

## **Item 10.0**

### **CLIMATE CHANGE IN THE FALKLAND ISLANDS A Project by the United Kingdom Falkland Islands Trust.**

#### **INTRODUCTION & BACKGROUND**

The United Kingdom Falklands Trust (UKFIT) is undertaking a project to investigate climate change in the Falkland Islands.

The Project started in late 2010 and involves 4 key parts:-

1. Acquisition and collation of all relevant weather records for the region.
2. Submission of the full data set of these records to competent and interested persons for analysis and comment on extent and direction of climate change in the Falklands.
3. Climate modelling to provide some more detailed predictions of possible future climates using appropriate models and modelling expertise that can be found in various specialized units in the UK.
4. Sectoral review to analyse how climate change might impact on governance and planning in the Falklands.

*Parts 3 and 4 will form the basis of an external funding bid.*

#### **EXECUTIVE SUMMARY**

All available weather records for the Falkland Islands and a wide range from southern Patagonia have been sourced and tabulated to enable analyses of spatial distribution and long term change to be evaluated. Rainfall distribution is broadly divided on a north – south basis with an obvious influence of altitude and relief. Seasonal differences are also relatively proportionate. The first digital elevation maps for rainfall distribution for the Falklands has been generated. Temperature records are less extensive and require further analyses.

The data is of sufficient quality to proceed to analyse long term changes and likely predictions. Long-term rainfall sequences from the Falklands and two stations in Patagonia show a cyclic tendency with rainfall tending to increase at all 3 stations. Already Suggestions have been made for the type of analyses to be carried out. This is the stage at which the project will require funding to proceed though the project might realistically come under the umbrella of the proposed SAERI. If some local funding were available, at least part 3 of the project (analysis of climate change) could be progressed now that the data is available and some preliminary spatial analysis has been carried out to indicate the type of presentation and parameters possible. FIG might consider this a reasonable investment, given the work already put into this project by UKFIT. Already the data are being used or worked on as part of a range of local projects eg, crop production, animal health, biodiversity. Part 4 of the project- analysis of the level of risk and potential mitigation measures- is the subject of a bid for further funding and a widening of the organisations and groups which can make an input to the project.

#### **PROGRESS REPORT**

## Part 1 – Acquisition of relevant data

### *Falkland Islands*

All known weather records for the Falklands have been sourced (Fig.1). These have come from a variety of sources including:- Dept of Agriculture records; Meteorological Office (UK) records; British Antarctic Survey reports; records from farms where the Grasslands Trials Unit operated in the 1970s. In the case of the latter, fortunately copies had been kept (by JMCA) as the originals were largely destroyed when Argentine troops occupied the Stanley Meteorological Office in 1982. Manfred Keenleyside has supplied a run of rainfall records (since 1874) that he has collated and also some other weather records. There are rainfall records of varying lengths from those stations mapped on Fig 1. and temperature records from Chartres, Westpoint Is, Fitzroy, Port Howard, Darwin, Fox Bay, Stanley and MPA. There are wind speed and direction, atmospheric pressure, cloud cover and humidity data available for some years from Stanley..

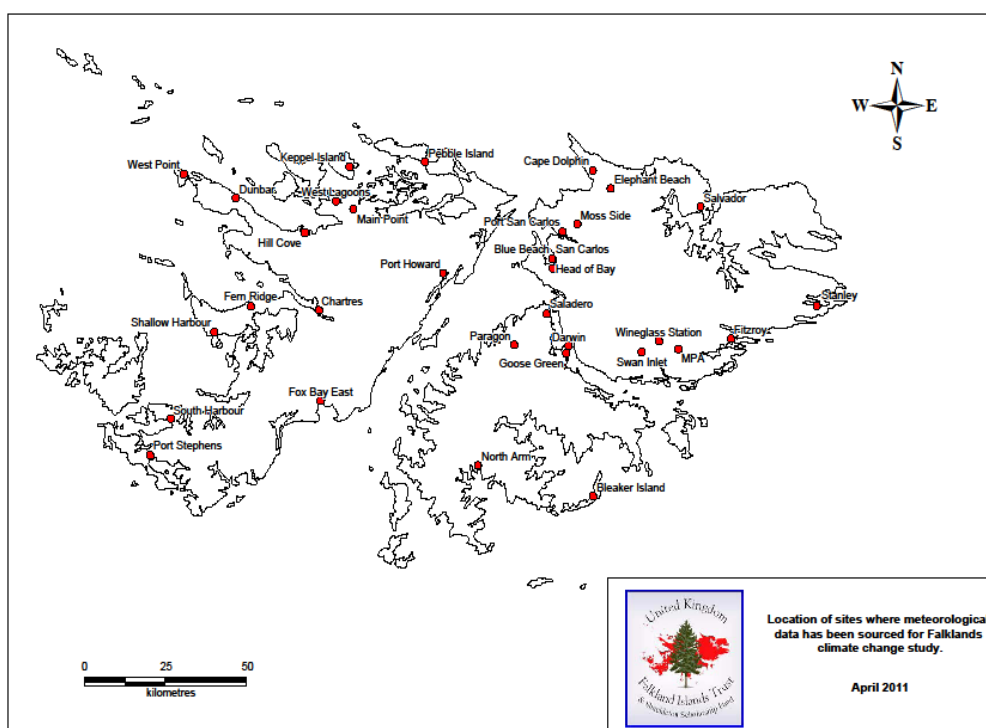


Fig 1. Site locations for weather records, Falkland Islands.

### *Southern Patagonia*

As much of the weather in the Falklands comes from a westerly direction, an indication of what is happening in southern Patagonia (including Tierra del Fuego) is extremely important. Rainfall and temperature records exist since 1888 and wind speed and direction, atmospheric pressure, cloud cover and humidity data for some years from Punta Arenas. Short term records (1995-99) have been sourced for two research stations on Chilean (northern) Tierra del Fuego (Vicuna and Rio Condor). To cover eastern Tierra del Fuego, long term records have been sourced from two Estancias (Cullen, 100yrs; Maria Behety, 50 yrs) and at Rio Grande (1979-2007).

### *Antarctic Peninsula.*

These data are all readily and publicly available for free download.

All these data are now available on Excel spreadsheets and are available to Nick Rendell. They are now in a form where they can be easily accessed and processed.

*Data analysis and presentation*

Analysis of long term changes in climate from weather records is not straightforward and trends cannot be easily seen from simple graphs of annual means. It is variation around the means which is most important and this is where the input from suitably qualified climate change specialists is necessary. To illustrate the value of some of the data, some analyses are presented.

**i. Seasonal variation in rainfall distribution across the Falklands.**

All available records for camp stations for which more than 10years of records are available are included in this analysis. Individual station records clearly show the consistent spring depression in rainfall across the islands.

	SPRING	SUMMER	AUTUMN	WINTER	TOTAL
East Falkland	100.6	155.4	146.9	127.0	534.2
West Falkland	102.7	153.1	154.2	138.9	555.0

Table 5. Mean seasonal and annual total rainfall ( mm) for East and West Falkland

While these data would permit, for example, a comparison between East and West Falkland, given the reasonable distribution of stations for which records are available, use of a GIS package better illustrates the spatial distribution across the islands, with the seasonal and annual distribution patterns much more related to relief and showing a more distinct north-south split rather than an east-west one for annual distribution. (Fig 2).

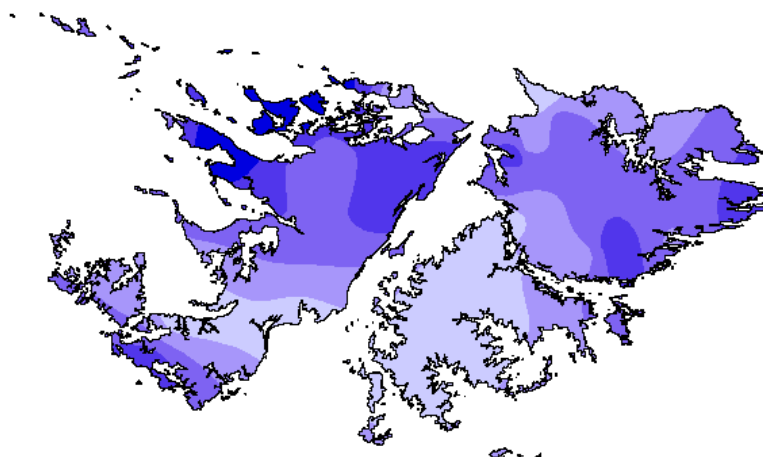
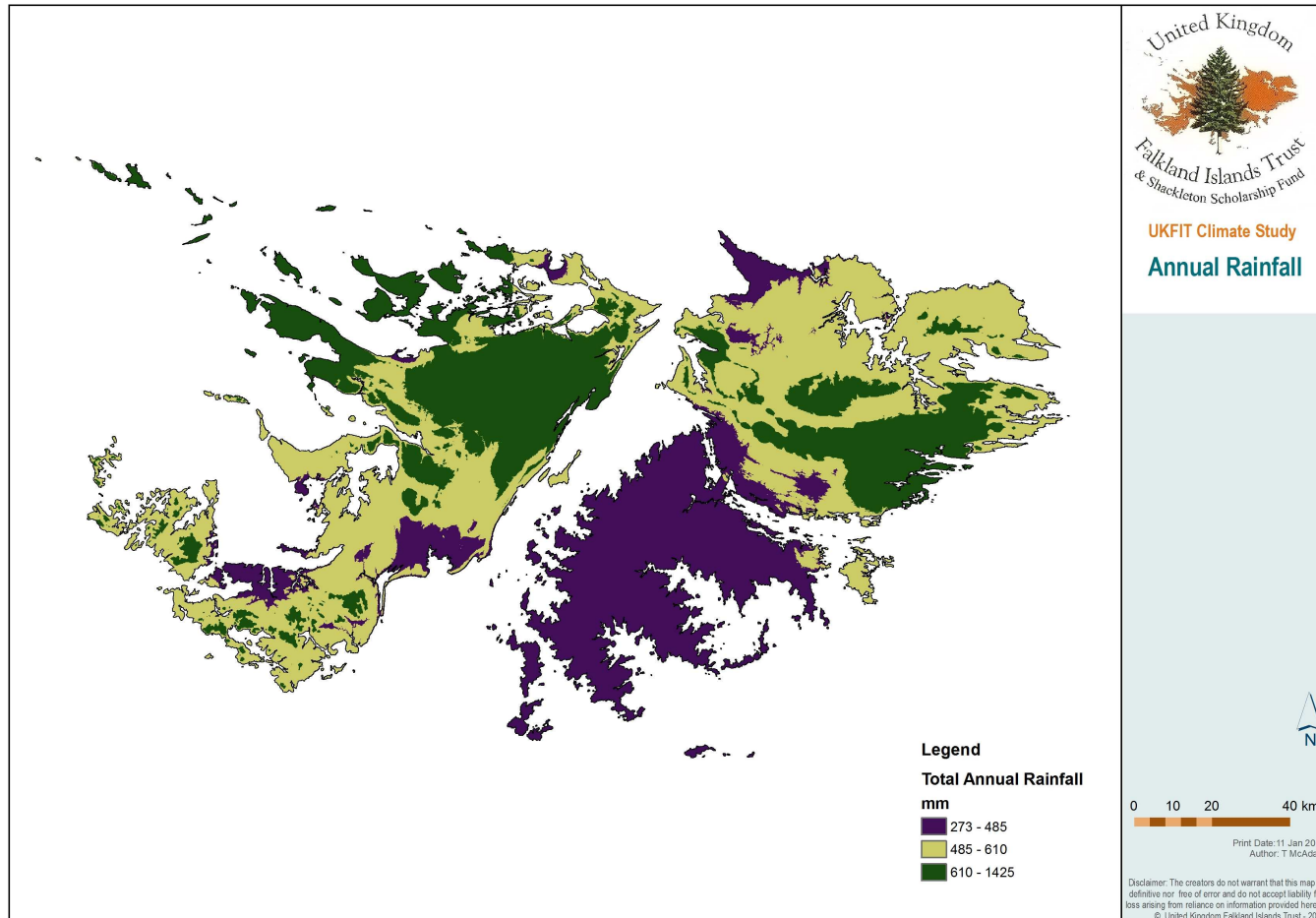


Fig 2. Falklands Islands Rainfall Model (surface stations) (Darker blue= higher rainfall)

Rainfall increases with elevation and, while most weather recording stations in the Falklands are at near sea level, there is some published research from other countries (eg western side of the Rockies) which has found a fairly constant, linear relationship between altitude and rainfall. Such elevation models are the backbone of most environmental planning, prediction and resource allocation programmes. Some of the findings from the research in the Rocky Mountains, Canada, Australia and Northern Ireland have been used (Tom McAdam) to calculate a factor of about 1.8 times rainfall at 700m than at sea level for the Falklands. The resultant rainfall distribution map based on elevation and using a best-guess estimate for the relationship between rainfall and elevation in the Falklands is presented in Fig 3.( next page). This is the first digital elevation map to be produced for rainfall over the Falklands.

Fig 3. Falkland Islands Rainfall Model (adjusted for elevation)





**ii. Long term changes in rainfall in the region.**

Fortunately there are 3 locations in the region with more than 100 years of rainfall records - Stanley, Punta Arenas and Estancia Cullen ‘ A comparison of the long term trends shows some similarity between the locations but undoubtedly a lot more can be extracted from these data (Fig 5).

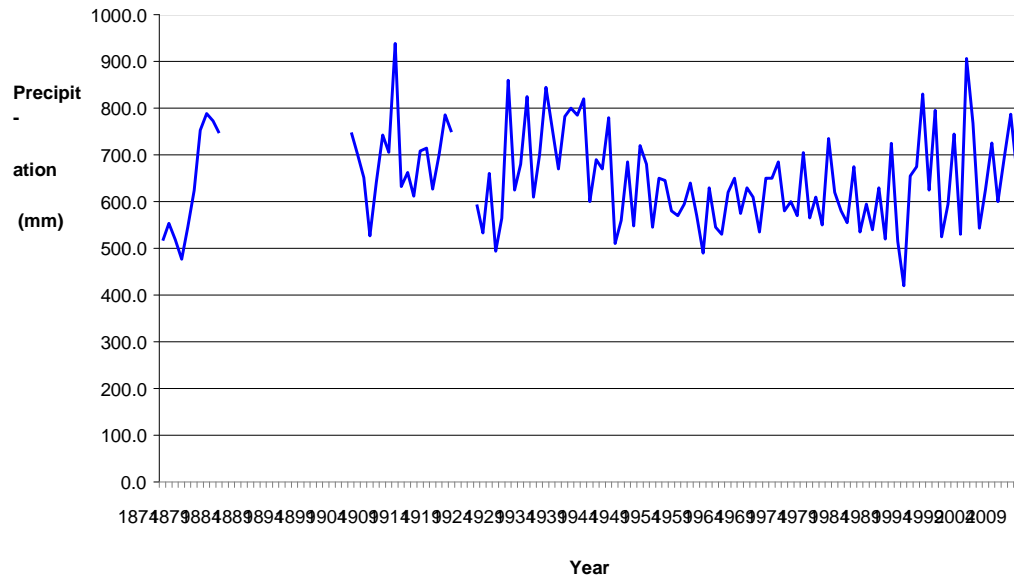


Fig 4a Annual precipitation for Stanley for the period 1874-2010

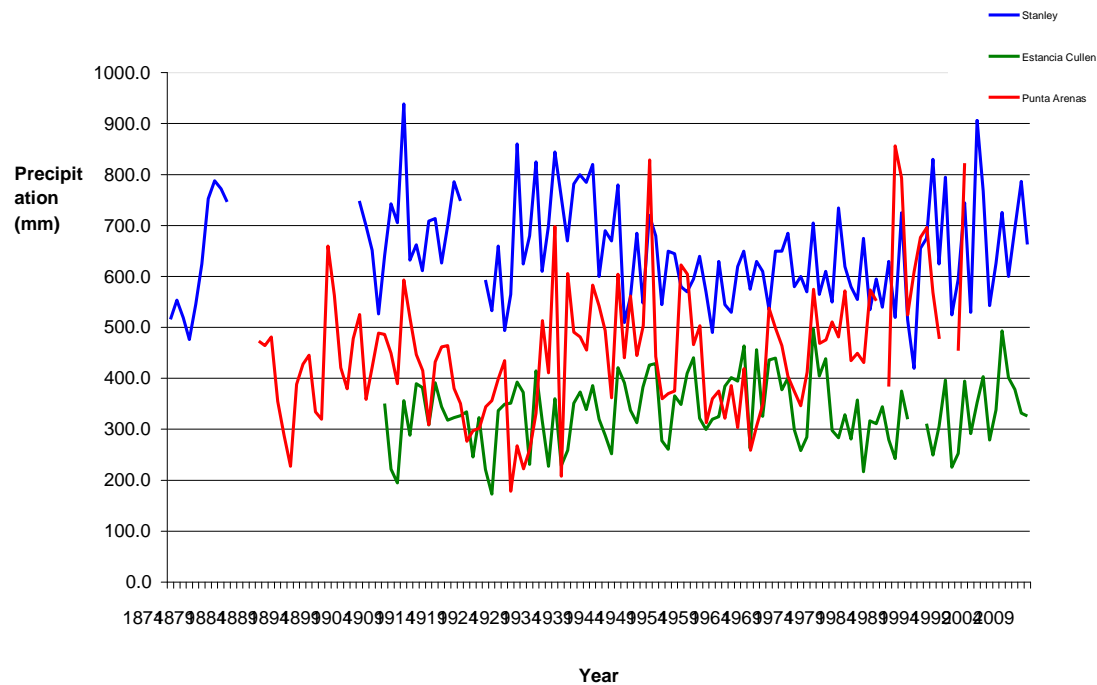


Figure 5 . Long term rainfall records over approximately a 100 year period for: a. Stanley, b. Punta Arenas, c. Estancia Cullen..

Overall, the rainfall at Stanley appears to be cyclic and becoming more similar to that of Punta Arenas, but there are wide fluctuations.

***Part 2 Comment on the data by Professor Nick Betts, Queens University, Belfast***

Prof Betts, an international authority on glaciology and climate change has commented that there is a good spatial network of stations providing data and that for the area, the network is sufficient to give indications of climate change. The location of southern Patagonian stations plus Port Stanley is useful, because it shows the impact on climate of islands in the shelter of a continental mainland within westerly airflows. This is particularly important regarding precipitation.



He states that the data indicates a drying and warming of the climate in the Falkland Islands.

Sea surface and land temperature data analysed by the UK Climatic Research Unit of the University of East Anglia suggests a steady increase in the number of warmer than normal sea conditions since the 1960s.

However, in the longer term, in contrast to some other UK Overseas Territories, there is unlikely to be any climate warming in the Falkland Islands. Scientists suggest that the initial strong melting of Antarctic ice due to global warming will result in cooler water and air temperatures, and increased cloud cover and levels of rainfall in the Falkland Islands. However, north of the Falkland Islands, water temperatures may be higher. So with this increased temperature gradient, there may be an increase in the intensity and frequency of extreme storms.

## **NEXT STAGES**

### *1. Extent and direction of climate change*

Discussions have been held with Professor John Sweeney (National University of Ireland, Maynooth) and he is trying to identify a suitable Masters student to undertake this analysis.

### *2. Modelling climate change in the wider South Atlantic context.*

This component of the project will require funding to commission an organisation with climate modelling expertise to conduct an analysis. That all the available records have been sourced will undoubtedly facilitate this process. Some organisations have been approached for expressions of interest and for expertise they can contribute-University of East Anglia (Dr Richard Davies); The Met Office ( Dr Richard Jones) are likely participants.

### *3. Sectoral review to analyse how climate change might impact on governance and planning in the Falklands.*

This would :-

- a. Address the likely impacts of climate change and their effects on the Falklands including:- agriculture; natural environment (terrestrial and marine); business; buildings and infrastructure; energy use and generation; health and wellbeing. This would follow the methodology used in the UK Climate Change Risk Assessment (UKCCRA) exercise just completed <http://www.defra.gov.uk/environment/climate/government/>
- b. Prioritise the recommendations of the UK OT global climate change report and propose how these can best be addressed by FIG.
- c. Propose a series of adaptation measures for the likely predicted climate-change scenarios.
- d. Review the Island Plan in the light of climate change scenarios, i.e. to introduce the concept of 'Climate-proofing' Government policy documents.

e. Consider and expand on opportunities created within the Falklands by potential climate change.

Funding to support this part of the project is being sought with RBG Kew, who may be able to bid in conjunction with UKFIT and Queen's University, Belfast under the EU's BEST (voluntary scheme for Biodiversity and Ecosystem Services in Territories of the EU Outermost Regions and Overseas Countries and Territories-[http://ec.europa.eu/environment/funding/finansup\\_12\\_best.htm](http://ec.europa.eu/environment/funding/finansup_12_best.htm)). Other options being explored are:- Regional Gateway for Technology Transfer and Climate Change Action in Latin America and the Caribbean (REGATTA).

## **OTHER APPLICATIONS OF THE DATA CURRENTLY BEING TAKEN FORWARD.**

### *1. Calculation of potential evapotranspiration*

From the perspective of the impact of climate on crop growth, calculation of Potential Evapotranspiration (ET) is the most valuable indicator of growth potential and will indicate if the Falklands are actually "drying up". Some limited work has been done on this by Sergio Radic and Andy Pollard. This will be extended using the rainfall data collected in this exercise and calculations made to determine if evapotranspiration is changing. Completion estimated early April.

### *2. Frequency of extreme events*

In a dry climate, the effectiveness of rainfall at bringing soils to field capacity (and hence capable of supporting plant growth) can depend on the frequency and severity of bursts of rainfall. Spring field capacity can depend on snowfall. The relationship between these parameters and how they are changing will be reported on. Completion estimated end April.

### *3. Potential impact on areas of high biodiversity*

In conjunction with Falklands Conservation, spatial analyses can be carried out on the Falkland Island botanical dataset overlaying with rainfall maps and other appropriate environmental data, to investigate likely impacts of climate change on species/ habitat distributions. Rebecca Upson is currently standardizing FC's botanical database (with over 41,000 plant species/ habitat records) to enable geospatial analyses within a GIS package. Completion of this preliminary work is estimated early to mid April. These data will allow impacts on vulnerable species and habitats/ invasive species to be investigated and these to be related, for example, to Important Plant Areas. The weather distribution maps can also be used with bird population data and results from the Shallow Marine Survey.

### *4. Comparison of change in wind speeds, direction and intensity of events.*

Nicolas Butorovic at the University of Magallanes wishes to compare wind frequencies, strengths and directions between Punta Arenas and the Falklands. I have tabulated and provided him with wind records from the Falklands.

*5. Analysis of the impact of climate on hydatidosis and other livestock diseases in the Falklands.*

Kevin Lawrence (previously a Vet in the Falklands) and Tom McAdam are using GIS and inputting the weather data sourced in this project so far (plus other “layers” of information-eg vegetation, geology, wildlife sites) to study the distribution of animal health across the islands and factors which may be affecting levels of disease/disorders.

*6. Close collaboration with the group in Imperial College, London under Dr Dominik Weiss.*

This group has applied for NERC funding to measure atmospheric deposition in peat bogs in the Falklands as an indicator of past climatic change and global environmental health. They are interested in regional climatic models.

**CONCLUSIONS.**

The first part of the climate change project is complete with sufficient records aggregated for long term climate change analyses. It is believed that most weather records available from any source for the Falklands and probably most for Tierra del Fuego has been sourced and put in a spreadsheet format. Some preliminary analyses show interesting trends within the islands and the comparison with wider regional trends may prove valuable in interpreting these. Studies using the data in a raw form and in GIS packages are already underway. Expert comment on the data indicates it is of sufficient quality to proceed to analyse long term changes and likely predictions. Suggestions have been made for the type of analyses to be carried out. This is the stage at which the project will require funding to proceed and external funding sources are being explored.

This work might realistically come under the umbrella of the proposed SAERI and if some local funding is available, at least part 3 of the project (Analysis of climate change) could be progressed now that the data is available and some preliminary spatial analysis has been carried out to indicate the type of presentation and parameters possible. FIG might consider this a reasonable investment, given the work already put into this project by UKFIT. It will be important to seek the expertise of other, interested parties.

**Acknowledgements**

I am extremely grateful to Manfred Keenleyside, Andy Pollard, Rebecca Upson, Enrique Freer, Sergio Radic, Rodrigo Olave, Fernando Coronato, Nicolas Butorovic and Natalie Goodall for assistance in the acquisition of weather records, to Professors Nick Betts and John Sweeney for comment on the data and suggestions as to how to proceed with the analyses and to Tom McAdam, a GIS specialist, working on rainfall distribution and water resource allocation in Australia for helping analyse and present some of the Falklands climatic data for the GIS analyses.

Jim McAdam

UKFIT

15<sup>th</sup> March 2012