PROPOSED FIELD LOCATION REPORT

DPLUS206 CLIMATE IMPACTS ON FI PAST, PRESENT AND FUTURE FRESHWATER DYNAMICS

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ABOUT THE SOUTH ATLANTIC ENVIRONMENTAL RESEARCH INSTITUTE (SAERI)

The South Atlantic Environmental Research Institute (SAERI) is an academic organisation conducting research in the South Atlantic from the tropics down to the ice in Antarctica. SAERI's remit includes the natural and physical sciences. It aims to conduct world class research, teach students, and build capacity within and between the United Kingdom's South Atlantic Overseas Territories. Its mission is to advance environmental understanding in the South Atlantic through research excellence and innovative scientific leadership. SAERI was a Falkland Islands Government initiative and operated as an arm's length government department from 2012 in July 2017.

Our vision is to be an internationally recognised academic institute with its main base in the Falkland Islands, operating in the South Atlantic from the equator down to the ice in Antarctica, conducting world class natural and physical science research, teaching students, and building capacity within and between the UK South Atlantic Overseas Territories.

Strategically, SAERI aims to be a world-class research institute that teaches students and builds capacity within and between the South Atlantic Overseas Territories. In order to achieve that it must be:

1. Project optimised – by operating as a streamlined and efficient organisation through the Focal Areas;

2. Fully funded – Falklands registered limited company is able to fund SAERI overheads, ensuring SAERI ultimately becomes fully financially independent from Falkland Islands Government and by ensuring that all grant applications (where possible) contain cost of seat coverage; and

3. The holder of proprietary environmental knowledge of the South Atlantic – by continuing to provide the research expertise offered to date.

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2. INTRODUCTION

We use satellite imagery from Landsat 5, 7, and 8, along with Sentinel-1 data (10–30 m resolution), to assess hydrological changes, specifically soil moisture and surface water dynamics over the past 30 years, and to examine how spatiotemporal trends relate to climate variability and land use practices.

For surface water analysis, we employed the Global Surface Water Explorer dataset, developed by the Joint Research Centre (JRC) under the Copernicus Programme. This dataset, derived from over 4.7 million Landsat scenes collected between 1984 and 2021, offers high-quality, global-scale maps of surface water extent and temporal change. Its classification products are particularly suitable for long-term hydrological monitoring and change detection [1].

We used two core products from this dataset: (1) the *Monthly History* (1984–2021), consisting of 454 monthly water detection maps, and (2) the *Yearly Seasonality Classification*, which provides annual classifications of water presence and seasonality. Both products have a spatial resolution of 30 m and classify pixels as water, non-water, seasonal water, or permanent water, enabling detailed temporal analysis of surface water patterns.

In the Falkland Islands, many shallow freshwater bodies commonly referred to as ponds are less than 1 m deep and vary in size from a few square meters to approximately 400 hectares. The islands also host several small rivers, ranging from narrow brooks a few meters wide to broader streams [2]. Due to the islands' unique geography and geology, these rivers are typically short and drain into creeks or inlets. While we were able to detect and map lakes and ponds using available surface water datasets, the current spatial resolution is insufficient for consistently detecting the narrower river water bodies in the Falkland Islands.

Nowadays, computational models are standard tools routinely used for runoff prediction in data scarcely regions or ungauged catchment. Rainfall-runoff information is important key for hydrological investigation [3]. There are different Rainfall-runoff models such as physically based models, distributed models, lumped models, conceptual models and statistical models for specific hydrological purposes. Selecting an appropriate model requires a solid understanding of the interactions among climate, topography, hydrology, and geology within the catchment. In addition, the choice of model depends on data availability, data requirements, model complexity, and performance, all of which are critical factors in achieving reliable rainfall–runoff simulations.

Currently, time series data for rainfall and temperature are available from Mount Pleasant Airport (MPA), located approximately 30 miles southwest of Port Stanley, with records dating back to the airport's establishment in 1986 [4]. Therefore, we selected the Hydrologic Modeling System (HEC-HMS), which is designed to simulate the full range of hydrologic processes in dendritic watershed systems. The model also offers advanced functionality for gridded runoff simulation through the linear quasi-distributed runoff transform method (ModClark).

3. METHODOLOGY

3.1. Study Area

Based on the available weather data, we selected the Swan Inlet River Basin, located on East Falkland Islands. The basin drains into Swan Inlet, a shallow coastal lagoon, and is characterized by cool oceanic climate conditions, sparse vegetation, and gently sloping topography. Swan Inlet River flows from Swan Inlet to Mare Harbour and Choiseul Sound with a total length of 13.6 km.

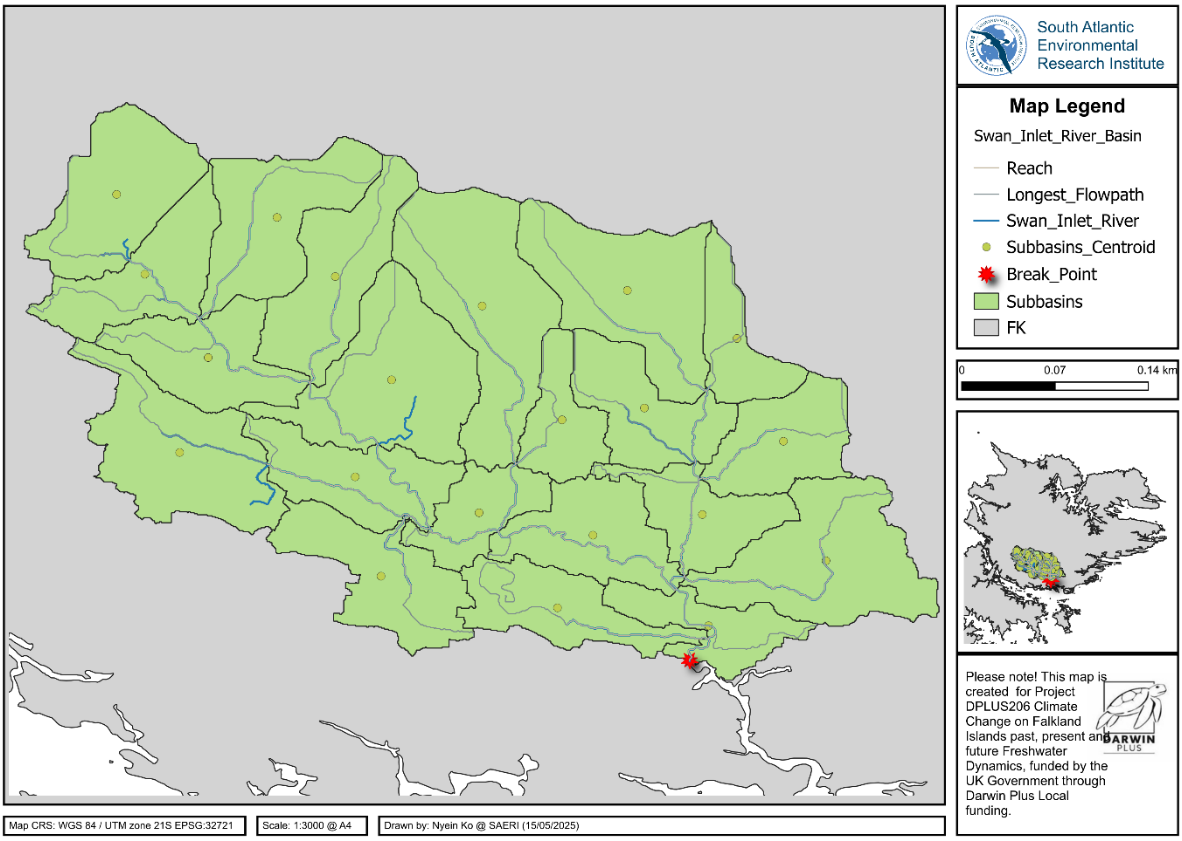

Figure 1 Swan Inlet River Basin with subbasins, reach, and breakpoint (outlet) created by using HEC-HMS

3.2. Data Collection and Processing

Hourly rainfall and temperature data spanning from 1 December 2000 at 00:00 to 31 March 2025 at 23:00 were obtained from the Mount Pleasant meteorological station, which offers the most complete and proximate observational record for the study area.

A 30-meter resolution Copernicus Digital Elevation Model (DEM) from April 2021 was used to delineate the watershed and its sub-basins using ArcGIS in combination with the HEC-HMS extension. Key terrain attributes, including slope, flow direction, and flow accumulation, were derived from the DEM to support hydrologic modelling.

Curve Number (CN) values were obtained from the GCN250m: Global Hydrologic Curve Number Explorer, a globally consistent dataset developed by USDA-ARS and Texas A&M University. This product integrates high-resolution land use and hydrologic soil group classifications at a spatial resolution of 250 meters [5]. The CN values were extracted for each sub-basin using GIS overlay techniques and averaged to represent spatially variable infiltration characteristics within the watershed.

3.3. Hydrologic Modelling Using HEC-HMS

Hydrological simulation was carried out using HEC-HMS (version 4.12), a semi-distributed model developed by the U.S. Army Corps of Engineers [6]. The watershed was divided into hydrologically significant sub-basins to represent spatial variability in rainfall-runoff processes.

We applied SCS Curve Number method to compute runoff losses from precipitation. This empirical method estimates the depth of direct runoff based on land use, soil type, and antecedent moisture condition. We used the GCN250m data to make sure high resolution and globally validated curve number input, which is particularly valuable in data-scare regions such as the Falkland Islands.

Excess rainfall was converted into direct runoff hydrographs using the SCS Unit Hydrograph method. This method, based on a synthetic triangular hydrograph shape, is well-suited for ungauged basins. Lag time was computed based on basin geometry and empirical formulas defined by the SCS.

We applied Muskingum method to model river routing to be able to account for both translation and attenuation of flow through channels.

4. RESULTS

The basin model was developed using HEC-HMS and configured with 20 sub-basins, each ranging in area from 7 to 24 square kilometres, and 16 reaches, with lengths ranging from 1 to 8 kilometres (Figure 2). The outflow of the Swan Inlet River at the designated outlet point (Sink-1) was simulated using observed hourly rainfall and temperature data from 1 December 2000 at 00:00 to 31 March 2025 at 23:00, obtained from the Mount Pleasant meteorological station (Figure 3). The outflow from each sub-basin was estimated based on the observed meteorological data, in combination with sub-basin area and topographic characteristics (Figure 4).

Since no observed streamflow data were available for the Swan Inlet River or its tributaries, model calibration and validation could not be performed. Therefore, the results presented in this study represent an initial estimation of runoff potential based solely on rainfall input, watershed characteristics, and hydrologic assumptions within HEC-HMS. These simulated flows provide a preliminary understanding of the basin's hydrologic response and highlight the applicability of the model in data-scarce environments.

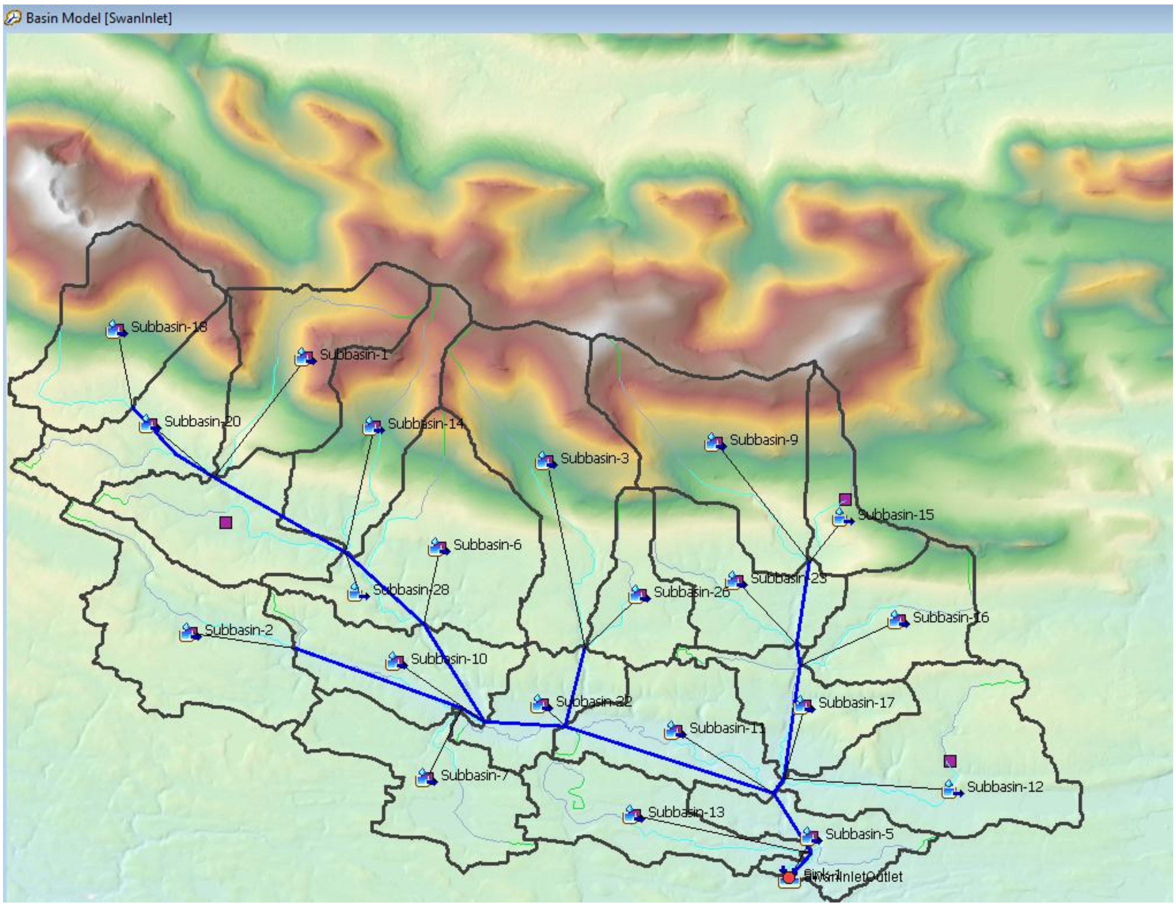

Figure 2 Swan Inlet River Basin Model with subbasins, reach and outlet point created by using HEC-HMS

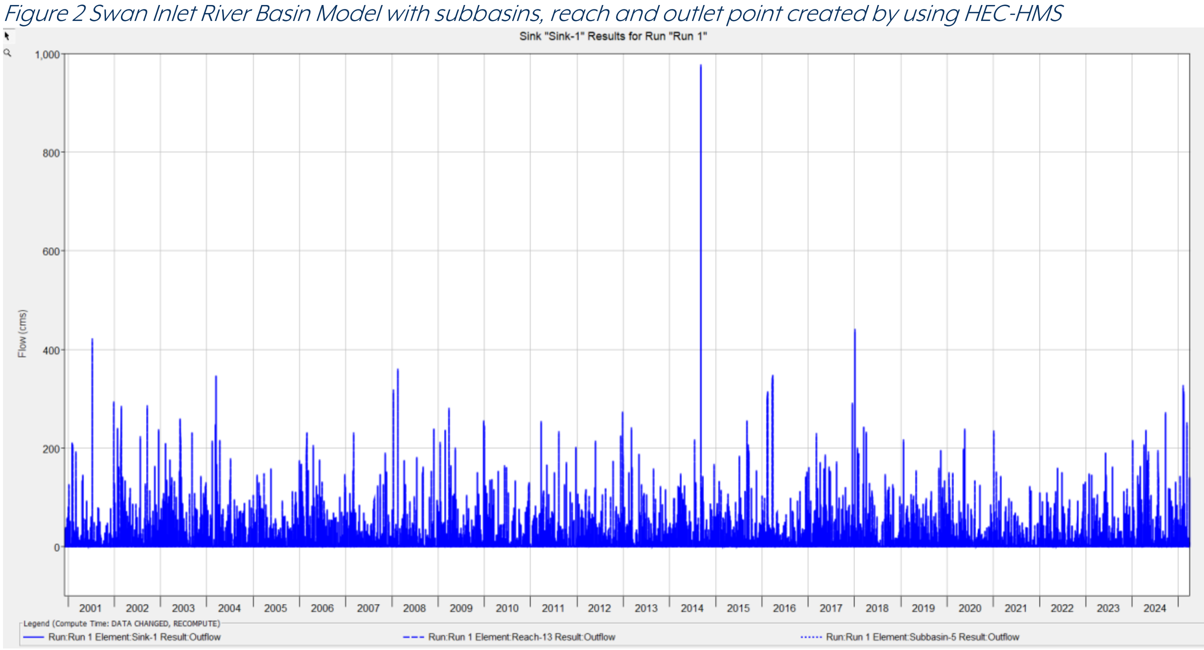

Figure 3 Estimated outflow (m^3/s) of Swan Inlet River using HEC-HMS

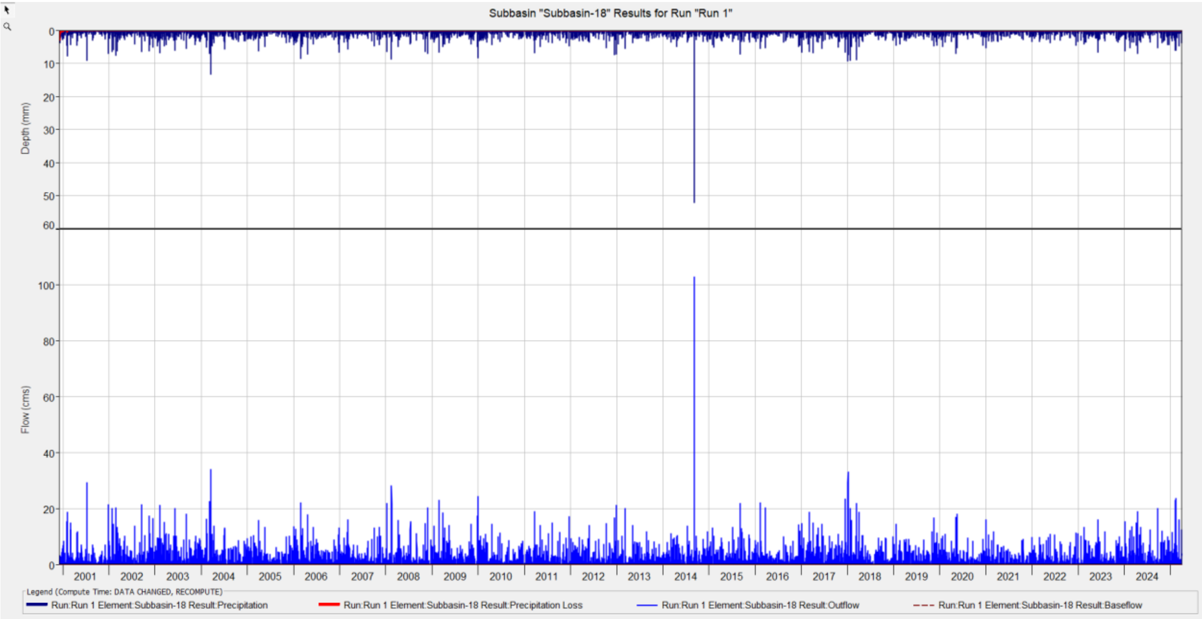

Figure 4Estimated outflow (m³/s) of subbasin-18 with precipitation using HEC-HMS

5. RECOMMENDATION FOR CONCLUSION

This study demonstrates the feasibility of using HEC-HMS to simulate river outflow in the Swan Inlet River Basin based on meteorological inputs and topographic data. The use of the SCS Curve Number, SCS Unit Hydrograph, and Muskingum routing method allows for a physically based yet computationally efficient approach to estimate runoff in ungauged basins.

However, due to the lack of observed streamflow or water level data in the Falkland Islands, the results remain uncalibrated. To improve the accuracy and reliability of hydrologic modelling in the region, it is strongly recommended that systematic hydrological monitoring be established. This should include the installation of stream gauges and water level sensors at key locations across the island's river systems. Such data would enable future studies to perform model calibration, assess hydrologic variability, and support flood risk assessments and water resource planning.

6. FURTHER FIELD OBSERVATIONS

We explored hydrological modelling to investigate the flow dynamics of the Swan Inlet River Basin. In alignment with the broader project objectives, we aim to expand in-situ hydrological monitoring across the Falkland Islands to enhance the accuracy of freshwater dynamics research supported by satellite remote sensing and hydrological models.

As part of this effort, we plan to install water level loggers (Baro Scout and Level Scout) in key rivers, including the Swan Inlet River, to obtain continuous water level data. These field observations will provide critical ground-truth information for model calibration and validation in future studies.

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