Archaeology use cases for palaeoclimate data

This document contains draft user scenarios and use cases for palaeoclimate data usage within archaeology.

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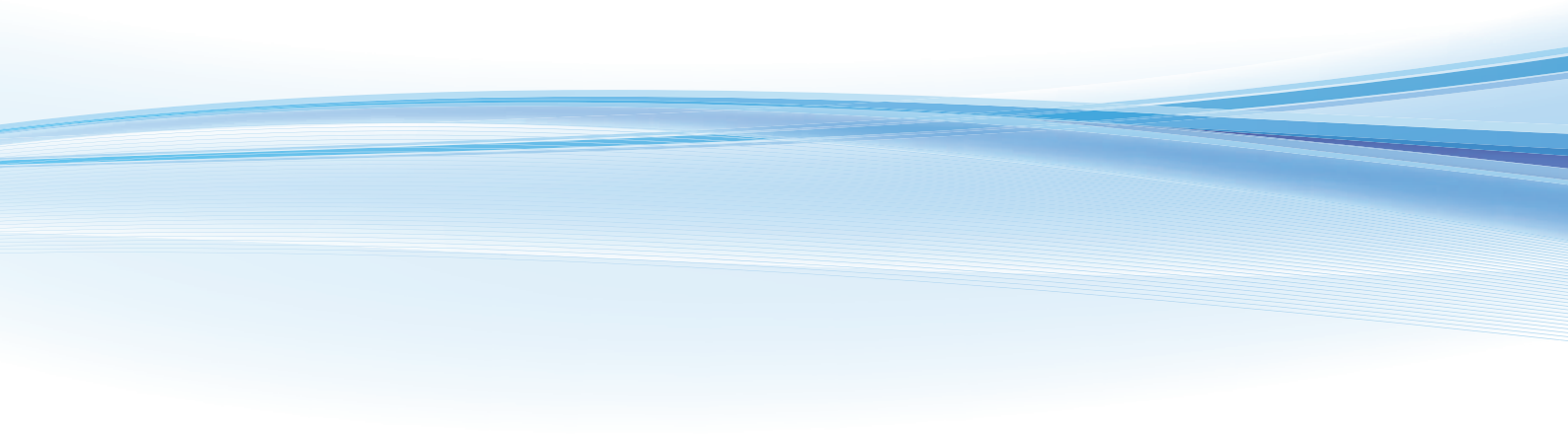


Palæoclimate Data
Functional Analysis :
Archæology

Executive summary

This document presents a number of user scenarios and use cases developed to support the archæology community's use of palæoclimate simulation and historical data.

The use cases presented are used as a source of functional requirements for PEG-BOARD metadata and API developments.

This information is currently (Feb 2011) being circulated for comments, and will be published following any requested amendments.

Introduction

Archaeology is a broad and complex subject that draws upon many external sources. Its interdisciplinary nature reflects the fact that many aspects of the ancient world – culture, environment, biology, geographical and social context – are likely to have had an impact on the way in which practices and communities alter and develop. The archaeologist is faced with a certain amount of evidence, often fragmentary and prone to complexities of interpretation and apparent contradiction, from which to puzzle out a vertiginous landscape of tens of thousands of years of human prehistory.

The role of technologies on the development of human societies and ways of life is profound and far-reaching. By 'technologies', the archaeologist refers to a large group of developments, for example:

- domesticated grain seed and livestock;
- effective methods of knapping flint;
- new architecture and construction mechanisms;
- administrative technologies allowing basic information on functional subjects to be written and read – in other words, writing.
- new developments, for example in metallurgy or textiles

Not all of these technologies are dependent on climate, but many are, and the ability to practice others is often dependent on the availability of a surplus enabling individual specialisation – specialist craftspeople can only exist when society has made it possible for that specialisation to occur. If the craftsperson is required to spend each day working for subsistence, then there is little chance of specialisation.

The climate may also act as a limiting factor in other ways. For example, consider the differential development paths of the Chatham Islanders (the Moriori) and the society from which they originated a few hundred years previously, the New Zealand Maori. The domesticated crops depended upon by the Maori were barely appropriate for the New Zealand climate, having arrived from Polynesia. They simply were not appropriate for the cooler, wetter climate of the Chatham Islands. As a consequence, the Moriori reverted to hunter-gatherer existence, and were eventually attached and routed by the larger and more warlike Maori population.

In the particular example of the Chatham Islanders, we know approximately what the prevailing climactic conditions were likely to have been during prehistory simply because the Western conception is that New Zealand's prehistoric period ended only in the 17th-18th centuries, and therefore it is somewhat unlikely to differ greatly from the currently measured values. In other cases, palæoclimate data is the only way to gain a good idea of the prevailing climatic conditions during the relevant period.

Furthermore, it has been suggested by many that the climate may be not only a limiting factor, but may also be causative – a catalyst for change. It is often suggested that the Younger Dryas may have been a causative factor for the development and adoption of agriculture by the Natufian people, formerly hunter-gatherers, in the Levant (Bar-Yosef & Belfer-Cohen, 1999).

To conclude, therefore, we see that the influence of the climate on the adoption of technologies – and indeed on a larger scale of the development of societies – is potentially very significant indeed. As a consequence, this information is of interest to a broad range of interdisciplinary teams and subject specialists on topics other than palæoclimatology. How best to support this type of work?

This document is the result of a series of discussions and investigation of academic practice. Like all documents of its kind, it must be understood to be partial both in the sense of incompleteness and in the sense that it can only contain a few fragmented snapshots of the overall landscape. The user scenarios contained here are neither exhaustive nor definitive, and it is to be hoped that the review process will surface a number of additional scenarios.

Please note also that there are elements within these scenarios that will almost certainly not be achievable on current platforms; part of requirements collection is development of a 'wish list'.

If you have any comments or suggestions, please write to Emma Tonkin at e.tonkin@ukoln.ac.uk.

References

Bar-Yosef, O. and A. Belfer-Cohen (1999). "Facing environmental crisis. Societal and cultural changes at the transition from the Younger Dryas to the Holocene in the Levant." In: *The Dawn of Farming in the Near East*. Edited by R.T.J. Cappers and S. Bottema, pp. 55–66. Studies in Early Near Eastern Production, Subsistence and Environment 6. Berlin: Ex oriente.

User Scenarios

Title	Historical climate information for a given area
Persona	Alice
Task	Retrieving climate information for a given area
User group	Students
Scenario	Alice is studying archaeology within her degree. She has been given an essay question that requires her to describe the likely factors behind the Viking movement in the 8th century AD and the fate of their expeditions to Vinland and elsewhere. She has read in various places that there is a strong likelihood that some of these changes have to do with climate – she is especially interested in the Medieval Warm Period. She knows roughly which areas are of relevance to her, and so she goes to the PEG-BOARD web site and picks out those areas on an embedded Google Map. On the options menu, she gives a time period covering the relevant times, and then clicks on 'download report'. The report page she receives contains data tables for each area, providing her with several pieces of information about climate – rainfall, temperature, and so forth. It also provides a sequence of graphs showing the progression of climate change over the time period she has entered, along with a cautionary note explaining the expected accuracy of the data, its sources, and inviting her to contrast the data with additional sources such as ice cores. Alice reads the information carefully, and then writes her essay, citing the web site and using the relevant images as she builds up her argument.

Title	Mapping the Fertile Crescent
Persona	Richard
Task	Developing learning materials for an introductory class
User group	Teaching staff
Scenario	Richard has been tasked with creating a series of learning resources to explain the 'cradle of civilisation' to a group of teenage students. He has decided that it would be best if he were to begin by siting the region according to present-day political geography, as he knows that many students would have difficulty identifying Mesopotamia on a map, and then to talk about the physical features of the Fertile Crescent, including the climate. He begins by creating his modern-day map of the region, using Google Earth. From this, he extracts a series of coordinates bounding the area under discussion. He then takes these coordinates to the PEG-BOARD site, where he requests a map of the area as it would have appeared at different times – from 11,000 to 6,000 BC. Richard would like to have a mechanism to improve the data presentation, as palæoclimate models use a very low-resolution model compared to the sort of visualisation that students are used to seeing from the BBC. For example, he'd like to be able to superimpose important physical features like the Tigris and Euphrates rivers. However, in the meantime he is happy with the fact that the data is available via a scientific data creative commons licence, and that the images he is creating using the system can be used according to a creative commons attribution licence, making it very simple for him to repackage it into the school's learning materials. An additional advantage for Richard is that the kids like the idea of working with real data, as it makes for an interesting project rather than just going 'through the motions.'

Title	Ocean currents and the 'express train to Polynesia'
Persona	Johann
Task	Assessing the impact of ocean currents on island ecologies
User group	Researchers
Scenario	Johann is a researcher looking at the impact of ocean currents on the lifestyles of island dwellers. He is aware of genetic studies and of linguistic evidence, written upon in some detail by Jared Diamond and others, to explain the colonisation of the Polynesian island grouping. He is looking at variation in the lifestyles and practices of various sites within the grouping, and exploring the impact of oceanic currents upon the subsistence methods used. This is a complex piece of work, and involves data taken from many sources. Contemporary information regarding ocean currents can be gleaned from satellite sources such as SEAWIFS, QuikSCAT and its successor, ASCAT. Trade winds, too, are well documented. However, historical data is not so easy to come by. Palæoclimate models can only partially respond to this need, acting as they do on a lower-granularity simplified model of the world, but they do offer a starting point from which Johann can work. He accesses the site looking for significant changes in relevant factors i.e. major ocean currents and similar, and for any historical observations or seed data that can be of use to him in scoping out the progression of his research project. His interest is broad and general and he is looking for a starting point rather than specific data, so he spends some time browsing the site before downloading some detailed data, which he will then use as one source among several in seeding his own model.

Title	High-definition video simulation output
Persona	Rebecca
Task	Extracting broadcast-quality video demonstrating climate change through the Younger Dryas
User group	Broadcaster
Scenario	Rebecca is working with a production company who are developing a project entitled 'The Cold World.' The resulting television programme has a lengthy section discussing wildflowers such as *Dryas octopetala*, which gave its name to the time period that it helped to define. They have three choices – to use the University's visualisation, to develop their own visualisation in-house, or to get an external organisation to do the work. Because the documentary will be published in HD, they need to ensure that the result is of a good enough quality to reuse in HD. Some years ago, this would not have been possible due to the bottleneck imposed on simulation research – the high cost of storage. However, as the price of storage has come down and the models have improved, it has become possible to offer such a visualisation service at a competitive price. Because scientific accuracy is important and Rebecca is not a subject expert, she assembles a small team – an external expert and a member of the BRIDGE project – to set the parameters of the visualisation that she needs. When the visualisation is complete, it would ordinarily become available on the service site. However, in this instance Rebecca asks that it be embargoed until the programme has been broadcast.

Title	Discovering data sources
Persona	Nashida
Task	Identifying sources of information about palæoclimate data
User group	Researcher
Scenario	Nashida is a researcher looking to build up an index of data sources. She is aware of a variety of existing sources, such as: • **NGRIP**, the North Greenland Ice Core Project; • the **NOAA** index of proxy data and of present-day data, the **GISP2** data; • the **PANGAEA** geoscience data publishing network. and a number of sources of palæoclimate reconstruction data: • the **NOAA** reconstruction index; • the GISS and GFDL reconstruction portals. But she knows that there are many groups working on palæoclimate reconstruction. She would like to glean an overview of the various groups' motivations, areas of interest, working methods and findings. As she is not a domain expert in the area of palæoclimatology, she is rather uncomfortable with navigating the area and is looking for a simple place to start, such as an index and an FAQ.

Introduction to use cases

In software design, functional analysis is typically used in order to identify necessary functionality and gain an overview of how it is likely to be used. This enables a functional specification to be written based on the use cases elicited during earlier stages of the process.

User scenarios describe the user's perception of a process; use cases describe the interaction between the user and the system, describing the role that the system takes.

Use cases

Two of these user scenarios have been extended into use cases:
Alice's user scenario – retrieving palæoclimate data for a given area
Richard's user scenario – Mapping the Fertile Crescent

Notes

Nashida's user scenario exceeds the scope of PEG-BOARD, as does **Johann's**.
Rebecca's user scenario remains under discussion.

Title	Historical climate information for a given area
Persona	Alice
Task	Retrieving climate information for a given area
User group	Students
Scenario	Using the Google Maps embedded onto the web page, Alice navigates the map interface and places pointers on areas on which she wants a report. She then fills in a dialogue for each of these pointers, which requests temporal coverage and provides a series of interface widgets enabling start and end dates to be input (e.g. 800-1000AD) Reports may be generated for each of these pointers, or a comparative report may be generated covering two or more pointers. When she clicks on 'download report' for an individual item, the system is faced with a complex problem; different palæoclimate reconstructions may not be entirely in agreement about certain features in the data. 'Under the hood', therefore, the system is likely to depend on appropriately set policy and the use of a 'known good' model – *we flag this up for information, and will amend this document when this point has been clarified.* On retrieving the dataset, the system checks whether the question asked can be answered (for example, due to the granularity of the model two nearby towns are to all intents and purposes likely to appear to be the same place); checks whether the question has been asked before, in which case cached data may be used; and if it has not, generates a series of responses. A database of proxy data is also queried to identify information of relevance to that region, if any, and citations for this data are added to the report. The report is generated in multiple formats: CSV for data, vector-based graphics for pregenerated graphs, and an accompanying PDF with the information in human-readable pre-generated format. An accompanying Dublin Core metadata record for this generated report provides basic information about authorship and coverage of the resource (geographical, temporal, etc).

Title	Mapping the Fertile Crescent
Persona	Richard
Task	Developing learning materials for an introductory class
User group	Teaching staff
Scenario	

Richard, using the information displayed by the system, manually extracts coordinates for the area from Google Earth.

He places this information in the PEG-BOARD site by copying and pasting. The form he is using allows him to add information about the temporal coverage that he has in mind – 11,000 to 6,000 BC. He then clicks on 'generate map'.

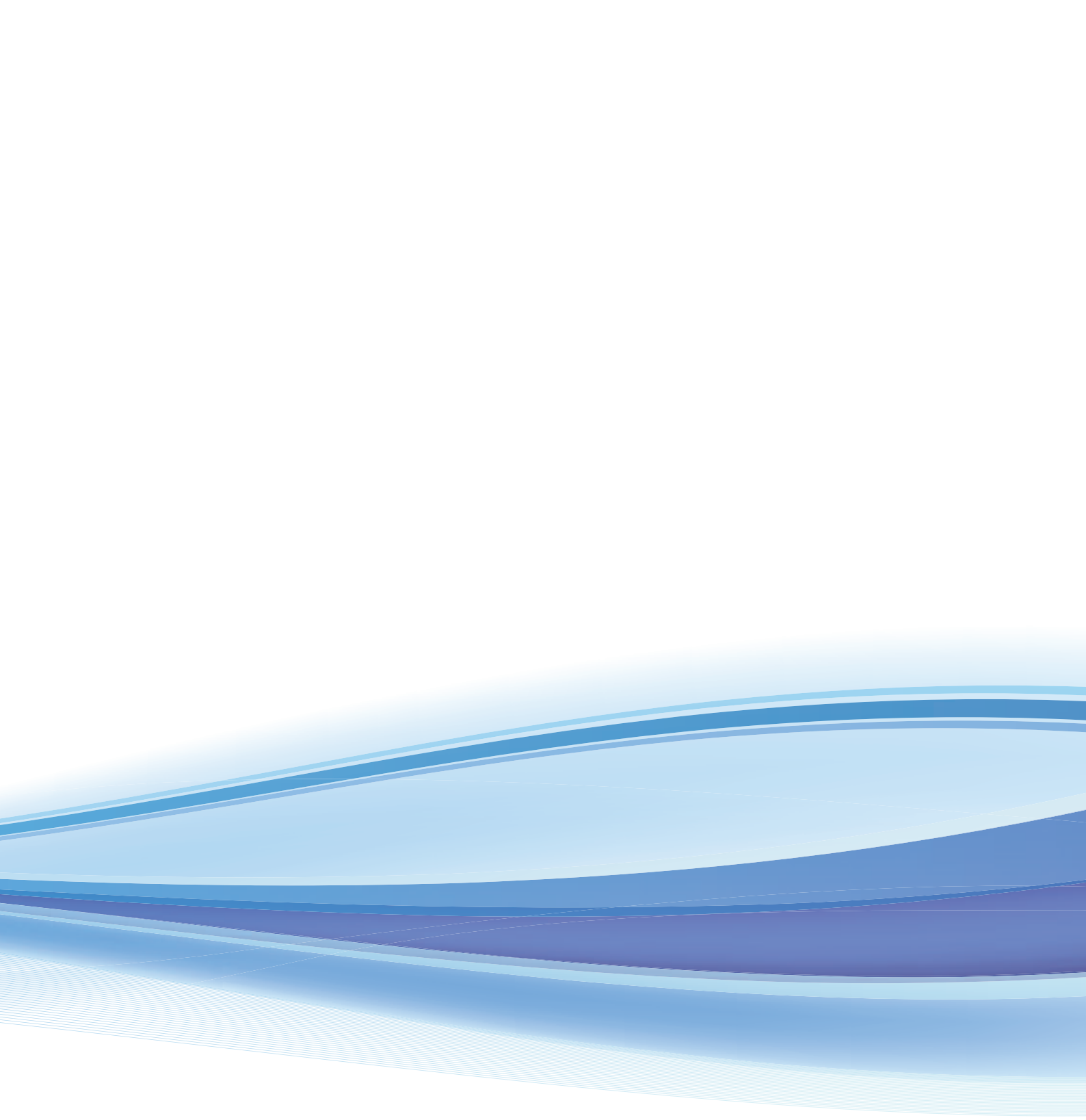
The system validates his input, ensuring that the temporal coverage and geographical extent are plausible. It then identifies an appropriate model to use in solving the problem. As in the previous use case, selection of the model used to respond to the query is a result of internally set policy.

If there is a cached response, the system simply returns the cache; if not, the response is generated using the selected model.

Several elements are returned:

- A human-readable report containing a shortened link to the online dataset
- A dataset
- The visualisation that Richard has requested - he can choose from several possible image formats.

These come complete with relevant licencing information: scientific data creative commons licence, and a creative commons attribution licence.



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