Quantifying and Understanding the Earth System (QUEST) Scoping Study – Phase 3.

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1. Introduction

This report describes the outcome of the scoping study carried out by the BADC to support work of the NERC programme *Quantifying and Understanding the Earth System* (QUEST) projects listed in table 1 below

Table 1: Summary of QUEST projects scoped in this document

Short name	PI	Core team rep	Value of grants (thousand £)	Theme	Number of project scientists
GSI	Nigel Arnell, Reading	Sarah Cornell	1,178	3	36
Forestry	Robert Matthews	Wolfgang Knorr	415	3	19
QUATERMAS	Jeremy Woods, Imperial	Jo House		3	14
FISH	Manuel Barange, PML		514	3	19
PETM	Mark Maslin, UCL		539	2	7
Feedbacks	Tim Lenton, UEA		460	1	5
FireMafs	Martin Wooster, KCL	Colin Prentice; Dr. Ilaria Palumbo, ip53@leicester.ac.uk	415	3	9
CCMAP	Eleanor Blyth	Wolfgang Knorr	825	1	1

It supplements initial scoping studies covering the majority of the theme 1 and theme 2 projects.

2. GSI: Global-scale impacts of climate change: an integrated multi-sectoral assessment

The project directly addresses the QUEST Theme 3 objective of ``*seeking to understand and, as far as possible, quantify the implications of global environmental change for the sustainable use of resources''*.
There are 15 work packages. Much of the output will be on global 0.5 by 0.5 degree grids. The total volume of data will be 2-5Tb. Many of the variables will be unfamiliar to BADC staff, so additional effort will be required to ensure that terms used are standardised and well defined.

The data volume expected is of the order of 5TBytes.

Table 2.1 GSI

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Climate Scenarios	UEA	Climate scenarios at 0.5 degree resolution from		<1Tb	Small

		ClimGen and IMOGEN.			
Socio-economic scenarios	Southampton Geography	Spatially disaggregated scenarios.		<100Gb	Large
Land use and land cover scenarios	Edingburgh	Global land-cover dataset under different scenario storylines.	Standardised names for land-use types.	<1Tb	Moderate
Global Water Resources	Southampton Geography	Global gridded water resource indicators. Output from hydrological models.		<1Tb	Moderate
Catchment scale impacts	UCL	Output from catchment scale hydrological models.	Format unknown	Small	moderate
Flooding	Southampton CEE	Flood risk on coastal segments and a global grid.		Small	Small
Crop production	Reading	Output from a process based crop model (GLAM). Productivity and water use of wheat, maize and groundnuts.		Moderate	Small
Aquatic Ecosystems	CEFAS	Output from the ``Ecopath with Ecosim (EwE)'' ecosystem modelling suite.	Format unknown;	Likely small	Moderate
Terrestrial Biodiversity	CEH	Net Primary Productivity (NPP) output from Jules-Imogen.	Novel variables: ant populations and other invasive species.	Likely small	Moderate
Human Health	LSHTM: Simon Lloyd simon.lloyd@lsthm.ac.uk	Projections of mortality and morbidity by region (21 regions) plus projections for case study areas for ~6 locations.	Spreadsheets	10Gb	<100
Soil Carbon Fluxes	Aberdeen: Smith, Professor Pete <pete.smith@abdn.ac.uk>	Soil Carbon, Soil Nitrogen		Moderate	<10

Food Security	Edinburgh	Malnutrition indicators		Small	Moderate
Drought	Leeds: Elisabeth Simelton [E.S.Simelton@leeds.ac.uk]	Food security, vulnerability index, agriculture, global, China, Africa, Malawi, sensitive/resilient, drought index, crop failure index	Socio-economic variables: non-standard names, stored on provincial scale	<1Tb	<100
The coastal zone	Southampton CEE	Vulnerability of coastal areas			

3. Forestry: A Research Project accompanying a Demonstrator Forestry Project for Climate Mitigation.

This project will examine the scientific basis for forestry-based climate mitigation projects, and test the principles for the specific case of a forestry project to be filed under one of the project-based flexible mechanisms of the Kyoto Protocol of the UNFCCC (United Nations Framework Convention on Climate Change). The output will be in the form of reviews and published papers.

4. FISH: Predicting the impacts and consequences of climate change on global fish production

This project will examine the impact of climate change on a key world food market, and the consequent global economic impact.

Table 2.3 FISH

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Planktonic ecosystem responses	Jason Holt	Scenario; time-slice; coastal shelf: Primary production simulations in Large Marine Ecosystems		1-10Tb	Small
Fish biomass	"Simon Jennings (Cefas)" <simon.jennings@cefas.co.uk", "Graham Pilling (Cefas)" <graham.pilling@cefas.co.uk>, "Julia Blanchard (Cefas)" <julia.blanchard@cefas.co.uk>	Development of fish biomass and productivity predictors		100Gb-1Tb	Small
Fishmeal	Manuel Barange	Impacts and consequences of global environmental		Small	

		change on fisheries based global food markets		
Economic impact	Edward Allison	Future Vulnerability of national economies and global fishmeal and food markets to effects of climate change and other drivers		Small

5. PETM: Dynamics of the Paleocene-Eocene Thermal Maximum

The Paleocene-Eocene Thermal Maximum will be studied with particular emphasis on trying to understand the role of methane hydrates and the impacts of surface ocean acidification on calcifiers such as foraminifera, coccolithophores, and corals. An interdisciplinary model-data approach will be followed, using both fully coupled GCMs and intermediate complexity Earth system models to explicitly evaluate the foremost hypothesis for the driver of hyperthermal events such as the PETM – that a change in ocean circulation and/or warming drove a large-scale destabilization of methane hydrate deposits, and thus assess the relevance of the PETM to future global change.

Table 2.4 PETM:

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Proxy data synthesis	UCL	Time series	Need name standardisation	Small	Small
WP2, 3 (FAMOUS)	Paul Valdes	GCM output: surface temperature, precip, evaporation, runoff, and deep ocean temperatures		<10Gb	Small
WP2, 3 (bio-geochemistry)	Andy Ridgwell [andy@seao2.org]; Dr Ron Kahana (ron.kahana at bristol.ac.uk)	2-D maps biological productivity, sedimentation and dissolution fluxes and sediments composition, 3-D simulations of ocean chemistry, and in the sediments: methane hydrate		<10Gb	

		and bubble concentration distribution			
WP4: GENIE	Robert Marsh [rma@noc.soton.ac.uk]	Biogeochemistry model output	CF netcdf	<10Gb	Medium

6. Feedbacks: Quantifying biogeochemical feedbacks on climate change

The project will use a range of models (GENIE, FAMOUS, UKCA, JULES, QPFT and ultimately QESM**)** to investigate biogeochemical feedbacks.

Table 2.5 Feedbacks

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Model output	Parv Suntharalingam (P.Suntharalingam at uea.ac.uk)	3D atmospheric and oceanic model distributions of a range of biogeochemical species. (there will be other datasets as well, but the above are likely to require the largest storage capacity		1-10Tb	<100

7. FIREMFAS: Fire Modelling & Forecasting System

Fire is the most important disturbance agent worldwide in terms of area and variety of biomes affected, a major mechanism by which carbon is transferred from the land to the atmosphere, and a globally significant source of aerosols and many trace gas species. The objective of FireMAFS is to develop a robust method to forecast fire activity (fire 'danger' indices, ignition probabilities, burnt area, fire intensity etc) via a process-based model of fire-vegetation interactions, tested, improved, and constrained using state-of-the-art EO data products and driven by seasonal weather forecasts issued with many months lead-time.

Table 2.6 Firemafs

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Reflectance	hb91@le.ac.uk Prof. Heiko Balzter	Reflectance images	Raw binary with ENVI header file.	3Tb	Small
Burned area	hb91@le.ac.uk Prof. Heiko Balzter	Burned area maps		<1Gb	Small

8. CCMAP: Climate-Carbon Modelling, Assimilation and Prediction

Table 2.7 CCMAP

Work Package	Data provider	Data description	Format issues	Volume	Number of Variables
Baseline	Wallingford	Observational		<1Gb	

		data for benchmarking		
Model output	Oxford/Bristol	Ocean model output/land feedbacks	150Gb	
Assimilation	Hamburg	Observations and assimilations	100Gb	

9. QUATERMASS: Quantifying the potential of terrestrial biomass to mitigate climate change.

Quatermass will carry out a quantitative assessment of the global potential for terrestrial biosphere management activities, including avoided deforestation, afforestation and biomass energy production, to offset fossil fuel emissions taking into account all long-term climatic effects, and their sustainability.

The main goal of the project is to characterise, quantify, map and evaluate the key mitigation options at national, regional and global level based on the demand and potential supply as well as implications from international trade (biomass fuels and emissions).

Table 2.8 Quatermass

Product	Data provider	Data description	Format issues	Volume	Number of Variables
Methodology and definitions		No data			
Characterisation of key mitigation options		No data			
Definition of demand trends	Jeremy Woods; Pete Smith; Jessica Bellarby	Maps of: feedstock supply; energy demand by sector; supply and demand.		<10Gb	
Quantitative mapping	Jeremy Woods; Pete Smith; Jessica Bellarby	Maps of: feasible land area; biomass potentials; vegetation carbon stocks; environmental sensitivity hotspots; demand conflict; GHG impacts and displacement potentials.		<10Gb	
Derivation of national, regional and global potentials	Jeremy Woods; Pete Smith; Jessica Bellarby	Tables of results at country and regional level; global maps.	Spreadsheets	<10Gb	
Interpretation of results	Jeremy Woods	Web pages: linked to			

	from BADC

10. Other cost items

Table 3 below lists some other cost items which relate to integrating activities, or (in the case of `Workspace') to new costs which have arisen for projects scoped in previous rounds.

Table 3: Miscellaneous cost items

Item	Description	Resource
Project meetings	For each of the 8 projects, we will attend one 2 day meeting per year	32 staff days, £3200 travel
Workspace	Tamsin Edwards (Bristol; PaleoQUMP) has requested 10Tb of workspace	10Tb disk space
Other data centres	The diverse nature of the QUEST programme will result in us archiving data types which are normally stored at other data centres. We should coordinate our activity with activity at those centres: Global Population Dynamics Database , Antarctic Environmental Data Centre, British Oceanographic Data Centre.	6 staff days, £600 travel
TOTAL STAFF		**38**
TOTAL TRAVEL		**£3800**
TOTAL DISK		**10Tb**

11. Overview

The final tranche of QUEST funding has been given to 8 projects which will produce a total of around 32 data products, ranging from climate model output to images and spreadsheets.

Additional issues:

1. Many of the projects will produce variables which are new to BADC. A special effort will be needed to ensure consistent and clear standardisation of names.

2. Several projects will produce spreadsheets: these need to be stored in a secure format which is will not become inaccessible when software versions evolve.

3. Image files: a policy on the documentation of image files needs to be developed.

These items are allowed for in the 6 days per data product allotted in table 4.

Table 4: Data volume and staff effort

Project	Data Volume [Tb]	Products	Staff days

GSI	4	14	84
Forestry	0	0	
QUATERMAS	0.03	3	18
FISH	5	4	24
PETM	0.03	4	24
Feedbacks	5	2	12
FireMafs	3	2	12
CCMAP	0.25	3	18
Other	10.		38
TOTAL	**27.31**	**32**	**230**