Climate Information Portal (CIP)
Background and roadmap

Introduction

The Climate Change Explorer (CCE) Tool was developed through collaboration between AWhere, a GIS/visualisation development company, the Stockholm Environment Institute (SEI Oxford), and the Climate Systems Analysis Group (CSAG) at the University of Cape Town.

The objective of the tool was to enable easy and effective exploration of the envelope of climate change projections (i.e. the range of scenarios generated by various climate models). The tool was designed to integrate with the statistically downscaled station scale climate projections generated by CSAG and distributed through the CSAG Data Portal (http://data.csag.uct.ac.za).

The tool provided some basic mapping of station locations in order to select appropriate stations and then allowed various plots to be produced of future projections. The CSAG downscaled data included various pre-calculated statistics which could be visualised through plots and graphs in the tool.

The tool was used effectively in a number of training workshops and short courses and by various end users throughout Africa and Asia.

The CCE Tool

The concept of a climate change projection *envelope* was central to the development of the CCE Tool. It was felt that end users should be engaging with the full envelope of projections that various global circulation models (GCMs), coupled with the statistical downscaling, produce. This we considered more realistic and appropriate to inform decision-making than attempting to only produce a single "best" projection. To this end, downscaled projections from 11 GCMs[1] were provided by CSAG and integrated into the tool. A simultaneous visualisation of all 11 projections for a particular station was possible. While this plot could be very complex and begged further refinement it was effective in communicating some of the issues applicable to the climate change problem.

The tool was also intended to allow the calculation of magnitude histograms for various variables and the projected changes in those histograms under future climate projections. This is a powerful means of visualising changes in extremes and the nature of daily events in future projections. In reality histograms were poorly and erroneously implemented within the tool so this functionality was largely lost.

The ability to plot multiple plots for multiple stations and multiple projections and view all of these simultaneously is powerful and certainly has potential, however, the actual presentation of such a complex set of plots in a way that is understandable is a challenge and further research and exploration is certainly required in order to achieve this goal.

1 Only GCMs that archive the daily variables needed for the downscaling methodology were included

Problems with the CCE Tool

As a first attempt at such a tool the CCE Tool was effective and opened up much greater understanding of, and interaction with, the projections for end users than was previously possible. However certain important limitations and problems arose during and since development. These are presented below:

- *Complex interface*: A number of otherwise IT literate users struggled to figure out the interface, particularly the interaction with the CSAG data portal. Other interaction issues arose around the multi-line plots which became incredibly confusing, non-persistent colouring of plots (one GCM not always the same colour) and just too much information in one display. Other selection boxes were laborious to use (selection of models) and not-persistent throughout a session requiring frequent repetition of tasks.
- *No observed data*: It has become increasingly obvious that any analysis of future projections should be done within the context of current observed climate and, if possible, current observed trends. This was not possible with the CCE Tool partly because of data availability (no observed data in the CSAG data portal) and partly because of the tool design.
- *No GCM data*: Many users expressed interest in the raw GCM output fields to compare with the statistically downscaled values. While some understanding of the caveats of using raw GCM fields is important this can often be a useful means of understanding why certain projections are being produced.
- *No spatial plots*: Many users are more used to working with spatial plots of various variables and spatial gradients or patterns are important. While the downscaled data is at the station scale and not inherently spatial, users often need to translate this data into some form of spatial representation for reporting or integration with other data sources.
- *Lack of documentation and supporting materials*: The tool provided plots and other representation of the climate projection data but only contained limited, static documentation regarding the use, interpretation or application of the projections. While the tool was intended to be used in conjunction with other resources such as the weADAPT/wikiADAPT platforms this linkage was not obvious and easily missed by end users.
- *Inflexible development*: Climate change science is progressing rapidly and methodologies and approaches are constantly in flux. The nature of a client side application is that it is inherently static unless updates or upgrades are frequently applied. This requires a robust update infrastructure which is complex to implement and verify. Development of client side applications is also expensive.

The Climate Information Portal (CIP)

The experienced gained from the CCE Tool development, as well as the progression of the science and methodologies underpinning climate change projections, has resulted in a need for a new means of interfacing and engaging with such projections and associated information. This has led to the development of the Climate Information Portal (CIP) to replace the CCE Tool. The term "*Climate Information*" is intended to capture the full spectrum of information that is required in a climate change study. This information ranges from raw GCM projection data to the statistically or dynamically downscaled projection

data to associated interpretation and guidance material, as well as integration with other data sources or models. The CIP will be almost entirely web based and a largely server-side application (some components will have client side elements for enhanced functionality).

Components of CIP

The portal will consist of a number of critical components. It is important to note that development and content will be flexible, able to be grown and change rapidly as the science, data and methodologies evolve. The following components however will form the basic framework for the current and future developments.

- **Geospatial Database engine**

  While the traditional view of climate projections has often focussed on time series analysis, the majority of end users work in a spatial framework. The geospatial database will integrate all available (observed and future projected) climate data and allow searches (spatial, temporal, meta) in order to access the most appropriate data for a particular study. Rich meta-data will be incorporated including quality flagging, licensing details, original source attribution and data specific notes or issues.

  The database engine will also allow integration with other applications such as GIS through data format conversions and exports. This functionality is currently being implemented using PostgreSQL/PostGIS and GDAL/OGR geospatial libraries. A Python/Django web services type interface is currently under development though other interfaces could easily be implemented if required.

  Climate change projections can not be considered a permanent data source. As the science, models and downscaling methodologies evolve, new data becomes available. The geospatial database will be regularly updated and older data deemed irrelevant will be removed. In some cases older data will be maintained for comparison purposes. This will be done at the discretion of the portal managers and researchers at CSAG.

- **Documentation and Guidance material**

  A comprehensive set of documentation, both technical and academic, as well as guidance material is under development. Initially this will be implemented through a wiki which will allow easy collaborative development and flexible structuring. However the user will interface with the content through the portal and not through the conventional wiki interface (see *Web Interface* below). Technical documentation will include technical details on models, methodologies and data. Academic documentation will include underlying theories and concepts, philosophies and links to journal papers and other publications. Guidance material will be structured into sector specific modules and will be contributed by a number of collaborators who have experience in using climate projections in the relevant sectors.

  It is important to once again note that documentation and guidance material should not be static. The wiki will allow continuous updates and additions to this material as the science and ideas develop and grow.

- **Web Interface**
  The most visible component will be the Web Interface. This will most likely be accessed through a number of aspects or *views.* Different views would be appropriate to different users ranging from portal managers and content contributors to expert users interested in accessing certain datasets, to more intermediate users who need more extensive documentation and guidance material as they explore the available data. Probably the most innovative view will be the latter where a user will be guided through a "decision tree" originating with a definition of an interest area, a choice of user sector, an analysis of current climate and trends and finally visualisation and analysis of future projections.

  At each step in the decision tree appropriate guidance material will be available as well as links to relevant documentation. Guidance material and documentation will be drawn from the wiki described above and so will be readily edited, updated and added to by a diverse group of sector specific exports. Guidance material will also support discussion threads and so will become a dynamic and interactive resource.

  Whereas the CCE tool solely presented statistically downscaled climate projections, the CIP will allow parallel exploration of GCM projections, statistically downscaled projections and when available, dynamically downscaled (RCM) projections. Innovative visualisation and data exploration techniques are currently being developed in order to allow this exploration to be effective and informative.

  While the web interface will largely rely on the server side application, some components such as mapping and plotting will use client side Javascript based code[2]. An awareness of bandwidth restrictions in some countries is important in order to ensure that the portal is usable even in low bandwidth situations. Server side mapping and plotting further reduces bandwidth requirements by avoiding the download of large images.

  Through the functionality of the *Geospatial Database*, the end user will also have access to the relevant climate projection data in a format that is easily integrated into applications such as GIS tools as well as more generic formats. It is appreciated that the scope of the CIP is limited and users will require integration with a wide range of further tools or software packages.

  Once again, the web interface will provide a framework for the development of innovative visualisation and exploration tools. It is envisaged that these tools will develop as the science and understanding of climate projections develops. The tool will therefore provide a cutting edge interface to current scientific understanding and methods.

2 (OpenLayers and Flot are currently being incorporated in the development for this purpose.