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FEATURE ARTICLE

HUMAN RESPONSES TO LATE QUATERNARY CLIMATIC CHANGES IN CENTRAL SRI LANKA

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The environment of the late Quaternary 24,000 yrs BP (Before Present) (i.e. late Pleistocene and Holocene) in Sri Lanka as experienced by the Mesolithic, Neolithic and Early Iron Age communities were different from today. Man's effect upon his environment was considerable during the late Pleistocene. However, more technologically advanced groups of people were stimulated to exploit new opportunities as they moved into new ecozones during the late Holocene. An attempt was made to reconstruct the palaeoclimatic sequence with radiocarbon dated multi-proxy data at a mire in the Horton Plains, central Sri Lanka. Since the end of the Last Glacial Maximum (LGM),approximately 18,000 years ago, the Indian ocean Southwest monsoon strengthen in stages during the late Pleistocene and early Holocene.

Late Pleistocene hunting, gathering and farming activities (24,000-10,000 yrs BP)

Between 24,000 and 18,000 years BP, the landscape of the Horton Plains was probably open with a prevailing semi-arid climate as indicated by pollen, stable carbon isotopes ($\delta^{13}C$) and Total Organic Carbon (TOC) records. The vegetation composition deduced from the pollen data and soil forming processes detected from mineral magnetic properties suggest that the population of the area consisted of nomadic groups of hunter-foragers. It is possible that this life style could have dominated due to the low carrying capacity (i.e. lack of rain forest) in the Horton Plains as well as in most parts of the island during the LGM. It is thought that they settled in small camps in different environments ranging from the damp and cold high plains (e.g. Horton Plains) to the lowlands (e.g. Mannar). Multi-proxy records (e.g. pollen, phytolith and TOC) from Horton Plains indicate that herding (*Bos indicus*?) and the incipient management of cereals (i.e. oat and barley) occured to some extent from 17,500 yrs BP onwards. Frequent burning and forest clearances (i.e. slash-and-burn) by prehistoric people may have contributed to the expansion of patanas in the Horton Plains. This also coincides with a semi-humid event (17.6 -16 ka BP) suggesting favourable climatic conditions (i.e. warmer/humid) influencing the plant management system. Multi-proxy records also indicate that the incipient management of oat and barley continued for a period of 4.5 ka BP (17.5-13 ka BP). During this period, prehistoric humans developed advanced techniques and practices for plant domestication. In the Horton Plains, environmental factors such as climate and soil forming processes coincided with incipient and succeeding land use. It is also suggested that the time lag (i.e. 4.5 ka BP) is reasonably long to consider that the origins of agriculture indicated a macro-evolutionary experiment.

Early Holocene farming

Pollen proxy records obtained from Horton Plains show that the systematic cultivation of oat and barley appeared around 13 ka BP, which is synchronous with similar records obtained from east and west Asia. It is suggested that prehistoric cereal cultivation spread to the south Asian region at the same time. The cultivation of oat and barley continued between 10 and 9.5 ka BP, associated with more humid conditions around 8.7 ka BP. Subsequently, towards the end of the early Holocene, cultivation became sporadic and decreased in the Horton Plains. This may indicate temporary habitations and/or shifting patterns of cultivation as shown by variation of pollen and mineral magnetic records. The decrease in cultivation can be explained by a gradual increase in aridity, which started around 8.6 ka BP and lasted until the end of middle Holocene i.e.3.6 ka BP.

Middle Holocene farming

During the middle Holocene (8-3.6 ka BP), a significant reduction of cultivation in the Horton Plains which is also in good agreement with the very abrupt decrease in the rain forest components implying unfavourable environmental conditions, i.e. persistent aridity. Observed palynological hiatuses appear to be consistent with the most prominent climatic change (i.e. severely increased aridity) between 5.4-3.6 ka BP. Thus, these multi-proxy data indicate a very significant reduction in south west monsoonal rains in the region. It is suggested that repeated severe drought cycles may have initiated a downward habitat trekking of agrarian communities of the Horton Plains, probably re-locating to the lowland areas in Sri Lanka. This severe drought period is probably the result of climatic conditions that prevented the Inter Tropical Convergence Zone (ITCZ) and its associated rainfall belt from penetrating far north. In south and west Asia, intensified aridity around 4 ka BP badly affected the Old World societies e.g. Mesopotamia and India.

Late Holocene farming

The Horton Plains area was subjected to very limited human activities at the beginning of the late Holocene (i.e. 3.6 -2.9 ka BP). This is indicated by the few sporadic findings of cultivated cereal type pollen together with the other supportive proxy records. The significant increase in the rain forest components implies a prevailing humid climate and a lower grazing pressure on the forest due to a decrease of cultivation. Thereafter, the cultivation activity was completely abandoned for 800 years as indicated by the lack of cereal type pollen. Uniform patterns of the mineral magnetic variation is probably the result of an absence of disturbances around the site. The last stage of cultivation in the Horton Plains has been postulated for the period between 2 and 0.15 ka BP. Most of the areas in the Indian sub-continent have been subjected to a settled farming system as a basic subsistence strategy during the late Holocene. Palaeobotanical evidence for these systems includes findings of cereals and other crop cultivation from 3.2 ka BP to modern times.

The earliest manifestation of the early iron using communities in Sri Lanka is radiocarbon dated from around 3,000 ka BP onward at sites located in lowland areas (<900 m a.s.l.) e.g. Anuradhapura and Sigiriya. The early iron using communities of Sri Lanka, 3-2.5 ka BP, is referred to as the transition from prehistoric to historic times. This transition is characterised by breeding of horses, practising of iron production and rice cultivation. This period is obvious in the lowland areas of the island and in much of the Indian sub-continent, suggesting an expansion of agricultural activities with advanced pottery, mortuary practices and irrigation techniques. These data imply that the prehistoric farming settlements in the Horton Plains (i.e. highland) were gradually re-located around 2.9 ka BP to the lowland areas, following the climatic regime.

It is reasonable to assume that the South West Monsoon (SWM) became stronger between 3.6 and 2 ka BP, indicated by the multi-proxy records obtained from the Horton Plains. According to the geomorphology of the island, the increased water budget received from the SWM could have been properly managed with the large-scale irrigation works which started around 2.4 ka BP at Anuradhapura. This intensified the rain-fed agriculture (e.g. rice) in the lowland areas of the island. This surplus of water, however, could not be utilised in the highland areas due to physiographic and technological barriers. Thousands of tanks and canals were built all over the lowlands during the rule of several kings of the Anuradhapura and Polonnaruva kingdoms. Between 1.6 and 0.8 ka BP, a most sophisticated hydraulic civilization existed, which served as a great economic foundation for a diversified agriculture. This strategy includes several cereal crops e.g. rice, millet and finger millet, but not barley, oat and wheat, mainly due to a lack of temperate climatic conditions in the lowlands. The last stage of cultivation, mainly of wheat, started in the Horton Plains nearly synchronous with the time of the start of irrigation techniques in Sri Lanka.

In short it is concluded that pollen records, plant opal phytoliths, TN, TOC, $\delta^{13}C$, C/N ratios, and mineral magnetic measurements, together

with radiocarbon dates on a peat sequence obtained from Horton Plains of central Sri Lanka, provide a framework to study land-use changes during the last 24,000 years. The different proxies show that the hunter-foragers in central Sri Lanka had a nomadic life style until around 17.5 ka BP in an open landscape associated with xerophytic vegetation *viz*

- incipient cereal plant management started around 17.5 ka BP.
- slash-and-burn activity, forest clearances and grazing have been applied.
- cultivation of oat (*Avena* sp.) and barley (*Hordeum* sp.) started ~13,000 ka BP. Wheat (*Triticum* sp.) was introduced around 2 ka BP.
- post-LGM and late glacial climatic ameliorations favoured the early development of cultivation while middle Holocene aridity caused a decrease.