CARIWIG Case Study Report 11

Effect of climate change on water availability in the Font D'Or catchment, Saint Lucia

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Keywords: water resources, hydrological modelling, climate change Saint Lucia

Summary

The water supply of St. Lucia is largely dependent on surface water sources. The surface water catchments of St. Lucia are relatively small and often rapidly responding catchments, due to the volcanic nature of the Island. Over the last decade an increasing population and a growing tourism sector has resulted in pressures on the water supply system increasing. Due to these pressures, water outages occur regularly (FAO-AQUASTAT Saint Lucia 2015).

This case study assesses the projected impacts of climate change on river flows in the Font D'Or catchment, Saint Lucia, under two climate change scenarios. The climate change scenarios have been provided by the CARIWIG online tool and are from the ECHAM5 [Roeckner et al., 2003] and HADCM3 [Pope et al., 2000] climate models.

The hydrological modelling used to evaluate the impacts on river flows suggest that climate change could lead to a severe decrease in river flows for the Font D'Or catchment. The largest decrease is expected during the wet season, which could affect the replenishment of water storage systems. This may result in the reduced availability of water supplies. A decrease in the available surface water could have major implications for important sectors such as agriculture and tourism, which are particularly dependent on adequate water resources.

Aim and objectives

HR Wallingford was invited by the CARIWIG project team to undertake this study and this report describes the findings. The aim of this work is to assess the projected impacts of climate change on mean monthly river flows for the Fond D'Or catchment in Saint Lucia as an indicator of potential future water availability in the catchment.

Which tools were used? How and why?

Methodology

In order to assess the impacts of climate change on the Font D'Or catchment, a new hydrological model was developed and calibrated. Climate Change scenarios were then run through the calibrated model and the results were analysed in terms of the changes in monthly flows. This process is presented in Figure 1.

Thanks to the following stakeholder organisations who were involved in the case study:
Organization 1.
Organization 2.

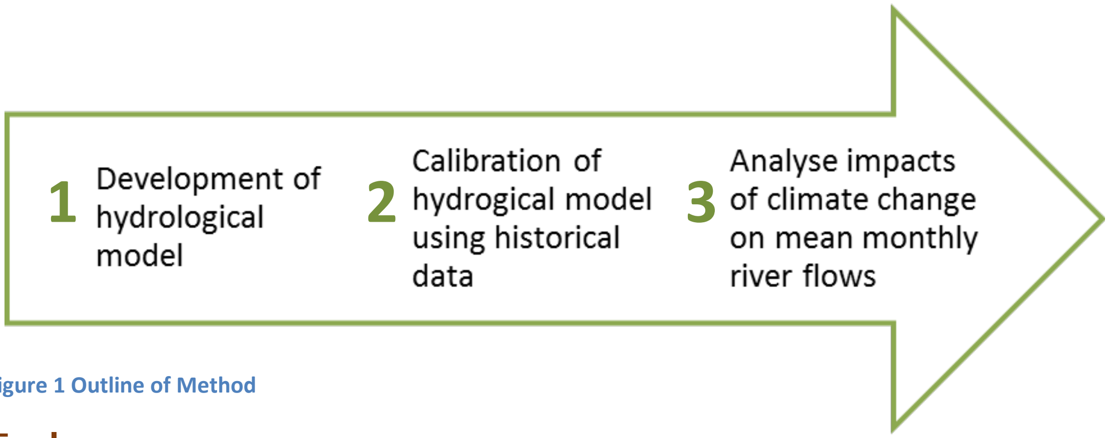

Figure 1 Outline of Method

Tools

Kestrel-IHM software

For the hydrological modelling of the Font D'Or catchment, the Kestrel-Integrated Hydrological Model (Kestrel-IHM) developed by HR Wallingford Limited was used. A baseline hydrological model was set-up using a modified form of the probability distributed model (PDM) [Moore, 1985, 1999, 2006; CEH Wallingford, 2005b]. Historical river flow data received from 19/03/1998 – 30/04/2005 for Font D'Or were used to calibrate the model. Figure 2 shows an overview of the surface water catchments in Saint Lucia.

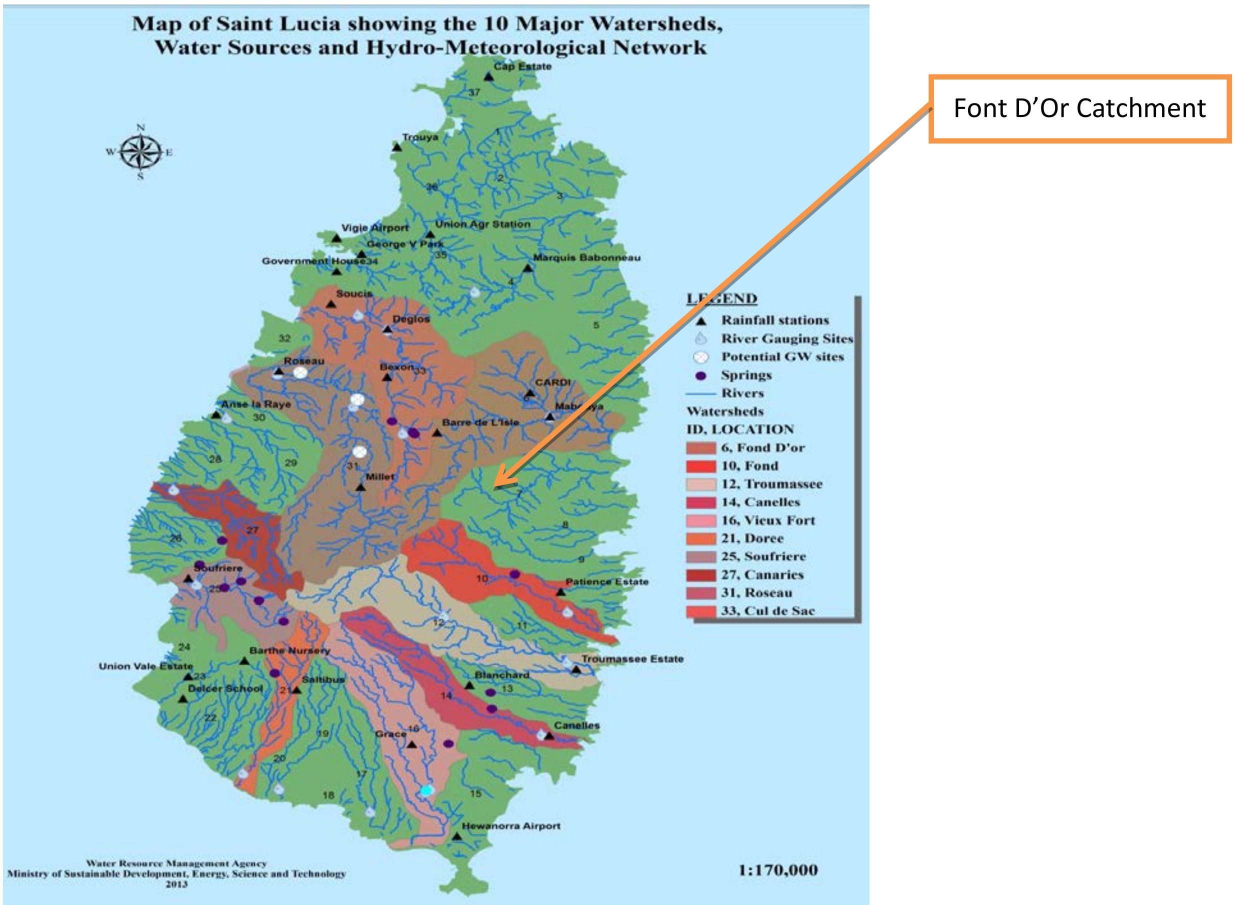

Figure 2: Overview of Saint Lucia surface water catchments, Courtesy of Water Resource Management Agency - Ministry of Sustainable Development, Energy, Science and Technology, Saint Lucia 2013.

CARIWIG Portal – Change Factors (Future Data)

The calculation of the projected river flows used the Climate Change data available on the CARIWIG portal. The most appropriate data for this analysis were monthly change factors. Change factors from two climate models are available, Echam5 [Roeckner et al., 2003] and HADCM3Q0 [Pope et al., 2000]. Three future time horizons have been considered: 2011-2040, 2041-2070 and 2071-2100. Two baseline time periods have been provided on the CARIWIG portal. For this case study the baseline period of 1971-2000 was selected. An example of the set of 12 change factors has been presented for change in precipitation in Figure 2.

Findings

Changes in flows for the Font D'Or River were calculated using the baseline hydrological model for the calibration time period 19/03/1998 – 30/04/2005. The set of 6 (2 climate models, 3 future time horizons) climate change factors were run through the model to create projected flow time series. These were compared to the baseline to calculate the change in mean flow for each month. The monthly changes in flows for the Font D'Or catchment are shown as Figure 3.

The CARIWIG portal supplies climate change factors. Change factors are dimensionless numbers that are calculated using a baseline period. A change factor of 1 indicates no change. A change factor larger than 1 is an increase compared to baseline, for example a change factor of 1.5 equals a 50% increase. A change factor smaller than 1 indicates a decrease compared to baseline, for example a change factor of 0.5 equals a 50% decrease.

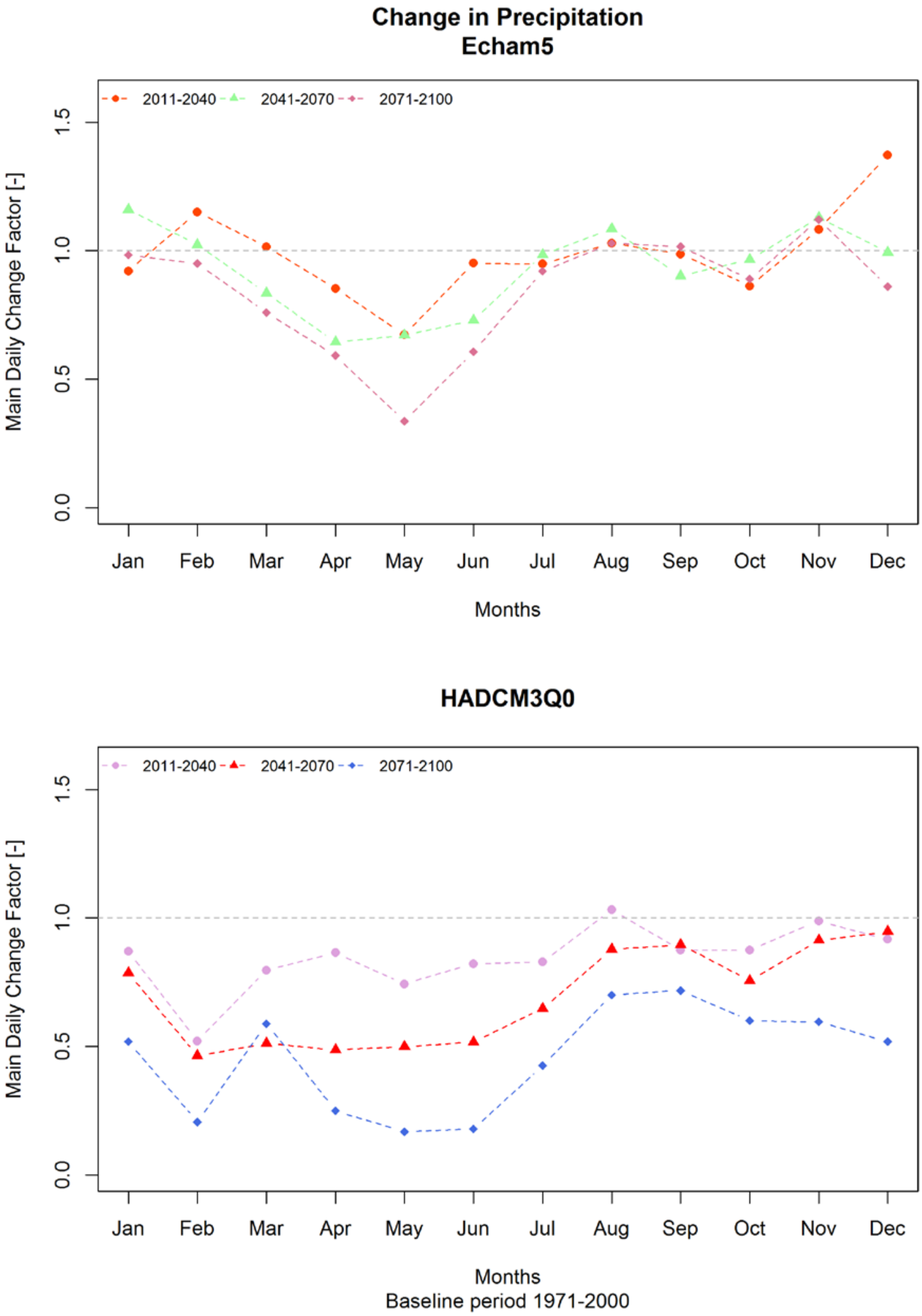

Figure 3: Change factors for Echam5 and HADCM3Q0.

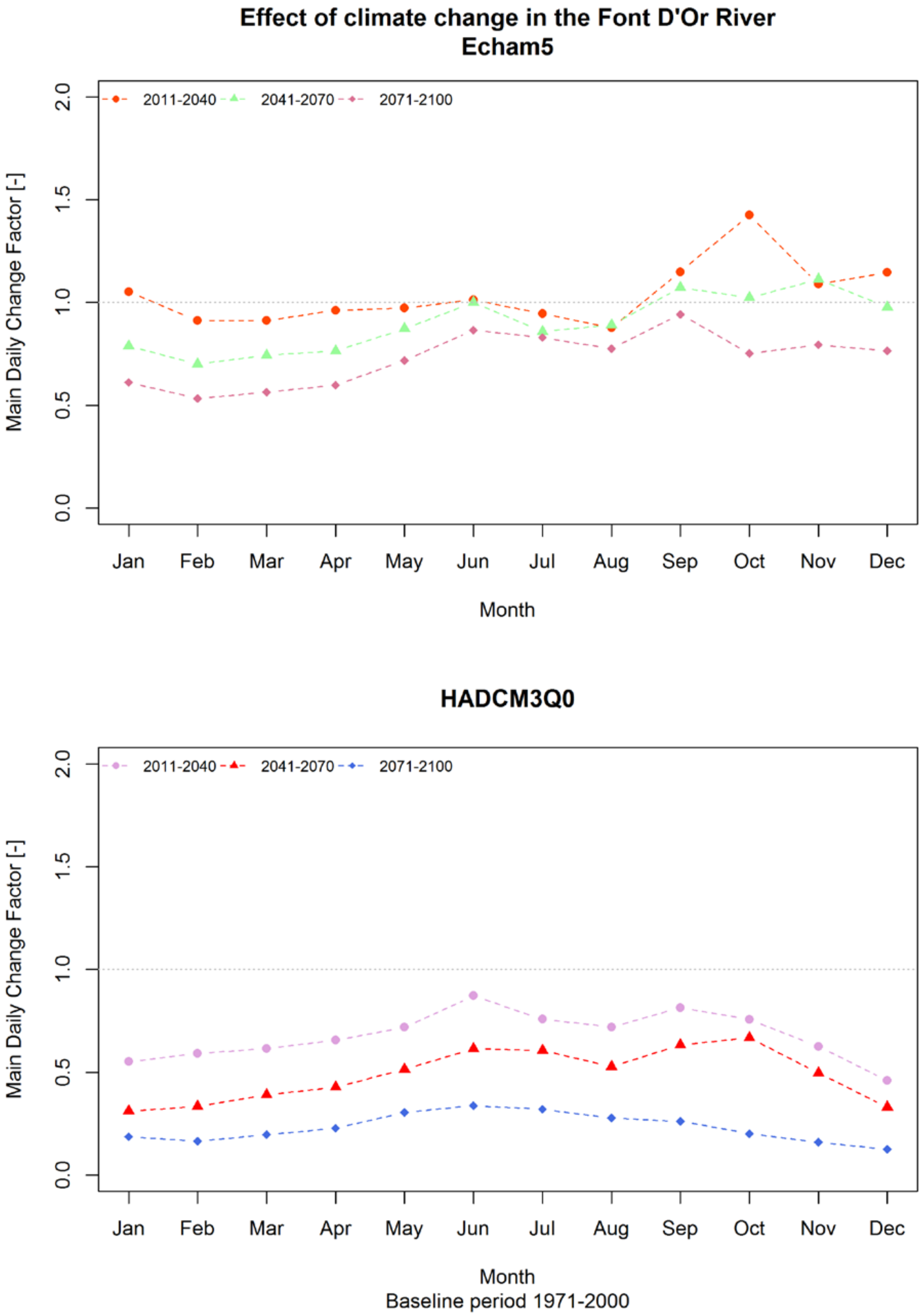

Figure 4: Effect of climate change on flow in the Font D'Or River for the Echam5 and HADCM3Q0 model with baseline time period 1971-2000.

Conclusions

The majority of the climate scenarios show a decrease in surface water availability in the Font D'Or catchment. This is not unexpected as all scenarios show a rise in temperature and precipitation is predicted to decrease during most months. The results for the HADCM3Q0 model are more severe than the Echam5 model. This is consistent with the temperature and precipitation change factors for these models.

Both the HADCM3Q0 and Echam5 models are predicting the largest decrease in precipitation during the dry season (Feb – April) and a smaller decrease or a small increase in precipitation during the wet season (May – Jan). The greatest effect of climate change on river flows in the Font D'Or catchment, according Echam5, will be in February where the mean monthly flow change factors are between a decrease of 10% for the future time horizon 2011 – 2040 (change factor of 0.9) and a decrease of 40% for the future time horizon 2071-2100 (change factor of 0.6). The results using the HADCM3Q0 are more severe, with this climate model suggesting a decrease in mean monthly flows for all of the future time horizons. The greatest effect of climate change according to HADCM3Q0 will be in December, where the mean monthly flow change factors are between a decrease of 50% for the future time horizon 2011-2040 (change factor of 0.5) and a decrease of 90% in 2071-2100 (change factor of 0.1) .

Figure 4 shows the magnitude of the potential change to river flow due to climate change during a period of low flow (1999 – 2000). The hydrographs were produced by applying the precipitation and temperature change factors from Echam5 and HADCM3Q0 to the calibrated hydrological model. For future time horizons 2041-2070 and 2071-2100 Echam5 shows a decrease in river flow during the rainy season. For the future time horizon 2011-2040 Echam5 shows an increase in peak flows. The HADCM3Q0 model shows more extreme results, which is consistent with the change factors for precipitation and temperature. All future time horizons in the HADCM3Q0 model show an expected decrease in river flow all year around. Both climate models indicate a decrease in river flow for the Font D'Or catchment during the rainy season, which will decrease the availability of surface water for water supply purposes.

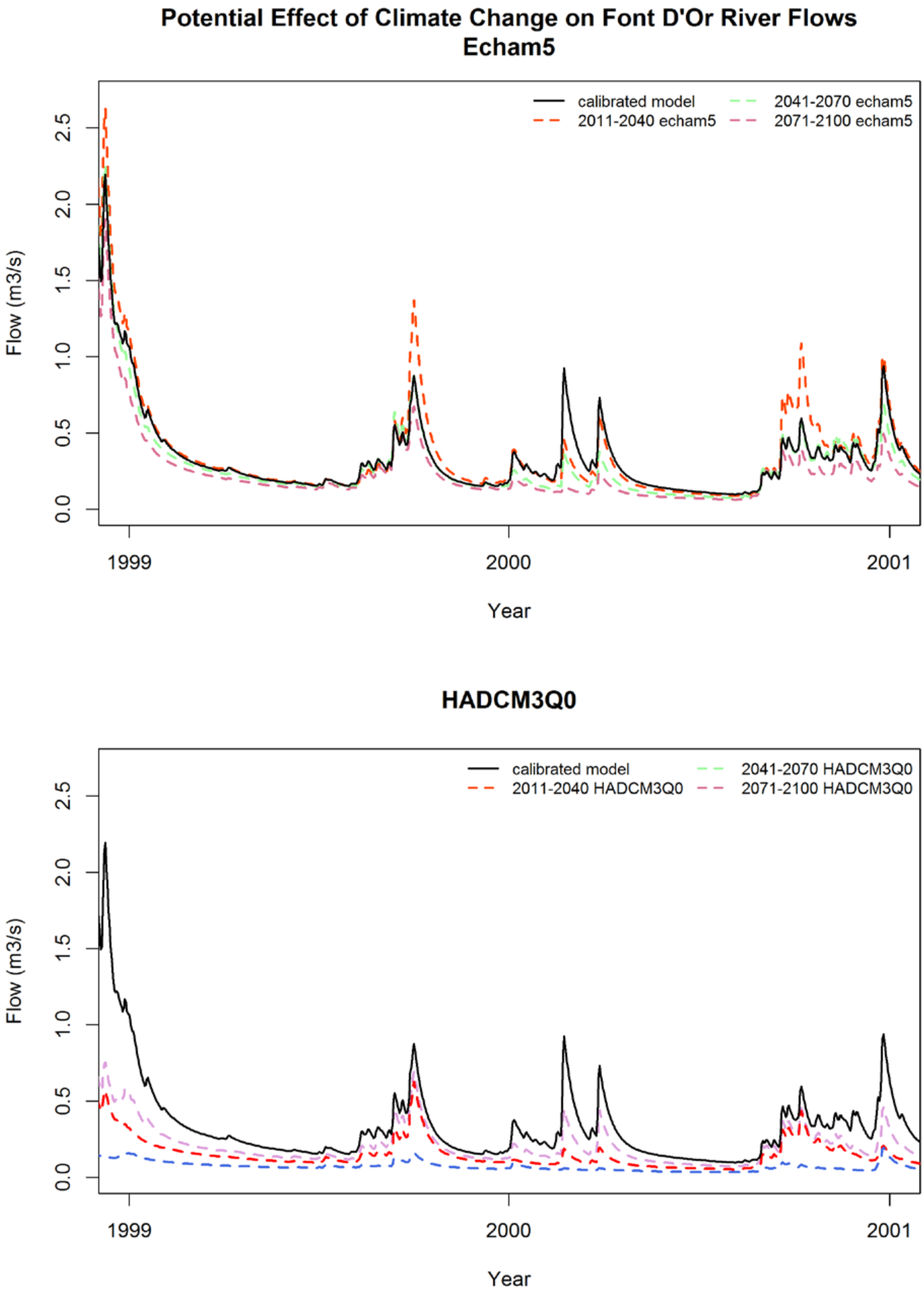

Figure 5 Potential Climate Change effect on flow in the Font D'Or.

Implications for policy and planning

The water supply of St. Lucia is largely dependent on surface water sources. The surface water catchments of St. Lucia are relatively small and often rapidly responding catchments, due to the volcanic nature of the Island. Over the last decade increasing population and a growing tourism sector has resulted in the pressures on the water supply system increasing. Due to these pressures, water outages occur regularly (FAO-AQUASTAT Saint Lucia 2015). A decrease in the available surface water, as predicted by Echam5 (2041-2100) and HADCM3Q0 (all future time horizons) could; therefore, have major implications for important sectors such as agriculture and tourism, which are particularly dependent on adequate water supplies.

Feedback on the tool

The CARIWIG portal has a map view through which climate model can be viewed and downloaded, this view is easy to navigate and intuitive to work with and provides a valuable resource for adaptation planning in the region. However, the technical documentation accompanying the tool is currently limited, both with regards to the user-guidance and background information on the climate scenarios available.

What more can we do?

To get a better indication of the likelihood of water supply shortages across Saint Lucia, additional catchments could be modelled, with key infrastructure such as the Roseau Dam included in the modelling.

The CARIWIG portal includes a weather generator that offers climate change models with ensembles. Running these through the hydrological model could provide additional evidence as to the variability in the predicted changes of water availability in Saint Lucia, although the skill of the Weather Generator with regards to reproducing drought sequences would need to be assessed prior to such sequences being used in this context.

The availability of observed river flow data is limited and additional monitoring or data collation may increase the confidence in the hydrological model for estimating flows under multiple climate scenarios.

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This document is an output from a project commissioned through the Climate and Development Knowledge Network (CDKN). CDKN is a programme funded by the UK Department for International Development (DFID) and the Netherlands Directorate-General for International Cooperation (DGIS) for the benefit of developing countries. The views expressed and information contained in it are not necessarily those of or endorsed by DFID, DGIS or the entities managing the delivery of the Climate and Development Knowledge Network, which can accept no responsibility or liability for such views, completeness or accuracy of the information or for any reliance placed on them.