

**The Integrated Program on the Central Dry Corridor (IPCADC):  
The View from the Guanacaste/Chorotega  
Field Report No. 1  
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## Resumen de Reporte

Este documento (escrito en inglés) resume observaciones y discusiones con colegas durante una visita en Costa Rica (Abril 2017) en el contexto del [Programa Integral del Corredor Seco Centroamericano](#) (PICSCS; IPCADC en inglés). Durante tres de los días visité la Provincia de Guanacaste con el objetivo de conocer más profundamente los sistemas naturales y el nivel de desarrollo humano típicos de este área.

Este área está localizada en el sur del Corredor Seco Centroamericano (CSC), una región transfronteriza en la vertiente Pacífica que es especialmente susceptible a los impactos geofísicos y socioeconómicos de la variabilidad y el cambio climático. Esta es una región rural de bajo nivel de desarrollo que sufre de pobreza, inseguridad alimentaria y emigración.

Durante la excursión en los cantones de Nicoya y La Cruz en Guanacaste yo discerní varias necesidades y potencial de desarrollo. Después de familiarizarme con los datos de estos cantones en particular y de la provincia en general y después de conversaciones que tuve con especialistas locales, formulé y detalle en este documento sugerencias preliminares (pendiente a investigaciones más comprehensivas) sobre posibles direcciones futuras que podrán ayudar al desarrollo resistente al cambio climático en la provincia.

Los actividades y proyectos que recomiendo son sobre el nivel regional y a nivel micro (enfocados en comunidades) orientadas a otorgar seguridad alimentaria, elevar la tasa de empleo, incrementar ingresos familiares, y mejorar la calidad de vida para la población rural.

Una de las metas más importantes del PICSCS es la retención de la población en sus tierras por medio del mejoramiento de las condiciones en sus comunidades. También, el PICSCS cree que la experiencia y lecciones aprendidas durante la implementación de los proyectos y actividades propuestas en la región de Guanacaste podrán ser aplicadas a otros lugares del CSC.

Este reporte describe la visita a Guanacaste y provee información relevante sobre los sistemas físicos y humano en esta provincia. También se adjunta un documento que describe al PICSCS, sus objetivos, estrategia de investigación y métodos de trabajo.

Entre las recomendaciones incluidas en este reporte podemos citar:

### I. A Nivel Regional

- A. [Recursos de Agua](#): Proyecto de infraestructura sub-regionales para irrigación; riego de “gotas” a nivel local; uso de aguas grises; tecnologías de cosecha de agua
- B. [Investigación y Desarrollo Agropecuario](#): Consolidación de entidades de investigación y fincas experimentales bajo un organismo central de investigación regional, dedicado a buscar soluciones tecnológicas y la adaptación de los estudios de la investigación que pueda ser utilizada por los agricultores y ganaderos
- C. [Acceso a Mercados](#): Dar prioridad al desarrollo de mecanismos de colección y transporte de productos provenientes de productores pequeños; uso del aeropuerto internacional de Liberia para incrementar exportación; alentar la formación de cooperativas de productores para comercializar sus productos sin necesidad de intermedios.
- D. [Comercialización de “super” alimentos y otros productos de la “Zona Azul”](#) en Nicoya

E. Promoción de “alojamiento y desayuno” (“bed and breakfast”) en casas rurales como alternativa de turismo

F. Creación de un centro de bio-materiales para el proceso de materiales derivados de cultivos regionales para uso medicinal, cosmético y aditivos nutricionales

## **II. A Nivel “Micro” (comunidades) Proyectos:**

A. Proyectos de desarrollo integral

1. Cantón de Nicoya -- enfoque en agricultura diversificada y especializada; riego local; red de transporte de cultivos; promoción de “alojamiento y desayuno”

2. Cantón de La Cruz -- enfoque en seguridad alimentaria y sistemas agrícolas optimizados a condiciones locales; cambios en el sistema socio-espacial para fortalecer el sistema de producción y capacidad local

## **III. Innovaciones en el Nivel de Educación y Comunicación:**

A. Uso de estudiantes universitarios como agentes de cambio, por ejemplo, en campañas de educación pública que tengan como meta educar a agricultores en el uso eficiente de aguas para riego,

B. Cursos y talleres especiales para estudiantes, equipos profesionales y productores,

C. Creación de un centro educativo que funcione como escuela de campo, estación de apoyo de investigación, finca modelo y finca experimental.

D. Intercambios inter-regionales y internacionales de investigadores, profesores y estudiantes

Para desarrollar el alto potencial de Guanacaste es necesario que las instituciones múltiples que existe en la región trabajen en manera conjunta y coordinada, bajo una clara visión y con un enfoque definido.

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## Summary

The Central American Dry Corridor (CADC) is a contiguous ecological and climatic region running inland from the Pacific coast along the Mesoamerican isthmus. While this landmass includes urban areas, it is predominantly rural in character. Characterized by continuities relating to drought and aridity, climatic controls, biodiversity, land cover and land use patterns, it is also an area with widespread poverty, including a relatively high incidence of severe poverty and unemployment.

[The Integrated Program on the Central Dry Corridor](#) (IPCADC) is an initiative aimed at enabling the 10.5 million inhabitants of this region to remain on their lands despite projected climate change (CC) impacts that have already endangered food security and increased aridity. Social dislocation including rural outmigration to urban areas and across borders is also considered a threat. The IPCADC strategy calls for incorporating mechanisms for climate change mitigation and adaptation as an integral part of development efforts in the region.

This report describes the observations resulting from a visit (April 19-May 1, 2017) to Costa Rica undertaken by the author to advance the IPCADC collaboration. Meetings were held in the national capital, San José, as well as in the regional capital, Liberia, and Santa Cruz in the Guanacaste Province (Chorotega Region) which constitutes the southern end<sup>1</sup> of the CADC.

A field visit was conducted to gain familiarity with Guanacaste's development and natural resources context. In the following [preliminary recommendations](#) are presented concerning Guanacaste as a whole (ex., a public education campaign geared to farmers on efficient irrigation use) as well as several local-level (village) projects aimed at directly increasing employment and family incomes among small producers.

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<sup>1</sup> The Arc of Panama, though geographically discontinuous, is considered by some analysts to be subject to the same conditions of the CADC and is therefore considered by them to be a part of it. Guanacaste is the southernmost area of the contiguous region.

These tentative recommendations are presented to illustrate the kinds of ameliorative activities that could be undertaken in Guanacaste and possibly applied elsewhere in the Central American Dry Corridor region. It is important to emphasize that *much more applied research* of the kind the IPCADC seeks to provide is needed before these recommendations should be considered.

The principal aim of the IPCADC is to support climate change-resistant development in the Central Dry Corridor in three aspects: 1) engaging in applied research and planning guidance, 2) providing educational and capacity-building opportunities, and 3) promoting intra-regional and international cooperation to better the lives of those living in the Corridor and to garner lessons that can be applied elsewhere. In its cooperative aspect, the IPCADC intends to apply Israeli technologies and experience in drylands development and resource management to the Central American Dry Corridor as well as seeking transborder solutions to shared problems in the countries involved.

An [annex](#) to this document describes the IPCADC's overall approach, research strategy and proposed methodology.

## Field Visit

A tour of rural areas in the region was conducted (April 24-27, 2017) to gain familiarity with field realities and to assess prospective focus areas for IPCADC activities. The Guanacaste Regional Directorate of the Costa Rican Ministry of Agriculture and Ganadería (MAG)<sup>2</sup> hosted the author and Prof. Hugo Hidalgo of the University of Costa Rica during the first two days of a three-day tour in the province. On Day One, the visitors participated in a workshop on preparing for climate change risks where representatives of government agencies, agricultural growers and industrial groups, and NGOs were present. Important discussions were held with many of the participants, who were useful sources of information concerning relevant issues.

### The Nicoya Sub-Region

During the second day of the three-day field visit the visitors were accompanied by the MAG's regional director, Ing. Oscar Vasquez Rosales and several members of his staff to Nicoya, a canton (one of eleven in Guanacaste) situated on highlands bordered by the Gulf of Nicoya and the Pacific Ocean. There the visitors observed a meeting of a local committee in [Naranjal](#),<sup>3</sup> a remote farming community, who sought irrigation infrastructure to make fuller and better use of their lands. During the meeting it became apparent that the villagers not only lacked access to irrigation infrastructure but also did not have a ready source of potable water for domestic use. Their agricultural activities are dominated by a few crops, yard chickens and a few head of cattle



*Figure 1 Village committee requesting irrigation technology*

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<sup>2</sup> Many thanks are due to Sr. Guillermo Edo González Perera, head of the MAG's International Affairs Unit and to Ing. Oscar Vasquez Rosales, the MAG's regional director for Guanacaste, the former for facilitating the visit and the latter for arranging much of Prof. Hidalgo's and my schedule and accompanying us for much of it.

<sup>3</sup> <https://earth.google.com/web/@9.97956617,-85.54107977,552.66752973a,5629.83665944d,35y,-78.2865005h,45.0000055t,or>

maintained on small family farms (typically <3 ha). Personnel of SENARA (National Service for Irrigation and Drainage) explained to the petitioners the long bureaucratic process needed to apply for water infrastructure and construction of an aqueduct.



Figure 2 Model organic farm, Cerro Negro

From Naranjal we proceeded to two model farms elsewhere in Nicoya in a mountain area known as Cerro Negro. One of them is owned by Maynor, who has developed his small farm into a thriving plot that produces leafy vegetables including kale,

bananas, peppers and other ground crops. His system of production is based on low-impact technology including drip irrigation, netting for shade, non-chemical plant protection and compost he mixes using local farm and home waste. Employing a brother, nephew and other family members, Maynor has created a steady market for his organic produce.

Significantly, Maynor became acquainted with composting and cultivation under shade during a local workshop he attended some years earlier aimed at introducing such



Figure 3 Low-impact technologies: Shade, drip irrigation, non-chemical plant protection

methods to local producers. This particular farmer is in a very good position as he established links with restaurants and communities along the coast that are willing to buy his produce and pay the extra price of organic products. His self-satisfaction was evident.



A second nearby farm had benefited from assistance deriving from a [Consejo Nacional de Rectores \(CONARE\)](#) grant obtained by specialists from the University of Costa Rica, the Instituto Tecnológico de Costa Rica and the National University to help



Figure 4 Prof. Hugo Hidalgo at a model farm

farmers improve their production systems. This farmstead was equipped in 2015 with three rainwater catchment ponds, including one containing tilapia, a species of edible fish. The ponds provides water for drip irrigation and feeds several plots of mixed crops grown under plastic cover.

Technically, this farm is worthy of emulation, but the fact that the reservoirs of plastic-lined pools serve only a single farm is potentially socially decisive as neighboring farmers do not have access to such an important resource. These assets make the differences between multiple cropping seasons and single yearly harvests. The latter leaves rural labor underemployed and farm owners unable to make full use of their lands' potential. It should also be noted that the added economic value of the tilapia is not realized, though this fish could be used for food, for sale, and as a source of fertilizer. Still, the farm serves as an example of how the provision of basic infrastructure can be used to develop local agriculture on the micro level.

### The Liberia Norte-La Cruz Subregion

On the third day of the field visit Prof. Helga Blanco of the University of Costa Rica accompanied the visitors to sites north of the regional capital, Liberia. There we visited the canton of La Cruz, one of Costa Rica's poorest with a rank of 72 of 81 according to the national Index of Social Development. This area in the Tempisque River watershed consists of gently undulating lands comprised of volcanic rock that supports tropical dry forests. At the time of our visit at the end of the dry season, the groundcover was conspicuously dry

though the same lands often become flooded and waterlogged as a result of the cresting of the local rivers, Rio Sucio and Rio Las Haciendas, which feed 1000 and 600 hectares of land, respectively, during the rainy season.

Many local plots had been burned to clear land. This practice is allowed only by permission of the local office of the Ministry of Agriculture as it is a source of greenhouse gas emissions. Nonetheless, it remains common.

Cattle-raising is a major branch in this area and rice is a leading crop along with sugarcane and melons. Large teak farms are found near the border between Costa Rica and Nicaragua and the production of oranges for the export of juice is significant in Santa Cecilia, near La Cruz.

A notable fact about rice production in Guanacaste is that 80 percent of the farmers own 20 percent of the land; stated conversely, eighty percent of land under rice is held by only 20 percent of the farmers. These producers use irrigation that supports multiple harvests per year while smallholders are confined to rainfed methods that yield one annual harvest. Small producers are also confronting increasing consolidation of land by larger ones who acquire their tracts and benefits from the economies of scale, which further weaken family farms.

During the tour to the La Cruz area, we stopped at the village of [Aguas Claras de Cuajiniquil](#)<sup>4</sup> which is characterized by dirt roads, desiccated lands and small farmsteads that are spartan and rely on traditional methods. The homes are made of wood and corrugated sheet metal and appear insubstantial. They are, however, connected to the electrical grid.

A group of 42 village women have formed an association to gain eligibility for economic assistance from the government to help them improve their families' meagre incomes. These women have formed a WhatsApp group to hold discussions on the subject and are exploring the possibility of joint initiatives. A relatively better-off member of the community has agreed to donate a tract of land to this group for joint development.

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<sup>4</sup> <https://earth.google.com/web/@10.95982682,-85.68557492,66.34572254a,35570.941352d,35y,19.70628373h,29.99996871t,-or>

The communities of La Paz Canton, with their high rates of poverty and social deprivation, stand virtually in the shadow of luxury hotels situated on the adjoining beaches. There are also a few large cattle ranches in the area as well as the Guanacaste Conservation Area and other nature reserves earmarked for preservation amounting to twelve percent of the regional territory. A refugee camp housing itinerant Cuban and African migrants is also found in this area.

### **Relevant Background: Guanacaste Province**

In Guanacaste, the impacts of natural climate variability occur mainly in terms of El Niño-Southern Oscillation (ENSO) and affect water supply and economic activities: the observed warming trends are significant and widespread (Hidalgo et al. 2016). Warmer temperatures augment the demand of water from the atmosphere, thereby increasing aridity resulting in drier soils. Anthropogenic CC will worsen this as future conditions suggest greater aridity in the future (Hidalgo et al. 2016), but of more immediate concern to farmers is dealing with a recurring drought cycle and a variety of socio-economical vulnerabilities.

With a population of 326,953 Guanacaste is the most sparsely inhabited part of the country (density 32 inhabitants/km<sup>2</sup>) or 7.6% of the national total. Females constitute 50.5% of the inhabitants, and the “urban” population is approximately the same, though the region is indisputably dominated by the rural sector. It is bordered on the east by the Pacific Ocean, and by Nicaragua in the north, the province of Alajuela to the west and Puntarenas province in the south. The principal economic sectors are agriculture (melons, sugar, grains (rice, corn), beans, fruits for juice and concentrates, meat and fish), the production of clean energy (hydroelectric, geothermal and wind, constituting 28.9% of the country’s total energy production) and tourism, including ecotourism (Mideplan 2014).

### **Poverty and Unemployment**

In 2012, 39% percent of the regional population was considered poor while the percentage of those living in extreme poverty is estimated at 14.6%, compared to the Costa Rican averages of 23.6% and 7.2%, respectively. The number of households categorized as poor is 34.5% and those that are extremely poor is 12.6%. Of these poor households some

44.1% are headed by women. The average income is 60,694 colones per month, or two thirds of the national average (Mideplan 2014). MAG-DAI (2016) reports a significant decline in the number of poor homes and extreme poverty in 2015 relative to 2014, which is attributed to increased employment, a decline in dependency ratios and increased incomes rather than a decline in the number of poor households. It is not clear that this improvement is a trend or merely transitory.

Mideplan (2014) describes the main reasons for poverty in Guanacaste as unemployment, chronic unemployment, low household income and a lack of economic opportunities.

The occupational structure of the region is revealing with regard to the economic state of the region. With an economically-active population (EAP) of 116,000, 35% work in the commercial and tourism sectors, 15% in public administration, while those working in agricultural-related occupations is 23% (MAG-DAI 2016).

Among the reasons given by the Ministry of Planning and Political Economy for regional poverty is the absence of both governmental and private investment in the region, a general lack of support for the region on the part of the central government, and the absence of employment-generating economic activities, particularly in the agricultural sector. Additionally, no vision for long-term development has been articulated for the region, which is also said to suffer from political paternalism and the underemployment of its many natural and human resources (Mideplan 2014).

The region's failure to actualize its potential is demonstrated in the agricultural sector by the underperformance of its 11,000 farms which, of varying sizes, encompass 593,000 hectares (MAG-DAI 2016). Agricultural production is largely geared toward internal consumption but is generally inefficient and unproductive and does not suffice for household food self-sufficiency. More diversified agricultural activity and the encouragement of agro-industry is viewed as a necessary lever for change (Mideplan 2014).

### Agriculture Constrained by Natural Resource Limitations

Agricultural development is constrained, however, by natural resource limitations and resource competition, particularly over water resources between the agriculture and tourism branches. Soils in some areas have limited porosity and though this is useful for the production of rice (a staple), higher valued crops require technological innovations to make the land more productive. Water resources are not well managed and shortages of this resource are due to natural dryness, which is intensifying due to climate change, as well as pollution (mainly from the runoff of agricultural chemicals) and the mismanagement of water sources (Mideplan 2014). According to the Ministry of the Environment, Guanacaste has the country's greatest risk for extreme events due to increasing dryness, particularly due to the relatively unfavorable state of human welfare and infrastructure in the region (MINAET, IMN, and PNUD 2012).

The region's economy, agriculture, and energy, fishery, forestry and tourism branches is based on its natural resources and while the Ministry of Planning and Political Economy's plan for Chorotega (Mideplan 2014) mentions problems of land and water, only cursory attention is paid to these and other environmental challenges. This is particularly lamentable given the threats posed by climate change. The lack of focus on this perils is at odds with the guidelines for the Environmental Sector of the National Plan which warns against the impacts of global warming and stresses the urgency of preparing for it, "especially in those sectors that are most vulnerable to climate change such as ecosystems, infrastructure and the productive sectors (housing, coastal zones and fishing, biodiversity, water resources and energy)" (Ministerio de Planificación Nacional y Política Económica, 2014: 470).

Chorotega/Guanacaste is just such an area. The Planning Ministry's Environment Sector plan describes it as being in a "critical" state when compared to the rest of the country, which is of "great concern to institutions, governmental and nongovernmental," especially concerning water availability and use (Mideplan 2014). The National Planning and Political Ministry states that "programs that increase the resilience of the communities in anticipation of climate change is the challenge that concerns us" (Ministerio de Planificación

Nacional y Política Económica, 2014: 470), yet concrete actions have not been specified. Identifying adaptive mechanisms in anticipation of such changes is a primary objective of the IPCADC.

CC will not only affect water availability but also crop patterns, habitats and the ecological web. Further, much of the region along the Pacific shore is low-lying and one meter rise in sea level could shift the entire coastline inland thereby causing tidal floods and endangering mangrove and wetlands (Global Facility for Disaster Reduction and Recovery 2011) as well as entailing hazards for the local population, civil infrastructure and property (Ministerio de Planificación Nacional y Política Económica 2014). In this context it is also important to note that fishing is an important primary sector activity which, along with cattle accounted for 23.6% of the region's exports in 2012 (Mideplan 2014). These branches, too will be affected.

Guanacaste's impressive biological endowment is also at risk. The area is rich in biodiversity and the Guanacaste Conservation Area, a UN Heritage Site, is home to 7,000 plant and more than 900 vertebrate species, including more than 500 birds, 40 types of bats, as well as primates and turtles. The area has 20,000 species of beetles, 13,000 species of ants, bees and wasps, and 8,000 species of butterflies and moths. It has numerous unique ecosystems including aquatic ones such as mangroves, wetlands and estuaries (UNESCO 2017). These areas are subject, however, to mounting human pressures due to population increase, tourism, poor water management, inadequate protection of water sources and pollution.

### Human Development

In human development terms, the region is lagging. Aside from having relatively high proportions of poor and extremely poor people, there exists a housing deficit amounting to 18% of the national shortage. The region suffers from a lack of educational infrastructure, inadequacies in early childhood education, poor educational standards of education, insufficient numbers of instructors for vocational training, and an absence of opportunities for job preparation. The region also contends with incidences of teenage motherhood,

delinquency and drug addition. In terms of health services, there is no tertiary healthcare center in the region, there is a shortages of specialist physicians; waiting times for specialized treatments can extend to two years. Additionally, the personal security of the local citizens is imperiled by high rates of crime, including homicide, and weak policing (Mideplan 2014).

The Ministry of Planning and Political Economy's plan for Chorotega is built on developing agriculture, tourism, the energy sector, and agro-industry in order to increase the quality of life and standards of living of the regional inhabitants. It proposes to do so by increasing productivity and strengthening the use of its internal resources. Yet, the institutional framework is reportedly both redundant and inadequate, which affects the quality of citizen services, the region's ability to mobilize internal resources, and its potential to attract investment from elsewhere in the country and abroad.

Currently, there is a lack of coordination and integration between institutions in the region at all levels, which are in the main weak despite their large numbers. There are some 79 institutional entities in the region, of which 54% are public, 15% municipal and 30% comprise of local organizations. The number of central government ministries and agencies represented in the region is large, as are the number of universities, mostly campuses of educational centers from outside the region. Each of the eleven cantons has a municipal framework as does one of the districts. Four private banks operate in Guanacaste and the cooperative sector has twelve entities. There are numerous trade groups and labor unions, various public committees and volunteer organizations.

Yet, despite these multiple institutions for a population of 326,000 people, regional actors have identified a lack of adequate development cooperation and focused effort among these structures (Mideplan 2014). The MAG-DAI also notes the cumbersome number of institutions operating in the region, which operate in an uncoordinated fashion.

## Outstanding Issues

The MAG-DAI (2016) report indicates that the most serious problems facing the region are related to a lack of investment, issues of transportation and communications, inadequate water resources, and deficiencies in the provision of basic services. It acknowledges several programs instituted under the National Plan for Development including assistance to those families (reportedly 6,877 in number) suffering from extreme poverty and especially the elderly among them, programs for adolescent mothers, adding irrigation to 7,200 hectares including the strengthening of river embankments, and an employment development program for 5,200 participants from vulnerable socioeconomic groups.

However helpful these projects may be, the MAG-DAI (2016) report provides a list of priorities for rural development, including:

- The introduction of high-value crops,
- Placing priority on insuring food security,
- Adopting technologies that increase production, improve quality, reduce production costs and expand incomes, especially for small- and medium-sized producers,
- Creating organizational frameworks that provide producers with greater negotiating power with respect to domestic markets; this entails the need for increasing information and communication concerning where, how and when the best conditions exist for farmers to market their produce,
- Providing producers with financial mechanisms to support production, facilitating access to markets, identifying activities that can be advantageous to small- and medium-sized producers including those related to scale with respect to preparing products for the external market
  - Introducing improved hygiene and quality control, pest control and likewise protecting products destined for the national market and for export,
- Improving the standard of rural life for young people in order to retain them in the region and improve the attractiveness of agricultural pursuits as a way of life and source of livelihood,
- Adopting measures for adaptation and mitigation to climate change, especially relating to its impact on agriculture; the goal of achieving carbon-neutrality is noted in this connection,
- Rationalizing the use of water resources by investing in infrastructure, including new projects and the rehabilitation of existing ones
  - In this regard, improving water catchment methods, water harvesting and searching for new reservoirs are listed.
  - The necessity of inter-institutional cooperation to achieve this is stressed.



- Coordinating sectorial and inter-sectorial development activities for the distinct areas of the region, some 25 in number, to reduce inequalities and improve the lives of the inhabitants
- Coordinating the public sector so that it offers services effectively and strengthening those agencies that function at high levels while reducing those that are obsolete.

Based on the discussions held with field staff and other stakeholders and observations made during the site visit, the above priorities articulated by the Ministry of Agriculture is in this author's view appropriate and fitting. Steps toward implementing the above should be explored.

### **Author's Recommendations**

Only a limited amount of sites could be visited and considerably more field research has to be undertaken before firm suggestions for development activities can be made. Nonetheless, based on the discussions held and the sites visited, the following ideas are offered.

These *preliminary* suggestions refer to two distinct socio-spatial levels: the Chorotega regional level and those that are micro (project) in scope. Included among the former are recommendations relating to education, capacity-building, communications and the forming of social values conducive to development.

#### Regional-Level

The Guanacaste Province/Chorotega Region is blessed with an abundance of natural resources. Its diverse terrain and landscapes are rich in biomass and plentiful biodiversity. Similarly, Costa Rica's investment in its human resources, especially education have made it in many respects an advanced country, especially when compared to many of its neighbors. Still, there remains much to be done to further sustainable development in a way that can strengthen climate change adaptation in the region. Retention of the regional population and perhaps adding to it is an achievable goal, especially if climate resilience is built into the development process.

### *A. Water Resources*

Given the natural dryness and drought cycles of Chorotega and the increasing effects of higher temperatures due to global warming, water resource management is the most prevalent subject of concern. One informant points out that there is sufficient water for agricultural use but that the squandering of this resource by farmers due to wasteful methods is a major problem. This problem is addressed in Recommendation Number One of the *Education, Communications and Social Values* section below.

Regional-scale irrigation works already in progress and under consideration should be adapted to take long-term drying trends into account, including subterranean storage facilities. On the micro level, the advantages of drip irrigation pioneered in Israel has been demonstrated in the region and making this technology more readily available to farmers is advised. Other farm- and homestead-scale technologies should also be looked into, including the use of treated gray water for non-edible field crops, rainwater catchments for local use, and the construction of simple reservoirs and the fortification of river embankments to serve multiple farms and ranches. The use of water pricing to encourage conserving this resource should also be considered, though this would require lobbying for changes in the national Water Law.

### *B. Agricultural R&D*

Established cash crops including as coffee and sugar, as well as staples like rice and beans, provide significant income streams, although small and medium producers experience increasingly difficulty contending with market forces and the concentration of land, water and financial resources in the hands of larger producers.

Given this reality, along with increasing temperatures and drying due to global warming, will make the production of basic food stuffs more difficult. Food security comes first and this would require the planting of varieties that are resistant to heat and drying.

Diversification of the small and medium farms is also necessary to round out diets and as a source of additional cash. A third variation of regional agriculture could involve introducing or expanding the production of niche crops such as those considered to be

“exotic” abroad (ex. papaya, pithaya, the sugar substitute *stevia rebaudiana*, seeds such as sesame and its products, and other local fruits and vegetable). These crops could be introduced among smallholders for production as primary products or as materials for higher-order products (medicines, health aids, cosmetics) to generate new sources of incomes.

The development of new plant varieties for local staples, traditional exports and niche crops will require methods for plant protection, pest control, cultivation and storage that are suited to local physical and economic conditions. Similarly, developing locally appropriate technologies for water use, planting, harvesting, packing and transportation that fully utilize available labor while making it more efficient should be developed for local use. Devising technologies appropriate to local conditions is not only needed with respect to existing and new varieties of field crops, but also to advance sustainable forestry and sustainable cattle and fish breeding as well. For this to happen, **research that is rooted in place-specific conditions** is required.

While the value of basic research conducted at universities cannot be overstated, translating the insights gleaned in the laboratory to the farm is essential. An organization that introduces innovations as a result of the dialog between the farmer, rancher and fishers and scientists is vital in effecting this. Accordingly, creating a **regional agricultural research organization** along the lines of Israel’s [Volcani Research Organization](#) is highly recommended. Such an institution would incorporate experimental stations and model farms including these already existing in the region. The dialog between researchers and producers should be mediated through a fully staffed agriculture extension network that convey’s the problems faced by producers in the field to researchers. The latter are then called on to develop solutions that are then transferred to fine-tuned back in the field.

### *C. Market Access*

Other issues raised during the visit relate to poor post-harvest management, inadequate transport mechanisms for the transport of produce to market, and underdeveloped market centers in the region. Those marketing systems that exist are said to

be dominated by brokers, which reduces the income to the producers. Among the potential solutions to these problems is a **dedicated agricultural transport network** linking the farm to markets and the fostering of **producers associations that collectively market produce** should be made a priority. Further, in keeping with the applied research function of an agricultural research organization such as that described above, adapting crop varieties that are sturdy in transport and have long shelf-lives also further the marketability of local produce. The construction of the [Canal Seco Interoceánico](#) project might very well present a unique opportunity to create such a regional marketing network that could feed into this major international transportation artery.

In this same regard, the **Daniel Oduber Quiros International Airport** can and should play an important role in the transport of agricultural outputs for export as an integral part of this network. Creating an **integrated sorting, grading, packing and packaging facility** adjacent to **the airport** with adequate temperature and quality control systems should be investigated.

#### *D. Biomaterials Complex*

If appropriately equipped, such a facility could also play a central role in a future **biomaterials complex** linked to a **regional medical campus with tertiary and quaternary capabilities**, integrated to fulfill the following roles:

- The preliminary processing of agricultural products that have medicinal, nutraceutical or health aids characteristics,
- Serving as the nucleus of a nascent high-tech industry focused on pharmaceuticals, medical devices and cosmetics,
- Providing medical tourism services,
- Meeting the tertiary medical needs of the Guanacaste population (they now have to travel to San José or elsewhere in order to receive advance medical treatment, often with considerable delay), and
- Serving as an incubator for biotech and green-tech industry.

Such a multifunctional center could provide a potent multiplier effect for both the rural and non-rural sectors of Guanacaste that could help propel the local population forward. Israel has substantial experience in these areas that it could share with Guanacaste.

#### *D. The “Blue Zone” Factor*

Finally, a significant regional fulcrum might very well be found in advantage of the “[Blue Zone](#)” status of Nicoya, specifically by creating products that respond to the increasing international demand for “**superfoods**” (e.g. kale, teff) among fitness-conscious markets abroad. This requires market research and business consultation that could perhaps be best fostered by a **public-private enterprise for agricultural development** in the region.

#### *E. Home-Based Rural Tourism*

Another area that has proven valuable to increasing rural incomes and job generation in Israel is the spread of home bed and breakfasts (B&B) throughout all regions. Rural families have adapted their homesteads to serve this function, which caters to both domestic and foreign tourists and has become a major services branch with its own supporting infrastructure.

The development of a similar network in Guanacaste that would serve as an affordable alternative to the luxury and other hotels along the coast could provide multiple advantages to the regional population.

#### Micro-level Pilot Projects

It is important to note that the ranching, fishery, forestry, tourism, and renewable energy branches were not observed during the field visit described above and these important branches require future study in order to provide a complete picture of the region.

However, as a result of field observation and following consultation with regional experts, at least two distinct rural development contexts based on crop production systems and human development factors can be discerned in Guanacaste. Corresponding to these distinct development contexts, two pilot projects are tentatively proposed for focused activities as part of the IPCADC initiative. These would take place in the *Nicoya* and *La Cruz*

(*Liberia Norte*) subregions, respectively. They would be based mainly on separate focuses for improved agriculture with differing approaches to income and employment diversification.

#### *A. The Nicoya Sub-Region*

In addition to the production of climate change-resistant staples, rural development in this highland area would benefit from a transition from subsistence farming to the production for export of:

- a. High-value and “exotic” crops and products including specialized fruits, forestry products, herbs, and flavorings that can be branded as delicacies abroad
- b. Artisanal products making use of the area’s Blue Zone renown
- c. Crops and marine products that have medicinal, nutraceutical, cosmetic, food flavoring and coloring characteristics
- d. The development of vegetation and wood products that are resistant to warming and drying trends
- e. Investigating prospects for home-based or otherwise small-scale rural tourism as an alternative to hotel options; this has been pursued with high benefit among rural communities in Israel
- f. The development of cattle breeds that produce lower levels of methane and other greenhouse gases.

Among the requirements for these developments are improved irrigation systems and farming practices that would be oriented toward farm diversification to satisfy home and local demand as well as the cultivation of high-value crops for markets abroad. Also needed is an adequate supporting infrastructure (see [Regional Level](#) projects above).

The guiding principle in this sub-region would be diversification and opening the farm-based economy so that it can articulate with external markets through adequate finance and micro-finance, marketing infrastructure, and a transportation network that would optimize the movement of inputs and products. Model farms, expanded extension services, fuller availability of irrigation infrastructure and education for modernized farming practices would be diffused in this region.

Among the future strategies for this region would be the expansion of agro-industrial options involved in the preliminary processing of more advanced products based on local crops and other inputs.

The IPCADC would conduct intense research of an appropriate area of this Sub-Region, perhaps the area of Cerro Norte, to help identify specific crops and measures that could be adopted to meet these ends. Prior to embarking in such changes, consultation with the local population to determine how they envision their future and what changes they feel are necessary to improve their lives is prerequisite.

Possibilities for establishing Bed & Breakfasts on rural homesteads for the tourism market would also be explored.

*B. The La Cruz (Liberia Norte) Sub-Region*

In terms of development, the La Cruz/Liberia Norte Sub-Region appears (and the data suggests) more impaired than Nicoya. Additionally, dryness was far more evident in the form of extensive fields of brown in the southern cantons. Also, the results of widespread burning was evident, a practice that is reportedly used as a low-cost means of weeding. The prevalence of “thin cows” seemed indicative of problems in the livestock sector. La Cruz was the only regional center observed that offers some urban functions and the state of commerce and industry of any scale appeared weak.

The Cuajiniquil village center consists of a clean and neat core with a primary school and several other buildings, yet the dirt roads leading to the farms and homesteads pass over riverbeds prone to flooding and virtually unpassable in the wet season, which seemed emblematic of the challenges facing the inhabitants of this settlement.

The homes in this community are constructed of wood and at least in one case corrugated metal sheeting, surely an uncomfortable abode in this hot area. Men were not in evidence, perhaps they have jobs elsewhere, though one hopes that if so, they remain in the vicinity and have gone to the cities or abroad looking for work. The few women and children seen did not appear active or productively engaged in work, study or play. Poverty and neglect is evident, though its severity was difficult to gauge given the prevalence of satellite dishes and cell phones. The social dimension of life in this community requires further study to determine what exactly are the challenges it confronts.

In terms of the physical setting, several tributaries about the settlement though the conveyance of its waters for irrigation is apparently a problem. The land is hard-packed and dry, though this would be expected at the end of the dry season. There was little cultivation in sight and none seemed robust. The group of women that have organized in order to better the lives of their families and for whom a plot of land behind several adjoining farmsteads has been made available, seem to have daunting conditions before them.

Two local land resources were noted that could be applied to help leverage this community from its current status. The first are *barreras vivas* or [living fences](#) comprised of oregano, juanilama (*Lippia alba*; which is used as a herbal tea and has [medicinal attributes](#)), lemongrass and [Pastos Corta](#), a pasture grass that is highly nutritional for bovines. Additionally, fast-growing *Azadirachta Indica* (neem), an evergreen, is found in the area and is known for its multiple uses as an oil, vegetable, adhesive, and as an ingredient in cosmetics and fertilizer.

The following development priorities making fuller use of its human and natural resources would seem appropriate for the *La Paz (Liberia Norte) Sub-Region*:

- a. Insuring food security through the cultivation of crops and fruits that provide for a nutritiously-varied diet on home plots and which include limited egg, poultry, pork and milk production geared for family consumption,
- b. Providing water harvesting and rain collection technologies for home use,
- c. Providing irrigation infrastructure for farm use,
- d. Providing simple technologies to expand employment activities and income generation, including
  1. The primary processing of local crops as inputs for the food industry,
  2. Preparing crop byproducts as agricultural inputs, for example, the production of high-quality compost.
  3. Marketing herbs and other products found in the living fences, and
  4. The commercialization of raw materials produced from *Azadirachta Indica* for use in natural insect repellants and other products.

Additionally, changes in the social and economic organization of this community such as the formation of cooperative frameworks might be part of the strategy aimed at



improving this communities' welfare. Some productive activities could be moved from a family farm model to more collective forms, such as those of the kibbutz or moshav models which during Israel's early stages of development proved highly effective in meeting basic food needs, making use of the economies of scale, economizing through the collective purchase of inputs and joint marketing in a way that would form the basis for the development of agro-industry.

Related to this is the possibility of altering the spatial pattern of the village to improve the delivery of service, facilitate economic improvements and foster solidarity. As with all proposed changes, these modifications of the status quo require the involvement and agreement of the people affected.

The fostering of local leadership, particularly among women and youth will be an important lever in the development stage of this area, which risks having its labor resources drained and confined to menial functions in the neighboring tourism and services sector. Such leakage of labor would not further the local population's economic mobility..

#### Education and Communications

*Public Education and University Students as Change Agents:* During a meeting of MAG regional staff members in Santa Cruz, an irrigation specialist noted that more problematic than the lack of water is its wastage due to inefficient practices by farmers. It was agreed that a **public education campaign** conducted door-to-door that would introduce and demonstrate appropriate irrigation methods to local producers would be, along with model farms, a useful tool to remedy this situation.

**University students** could prove to be a **formidable resource** in implementing such a campaign – in fact, in catalyzing constructive change in Guanacaste's development, generally. Following specialized courses combining both academic and practical instruction and guided by experts in the field, these students would be deployed to conduct the public information campaign as part of the social action requirements that the participating universities demand

*Specialized Courses and Workshops:* The role of education in building climate change resilient development cannot be stressed enough. In the course of meetings with regional staff, **several courses and a workshop** were identified as being pertinent:

- A workshop aimed at introducing basic principles of land-air-water dynamics and elements of geographical, sociological and economics to regional staff, teachers and field activists. This could broaden the perspective of personnel whose training and mission is specialized, say in agriculture, water resources, or management and have not been exposed to a fuller understanding of the origins, causes and impacts of climate change.
- In anticipation of public education campaign, such as one directed to farmers concerning water savings methods, students participating in the campaign would undergo a preparatory course on soil and water interaction and production systems in Guanacaste.
- Following a meeting between the author and professors Hugo Hidalgo, Rafael Arce of the UCR's School of Geography and Rodrigo Carerras of UNA it was decided that an intensive interdisciplinary graduate-level course on advancing development and climate change resilience with both classroom and field instruction dimensions would be conducted during an inter-session period. Prof. Helga Blanca also provided input concerning on this subject.

*Field School/Training Center/Model Farm/Experimental Station:* Establishing a **field school** in Guanacaste that would be a training center for Costa Rican, other Central American students and international participants would also serve the following functions:

- Serve as a training and continuing education center for regional staff involved in agriculture, development and climate change adaptation,
- Equipped with a demonstration site and model farm, the field school would serve as a public education site for area farmers, ranchers, tourism operators, thereby strengthening local capacities,
- Provide a focus for general education of school children and families,
- Serve as a field station for IPCADC researchers.

*Communications and Media:* Utilizing existing media in the region, including television, radio, newspaper and other channels to

- Communicate real-time weather updates, climate projections, and news concerning the state of regional resources and their use directly to farmers, ranchers, fishers and tourist operators,

- Profiling successful farmers, ranchers, fishers and tourist operators and their enterprises in order to encourage young people to remain in the region and pursue these livelihoods
- Promoting healthy and low-carbon footprint practices and lifestyles.

Faculty and Student Exchanges: The Israeli experience in cooperative settlement, natural resource management, water use in drylands, curtailing desertification and other areas could be imparted through seminars and short courses in Israel for professionals and students from Guanacaste in association with Israeli institutions. Such a visit would enable the participants to observe various stages in the evolution of Israeli rural space, from basic farming, to export-based agriculture, specialized agriculture, agro-industry and rural tourism all of which are evident in present-day Israel.

### **Summary**

The above reflections based on a brief visit to Guanacaste surveys the author's impressions rather than the findings of a rigorous study. The proposed recommendations are preliminary and based on a survey of conditions. Nonetheless, direction for future development activity and adaptation to a changing environment was discerned.

The Integrated Program on the Central American Dry Corridor proposes to begin its field work in pilot areas<sup>5</sup> (representative areas (RAs) of Guanacaste/Chorotega) with the aim of assisting the target population and applying the lessons learned to similar land-people context elsewhere in the Central American Dry Corridor.

A review of data and the impressions from this initial visit reinforce the impression that Guanacaste/Chorotega has abundant potential for sustainable development and that its natural and human resources can be fortified as a part of a **focused effort** that **harnesses the resources of all institutional actors**, the **business community**, and **local citizens** in a **sustained campaign** to make the region resilient to climate change impacts, thereby retaining the population in place. That same potential suggests that the region could

become a leader of successful innovation and a model that could be adapted to local conditions throughout Mesoamerica.

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## **Annex IPCADC Research Strategy and Methods**

Given that physical, socioeconomic and institutional dimensions are involved, an interdisciplinary approach is indispensable. Tools from the natural sciences, the social sciences, agricultural sciences, resource management, public administration and the humanities -- specifically those dealing with institution-building, policy and regional cooperation -- are necessary to this enterprise. This Collaboration is inter-institutional and specialists representing Costa Rican and Israel institutions are involved. It is expected that researchers from other Central American institutions will join the IPCADC.

The challenges encountered in Guanacaste are an extension of a cross-border, regional conditions and the latter which requires international cooperation. Israel, a Middle Eastern country that is subject to any of the same stressors that the CADC faces as a result of CC, has developed innovative land and water management systems to contend with these challenges. The allocation of resources it shares with its neighbors, Jordan and the Palestinian Authority, especially water, has resulted in cooperative agreements on the levels of both government and civil society. Accordingly, there are lessons to be learned from the Israel experience and the partnership is intra-region and international in character.

### Research Strategy

The research to be conducted in the course of the Collaboration aims at providing

1. An overall perspective of the current standing of a) natural resource endowment (amounts and status), b) vulnerability to exceptional hydro-climatic events, and c) the status of human development on a regional and micro-level scale, and
2. To determine intra-regional differences in these variables based on indices representing these sets of variables (a), b), and c) above), and
3. To identify problems at the interface of the prevailing production and support systems which impede development and do not allow employing resources in a sustainable and climate-resilient way.

The Collaboration will focus on Representative Areas (RAs) that typify the prevailing rural production system and other economic activities with significant impacts on the environment and natural resource base in Guanacaste (e.g. highland communities; coastal communities economy; the tourism sector).

### Research Goals

Satellite (e.g. Landsat) and other remotely-sensed data sets that are in the public domain or licensed by the collaborating institutions will be tapped and indexes created to map the following sets of variables will be compiled regarding at the highest resolution that is possible.

For the bio-physical variables indexes will be compiled for the following.

1. Retrospective Climate Index: compiled of data representing place-specific air and surface temperature, evapotranspiration, precipitation, humidity, and wind, including biomass potential. This will be used as a baseline against which future variance can be monitored.
2. Biodiversity and Ecosystem Health Index
3. Soil Index: reflecting characteristics related to composition that influence production
4. Terrain and Topography Index, with reference to both agricultural potential and propensity for hydro-climatic disasters (e.g. coastal areas vulnerable to sea-level rise; areas prone to landslides)
5. Land Degradation Indexes: measuring resources degraded by unsustainable land use patterns, deforestation, increased aridity or flooding
6. Agricultural Resource Potential Index
7. Retrospective and future Hydro-Climatic Disaster Potential Index

Concerning human systems, the following measures will be used:

8. The UN's Human Development Index incorporating Sustainable and Millennium Development indicators relating to economic, health, demographic, education and gender,
11. The Social Development Index, available in Costa Rica, A comparison of alternative agronomic systems that could make better use of the land-people system, and an Index of Social Displacement Potential, intended to measure

the propensity or rural outmigration, emigration, displacement with attention to potential for the emergence of a refugee crisis.

### Research Tools

Hydrometeorological data will be obtained from the databases of the Center for Geophysical Research (CIGEFI) at the University of Costa Rica. For example, daily precipitation station data for the region will be obtained from the database NUMEROSA from CIGEFI. The original sources are the National Weather Services of the Central American region. Monthly mean surface air temperature data from 1970 to 1999 covering Central America will be obtained from Hidalgo et al. (2016). The data were originally obtained in a grid at  $5 \times 5$  km spatial resolution. The data from the nearest grid-point to the locations of the precipitation stations were used to represent the temperature time-series at the stations.

Climate indexes will be obtained from the Earth System Research Laboratory, Physical Sciences Division of the National Oceanographic and Atmospheric Administration (<https://www.esrl.noaa.gov/psd/data/climateindices/list/>). Available water holding capacity (AWC) data, needed for the calculation of drought indexes will be obtained from the Global Soil Texture and Derived Water-holding Capacities by Webb et al. (2000), available at  $1 \times 10$  spatial resolution.

Climate projections data (1979-2099) will be obtained from Hidalgo et al. (2016). Remote sensing data will be obtained from the United States Geological Survey (<https://landsat.usgs.gov>), and from NASA (<https://modis.gsfc.nasa.gov/data/dataproduct/mod13.php>).

Other Georeferenced information will be obtained from the *Atlas Centroamericano Para la Gestión del Territorio* (CICAD 2011).

The specific indicators to be considered and their composition into indexes will be made from existing measures or new ones selected or formulated by the interdisciplinary Work Groups. These indexes will be validated and corrected as necessary following the onsite evaluation of the Representative Areas to be studied. Such evaluation consist of:



- Rapid Rural Appraisal techniques (RPA (Townsend 1996) applied by faculty-led student teams trained in RPA and other qualitative methods,
  - Assessment of natural resource use (land, water) and labor utilization practices, and production systems (irrigation, pest control, fertilizer use and other), and land tenure on the prevailing land-based economic units in the region.
  - Evaluation of the rural support infrastructure (financing, extension services, produce marketing), community life and gender roles and institutional framework in which land-based activities take place.
  - The review of cadastral and population registries and economic records, specifically those dealing with population, production, consumption and land settlement patterns, and local natural resources potential and use.
- Field research will be conducted by faculty-led teams of students trained in special course, pending approval of the Ethics Commission of the University of Costa Rica.

#### Research Products (Output)

The tangible output of the Collaboration include:

1. A Natural Resource-Based Poverty Map (Szonyi et al, 2010),
2. Maps and other representations of climatic, soil and land use-land cover variability
3. Intensive profiles of the Representative Areas and a description of deficits and strengths in
  - a. Natural resource use
  - b. Climate-related environment
  - c. Labor-utilization
  - d. Mode of production
  - e. Institutional infrastructure
  - f. Communal aspects
4. An annotated listing of stakeholders, decision-making bodies and planning and executive agencies
5. Highlighting points of conflict between the agricultural and tourism branches concerning resource use (principally water) and prospective solutions
6. Proposal for redundancy, streamlining and strengthening the regional institutional framework

7. Presentations of climate variability and climate change scenarios
8. At least three per-reviewed indexed research articles in these topics.

#### Educational Exchanges and Capacity Building

The proposed Collaboration will offer a unique experience intra-regional and international research exchange among faculty and professionals. Similarly, it will present a singular learning opportunity for both undergraduate and graduate students in Central American, Israel and other countries consisting of both classroom and field work that will enable them to encounter the realities of other countries, observe environmental change, expand cultural horizons and participate in a unique interdisciplinary endeavor that may help improve the lives of tens of millions of people in the CADC.

The Project will also endeavor to strengthen the capabilities of regional professionals and para-professional by creating frameworks for in-service training and capacity-building in Guanacaste.