

**ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE
STABILITY OF THE AMAZON RAINFOREST**

BR-T1284

CERTIFICATION

I hereby certify that this operation was approved for financing under the Sustainable Energy and Climate Change Initiative (SECCI-SCI) through a communication dated on September 10, 2013 signed by Gerhard Lair (ORP/GCM). Also, I certify that resources from the Sustainable Energy and Climate Change Initiative (SCI) are available for up to \$1,000,000 in order to finance the activities described and budgeted in this document. This certification reserves resources for the referenced project for a period of four (4) calendar months counted from the date of eligibility from the funding source. If the project is not approved by the IDB within that period, the reserve of resources will be cancelled, except in the case a new certification is granted. The commitment and disbursement of these resources shall be made only by the Bank in US Dollars. The same currency shall be used to stipulate the remuneration and payments to consultants, except in the case of local consultants working in their own borrowing member country who shall have their remuneration defined and paid in the currency of such country. No resources of the Fund shall be made available to cover amounts greater than the amount certified herein above for the implementation of this operation. Amounts greater than the certified amount may arise from commitments on contracts denominated in a currency other than the Fund currency, resulting in currency exchange rate differences, for which the Fund is not at risk.




Sonia M. Rivera
Chief
Grants and Co-Financing Management Unit
ORP/GCM

12/02/2013
Date

APPROVAL

Approved by :



Alexander Meira Rosa
Sector Manager
Infrastructure and Environment Sector
INE/INE

12/02/2013
Date



TC DOCUMENT

Assessment of the Impacts of Climate Change on the Stability of the Amazon Rainforest (BR-T1284)

I. BASIC PROJECT INFORMATION

▪ Country / Region:	Brazil / Southern Cone
▪ TC name:	Assessment of the Impacts of Climate Change on the Stability of the Amazon Rainforest
▪ TC number:	BR-T1284
▪ Team leader/members:	Axelle Boulay (INE/CCS), team leader; Gloria Visconti (INE/CCS); Anne Gander (CCS/CBR); Carlos Lago (FMP/CBR); Fernanda do Vale Caribé (CCS/CBR); Felipe Capella (LEG/SGO); and Milagros De Pomar (INE/CCS).
▪ Taxonomy:	Client Support
▪ Reference to request (IDB docs #):	37931922
▪ Date of TC Abstract authorization:	September 10 th , 2013
▪ Beneficiary:	Republic of Brazil, through the Ministry of Science, Technology and Innovation (MCTI)
▪ Executing agency and contact name:	Fundação Amazônica de Defesa da Biosfera (FDB; Amazonian Foundation for Biosphere Protection), Adriano Premebida
▪ Donors providing funding:	Fund for the Sustainable Energy and Climate Change IDB Special Program (SCI) ¹
▪ IDB funding requested:	US\$1,000,000.00
▪ Local counterpart funding, if any:	US\$500,000.00
▪ Disbursement period (which includes execution period):	30 months (24 months of execution)
▪ Required start date:	December, 2013
▪ Types of consultants:	Consulting firms and individuals
▪ Prepared by Unit:	CCS/CBR
▪ Unit of Disbursement Responsibility:	CBR
▪ Included in Country Strategy (y/n):	Y
▪ TC included in CPD (y/n):	N
▪ GCI-9 Sector Priority:	Protect the environment, respond to climate change, promote renewable energy and ensure food security.

II. OBJECTIVE AND JUSTIFICATION

2.1 The objective of this technical cooperation (TC) is to assist the Government of Brazil (GoB), through the Ministry of Science, Technology and Innovation (MCTI), to assess the

¹ This TC requests funding from the Sustainable Energy and Climate Change IDB Special Program (IDB SECCI Fund) after a careful analysis of other sources of financing in the Bank.

effects of increased atmospheric CO₂ on the resilience of the Amazon forest² (a key factor in the likelihood of a dieback), and its potential economic implications.

- 2.2 This objective is expected to be achieved through the following activities: (i) assessment of the economic impacts of a potential dieback of the Amazon forest; (ii) definition of the location, engineering plans, budget and technical requirements for an elevated CO₂ experiment in the Amazon rainforest; (iii) development of a protocol of measurements to be used throughout the experiment; (iv) site characterization studies and evaluation of ecosystem models for the site; (v) organization of workshops with the participation of academic experts and policy makers and communication of the outcomes of this TC to the non-specialist community; (vi) organization of training courses aimed at building long-term regional capacity to conduct the experiment; and (vii) consolidation of a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest.
- 2.3 This operation will support the GoB's efforts to assess the implications of climate change in the Amazon biome. The studies to be made will substantially improve the understanding of the risk of a possible 'dieback' of the Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank's 2012-2015 Climate Change Action Plan as one of the key concerns on the natural resource base of Latin America that may result from 21st century climate change.
- 2.4 An increase in atmospheric CO₂ concentration has been repeatedly identified to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this "CO₂ fertilization effect" remains untested in tropical forests. If this effect is not realized, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region's economy via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is therefore critical to steer future development policies for the Amazon region. In that sense, the overarching goal of this TC is to support pre-experimental studies and assessments that will subsidize a larger and innovative field experiment on the effects of rising CO₂ levels on the Amazon forest.
- 2.5 This TC is consistent with the GCI-9 objective to "protect the environment and response to climate change," as it substantially increases the information available to design the Bank's projects. This TC is also in accordance with the IDB Country Strategy with Brazil for 2012-2014 (document GN-2662-1), as it supports science and technology initiatives that enable the generation of information for the public and private sectors related to climate change. It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: "implementation of monitoring systems to observe the impacts of climate change", which is consistent with Brazil's national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).
- 2.6 Further, this TC is consistent with paragraph 4.4 of the document "Sustainable energy and climate change IDB special program (IDB SECCI Fund)" (GN-2435-5), as it identifies and manages the existing vulnerabilities regarding the effects of climate change.

² For full experiment description, see [Document Amazon-FACE](#).

III. DESCRIPTION OF ACTIVITIES AND OUTPUTS

- 3.1 The execution of this TC will be divided into five components, which are designed to lead to the development of a technical-scientific proposal in order to attract other potential funders (e.g. Amazon Fund, with support from MCTI) and secure the long-term provision of funds for the full implementation of the experiment. The components will be executed through individual consultants, non-consultancy services and the acquisition of goods.
- 3.2 **Component 1: Economic Impacts of the Amazon Dieback.** This component will finance an individual consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and having at least first-order estimates on the uncertainties associated with those impacts will strengthen the justification for the increased CO₂ experiment, and it will also increase the chances of attracting complementary funds for the long-term conduction of the experiment. An initial product will be an assessment of the physical implications of an Amazon dieback (funding for this report will come from MCTI through its *in kind* counterpart funding). The product resultant from this component will be a report on the potential economic impacts of the Amazon forest dieback, which should be a compilation study elaborated based on the review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example, the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).
- 3.3 **Component 2: Design and Assessment.** This component will finance individual consultancies of high-level academic subject matter experts, as well as an engineering firm. The expected product will be the detailed engineering plans for construction and operation manual of a scientifically robust, comprehensive and replicable CO₂ experiment. The activities of this Component include: a) identifying the exact location for experimental plots; b) evaluating logistical constraints (roads, power, and hazards); c) developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access; d) preparation of construction plans; and e) preconstruction site preparation. The consultant will actively interact with the engineering firm to prepare these documents and to identify local vendors and providers of material needed for the implementation of the experiment. The contracted engineering firm will be responsible for elaborating the technical plan (construction blueprints and executive project) and will hold the technical responsibility for it. The consultant will be an expert in FACE (Free-Air CO₂ Enrichment) technology in order to assist the engineering firm with technical details specific for this type of construction and will also be responsible for elaborating the report describing the technical plan and other operational recommendations on the topics mentioned above. Therefore, this technical report with technical standards, engineering plans and operations manual will be the outcome to be reported at the end of this component.
- 3.4 **Component 3: Site Characterization.** This component will finance individual consultancies that will be responsible for carrying a series of on-site measurements (meteorological monitoring and above-/below-ground carbon, water and nutrient fluxes and

stocks),³ as well as evaluation of ecosystem models for the experimental site –which will allow the identification of priority areas for model development in the future. It will also finance the acquisition of equipment and infrastructure necessary for taking those measurements. Modeling exercise will be one of the first project activities, since model results can actively steer the type and frequency of measurements to be conducted at the experimental plots. After that, a structured protocol on the measurements to be taken in the experimental plots (incl. access rules for the site) will be elaborated. The measurements that will follow will be primarily conducted in two 30 meter-diameter forest plots, with trees reaching 35m height in the ZF2 road,⁴ located approximately 60km north of Manaus in an area owned and managed by Brazil's National Institute for Amazonian Research. The ZF2 site has been chosen for a series of reasons: the vegetation and soil found in the area are representative of ~32% of the forests found in the Amazon basin (and 60% Brazilian Amazon); its proximity to a large city such as Manaus and good accessibility in light of the long-term need for provision of liquid CO₂ to be used in the experimental plots; the comprehensive record of climatic and environmental studies already available at the place; and the infrastructure already in place, which includes two fully-equipped research stations and two 50m-tall eddy-flux towers. Nevertheless, the exact location of the experimental plots within this 380 km² area will be determined through this project component. Therefore, the outcome from this component will be a milestone report detailing: (i) initial ecosystem modeling results for the experimental site; (ii) a protocol on the measurements to be taken in the experimental plots throughout the experiment; and (iii) the site baseline characterization in terms of carbon/water/nutrient fluxes and stocks.

- 3.5 **Component 4: Workshops/Outreach.** This component will finance two annual workshops, during the executing period of the operation, gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this TC. The outcomes will be short communications elaborated after each workshop. The discussions held and the decisions made in these workshops will give support for the elaboration of the working papers from components 1 and 2.
- 3.6 This component will also finance two short training courses on climate change and tropical forests. Each course will be dictated to approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC, who will be brought, once per year, to the experimental site. The underlying objective of these courses is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

³ Leaf area index, phenology, tree growth, tree position, plant tissue analysis, litter fall, leaf/canopy temperature, root distribution and growth; soil moisture, soil nutrient and organic matter load; vertical profile of CO₂ concentration/temperature/humidity/wind/radiation; precipitation

⁴ The increased atmospheric CO₂ experiment is planned to happen in three phases: I – Pre-experimental measurements (first 1.5 years), in which this TC is placed; II – Pilot experiment (two subsequent years) includes a pair of experimental plots equipped with FACE (Free-Air CO₂ Enrichment) technology, one for control and one for treatment with increased CO₂; III – Full long-term experiment (ten subsequent years), comprises the addition of three pair of control/treatment experimental plots.

- 3.7 Another outcome from this component will be the elaboration of a research proposal to be submitted to potential funding agencies (Amazon Fund with support from MCTI) to look for long-term provision of resources for the experiment. That elaboration of such a proposal will greatly benefit from the outcomes of this TC in general – therefore it will be elaborated towards the end of this cooperation.
- 3.8 **Component 5: Project Administration.** This component will finance the personnel needed for the financial administration of the project.
- 3.9 The results matrix is included [here](#).
- 3.9 **Budget.** This TC will finance consultancies, acquisition of goods (limited to 30% of the total IDB funding), workshops and training courses. As such, the procurement plan is divided into consulting services (US\$638,000), non-consulting services (US\$150,000), events/courses (US\$132,000), acquisition of goods and other non-consulting services (US\$267,500), and operating expenses (US\$62,500).

Summarized Budget

RESULTS		Funding source		TOTAL	%
		IDB - SECCI	MCTI Couterpart		
Component 1. Economic impacts of Amazon dieback assessed		10,000	-	10,000	0.7%
1.1	Economic impacts of Amazon dieback assessed	10,000	-	10,000	0.7%
Component 2. Technical plan defined		390,000	-	390,000	26%
2.1	Engineering plans defined	390,000	-	390,000	26%
Component 3. Experimental area biophysically characterized		405,500	500,000*	905,500	60.3%
3.1	Protocol for site use and access established; component coordination	155,000	-	155,000	10.3%
3.2	Site meteorology assessed	52,000	62,500**	114,500	7.6%
3.3	Site aboveground ecology assessed	55,000	62,500**	117,500	7.8%
3.4	Site belowground ecology assessed & activities coordinated locally	70,000	62,500**	132,500	8.8%
3.5	Ecosystem model priorities defined	56,000	62,500**	118,500	7.9%
3.6	Supporting equipments/infrastructure acquired	17,500	250,000	267,500	17.8%
Componente 4. Project disseminated (outreach)		132,000	-	132,000	8.8%
4.1	Information exchanged internal and externally (workshops)	72,000	-	72,000	4.8%
4.2	Students trained (short courses)	60,000	-	60,000	4.0%
Component 5. Project execution and management		62,500	-	62,500	4.2%
5.1	Acquisition, contracts and payments administered properly	62,500	-	62,500	4.2%
TOTAL		1,000,000	500,000	1,500,000	100.0%
US\$1.00 = BRL\$2.30 ; * 50% as in kind resources		66.7%	33.3%	100.0%	
** in kind resources					

IV. EXECUTING AGENCY AND EXECUTION STRUCTURE

- 4.1 Brazil's Amazonian Foundation for Biosphere Protection (FDB) will execute this TC, as requested by the Brazilian Ministry of Science, Technology and Innovation. Located in Manaus, the FDB's council is mainly composed by members of the National Institute for Amazonia Research (INPA), who have substantial expertise in the management and execution of large projects in the region (such as the PPD-G7 [Pilot Program for The Protection of The Tropical Forests of Brazil]) and in the context of climate change and tropical forests. The executing team is qualified for the selection and hiring of high quality consulting services. As such, FDB will have the principal technical and fiduciary responsibility.
- 4.2 The selection and contracting of consulting services will be done by the Executing Agency in accordance to the document GN-2350-9 (Policies for the Selection and Procurement of Consulting Services Financed by the IDB), while the procurement of goods and related services will be carried out in accordance with document GN-2349-9 (Policies for the Procurement of Goods and Works Financed by the IDB).

V. PROJECT RISKS AND ISSUES

- 5.1 The main risk of this TC is the possible existence of delays and quality related to the execution by FDB. To address this risk, CCS/CBR will oversee the execution and will specifically request the presentation of trimestral reports on the agreement to be signed.

VI. ENVIRONMENTAL AND SOCIAL CLASSIFICATION

- 6.1 Potential impacts were identified on the physical environment albeit geographically restricted and of a localized magnitude. Therefore this TC is classified as a low risk Category B operation ([Safeguard Screening Form](#) and [Safeguard Policy Filter Report](#)).
- 6.2 This project will be conducted in the Cuieiras Biological Reserve/Experimental Station of Tropical Forestry, which is located 60km north from the city of Manaus and is owned and administered by Brazil's National Institute for Amazon Research – INPA. The 380 km² area is dedicated solely to scientific research, is in its majority covered with primary undisturbed forest, and has no human settlements (besides research stations). To be successful, this experiment requires minimal disturbance to the research site and surrounding areas during the planning, construction and operational phases, because every soil or vegetation disturbance artificially modifies carbon and water fluxes and stocks. Therefore, the engineering plans for construction of towers and access pathways will have to be - mandatorily elaborated in a way that minimizes, as much as possible, disturbances at the experimental site. Failure to follow predetermined work plans that minimize site disturbance will be grounds for termination of surveying, construction and research contracts.
- 6.3 The Amazonas state environmental agency (IPAAM) exempts from environmental licensing the activities with low impact on the environment, such as for the construction of research towers. Nevertheless, the agency will be contacted in order to obtain a formal permit letter prior to the start of any construction activity on the experimental site. Site access will be restricted to those who have received advance permission to work at the site and who have been properly trained to mitigate local hazards. Visitors who have not received orientation training will be chaperoned while on the site.

VII. ANNEXES

Annex I- Letter of Request

Annex II- Terms of Reference

Annex III - Procurement Plan



032152/2013

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
SECRETARIA DE POLÍTICAS E PROGRAMAS DE PESQUISA E DESENVOLVIMENTO
Esplanada dos Ministérios – Bloco E – 2º andar – sala 218 - CEP: 70.067-900 Brasília – DF
Fone: (61) 2033-8128 – Fax: (61) 2033-7766

Ofício n.º 095/2013 – SEPED/MCTI

Brasília, 24 de julho de 2013.

À Senhora
Daniela Carrera-Marquis
Representante no Brasil
Banco Interamericano de Desenvolvimento – BID
Setor Embaixadas Norte
Quadra 802 Conjunto F Lote 39 – Asa Norte
70800400. Brasília – DF

Assunto: Proposição de Cooperação técnica com o BID – Experimento de fertilização de carbono na Amazônia

1. O Ministério de Ciência, Tecnologia e Inovação vem por meio desta pedir o apoio do BID para uma cooperação técnica a ser desenvolvida com o objetivo de executar um conjunto de ações para a implementação de um experimento tipo FACE (Free-Air CO₂ Enrichment) na floresta Amazônica Brasileira.
2. Esta cooperação técnica apoiará a mobilização de instituições e pesquisadores-chave para o desenvolvimento de estudos preparatórios que irão gerar informações sobre as implicações da elevação da concentração do CO₂ atmosférico para a estabilidade da floresta amazônica e da biodiversidade nela contida, assim como dos serviços ecossistêmicos por ela providos.
3. A agência executora da cooperação técnica será a Fundação Amazônica de Defesa da Biosfera (anteriormente Fundação Djalma Batista). O conselho curador da fundação é formado em sua maioria por membros do Instituto Nacional de Pesquisas da Amazônia (INPA), Instituto esse vinculado ao MCTI. A fundação tem larga experiência na execução de grandes projetos na região.
4. Estimariamos que a cooperação técnica entre as duas instituições envolvesse a execução das seguintes atividades:

BID-BRASIL (Arquivo) -26-Jul-2013-17:47-030991-2/3

- Contratação de consultorias e aquisição de equipamentos e materiais necessários para implantação do experimento;
- Apoio a workshops envolvendo a comunidade científica, os tomadores de decisão e os formuladores de políticas públicas para avaliação do contexto, do alcance e dos impactos dos objetivos e dos resultados dessa cooperação técnica;
- Apoio ao treinamento de recursos humanos associados ao desenvolvimento do plano científico do experimento.

Atenciosamente,



ANDREA PORTELA
Secretária - Substituta

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)
TERMS OF REFERENCE (REF. 1)

Consultancy for Preparation of Component 2 Report on the Amazon-FACE
ECONOMIC IMPACTS OF THE AMAZON DIEBACK

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of

outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

I. Objectives of the consultancy

The objective of the consultancy is to assess the type and severity of the economic impacts of a potential dieback of the Amazon forest. Specifically, the Consultant will be responsible for:

A review of scientific and non-scientific literature, as well as database research that correlates current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale.

III. Main Activities

- 3.1** Review of scientific and non-scientific literature.
- 3.2** Database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale.
- 3.3** Writing of report about research results.
- 3.4** Communicating the research outcomes to the team involved in the TC.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A single report on the potential economic impacts of the Amazon forest dieback, elaborated based on review of scientific and non-scientific literature, as well as through database research.

V. Payments

- 5.1** The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:
 - a. 25% at the signature of the contract and presentation of a workplan by the consultant
 - b. 75% upon delivery of Product 1
- 5.2** The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC.

VII. Characteristics of the assignment

- Type of Consultancy: Individual Consultants
- Term of Contract: 120 days
- Place of work: Manaus, Brazil; or consultant's place of residence.
- Traveling: no travels are predicted in this consultancy

VIII. Qualifications

- Degree: Undergraduate and graduate degrees in ecology, environmental sciences, or economy; experience with research on climate change impacts on the Amazon forest and economic assessment; good networking with Brazilian and international research groups on the topic
- Language: English and Portuguese
- Area of Expertise: Impacts of climate change on the Amazon forest
- Excellent writing and oral/written communication ability; proven ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 2)

Preparation of Component 2 Report on the Amazon-FACE Implementation Plan
LIST OF REQUIREMENTS FOR THE IMPLEMENTATION OF A HIGH CO₂ EXPERIMENT

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of

outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare the Amazon-FACE implementation plan as the 2nd objective of Component 2 described in the TC document,

Specifically, the Consultant will be responsible for preparing and disseminating a report defining the engineering and infrastructure requirements to implement both a prototype and a fully replicated experiment to study the effects of elevated levels of atmospheric CO₂ on the Amazon.

The Consultant will work with other technical collaborators and consultants to prepare a detailed list of necessary activities and components for the above experiments, including costs and potential vendors.

III. Main Activities

3.1. Working with a group of internal and external collaborators, engineers and consultants, determine the engineering requirements needed for road improvements, electrical supply, CO₂ delivery, and tower and crane installation. Locate and survey a temporary access road through the forest to the research plots. Calculate electrical needs for FACE equipment to determine the additional generator capacity that will be required. Determine the height, strength, and support requirements for FACE vent pipe towers, stairway towers and overhead cranes and define the performance specifications for their installation. Define specifications for delivery, storage, quantity, and quality of CO₂ supply needed for the experiments. Document road improvements needed to ensure reliable CO₂ delivery throughout the year.

3.2. Prepare lists of equipment and services to be acquired for construction of the pilot and fully replicated experiments. This list would include all materials for towers, vent pipes, blowers, instrument sheds, generators, piping, ducting and wiring. Technical specifications will be defined, and potential vendors will be identified.

3.3. Coordinate with others the preparation of lists of equipment and services needed to install tower cranes, roads, access trails, electric services, CO₂ delivery, storage, vaporization and distribution to the research plots.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 - A working plan describing the strategy, procedures and steps consultant will use to consolidate a report describing engineering requirements for implementing the experiment.

PRODUCT 2- A report describing engineering requirements as described above.

V. Payments

5.3 Consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- c. 25% upon acceptance of a contract with Consultant. Consultant must receive the advance payment prior to commencement of work. The advance payment shall be recorded in Consultant's account until the last three months of the agreement term, at which time it will be liquidated by charging costs incurred to the advance payment account. Upon completion of work, or upon termination of this agreement, Consultant shall promptly return any portion of the advance payment that is unexpended.
- d. 25% after approval of Product 1.
- e. 50% after approval of Product 2.

5.4 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC.

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Manaus, Brazil
- Traveling: 5 to 14 day trips to Manaus or other locations, as appropriate.

VIII. Qualifications

- Firm or institution with at least 10 years' experience in engineering design of large field experiments, ability to communicate in English

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 3)

Consultancy for Preparation of Component 2 Report on the Amazon-FACE Implementation
Plan

GENERAL SCIENTIFIC COORDINATION

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest

- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment
- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to coordinate scientifically this TC, cross-linking and integrating project components 1 (technical implementation plan for a CO₂ enrichment experiment in the Amazon), 2 (experimental site biophysical characterization) and 3 (workshops/outreach).

Specifically, the Consultant will be responsible for:

Overseeing and ensuring the good scientific conduction of this TC in general, planning and reporting workshops and training courses and, above all, preparing and disseminating a research proposal (that integrates the outcomes from the several project components) to be submitted to potential funders as a way of ensuring the long-term continuity of the project.

III. Main Activities

- 3.1** Promoting and facilitating cross-communication between project components 1 and
- 3.2** Writing of reports and other documents related to this TC
- 3.3** Scientific planning of workshops and training courses
- 3.4** Communicating this project and its outcomes to stakeholders, the press and the public in general
- 3.5** Set up a strategy on the provision of funds to ensure the long-term continuity of the project
- 3.6** Prepare a document with results from a survey about potential vendors and service providers that will be needed for the CO₂ enrichment experiment

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A chapter in the technical implementation report with a list of potential vendors and service providers needed for the CO₂ enrichment experiment in the Amazon.

PRODUCT 2 – Short reports arising from the two planned scientific/stakeholder workshops (one per project year)

PRODUCT 3 – A single report/research proposal integrating the outcomes from all project components to be submitted to potential funders of the long-term experiment

V. Payments

The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

50% upon delivery of a work plan in accordance with the activities described in this TOR;

25% upon delivery of Product 1

25% upon delivery of Products 2 and 3

The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC.

VII. Characteristics of the assignment

- Type of Consultancy: Individual Consultants (based in Universities or Research Institutions)
- Term of Contract: 2 years
- Place of work: Manaus, Brazil; or consultant's place of residence.
- Traveling: 2 to 5-day trips to Manaus

VIII. Qualifications

- Degree: Undergraduate and graduate degrees in ecology, environmental sciences, environmental engineering, or Earth System science; experience with research on climate change impacts on the Amazon forest; good networking with Brazilian and international research groups on the topic
- Language: English and Portuguese
- Area of Expertise: Impacts of climate change on the Amazon forest
- Excellent writing and oral/written communication ability; proven ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 4)

PREPARATION OF COMPONENT 3 REPORT ON THE AMAZON-FACE SITE CHARACTERIZATION
Overseer of Component 3

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of

outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Coordinating, overseeing and synthesizing the meteorological, above- and below-ground measurements made to characterize the potential site for an elevated CO₂ experiment in the Amazon forest as well as the activities for identification priorities on the development of ecosystem models.

III. Main Activities

- 3.1.** To integrate the methods and results from the meteorological, above- and below-ground physiology, and modeling groups.
- 3.2.** To schedule, organize and concatenate field campaigns for the four mentioned groups.
- 3.3.** Synthesis of the contributions from each of the four groups into a single report.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A single integrated report on the physic-biological characterization of the potential site for an experiment on the effects of elevated CO₂ on the Amazon forest.

PRODUCT 2 – A plan/map indicating the overall preferred location of the experimental plots and monitoring locations accordingly to the outcomes from the four mentioned characterization groups.

V. Payments

The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

50% upon delivery of a work plan in accordance with the activities described in this TOR;

25% upon delivery of Product 1

25% upon delivery of Product 2

The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC.

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Manaus, Brazil or other location.
- Travelling: two 5-10 day trips to Manaus of the coordinator responsible for the consultancy in the hired institution.

VIII. Qualifications

- Institutions with recognized experience in the planning and implementation of CO2-enrichment experiments in forest areas
- Language: English demanded / Portuguese desirable

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 5)

PREPARATION OF COMPONENT 3 REPORT ON THE AMAZON-FACE SITE CHARACTERIZATION
Meteorological Measurements

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops. This component will finance annual closed workshops (travel expenses) gathering the scientific community to discuss progress and broader impacts of

outcomes. In parallel, two specific thematic workshops/meetings (on topics such as plant physiology, soil dynamics, and modeling) will also take place. Outcomes will be short reports elaborated after each workshop. This component will support the making of working papers from components 1 and 2.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Preparing the meteorological site characterization to the above-mentioned report.

III. Main Activities

3.1. A list of resources will be prepared (equipment, consumables, personnel) that are required for the detailed monitoring of meteorological properties and processes in the pilot experiment, as well as the subsequent full experiment.

3.2. Installation of instruments and collection of meteorological data at N different vertical levels within each of the two experimental plots.

3.3. Organization of a database containing the collected data.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A list of the resources necessary for understanding the focal meteorological characteristics of the forest plots, and their responses to elevated CO₂.

PRODUCT 2– A contribution to the overall report on the experimental strategy detailing meteorological properties of the forest plots.

PRODUCT 3 – A plan/map indicating the selected location of the experimental plots and monitoring locations for meteorological measurements.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- a. 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- b. 25% upon delivery of Product 1
- c. 25% upon delivery of Products 2 and 3

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC.

VII. Characteristics of the assignment

- Type of Consultancy: Individual consultants (based in research institutes and universities)
- Term of Contract: 2 years
- Place of work: Manaus, Brazil; or place of residence of the consultant.
- Travelling: two 5-10 day trips to Manaus
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VIII. Qualifications

- Degree: Undergraduate and graduate degrees in environmental biology or meteorology with experience in running subject-related field experiments
- Language: Portuguese and English
- Expertise: Micrometeorology
- Excellent written and oral communication ability; proven ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 6)

Preparation of Component 3 Report on the Amazon-FACE site Characterization
Above-ground measurements I

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil

dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Preparing part of the above-ground ecophysiological site characterization to the above mentioned report as specified below.

III. Main Activities

3.1. A list of resources will be prepared (equipment, consumables, personnel) that are required for monitoring key above-ground components including canopy physical properties (e.g. leaf area) and tissue sampling. This analysis will be conducted in close collaboration with the below-ground, integrative and modeling science components.

3.2. A review will be carried out of the available data on focal above-ground parameters and process rates at the site in order to help define the optimal approach for detailed above-ground monitoring of tree, canopy and tissue properties, and energy and mass fluxes.

3.3. Planning and implementation of logistical support at INPA

IV. Deliverables

The Consultant will deliver the following products. All be produced in collaboration with the below-ground, and data integration components in order to maximize efficiency and scientific coherence.

PRODUCT 1 – A list of the resources necessary for understanding variability in above-ground tissue and canopy properties, and their responses to elevated CO₂.

PRODUCT 2– A contribution to the overall report on the experimental strategy summarizing datasets on key tree and canopy properties.

PRODUCT 3 – A summary of the available supporting logistical and scientific network at INPA and collaborating institutions, in the context of resources needed for both the pilot and full experiment phases.

V. Payments

- 5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:
- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
 - 25% upon delivery of Product 1
 - 25% upon delivery of Products 2 and 3
- 5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Individual consultant
- Term of Contract: 2 years
- Place of work: Manaus, Brazil or location of residence of the consultant
- Traveling: to Manaus or other location for relevant funded workshops/meetings.

VIII. Qualifications

- Degree: Undergraduate and graduate degrees in environmental and agriculture sciences.
- Language: English
- Expertise: Forest science and ecosystem processes, plant-atmosphere interactions; ecophysiology & Stable isotopes;
- Excellent written and oral communication ability; proven ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 7)

Preparation of Component 3 Report on the Amazon-FACE site Characterization
ABOVE-GROUND MEASUREMENTS II

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site

- Develop a protocol of measurements to be used in the experiment
- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Preparing part of the above-ground ecophysiological site characterization to the above mentioned report as specified below.

III. Main Activities

3.1. A list of resources will be prepared (equipment, consumables, personnel) that are required for the monitoring of above-ground fluxes and growth in the pilot experiment and the subsequent full experiment. This analysis will be conducted in close collaboration with the below-ground, integrative and modeling science components.

3.2. Limited tree size and related above-ground data are available for the area where the pilot experiment will be installed. The two pilot experiment plots will need to be characterized for species composition, tree and canopy properties to enable tests of the effect of the experimental treatment. Assistance will be provided for the review of available data and monitoring needs, in relation to above-ground fluxes.

3.3. Based on this information, together with the information available from the below ground review, additional baseline data collection will be initiated with regard to tree and canopy size, and growth.

IV. Deliverables

The Consultant will deliver the following products. All be produced in collaboration with the below-ground, and data integration components in order maximize scientific coherence.

PRODUCT 1 – A list of the resources necessary for understanding variability in above-ground fluxes, and their responses to elevated CO₂ in the pilot and full experiment phases.

PRODUCT 2– A contribution to the overall report on the experimental strategy summarising datasets on key tree and canopy properties.

PRODUCT 3 – A graphical description of available baseline data for the pilot experiment plots. To be presented in combination with the below-ground science component.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2 and 3

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Manaus, Brazil or place of residence of the consultant
- Traveling: to Manaus or other locations in Brazil for relevant funded workshops/meetings.

VIII. Qualifications

Firm or institution with experience in forest science and ecosystem processes; plant ecology & ecophysiology and ecological experiments in the Amazon; ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 8)

Preparation of Component 3 Report on the Amazon-FACE site Characterization
BELOW-GROUND MEASUREMENTS I / LOCAL COORDINATION

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of

outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Preparing part of the below-ground ecophysiological site characterization to the above mentioned report as specified below.

III. Main Activities

3.1. To prepare a list of resources (equipment, consumables, personnel) that are required for the detailed monitoring of soil organic matter and nutrient stocks, root productivity and litter fall in the pilot study, as well as the full experiment.

3.2. Lead the review of what is known about the key soil parameters at the site, and within the broad areas identified as suitable based on the above-ground data, identify the optimal approach for detailed below-ground surveys of organic matter and nutrient stocks, root biomass, and above-ground litter inputs in these areas.

3.3. Local (Manaus) scientific coordination of the TC, providing logistical support and guidance for the measurements and experimental plot establishment.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1– A list of the resources necessary for fully understanding spatial variability in soil organic matter and nutrient stocks, root productivity and litter fall and their response to elevated CO₂.

PRODUCT 2– A contribution to the overall report on the experimental strategy detailing what is known about key soil properties at field site, and the best way of surveying below-ground stocks at the proposed plot locations.

PRODUCT 3– A summary of how INPA staff and facilities can help with some of the coordination of the wider project.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2 and 3

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Individual consultant
- Term of Contract: 2 years
- Place of work: Manaus, Brazil - based at INPA
- Traveling: attendance at all project workshops

VIII. Qualifications

- Degree: Undergraduate and graduate degrees in ecology and soil science, with experience in working in Amazonian forest.
- Language: English and Portuguese
- Area of Expertise: Soil science, biogeochemistry
- Excellent written and oral communication ability; proven ability of communicating complex concepts, and preparing clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 9)

Preparation of Component 3 Report on the Amazon-FACE site Characterization
BELOW-GROUND MEASUREMENTS II

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil

dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Preparing part of the below-ground ecophysiological site characterization to the above mentioned report as specified below.

III. Main Activities

3.1. Preparing a list of resources (equipment, consumables, personnel) that are required for the detailed monitoring of below-ground fluxes of CO₂, water and nutrients in the pilot study, as well as the full experiment.

3.2. Above-ground measurements of forest structure are essential for identifying potential plot locations. However, paired fumigated and control plots must also show similar below-ground properties to allow fair comparisons to be made. Characterizing the spatial variability in soil organic matter and nutrient concentrations, root biomass, and litter fall are therefore essential. I will assist with the review of what is known about these key parameters at the site, and within the broad areas identified as suitable based on the above-ground data, identify the optimal approach for detailed below-ground surveys of CO₂, water and nutrient fluxes in these areas.

3.3. As well as identifying the optimal surveying approach for the below-ground properties, The consultant will help establish soil moisture monitoring stations within the potential plots to determine whether soil water availability (a variable critical to predicting forest resilience) is comparable between the proposed study sites.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1– A list of the resources necessary for fully understanding the below-ground fluxes of CO₂, water and nutrients and their response to elevated CO₂.

PRODUCT 2– A contribution to the overall report on the experimental strategy detailing what is known about key soil properties at field site, and the best way of surveying below-ground fluxes at the proposed plot locations.

PRODUCT 3– A written and graphical summary of the temporal and spatial variability in soil moisture within the proposed experimental plots.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2 and 3

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Manaus, Brazil or residence location of the consultant
- Traveling: attendance at all project workshops

VIII. Qualifications

Firm or institution with experience in Soil science, soil ecology, biogeochemistry and ecological studies in the Amazon; ability to communicate complex concepts and prepare clear, concise and meaningful reports.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 10)

Preparation of Component 3 Report on the Amazon-FACE site Characterization
MODELING ACTIVITIES I

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment
- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.

- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each

workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site and detailed strategy for the CO₂-enrichment experiment in the Amazon and application of its outcome.

Specifically, this consultant will be responsible for:

Preparing a contribution to the above mentioned report about key areas for ecosystem model evaluation and application according to the main activities described below.

III. Main Activities

3.1. Identify potential dynamic vegetation models for application and analyze differences in process formulations. Prepare schematic overview of process differences based on the outcome of a first workshop.

3.2. Co-ordinate and evaluate simulations with the selected subset of dynamic vegetation models for elevated CO₂ conditions in the experimental area

3.3 Identify key areas of potential model development based on the analysis of different models and their process formulations.

3.4. Generate working hypotheses for the experiment from insights gained from the analysis of existing models based on the outcome of a second workshop bringing together modelers and experimentalists.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A report containing a schematic overview of differences in process in different vegetation models.

PRODUCT 2– A report on potential model improvements and hypotheses for guiding the experiment.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Brazil or other
- Traveling: 2 to 5-day trips to Manaus of the coordinator responsible for the consultancy in the hired institution

VIII. Qualifications

Institution with experience in forest ecology experiments, environmental science, or environmental engineering with experience in ecosystem modeling or analysis of ecosystem and climate change data; ability to communicate and complex concepts and prepare clear, concise and meaningful reports in English.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 11)

PREPARATION OF COMPONENT 3 REPORT ON THE AMAZON-FACE SITE CHARACTERIZATION

MODELING ACTIVITIES II

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site

- Develop a protocol of measurements to be used in the experiment
- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of

outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site and detailed strategy for the CO₂-enrichment experiment in the Amazon and application of its outcome.

Specifically, this consultant will be responsible for:

Preparing a contribution to the above mentioned report about key issues, not covered by current models, to be addressed in experiments and model development according to the main activities described below.

III. Main Activities

3.1. Identify key areas, relevant to response of tropical rain forest to elevated CO₂ that are currently not or not enough represented in existing dynamic vegetation models. Prepare a schematic overview of the processes involved based on the outcome of a first workshop.

3.2. Formulate a conceptual model structure that contains all relevant processes including those not covered in existing models, and subject this model to a sensitivity analysis.

3.3 Based on the results of the sensitivity analysis, identify key model development areas for existing dynamic vegetation models

3.4. Generate working hypotheses for the experiment from insights gained from the sensitivity analysis and based on the outcome of a second workshop bringing together modelers and experimentalists.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1 – A report containing a schematic overview of differences in process in different vegetation models.

PRODUCT 2– A report on potential model improvements and hypotheses for guiding the experiment.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Consulting Firm
- Term of Contract: 2 years
- Place of work: Brazil or other location
Traveling: 2 to 5-day trips to Manaus of the coordinator responsible for the consultancy in the hired institution

VIII. Qualifications

Firm or institution with high experience in ecosystem modeling, climate change assessments and its relation to field experiments; ability to communicate and complex concepts and prepare clear, concise and meaningful reports in English.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 12)

Preparation of Component 3 Report on Amazon-FACE site Characterization
SCIENTIFIC SUPPORT ON DATA COLLECTION

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil

dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to prepare a report comprising the environmental baseline characterization of the potential experimental site for the CO₂-enrichment experiment in the Amazon.

Specifically, this consultant will be responsible for:

Elaboration of a protocol on people's access and collection of data in the experimental plots; day-to-day conduction and report of permanent on-site measurements made to characterize the potential site for an elevated CO₂ experiment in the Amazon forest and elaboration of first-order documents comprising the description and analysis of collected environmental data.

III. Main Activities

3.1. In-field collection of environmental data for characterization of the potential site for the elevated CO₂ experiment.

3.3. Contribution to writing reports and other project documents, including a protocol for collection of data and reduction of disturbance in the experimental plots.

3.4. Construction and management of a project database comprising the environmental variables collected during the project term.

3.5. Management of a project website communicating the project development.

3.6. Locate, quote and prepare the ToR for hiring a private engineering company to assist in the elaboration of the technical implementation plan for the elevated CO₂ experiment in the Amazon forest.

IV. Deliverables

The Consultant will deliver the following products:

PRODUCT 1– ToR for hiring a private engineering company to assist in the Amazon-FACE technical implementation plan.

PRODUCT 2 – A contribution (protocol for people access and data collection) for the report on the physic-biological characterization of the potential site for an experiment on the effects of elevated CO₂ on the Amazon forest.

PRODUCT 3 – An accessible database comprising all the data collected along the project.

V. Payments

5.1 The consultant will be paid for the consulting services provided in connection with this assignment according to the following schedule:

- 50% upon delivery of a work plan in accordance with the activities described in this TOR;
- 25% upon delivery of Product 1
- 25% upon delivery of Products 2 and 3

5.2 The documents and other materials will be written in English and submitted in digital format (Microsoft Office 2007 or higher or PDF).

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Individual Consultant
- Term of Contract: 2 years
- Place of work: Manaus, Brazil

VIII. Qualifications

- Degree: Undergraduate and graduate degrees in forest ecology, environmental science, meteorology or environmental engineering
- Language: English and Portuguese
- Area of Expertise: Climate change and forest ecosystems, ability with environmental databases
- Excellent writing and oral/written communication ability; proven ability to communicate complex concepts and prepare clear, concise and meaningful reports.

• **ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)**

TERMS OF REFERENCE (REF. 13)

**Preparation of Component 3 Report on Amazon-FACE site Characterization
FIELD TECHNICAL SUPPORT ON DATA COLLECTION**

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

Component 3: Site Characterization. This component will finance the acquisition of the equipment and instrumentation necessary for measuring ecosystem responses and for support for students and senior researchers to make initial measurements in the experimental plots identified in Component 2. Measurements will include environmental monitoring, tree inventories, historical growth rates, soil characteristics, and root distribution. This data will be used to parameterize ecosystem models for generating testable hypotheses to guide experimental protocols. A milestone report will be prepared describing site conditions and initial model results.

Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil

dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to provide technical support for field campaigns; to work in close collaboration with the other consultants in the installation and constant monitoring of field equipments and collection of samples for scientific analysis.

III. Main Activities

3.1. Collections of soil and biological samples

3.2 In-field geographical guidance of research team

3.3 In-field identification of plant material

3.2 Maintenance of field trails and camp conditions

IV. Deliverables

The Consultant will deliver the following products:

Monthly reports of his/her activities based on a report model provided by FDB

V. Payments

On a monthly basis, upon approval of monthly reports

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Individual Consultant
- Term of Contract: 2 years
- Place of work: Manaus, Brazil

VIII. Qualifications

Experience with field work in the Amazon forest, ability for climbing trees (for collection of samples); familiarity with equipment for environmental monitoring; and at least basic communication in English.

ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)

TERMS OF REFERENCE (REF. 14)

Preparation of Component 3 Report on Amazon-FACE site Characterization
LOGISTICAL SUPPORT

I. Background

1.1 Project Description

This TC will support: (1) technical assessments, (2) institutional arrangements, (3) economic assessment of dieback implications, and (4) proposal preparation that eventually will lead to a larger and innovative study on the effects of rising CO₂ levels on the Amazon forest. This study will substantially improve our understanding of the risk of a possible ‘dieback’ of Amazon rainforest under future climate change. The possibility of such a dramatic path for the Amazon forest is listed in the Bank’s 2012-2015 Climate Change Action Plan as one of the key impacts on the natural resource base of Latin America that may result from 21st century climate change. The effects on forest ecosystems of an increase in atmospheric CO₂ concentration during this time have been repeatedly modeled to potentially counterbalance the negative effects of climate change by stimulating forest growth and resilience to drought. However, this “CO₂ fertilization effect” remains untested in tropical forests. If it does not occur, then tropical forests are predicted to be much more vulnerable to climate change. At large scale, this would represent a significant threat to the region’s economy, via the occurrence of natural disasters associated to the regional and global rainfall patterns, agricultural losses and impairment of hydropower supply. Reducing uncertainty in this area is critical to steer future development policies for the Amazon region.

This TC will support preparatory studies and workshops on the implementation of an elevated-carbon dioxide (CO₂) experiment in the Amazon rainforest. The topic covered in this TC is new since no such experiment has yet been conducted. This TC is consistent with the GCI-9 objective to “protect the environment and response to climate change”, as it substantially increases the information available to design IDB projects. This TC is also in accordance with the IDB Brazil country strategy for 2012-2014 (document GN-2662-1). It is also in line with the National Strategy for Science, Technology and Innovation 2012-2015 of MCTI and its priority program for climate change objective #5: “implementation of monitoring systems to observe the impacts of climate change”, which is consistent with Brazil’s national strategy for minimizing the impacts of natural Disasters (Federal Decree 7.513/2011).

General objective: Assist the government of Brazil, through the Ministry of Science, Technology and Innovation, to assess the likelihood and implications of the potential for Amazon dieback and the relevance of carbon fertilization to ameliorate its effects.

Specific objectives:

- Define the location, engineering plans and costs for an elevated CO₂ experiment in the Amazon rainforest
- Conduct site characterization studies and parameterize ecosystem models for the site
- Develop a protocol of measurements to be used in the experiment

- Compile a milestone report on technical and methodological recommendations for an elevated CO₂ experiment in the Amazon rainforest.
- Prepare workshops with the participation of academic experts and policy makers.
- Communicate the outcomes of this TC to the non-specialist community
- Consolidate a proposal to finance the CO₂ fertilization experiment in the Amazon rainforest

1.2 Description of activities and outputs

The execution of this TC will be divided into four components, which are designed to lead to development of a proposal to other potential funders (e.g. Amazon Fund, with support from MCTI) to secure the long-term provision of funds for the full implementation of the experiment.

Component 1: Economic Impacts of the Amazon Dieback. This component will finance a consultant that will assess the type and severity of the economic impacts of a potential dieback of the Amazon forest towards the second half of the current century. Assessing those economic impacts and at least first-order estimates on the uncertainties associated with those impacts will subsidize and strengthen the justification for the increased CO₂ experiment, besides increasing the chances of attracting complementary funds for the long-term conduction of the experiment. The product resultant from this component will therefore be a report on the potential economic impacts of the Amazon forest dieback, which should be elaborated based on review of scientific and non-scientific literature, as well as through existing database research correlating current climatic extremes in the Amazon and its multi-sectorial impacts at the local and regional scale (for example the cross-analysis of climatic records available at MCTI's National Institute for Space Research – INPE and agricultural production statistics made available by the Brazilian Institute for Geography and Statistics – IBGE).

Component 2: Design and Assessment. This component will finance consultancies by high-level academic experts on the subject as well as an engineering firm. The first objective is to do an economic assessment of the implications of an Amazon dieback. The second objective is to develop full engineering plans for construction and implementation of a full replicated CO₂ experiment. Activities include identifying an appropriate location for experimental plots, evaluating logistical constraints (roads, power, and hazards), developing a list of sources and costs of all materials and equipment needed for CO₂ exposure and canopy access, preparation of construction plans, and pre-construction site preparation. A technical report with recommendations on these issues and full engineering plans is the outcome to be reported at the end of this component.

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Component 4: Workshops/Outreach. This component will finance two annual workshops gathering the scientific and stakeholder community to discuss progress and broader impacts of outcomes. In addition to the parallel sessions on scientific topics such as plant physiology, soil

dynamics and modeling, these two workshops will hold sessions on the economic and political implications of this cooperation. Outcomes will be short communications elaborated after each workshop. The discussions held and decisions taken in these workshops will support the making of working papers from components 1 and 2.

This component will also finance two short training courses on climate change and tropical forests. Each edition of the course will comprise approximately 15 graduate students from Universities/Research Institutes associated with the scientific planning for this TC who will be brought, once per year, to the experimental site. The underlying objective is to build regional capacity in the project subject, as a way of assuring, in the short and medium term, the provision of complementary human resources to achieve the general objectives of this TC.

Component 5: Project Administration. This component will finance personnel needed for the financial administration of the project.

II. Objectives of the consultancy

The objective of the consultancy is to provide broad logistical support for all the consultants working under this TC, as well as bridge administrative issues between FDB, IDB, MCTI and the consultants.

III. Main Activities

3.1. Logistical organization of workshops and field campaigns, which involves scheduling flights, booking hotels, helping with visas and getting needed permits

3.2 Assist in the quotation and procurement of goods; import and custom procedures

3.3 Contact potential vendors and service providers

3.4 Co-administration of the project budget

IV. Deliverables

The Consultant will deliver the following products:

Monthly reports of his/her activities based on a report model provided by FDB

V. Payments

On a monthly basis, upon approval of monthly reports

VI. Coordination

Coordination and supervision of the products will be made by the coordinator responsible for the TC at Brazil's Amazonian Foundation for Biosphere Protection (FDB), the executing agency for this TC

VII. Characteristics of the assignment

- Type of Consultancy: Individual Consultant
- Term of Contract: 2 years
- Place of work: Manaus, Brazil

VIII. Qualifications

Experience with administration of scientific projects and organization of events/meetings; excellent communication skills in English and Portuguese; experience with importing procedures of scientific equipment

**ASSESSMENT OF THE IMPACTS OF CLIMATE ON THE STABILITY OF THE AMAZON
RAINFOREST (BR-T1284)**

DESCRIPTION OF (NON-CONSULTANCY) SERVICES TO BE PROCURED

1. ENGINEERING PLANNING (REF. 15)

Objectives: to work in close collaboration with the consultants in the elaboration of the engineering plans (blueprints) for building the infrastructure necessary for the elevated CO₂ experiment in the Amazon forest, including installation of towers, cranes and repairing of road to access the experimental site, all with minimal disturbance to the forest.

Place of work: Manaus, Brazil

Type of Procurement: Competitive bidding

Qualifications: firm with experience in the implementation of infrastructure in forest sites and hability for communication in English.

2(A). TRAVEL, ACCOMODATION AND SUPPORT FOR WORKSHOPS (REF. 16)

Objectives: flight tickets, hotel rooms and coffe breaks for scientific workshops aiming at the integration of methods and results acquired in the project, as well as a workshop for outreach, with the participation of stakeholders.

Place: Manaus, Brazil

Type of Procurement: Price comparison

4(B). TRAVEL, ACCOMODATION AND SUPORT FOR TRAINING COURSES (REF. 16)

Objectives: flight tickets, hotel rooms and coffe breaks for two (one per year) training courses. These training courses aim at boosting the participation and interaction of the scientific community with stakeholders in the development of this TC as well as in the evaluation of the broader consequences arising from its outcomes.

Place: Manaus, Brazil

Type of Procurement: Price comparison

6. FINANCIAL ADMINISTRATIVE SUPPORT (REF. 18)

Objectives: general administration of the cooperation funds (FDB)

Place of work: Manaus, Brazil

As a nonprofit private entity, the Fundação Amazônica de Defesa da Biosfera (FDB) was created by researchers from INPA, professors of the Federal University of Amazonas, businessmen and others interested in science and technology in July 1994.

Working for over nineteen years, FDB has provided support to the management of resources intended for very diverse sources including scientific and technological research, dissemination of scientific and technological knowledge and the realization of events tied to its statutory objectives.

The topmost “organ” for collective deliberation at FDB is the Curator Council which has representatives of INPA, public organizations and other stakeholders. FDB is the foundation that supports INPA, and is recognized by the Brazilian Ministry of Science and Technology and Innovation and the Ministry of Education. The Fiscal Council also has participants linked to public entities and individuals, elected by the Council Curator. The day-to-day work of the Foundation is administered by a board composed by the Executive Director, Administrative Director and Finance and Scientific Director.

Under the auspices of the Administrative and Finance Directors is the Administrative Management-Finance that oversees all administrative services such as managing people, materials, finance, budget and accountability. All these sectors will be working for the project. FDB maintains contracts and agreements with various organizations, national and international, public and private, with accounts of funds received in accordance with contract terms. FDB charges extra expenses for 5%-15 % of the value of each scientific project. This value keeps the staff and other expenses specific to the maintenance of the Foundation.

Thus, in addition to supervised by State Public Prosecutor (Curator of Foundations and Failed Masses), provides accounts for the national audit of the Union and State, Controller General of the Union and special audits.

The Foundation keeps separate bank accounts for each contract / project, moving it only by the provocation of their scientific coordinator; records all expenditure under the law applicable; organizes the corresponding documentation in a separate file, conventional or recorded electronically.

The Foundation works in the headquarters, located in the street of Crisântemos, n. 70 - Aleixo - CEP. 69.083-231 - Manaus – Amazon - Brazil.

Among FDB projects under implementation are:

- Foundation of Health Surveillance - FVS / INPA / Petrobras: for monitoring of malaria in the Urucu-Manaus pipeline;
- Gordon and Betty Moore Foundation / Secretaria de Estado do Meio Ambiente e Desenvolvimento Sustentável-SDS’s efforts to create, improve and expand the existing protected area system in the state of Amazonas (the “Protected Areas Project”;
- World Wildlife Fund – WWF / SDS’s efforts to create, improve and expand the existing protected area system in the state of Amazonas (the “Protected Areas Project”;

- Manaus Free Trade Zone Superintendence (Suframa): For deployment oil in the Amazon and Infrastructure of the Amazon Biotechnology Center - CBA;
- Gret (France): For sustainable management of forest resources;
- FINEP/MCTI: Scientific infrastructure for the National Institute of Amazon Research;
- Los Alamos Lab: Observations and Modeling of the Green Ocean Amazon (GOAMAZON 2014);
- European Union: European Biodiversity Observation Network.

Assessment of the impacts of climate on the stability of the Amazon rainforest (BR-T1284)

LIST OF GOODS TO BE PROCURED (REF. 17)

Item	Equipment	Justification	Units	Cost/unit USD x1000	Total cost USD x1000
1	Scaffold towers	Access to forest canopy; vertical profile of environmental variables	2	30	55
2	Dataloggers	Automatic data collection and storage	4	1.65	6.6
3	Multiplexers	Automatic data collection and storage	4	0.5	2.5
4	Interface	Automatic data collection and storage	4	0.32	1.28
5	Multiplex cables	Automatic data collection and storage			0.32
6	IRGA840	Gas analyser	2	6	12
7	Termohigrometer	Meteorological data collection	8	0.6	4.8
8	Anemometer	Meteorological data collection	8	2	16
9	Pluviometer	Meteorological data collection	2	1.5	3
10	PAR Sensor	Photosynthetically active radiation measurement	8	0.75	6
11	Accessories	Meteorological data collection			3
12	Battery	Photovoltaic autonomous system	2	2.5	5
13	Hemispherical camera	Leaf Area Index monitoring	2	5	10
14	Laser positioner	Tree inventory equipment			6
15		Tree growth equipment			5
16	Litterfall traps	Carbon inventory			5
17		Leaf and woody tissue sampling (600 analysis)			18
18	Camera traps	Basic phenology monitoring	8	1	8
19	IR sensors	Canopy temperature	8	0.5	4
20	IR sensor datalogger		4	1.5	6
21	Soil moisture logging	Monitoring of soil water content	30	0.5	15
22	Material for in-growth cores	Monitoring of root growth	10	0.5	5
23	Soil analysis	Analytical costs for root, litter and soil			20

		samples			
24	Computer and software				10
25	4x4 vehicle	Travel from Manaus to project site	1	40	40
TOTAL					267.5

**PROCUREMENT PLAN FOR NON-REIMBURSABLE
TECHNICAL COOPERATION**

Country: Executing Agency: Fundação Amazônia
de Defesa da Biosfera - FDB, Manaus,
Brazil Brazil
Project title: Assessment of the impacts of
Project no: climate on the stability of the Amazon
BR-T1284 forest

Item no.	Description ¹	Type of contract	Estimated Contract Value (US\$ x1000)	Procurement method ²	Procurement Review (ex-ante or ex-post) ³	Source of financing and percentage		Estimated Dates Publication / Specific Procurement Announcement	OBS.
						IDB/SECCI	MCTI (%)		
1	Component 1- Economic Impacts of the Amazon Dieback	Individual consultant	10	CI	Ex-post	100	0	Jan/2014	
2	Component 2 Report 2 - Tehcnical implementation plan for the CO2 experiment	Consulting firm	146	QBS	Ex-post	100	0	Jan/2014	
3	Component 4 (2&3 too) – Integrated Proposal, General coordination	Individual consultant	70	CI	Ex-post	100	0	Jan/2014	
4	Component 3 Report 1 - Site Characterization / Overseer of Comp. 3	Consulting firm	85	QBS	Ex-post	100	0	Jan/2014	
5	Background measurements	Individual consultant	28	CI	Ex-post	100	0	Mar/2014	
6	Above-ground measurements	Individual consultant	27	CI	Ex-post	100	0	Mar/2014	
7	Above-ground measurements	Consulting firm	28	CQS	Ex-post	100	0	Mar/2014	
8	Below-ground measurements, local-coordination	Individual consultant	42	CI	Ex-post	100	0	Mar/2014	
9	Below-ground measurements	Consulting firm	28	CQS	Ex-post	100	0	Mar/2014	
10	Modeling activities	Consulting firm	28	CQS	Ex-post	100	0	Mar/2014	
11	Modeling activities	Consulting firm	28	CQS	Ex-post	100	0	Mar/2014	
12	Component 3 Report 1 - Site characterization / Scientific support on data collection	Individual consultant	70	CI	Ex-post	100	0	Jan/2014	
13	Component 3 Report 1 – Site characterization / Technical support	Individual consultant	24	CI	Ex-post	100	0	Mar/2014	
14	Component 2/3/4 – Logistical support	Individual	24	CI	Ex-post	100	0	Jan/2014	

		consultant							
		TOTAL CONSUL TING SERV	638			100	0		
15	Component 2 Report 2 - Technical implementation plan for the Amazon-FACE / Engineering plan	Services	150	NCB/ PE	Ex-post	100	0	Abr/2014	Engineering firm
		TOTAL NON- CONSUL T SERV	150			100	0		
16	Component 4 - Workshops + Training	Services	132	PC	Ex-post	100	0	Mai/Jun/2014 Jun/Nov/2015	Travel & acquisitions (coffee-breaks)
17	Component 3 - Supporting infrastructure	Acquisition of goods	267.5	PC/ PE	Ex-post	6.5	93.5	Abr-Ago/2014	See procurement plan for acquisition of goods
18	Component 5 - Administrative costs	Operating expenses	62.5			100	0	Dec/2013	
		TOTAL GOODS & OTHER SERV	462			45.9	54.1		
		GRAND TOTAL	1250						
			+250 in kind						
	USD 1.00 =R\$ 2.30								

(1) The grouping together of procurement transactions of a similar nature (such as IT equipment, publications, air fares, etc.) is recommended. If groups of similar individual contracts are to be executed in different periods, these may be grouped together with an explanation in the comments column indicating the average individual value and the period in which they will be executed.

(2) Goods and Services: Shopping: Price Comparison; PE: reverse auction; DC: Direct Contracting; NCB: National Competitive Bidding; ICB: International Competitive Bidding

(2) Consulting Firms: QCBS: Quality and Cost-Based Selection; QBS: Quality-Based Selection; FBS: Fixed Budget Selection; DC: Direct Contracting or Single Source Selection; LCS: Least Cost Selection; CQS: Selection Based on the Consultants' Qualifications.

(2) Individual Consultants (IC): Individual Consultants; CQS: Selection Based on Consultant's Qualification; DC: Direct Contracting or Single Source Selection.

(3) Ex-ante / Ex-post Evaluation: In general, depending on the institutional capacity and level of risk associated with the procurement, the ex-post review is the standard modality. Ex-ante review can be specified for critical or complex procedures.

(4) Technical Review: This column will be used by the Project Team Leader to define those procurement transactions considered "critical" or "complex", that require ex ante review of terms of reference, technical specifications, reports, outputs, etc.