CALL FOR PROPOSALS

Studying the effects of climate change and variability on water resources in Uruguay

1. Programme summary

The Foreign, Commonwealth and Development Office (FCDO) Research Commissioning Centre (RCC) has been established to effectively commission and manage research to enhance FCDO's development and foreign policy impact. Led by the International Initiative for Impact Evaluation (3ie), the University of Birmingham, and a consortium of UK and global research partners, the RCC aims to commission different types of high-quality research in FCDO's key priority areas. All FCDO-funded research and development (R&D) investments commissioned by the RCC will be implemented using rigorous and robust research methodologies and quality standards. These R&D standards include meeting the Frascati definition requirements and FCDO's Ethical Guidance for Research Evaluation and Monitoring Activities (European Union 2014; FCDO 2019; Organisation for Economic Co-operation and Development 2002). For this research, the RCC is working with the British Embassy in Montevideo.

2. Description of the research to be commissioned

Research title: Studying the effects of climate change and variability on water resources in Uruguay

This is a call for proposals to assess the impacts of climate change and variability, as well as socio-economic activities on water resources in Uruguay and to recommend sustainable strategies for water resource management and adaptation. Specifically, the research project aims to a) study the impact of climate change and variability on water availability, b) conduct mapping of groundwater resources, and c) undertake groundwater characterisation and assess the hydrogeological potential of Uruguay.

3. Background

Uruguay is highly vulnerable to climate change and variabilities, facing risks from drought, flooding, heatwaves, and storms (World Bank 2021). Uruguay is facing mounting challenges to its water resources due to the interplay of climate change, land use changes, and unsustainable practices. This section provides a comprehensive overview of these issues, highlighting the impacts on surface and groundwater resources and emphasising the need for urgent and integrated solutions based on evidence.

Surface water resources (such as rivers and lagoons) provide drinking water for 90% of households and supply almost all agricultural irrigation, accounting for 90% of the country's total water consumption. Surface water also supports livestock production, industries, and tourism. Additionally, it is used for hydropower generation (20% of the energy matrix under average rainfall) and plays a role in waste management. These water resources, however, are threatened by industrial pollution and agricultural runoff. The country also has two significant aquifers, including the Uruguayan part of Guaraní Aquifer, considered to be one of the world's largest. However, there is a severe lack of information about the degree of degradation of water resources in Uruguay (Taks 2008).

Studies have shown that climate change and variabilities negatively affect water availability and quality in Uruguay through increased extreme precipitation, seasonality shifts, more frequent droughts, altered streamflow patterns and decreased groundwater recharge. Floods and droughts are major climate events in Uruguay that adversely affect the economy and its citizens. For example, in 2019, the country suffered from severe flooding affecting more than 17,600 residents (MVOTMA 2019). Additionally, sea level rise, as evidenced in the Rio de la Plata coast case, has impacted coastal services, morphology, ecosystem resources, and even infrastructure and housing (Verocai et al. 2015). About 30% of Uruguay’s population is exposed to a sea level rise of 1 metre and wind-induced flooding of up to 3 metres above mean sea level (AMSL) (Nagy et al. 2014; Verocai et al. 2015). Trends and maxima of air temperature, water/sea levels and river inflow in the Río de la Plata river estuary show temporal changes attributable to climate change and El Niño-Southern Oscillation (ENSO) (Nagy et al. 2023). Similarly, a participatory expert assessment run by Nagy and colleagues (2014, 563) also identified a high probability of increasing temperature and sea level rise between 2030 and 2050. A modelling projection made for the Laguna del Sauce catchment predicted the experience of a wetting trend, higher temperatures, seasonality shifts and an increase in extreme precipitation events, particularly in frequency and magnitude, resulting in reducing erosion control and aggravating eutrophication (Aznarez et al. 2021). Nevertheless, studies show a deficit of successful climate change adaptation (Nagy et al. 2014). Please see further background information in Annex 1.

At this juncture, undertaking groundwater potential mapping and climate change impact on water availability in Uruguay is imperative to devise a sustainable water resource management strategy. Groundwater potential mapping involves “a spatially distributed estimate of the physical capacity of the terrain to yield enough groundwater for a given use based on a series of indirect indicators” (Díaz-Alcaide and Martínez-Santos 2019). A review of previous studies conducted in different parts of the world revealed that groundwater potential mapping (such as on indicators including geology, lineaments, landforms, soil, land use/land cover, rainfall, drainage density, and slope), using remote sensing and geographical databases, has significant potential for groundwater exploration (Díaz-Alcaide and Martínez-Santos 2019). It is also essential to investigate how climate variability and change influence groundwater systems both directly through replenishment by recharge and indirectly through changes in groundwater use and land use (Taylor et al. 2013). Similarly, it is also critical to study climate change and variabilities’ impact on water resource availability in Uruguay along with increased population growth, urbanisation, industrialisation, agricultural intensification, competing/conflicting demands, and socio-economic conditions putting additional pressure on water supply (Bano and Arshad 2018).

Accordingly, this research project has three areas of focus: a) study the impact of climate change and variability on water availability, b) conduct mapping of groundwater resources, and c) undertake groundwater characterisation and assessment of the hydrogeological potential of Uruguay.

4. Research needs

The research on water risk in Uruguay due to climate change and variability will include surface and groundwater dynamics, precipitation trends, land use (including for economic activity) and land cover changes, flooding monitoring and mapping, and other activities. The results can significantly influence the design of policymaking or programming by the governments of Uruguay and the UK in the following ways:

- **Evidence-based decision-making and policy formulation**: This research will provide a solid evidence base to guide Uruguayan policies on better water management and integrating climate resilience into wider fiscal decision-making.
- **Synergy with green initiatives**: This study will provide insights into how to align water resources management with green energy goals. Understanding water availability and quality in the context of green hydrogen and agricultural production will help determine the direction of these sectors in Uruguay and inform the UK support for or participation in them.
- **Stakeholder engagement**: The research will promote meaningful engagement with stakeholders such as local communities, NGOs, and industries. Involving these stakeholders in project and policy design would improve the effectiveness of interventions and ensure wider buy-in.

5. Research questions and approaches

This research contributes to addressing the following broad questions:

1. How do climate change and variability affect water availability and quality in Uruguay?
2. What is the relationship between precipitation and temperature patterns and the frequency and intensity of droughts and floods in Uruguay?
3. How do changing precipitation patterns, increasing temperatures, evapotranspiration and changes in land use and land cover affect the recharge rates and the water levels of the Guaraní Aquifer?
4. What are the effects of climate change and variability on river flow patterns in urban and rural areas of Uruguay?
5. What are the effects of Uruguay’s current economic activity and urban distribution on water reserves?
6. How does sea level rise affect the vulnerability of coastal aquifers to seawater intrusion, and how does this affect the availability of freshwater resources in coastal communities?
7. What strategies can be implemented to enhance water resource management and resilience?

To contribute to addressing the above research questions, the research project is subdivided into three research packages as mentioned above:

Research package A

Assess the impact of climate change and variability on water availability by adopting the following research approaches:

a) Identify two pilot study areas using vulnerability, density and populated regions as selection criteria. At least one study area should include coastal aquifers. At least one study area should include the recharge area of the Guaraní Aquifer.
b) Develop statistical models, codes or simulations to assess the impact of climate change and variability on river flow patterns.

c) Use databases such as the Global Land Data Assimilation System (GLDAS) to analyse the temporal variation of land surface variables.
d) Satellite imagery processing to monitor changes in land cover, vegetation, and surficial water bodies.
e) Integrate GLDAS and satellite data to develop models to understand the interaction between river dynamics, surface processes, and climate.

Research package B

Develop a groundwater map in two pilot study areas by adopting the following approaches:

a) Identify two pilot study areas using vulnerability, density and populated regions as selection criteria. At least one study area should include coastal aquifers. At least one study area should include the recharge area of the Guaraní Aquifer. The study areas used for research package A could be used for this as well.

b) Identify the sectors linked to water consumption and know the quantities and qualities they require; and

c) Assess the viability of adding groundwater as a new source of water while mitigating the conflicts generated by the effects of climate change and variability and contributing to economic growth and the well-being of the population.

Research package C

Develop a groundwater characterisation and assess the hydrogeological potential of Uruguay in two pilot study areas by adopting the following approaches:

a) Identify two pilot study areas using vulnerability, density and populated regions as selection criteria. At least one study area should include coastal aquifers. At least one study area should include the recharge area of the Guaraní Aquifer. The study areas used for research packages A and B could be used for this one as well.
b) Assess how geological, geomorphological, and climatic factors influence groundwater potential and characteristics.
c) Propose modalities to improve management and sustainable use of water resources (ground and surface water) that integrate climate resilience considerations, as well as strategies to strengthen water quality and quantity monitoring systems. The proposed modalities and strategies need to be accompanied by their respective implementation capacity implications (such as institutional and human resource capacity building requirements, necessary technology transfer and adoption, financial implications and potential sources of financing, etc.).

6. Deliverables and timelines

The first step of the research project will be a kick-off meeting between the partners and the research project implementing team. Following this meeting, the implementing team is expected to prepare an inception report and deliver a slide presentation of the report. The inception report highlights a detailed roadmap of the research process based on the requirements outlined in this call document. It presents the conceptual framework of the research, the research methodology, a detailed plan of work and milestones, and a research project evaluation matrix.

Furthermore, the inception report needs to identify potential risks or challenges in undertaking the research project (such as data availability and quality, communicating results, managing interdisciplinary teams, etc.) and highlight relevant mitigation strategies for each potential risk and challenge. After the inception report has been accepted, the interim phase can commence.

The research project will last 15 months from the kick-off meeting. The implementing team is expected to submit a report every five months and receive feedback on the project's progress.

The final output of the research project will be the listed products (see below) for each research package, supplemented by a consolidated narrative report edited in English. The narrative report should not exceed 50 pages, excluding annexes and the reference section.

Research package A: Impact of climate change and variability on water availability

The expected deliverable visualisation products should include the following:

a) maps, time series plots, and other visualisation products using GLDAS data and satellite imagery

All cartographic products should be presented at a scale of 1:100.000 in .shp format. The database should be submitted in .csv format. Images should be presented in GeoTIFF format (or similar). All products should be submitted in the same coordinate system. Codes should be available in a GoogleColab notebook (preferred language Python). Time series should represent a minimum of 20 years. Time series plots should represent precipitation, temperature, evapotranspiration, etc.

Research package B: Groundwater resources map

The expected deliverable products should include the following:

a) groundwater flow map
b) groundwater level maps
c) inventory of activities and socio-economic data.

All cartographic products should be presented at a scale of 1:50.000 in .shp format. The database should be submitted in .csv format. Images should be presented in GeoTIFF format. All products should be submitted using the same coordinate system.

Research package C: Groundwater characterisation and hydrogeological potential of Uruguay

The expected deliverable products should include the following:

a) geological maps;
b) geomorphological maps;
c) slope maps;
d) elevation model;
e) topographic moisture Index map;
f) curvature profile map;
g) drainage density map;
h) distance map of watercourses;

i) rainfall distribution map;
j) precipitation distribution map;
k) evapotranspiration maps;
l) temperature maps;
m) groundwater potential maps; and
n) water chemistry maps.

All cartographic products should be presented at a scale of 1:50.000 in .shp format. The database should be submitted in .csv format. Images should be presented in GeoTIFF format. All products should be submitted in the same coordinate system.

The accompanying consolidated narrative report, synthesising the findings of research packages A, B, and C, should include the following:

- An executive summary
- Background information about the study area and the topic under study
- A brief summary of ongoing and/or recently completed initiatives and studies pertinent to addressing the research questions of this research project
- Detailed methodology, including challenges faced in undertaking the research and how the challenges were addressed
- Highlight issues, related findings and lessons learned
- Conclusions
- Proposal for improving the management and sustainable use of water (surficial and groundwater) in the study areas and recommendations to strengthen the monitoring systems (quality/quantity). Each proposal needs to be accompanied by the implementation capacity requirements to implement the respective proposals and include available facilities.

Table 1: Deliverables, meetings and expected timelines

The project duration is a maximum of 15 months (60 weeks). The table below outlines indicative timelines

Phase	Deliverables and meetings	Expected time
Inception phase	Kick-off meeting	After designation of team (Week 1)
	Inception report	Within four weeks after team designation (Week 4)
	Presentation to the British Embassy Montevideo team	Within one week after sending the inception report (Week 5)
Interim phase	Evidence analysis	Start the analysis (starting from Week 6)
	First notes on research progress and preliminary findings	Within 20 weeks after the presentation of the inception report (Week 25)
	First presentation of research progress and preliminary findings	Within one week after sending the first notes on research progress and preliminary findings (Week 26)
	Second notes on research progress and findings	Within 20 weeks after the first presentation of research progress and preliminary findings (Week 46)

	Second presentation of research progress and findings	Within one week after sending the second note on research progress and findings (Week 47)
Final phase	Draft final report and products	Within nine weeks after the presentation of the second research progress and findings (Week 56)
	Final report, products and executive summary	Within two weeks after submission of the draft final report and products (Week 58)
	Presentation of final report and products	Within one week after sending the final report and products to FCDO (Week 59)
Dissemination	Dissemination of the final report and products	Post-approval of the final report and products (Week 60)
	Stakeholder engagement - executive summary and presentation of findings	Share the executive summary and present the main findings to Uruguay's public stakeholders (Week 60)

7. Preferred expertise and skills of the team

The team members shall have the following qualifications and expertise:

- Excellent knowledge and experience in geosciences, hydrogeological analysis, hydrological modelling, spatial analysis, remote sensing, atmospheric sciences, and or/physics with practical experience in advising national governments or development partners on designing and implementing policies and strategies focused on Uruguay.
- Proven experience in conducting hydrogeological and geological studies, hydrological modelling, water resources management, land use and land cover dynamics analysis, remote sensing and GIS analysis, and database processing and data visualisation will be considered an asset.
- Understanding of the challenges and the necessary reform required in implementing policies and strategies to adapt to climate change's impact on water resources management in Uruguay.
- Excellent writing and communication skills.
- Fluency in English is required, and fluency in Spanish is desirable.

8. Estimated Budget

The estimated budget limit of the project is £80,000 for the three research packages. The implementing team has the discretion to allocate the total budget across research packages as they deem appropriate.

Milestone	Timeline or target date
Satisfactory delivery of inception report and initial slide presentation	Within five weeks of the contract signing
Satisfactory delivery of the first presentation of research findings	At the end of Week 26
Satisfactory delivery of the final report, products and slide presentation	On Week 59 of the project period

- Payments will be made upon delivery of outputs and the RCC's confirmation of receipts and utilisation of the resources.
- The process for budget and technical scope virement (i.e. any changes between project lines or to technical scope) will need to be discussed with RCC and approved by FCDO.
- Upon commencing the commissioned research, the RCC will agree upon engagement arrangements with FCDO and a reporting schedule. This may include touchpoints on key areas such as delivery and progress, financial management, and risk.

9. Eligibility

- An organisation capable of undertaking high-quality research will likely qualify, either independently or in collaboration with a partner. Only legally registered organisations and/or their consortia of registered organisations, not individuals, may apply.

10. Page limits and criteria for selection

Curriculum vitae (CV) for each of the named principal investigators and core team members should be included. The CVs should not exceed two pages. The proposals will be appraised based on the criteria summarised in the table below.

The FCDO claims the rights to use the research project's results and deliverables. The selected team must ensure the confidentiality of information and anonymity of research participants.

Table 2: Criteria for selection

Criterion	Description	Maximum score
Understanding of call for proposals	The extent to which the application reflects the call for proposal. The application shall address important aspects of the project's objectives, directly tackle the issue to be solved, and embrace a critical approach to solve the question.	15
Methodological approach and academic rigour	The overall quality of the methodological approach. This includes but is not limited to the logical and theoretical coherence of the proposal, the design, the proposed methods and technical instruments, innovative components of the research, and stakeholders' engagement.	15
Proposed team	The overall quality of the proposed team is compared to the required expertise. This includes expertise and experience in the relevant fields of the project, proven experience in development projects and in advising governments and affiliated agencies, expertise in using the required research methods, and team experience in the geographical area.	15

Equity and inclusion	To what extent does the proposal take into consideration cross-cutting issues, including aspects such as stakeholders' involvement and participation, gender issues, safeguarding of minorities and vulnerable groups, and protection of participants and/or respondents from risks or any harmful activity?	15
Financial feasibility and value for money	To what extent do the proposed methodology and the expected outcomes justify the budget request? This includes the potential societal impact, clarity, organisation of activities and planning feasibility, and the alignment of ambition of resources.	15
Research uptake plan	The overall quality of the research uptake plan. This includes the clarity of the influence goals and their consistency in relation to the uptake objectives; whether the proposal specifies strategies that will encourage the active use of the research findings; and the feasibility of the research plan along all stages of the research: design, implementation, and dissemination strategies.	15
Overall evaluation of the project	The extent to which the project, as a whole, provides a good approach to solving the critical elements of the research questions	10

Proposals will be assessed to ensure optimal value for money while balancing costs and quality. Proposals with clear pathways to meaningful impact will be favoured. The RCC strongly encourages the inclusion of in-country research partners where primary research is undertaken.

11. Deadline

Completed proposals should be submitted to rcc@3ieimpact.org **by 23:59 GMT on 10 October 2024**.

12. Competition process and timeline

Stage	Target dates
Call for proposal launched	10 September 2024
Deadline for queries	18 September 2024
FAQs posted	20 September 2024
Proposal submission deadline	10 October 2024
Proposals moderation	10 – 18 October 2024
Selection committee meetings	21 – 25 October 2024
Outcome decided and bidders notified	28 October 2024
Due diligence completed	15 November 2024
Signing of the accountable grant	15 November 2024 (dependent on successful completion of due diligence)

13. Q&A and contact

This project is managed by the FCDO Research Commissioning Centre. If you have any questions related to this opportunity, please submit them to the rcc@3ieimpact.org mailbox, including “RCC Water Risk in Uruguay - Request for Clarification” in the subject line. In the interest of fairness and transparency, all questions and answers will be published on the FCDO Research Commissioning Centre page alongside other information on how to apply.

Annex 1: Further background information

Future regional climate change scenarios show an increase in rainfall and temperatures in the upcoming years, with a strong influence of both El Niño–Southern Oscillation (ENSO) and La Niña phenomena (MVOTMA, 2019). Extreme rainfall events usually cause social damages such as population displacement, road closures and electricity cuts—for example, 926,000 homes were deprived of electricity as a consequence of a storm in January 2016 (Ungerovich and Barreiro 2019). A study by Ungerovich and Barreiro (2019: 3666) in Southern Uruguay found that the amount of extreme rainfall events during El Niño years is almost the same as the amount of extreme rainfall events during La Niña events (17 and 20, respectively). A study by Barresi Armoa and colleagues (2023) on the Uruguay River Basin, which covers Uruguay (38%), Brazil (32%), and Argentina (30%), between 1990 and 2020, found increasing trends in temperature, soil water content, and evapotranspiration, indicating climate change impacts. Similarly, a study by Berbery and Barros (2002) on La Plata Basin revealed that climate change-induced variability in the basin's precipitation amplified streamflow, especially during the year following the onset of El Niño. The most significant contribution during flood episodes of the La Plata River comes from the Paraná River (Berbery and Barros 2002).

Additionally, Uruguay also suffers from drought episodes. In Uruguay, agricultural drought events significantly impact the country's most important economic activity, i.e., livestock production, which relies mainly (more than 90%) on grazing native grasslands (Cruz et al. 2021). In June 2023, the Uruguay president declared a state of emergency in the capital, Montevideo, because of a water shortage implementing water supply rationing (CAF 2023; Reuters 2023). Despite these challenges, Cruz and colleagues' (2021) research identified the limitations of using climate information by users (such as farmers, policymakers, and academic researchers) for adaptation interventions and recommended effective climatic information translations and communications to inform decisions.

In addition to climate change impacts, land use change, such as afforestation, was found to decrease streamflow to the Santa Lucía River in Uruguay (Navas et al. 2019). The substitution of natural grasslands with forest plantations for industrial use has led to a 17% decrease in the amount of water flowing in the river during average years, as a study conducted in the Western region of Uruguay showed (Silveira et al. 2016). There is also a significant conversion of one of the world's richest grasslands into Soyabean plantations and a reduction of herbaceous cover for large-scale exotic forest (Eucalyptus and Pinus) plantations, leading to environmental destructions and social injustices (Redo et al. 2012; Rocha et al. 2019). The government's effort in afforestation since 1993 in the Negro River basin also resulted in a significant reduction in water runoff volumes and an increase in water loss (Silveira and Alonso 2009).

Moreover, water quality in Uruguay is also slowly deteriorating due to the release of untreated effluents from industries and cities, as well as agricultural runoff. Water quality in Uruguay is being compromised by phosphate-based agricultural intensification, urban areas atmospheric deposition, wastewater effluent, lawn fertiliser application and leaky sewage infrastructure, as evidenced by a study on the primary potable source of the country, the Santa Lucía river basin (Gorgoglione et al. 2020). In the Santa Lucia River basin, which provides drinking water to 60% of Uruguay's population, intensive agricultural land use leads to high phosphorus and nitrogen concentrations in surface water, potentially impairing water quality for human consumption (Barreto, Dogliotti, and Perdomo 2017). In 2013, cyanobacteria blooming that exceeded the water purification capacity, causing a bad smell and taste of the tap water, triggered the establishment of the Santa Lucía River Basin Commission (Aubriot et al., 2017 cited in Dias Tadeu et al. 2023).

Furthermore, uncontrolled groundwater use can also lead to pollution or overexploitation of aquifers. Groundwater represents approximately 10% of the total water supplied by Obras Sanitarias del Estado (OSE, State Water Works), varying geographically, from more than 90% of dependence on groundwater in inner Rivera to only 8% near the coast in Flores (OSE 2024). However, almost half of the groundwater (private wells) samples analysed by Machado and colleagues (2019) in Montevideo revealed arsenic concentration levels above WHO recommendations for drinking water, posing risks to human health.

Uruguay's underground water systems are classified into three types: Paranaense (northeast/north central), Meridional (majority of the country), and Costero (south/east coast). Guaraní Aquifer System (GAS) is one of the world's largest transboundary aquifers, spanning Argentina, Brazil, Paraguay, and Uruguay, and is crucial for drinking water and agriculture (Samaniego et al. 2022). Generally, the GAS water is fresh with low mineralisation, but in some areas, it can have high mineralisation and fluoride levels, making it unsuitable for drinking (Meroni, Piñeiro, and Gombert 2021). However, unprotected groundwater sources, such as the GAS, are vulnerable to pollution from human activities like waste disposal, pesticide use, and cesspools in places lacking proper sanitation (Samaniego et al. 2022).

Additionally, a lack of information about how much water is being taken out of the aquifer makes it difficult to manage and use the resource sustainably (Samaniego et al. 2022). Even though the GAS riparian countries drafted an international agreement in 2010 to manage the transnational aquifer system, it has still not entered into force a decade later due to the lack of ratification (Meroni, Piñeiro, and Gombert 2021). With anthropogenic climate change underway and its potential effects on the GAS groundwater resource, it is crucial to understand how it works in order to provide a future basis for effective concerted plans for sustainable transboundary groundwater management (Meroni, Piñeiro, and Gombert 2021). Additionally, Manganelli and colleagues' (2021) study on GAS confirmed the regional flow from north to south (from Brazil to Uruguay), but the way the deeper parts of the aquifer are recharged needs to be studied further. This study also calls for coordinated management of the GAS, especially across borders, to ensure sustainable use of this valuable resource.

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