

## TC DOCUMENT

### I. Basic Information for TC

▪ Country/Region:	REGIONAL
▪ TC Name:	Development of Case Studies of the Water-Energy-Food Nexus in Latin America
▪ TC number:	RG-T2660
▪ Team Leader/Team members:	Fernando Bretas (INE/WSA); Team Members: Pedro Coli, Silvia Ortiz, Miguel Campo Llopis and Yolanda Galaz (INE/WSA); Monica Lugo (LEG/SGO); Ana Rios (INE/CCS); Ramón Espinasa (INE/ENE); David Corderi (INE/RND) and Raul Muñoz (VPS/ESG)
▪ Taxonomy:	Knowledge Generation and Dissemination
▪ Date of the TC abstract authorization:	June 22, 2015
▪ Reference to request:	N/A
▪ Beneficiary:	Latin America Region
▪ Executing agency and contact name:	Interamerican Development Bank (IADB)
▪ Donors providing funding	Latin American Investment Facility (LAIF) <sup>1*</sup>
▪ IDB funding requested:	US\$1,000,000
▪ Local counterpart funding:	None
▪ Disbursement period:	24 months (execution period) 30 months (disbursement period)
▪ Required start date:	October 2015
▪ Types of consultants:	Firm and individual consultants
▪ Prepared by Unit:	INE/WSA
▪ Unit of Disbursement Responsibility:	INE/WSA
▪ TC included in Country Strategy:	N/A
▪ TC included in CPD:	N/A
▪ GCI-9 Sector Priority:	Climate Change and Environmental Sustainability

### II. Objective and Justification of the TC

- 2.1 The main objective of this Technical Cooperation (TC) 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 tradeoffs 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.
- 2.2 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

<sup>1</sup> This TC is financed with funds from the LAIF grant for Climate Change and Water and Sanitation, awarded by the "Grant Resolution Subsidy" of June 5, 2014 of the Spanish Agency for International Cooperation for Development (AECID), with funds from the "Investment Facility in Latin America" (LAIF) of the European Union (link is included to the agreement signed between the IDB and AECID (IDBdocs 38916728)). This document is consistent with the requirements established in the agreement between the Bank and the donor to the components integrated Water Resources Management, and Adaptation to Climate Change.

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.

- 2.3 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.
- 2.4 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.
- 2.5 The approach to the WEF nexus normally depends on the perspective of the policy maker (Harris, 2002). If a water perspective is adopted, then food and energy systems are users of the resource (see e.g., Hellegers and Zilberman, 2008); from a food perspective energy and water are inputs (see e.g., Mushtaq et al., 2009; UN-DESA, 2011; Khan and Hanjra, 2009); from an energy perspective, water as well as bioresources (e.g., biomass in form of energy crops) are generally an input or resource requirement and food is generally the output. Food and water supply as well as wastewater treatment require significant amounts of energy. Areas such as food-as-fuels (i.e., biofuels) tend to blur these descriptions (see e.g., Nonhebel, 2005) due to additional impacts associated with land use, land use change and use of the available biomass resource. In any case, the perspective taken will affect the policy design. This is due to the specific priorities of the institution or ministry, as well as the data, knowledge and analytic breadth of the tools of the associated experts and support staff.
- 2.6 It is worth pointing out that agriculture is the main user of water available in the region (more than 70 percent of total water use). From an agriculture/food point of view, the major tradeoffs with energy are the competing uses of water and land. In terms of water, there are plenty of examples of the tradeoffs with regards to water releases from multipurpose dams/reservoirs when hydropower and irrigation are two of the uses of the reservoir. In terms of land and water, the most notable tradeoff in the past years has been the competition for input use that biofuels and non-energy crops have exhibited with the recent spikes in energy prices (though, the competition has slowed down in the last two years due to a decrease in oil prices).

### III. Description of Activities

- 3.1 The project will support the development of methodologies and outputs consisting of the following activities.
- 3.2 **Component 1 - Development of base analytical tool for WEF Nexus:** this component consists of the development of an integrative modeling tool of water, energy and food production/security issues, following the approach of existing global Integrated Assessment Models (IAM), but tailored and localized to the Latin America region. An IAM will be developed for the Latin America region building upon the Hydro-BID system developed by the IADB, integrating it with an existing IAM (e.g., GCAM: Global Change Assessment Model) 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.
- 3.3 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.
- 3.4 The modeling approach will consist of integrating the Hydro-BID computational database and simulation engine with the Global Change Assessment Model (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.
- 3.5 **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., Corporación del Valle del Cauca (CVC) in Colombia and Autoridad Nacional del Agua (ANA) in Peru). Particular focus will be placed on water allocations for energy generation and food production purposes.
- 3.6 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, International Energy Agency (IEA), as well as national data sets. Energy use data in water and wastewater treatment facilities has been compiled by WSA.
- 3.7 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).
- 3.8 A technical note on the WEF Nexus tool, including the technical description and user manual will be prepared.
- 3.9 The work under this component will be performed by a consulting firm or a university that has proven experience and technical capacity related to integrated models in the water-energy-food sectors.

- 3.10 **Component 2 - Case Study Applications:** This component will include assessment of data availability and needs of countries to implement the WEF nexus methodology, travel to the countries for data collection and interviews, data analysis, and the identification of pilot case studies (3-4) for implementation. Selection of countries for case study applications will depend on the access to available data to perform the study, need to implement the WEF nexus methodology at the country or local level, and interest of governments to participate in the study.
- 3.11 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.
- 3.12 A technical note for each case study (3-4) will be developed under this component. These technical notes will include a complete description of the analysis performed in each study.
- 3.13 The work under this component will be performed most likely by the consulting firm or university that developed the analytical tool for the WEF Nexus with the supervision of the Bank. The consulting firm or university will have the technical capacity of running and implementing the developed tool for the pilot case study applications.
- 3.14 **Component 3 – Knowledge Dissemination:** this component will include seminar/workshop(s) to disseminate knowledge and generate policy through our clients and inside the Bank.
- 3.15 It will also include a series 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.

- 3.16 This component will result in the drafting of a Bank Working Paper for the WEF Nexus tool developed as well as an article for submission to a peer-reviewed journal.
- 3.17 The work under this component will be performed by the consulting firm or a university that developed the WEF Nexus tool and carried out the case study applications. The objective is that the consulting firm or a university transfers the technical knowledge of the products developed under this TC to the Bank staff and to our clients in the region.

#### IV. Indicative Results Matrix

Project Components	TC Outputs	TC Outcomes
Component 1: Development of base analytical tool for WEF Nexus	<p><u>Output 1A:</u> New data bases and data sets developed have been delivered by the consultant and approved by the Bank (one WEF nexus data base for the Latin America region).</p> <p><u>Output 1A:</u> Working Paper on the evaluation of the WEF Nexus in Latin America: analytical tool development has been delivered by the consultant and approved by the Bank (one working paper).</p> <p><u>Output 2A:</u> Technical note on the WEF Nexus tool has been delivered by the consultant and approved by the Bank (technical description/user manual)(1).</p>	<p><u>Outcome 1A:</u> Nexus information and tools are used for planning, management and decision-making actions (number of times).</p> <p><u>Outcome 2A:</u> Knowledge deepened on challenges of the WEF nexus in Latin America countries (number of country and sector programming documents that consider the topic explicitly).</p> <p><u>Outcome 3A:</u> Operations approved by the Bank through the Water and Sanitation Division that mentioned the work of this TC as support for the new project or TC document (number of TCs or Operations) (1).</p>
Component 2: Case study applications	<u>Output 2A:</u> WEF Nexus case study technical notes have been delivered by the consultant and approved by the Bank (3-4).	
Component 3: Knowledge Dissemination	<p><u>Output 3A:</u> Dissemination and engagement workshops have been provided by the consultant and the Bank (1-2).</p> <p><u>Output 3B:</u> Training and Capacity Building workshops have been provided by the consultant and supervised by the Bank (3-4)</p>	

#### V. Budget

- 5.1 An indicative budget is presented below. These TC activities will be financed with the EU's Latin American Investment Facility (LAIF), through the Spanish Agency for International Cooperation (AECID). The distribution of resources is as follows:

##### Indicative Budget ([Detailed Budget](#))

Component	Total Funding (US\$)
1. Development of base analytical tool for WEF Nexus	200,000
2. Case Study Applications	600,000
3. Knowledge Dissemination	200,000
<b>TOTAL</b>	<b>1,000,000</b>

#### VI. Executing agency and Execution Structure

- 6.1 This is a Bank-originated TC focused on integrating recently developed methods and tools in modeling, visualization and decision-making processes, which that are particularly

applicable to water scarce areas as case study applications that may be replicated in other climate-sensitive parts of the Latin America region. In addition, this detailed research and development effort will add value by offering the opportunity of mainstreaming climate change impacts in the design of water resources planning and Bank' infrastructure operations in different sectors (water supply, water resources management, hydro-energy, irrigation, natural hazards and risk management and transport). Besides the water resources management and planning uses of Hydro-BID and GCAM, the knowledge and tools developed through this TC will be able to serve as support for the environmental evaluation and screening of Bank's project loans at regional scale. The execution of this TC will provide a learning, knowledge transfer and data gathering opportunity for Bank staff involved in issues of water resources, vulnerability and adaptation to climate change, which is a growing area of work for the Bank (and particularly the WSA division). Therefore, it is deemed critical that this TC is Bank-executed. The Bank will contract individual consultants, consulting firms and non-consulting services in accordance with Bank's current procurement policies and procedures.

## **VII. Project Risks and Issues**

- 7.1 The primary risk for implementation of this TC project is the lack of technical capacity of some of Bank's clients and the gap of information for model parameterization in particular areas. To mitigate this risk, the TC includes providing technical support and guidance to model users and building capacity with our client country counterparts (CVC, ANA and Agencia Pernambucana de Agua y Clima (APAC), as well as with a local universities to sustain this effort beyond the duration of this TC. An additional risk stems from the pioneering nature of this TC; there isn't much operational experience with the kinds of products that this TC will yield. We have therefore included peer review of all outputs of this TC by at least 2 anonymous reviewers (one within the Bank and one outside the Bank) to insure quality of the TC deliverables.

## **VIII. Exceptions to Bank Policy**

- 8.1 This TC does not involve any exceptions to the Bank's Policies.

## **IX. Environmental and Social Strategy**

- 9.1 Following ESG's project classification process (Safeguard Policy Filter and Safeguard Screening Form) requirements, it has been determined that this project falls under Category "C". No environmental assessment studies or consultations are required for Category "C" operations ([Link](#)).

### **Required Annexes:**

Annex I: [Terms of Reference](#)

Annex II: [Procurement Plan](#)

## DEVELOPMENT OF CASE STUDIES OF THE WATER-ENERGY-FOOD NEXUS IN LATIN AMERICA

RG-T2660

### CERTIFICACIÓN

Por la presente certifico que esta operación no reembolsable de inversión fue aprobada para financiamiento por el Fondo de Subvención de LAIF para CC y AyS (LAF) de conformidad con la comunicación de fecha 19 de junio de 2015 suscrita por la Sra. Carmen Jover Gomez-Ferrer, Jefa del Departamento del Fondo de Cooperación para Agua y Saneamiento, de la Agencia Española de Cooperación Internacional para el Desarrollo (AECID) del Ministerio de Asuntos Exteriores y de Cooperación (MAEC) y comunicación de fecha 22 de junio de 2015 suscrita por Kai Hertz, ORP/GCM. Igualmente, certifico que existen recursos hasta la suma de **US\$1.000.000**, para financiar las actividades descritas y presupuestadas en este documento. La reserva de recursos representada por esta certificación es válida por un periodo de cuatro (4) meses calendario contados a partir de la fecha de firma de esta certificación. Si el proyecto no fuese aprobado por el BID dentro de ese plazo, los fondos reservados se considerarán liberados de compromiso, requiriéndose la firma de una nueva certificación para que se renueve la reserva anterior. El compromiso y desembolso de los recursos correspondientes a esta certificación sólo debe ser efectuado por el Banco en dólares estadounidenses. Esta misma moneda será utilizada para estipular la remuneración y pagos a consultores, a excepción de los pagos a consultores locales que trabajen en su propio país, quienes recibirán su remuneración y pagos contratados en la moneda de ese país. No se podrá destinar ningún recurso del Fondo para cubrir sumas superiores al monto certificado para la implementación de esta operación. Montos superiores al certificado pueden originarse de compromisos estipulados en contratos que sean denominados en una moneda diferente a la moneda del Fondo, lo cual puede resultar en diferencias cambiarias de conversión de monedas sobre las cuales el Fondo no asume riesgo alguno.

**(original firmado)**

10/20/12015

Sonia M. Rivera  
Jefa

Fecha

Unidad de Gestión de Donaciones y Cofinanciamiento  
ORP/GCM

### APROBACIÓN

Aprobado:

**(original firmado)**

10/21/15

Nestor Roa, a.i.  
Gerente de Sector

Fecha

Sector de Infraestructura y Medio Ambiente  
INE/INE