CONCEPT NOTE

ACCESS PHASE 2 Research Approach

<working title> Southern African Seasonality Climate Project

Climate variability, the seasonal cycle, seasonality and its impact of social-ecological systems, on seasonal, annual, decadal and centennial / millennial time scales, local to global spatial scales.

1. This document

This is to be regarded as a working document and a point of departure. It has been developed in consultation with some ACCESS PIs and DST/NRF officials and is to be used as a means for discussion and debate among members of the ACCESS community. The final form of the ACCESS programme's operational plan will be based upon the finalised conceptual, logistical and institutional arrangements currently under discussion. The programme document to be drafted for the second phase will ultimately integrate the research aspects and the education and training aspects of the programme. This document is to give some shape and definition specifically to the scientific and research direction of the programme.

This concept represents the best opportunity to achieve the following outcomes:

a) An opportunity for discovery and generation of new knowledge
b) A platform for inter/trans-disciplinary science
c) A platform for basic and applied research
d) To provide a common national strategic goal for the respective Earth Systems Science (ESS) disciplines
e) An opportunity to capitalise on South(ern) Africa's unique geographical position
f) A platform for integrated ACCESS education and training efforts
g) A means of articulation with the planned ESS Flagship programme and the SASSCAL programme
h) Production of scientific information and a resource for science-based policy development

2. Theoretical framework

2.1 Point of departure:

The basic premise is that the relationship between the physical and biotic components of the earth system, including human social and economic systems, is dominated at the temporal scale by the seasonal mode, which originates from radiative forcing (variable on millennial time scales) from the sun (expressed as variable insolation on intra-annual time scales at any given location on the planet) and is imposed on the closed earth

system. This signal is then propagated through the earth system and is mediated by internal earth systems' processes on intra- to interannual, decadal and millennial timescales. Environmental change (at all time scales) forced by various components of the earth system (including those that cause global warming and climate change), thus manifests and is propagated through the socio-ecological sub-systems in this seasonal mode, since intra-annual oscillation through the seasonal extremes provides the most robust and regular cues that drive the phenology of biological and social systems. The strength of this signal varies in space but is particularly acute in temperate regions.

The relationship between the physical and biotic components of the earth system is thus modulated and forced by variability inherent in this oscillating mode. Together with feedbacks from trends in the closed earth systems' intra-actions, dynamics, properties and changing states, at a range of time (past, present and future) and spatial (local, regional and global) scales, understanding the seasonal cycle, seasonality and variability in this mode is fundamentally important if we are to manage both current and future change in the relationship.

Given that the biotic component of the earth system, including human social-ecological-economic systems (SEES), is adapted and even dependent on this seasonally defined mode, understanding the mode's dynamics, in terms of its periodicity, amplitude and their trajectory (past, present future) and the manifestations of this in changing ESS state, is the basis for predicting and ultimately managing and adapting to the impact of variability and change. Appropriate responses to environmental change and its impacts on the SEES will be best determined with a robust exploration of future scenarios of the seasonal cycle and seasonality at a range of spatial and temporal scales.

As a problem statement: Inadequate understanding of the biophysical dynamics of the seasonal mode, its influence as a pressure and force determining the dynamic state of the interacting biogeophysical systems and the consequent impacts on the earth systems components (including SEES) results in limited predictability and constrained set of response options (in terms of adaptation and management decisions envelopes) for both current (including retrospective explications) and future climate scenarios.

2.2 The Driver-Pressure-State-Impact-Response (DPSIR) framework (see Kirsten 2004, Carr et al., 2007) has been used here to assist in conceptualising the proposed design of the research strategy (there are some alternative approaches such as Collins et al 2011). The key point of departure is that interaction among the basic elements of the earth system (ES; biophysical, social & ecological) is mediated by the seasonal cycle and choreographed by the seasonal mode, and therefore adaptation and response to changes and trends in seasonal variability should be a key research outcome. Given that this external driver is expressed and propagated through a range of earth system components, at a range of scales, it thus makes sense that this be the common currency and research thread that runs through the earth systems research programme.

2.2.1 **Drivers** – here we will consider the interactions among the fundamental components of the ES in the seasonal mode, namely the global to regional scale constructs and features of the of the climate, terrestrial, oceanographic sub-systems and the Social Ecological Economic System (SEES) and their intra-annual variability (and trends inter-annually and beyond). The range of possible future states can be best projected by an understanding of the trajectory of seasonal variability of these long term and large scale features that define the global and regional biosphere, and which will propagate varying and changing biophysical signals down to local spatial and temporal scales (see *Pressures* below). Dynamics at millennial and interannual to decadal timescales (both empirically determined and projected at short to long term time scales) are pertinent in understanding the trends and measurable range of states (on all spatial scales), to which policy and management decisions must respond. Here observations and models will be key tools.

2.2.2 **Pressures** – These can be regarded as secondary or more locally scaled drivers or forces of the seasonal mode. In this element of the scheme, ES subsystems are regarded as means by which the large scale/long term features and drivers are expressed and propagated intra-annually (with consideration of interannual + variability and change to these intra-annual features) through the regional to local scale ES. For example the hydrological system is subject to both seasonal and long term dynamics at a range of space scales and variability of several wavelengths should be considered. This would also hold for other subsystems such as the biogeochemical cycles of carbon and other key sources of pressure on the ES. Here observations and models will be key tools.

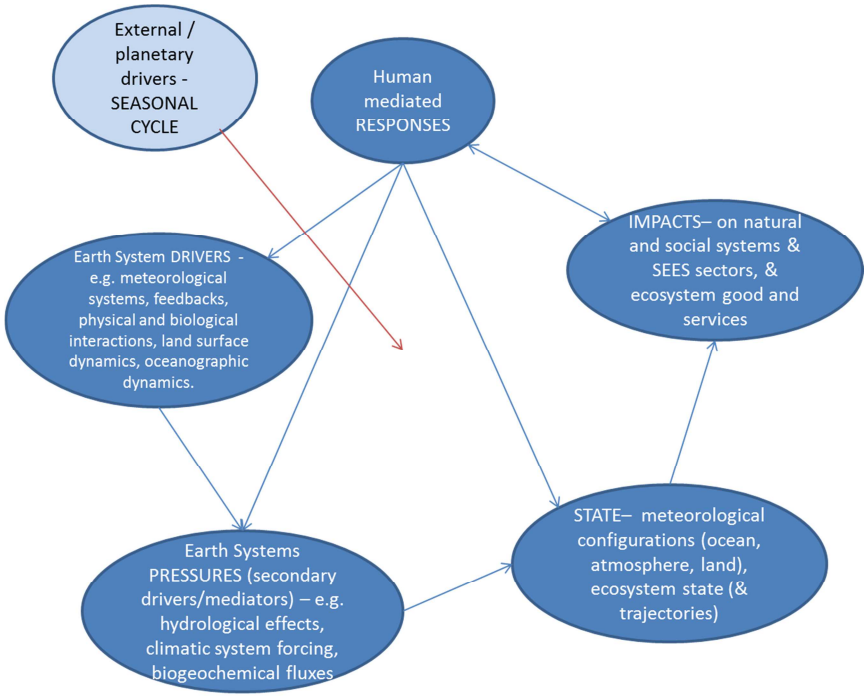
2.2.3 **State** – this would be an assessment of the varying state of the ESS, again at a range of scales (from regional to local, short term to long term). While this state may vary seasonally and inter-annually, there are also longer term trends in the seasonal state, both observed in the past and projected for the future. The envelope of variability (and frequency, duration and intensity of seasonal extreme events/states), for example, will be determined by primary and secondary drivers operating at a range of spatial and temporal scales, which in turn will affect the provision of ecosystem goods and services. Existing and new data sets will be required and modelling of ES state variability will be a key activity.

2.2.4 **Impacts** – this considers the impacts of the varying and changing states on the SEES, and hence livelihoods and human well-being. All aspects of the impact on the SEES (from intra-annual to multi-decadal time periods) can be considered,

including to various sectors including the distribution of biomes, phenology and provision of ecosystem goods and services, impacts on agriculture, human health and economics. Here an emphasis on attribution and statistics (with appropriate data sets and observations) will be key.

2.2.5 **Responses** – here we consider the strategies to deal with the dynamics and trends described above. This considers the communication of the science (e.g. forums and early warning systems and other services) as well as strategies and interventions to cope with and adapt to these changes in the seasonal mode (at appropriate implementation and management scales devolved accordingly from national to local levels of governance) and the study of managing changing itself. As drivers are continuously in flux and new knowledge emerging, the responses will need to be adaptive, requiring careful consideration for innovative methodology, monitoring and assessment.

Figure 1: Graphic representation of the DPSIR approach to the seasonality concept with the external imposition of the seasonal signal.



3. Proposed structure

3.1 Research projects

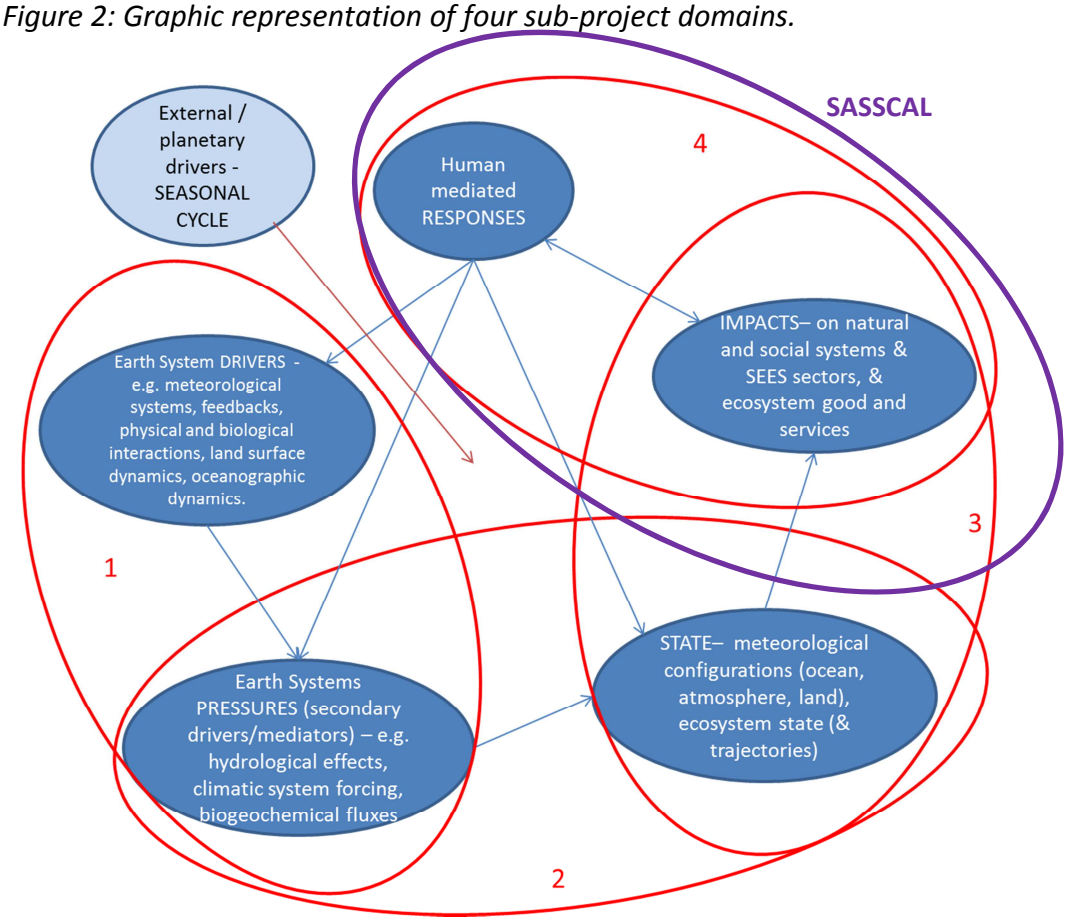
It is proposed that the research plan be implemented in four overlapping segments with four 5-year sub-projects with a nominal budget of between R3-4/py (including

staff and student and running costs). The design allows for a range of basic as well as applied research. This will result in a call for proposals addressing the agreed DPSIR (or alternate scheme) for these four sub-projects which will each need to account for the following criteria:

a) A multi-institutional team including appropriate participation from HBUs
b) Multi-disciplinary team (with a broad definition)
c) Associated requirements for student and transformation outcomes
d) Normal budgetary and reporting guidelines as defined by NRF.

3.2 Four sub-project domains.

Figure 2: Graphic representation of four sub-project domains.



1 – The seasonal variability at all time ranges of biophysical drivers and mediators

2 – The propagation of the seasonal signal and its effect on the ranging state of the SEES and all time ranges (geological, short term and long term projections)

3 – The sectoral impact[1] of seasonal variability on the SEES at all time ranges

[1] **This could be a role for SASSCAL**

4 – Adaptation strategies and management responses (including services)[2] to seasonal climate variability at all time scales and at appropriate space scales and levels of governance.

A fifth function of this scheme will be a projected aimed at managing and integrating outputs from this project in various forms.

3.3 Centralised activities

In addition to this scheme of sub-projects, several central activities will be conducted (with the main goal of integrating the programmes outcomes in line with DPSIR scheme). The programme must be robustly led with continued engagement to insure that the various elements of the design interact and adapt as the learning occurs.

a) Annual science meetings of sub-projects with published proceedings (with one international conference in the funding period).
b) Special issues of selected science journals dedicated to outcome so of the research
c) Integrated review and position papers
d) Communication forums and briefings
e) Student cohort management and training courses (integrated education programme)
f) Mid-term review
g) Funding leverage and international engagement

4. Process to follow

There will need to be a process that will lead to the finalisation and formal drafting of this plan and the call. The goal is to have the final form of this document and a prepared call ready for the 2016/17 financial year. The concept document will be used to guide the ACCESS community in preparing (and recruiting students in the interim) for this second phase.

The steps will include:

a) Once this concept has been accepted/modified by the GS committee a reference group (comprising senior ACCESS scientists and additional scientists from other government departments and HBUs) will be assembled in early January to develop the concept further via a 2 day workshop.
b) A publication will be produced from this meeting.

[2] **This could be a role for SASSCAL**

c) A project document will be assembled with the detail of the above costed and clearly articulated.
d) A call for research proposals will be drafted and issued through the NRF.
e) The institutional and logical arrangement for managing this programme remain to be finalised

5. Items to deal with in the short term:

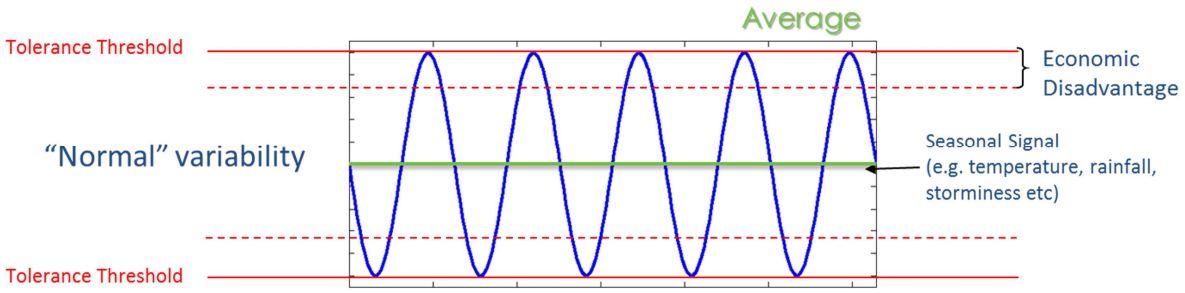
a) The articulation with SASCAL
b) The articulation with the ESS Flagship
c) Phasing of ACCESS 1.0 and ACCESS. 2.0 (interim plan).

- Kristensen, P. 2004. The DPSIR Framework. http://wwz.ifremer.fr/dce_eng/content/download/69291/913220/file/DPSIR.pdf
- Carr, E.R. et al. 2007 Applying DPSIR to sustainable development. International Journal of Sustainable Development & World Ecology Volume 14 (6): 543-555
- Collins et al. 2011.An intergrated conceptual framework for long-term social-ecological research. Front. Ecol. Environ. 9(6):351-357

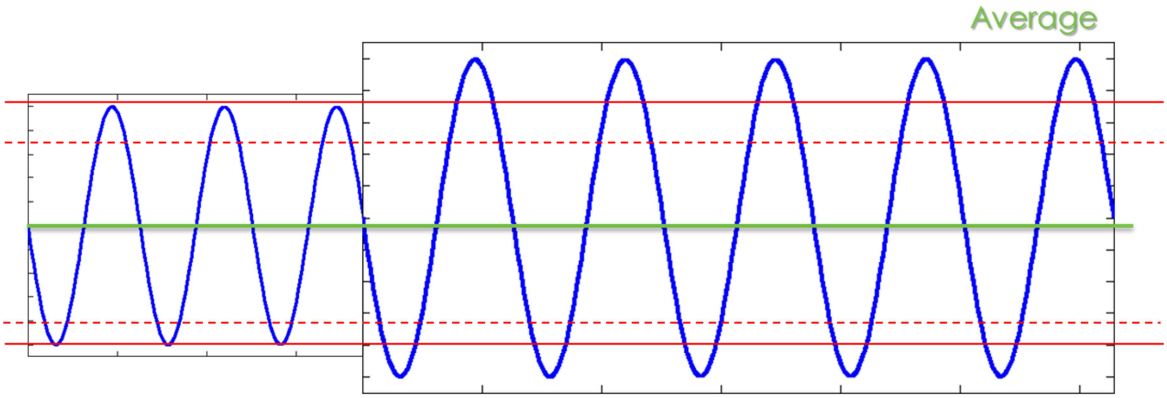
A bit more on some of the seasonal cycle/seasonality concept (refer to the DPSIR scheme above):

A key research element here is to understand the ES drivers of this signal and its variability/trends and its predictability over a range of time and space scales. Understanding the influence of this (and variability of the oscillations and trends on a range of time scales) signal on SEES state and the consequent impacts on various sectors (and responses thereto) is another key element.

1. Idealised typical / normal seasonal climate shows red lines (tolerance threshold – adaptation to current climate variability). This represents the idea that an idealised oscillating cycle is produced by ES processes (forced originally by an oscillating insolation signal at any one location) that reaches seasonal extremes. Solid lines represent the limits of adaption to anticipated or "normal" extremes. Stippled lines represent the economic disadvantage (reduced adaptation capacity) to current climate variability. Average says little despite the signal variation intra-annually.



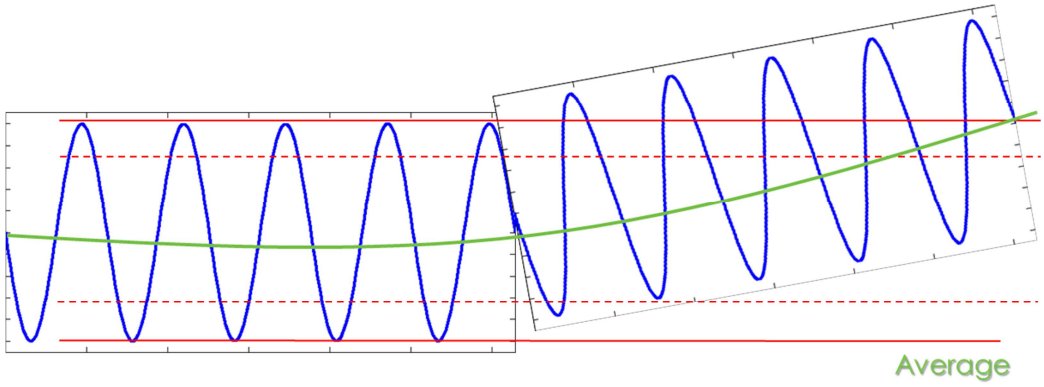
2. Changing/trending amplitude: Here is a scenario where the extremes of seasonal climate cycle variability exceeds the tolerance envelope (resulting in extreme events). The poor are worse affected and annual average says not much about this



"Trending" variability I (increasing amplitude)
Increased amplitude (more frequent and intense extreme events)

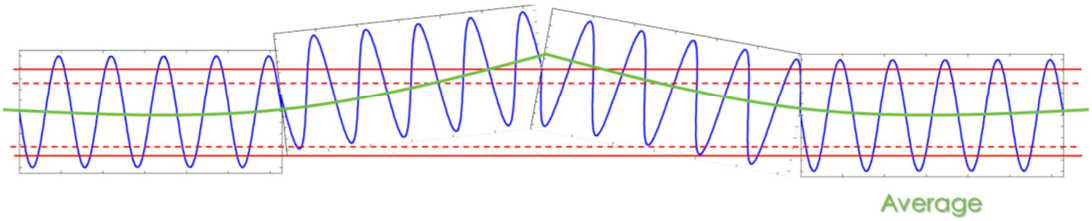
change. Must look at seasonal extremes and trends.

3. Uni-directional trends -Here we see a changing range of climate – winters and summers still exist. Extremes may exceed tolerance levels at one end – annual average says something about this trend but this belies the seasonal impact.

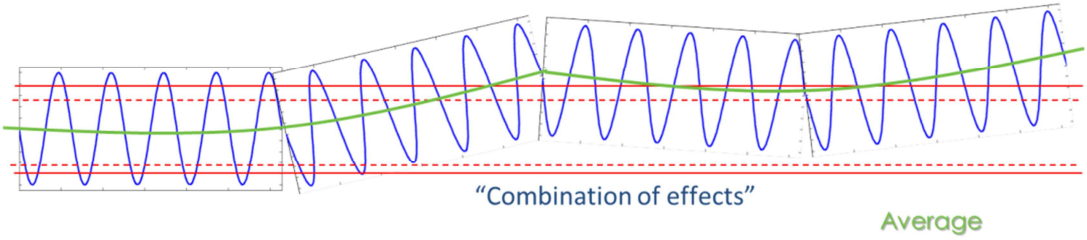
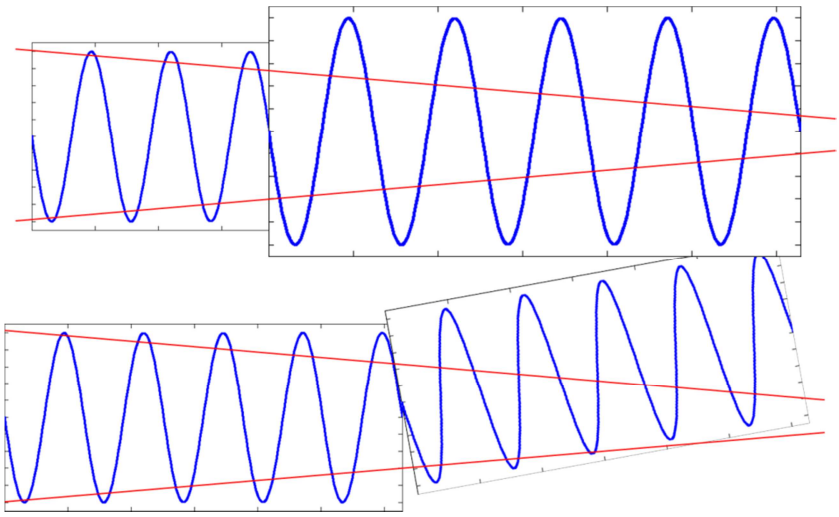


"Trending" variability II (shifting envelope)
Shifting variability envelope and ecological ranges

4. Combining time scales and a range of drivers of variability- This accounts for oscillations – medium term which could themselves trending on different wave lengths or is unidirectional. Average is useful but not everything we need to know.



"Trending" variability III (oscillating envelope)
Shifting variability envelope and ecological ranges



5. The red lines converging indicate reduced resilience – tolerance is reduced as a consequence which adds to the impact of change.