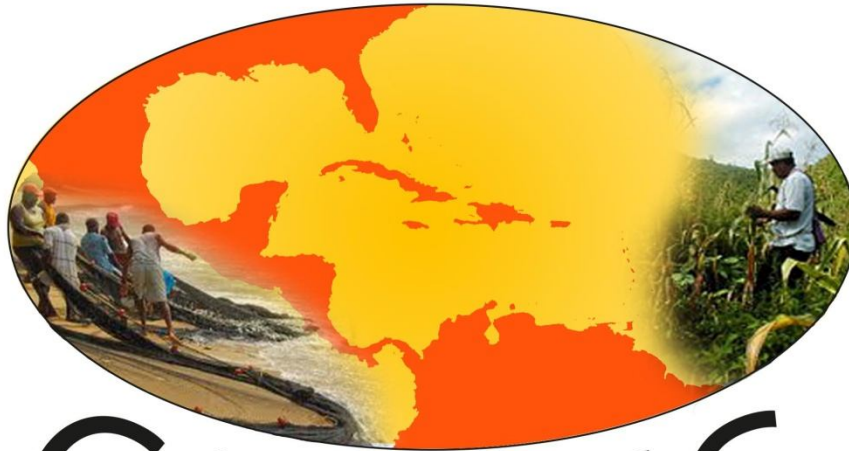


Caribbean Weather Impacts Group
Supporting risk based decision making



CARIWIG

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Deliverable KD2.2.1

Report on stakeholder requirements for a Caribbean web tool to provide climate information

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Kingston, Jamaica

A deliverable of
T2.2. Understanding the stakeholder needs for climate
information
of
Workpackage 2. Translating stakeholder requirements into
specific tools, data and services

Contents

- Contents 2
- 1 Summary of deliverable 3
 - 1.1 Context of this deliverable 3
- 2 Methods for identifying stakeholder requirements 4
 - 2.1 The first CARIWIG stakeholder workshop 4
 - 2.2 The workshop structure 5
 - 2.3 The workshop outcomes 6
- 3 The CARIWIG tools 6
 - 3.1 The CARIWIG weather generator 8
 - 3.2 The CARIWIG tropical storm model 9
 - 3.3 Regional climate model-based projections 10
- 4 The CARIWIG Web Service 12
- 5 Conclusions 16
- Appendix: Regional Stakeholders in Attendance 17
- Acknowledgements 18
- References 18

1 Summary of deliverable

This deliverable reports the needs of Caribbean regional-scale stakeholders with regards to the services and tools proposed by the CARIWIG project. Together with KD1.2.1, the stakeholder policy context report, these deliverables form a pair of complementary reports of the outcomes of the first CARIWIG stakeholder workshop held in Kingston, Jamaica, 6-7 February 2013.

The first project workshop was structured so as to first inform regional stakeholders of the aims, tools and services of the CARIWIG project and then to sectorally and cross-sectorally discuss the potential utility, benefits, gaps and improvements of these in depth. A summary of the three proposed tools and the proposed web service is provided and a synthesis of the desired attributes of these is presented from a stakeholder perspective. Feedback from the workshop was very positive with stakeholders expressing the view (through the workshop evaluations, group and in plenary sessions) that, given their understanding of the utility of the proposed tools and service, the majority of their requirements can be addressed.

1.1 Context of this deliverable

This deliverable is the main output of Workpackage 2, *Translating stakeholder requirements into specific tools, data and services*, which involved two tasks. Task 2.1 concerned a review of currently available tools, data and other products that provide information on climate and projections for the Caribbean (D2.1.1). This provided background information for the workshop. This deliverable has been produced as part of Task 2.2, *Understanding the stakeholder needs for climate information*, which involved: running a workshop, developing focus group questions and analysing workshop outcomes.

Other tasks and deliverables from the early stage of CARIWIG relevant to this deliverable are:

- Task 1.1: identification of preliminary stakeholders and case study locations (D1.1.1)
- Task 1.2: bringing stakeholders together for a workshop to understand the policy context.
- D3.1.1: collection of meteorological data with suitable licensing conditions.
- D3.4.1: list of available RCM integrations, driving GCM, time slices and emissions scenario and list of important missing scenarios.
- D3.5.1: Specification of locations for RCM data to be extracted.

This deliverable provides support and further justification for development of the following CARIWIG tools and services:

- The CARIWIG weather generator (Tasks 4.1 and 4.2)
- The CARIWIG tropical storm model (Task 4.3)
- Provision of regional climate model-based projections (WP3)
- The CARIWIG web service (Task 4.4).

2 Methods for identifying stakeholder requirements

2.1 The first CARIWIG stakeholder workshop

The CARIWIG proposal identifies three tools for the development of regional climate information considered to be useful and actionable for regional stakeholders in the assessment of climate change impacts and in adaptation decision making. These tools are:

- The CARIWIG weather generator
- The CARIWIG tropical storm model
- Regional climate model-based projections

It is proposed to deliver these tools, together with additional climate related information and knowledge, through the CARIWIG web service.

These tools were considered by the proposers to have the potential to provide climate knowledge at locally relevant scales and at time horizons relevant to managers and policy makers, thus providing a robust evidence base for decision making in the context of climatic risk and uncertainty.

Before implementing these tools and services, however, it was considered essential to undertake a dialogue with regional stakeholders to determine their specific requirements for quantitative climate information to support climate impact assessments and decision-making, with a focus on the water, agriculture and coastal resource sectors and to determine the extent to which the proposed tools and services are likely to prove useful and/or might need further refinement.

For this purpose, CARIWIG held a workshop for regional stakeholders in Kingston, Jamaica over two full days (6 and 7 February 2013). The specific workshop objectives were:

- To inform senior level stakeholders of the aims and objectives of the CARIWIG project;
- To introduce the CARIWIG weather generator and other tools;
- To demonstrate the utility of the tools;
- To foster ownership among stakeholders.
- To establish the north-south research collaboration framework.
- To formulate a sustainability approach for post project activities.

The workshop was attended by 40 participants (see Appendix) from ten Caribbean countries and the UK. Of these, 16 participants came from the Caribbean (CCCCC, Belize; INSMET, Cuba; UWI, Jamaica) and UK (NCL and UEA) research teams and 24 from stakeholder organisations primarily focused on water, agriculture and coastal resources.

2.2 The workshop structure

On the first morning of the workshop, members of the CARIWIG research team gave brief overviews of the proposed tools and the web service, together with a short review of existing web tools for climate observations and projections. All of these presentations are publically available¹.

The afternoon was devoted to a structured dialogue between the research team experts and stakeholders in cross-sectoral focus groups. The following questions were asked about each of the CARIWIG tools:

- Does this seem useful/helpful to you?
- If yes – why?
- If no – why not?
- What is missing?
- What could be improved?

For the CARIWIG web service, the focus groups were asked to consider the functionalities and capabilities of the proposed web service and to rank each functionality and capability according to whether it is: essential, desirable, good to have, or not useful, and also to state what people would improve or remove or why.

The report-backs from these focus groups (in plenary session and from working notes and flip charts) provide the primary input to this deliverable.

Supporting information as to the potential utility of the proposed tools and services also came from sectorally-based discussions on the second day of the workshop on the decision-making context and identification of potential CARIWIG case studies. Three of the four aims and objectives of these case studies relate to the CARIWIG tools:

- To provide a real-world testing ground and demonstration platform for the CARIWIG tools
- To enhance the utility of the CARIWIG tools for regional decision makers
- To demonstrate the value of the CARIWIG tools for regional decision makers

The case study selection criteria also refer to the CARIWIG tools:

- Should contribute to capacity building within the region using CARIWIG tools
 - Ability to significantly benefit from the application of the CARIWIG weather generator, and other climate modelling, vulnerability and risk assessment tools and methodologies
 - Studies selected must/should have the potential to become the most robust studies and provide the most benefits to stakeholders

¹ <http://www.cariwig.org/en/presentations/workshop/>

2.3 The workshop outcomes

The workshop is considered to have been very successful in terms of meeting the specific objectives (listed in §2.1). This is evident from the feedback forms which were completed and returned by 17 participants. The vast majority (15-17) of respondents rated the clarity of objectives, content, facilitation and relevance as either good or very good. Learning about the various CARIWIG tools and the web services was highlighted by many respondents and many comments indicate that stakeholders found the workshop useful in understanding the potential relevance and importance of the CARIWIG project and tools for their organisation. The fewer negative comments tend to indicate the high level of interest: requests for more practical examples of the tools and their outputs and application; more information; and, a desire for hands-on experience of the tools. These points will be addressed as work progresses – particularly in implementation of the CARIWIG case studies and development of plans for the second CARIWIG workshop and training event (currently scheduled for Spring 2014).

The focus group discussion outcomes are reported in the following two sections and generally confirm the perceived utility of the proposed tools and web service.

3 The CARIWIG tools

Table 1 provides a brief overview of the CARIWIG tools. Additional information is available in the meeting presentations 1.

Based on a recommendation from the workshop, short (one page) briefing notes are being produced for each tool, together with another providing an overview of methods for the development of climate projections (and explaining the distinction between shorter-term forecasts and predictions and longer-term (several decades, out to the end of the century) climate projections).

Climate projections will initially be based on RCM (PRECIS) downscaled GCM runs (HadAM3P, HadCM3Q0, ECHAM4, ECHAM5) for a range of time periods (from 1961-2099) and three SRES emissions scenarios as set out in Table 6. During later stages of the project and beyond, it will be possible to use additional RCMs including simulations undertaken within the CORDEX framework² using Representative Concentration Pathways rather than SRES.

² <http://wcrp-cordex.ipsl.jussieu.fr/>

Tool (reference)	Geographical coverage	Spatial and temporal scale	Variables	Projected changes
Weather generator (§3.1)	Any station locations with sufficient observed data for calibration	Daily time series for (initially) about 40 locations	Rainfall, temperature (mean, max. and min.), vapour pressure, sunshine duration, wind speed, relative humidity. Diffuse and direct radiation. Reference potential evapotranspiration. Note ³ .	Monthly change factors from RCMs
Tropical storm model (§3.2)	Module 1: Any station locations with sufficient observed data Module 2: Basin wide	Module 1: Daily time series for (initially) about 40 locations Module 2: Hourly data	Module 1: Rainfall Module 2: Maximum surface wind speed	Module 1: Monthly change factors from RCMs Module 2: Changes in the El Nino Southern Oscillation or the Atlantic Warm Pool location from GCMs
RCMs (§3.3)	See Figure 1.	25 or 50 km grid boxes	See Table 2 for PRECIS daily variables	Initially SRES to 2040 or 2099 PRECIS simulations – see Table 6

Table 1 – Overview of the CARIWIG tools

TOTAL DOWNWARD SURFACE SW FLUX
MAXIMUM TEMPERATURE AT 1.5 METRES
MINIMUM TEMPERATURE AT 1.5 METRES
MEAN TEMPERATURE AT 1.5 METRES
RELATIVE HUMIDITY AT 1.5 METRES
WIND SPEED AT 10 METRES (WIND GRID)
POTENTIAL EVAPORATION RATE
TOTAL PRECIPITATION RATE

Table 2. Variables archived from PRECIS RCM

³ The availability of each variable depends on the availability of suitable meteorological observations at each location.

3.1 The CARIWIG weather generator

Weather generators were developed to produce long weather sequences with the same characteristics as observed weather. This helps estimate the hazard of extreme events and impacts (for example on agriculture or hydrology). In a climate change context, they can perform a statistical downscaling role by providing locally relevant weather scenarios that correspond to future projections of climate models (e.g. the UKCP09 weather generator; Jones et al., 2009).

The weather generator developed for UKCP09 will be adapted for the Caribbean region. It is comprised of two parts: a stochastic conceptual rainfall model; and a conditional auto-regressive weather variable generator. The rainfall model simulates rainfall occurring in storms formed of clusters of additive raincells (simple rainfall generating events). Other weather variables (mean temperature, temperature range, vapour pressure, sunshine duration and wind speed) may be simulated by the auto-regressive generator conditional on rainfall. Potential Evapotranspiration (PET) may also be estimated from these. Model calibration requires about 30-years of observed records of each weather variable.

The properties of future climate weather scenarios are derived by applying either differences or ratios of regional climate model projected changes in precipitation (daily mean, variance, proportion dry, skewness and autocorrelation), temperature, temperature range, sunshine, wind speed and vapour pressure, to observed weather properties. The future scenarios may then be simulated by the weather generators.

Benefits and Utility	Improvements Desired by Workshop Participants
Provides high-resolution (station point scale) downscaled information	Inclusion of more than 40 stations
For building resilience into construction works	Better access to data from existing sites in order to represent all parts of the region/islands. Water and agricultural agencies and companies, for example, may be able to help as well as meteorological agencies.
Necessary level of detail for supporting different agricultural project areas (infrastructure, marketing, flooding resilience etc)	Hourly timescale
Useful to the water agencies for projecting water resource availability	Reliability will depend on quality of input information (both from station observations and RCM simulations)
Historical information helpful in fisheries sector	Need for validation of performance.
Useful for improved management planning and decision making, including deployment of financial and human resources	
For building resilience into construction works	

Table 3 – Key perceived benefits and utility of the CARIWIG weather generator and desired improvements.

3.2 The CARIWIG tropical storm model

There have been several improvements in the statistical and dynamical models used to predict or project tropical storm activity, including updated and improved datasets, simulations of hurricane activity at higher resolutions and new satellite based intensity analyses. The CARIWIG tropical storm model aims to build on these developments. The tool is being developed along two approaches. The first uses daily data for stations across the Caribbean and attempts to develop a methodology for identifying extreme rainfall events that may be associated with tropical storm/ cyclone activity. The methodology can then be applied to the outputs of the CARIWIG Weather Generator (§3.1) to suggest future changes in rainfall events attributable to tropical storm/cyclone activity. Inferences may also be possible about the frequency and intensity of tropical storm/cyclones in the future.

The second component of the tropical storm model will allow the stochastic modelling of tropical cyclone tracks. This will allow for the computerized generation of a large number of synthetic cyclone tracks and should allow users to assess a number of parameters including maximum wind speeds and land fall rates for present day and future scenarios for any Caribbean location of interest. The relationship between tropical cyclones and the El Nino Southern Oscillation or the Atlantic warm pool will be used to incorporate the influence of a changing climate on storm tracks and their impacts.

Benefits and Utility	Improvements Desired by Workshop Participants
All four variables – wind speed, tropical storm frequency, landfall rates and cyclone tracks - are important	Speed of the tropical storm should be included i.e. how long does a cyclone influence the weather conditions of a particular country?
Rainfall amounts and maximum winds very useful for utility sector	Rainfall rate per hour.
Will inform building codes and land use management practices	Linkages with storm surge modelling and sea level rise desirable in the future (for coastal zone management)
Could help fashion insurance programmes for the agriculture sector and more generally	
Wind speed useful for determining crop damage	
Important for coastal zone management	
Useful for physical planning and for sector planning and economic development	

Table 4 – Key perceived benefits and utility of the CARIWIG tropical storm model and desired improvements.

3.3 Regional climate model-based projections

General Circulation Models (GCMs) are the most appropriate tool for assessing the future climate. A typical GCM resolution (~300 km) provides a reliable simulation of the general atmospheric circulation at large scale, but is not adequate to solve meso-scale details required for regional and national studies. To address the inadequacy of the resolution we can use a regional climate model (RCM) that uses a technique called dynamic downscaling to generate higher resolution output from a GCM input.

One of the main goals of regional climate models (RCMs) is to reproduce the main climatic features in complex terrain, where mesoscale forcing becomes important (Giorgi and Mearns, 1991) and coarse-resolution GCMs are not sufficient for assessing local climate change (Aldrian et al., 2004). An example of a region where present-generation GCMs are especially lacking in their ability to represent complex terrain and land–sea contrasts is the Caribbean zone, where thousands of islands with a wide spectrum of extensions are surrounded by the Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico, limited by the coasts of North and South America. In this region, tropical and extratropical systems interact.

PRECIS, a regional climate modelling system developed by the Hadley Centre (Jones, et al, 2004), is initially the preferred tool. PRECIS is nested into a GCM output to generate future representations of the climate. In this study we used a set of different GCM's, Green House Gas (GHG) scenarios, domains, resolutions and time slices. In applying PRECIS it is not necessary to have climate information from observations although these are essential for model validation (i.e., how well does the model simulate present-day conditions?). However, as the model produces its own climate, it is recommended to combine observations with the modelled changes to provide more relevant information for users and stakeholders. Changes in important climate variables such as temperature and rainfall as well as in weather/climate events like tropical cyclones, cold fronts or droughts can be obtained from the RCM outputs. As new outputs from different RCMs/GCMs become available for the region these can be included into the CARIWIG analyses.

Benefits and Utility	Improvements Desired by Workshop Participants
Relatively high-resolution (higher than GCM) and spatially consistent information for many variables covering the whole region. More detail on regional characteristics.	Quantitative validation and assessment of performance – but may be limited by observed data availability especially in Eastern Caribbean
Output can be input to impacts models and other CARIWIG tools – e.g., the weather generator	Due to their size, small islands are still not well represented at 50/25 km and it is potentially dangerous to look at single grid points – so there is a need for still higher resolutions (e.g., 3 km).
	Better information about reliability and uncertainty and underlying assumptions - particularly with respect to parameters which are relevant for drought

Table 5 – Key perceived benefits and utility of Regional Climate Model based projections and desired improvements.

The list of currently available PRECIS simulations is shown in Table 6 and the two main domains used are shown in Figure 1. The experiments were obtained mainly using two different domains; one named CUBA_new_pole_1_final at 50 Km resolution that covers Central America, Mexico, all the Caribbean, and part of South America and the United States. The other domain, which was run using PRECIS version 1.8.2 at 25 km resolution, was substantially smaller in size but bigger in the number of points. The Caribbean_HighRes_25km-last-OK domain covers all the Caribbean region, Central Americas, part of Mexico and goes further to the east taking in this time Guyana and Suriname into account.

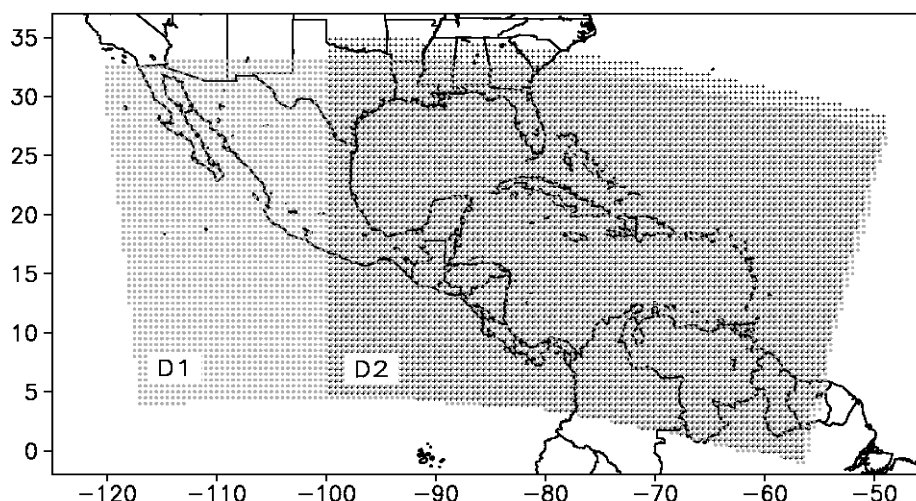


Figure 1. Model domains for which PRECIS RCM projections are currently available. Grey dots indicate the big domain (D1) at 50km resolution whilst black plus signs indicate the small (D2) domain at 25km resolution.

Driving GCM	Time Period	Emission Scenario ⁴
HadAM3P	1961-1989 2071-2099	SRESA2
HadAM3P	1961-1989 2071-2099	SRESB2
ECHAM4	1961-1989 2010-2099	SRESA2
ECHAM4	1961-1989 2010-2099	SRESB2
HadCMQ0	1961-2040	SRESA1B
HadCMQ3	1961-2040	SRESA1B
HadCMQ4	1961-2040	SRESA1B
HadCMQ10	1961-2040	SRESA1B
HadCMQ11	1961-2040	SRESA1B
HadCMQ14	1961-2040	SRESA1B
ECHAM5	1961-2036	SRESA1B

Table 6. Description of the PRECIS experiments developed to generate the initial climate change scenarios

⁴ From 1960 to 1990 observed GHG concentrations are used to provide information on atmospheric composition. Beyond this period, the evolution of GHGs follows the corresponding SRES emission scenarios.

4 The CARIWIG Web Service

In order to set the context and scope of the CARIWIG web service, a presentation was made to the workshop on the proposed service by the Newcastle University team who have primary responsibility for its technical development. Some of the key points from this presentation are summarised here:

- Web services and portal:
 - A server-based platform built on Open Source components made up of two servers
 - Data repository and processing, web services and caching
 - Extensible framework as new data comes on line
 - Delivered functionality will depend on:
 - Data that can be acquired
 - What pre-processing/aggregating can be carried out on this data
 - Effective and prioritised targeting of resources
 - Access to data is the main priority
- Basic portal concepts:
 - A portal is a door
 - A door is a pathway to a specific location.....
 - And a door is an opening to explore and.....
 - A door is a barrier (when locked)
 - A portal is not an application nor is it a replacement for scientific tools and analysis
 - Focusing on:
 - Locating relevant information
 - Assessing and exploring other data
 - Providing access to the data in a suitable form
- Data:
 - Two broad categories of data to support services and tools
 - Historic climate data
 - Derived products and any unrestricted station data
 - Projected climate data
 - Derived and unrestricted RCM data
 - Weather generator/storm model outputs
- Two types of services:
 - Synchronous processes
 - Maps, data, graphs etc - data is pre-processed or can be retrieved in a short amount of time
 - Most data should fall into this category
 - Asynchronous process
 - Data takes some time to be processed and will be queued
 - The weather generator tool fits in this category
 - The tropical storm model may fit in this category

- Types of tools/services:
 - Derived data (processed data either pre-processed or on the fly), e.g.
 - Gridded data, pre-processed by month and year
 - Maps
 - For data exploration and location overlay
 - Tools to select and limit data
 - Query tools e.g., climate variables, locations, temporal slices, climate change scenarios, etc, etc
 - Tools to request information and data
 - Images, map formats, data formats, graphs, raw data, metadata
 - Tools to visualise content
 - Maps, graphs, images
 - Links to information to make informed decisions
 - Administrative tools (manage users, jobs etc)
 - Weather generator and storm modelling job creation and submission

Both the Newcastle team and CCCCC in a presentation based on D2.1.1 (Identification and documentation of currently available tools, data and other products that currently provide information on climate and projections for the Caribbean) showed some examples of climate change related web services and portals and their content.

Based on this background material, cross-sectoral focus groups then assessed the utility of the proposed CARIWIG web service (§2.2). In general, the proposed functionalities and capabilities were welcomed by stakeholders and a number of additional guiding principles identified:

General scope

- There is a need for a comprehensive and integrated system for the Caribbean bringing together available tools and information
- The CARIWIG web service should not duplicate existing systems and services – but should link to these
- The service should provide both a Caribbean overview as well as details of regional and national characteristics. Thus it should integrate relevant global, regional and national information, and include data for all parts of the Caribbean (particularly all islands)

Interface look and feel

- Starting from the same map, the web service should allow drill down functionalities to more detailed information. Ideally, this scaling down should be seamless.
- Guidance and explanations are necessary for all datasets and tools – together with training – in order to build capacity and to prevent misuse of information. It is intended that online guidance material will be provided through the web service. Training will be provided to stakeholder technical staff through the case study process and through a focussed hands-on event towards the end of the project.

Provided data

- There is a specific demand for national information, i.e., country-averages based on observations, RCM outputs and historical data. At the same time, time series data should be available for specific locations.
- For point locations where the weather generator is implemented, it would be good to show the other data sets available for these locations and provide links to them.
- There is a strong desire for information based on historical observations, including longer term time series and charts (i.e., both spatial and temporal information).
- All products should be based on reliable and, wherever possible, consistent datasets.
- The web service needs to be flexible to allow the incorporation of new information (such as new RCM runs) as it becomes available.

Accommodating different target audiences

- Some pre-configured/pre-processed maps and datasets should be provided for different target audiences and stakeholder groups (various end users are envisaged including consultants, academia and technocrats).
- The differing needs in respect to the types and formats of information required by different types of user should be identified and catered to (e.g., a public policy analyst needing to give recommendations for policy choices vs. an engineer involved in planning). Needs vary along the user chain and over policy/decision-making chains (e.g., from government to more local stakeholders) and life cycles (e.g., development and implementation of a fisheries management plan). Some users need lots of data whereas a simple graph may be sufficient for others.

Accessibility and protocols, authentication and authorization:

- The web service should be easy to use and no other protocols to use the service should be necessary other than the user having to wait for the results (particularly from asynchronous processes).
- Thus, in a first instance, access should be open as far as possible. Access and usage should be straightforward without requiring a user to register or login or otherwise generally preventing quick access to the functionality of the tools or the majority of the data.
- Following further discussion on this issue, the research team has concluded that there should however be functionality for users to subscribe to notifications about updates and changes of datasets.
- In the event that datasets are provided that require specific “**Conditions for access and use constraints**” or have “**Limitations on public access**” then a functionality to unlock these datasets by registration and functionalities to ensure that these specific conditions are satisfied, or instructions on the protocols to follow in order to do so, may be provided.

These expressed requirements and principles are generally consistent with the functionalities and capabilities proposed by the research team. Some new functionality has already been identified and work commenced, e.g., following the workshop monthly averages have been produced for Caribbean countries (together

with regional series for the eastern and western parts of the Caribbean) using the observed gridded (0.5 by 0.5 latitude/longitude degrees) CRU TS dataset for a number of variables (mean temperature, diurnal temperature range, precipitation, vapour pressure, sunshine and potential evapotranspiration).

Other issues raised in the workshop discussions require further consideration by the research team and ongoing consultation with stakeholders (e.g., in the context of the CARIWIG case studies):

- To what extent is sector-oriented packaging desirable and feasible within the web service itself?
- How can the web service be used to help bridge the gap between policy (see D1.2.1/KD1.2.1) and climate information?
- How to handle the expressed needs for information which is not available from the CARIWIG tools (e.g., with respect to sector specific impacts data, storm surges and sea level rise)?

Some of these issues relate to communication issues and in particular to the transfer and translation of information down to the very local level (e.g., to the farmer level). Thus they perhaps relate more other activities built around CARIWIG (§2) rather than to the specific focus of CARIWIG on the providing of climate information tools to stakeholder groups. It is also important to aim for a web service that can realistically be implemented within the lifetime and resources of CARIWIG while still providing the potential for further development and enhancement in the future.

Sustainability

Whilst the formal web service deliverable will be at the end of the project (i.e. at the end of the CARIWIG project web service development cycle), the project work plan involves the provision of prototype web based services as soon as suitable data is available. Such a service will be necessary for stakeholder engagement as part of the case study activities and for training and feedback associated with the second Workshop. Stakeholders will provide feedback in response to which there will be the opportunity to further revise the web service.

Whilst the web service will be both developed and initially hosted at Newcastle, through the training, installation and deployment activities of the project the web service will be additionally hosted at partner locations in the Caribbean. This service will continue to be mirrored at Newcastle.

It is in the interests of the partner organizations to maintain the web services, and both the proposed development of the service and the associated capacity building will ensure the persistence of the website beyond the end of the project. Furthermore, Newcastle University guarantees to host the web service for a minimum of 12 months from the Project Completion Date. The web service will be absorbed into the clearing house function of the CCCCC and will be maintained as one of the many tools that are provided for the cadre of Climate Change professionals in the Caribbean. In fact the clearing house function (a one stop regional functionality for all climate change related information and issues) is a core service of the CCCCC, one which has not been assigned to any other regional organisation. This will ensure the sustainability of the CARIWIG web service.

5 Conclusions

It is concluded that the proposed CARIWIG tools and web service (see KD5.3.1) can meet the majority of stakeholder requirements for climate information expressed during the workshop. The very positive feedback from this workshop indicates their potential utility for decision making and that the proposed approaches are sound and appropriate. They will be developed in the light of the workshop discussions and further refined and evaluated in the context of the CARIWIG case studies (see KD5.1.3). It was particularly satisfying that during the second day workshop discussions, stakeholders were able to identify some very specific examples of where particular tools could feed into particular case studies. Feedback from the second workshop and provision of supporting training and guidance in their use will also be an important component of ongoing work. Preparation of scientific publications describing these tools will help to demonstrate that they are sufficiently robust and reliable for use in decision making (see KD6.3.1).

Underlying all the CARIWIG tools and web service, is a requirement for appropriate observed data. Ongoing work by the CARIWIG research teams on identifying data sources together with the workshop discussions highlight the need for improved access to observed climate data within the region.

Appendix: Regional Stakeholders in Attendance

Name	Representing	Country
Avril Alexander	Global Water Partnership-Caribbean (GWP-C)	Trinidad
Victor Poyotte	Caribbean Water and Sewerage Association Inc. (CAWASA)	St Lucia
Ms. Patricia Aquing	Caribbean Environmental Health Institute (CEHI)	St Lucia
Susanna Scott	Organisation of Eastern Caribbean States Commission (OECS)	St Lucia
Dr. Susan Singh-Renton	Caribbean Regional Fisheries Mechanism (CRFM)	St. Vincent and the Grenadines
Saudia Rahat	Caribbean Disaster Emergency Management Agency (CDEMA)	Barbados
Marvin Boyce	Coastal Zone Management Unit (CZMU)	Barbados
Mr. Vincent Gillett	Coastal Zone Management Authority & Institute (CZMAI)	Belize
Keith Nichols	Caribbean Community Climate Change Centre (CCCCC)	Belize
Tyrone Hall	Caribbean Community Climate Change Centre (CCCCC)	Belize
Ottis Joslyn	Caribbean Community Climate Change Centre (CCCCC)	Belize
Timo Baur	Caribbean Community Climate Change Centre (CCCCC)	Belize
Arnoldo Bezanilla	Institute of Meteorology in Cuba (INSMET)	Cuba
Humberto Gomez	Inter American Institute for Cooperation in Agriculture (IICA)	Trinidad
Nigel Durrant	Caribbean Community Secretariat (CARISEC)	Guyana
Manuel Pereira	Caribbean Desalination Association (CaribDA)	Curacao
Rupert Lay	Organisation of Eastern Caribbean States Commission (OECS)	St. Lucia
Cedric Van Meerbeeck	Caribbean Institute of Meteorology and Hydrology (CIMH)	Barbados
Shawn Boyce	Caribbean Institute of Meteorology and Hydrology (CIMH)	Barbados
Leslie Simpson	Caribbean Agricultural Research and Development Institute (CARDI)	Jamaica
Tina Williams	Caribbean Catastrophic Risk Insurance Facility (CCRIF)	Jamaica
Mr. Herbert Thomas	Water Resources Authority	Jamaica
Mr. Hopeton Peterson	Planning Institute of Jamaica	Jamaica
Mr. Ignatius Jean	Inter American Institute for Cooperation in Agriculture (IICA)	Jamaica
Dr. Michael Taylor	University of the West Indies (UWI)	Jamaica
Jayaka Campbell	University of the West Indies (UWI)	Jamaica
Tannecia Stephenson	University of the West Indies (UWI)	Jamaica
Aidan Burton	University of Newcastle (NCL)	UK
Phil James	University of Newcastle (NCL)	UK
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