**ANNEX A**

**REGIONAL**

**Water and Sanitation Division (INE/WSA)**

**Development of Case Studies of the Water-Energy-Food Nexus in Latin America**

**TERMS OF REFERENCE**

**Background**

The Inter-American Development Bank (IDB) provides substantial financial and technical support for infrastructure projects in water and sanitation, irrigation, flood control, transportation and energy. Many of these projects depend upon water resources and have a significant potential of being negatively affected by local and regional changes in development variables that alter water availability, such as climate, population growth and shifts in land use associated with urbanization, industrial growth and agriculture. Assessing the potential for future changes in water availability is an important step for ensuring that infrastructure projects meet their operational, financial and economic goals. It is also important to examine the implications of such projects for the future allocation of available water among competing users and uses, to anticipate and help mitigate potential conflict, and enable such projects to be consistent with long-term regional development plans and preservation of essential ecosystem services.

As part of its commitment to help member countries adapt to climate change, the IDB has sponsored work to develop and apply an integrated suite of water resources modeling tools. Recently, the IDB is working on developing simulation models that can integrate the water, energy, and food sectors which are the most important resources for the Latin America region development and growth.

The interdependency between water, energy and food is growing in importance as demand for water, energy and food (WEF) securities increases. Several regions of the world are already experiencing WEF security challenges, which adversely affect sustainable economic growth. Specifically in the Latin America region, population and income per capita continue to grow, which in turn increases demand for water, energy and food, especially in fast-growing countries. At the same time, scarcity in water, energy or food is caused not only by physical factors, but there are also political and economic issues at play that effect the allocation, availability, and use of these resources.

Almost all primary energy production and electricity generation processes require significant amounts of water, and the treatment and transport of water require energy (mainly in the form of electricity); food production requires both water and energy resources. For instance, even though water use for energy generation is non-consumptive, temperature changes in return flows have impacts on aquatic ecosystems, and conflicts with other uses of water (such as food production) may arise in water scarce regions and basins due to different demand regimes. Climate change will further exacerbate problems like this, as local climate dictates spatial and temporal variations of water availability, and lead to intensified flooding and drought events. This is likely to increase competition for water across sectors, such as agriculture, the biggest consumer of water worldwide, but also energy generation, potable water supply, as well as the environment.

As a consequence, there is a pressing need for integrated planning of WEF resource development and use, to avoid unwanted and unsustainable scenarios in the coming years. Although the WEF nexus is now fairly evident, these three sectors have historically been regulated and managed separately; and despite growing concern over these trends, decision makers often remain ill-informed about their drivers and ill-equipped to deal with possible outcomes.

## OBJECTIVE

The main objective of this project is to contribute to sustainable management and development of the water, energy and food production sectors by increasing analytical capabilities and documented case studies on integrated resource planning in Bank investments, identifying and evaluating trade-offs and synergies between water resources management, energy generation and food production, when planned in an integrated fashion. This overarching objective can be achieved by supporting client countries develop and use innovative approaches and evidence-based operational tools to assess the economic and social tradeoffs of constraints in water, energy and food and their corresponding and intertwined security.

## MAIN ACTIVITIES

The scope of work for this project includes the following activities:

**Activity 1 – Data collection and calibration of analytical tool for WEF Nexus analysis in the Latin America Region (country scale)**: this activity consists in gathering all the necessary data to calibrate the integrative modeling tool of water, energy and food production, following the approach of existing global Integrated Assessment Models (IAMs), such as, GCAM: global change assessment model, but tailored and to a country scale in the Latin America region.

The contractor will calibrate a country scale IAM for the Latin America region building upon the Hydro-BID system database developed by the IDB, integrating it with an existing IAM (e.g., GCAM) with four major stock groups (water, energy, food and ecosystems), including modules for economic (trade-off, optimization, economic output) analysis, and environmental impact analysis. The economic analysis modules will include ecosystem services trade-offs assessment capabilities.

The analytical methodology for this project will be based on an integrative modeling approach able to define potential synergies and constraints for the sustainable development of water, energy and food planning and investments. The outcome is intended to inform policy making at the national level.

The modeling approach should consist of integrating the Hydro-BID computational database and simulation engine with GCAM (a partial market equilibrium model), which is amply documented in references such as Hejazi et al. (2013), Davies et al. (2013) and Kyle et al. (2013). This integration effort will be focused primarily in adapting the spatial and temporal scales of the models for integration into a seamless analytical tool.

Data Sources: Water Resources Management data will be derived through the Bank’s existing Hydro-BID system for water availability (water sources and quantities), water demand use and efficiency data available from INE/WSA clients through the region (e.g., CVC in Colombia, ANA in Perú). Particular focus will be placed on water allocations for energy generation and food production purposes.

Energy data will comprise the location and magnitude of generation facilities, as well as energy use matrices and fluxes. Both of these data has been recently generated by INE/ENE, derived from international data sources (IEA), as well as national data sets. Energy use data in water and wastewater treatment facilities has been compiled by WSA.

Food production data is currently available from the national ministries of agriculture, as well as by global databases such as FAO. Both agricultural and livestock food sources will be considered. Water use data for both of these food sources can be estimated using FAO estimating techniques, as well as other recent developments in the literature (e.g., Konar et al. 2011).

The contractor should use the developed integrative model to define effects of climate change on the availability and variability of water, energy, and food resources at the regional, basin and country scales: this task consists of the parameterization of the integrative model, its testing and application of the model to obtain test results at the regional, basin and country scales in an IADB (or other existing) project for which the necessary parametric data has been compiled.

The contractor will prepare a technical note on the calibrated WEF Nexus tool, including the technical description and user manual of the tool.

**Activity 2- Case Study Applications**: This activity will use the developed WEF Nexus model as a pilot experience in a series of 3-4 case study application projects of water, energy, and food resources management in the region to define adaptation measures to climate change; this task comprises the identification of pilot projects in the Latin America Region so that the model can be applied to identify and define potential impacts of climate change, as well as potential adaptation measures.

Also, the activity will include assessment of data availability and needs to implement the WEF nexus methodology, travel to the countries for data collection and interviews, data analysis, and the identification of pilot case studies for implementation.

The following methodological steps will be tailored to each case study, in consultation with country counterparts and other local stakeholders:

* + Analyze and assess water balances through the Latin America region, quantifying the existing water allocation for energy generation and food production, and assess the existing models handling of basins/regions.
  + Analyze the future demand for water, energy and food, and different scenarios for WEF supply based on the existing country strategy and plans.
  + Analyze the future demand for water per basin (including water for power and water for food production) by overlapping existing and future power plants/coal mining/shale gas areas, irrigation and production of meat and other food products), focusing on those geographical areas where the energy generation and food production activities are located.
  + Identify the basins where potential conflicts might arise in the future and quantify potential WEF deficits.
  + Incorporate climate change impacts on water availability, energy demands, and food production outputs.
  + Analyze opportunities to decrease these conflicts, by looking at different WEF management schemes and different technologies to reduce water and energy use (such as dry cooling), and looking at opportunities to curb both energy and water demand growth through demand-side actions.
  + Quantification of costs and benefits (through partial or general equilibrium frameworks) of different solutions and synergies.
  + Analyze the impacts of changes in WEF prices/tariffs to the water, energy and food demand and planning.

The contractor will prepare a technical note for each case study (3-4) developed under this activity. These technical notes will include a complete description of the analysis performed on the project.

**Activity 3- Capacity Building and Training Workshops:** The contractor will provide capacity-building workshops about the use and management of the WEF Nexus tool to Bank staff, as well as the public sector, academia, clients (public and private), NGOs and the industrial sector in IADB member countries. This task entails the organization and execution of 4-6 workshops for capacity building related to Nexus tool developed and pilot case studies: 1-2 within the IADB, and other 3-4 in the region, either organized and called for IADB itself, or through organization of special sessions in conferences in the region and worldwide. These workshops will cover the preparation of projects according to the effects of climate change on the availability of water, energy, food resources for different uses in the region.

## REPORTS / DELIVERABLES

The table below summarizes the deliverables and schedule for this contract.

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| --- | --- | --- |
| **Project Activity** | **Deliverables** | **Anticipated Delivery** |
| **Activity 1-Data collection and calibration of analytical tool for WEF Nexus analysis in the Latin America Region (country scale)** | Deliverable 1A:  Detailed Work Plan: Data gathering and calibration process; case study selection and possible applications.  Deliverable 1B:  Calibrated country scale WEF Nexus tool for the Latin America Region (software)  Deliverable 1C:  Technical Note: Technical description and user manual of the WEF Nexus tool | November 2016  July 2017  September 2017 |
| **Activity 2- Case Study Applications** | Deliverable 2A:  Technical notes for pilot case studies (3-4) | May 2018 |
| **Activity 3- Capacity Building and Training Workshops** | Deliverable 3A:  1-2 training workshops to the IDB’s staff  Deliverable 3B:  3-4 training workshops to in the region (countries where case studies where performed) | May 2018  May- September 2018 |

## CONTRACTOR ELIGIBILITY INFORMATION

Proposals in response to these Terms of Reference may only be submitted by the following:

* Non-profit, non-academic organizations: Independent research institutions, observatories, research laboratories, professional societies and similar organizations associated with educational or research activities.
* Universities and academic research centers, acting on behalf of their researchers and faculty members; such organizations also are referred to as academic institutions.
* Technical team from the WEF nexus research area with specific expertise in integrated water, energy, and food resources management, adaptation to climate change impacts and roles of project manager similar to the one proposed, including modeling tools development and decision making support.
* Professionals or specialists with over 10 years of experience in water resources management, watershed management, flood control, management of extreme events-disaster (droughts and floods) and water resources modeling and information systems for integrated resources management.
* Professionals or specialists with over 10 years of experience in hydro-climatology and specifically with demonstrated expertise in projects for climate change adaptation measures in relation with the water sector.
* Professionals or specialists with over 10 years of demonstrable experience in numerical simulation of hydrology, energy, agriculture systems, valuing especially those on simulation of extreme events and uncertainty analysis. It is specifically assessed experience in development of simulation tools that combine climatic and hydrological forecasts.

Proposals from individual consultants or for-profit organizations will not be accepted.

## CONDITIONS AND TIME OF COMPLETION

## The proposed project timeline is shown in Section IV. The work will start upon receipt of a formal Notice to Proceed by the IDB.

## Draft deliverables will be delivered to the IDB within 30 calendar days of the proposed deliverable due dates. The contractor assumes that the IDB will review and prepare written comments within fifteen (15) calendar days of submittal. Upon receipt of comments from the IDB to such drafts, the contractor will submit the final version within fifteen (15) calendar days of receipt of such comments.

## The contractor will submit a more detailed work plan and schedule within thirty (30) calendar days after the receipt of the Notice to Proceed.

Other conditions applicable to this research and development contract are as follows:

* Peer Review: all Project Technical Notes produced, its documentation will be reviewed by at least 2 anonymous reviewers (per deliverable). The IDB has included this peer review component in the budget for this TC.
* During the proposed capacity building workshops, the participants will have a chance to evaluate the facilitators and presenters. The IDB has included this component in the budget for this TC.
* During the proposed capacity building workshops, the participants will be involved in hands-on exercises, which will be evaluated by IDB staff. The participants will receive feedback on these exercises as a result of this evaluation. The IDB has included this component in the budget for this TC.

## COMPENSATION

The compensation for this research and development contract described under Activities 1, 2 and 3 shall be a lump sum amount as approved during negotiations between the IDB and the contractor. The IDB will be invoiced monthly, based on the percentage of completion method and meeting the date of each deliverable as stated in Section IV, as well as the conditions specified in Section VI.

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| --- | --- | --- |
| **Milestone** | **Anticipated Date** | **Amount (%)** |
| Upon signature of the contract (project initiation) | September 2016 | 10 |
| Upon Bank’s acceptance of Deliverable 1A:  Detailed Work Plan: Data gathering and calibration process; case study selection and possible applications  Upon Bank’s acceptance of Deliverable 1B:  Data collection and calibration of analytical tool for WEF Nexus analysis in the Latin America Region (country scale)- **software**  Upon Bank’s acceptance of Deliverable 1C:  Technical Note: Technical description and user manual of the WEF Nexus tool | November 2016  July 2017  September 2017 | 15  25  10 |
| Upon Bank’s acceptance of Deliverable 2A:  Technical notes for pilot case studies (3-4) | May 2018 | 20 |
| Upon Bank’s acceptance of Deliverable 3A:  1-2 training workshops to the IDB’s staff  Upon Bank’s acceptance of Deliverable 3B:  3-4 training workshops to in the region (countries where case studies where performed) | May 2018  May-September 2018 | 10  10 |

## CHARACTERISTICS OF THE CONSULTANCY

* Consultancy category and modality: Products and External Services Contractual
* Contract duration: September 2016 - September 2018.
* Place(s) of work: Regional.
* Division Leader or Coordinator: The supervision of the contractual’s work and deliverables will be done in coordination with Mauro Nalesso (INE/WSA), Pedro Coli (INE/WSA), Raul Munoz (ESG).