important to reiterate the contentiousness, however, of Childe's 'oases' meta-narrative. New techniques in multi-proxy analysis (such as in dendrochronology, geochronology and sedimentology) deduct that the early Holocene climate of the Fertile crescent was erratic yet more warm and wet than dry, characterised by dramatic and rapid shifts of microclimatic conditions associated with the processes of deglaciation, sea eustasy/ isostasy and orogenesis. Sauer (1963) furthermore refutes Childe's vision of early agriculturalists as clustered around water sources in his own positivist account of its origins, he writes: agriculture 'would be found amongst societies meeting a number of conditions: (i) a flourishing economic base, relying on gathering more than hunting (as gathering would mean detailed knowledge of, and a pre-disposition to experiment with, plants), and on fishing (which would together allow them to be more or less sedentary) (ii) unexposed to any major river valley, where crop farming would be difficult because of flooding; (iii) exposed to wooded rather than open country, because woodland soils could be cultivated with simple digging tools and (iv) to a wide variety of plants, fish and animals. These conditions, Saeur posited, came together in south-east Asia. 'Oasis Theory' further proposes that early Neolithic Agriculture was a mobile, spatial practice, he writes: 'the nature of Neolithic agriculture favours movement, and the combination of semi-nomadic farming and rising populations took the Neolithic Revolution from South-west Asia as a movement of people (Neolithic farmers) westwards right across Europe to the Atlantic and Baltic, south from the Nile into Africa, and eastwards eventually into India.'

Zvelebil et. al (1986) move Childe's theory into possibilism, locating his diffusion model within three distinct transitionary stages in Europe: (i) the availability phase of agriculture (systems are known through contact but not adopted); (ii) the substitution phase (adoption and the emergence of an ecological, frontier zone in the south-west) and (iii) a consolidation phase (maturation of the socio-economic structures associated with agrarian community.) Early agriculture, in this sense, spreads throughout Europe not through sole (climatic) cause but as the result of interactions between climatic (crisis; Oasis theory) and human agency (communication, collaboration and exchange of ideas) within the medium of the landscape (Europe). Cohen (1977) goes a step further, removing the assumption of human willingness or desire to adopt agriculture. Rather he suggests - with Boserupian undertones - that the mass extinction of Pleistocene megafauna from climatic change (deglaciation) and over(kill) hunting led to a 'food crisis' that led to agriculture as a necessary adaptation of survival. He adds to the idea of 'food crisis' that of population pressure as a precondition in the development of agriculture. Cohen concludes observing the plasticity and flexible adaptation of these early, agricultural societies to climatic change, and in so doing, leans towards the 'co-evolutional' possibilist mode of thinking (attuned to the multiple intimacies and entanglings between Man, the soil and sky):

Characteristic	Effect of cultivators: Permanent (P) Shifting (S)
Energy Flow	S cultivators interrupt normal flows for finite period then allow successional flows to resume; but long-term vegetational change (e.g forest to savanna) may produce permanent changes in flows. P cultivators eliminate many natural flows and direct new ones to themselves. Quantity of energy going to animals is small in any system, so vegetarians get more nutrition per unit area: many traditional cultivators are more or less vegetarian with animal protein likely to come from fish.
Nutrient Cycling	Natural cycles often held 'tight' by vegetation - soil complex; agriculture usually increases potential for loss through runoff, soil loss and (to a lesser extent) through cropping. Most systems aim at replacing the nutrients, e.g. by forest fallow or bush fallow (S), fallowing as part of a rotative field system (P), manuring and/or use of night soil (P), folding of animals onto fields for manure (P), leading of silty waters onto fields (P), and *padi* construction with regulated water supply containing nutrients (P)
Biological productivity	Global average for agriculture is 650g/m^2/yr (current figure so pre-industrial agriculture presumably much less), which is same as a natural temperate grassland. Thus NPP is generally lower than that of natural vegetation which it replaces: smaller plants, growth season shorter, more space between plants are some of the reasons. But culturally acceptable crop is usually higher from same patch of land
Population dynamics (non-human populations)	Selective culling/extirpation of culturally undesirable species, labelled 'weeds' and 'pests', e.g non-edible plants for predators upon crop animal species. Crop species encouraged nutritionally and genetics gradually altered by selective breeding. Crop may provide favourable expansion for hitherto insignificant species to expand to 'weed' or 'pest' status
Successional stages	*P* agriculture is analogous to early successional stage with much bare ground, and tillage normally aims at keeping it that way. *S* agriculture may (especially in wet tropics) mimic tropical forest and aim to cover ground with growing plants or a 'mini-forest'. Abandonment of plots of either allows natural secondary vegetation to develop; this may colonise more or less to original vegetation if left long enough.



Population Growth Theory (Cohen, 1977 cited in Sutton et. al, 2010)

'the resilience [of early Neolithic peoples] 'varied [spatially and] contextually, dependent upon [environmental] conditions and the nature of the society, the rigidity of its social organisation, its technology and population structure, and capacity for dissemination of knowledge' (Cohen, 1977).

The Neolithic Revolution is often conceptualised as a moment of grand historic change in the relations, or interactions, of Man and his environment. Here, I explore several of these narratives before suggesting a more dynamic ecology which integrates multiple actants - of climate, land and human - rather than framing post-Neolithic history through the acts of a sole actor - Man. Several scholars (Oldfield, 2003; Ruddiman, 2004) skirt with the idea that the Neolithic signified a fundamental yet subtle exchange - from climate to humans - of the capacity to transform and modify the landscape, Ruddiman (2004) writes: environmental changes brought about by natural agencies such as climate essentially diminish in amplitude as one moves forward in time...human impact on the environment has increased progressively since the [transformations] of the Neolithic.' Oldfield (2003) furthers this, positing: 'human activity...has begun to reshape the Earth system, not only through systematic impacts on the composition and concentration of atmospheric trace gases, but through the cumulative effects of land clearance, soil erosion, salinisation, urbanisation and a myriad of other impacts.' Roberts (1989) conceptualises the changing relationship of Man and his environment, from hunter-fisher-gatherer to agricultural and urban-industrial systems. Cultural landscapes associated with modification of the environment, appear with agro-ecosystems, and are the period of the Holocene when human influences (H) are seen to override environmental ones. Ruddiman (2004) proposes that since the Neolithic Revolution, human activity has altered the natural atmospheric budgets of carbon dioxide (through extensive slash and burn agriculture and deforestation) and methane (through irrigated rice farming and livestock production) commensurately enough to delay a glaciation.

Ruddiman draws further empirics of the close relationship between human (agricultural) activity and atmospheric CO2 concentration from census records positing that, in 'periods of pandemic - Bubonic plague in Europe, Arabia and North Africa in 540-590 AD - CO2 levels fall in close correlation with the levels of abandonment and subsequent non-occupation of farmland.' Accounts of human-landscape interaction during the Neolithic are further suffused with a sense of Man's pathological and disruptive presence in the land. Roberts (1989) explores how the selectivity of early agriculturalists - their choosing of the most productive, efficient and manageable strains of crop and animal - has decreased ecological diversity and bred sub-climatic, neutered monocultures.

Much of the content of these accounts cannot be refuted, indeed it is a historical truism that man has affected, often detrimentally, the post-Neolithic landscape(s) and climate. However, the epistemological framework it applies to reach these conclusions is contentious, foreclosing possibilities and the actings of non-human agencies. Ruddiman's (2004) analysis, as such, might be regarded as a reiteration of the dualism between humans (culture) and climate (nature) because it explains environmental change narrowly, and in strict terms of a single, anthropogenic actor. In a sense, this epistemology can be traced back to (i) Marxism and the supposition of the rise of Man and (ii) early western conceptions of pristine nature and 'transported landscapes.' Ruddiman's ideas, for instance, placing Man as sole actor and aggressor in the atmosphere is embedded in the Marxist idea of the '[capitalist] production of nature', Smith (1994) writes: 'increasingly at scales from the atmospheric to the genetic, the material natures of everyday life are increasingly transformed either by intentional manipulation for the purposes of commodity production (e.g. genetically modified crops), or by the myriad ecological impacts of industrial, capitalist activities and related processes (e.g. the deposition of persistent organic pollutants in Arctic and Antarctic ecosystems.'

These Promethean discourses - which inflect much of Post-neolithic research on human-landscape-climate interaction - as such, downplay the productive capacity of biophysical processes and the agencies of 'more-than-human' actants. Secondly, 'the epistemology of single actant' is reinforced by historical conceptions of (pristine) nature, Bell et. al (2005) write: 'in debates over human transformations of the Earth, writers have traditionally distinguished between old lands such as Africa, where humans co-evolved with other parts of the biosphere, and newly colonized parts of the world. Human colonization of new lands theoretically provided the laboratory experiment about human transformations of those environments, Sauer's 'datum line'' (Bell et. al, 2005). In such key, there is a tendency within historical (western) narratives to classify landscape change in strict terms of anthropogenic impact - of (Marxist) Man, the single actor/disturber of pristine nature - rather than of landscape change as the result of multiple actants/disturbers - both non-human (climate) and human (agriculture). Lamb (1995) further contends that - much like the idea of Man as 'triumpher' over Nature, these 'new lands' or laboratories of experiment were in fact not unpopulated but long occupied by pre-Neolithic hunter-gatherers: '[in Britain] human occupation during the Early Middle Pleistocene (EMP) occurred in a range of climatic and environmental niches, although the earliest definitive episode of occupation, Pakefield, occurred in association with a period of extreme warming.'

Rather than seeing people, landscape and climate as separate - and attempting to 'decouple' or 'disentangle' causes - I thus suggest a praxis of coevolution, a dynamic ecology - cognisant of the interlinkings and the meshwork of actants (ANT) - wherein 'each may be responsible for modifying the other, giving rise to conditions of increasing interdependency' (Bell et. al, 2005). In this vein, much ecology has re-placed the emphasis, not on finding a single cause, or actor, but on the roles of multiple disturbances; of disharmony, threshold and chaos. Furthermore, as I suggested in the introduction, the Neolithic revolution itself was produced through these multiple and diffuse (human and non-human) agencies. Moving away from the myopia of dualistic thinking, one begins to see how early African agriculturalists co-evolved with the landscape as 'shifting cultivators [making] use of natural forest gaps and vegetation dynamics or how certain plants and animals of the Neolithic (dung-heap theory) 'elected' to live near humans rather than human subjects knowledgeably selecting species for domestication. The entanglings of human-landscape-climate interactions - where each, often commensurately, affect the other - are exposed in Lewis et. al's (2009) account of Denmark: Linking Sea and Society: did environmental change force the Mesolithic-Neolithic transition in Denmark? They write of the natural affinity that early, Danish peoples held with the sea and the eventual adoption of agriculture was withheld until almost the very days that the sea stopped giving. In this sense, a truism is illuminated, humans (and non-humans) do not experience climate change but a sequence of (local) meteorological events or weather.

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