CONNECTA, Major Societal Challenges (2014)

**Modeling the effects of climatic and economic pressures on land use evolution and functional CONNECTivity in biological corridors: a co-construction with local actors, Costa Rica.**

### 1. Scientific and technological objectives

Ecosystem based adaptation has been presented as a new approach, emphasizing the contribution that biodiversity conservation makes to sustainable development and livelihood improvement by supporting the provision of ecosystem services (ES). The rise of the ES paradigm shifts thinking from nature as the victim of development, to nature as means to sustainable development. Although ecosystem-based management is often more complicated than other options, the adaptive character of ecosystem services is anticipated to improve sustainability with respect to global changes. This paradigm shift has particularly been adopted in Costa Rica, recognized as a global leader in ecosystem conservation. The country is divided into 47 biological corridors whose chief original aim was ensuring biological connectivity between protected areas. These corridors are large, well-defined, multifunctional landscapes typically dominated by agricultural land uses that can be classified as socio-ecological systems. They are often led by voluntary multi-stakeholder group, comprised of private individuals and organizations working alongside representatives of public agencies. These groups are challenged with defining landscape visions, identifying suitable interventions based on landscape opportunities and constraints, negotiating conflicts between stakeholders, and maintaining dialogue and interest in collective decisions. Many of these groups have turned to ecosystem-based approaches as a driving mechanism to drive the public debate and to ensure conservation outcomes though ecosystem services that benefit human interests in the landscape. **A central question to the region is how the ecosystem based approach, focusing on those services that are particularly sought by local communities, contributes to increasing the resilience of these communities to global changes, while ensuring conservation outcomes.**

This project will use a research in development approach, combining strong academic and research expertise in the social and the biophysical sciences and direct engagement with the multi-stakeholder group charged with the management of the Volcanica Central Talamanca Biological Corridor (VCTBC). We will develop a modeling approach with the actors to strategically complement their knowledge and analyze the effects of climatic and economic pressures on (i) production and pest regulation services; (ii) producer decisions regarding the management of their fields (principally coffee and pasture); and (iii) the consequences of these decisions on the functional connectivity of the corridor at different spatial scales. The project will produce a model co-constructed with the stakeholders, serving as a dialogue platform to explore global change scenarios coupled with management options and their consequences on production and conservation functions. This participatory model, will serve as the basis for the development and implementation of adaptive strategies within the Corridor.

 The goal of this project is to work with local partners to enhance capacities for the sustainable management of ecosystem services and biodiversity conservationin the face of global changes – economic, social and climate. To achieve this goal, we have assembled a team of scientists working directly with the VCTBC council – a local multi-stakeholder group charged with developing and implementing an action plan for the 114 000 ha agricultural matrix spanning critical Costa Rican conservation areas. This science and decision-making team **will jointly develop information systems,** **methods and decision-making tools to identify, negotiate and implement agricultural and ecosystem based management options that contribute to biodiversity conservation and connectivity in the corridor**. The project supports a vision of research in development, that is, we view the participation of local actors in the production/generation of research questions and the adaptation of these questions to be an essential component of the project. The research community is actively engaged in adapting research questions according to the community’s research needs, made possible because the research team is physically embedded in the research landscape. Our proposal builds on an existing and growing knowledge-generating relationship between the management team of the VCTBC and the CATIE based research community (Bioversity, CIRAD). We view this active, embedded and integrated research approach as crucial to transforming research outputs to outcomes. The VCTBC management committee is a full and active research partner central to the development of research questions and design.

**CONNECTA is the result of a workshop** held in Costa Rica in February 2013, with funds from Foundation of Research on Biodiversity(FRB), where scientists and representatives of the VCTBC management teamdiscussed the context, objectives and key issues faced by VCTBC**.** The discussion was used to formulate the research questions and objectives presented in this proposal. The Corridor Council plays a key facilitation role, often with groups that are traditionally in conflict. One of the main challenges faced by the Council is enabling landscape scale conservation impacts through the actions of individual landowners. As such, **a key challenge, not just for this group, but for integrated landscape management globally, is identifying incentive mechanisms, and intervention options for the management of common-pool resources such as biodiversity and water**. **Thus, one of the main gaps identified by the Corridor Council is the need for scientific and technical information to identify and guide effective management options for biodiversity conservation and connectivity**. Ecosystem services, the benefits that nature provides people with, have increasingly been highlighted as one means of ensuring livelihood benefits through conservation. Key research questions posed by this team are: What are the potential outcomes of future land use change scenarios in the face of global changes (financial, climate, land use)? How do these scenarios affect farm and regional productivity and conservation goals? Do ecosystem based management options make a measurable improvement on livelihoods? What ecosystem service incentive options exist? How can these incentive systems, financial or otherwise, be operationalized by local management groups? Do ecosystem based interventions, which focus primarily on benefits to humans, also provide conservation benefits to wild biodiversity?

The scientists and VCTBC council will **fill this gap by** **developing a participatory modeling approach** to better build on existing knowledge and to (i) understand how global changes affect land use composition and configuration and thus biological connectivity of both desired (biodiversity conservation) and pest species (pest control ES) in agricultural landscapes; (ii) identify and negotiate priority management and economic options for strategic areas of the VCTBC in the face of global change scenarios to evaluate their impact on multiple outcomes including agricultural productivity and biodiversity conservation; and (iii) use these model outcomes to facilitate dialogue and negotiation within the VCTBC management team and to identify a menu of actionable management options to address meeting VCTBC goals in the face of global change.

**The main research objective of this project is to build a participatory modeling process that identifies key pressure states, options, and needs of the local community regarding livelihood improvement and biodiversity conservation, and which provides evidence based and actionable and adaptable interventions to cope with global change.** The main products of the project are: (i) knowledge regarding the capacity of different land uses to provide key ecosystem services; and (ii) an agent-based model used for knowledge transfer, dialogue and negotiation between actors.

Methodology and activities: The project will reinforce an effective and sustainable platform of dialogue between actors in the VCTBC using socioeconomic tools and through an initial diagnosis of the VCTBC composition and functioning in the territory, highlighting the diversity of actors, their interactions and their representation in the existing consultation and decision arenas, their expectations and the corresponding development trajectories they contemplate. Thereby, the roles of institutions in supporting the co-management of landscapes will be better understood. The project will model ecosystem services that support production functions (pest and disease regulation) and productivity in the critical land uses of the VCTBC. We will model the provision of these services under different management and climate change scenarios. Another multidisciplinary activity will collectively characterize land use dynamics in the VCTBC by focusing on decisions taken at the plot and farm levels. This activity will require inputs regarding the perceived socio-economic pressures, and on the predicted coffee and pasture yields according to climate and management scenarios. Another activity will identify indicator species for the corridor, will conduct field surveys on those species, and use molecular markers to model current functional connectivity throughout the corridor. Participatory methodologies will be used to develop future land use and management change scenarios for the VCTBC as a function of climate and management pressures. This will identify landscape productivity and connectivity under these scenarios and requires the inputs of all the activities.

2. Relevance and strategic nature of the project with regard to the orientations of the call for proposals

We have elected to work in the Volcanica Central Talamanca Biological Corridor (VCTBC) for this project building on four important contextual elements: (1) the biological corridor is one of many similar landscapes within the greater Mesoamerican Biological Corridor and offers the project important lessons learnt, as well as an opportunity to rapidly scale up results to similar regions; (2) Costa Rica has pioneered a nationalized Payment for Ecosystem Services Program which has gained international attention, allowing our project to contribute directly to an existing but rapidly evolving incentive mechanism for environmental conservation; (3) the VCTBC Council management, representing a diverse multi-stakeholder group (including governmental and private institutions) exists, is active in the region (capable of simultaneously guiding research and acting on results); (4) the research partners included in this proposal actively conduct research in the region, have access to a local student pool, and have a long-term commitment to the landscape.

The project addresses several global challenges. First it tackles the impact of a fluctuating global economy, on both price crisis or opportunities for traditional and novel crop commodities (coffee, sugar, newly demanded products such as bamboo or passion fruit) by exploring how these changes affect land use change decisions in the Biological Corridor. This also addresses notions of mobility – both from the point of view of migration into and out of regions in the face of these changes; as well as the plasticity of distinct cropping systems in the face of change. Coffee production systems for example have little plasticity, although the inclusion of tree crops within the system is understood to provide important buffering to short-term fluctuations. Climate change is also addressed by the project with a focus on how ecosystem service based approaches to land use management can be used to strategically increase landscape resilience to external climate shocks including hazard mitigation, and resilience to climate change driven alterations of pest complexes. The project uses ecological approaches to identify the scales at which priority ES are provided, and works with the VCTBC council to match governance scales and ecological scales for ES management. With the corridor members, we dedicate significant project resources to consider adaptation responses to change using both historical and projected perspectives to better understand the evolution of human needs (decision rules) and vision (projections/scenarios).

We propose that the strategies included in the proposal are particularly innovative. We focus on an approach that embraces research in development and include critical stakeholder participation in the modeling process at project inception. More so in fact, project staff has been engaging and collaborating with the Corridor Council over the past eight years. This inclusion is essential to ensure the societal relevance of the simulations and projections (companion modeling) produced by the project. We also focus on a strong collaborative platform with continuous and open access to data/technical knowledge by the Corridor Council. This open access policy is mirrored with the continuous dialogue, and focuses on adaptive management methodologies embedded in the research process, and driving towards modeling approaches that support intervention decisions. This constant updating allows the possibility of reorienting the research focus, flexibility and polyvalence of the modeling tool in the face of shifting stakeholder priorities when faced with new information. The project not only considers the system resilience but includes system transformation within the resilience framework. We view that an important contribution of biodiversity conservation is the restoration of ecosystem services where they are most needed.

The project will capitalize on a multidisciplinary research approach combined with research excellence, drawing on the broad range of strong expertise among the project consortium partners. A high level of responsiveness is foreseen through open and continuous dialogue among project team partners and stakeholders, addressing research questions that arise or are posed by the stakeholders, and understanding the specific inputs of each discipline at the different scales, and how they combine to provide specific insights on socio-ecological dynamics.

**Project position with respect to other projects in the region**: CONNECTA will benefit from ongoing international initiatives directed towards the study of agroforestry systems. The PCP (*Pôle de Compétences en Partenariat*) *Agroforestry Systems with Perennial Crops* platform is one of them (http://www.pcp-agroforestry.org/).The PCP platform is an initiative bringing together 25 scientists from organisms with international mandates as CIRAD, CATIE, Bioversity, INCAE, CABI PROMECAFE and ICRAF to address this challenge. **CONNECTA will be developed within the framework of this platform and will benefit from this strong scientific partnership.**

3. Presentation of the consortium

 *Composition of the proposed CONNECTA consortium*

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| --- | --- | --- | --- | --- | --- |
| Organization | Name | Surname | Current position | Field of research | Contribution to the CONNECTA project |
| Bioversity International (CGIAR) | Fabrice | DeClerck | Leader, Agrobiodiversity and Ecosystem Services Research Program | Community and Landscape Ecology | Project leader, coordinates functional connectivity activities  |
| UPR 106-CIRAD | Jacques | Avelino | Researcher posted at CATIE, Costa Rica | Plant Pathology | Scientific leader for partner 2, in charge of research on coffee pests and diseases in and co-coordinator of the project with Partner 1 |
| UPR 47-CIRAD | Christophe | Le Page | Researcher posted at Montpellier | Natural resources management/Socio-Ecosystem Modeling | CONNECTA proposal work: Companion modeling  |
| UMR Innovation-CIRAD | Nicole | Sibelet  | Researcher poste at CATIE, Costa Rica | Socio- Anthropology | CONNECTA proposal work: characterization and enhancement of the dialogue platform |
| CATIE (and VCTBC) | Mildred | Jiménez | Forest engineer and Professor, member of the VCTBC committee | Participatory and Communal conservation programs | CONNECTA proposal work: CVBCT committee characterization |
| CATIE | Alejandra | Martínez | Ecologist and ornithologist | Ecologist | Facilitate interaction with the VCTBC Council |

The consortium includes 6 research units and one stakeholder organization VCTBC. UPR 106-CIRADis a biophysically oriented group, looking for management options to improve the performance of tropical production systems, by studying the determinants of the production, and the conditions that promote pest and disease regulation. UMR Innovation-CIRAD and UPR 47-CIRAD are socio-economically oriented groups. They focus on the understanding of how stakeholders at different scales (producer, family, organization, and politician) make decisions and on the actions that can be implemented to improve socio-economical processes. Bioversity and CATIE are two units focused the use and conservation of biodiversity in agricultural landscapes. Bioversity’s Agrobiodiversity and Ecosystem Service Program focuses on mechanistic approaches by which the conservation and use of biodiversity contributes to human well-being, while CATIE is a transversal unit and will participate across all of the project activities. CATIE is located in the heart of the VCTBC and is an official member of the Corridor Council. CATIE has been actively involved the development of this landscape, through research, development projects, and education. CATIE has a strong experience on agroforestry and silvopastoral systems, biodiversity conservation, and social-economic processes. The VCTBC Council will be involved under CATIE. Complementarities also exist in terms of modeling approaches. Biophysical modeling approaches are strongly developed in UMR System and UPR 26 from CIRAD, whereas socio-economical modeling approaches are developed by UPR 47-CIRAD. Finally, all the teams are based in Costa Rica. The project leader, F. DeClerck, from Bioversity, has more than eight years’ experience working in the CVTBC including developing its early connectivity models, and its environmental education program. J. Avelino, from UPR 106-CIRAD, based in Costa Rica, will be co responsible for in situ project coordination.

 **Bioversity (partner 1)** is a research-for-development organization working with more than 700 partners in over 90 countries worldwide to use and conserve agricultural and forest biodiversity for improved livelihoods, nutrition, sustainability and productive and resilient ecosystems. Bioversity is working towards a world in which smallholder farming communities in developing countries of Africa, Asia and the Americas are thriving and sustainable. Bioversityis a member of the CGIAR Consortium, a global research partnership engaged in research addressing complex development issues related to agriculture and forestry ([www.cgiar.org](http://www.cgiar.org)). The Centers are independent, non-profit research organizations, innovating for and with poor people in developing countries, through hands-on research programs and operations. Bioversity is actively engaged in the CGIAR Consortium Research Program on Water, Land and Ecosystems whose vision is of productive and resilience agriculture in vibrant ecosystems.

 **UPR 106 “Bioagresseurs: analyse et maîtrise du risque” CIRAD (Partner 2)** is a specialized unit on the ecology of pests and diseases of tropical crops with a strong experience on coffee and cacao crops. The scientist involved in CONNECTA has an extensive knowledge of the Mesoamerican region. J. Avelino has worked in the region for 24 years with a network of coffee institutes (PROMECAFE) and CATIE. The unit has published around 40 papers on coffee pests and diseases in peer review journals, and holds a patent on a trap to control coffee berry borer (Brocap®).

 **UPR 47 “Gestion des ressources renouvelables et environnement”- CIRAD  (partner 3)** research aims to provide knowledge, methods and tools based on the modeling of complex systems to support collective processes for renewable resource management and to help stakeholders improve their capacity to manage their eco-social system. The issues at stake are twofold: (i) to develop conceptual and technical tools to represent socio-ecosystems in their multiple dimensions (economic, social, ecological, spatial and temporal), and to consider the plurality of the points of view of the parties involved (experts and non-experts) at different levels of organization; (ii) to develop approaches for using these tools so that local stakeholders, as well as scientists, are involved in the management processes, from collective learning, through negotiation to decision making. This team involves one scientist from UMR Art Dev on public policies.

 **UMR 85 - Innovation “Innovation et Développement dans l’Agriculture et l’Agroalimentaire”- CIRAD (partner 4)** develops research on innovation processes, looking at the series of processes, from actors’ aims to innovate up to the effects induced by these innovations on the development. UMR Innovation associates various competences in social sciences: economy, sociology, anthropology, geography, sciences of management and has a long-established presence in various countries of Latin America.

 **CATIE (partner 5**) is a regional center, working in Central and South American countries, integrating education, research and development activities. The center has been a recognized leader in the region in the development and promotion of agroforestry systems (coffee, cacao, and silvopastoral systems); recognition reinforced with the tropical agroforestry master’s program. CATIE has the actual leadership of the Mesoamerican Agroenvironmental Programme (MAP), an ambitious intersectoral platform designed to achieve climate-smart territories to improve human wellbeing in rural areas of Mesoamerica. CATIE has published more than 70 papers on coffee in peer-review journals.

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