**TERMS OF REFERENCE**

**RG-T2659**

**Development of High-Resolution Remote Sensing Data Sets and Applications for Water Security and Climate Adaptation in Latin America**

# **INTRODUCTION**

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 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. In addition, improving the security and resilience of drinking and wastewater infrastructures is crucial to ensure the provision of clean and safe water, and also to provide a sustainable economic and social development.

Providing water security is especially important in the Latin America region where water supply, sanitation, and a healthy environment form the basis to successfully reduce poverty and develop shared-growth strategies. In order to provide water security, decision-makers need to have accurate information of biophysical parameters relevant to the hydrology and meteorology of the region, which are spatially distributed and may present significant temporal variability. However, in developing countries and most certainly in the case of the Latin America region, groundwater information, water quality data, and even basic hydro-meteorological data may be scarce.

The use of Remote Sensing (RS) tools for hydrology and water resources operational purposes, while not new, definitely is a fast-growing field that can provide useful, efficient, and effective information to create innovative solutions for water security and fill the gap on data availability to strengthen water resources management. RS offers a solution to the data-scarcity problem in the Latin American region by providing relevant data on surface water resources, land cover, surface geology, water quality, temperature, and soil moisture among other (bio) geophysical parameters.

The objective of this project is to evaluate the potential, advantages and limitations of various RS tools, and to identify prospective areas of application for water-related operations. Furthermore, this project is aimed to develop high-resolution RS datasets of different environmental parameters for solving data scarcity and water resources management problems. The project will integrate high-resolution datasets into Hydro-BID modules in order to obtain higher spatial resolution water balances from the rapidly changing surface of the Earth, which ultimately can support more accurate decisions on water resources management. The synergetic potential of high-resolution RS data and Hydro-BID will be explored through case studies applications in the Latin American region. All the knowledge generated through this project will be disseminated by creating several seminar/workshops, technical notes and peer-review journal publications.

## BACKGROUND

Achieving water security requires, among other things, the provision of sustainable access to adequate quality and quantities of water for human well-being and socio-economic development, and safeguard population resilience to water-related disasters including floods, droughts, and pollution. Water security plays a key role in other security areas, such as infrastructural, social, institutional, and financial. Therefore, achieving water security could inherently contribute to address multiple priority development areas: growth and employment, health, environmental sustainability, and hunger. Addressing water security requires an evaluation of the water resources which are spatially varied and dependent of the interaction of climate, geology, and topography. Water resources are especially vulnerable to the effects of climate change. Therefore, it is important to understand the potential impacts of meteorological changes on the availability and adequacy of water resources.

Monitoring of biophysical parameters relevant to the hydrology and meteorology is an essential part to provide water security and climate adaptation strategies. Some of these environmental parameters can be determined by remote sensing with reasonable accuracy. The advantage of remote sensing techniques lies in their ability to provide both spatial and temporal views of several environmental variables over large and often not accessible areas. This capability has made RS technologies to become very useful tools over a wide-range of applications. Indeed, the use of satellite remote sensing has been an important source of information in the field of energy (biomass energy and forest inventory), water (prevention and management of draughts, floods, monitoring of water quality, observations of the temporal and spatial variations in water volumes stored in rivers, lakes, and wetlands in order to fulfill water demands), and the environment (detection of pollution, measurement of the climate change, monitoring of urban growth and management of urban planning, data assimilation with large-scale models). RS products can also be used in other applications involving the water-energy-food nexus, governance and adaptive management, or transboundary settings. RS data might help to adjust past policies or provide information from parts of a basin lying outside a nation’s borders to facilitate early warnings.

For instance, in poorly gaged basins with times of concentration of several days, real-time satellite estimates of precipitation and derived streamflow forecasts can help managers allocate water among users and operate reservoirs more efficiently. In large rivers, satellite data on the river and lake surface elevation can be used to estimate flow in the upper parts of the basin and make predictions for downstream flows. Soil moisture observations may give insights into how much irrigation is needed, and help forecast and monitor drought conditions as well. Furthermore, RS allows monitoring of surface water quality parameters to assess the repercussions of river basin management policies, land use practices, and non-point source pollution, as well as to monitor the likelihood of algal blooms and other water quality threats to water supply systems.

In order to fully exploit all the potential offered by the RS tools and to actually explore all areas of applications with a very high societal impact, high-resolution processing methods for assimilation and use of RS data are required. In addition, the combination of RS observations with climate impact studies using land surface and hydrological models (such as Hydro-BID) offers an advantage stage to inform adaptation to climate and global change.

This Technical Cooperation (TC) is aimed to demonstrate and create awareness among Bank staff and its client counterparts of the potential of remote sensing in managing water-related operations to provide water security and climate adaptation strategies.

## SCOPE OF WORK

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

**Activity 1. Evaluation of the Potential of Remote Sensing (RS) Tools for Water Security and Climate Adaptation**

Under this activity the contractor will prepare a thorough literature review to assess various RS products available for water-related operations and to identify prospective areas of application for solving water resources management problems. In addition, the contractor will give insight on the potential and limitations, data accessibility, and costs of RS tools, describe how remotely sensed data can jointly be used with in-situ measurements to improve results, and explain the validation and evaluation processes to better inform the client and enhance Bank water-related operations.

This detailed discussion will help to better inform the client for deciding whether the use of RS products could be worthwhile in a specific situation and enhance water-related operations. In addition, this evaluation will help to identify different types of water resources management problems where RS tools can be applied. This analysis will provide guidance to Bank staff by showing when, how and which RS instruments are desirable to apply based upon their project needs and constraints. This will place the foundation for the actual application of RS instruments in case studies in the Latin America region.

The objectives of this activity will be to:

* Identify the RS’s advantages, limitations, areas of application, and validation procedures.
* Assess the capabilities of RS tools to fill biophysical data gaps in the Latin America region.
* Evaluate how satellite-related technologies can be integrated with in-situ monitoring programs to improve results.
* Present through case studies how decision-makers have used RS tools to address water resources management challenges.

**Activity 2. Development of High-resolution RS Products for Water Resources Management**

Under this activity the contractor will apply processing techniques to extract information from RS images and create GIS map layers of high-resolution (order of meters spatially and sub-hour temporally) of key environmental parameters that can be used for water resources management. It is worth noting that such high resolution data do not yet exist for the Latin America region, and this dataset product will be a primary contribution of this TC. Environmental parameters will include precipitation, evapotranspiration (ET), temperature, soil moisture, land use, crop yield, crop type, groundwater, and water quantity (surface flows) and quality (phytoplankton concentrations) variables among other environmental parameters.

The objectives of this activity will be to:

* Develop a high-resolution spatial dataset of key bio-physical and meteorological variables for the Latin America region.
* Represent in GIS maps each of the environmental parameters obtained from satellite images to facilitate further examination and interpretation.

**Activity 3. Case Study Applications**

Under this activity the contractor will explore the synergetic potential of high-resolution RS data and Hydro-BID hydrological model through three (3) case studies applications in the Latin American region. The contractor will apply RS products from Activity 2 in countries/watersheds that are presenting problems related to: 1) data scarcity, 2) climate variability, and 3) agricultural and water systems planning and management. Each case study will be chosen to reflect a specific problem related to water scarcity (droughts), inundation (floods), and water quality (pollution), and will involve clients that have expressed interest and need of high-resolution RS data.

The objectives of this activity will be to:

* Incorporate high-resolution spatial datasets of key bio-physical and meteorological variables into Hydro-BID to provide higher spatial resolution water balances in three countries/watersheds.
* Apply high-resolution outputs from Hydro-BID for assessing the potential impacts of climate change on water flows and infrastructure and for formulating adaptive projects and strategies.

The contractor will produce a technical note containing a summary of each case study and the main lessons learned from this activity. This technical note will be submitted to a peer-reviewed journal for publication in the research literature.

**Activity 4. Knowledge Dissemination**

Under this activity the contractor will disseminate all the knowledge and products generated through this TC project through several seminar/workshops, technical notes, and peer-review journal publications.

The objectives of this activity will be to:

* Organize workshops to disseminate the results and encourage sector policy dialog.
* Present and publish the results of this TC in a technical conference and in a peer-review journal, respectively.

## EXPECTED WORK PRODUCTS AND SCHEDULE OF DELIVERY

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

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| --- | --- | --- |
| **Project Activity** | **Deliverables** | **Due Date** |
| **Activity 1:** : Evaluation of the potential of RS tools for water security and climate adaptation | Deliverable 1A:   * Analysis of RS technologies and their applications towards water security issues in the Latin America region. * Identification of three (3) countries/ watersheds for RS applications using criteria specified in Component 3. * Dissemination and engagement workshops (2) and a Technical Note. | June 15, 2016 |
| **Activity 2:** Development of high-resolution RS products for water resources management | Deliverable 2A:   * Satellite RS images are processed. Key environmental parameters information is extracted, mapped, and analyzed.   Deliverable 2B:   * New high-resolution datasets of biophysical parameters are created.   Deliverable 2C:   * Capacity Building workshops (2). | December 15, 2016  December 15, 2016  February 15, 2017 |
| **Activity 3:** Case study applications | Deliverable 3A:   * RS datasets are incorporated into Hydro-BID for three (3) water security case study applications.   Deliverable 3B:   * Case study reports (3). | June 15, 2017  September 15, 2017 |
| **Activity 4:** Knowledge dissemination | Deliverable 4A:   * Dissemination and engagement workshops of case studies (1-2).   Deliverable 4B:   * Training and Capacity Building workshops (3-4) for personnel in the countries/ watersheds analyzed in Component 3. | November 15, 2017  December 15, 2017 |

## 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.

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- 4 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** | **%** |
| Upon Full Execution of the Agreement | February, 2016 | 15% |
| Upon Bank’s acceptance of Deliverable 1A | June, 2016 | 10% |
| Upon Bank’s acceptance of Deliverable 2A  Upon Bank’s acceptance of Deliverable 2B  Upon Bank’s acceptance of Deliverable 2C | December 15, 2016  December 15, 2016  February 15, 2017 | 15%  10%  5% |
| Upon Bank’s acceptance of Deliverable 3A  Upon Bank’s acceptance of Deliverable 3B | June 15, 2017  September 15, 2017 | 20%  15% |
| Upon Bank’s acceptance of Deliverable 4A  Upon Bank’s acceptance of Deliverable 4B | November 15, 2017  December 15, 2017 | 5%  5% |

## CHARACTERISTICS OF THE CONSULTANCY

* Consultancy category and modality: Products and External Services Contractual
* Contract duration: February 2016- December 2017.
* Place(s) of work: Multiple locations.
* Division Leader or Coordinator: The supervision of the contractual’ s work and deliverables will be done in coordination with Fernando Soares Bretas (INE/WSA), Pedro Coli (INE/WSA), and Juliana Corrales (INE/WSA).