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Stanford Woods Institute for the Environment

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INOGO
Iniciativa Osa y Golfito

The Osa and Golfito Initiative

OSA AND GOLFITO, COSTA RICA

FINAL EVALUATION REPORT | An Exploration of Scenarios for a Sustainable Future

Osa & Golfito Initiative

December 2015

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Osa and Golfito, Costa Rica

Final Evaluation Report
An Exploration of Scenarios for a Sustainable Future

The Osa and Golfito Initiative

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Glossary

Alternative Futures: a projection of how existing land cover might have changed over a specified time frame, based on the different factors illustrated in a specific scenario. A scenario is made up of a specific conditions and rules; an alternative future demonstrates how these rules and conditions impact the changes in the landscape over time. The Alternative Futures are a model intended for learning, and do not predict the future.

Analysis Map: a map derived from other maps using analytic operations such as geoprocesing.

Assumption: the content of a particular dimension. For example, a 3.6 m sea level rise is an assumption within the dimension of sea level rise. There are also higher-order assumptions: within the first-order assumption of "proactive" for the dimension of "political environment", several second-order assumptions could be made to characterize this condition, such as "state income-tax" and "restoring natural stream and river conditions". An assertion assumed to be true for the purpose of a scenario. Assumptions are often grouped into "dimensions".

Trend: a designation used in the scenarios to describe the political climate. It means that planning and management actions continue along the current trajectory without a substantial deviation of course.

Evaluation Indicator: a metric used to characterize the outcomes or conditions of an alternative future. They provide a window through which to assess the impact of the scenario's assumptions on various areas of concern. For example, if a given scenario assumed a particular land-use policy, one evaluation indicator could be "acreage of land used for agriculture".

Evaluation Map: a map which expresses normative judgments. The standard of evaluation can vary, and often includes scientific or best professional judgment.

Proactive: like trend, proactive is used to describe the political climate. It indicates aggressive or bold new planning and management actions creating a break with the status quo.

Scenario: in this project, a scenario is a discrete set of plausible and internally coherent conditions at one or more given time intervals. They are generated in a consultative process with stakeholders. The first component is the set of dimensions, and the second component is the set of primary and higher-order assumptions for each of those dimensions. Scenarios are groups of consistent concepts, sometimes organized in iterative form.

Spatial Impact Assessment Model: given a set of conditions (the scenario), and a spatially explicit set of land uses and population allocation (alternative future), an impact model looks at the effects that these conditions would have on particular areas of concern, examined through the lens of an evaluation indicator. It is important to distinguish impact studies from scenario generation.

Suitability Map: a map which ranks or rates land according to its suitability for a particular purpose.

Thematic Map: a map which displays categorical data.

Abbreviations

ACOSA	Área de Conservación Osa (Osa Conservation Area)
ASADA	Asociaciones Administradoras de Acueductos Rurales (Administrating Association of Rural Water Supply)
BAU	Business As Usual
BID	Banco Interamericano de Desarrollo (Inter-American Development Bank)
CIMAT	La Comisión Interinstitucional de Marinas y Atracaderos Turísticos (Inter-Institutional Commission on Marinas and Tourist Piers)
CCSS	Caja Costarricense de Seguro Social (Costa Rica's Social Security Administration)
CNE	Comisión Nacional de Emergencias (National Commission for Emergencies)
CR	Costa Rica
CTP	Colegio Técnico Profesional (Technical Professional High School)
DEM	Digital Elevation Model
EBAIS	Equipos Básicos de Atención Integral en Salud (Basic Teams for Comprehensive Health Care)
FE	Finca del Estado (state owned land)
FENOPEA	La Federación Nacional y Organizaciones de Pescadores Artesanales (National Federation of Artisanal Fishermen's Organization)
FOD	Fundación Omar Dengo (Omar Dengo Foundation)
GIS	Geographic Information Systems
HNTS	Humedal Nacional Térraba-Sierpe (Térraba-Sierpe National Wetland)
HH	Humedal (wetland)
ICT	Instituto Costarricense de Turismo (Costa Rican Tourism Institute)
INOGO	The Osa and Golfito Initiative
INCOPESCA	Instituto Costarricense de Pesca y Acuicultura (Costa Rican Institute for Fisheries and Aquaculture)
LU	Land Use
LULC	Land Use Land Cover
MPA	Marine Protected Area
MEP	Ministerio de Educación Pública (Ministry of Public Education)
MOH	Ministry of Health
MOPT	Ministerio de Obras Públicas y Transportes (Ministry of Public Works and Transportation)
NGO	Non-governmental organization
PASE	The Partido Accesibilidad Sin Exclusión (Party for Accessibility without Exclusion)
PES	Payments for Ecosystem Services
PN	Parque Nacional (National park)
PNC	Parque Nacional Corcovado (Corcovado National Park)
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RI	Reservas indígenas (Indigenous reserve)
RB	Reserva biológica (Biological preserve)
RNA	Reserva natural absoluta (Absolute natural preserve)
RVS	Reserva de vida silvestre (Wildlife preserve)
SINAC	Sistema Nacional de Areas de Conservación (National System of Conservation Area)
VPSA	Visual Preference Survey and Analysis

Introduction

1.0 Introduction

The Osa and Golfito region of Costa Rica is considered a rare paradise due to its natural beauty and rural character. This status is threatened by the rapid changes that the region is experiencing. The accelerated changes generate challenges in terms of decision making, at both the planning and policy level, and threatens the well-being of the region's landscape and its inhabitants. As a result, increased land use modification due to factors such as growth in tourism, development, conservation, and changes in the agricultural and forestry markets can be seen as a consequence of this rapid change. These changes represent more than just issues related to deforestation and loss of biodiversity. They are the expression of profound historic, socio-economic, and policy related issues. Confronting these issues requires the consideration of the social, economic and political structures of the region. Most importantly, it requires an understanding of the decision-making dynamics that shape this landscape and its operations; resulting from complex and dynamic exchanges between local actors and national and international policies and initiatives.

1.1 THE OSA AND GOLFITO INITIATIVE

The Osa and Golfito Initiative, "INOGO" is an international collaborative effort created to develop strategies for sustainable human development and environmental stewardship in the Osa and Golfito cantons of Costa Rica. This effort is a collaboration between people and institutions in the United States and Costa Rica, facilitated by the Stanford Woods Institute for the Environment at Stanford University.

INOGO is designed to build on the many previous efforts in the region, working hand in hand with Costa Ricans in local communities, the public and private sector, and non-governmental organizations (NGOs) to create shared visions and long-term strategies for a sustainable future for the region. The project integrates social, cultural, and economic dimensions of the region with the marine and terrestrial ecosystems.

In addition to producing new studies and reports, the goal of this initiative is to generate a living process for sustainable development led by Costa Ricans, in particular the residents of Osa and Golfito. The initiative also aims to provide information and products that are useful to stakeholders in the region for their ongoing decision-making processes.

Phase 1 of INOGO features four key components for the study region (Figure 1):

- Synthetic analyses, written to interpret existing information, and the identification and fulfillment of gaps, therefore creating a baseline for future work;
- Case studies to address timely issues, where it is clear that local actors need more information to advocate for community and environmental well-being;
- Interactive co-development with stakeholders, developing possible alternative future scenarios, a process which in itself has value as it gives leaders the space to think about long-term goals alongside potential collaborators;
- Design of strategic pathways towards sustainable development.

An important goal of the INOGO process is to maintain an inclusive, participatory process that engages actors at the local, regional, and national levels. Throughout the initiative, INOGO has been working to make sure that the local communities' concerns, aspirations and needs are heard, in particular those relevant for a more positive future, where families have a chance to improve their quality of life in a healthy, social and natural surroundings.

1.2 THE STUDY REGION

The Osa and Golfito region is located in southeastern Costa Rica on the Pacific coast, approximately 300 km south of the capital of San José, in the province of Puntarenas. The region is considered a rare paradise due to its natural beauty, tropical habitats and rural character. Despite its natural attributes, the region is considered complex because of its socioeconomic, natural and historical dynamics. Its future will depend on the extent to which the decision-making processes integrates socioecological and economic factors, engages national, regional, and local actors, and includes the voice of the private sector. The well-being of those communities and the region will depend on the future strategies that are defined today.

The study region of the Osa and Golfito Initiative was initially defined by ecological boundaries. A focus on the Osa Peninsula was considered, however the importance of the Golfo Dulce to both human and natural processes was too great to be left out. As a result, the surrounding communities and other natural features located along the borders of the Golfo Dulce were also included.

These ecologically-based boundaries include parts of the cantons of Osa and Golfito. While this provides a significant challenge for the data collection and analysis processes, it is clear that all boundaries have their own challenges. Our map thus shows the initial boundaries of INOGO as a living process, as it is anticipated that these boundaries may change over time (Figure 2).

1.3 THE CHALLENGE

The Osa and Golfito region is following an unusually sustainable path, which is threatened by rapid changes that do not consider long term impacts. The regional challenges can be summarized into the following: uncoordinated development, a weak local economy, little economic diversification, a fragile socioeconomic structure, and limited public infrastructure. The impacts of these changes are tangible and are expressed or reflected in land use alterations, natural resource management conflicts and the weakness of the region's human development indicators. These problems require a reformulation and reconsideration of the structures and socioecological (natural, socioeconomic and cultural) relationships found in the region.

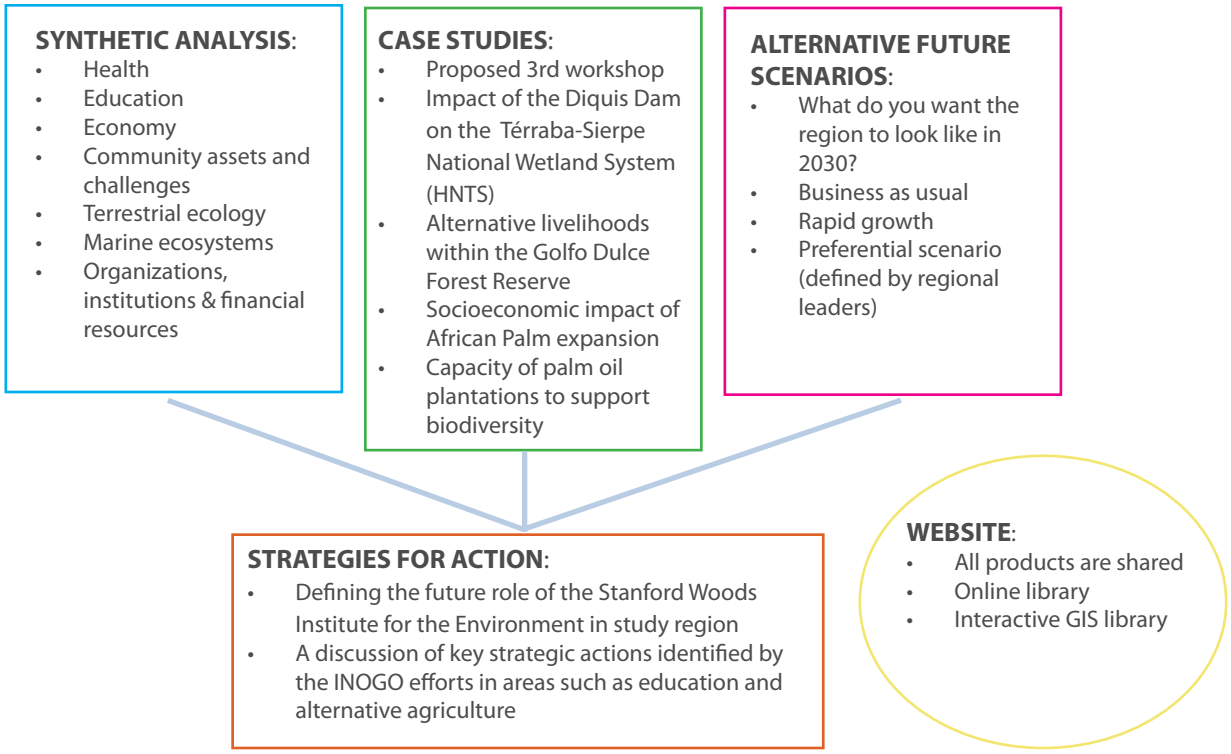


Figure 1. The Osa and Golfito Initiative phase I products

Osa and Golfito | Current Land Cover (2011)

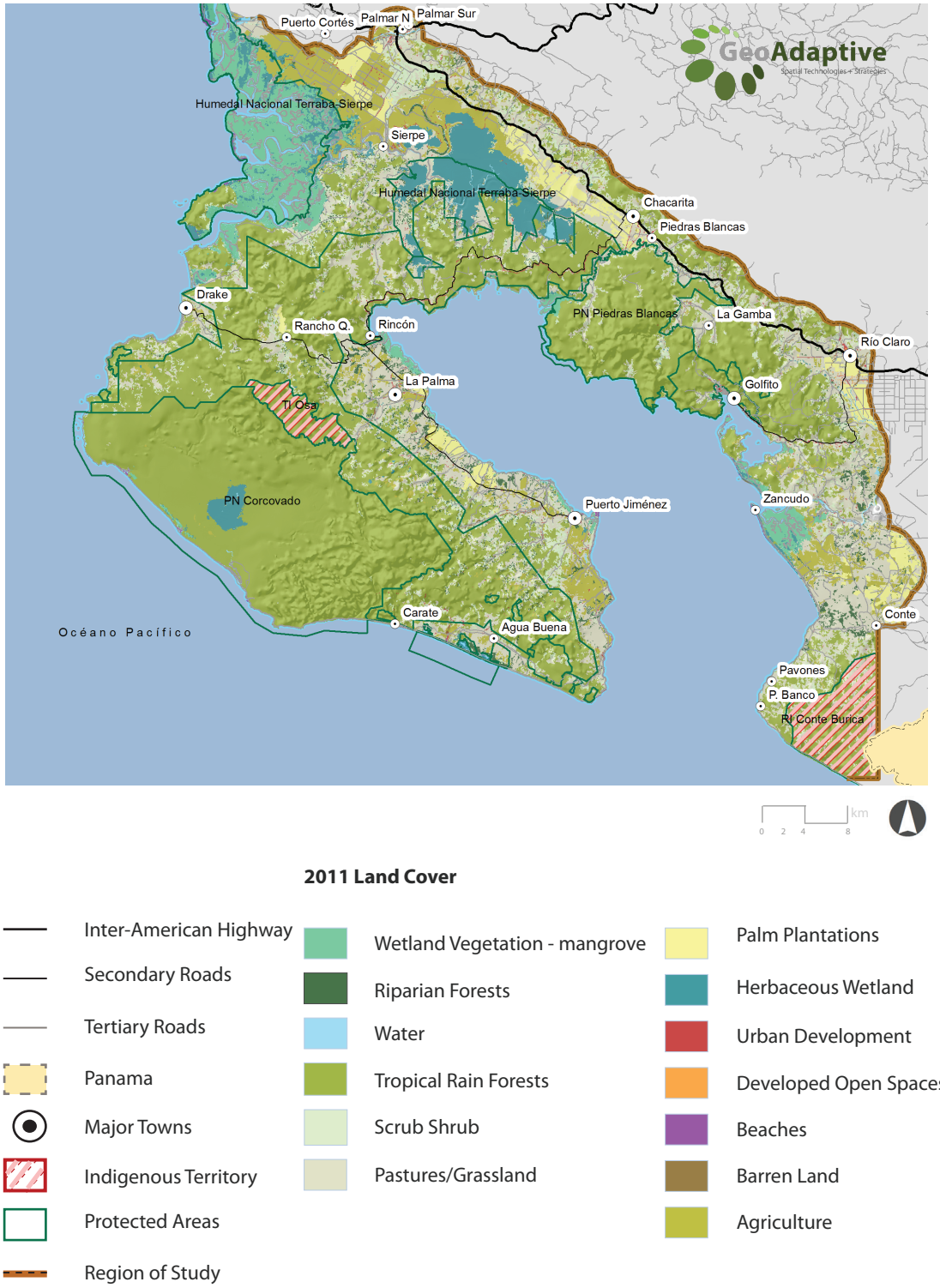


Figure 2. The Osa and Golfito 2011 land cover

INOGO 2030 Scenario Background

2.0 INOGO Scenario Background

2.1 WHY SCENARIOS?

Scenarios are designed as processes to support actors involved in the development and conservation of a region. Through the scenarios, actors are given the opportunity to contemplate an uncertain future by examining the possibilities, likelihoods and the impacts different future conditions would bring. Through these processes, decision makers are able to choose a more sustainable future for tomorrow through the consideration of the long term impacts of the actions they take today.

Scenarios are developed for several reasons:

- To understand the uncertainties about the future: economic, population, and political dynamics.
- To understand the direction of where the region is going and to identify new opportunities for development.
- To understand possible changes in the values of the inhabitants within the area.
- To provide tools for action; what should be prioritized as short, medium, and long term?
- To allow actors within a society to share their visions and establish guidelines for sustainable development together.

The scenarios represent alternative futures and reflect the social, economic, environmental, cultural, and political impacts they may have in the future. Recognizing alternative futures would allow for better decision making about the future.

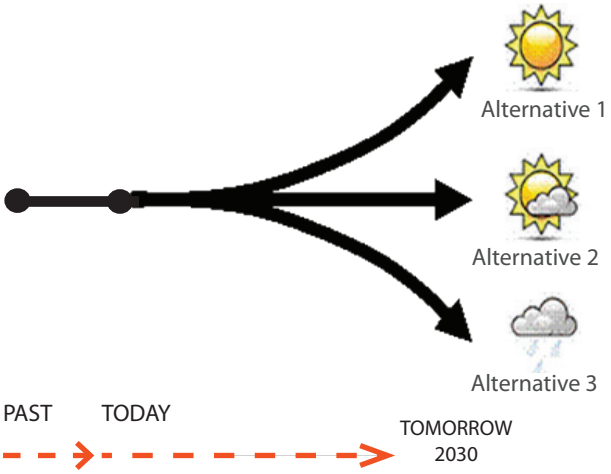


Figure 3. What is a scenario?

- To participate in the exploration of the future.
- To ask "where are we going?"
- To ask "what do we want?"
- To understand challenges and dilemmas.
- To picture the future using visual tools, allowing us to learn from the trajectories that are modeled.

2.2 WHY 2030?

The scenarios were modeled and projected for 2030. The 2030 time horizon was selected for the following reasons:

- The time horizon is not so far into the future that it remains disconnected to our current situation.
- It is relevant not only to our own future but to our children's future as well.
- The time horizon is close enough that there is a good understanding of the infrastructure needs and the economic patterns (based on current and historic trends).

3.0 Scenario Development

3.1 SCENARIO DEVELOPMENT

The INOGO scenarios were developed as learning and exploratory tools to help actors visualize the likely changes the region could undertake if certain hypothetical groups of conditions became reality. Scenarios are narratives that are deliberately crafted to describe multiple plausible futures constructed from facts, policies, and assumptions that rule the most important systems and therefore define the trajectories of change that the region may experience.

The INOGO scenarios recognized a series of drivers of change and were constructed from an analysis based on a series of socioeconomic, policy, and environmental assumptions and projections. These were explored, discussed and validated in conjunction with a wide range of stakeholders and advisors. These conditions of "ingredients" for each scenario were simulated in space and time using computer models which calculate likely changes in land use patterns. The results are a series of land use and biophysical characterizations (features found in a natural environment, such as, soil, land cover, etc.) that depict how the region may look by 2030. The types of land use considered in the scenarios include conservation, urban development, agriculture, African Palm, vacation homes and hotel development.

The scenarios were developed through a geographical simulation that captures three variable strategies for the region: (1) economic and demographic projections, (2) public policy and regulation options, and (3) projected improvements of road and electrical infrastructure. These variations were modeled on a landscape that depicts over 30 layers of data, including factors such as education and health care infrastructure, soil type, slope, and rainfall.

The INOGO scenarios reflect three different strategies: Trend, Rapid Growth and Proactive. The elements considered for each are described in Table 1.

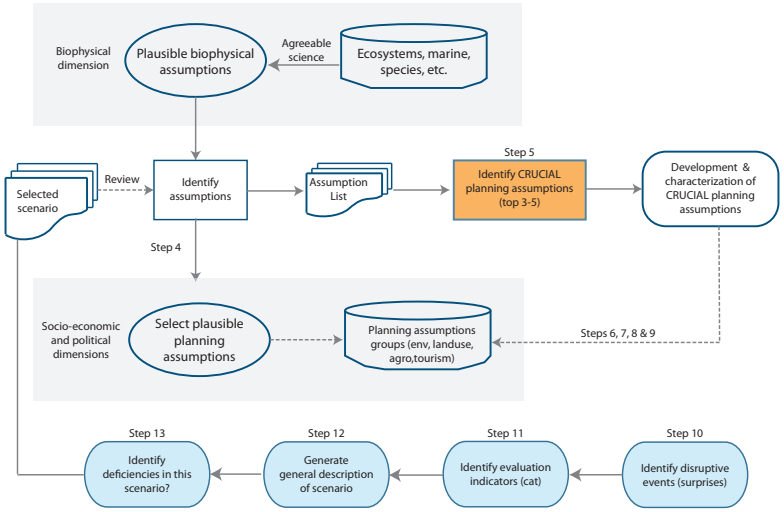


Figure 4. Assumption-based scenario planning process

Elements	Scenarios (2030)		
	Trend	Rapid Growth	Proactive
	Without Enforcement of Regulation	No Enforcement of Regulation *(anything goes)*	Enforcement of Regulation
POPULATION	Current growth patterns (+~16,000 people) (+23%) Population: 85,000	Rapid growth of population (+23,500 people) (+35%)) Population: 92,000	Current growth patterns (+~16,000 people) (+23%) Population: 85,000
INFRASTRUCTURE	Maintenance of existing infrastructure (roads, bridges, electricity and the Diquis Dam)	Additional paved infrastructure (roads, bridges, electricity, international airport and the Diquis Dam)	Additional paved infrastructure (roads, bridges, electricity, regional airport)
CONSERVATION	Conservation/PES as today (+5000 ha/year PES)	Minimal conservation & PES (+1000 ha/year PES)	Increase in conservation/ PES (+7000 ha/year PES; +GRUAS II)
AGRICULTURE	Decrease in agriculture	Growth in agriculture	Increase in agricultural productivity
African Palm	Moderate growth in African Palm	Rapid growth in African Palm	Growth in African Palm
TOURISM	Moderate growth in tourism (225 rooms (+15 hotels))	Rapid growth in tourism (700 rooms (+50 hotels)	Rapid growth in tourism (450 rooms (+30 hotels))

Table 1. INOGO scenario elements

3.2 PARTICIPATORY SCENARIO DESIGN

Scenarios offer a powerful vehicle for learning and preparing for an uncertain future shaped by the complex behaviors of socioecological systems (van der Heijden 1996). In order to validate and promote a continuous learning process, the GeoAdaptive team (on behalf of INOGO) led a consultative process involving a wide range of actors and experts. The scenarios were constructed, developed and evaluated through this process. This enabled participants to coalesce a range of insights into coherent narrative frameworks and allowed the technical team the opportunity to integrate varied and diverse ideas into the scenarios. Moreover, the process allowed local stakeholders to listen to others' viewpoints and expand their own understanding of their regional community.

The scenarios were developed through a series of workshops. In these workshops, stakeholders and experts worked together to identify, verify and evaluate the conditions and components of each scenario. Within the region of study, a total of three scenario design workshops took place in Puerto Jiménez, Sierpe and Golfito. These workshops brought together more than 62 community leaders and representatives of various organizations. In addition to the over 40 small group consultations, two additional scenario design workshops were held in San José where over 50 experts, academics, and public sector workers were consulted.

The scenario development and validation workshops served as a space for exploration, as well as an opportunity to foster discussion on the preferred criteria for each scenario. The workshops were comprised of discussions and hands-on activities where participants drew on printed maps of the region to designate culturally and environmentally significant areas, desired infrastructure improvements, and their (positive or negative) reactions to different aspects of each scenario. Active discussions took place around maps, allowing participants to sketch, mark-up, circle and add components and considerations for each scenario.

In order to explore local residents' preferences regarding the visual character of their region, a Visual Preference Survey and Analysis was conducted (Please refer to chapter 5 for more detailed process of the Visual Preference Survey and Analysis). The visual survey used pictures that captured different conditions of the regional landscape, from fully developed landscapes to pristine natural landscapes. Sixty pictures were selected from over 450 pictures taken within the project region. The pictures were selected using criteria that represented 33 characteristic conditions present in the region. The selected 60 photographs represent the different types of land use and land cover in the INOGO geodatabase. These final photos were retouched and reformatted to show similar conditions in terms of weather, depth and composition. Each photo was assessed and encoded with a set of factors that could explain the visual preference for a specific view. A unique "identifier code" (1 to 60) was given to each photo. These coded pictures were provided to INOGO team members who conducted interviews across the project region, asking participants to organize the 60 photos from most preferred to least preferred. Over 160 interviews were conducted throughout the project region.

Figure 5. Regional community members using the participatory scenario framework

3.3 SCENARIO SIMULATION

The 2030 land use distribution projection was simulated using three components of analyses (demand, constraints and attractiveness) allowing the technical team to capture complex socioeconomic, political, environmental and cultural processes for the region. This process replicated real estate market conditions between supply (land available for development) and demand.

Following is a brief description of the inputs that were used to determine future land use distribution.

- Demand: The demand analysis was based on future population projections and identified the distribution of growth within the land use categories.
- Constraint: The constraint analysis represented areas that were restricted for future development and should not be developed for legal, natural and geomorphological reasons.
- Attractiveness: The attractiveness analysis represented areas that were "attractive" or suitable for future growth.

Analyses were conducted using Geographic Information Systems (GIS) to visually capture three different scenarios: Trend, Rapid Growth and Proactive. The Trend Scenario reflected a continuation of historical and current growth patterns observed today. The Rapid Growth Scenario represented a rapid growth in population and considered development upgrades, but placed low prioritization on conservation. Similar to Rapid Growth, the Proactive Scenario represented a rapid growth in population and considered infrastructure upgrades, while placing high prioritization on conservation.

3.3.1 FUTURE PROJECTIONS

Future population projections, as well as future African Palm, agriculture and environmental services projections were calculated using historical data to determine the estimates by 2030.

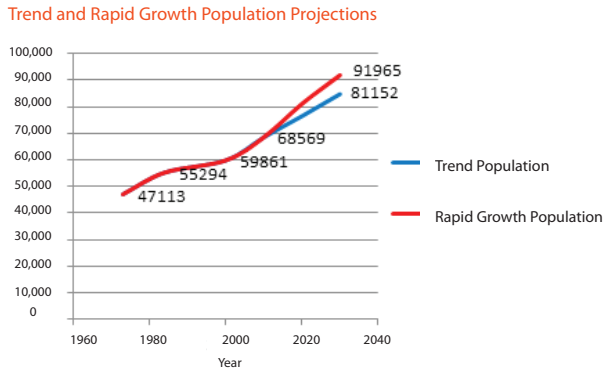


Figure 6. Trend and rapid growth population projections for the 2030 scenarios

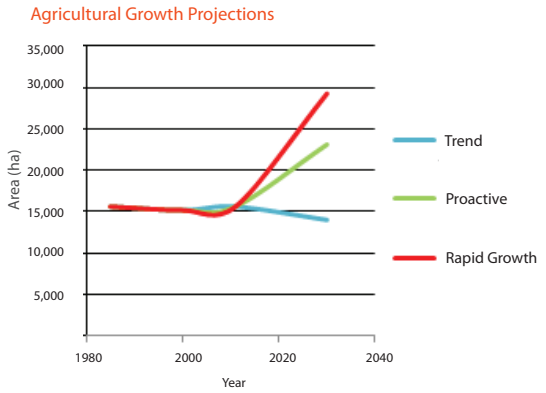


Figure 7. Agricultural growth projections (area (ha)) for the 2030 scenarios

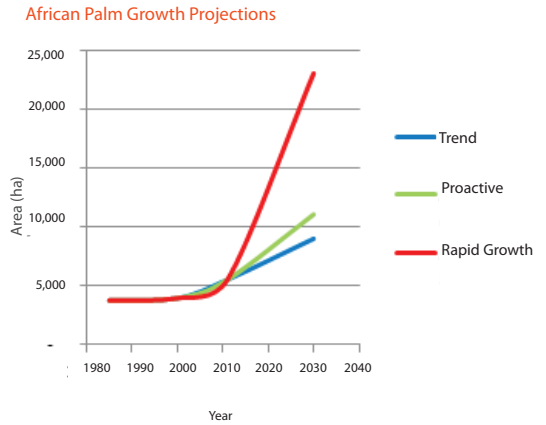


Figure 8. African Palm growth projections (area (ha)) for the 2030 scenarios

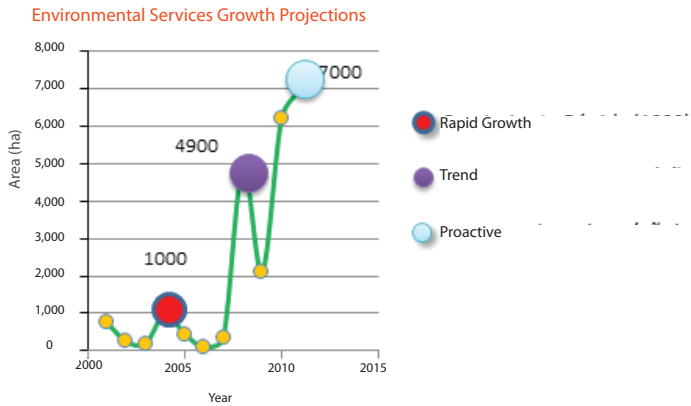


Figure 9. Environmental services growth projections (area (ha)) for the 2030 scenarios

3.3.2 RESTRICTED USE AREAS

A key component of the analysis was the identification of a set of development limitations to restrict future growth. The analysis considered a specific set of limitations for each scenario that involved gemorphological, legal and natural considerations. These limitations included changes in policy and legislation, socio-economic projections, attractive areas for future development and the improvement of gray infrastructure and municipal services (Table 2).

Following is a brief description of the primary categories considered:

Geomorphological: geomorphological considerations included any physical limitation that would restrict future land use growth, such as a steep slope.

Legal: legal considerations followed current laws and zoning restrictions. These also included existing infrastructure such as roads.

Natural: natural considerations included areas that are ecologically sensitive, for example, protected wetlands, parks, and water bodies.

Development Restriction	Trend	Rapid Growth	Proactive
Protected areas	State owned land, wetlands, national parks, biological preserves, indigenous territories, nature preserves, and wildlife preserves.	State owned land, wetlands, national parks, biological preserves, indigenous territories, nature preserves, and wildlife preserves.	State owned land, wetlands, national parks, biological preserves, indigenous territories, nature preserves, and wildlife preserves.
Land use & coastal zones	All protected wetlands and only the protected forests within concession lands. (50 to 200 m from the coast).	Protected forests and wetlands within concession lands. (50 to 200 m from the coast).	All protected wetlands and forests (based on 2011 land cover, derived from remote sensing analysis).
Slope	Slope < 50% restricted.	No slope restriction.	Slope < 30% restricted (derived from the Digital Elevation Model (DEM)).
Flooding	National Emergency Commission designated flood areas.	No restrictions for flood areas.	National Emergency Commission designated flood areas.
Proposed 3rd international airport	No restriction for proposed airport.	Land for airport project restricted.	Land for airport project restricted.
Rivers & riparian areas	Legal restrictions on rivers: 50 m if river has "high slope" (>30%); 10 m if slope is small and land cover is urban; 15 m if land cover is not urban (land use from 2011 land cover; urban = developed and sparsely developed).		
Right of way	25 m buffer for primary roads; 8 m buffer for other roads.		

Table 2. List of development restrictions used for the 2030 scenarios

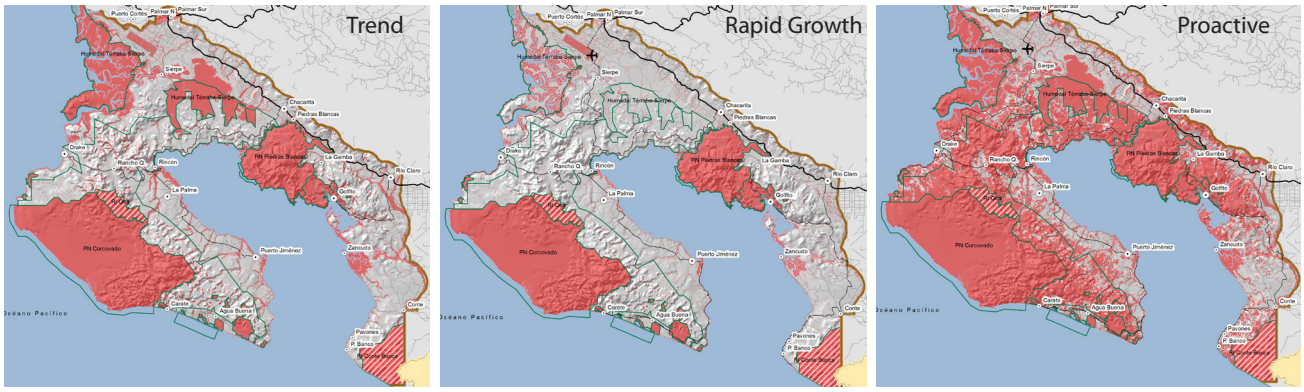


Figure 10. Results of the development restriction analysis used for the 2030 scenarios

3.3.3 CREATING THE ATTRACTIVENESS ANALYSIS

STEPS TO THE ATTRACTIVENESS ANALYSIS

The attractiveness or "suitability" analysis allows the identification of areas that were suitable for several types of future development or land use including urban development, vacation homes, hotel development, conservation, and agriculture (African Palm) for each of the development scenarios (Trend, Rapid Growth and Proactive). This analysis examined the future land use distribution based on the proximity to amenities, services and other areas of interests (i.e. proximity to beaches, roads, etc.). These areas of interest or "cost distance factors" were based not only on the physical distance to a place, but also on the travel time to the area. Factors that can affect travel time, such as difficult river and wetland crossings, as well as road types (paved or unpaved - affecting travel speeds) were taken into consideration to provide a hypothetical travel time in the region.

For each future land use category or development type, different factors were considered in order to analyze the particular suitability for each category or type within the region. The particularities for each are outlined in the following pages (Figure 13 - Figure 18).

The suitability for the region was measured using an index ranging from 1 (=lowest) to 9 (=highest).

ATTRACTIVENESS OUTPUTS AND RESULTS

The inputs for the attractiveness analysis for each scenario remain mostly the same. A key difference was the road infrastructure (the road type dictated the road speed) and the addition of upgraded or additional roads, particularly between the following locations: Drake-Sierpe, Rincón-Drake, Puerto Jiménez-Carate, Golfito – La Gamba and Conte – Pavones (Figure 11). The Rapid Growth and Proactive Scenarios also featured new airports: an international airport for the Rapid Growth Scenario and a regional airport for the Proactive Scenario.

Rapid Growth and Proactive | Upgraded and Additional Roads

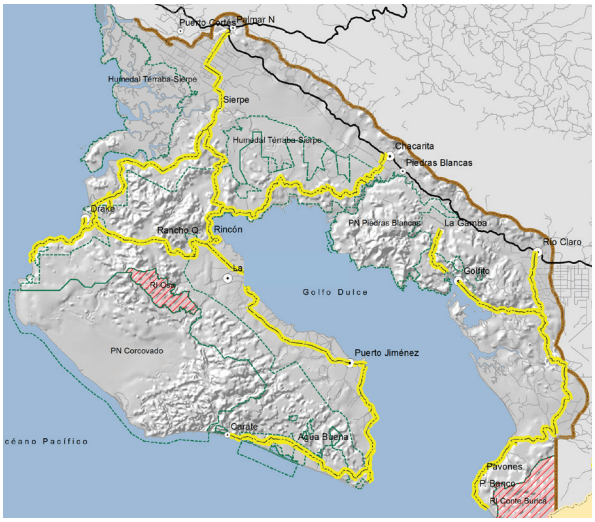


Figure 11. New and upgraded roads (Rapid Growth and Proactive Scenarios)

The following diagram shows an example of the components involved in the suitability analysis process.

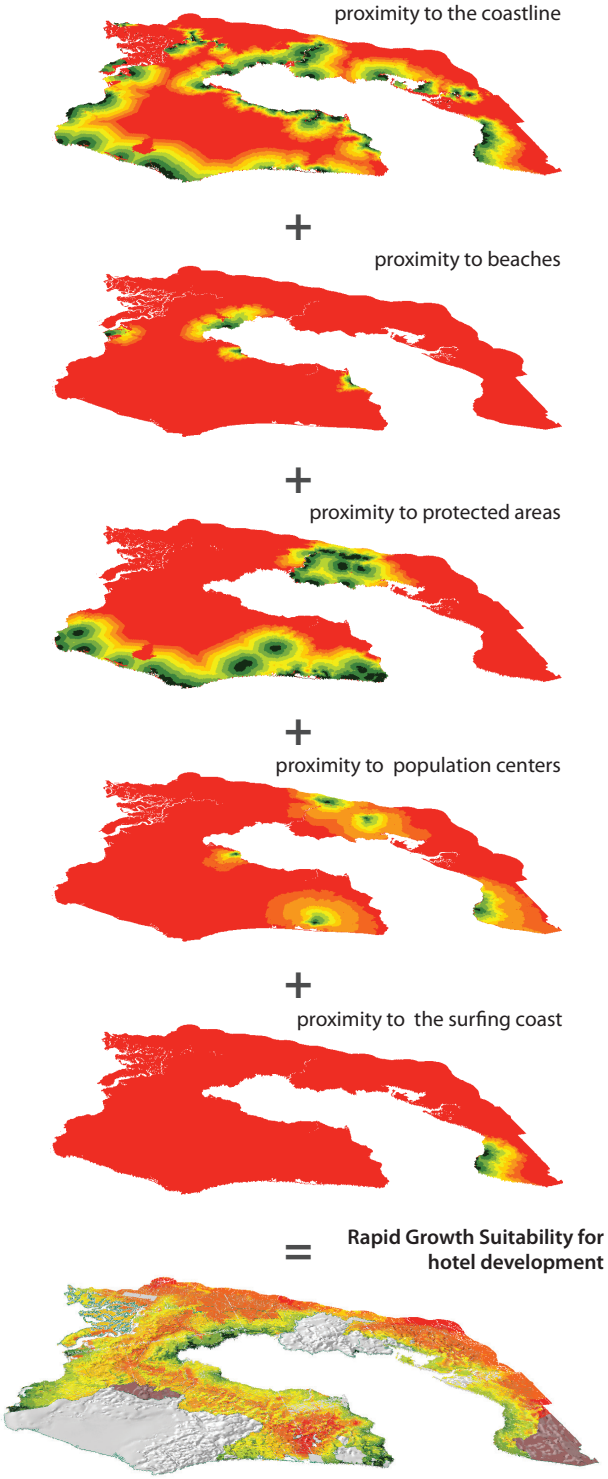


Figure 12. Example of the suitability analysis process (example: hotel development under the Rapid Growth Scenario)

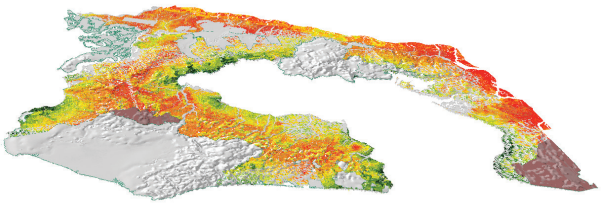
HOTEL DEVELOPMENT

Hotel development: Cost distance factors
Proximity to protected areas
Proximity to beaches
Proximity to surfing coast
Proximity to coastline
Proximity population centers
Proximity to wetlands

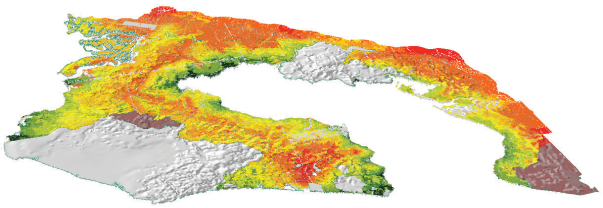
VACATION HOMES

Vacation homes: Cost distance factors
Proximity to surfing coast
Proximity to local roads
Views to coastline
Proximity to protected areas
Views to wetlands
Proximity to beaches
Proximity to coastline
Slope between 10° and 30°

Trend



Rapid Growth



Proactive

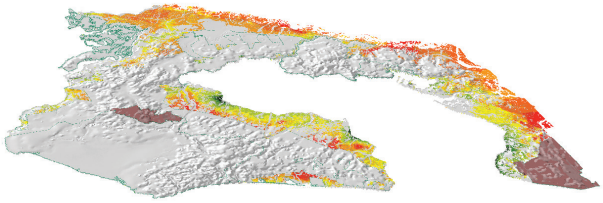
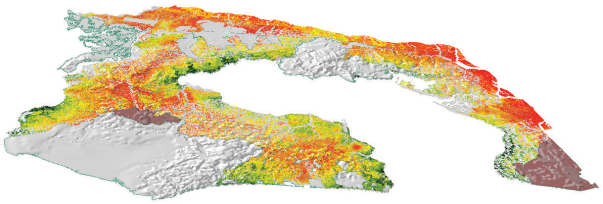
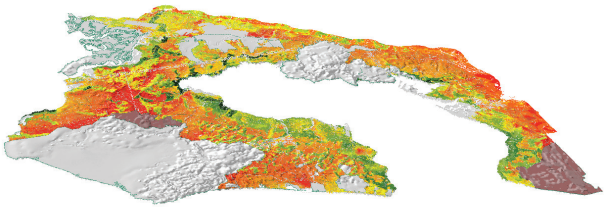


Figure 13. Hotel development attractiveness

Trend



Rapid Growth



Proactive

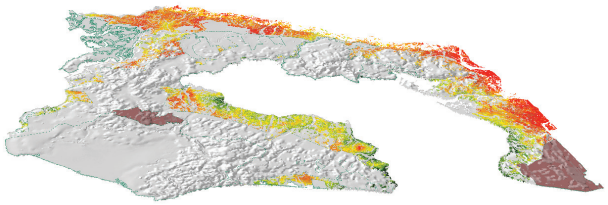


Figure 14. Vacation homes attractiveness

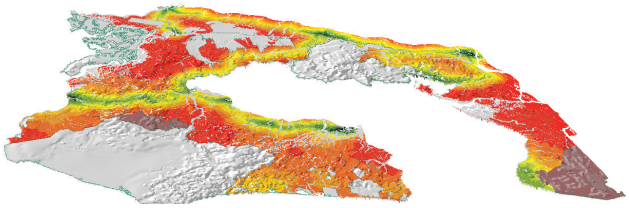
URBAN DEVELOPMENT

Urban development: Cost distance Factors
Proximity to protected areas
Proximity to beaches
Proximity to surfing coast
Proximity to coastline
Proximity to tourism hub
Proximity to population centers
Proximity to wetlands
Views of the coastline

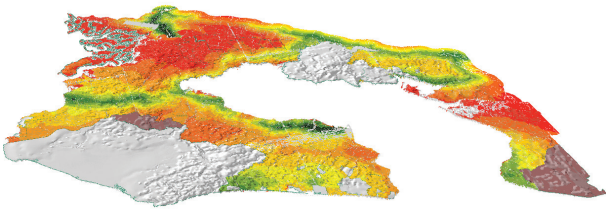
AFRICAN PALM

African Palm: Cost-Factor
Proximity to primary roads
African Palm slope factor
Proximity to palm plantations
Existing Capuso Class A - prime agriculture soil
Proximity to secondary roads

Trend



Rapid Growth



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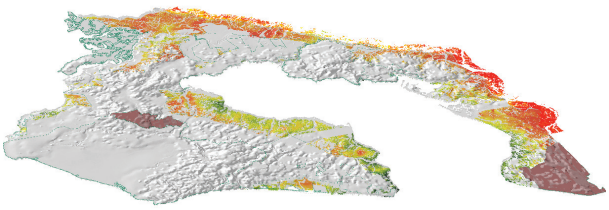
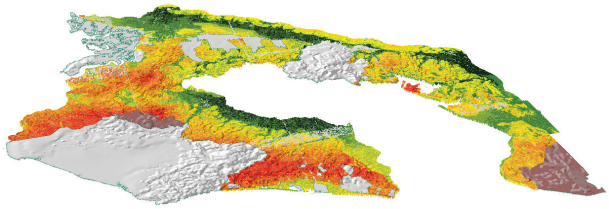
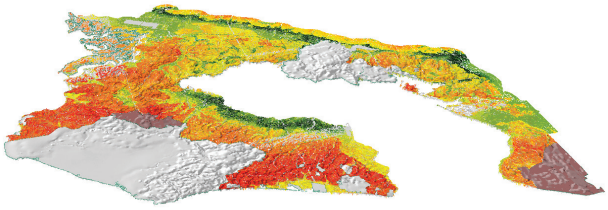


Figure 15. Urban development attractiveness

Trend



Rapid Growth



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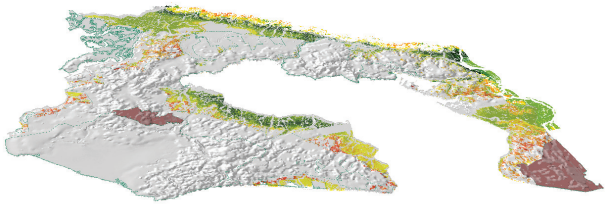


Figure 16. African Palm attractiveness

Low suitability (1) High suitability (9)

AGRICULTURE

Agriculture: Cost-Factor
Proximity to road network
Existing agriculture
African Palm slope factor
Capuso Class A - prime agriculture soil

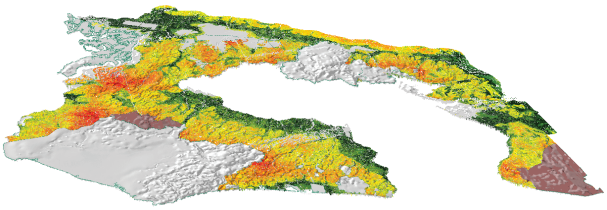
CONSERVATION

Conservation: Cost-Factor
Existing wetlands
Proximity to protected areas
Existing forests
Existing corridors
Existing conservation gaps

Trend

(The trend scenario considered a decrease in agriculture, therefore it did not model the attractiveness analysis for this land use, see Table 1 for the specific components of this scenario)

Rapid Growth



Proactive

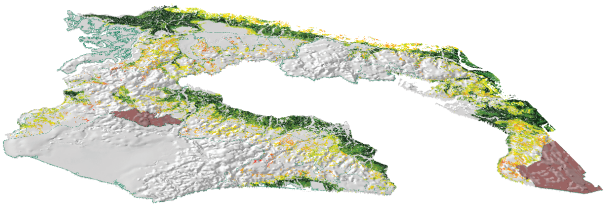
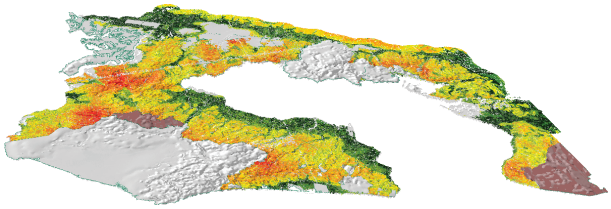
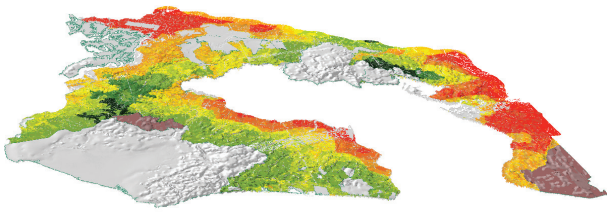


Figure 18. Proactive agriculture attractiveness

Trend



Rapid Growth



Proactive

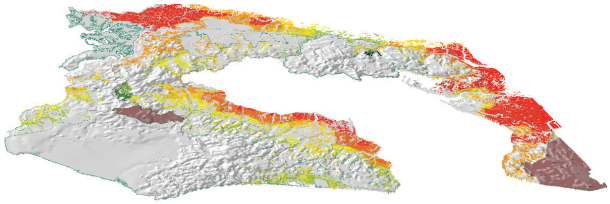


Figure 17. Rapid growth conservation attractiveness

3.3.4 DISTRIBUTION OF FUTURE POPULATION AND LAND USES

The amount of land (ha) required for the activity under each scenario was calculated based on the projected population estimates. Each particular land use (conservation, urban development, vacation homes, hotel development, African Palm, and agriculture) was assigned based on the level of suitability, determined by the results of the suitability (attractiveness) analysis and the additional variables established for each scenario. These variables are summarized in Table 3.

The total land demand was assigned in order of suitability, beginning with the most suitable areas, followed by the next group of suitable areas, until the total demand was met.

TREND

Within the Trend Scenario land use was allocated in the following order: hotel development, vacation homes, African Palm, agriculture, urban development, and conservation. (Figure 19).

RAPID GROWTH

Suitable areas for the Rapid Growth Scenario were determined in the following order: hotel development, followed by vacation homes, then African Palm, agriculture, urban development and finally conservation (Figure 20).

PROACTIVE

Since prioritization was placed on conservation for the Proactive Scenario, these areas were determined first, followed by urban development, then agriculture, African Palm, hotel development, and finally vacation homes (Figure 21).

Components of the INOGO Scenarios						
Scenario & Population Increase (2030)	Local Homes	Agriculture	Vacation Homes	Hotels	African Palm	Conservation
TREND +16,000 people	6,086 housing units	-208 ha	755 units 3,775 ha	15 (225 rooms)	3,529 ha	5000 ha (Payment for Ecosystem Services)
RAPID GROWTH +23,500 people	8,053 housing units	15,417 ha	866 units 4,330 ha	50 (700 rooms)	21,091 ha	1000 ha (Payment for Ecosystem Services)
PROACTIVE +16,000 people	6,086 housing units	4,707 ha	866 units 4,330 ha	30 (450 rooms)	5,088 ha	7000 ha (Payment for Ecosystem Services + Conservation "voids" in GRUAS II

Table 3. INOGO scenario components (reflects additional unit/area to current numbers)

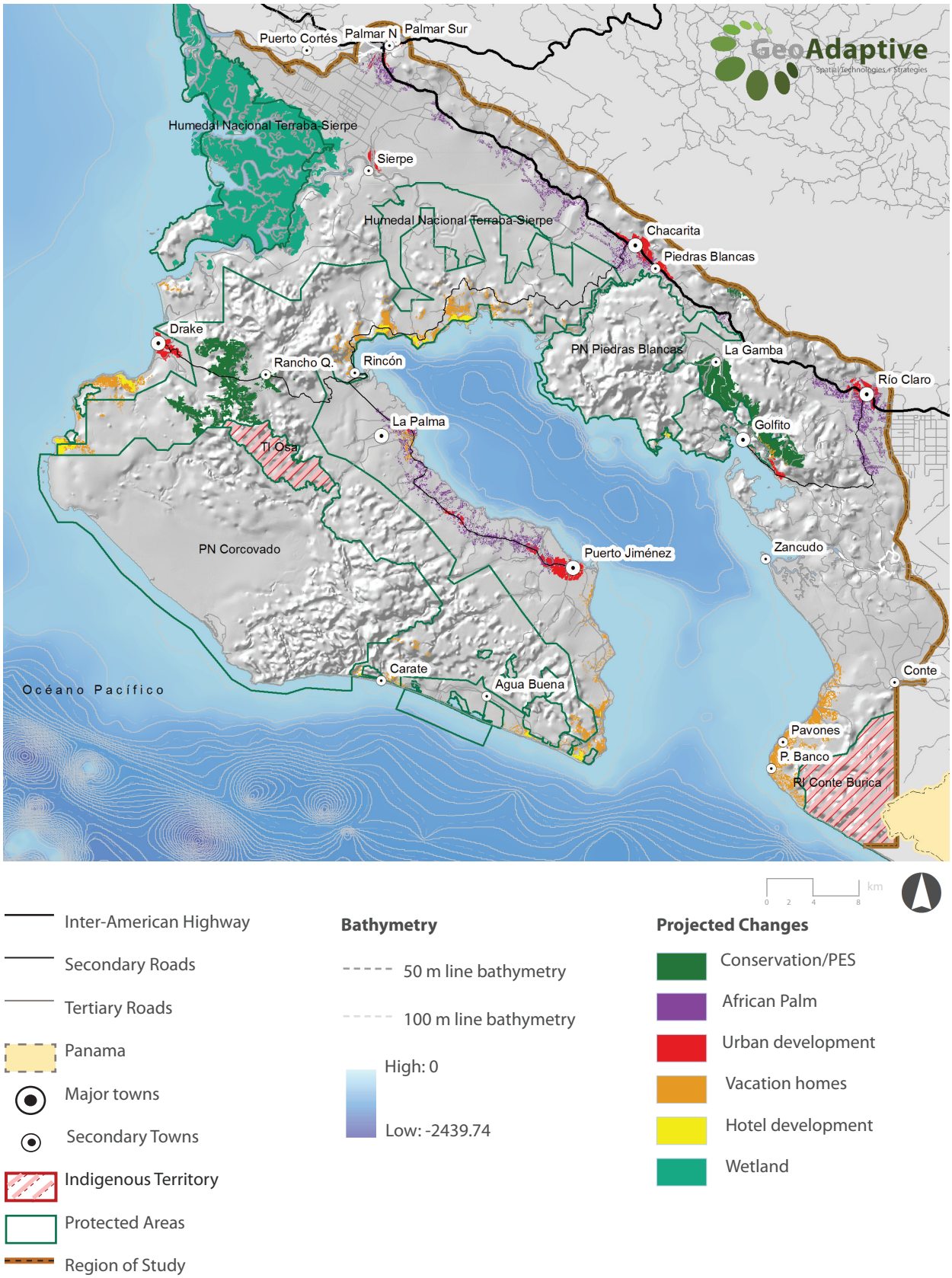


Figure 19. Trend (2030) future growth distribution results

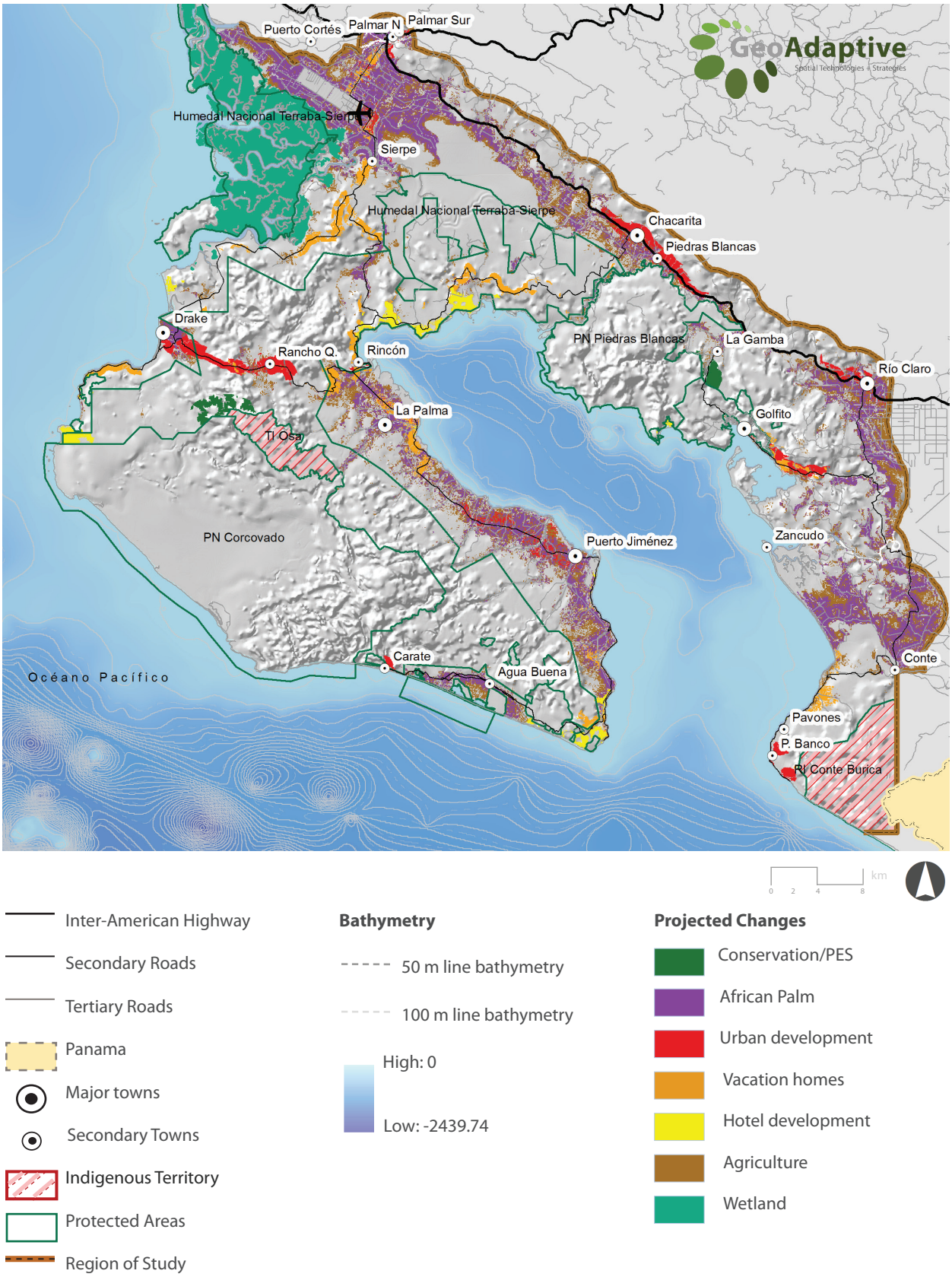


Figure 20. Rapid Growth (2030) future growth distribution results

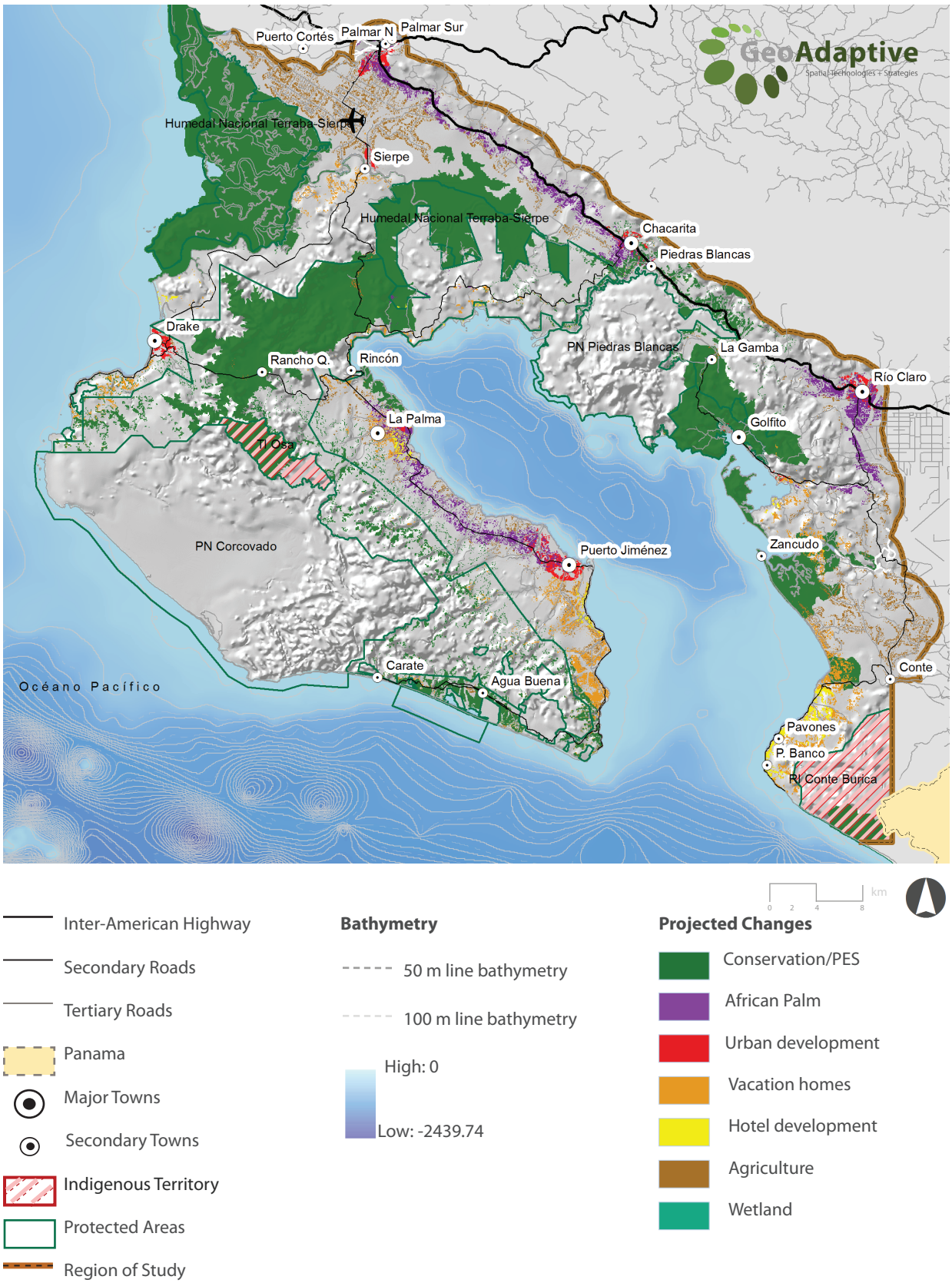


Figure 21. Proactive (2030) future growth distribution results

Scenario Evaluation

4.0 Scenario Evaluations

4.1 SCENARIO EVALUATIONS

Once the alternative futures scenarios were constructed and the potential changes were identified within the Osa and Golfito region, it was important to understand the effects these would have on the residents in the area. For example, what would be the socioeconomic impacts or ecological effects of the expansion of African Palm in the region? What would be the impacts of paved roads and bridges on the character of a community? Which scenario – and which part of each scenario – would provide the best future for the children of the Osa and Golfito region?

An overview and evaluation of the current state of each complex system in the region (such as education and health, marine and terrestrial ecosystems, and land cover/land use) was realized as a base analysis. Additionally the impacts of the scenario changes on each system was also assessed. Topical experts participated in the evaluation of the scenarios to identify the most likely outcomes based on their experience and knowledge. As part of the overview analysis, experts also evaluated the study region to determine which areas would require the most attention. They ranked these areas as "highest priority," "middle priority," and "lowest priority." Conclusions were drawn based on the consideration of each system separately, as well as how the systems interacted and impacted one another.

In order to think strategically about where time and resources should be concentrated, it was important to consider which areas would experience the most drastic changes. These priority areas would require careful planning and the implementation of policies within the decision-making frameworks employed at the local, regional, and national level.

It is important to not only look at each system individually, but to cumulatively evaluate the changes in multiple systems that would affect the future of the region. For example, the evaluation of impacts on terrestrial systems also requires the consideration of the potential impacts on marine systems. Deciding what path should be taken as we move towards 2030 requires a holistic view of the region – each intervention would impact a particular ecosystem and would have effects that radiate into many other sectors. The following evaluation overview details sector-specific impacts and identifies some of the cross-sectoral connections as well.

4.1.1 HEALTH

Osa and Golfito | Health Centers

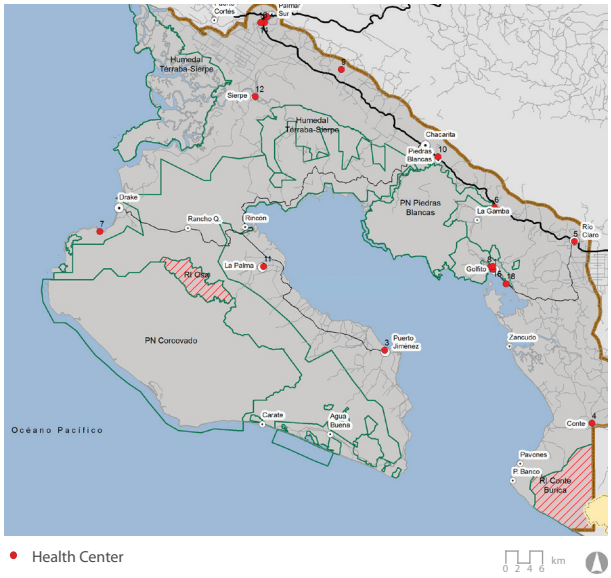


Figure 22. Map of health centers in Osa and Golfito region

Osa and Golfito | Health System Heat Map

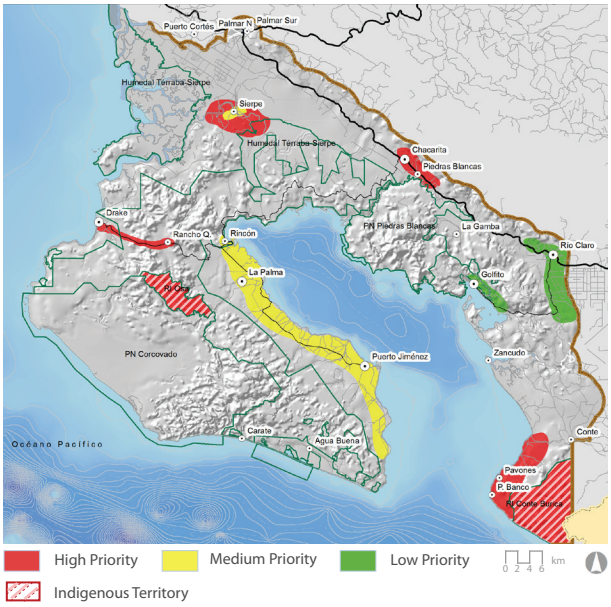


Figure 23. Health system heat map (indicates which areas are highly stressed and require attention)

Figure 24. Golfito Hospital

In the 1990s, Costa Rica underwent a health care reform where the country focused on improving its overall health equity and health care system (Gaffikin, 2013). A key actor in the health sector of the country is the Ministry of Health (MOH), now under the guise of the CCSS (Caja Costarricense de Seguro Social) who manages the delivery of public health care in the country. The MOH focuses on providing access to basic services, including vaccination, clean water, sewage systems and child nutrition, amongst others. (Gaffikin, 2013).

The health system is organized by geographic areas known as "health areas" and have teams who are responsible for providing care for that particular region (Gaffikin, 2013). These areas are categorized as Type 1, 2 or 3 based on the kind and range of services provided. Each health area also houses several EBAIS (*Equipos Básicos de Atención Integral en Salud*) or primary outpatient health care clinics which are comprised of a medical doctor, a nurse/auxiliary, a medical records technician, a pharmacist technician and a primary care technician (Gaffikin, 2013). The EBAIS might also have other professionals, depending on the availability of local resources. EBAIS can form part of larger teams that are known as clinics or "sedes".

The next level of health services offered are hospitals. There are two referral hospitals in the Osa and Golfito region: Tomás Casas Casajús (the referral hospital for Osa) and Hospital Manuel Mora Valverde (the referral hospital for Golfito). These hospitals provide services that include general medicine, obstetrics, gynecology, and pediatrics.

The evaluation of the health system of the region consisted of two separate analyses. One analysis focused on the potential health services to be provided by the Costa Rica's national health care system (CCSS), which are typically tied to changes in demography. The second analysis focused on the key factors impacting the health and well-being of the people in the area, which were identified by MOH representatives when reviewing the different scenario maps. The issue of local well-being also included a discussion of economic development, education, and water issues.

The first analysis focused on the changes in the services provided by the CCSS, which was done by looking at the changes in population in relation to the change in the health care staffing at local clinics (data provided by EBAIS teams). Based on the challenges that the health system currently faces (discussed by Gaffikin et. al.), inferences were made on the scenario outcomes. This discussion included waiting time at clinics, the availability of resources, and the ease of transportation in case of emergency.

A diversity of factors were considered for the analysis regarding the overall health and well-being of the residents of the region, such as employment opportunities and sanitation.

4.1.2 MARINE ECOSYSTEM

Osa and Golfito | Marine Systems

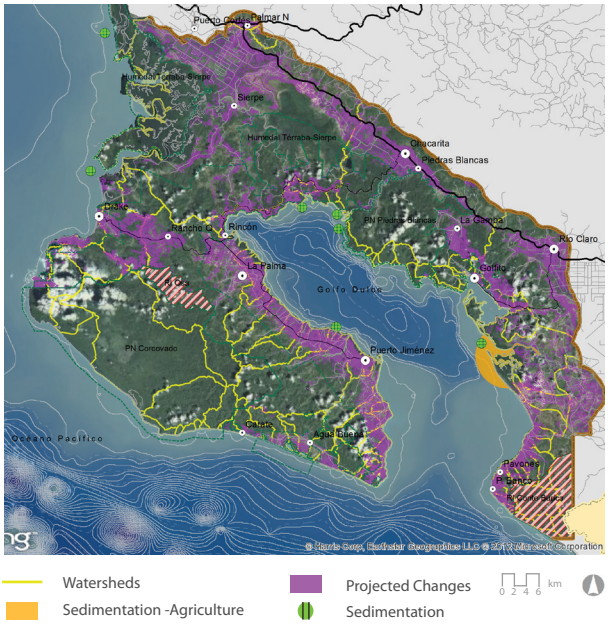


Figure 25. Marine Systems Map

Osa and Golfito | Marine System Heat Map

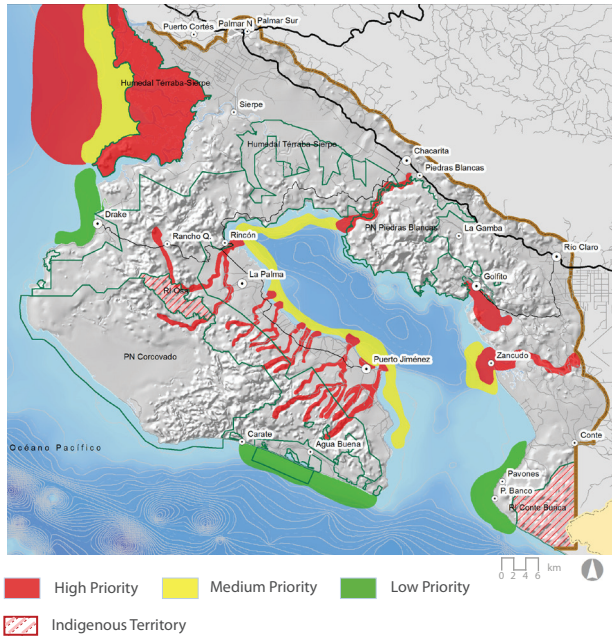


Figure 26. Marine systems heat map (indicates which areas are highly stressed and require attention)

Figure 27. Marine life in Osa

The ocean surrounding the Osa and Golfito region is characterized by rich marine resources. The marine system in the region is also home of three species of odontocetes: Bottlenose Dolphins (*Tursiops truncatus*), Pantropical Spotted Dolphin (coastal form) (*Stenella attenuata*) and False Killer Whales (*Pseudorca crassidens*) (CEIC, 2011). However, the marine systems in the Osa and Golfito region are experiencing environmental degradation and increased conflict between users. In addition, the marine area suffers negative impacts from pesticide and agrochemical runoff from rice plantations, overfishing, pollution and deforestation. Major impacts are observed in the Térraba-Sierpe National Wetland System (HNTS) and the area located between La Palma and Puerto Jiménez.

The marine scenarios were developed with the trends described by the many marine scientists working in the Osa and Golfito region who were consulted for this analysis. This group of marine base experts also provided well-informed speculations as to how anticipated changes could impact the marine environment. However, because the region is lacking specific environmental information, such as hydrological data, the land/marine interaction was not modeled or included in the scenarios.

Similar to the marine scenarios themselves, the marine evaluation was conducted through a series of meetings with local experts, in which each expert was asked to give their opinion on how each scenario would impact the ecosystem of their area of expertise. The ranges of expertise varied from sea turtles, to artisanal fishing communities, to the construction and operation of marinas.

4.1.3 EDUCATION

Osa and Golfito | Education

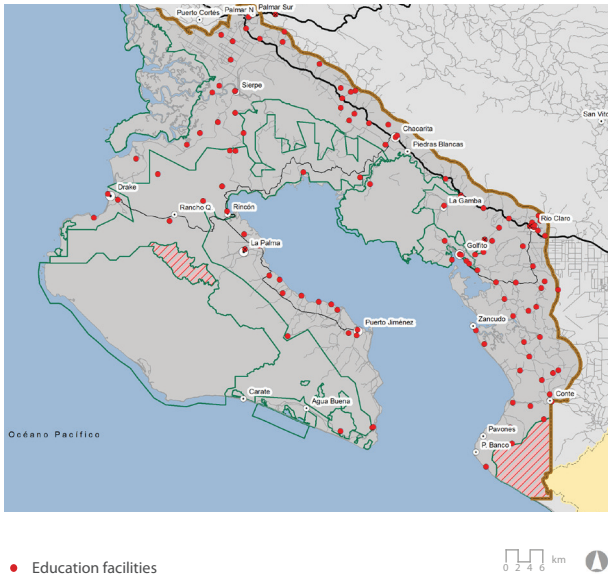


Figure 28. Location of schools in Osa and Golfito region

Osa and Golfito | Education System Heat Map

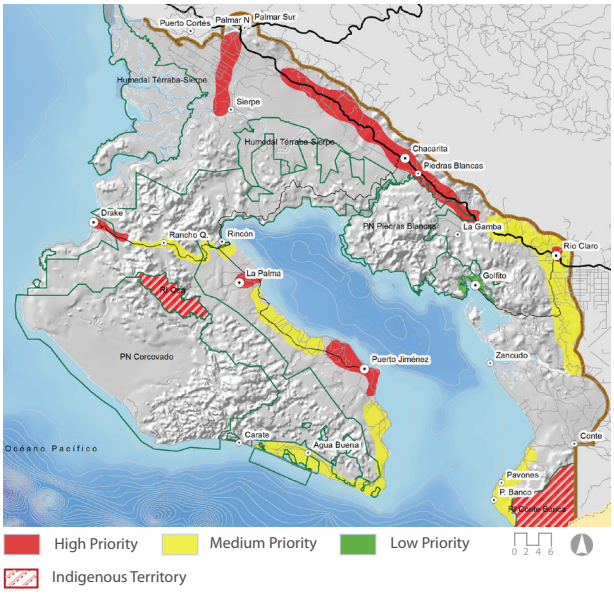


Figure 29. Education systems heat map (indicates which areas are highly stressed and require attention)

Figure 30. School children from the region

Education in Costa Rica is overseen by the Ministry of Public Education (MEP - *Ministerio de Educación Pública*) which supports pre-primary, primary and secondary public education levels (\Menke and Carnoy, 2013). Additional technical training is provided for residents over 15 years of age by the National Learning Institute (INA - *Instituto Nacional de Aprendizaje*), a local government agency.

The structure of the public education system includes the following core subjects: Spanish, social studies, science, mathematics, foreign languages (English, French, Italian, etc.) and computer science (Menke and Carnoy, 2013).

Educational goals are generally measured on a level by level basis (Menke and Carnoy, 2013), which are summarized as follows:

- pre-primary: focuses on early childhood development and primary education preparation;
- primary: provides basic education level;
- secondary: prepares students for employment for post graduation.

The Osa and Golfito region is one of the poorest in Costa Rica and its biggest challenge is the gap between students' weak academic preparation and the high demand for resources and well-trained teachers (Menke and Carnoy, 2013). The cost for supporting students with strong academic preparation (by national standards) is expensive and low-income families do not have the finances to support their children's needs (Menke and Carnoy, 2013). According to a 2012 survey conducted by the Ministry of Economics, it costs approximately between 80,495 colones (US$164) and 101,463 colones (US$206) to fully support a student while meeting national standards for an entire year.

The education evaluation was based on the trends and statistics of the educational system in the region, and how the changes in factors such as population and infrastructure could impact the provision of services by the MEP. Additional factors such as cultural shifts leading to more family involvement in education were also considered.

MEP employees in San José, and teachers and administrators in the Osa and Golfito region were consulted to gain a better understanding of the school system and the likely outcomes given the changes shown in the scenarios. With this information, the scenario evaluations were constructed.

4.1.4 LAND USE & LAND COVER

Osa and Golfito | Land Cover

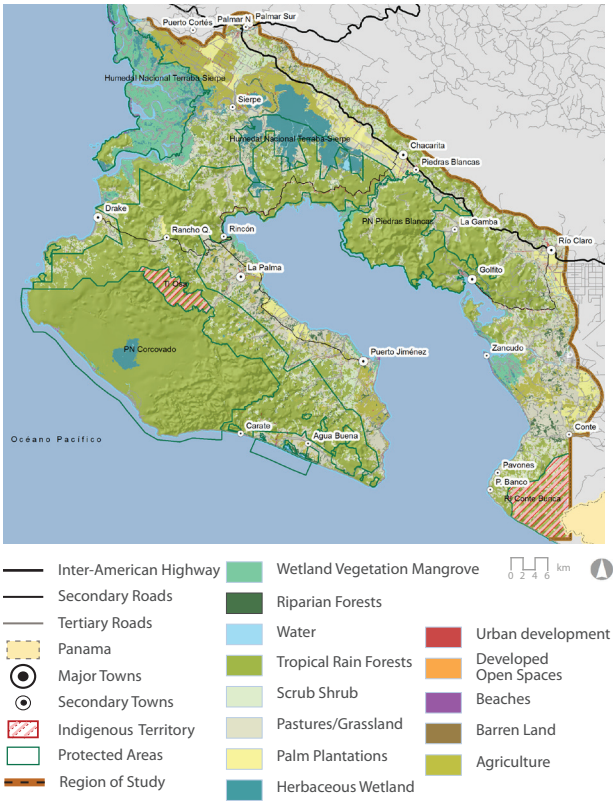


Figure 31. Osa and Golfito region

Figure 33. Agriculture in the Osa and Golfito region

Land cover is defined as the vegetation cover or man-made constructions found on land, and land use is defined as activities carried out by humans on land as a benefit or a resource (Coffey, 2013). The land cover analysis used remote sensing detection from satellite imagery which displays land cover type based on existing vegetation patterns. While satellite imagery provides information on land cover, it also provides some indication of potential land use options. For example, any land cover that is classified as forests could be used as "parks" in the future.

Osa and Golfito | Land Cover/Land Use Heat Map

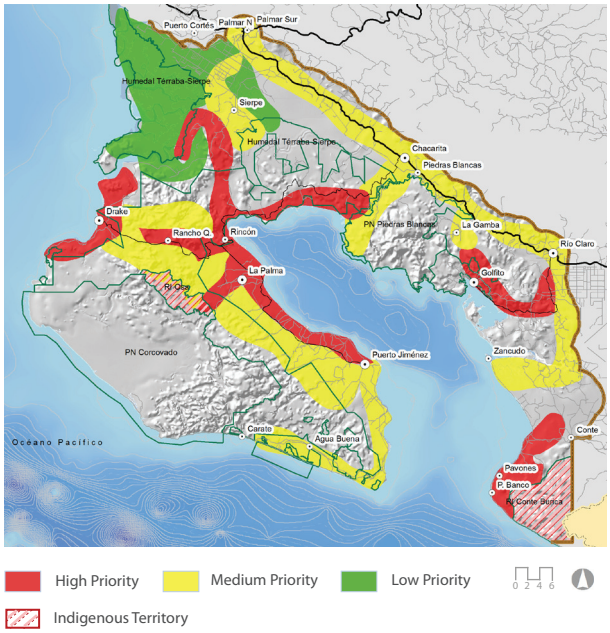


Figure 32. Land cover/land use heat map (indicates which areas are highly stressed and require attention)

A land cover analysis was conducted to determine the area (ha) of each land use type and to identify the difference in coverage between the following categories: conservation, African Palm, urban development, and agriculture. Land use categories, such as vacation homes and hotel development, were also included in some analyses.

Land cover analysis is key because it helps determine how land cover and the landscape patterns would change under different scenarios. Land cover is a strong indicator of many changes and provides decision makers, planners and researchers information that is necessary to better support and accommodate future changes. For example, land cover data can be used to better understand the following phenomena (USGS, 2012):

- Habitat Loss: Encroaching population accompanied by increased development and consumption of resources could lead to habitat loss.
- Climate: Increasing climate change could significantly impact land cover and the uses associated with it. For example, these types of effects could cause changes to that natural environment that would impact overall biodiversity.
- Management: land cover information could improve land management practices to protect or restore lands.

The previously listed reasons are relevant to all the scenarios, in particular, the Proactive Scenario. The Osa and Golfito region is a leader in conservation with 176,651 ha of tropical wet forests and tropical rainforests (Figure 31). Currently, Costa Rica has a highly diverse biodiversity with 5% of the world's living species (Sanchez-Azofeifa et al., 2002) and 25% of its national territory is reserved for national parks and biological reserves. The areas outside the national reserves are at high risk for "deforestation and habitat fragmentation" as a result of economic pressures. In 1992, Costa Rica's Strategy for Sustainable Development predicted that if trends continued, all "primary forests of commercial timber" would disappear by 1995. However, as a result of Costa Rica's strong conservation efforts, deforestation rates have slowed (Sanchez-Azofeifa et. al., 2002).

LAND COVER LAND USE CHANGE ANALYSES

A series of analyses related to land use and land cover (LULC) change were performed for each scenario. By exploring the anticipated impacts of these changes in land cover, decision makers can use this information to inform their decisions related to land management practices and policies.

The total area (ha) of LULC categories were calculated for 2011 and 2030 scenarios and compared. All analysis was conducted using model builder in Arc GIS 10.1.

Projected future growth (2030)

The total area (ha) of additional growth between 2011 and 2030 was calculated.

Total area of LULC (current + future) (2011+2030)

The total future growth and current land cover area (ha) were added together to determine the total area (ha) per LULC type for 2030.

Change in LULC from 2011-2030

The changes in area (ha) and type of land use/land cover from 2011 to 2030 was determined.

4.1.5 TERRESTRIAL ECOSYSTEMS

Osa and Golfito | Land Cover

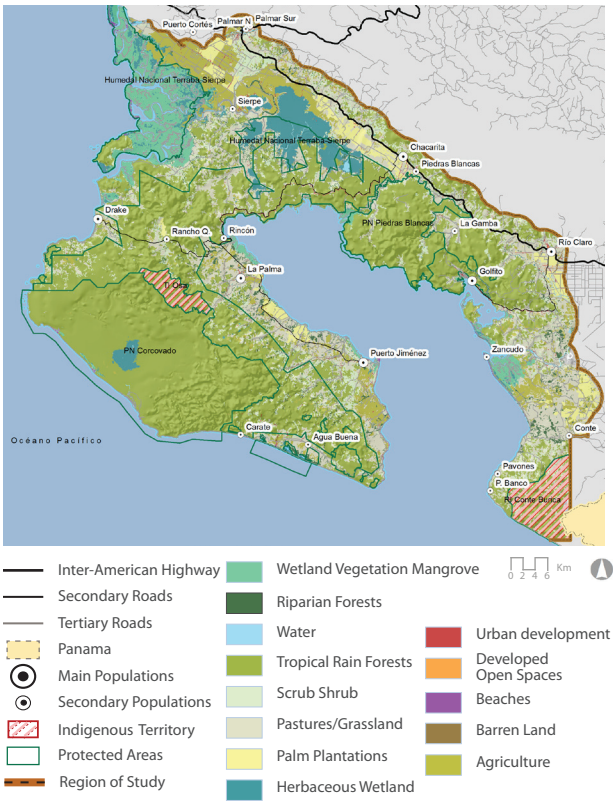


Figure 34. Osa and Golfito land cover (2011)

Osa and Golfito | Land Cover/Land Use Heat Map

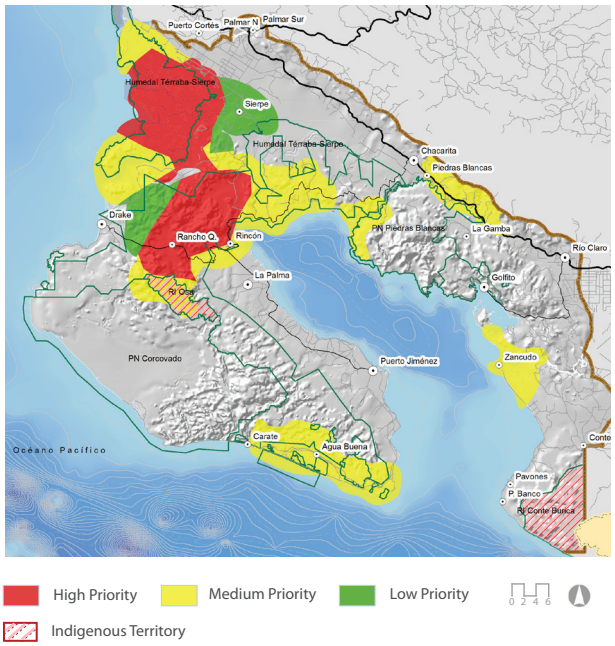


Figure 35. Terrestrial Heat Map (indicates which areas are highly stressed and require attention)

To gain a better understanding of the impact of each alternative future on the terrestrial ecosystems of the INOGO study area, a panel of six experts was interviewed. To begin the evaluation, the experts were given a general description of the current state of the terrestrial ecosystems to serve as a baseline for their discussion.

This scenario evaluation built upon a participatory process undertaken in 2012 to identify the most important threats, conservation priorities, and indicator species for the terrestrial ecosystems in the INOGO study region (see Dirzo et. al). Following are several key points from the interviews with the experts:

1. Poaching continues to be persistent threat in the Osa and Golfito region. Poaching occurs in the region for two primary reasons: 1. Hunting is still a part of the culture in the region. People hunt based on their family tradition and there are poachers in all of the communities in the region. 2. Hunting has increased with the expansion of gold mining in the region. One of the most impacted animals is the *chancho de monte* [white-lipped peccary (*Dicotyles pecari*)].

2. Gold mining is a complex threat, there are unofficially around 500 gold miners in Corcovado National Park (PNC) however the actual number is unknown. In addition to hunting, the gold miners have established yucca and banana plantations in PNC. The high price of gold, at 27,000 colones per gram, is attractive to both miners and to those who provide gold mining equipment to gold miners-for-hire. There are even tunnels and cell phones used in the El Tigre region of PNC to warn miners of park guards entering on patrol.

3. Loss of biodiversity is another key threat in the region. In the last 23 years poachers and gold miners have caused an important decrease in the populations of important indicator species, such as the white-lipped peccary and the jaguar. The species richness of plants and animals is a conservation priority that could be rapidly impacted due to the decrease of the indicator species. For example, this decrease impacts jaguars, which then have a higher propensity to leave the forest to look for prey, increasing the jaguar's risk of being poached. There are also specific tree species which could be affected, such as the yoliyal in Sirena and Sierpe which depend on the white-lipped peccary to disperse their seeds.

4.2

TREND

BUSINESS AS USUAL

The Trend Scenario features the "business as usual" vision of the future. In other words, this scenario shows what happens if the Osa and Golfito region continues along the same path it is now.

In the Trend Scenario we see the following elements:

- Moderate population growth
- Maintenance of existing infrastructure
- Moderate growth in African Palm
- The same conservation strategy-Payment for Environmental Services (PES) as today (High)
- Decrease in agricultural areas
- Moderate growth in tourism (small-scale)
- Construction of the Diquis Dam
- Same education and health infrastructure

4.2.1 TREND | HEALTH

The population growth under the Trend Scenario would lead to an increase in demand for health care services, resulting in longer waits at the existing EBAIS facilities. When a community experiences an increase of population between 2,500 - 4,000 people, new EBAIS teams are added to existing locations. Based on the population growth in this scenario, it is anticipated that between 4 and 6 additional EBAIS teams would be added to the region. However, with an additional increase in tourists, even with additional EBAIS staff, there would be an additional strain put on the facilities, particularly if tourists continue to access the system free of charge.

Urban Growth

The most prevalent health issues (in terms of number of visits to health clinics) in the region are currently caused by parasites and respiratory infections; this is expected to remain the same through 2030. In larger towns, the most prevalent health issues are related to hypertension and diabetes, possibly because they experience these diseases at higher rates, because they have greater access to health clinics, or it can be due to a combination of these factors. The number of visits due to these health conditions is expected to increase with the population growth in the region.

Infrastructure

Although existing infrastructure is maintained in this scenario, transportation challenges still exist due to a lack of bridges, paved roads, and reliable electrical service. These challenges

would continue to be barriers in regards to access to health care and education, as well as employment. Resources such as water would also be taxed, even with a modest increases in tourism, towns that are currently water-stressed, such as Drake Bay and towns south of Zancudo would experience significant water shortages. These changes would affect local populations and ultimately harm the tourism industry. Additional water filtration and wastewater treatment would also require attention in order to best address the projected population growth.

labor required for the Diquis Dam construction there could also be an increase in work-related accidents, which could put a strain on the regional hospitals. Additionally, any effect on water flow and quality could negatively affect community health, and could potentially damage the livelihoods of fishing communities downstream.

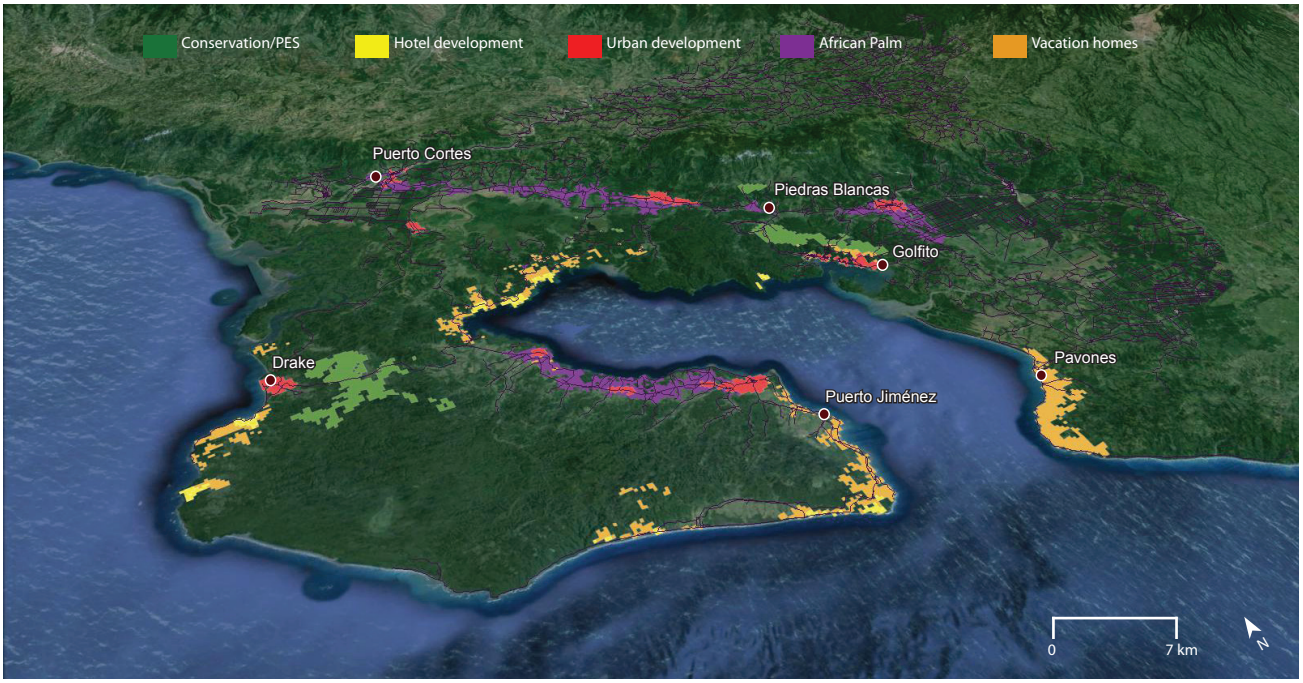


Figure 36. Trend (2030) future growth distribution on satellite imagery using Google Earth bird's eye view

African Palm

A range of impacts on the livelihoods and well-being of the residents in the Osa and Golfito region would be expected with the moderate growth of palm oil plantations. With this expansion comes a loss of other agricultural zones, the region would have even less land available for the production of more nutritious, locally grown, affordable food. A reduction in locally grown food could lead to increases in already high rates of diabetes, hypertension, and cardiovascular disease as people turn to more processed food high in salt, sugar, and fats. Another potential danger that African Palm plantations bring is the misuse of fungicides (*plagicidas*) and other potentially harmful agrochemicals. However, the moderate expansion of palm is expected to result in educational improvements, since it has been observed that families with African Palm plantations provide better educational opportunities for their children.

Diquís Dam

The Diquis Dam, if constructed, could have a significant impact on the livelihoods of many groups in the region. Laborers in the region could find new salaried jobs, which would in turn increase the contributions towards the CCSS. However, due to the construction and the amount of physical

4.2.2 TREND | MARINE

Within the Trend Scenario, spatial marine planning is not taken into consideration. Proceeding under this assumption, conditions would lead to an increase in resource degradation and a surge in conflicts between users. Although this scenario assumes a moderate population growth, the population increase would still place a stress on the marine resources that act as an economic safety net, consistent with current growth rates (fishermen, *piangueros*).

Runoff

The areas that receive the runoff from fields containing pesticides and agrochemicals, such as rice plantations, would be impacted by significant levels of contamination. These areas include the Térraba-Sierpe National Wetland System and the area between La Palma and Puerto Jiménez.

Marine Spatial Planning

Although local efforts have been underway to complete a marine spatial planning process for the region, it has yet to be fully realized. Base inventories have been conducted by the Inter-American Development Bank (IDB-Golfos), and the National System of Conservation Areas (SINAC), while the

MarViva Foundation has developed a methodology behind the marine spatial planning processes. However, marine spatial planning must be undertaken carefully, because if – for example – SINAC establishes a marine management plan for the Golfo Dulce, it could conflict with the Responsible Fishing Area which is run by Costa Rican Institute for Fisheries and Aquaculture (INCOPESCA), which in turn could generate conflict with stakeholders such as National Federation of Artisanal Fishermen's Organization (FENOPEA). Additionally, as part of the planning process it will be key to establish implementation and enforcement standards to help guide future efforts.

Fishing
With increased fishing in the Golfo de Nicoya, it is anticipated that trawlers (approximately 50 shrimp trawling boats) would migrate down to the southern Pacific end and further increase the pressure on local fisheries.

Tourism
Today, Corcovado National Park is already experiencing days when the demands for tourist entries cannot be satisfied. Since all of the scenarios show an increase in tourism for the region, the management of tourism use in the protected areas is a key factor in the future conservation of both land and water resources.

The Trend Scenario has a moderate increase in tourism and lacks the incorporation of land use planning. Considering the funding challenges that SINAC has in the region and the current stress between tour operators and the limitations that SINAC places on park entries, it can be anticipated that this use conflict would continue in the future. With government approved management plans, it would be possible to open additional options within the Golfo Dulce Forest Reserve. However, without proper management and enforcement, this natural resource would degrade, further stressing the relationship between SINAC/Osa Conservation Area (ACOSA) and the communities which rely on tourism. Although the degradation would be less severe than what is projected in the Rapid Growth Scenario, it would still be significant. A strong future in ecotourism in the region needs a strong ACOSA to manage the area and collaborate with communities.

Illegal operations of tuna and sport fishing boats would continue in the Isla del Caño Biological Reserve. This is a persistent conflict with tour operators and fishing boats, who operate with knowledge of the protected area but show little regard for the laws against fishing in these areas.

Narcotrafficking is expected to continue in the Térraba-Sierpe National Wetland System, endangering local communities and impacting the ability for commerce in the region.

4.2.3 TREND | EDUCATION

In the Trend Scenario, current trends in education are expected to continue.

School aged children receive weak preparation from their families, and teachers struggle to compensate for this gap. Also, teachers in one- and two-teacher schools do not have the training required to manage these complex teaching environments.

Attendance
Low preschool attendance, which has been shown to contribute to poor high school outcomes, is prevalent in the region. Preschool attendance is affected by having a dispersed population and lack of land use planning (service allocation). Most children complete Ciclo III (equivalent to 9th grade in the US), but the number who continue on to the next level diminishes significantly, with few students earning their high school diploma or enter university. Only 21% of students who attend school advance on to Ciclo IV (equivalent to 10th - 12th grade in the US).

Among high school students, 44% (2,643) attend a technical high school (CTP), 29% attend a rural high school, and only 6% (343) attend an academic school. A large percentage of students (29%; 1,724) attend night school as a means to complete their high school degrees.

Jobs
Students who graduate from technical schools tend to receive better jobs. The Trend Scenario would mean continued dominance of technical degrees. The scenario would also feature continued growth of the "NiNis" who are students that do not work or study ("ni trabaja, ni estudia") a year after finishing technical high school. Many students complete their high school course work but never take the *bachillerato* exam which is required for graduation. This could be attributed to economic reasons or because they are intimidated by the national universities' application process. In many cases, students justify their decision to finish their high school training but not pursue a job due to the high opportunity cost for studying, since there is no guarantee of employment upon completion.

Resources
In the Trend Scenario, there would continue to be limited access (including to teachers) to computer labs or libraries, which are more common in larger cities. About 50% of secondary schools in the region have libraries, and it seems that the region was not excluded from a larger book distribution by MEP in 2009. In the Trend Scenario, the level of resources provided in the region by the national government would continue.

Transportation
School transportation is sufficient for secondary schools, and the assumption remains that all students can walk to primary school. Children in areas where primary schools are hard to reach by foot would continue to experience great difficulties getting to school.

4.2.4 TREND | LAND USE LAND COVER

Projected future growth (2030)
Table 4 and Figure 37 show the additional area (ha) of future growth that is projected under each LULC category by 2030.

Since agriculture is expected to experience a loss under the Trend Scenario, it is not reflected here. Rather, agricultural land becomes converted to African Palm plantations. It is important to highlight that the agriculture land that is converted under the Trend Scenario potentially would affect the food security and other forms of economic production in the region.

Total area of land cover (current + future) (2011+2030)
Table 5 and Figure 38 show the projected total area (ha) of LCLU for 2030, which includes current conditions (2011) and the addition of any changes in future coverage (2030). These amounts only include four categories (excluding vacation homes and hotel development) because the satellite imagery and remote sensing analysis can only detect the land cover for the region, not the land use. Therefore a comparison cannot be made for land uses such as vacation homes and hotel development.

The most significant change in area, registered by the analysis, is the conservation category with an increase of 4,593 ha. The remaining categories of urban development (+1,683 ha) and African Palm (+3,529 ha) show significant growth as well.

Total area (ha) per LULC category (2030)	
Land Cover/Land Use	Area (ha)
Conservation	4,593
African Palm	3,529
Urban development	1,683
Vacation homes	4,036
Hotel development	563
Agriculture	0

Table 4. Total area (ha) of projected future growth (2030 - Trend)

Total Land Cover (2011 + 2030)			
Land Cover	Existing 2011 (ha)	Additional Growth (2030) (ha)	Total Area by 2030 (ha)
Conservation	176,651	4,593	181,244
Urban development	78	1,683	1,761
African Palm	10,917	3,529	14,446
Agriculture	19,904	0	19,904

Table 5. Total land cover area (ha) (2011 +2030) (Trend)

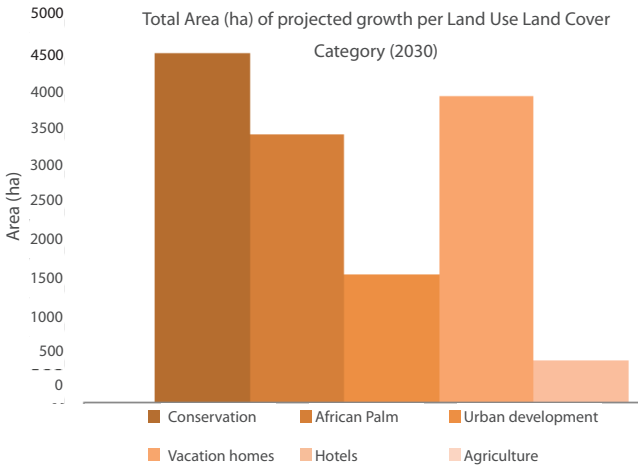


Figure 37. Total area (ha) of projected future growth by category (2030 - Trend)

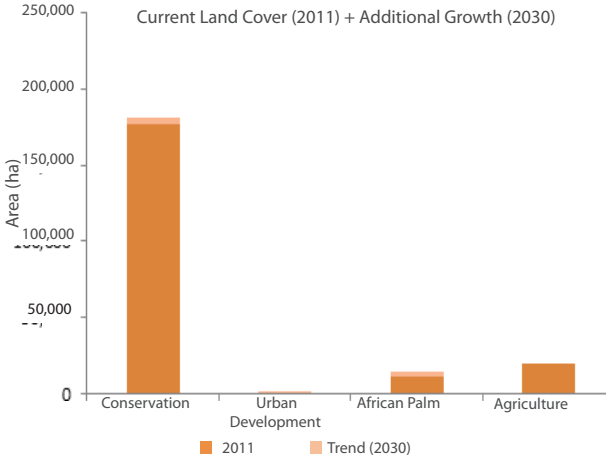


Figure 38. Current and future additional growth (ha) (2011+2030) (Trend)

Land Use/Land Cover Change from 2011-2030					
Land Cover Type (2011)	Conservation (ha)	Urban Development (ha)	African Palm (ha)	Hotel development (ha)	Vacation Homes (ha)
Urban development	2	76	130	3	38
Tropical rain forests	4,186	457	40	426	2,378
Wet forests	10	57	91	3	100
Wetland vegetation Mangrove	0	1	4	0	2
Herbaceous wetland	1	2	5	0	1
Developed open spaces	0	3	20	0	0
Scrub/shrub	93	167	165	34	247
Water	0	1	0	0	6
Pastures/grassland	296	672	1,716	91	1,087
Agricultural land	5	172	464	2	150
Palm plantations	0	60	886	4	18
Beaches	0	6	0	0	9
Barren land	1	7	8	0	0
TOTAL	4,594	1,681	3,529	563	4,036

Table 6. Breakdown of change in land use/land cover types between 2011-2030 (Trend)

Change in LULC from 2011-2030

Table 6 examines the LULC change between 2011 and 2030 (Trend). The table represents the amount of land (ha) and type of land use/land cover in 2030 that is expected to take over current land cover (2011). Agricultural land is projected to become urbanized by other LULC, mostly African Palm (464 ha). Also, large areas of pastures/grasslands and tropical rain forests are projected to become urbanized by several other LULC categories.

4.2.5 TREND | TERRESTRIAL ECOSYSTEM

The Trend Scenario, as shown in Figure 39, would have a moderate impact on the terrestrial ecosystems.

Diquís Dam

The presence of the Diquís Dam would lower the water levels in the Térraba-Sierpe National Wetland System, which would in turn decrease the population of fish, crustaceans, and other animals that depend on the wetland for their development or use it as their primary habitat. The impact on these marine populations would thus have an effect on the fishermen and other people who depend on marine resources.

Biodiversity

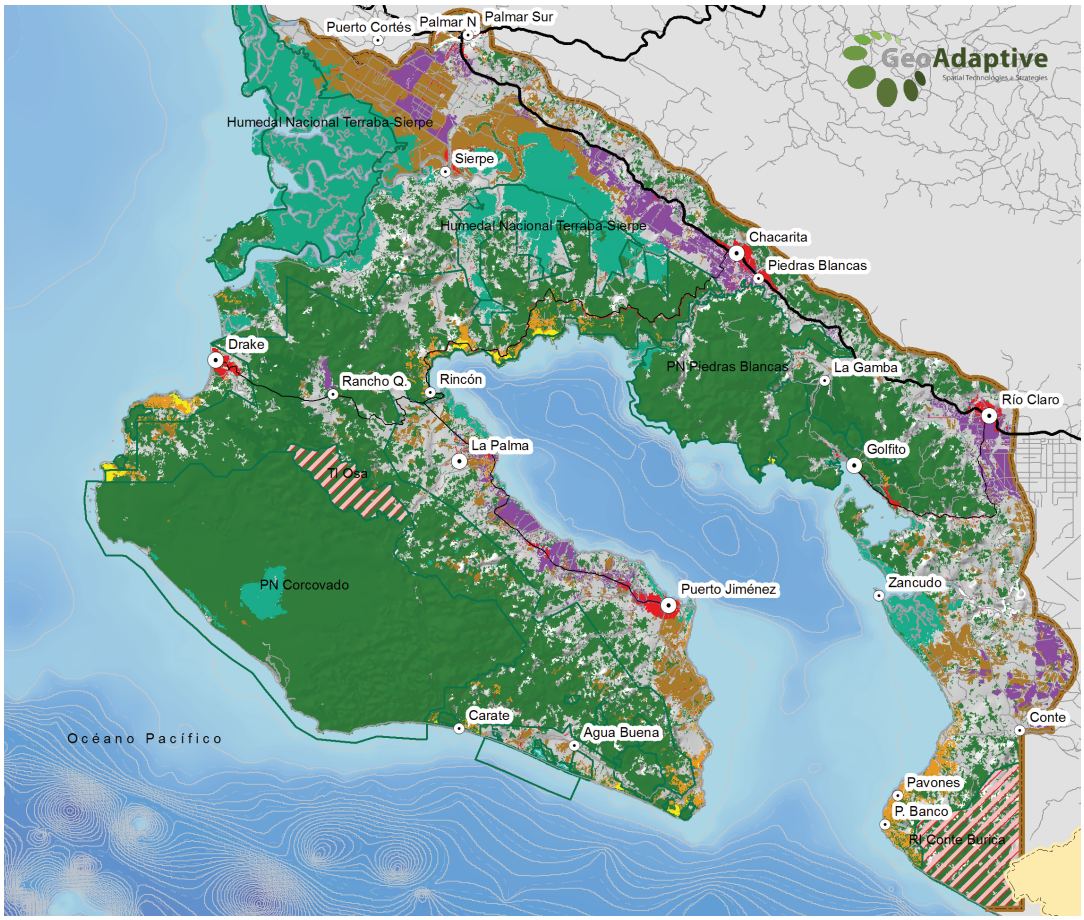
The moderate growth in the number of African Palm plantations would have a negative impact on wildlife because it would reduce the available habitat. For example, the titi monkeys, attracted to the palm plantations as sources of food (such as palm fruit, insects), would risk being captured and/or killed by plantation workers.

The unregulated growth in the tourism sector would represent an increased threat for sea turtles; the potential nighttime illumination from hotel developments would affect and ultimately reduce the number of successful nestings. Similarly, the growth of the human population frequently corresponds to an increase of the canine population. This is also a threat to sea turtles since dogs disrupt turtle nests, eat the turtle eggs and harass the turtles when they are laying their eggs.

Payment for Ecosystem Services (PES)

Not increasing the PES would mean that many local residents would not have the opportunity to take advantage of this program and consequentially pressure would be increased on the surrounding forested areas.

Trend Scenario | 2011 Land Cover + 2030 LULC



Km
0 2 4 8

Inter-American Highway
Secondary Roads
Tertiary Roads
Panama
Main Populations
Secondary Populations
Indigenous Territory
Protected Areas
Region of Study

Bathymetry

50 m line bathymetry
100 m line bathymetry

High: 0
Low: -2439.74

Projected Changes

Conservation/PES
African Palm
Urban development
Vacation homes
Hotel development
Agriculture
Wetland

Figure 39. Current (2011) land cover with Trend (2030) future growth

4.3

RAPID GROWTH

BUSINESS AS USUAL

The Rapid Growth Scenario features a more dramatic rise in population, as well as both additions and improvements to the local infrastructure, including the construction of a international airport

The Rapid Growth Scenario is characterized by the following elements:

- Rapid growth of population
- Minimum conservation/ Payment for Ecosystem Services (PES)
- Agricultural growth
- Rapid growth of African Palm
- Rapid tourism growth (small-scale)
- Construction of the Diquis Dam and the international airport
- Education and health infrastructure remains the same

4.3.1 RAPID GROWTH | HEALTH

In the Rapid Growth Scenario, the increase in population would required an additional 4 to 6 EBAIS teams, concentrated in those areas with the highest population increases or where an EBAIS could be strategically placed to meet the changing population distribution. Even with these additional EBAIS teams, it is anticipated that the wait time at the health care facilities would increase.

Infrastructure

The pavement of roads and addition of bridges would ease the travel time to health service facilities for those communities where access is limited by a lack of regional infrastructure. This infrastructure improvement would be especially important for emergency care, where travel time can greatly impact the health of a patient. The infrastructure upgrades would also improve the general access to health care provided by the CCSS.

The expansion of the electric service can have positive impacts upon the local health of the population, both in terms of disease prevention and general well-being. Families with access to electricity can boil water (purify) for drinking and cooking and children can do homework at night.

Figure 40. Rapid Growth (2030); Future growth distribution on satellite imagery using Google Earth bird's eye view

The construction of an international airport in the region would result in an increase in noise, light, and other sources of pollution. These disturbances would affect health and quality of life of both humans and the biodiversity of the region, primarily for those near the airport. However, the introduction of a new airport could also provide additional regional security, and as a means of evacuation and medical help during large emergencies.

Agriculture

With an increase in the diversity of the agricultural production and the availability of locally grown affordable food, the nutritional security of the region would increase. These improvements would influence local rates of diabetes, hypertension, and cardiovascular disease; thereby improving overall quality of life and reducing the strain on the national health care system due to the continuous treatment for these chronic diseases.

Tourism

The increase in tourism in the Rapid Growth Scenario would impact the health care system in the region in a number of ways. Increased tourism could place a greater strain on the provision of health services from the CCSS. Tourists who require medical attention receive care free of charge from the CCSS due to the lack of structure that would allow tourists to pay for services. However, a growth in the tourism sector, or any other improvements in the formal economy, would mean an increase in jobs and ultimately and increase in the number of residents contributing to the CCSS.

Conservation

Additional conservation efforts in the region would greatly help protect the water security for some communities in the region. The significant increase in a healthy forest cover can help support the water cycle and water can be properly filtered through these lands and become available for communities downstream. However, due to the increase of agriculture and population in this scenario, there would also be a corresponding increase in the demand for water. This expanded need for water could be met in some places through communication and collaboration between upstream and downstream communities. For example, the watershed located in the Punta Burica Indigenous Reserve contains the water sources that currently serve the Punta Banco and Pavones communities. This could potentially create an opportunity for indigenous communities to negotiate compensation in return for allowing controlled access of water to those downstream communities.

These same factors that foreshadow an increase in demand for water also highlight the need for wastewater treatment. An increase in population, dense development, and tourism activity highlight the vital need for wastewater treatment to ensure the health of local populations, tourists, and the marine environment.

4.3.2 RAPID GROWTH | MARINE

Infrastructure

The proposed international airport would bring an increase in transit to Rio Sierpe. If the road from San Juan – Chocuaco

– Puerto Jiménez is paved, this would significantly reduce marine transit. With the airport and the anticipated increase in tourism, the sport fishing sector is expected to grow, as well as other tourism activities that use and rely on the marine resources.

With increased development and agriculture around the Térraba-Sierpe National Wetland System (HNTS), sedimentation in the wetland is expected to increase. Changes in land ownership in the northernmost part of the study area, perhaps with more coastal lands being concessioned by developers would lead to a displacement of local fishermen and local piangueros. There are concerns that this would occur in places such as Dominicalito, Isla Garza, and Playa Tortuga.

Marine Spatial Planning
No marine spatial planning would be conducted in this scenario, but it is possible that there would be additional degradation of the resources and an increase in conflicts between users. There is an increased pressure on the local fisheries, which would impact some of the most vulnerable residents in the region. Pingueros work in the Térraba Sierpe Estuary and in the mangroves near Golfito, if these areas are increasingly contaminated by agriculture, their social safety net would be greatly impacted.

Tourism
Today, Corcovado National Park is already experiencing days when the demands for tourist entries cannot be satisfied. Since all of the scenarios show an increase in the tourism in the region, the management of tourism in the protected areas is a key factor in the future of conservation on both land and water.

The Rapid Growth Scenario shows a lack of land use planning and a steep increase in tourism, leading to the speculation that tourism could place additional pressure on the protected areas and create areas of conflict, with potential degradation to the resource.

4.3.3 RAPID GROWTH | EDUCATION

In the Rapid Growth Scenario the observed trends concerning limited preschool access would likely to continue, which contribute to lower lifetime academic achievement. A contributing factor to this trend is the lack of land use planning and a dispersed population. Additional information is needed to understand how this challenge would be solved, but it seems clear from the planning procedures from the Ministry of Public Education (MEP) that a sprawling population is less likely to receive allocated resources.

Infrastructure
With infrastructure improvements, access to education is expected to improve by 2030. However, there are still remaining issues with infrastructure quality and crowding at schools.

Population Increase
The provision of educational services would not be problematic when faced with a population increase, however this would require additional government funding.

Education outcomes are hard to predict. While MEP's resources are allocated based on the number of children in a particular region, low population density does not allow for the development of strong school networks. A significant change in density would drive the reorganization of schools, while continued sprawl would probably exacerbate existing challenges.

A huge cultural shift would be required to better prepare children for school and to support studying at home. This change would most likely be related to the development of a job sector that validates the value of educational training, which can help students achieve better outcomes and lead towards a well paying job after school. This change would have to rely on family and community involvement, as well as the collaboration of regional and national development efforts.

4.3.4 RAPID GROWTH | LAND USE LAND COVER

Projected future growth (2030)
Table 7 and Figure 41 show the additional area (ha) of future growth that is projected under each LULC category by 2030.

Projected growth under the Rapid Growth Scenario shows that African Palm experiences significant increase (+21,091 ha), as does the agricultural land (+15,417 ha).

Total area (ha) per LULC category (2030)	
LULC	Area (ha)
Conservation	876
African Palm	21,091
Urban development	4,111
Vacation homes	4,358
Hotel development	1,605
Agriculture	15,417

Table 7. Total area (ha) of future growth (2030-Rapid Growth)

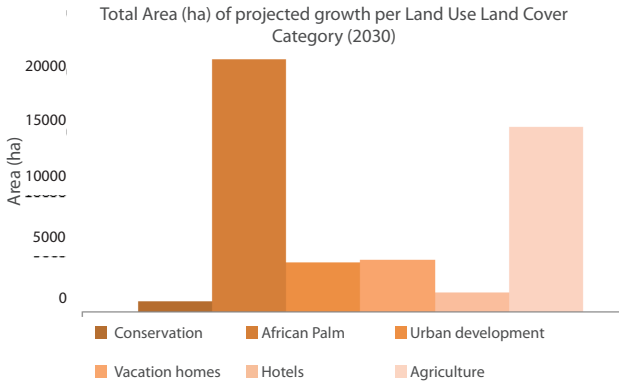


Figure 41. Total area (ha) of projected future growth by category (2030-Rapid Growth)

Total Land Cover (2011 + 2030)			
Land Cover	Existing 2011 (ha)	Additional Growth (2030) (ha)	Total Area by 2030 (ha)
Conservation	176,651	876	177,527
Urban development	78	4,111	4,189
African Palm	10,917	21,091	32,008
Agriculture	19,904	15,417	35,321

Table 8. Total land cover area (ha) (2011 +2030) (Rapid Growth)

Figure 42. Current and future additional growth (ha) (2011+2030) (Rapid Growth)

Total area of LULC (current + future) (2011+2030)

Table 8 and Figure 42 show the projected total area (ha) of land cover for current and Rapid Growth conditions by 2030. The total area represents the current 2011 land cover area in addition to future land cover (2030). These amounts only include four categories (excluding vacation homes and hotel development) because the satellite imagery and remote sensing analysis can only detect the land cover for the region, not the land use.

For the Rapid Growth Scenario, conservation represents the largest (ha) land cover while development represents the smallest (ha). When comparing the three scenarios explored, the Rapid Growth Scenario results in the most changes to the land cover structure and in the provision of ecosystem products and services. It also presents the most intense transitions, which can represent those conditions that would be the most difficult to reverse. This scenario is also characterized by a rapid population growth and an intense use of resources due to rapid tourism growth. The scenario draws from an economic model that discriminates the provision of resources to secure livelihoods.

Change in LULC from 2011-2030

Table 9 examines the urbanized land use/land cover between 2011 and 2030. In other words, it analyzes the changes between the current land cover (2011) and the expected (2030) land cover in terms of amount (area in ha) and type of coverage. Under the Rapid Growth Scenario, several land covers such as pasture/grassland (8,148 hectares) and

Land Use/Land Cover Change from 2011-2030						
Land Cover Type (2011)	Conservation (ha)	Urban Development (ha)	African Palm (ha)	Hotel Development (ha)	Vacation Homes (ha)	Agriculture (ha)
Unclassified	0	0	21	0	0	12
Development	0	38	234	14	28	94
Tropical Rain Forests	869	1,952	520	1217	1760	924
Wet Forests	0	95	698	6	263	593
Wetland Vegetation Mangrove	0	4	22	2	3	24
Herbaceous Wetland	0	11	48	2	2	70
Developed Open Spaces	0	2	29	0	1	11
Scrub/Shrub	3	383	1,068	70	352	922
Water	0	16	54	6	6	34
Pastures/Grassland	4	1,214	8,148	264	1,314	7,087
Agricultural Land	0	186	7,541	16	393	3,173
Palm Plantations	0	198	2,559	6	176	2,348
Beaches	0	3	19	2	6	10
Barren Land	0	9	123	0	1	95
TOTAL	876	4,111	21,084	1,605	4,305	15,397

Table 9. Breakdown of change in land use/land cover types between 2011-2030 (Rapid Growth)

agriculture land (7,541 hectares) are converted to African Palm plantations. Additional pasture/grasslands are also projected to become agriculture (7,087 hectares) land.

4.3.4 RAPID GROWTH TERRESTRIAL ECOSYSTEM

The Rapid Growth Scenario reflects a lack of land use planning and a steep increase in tourism, which could lead to conflicts between protected areas and the tourism sector, and the potential degradation of the surrounding natural resources.

The scenario captures significant and rapid economic improvements with the increase of African Palm plantations, the production of other agricultural goods, the growth of tourism and improvements in local infrastructure such as the construction of the Diquis Dam and the international airport. However, the environmental cost of this scenario is projected to be very high.

In particular, the local terrestrial ecosystems would be affected by the uncontrolled growth of the African Palm plantations, agricultural use, new infrastructure, tourism activity, etc. These changes, as represented in the map in Figure 43, would have the following direct impacts:

Biological Corridors
The Rapid Growth Scenario is expected to disrupt biological corridors, significantly impacting connectivity. This would place additional pressure on species like jaguars, which require large areas of habitat for their survival. Specifically, the development in the region between Rancho Quemado and Drake Bay would result in a significant loss of ecological connectivity. The loss of habitat from deforestation, especially on the coast of the Golfo Dulce, would have extensive negative impacts on the local flora and fauna.

Sedimentation
The increase in erosion due to the loss of forest cover in areas of higher elevation of the Osa Peninsula would bring large quantities of sedimentation into the Golfo Dulce affecting the marine environment.

Fluctuations of the water level in the Térraba-Sierpe National Wetland System would lead to changes in the quantity of fish and other animals that depend on this habitat as part of their life cycle.

Economic Growth
The economic growth in all sectors would be unequal and unregulated. For example the growth in employment may not be sufficient to meet the local needs, which could lead to an increase of illicit activities such as mining, poaching, trafficking of wild animals, and illegal logging.

It is also important to mention that this scenario does not include any improvements to the services in the region such as health and education.

Land Use Planning
Without the implementation of land use planning, advancements cannot be made to address issues related to climate change. The growth in the population and of the economy would both produce larger quantities of waste (solid and waste water) and increase the demand for water. The development as shown in this scenario would have an overall negative impact on the visual and environmental conditions of the region.

Rapid Growth | 2011 Land Cover + 2030 LULC

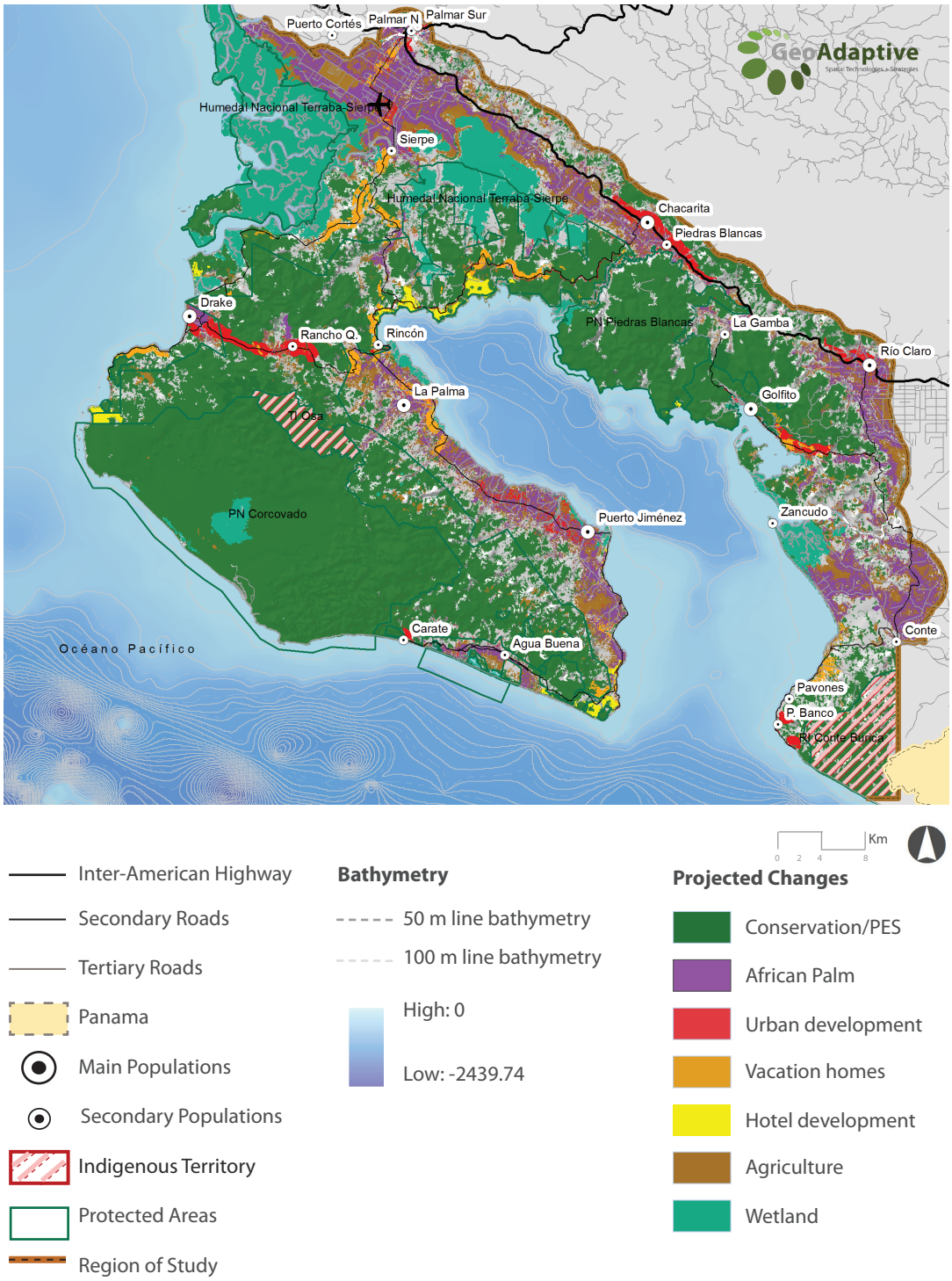


Figure 43. Current (2011) land cover with future Rapid Growth (2030)

4.4

PROACTIVE

ILLUSTRATING LOCAL PRIORITIES

The Proactive Scenario features a growth in population that reflects current trends and has a primary focus on the sustainable growth and conservation of the region.

The Proactive Scenario was constructed based on the feedback from members of the Osa and Golfito communities as well as leaders in the region. This option is the reflection of the optimal scenario for those who were consulted, however these elements would most likely not happen without significant coordinated efforts to create this type of change.

The Proactive Scenario is characterized by the following elements:

- Normal growth in population
- High Payment for Ecosystem Services (PES)
- Increased diversity of agricultural productivity
- Rapid tourism growth
- Regional airport (without the construction of the Diquis Dam)
- Improvements in infrastructure (i.e. roads, bridges and electricity) (accessibility and quality)
- Upgraded and improved infrastructure for education and health

4.4.1 PROACTIVE | HEALTH

Population Increase

The population increase in the Proactive Scenario assumes an additional 24,000 people. This increase would require the addition of 6 to 8 new EBAIS teams to provide health care services to the local population. Along with the infrastructure upgrades that would improve health care access to existing communities, the population increase would likely lead to longer lines at existing EBAIS locations. The increased infrastructure would also improve access to emergency care, with faster travel times on paved roads and an increased ability to travel across rivers during the rainy season due to the addition of bridges.

The existing stress already being felt on current water supplies would be significantly exacerbated by the compounding factors of agricultural expansion, infrastructure improvements, population growth, and the growth of the tourism sector. These factors and changes in the environment would result in a fragmented environment, limiting the filtering opportunities of fresh water sources,

as well as an increase in pesticides/insecticides use which would eventually end up in the water cycle. Challenges with wastewater would be anticipated in areas of high population concentrations, and could result in significant impacts on the marine ecosystem if the wastewater is not treated. Similarly, untreated wastewater would negatively impact the tourism industry, and the health of the local population.

CCSS, which would help compensate for the increase in use. However this relies on the assumption that the centralized CCSS funds would be distributed back into the region.

Infrastructure

With large infrastructure projects such as the improved regional airport, there could be an increase in construction

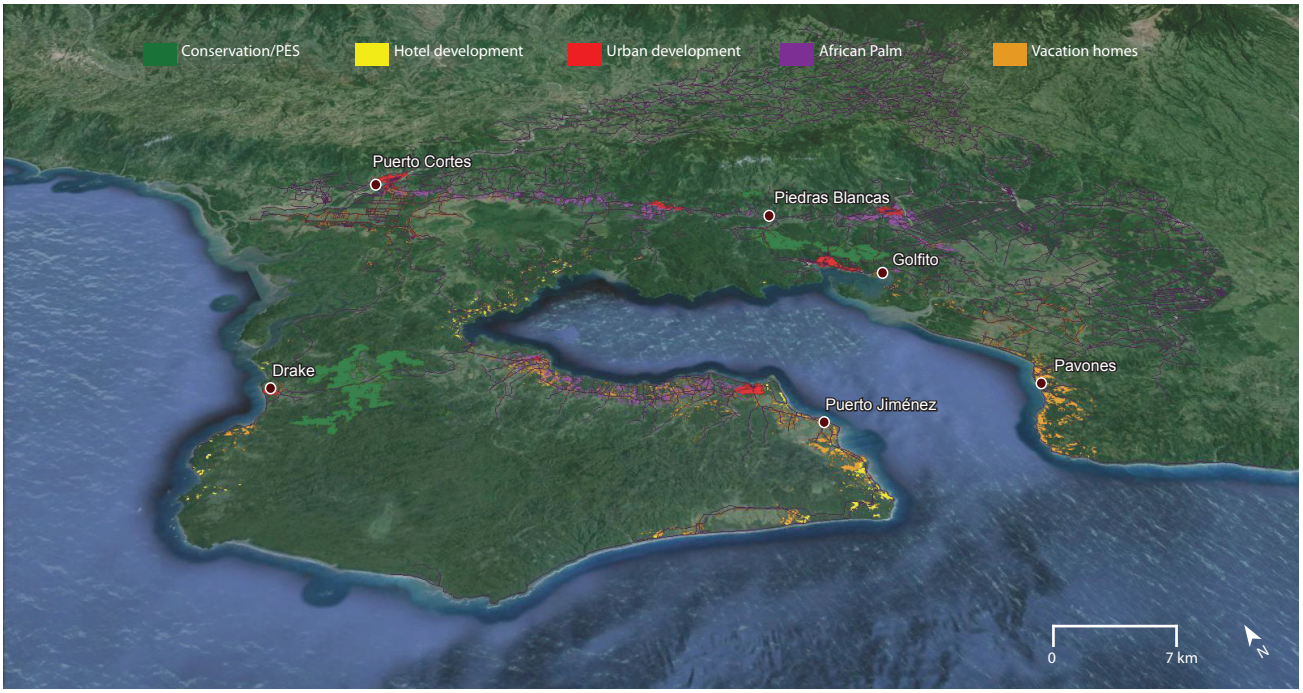


Figure 44. Future Proactive Growth (2030) distribution on satellite imagery using Google Earth bird's eye view

Access to fresh water would also be a significant challenge, especially for those communities already experiencing water stress. Without fresh water, both agriculture and tourism - two of the key sectors of the local economy - would suffer. Increased resources would need to be dedicated to the filtration of water, most likely these would need to come from local funds. For those communities living downstream from indigenous territories, negotiations would need to be undertaken to secure access to additional to water.

Palm Plantations

The increase of palm plantations on agricultural land used for staple crops would threaten the food and nutritional security of the region. This change would also cause additional health problems (chronic conditions) within those families who have sold their farmland to palm growers as they take on a more sedentary lifestyle. However, families who grow African Palm tend to provide better educational opportunities for their children, so improved school attendance could be one outcome of the expanded palm plantations.

Tourism

With a expansion of the tourism market, the CCSS would be further strained in the region because tourists are able access care, but the mechanisms to pay for the services are not in place. Conversely, additional salaried jobs in the region would mean greater monthly contributions to the

related accidents, putting additional pressure on the CCSS. Unregimented construction projects would also significantly impact the water quality near their construction, as well as downstream in the Térraba Sierpe Estuary. Both water quality itself and the negative impacts on the marine ecosystems would have a negative impact on the health and the well-being of local populations. Noise, light pollution, and other effects from projects such as the airport would also impact quality of life. However, with the improved airport capacity, there would also be increased access for those with medical emergencies to be flown out of the region.

4.4.2 PROACTIVE | EDUCATION

Access to preschool directly correlates to higher high school graduation rates. Land use planning would help concentrate populations and provide more access to preschools, which can also encourage overall higher school attendance.

It has been announced that a satellite campus for Costa Rica's Technological University (the Techonológico de Costa Rica) could be located on the peninsula. If this happens, in addition to an offering of well-selected majors for students, it would cause a significant improvement in the level of employment for young people in the region.

The Ministry of Education, in cooperation with the Omar Dengo Foundation (FOD), would also work to bring computer literacy to all students in Costa Rica.

The increase in population could have both a negative and a positive impact on the education outlook of the region. Assuming that more resources are dedicated to the region, children would ultimately benefit, as larger budgets bring diverse offerings and the possibility of more specialized and technical education. For example, in response to the need of the sustainable management of marine resources, educational offerings could include curriculum improvements such as the implementation of the National Marine Education program. Also, under a Proactive Scenario education, teachers and administrators could rely on a stronger support network within schools and among regional schools. However, if population increases without strategic improvement to the education system, the quality of education could actually decline.

Transportation in the region would improve with infrastructure upgrades such as paved roads, bridges, and electrification, facilitating the consolidation of many smaller schools into larger schools with better infrastructure. In fact, this process has already begun, albeit informally, with the new Escuela San José de Golfito, which is attracting students from as far away as Rio Claro. However, a barrier towards this change includes the need to ensure job security for teachers. Additionally, teachers who operate single-teacher facilities (*escuelas unidocentes*) do not receive training for classroom management techniques, making the overall education experience in these schools challenging for both teachers and students.

In the Proactive Scenario, vocational high schools (*colegios técnicos professionales*) would be equipped with the appropriate tools to better predict future market conditions and improve the rate of employment upon graduation. Furthermore, schools can also identify which areas of study should be taught, and which areas might need to be phased out.

4.4.3 PROACTIVE | MARINE

Marine Policies

The Proactive Scenario considers an enforcement of marine policies. This is based on two assumptions: that the state has long term funding to undertake this effort, and that civil society continues their support for the marine planning processes. A proactive perspective could envision the continued to advancement of marine spatial planning including the protection of the area from HNTS to Isla del Caño to Rio Oro and the probable creation of a Marine Protected Area (MPA), aiming to control, if not eliminate, trawlers in this region. Adequate and balanced policies for an MPA would be beneficial to artisanal fishermen in the multiple fishing communities. In terms of tourism activities, tour operators who run diving, snorkeling, and whale watching trips would also view this change favorably, as the trawling deteriorates marine resources. However, working to remove the trawlers could have two negative outcomes – the trawlers could either rely on their political influence to avoid the measure, or once they are removed they would merely find another place to fish, displacing the issue to another area.

Lastly, the Proactive Scenario considers a comprehensive perspective of the management of marine resources by increasing coordination with the enforcement of marine protection policies on land. Under this approach, activities taking place on the land generating erosion and pollution would be penalized and their effects considered in further marine planning efforts. This would require inter-institutional coordination and a carefully designed monitoring procedure that would assist management and policy makers in enforcing these considerations.

Térraba-Sierpe National Wetland

In the Proactive Scenario, the increase in perceived and actual value of the ecosystem services associated with the Térraba-Sierpe National Wetland (HNTS) would trigger more coordinated management of resources. Management efforts could include monitoring and reducing emissions from deforestation and forest degradation (REDD+). Forever Costa Rica is also putting together a satellite monitoring and patrolling program, which would be run by the Coast Guard. Enforcement led by such a program would have a very significant impact on the marine environment of the region.

Under the Proactive Scenario, groups like the Party for Accessibility without Exclusion (PASE) could explore the potential for policies that would allow the HNTS to have concession zones for artisanal fishermen, modeling the concession after the Tarcoles case. This type of concession needs to be studied carefully, in order to understand the full legal and political limitations and ramifications. Concession models in other countries could also be studied to better understand lessons learned.

Fishermen's Associations of the HNTS are exploring the possibilities of engaging in ecotourism. Thus, under the Proactive Scenario, the transition to a tourism model, as a means to reduce fishing within the HNTS, could be an important shift and as an added benefit would help reduce the pressure on current fisheries. This change would also bring socioeconomic improvements to the fishing communities. In order to develop successful ecotourism businesses in this area, training and capacity building would be undertaken. One opportunity for the promotion of ecotourism would be to work with the fishermen who are already collaborating with scientific investigations, and would be interested in learning more about the different species in the HNTS and their biological processes.

Forever Costa Rica Program

The Proactive Scenario would include the attainment of the goals of the Forever Costa Rica program. This program defines conservation objectives according to three important thematic areas related to the Work Plan for Protected Areas and the UN Convention on Biological Diversity. This program used GRUAS as a starting point.

The diversification of activities and the development of tourism alternatives would represent an important component of the Proactive Scenario. Alternative destinations, proactive policies and the decentralization of tourism activities away from the traditional resources would help reduce unsustainable pressures on certain sites which would be exceeding their carrying capacity (such as Drake Bay).

Security

Security is an important component of the future of the marine resources of the region. Certain sectors of the HNTS are used by narcotraffickers, and in general – according to opinions shared during the scenario workshops – there is a frequent presence of narcotrafficking boats in the southern Pacific. Local capacity could be improved to allow and encourage local actors to play a stronger role in the generation of solutions to this challenge. For instance, tour operators in Ballena, Drake, and the Golfo Dulce have expressed an openness and desire to participate in a network for monitoring and reporting illegal fishing and narcotrafficking. However, the death of Jairo Mora (May 31, 2013, in Limón) shows that the community's role in vigilance against narcotraffickers can only be strong when citizens are protected and supported by their national justice system.

Jobs

Resources that are more clearly managed between groups would have less conflict. There is a need for a more diverse job market and productive alternatives for the local population. The challenges of job diversification are connected to education. There is a need to improve the diversification of education, as well as increase the school's ability to train the youth for local jobs that secure adequate wages.

Tourism

Today, Corcovado National Park is already experiencing days when the number of allowed visitors is surpassed. Since all of the scenarios show an increase in tourism in the region, the management of tourism in the protected areas is a key factor in the future of conservation on both land and water.

The Proactive Scenario considers a series of planning procedures and regulations that would secure a more equitable and sustainable future. One important consideration would be to incorporate carrying capacity of the national parks and marine areas into urban planning and other regulations.

4.4.4 PROACTIVE | LAND USE LAND COVER

Projected future growth (2030)

Table 10 and Figure 45 show the additional area (ha) of future growth that is expected to be projected under each LULC category by 2030.

Projected growth under the Proactive Scenario shows that conservation (57,533 ha) and African palm (5,088 ha) land uses experience significant growth. The Proactive Scenario includes an additional 7,000 hectares/year of PES, in addition to GRUAS II. Therefore, the majority of the area is within conservation areas. The Proactive Scenario also includes a large amount of development, with the addition of a regional airport and additional road upgrades. With the implementation of sustainable practices and policies under this scenario, this shows that conservation management is necessary to maintain the biological corridors in order to protect species and their habitats.

Total area of LULC (current + future) (2011+2030)

Table 11 and Figure 46 show the total area (ha) of land cover for current and Proactive Scenario (2030). This only includes four categories (excluding vacation homes and hotel development) because the remote sensing for 2011 only detects land cover and not land use, so a comparison cannot be made for vacation homes and hotel development.

The most significant change in area is the conservation

Total area (ha) per LULC category (2030)	
Land Cover/Land Use	Area (ha)
Conservation	57,533
African Palm	5,088
Urban development	1,520
Vacation homes	4,503
Hotel development	920
Agriculture	4,707

Table 10. Total area (ha) of projected future growth (2030-Proactive)

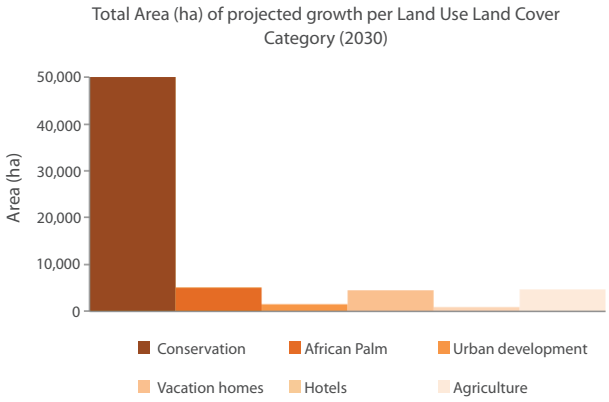


Figure 45. Total area (ha) of projected future growth by category (2030-Proactive)

Total Land Cover (2011 + 2030)			
Land Cover	Existing 2011 (ha)	Additional Growth (2030) (ha)	Total Area by 2030 (ha)
Conservation	176,651	57,533	234,184
Urban development	78	1,520	1,598
African Palm	10,917	5,088	16,005
Agriculture	19,904	4,707	24,611

Table 11. Current and future additional growth (ha)(2011+2030) (Proactive)

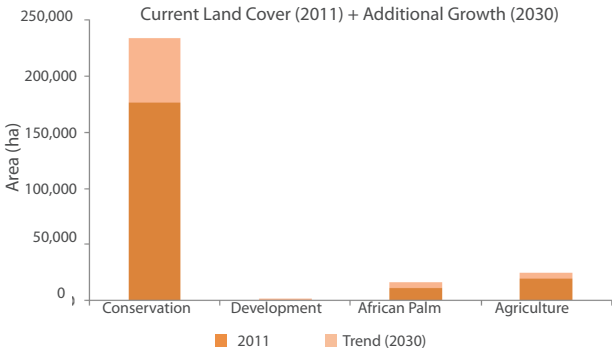


Figure 46. Total land cover area (ha) (2011+2030) (Proactive)

use with an increase of 57,533 ha. This is the result of the application of the GRUAS II under this scenario.

Change in LULC from 2011-2030

Table 13 examines the change of land use/land cover between 2011 and 2030. In other words, it analyzes the changes between the current land cover (2011) and the expected (2030) land cover in terms of amount (area in ha) and type of coverage. Under the Proactive Scenario, several land cover types are converted to conservation: tropical rain forests (21,249 ha), pasture/grassland (9,828 ha), herbaceous wetland (8,341 ha), and wetland mangrove forests (8,619 ha). Development on the other hand converted land covers such as: pasture/grassland (767 ha) and agriculture land (236 ha).

4.4.5 PROACTIVE | TERRESTRIAL ECOSYSTEM

This scenario presents the most favorable conditions for the terrestrial ecosystems in the Osa and Golfito region. The Proactive Scenario includes planned development, with the implementation of Regulatory Plans. Economic growth is shown to benefit from a diversification in agricultural production and the growth of tourism on a smaller scale. This scenario depicts economic activities that are most well suited for each location.

Connectivity

It is important to note that while this scenario allocates the most land to the conservation of terrestrial resources, important connectivity between critical habitats is lost, such as the area between the Térraba-Sierpe National Wetland System and the forest. There also appears to be a break between the Piedras Blancas National Park and the Osa Biological Corridor and between the areas from Conte to Punta Burica.

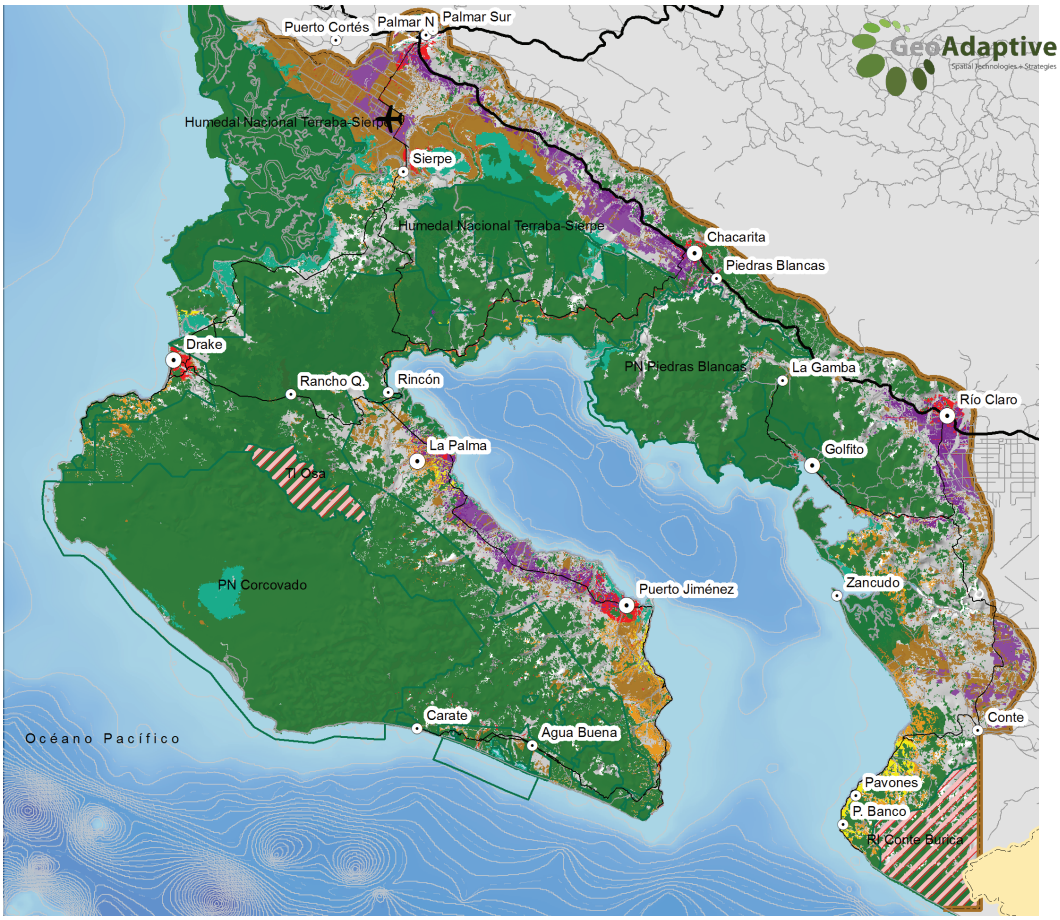
Improvements

This scenario also includes improvements in the education and health sector, and the promotion of PES (payment for ecosystem services) for biodiversity projects, both of which are important for climate change adaptation and mitigation.

Land Use/Land Cover Change from 2011-2030						
	Conservation	Urban Development	African Palm	Hotel development	Vacation homes	Agriculture
Development	107	88	189	2	48	32
Tropical Rain Forests	21,249	70	50	56	224	13
Wet Forests	667	27	101	3	52	44
Wetland Vegetation Mangrove	8,619	1	2	0	3	1
Herbaceous Wetland	8,341	2	3	0	4	3
Developed Open Spaces	0	4	31	0	0	0
Scrub/Shrub	2545	187	377	130	601	184
Water	704	2	0	2	7	3
Pastures/Grassland	9,828	767	2,612	581	2,307	1147
Agricultural Land	1,461	236	744	118	678	2,156
Palm Plantations	279	94	906	13	21	473
Beaches	57	5	1	2	13	2
Barren Land	35	11	12	0	3	4
TOTAL	53,892	1,494	5,028	907	3,961	4,062

Table 12. Breakdown of change in land use/land cover types between 2011-2030 (Proactive)

Proactive | 2011 Land Cover + 2030 LULC



Km
0 2 4 8

Inter-American Highway
Secondary Roads
Tertiary Roads
Panama
Main Populations
Secondary Populations
Indigenous Territory
Protected Areas
Region of Study

Bathymetry

50 m line bathymetry
100 m line bathymetry
High: 0
Low: -2439.74

Projected Changes

Conservation/PES
African Palm
Urban development
Vacation homes
Hotel development
Agriculture
Wetland

Figure 47. Current (2011) land cover with Proactive (2030) future growth

Visual Preference Survey

5.0 Visual Preference Survey

5.1 MOTIVATION

A significant portion of the economy of Osa and Golfito is fueled by tourism and development activities that capitalize on the visual amenities provided by its natural and traditional landscapes. As with many other leisure-based economies, this region thrives by marketing and finding ways to monetize access to these amenities (for example, with tourism services and developments with magnificent views to the natural landscape). The region of study lies in an exceptional landscape of high visual quality, which drives a cultural and natural identity, and in many ways supports a higher quality of life. Despite the importance of these visual attributes, the visual integrity of the landscape of Osa and Golfito is threatened by land use changes, such as increased deforestation associated with agriculture, cattle ranching, palm plantations, and by development which is changing in character and intensity.

Knowing which aspects of the landscape are valued by both local residents and visitors to the region can provide important guidelines for identifying instruments and actions to protect its visual landscape. To do this, a visual survey was designed to capture how people value the landscape and the conditions that determine their visual preference. The survey results were used in this study to explore the differences in visual preferences from residents and visitors alike, acknowledging the region's needs to reconcile both preferences to continue on a sustainable path.

5.2 VISUAL SURVEY DESIGN

With these goals in mind, GeoAdaptive designed a survey to capture those visual preferences. The survey employed a set of photographs and questions presented to groups of both residents and visitors. The first part of the survey was the ranking of the visual preferences. The same content and procedure was used for both groups. Interviewees were asked to score (from 1 to 5) a set of 60 pre-prepared photographs. The higher the score, the greater preference they have for the landscape in that photo. These photographs captured and represented different conditions of the regional landscape, from fully developed scenes to pristine natural landscapes. Initially, over 450 photographs were taken by our surveyors from various locations throughout the project region. 50 pictures were selected using criteria designed to ensure representation of 33 characteristic conditions present in the project region, which are listed in Table 13. These selected 50 photographs represent all the land use and land cover types in the INOGO Geographic Information Systems database. The photographs were cleaned up, retouched and reformatted, aiming to maintain the same conditions in terms of weather, depth and composition. Furthermore, ten additional photographs were modified using an image-enhancing program to depict potential future changes in the region captured in the Trend, Rapid Growth and Proactive Scenarios (e.g. more development in pristine coastal zones, reforestation and conservation efforts, or more aggressive and intense tourism development in the urban centers). Two examples are provided in Figure 48. Finally, a unique "identifier code" (#1 to 60) was assigned to each photo and written on the back of each picture. These coded pictures were then provided to the field agents to conduct the interviews.

Figure 48. Two examples of modified photos

Land use, land cover and landscape conditions captured in survey pictures	
Residential • High income/second home • Middle income • Poor/low income • Informal • Traditional • Modern Commercial – main street • Traditional • Abandoned • Outside development (ie.. McDonalds) Industry • Duty free zone Agriculture • Forestry • African Palm Ranching • Ranchland/cattle • Overgrazing Tourism • Resorts • Eco-lodges	Conservation • Dense forest/untouched • Deforestation Cultural/Historic Spheres • *Esferas Indígenas* Gulf/Bay • Gulf-preserved • Cruise lines • Port • Marine-overcrowded Beach • Natural • Overdeveloped (Acapulco) Dump/informal River • Clean • Polluted Aerial • Conditions as is • Dense • Very dense

Table 13. 33 characteristic conditions present in the project region

The second part of the survey was based on two questions. One was designed for residents and one for visitors. Interviewees were asked to select a specific number of photographs from the previous collections that represented their expectations or hopes for the future of the region. An outline of the survey presented to each group is provided in Figure 49 and Figure 50.

CONDUCTING THE SURVEY

The first part of the visual survey was conducted by asking interviewees to rank the set of 60 photographs from least to most visually preferable. The sorting and raking of the photographs took place on a table large enough to sort the full set of pictures.

Interviewees were asked to evaluate their relative preferences for the views in the given photos through a free-form process. As shown in the following pictures (Figure 52), each interviewee received a randomly ordered set of the 60 photographs, and were asked to place them on the table in 5 piles, from most preferred to least preferred. The pictures were then organized in a normally distributed set of piles in the following configuration (Figure 51 and Figure 52):

6 pictures being the most preferred (score of 5),
12 pictures the next preferred (score of 4),
24 in the middle (score of 3),
12 less preferred (score of 2),
6 least preferred (score of 1).

In the second part of the survey, interviewees used the same 60 photographs, but only selected unranked subsets of the photos, depending on the question they were asked.

Questions 1 and 2 for residents:

Question 1: Please select the 10 photographs that best represent the landscapes that you would like to see in Osa and Golfito by 2030?

Figure 49. Example of a completed survey

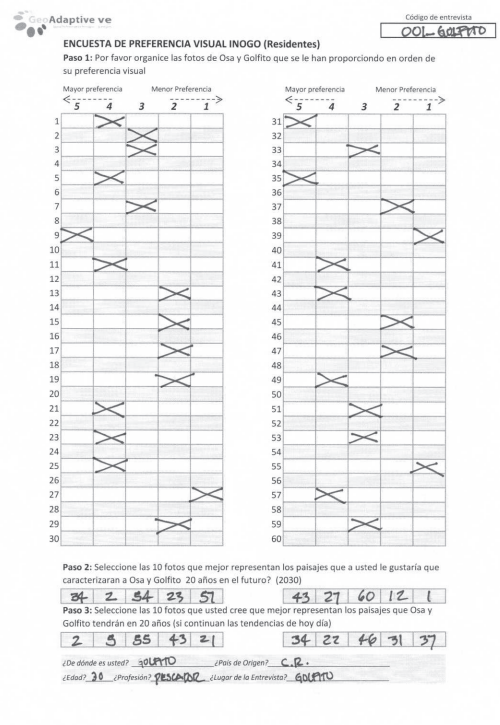
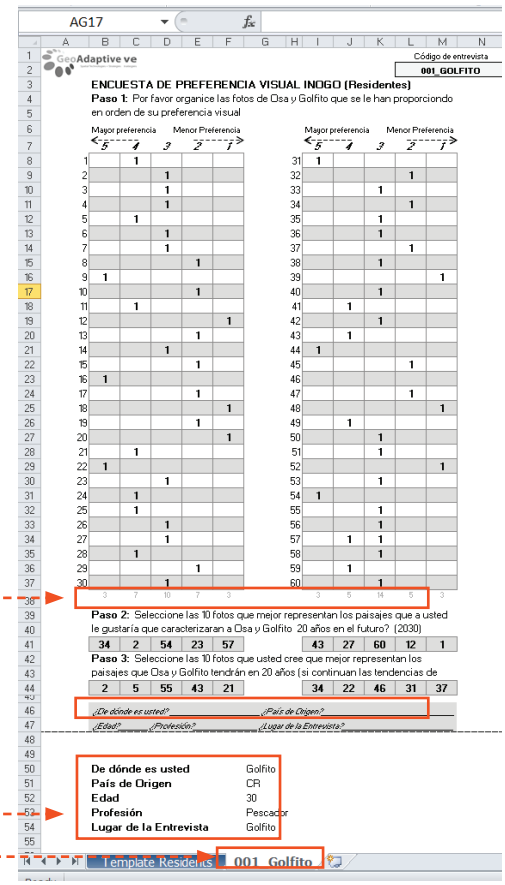


Figure 50. Example of a completed survey recorded as an excel sheet



Sum of total of data entries per column (serves to check data entry errors - only in excel not paper copy)

Area to enter demographic information (only in the excel)

Sample of tab (worksheet) for interview 001_Golfito

Question 2: Please select the 10 photographs that you believe would represent the landscape of Osa and Golfito by 2030 if current trends persist?

Questions 3 and 4 for visitors, tourists:

Question 3: Select the 10 photos that best represent the landscapes you expected to see before your first trip Osa and Golfito?

Question 4: Select the 10 photos that best represent the landscapes that you found in Osa and Golfito? How did you feel about the actual landscapes you encountered?

SAMPLE AND QUESTIONNAIRE DESIGN

Approximately 194 surveys were conducted, with seventy percent of the surveys completed by residents and thirty percent of the surveys by visitors (tourists). The interviewees were selected randomly from major towns, small towns and other primary districts. Considering the decisive influence of interviews' social characteristics on survey results, the number of samples we took in each place was evenly distributed, in order to increase the reliability of the results.

Major towns:

- Golfito
- Puerto Jiménez
- Drake Bay
- Sierpe/Chocuaco
- Rio Claro (few tourists)
- Chacarrita (few tourists)

Small towns:

- Punta Banco/Pavones:
- La Palma
- Cañaza, Agujas, Barrigones
- Mogos-Rincon
- Rincón-Rancho Quemado
- Agua Buena-Carate

5.3 VISUAL SURVEY RESULTS

Approximately 129 residents and 65 tourists answered the questionnaire. The answers were statistically analyzed to identify patterns and correlations between the different groups. Based on these patterns several key conclusions and implications were made.

The results from the visual survey show many commonalities in preferences between residents and tourists. Figure 53 and Figure 54 show the results ranked in order from top to bottom and from left to right. The number at the bottom of every picture represents the average preference score, with higher scores indicating more preferable landscapes. The results clearly show that both visitors and tourists prefer scenic and aesthetic views that encompass forests, mountains, beaches and lakes—all characterized by natural and pristine features. The results also show that both groups have the lowest preference for landscapes with buildings, informal structures, landfills and waste.

Visual survey responses were also similar in terms of the landscapes they would like to see characterizing the Osa and Golfito region. For example, both groups hope to see a future Osa and Golfito region with landscapes that feature forests, water and beaches. In addition, residents are more tolerable to man made structures than visitors. For example, four out of the top 15 landscapes selected by residents contained small villas, while tourists' top landscapes had no development features.

The GeoAdaptive team found that residents value cultural and historic landscapes more than tourists. For example, residents gave the stone spheres of the Diquís, a much higher average value than the tourists. Perhaps this is because residents value the historical and cultural significance of these sites, which are not well known among tourists.

Although residents and tourists shared many similarities in the visual preference survey, they also had many differing opinions. For example, tourists had expectations of more natural landscapes when compared to residents' outlook for the future. Tourists believed the landscapes would be characterized by aesthetic landscapes featuring beaches and forests, whereas residents believed the landscapes would feature deforestation and a landfill in 20 years. This can be explained by the conservation policies that are implemented around tourism areas, and perhaps the local knowledge that residents have about how the region has been changing over time.

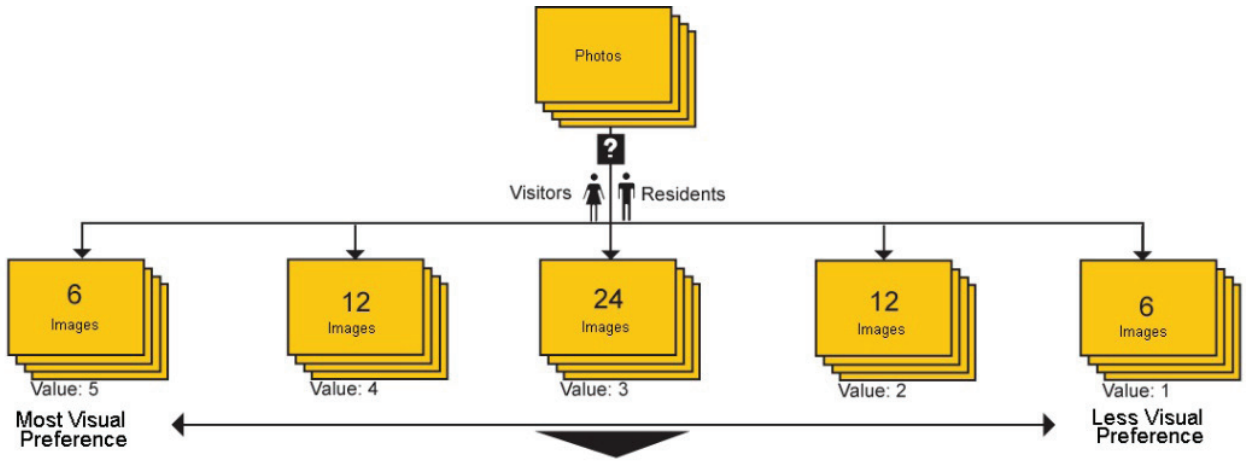


Figure 51. Visual organization and scoring the visual preference survey

Figure 52. Visual Preference Survey

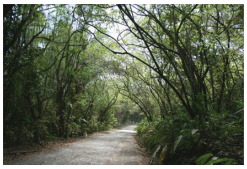
Based on the results from the visual preference assessment, it is clear that the Trend Scenario, and to a greater degree, the Rapid Growth Scenario, would generate a transformation of the landscape of Osa and Golfito that would produce less preferable landscapes for both residents and tourists. The landscapes where these visual transformations would occur are located in the areas where unplanned development, as well as agro-productive uses such as African Palm, would dominate the future land use. Also, under Rapid Growth, with the exponential increase of population, urban centers would become less preferable, as informal development begins to take over areas where natural features previously dominated (for example the hills in Golfito).

Conversely, the Proactive Scenario would be able to maintain the integrity and preferences of highly-valued landscapes through conservation initiatives, smart growth and land use initiatives, and the smaller scale development and tourism typologies that the scenario considers. The reduced development footprint in this scenario preserves more highly preferable landscapes, which are dominated by natural features such as forests, unobstructed views of protected landscapes and pristine coastal zones.

Visual Preference Ranking | Residents

Most preferred


4.16


3.94


3.53


3.23


3.15


4.14


3.84


3.52


3.23


3.10


4.13


3.78


3.48


3.22


3.09


4.05


3.74


3.46


3.19


3.07


4.03


3.71


3.45


3.18


3.04


4.00


3.53


3.31


3.16

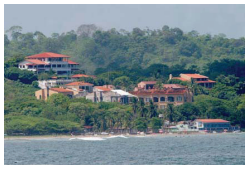

2.97

Figure 53. Residents' visual preference survey results (ranking and average value score)

Visual Preference Ranking I Residents


2.90


2.81


2.66


2.47


2.11


2.89


2.79


2.64


2.40


2.07


2.88


2.76


2.64


2.39


1.95


2.87


2.70


2.62


2.34


1.81


2.84


2.69


2.60


2.30


1.64


2.83


2.67


2.57


2.29


1.50

Least preferred

(continuation) Figure 53. Residents' visual preference survey results (ranking and average value score)

Visual Preference Ranking I Visitors

Most preferred


4.73


3.80


3.67


3.27


3.07


4.67


3.80


3.60


3.27


3.07


4.40


3.80


3.60


3.20


3.00


4.33

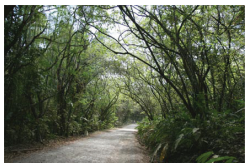

3.73


3.47


3.20


3.00


4.13


3.73


3.40


3.20


3.00


3.87


3.67


3.27


3.13


3.00

Figure 54. Tourists' visual preference survey results (ranking and average value score)

Visual Preference Ranking I Visitors


3.00


2.87


2.60


2.33


2.00


3.00


2.80


2.53


2.27


1.87


2.93


2.73


2.47


2.27


1.87


2.93


2.73


2.47


2.13


1.80


2.93


2.60


2.40


2.13


1.80


2.87


2.60


2.33


2.13


1.27

Least preferred

(continuation) Figure 54. Tourists' visual preference survey results (ranking and average value score)

Ranking of the results of residents' question #1

Figure 55. Residents' question 1

Please select the 10 photographs that best represent the landscapes that you would like to see characterizing Osa and Golfito in 2030.

Ranking of the results of residents' question #2

Figure 56. Residents' question 2

Please select the 10 photos that you think best represent the Osa and Golfito landscapes in the next 20 years (assuming current trends continue).

Ranking of the results of visitors' question #3

Figure 57. Visitors' question 3

Please select the 10 photos that best represent the landscapes you expected to see before your first trip to Osa and Golfito.

Ranking of the results of visitors' question #4

Figure 58. Visitors' question 4

Please select the 10 photos that best represent the landscapes that you saw in Osa and Golfito.

Conclusion

6.0 Conclusions

6.1 THE INOGO SCENARIO APPROACH AND ITS UTILITY

Three very different futures for the Osa and Golfito region have been explored as part of this project. Each provides an opportunity to investigate the conditions and actions that may lead the region to different outcomes in terms of economic alternatives, services, infrastructure, social wellbeing, environmental protection, and overall sustainability. The scenarios encompass a likely range of trends and choices that are expected to influence the transformation of the region. They incorporate a variety of quantitative and qualitative information, including demographic, agricultural and environmental data, as well as preferences identified for the future trajectories of change for this landscape.

The study has concluded that the Proactive Scenario is the most suitable option to support several forms of development and socio-ecological transformations without altering the delicate social fabric and ecological functionality of the region towards 2030. The resulting land patterns best support protected areas, ecological connectivity and sustainable agriculture practices. These patterns also maximize the maintenance of natural capital through ecotourism and agro-ecotourism options, which integrate local communities and minimize the negative visual transformation of the landscape. Contrarily, the changes seen through the Rapid Growth Scenario, include the increase in monocultures such as African Palm, large-scale hotel developments, and the diminishing support for conservation efforts, which are not aligned with the sustainability principles the regional communities want for their future. The economic model that supports the Rapid Growth Scenario is furthermore characterized by the intense use of the natural resources, and a disconnect between the job market and the natural capital of the region. In return, these changes would lead to a rapid, but unsustainable economic growth for the region.

The Trend Scenario, while it represents the historical and current trends of the region, it fails to provide the appropriate investment environment or the instruments needed for local communities to propitiate a sustainable future. The Trend Scenario would also impact the region's fragile social, natural, and economic environment by failing to adequately invest in the institutions, services, environment, and people of the region. Under this scenario, the overuse of natural resources, pollution, and loss of biodiversity would irreversibly transform the culture of sustainability guarded by local communities. It is important to also highlight that this scenario is characterized by a reduction in the investment in social services, including health and education, creating a major impediment for the growth of the region.

The trajectory of change for this region will be influenced by the continuous conflict between the economic interests associated with the extraction and use of natural resources, and the local values of sustainable development that require long-term solutions for economic well-being, social justice and environmental conservation. This study has contributed to this discussion in many ways, but particularly in the geographic identification of key areas in which the conflict between development, and socio-ecological and cultural protection is anticipated. This identification facilitates a continued dialogue concerning the alternative needed to bridge national plans, private interests, and local values.

The results of the study can be used as a rapid evaluation tool of the likely outcomes of a range of scenarios of different influences upon the future of the region. Drawing on existing information, the study integrates a wide range of perspectives and values from multiple levels of decision-making efforts. This has been a complex task; as development and conservation decisions about how, when, and where to act are typically based on a diversity of stakeholders' expectations for the future. In order to answer

those questions adequately, the INOGO team systemically analyzed the dynamics and complex human and natural interactions that regulate this region. Information was also reduced and simplified into analyzable variables to best work with the complexities put forth. The goal of the project was not based on the preciseness of all aspects, but rather concentrated on the collaborative process to construct, validate, and implement discussions with the many groups that participated in the project. This was particularly relevant in Osa and Golfito, where interactions amongst groups were dynamic and difficult to represent, particularly because they were proposed, regulated, and guarded by multiple stakeholders who often had contradicting values, levels of authority, or management systems. Additionally, its important to consider that many of the factors that regulate the future are unknown and most often uncertain.

The project has a particular approach towards social issues. It recognizes that despite the changes the region will experience as a response to natural and climatic changes, the primary transformations would occur due to societal decisions. Thus, in order to adequately develop this project, the team embarked on a process to capture a set of relevant and representative perspectives about the region's driving forces. These were particularly important for the formulation of the recommendations for conservation efforts. The set of identified driving forces were bundled into a coherent set of storylines that could be understood by all. This ensured that the results would be inclusive of the diversity of ideas and positions that characterized the region. Multiple stakeholders, including the government (at different administrative levels), civil society, academia, international aid, and local communities, participated in a rigorous collaborative process that validated this approach and its results. These scenarios are not plans for any particular group, but should be used as a tool for all contributors. As a result, the scenarios created a reference framework to enrich discussions and help inform dialogues about the future of the region. Despite these inclusive intentions, the scenarios and their components will require continuous revisions. The underlying assumptions used to develop the scenarios will evolve and transform as society and economic interests change and respond to local and global forces.

DESIGN OF THE SCENARIOS

The scenarios were designed as differentiated formulations based on specific development models. The intention of these was to be able to compare and contrast the outcomes generated for each scenario through the year 2030. The following table (Table 14) summarizes the primary components and assumptions used to develop each scenario.

Most of the assumptions considered for the analysis varied across scenarios to ensure that different outcomes between scenarios could be attributed to a specific factor. This design also recognized that some variations of the key assumptions needed to remain consistent through all scenarios in order to create a rational or plausible future. Regardless, during the design process, the consulted stakeholders requested that certain future interventions be included, such as the addition of the international airport, the Diquis dam, and other infrastructural projects, within the "Trend" and "Proactive" Scenarios. In essence, these additions allowed the inclusion of elements that served as a way to bracket the scenarios. These elements were also identified as "scenario triggers". For instance, an intensification of the tourism or second home market in the scenarios was a direct result of incorporating elements of more intense visitation and the arrival of international tourists. Triggers also created sectorial responses; for instance, the diminishing PES funding was a reaction to an unsustainable capitalization of the environmental base because the model reflected an intense use of the natural environment.

SCENARIO DESIGN ELEMENT: INFRASTRUCTURE

Government-funded infrastructure, specifically the expansion of the road system, represented a key intervention and a trigger across all scenarios. Given the lack of connectivity across the region and the array of protected areas, the region is difficult to access by road. This affects the access to services, particularly health and education, by communities across the region. The expanded infrastructure network would increase access to services and improve mobility across the region. Greater access would also have a profound impact on the economic development and environmental protection of the region, as it would also increase the mobility of goods and tourists in the region. However, the growth of the economic base would also stimulate population growth and movement to the region, prompting the need for additional resources (water) and other social services to attend the growing population (such as waste disposal, energy, and food security).

The expansion of the road network would substantially improve access to education and health services, as well as potential development and expansion of electrical and communication lines. However, improved transportation networks and increased access would also affect the growth of consumptive land uses such as second home development, urban growth, and palm oil plantations. Whether these secondary impacts are considered beneficial or detrimental depends on the viewpoint of the stakeholder.

SUMMARY OF SCENARIO COMPONENTS			
PARAMETERS	SCENARIOS		
	TREND	RAPID GROWTH	PROACTIVE
POPULATION	• Current growth rate	• Rapid growth rate (same as Guanacaste)	• Current growth rate
INFRASTRUCTURE (ROADS, PORTS)	• No new infrastructure or improvements (same road system, bridges, electricity, education, and health network) • Current level of maintenance	• Upgrades and new roads interconnecting the region • Bridges and electricity network expansion	• Road upgrades and new roads interconnecting the region • Bridges and electrical network expansion to undeserved areas • New education and health facilities
CONSERVATION	• Current conservation areas and current level of funding for PES	• Current conservation areas and diminishing level of funding for PES	• Protection and management of current conservation areas. • New land acquisitions for conservation (GRUAS II) • High level of funding for PES
AGRICULTURE	• Continue decreasing trend in agriculture activities • Moderate increase of African Palm plantations	• Continue decreasing trend of agriculture activity • Rapid increase of African Palm plantations	• Increase and diversification of agriculture productivity and areas devoted to the activity
TOURISM	• Moderate tourism growth (small-scale) • Reach an additional 225 rooms by 2030	• Rapid tourism growth (small-scale) • Reach an additional 700 rooms by 2030	• Rapid tourism growth (small-scale) • Reach an additional 450 rooms by 2030
POLICY	• Plans developed and approved but not implemented or enforced. (land use, forestry and marine)	• Plans developed and approved but not implemented or enforced. (land use, forestry and marine)	• Plans developed, approved and enforced (land use planning and management, forestry and marine)
SPECIAL PROJECTS	• With the Diquis Dam	• With the Diquis Dam and the international airport	• No Diquis Dam, yet includes regional airport

Table 14. Summary of the primary components and assumptions used for each scenario

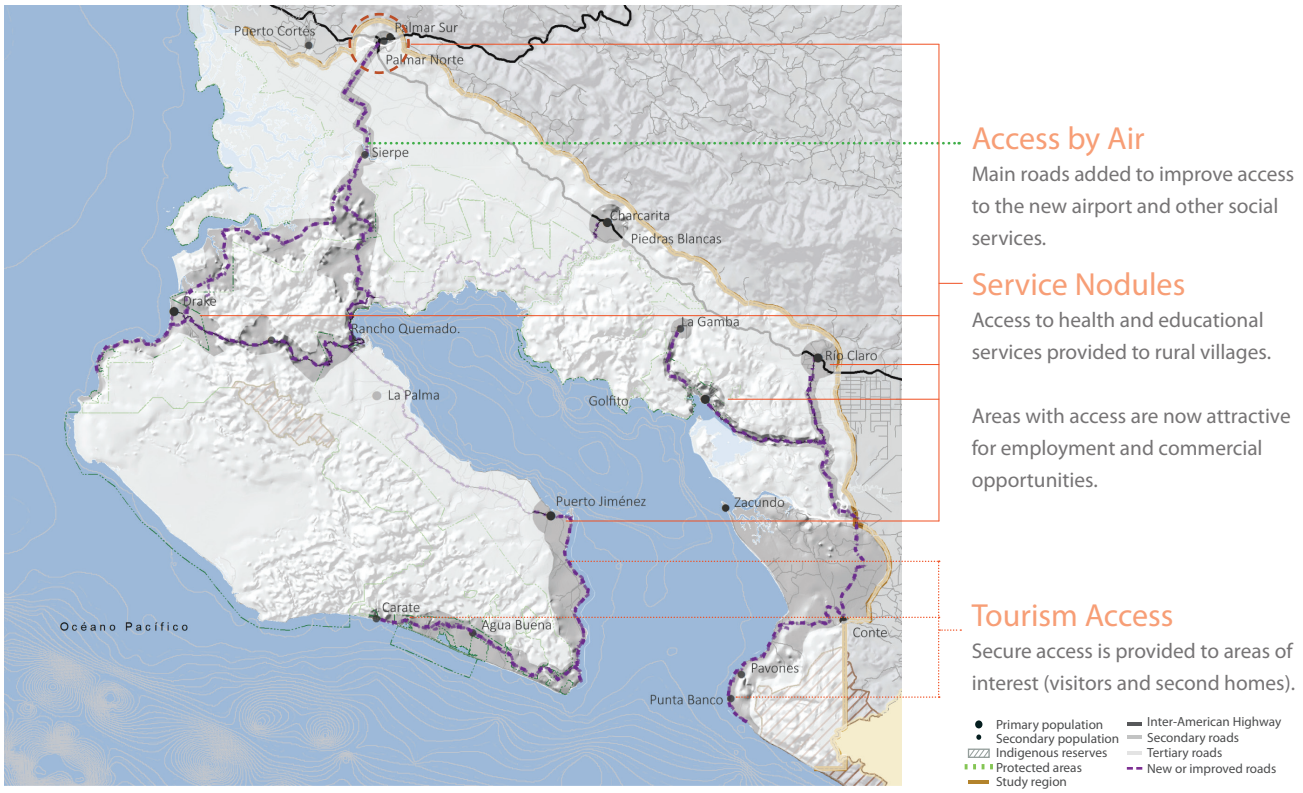


Figure 59. Infrastructure expansion in the region

The following maps (Figure 60 and Figure 61) summarize the population density and the distribution of the geostatistical units (census tracks based on the 2012 National Census) relating the location of health and education infrastructure with the geographic arrangement of the new or improved roads. Despite these improvements, the need for additional health and education facilities remains mainly in communities such as Rancho Quemado, Pavones, eastern portions of Palmar Norte, surrounding areas in Carate, and the areas expanding toward Corcovado National Park. An increase in the number of health care facilities aids in the provision of preventative care and other health programs that are necessary to boost nutrition and healthy birth rates. One of the remaining challenges in the region is the location of the only specialty hospital in Golfito. The isolated location of the Osa Peninsula communities, confounded by the unreliable marine transportation, will continue to impose challenges on the mobilization for specialized treatment and emergency attention.

The education sector will also require infrastructural improvements. The distribution of educational centers relative to population clusters is explored in the scenarios. However, tackling issues related to retention and dropout rates are key to the improvement of the local system. An integrated education improvement plan should be implemented in conjunction with an infrastructure expansion program. For example, one possible design could incorporate a rotational education program with amendments that are tied to a series of infrastructure improvements. In this scheme, specialized educators could work on a rotating basis, providing weekly or biweekly specialized classes to students across the region, along with program modifications coinciding with building and road development.

6.2 SCENARIO IMPLICATIONS

The scenario which portrays the greatest balance between infrastructure improvements and local development goals is the Proactive Scenario. This scenario presents a diverse growth model based on a balance between the capitalization of natural capital, the important agro-industrial base, and a diverse tourism industry (in spite of not incorporating all road extensions). Under this model service industries would be supported by the expansion of major towns, the introduction of agricultural improvements and technical support, as well as tourism training and expanded services for the region. It is plausible that a model based on agriculture, services, and the tourism industry could be sufficiently attractive to continue the investments in road improvements and spur development of new alignments. The African Palm Industry, for instance, has funded several road improvements, including the gravel road between Rancho Quemado and Sierpe. This improvement alone has increased connectivity across the region, reducing travel time between these points by almost two hours. The following Table 15, summarizes quantifiable results from each scenario.

Road Expansion and Heath Infrastructure:

Road expansion would increase access and mobility across the region.

Figure 60. Access to health facilities in the region

Road Expansion and Education Infrastructure:

Road expansion would increase access to education facilities and mobility across the region.

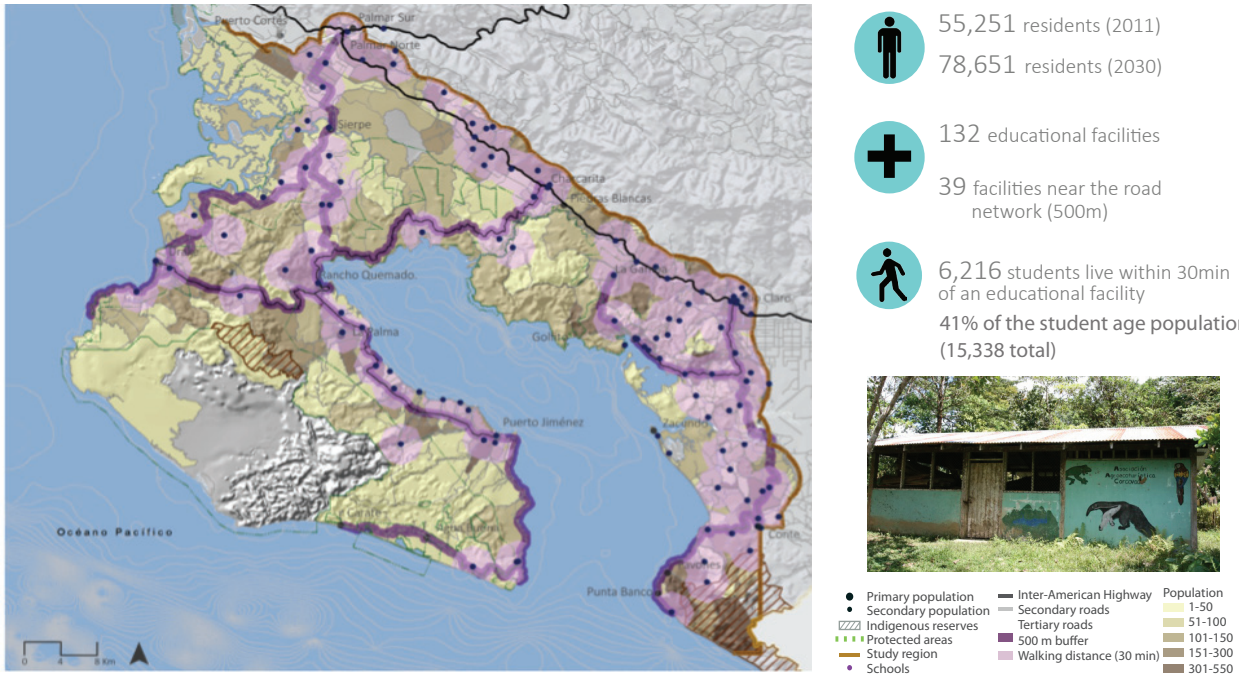


Figure 61. Access to education facilities in the region

Components of the INOGO Scenarios						
Scenario & Population (2030)	Urban Development	Agriculture	Vacation Homes	Hotels	African Palm	Conservation
TREND +16,000 people	6,086 housing units	-208 ha	735 units 3,775 ha	15	3,529 ha	5,000 ha (Payment for Ecosystem Services)
RAPID GROWTH +23,400 people	8,053 housing units	15,417 ha	866 units 4,330 ha	50	21,091 ha	1,000 ha (Payment for Ecosystem Services)
PROACTIVE +16,000 people	6,086 housing units	4,707 ha	866 units 4,330 ha	30	5,088 ha	7,000 ha (Payment for Ecosystem Services + Conservation "Voids" in GRUAS II)

Table 15. Components used for each of the INOGO scenarios

Although each scenario presents promising growth and advancement, these components may come at a cost to the social and biological environments in the region. In some cases, the combination of components could potentially create compounded impacts difficult to minimize or reverse once the actions are in motion. Careful planning and foresight will be needed to reap the benefits of growth while still maintaining important social elements and a functioning ecosystem. The following table identifies examples of some of the areas of potential concern or consideration based on the components of each scenario.

Trend Scenario	Rapid Growth Scenario	Proactive Scenario
• Infrastructure - only maintenance: Minimizing the expansion of infrastructure limits the growth of second homes and palm plantations, inadvertently controlling growth in the absence of zoning or land use enforcement. • With the Diquis Dam: Multiple impacts to ecological, social, and political systems occur when large dams are constructed, regardless of the location. Many of the impacts can be positive, but typically, environmental impacts can be detrimental, long-term, and irreversible. Environmental impacts occur to both terrestrial and marine systems. Societal impacts can include water access and availability issues, cost, and lost revenue related to reduced natural resource harvests.	• Rapid growth of population: Without foresight or planning, rapid growth can put tremendous stress on local services, local cultures, and the environment. Every ecological aspect of human use and subsequent impacts should be examined in order to minimize potential stressors. • Minimal PES: Under rapid growth, the environment is often not prioritized until it is too late. Habitat loss and fragmentation, loss or impairment of ecosystem services, loss of biodiversity, and reduction of natural resources are all potential impacts of rapid population growth with minimal conservation efforts or funding. Negative impacts to the environment in this region would in turn have negative impacts on tourism. • Heath and education infrastructure: In areas of rapid growth, municipalities may struggle to keep up with the health and education needs of the population. Regulatory and/or programmatic policies should be developed in advance of acute needs, and infrastructure development, including its detractors, should be included in the discussion.	• Diversity of agriculture: An increase in the diversity of agricultural crops can directly benefit local populations through food security and increased nutrition, and may indirectly benefit the environment through reduction of agriculture land converted to monoculture palm plantations. • Small scale tourism: In light of the rapid growth of small scale tourism in the region, proactive planning and management in this scenario can promote a more equitable and sustainable future. • Regional airport: The development of an airport increases opportunities for the local labor force, provides economic benefits, regional connectivity, and access to emergency medical care, and tourism. This type of intensive land use also has severely negative direct and indirect impacts on the environment. Choosing to build a regional instead of an international airport may reduce the overall economic returns, but can benefit the local economy through a slower or more controllable rate of growth. • With regional plans and implementation: With planning efforts, local communities and the environment win, without planning, opportunists and big business win.

6.3 EXPERT OPINION

In order to conduct a systemic and detailed evaluation of the scenarios, several experts in key critical topical areas were consulted about the potential implications each scenario could have on the future of the region. Their comments were incorporated into the scenario evaluations. The experts consulted and their areas of expertise are listed in the following Table 16:

System Evaluated	Expert Consulted	Institution
Education	Martin Carnoy, Claire Menke	Stanford University
Health	Lynne Gaffikin	Stanford University
Economy	Marcela Román Forastelli, José Eduardo Angulo Aguilar	Consultants
Terrestrial ecosystems	Rodolfo Dirzo, Eben Broadbent	Stanford University
Marine ecosystems	Larry Crowder, Catalina Molina	Stanford University, Fundación Keto
Land use and land cover	Juan Carlos Vargas	GeoAdaptive

Table 16. Expert opinion consulted for the validation of scenario components

Beyond the sectorial evaluation, the INOGO team was interested in the confluence of the impacts identified by each expert. Both narrative and geographic based evaluations were conducted. The main goal was to identify which areas would be most affected by the conditions present in the scenarios. In order to evaluate the scenarios from a comprehensive perspective, but building on sectorial knowledge, experts were asked to indicate, on a map of the project region, the areas that (1) would reflect improvement or no significant change, and (2) that would reflect change that could create an important stressor to the socio-ecological environment. These results were entered into a Geographic Information System, allowing for the development of a spatial evaluation of the implications identified. In the GIS software, a spatial overlay with all considerations and areas was created, and the results were indexed using a 1 (lowest) to 9 (highest) categorization.

The interest of the INOGO team in developing this exercise was not to promote any particular scenario, but to create a sensitivity analysis that would indicate the areas of highest concerns (stress) across all plausible future scenarios, given the collective set of experts' evaluations. Despite the fact that this represents a qualitative evaluation, it served as a base to draft the recommended actions. The actions drafted from this evaluation would lead towards a more resilient future as they incorporate decision-making processes from several plausible scenarios, instead of concentrating recommended actions solely on one future scenario.

The summary map (Figure 62) shows which areas present the highest concentrations of stressors and adverse changes. These changes, and the triggers that led to the stressors, should be considered in setting up recommended and strategic actions to secure long term sustainability. The map shows the overall concentration of priority areas which have the most urgent needs, given the conditions of all scenarios and as indicated by the expert opinions.

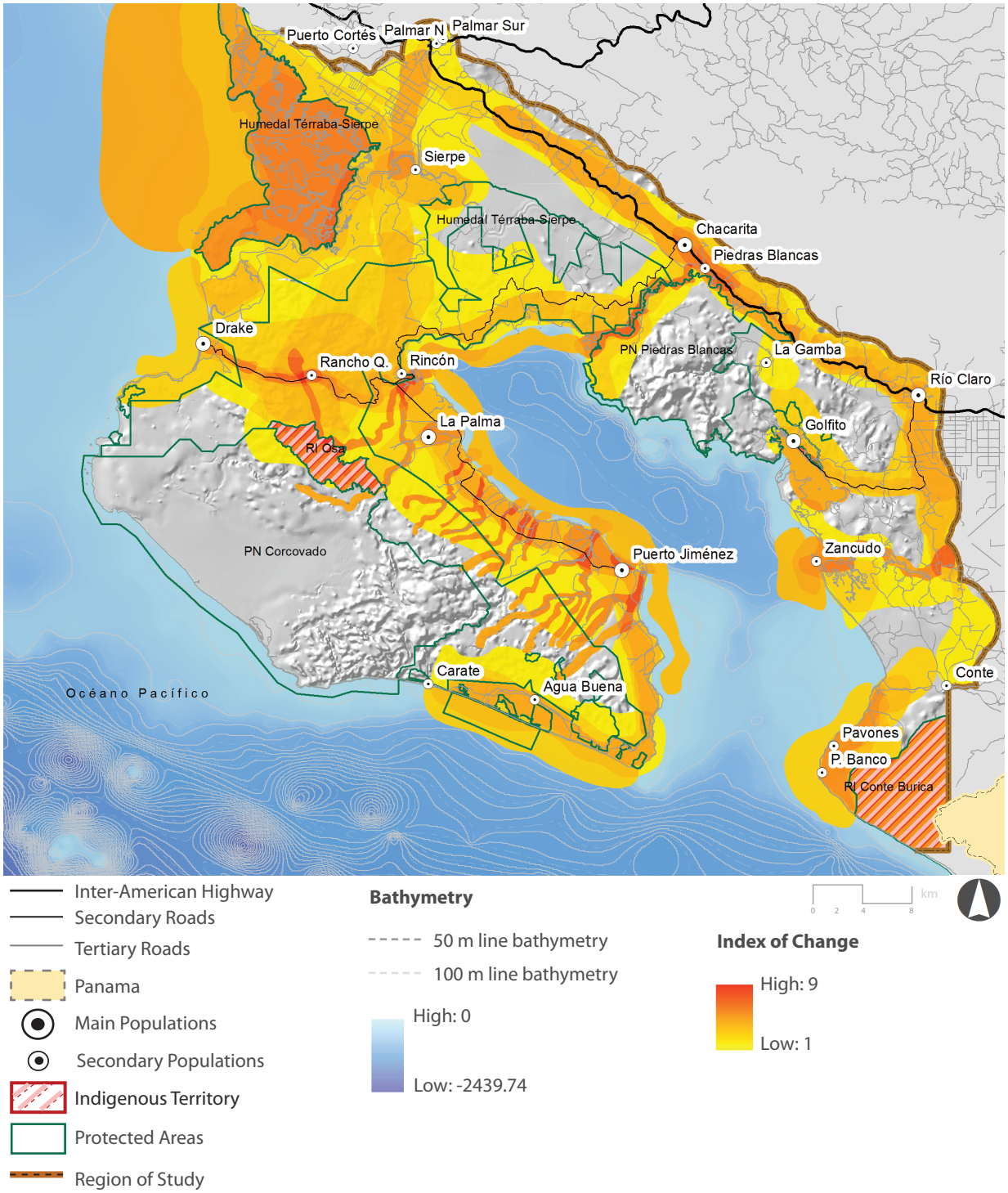


Figure 62. Concentration of changes map

The inspection of the stressor evaluation clearly describes a pattern across the region. The most adversely affected areas and systems considered in the ranking assessment are as follows:

AREAS OR SECTOR (highest rank in evaluation map)	CONSIDERATIONS
Humedal Terraba-Sierpe Sector	Affected by changes in the regional hydro regime due to the potential operation of the dam and changes in land use conditions promoted by the economic model (airport or extensive African palm plantations). This would affect the fragile marine environment and wildlife in the wetland, and in-shore and coastal areas.
Corridor from La Palma to Puerto Jiménez	Area affected by changes due to intense agriculture (rice and African palm) and urban development. These changes would impact riverine corridors running from Corcovado National Park to the Gulf. In addition coastal and marine resources would be impacted due to an increase of sedimentation and runoff and resulting potential pollution.
The road between Drake and Rancho Quemado	Area affected by changes due to intense agriculture, land use and development of the areas of Rincón, Rancho Quemado y Drake. Irreversible impacts on the ecological integrity due to deforestation, and landscape fragmentation. This area is critical for the connectivity of the peninsula with the rest of the territory.
Northwest border of Piedras Blancas National Park	Areas affected by African Palm. Impacts triggered by erosion and the deforestation of riparian corridors. Significant visual impacts.

Table 17. Areas most adversely affected by the regional stressors

The areas listed above require the most urgent attention and should be prioritized when developing the recommended strategic actions. While the areas listed in Table 17 are the most critical, additional areas that would require special consideration, due to the extent of the potential impacts, were also identified by the consulted experts. These areas may require additional attention when developing regional policies or considering alternatives for the region. A short description of the secondary locations that would require additional consideration (but are not of highest priority) are described in the Table 18.

ADDITIONAL AREAS TO BE CONSIDERED	CONSIDERATIONS	POTENTIAL IMPACTS
The marine and near shore areas of the Humedal Terraba-Sierpe.	Tourism activities and air traffic impacts	• Soil and coastal marine sediment loading. • Noise and visual disturbance to marine mammals.
Area between Drake and Sierpe	Attractive to second home development	• Fragile visual landscape. • Erosion. • Adverse affects to subsistence-based local economy.
Area along the Carretera Interamericana	Imminent transformation of the area into a development corridor; industrialization to support agro-industrial activities	• Loss of habitat and species migration corridors. • Deterioration of habitat quality.
Area outside of Conte Burica reserve	High attractiveness as a tourist destination	• Deterioration of very fragile indigenous cultural fabric and sensitive ecological base.
Area between Carate and Agua Buena	Intense land use and land cover transformation	• Impacts to critical areas of ecological connectivity. • Increases in sediment and fertilizer concentrations in Golfo Dulce • Impacts on marine ecosystem and subsistence fishing.
Protected Areas	Changes in land cover and land use	• Increased potential for landscape fragmentation, affecting connectivity and ecological functioning between parks.

Table 18. Areas requiring further consideration and the manifestation of the potential impacts

6.4 EVALUATION SUMMARY

The systematic region-wide and multi-scenario evaluation summary provides decision-makers with critical information about which areas should be prioritize when implementing policies. The following section presents the overall conclusions for several critical conditions underlying the scenarios that are crucial for the future of the region.

INFRASTRUCTURE

The impact of big infrastructure projects like the Diquis Dam and the proposed international airport are dependent on the extent to which local residents are hired to work on these projects. During the previous construction booms in the region, the majority of the jobs were held by migrant workers from San Vito, Perez Zeledon, and Nicaragua. Job training from ICE and Aviación Civil would help improve the likelihood of local hires, which in turn would help improve the local economy and maintain some of the economic benefits in the region.

The construction of the airport and the Diquis Dam would spur significant changes in the character of the surrounding areas, regardless if they directly employ residents from the region. The airport is shown to stimulate urban development in Palmar Sur and push agriculture to the periphery of the airport. While the Diquis Dam could potentially have significant impacts on the operation of the HNTS, as described by Umaña (2013).

TOURISM

Tourism has been a key driver of development in the region and is anticipated to continue to play a strong role. However, it is important to note that the scenarios cannot take into account the millions of factors that influence the international markets. The projections used in this project are modeled on international trends. The number of hotels shown, even in the most modest scenarios, may or may not be viable due to market trends.

Residents of the Osa and Golfito region are aware that in other places in Costa Rica, tourism development has depleted local aquifers. Understanding the impacts of future growth on the water supply must be a key factor evaluated in future planning for development and agriculture in the region.

VACATION HOMES

The location of vacation homes and hotels shown in the scenarios was chosen because of the characteristics of the land, access to transportation, viewshed, access to water, and a number of other factors that are considered by home buyers, developers, and investors. The models used in the scenarios can only show likely locations for these developments and do not intend to pinpoint the locations of specific developments.

The models used in the project help provide an educated guess as to where future development can go in each of the identified scenarios. This information can provide government entities, conservation groups, and others with guidelines of what can be anticipated. For example, some government entities expressed that the Rapid Growth Scenario can provide an informed guess as to the "worst case scenario" for future growth, allowing them to anticipate services that they may need to provide.

PALM PLANTATION

With the rapid growth of African Palm, it is important to note the limited economic impact that this phenomenon is anticipated to have. The socioeconomic analysis of African Palm done by INOGO shows that even with the rapid and significant growth of the African Palm cultivation, it would not be enough to pull the region out of poverty. The value chains are not established in the region, and the employment that is generated is not significant. Even the processing of the fruits is anticipated to be limited, since there is significant capacity already installed on the Panamanian side of the border. However, palm would continue to replace cattle, and plantations (rice) in the region. Palm growers expressed concern regarding the economic opportunities for their children since there is not enough land for the next generation to grow palm, and this is certainly an important factor to consider.

Dr. Cristian Valverde, Director of the Ministry of Health for the Brunca region, commented that: "(w)hen families are farming palm, children are usually in school since the family is economically stable". Farming palm could potentially be one instrument of change that would encourage children to attain higher levels of education. An education could help lead the next generation towards economic success, despite the lack of access to additional land for farming.

The INOGO team also received many questions regarding the environmental impact of the expanding palm plantations. Additional work needs to be done on this topic; however initial anecdotal evidence from Beggs and Moore (2013) and Dirzo and Broadbent (2013) shows that some biodiversity is found within palm plantations. Sightings of fauna in the plantations included puma (*Puma concolor*), anteater (*Tamandua mexicana*), collared peccary (*Pecari tajacu*), tapir (*Tapirus bairdii*), white-headed capuchin (*Cebus capucinus*), jaguar (*Pantera onca*), and great currasow (*Crax rubra*). Flora within the plantations was also more diverse than investigators had anticipated, with a significant variety of epiphytes found growing on the palm trees. Farmers and others expressed uncertainty about the impacts of the palm plantations on the environment, a topic which INOGO researchers intend to explore further.

A number of comments were concerned that the amount of palm shown in the scenarios is actually less than is what is believed to be occurring now. At the request of those who participated in the scenario development and evaluation processes, the illegal expansion of agriculture is not shown in the scenarios. Since the scenarios are meant to explore the potential dynamics of the region, it is anticipated that the future would not specifically look like any of the scenarios, but a combination of the factors presented. For example, just about any land cover can be converted into palm, and it is likely that in the future, the agriculture areas of the region would mostly become palm plantations. It is important to consider the danger that a monoculture might present to the economic stability of the region, and it is important to ask questions about the environmental impacts of these plantations. The scenarios cannot foresee all aspects about the expansion of the crop, but they can help guide planning in order to best consider the consequences of the expansion of palm in the region for current and future generations.

MARINE

INOGO would like to acknowledge the multiple requests to include marinas in the scenarios. At this point, there is not enough information to accurately model the introduction of a marina into the scenarios; however, la Comisión Interinstitucional de Marinas y Atracaderos Turísticos (CIMAT) provided information on the potential impacts of a marina.

One question related to the marina is the extent to which the maritime transit would increase in the region. There are different opinions on this – some state that the boats in Golfito and Puerto Jiménez would fill most of the initially built slips, and others believe that there would be a significant increase of maritime traffic. INOGO cannot opine on whether or not the transit in the Golfo Dulce would have a net increase related to the construction of a marina, however if the traffic did increase, it could have an impact on the marine mammals which navigate the gulf. Increased traffic would also imply increased pressure on the marine resources by sport fishermen and others involved in marine tourism.

It is important to note that in Los Sueños, CIMAT studied the marine economic value chain and found that 90% of the boats remain in the marina on a regular basis, with 10 to 15 boats going out for fishing tournaments. The boats that moved the most were owned by the resort but rented to visitors, and the same could be expected in other marinas – that the most used boats would belong to the local fishing lodges.

An important characteristic of a marina is that because CIMAT is under Costa Rican Tourism Institute (ICT), a marina would be classified as a tourism feature. Therefore, the marina would not be available for artisanal fishermen, since fishing infrastructure would fall under the responsibility of INCOPESCA and Ministry of Public Works and Transportation (MOPT). The municipality could, however, build a small marina for local fishermen next to the tourism marina, or try to negotiate lower prices for slips designated for local use. By law, the marina would have to offer public areas

with restaurants, gas service, oil change service, electricity, internet, and bathrooms.

The population increase shown in all scenarios is expected to have an impact on the marine environment. As a result, an increase in population would mean an increase in people trying to work in the sport fishing and tourism industry. Foreigners are currently developing many of these businesses, but locals could run more of these businesses in the future. The demand for work is continually increasing since fishing is the primary form of employment in coastal communities. However, local fishermen have indicated that the natural resource is collapsing, and that artisanal fishing can no longer support local families. Additionally, the lowest economic level in the region is represented by the piangueros, who extract clams from the mangroves. If this resource is further diminished, it could mean that another social safety net is lost.

In general, the increase use of the marine environment and the additional transportation in the region would lead to more contamination and more conflicts between users of the marine resources.

CONSERVATION

The Proactive Scenario shows an increase in conservation, reflecting the opinions of those participants consulted in the INOGO process and the importance of continuing to support conservation efforts. The challenge remains in how to operationalize viable economic opportunities which support these continued efforts. In Aguilar et. al. (2013), the Management Plan is identified as the most important first step in securing better viable economic opportunities for those living within the Golfo Dulce Forest Reserve.

Economists collaborating with INOGO also reiterated the following (that is perhaps thought more than it is shared): the focus on conservation and environmental stewardship can be a barrier to economic growth in the region. This feeling must be validated, because even though natural capital (the services that nature provides which are essential for life and impossible for humans to produce) is of inherent value, without the financial mechanisms to support these efforts and the local communities, conservation would continue to be seen as a barrier to economic growth.

AVAILABILITY OF WATER

There was not enough information to evaluate the impact of the scenarios on the regional hydrograph or the availability of water. The availability of water would of course be a limit to growth and a key factor in the consideration of what kind of growth should occur in which location and what the impact of that growth could be.

The region of study is already experiencing challenges related to the availability water. The town of Uvita has an Administration Association of Rural Water Supply (ASADA) with 100% subscription. In Piedras Blancas, untreated water is flowing into Piedras Blancas National Park. Along the south eastern shores of the Golfo Dulce, in towns such as Punta Banco and Pavones, the headwaters of local water sources are in the Punta Burica territory, meaning that non-indigenous residents of that region do not have control over the mountain springs that serve as their main water supply. Additionally, one of the concerns related to the proposed Crocodile Bay Marina was whether or not Puerto Jiménez had the necessary water to support a large hotel development. As growth continues in the region, this subject must be explored further in depth to secure a sustainable and viable future for local communities.

AIRPORT

Airports are the type of infrastructure normally associated with the development of a region. The proposed airport could provide improved access and a greater volume of access to the region, as well as a method of rapid evacuation in case of emergency. The airport signifies the desire to increase tourism and commerce in the region, increasing employment opportunities and possibly stimulating migration to the region.

The airport would indirectly generate more pressure on the natural resources of the area and directly increase demand on the fresh water resources. The airport would also have an impact on many of the ecosystems of the region:

- A land use change in the large area designated for the construction of the airport.
- The consumption of resources and generation of waste during the construction of the airport.
- The consumption of resources and generation of waste during the operation of the airport.
- The noise and visual disturbance that would cause many species to leave the area.
- The change in the flight patterns of some species of birds due to the air traffic.
- Air, soil, and water contamination.

DIQUIS DAM

The Diquis Dam would have negative impacts on the ecosystems of the region. Although this type of infrastructure would generate economic benefits it would have a very high environmental cost.

A dam signifies a change in the flow of the water resources and would affect the hydrologic regime of the wetlands and adjacent ecosystems.

The changes in the water flows would result in:

- Changes in the populations of fish and other animals that use the wetland.
- Changes in the water levels would affect the area that the wetland occupies.
- A change in the water levels and salinity that would affect the species of mangroves, impacting the composition of the wetlands within each area.

Additionally, the construction of the dam would generate changes in the land use patterns, increasing fragmentation and the isolation of some portions of the forests.

6.5 CONCLUDING REMARKS

Given a highly uncertain and unpredictable future, this effort does not aim to predict, but rather simulate a set of storylines. The scenario exploration effort has offered a framework for developing more resilient conservation and development strategies. The intent is to face uncontrollable and irreducible uncertainty, and to offer communities and authorities alike the chance to build their own future. Each of the scenarios in this context is an account of a plausible future, but not necessarily the future. The desirable and perhaps dissimilar future for 2030 and beyond could be different to any of the ones developed as part of this effort, if communities, institutions, and the private sector wish it to be so.

The desire and strategy behind the INOGO scenarios has been to enable a process leading to a few representative, contrasting but plausible, scenarios to explore the uncertainty surrounding the future consequences in order to help the region design their own sustainable future.

Annex

7.0 Annex

Health System			
	Trend	Rapid Growth	Proactive
Additional EBAIS	• Additional 4-6 EBAIS added • Longer waits in line. • Additional strain on services if tourists do not pay for care.	• Additional 6-8 EBAIS added. • Longer waits in line.	• Additional 4-6 EBAIS added • Longer waits in line.
Prevalent Diseases	• Parasites and respiratory infections. • Larger towns would experience more visits due to hypertension and diabetes. • More automobile accidents due to increased road traffic.		
Tourism	• Increased tourism would provoke water shortages in towns that are already water-stressed, ultimately affecting the tourism industry.	• With the expansion of the tourism market, the CCSS could further be strained in the region given that there are no mechanisms in place for tourists to pay for services. • However, more salaried jobs would also mean more people contributing to the CCSS each month, which could help compensate for the increase in services required.	• Increased tourism would place a greater strain on the CCSS services, given that there are no mechanisms in place for tourists to pay for services.
Infrastructure	• Lack of bridges, paved roads or reliable electricity would continue. • Infrastructure challenges: accessing the CCSS system, education and employment. • The impact of the Diquis Dam would increase in work-related accidents with the physical labor required for Diquis which would put a strain in the regional hospitals.	• The increased infrastructure (airport and road) would also improve access to emergency care. • Increase in accidents related to these construction jobs.	• The increased infrastructure (airport and road) would also improve access to emergency care. • Health can also be improved by electrification, with the ability for families to boil water to purify it, and for children to do homework after dark. • The additions of paved roads, increased agriculture, and significant population increase, there would be considerable increased demand for water and need for wastewater treatment.
Agriculture / Palm Plantation	• Reduction in agriculture and moderate growth of palm plantations - experience a reduced likelihood of food and nutrition security from locally grown, affordable food sources. • Could lead to increases in diabetes, hypertension, cardiovascular disease.	• The increase in palm plantations could cause a decrease in nutrition and food security, as there would not be land available for locally grown crops. • Increase in chronic conditions with the more sedentary lifestyle of palm growers.	• Increase in the diversity of the agricultural production, food and nutrition security could increase and help reduce diabetes, hypertension, cardiovascular disease thereby improving quality of life.
Environmental	• Any downstream effect on water flow and quality could negatively affect community health.	• The Diquis dam and the airport projects could significantly impact the water quality in the region where they would be constructed, as well as downstream in the Térraba Sierpe Estuary and marine ecosystems. • Noise, light pollution, and other pollution from these projects could also impact quality of life.	• With a regional airport, there could be an increase in noise, light, and other pollution which would affect health and quality of life.
Conservation			• With significant increases in healthy forest cover, water can be properly filtered for downstream communities.

Table 19. Health evaluation summary table

Education System			
	Trend	Rapid Growth	Proactive
Student	• Children attend school with weak preparation from their families • Low preschool attendance continues to contribute to poor high school completion. • Most children complete *Ciclo* III, but the number who continue after that diminishes significantly, with few students earning their *bachillerato* or attend university. • Many students finish high school, but never take the *bachillerato* exam – for economic reasons, or because they are intimidated by the national universities' application process.	• Low preschool attendance continues to contribute to poor high school outcomes.	• High preschool attendance. Land use planning could help concentrate services near populations and provide more access to preschools. • It has been announced that a campus for the Tecnológico De Costa Rica would be located on the peninsula. If this happens, the offering of well-selected majors could have a significant improvement on the level of employment for young people in the region.
Transportation	• Transportation is only provided to *colegios*, with the assumption that all students can walk to primary school. • Children in areas where primary schools are hard to reach by foot still experience great difficulties in getting to school.		
Facilities	• Only students in the larger cities have access to computer labs or libraries. • In many schools, even the teachers do not have access to a computer.		• The Ministry of Education, in cooperation with the Omar Dengo Foundation (FOD), could work to bring computer literacy to all students in Costa Rica.
Teachers	• Teachers in the *unidocente* and *bidocente* schools don't have the special training required to adequately manage these complex teaching environments.		• Improved regional support network for teachers and administrators, within schools and amongst regional schools. • Room for improvement in instructional quality, resources should be increased for the schools in the region.
Job Prospects for Students	• Continued dominance of technical degrees which may or may not lead to stable jobs in the region.		• CTPs are equipped with tools to better predict future market conditions, improving the level of employment upon graduation.
Infrastructure (Education)		• Better infrastructure access, but potential issues with infrastructure quality, crowding, and the adequacy of the education provided as it relates to the local job market and opportunities for youth.	• With more educational infrastructure, as well as land use planning, there could be a consolidation of smaller schools, into larger schools that can provide better physical resources.
Curriculum			• Multiple schools in the region are identifying the importance of the coastal and marine characteristics of their region. Education will likely focus on the marine environment and there will be an increase in jobs related to marine and coastal resources. • This scenario would include curriculum changes such as the implementation of the National Marine Education program. • Improved English language education.

Table 20. Education systems evaluation summary table

Marine Systems			
	Trend	Rapid Growth	Proactive
Environmental	• Runoff from rice plantations with pesticides and agrochemicals will cause significant contamination and impact the marine systems.	• With increased development and agriculture around the HNTS, sedimentation in the wetland is expected to increase. • With the construction of the Diquis Dam there will be a slew of environmental issues such as the increased sedimentation in the Rio Terraba. • The Diquis Dam would also cause a change in the water availability and temperature, impacting the physiology of the aquatic organisms in the mangroves and wetlands. • Areas that would be impacted include: fish nurseries, and feeding grounds.	
Fishing	• The increased fishing pressure in the Golfo De Nicoya, would cause trawlers to migrate down to the southern pacific and further increase pressure on those fisheries.	• An increase in the degradation of the resource, and increasing conflicts between users, would cause further pressure on the fisheries.	• Groups like PASE could explore the potential for policies that would allow the HNTS to have concession zones for artisanal fishermen, modeling the concession after the Tarcoles case.
Tourism	• Current stress between tour operators and the limitations that SINAC is placing on park entries, it can be anticipated that the management of this conflict would continue to be weak.	• The construction of the international airport is anticipated to bring additional tourism to the region, increasing the sport fishing sector, as well as other tourism activities that rely on marine resources. • A lack of land use planning and a steep increase in tourism, will place further pressure on protected areas and it could become a key area of conflict, with the potential to seriously degrade the resource.	• Fishermen Associations of the HNTS are exploring the possibilities of engaging in ecotourism.
Conservation			• Goals of the Forever Costa Rica program being accomplished. This program defines the objectives for conservation of three important thematic areas related to the Work Plan for Protected Areas and the UN Convention on Biological Diversity.
Commerce	• Narcotraffic will to continue in the HNTS, endangering local communities and impacting the ability to attract commerce to the region.		
Infrastructure		• The proposed international airport will bring an increase in transit on the Rio Sierpe. • The airport could have additional impacts on the fauna due to the noise produced by airplanes.	
Development	• More coastal lands are being concessioned by developers, which could lead to a displacement of local fishermen and piangueros.		

Table 21. Marine systems evaluation summary table.

Terrestrial Systems			
	Trend	Rapid Growth	Proactive
Employment	• High unemployment rates would cause an increase in informal economies such as mining, poaching, trafficking of wild animals, and illegal logging.		• Since the growth in all sectors would be unequal and unregulated, there would also be indirect impacts in the economic growth. Growth would not be sufficient to meet the employment demands.
Conservation	• The growth, even moderate, in the number of palm plantations would have a negative impact on wildlife because it would diminish their habitats. • Not increasing the PES would further stress the existing forested areas	• Connectivity between important habitats is lost, such as: the area between the Térraba Sierpe Wetland and the Rainforest; the area between the Piedras Blancas National Park and the Osa Biological Corridor; and the area from Conte to Punta Burica. • The interruption of biological corridors would put additional pressure on species like jaguars, which require large areas of habitat for their survival.	
Development	• Land use planning regulations or other methods of organizing development is not applies. • Without land use planning, there also cannot be advance in strategies to combat climate change.	• Includes the Regulatory plans but not the implementation. • The increase in palm plantations in the zones close to Puerto Jiménez, the Diquis Dam, and the Airport would cause an increase in the population, and the growth of the commerce and services sector.	
Infrastructure	• The presence of the Diquis dam would result in a lower water level in the Térraba-Sierpe National Wetland System, which would in turn decrease the populations of fish, crustaceans, and other animals that depends on the wetland for their development.	• The presence of the Diquis dam would result in a lower water level in the Térraba-Sierpe National Wetland System, which would in turn decrease the populations of fish, crustaceans, and other animals that depends on the wetland for their development.	
Environmental / Marine Systems	• Impacts upon the marine environment would have a reciprocal impact on the fishermen and other people who depend on marine resources. • The unregulated growth in the tourism sector represents a threat for the sea turtles, affecting the number of successful nestings and migrations of hatchlings to sea.	• Changes in the water level in the wetland would lead to changes in the number of fish and other animals that are able to use that zone for reproduction. • The loss of habitat from deforestation, especially on the cost of the Golfo Dulce, would have large negative impacts on the local flora and fauna. • The increase in erosion due to the loss of forest cover in the high zones of the Osa Peninsula would bring large quantities of sedimentation into the Golfo Dulce.	

Table 22. Terrestrial systems evaluation summary table

Land Cover			
	Trend	Rapid Growth	Proactive
Agriculture	• Loss of agriculture.	• Growth of agriculture.	• Increased diversity of agricultural productivity.
African Palm	• Moderate growth in African Palm.	• Rapid growth of African Palm.	
Conservation	• Conservation/PES as today.	• Minimal PES / Conservation.	• High PES and proactive procurement (GRUAS II).
Development	• Same education/health infrastructure	• New developments: international airport and additional paved roads • Pavement, electricity, bridges	• New developments: the regional airport and additional paved roads. • Overall infrastructure upgrades to improve both existing conditions and regional accessibility.

Table 23. Land cover systems evaluation summary table

Areas of Interest	General Themes	Specific Themes
Threat	• Climate change • Forest harvesting • African palm plantations • Hunting • Mining	
Species Indicators	• Sea turtles • Mountain pig • Big cats • Other cats • Bats • Monkeys • Moose • Piangua / cockle • Amphibians • Deer	• Jaguar • Puma • Ocelot • Oncilla • Jaguarundi • Squirrel monkey • Red monkey • Mantled howler • Capuchin monkey
Ecosystem Services	• Above ground biomass • Quality and quantity of freshwater • Recreation, including tourism	• Agriculture • Human use • Erosion and sedimentation
Conservation Priorities	• Biological Corridors • Critical habitats (which, where)	• Connectivity and fragmentation • The richness of species (flora and fauna) • Endemic species (flora and fauna)

Table 24. The components for the terrestrial system

8.0 References

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The focus of the work of the Stanford Woods Institute is to promote, support and encourage the initiatives of the academic staff of the University to address environmental problems, with an interdisciplinary and integrative approach. This is done with the support of the quota of academics at Stanford -with recognition of first line- in the social sciences, education, health, and environmental sciences, through research, teaching and dissemination of knowledge to the realm of decision-makers. All of these activities are directed to the search for solutions to environmental problems in general.

INOGO

The Osa & Golfito Initiative, "INOGO", is an international collaborative effort to develop a strategy for sustainable human development and environmental stewardship in the Osa and Golfito Cantons of Costa Rica. The effort's core is a collaboration between people and institutions in the US and Costa Rica, facilitated by the Stanford Woods Institute for the Environment at Stanford University.

INOGO is designed to build on the many previous efforts in the region, working hand in hand with Costa Ricans in local communities, in the public and private sector, and with NGOs to create a shared vision and long-term strategic plan for a sustainable future for the Osa and Golfito region. The project integrates the sociocultural dimensions of the Osa and Golfito region with both its marine and terrestrial ecosystems.

GEOADAPTIVE

GeoAdaptive is a consulting and research group located in Boston Massachusetts, dedicated to the development and analysis of urban and environmental information systems. They focus on the strategic and integrated use of geographic information technologies to understand the spatial and temporal relationships underlying urban and natural environments. In doing this GeoAdaptive facilitates and provides services that improve the decision making process in cities and regions across the world.

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FINAL EVALUATION REPORT