Sustainability Analysis in La Amistad Panama

Biosphere Reserve

Dissertation
zur
Erlangung des Doktorgrades
der Naturwissenschaften
(Dr.rer.nat.)

dem
Fachbereich Biologie
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Ariel Rodrigo Rodríguez Vargas
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Erstgutachter: Prof. Dr. Dr. h.c. Harald Plachter

Zweitgutachter: Prof. Dr. Roland Brandl

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List of Abbreviations and Symbols

ARAP	Aquatic Resources Authority of Panama
ANAM	National Authority of Environment of Panama
BR	Biosphere Reserve
BOD	Biological oxygen demand
C2H3Cl3	Methyl chloroform
CCL4	Carbon tetrachlorides
CEPAL	= ECLAC (English) Comisión Económica para América Latina y el Caribe
CF2ClBr	Halons
CFCs	Clorofluorocarbons
CGRP	General Controllers Office of Republic of Panama
CH4	Methane
CHFBr	Carbonohidrofluorobromomethanes
CO2	Carbon Dioxide
CSD	United Nations Commission on Sustainable Development
DMC	Domestic Material Consumption
ECLAC	= CEPAL (Spanish) Economic Commission for Latin America and the Caribbean
ENV	Survey about living standard of life (Spanish language acronym)
EPL	Extreme Poverty Line or Absolute Poverty
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign direct investment
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GHGs	Greenhouse Gases
GNI	Gross national income
GPL	General Poverty Line
GWPs	Global Warming Potentials

HClFCs	Hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HIV/AIDS	Human immunodeficiency virus infection / acquired immunodeficiency syndrome
IBP	The International Biological Programme
IGNTG	National Geographical Institute “Tommy Guardia”
ILO	International Labour Organization
INADEH	National Insitute for Training and Human Development
INEC	National Institute of Statistics and Census of Panama
IUCN	International Union for Conservation of Nature
JPOI	2002 World Summit on Sustainable Development or Johannesburg Plan of Implementation
LAPBR	La Amistad Panama Biosphere Reserve
LCDs	Least-developed countries
LULUCF	Land use, land-use change and forestry
MAB	Man and Biosphere Programme
MDGs	Millenium Development Goals
MEDUCA	Ministry of Education (Panama)
MEF	Ministry of Economy and Finances (Panama)
MINSA	Ministry of Health (Panama)
NH2	Nitrous Oxide
ODA	Net official development assistance
ODSs	Ozone Depleting Substances
PFCs	Perfluorocarbons
PILA	La Amistad International Park or La Amistad National Park
PNUD	United Nations Development Programme (spanish acronym)
PNVB	Volcan Baru National Park
PPP	purchasing power parity
QGIS	Quantum GIS or Quantum Open Source Geographic Information System

R&D	Gross Domestic Product (GDP)
Rio+20	United Nations Conference on Sustainable Development, Rio of Janeiro 2012
SF6	Sulphur hexafluoride
TCA	Tourism satellite account
UN	United Nations
UN DESA	UN Department of Economic and Social Affairs
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-MAB	UNESCO's Man and the Biosphere Programme
UNICEF	The United Nations Children's Fund
UP	University of Panama
UTM	Universal Transverse Mercator coordinate system
UTP	Technological University of Panama
WB	The World Bank (World Bank Group)
WCMC	World Conservation Monitoring Centre
WCS	World Conservation Strategy (IUCN 1980)
WHS	UNESCO World Heritage Site
WHO	World Health Organization
WWF	World Wildlife Fund

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To my daughter Amarantha Theodora.

To my parents Virgilio and Melva, and my siblings Diógenes, Marixel, Melva, Mariela, Yanina, Virgilio, Edwin, and Eucaris.

To the founders of the biosphere reserve concept.

Summary

This study is a valuation model of sustainability in a biosphere reserve. It was applied to the La Amistad Panama Biosphere Reserve (RBLAP), located in the northwest of the Republic of Panama, in Central America. The evaluation model is intended to be widely used in the analysis of whole sustainability and nature conservation status in any other biosphere reserve of the world.

As the main methodology were used the indicators recommended by the United Nations Commission on Sustainable Development (CSD indicators). They were chosen because they are the most complete set of indicators available. They have been discussed in extensive global consultations and adapted with consensus on the global agenda on this topic.

This study also shows, in the sense of a didactic exercise, how recommendations on sustainable development issues were evolving in global forums, especially since 1980 with the publication of the World Conservation Strategy of IUCN (International Union for Conservation of the Nature) and the Brundtland Report of 1987 and subsequent United Nations conferences about development and environment. Based from these ideas, the concept of the Biosphere Reserve developed the own conceptual framework, or guidelines of sustainable development, beyond the biological issue of biodiversity conservation by itself.

The valuation of each of the CSD indicators in LAPBR was necessary to define with certainty the extent of the area of the biosphere reserve. This study analyzed the boundaries of the core, buffer, and transition zones of the LAPBR. The map of LAPBR was clearly defined, because many indicators under analysis required a precise area for the analysis.

The result of sustainability analysis is based on a network of indicators that are grouped in three pillars. These three main theoretical pillars of sustainable development are presented in this research: The social, the environmental (segregated in general and nature conservation) and the economic pillar. These pillars are divided into sub-issues in order to deal with more specific analysis.

Thus, the RBLAP has a total of 56.3% of progress in sustainability, which is a low

percentage compared to the acceptable minimum (>70%). In the pillar analysis, the best progress in sustainable development is the environmental pillar with 73.3%, 46.7% for social pillar and 36.1% for the economic pillar.

The progress for the environmental sub-pillar about general-physical indicators was 71.64% and for the environmental sub-pillar of nature conservation was 75%.

The synopsis of the study shows that if the CSD indicators are segregated into sub-pillars and themes then they can be used for the public and decision-makers, and of course, for development programs and projects in a biosphere reserve with the purpose to improve the levels of advances in sustainable development.

The conclusions show that the whole set of CSD indicators used are adequate to properly assess sustainability, including analysis of nature conservation within a biosphere reserve, and therefore can be seen as the best way to incorporate a priority and biologically rich area within the global agenda of sustainable development.

Zusammenfassung

Diese Studie ist ein Bewertungsmodell der Nachhaltigkeit in einem Biosphärenreservat. Es wurde im La Amistad Panama Biosphärenreservat (RBLAP), im Nordwesten der Republik von Panama in Mittelamerika eingesetzt.

Das Bewertungsmodell, welches hier dargestellt wird, soll universell in der Analyse der Nachhaltigkeit in allen anderen Biosphärenreservaten der Welt anwendbar sein.

Aufgrund der Existenz von zahlreichen Indikatoren zur Nachhaltigkeit, habe ich in dieser Forschung als Hauptmethode die von der Kommission der Vereinten Nationen empfohlenen Indikatoren für nachhaltige Entwicklung (CSD-Indikatoren) verwendet, unter Berücksichtigung der Tatsache, dass diese komplette Reihe von Indikatoren, in umfangreichen globalen Konsultationen bereits diskutiert und mit breitem Konsens in der globalen Agenda (zu diesem Thema) angenommen wurden.

Diese Studie zeigt auch, im Sinne einer didaktischen Übung, wie Empfehlungen zu Fragen der nachhaltigen Entwicklung in globalen Foren weiterentwickelt wurden, vor allem seit 1980 mit der Veröffentlichung des World Conservation Strategy der IUCN (International Union for Nature Conservation) und dem Brundtland-Bericht von 1987 sowie Folgekonferenzen der Vereinten Nationen über die Entwicklung und Umwelt.

Based from these ideas, the concept of the Biosphere Reserve developed the own conceptual framework, or guidelines of sustainable development, beyond the biological issue of biodiversity conservation per se.

Anhand dieser Ideen, das Konzept des Biosphärenreservats innerhalb des eigenen konzeptionellen Rahmen hinzugefügt, diese Leitlinien der nachhaltigen Entwicklung, über die Frage der Erhaltung der biologischen Vielfalt an sich. Die vorgeschlagenen Indikatoren zur Beurteilung der Nachhaltigkeit in einem Biosphärenreservat werden von dem internationalen Kontext unterstützt und ermöglichen somit deren universelle Anwendung. Die Bewertung der einzelnen CSD -Indikatoren in LAPBR war notwendig, um mit Sicherheit, das Ausmaß der Fläche des Biosphärenreservats zu definieren.

Diese Studie untersucht die Grenzen des Kerns, Puffer- und Übergangszonen des LAPBR. Das vorhandene Kartenmaterial wurde aktualisiert und verbessert, weil viele

Indikatoren eine präzise Flächenangabe erfordern, um in der Studie untersucht werden zu können.

Das Ergebnis der Nachhaltigkeitsanalyse basiert auf einem Netzwerk von Indikatoren, die in drei Säulen eingeteilt werden. Diese drei Hauptsäulen der nachhaltigen Entwicklung werden in dieser Forschung vorgestellt: Die Sozial-, Umwelt- und Wirtschaftsfragen. Diese Säulen sind in Unterthemen unterteilt, um so auch didaktische Zwecke zu erfüllen. So hat das RBLAP einen Gesamtfortschritt von 56,3% in der Nachhaltigkeit aufzuweisen, was einen sehr geringen Prozentsatz im Vergleich zu dem minimalen annehmbaren Wert von > 70% darstellt.

Betrachtet man die Analyse der nachhaltigen Entwicklung in den drei einzelnen Säulen, so bekommt man die besten Werte im Bereich Umwelt mit 73,3%, gefolgt von 46,7% im sozialen Bereich und 36,1 % für den wirtschaftlichen Bereich.

In der Synopse der Studie wird ersichtlich, dass bei Einteilung der CSD-Indikatoren in Unterthemen, die Vervendbarkeit dieser der allgemeine Öffentlichkeit und bei Entscheidungsträgern möglich ist. Ebenso können diese Indikatoren für die Entwicklung von Programmen und Projekten in Biosphärenreservaten bei denen man das Niveau der Fortschritte in der nachhaltigen Entwicklung erhöhen will dienlich sein.

Resumen

Este estudio ha demostrado cómo usar un conjunto de indicadores de desarrollo sostenible para desarrollar una evaluación de sostenibilidad en la Reserva de la Biosfera La Amistad Panama (RBLAP), localizada en el noroeste de la República de Panamá, Centroamérica. El modelo de evaluación presentado intenta ser universal para que sea útil en el análisis de sostenibilidad en cualquiera otra reserva de la biosfera del mundo.

Debido a la existencia de numerosos indicadores, esta investigación ha utilizado como insumo principal los indicadores recomendados por la Comisión de las Naciones Unidas para el Desarrollo Sostenible (indicadores CSD), que son el conjunto de indicadores más completos y discutidos en amplias consultas mundiales y adoptados con consenso por la comunidad internacional e integrados en la agenda mundial sobre el tema.

Este estudio también muestra con ejercicio didáctico que las recomendaciones sobre temas de desarrollo sostenible fueron evolucionando en los foros mundiales, especialmente desde 1980 con la publicación de la Estrategia Mundial de Conservación de la Unión Internacional de la Conservación de la Naturaleza (UICN), y con el Informe Brundtland de 1987 y las subsecuentes cumbres de las Naciones Unidas sobre desarrollo y medio ambiente de 1992 y 2002. Paralelo, las Reservas de Biosfera como concepto fueron incorporando, dentro del marco conceptual, estos lineamientos de desarrollo sostenible, más allá del tema de la conservación de la biodiversidad.

Para desarrollar o estudiar el estado de avance de cada uno de los indicadores CSD en LAPBR definimos con certeza el área o extensión que comprende la reserva de la biosfera. Este estudio diseñó los mapas de la zonas núcleos, amortiguamiento y transición de la RBLAP, con tal el fin de poder analizar los indicadores de sostenibilidad quer requieren una definición precisa de la extensión del área de estudio o sus partes.

En esta investigación se presentan los resultados de los indicadores evaluados, primero separados en los tres principales pilares teóricos del desarrollo sostenible:

social, ambiental (dividido indicadores físico-generales e indicadores de conservación de la naturaleza) y económico. También se presenta el análisis unificado y por temas de desarrollo. Así tenemos que, la RBLAP tiene un avance total en sostenibilidad de 56.3%, que es un porcentaje bajo a lo mínimo aceptable que debe ser mayor a 70%. El análisis por pilares demostró que el mejor avance en desarrollo sostenible lo tiene el pilar ambiental con 73.3%, 46.7% el pilar social y 36.1% el pilar económico. El pilar social también incluyó los aspectos institucionales del desarrollo.

El avance para los sub-pilares ambientales fisico-generales fue de 71.64% y para el sub-pilar relacionado a la conservación de la naturaleza fue de 75%, que son valores aceptables (>70%), pero no buenos (>80%) o excelentes (>90%).

La sinopsis de la investigación muestra el análisis de los indicadores CSD, segregados en sub-conjuntos temáticos, con tal ser más comprensibles al público en general y para los tomadores de decisión; y que a su vez sean útiles para el desarrollo de los planes, programas y proyectos que requiere la reserva para mejorar los niveles de avances de desarrollo sostenible que requiere la reserva.

Las conclusiones demuestran que todo el conjunto de indicadores CSD utilizados son adecuados para evaluar adecuadamente la sostenibilidad dentro de un reserva de biosfera, y por tanto, pueden vistos como la mejor manera de incorporar un área prioritaria y de riqueza biológica, en la agenda mundial del desarrollo sostenible.

CHAPTER 1

Biosphere reserve concept and sustainable development indicators

1. Introduction

La Amistad Panama Biosphere Reserve (LAPBR) was awarded as part of the network of biosphere reserves of UNESCO MAB program in 2000, with the official name of "La Amistad Panama Biosphere Reserve" (LAPBR). This name allows people to identify the 'Reserve' with the main core zone --La Amistad National Park[1], also is known La Amistad International Park (PILA). The addition of the country name if to avoid confusion with the same name of a separate biosphere reserve in Costa Rica.

Is worth highlighting that both the Costa Rican and Panamanian parts of PILA are jointly inscribed in 1990 on the UNESCO World Heritage List[2] under the name of 'Talamanca Range-La Amistad Reserves/La Amistad National Park[3]'. Therefore, this core area of LAPBR has a strong legal conservation priority at the local, national, regional and global[4] levels and can not be ignored, in any circumstances by the binding compromises by national law and World Heritage Convention.

In this chapter I develop an introduction of this research based on three themes: history of biosphere reserves, discussion about biosphere reserve concept, and the linking with sustainable development indicators. It also contains the hypothesis, goals, objectives, and explanation of the structure of this document.

The underlying philosophy in this study is to test the feasibility of using sustainability indicators, already existing, to determine the status of sustainable development in a biosphere reserve, as is expected of those reserves according its statuary framework

1 La Amistad International Park= La Amistad National Park. La Amistad Transboundary Biosphere Reserve is both Panama and Costa Rica. La Amistad BR in Costa Rica was created in 1988 and in Panama in 2000.
2 UNESCO-UK. 2014. Online: http://www.unesco.org.uk/uploads/biopshere%20reserves%20faq.pdf. 02/26/14
3 UNESCO. 2014. Online: http://whc.unesco.org/en/list/205. 02/26/14
4 Article 6 of WH Convention. See details in UNESCO (1972).

and guiding principles. It is therefore important, to know the history and evolution of the concept, from its origen in the early 1970s, in relation to the origin of the definition of sustainability indicators and the whole evolution the sustainable development concept.

I am completely aware that sustainable development is a key framework for justify in ethical, political, scientific and pragmatical terms, a key support for nature conservation, as a part of a 'true' sustainable development objective, beyond the discourse of the political community at a side, or the rest of stakeholders at the other side. In this chapter and in the next I explain briefly these ideas.

1.1. Biosphere reserve history

UNESCO has the merit of being the first multilateral[5] agency that scientifically studied global issues about environmental problems that resulted in the creation of biosphere reserves in the world. The goal of the UNESCO Man and Biosphere Programme (UNESCO-MAB) was, promoting an interdisciplinary work, looking for modern overview for international environmental policies based in ecosystem approach (UNESCO-MAB, 2007).

The Biosphere Reserve as a concept born in 1968 in the Conference on the Rational Use and Conservation of Resources of the Biosphere[6] for promote scientific knowledge and personnel necessary for rational use and conservation of land resources (Batisse, 2003, 1982) headed by the Man and the Biosphere (MAB) Programme, an Intergovernmental Scientific Programme, founding the scientific basis “for the improvement of the relationships between people and their environment globally”[7].

Batisse (1982) states, that the simplest way to describe a biosphere reserve concept is to say that, “*it is essentially an attempt to make conservation more systematic, more scientific, more relevant to human needs, and more socially and economically*

5 Government, politics and diplomacy decisions involving more than two nations or parties. (Source: Enciclopedia Britanica and Free Online Dictionary).

6 UNESCO. 1968. Final report of Intergovernamental conference of experts on scientifical basis for rational use and conservation of the resources of the biosphere. Paris. 4-13 september 1968. Online: http://unesdoc.unesco.org/images/0001/000172/017269eb.pdf. 10/16/13

7 UNESCO. nd. Man and Biosphere Program online. Online: http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/. 10/20/13

acceptable to the populations concerned".

Officially born with the Resolution 16 C/Res. 2.313, adopted at its 16th session in 1970. During the General Conference was decided to launch a long-term intergovernmental and interdisciplinary programme on "Man and the Biosphere" known as UNESCO-MAB. Statutes were later proclaimed by the subsequent UNESCO General Conference 19th (19C/Resolution 2.152) (1976), 20th (20 C/Resolution 36.1) (1978) 23rd (1985), 25th (1989) and 28th (28 C/Resolution 22) (1995) sessions[8]. The biosphere reserves formal statutes were formulated in 1995, together with the Sevilla Strategy (UNESCO-MAB, 1995).

According Batisse (2003) in the beginning no reference to 'biosphere reserves' were dealt, but later, in 1969 in scientific consultations the idea emerged as a network of protected areas serving as conservation, research, and education. They arrived to be as multi-functional biological reserves in the language of UNESCO-MAB and they were referring these areas as 'biosphere reserves' without any precising meaning to this term (Batisse, 2003).

From the launching plan of MAB in 1970 was given the first official definition of 'biosphere reserves' (Batisse, 1982), where "this definition continued to stress their research and logistic role rather than conservation per se...". UNESCO's MAB Programme meeting declared objectives in utilization, preservation of ecosystems, genetic resources, habitats of domesticated plants and animals, remnant population of rare and endangered species (Batisse, 2003). The facts expressed of Batisse, as expert-participant[*] show clearly the philosophy of BR in terms of conservation, but in this case, including for first time, the society as user of the natural resources and as a part of solution for conservation of nature in long term.

In 1971 (UNESCO-MAB, 1972) was officially the first meeting of the MAB council and the statutes were of this program was launched, establishing the general scope of this programme. The scope emphasized in a MAB interdisciplinary programme with ecological approach 'for to study' the interrelationships between the environment and human. It, also, was focussed in studies of structures and functioning of the

8 International Coordinating Council of the Man and the Biosphere Programme (MAB). 2013. Online: http://www.unesco.org/confgen/sub_bodies/en_sub_3.shtml. 10/25/13

* Senior Environmental Adviser (formerly Assistant Director-General [Science Sector]), UNESCO, 7 Place de Fontenoy, 75015 Paris, France.

biosphere reserve.

In the objectives of the MAB Programme in 1971, was established to develop the basis inside of natural and social sciences for 'rational use and conservation of resources' (UNESCO-MAB, 1972). In 1973, the BR continued only in conservation role, and was interpreted as a bias, that was mitigated in 1974 (UNESCO-MAB, 1973; Batisse, 2003). According to Batisse (2003) were UNESCO and UNEP in a joint task force who drew up in 1974 the objectives and characteristics for Biosphere Reserves valid to the present (see UNESCO-MAB, 1974).

Is in 1974 that born three BR functions: 1-) protective; 2- logistical, and 3-) development. Is mandatory within a good management of BR a function as an area for natural resources conservation; an area for collaborative international working and exchange of information and experience, as well as a model of monitoring area and environmental education. This is the true beginning of the MAB Programme with interdisciplinary research agenda and capacity building, targeting the ecological, social and economic dimensions[9] for a sustainable development (although without use explicitly the concept) as paradigm of growing in human terms and conservation of ecosystems at the same time.

The original focus of UNESCO-MAB on Biosphere Reserves, used only two main keywords in the statement: 'sustainable use' and 'conservation.' At that time, the integration of the concept was approaching the definition, but definitely was incomplete, since not included in the direct context of the broader concept of 'development' that includes the social and economic dimension, in addition to environmental dimension emphasized from the start that program.

Literally, in 1984, was clear that a Biosphere reserves, “by definition and intent” should have economic and social benefits for stakeholders, especially local people. Also should be an area for sustainable development model, “tied to conservation” (UNESCO-MAB, 1984). The IUCN report from 1980 (IUCN et al., 1980) could be the main cause of the explicit use of the “sustainable development” concept in the UNESCO BR definition, by that time. The article of (Ishwaran et al., 2008) was wrong in to highlight that 'Action Plan for Biosphere Reserves' was the origin of use of sustainable development concept before the statements of United Nations

9 Idem 2

Conference on Environment in 1987.

However, these goals at the time of creation were completed towards sustainable development or idiomatic paradigm called: sustainability and was fully assumed by the program formally with the Seville Strategy and the statutes were launched in 1995. This is the reason why UNESCO-MAB currently framed clearly as program objectives, the development of the bases within the natural and social sciences, for the sustainable use and conservation of biological diversity, and for the improvement of the relationship between people and environment globally.

Those are the underlying reasons for today Biosphere Reserves are recognized as demonstrative purpose, with good sustainability indicators and should be the first regions of a country with a sustainable development model in the full sense of the word. These areas should be an implicit mission to be a model of sustainability area, where they are considered equally the three current paradigms of sustainable development: society, environment, and economy.

It is therefore, necessary to know, whether it is indeed possible to have full or partial estimates of sustainability in a biosphere reserve, which in turn serve as a basis and example of application of models of sustainability in other areas with spatial dimensions, natural resources and similar society within a country.

Some experts, as Bridgewater (2002) supports the term 'cultural landscape', referring to the interaction between cultural influences and nature. They states that for protect and manage particular ecological systems, is necessary an understanding of its cultural context for to achieve sustainability, because local culture is shaped in many ways from the landscape where the people are living. This focus is near to ecosystem approach proposed by MAB as a model to follow, specially in Biosphere Reserves Network and is a good context for comprehension of landscapes with nature and people as basic scale of action for long term results in the social, economic and environmental agenda. They are complementaries and not contradictories.

Batisse (1982) indicated that the greatest merit of the 'Biosphere Conference' from 1968 was the statement of the conservation of environmental resources “could and should be achieved alongside of their utilization for human benefit”, but with preservation of genetic resources.

UNESCO (1974) too proposed a zonation in a biosphere reserve with a core area strictly protected, a buffer zone or inner buffer zone strictly delineated, ables for develop non-destructive activities, and the transition area or outer buffer zone ables for the function of experimental research, traditional use, rehabilitation including cooperation of the BR. Buffer zones are useful for education and training, tourism and recreation, research and experimentation; and transition zone are useful for research and experimentation too with tourism and recreation; core area should be used for environmental observation and monitoring (see schemes and details in Batisse, 2003). These zoning have been key to better understand the concept of sustainable development in a region.

A Biosphere Reserve for to be different to a category of protected area existing should do not only nature conservation, also should build up the multiple functions of BRs explained for the beginning of the idea. In 1984 is established by MAB Council the 'Action Plan for BRs' subsequently endorsed by UNEP, UNESCO and IUCN (Batisse, 2003) incorporating the official Scientific Advisory Panel for BRs, a sensitive step required earlier according Batisse (2003) specially for define the nature and uniqueness of BRs beyond a traditional protected area.

The first Action Plan for Biosphere Reserves or programme framework for Biosphere Reserves (BR) was incubated in 1983 in the First International Biosphere Reserve Congress, and adopted by the International Coordinating Council of the Programme on Man and the Biosphere (MAB) in December 1984 and discussed by UNEP and UNESCO in 1985 (Batisse, 1985). This framework (1985-1989) delineated a wide range of actions for consideration by Governments and international organizations working in the functions of Biosphere Reserves within the overall context of the Man and Biosphere (MAB) Programme as a World Conservation Strategy for BR (Batisse, 1985).

In this scenario of international environmental politics is imperative the active participation of governments and international organizations for to enhance the role of BR network, linking with success conservation and development as the broad objectives of MAB (Batisse, 1985).

For first time was pushed the idea of the management of protected areas depends highly of communities, not only law and regulations in isolated protected areas, specially in developing countries. The biosphere reserve concept, allows to incorporate the conservation issues as basic ingredient and in counterbalance of attention and priorities highly required for a concrete human development. In few words, with this model is possible to enhance the quality life of people through conservation activities. The sustainability can be analyzed in BRs as laboratories of application of the concept. Now it is obvious, that the idea that the conservation is basic for the development and not inverse.

Nowadays the MAB Programme is located in UNESCO Division in Ecological Sciences and continues with support of interdisciplinary research, demonstration and training in natural resource management. MAB contributes to better understanding of the environment, including global change and greater involvement of science and scientists in policy development concerning the wise use of biological diversity[10].

From BRs were designed in 1976 and today the international network has reached more than 610 BR in 117 countries, including 12 new ones in 2012. In 1982 grow up to 208 BRs, but with bias in conservation function not well integrated with the development and logistic functions of BRs (Batisse, 2003). According to this author in 2003 "by and large" the list of designated BRs did not properly convey the innovative multi-functional approach embodied in the original concept launched by UNESCO in 1971. In 2012 in the 24th session of UNESCO-MAB was approbed to review this problem stressed by Batisse.

At present, the evolution of BR concept is going to various themes as transboundary co-operation, sustainability science; the importance of local governments, local, national and global governance processes to demonstrate nested governance arrangements. Furthermore, the BR are involving public and the private sector and the civil society critical for effective functioning; food security, follow-up Rio+20; also strengthen its relations and co-operation with other Conventions (CBD, UNFCCC, UNCCD), international initiatives (UN Forest Forum) and international events related to protected areas and sustainability, as well as themes about green economy and

10 UNESCO. 2013. What is a Biosphere Reserve. Online: http://www.unesco.org/new/en/phnompenh/natural-sciences/biosphere-reserves/tonle-sap-biosphere-reserve/what-is-a-biosphere-reserve/. 01/08/13

sufficiency economy[11].

1.2. Clarifications about biosphere reserve concept

Even in these times, the biosphere reserve (BR) concept is confusing. In fact, it has been from the beginning as indicated by Batisse (1982). This author indicated that this confusion is due to the multifaceted concept and it has needed some development to move from theory to practice. A similar case is the concept of sustainability that was adopted by the MAB for RB in 1995.

The concept is in evolution because has been progressively clarified (Batisse 1982), and it has been seen mainly as a response to wider trends in the fields of conservation and resource management and was the base for the evolution of sustainable development concept (Kellert, 1986). The theoretical experts in conservation have high interest in the outer zones of biosphere reserves (transition and buffers) because the long term conservation challenge is just inside of the local communities as neighbors of protected areas.

Currently the transition zones and some buffer zones of BRs are the most big challenge in order to get a sustainable model because is full of human needs, motivations, and individual/corporative interests, plus the missing institutional strengthening. In this scenery the major goal in to convince through education; social support and political compromises, and many other social factors of development.

Today the official vision of biosphere reserve is described in Madrid Action Plan for Biosphere Reserves as "*a dynamic and interactive network of sites"* with characteristics of excellence for sustainable development with dialogue with stakeholders for decision takers. They should share experiences for to alleviate poverty and improve human conditions under the paradigm of respect to cultural values and abilities of society for to head with leadership in the relation between man issues and nature resources for a good and real sustainable development in many contexts (Madrid Action Plan for Biosphere Reserves 2008–2013[12]).

According to Ishwaran et al., (2008), as UNESCO staff, states that after Seville

11 24th session proceedings of UNESCO-MAB Conference 2012.

12 UNESCO. 2012. Biosphere Reserves – Official Documents: http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/related-info/publications/biosphere-reserves

Strategy the biosphere reserves were not longer considered 'merely as protected areas' plus additional zones. In post-sevilla time the BRs should be considered as "*ecosystems and landscapes where sustainable development, characterised by a context-specific relationship between biodiversity conservation and socio-economic growth, came to be viewed as the essence of the governance and management of the designated area" (Ishwaran et al., 2008).*

1.3. Sustainable Development indicators

The sustainable development indicators are based on the evolution of the concept of sustainable development which I will develop in Chapter 3. This evolution has a history of at least 45 years of advancing. It is based on multilateral dialogue involving political and technical actors in various disciplines and interests. In my opinion the concept needs to evolve a bit more and therefore also the respective indicators.

In my historical analysis about sustainable development indicators I can register ideas from the following multilateral conferences and publications: 1-) The Biosphere Conservation Conference achieved in 1968; 2-) The Human Environment Conference achieved in Stockholm in 1972; 3-) World Conservation Strategy, a strategic publication of IUCN, that launched, for first time, the concept of sustainable development in 1980; 4-) Conference on Environment and Development -Earth Summit achieved in Rio of Janeiro in 1992; 5-) the World Summit on Sustainable Development, achieved in Johannesburg in 2002. The next conferences will open discussions about additional indicators, but also the merging, deleting and improvement of the current list of indicators.

The indicators as concept are old in use for many purposes. UN DESA (2007a) established that,

> *"Indicators perform many functions. They can lead to better decisions and more effective actions by simplifying, clarifying and making aggregated information available to policy makers. They can help incorporate physical and social science knowledge into decision-making, and they can help measure and calibrate progress toward sustainable development goals. They can provide an early warning to prevent economic, social and environmental setbacks. They are*

also useful tools to communicate ideas, thoughts and values".

Agenda 21 clearly established global problems and challenges that must be studied and applied to achieve a sustainable development model. Indicated how to find the best indicators of sustainability beyond the traditional and commonly used gross domestic product (GDP) or the isolated measurement of environmental problems and misuse of natural resources.

Agenda 21 discussions concluded that, in fact, until 1992 there was no consensus on methods for assessing the human dimensions of development and their interactions in the environmental, demographic, social, or development plans with appropriate analysis parameters that, would be useful to establish policies or regional consensus for development. It means that the path toward sustainability measurements have only a little more than 20 years of theoretical and practical journey.

Agenda 21 also strongly emphasized that "indicators of sustainable development need to be developed to provide solid bases for decision-making at all levels and to contribute to a self-regulating sustainability of integrated environment and development systems" [13]. In this sense, over the last decade and across the world, a multitude of indicator systems has been developed on international, regional, national and local scales (UN DESA, 2007a).

According UN DESA (2006) the indicators of sustainable development have flourished since the early 1990s, containing 669 indicator initiatives as of December 2005, in the database Compendium of Sustainable Development Indicator Initiatives database, maintained by the International Institute for Sustainable Development.

The current problem, and challenge, is how to filter, to choose, to implement or to analize together one set of indicators, useful in national or other scale of analysis.

Many countries have already chosen their own sustainability indicators, as is the case in several countries in Europe and then across the European Union as a geo-political body.

There are also several global initiatives that promote appropriate indicators for measuring sustainability, which is resulting in triggering many indicators, almost all at the country level. The international financial institutions and cooperation are the main

13 UNEDE/OECD/Eurostat WG on Statitics for Sustainable Development 2008

promoters driving the adequacy of the statistical data of the countries.

The key fact about indicators is how to use these indicators values for decision takers. Indicators with good statistics also require additional management for a good comprehension of cluster dataset, showing the status of sustainable development in a country, area, or region. The analysis for smaller areas or regions is also key to decentralized decision making.

The sustainable development, as a multi-dimensional concept, is difficult to measure (Herrera-Ulloa et al., 2003). They are proposing that national sustainability indicators should result from a combination (whether additive or proportional) of regional (inside a country) sustainability indicators.

The challenge with regional data and even national data from a country's that are still in development or incomplete. This is most evident in developing countries. Even so in necessary to complete an assessment of sustainability with the existing data and to probe the data quality. This also is useful for to know what data should be included in a statistical program within a region or within a special area as a biosphere reserve.

Commonly, outside of the official protected areas the proper performance of a conservation area depends mainly on local actors, but in protected areas never can be ignored the national stakeholders, and the international community if the area is a World Heritage Site or a Ramsar Site. This is one reason that a Biosphere Reserve can be the best body of integration of nature conservation and general environmental topics, inside the agenda of sostenible development, without barriers, between stakeholders. In my opinion the sustainable development in a region is only possible, if the majority of local sustainability indicators show good progress. It means that the long term success of nature conservation is directly linked with the quality life of the people and its demands in diverses forms.

Some national indicators can be incorporated as the foundation of the local situation, but in many cases, is more convincing, to know the local state of the indicators, which I assume is also reflected in the incorporation of the natural area in the development scheme of the people.

The UN DESA (2007a) indicators were product of the two earlier sets of indicators from 1996 and 2001 required by the UN Commission on Sustainable Development in 1995. All these indicators are coming from a global perspective to a national view, to a local view.

This study uses the indicators of sustainable development proposed by UN DESA in 2007 adapted to the geographical scale of the Biosphere Reserve La Amistad, and the feasibility and convenience of using such indicators.

The set of indicators used from UN are from a mandate of work programme on indicators of sustainable development approved by the Commission on Sustainable Development at its Third Session in 1995. They were consulted with collaboration between governments, international organizations, academic institutions, non-governmental organizations and individual experts, and based in network of cooperation and consensus building (UN DESA, 2001).

According UN DESA (2001) these set of indicators were created for to get a better understand the various dimensions of sustainable development and the complex interactions that takes place between these dimensions. Is important to highlight that now exists a myriad of ideas about how to deal the big sustainable concept, and specially how to measure this development.

No set of indicators can be final and definitive for a country, but could be developed and adjusted over time to fit country-specific conditions, priorities, and capabilities, according the opinion of JoAnne DiSano, Director of Division for Sustainable Development in 2001 (UN DESA, 2001). One challenge is to adapt these indicators to small scale in a country or region.

In a revision of 2006, UN DESA established and reaffirmed that indicators of sustainable development are important tools to increase focus on sustainable development, and to assist decision-makers at all levels to adopt national sustainable development policies (UN DESA, 2006).

UN DESA (2006) recognized that sustainability indicators, indices and reporting systems are growing popularity, but their effectiveness in influencing current policy and practices are still limited. The hypothesis of this statement are two: bad comprehension of the concept, and lack of idea in how to analyze together a chosen set of indicators. Under this idea was choosed only one set of indicators proposed by

UN DESA in 2007 under the assumption that is a first international filter of sustainable development indicators, with consensus and with basic definition, explanation about sustainability and methodology. Some authors as Mebratu, (1998); Parris and Kates (2003) are critical about all existing indicators before 2003, but they do not have alternatives proposal for to solve the critics, although the analysis together was well grounded for future discussions for to improve the new versions of indicators.

The 2007 revised edition of the indicators was developed by request of CSD and the World Summit on Sustainable Development in 2002, which encouraged further work on indicators at the country level in line with national conditions and priorities, emphasising on measuring progress on achieving sustainable development (UN DESA, 2007a).

In the biosphere reserve, I am trying to solve how many indicators can be useful for sustainability analysis, and how I can deal, as a set of indicators, for accurate analysis and mainly for to establish a model for to do this analysis with feasible and clear methodology and comprehensive results.

1.4. Research questions

1. ¿How to do and to apply a model of sustainability analysis for the LAPBR?
2. ¿How are the current advances of social sustainable development in LAPBR?
3. ¿How are the current advances of environmental sustainable development in LAPBR?
4. ¿How are the current advances of economic sustainable development in LAPBR?
5. ¿What is the current progress of sustainable development as a whole in the Biosphere Reserve La Amistad Panama?

1.5. Hypothesis

La Amistad region in the NW of the Isthmus of Panama (highlands of Chiriqui Province, Western Ngäbe Bugle Comarca and the province of Bocas del Toro) has a high sustainable development, since it is a biosphere reserve and follow the guidelines of sustainable development that have arisen globally to achieve those goals.

The application of valuation models for sustainable development through validated indicators by consensus are feasible and easy to apply methods to establish a complete evaluation of sustainability in a biosphere reserve.

1.6. Goals

1. Analysis of general facts and sustainability related to LAPBR.
2. Analysis of social indicators of sustainability in LAPBR.
3. Analysis general environmental indicators of sustainability in LAPBR.
4. Analysis of nature conservation indicators in LAPBR
5. Analysis economic indicators of sustainability in LAPBR.

1.7. Objectives

1. To define and map the complete area and zones of LAPBR.
2. To develop a social analysis of sustainability in LAPBR.
3. To develop an environmental analysis of sustainability in LAPBR.
4. To validate the biotic heterogenity through the study of vertical structure of the key natural forests of LAPBR.
5. To develop an economic analysis of sustainability in LAPBR.
6. To develop a total analysis of sustainability in LAPBR.

1.8. Structure of the thesis

This research is divided into 9 main chapters. Chapters 5, 6 and 7 are core of this research. It includes appendixes with the first maps of the biosphere reserve under study.

Chapter 1 develops an introduction about history of the biosphere reserves and the conceptual approach connected with sustainable development. As third part of this chapter, I introduce the indicators of sustainable development, including the indicators given by the United Nations Department of Economy and Sustainable Development (UN DESA). These indicators are the main input for the development of sustainability analysis proposed to LAPBR. The exercise intended to show a local experience to provide an example for application in other biosphere reserves of the world to another different scales beyond a country scale.

Chapter 2 develops the general and specific methodology for the development of each research objective and the complete analysis of sustainable development in LAPBR as study area.

Chapter 3 discusses the history of the concept of sustainability, which is the contemporary development paradigm, which is analyzed and discussed in this research. The chapter tries to demonstrate that the indicators discussed in the research have emerged from the global consensus on environmental, social and economic problems that have been discussed at global summits, led by the UN, since the late 1960s.

The 'route' of the historical evolution of the concept of sustainable development and the concept of biosphere reserve, are key to support decision makers, biosphere reserves and sustainable development are the best elements, pragmatic to follow the model throughout the country.

This chapter also tries to emphasize that the current guidelines for sustainable development have come at least four decades and even now are being consolidated into practice through standard indicators.

Chapter 4 attempts to analyze, discuss and finally map the entire context of the LAPBR and includes basic information about the major regions and areas of the Reserve. This chapter presents, for the first time, a complete map of the LAPBR with three complete areas. Without a clear definition of the area of a biosphere reserve is impossible to implement most of the sustainability indicators and is one of the reasons for the importance of this chapter.

Chapter 5 is one of four core chapters on the status of sustainable development in LAPBR. This chapter reviews the status of social indicators that are part of the social dimension of development. The last paragraph of analysis of each indicator shows a final assessment evaluation of the progress of every indicator, based on the scientific judgment of the researcher, but supported by the local knowledge of the area and in the raw data, official data or scientific information existing for the study area. If the indicator does not apply to the biosphere reserve in study, then I explain the reason. In the last section of this chapter I show a complete matrix and analysis of all social indicators evaluated, of which I obtain a reference value of sustainability.

Chapter 6 is one of four core chapters on the status of sustainable development in LAPBR. This chapter reviews the status of environmental indicators that are part of the environment dimension of development. The last paragraph of analysis of each indicator shows a final assessment evaluation of the progress of every indicator, based on the scientific judgment of the researcher, but supported by the local knowledge of the area and in the raw data, official data or scientific information existing for the study area. If the indicator does not apply to the biosphere reserve in study, then, I explain the reason. In the last section of this chapter I show a complete matrix and analysis of all environmental indicators evaluated, of which I obtain a reference value of sustainability.

Chapter 7 is the core chapter related to nature conservation, using the UN DESA (2007a) indicators about sustainable development. Similar to Chapter 5 and 6 the last paragraph is an assessment evaluation about the progress of these indicators in the LAPBR. The section about key ecosystem was enriched with field data about vertical structure of the natural forests in the study area. The last section of this chapter I have the matrix of evaluation of all indicators about nature conservation under analysis.

Chapter 8 is one of four core chapters on the status of sustainable development in LAPBR. This chapter reviews the status of economic indicators that are part of the economics dimension of development. The last paragraph of analysis of each indicator shows and assessment and numerical evaluation of the progress of every indicator, based on the scientific judgment of the researcher, but supported by the local knowledge of the area and in the raw data, official data or scientific information existing for the study area. If the indicator does not apply to the biosphere reserve in study, then, I explain the reason. In the last section of this chapter I show a complete matrix and analysis of all economic indicators evaluated, of which I obtain a reference value of sustainability. Also this study has the final evaluation of sustainability of the LAPBR as a whole.

Chapter 9 is a synopsis of analysis the whole of CSD indicators by themes in LAPBR.

Chapter 10 corresponds to the conclusions and recommendations of this research.

CHAPTER 2

Study area and methodology

2. Methodology

2.1. Study area

La Amistad Panama Biosphere Reserve (LAPBR) is an area located, near the Costa Rica border, in the northwest of Panama in Central America at 09°05' N; 82°40' W, in the NW of Panama Isthmus (Fig. 1). Within the political division in Panama, includes all province of Bocas del Toro in the extreme NW, a third part of Comarca Ngäbe Bugle (East) and the highlands of Chiriqui province (South) (Fig. 2).

This area includes lands with an altitudinal gradient from the Caribbean Sea to the Caribbean highlands of the Cordillera Central or Cordillera de Talamanca; also includes, highlands of the Pacific basin from 1000 meters above sea level to the peak of the Volcan Baru (3,474 m high, the highest peak in Panama) and the continental division in the Cordillera Central (Fig. 3). The Baru volcano is located exclusively in the Pacific side of this mountain range.

The Cordillera Central in Panama and Costa Rica is the highest non-volcanic mountain range in Central America, formed by the orogenic activity which created the land dividing the Pacific Ocean from the Caribbean (WCMC, 1990).

The reserve includes also a portion of Caribbean Sea with the Chiriqui Lagune and Almirante Bay in Bocas del Toro Archipelago. Furthermore the marine area includes shallow and deep waters (-400 m).

Fig. 1: La Amistad Panama Biosphere Reserve (LAPBR) is located in the extreme NW of Panama Isthmus.
Note the location in relation to Panamanian isthmus. Source: Background map from Openstreetmap (CC_by_SA) [14]

The relief in the Reserve is the main factor that defines the biological, physical and socioeconomic characteristics of the area. Near 90% of this area is rugged area (Fig. 3).

Many additional details about biophysical and social information are available from management plans, regional reports, and formal publications (ANAM, 2004; Aparicio, Candanedo, Martínez, & Delgado, 2006; Castro et al., 2010; Hidroteribe, 2000; MWH, 2008; Thorson, Barrera, & Gray, 2007; TNC, 2004; UNESCO-MAB, 2012; WCMC, 1990; West & Clark, 2006).

LAPB contains seven protected areas, six are core zone of the biosphere reserve: Volcan Baru National Park, La Amistad International Park[15], Bastimentos Island National Marine Park[16], San San Pond Sak Wetland, Lagunas de Volcán Wetland, Fortuna Forest Reserve. Only Palo Seco Protector Forest is a protected area considered as buffer zone (Fig. 4).

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14 OpenStreetMap is open data, licensed under the Open Data Commons Open Database License (OdbL). People are free to copy, distribute, transmit and adapt Openstreetmap data, as long as people credit OpenStreetMap and its contributors. More details online: http://www.openstreetmap.org/copyright.
15 La Amistad International Park is a national park and also UNESCO WHS in legal terms.
16 Bastimentos Island National Marine Park is also a national park in legal terms, and no difference exists with respect others national parks in Panama.

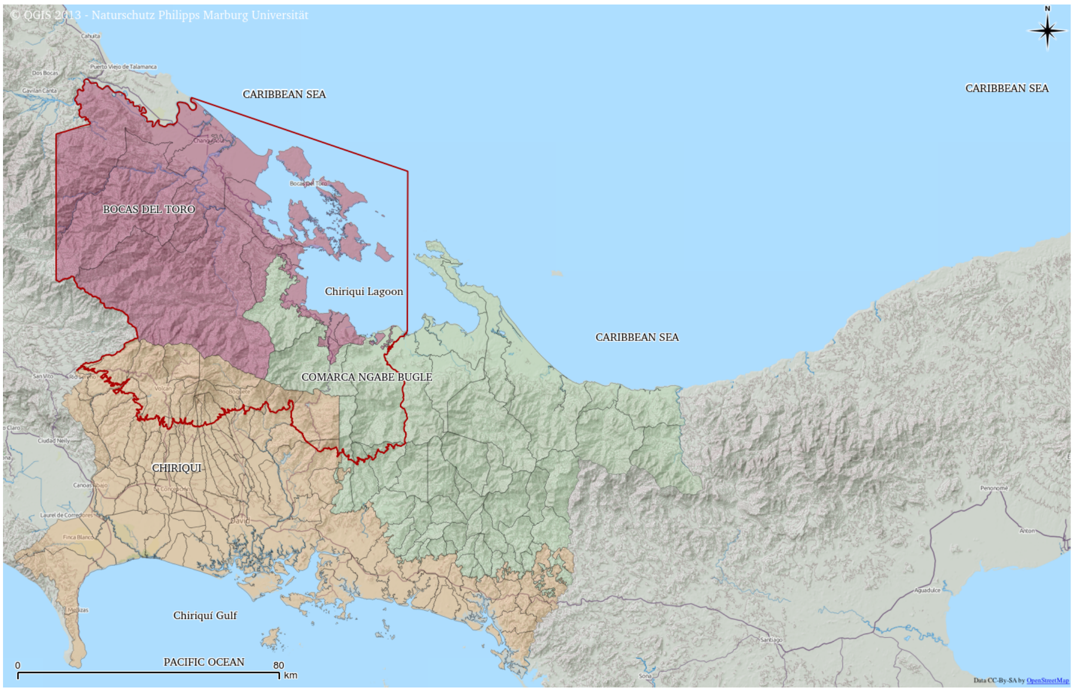

Fig. 2: LAPBR: La Amistad Panama Biosphere Reserve location in the NW of Republic of Panama (Bocas del Toro, Chiriqui and Ngäbe Bugle provinces)

Source: Provinces polygons from CGRP. Background from Openstreetmap (CC_by_SA) . Note in different colors, the location of Bocas del Toro, Chiriqui, and Ngäbe Buglé[17] provinces associated to the LAPBR.

2.2. Evaluation method for sustainable development indicators

The analysis of social (Table 1), environmental (including nature conservation indicators) (Table 2) and economic (Table 3) sustainable indicators for La Amistad Biosphere Reserve are following the definitions of CSD Indicators of Sustainable Development: Guidelines and Methodologies (UN DESA, 2007, 3th Edition). The first two paragraphs of every indicator are basically the international consensus definition adopted by the UN DESA publication, under the mandate of United Nations Commission on Sustainable Development (CSD)[18] (Table 1). Officially these

17 For this study was used, either, the word 'comarca' or 'province' when I am referring to the indigenous Ngäbe Bugle region. The Comarca term in Panama is used to identify regions with indigenous traditional right to autonomy, but also they have all the proper political and institutional structure of a province.

18 The United Nations Commission on Sustainable Development (CSD) was established by the UN General Assembly in 1992 to ensure effective follow-up of United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit. It was established as a functional commission of the Economic and Social Council by Council decision 1993/207. Its functions were set out in General Assembly resolution 47/191 of 22 December 1992 (Source: CSD Web page).

indicators are called CSD indicators.

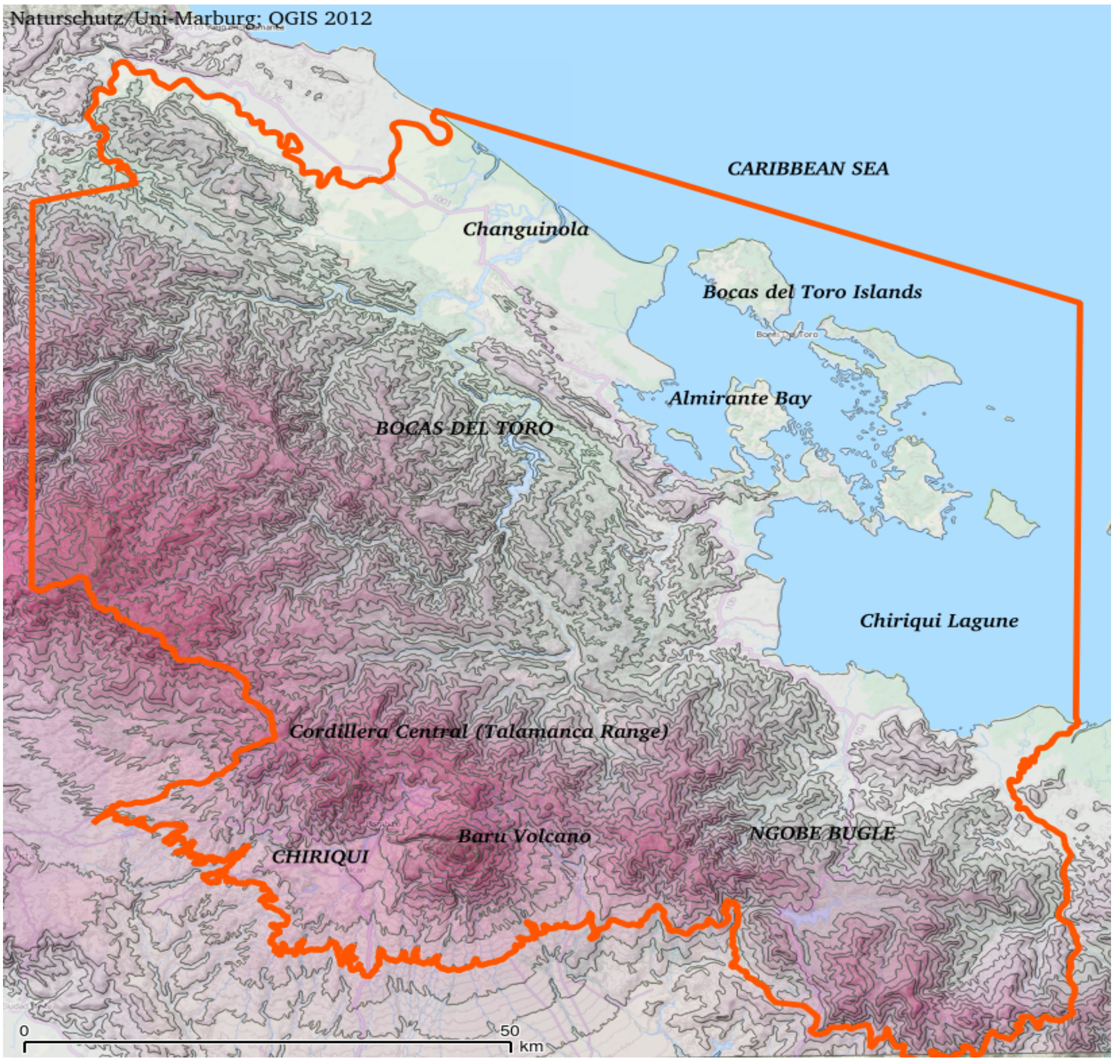

Fig. 3: LAPBR: The mainland area is a rugged relief with the highest mountains and peaks of Panama

Source: Background map from Openstreetmap (CC_by_SA) and data of altitudes from ANAM. Note the Baru volcano position in the south and outside of Cordillera Central.

Is not the intention of this research to change the meaning of the indicators. The aim is to use directly or adapt for analyzing the progress of sustainable development in a biosphere reserve. The definition and brief explanation adopted by UN DESA (2007a) are clear enough to understand its relation to sustainable development, without additional discussion.

CSD is an inter-governmental body whose members are elected by the Economic and Social Council (ECOSOC) from amongst the Member States of the United

Nations and its specialized agencies. This organism procures high participatory decisions in structure and outlook, by engaging in its formal proceedings a wide range of official stakeholders and partners around the world[19].

With every indicator I made an analysis with available data and information in formal publications, government agencies reports (e.g. census and survey of standard of living), internet publications, NGO's reports or publications, news, some informal interviews with stakeholders, World Bank (WB) database, (Inter-American Development Bank (IADB) database, the Economic Commission for Latin America and the Caribbean (ECLAC) and many another organizations with social, economic and environmental data from countries. The references also included local observation, and mapping of data, and incorporating my experience in the area for a good assessment (quality) and evaluation (quantity) for every indicator. The assessment also included decision by inference, when the data was insufficient for a direct analysis in LAPBR. Finally as researcher and expert in the area I decided an evaluation between 1 and 10 for each relevant indicator to LAPBR.

Some indicators by definition are not possible to apply to a biosphere reserve context. In these cases, I am calling these indicators under the term 'irrelevant'. An indicator is irrelevant, additional to the previous statement, when no elements about the indicator is present in the area. By definition, irrelevant means not relevant; not applicable or pertinent.

For many indicators, there were only general data for the country, and not detailed to the provinces associated with LAPBR. In these cases, national data were taken to try to understand the reality at the level of the reserve. I use in this case, extrapolation of these data, the area and the social-economic and environmental development of the biosphere reserve. In the chapters of the evaluation of the indicators, I explain the use or origin of the data. I am reporting when data are indirect, inferred or extrapolated from another values, especially from provincial data, but taking account of the area of every province inside of the biosphere reserve. In case of LAPBR are in the following proportion of the territory of provinces inside of the polygon of LAPBR: Bocas del Toro (100%), Chiriqui (~10%) and Comarca Ngäbe Bugle (~10%).

As a final evaluation procedure, I analyze separately, each pillar and sub-pillars of

19 Commission on Sustainable Development (CSD). 2013. Online: http://sustainabledevelopment.un.org/csd.html. 01/01/14

sustainable development (social, environmental and economic). Each indicator is assigned a weight between 1 and 3, that frame the priority or importance of the indicator in the study area. These weights are multiplied by the valuation and compared with the expected maximum values. From these valuation is possible to get the percentage of completion of each indicator, and is posible to obtain the rate of progress of every indicator, every pillar, sub-pillar or by themes, and the total advance or progress in sustainable development.

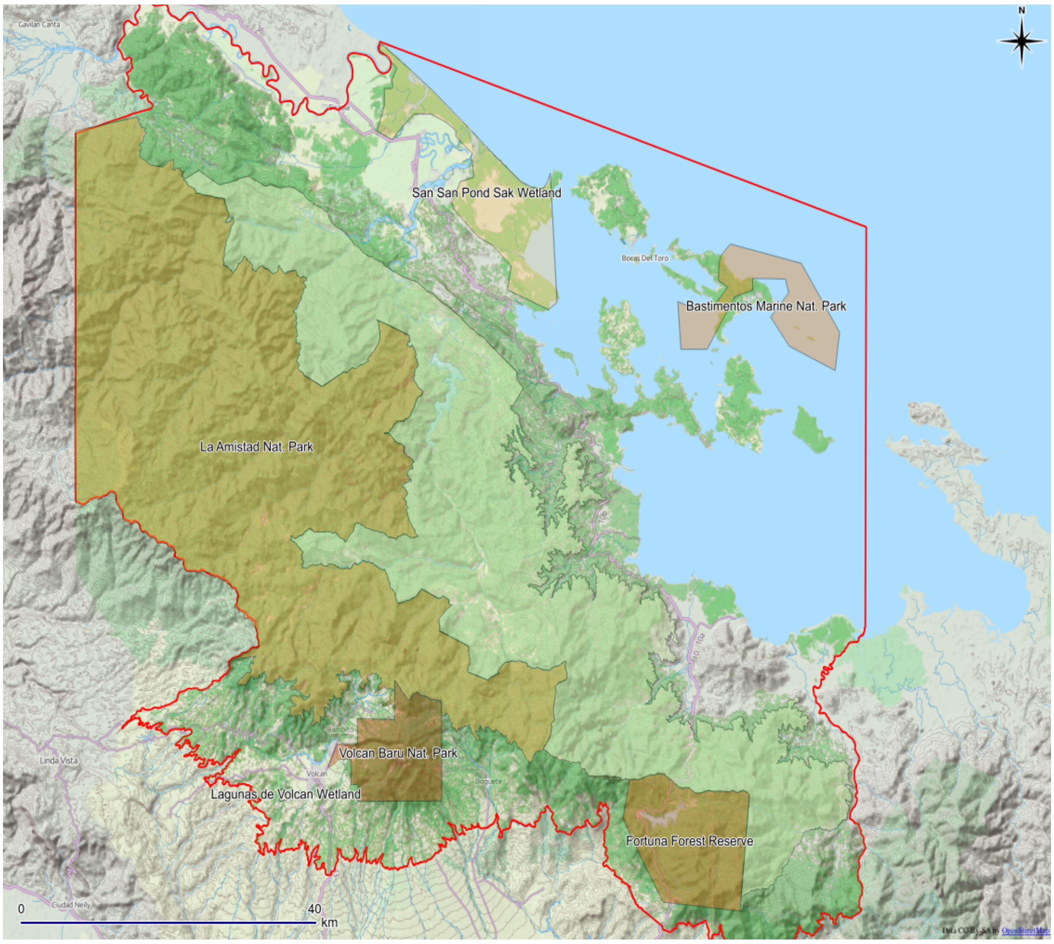

Fig. 4: Location of the protected areas of La Amistad Biosphere Reserve

Source: Modified from ANAM. Openstreetmap (CC_by_SA) as background map.

Table 1: List of social indicators about sustainable development proposed by the Commission on Sustainable Development of United Nations (CSD) used for the analysis of sustainability in La Amistad Panama Biosphere Reserve (LAPBR)

Nr.	Social Indicators of Sustainable Development
1	Proportion of population living below national poverty line
2	Proportion of population below $1 a day
3	Ratio of share in national income of highest to lowest quintile
4	Proportion of population using an improved sanitation facility
5	Proportion of population using improved water source
6	Share of households without electricity or other modern energy services
7	Percentage of population using solid fuels for cooking
8	Proportion of urban population living in slums
9	Percentage of population having paid bribes
10	Number of intentional homicides per 100,000 population
11	Under-five mortality rate
12	Life expectancy at birth
13	Healthy life expectancy at birth
14	Percent of population with access to primary health care facilities
15	Immunization against infectious childhood diseases
16	Contraceptive prevalence rate
17	Nutritional status of children
18	Prevalence of tobacco use
19	Suicide rate
20	Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis

21	Gross intake into last year of primary education
22	Net enrollment rate in primary education
23	Adult secondary (tertiary) schooling attainment level
24	Life long learning
25	Adult literacy rate
26	Population growth rate
27	Total fertility rate
28	Dependency ratio
29	Ratio of local residents to tourists in major tourist regions and destinations
30	Percentage of population living in hazard prone areas
31	Human and economic loss due to natural disasters

Source: Adapted from UN DESA (2007a).

The list of environmental indicators include 37, but for analysis they will be segregate in physical SD indicator and nature conservation SD indicators. These indicators are listed in the Table 2.

Table 2: List of environmental indicators about sustainable development proposed by the Commission on Sustainable Development of United Nations (CSD) used for the analysis of sustainability in La Amistad Panama Biosphere Reserve (LAPBR)

Nr.	**Environmental Indicators of Sustainable Development**
1	Emissions of greenhouse gases
2	Carbon dioxide emissions
3	Consumption of ozone depleting substances
4	Ambient concentration of air pollutants in urban areas
5	Land use change
6	Land degradation

7	Land affected by desertification
8	Arable and permanent cropland area
9	Fertilizer use efficiency
10	Use of agricultural pesticides
11	Area under organic farming
12	Proportion of land area covered by forests
13	Percent of forest trees damaged by defoliation
14	Area of forest under sustainable forest management
15	Percentage of total population living in coastal areas
16	Bathing waters quality
17	Proportion of fish stocks within safe biological limits
18	Proportion of marine area protected
19	Marine trophic index
20	Area of coral reef ecosystems and percentage live cover
21	Proportion of total water resources used
22	Water use intensity by economic activity
23	Biochemical oxygen demand in water bodies
24	Presence of faecal coliforms in freshwater
25	Waste-water treatment
26	Proportion of terrestrial area protected, total and by ecological region
27	Management effectiveness of protected areas
28	Area of selected key ecosystems
29	Fragmentation of habitats

30	Abundance of selected key species
31	Change in threat status of species
32	Abundance of invasive alien species
33	Generation of waste
34	Generation of hazardous waste
35	Waste treatment and disposal
36	Management of radioactive waste
37	Energy intensity of transport

Source: Adapted from UN DESA (2007a).

The list of economic indicators for SD and it includes 29. These indicators are listed in the Table 3.

Table 3: List of economic indicators about sustainable development proposed by the Commission on Sustainable Development of United Nations (CSD) used for the analysis of sustainability in La Amistad Panama Biosphere Reserve (LAPBR).

Nr.	Economic Indicators of Sustainable Development
1	GDP per capita
2	Investment share in GDP
3	Savings rate – Gross savings
4	Adjusted net savings as percentage of GNI
5	Inflation rate
6	Debt to GNI ratio
7	Employment-population ratio
8	Vulnerable employment
9	Labor productivity and unit labor costs
10	Share of women in wage employment in the non-agricultural sector

11	Number of Internet users per 100 population
12	Fixed telephone lines per 100 population
13	Mobile cellular telephone subscribers per 100 population
14	Gross domestic expenditure on R&D as a percent of GDP
15	Tourism contribution to GDP
16	Current account deficit as percentage of GDP
17	Share of imports from developing countries and from LDCs
18	Average tariff barriers imposed on exports from developing countries and LDCs
19	ODA net given or received as a percentage of GNI
20	FDI net inflows and net outflows as percentage of GDP
21	Remittances as percentage of GNI
23	Material intensity of the economy
24	Domestic material consumption
25	Annual energy consumption, total and by main user category
26	Share of renewable energy sources in total energy use
27	Intensity of energy use, total and by economic activity
28	Modal split of passenger transportation
29	Modal split of freight transport

Source: Adapted from UN DESA (2007a).

2.3. Vertical structure of the forest as indicators of diversity

This field study was conducted in the second half of 2011. The study of the vertical structure of the forest is intended to validate the structural and biotic variability of the LAPBR terrestrial ecosystems, especially about the montane forests.

The study took data on species diversity, but this variable has not been resolved because, it has numerous samples, and by taxonomy complexity of these samples.

With that goal, I chose forest stands in the less disturbed conditions, in different locations and at different altitudinal gradients. The study emphasized the gradient of the sub-montane forests (Sm), alti-montane (Am), cloudy (C), montane (M) and 2 plots in the lowland forest (L) (Table 4). In total, 20 sampling sites, with a plot of study with 10 x 30 m. Each one was subdivided into 12 subplots of 5 x 5 m for to improve the accuracy of sampling.

Table 4: LAPBR: Plots for the study of vertical structure of forests as key ecosystems

Nr. Plot	Altitud (m)	Forest type & basin	Forest type Code - basin	Coordinate X	Coordinate Y
1	1931	Montane Caribbean	M-C	336815	980720
2	1704	Montane Pacific	M-P	337087	978339
3	1788	Montane Pacific	M-P	336708	978976
4	1856	Montane Pacific	M-P	337809	977054
5	1835	Montane Pacific	M-P	345968	975456
6	1395	Montane Pacific	M-P	341573	973918
7	1839	Montane Pacific	M-P	338030	977280
8	1972	Montane Pacific	M-P	335529	972735
9	2437	Altimontane Pacific	Am-P	333992	972929
10	2374	Altimontane Pacific	Am-P	333866	972995
11	1871	Altimontane Pacific	Am-P	333867	972996
12	2539	Cloudy Pacific*	C-P	321432	985250
13	5	Lowland Caribbean	L-C	374017	1032546
14	10	Lowland Caribbean	L-C	373993	1032499
15	2488	Altimontane Pacific	Am-P	342516	970207
16	2489	Altimontane Pacific	Am-P	331577	977256
17	3151	Cloudy Pacific	C-P	331695	974597
18	1218	Sub-montane Pacific	Sm-P	363665	967842
19	1224	Sub-montane Pacific	Sm-P	363434	967841
20	842	Sub-montane Caribbean	Sm-C	368392	970813

**Located at continental division Caribbean-Pacific*

Within each sub-plot the following data were collected: small number of trees with DBH <10 cm, number of large shrubs with diameter <10 cm and >3 m in height, number of lianas with diameter > 3 cm, and percentage of vegetation cover in the center of each sub-plot. Also a botanical sample of each morph-species in subplots 1 and 12 were collected. Due to the large number of morph-species complex with systematic botany, this information is not available for this research.

The rest of the data that were taken in each plot were: Geographical position of the plot and altitude mapping and numerical coding within the plot of each tree with DBH[20] >10 cm, the DBH of all trees >10 cm, the photographic record of each tree to complement the systematic identification retrospectively; botanical sample each tree for herbal identification (these data are always taken in such studies, although the goal itself is not taxonomic or systematic), number of dead trees with DBH >10 cm.

Other data collected were epiphytes density and physical condition of the tree. The density of epiphytes was based on a qualitative scale of 0-10, with 0 representing the absence of epiphytes in a tree and 10 represents a remarkable abundance of epiphytes in every part of the tree, massively. The value 5 represents an intermediate value between these two conditions, and so on.

The physical condition of the tree is also based on a qualitative scale 1-3. The 3 means completely healthy tree according to the discretion of the investigator, and 1 means a very sick or broken or significantly over saturated with lianas or epiphytes tree.

Exploratory analysis of quantitative and qualitative data showed a high divergence in the variance, so the main statistical analysis that I used for analysis of the results of this part of research were nonparametric tests, highlighting the Chi-Square Test (X^2).

2.4. Mapping and software for analysis

The data were prepared, edited or processed from many sources: the main ones were: shape files of natural resources and physical data from IGNTG, ANAM; maps, vector or polygons processed in Openstreetmap[21], Google Earth 7.1.2.2041[22] images

20 For protocols about DBH measurements and basal area data I recommend the following references: Abed and Stephens, 2003; Reid and Stephen, 2001.
21 Openstreetmap. 2012-2013-2014. Online: http://www.openstreetmap.org/#map=10/9.0953/-82.1640
22 Google Earth. 2011-2012-2013. Online: http://www.google.com/earth/

and Bing[23] map images, using QGIS as main geographical information system software of data processing.

For direct viewing and exploration of spatial data as vectors, raster, and databases in different formats, ESRI shape files, KML/KMZ, and others with QGIS 3.2[24] and QGIS 4.0[25] geographic information system. Also was used Google Earth online software as complement of exploration, verification and analysis of the Geo-spatial data.

For complex statistical analysis for the forest data, was used a software called "psppire 0.7.9"[26], a program for the analysis of sampled data (open source software).

Additionally also, was used Libreoffice Calc spreesheet Version: 4.1.4.2 for the management of numerical data, graphing, basic statistical analysis and database reader.

23 Bing. 2012-2013-2014. Online: http://www.bing.com/maps/

24 QGIS Development Team, 2013. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://qgis.osgeo.org.

25 QGIS Development Team, 2013. QGIS 2013 Geographic Information System User Guide. Open Source Geospatial Foundation Project. Electronic document: http://download.osgeo.org/qgis/doc/manual/.

26 Free Software Foundation. 2014. http://www.gnu.org/software/pspp/. 02/16/2014

CHAPTER 3

Evolution of sustainable development concept

3. Brief history

The history of Biosphere Reserves is closely linked to the evolution of the concept of sustainability, especially in the first two decades, but since 1987 with the Brundtland Report, and in 1992 the outcomes of the Earth Summit, with sustainability statements on the global agenda, all sustainable principles were strengthened and consolidated.

This new agenda had a positive effect, consolidating and defining for first time, the statutes of Biosphere Reserves in 1995, together with the Seville Strategy which defines the action plan and the philosophy behind these biosphere reserves within the Programme on Man and the Biosphere of UNESCO.

In my opinion, definitely the strength of the concept of biosphere reserve in the global development framework has been obvious, especially with the work plan performing successful models of sustainable development. Entlebuch in Switzerland is a good model in this way. In this reserve they have plans for scientific research, education, training, industry, tourism and many other activities directly related to the biosphere reserve concept[27].

In this chapter is developed briefly a review of the evolution of the concept of sustainable development that has led to the creation of estimators or sustainability indicators, including indicators promoted by sustainable development agencies of the United Nations, that I will use in the sustainability analysis in La Amistad-Panama Biosphere Reserve.

3.1. Biosphere Conservation Conference (Paris 1968)

Not many people and researchers relate the positive impact of the Stockholm Conference of 1972 and their outcomes with the previous conference organized by

27 Entlebuch Biosphere Reserve Web Page. 2014. http://www.biosphaere.ch/english/index.html. 02/20/14

representatives of FAO, UNESCO, WHO, IUCN and IBP mandated by the 14th resolution of the General Conference of UNESCO in 1966[28], which in turn followed the mandate of the first session of the UNESCO Natural Resource Research Advisory Committee in September 1965.

Only two precedent documents about environment from UN Economic and Social Council were as background for that previous conference; the first was in conservation and rational use of the environment prepared by UNESCO/FAO and the second about pollution prepared by OMS (UNESCO 1968).

This conference definitely outlined, based on scientific arguments, the priority issues of global environmental concern displayed by the experts. This was the “Intergovernmental conference of experts on the scientific basis for rational use and conservation of the resources of the biosphere”, held in 4-13 September 1968 in Paris. The title of this conference associated rationality and conservation in the global scale of resources, indicating th beginning of broad vision of the environmental problem and the way to solve it.

This conference highlighted 8 themes, mainly in terrestrial natural resources, with focus in alive resources and some abiotic natural resources as support of the living resources. The emphasis was mainly in science as fundamental of knowledge of environmental problems and solutions. The main themes discussed were: soil resources, water resources (excluding oceans), living aquatic resources, vegetation resources, animal resources (mainly terrestrial), protection of areas and species, deterioration of environment, human ecology or man and his ecosystems. Also, was discussed as secondary themes the research problems in ecosystems, inventories of resources, methodologies, pollution, deterioration, conservation and rational use of resources. These were the first basis of international discussion about natural resources and environmental problems in global scale.

The majority of the experts involved were academics, and the main results of this conference were a little biased to scientific or academic analysis in natural sciences and similar, but the conclusions and recommendations were useful and clear and a fundamental way for to establish, later, analysis and discussions about conservation

28 UNESCO.1967. Meeting of the Steering Committee for the Conference on the Rational Use and Conservation of the Resources of the Biosphere. UNESCO/SC/CS/30/2. Paris. 18 april 1967. Online: http://unesdoc.unesco.org/images/0001/000177/017760EB.pdf.

issues and for to establish the Biosphere Reserve concept. This strong support in scientific terms of natural resources was a triggering for to incorporate later the complete human dimension as architect of deterioration of also a part of the solution for protection of the “biosphere”, that was the key word in UNESCO programs from the beginning, including the preparatory meeting[29] for the Conference Meeting of UNESCO in 1968.

3.2. The Human Environment Conference (Stockholm 1972)

The official name was United Nations Conference on the Human Environment, carried out in Stockholm in 1972.

Sustainable development as a theoretical concept already has 4 decades of existence. Officially began with the final declaration of the Stockholm Conference on the Environment held from 5 to 16 June 1972, sponsored by the United Nations. Just this conference gave rise to the creation of the United Nations Environment Programme (UNEP) and the commemoration of June 5 as World Environment Day.

It is the first multilateral institution to support the need to preserve the natural habitat of the planet to produce a 'sustained' improvement of living conditions for humanity and recommended the need to work towards these goals through cooperation between all countries.

While the Conference emphasized on 'environment' also included the social, economic and underlying development policies in the field of 'environmental conservation' (UN Conference discussions 1972[30]) whereby the vision included the basic pyramid of sustainable development even included the 'development' as a quarter of the total.

This conference proclaimed that the man is part of the environment structure with includes opportunities for intellectual, moral, social and spiritual growth (UN Conference discussions 1972[31]) and recognize that the human environment is a major issue in the World because affects the “well-being of the peoples and

29 Idem 28

30 UN. 2013. Annex I about discussion in the Working Group on the Declaration on the Human Environment. Online: http://www.unep.org/Documents.multilingual/Default.asp?DocumentID=97&ArticleID=1501&l=en. 11/25/13

31 Idem 30

economic development”.

They recognized the existence and concatenation of environmental and social issues as a single large complex problem.

Among the topics discussed included:

a- the dangerous levels or pollution in water, air, earth and living beings;

b- major and undesirable disturbances to the ecological balance of the biosphere;

c- destruction and depletion of irreplaceable resources;

d- and gross deficiencies harmful to the physical, mental and social health of man, in the man-made environment, particularly in the living and working environment.

They related many environmental problems linked to the existence, especially in less developed countries, key social factors affecting human dignity such as the lack of food and clothing, shelter and education, health and sanitation. Thus it can be said that this conference put all structural stones of what was later known as Sustainable Development, which is just the substantial improvement or attention of the whole set of problems you listed the Stockholm Conference.

In abstract the key recommendations for action at the international level for the environment and for sustainable development, include what would be: the increase of human welfare and quality of life in the long term also joined with significant maintenance and improvement of the environment on the scales local, national, regional and global the long run, through the rational use of natural resources to ensure their existence along time. For those public policy objectives require precise and concatenated all social and political elements, from the level of a person to other human bodies, cooperating to achieve the desired goals of development.

The Human Environment Conference explicitly calls upon Governments and peoples to exert common efforts for the preservation and improvement of the human environment, for the benefit of all the people and for their posterity. In my opinion, this statement about 'posterity' is a term linked to a sustainable vision.

These statements contain clear principles on environmental protection and development and recommendations for implementation. Therefore, this conference can be considered as the first foundation stone of the sustainable development concept with 69 recommendations. I am highlighting the following recommendations related to the principles of sustainability as they are now known:

1. Planning and management of human settlements for better environmental quality (land use planning);
2. a long-term global promotion and improvement of the environment;
3. an environmental and socioeconomic indicators of the quality of human settlements, the causes of migration and spatial distribution of the population;
4. water supply, sewerage and waste-disposal systems, specially in tropical, subtropical and sub-Arctic areas;
5. scientific interchange for study the global human settlements and environmental problems, including specialists in environmental planning and rural development;
6. community specialist for to help and advice the low-income groups, specialists for organize mass transport systems; assistance for combat human malnutrition; also include to establish a cooperative information exchange about soils, climate and agricultural conditions; establish programs for biological pest control and reduction of the harmful effects of agro-chemical;
7. establish control and recycling of wastes in agriculture;
8. development and management of domesticated livestock of economic importance and their environmental aspects as part of the ecosystems;
9. additional knowledge about environmental aspects of forests and forest management. It included a work PNUD-UNESCO for the emphasize the role of the forests with the soil conservation, watersheds and protection of tourist sites and wildlife and recreation of the 'biosphere', including a survey of world's forest cover for multiple purposes, including forest fire, pests and diseases.
10. Transfer of research, experience and knowledge of the forests and their

management.

11. Establish an environmental monitoring plan that includes indicator species.
12. Assess the total economic value of wildlife resources, monitoring animals endangered, including training courses and graduates courses in wildlife, parks and protected areas. Exchange of information on national parks legislation and planning and management techniques as guidelines available to another country.
13. Preservation of genetic diversity.
14. Fisheries responsible.
15. Natural resource inventories.
16. Establishment of water management of watersheds.
17. Data collection on the use and production of energy, including emissions monitoring carbon dioxide, sulfur dioxide, oxidants, nitrogen oxides, particulates and heat, the residues of oil and radioactivity.
18. Support to Man and the Biosphere Programme (MAB) administered by United Nations Educational, Scientific and Cultural Organization in cooperation with other United Nations organizations and other international scientific organizations.

This support for the MAB program can be interpreted as a green light for this program for to have more relevance as a global project of international conservation, later known as sustainable development in the biosphere reserves.

3.3. World Conservation Strategy 1980

It is a formal publication of the IUCN, funded by WWF, and by request and with the assistance of UNESCO, FAO and UNEP (IUCN et al. 1980) that first defined and widely used as the main argument for human development the concept of sustainable development. The publication of IUCN has as a major argument the inclusion the needs of future generations. With this argument the next generations are also stakeholders of resources and needs. Today this thinking is angular pillar in sustainable development. By default if the humanity is taking care of future generations, it means that is protecting the resources and development of the current generation.

This global strategy was designed for decision makers at the government level; conservationists and others working with living resources; developments practitioners such as aid agencies, industry and commerce. It is the first time experts, governments and non-governmental organizations came together to prepare content that outlines a global conservation strategy within the development paradigm[32].

One can say that the product of this publication is the strength of non-governmental civil society organizations that have been marked global agenda for sustainable development and this publication is the clear example of this fact.

3.4. Brundtlant Report 1987

This report is considered the definitive fundamental pillar of the "global agenda for change" the traditional system development to sustainable development system and responds to the multilateral track of the 1972 Stockholm Conference. Of course, many of the ideas of the Brundtland report also come from the World Conservation Strategy of IUCN of 1980.

This report was designated under the name of "**Our Common Future**" and the full text was coordinated by Ms. Gro Harlem Brundtland (former Prime Minister of Norway). This is the reason this report is also known under the name of "Brundtland Report". In words of Mrs. Brundtland this report put the society and the political of the world into the "sustainable development paths”.

In this report, thousands of people around the world, including citizens groups, non-governmental organizations, educational institutions, and scientific community participated in consultations. Even public hearings were held in several cities around the world.

The report recognized a growing and noticeable awareness among macro-stakeholders that they could not separate the economic development issues from environment issues. Still have some money tied to economic issues, but they were definitely key moments in the global definition of agenda for change in the vision

32 Conservation: historical perspective. ND. Online. http://www.culturalecology.info/cons_hist/WorldConservationStrategy.1980.html. 11/25/13

development.

The Commission recognized that many of the concerns and suggestions for a new model of growth and development collected from those consulted, existed prior to 1983 and the probable reason for this development, I attribute to the Stockholm Conference and the previous framework document: World Conservation Strategy of 1980, led by IUCN, who also made consultations within partners worldwide.

In fact, the Commission includes the same definition of sustainability of WCS 1980:

"*Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs*".

The Commission agreed that sustainable development equally must be established on political willingness of governments and should be considered a process of change and not a stationary condition of wellness. Production processes, the exploitation of resources and investment, technological development and institutional change must be consistent with the development goals for to ensure present and future generation wellness.

3.5. Earth Summit from Rio of Janeiro 1992

The official name was United Nations Conference on Environment and Development (UNCED) based on two major themes: environment and sustainable development. This conference is better known as the Rio Summit and may be considered the Stockholm Conference + 20, since this is a continuation. It is ratified, for the new generations, the concept of sustainable development highlighted and launched in the 1987 Brundtland Report.

The conference discussed and established guiding principles for business and government such as[33]:

Patterns of production — especially dangerous products for man and environment; the alternative sources of energy - especially air pollutants, and the management of public transport in order to reduce emissions of automobiles especially in large

33 Earth Summit. ND. Online: http://www.un.org/geninfo/bp/enviro.html.11/25/13

ciudadaes and water scarcity in the world.

It can be considered one of the most influential global summits of the contemporary times. This conference received good media coverage, although the Internet as a communication was not yet developed as mass media or network.

The main products of this summit were:

a) Rio Declaration on Environment and Development (Policies on the environment and sustainable development as concatenated paradigms. They are principles defining the rights and responsibilities of States;).
b) Agenda 21 (Sustainable development policies).
c) Forest Principles (Policies on forest conservation based on principles to underlie the sustainable management of forests worldwide).
d) Convention on Biological Diversity (Global conservation policies).
e) Framework Convention on Climate Change (Policies for protecting atmosphere).
f) United Nations Convention to Combat Desertification (Policies for soil conservation)

Also born institutions of follow-up, such as: 1-) Commission on Sustainable Development; 2-) the Inter-agency Committee on Sustainable Development, and 3-) High-level Advisory Board on Sustainable Development

3.6. Sustainable Development Conference (Johannesburg 2002)

The **World Summit on Sustainable Development** or Johannesburg Summit 2002 was a summit to follow-up the global plan of action for sustainable development developed by **United Nations Conference on Environment and Development** 1992 in Rio of Janeiro.

The result in sustainable development was the Johannesburg Declaration on Sustainable Development with 37 statements[34] supporting:

34 Adopted at the 17th plenary meeting of the World Summit on Sustainable Development, on 4 September 2002. http://legal.icsf.net/icsflegal/uploads/pdf/bakupsept182006/wss0201.pdf. 11/25/13.

1. Collective responsibilities for “to advance and strengthen" the pillar of sustainable development — economic development, social development and environmental protection — at the local, national, regional and global levels (Statement 5).
2. The Plan of Implementation of the World Summit on Sustainable Development (Statement 6)
3. The protection of the environment and social and economic development are fundamental to sustainable development, following Stockholm (1972) and Rio Summit (1992) statements (Statement 6).
4. The sustainable development require effective management on natural resources, social and economic development. The States should be attend with solutions the high levels of poverty, high consumption and the inapropiate patterns of production (Statement 11).
5. The social inequity should be solved (Statement 12).
6. The rich diversity, as collective strength, will be used for constructive partnership for change and for the achievement of the common goal of sustainable development (Statement 16).
7. Strength the human dignity increasing access to basic requirements: clean water, sanitation, adequate shelter, energy, health care, food security and protection of biological diversity (Statement 18).
8. Help for to gain financial resources, ensure capacity building, use of high technology, development of human resource with education and training (Statement 18).
9. Ensure women's empowerment in the society (Statement 20).
10. Recognize the vital role of indigenous people in sustainable development (Statement 25).
11. Build broad-based participation for sustainable development through policy formulation, decision-making, and implementation of sustainable development at all levels (Statement 26).

12. Strengthen and improve governance at all levels for to achieve goals of Agenda 21 (1992), the Millenium Development Goals (2000) and the Plan of Implementation of the Summit (Statement 30).

3.7. Rio+20 Sustainability Summit (Rio of Janeiro 2012)

The United Nations Conference on Sustainable Development (Rio+20) was developed in Rio of Janeiro, 20 years after the Rio Conference 1992.

The main product was the Resolution 66/288 on 27 july 2012 with the name of "*The future we want*" focused in political outcome with 283 statements about the last vision about sustainable development regarding previous statements, themes, topics, and goals as the following:

1. To have a common vision about sustainability;
2. reaffirming the Rio Principles and past action plans;
3. engaging major groups and other stakeholders (regional, national and subnational legislatures and judiciaries, furthermore all major groups as women, children and youth, indigenous peoples, non-governmental organizations, local authorities, workers and trade unions, business and industry; the scientific and technological community, farmers, local communities, volunteer groups and foundations, migrants, families, older persons and persons with disabilities) (Statement 43).
4. Developing a green economy for sustainable development and poverty eradication.
5. Strengthening the three dimensions of sustainable development.
6. Strengthening intergovernmental arrangements for sustainable development.
7. Environmental pillar in sustainable development.
8. A framework for action and follow-up
9. Food security and nutrition and sustainable agriculture
10. Water and sanitation

11. Energy
12. Sustainable tourism
13. Sustainable transport
14. Sustainable cities and human settlements
15. Health and population
16. Employment and social protection
17. Oceans and seas
18. Developing States and small islands
19. Least developed countries
20. Landlocked developing countries
21. Disaster risk reduction
22. Climate change
23. Forests
24. Biodiversity
25. Desertification, land degradation and drought
26. Mountains
27. Chemical and waste
28. Sustainable consumption and production
29. Mining
30. Education
31. Gender equality and women's empowerment
32. Implementation
33. Financing strategy
34. Technology
35. Capacity-building

36. Trade

This summit included virtually all topics related to sustainable development in the world. The challenge remains how to implement and measure progress. Binding legal systems where states regularly demonstrate that they are working in this direction are needed.

CHAPTER 4

Revision of boundaries of the biosphere reserve and general description

4. Introduction

The complete definition of LAPBR boundaries was incomplete in the original proposal and I am deducing that it was combined with the corrections asked by UNESCO Commission. The Core Zones are clear, but the buffer and transition zones never was completed and revised for to avoid contradictions in mapping.

Sometimes UNESCO does not take care about strict boundaries for transition zones, but it is necessary for all basic spatial analysis and scientific studies and for political reasons. In otherwise, the stakeholders and decision takers have not control about a complete context of a Biosphere Reserve.

By definition Biosphere Reserves have no binding limits, except for the protected areas under a category of core areas, but require that the boundaries of the buffer zones are well defined and the transition zone are effectively the heart of the major human and hence sustainability actions to ensure or promote this objective.

Human populations are those that define the long term, the fate of an entire landscape context. One of the claims of this study is to make suggestions for changes to adjust even better mapping and spatial planning of the Reserve.

Therefore, and legal aspects and compliance is not required according to national law the designation of an area as a biosphere reserve. "However, the core areas of biosphere reserves should be included in national networks of protected areas with legal protection" (UNESCO-MAB[35]), as is the case of LAPBR. The working group on criteria and guidelines for the choice of establishment of biosphere reserves in 1974 recommended that "both core areas and buffer zones are expected to have adequate legal protection long term" (UNESCO-MAB, 1974), which not discussed at this time.

35 UNESCO-MAB. FAQ – Biosphere Reserve? Online: *www.unesco.org/mab/doc/faq/brs.pdf. 9/10/13*

Covered in this philosophy is entirely feasible and appropriate, to define on the LAPBR, polygons transition and buffer free of contradictions. Managers and stakeholders need to know with certainty the area of the biosphere reserve for joint actions to strengthen information and promotion actions for conservation and sustainable development of this reserve.

4.1. LAPBR transition zone boundary clarification

Originally the proposal from the Panamanian authorities to UNESCO indicated that the transition zone corresponded to the Caribbean mainland bounded by the contour of 100 m north of the border of the Palo Seco Basin Protector Forest to the south.

For two contradictions this option should be discarded and considered simply an unintentional mistake and maybe it was also a mistake to understand the philosophical concept or pragmatic sense of the transition zone in a biosphere reserve. The contradictions are:

1 - Overlap strongly with the buffer zone of the reserve for the Palo Seco Basin Protector Forest, the Naso indigenous Teribe region and the wetlands of San San Pond Sak. In view of that any interpretation induces to inevitable change, then it is appropriate to satisfactorily correct all error. The proposal consists in taking as valid the limit of the buffer zone established and leaving as a transition zone, in the Caribbean, all the marine and coastal area, external to the core and buffer zones from the protected areas of lowland of Bocas del Toro lowlands (San San Pond Sak Wetland and Bastimentos Island National Marine Park).

The philosophical and pragmatic reason for this change to amend these errors are set by the own rules of UNESCO[36] to establish that a biosphere reserve "*only the core area requires legal protection and therefore may correspond to an existing protected area, as a nature reserve or national park. This zoning scheme is applied in different ways in the real world to suit the geographical, socio-cultural settings and legal protection measures and local restrictions. This flexibility can be used creatively and is one of the strongest points of the biosphere reserve concept, which facilitates the integration of protected areas into the wider landscape*. "

2- Excludes most of the communities adjacent to the coast and the Caribbean islands

36 Idem 35

of Bocas del Toro and Ngobe Bugle West sector, which all sense of representing the concept of a Biosphere Reserve is lost. The entire coast of Chiriqui Lagoon, the city of Bocas del Toro, Bastimentos be outside, in a kind of biosphere reserve 'absque homine', that is, no people.

Changes in the polygon that I am proposing, fixing all the problems of overlapping and the exclusion of core population of Caribbean coastline and archipelago of the concerned region.

4.1.1. Pacific transition zone

The layout line of 1000 m elevation on the Pacific west area, that defines the outer boundary or south transition zone of the reserve begins in Rio Sereno, District of Renacimiento, Chiriqui Province near Panama-Costa Rica border (~977 041 N and 293243 E UTM) confronts an overlap when it reaches the core area called Fortuna Forest Reserve (FFR). Clearly, this fact distorts the limits established in this part of the reserve and not possible a mapping of the three zones of the biosphere reserve.

To improve and clarify the meaning of this line (1000 m)I have corrected this line from the point of intersection of this contour with Casita de Piedra river. The re-definition is as follows:

From the intersection of the contour with the Casita 1000 Stone River east of Fortuna Forest Reserve (~968040 N and 357552 E UTM) the line continues this river downstream to the confluence with the Chiriqui river; there continues downstream until the confluence with Chiriquicito creek. Continue along the main course of this creek to the geographic point ~955225 N and 363128 E UTM in the watershed boundary of this creek with the -de la Sabana- creek (tributary of Esti river).

From this point is an imaginary straight line (3343 m and 173° SE ft) over the canyon of this stream to the intersection with the contour of 1000 m (~953234 N and 365850 E UTM) in the extreme southwest of the base of Hornitos hill.

Continues this contour eastward to the upper basin of Rio Fonseca, specifically to the intersection with the primary course of Quebrada Cogollo (~954065 N and 391305 E). Continues ~1840 meters upstream from the creek to the top of Cerro 'X' (without name) of the Continental Divide, which separates the waters of the Pacific (Fonseca basin) and the Caribbean (Guariviara basin).

Note that in the original proposal to UNESCO never defined intersections or closing angles of the polygon in the Eastern Pacific Sector. Hence, I decided that the most appropriate point is just the Quebrada Cogollo, mentioned above, and then was defined a Caribbean adjustment with the immediate sector, where there was no definition of this boundary. This adjustment surrounds the core area of Fortuna in order to maintain the philosophy of UNESCO concepts of buffer zones and transition.

4.1.2. Caribbean transition zone

From the top of Cerro 'X' of the Continental Divide, the line of the polygon of the Reserve continues throughout the course of Guariviara River (tributary East) to its mouth in Chiriqui Lagoon, in the Caribbean Sea (988755 N and 393260 E UTM).

Then, from the mouth of the Guariviara river it follows an imaginary north straight line of 47.4 km long to the geographic marine point 393614 N and 1036204 E UTM and located at the NNE of Bastimentos Island Marine National Park. From this point, continues straight (~68.5 km) WNW direction to the mouth of Sixaola River, which is itself a boundary point between Panama and Costa Rica and follows this international boundary in south direction to the origin point in Rio Sereno at 1000 msnm.

Note that in Pando hill summit occurs the Caribbean watershed change to Pacific watershed again.

4.2. LAPBR Buffer Zone clarification

The official proposal to UNESCO Panama indicates that the buffer zone of the reserve in the Pacific corresponds to the contour line of 1200 m but this line also strongly overlaps the core of the Fortuna Forest Reserve area. For this reason was re-defined the line trying to bring it as close to the original definition and that definition of UNESCO should surround the core area of a biosphere reserve. In other words, it is inconceivable that the core and buffer zones of a biosphere reserve are overlapping.

4.2.1. Pacific Buffer Zone from Rio Sereno to Fortuna

The boundary of the buffer zone of the Reserve, corresponding to the level of 1200 m elevation in the Pacific has no conflict of overlap in most of its length. The overlap occurs in the polygon Fortuna Forest Reserve. Then, I am proposing that the buffer zone in this area should be a polygon, more or less equidistant between the polygon line of the redefined transition zone, and the official polygon of Fortuna Forest Reserve. Therefore, a new description of boundaries of the buffer zone in this area is required and presented below:

1. the buffer zone of the Bastimentos Island National Marine Park, as defined in the Management Plan 2004.

4.2.2. Pacific Buffer Zone around Fortuna Forest Reserve

As a starting point, is the intersection of the Chiriqui River with the eastern boundary of the Fortuna Forest Reserve (967129 N and 360770 E UTM). From this initial point, the edge of the polygon follows the course of the Chiriqui River downstream to the intersection with the line of elevation of 800 m (967208 N and 359574 E UTM).

It continues this contour, SE to the intersection with the road Chiriquicito- Fortuna (957374 N and 363633 E UTM) and continues rising 2,200 meters along this road to the intersection with the contour of 1000 m high and the intersection with trans-isthmian road Chiriqui-Bocas del Toro (956134 N and 364967 E). Follow this path towards contour SE to the intersection again with the Chiriqui-Bocas del Toro road (954722 N and 366571 E), in the town of Los Planes.

From this last place, continued on an imaginary straight line ~819 meters and 90° East to the intersection with the contour of 1200 m. From there, it continues along this contour elevation, heading east to the Balsita creek in the upper basin of Rio Fonseca (East) at the point that the line of elevation 1200 m is closer to the continental divide (~955302 N and 387940 E). From this referential point, continues with an imaginary line 90° north and 360 meters long that connects the contour of 1200 m in the most near Caribbean area (~955626 N and 388098 E). Finally, the line continues the contour of 1200 m to intersect the official boundary of Palo Seco Basin Protector Forest (~957513 N and 378407 E UTM).

With this spatial arrangement, the buffer zone around the south of Fortuna Forest Reserve is fused to the official area of Palo Seco Protected Forest, which is the most extensive buffer zone of the reserve in the Caribbean.

4.2.3. Caribbean buffer zone boundaries

The buffer zone in the Caribbean of the Reserve has five spatial areas corresponding to the following:

2. High Guariviara River Basin has been resolved with the re-definition of the area around Fortuna Forest Reserve;
3. the entire polygon of Palo Seco protector forest, which has limits defined by law;
4. the northern end of the proposed polygon of Naso Teribe (Tjer Di) indigenous comarca;
5. the outer area of about 10 km over the limit of the San San Pond Sak Wetland, as defined in the Management Plan 2004;

It is noteworthy that the official registration of the LAPBR to UNESCO indicated that the buffer areas identified in the management plans of protected areas in the coastal marine region of Bocas del Toro, would also be the buffer zone of the reserve.

Also is worth clarifying that the definition of indigenous Naso Teribe area has several unofficial versions, including a political corregimiento called Teribe. I have chosen the proposal that gives additional land to indigenous peoples of the Caribbean of Costa Rica Panama border, specifically the Naso and Bri-Bri, based on historical and current data on the presence of these indigenous populations in the Talamanca region, since before the existence of the State of Panama. Is worth mentioning that 90% of the Naso indigenous territory is already inside of La Amistad International Park, a biosphere reserve core.

The all buffer zones included in the Fig. 6, presents the main buffer zones resulting after analyzing the text of the proposal for the creation of the LAPBR and overlap corrections. Highlights include the following areas and circling the green core areas:

1. Buffer Zone of Chiriqui highlands (light blue polygon). It comprises the territory

between the line of the 1200 meters and the limits of Volcano National Park, the southern end of La Amistad National Park, Las Lagunas de Volcán wetland sector and Palo Seco Protector Forest on the Continental Divide, east of Fortuna.

4.3. All buffer zones of the biosphere reserve

2. Buffer Zone Fortuna (orange polygon): it is the area west, south, and southeast of Fortuna Forest Reserve.
3. Buffer Zone Palo Seco (purple color): it is all official polygon del Palo Seco Protector Forest, which also is an official buffer zone of Fortuna Forest Reserve and La Amistad International Park.
4. Buffer Zone Naso Teribe (red color): corresponds to the northern end of Teribe Naso indigenous territory.
5. Buffer Zone of San San Pond Sak (brown color): it is the area of 10 km around the wetlands of San San Pond Sak, especially considering the mainland area with villages.
6. Buffer Zone Bastimentos (blue color): corresponds to the buffer zone established in the Management Plan for the Bastimentos Island Marine National Park.

4.3.1. Spatial maps of the LAPBR clarification

In the following graphical material I have a spatial clarification about LAPBR, with clear mapping of boundaries for transition, buffer, and core zones as follows:

In the Fig. 5 the contour line of 100 m can be seen in the Caribbean sector of the Biosphere Reserve La Amistad, showing the strong overlapping with the Palo Seco Basin Protector Forest and even overlapping certain areas of La Amistad International Park. Also overlaps the area Naso Teribe and the buffer zone of San San Pond Sak Wetland. Eastbound of Palo Seco Protector Forest no overlap occurs, but this strip becomes a laughably thin and completely irrelevant to represent the ecological and social realities of the region, making it impossible practical use to good management purposes.

In Fortuna Forest Reserve I find similar overlapping to that presented in Fig. 5, but the overlapping includes both the buffer zone and transition.

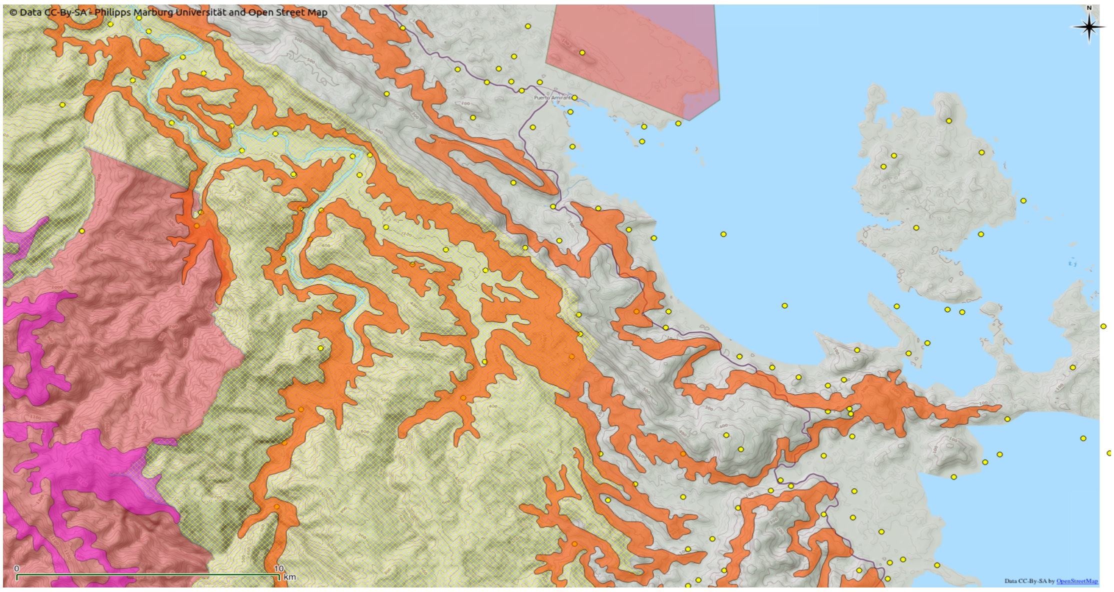

Fig. 5: LAPBR: Map showing overlapping areas according original description of the buffer zone in the Caribbean area of the Reserve.
Note: overlapping area in orange color (100 m) and pink (1200 m).

4.3.2. La Amistad Panama Biosphere Reserve description by zones

After all zone definition, clarification, and corrections, now exists the complete map that completely defines all zones of LAPBR:

1 - Core Zone (blue in Fig. 7): it includes a separate set of polygons in the overall landscape of the reserve. These core areas include the two major national park in the western highlands of Panama, these are the La Amistad International Park and Volcano National Park. Also includes Bastimentos Island National Marine Park, which is a coastal and marine park that protects the main reef systems and the lowland forest of this island in the NW of Panama.

This area also includes two wetlands: San San Pond Sak and Las Lagunas de Volcán. The first protects a cluster of lowland wetlands, including a marine section and the second protects small upland lakes.

The core area also includes the Fortuna Forest Reserve, which protects the forests of the upper basin of Chiriqui river and whose forests at medium altitudes (900-1200 m) are the first ecosystem transition (West-East) in Talamanca mountains, from forests from higher altitude to cloudy forest with medium altitude of Central Cordillera of Panama.

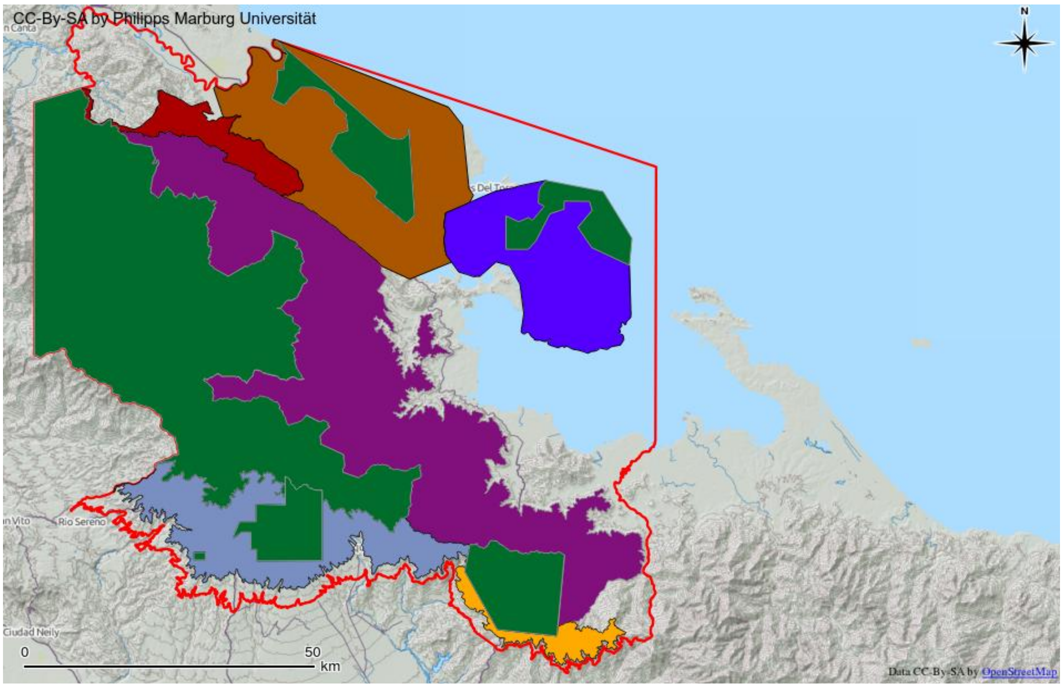

Fig. 6: LAPBR: buffer zones differentiated by colors.

Core Zones in green color. Buffer zones: high lands of Chiriquí (light blue); Fortuna south and east (orange); Palo Seco (purple); Naso Teribe (red); San San Pond Sak (brown) and Bastimentos (blue).

2 - Buffer Zone (yellow in Fig. 7): Includes marine area in the archipelago of Bocas del Toro. The buffer zones are subject to the management plan of protected areas in the coastal marine area of the Reserve. These management plans took effect four years after UNESCO recognized the existence of LAPBR. Overall, the buffer zones of LAPBR contains major towns and cities of the Reserve.

3 - Transition Zone (pink in Fig. 7): The proposal never clearly defined what was the transition area corresponding to the marine section of LAPBR. My proposed polygon simply established a geographic reference point to join the terrestrial context with the context of coastal marine reserve. As shown in the preceding figure, the redefinition avoids overlap with existing protected areas clearly defining all the basic polygons of the Reserve and solves the mapping of the area.

This transition zone includes a portion of the upper basin of Rio Guariviara, adjacent to Palo Seco Protector Forest and all the lowlands and coastal areas of the Caribbean Sea. Also included Yorkin area in the border area with Costa Rica and the marine waters of the Chiriqui Lagune, including open marine waters north of Bastimentos Island.

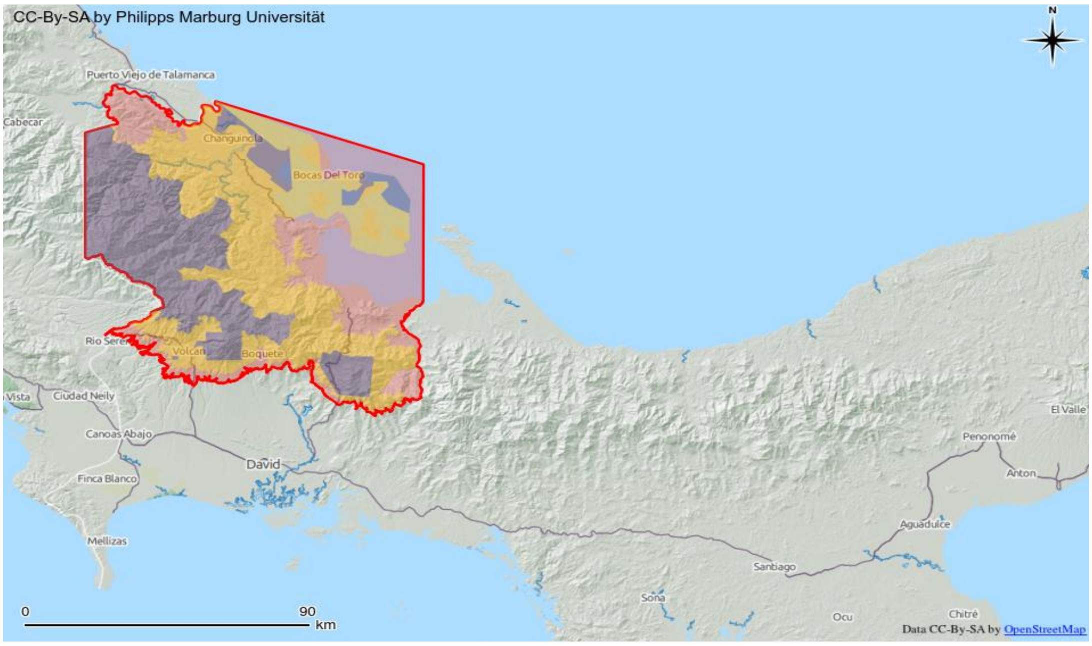

Fig. 7: LAPBR: regional view and location in the Panamanian Isthmus
Source: Background map from Openstreetmap (CC_by_SA) . Note: Core zone in blue color; buffer zone in yellow color, and transition zone in pink color.

Also the transition zone include the strip of lands between 1000-1200 m of altitud in the highlands of Chiriqui province and a little portion of strip of land in sorrounding Fortuna Forest Reserve.

4.3.3. LAPBR Pacific SW and SE

The south-west of the RBLAP (Fig. 8) area are the main national parks in the highlands of the Pacific slope: La Amistad International Park (Pacific side) and Volcan Baru National Park. It also contains Las Lagunas de Volcán Wetland.

This buffer area includes the communities of Volcan and Cerro Punta. It is an area with intensive agricultural and livestock activity. The transition area in this part of the reserve is only a thin strip of the total area.

Meanwhile the south-east region of the RBLAP (Fig. 9) corresponds to a little known area, sparsely populated and difficult to access, except the core zone of Fortuna area. Corresponds to the first segment of the Central Cordillera of Panama. This area contains the high basin of Fonseca river.

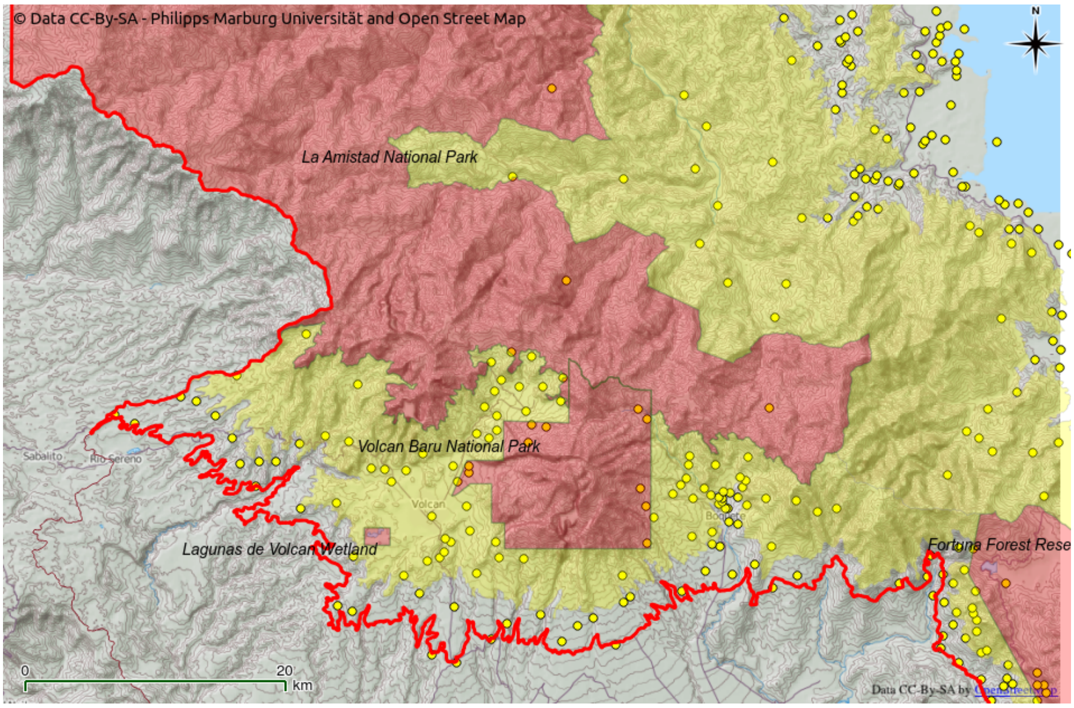

Fig. 8: LAPBR South West (SW) near Costa Rica Border showing core zones (red) and buffer zones (yellow)
Source: ANAM, INEC. Background map from Openstreetmap (CC_by_SA).

In figs. 8 and 9 is also clearly observed the distribution of communities (yellow dots) inside the buffer zone and the transition zone of the Pacific. This spatial arrangement of villages inside the buffer zone can indicate what plans of social sustainable development projects require greater emphasis in an area.

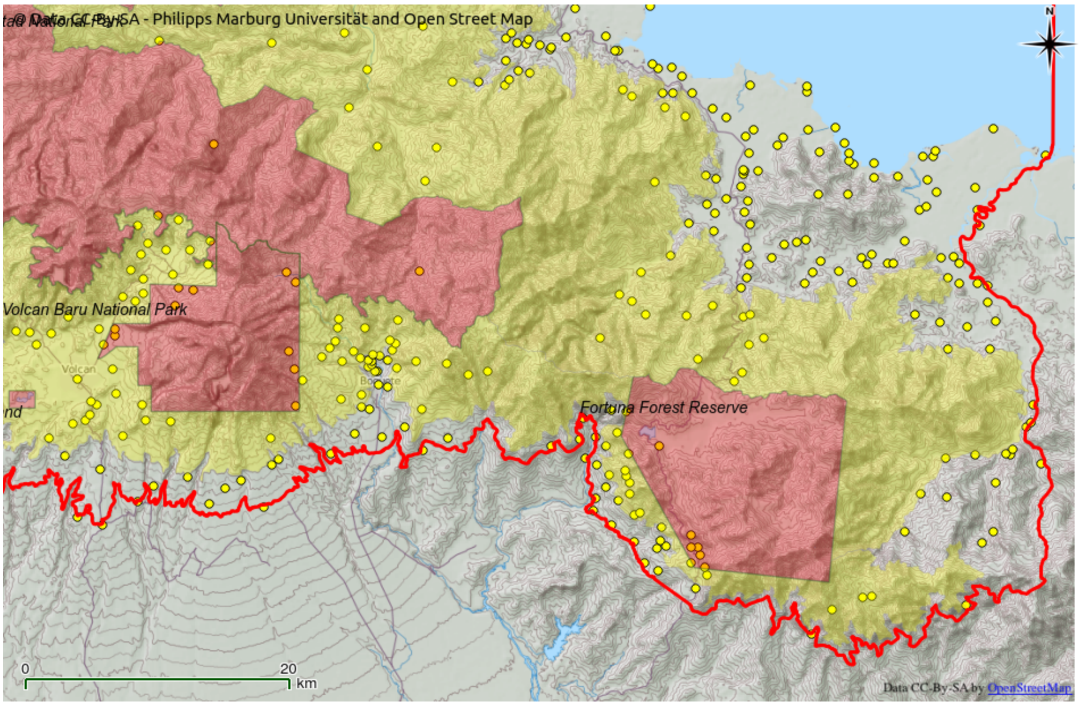

Fig. 9: LAPBR South East (SE) showing core zones (red) and buffer zones (yellow)

Source: Openstreetmap (CC_by_SA), ANAM, INEC. Note: yellow dots are communities.

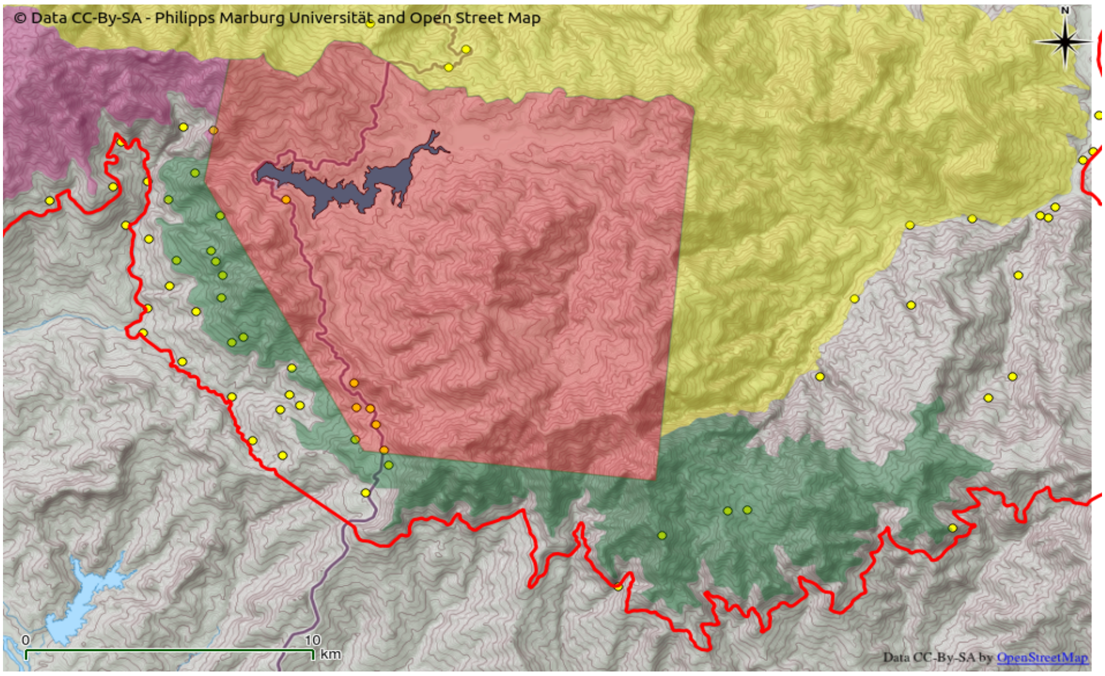

Fig. 10: LAPBR: Fortuna as core zone with a fixed area of buffer zone and transition zone

Source: ANAM, INEC. Background map from Openstreetmap (CC_by_SA). Note: Fortuna as core zone (red color) is sorrounded by buffer zones as Palo Seco in the north (yellow), Fortuna South-East (green), and Fortuna East (Pink).

4.3.4. LAPBR Caribbean Center and West

This area is the one that best represents the theoretical concept of the three basic areas of a biosphere reserve. It has a well-defined core area (La Amistad International Park), a wide buffer zone (Palo Seco Basin Protector Forest) and a transition region with the highest density of inhabitants and therefore with intense human activities (yellow circles) (Fig. 11).

A further important fact is that the transition zone incorporates an important marine area of the Chiriqui Lagoon, but the north of the Chiriqui Laggon is the buffer zone of Bastimentos Island National Marine Park.

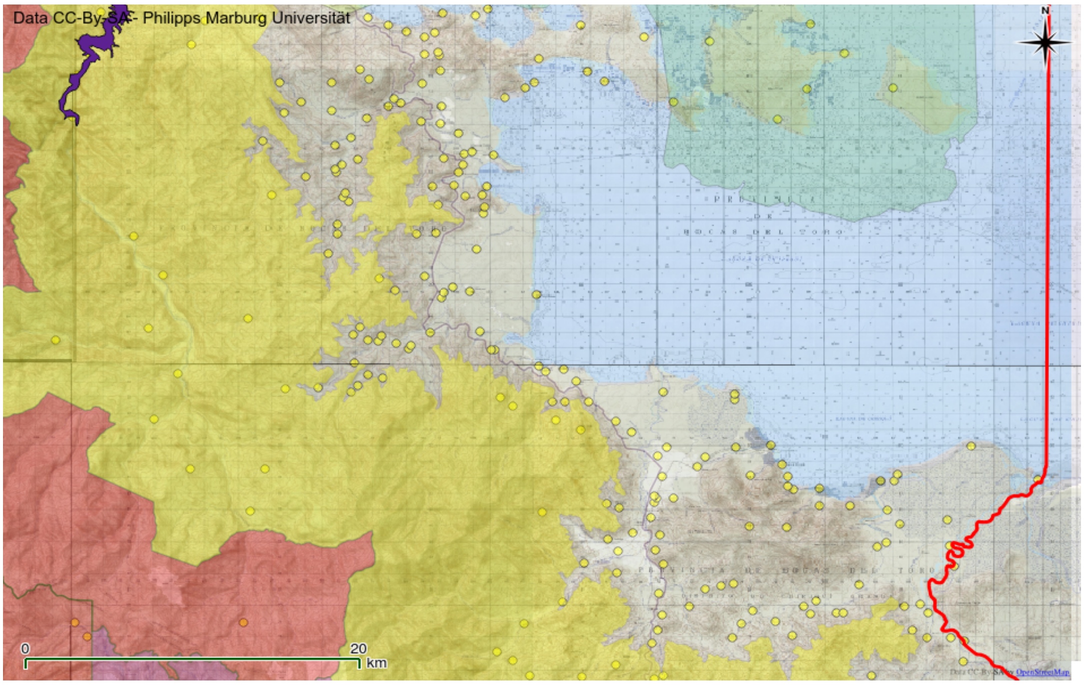

Fig. 11: LAPBR Caribbean Center West showing core zones (red) and buffer zones (yellow).

Source: ANAM, INEC, IGNTG. Note: core zone in red; buffer zone in yellow.

This area as a whole, incorporates complex ecosystems and is a good area to experience sustainability models, given the variety of resources and concentration of human populations in the transition zone.

4.3.5. LAPBR Caribbean North West (NW)

The NW of LAPBR contains the archipelago of Bocas del Toro, a group of islands and islets, that in biological terms is called 'The Galapagos of Mesoamerica.' It is the area of the biosphere reserve with most marine area. The zones are rich in marine biodiversity; including, coral reefs, mangroves, and lowland forests. Bastimentos Island Marine National Park is the core area. The buffer zone was defined in its latest 2004 Management Plan, and it includes major neighboring islands with special biological richness and indigenous communities.

As can be seen in Fig. 12 the buffer zones of San San Pond Sak and Bastimentos are united in Almirante Bay (Fig. 13), and 85% of the archipelago is included as a buffer zone, 5% of the archipelago with the highest density of human population is inside the transition area (Fig. 14). This area is also ideal to fully develop the approach of a biosphere reserve.

This sector LAPBR also includes a small portion of marine waters of the open sea.

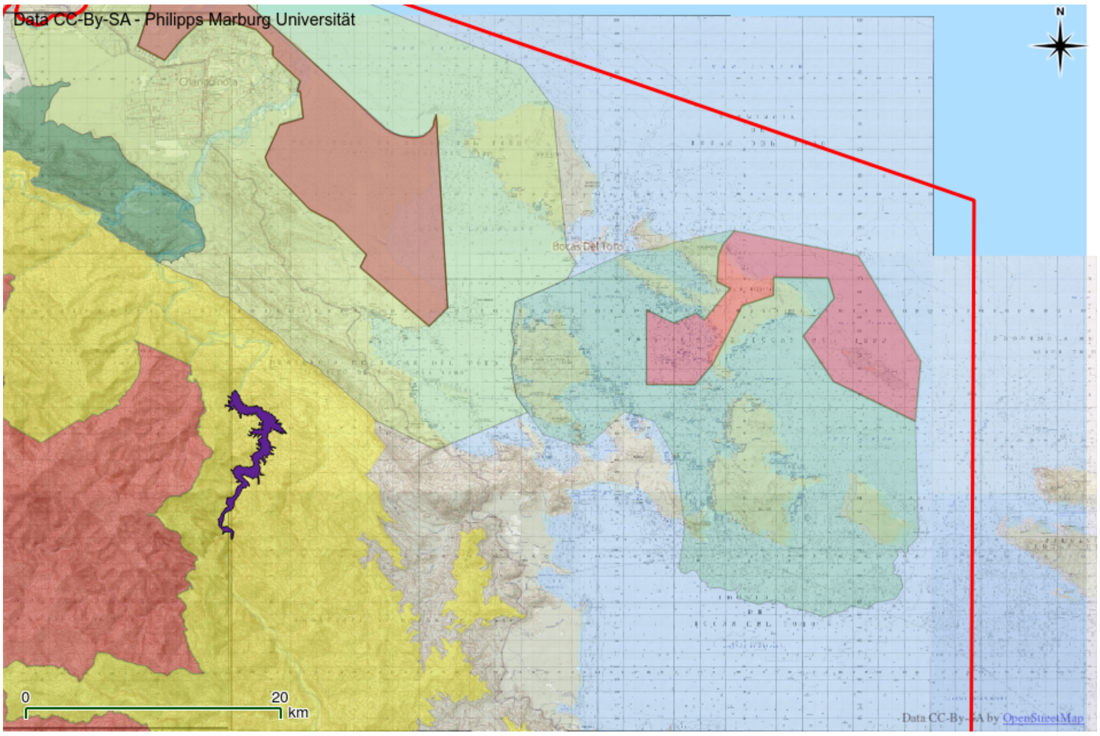

Fig. 12: LAPBR Caribbean North West (NW).

Source: ANAM, INEC, IGNTG.

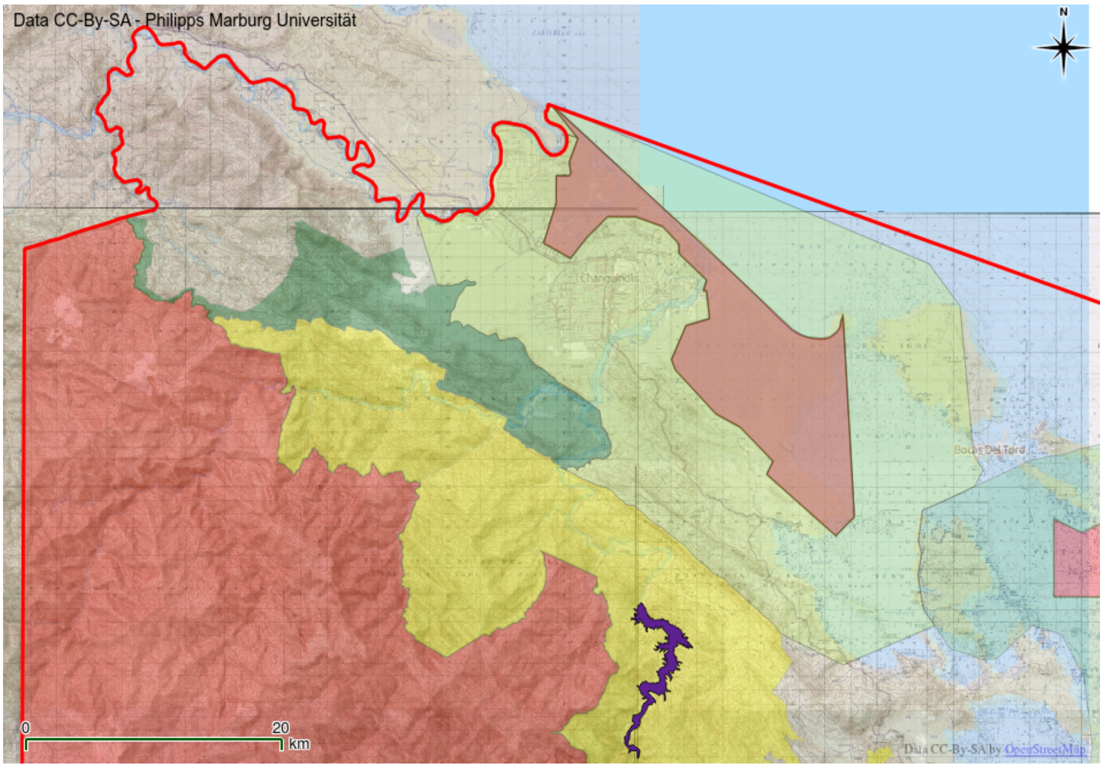

Fig. 13: LAPBR Caribbean North West (NW) showing core zones (red) and buffer zones (yellow), including the Naso buffer zone (green).
Source: ANAM, INEC, IGNTG.

4.3.6. LAPBR Pacific – Boquete, Volcan and Cerro Punta highland areas

The biosphere reserve in Boquete area (Fig. 15) has a adequate zoning. Boquete, like a small city, is located in the transition area and surrounded by a significant land area of the buffer zone and very close to the core areas (Volcan Baru National Park and La Amistad National Park - Pacific in red). These core areas are close and accessible to the citizens of this turistic city and visitors.

This area is suitable for implementing various models of sustainable development, as stated the philosophy creation of biosphere reserves. Unfortunately the transition in other areas of the Pacific Highlands Reserve correspond to narrow strips of land, with few human populations, making it difficult to apply the concept of biosphere reserves.

In the case of the town of Volcano and the village of Cerro Punta, unlike the situation in Boquete, these communities are inside the buffer zone of the reserve. This implies that the efforts of these communities to adapt the concept of biosphere reserve is more difficult, since a less intensive soil conservation practices and the advanced nature of use is required, in relation to the curren situation.

On a positive action for the conservation and sustainable development, as peoples inside the buffer area can be seen as an opportunity to increase sensitivity for that goal, and may also represent better cooperation of the state and society to achieve the commendable objectives of sustainable development.

At present, both Volcano and Cerro Punta are communities with poor practices of nature conservation, massive use of pesticides in agricultural crops and urban development with low environmental and cultural emphasis. Additionally, the above problems have joined the environmental impacts of new water infrastructure that have greatly impacted the course and the aquatic ecosystem of the Chiriqui Viejo River.

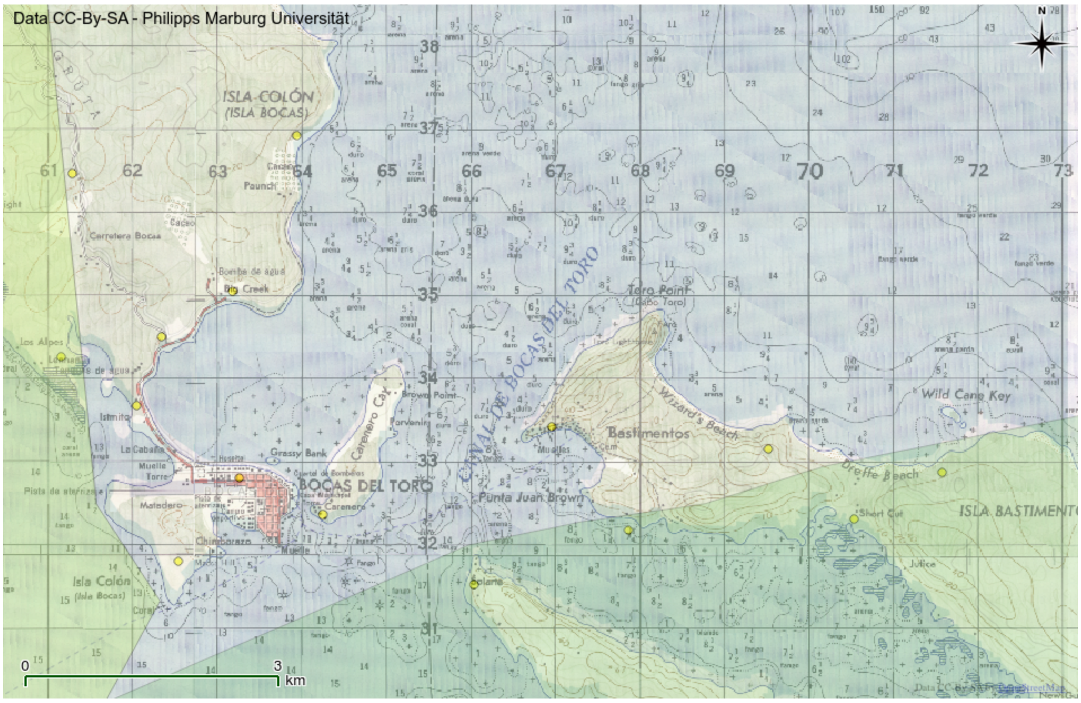

Fig. 14: LAPBR: Bocas del Toro city and the another villages are located in the transition zone

Source: Background map from IGNTG. Note: buffer zones in yellow color.

In summary, the location of these communities in the buffer and transition zones should be seen as an opportunity to work for sustainable development, taking into account the human potential and valuable natural resources that require management strategies and conservation for long term.

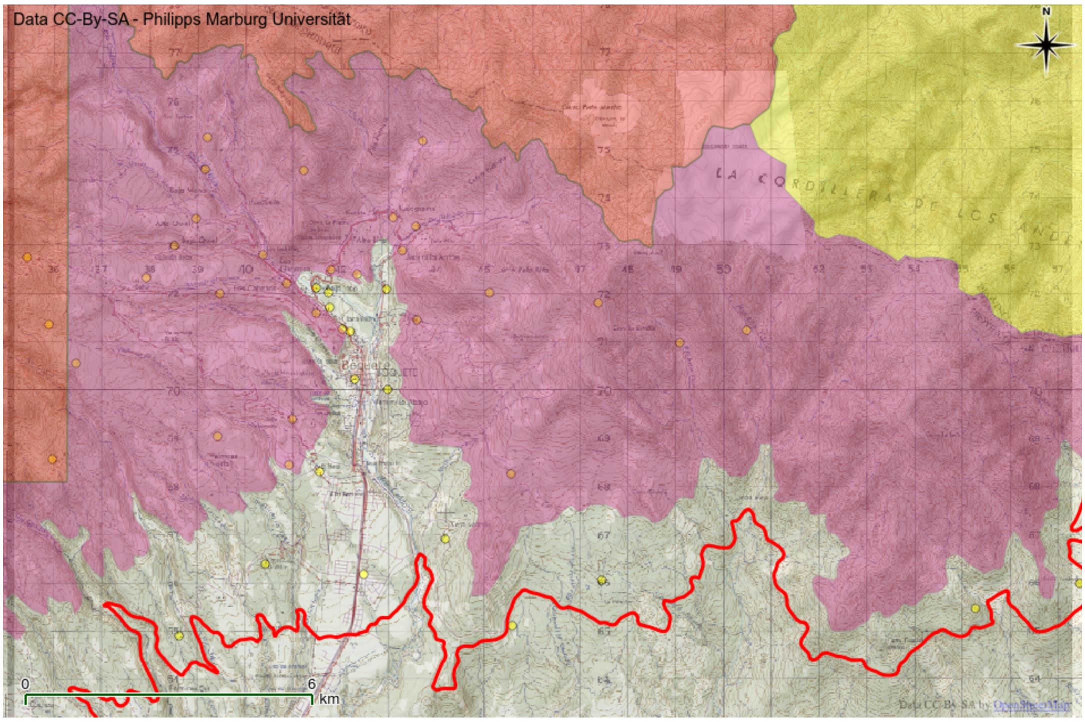

Fig. 15: LAPBR: Boquete town, inside of the transition zone represents a adequate model of spatial organization in a biosphere reserve.

Source: ANAM, INEC, IGNTG. Background map from Openstreetmap (CC_by_SA).

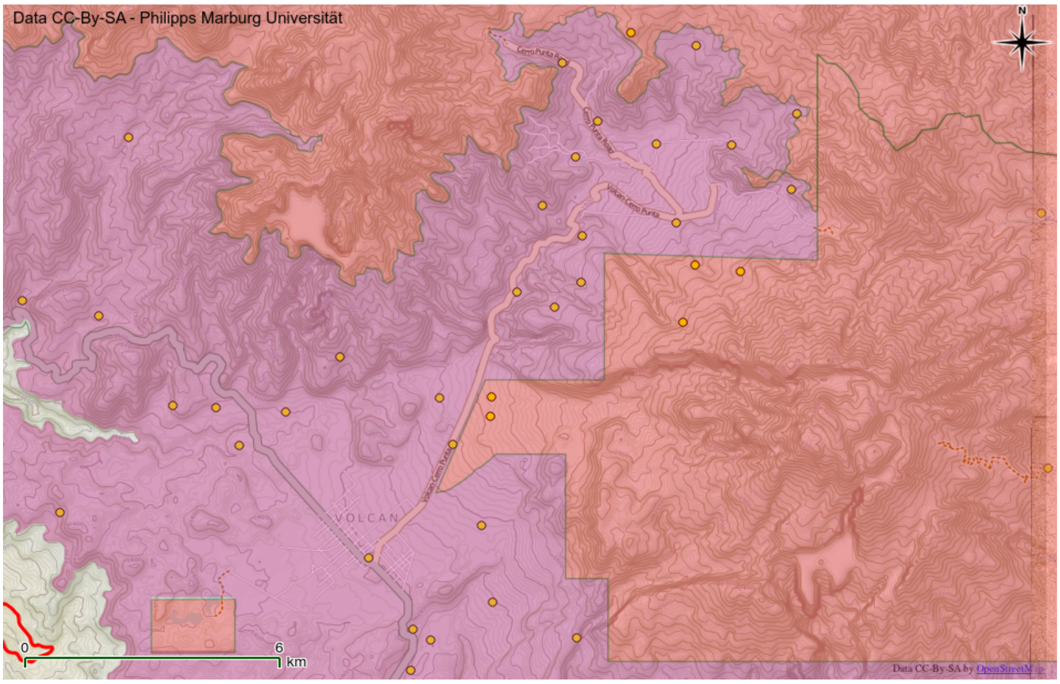

Fig. 16: LAPBR - Pacific: Cerro Punta and Volcan communities in the central highlands in Chiriqui Province and located in the buffer zone (pink color)

Source: ANAM, INEC. Background map from Openstreetmap (CC_by_SA).

CHAPTER 5

Analysis of Social Sustainability in La Amistad Panama Biosphere Reserve

5. Social Indicators for Sustainable Development

The following analysis of sustainable indicators for La Amistad Biosphere Reserve indicators are following the definitions of Indicators of Sustainable Development: Guidelines and Methodologies developed by the Department of Economic and Social Affairs of the United Nations Secretariat (UN DESA, 2007, Third Edition). The first two paragraphs of every indicator is basically the international consensus definition and they are a complete inclusion of indicators adopted by MDG indicators, Agenda 21 and JPOI chapter. A comparison list is presented in the table 1.

The indicators suggested by the United Nations include all sustainability guidelines that have been raising on development and the environment since the World Summit in Stockholm in 1972 to the Johannesburg Summit 2002 and was discussed in Chapter 1. In this case, Table 5 shows the social indicators that I used to the context of the Biosphere Reserve La Amistad. When one of the indicators can not be used for the context of a biosphere reserve, I discuss the reasons or motives of that fact.

If the indicator is applicable, was added the information available for the study area. Obviously for most indicators there is no specific statistics for a biosphere reserve, which forces us to use data from the provinces or territories inside the reserve to provide data that can be used directly or extrapolated.

The review 2007 of the United Nations -CSD indicators has identified a number of inconsistencies between previous definitions of CSD and MDG indicators. The concurrent review of the MDG Indicators lead to the inclusion of selected CSD indicators into the revised MDG framework, especially in the areas of natural resources, biodiversity, and employment (UN DESA, 2007a). In the Table 5 it is indicated with “additional”.

Social indicators are 32 (Table 5) and are subdivided into the following six themes: a-) poverty; b-) governance; c-) health; d-) education; e-) demographics; and f-)

natural hazards.

Table 5: CSD social indicators of sustainable development vs MDG indicators, Agenda 21 and JPOI chapters

Nr.	CSD Indicator of Sustainable Development	MDG Indicator	Agenda 21 Chapter	JPOI chapter
	Poverty			
1	Proportion of population living below national poverty line	Additional	3 (3.4 a)	II (7a)
2	Proportion of population below $1 a day	# 1	3 (3.4 a)	II (7a)
3	Ratio of share in national income of highest to lowest quintile		3	V (47)
4	Proportion of population using an improved sanitation facility	# 30	6 (6.12 e)	II (8); IV (25)
5	Proportion of population using improved water source	# 31	6 (6.12 e)	II (8); IV (25)
6	Share of households without electricity or other modern energy services		7 (7.40)	II (9 a)
7	Percentage of population using solid fuels for cooking	#29	6 (6.41 b); 11 (11.21 b)	VI (56 d)
8	Proportion of urban population living in slums	# 32*	7 (7.8)	II (11 a)
	Governance			
9	Percentage of population having paid bribes		2 (2.32)	I (4)
10	Number of intentional homicides per 100,000 population			I (4)
	Health			
11	Under-five mortality rate	# 13	6 (6.24)	VI (54f)
12	Life expectancy at birth		6	
13	Healthy life expectancy at birth		6	
14	Percent of population with access to primary health care facilities		6 (6.4)	VI (54b)
15	Immunization against infectious childhood diseases	# 15*	6 (6.12; 6.27)	VI (54 f)
16	Contraceptive prevalence rate	# 19 c	5 (5.50); 6 (6.12)	VI (54 j)
17	Nutritional status of children	# 4 c	6 (6.27)	VI (54n)
18	Prevalence of tobacco use		6	VI (54 o)
19	Suicide rate		6	VI (54 o)
20	Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis	# 18*; # 21*; # 23*		VI (55)
	Education			
21	Gross intake into last year of primary education	Additional		II (7 g) X (116)
22	Net enrollment rate in primary education	# 6		II (7 g) X (116)
23	Adult secondary (tertiary) schooling attainment level			II (7 g) X (116)
24	Life long learning		36	X (123)
25	Adult literacy rate	# 8*	36 (36.4)	X (123)

	Demographics			
26	Population growth rate		5 (5.17)	
27	Total fertility rate	New*	5 (5.17)	
28	Dependency ratio		5 (5.17)	
	Natural hazards			
30	Percentage of population living in hazard prone areas		7 (7.58)	IV (37)
31	Human and economic loss due to natural disasters		7 (7.58)	IV (37)
32	Ratio of local residents to tourists in major tourist regions and destinations		7 (7.20)	IV (43)

Source: Modified from UN DESA (2007a).

Additional there is an analysis about genera inequality and related indicators useful as traversal analysis about development.

5.1. Poverty indicators

> *"Fundamentally, poverty is a denial of choices and opportunities, a violation of human dignity. It means lack of basic capacity to participate effectively in society. It means not having enough to feed and cloth a family, not having a school or clinic to go to, not having the land on which to grow one's food or a job to earn one's living, not having access to credit. It means insecurity, powerlessness and exclusion of individuals, households and communities. It means susceptibility to violence, and it often implies living on marginal or fragile environments, without access to clean water or sanitation"*
>
> (United Nations[37], 1998)

In Agenda 21, poverty is a complex multidimensional problem with origins in both the national and international domains. The eradication of poverty and hunger, greater equity in income distribution and human resource development remain major challenges everywhere. The 1992 Summit, the UN Conference in Environment and Development, states the struggle against poverty is the shared responsibility of all countries. An international objective is enabling all people to achieve sustainable livelihoods for to provide an integrating factor that allows policies to address issues of

37 United Nations Statement in June 1998, signed by the heads of all UN agencies (Cited in a Gordon, David Conference, achieved in the Expert Group Meeting on Youth Development Indicators United Nations Headquarters, New York 12th – 14th December 2005).

development, sustainable resource management and poverty eradication simultaneously.

The reduction or elimination of poverty should be the primary social outcome of a country looking for a model of sustainable development, as it is well known that poverty is a trigger for other social problems that accumulated over time make it difficult to solve these problems in the short term.

Quantification and analysis of poverty can be developed from different perspectives. Includes 'indirect' methods, such as income or consumption, in absolute or relative values reveal a more complex condition of the lifestyle of people. Also includes multidimensional methods incorporating other variables that are not being reflected in the income indicator per se (CEPAL, 2011a).

(CEPAL, 2011a) asserts that lack of income, despite its limitations is a good indicator to measure and monitor the status and trends of poverty in a country or region. It also indicates that the poverty line does not guarantee that those who do not fall below this line have satisfied the requirements in non-food goods and services that people need.

The absence of official parameters to establish the minimum elements to satisfy non-food needs usually leads to discretionary criteria adopted to assess the cost of other goods and services which also requires a citizen (CEPAL, 2011a).

The current poverty measure is called absolute, based on caloric and nutritional requirements that a person needs, but this measurement, by itself, does not meet standards associated with survival to historical definitions of poverty. This definition should be supported on the basis of the behavior of reference groups (eg. Population of a biosphere reserve) and on the adequacy level of life that exists in every country and time (CEPAL, 2011a). Hence the need to update regularly in a not too long time (usually 5 years period) to measure changes in the level of development of the country or region and consumption patterns and price systems (CEPAL, 2011a).

Poverty levels in Panama as a country are still high, especially in rural populations. Poverty in rural environments indicate a structural deficiency in the political and economic system of the country (Table 6).

The main input for the calculation of the basic basket of poverty in Panama for the period 2008-2013 is the Household Income and Expenditure Survey (HIES) 2007-2008. Additionally, this information is supplemented by tables of caloric and nutritional composition of foods and estimates of the nutritional requirements of the population (Table 6).

ECLAC estimated the extreme poverty line in B/.50.99 in urban and in rural $42.74, and poverty line, and $82.91, $112.69 respectively, at 2008 prices. The Panamanian Ministry of Finance took these values and apply the settings for the own measurement poverties (Fig. 17)

Table 6: Panama: Comparative poverty data between ECLAC and Panamanian government 2006 – 2011 (Percentage)[38]

	Total Urban		Urban		Rural	
	ECLAC	MEF	ECLAC	MEF	ECLAC	MEF
People living under General Poverty Line						
2006	29.6	38.3	19.5	23.6	47.4	64.4
2007	28.6	36.5	18.9	22.1	45.9	62.3
2008	27.2	33.8	17.1	19.6	45.3	59.4
2009	26.4	33.4	16.3	19.1	43.9	59.6
2010	nd	29.8	nd	16.6	nd	54.1
2011	nd	29	nd	16.4	nd	52.1
People living under Extreme Poverty Line						
2006	14.1	17.6	5.7	5.7	28.7	38.6
2007	11.7	15.7	5	4.6	23.7	35.4
2008	12.9	15.3	4.7	4.2	27.7	35.2
2009	11.1	15.3	4.6	4.2	22.3	35.5
2010	nd	12.2	nd	4.1	nd	27
2011	nd	11.4	nd	3.3	nd	26.4

Source: MEF and CEPAL

In 2012 the state's population in extreme poverty was 10.4%, down 11.5% in August 2011, which is equivalent to ~34,058 people who were no longer in poverty for that year (MINSA, 2013). Also, the proportion of people in poverty in general declined from 27.6% in 2011 to 25.8% in March 2012, with a net decrease of approximately 108,469 people under poverty (MINSA, 2013).

38 The difference between institutions is due to use of different methodological protocols.

In summary, recent data with formal surveys of living levels in Panama in 2008, reveal that regions with higher levels of poverty are Bocas del Toro (53%), Darien (52.7%), Veraguas (52%), Cocle (51.6%) and indigenous areas (96%) 1. This list includes the provinces of Bocas del Toro and Ngobe Bugle (mainly indigenous people) that are part of LAPBR.

The next indicators will be used by analysis of poverty in LAPBR:

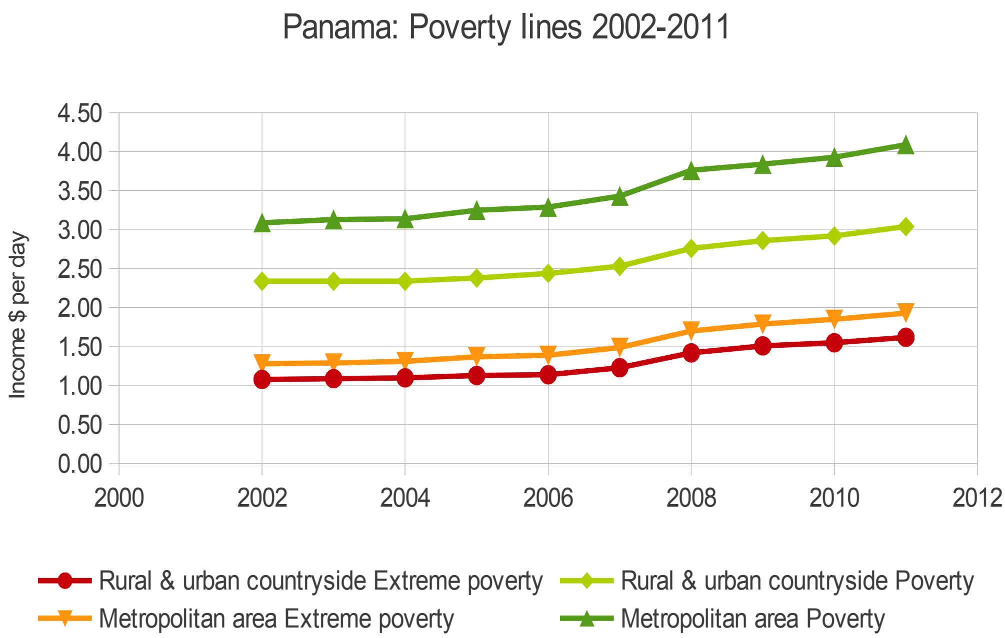

Fig. 17: Panama: Poverty line and extreme poverty per area by diary income ($ current per person).

Source: MEF and CEPAL

5.1.1. Proportion of population below $1.08[39] per day – Extreme poverty

This is a social non core indicator about poverty and income. It is the proportion of the population having per capita consumption of less than $1.08 (now adjusted to $1.25) a day, measured at 1993 international prices (UN DESA, 2007a). This indicator in Panama is known under the term extreme poverty. CEPAL (2011a) call this poverty as homeless people.

The population below $1 a day provides a uniform measure of absolute poverty.

39 The indicator of $1.08 was replaced with $1.25 for to work with the current international standard from UNDP and WB.

Progress against absolute poverty is widely accepted yardstick for assessing the overall performance of economies (UN DESA, 2007a). UNDP (2011) defines this indicator as the percentage of the population living below the international poverty line $1.25 (in purchasing power parity terms) a day.

This indicator is related to the Extreme Poverty Line (EPL) defined by the Panamanian government as the value of annual consumption of a food basket per person that meets a minimum requirement of 2297 calories a day average. The cost for 2008 was estimated at $639 per person per year ($53 per month or $1.77 per day). According the panamanian authorities (MEF), people who consume less than the annual per capita value is considered to be living in extreme poverty.

The poverty gap at $1.25 a day (PPP) (%) in Panama was 11.47% in 1995, 11.50% in 2000, 9.5% in 2006 [UNDP 2011] and 27% in 2009, and at $2 a day (PPP) was 2.39%. Meanwhile poverty gap at rural poverty line in 2007 was 32.1%, and urban poverty was 3.9% (UNDP 2011).

The poverty in LAPBR is estimated between 28.3% to 35.3% in the five years 2008-2011. The high rate of poverty in the indigenous area is biasing this rate in the biosphere reserve. Bocas del Toro, even with the presence of agro-industries and tourism also has relatively high levels of poverty. Only Chiriqui province have low level of poverty in relation to national levels.

In all cases (Table 3) the rates are high in relation to international standards in countries with low levels of extreme poverty.

Table 7: Population by provinces related to LAPBR living below income of Extreme Poverty from 2008-2011 (in Percentage)

Region	2008	2009	2010	2011
Country	15.3	15.3	12.2	11.4
Bocas del Toro	20	23	12.6	18.7
Chiriqui	14.9	14.7	8.9	11.9
Ngäbe Buglé*	70.9	70.8	63.3	61
LAPBR**	35.3	36.2	28.3	30.5

Source: Adapted from MEF – Updated poverty lines 2011.

** Estimated from all indigenous regions in the country*

*** Extropolated from Chiriqui, Bocas del Toro and Ngäbe Buglé*

The evaluation for this indicator is low, since the poverty percentages are high and they should be less than 5% for to be with a manageable value in the short term for to eradicate extreme poverty.

5.1.2. Proportion of population living below national poverty line

It is a social core indicator about income poverty analysis. It is the proportion of the population with a standard of living below the poverty line as defined by the national government. This indicator (also known as national poverty rate or Poverty headcount ratio at national poverty line -% of population) is a standard measure of poverty, especially income poverty. It provides information on progress towards poverty alleviation, a central objective and requirement of sustainable development (UN DESA, 2007a).

The national poverty rate is one of the core measures of living standards and it draws attention exclusively towards the poor (UN DESA, 2007a). Poverty should be understood as limited resources to meet all basic needs, and should be studied as a complex and multidimensional problem, looking for its causes, consequences and structural social society (CEPAL, 2011a, 2007). Erradication of poverty should be a highest goal.

UNDP defines population below national poverty line as a percentage of the population living below the national poverty line, which is the poverty line deemed appropriate for a country by its authorities (UNDP, 2011). The national estimates of poverty are based on population-weighted subgroup estimates from household surveys[40].

Poverty line as an indicator is very difficult to analyze the living conditions and inequality deficit, as this is a unidimensional indicator that is consistent with the structural aspects of quality of life of the population, since many basic needs are not satisfied with the fact that they are above the poverty line (AUSJAL, 2011).

Another method for poverty analysis is based in consumption information[41] because this indicator tends to be more reliable and accurate, and better than income by self. It occurs because the person does not relate to the payment of taxes and is more easily measured than income when a substantial part of it is income informal

40 WB. 2013. Online: http://data.worldbank.org/indicator/SI.POV.NAHC. 11/10/13

41 WB. 2013. Online: http://microdata.worldbank.org/index.php/catalog/70/download/11491 (Panama)

activities or received in kind (MEF and PNUD, 1999). But, WB[42] explains that consumption expenditure accurate measurement "is a challenge", and household expenditure surveys can vary widely across many dimensions, such as: a-) level of reporting, b-) the length of the reference period, and c-) the degree of commodity detail.

In other hand, is neccesary to know the difference between consumption for survive and consumption related to the purchase, use and disposal of products and services in persons with better income. In this case, it should include the analysis of sustainability in lifestyles is a broader concept and includes activities such as interpersonal relationships, leisure activities, sports and education as well as, but not limited to, material consumption. Lifestyles are based on trends in consumption and production patterns and are intricately interwoven with people's choices and practices (Mont, 2007). See in Backhaus (2013), and Scott (2009) additional literature and information about sustainabilty, consumption and lifestyles.

The Panamanian Ministry of Economy and Finance in 2009 defined poverty line of Panama as the sum of the value of the Extreme Poverty Line and an additional amount to cover non-food consumption of essential goods and services (housing, health, education, clothing, transportation, among others). It was estimated at $1126 per year per person ($94 per month or $3.13 per day), under which a person classified as poor (including the extreme poor). This line of poverty in Panama is known as General Poverty Line (GPL).

Under the official definition above, for 2008 approximately 1.09 million (32.7%) people in Panama were in poverty, and 481,000 (14.4%) people were in extreme poverty (MEF official data from 2011). CEPAL (2011b) stated a value of 27,7% for general poverty, and 13,5% of extreme poverty for that year.

It is important to clarify, the levels of poverty in Panama are different according to the region or area, inclusive related to ethnic origin. In the category 'rural area' includes rural areas themselves and areas of difficult access and are not included in the geographic areas with indigenous communities. The geographic areas where live permanently indigenous inhabitants are grouped into a separate category called 'indigenous area' or 'Indigenous'. The combination of the two types of rural poverty is

42 WB. 2010. Methods of household consumption measurement through surveys : experimental results from Tanzania. Online: http://go.worldbank.org/UE8VCVJXK0. 11/10/13

called “rural total” (UNDP, 1999).

Most of the poor and extremely poor in Panama are living in rural and indigenous areas (MEF and PNUD, 1999). Considering that 44% of Panama's population lives in these non-urban areas, it is meaningful to know that 77% of all poor people live in these areas. It was also significant that in 1997, 91% of all extremely poor people of Panama are from rural areas, especially indigenous areas (MEF and PNUD, 1999).

The specific data do not exist for the LAPRB. This is the reason that, was extrapolated the data for the provinces of Chiriqui, Bocas del Toro and indigenous areas, which are the provinces directly related LAPBR area (Table 8).The observed rates are high. Therefore, I can infer that there are still many people in the biosphere reserve with basic needs and lack of opportunities for full development.

Table 8: Panama: Population living below income of Poverty Line 2008-2011

Region	2008	2009	2010	2011
Country	33.8	33.4	29.8	29
Bocas del Toro	48.1	52.5	49.3	47.9
Chiriqui	38.5	35.1	30.9	33.6
Ngäbe Buglé	88.6	91.1	88	84.1
LAPBR**	58.4	59.6	56.1	55.2

Source: MEF 2011 (July). ** Extrapolated from Chiriqui, Bocas del Toro and Gnäbe Buglé

With poverty data shown in Table 8, I estimate that LAPBR still requires many years and strong economic investment and strategic social planning to lower poverty levels now below 5%.

In this comparative scenario the values of the biosphere reserve poverty are high. The evaluation for this indicator is low.

5.1.3. Ratio of share in national income of highest to the lowest quintile

It is a non core indicator about income inequality. It is “the ratio of the share in national income (or consumption)” with respect to the highest quintile (20%) or richest people “of the total population to share of accruing” to the lowest 20 percent or poorest people. United Nations defines that “this indicator shows the extent of inequality in income distribution within a country”. “Inequality in outcomes such as income or consumption and inequality in opportunities hinder human development and are detrimental to long-term economic growth" (UN DESA, 2007a).

Under this scenery the poor people have less voice for governance, less income, and less access to multiple services than wealthier people (UN DESA, 2007a). When societies become more equitable in ways that lead to greater opportunities for all, the poor stand to benefit from a "double dividend." Empirical studies suggest that the impact of growth on poverty reduction is greater when initial income inequality is lower (UN DESA, 2007a).

The trend of income growth in Panama is highly significative from 1980 to 2012 (Fig. 18). It has grown exponentially from 3150 in 1980, 4170 in 1990, 6830 in 2000 to 12,770 in 2010, but the inequity is still high, despite that Panama is a country with small population.

Many institutions agree that income distribution in Latin America is biased in favor to the richest people. According CEPAL (2011b) in this region the Gross national income (GNI) is among "the most unequal in the world" and that situation has remained from 1970.

In broad terms, "the income received by the four poorest deciles is, on average, less than 15% of total income while the richest decile takes about a third of total income" (CEPAL, 2011b). The average income of richest people in Latin America was calculated by ECLAC as 19.3 times the poorest quintile. Recently, they report most countries have presented least income concentration with a decline about 5% in 11 countries. Panama still has high of inequality or gap in income between richest and poorest. This situation is very obvious in the main cities of the country.

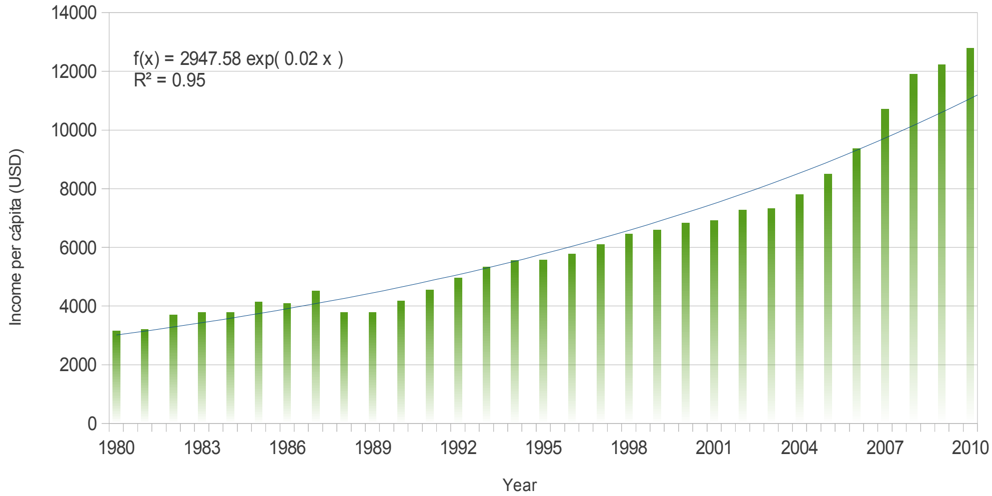

Fig. 18: Panama: Growth National Income (GNI) per capita, Purchasing Power Parity (PPP) at current US dollar per capita.
Source: adapted from World Bank: World Development Indicators Database (WDI) – on-line 23.01.2012.

In Panama in 2010, 40% of the population with the lowest incomes caught on average 15.1% of total income, while 10% of the population in the upper end of the distribution captured 32% of total income. Also, the average income of the richest quintile is 17.7 times that of the poorest quintile (Table 9).

Table 9: Panama: values for percentage share of income or consumption.

	Mean	Share of total income				Mean rate income per capita	
Years	Income	40% poorest (P40)	30% next	20% before to 10% richest	10% Richest (R10)	P40/R10	Q5/Q1
2002	9.8	12.1	23.6	28.0	36.3	20.1	25.8
2004	9.8	12.9	25.5	28.7	32.9	16.8	22.5
2005	9.7	13.9	25.5	29.2	31.4	15.5	20.0
2006	10.3	13.5	25.2	29.1	32.2	16.8	21.9
2007	10.1	14.6	25.5	28.2	31.7	15.6	18.9
2008	10.3	14.4	25.7	27.8	32.1	15.2	18.8
2009	10.4	14.8	25.5	28.3	31.4	15.3	18.2
2010	10.2	15.1	26.0	27.0	31.9	14.4	17.7

Source: adapted from CEPAL, 2011[43]

The Gini index measures the extent to which the distribution of income or

43 CEPAL. 2011. Online: http://www.cepal.org/publicaciones/xml/1/45171/PSE2011-Panorama-Social-de-America-Latina.pdf. 11/25/13

consumption expenditure among individuals or households within an economy deviates from a perfectly equal distribution[44]. In 2010 Panama was with a value of 52. This value is high and reflects high level of inequality. There are insufficient data to generate a Gini Index at the LAPRB.

The Panamanian state administration has created some social assistance programs such as the so-called 'Network of Opportunities' and '100 at 70', which includes monthly cash financial support to poor people. 95% of the beneficiaries of these social programs are people from the two poorest quintile (Mojica 2009).

Although the 'network of opportunities' represents a relatively small and insufficient income, it has generated positive changes, which has helped to improve the indicators of development of people and target communities, especially in rural communities, Latino and Indigenous. According Mojica (2009) This program has increased the educational success of primary school children, from families benefiting from the program with respect to families without this benefit.

The program '100 at 70 'as the name implies, is a direct financial support of 100 USD from the State to the poor people, over 70 years old. This program began in 2009 and is being developed across the country, but has not yet been evaluated. It is assumed that as an immediate result of extreme poverty people leave that status and become the second quintile of poverty.

Mojica (2009) highlights, that children who participate in the 'Network of Opportunities' under 6 years old and over 12 years old, have problems with easy access to schools for these ages. In this case, I can infer that this program does not have sufficient impact for to solve the problem of access to education for all children of a poor family. One of the main difficulties reported by this author with respect to this problem is the long distance of the schools. From this situation, I may infer that a solution would be to build in rural areas a higher density of premedia schools and pre-school, including transportation and other logistic facilities for students and families.

This problem is in the buffer and transition zone of LABR affecting directly rural and indigenous communities in the Comarca Ngäbe Bugle and in the mainland of Bocas

44 World Bank, Development Research Group. 2013. Online: http://data.worldbank.org/indicator/SI.POV.GINI. 11/25/13

del Toro, but not in Chiriqui province. In Bocas del Toro they have premedia schools only in four communites: Chiriqui Grande, Rambala, Almirante, Changuinola and Guabito, but they distant from the most rural and poor people from this area (Northeastern of LABR).

This indicator requires local field data to be analyzed LAPRB level since the data used are national. With these data I am inferring the national context of the biosphere reserve. These data should be interpreted with caution until specific data are available for the area.

With this clarification and inferring a similar country situation (maybe even worse), the evaluation of progress for this indicator is low.

5.1.4. Proportion of population using an improved sanitation facility

It is a social core indicator about sanitation infrastructure. It is the proportion of population with access to a private sanitary facility for human excreta disposal in the dwelling or immediate vicinity. Improved sanitary facilities range from simple but protected pit latrines to flush toilets with sewerage (UN DESA, 2007a).

WB defines this indicator as the access to improved sanitation facilities is the percentage of the population using improved sanitation facilities such as flush/pour flush connected to piped sewer system, septic tank or pit latrine; ventilated improved pit latrine, pit latrine with slab, and composting toilet[45].

The provision of adequate sanitation is necessary for poverty alleviation and to protect human health and the environment. The indicator clarify about accessibility of the population to sanitation facilities, considering these home structures as a basic and essential social service. Accessibility to adequate excreta disposal facilities is fundamental to decrease the faecal risk and frequency of associated diseases (UN DESA, 2007a)

This indicator can be broken down by geographic or social or economic criteria, and it also can provide tangible evidence of inequities in the population (UN DESA 2012).

The communities of LAPBR have geographically unequal access to sanitation

45 WB. 2013. World Development indicators. Online: http://data.worldbank.org/indicator/SH.STA.ACSN. 11/29/13.

facilities (Fig. 19). There is a percentage of at least 27% (n=187) of communities where all households have improved sanitation facility, while 23.6% (n=164) of these communities completely lacking sanitary facilities. In total, I estimated that 53.4% of communities lack access to improved sanitation facilities.

Areas with communities with better access to health services are located in urban and semi-urban communities, specially in the Pacific area of the biosphere reserve. Notable is the lack of sanitary facilities in rural areas of the biosphere reserve, but with the highest rates in the Ngäbe Bugle area (red points in East of LAPBR map, Fig. 3).

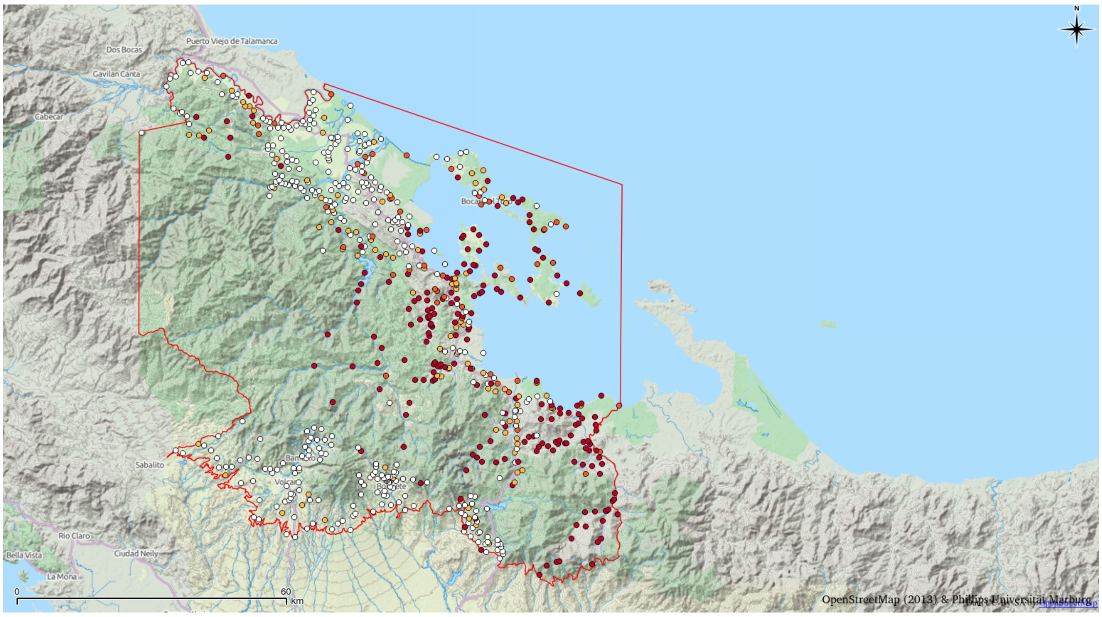

Fig. 19. LAPBR: Sanitary facilities in communities showing high deficit in the Caribbean area in comparison with the Pacific area. Red points are communities with highest deficit.

Source: INEC. Background map from Openstreetmap

In the case of LAPBR the overall value is below the national average of 50% in rural areas. The raw data (Census 2000) indicated that at least 187 communities had full access to health services, but also more than 50% of other communities had poor percentages, and even were 164 communities completely lacking sanitation (Fig. 20).

Based on the data shown above, I evaluated the evolution of this indicator in LPBR as low, because still most rural communities lack adequate sanitation facilities.

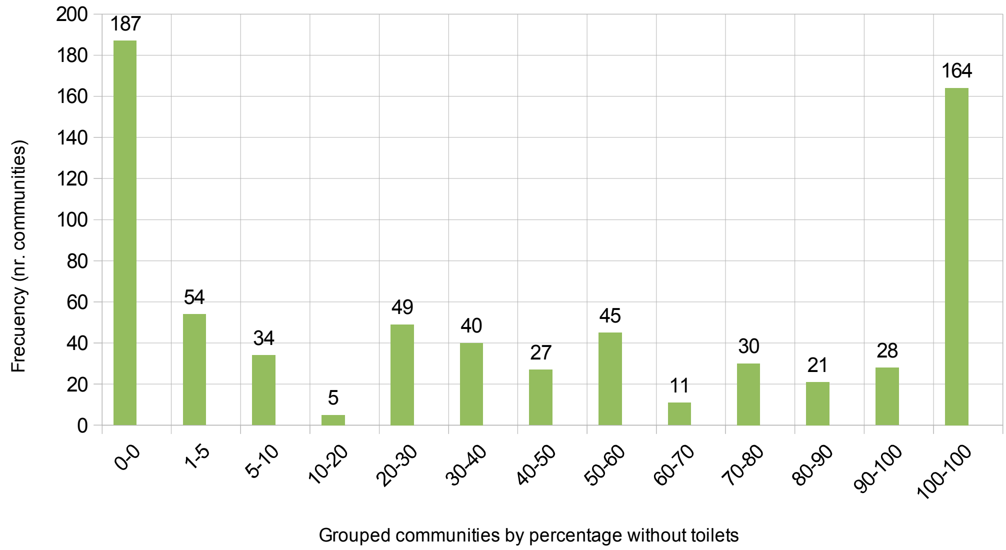

Fig. 20: LAPBR: Communities without improved sanitation facility (2000).
Source: adapted from INEC

This indicator is relatively easy to manage and improve it compared to other indicators. The positive evolution of this indicator in the future will indicate the level of progress in development in the whole area of the LAPBR.

5.1.5. Proportion of population using an improved water source

It is a social core indicator of drinking water access. It is the proportion of population with access to an improved drinking water source in a dwelling or located within a convenient distance from the user's dwelling. Improved drinking water sources include bottled water; rainwater; protected boreholes springs and wells; public stand-pipes and piped connections to houses (UN DESA, 2007a).

The provision of adequate sanitation is necessary for poverty alleviation and to protect human health and the environment. The indicator monitors progress in the accessibility of the population to improved water sources. Accessibility to improved water sources is fundamental to decrease the faecal risk and frequency of associated diseases. It is also a universal human development indicator. When broken down by rural and urban zones or by social or economic criteria, it also provides tangible evidence of inequities (UN DESA 2012).

Official data from Panama, in 2010, indicates a clean water accessibility around 93%

in the country, but in rural areas is around 80% (Fig. 21). Updated data for the BR area is not available and only I have data from 2000. This data should be installed in geographic information system for analysis in specific regions.

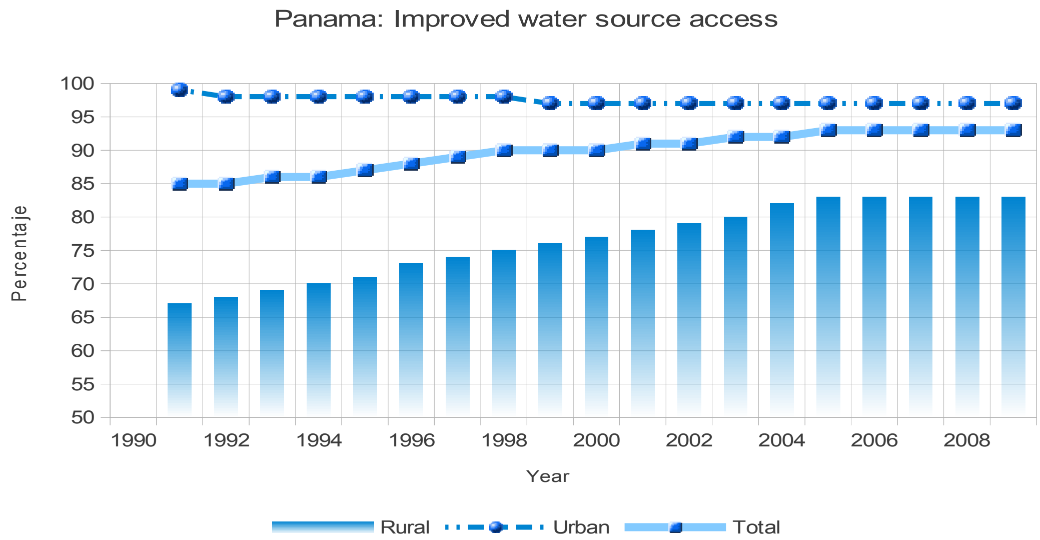

Fig. 21: Panama: improved water source access between 1990-2008

Source: Adapted from WB Data Center 2012

For data 2000 in LAPBR shows that only 17.6% (122/695 of communities) of communities had high cover of improved water supply and inverse 40.6% (282/695 of communities) had not access to improved water (Fig. 22).

The problem of access to clean water in the RB is widespread in the Caribbean (Bocas del Toro and Ngäbe Bugle). In contrast Pacific communities in the province of Chiriqui have remarkably improved accessibility (Fig. 23).

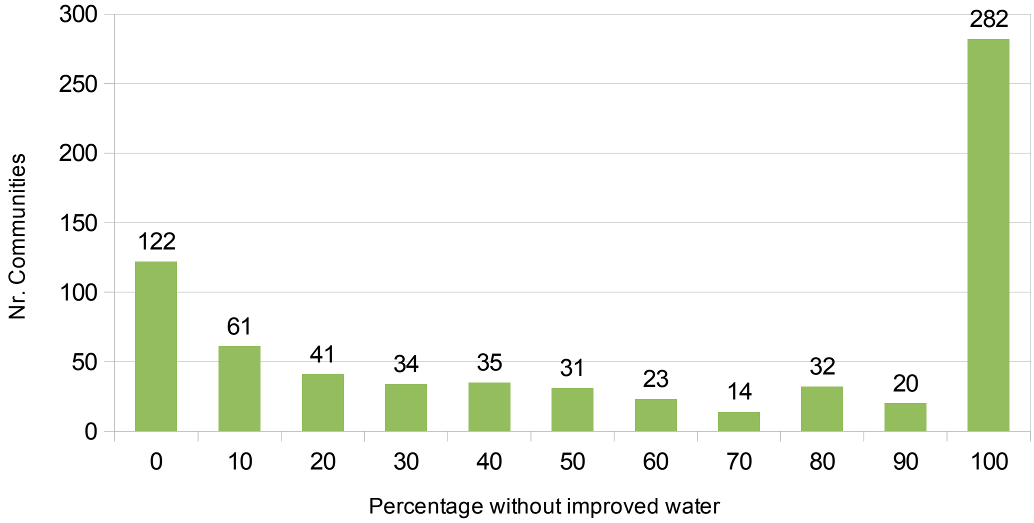

Fig. 22: LAPBR: Analysis of frequency of communities with/out access to improved water sources.

Source: INEC 2000

In the decade of 2000 to 2010 there have been improvements in access to water, but no data are Geo-referenced to map the conditions in the 2010s.

It is important to note that the major communities in the RB have good levels of access to clean water, counterpart small, rural and remote communities are the most lack of full or partial access to clean water.

In the case of improved water for rural communities in LAPBR is easy to establish the infrastructure for water purification, as it depends on technology easily applicable and inexpensive.

Based on the data shown above, I evaluated the evolution of this indicator in LPBR as low, because still most rural communities lack adequate improve water source.

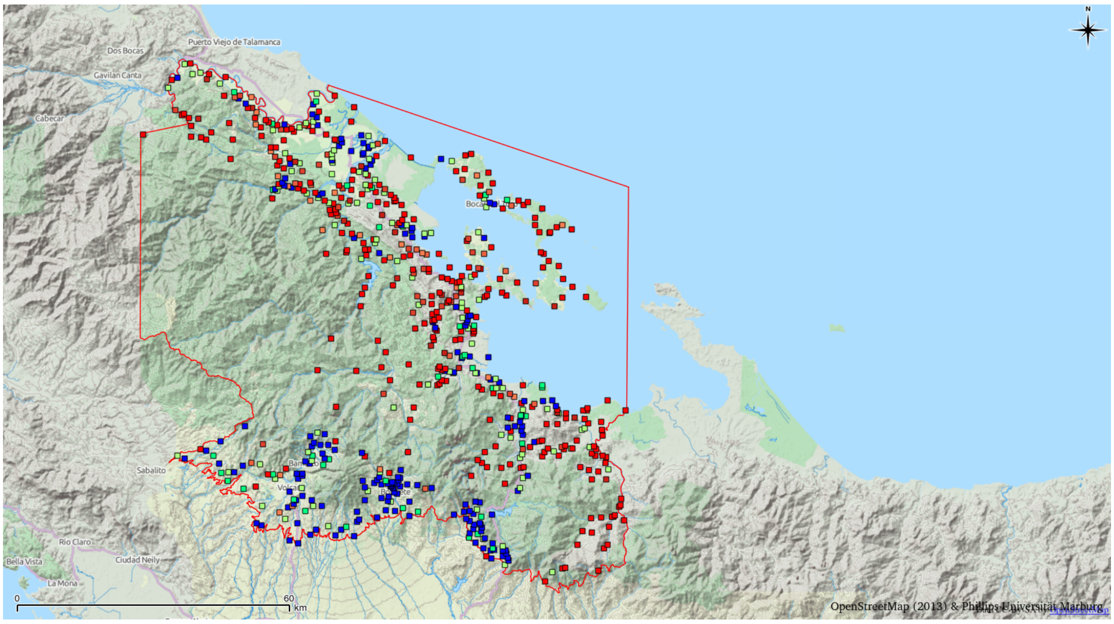

Fig. 23: LAPBR: Access to communities of improved water source in 2000.

Source: adapted from INEC. Legend: Red icons are communities deprived of improved water access and blue indicates high level of access. Green icons are intermediate values.

5.1.6. Share of households without electricity or other modern energy services

It is a social core indicator of access to energy. UN DESA (2012) defined it as a share of households without access to electricity, and share of households using ‘traditional’ non-commercial energy options, such as fuel wood, crop wastes and dung, as primary fuel for cooking and heating.

The indicator monitors progress in accessibility and affordability of modern energy services including electricity. Electricity and other modern energy services are an essential component of providing basic social services. Lack of access to modern energy services contributes to poverty and deprivation and limits economic development. Furthermore, adequate, affordable and reliable energy services are necessary to guarantee sustainable economic and human development (UN DESA 2012).

LAPBR there is a significant number of communities without access to electricity[46] (Fig. 24). They are mainly rural communities and many of these communities are in areas without access to roads, which further hinders the expansion of electricity

46 INEC census data 2000

coverage.

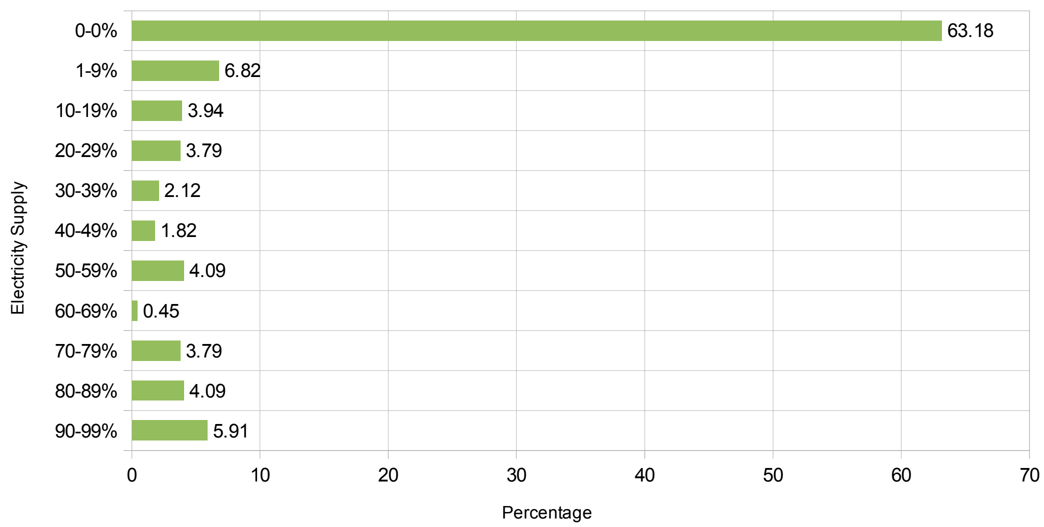

Fig. 24: LAPBR: Percentage of electricity supply in 660 communities. Source: INEC 2000.

Less than 10% of the communities in the RB have good coverage of electricity, in counterpart over 75% of the communities lack or have low electricity service coverage (Fig. 24).

In the Caribbean sector of the biosphere reserve only good electrical coverage is located in Changuinola area, around banana farms. Also the Archipelago of Bocas del Toro has at least 4 communities with good coverage of electricity (Fig. 25).

In the Pacific sector, the better coverage of electricity corresponding to some communities of Boquete district, and Volcan and Cerro Punta sub-districts.

In the Caribbean, the communities from Ngäbe Bugle area has a significant deficit of electricity service coverage (Fig. 26).

I do not have Geo-spatial data from 2010 census. It is likely that the coverage has increased, but I believe the data from 2000 still represents the magnitude of this indicator in the area.

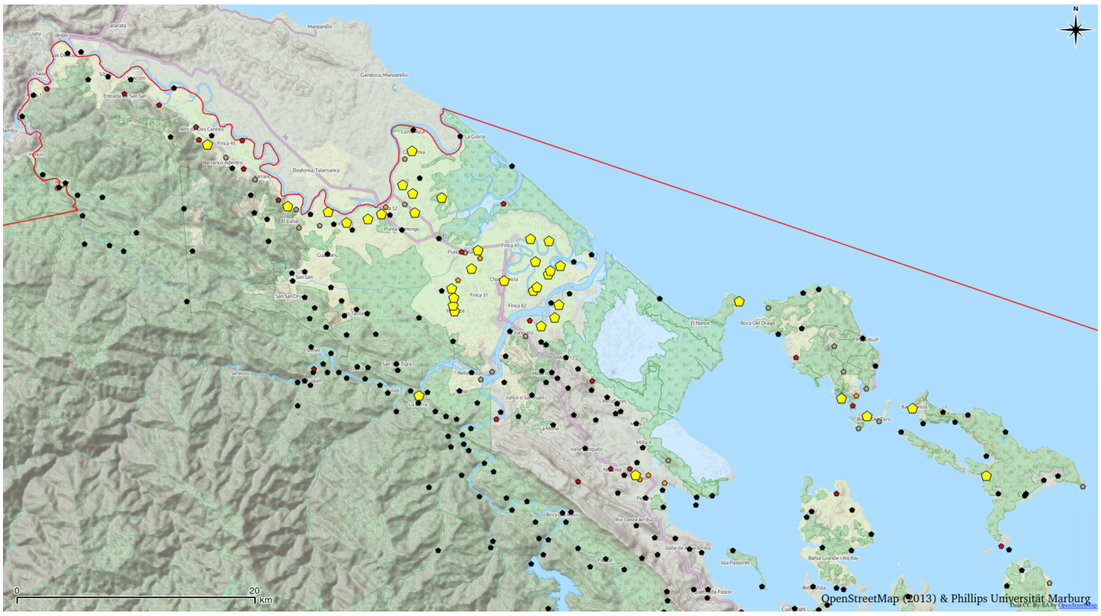

Fig. 25. LAPBR Caribbean: Communities with/out electricity in 2000

Source: Adapted from INEC. Legend: black icons = without electricity and yellow color = all houses with electricity; another colors are gradient of electricity cover.

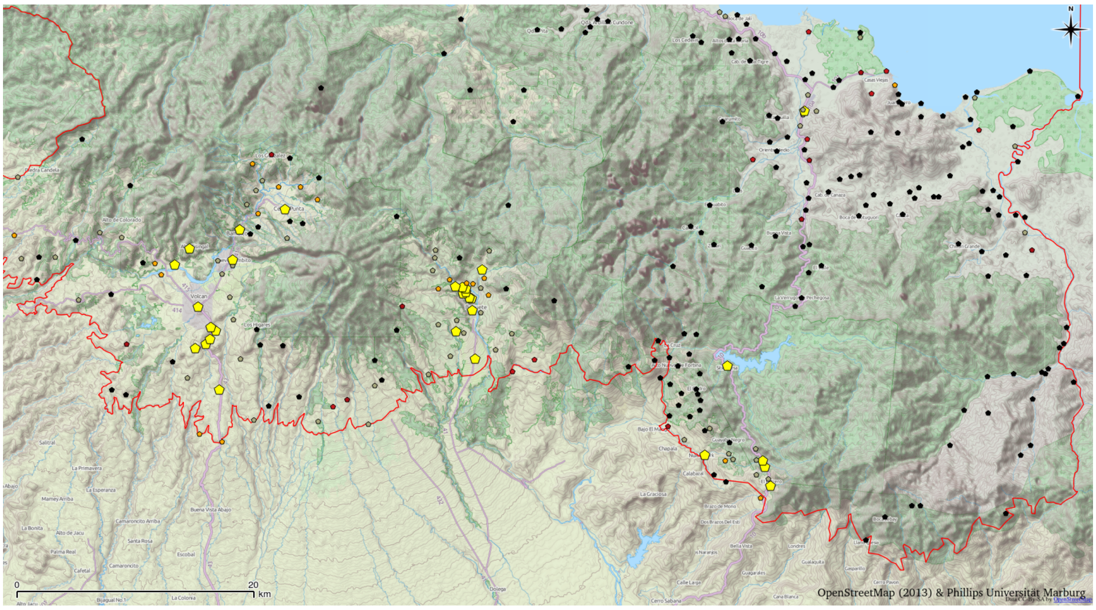

Fig. 26. LAPBR Pacific and East: Communities with/out electricity in 2000.

Source: Adapted from INEC (Census 2000) . Legend: black icons = communities without electricity and yellow color = communities with more than 90% of electricity; another colors are gradient of electricity cover.

With the data analyzed for this indicator above I can conclude that this indicator still shows high levels of deficit in electricity coverage in the communities of the biosphere reserve to than it should be. The evaluation is low.

5.1.7. Percentage of population using solid fuels for cooking

It is a social non core indicator of access to energy. UN DESA (2012) defined it as a percentage of population using solid fuels as source for cooking. Solid fuels include biomass fuels, such as wood, charcoal, crops or other agricultural waste, dung, shrubs and straw, and coal.

The indicator covers multiple sustainable development issues related to health, economy and environment. The use of solid fuels is an indicator of households indoor air pollution (environment), and related to rates of pneumonia and other acute lower respiratory infections among children and adults, including chronic obstructive pulmonary disease and lung cancer (where coal is used). Additionally high demand for biomass fuels to meet household energy needs can contribute to deforestation and land degradation. In the other way the indicator also measures the access rates to modern energy services, central to poverty alleviation and sustainable development in general (UN DESA 2012).

Data from 2000 show that there in LAPBR in a large proportion of the population or households using solid fuels for cooking (Fig 27).

The largest proportion of these communities are in rural areas in the buffer zone of the biosphere reserve. Notable is the use of solid fuel, especially wood in communities Ngäbe Bugle and rural communities in Bocas del Toro. The coal is hardly used for cooking. There are records of coal use in 11 houses Almirante town and 6 houses in the Bocas del Toro island (INEC -Census 2000).

In my opinion it is too high the number of communities depending of solid fuel as a form of energy for cooking. This use is especially wood, and it is extracted from the forests or mangrove forests without any management.

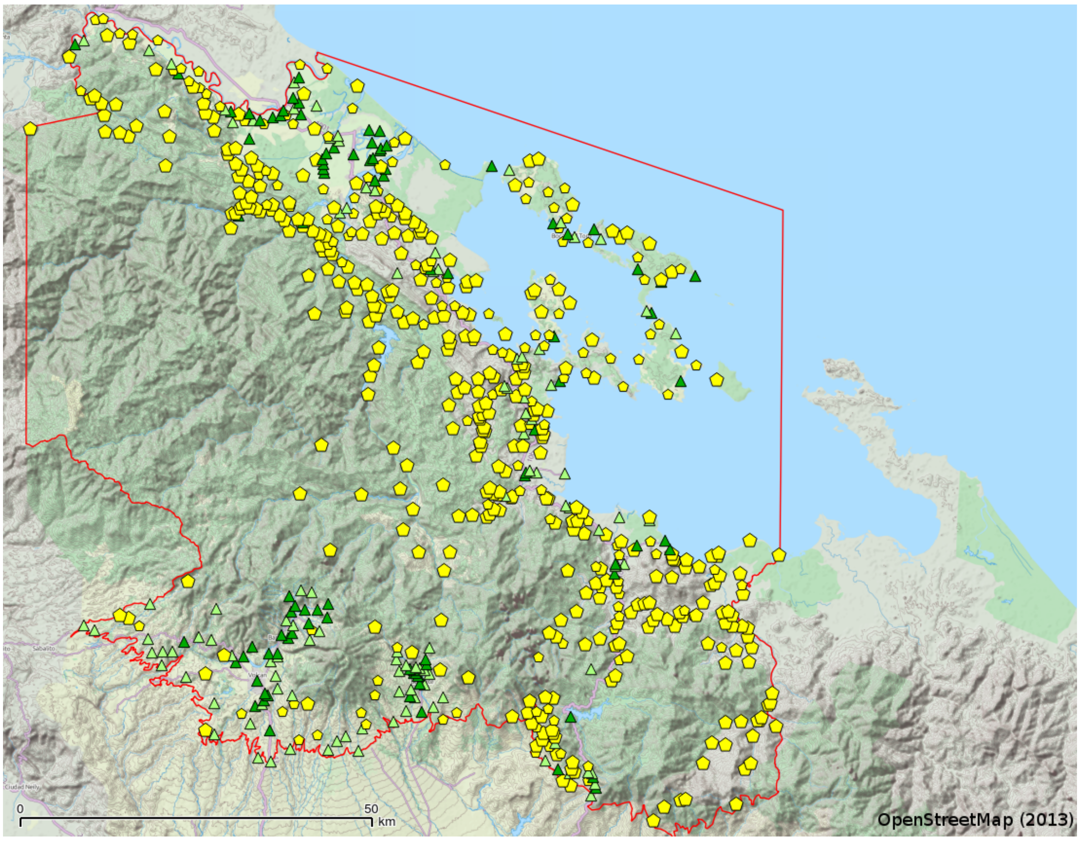

Fig. 27. LAPBR: communities cooking with solid fuels (yellow icons).
Source: Adapted from INEC (Census 2000). Legend: Green icons represent less use of solid fuel and yellow icons represent high levels of use of solid fuel.

This indicator is quite clear and easily measurable in future surveys to determine progress in this indicator. Surveys and studies on the subject should well define whether the use of solid fuel is primary or supplementary, to differentiate and estimate the level of fuel used and the effects on the health of people exposed and the environment.

The distribution map of the communities that use firewood for cooking shows is extended. The evaluation of this indicator is low.

5.1.8. Proportion of urban population living in slums

This is a social core indicator of living conditions. By definition is the proportion of urban population lacking at least one of the following five housing conditions: a-) access to improved water; b-) access to improved sanitation facilities; c-) sufficient, not overcrowded, living area; d-) structural quality/durability of dwellings; f-) security of tenure (UN DESA 2012).

This is a key indicator measuring adequacy of shelter. This urban and global problem was included by UN from the Brundlant Report in 1987 and the consequences were connected with urban diseases that arise from slum conditions (UNDP, 1987).

Overcrowding, inadequate housing, lack of water and sanitation are social symptoms of poverty. They deprive residents from their human rights with high detriments to future development. An increase of this indicator is sign of deteriorating living conditions in urban areas. Disaggregating the indicator by type of housing conditions gives further information on the severity of inadequate living conditions (UN DESA 2012).

Panama does not have statistics about this indicator[47]. Only it has a country estimated number near to 526,213 persons[48] in 2005, specially in Panama and Colon cities.

Bocas del Toro have some small communities living in areas as slums in three urban areas: Changuinola (some spots in the city), Almirante (around the harbour), and Bocas del Toro (Solución town and Carenero SW). In Chiriqui highlands and western Ngobe Bugle communities are free of slum areas because normally they are small communities.

The proportion of people living in slums in Bocas del Toro is low but without enough data. My estimated is less than 0.5% of biosphere reserve population. This fact show that is completely feasible to improve these slums and life condition of the people.

47 UN. 2012. Unstats - Indicadores Del Milenio. Online: http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=711.

48 State of the World's Cities Report 2006/7, cited in http://mdgs.un.org/unsd/mdg/

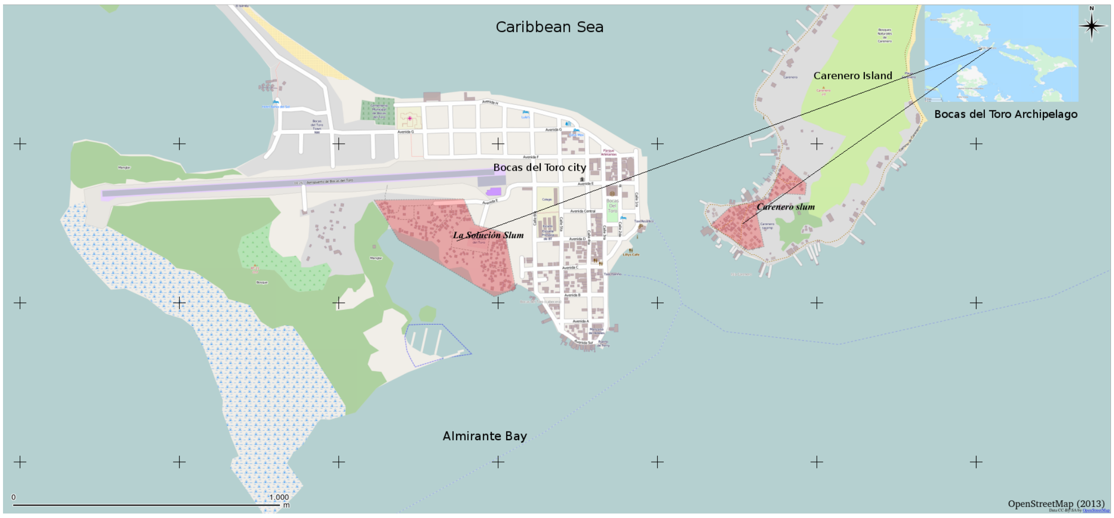

Fig. 28. Bocas del Toro archipelago has two little areas with urban population living under slum definition (Red polygons).
Source: Background map from Openstreetmap

5.2. Governance indicators

I have a few referential studies about governance in Panama. The main reference document is the PNUD (2008) about development and institutionality.

In Panama citizens have not confidence in the institutions, because they do not adequately respond to their interests and motivations and that lack of effective communication and participation in decision-making (UNDP 2008).

UNDP (2008) also identified that the country needs judicial reforms, bureaucracy and corruption eradication. Also identified that governance has a strong centralist tradition, ignoring human strengths locally and creating an attitude of dependency citizen of central estates. This has led to lack of planning, misuse of public funds and mismanagement in general, since the default centralism, lacks the ability to adequately visualize and resolve issues at the level of communities, districts, municipalities or provinces.

Centralism is compounded when different centralized institutions do not cooperate with each other to solve common problems, losing the synergy and money for solutions that require various communities. This situation has increased inequality in levels of development and welfare. It is now obvious that the attention of the State in rural and indigenous communities is poor and of lower quality in relation to urban communities. The absence of continuous government policies further aggravated the situation (UNDP 2008).

Clientelistic practices still prevail that are above the common interest and welfare, civic participation discouraging, with the negative consequences it has on the overall development of society (UNDP 2008).

In terms of values and culture UNDP (2008) identified that is common in Panamanian society the presence of abstract ideals and values that everyone accepts but does not apply to the reality of their daily lives, being all under one 'ethical relativism' . This also has led to mutual distrust between citizens and state officials. Everything ends in informal actions of citizen participation, which often only conducive to survival under the principle of individualism.

The two following indicators are related to governance:

5.2.1. Percentage of population having paid bribes

It is a social core indicator about corruption. It consists in the percentage of population having been asked or having complied to expectation by government officials to pay a bribe for his or her services (UN DESA 2012).

This indicator measures prevalence of corruption among government officials through crime surveys. A decline of this indicator is a sign of progress on the corruption component of good governance. Good governance is essential for sustainable development (UN 2012).

From 2011-2012 the level of corruption perception in Panama has been registered between 3 and 3.8 in a scale from 0 to 10, that means that a country is perceived as relatively corrupt[49]. Details of original data in other format of these indicators are available in Transparency International online site[50].

According the World Bank[51] the percentile rank of control of corruption in Panama has 46% of control of corruption. This indicator measures the level to which public power is exercised for private grant. A low percentile ranks indicates that a country is

49 Findthedata. 2013. Corruption by country. Onlne: http://country-corruption.findthedata.org/. 11/25/13

50 Transparency International. 2012. Corruption Perceptions Index 2012. Online: http://www.transparency.org/

51 World Bank. 2013. WB Data Base. Online: http://data.worldbank.org/country/panama

relatively corrupt while a high percentile rank indicates that a country is relatively clean and with strong corruption control.

There are no specific data concerning provinces or regions, nor at the level of the biosphere reserve. My view is that this indicator is difficult to extrapolate to the context of the biosphere reserve in a reliable manner, but in absence of specific data for the area, is necessary to use the global data of the country.

The evaluation of this display is similar to the evaluation at the country level. The data indicate that levels of corruption are not satisfactorily controlled, even by 50%. Therefore, the evaluation is low.

5.2.2. Number of recorded intentional homicides per 100,000 population

It is a core social indicator about crime. It is the number of intentional homicides recorded in criminal (police) statistics. Countries with sufficiently reliable crime statistics may wish to expand the indicator by including violent crimes, such as assault, rape and/or robbery (UN DESA, 2007a).

The indicator measures the development of intentional homicides over time. Intentional homicides, have a very significant negative impact on sustainable development. The crime in a society compromises human dignity, creates a climate of tension and fear and destroy the quality of life in a region or country (UN DESA, 2007a).

In 2011 in the region of Chiriqui, Bocas del Toro and Ngobe Bugle 35 homicides occurred, however, at the level of the biosphere reserve, I am projecting 22 murders, of which 17 occurred in the province of Bocas del Toro. In summary in the area of a biosphere reserve 11 intentional homicides occur per 100,000 people per year. It is a low value, but this value must lower, as it is an area of low population density.

En Panama from 2004 crime rate increased “rapidly” (MEF, 2009). High rates of intentional homicides/100,000 persons reached values from 9.7 in 2004 to 19.3 in 2008 (MEF, 2009). It is calculated than approximately 70% are occurring in the main urban areas of central Panama (MEF, 2009).

Also is valuable to know general crime incidents (thefts, robbery, armed robbery, domestic violence) as complement of homicide statistics. In this scenery, as example, Panama registered a total of 61,352 incidents in 2007, and 64,893 in 2008 (MEF 2009). These values represent a rate of 191.1 incidents/100,000 persons. More than 50% of all kinds of crimes occurs in the Province of Panama (MEF 2009).

Levels of crimes at the biosphere reserve are low, but should be even lower. The evaluation is high.

5.3. Health indicators

The indicators of health indicators for the sustainability are 10: 1-) Under-five mortality rate; 2-) Life expectancy at birth; 3-) Healthy life expectancy at birth; 4-) Percent of population with access to primary health care facilities; 5-) Immunization against infectious childhood diseases; 6-) Contraceptive prevalence rate; 7-) Nutritional status of children; 8-) Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis; 9-) Prevalence of tobacco use, and 10-) Suicide rate.

5.1.1. Under-five mortality rate

It is a core social indicator about mortality. It is refers to the probability of dying before age 5[52]. It is expressed as deaths per 1,000 live births (UN 2007).

This rate is calculated using the total number of deaths of children under five (5) years of age, divided by live births in a given year, multiplied by 1,000 (MINSA 2013). This indicator also considers the results of population projections based on the national population censuses (MINSA 2013).

In other words, this indicator measures the risk of dying in infancy and early childhood. Under-five mortality levels are influenced or directed related by the availability, accessibility and quality of health services; maternal education; safe water and sanitation in households; as well as, level of poverty and state of nutrition, among other factors (UN 2007). *WHO[53] is more specific and include as a consequence the complete social,* economic and environmental conditions in which children and families live, including their health care.

Mortality rates for different age groups (infants, children, and adults) and overall

52 WHO. 2013. http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=7
53 52

mortality indicators (life expectancy at birth or survival to a given age) are important indicators of health status in a country. Because data on the incidence and prevalence of diseases are frequently unavailable, mortality rates are often used to identify vulnerable populations. And they are among the indicators most frequently used to compare socioeconomic development across countries[54].

Global latest estimates of under-five mortality show that under-five mortality declined 47 percent, from 90 (89, 92) deaths per 1,000 live births in 1990 to 48 (46, 51) in 2012 (UNICEF, 2013).

Panama has positive trend of decline in mortality rate in children under five years old in the last two decades. It is a significant rate to pass from a high mortality rate (> 95) in the 60's to a lower rate in the last decade (± 21) (Fig. 29) but this value is also high for a good standard around 5.

Recent data from the WHO show the trend from 1990 to 2012. Importantly, the infant mortality rate of children under five has not dropped below 20, even increased again in 2012. This mortality rate for infants under one year and neonates also shows high values with respect to countries with better quality of care the baby and the mother (Fig. 30).

With some more specific data in provinces related to the biosphere reserve, these provinces have high levels of mortality of infants under 5 years compared with the national average. Chiriqui has the lowest infant mortality 5 years (Table 10). It is noteworthy that the national numbers of Panama and LAPBR are high compared to countries with better coverage of pediatric health as Cuba, Costa Rica or the European countries, Canada, New Zealand and USA Union, among others.

High rates of infant mortality in children under 5 in the provinces of Bocas del Toro and Ngobe Bugle mainly affect the poor indigenous population, which is the dominant ethnic group in these provinces. Do not have more specific and existing data are scattered and it is difficult to generate large tables per year.

The evaluation for this indicator is low, since the data analyzed and inferred facts about the existing condition is not good. Additionally there is incomplete information on the status of the indicator.

54 World Bank. 2013. WB Data Base of Indicators. http://wdi.worldbank.org/table/2.21.

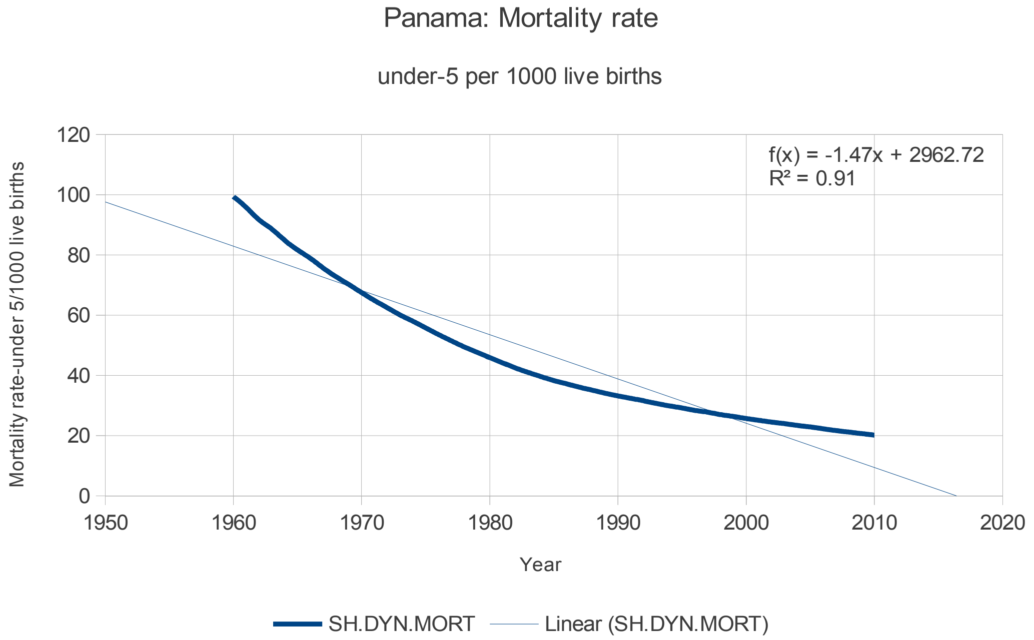

Fig. 29: Panama: Trend by decades in mortality rate under-five per 1000 live births from 1950 to 2010
Source: Adapted from WB Data Base 2012.

*Table 10: LAPBR**: Under five mortality rate (death under 5/1000 live births) in 3 provinces related to BR: Chiriqui, Bocas del Toro, Ngäbe Buglé*

Region	2001	2002	2003	2004	2005	2011*
Bocas del Toro**	54	53	67	60	74	30
Chiriqui**	27	21	19	20	21	20
Ngobe Bugle**	72	52	55	39	48	33
Country	-	-	-	-	20**	16.7

*Source: INEC; * MINSA 2013; ** WHO 2013.*

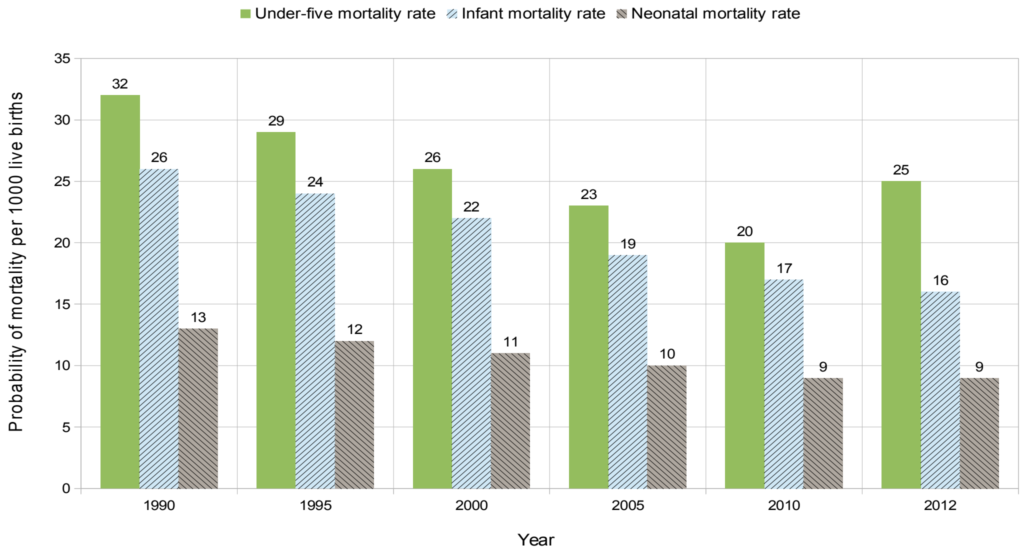

Fig. 30: Panama: Probability of dying under-five, infant and neonatal age per 1000 live births.
Source: Adapted from WHO (Indicator and Measurement Registry version 1.7.0)

5.1.2. Life Expectancy at Birth

It is a core social indicator about mortality. It is the average number of years that a newborn could expect to live, if he or she were to pass through life subject to the age-specific death rates of a given period (UN 2007).

This indicator measures how many years on average a newborn is expected to live, given current age-specific mortality risks; in other words is the average life span of a person if mortality patterns at the time of its birth remain constant in the future[55]. Life expectancy at birth is an indicator of mortality conditions and, by default, also it means the population health conditions in general in a country in a given year (UN 2007). High mortality in young age groups lowers the life expectancy at birth[56].

Mortality rates have development relevance for different age groups and overall mortality indicators because they are important indicators of health status in a country, including identifying vulnerable population in countries where the data about diseases are unavailable[57].

Life expectancy at birth in Panama has increased over the past 21 years (Table 11)

55 WB 2013. 2.21World Development Indicators: Mortality online: http://wdi.worldbank.org/table/2.21#.11/07/13
56 Idem 55
57 Idem 55

and can be considered that there are good indications or trend that will continue improving, including in the biosphere reserve.

Table 11: Panama: Life expectancy at birth between 1990 and 2011.

Year	Males	Females	Both sexes
1990	72	75	73
2000	73	78	76
2011	74	80	77

Source: WHO 2013

In the biosphere reserve, for both sexes, values have risen slowly, totaling one year in 2007-2011 (Table 12-line 5). Still, this value is 4 years less than the national total. The data for men in the biosphere reserve follows the national pattern, which means a life expectancy at birth lower than in women, in about 5 years (Table 12 - Line 6 and 7).

These data show that, indeed, there are unfavorable factors in the quality of life for residents inside LAPBR, especially Ngäbe Bugle and Bocas del Toro. Chiriqui has acceptable standards and even better than the national average. In the highlands of Chiriqui is remarkable a good quality life, higher than all rest of the LABR.

Table 12: Comparative life expectancy at birth in Panama, Chiriqui, Bocas del Toro, Ngäbe Buglé vs LAPBR between 2007-2011

	2007	**2008**	**2009**	**2010**	**2011**
Country	76.3	76.5	76.6	76.7	77.0
Bocas del Toro	71.2	71.4	71.6	71.9	72.2
Chiriquí	77.0	77.1	77.2	77.4	77.6
Comarca Ngäbe Buglé	67.5	67.8	68.1	68.5	69.0
LAPBR* total	71.9	72.1	72.3	72.6	72.9
LAPBR* males	69.7	69.8	70.0	70.2	70.6
LAPBR* females	74.3	74.5	74.8	75.1	75.4

Source: Adapted from INEC. Legend: * Average from Bocas del Toro, Chiriqui and Ngäbe Buglé.

In Panama, in 2002, life expectancy at birth in rural areas was relatively minor compared to urban areas (~76 vs 69.61 years). This condition of rurality is present in LAPBR and is one of the factors that influences that this biosphere reserve has deficient levels of this indicator.

Given that the best global standards are above 80 and the lowest between 40 and 60, I consider the status of this indicator in the reserve as low.

5.1.3. Healthy Life Expectancy at Birth (HALE)

It is a non core social indicator about mortality. It is the average equivalent number of years of full health that a newborn could expect to live, if he or she were to pass through life subject to the age-specific death rates and ill-health rates of a given period (UN DESA, 2007a).

HALE captures both fatal and non-fatal health outcomes and provides a best assessment of the impact of morbidity and mortality on populations than life expectancy alone (UN DESA, 2007a).

Estimates of healthy life expectancy (HALE) can be registered at birth or also at 60 years old [58]. This indicator also includes the expectation of lost of healthy years at birth (years).

In 2004 WHO calculated for Panama a HALE of 66.2 years for both genera, and 64.3 years for males and 67.2 for females; meanwhile males at age 60 was 14.9 years and female was 16.8 years. These data indicate that males are losing 8.5 years (11.7%) and female 10.2 (13%) of expectation of healthy life at birth. In 2007 the HALE was 67 years for both sexes, 65 for males; 68 for females (UN Data[59]).

With comparative data in 2000, Panama have high level in comparison with countries with the longest healthy life expectancy, above 70 years, and countries with lesser HALE, less than 30 years[60].

It is highly probable that the HALE in LAPBR is lower than the national average, because the conditions for preventive medicine is scarce and this fact results in the acquisition of more diseases in the population. The estimate for LAPBR is between 60 and 65 years. This valuation of this indicator is high.

58 WHO. 2004. World Health Report. http://www.who.int/whr/2004/en/. 11/25/13
59 UN Data. 2013. Online: www.data.un.org
60 WHO 2000. http://www.who.int/inf-pr-2000/en/pr2000-life.html. 11/25/13

5.1.4. Percent of population with access to primary health care facilities

It is a core social indicator about care delivery. It is the proportion of population with access to primary health care facilities. Primary health care is defined as essential health care made accessible at a cost the country and community can afford, with methods that are practical, scientifically sound and socially acceptable (UN DESA, 2007a).

The indicator monitors advances in the access of the population to primary health care. Accessibility of health services, going beyond just physical access, and including economic, social and cultural accessibility and acceptability, is of fundamental significance to reflect on health system progress, equity and sustainable development (UN DESA, 2007a).

This indicator also can be enhanced by indicators of low-cost of services, utilization of services, or actual coverage, and quality of care (UN DESA, 2007a).

High accessibility and acceptability is necessary for to get health services as a final intrinsic goal of the system for to improve their health (UN DESA, 2007a). If one person does not attend preventive medicine means that fact a handicap for to advance in good access to health for population. Education in public health should be one method for to improve health system, specially in rural areas.

UN DESA (2007a) proposed as measurement method the number of persons living within a convenient distance to primary care facilities with respect the total population, but the facilities should be properly functioning with adequate quality.

This indicator is difficult to measure in LAPBR, especially in the Ngobe Bugle area and Chiriqui highlands, because primary care centers are not necessarily inside the biosphere reserve and the distances to these centers is not directly related to primary care. Furthermore, hospitals and health centers, are been used, for treatment of sick persons and not for preventive medicine. This fact occurs because exists shortage of medical staff and infrastructure for health care with high quality.

It is normal in the current conditions that people are mobilized to hospitals in the province of Chiriqui and the three major cities of Bocas del Toro for preventive or curative medical care, despite being far from their areas of residence. The Comarca Ngobe Bugle does not have a hospital, and all residents are required, despite the isolation and distance, to be treated in hospitals in Chiriqui or Bocas del Toro. Small health centers usually have no staff, no medicine. This is an endemic health problem in the country. An official social report[61] in indigenous communities, in the northeast of LAPBR, shows the people have high demand of primary health care, because is normal to find in this indigenous communities cases of malaria, tuberculosis, leshmaniasis, and many others.

The LAPBR has five health centers serving primary care population of Bocas del Toro. These are: Regional Hospital of Changuinola, Almirante Hospital, Hospital Chiriqui Grande, Polyclinic Guabito, Local Unit of Primary Health Care Las Tables (See red icons highlighted, Fig. 31).

In the highlands of the Pacific there are two primary care center: Local Unit of Primary Health Care Volcan and Boquete Basic Polyclinic. The main hospitals in the province of Chiriqui are outside the biosphere reserve, but they are accessible to the entire population of this province.

In the whole area of the biosphere reserve there are over 40 small care centers administered by the Ministry of Health (for people without social security) or the Social Security Fund (for people who pay social security). These center I called health centers, sub-health centers, rehabilitation centers, health clinics, shelters, nursing homes (see approximate distribution inside the biosphere reserve in yellow icons, Fig. 31) .

The main hospital in the east of the biosphere reserve, which attends the indigenous population living in rural areas of Bocas del Toro and Ngäbe Bugle is Chiriqui Grande Hospital. This hospital is small and with low capabilities.

Therefore, theoretically, all communities have access to health care facility, especially access to health sub-centers, but in general these have malfunction and shortage of staff and medicines. It can be said that the main problem of access to primary health care is the lack of quality of service and also detected lack of medical access for cultural affairs in the indigenous (Ward & Bil, 2011) population which shun contact with medical personnel who do not understand him well in his native language, among other factors (Ward and Bil, 2011).

61 National Authority of Environment unpublished report from 2008.

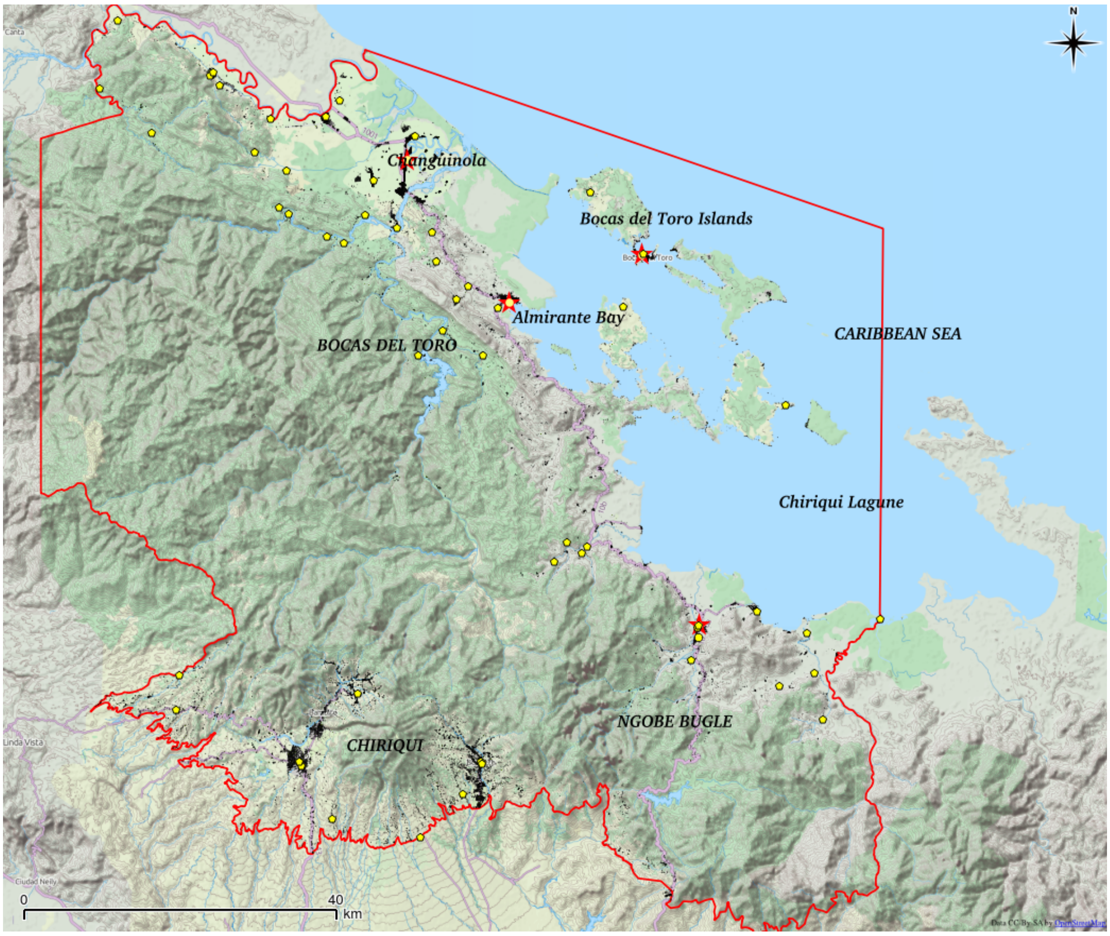

Fig. 31. LAPBR: spatial location of hospitals (yellow-red star icons) and health centers from different categories (yellow icons).

Source: INEC. Background map from Openstreetmap

In the province of Chiriqui, the non-indigenous population has better access to primary care, but the indigenous people living in the area, especially indigenous families are migrant workers, do not have adequate medical care.

According to the latest health report of the Republic of Panama, the province of Bocas del Toro has only 17.1 physicians/10000 population (including Ngäbe Bugle area); Chiriqui has 27.2 physicians/10000 people. At national level the ratio is 27.6 physicians/10000 population (MINSA, 2013).

With the previous data I conclude that good access in quantity and quality of service in the biosphere reserve is still deficient. Investment is needed in infrastructure and logistics and health education to the communities of the biosphere reserve for improve this indicator.

5.1.5. Immunization against infectious childhood diseases

It is a core social indicator about care delivery. It is the percent of the eligible population that have been immunized according to national immunization policies. The definition includes the proportion of children immunized against diphtheria, tetanus, pertussis, measles, poliomyelitis, tuberculosis and hepatitis B before their first birthday; the proportion of children immunized against yellow fever in affected countries of Africa; and the proportion of women of child-bearing age immunized against tetanus (UN DESA, 2007a).

This indicator monitors the implementation of immunization programs. Good management of immunization Programme is essential to the reduction of morbidity and mortality from major childhood infectious diseases, and is integral to the achievement of sustainable development (UN DESA, 2007a).

In general terms, Panama has good standard of immunization rates in the population. Dispersed population in indigenous and rural areas has less cover, but ambulatory medicine also is used in these cases.

With the 2008 data in specific provinces related to the biosphere reserve, immunization is higher than expected values inside the reserve, although there are still some deficiencies in levels of full immunization coverage (Table 13).

Whereas the purpose of immunization is to achieve 100% coverage of children, the rates inside the biosphere reserve are still incomplete. Various facts as logistics, budget and health care education, influence that immunization targets are not met.

Table 13: Immunization against infectious childhood diseases in LAPBR and provinces related (percentage)

Vaccine type	Country	Bocas del Toro	Chiriqui	Ngäbe Buglé	LAPBR*
DTP	94.3	95	96.3	91.2	94.2
SPR (MMR)	77.7	72.3	86.2	74.5	77.7
Poliomelytis	94	93.8	96.8	89.1	93.2
Tuberculosis	91.6	87.2	96.8	90	91.3
Hepatitis B	74.9	74.9	85.1	40.1	66.7
Influenza	57.6	58.2	58.5	35.1	50.6
Rotavirus	55.2	49.2	63.8	32.8	48.6

Source: MEF & WB 2008. Legend: SPR (MMR): vaccine against measles, mumps and rubella; DPT: vaccine against diphtheria, tetanus and pertussis (whooping cough).* Extrapolated from Chiriqui, Bocas del Toro and Ngäbe Bugle.

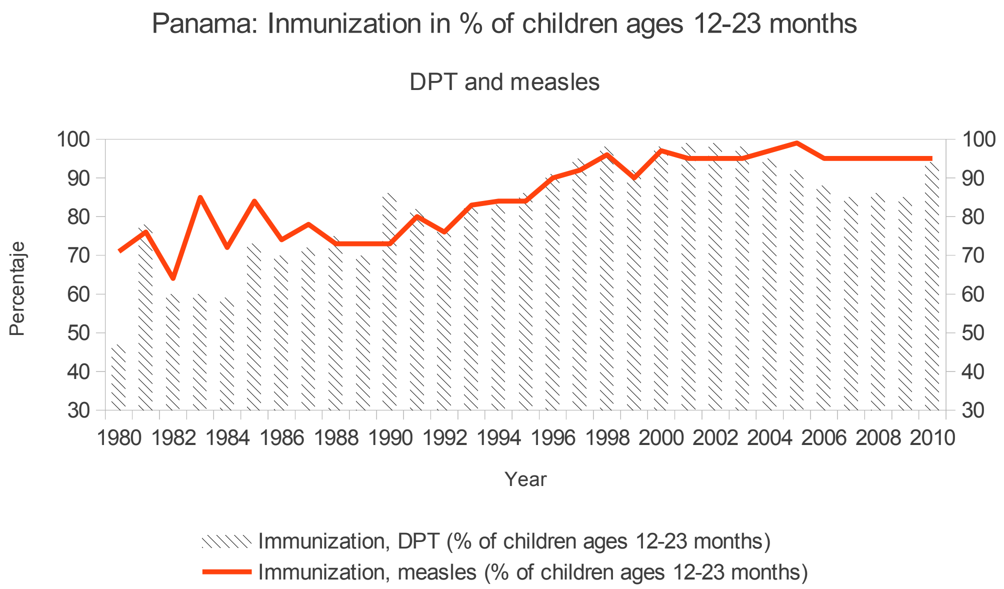

Fig. 32: Rates of immunization against diphtheria, tetanus, pertussis and rubella between 1980 and 2010 in Panama.
Source: WB (2012)

5.1.6. Contraceptive prevalence rate

It is a non core social indicator about health care delivery. It is the percentage of women of reproductive age (15-49 years) using any method of contraception at a given point in time. It is usually calculated for women married or in union of reproductive age, but sometimes for other base population, such as all women of reproductive age at risk of pregnancy (UN DESA, 2007a).

The measure indicates the extent of couples conscious efforts and capabilities to control their fertility. Contraceptive prevalence is also an indicator of access to reproductive health services, an important element of primary health care. Reproductive health Programme, which include family planning, are among the factors that promote changes in demographic behavior and trends, which in turn affect sustainability and development in a country or region. The health benefits of contraceptive use include the ability to prevent unwanted pregnancies, thereby reducing the resort to induced abortion as well as potential complications of pregnancy and the risks of maternal mortality (UN DESA, 2007a).

Data from 2007 show that among married women of Bocas del Toro 41.3% used some method of family planning, while 58.7% did not use any family planning method. In the province of Chiriqui was 59.3% and 40.7% respectively. In the Ngobe Bugle was 18.7% and 81.3% respectively (De León et al., 2009).

With regard to modern contraceptive use, the data reveal that, in Chiriqui were used by 51.5% of married women, while in Bocas del Toro and the Comarca Gnäbe Bugle was 33.1% and 17.6% respectively (De León et al., 2009). These data demonstrate that Gnäbe Buglé Comarca and Bocas del Toro have low levels of sexual reproductive education, which strongly influences the quality of life for women and families who do not have effective methods of birth control.

With the data shown above I infer that at the biosphere reserve, occurs a low rate of contraceptive use in the population in reproductive age. Cultural patterns and poverty influence increase the problem. Under this analysis I consider this indicator has a low assessment.

5.1.7. Nutritional status of children

It is a core social indicator of health about nutritional status. This indicator measures three parameters (UN DESA, 2007a):

a-) the percentage of underweight (weight-for-age below -2 standard deviation (SD) of the WHO Child Growth Standards median) among children under five years of age;

b-) percentage of stunting (height-for-age below -2 SD of the WHO Child Growth Standards median) among children under five years of age; and

c-) percentage of overweight (weight-for-height above +2 SD of the WHO Child Growth Standards median) among children under five years of age.

This indicator measures long term nutritional imbalance and malnutrition resulting in under-nutrition (assessed by underweight and stunting) and overweight. Anthropometric measurements to assess growth and development, particularly in young children, are the most widely used indicators of nutritional status in a community (UN DESA, 2007a).

Different rates of progress have led to significant changes in the distribution of the undernourished in the world between 1990–92 and 2010–12 (UNICEF, 2011). Some historical data in Panama shows positive evolution of this indicator, but also some out-layer years. For example, malnutrition prevalence, weight for age (% of children under 5) was 11.7% in 1980 but in 2008 was 13.8% in 2003 and 7.9% in 2008; in rural areas, the reduction was from 18.5% to 14.5%, but in indigenous areas, the decline was slight. At the national level, chronic malnutrition in under-fives also showed a slight decline, from 20.6% to 19.1% (UNICEF, 2011).

The national survey of quality of life 2008 reveals (Table 14) that in the LAPBR persists, as in the country, a significant percentage of children under 5 with malnutrition. Only the indicator of weight for height has better condition than in the country overall. The province of Chiriqui has the best condition is for children under five.

Table 14: Malnutrition prevalence in LAPBR and associated provinces (percentage)

Malnutrition prevalence status	Bocas del Toro	Chiriqui	Ngäbe Buglé	LAPBR§	Country
Malnutrition height-for-age (2008)*	32.10%	10.60%	63.60%	35.40%	23.60%
Malnutrition height-for-age (2011)**	33.48%	22.01%	44.36%	33.28%	27.87%
Malnutrition weight-for-age (2008)*	3.90%	2.20%	13.30%	6.40%	4.50%
Malnutrition weight-for-height (2008)*	0.30%	0.60%	1.00%	0.63%	1.20%

Source: *MEF & WB 2008 and **MINSA 2011. § Average from Bocas del Toro, Chiriqui and Ngäbe Buglé

Because data prevalence of malnutrition in children still are high, I evaluate this indicator as low, although has improved markedly in the Ngäbe Bugle in a short period. Probably the supplementary food program that supplies food to regions that exhibit this problem, has helped to improve the levels of this indicator.

5.1.8. Morbidity of major diseases

It is a core social indicator about health status and risks. It is the prevalence or incidence of major diseases such as HIV/AIDS, malaria, tuberculosis in the population. The national indicator is measured separately for relevant major diseases, typically in cases per 100,000 people (UN DESA, 2007a). This indicator is easy to segregate in regions or sub-regions.

The health indicator measures the morbidity caused by major diseases. The goals of sustainable development can only be achieved in the absence of a high prevalence of debilitating diseases in the population. HIV/AIDS, malaria, tuberculosis and other diseases are major impediments to sustainable development, especially in many developing countries. The indicator also provides information on the success of measures to fight major diseases. For that purpose, especially over a longer horizon, measuring death rates of major diseases is also important (UN DESA, 2007a).

5.1.8.1. Human immunodeficiency virus infection/ AIDS

The first case of HIV/AIDS- Human immunodeficiency virus infection - acquired immunodeficiency syndrome was diagnosed in Panama in 1984, and increased to 1,044 cases in 1995. The largest number of cases occur in the cities of Panama and Colon. None of the provinces associated with biosphere reserves have significant mortality rates associated with HIV[62]. The highest peak of HIV positives was in 1995 and now is in decline (Fig. 33).

WB (2012) reported by 2009, a 31.03% of population (15+) with HIV are female adults. A 0.4 % were males aged 15-24, and 0.3% were females (aged 15-24). In 2009 the prevalence of HIV, female (% ages 15-24) was 0.3

The measures of official attention to this disease has included the adoption of the anti-retroviral therapy coverage for people with advanced HIV infection. From 2004-2009 the percentage of HIV+ people under anti-retroviral therapy were 16, 22, 22,

62 MINSA. 2012. Anuario Estadístico de Salud 2011. http://www.minsa.gob.pa/sites/default/files/publicacion-general/anuario2011.pdf. 11/19/13)

32, 33, 37 respectively (WB, 2012).

The official data of Panamanian government for the provinces associated with biosphere reserve in 2008 reveal that Bocas del Toro had the highest prevalence rate of HIV-positive individuals (1%), followed by Ngäbe Buglé with a rate of 0.8% and Chiriqui with 0.3%.

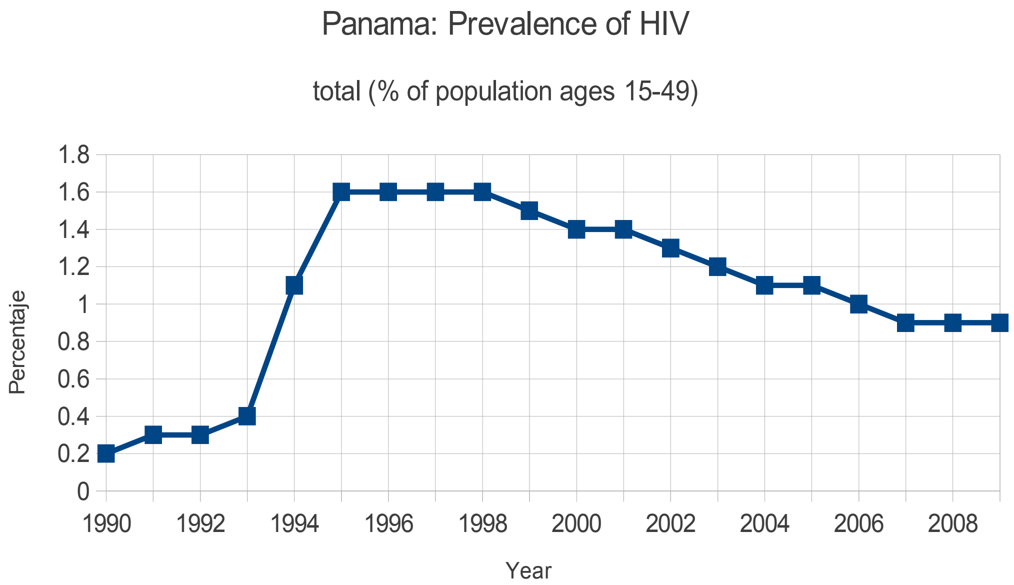

Fig. 33: Historical prevalence of HIV total (% of population - old age 15-49) 1990-2010
Source: Adapted from WB, 2012.

5.1.8.2. Malaria

Historical and current records indicate that malaria in Panama is geographically located in the extreme northwest, northeast, and east of the Isthmus of Panama in the provinces of Bocas del Toro Ngobe Bugle (Caribbean sector), Guna Yala, Embera, Wounaan and Darien[63](Loaiza et al., 2008).

Panama reported 5,095 cases of malaria during 2004, a six-fold increase in incidence since 2001. Previously, Panama had never reported more than 2000 cases per year. The highest prevalence of malaria occurs in indigenous areas; however, recently, also is occurring in peri-urban and urban areas as well[64] (MINSA 2005). In 2008 Panama registred about 31 cases of malaria (per 100,000 people) (WB, 2012).

63 La salud de las américas. Panama. 1998. Online: http://www1.paho.org/Spanish/HIA1998/Panama.pdf.11/25/13
64 Cited from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2874935/?report=classic

Caribbean sector of the biosphere reserve has malaria incidence. Socio-economic data of the National Environmental Authority 2008 recorded malaria cases in some coastal communities of Laguna de Chiriqui in Ngäbe Bugle area.

Being Bocas del Toro and Bugle Ngäbe an endemic malaria area, I can say that this parasitic disease is a big challenge about health problem in the biosphere reserve, that has not been eradicated in many decades.

5.1.8.3. Tuberculosis

The greatest incidence is in Ngäbe Buglé, Bocas del Toro in the NW of Panama and Guna Yala in the NE. The incidence of tuberculosis (per 100,000 people) has been fluctuating from 47.1 from 1990-2010 (WB, 2012) to 52.7 in 2006 to 40.5 in 2010[65].

Socioeconomic data of the National Environmental Authority 2008 recorded tuberculosis cases in some communities of Ngäbe Bugle area.

With the data analyzed for this indicator, I can assert that, mainly tuberculosis and malaria are endemic diseases for the Caribbean area of Biosphere Reserve, with high incidence in the field of Ngäbe Bugle.

Socioeconomic conditions and ecosystems are key elements for these diseases continue occurring in the reserve.

The State has spent decades in fumigation control against vectors, with household fumigation, but infections persist in the indigenous area of the reserve.

The evaluation of this indicator is medium. More advances are required for to improve this indicator.

5.3.9. Prevalence of tobacco use

It is a non core social indicator about health status and risks. It is percentage of the population aged 15 years or older that daily smokes any tobacco product. It is calculated from the responses to individual or household surveys that are nationally representative (UN DESA, 2007a).

Prevalence of current daily tobacco smoking among adults is a measure useful to determine of the economic and future health burden of tobacco use, and provides a

65 Ministerio de Salud. 2010. Programa Nacional de Tuberculosis. Panama.

primary basis for evaluating the effectiveness of tobacco control programmes over time. Tobacco is an indisputable health threat, causing 5.4 million deaths in 2005, and representing the second risk factor for mortality worldwide (UN DESA, 2007a).

Tobacco consumption is costly and contributes to poverty and associated health inequalities at the individual and national levels. The prevalence is higher among the poor illustrating a negative association between prevalence and household income and/or wealth. The cost of treatment of tobacco-caused diseases is high and falls heavily on the finances of poor households and countries. Premature deaths from tobacco-related diseases also lead to productivity losses (UN DESA, 2007a).

Smoking prevalence related to all smoker adults in Panama is 3.64% in females and 17.38% in males (WB, 2012). There are no specific data for LABR or for the provinces, but one infer low prevalence of smoking.

The evaluation of this indicator in the biosphere reserve is high.

5.3.10. Suicide rate

It is a non core social indicator about health status and risks. It is the number of deaths from suicide and intentional self- harm per 100 000 people (UN DESA, 2007a).

The indicator is an important proxy for the prevalence of mental health disorders in a country, as mental health disorders, especially depression and substance abuse, are associated with 90% of all suicides. Mental health disorders are a major impediment to the well-being of populations in developed and developing countries. People with these disorders are often subjected to social isolation, poor quality of life and increased mortality. These disorders are the cause of staggering economic and social costs (UN DESA, 2007a).

No data available at the reserve, nor are there good data for the associated provinces. There is a national data but it cannot be extrapolate to the biosphere reserve, because many factors are involved in this behavior and rates of occurrence.

Given that the national suicide rate is low and more related to urban environments, I interpret that the suicide rate at the level of the biosphere reserve is negligible.

The evaluation for this indicator is high, but verification with specific data for the area in required for a second evaluation in the future.

5.4. Social Sustainability indicators about education

The formal education is very important for full participation in the economy, society, and politics, and is key for full access and use of information technology and communications as a precondition for complete social inclusion (CEPAL, 2011b).

Public expenditure on education is a fundamental tool for to promote greater equality of opportunity throughout the education cycle and to close the achievement gaps by level according to household socioeconomic background (CEPAL, 2011b).

People enrolled in education system are able for full integration and participation to advanced levels (CEPAL, 2011b). A society with, profesionals, experts and technicians with experts in every field of knowledge is a desired goal for a complete sustainable development model.

The importance of education in the lives of people and society is unquestioned. Therefore education should not be seen only as a pragmatic means for a person to get a well-paid job positions, but also the deeper meaning in the formation of the individual to exercise their role as citizen, live in multiculturalism and with full power intellectual discernment (CEPAL, 2011b).

Sustainability indicators related to education there are five: 1-) Gross intake rate into last year of primary education - Primary completion rate; 2-) Net enrollment rate in primary education; 3-) Adult Secondary (tertiary) schooling attainment level 4-) Life Long Learning and 5-) Adult literacy rates.

5.4.1. Gross intake rate into last year of primary education

It is a core social indicator about education level. It is the total number of new entrants in the last grade of primary education, regardless of age, expressed as a percentage of the population of the theoretical entrance age to the last grade of primary education (6th) (UN DESA, 2007a).

The indicator measures whether, or not the entire eligible school age population has access to school and whether, or not they complete the full primary cycle. Universal primary education is an important goal of sustainable development, because is the base of a process by which human beings and societies enhance their fullest potential. Furthermore education is key for the promotion of sustainable development in a full context (UN DESA, 2007a).

The data indicate that the entire population of 11 years of the biosphere reserve attends the sixth grade of primary school. Even the rate exceeds 100% and may be due to lagging students of previous generations (Table 15).

Table 15. Gross intake rate into last year of primary education - Primary completion rate in Panama vs Bocas del Toro, Chiriqui and Ngäbe Buglé vs LAPBR.

Region	6th grade population	Population at age 11	Rate (%)
Country	58678	64482	91
Bocas del Toro	5313	3055	173.91
Chiriqui	13750	7690	178.8
Ngäbe Buglé	51118	4880	104.88
LAPBR*			154.76

Source: INEC -census 2010.

** Estimated from average rates from Chiriqui, Bocas del Toro and Ngäbe Buglé provinces.*

With the data recorded above assessment for this indicator is good. Even data rate of schooling at the sixth grade in the biosphere reserve are better than the national rate.

5.4.2. Net enrollment rate in primary education

It is a core social indicator about education level. It is the ratio of the number of children of official school age who are enrolled in primary school to the total population of children of official school age (UN DESA, 2007a).

The indicator shows the proportion of children of primary school age who are enrolled in primary school (normally from 1st to 6th grade). Net enrollment refers only to children of official primary school age (normally 6 to 11 years old). The indicator excludes children of other age groups enrolled in primary school age as well as children of primary school age enrolled in other levels of education. Universal primary education is a key goal for the sustainable development (UN DESA, 2007a).

Educational attainment reflects the levels and distribution of the knowledge and skills base of the youth labor force (ILO, 2013[66]).

Data from the 2007-2011 five-year period (INEC) for the biosphere reserve show high rates of enrollment in primary education. Rates exceed 100% of the enrollment of children in primary school system of public education (Table 16). It is quite possible that these figures are due to that children are not segregated from below or above the official age who are enrolled in primary education.

The three provinces of LAPBR have higher enrollment rates over 100%. The values above the ideal value is because the Panamanian educational system, a little percentage of children of each school year generation are repeating the same grade, resulting in each generation there is a remnant that repeats the same degree with the generation one year younger.

This high level of enrollment can help in the near future to grow the capacity in LAPBR to achieve more easy social and economic goals and can put down the degree of inequality, and it can help for to improve the skills of the future labour force, and improving the overall potential of the people in the region.

Definitely these values above the expected ideal, are good overall, but also show a problem in the background of how the education system, manages and serves the correct progress and learning of children in primary school. The final evaluation is high.

Table 16: Net enrollment rate (%) in primary education in Panama vs LAPBR and provinces related to BR.

Region	**2007**	**2008**	**2009**	**2010**	**2011**
Country	112.8	111.4	109.3	108.2	102.8
Bocas del Toro	133.0	135.8	134.1	136.8	118.1
Chiriqui	106.7	107.6	104.6	107.6	100.7
Ngäbe Buglé	171.0	175.6	174.3	183.4	153.6
LAPBR*	136.9	139.7	138.2	142.6	124.2

** Average of Bocas del Toro, Chiriqui and Comarca Ngäbe Bugle*

66 ILO. 2013. The youth employment network. http://www.ilo.org/public/english/employment/yen/whatwedo/projects/indicators/8.htm. 11/25/13

5.4.3. Adult Secondary schooling attainment level

It is a core social indicator about education level. It is the proportion of the population of working age (25-64 years) which has completed at least (upper) secondary education (12th grade). Adult Tertiary Schooling Attainment Level is defined as the proportion of the population of working age (25- 64 years) which has completed at least the first stage tertiary education (UN DESA, 2007a). Tertiary education is referred as post-secondary schools, including universities, colleges, technical training institutes and distance learning centers, and another set of public and private institutions engaged in post-secondary education[67].

These indicators provide measures of the quality of the human capital stock within the adult population of approximately working age (UN DESA, 2007a).

According the World Bank[68], higher education is critical determinant of a country's economic growth and standard of living, because it produces greater outcomes in social, technical, scientific and institutional capacities. With higher education a country or region also has professional and effective public sector, a stronger civil society working together or parallel with states in many development topics, and a good state of affairs for business, innovation, scientific research and another fields.

Also, a good tertiary education system allow to a country or region to adopt, disseminate, and maximize rapid technological advances[69] and cooperation with another regions with less standard of development.

The estimated data rate of tertiary schooling of population of working age between 25-64 years also is not available. Available data is for people younger than 25 years old in the population of the LAPBR showing that this indicator has an approximate rate of 34.58% (Table 17). In my point of view an appropriate value should be higher than 40% and within this percentage must be at least 5% with advanced college. Only the province of Chiriqui, which is the province with the best indicators of development of the reserve reaches an adequate minimum level for this indicator.

The Comarca Ngäbe Bugle in 2010 had a rate of tertiary education and excessively low which affects the expected average rate for the biosphere reserve. Bocas del

67 World Bank. 2013. Tertiary education. Online: http://web.worldbank.org/.12/04/13
68 Idem 67
69 Idem 67

Toro also has a low rate, but is less critical than the Comarca Ngäbe Bugle.

Table 17: Proportion of tertiary (12th grade) schooling attainment level in LAPBR and provinces related with people younger than 25 years old in 2010

Region	Cases	Rate of tertiary schooling level (12th grade)
Bocas del Toro	13263	29.07%
Chiriqui	81064	42.57%
Ngäbe Buglé	2609	5.9%
LAPBR*	96936	34.58%

*Source: INEC. * Average from Bocas del Toro, Chiriqui and Comarca Ngäbe Bugle*

Under the assumption that data from 10 years ago are worse than the 2010 data shown in Table 17, I can infer that the enrollment rate for people aged over 25 is low, relative to that expected for LAPBR. Therefore, the evaluation of this indicator is low.

In Latin America, access to the last cycle of post-secondary education is reserved for a relatively small portion of young people. In the age group 25 to 29 years old, only 8.3% achieved complete at least five years of post-secondary education (CEPAL 2011b).

5.4.4. Life Long Learning

It is a non-core social indicator about education level. It is the percentage of the population aged between 25 to 64, enrolled in education or training (UN DESA, 2007a).

The indicator measures the level to which working-age population is engaged in learning activities, normally associated to develop and adopt new technologies and organization techniques as workers (UN DESA, 2007a).

In Bocas del Toro and Chiriqui, there is the National Institute for Training and Human Development (INADEH). This is an institute of vocational education for people of working age and in order to learn a skill semi-qualified. A more advanced level of continuing adult education, vocational beyond does not exist in the plans and policies of the State, except the university system, which is oriented toward young people under 25 years old.

According INADEH 2013[70], 72% of students nationally are people over 25 years. It is also valid to clarify that there may be other forms of private job training and workers' organizations, but there is no data available.

In 2013 (January-October), Bocas del Toro, Chiriqui and Bugle Ngäbe had an estimated 1500 people over 25 years old, enrolled in training processes. This number represents ~0.027% of the total population aged 25-64 years in LAPBR.

Therefore it is clear that in Panama, or the LAPBR not have a policy of lifelong learning for the adult population over 25 years, following the goals enunciated in the UNESCO Mumbai Declaration on lifelong learning[71] from 1997.

Considering the limited data and the low percentage of people enrolled in adult learning systems, and the lack of infrastructure to handle this type of education, I evaluated this indicator as low.

5.4.5. Adult literacy rates

It is a core social indicator about literacy. It is the proportion of the adult population aged 15 years and over that is literate (UN DESA, 2007a).

This indicator measures the number of literate persons within the adult population who are capable of using written words in daily life and to continue to learn (e.g. long life learning programs). It reflects the accumulated accomplishment of education in spreading literacy in the population (UN DESA, 2007a).

Panama has a 94.6% coverage of literacy of the population aged 15 years and older. However, literacy is not homogeneous: while almost all the non-poor population is literate (98.2%), this proportion decreases to 84.9% among the poor and 75.2% among the extremely poor (Table 18*).*

In LAPBR, the expected adult literacy rate is 83.5% (Table 18), which indicates that still requires increased effort and cooperation of civil society and the state to achieve excellent coverage rates of adult literacy.

Another problem observed is that this indicator is based on surveys or censuses,

70 INADEH. 2013. Estadísticas. Online: http://www.inadeh.edu.pa/. 12/04/13

71 UNESCO. 1997. La Declaración de Mumbai sobre el Aprendizaje Permanente, la Ciudadanía Activa y la Reforma de la Educación Superior. Online: http://www.unesco.org/education/uie/confintea/mumbspa.html

which do not verify the true ability of the individual to read and write in the sense required by this indicator. It is highly probably that, considering the rate of functional illiteracy, this education problem in the population is even higher at the country level and by default in the LAPBR.

Table 18: Literacy of the Panamanian population of ± 15 years, by area, by level of poverty (%) in 2008.

Location	Total	Poverty			Non-poor
		Total	Extreme	Poor	
Country	94.6	84.9	75.2	91.5	98.2
Urban	98.4	94.6	91.3	95.2	98.9
Rural	91.9	87.6	85.5	89.0	95.4
Indigenous	60.3	59.0	56.3	76.6	83.5
LAPBR*	83.5	80.4	77.7	86.9	92.6

Source: MEF (2009, based in surveys of living levels 2008)

** Average from urban, rural and indigenous locations.*

The score for this indicator is high, but no enough for expected values that should be around 100%.

5.5. Demographics

The population growth have relevance to sustainable development in a region or a country because is one of the most core social elements in relation to long-term sustainability[72]. Population growth, “at both national and sub-national levels” as LAPBR region, represents a basic indicator for decision makers and administrators[73].

This indicator is intrinsically related to economic, social and environmental issues, specially when this growth occurs in conjunction with poverty and lack of access to resources[74].

Also can be significant in areas with non-sustainable patterns of production and consumption or in vulnerable areas with high ecological values[75].

72 United Nations. 2012. United Nations Division for Sustainable Development-National Information-Indicators of Sustainable Development. Online: http://www.un.org/esa/sustdev/natlinfo/indicators/indisd/english/chapt5e.htm. 29/08/13.

73 Idem 72

74 Idem 4.

75 Idem 4.

Sustainability indicators related to demographics there are four: 1-) population growth rate; 2-) total fertility rate; 3-) Dependency Ratio; 4-) Ratio of local residents to tourists in major tourist regions and destinations. The definition of every indicator is based mainly in UN DESA (2007a).

5.5.1. Population growth rate

It is a core social indicator about population change. It is the average annual rate of change of population size during a specified span period (UN DESA, 2007a).

The population growth rate measures how fast the size of population is changing by total or by rural and urban. The urban population growth rate measures level of urbanization. The high growth of urban populations, caused by many reasons is of concern in many countries. In the other side, settings where the conditions for sustainable agricultural and rural development are not in place, high rates of rural population growth could negatively affect the use of land, water, air, energy and other resources (UN DESA, 2007a).

The growth rate in LAPBR is 42.36% in 10 years (Table 19), or 4.24% per year, which is a high rate. May be considered a growth rate is very high when it is above 3%.

Countries with high growth rates, usually have serious problems in meeting the basic needs of the population. An example of this occurs in the central African countries with high rate of population growth but low human development. This same effect or subnational level of a RB can have the same consequences, as I discussed the definition of the indicator.

The population of the province of Bocas del Toro whose territory is entirely inside the LAPBR, registered a 4.05% annual increase in population between 2000 and 2010, while, Kankintú district which is the main district of the Comarca Ngobe Bugle inside the biosphere reserve, grew 6.84% (INEC – Census 2000 and 2010) in the same period, which is disproportionately and that needs to be considered as a priority issue in population management future of the biosphere reserve.

The data shown indicate that the issue of population growth is worrying and is a priority to treat you, and if demand continues in this trend for natural resources and infrastructure for human development will be high and it is likely that the goals of adequate coverage not are achieved.

The score for this indicator of sustainability in LAPBR is low.

5.5.2. Total fertility rate

It is a non core social indicator about population change. It is the average number of children (live births) a cohort of women would have at the end of their reproductive period if they were subject to the age-specific fertility rates of a given period. This indicator assumes that there is no mortality. The total fertility rate is expressed as children per woman, and can be disaggregated into various age-specific fertility rates (UN DESA, 2007a).

Fertility is one of the variables that directly affect population change. With low fertility, normally, is possible to improve the quality of life of all population in social, environmental and elements for full human development and sustainability. On the other hand, some countries, specially industrialized countries, experiencing below-replacement fertility levels could face rapid population aging, that can affect productivity and competitiveness (UN DESA, 2007a). More details of methodology for this indicators in (UN DESA, 2007b).

Table 19: LAPBR: population growth rate in the main districts or sub-districts between 2000–2010.

Places	***Houses 2000***	***Population 2000***	***Houses 2010***	***Population 2010***	***Growth rate (%)***
Bocas del Toro**	2,355	9,916	4,801	16,135	62.72
Changuinola**	15,655	71,922	22,133	98,310	36.69
Chiriqui Grande**	1,657	7,431	2,886	11,016	48.24
Kankintu**	3,068	19,670	6,930	33,121	68.38
Boquete**	4,483	16,943	7,913	21,370	26.13
Guacá*	509	1,726	650	1,891	9.56
Hornito*	440	1,251	494	1,230	-1.68
Potrerillos*	480	1,378	587	1,562	13.35
Río Sereno*	741	3,289	1,776	5,463	66.1
Cordillera*	144	471	228	590	25.27
Paraíso*	87	248	157	429	72.98
LAPBR	29,619	134,245	48,555	191,117	42.36

Source: INEC 2013. Notes: ** districts; * sub-districts

The fertility rate in Panama in the 1960s was more than 5 children per woman. In the 1970s started a decline that has continued to drop over the 2000s (Fig. 34).

In the period 2007 - 2011 the national rate of children per woman has remained at a near 2.6 average, but in Bocas del Toro and Ngäbe rate is high, except in the province of Chiriqui which remains close to the average national (Table 20).

The high fertility rate in Comarca Ngäbe Bugle and Bocas del Toro strongly influences the average expected rate LAPBR, which is high and is decreasing very slowly, but with strong trend in the last years (Fig. 35).

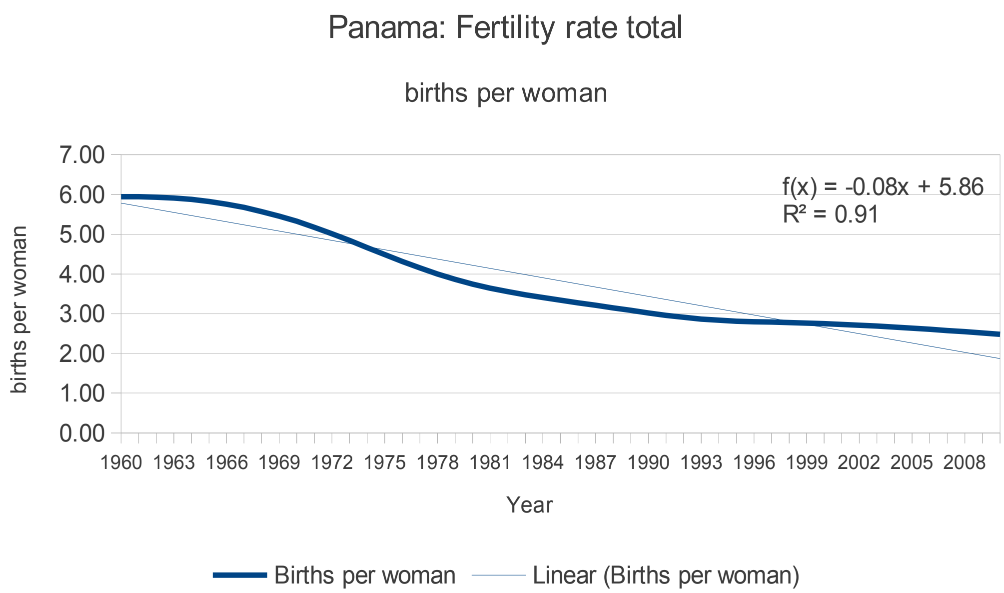

Fig. 34: Panama: Historical fertility rate from 1960 - 2008
Source: Adapted from The World Bank database

Table 20: Comparative fertility rate per 1000 woman in Panama, provinces and LAPBR

Region	2007	2008	2009	2010	2011
Country	81.4	80.1	78.9	78.2	77.7
Bocas del Toro	144.7	142.5	140.4	138.2	136.0
Chiriqui	82.4	82.0	81.7	81.5	81.4
Ngäbe Buglé	169.3	164.5	159.8	155.3	151.3
LAPBR*	132.1	129.7	127.3	125.0	122.9

Source: INEC

In Panama the high fertility of mothers is related to poor woman. This fact produces additional problems with teenager pregnancy increasing the social problem over time in the population in poor conditions (CEPAL 2011).

With this indicator the states can achieve policies for protect the mothers and their children and to stablish better programs of education about reproduction information, and policies for the permanence of woman in education system and additional logistic support for child care, and others (CEPAL 2011).

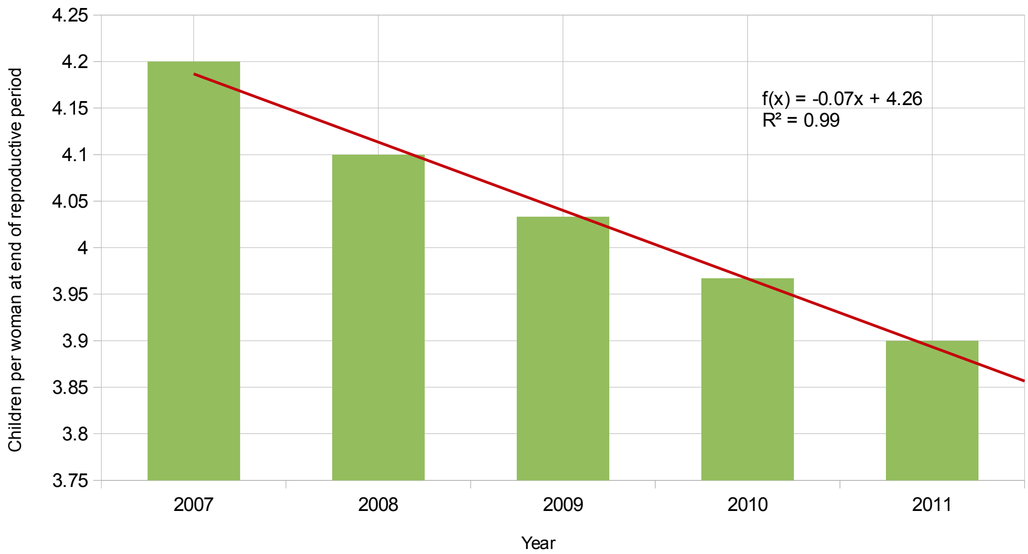

Fig. 35: LAPBR: fertility rate (children per woman in fertile age) among 2007 and 2011
Source: Adapted from INEC

With data and brief analysis of the situation in Panama and observed for LAPBR, the score for this indicator is low, despite the downward trend observed.

5.5.3. Dependency Ratio

It is a core social indicator about population change. It is the dependency ratio relates the number of children or younger people than 15 years old and older than 64 years to the working-age population (15-64 years old) (UN DESA, 2007; WDB 2013). Data can be interpreted as the proportion of social dependents per 100 working-age population[76].

Dependency ratios indicate the potential effects of changes in population age structures for social and economic development, in particular regarding social support needs, specially social security and education (UN DESA, 2007a).

Data from Chiriqui, Comarca Ngobe Bugle and Bocas del Toro from 2007-2012, the

76 46

average dependency ratio was 56.4%, and for LAPBR was ~74.51%. That is a high dependence rate.

Ngäbe Bugle is the region that has a disproportionate dependency ratio, with a total rate of 122.56% in 2010. Young people under 15 years is the greatest weight in making this high value (Fig 36). Ngäbe Bugle is the region that has a disproportionate dependency ratio, with a total rate of 122.56% in 2010. Young people under 15 is acting more weight for this high value (Fig 36). In contrast, the Chiriqui province shows a more balanced ratio dependency. The province of Bocas del Toro, whose territory is entirely inside the biosphere reserve, also has a high dependency ratio, since over 80%, which is interpreted as a notable imbalance (see data and graph in Fig. 36).

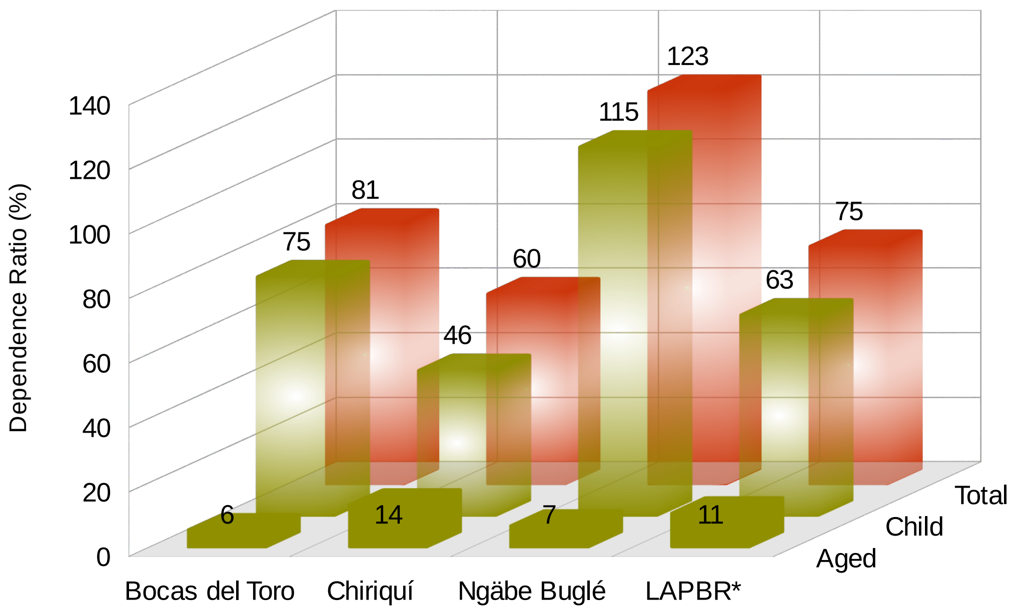

Fig. 36: LAPBR: Dependency ratio total (aged + child), and by aged (+64 year old) and child (0-14 year old) in 2010.
Source: INEC – Census 2010

Analyzing the evolution of this indicator in the period 2007-2011 the values in the provinces of Bocas del Toro and Ngobe Bugle have decreased slightly over time. The total values calculated for LAPBR are also high, as over 75% (Table 21). The effort to reduce the dependency ratio is the Ngäbe Bugle and rural populations in the province of Bocas del Toro.

While there is no ideal number defined for the dependency ratio, I infer from other countries with better standards of development, that an acceptable value can be between 40 minimum and 60 maximum. Below or above these values usually confront imbalances countries either by low population growth or population explosion.

Table 21: Total dependency ratio in LAPBR vs country and provinces related (2007-2011)

	2007	**2008**	**2009**	**2010**	**2011**
Country	56.9	56.6	56.2	55.9	55.5
Bocas del Toro	79.1	78.8	78.4	77.8	77.0
Chiriquí	60.9	61.0	61.0	61.0	61.0
Ngäbe Buglé	102.2	100.3	98.4	96.6	95.1
*LAPBR**	80.7	80.0	79.3	78.5	77.7

*Source: INEC. *= average from Bocas del Toro, Chiriqui and Ngäbe Bugle. **= this rate is different to the original data from census 2010.*

With the information analyzed for this indicator, I can conclude that the status of this indicator in the LAPBR is poor and much time and effort is required to reach balanced rates of dependency. The score for this indicator is low.

5.5.4. Ratio of local residents to tourists in major tourist regions and destinations

It is a non core social indicator related to population change. It is the number of tourists and same day visitors per day, peak seasons or whole year, divided by the number of local residents in tourist regions and destinations (UN DESA, 2007a).

The ratio can indicate total and seasonal pressure on the environmental and social resources of touristic regions in a country and their population (UN DESA, 2007a).

The tourism represents a key source of income and employment but also the bad management exerts a considerable pressure on the environmental and sociocultural resources of host populations (UN DESA, 2007a).

The biosphere reserve there are several locations that are points of tourism, among these include the highlands Pacific: Boquete, Volcan, Cerro Punta and Fortuna. In the Caribbean archipelago of Bocas del Toro. Of these the most popular places for national and international tourists is Boquete, which is not a mass tourism activity in the area.

In the Caribbean of LAPBR, tourism occurs mainly in the archipelago of Bocas del Toro. According to official data, the higher rate of visits to the archipelago is of domestic tourists, but also is one of the sites of Panama, most recognized for eco-tourism and beach tourism.

The annual rate of international visitors to the Province of Bocas del Toro from 2007-2011 was 52,028 tourists (INEC). The final destination within the province of those tourists is unknown, but I assume that the destination of 90% of these tourists was the archipelago of Bocas del Toro.

Official data[77] from ports records 254,285 visitors in 2002 at the port of the island of Bocas del Toro and they expect this number to be multiplied sevenfold in 2024. This data represents a density of ~696 visits per day. This rate represents approximately 7.5% of all residents in the Bocas del Toro Archipelago (using population density data from Census 2010).

According to the above information I can suggest a high score for this indicator. The social, environmental or economic problems relative to Bocas del Toro Archipelago are not a function of the current rate of tourism, but in terms of the lacking of basic sufficient public structures, the management of land tenure, urbanism management and a strong framework of development strategy. The main problems in this area are previous to tourism increase in the region.

Many tourism projects are impacting ecosystems, landscapes and local people. This problem are mainly related to weak institutionality and corruption, more than rates of visitants by itself.

5.6. Natural hazards indicators

These indicators contribute to a better understanding of the level of vulnerability to natural hazards in a given country, including sub-national level. With this updated information the decision takers can implement long-term, sustainable risk reduction programs to prevent disasters (UN DESA, 2007a).

77 AMP. http://www.amp.gob.pa/newsite/spanish/planificacion/jica/02_S_VOL_2/S_VOL_2_02.PDF. 11/25/13

UN claims that high vulnerability means higher exposure to natural catastrophes in the absence of disaster reduction measure (mainly in vulnerable areas), causing after disasters big social and economic collapses. Big disasters without contingent plan produce a strong negative impact on the development process (UN DESA, 2007a).

The natural hazardous indicators have two indicators: 1-) percentage of population living in hazard prone areas and 2-) human and economic loss due to disasters.

5.6.1. Percentage of population living in hazard prone areas

It is a core social indicator about vulnerability to natural hazards. It is the percentage of national population (in the analysis only inside of LAPBR) living in areas subject to significant risk of prominent hazards: cyclones, drought, floods, earthquakes, volcanoes, landslides and others (UN DESA, 2007a).

The indicator may be calculated united or separately for each relevant prominent hazard at sub-national level for to arrive at national levels. The risk of death or serious injuries in a disaster caused by natural hazards is a function of physical exposure to a hazardous event and vulnerability to the hazard (UN DESA, 2007a).

The LAPBR has some areas that are exposed to dangerous floods that periodically there are flood events, the main damage is caused on crops and urban or semi-urban areas, but in any case it is considered that these areas produce prominent risks to physical integrity population, but produce damage affecting the quality of life of citizens. Among the areas subject to flooding in the reserve are the lower basins of Sixaola, Changuinola, Guarumo and San San.

In the highlands of the reserve there are no recurring problems with vulnerability to disasters. There have been isolated cases as the overflowing of Caldera River in the district of Boquete, affecting infrastructure and residences near the shore of the river overflow.

In the corregimiento of Cerro Punta there have been isolated cases of overflow of Chiriqui Viejo River, especially in the sector of Bambito, which has caused damage to residences and shopping centers that were built improperly on the natural floodplain of the river.

Meanwhile, in the Bocas del Toro Archipelago no records of major disasters from storms or hurricanes. Panama, as isthmus south of the Caribbean Basin, is not directly impacted by the hurricane system that forms in the Caribbean Sea.

At the beginning of 20th century the state has begun an expansion of electricity production system. The water resource LAPBR both the Pacific and the Caribbean, is the main natural resource used for this purpose.

In the Caribbean have proposed a number of medium and large dams. Most of these dams are planned on the Changuinola River. Of the total proposed dams have already built two: 1 -) Bonyic in the sub-basin river Teribe and 2 -) Chan 75[78] in the middle basin of the Changuinola River. These dams, more than any other in the country, represent a potential hazard to populations downstream thereof. The danger is related to that are built on an area of high seismic activity[79] and high rainfall. In an event of dam break or lose control of water management of these dams, may cause life-threatening flash floods for residents and agro-industrial activity in the lower basin of the Changuinola River.

In general terms the potential of natural catastrophes in LAPBR which can be a constant source of danger to human life and infrastructure can have a range between 10-15% (~25,000 to 37,000 people) of the total population of the biosphere reserve.

Since there are obvious potential hazards in the area, I evaluate this indicator with a medium evaluation.

5.6.2. Human and economic loss due to disasters

It is a non core social indicator about disaster preparedness and response. It is the number of persons deceased, missing, and/or injured as a direct result of a disaster involving natural hazards; and the amount of economic and infrastructure losses incurred as a direct result of the natural disaster. The indicator may be expressed as percentage of total population for human loss and of GDP for economic loss (UN DESA, 2007a).

The indicator provides estimates of the human and economic impact of disasters.

78 This lake has a volumen of 130 millions of m³ of water, with a power potential of 223 MW and a production of 1,046.3 GWh per year. Online: http://dev.aida-americas.org/sites/default/files/INFORMEREP5Dchan_0.pdf. 11/25/13

79 In 1992 occurred in earthquake in Bocas del Toro that lifted the coast in front of mainland of Bocas del Toro and Limon in Costa Rica between 1 and 2 meters.

Disasters involving natural hazards affect in short and long term the sustainable development goals because it impacts deeply the society and the local and national economy (UN DESA, 2007; UN DESA 2012).

In the last 10 years in the area of the biosphere reserve has not occurred loss of life or personal injury or loss due to natural disasters. There are isolated cases of loss of life in rivers overflowing, but these are not victims within a disaster context as such, however the risks of cyclones and earthquakes in particular can not be ruled out, especially in the Caribbean coastal marine region (Bocas del Toro and Ngobe Bugle), as I mentioned in the previous indicator.

For example, the April 22, 1991 occurred an earthquake of magnitude 7.4 (Richter scale). This earthquake caused severe damage in a large area of the province of Limón in Costa Rica and Bocas del Toro in Panama. There was in both countries a total of 79 deaths, 1,085 injured and 15,000 people with destroyed houses. Many structures and buildings were destroyed or damaged (Malaver et al. 1993; UTP 1991). It is one of the few disasters with documentary records of its effect, however a detailed economic effect was not included.

In view of this poor record on science policy disasters and loss of life and economic lives, the assessment for this indicator is barely acceptable. This indicates that a biosphere reserve or a country should have clear policies and guidelines in how to generate scientific reports of disasters that contribute to the future disaster management by researchers and decision makers to make informed decisions that promote that natural disasters do not become catastrophes that affect quality of life and economy.

The valuation for this indicator is medium.

5.7. Analysis of social indicators of sustainability

The table 22 shows a complete matrix of scores, weights and values observed and expected for every social indicator for sustainability. With this table was obtained the mathematical analysis about social sustainability in LAPBR.

With the observed percent values of development advances with respect the expected I am able for to say with specific results that the level of advances in this set of social indicator in LAPBR is yet low. In this case I have a 47.76% in development advances against 52.24% as shortfall.

Table 22: LAPBR: Final mathematical results about social indicators for sustainability

Nr.	Social Indicators of Sustainable Development	Evaluation	Weight	Observed value	Required value
1	Proportion of population living below national poverty line	3	3	9	30
2	Proportion of population below $1 a day	3	3	9	30
3	Ratio of share in national income of highest to lowest quintile	3	3	9	30
4	Proportion of population using an improved sanitation facility	4	3	12	30
5	Proportion of population using improved water source	3	3	9	30
6	Share of households without electricity or other modern energy services	2	3	6	30
7	Percentage of population using solid fuels for cooking	2	2	4	20
8	Proportion of urban population living in slums	9	3	27	30
9	Percentage of population having paid bribes	3	1	3	10
10	Number of intentional homicides per 100,000 population	8	1	8	10
11	Under-five mortality rate	3	3	9	30
12	Life expectancy at birth	4	1	4	10
13	Healthy life expectancy at birth	7	1	7	10
14	Percent of population with access to primary health care facilities	5	3	15	30
15	Immunization against infectious childhood diseases	7	3	21	30
16	Contraceptive prevalence rate	3	2	6	20
17	Nutritional status of children	3	3	9	30
18	Prevalence of tobacco use	8	1	8	10
19	Suicide rate	8	1	8	10
20	Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis	5	3	15	30
21	Gross intake into last year of primary education	10	3	30	30
22	Net enrolment rate in primary education	9	3	27	30
23	Adult secondary (tertiary) schooling attainment level	2	2	4	20
24	Life long learning	1	3	1	10
25	Adult literacy rate	7	3	21	30

Nr.	Social Indicators of Sustainable Development	Evaluation	Weight	Observed value	Required value
26	Population growth rate	3	2	6	20
27	Total fertility rate	2	2	4	20
28	Dependency ratio	4	2	8	20
29	Ratio of local residents to tourists in major tourist regions and destinations	10	1	10	10
30	Percentage of population living in hazard prone areas	5	1	5	10
31	Human and economic loss due to natural disasters	6	1	6	10
			Sum	**322**	**690**
		46.67%	Advances of Social Indicators		
		53.33%	Deficit of Social Indicators		

CHAPTER 6

Environmental indicators: atmosphere, freshwater contamination, and energy

6. Physical environmental indicators for sustainable development

Human history in complex societies has led it to live a multidimensional socioeconomic and environmental reality. The nature conservation studies, strategies and programs should adapt to this reality.

After multiple regional and global wars, that strongly affected human development across the globe during the late nineteenth century and early twentieth century, led, first, to the approach of defending the rights and human dignity globally. Amidst this scenario, the ideological war grew based on the style of economic policies and the management and control of capital within countries. So were consolidated economic models that are partially fused today, and the discussion continues about every tendency arguing collective welfare.

Environmental concerns and development paradigm born just after the implementation of various policies to promote economic growth for development under the arguments to meet the needs of society as a whole.

Environmental disasters in all existing political systems is obvious. Hence the global movement that calls for 'saving' the planet's natural resources was born. The concept was evolved to materialize the global discussion on global environmental future at the UN World Conference on Environment in Stockholm in 1972.

On that global conference was born, formally, an agenda that incorporated environmental elements as key elements in implementing development strategies. The concept of development by itself ceased to exist. A multidimensional concept of development was born. Is still weak in most countries, but it seems to have a global consensus that development is really multidimensional, and the environmental elements are key pillars to achieve the global goal of sustainable development in its fullest sense.

Some global conferences have defined and redefined the development of the most suitable and practical indicators for use in the study of the state of sustainable development of countries and regions. There is no full consensus on what are the most suitable according to the characteristic of the country.

In this study I attempt to zoom in on a scale of a biosphere reserve, that within the global consensus, have also been launched as a sustainability model region, which are special areas inside countries, able for to implement full sustainable development strategy.

The following analysis of physical environmental indicators for LAPBR indicators are following the definitions of Indicators of Sustainable Development: Guidelines and Methodologies developed by the Department of Economic and Social Affairs of the United Nations Secretariat (UN DESA, 2007, Third Edition) by mandate of the United Nations Commission on Sustainable Development in 1995.

The indicators suggested by the Commission on Sustainable Development (CSD) of the United Nations include all sustainability guidelines that have been raising on development and the environment since the World Summit in Stockholm in 1972 to the Johannesburg Summit 2002 and I have discussed in Chapter 1. In this case, Table 23 shows the first of two sets of environmental indicators, that I will be applying to the context of the Biosphere Reserve La Amistad. Also, I am showing the linking of these indicators with MDG, Agenda 21 and JPOI goals.

When one of the indicators cannot be used for the context of a biosphere reserve, I discuss the reasons or motives about the characteristics of this indicator. UN DESA (2007a) calls as irrelevant an indicator that is impossible to apply in a country, for example, marine indicators in countries without marine ecosystems or radioactive wastes management in countries without nuclear energy systems and so on.

If the indicator is applicable, I add the information available for the study area. Obviously for most indicators there is no specific statistics for a biosphere reserve, which forces us to use data from the provinces or territories inside the reserve to provide data that can be used directly or extrapolated.

Environmental indicators to be analyzed are 36, but they are splitted in 14 indicators related to contamination, management, and consumption (Table 23); and 23 indicators related to nature conservation in the Chapter 7 (Table 26). The analysis of sustainability of these first set of environmental indicators are divided in detail, into the following themmes, a-) atmosphere; b-) freshwater; c-) contamination and management, and d-) consumption of natural resources in transportation.

Table 23: CSD environmental indicators of sustainable development related to contamination, management and consumption,compared with MDG indicators, Agenda 21 and JPOI chapter.

Nr.	Environmental CSD Indicator of Sustainable Development	MDG Indicator	Agenda 21 chapter	JPOI chapter
	Atmosphere			
1	Emissions of greenhouse gases		9 (9.11, 9.14 9.17, 9.20)	IV (38)
2	Carbon dioxide emissions	# 28 a *	9 (9.11)	IV (38)
3	Consumption of ozone depleting substances	# 28 b	9 (9.23)	IV (39)
4	Ambient concentration of air pollutants in urban areas		9 (9.11, 9.14, 9.17)	IV (39); VI (56)
	Freshwater			
5	Proportion of total water resources used	New	18	IV(25 e, 26)
6	Water use intensity by economic activity		18	IV(26)
7	Biochemical oxygen demand in water bodies		18 (18.39)	IV(25 d)
8	Presence of faecal coliforms in freshwater		18 (18.39 c)	IV(25 d)
9	Waste-water treatment		18 (18.39)	IV(25 d)
	Contamination and management			
10	Generation of waste		21 (21.8)	III (22)
11	Generation of hazardous waste		20 (20.11)	III (23)
12	Waste treatment and disposal		21 (21.17)	III (22)
13	Management of radioactive waste		22 (22.3)	III (35)
	Consumption of natural resources in transportation			
14	Energy intensity of transport		4	III (21)

Source: adapted from UN DESA (2007a).

6.1. Atmosphere indicators

6.1.1. Emissions of greenhouse gases

It is a non-core environmental indicator about climate change. It measures the anthropogenic emissions, less removal by sinks[80], of the main greenhouse gases (GHGs) in the Earth atmosphere: 1- carbon dioxide (CO2 and formule CO_2), 2- methane (CH4 and formule CH_4), 3- nitrous oxide (N2O and formule: N_2O), 4- hydrofluorocarbons (HFCs), 5- perfluorocarbons (PFCs), 6- sulphur hexafluoride (SF6 and formule SF_6) (UN DESA, 2007a).

These gases are main and stronger destructor of ozone layer that CO2 emissions. That is the reason for to use CO2 equivalents emissions for to measure CH4, N2O, HFCs, PFCs and SF6, using the so-called global warming potentials (GWPs) provided in assessments of the Intergovernmental Panel on Climate Change (UN DESA, 2007a).

This indicator measures the emissions of the six main GHGs which have a direct impact on climate change, less the removal of the main GHG CO2 through sequestration as a result of land-use change and forestry activities. An increase of greenhouse gas concentration in the atmosphere contributes to global warming, which is a major global challenge to sustainable development. This indicator is relevant specially in countries that have committed to reduce or stabilize their GHG emissions[81] (UN DESA, 2007a)

Methane emissions

The official definition of methane emission are those stemming from human activities such as agriculture and from industrial methane production, whereas agricultural methane emissions is refereed to emissions from domesticated animals, animal waste, rice production, agricultural waste burning (non-energy, on-site), and savannah burning, while methane emission in energy means those from energy

80 Only a valid sink is Carbon sink defined by Morison et al (2012) as any system which causes a net C transfer from the atmosphere to the system. A growing forest is normally a sink, but there are situations where a forest can become a carbon source, transferring C to the atmosphere by deforestation or fires.

81 Complete discussion about Carbon sink can be consulted in https://en.wikipedia.org/wiki/Carbon_dioxide_sink and its references.

processes and from the production, handling, transmission, and combustion of fossil fuels and bio-fuel[82].

In Panama, the largest emissions of methane to the atmosphere are produced by the agricultural industry. Since 1990 the country data reveal that agriculture generates an average of 79.8% of total emissions of this gas. Meanwhile the power generation industry is the second largest source of emission of this gas, with 4.5% of the total. 15.7% comes from a number of other sources including emissions generated by the car park nationwide (Fig. 37).

No data for LAPBR, even at the provincial level. A conservative estimate would be between 3-5 percent of all methane emissions in the country. A good basic research would just know the current amount of such methane emissions, taking into account that the RB has areas of production of vegetables, coffee, banana, other crops on a smaller scale, and livestock.

Hydrochlorofluorocarbons (HCFCs)

They are fluorocarbon compounds used primarily as chlorofluorocarbon (CFC) substitutes, but the results in atmosphere contamination were worst[83].

These industrial products increase by default the pollution of atmosphere because possibly all production will be released to environment during “manufacture, handling, use or disposal” of those chemicals[84].

By the size population, low industrialization levels and an economy based in services Panama as country does not have major production in these gases. ECLAC statistics show values near to cero in all CFCs gases except HCFCs. Panama is using HCFCs. I am inferring high consumption by the national refrigeration system.

UNEP estimated for Panama a consumption of 43,976 Ozone Depletion Potential Tons[85] related to CFCs in between 1986-1998 and ranking as 24th country with higher

82 International Energy Agency data. Online: http://data.worldbank.org/indicator/EN.ATM.METH.AG.ZS and http://www.indexmundi.com/facts/nigeria/methane-emissions. 05/23/13

83 Chlorodifluoromethane. Online: http://en.wikipedia.org/wiki/HCFC-22. 05/20/13

84 WHO. Fully Hallogenated Chlorofluorocarbons, 1990. Online: http://www.inchem.org/documents/ehc/ehc/ehc113.htm#SectionNumber:1.8. 05/20/13.

85 The indicator was obtained by multiplying the Total CFCs emissions (metric tons per ozone depletion potential) with the Per capita CFCs emissions (obtained by dividing the total CFCs emissions by the population in 1997). In calculating these values the base-10 logarithm of this variable was used.

world CFC consumption[86]. With these estimates, indicates country level should be lowered consumption levels of CFCs, since the most recent values indicate increased significantly compared to the previous decade. It is expected that by 2030 all of these products disappear from the developing countries, according to the compliance schedule of the Montreal Protocol (UNEP[87]).

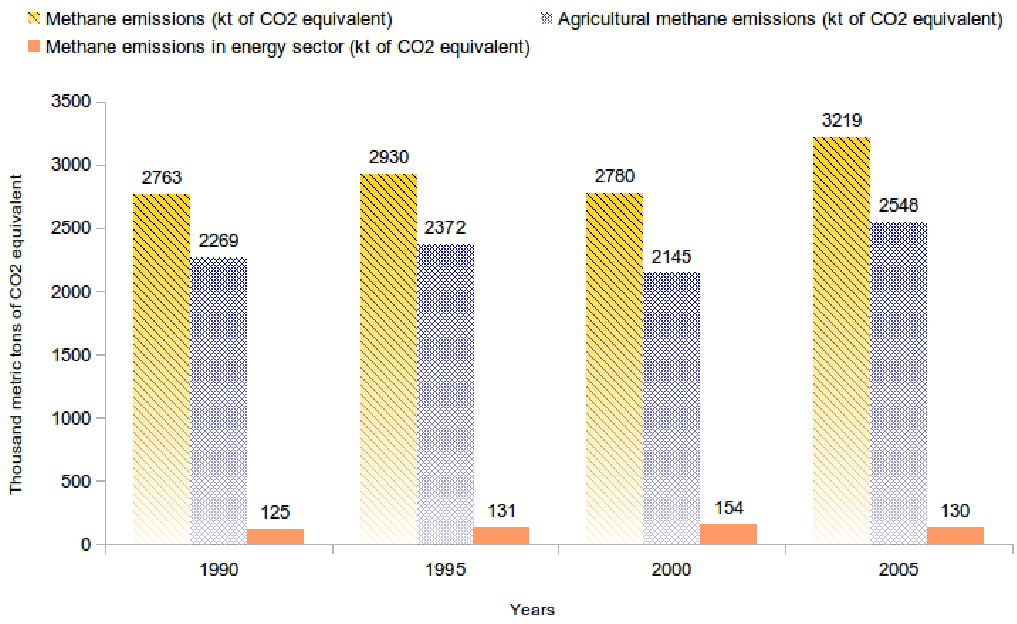

Fig. 37: Panama: Methane emissions between 1990-2005

Source: adapted from WB.

This indicator is difficult to apply with certainty to a biosphere reserve, anyway, in LAPBR, at this time, I believe that this indicator is unreliable unless it could obtain accurate data for municipalities or localities inside the reserve they prove otherwise.

Considering the size of the population and infrastructure of Bocas del Toro, Chiriqui highlands and Ngäbe Bugle, I can estimate that GHG emissions LAPBR represent less than 2% of greenhouse gas emissions in the country.

The evaluation for this indicator of GHGs (methanes and HCFCs) is high. Inferred and expected pollution is not significant in relation to national and global context.

86 UNEP. 'CFC consumption by country, UNEP, Production and Consumption of Ozone Depleting Substances, 1986-1998, October 1999, via ciesin.org'. Online: http://www.NationMaster.com/graph/env_cfc_con-environment-cfc-consumption. 05/20/13.

87 Idem 86

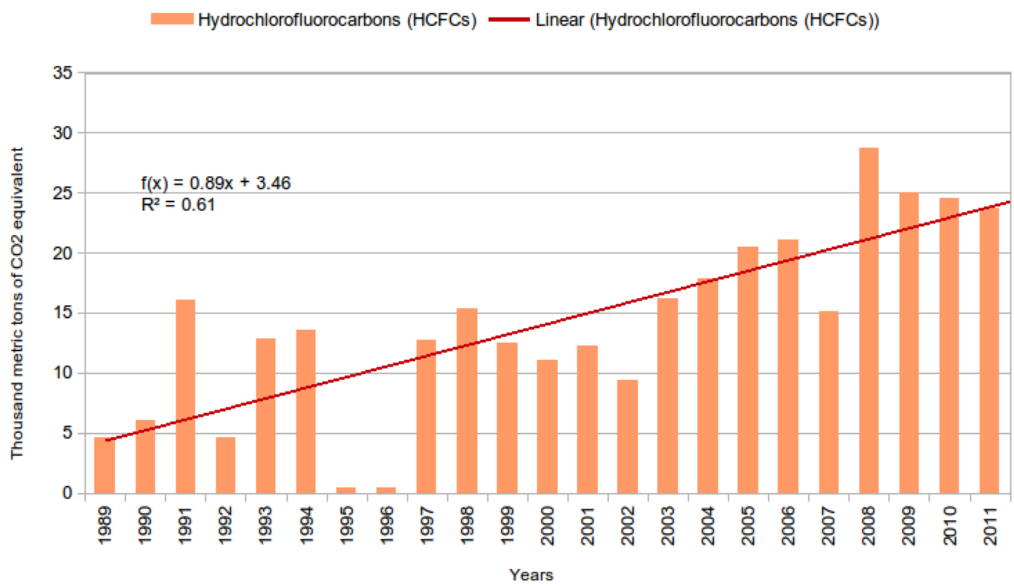

Fig. 38: Panama: Level of consumption of HCFCs between 1989-2011
Source: Data from PNUMA/ECLAC statistics 2012

6.1.2. Carbon dioxide emissions

It is a core environmental indicator about climate change issue. It measures the anthropogenic emissions, less removal by sinks[88], of carbon dioxide (CO_2). In addition to total emissions, sectoral CO_2 emissions can be considered. The typical sectors for which CO2 emissions/removals are estimated are 1-) energy industry, 2-) industrial processes, 3-) agriculture, 4-) waste, and the sector of 5) land use, land-use change and forestry (LULUCF) (UN DESA, 2007a).

Carbon dioxide is known to be the most important, by quantity, in terms of impact on global warming, anthropogenic greenhouse gases (GHG). A doubling of the CO_2 concentration in the atmosphere is believed to can cause an increase in the global mean temperature of 1.5 to 4.5 °C, which is expected to produce high impact in the ecology and economy systems in many countries around the world (UN DESA, 2007a).

The fossil fuel supply for the country in 2012 is approximately 78.6% meanwhile was 21.5% in renewables, with Carbon dioxide emissions reaching a total of 7 mega-

88 A carbon sink is any system which causes a net C transfer from the atmosphere to the system. A growing forest is normally a sink, but there are situations where a forest can become a carbon source, transferring C to the atmosphere by deforestation or fires (Morison et al., 2012)

tonnes with 2 tonnes per capita, with an average annual per capita growth of 0.9% (UNEP, 2013).The fossil supply includes coal, oil and natural gas. In Panama, auto mobiles are using mainly gasoline, diesel and gasoline-ethanol mixture.

Specific data for provinces or comarcas are unavailable and it is impossible to analyze in regional or LAPBR context, but in the following two atmospheric indicators I am analyzing the national context as a proxy to the study area.

In the last two decades, Panama has produced carbon dioxide emission slowly but increasingly. In 1990 the Panama carbon dioxide emissions was 3,135 thousand tonnes and in 2009 was 7,844 thousand tonnes (Fig. 39).

From 1985 the transport sector is the main activity with higher production of carbon dioxide emissions. In the last year, from 2003, the increasing has more significance, followed by emission from electricity and heat production. The third most important sector producing carbon dioxide emissions is the manufacturing industry, residential and public sector (see Figs. 40 in percentage and Fig. 41 in tonnes).

Historical data shows that in the 1970's the main factor of carbon dioxide emissions was the power generation, but later with incorporation of new hydroelectric projects, as Bayano and Fortuna, the situation changed. Nowadays automobiles are the main producer of carbon dioxide emissions. From 1990 to 2008 the pattern of emission shows similarities and the same proportion between sources (Figs 40 and 41).

Data from 2001 reveal transport sector (automobiles) produces the largest quantity in tonnes of carbon dioxide (more than 2 million metric tons), followed by the industry sector of electricity generation. Too below followed the manufacturing industry. The carbon dioxide emissions from the residential sector are insignificant in relation the main sector producers (Fig. 41).

Diesel is the higher fuel consumption in Panama (Fig. 42). The average consumption was 27.5 million gallons (104,098 m^3), followed by gasoline with 18 million gallons per year (68,137 m^3)[89]. The consumption of diesel is mainly used in the power generation industry and automobile especially trucks.

89 INEC

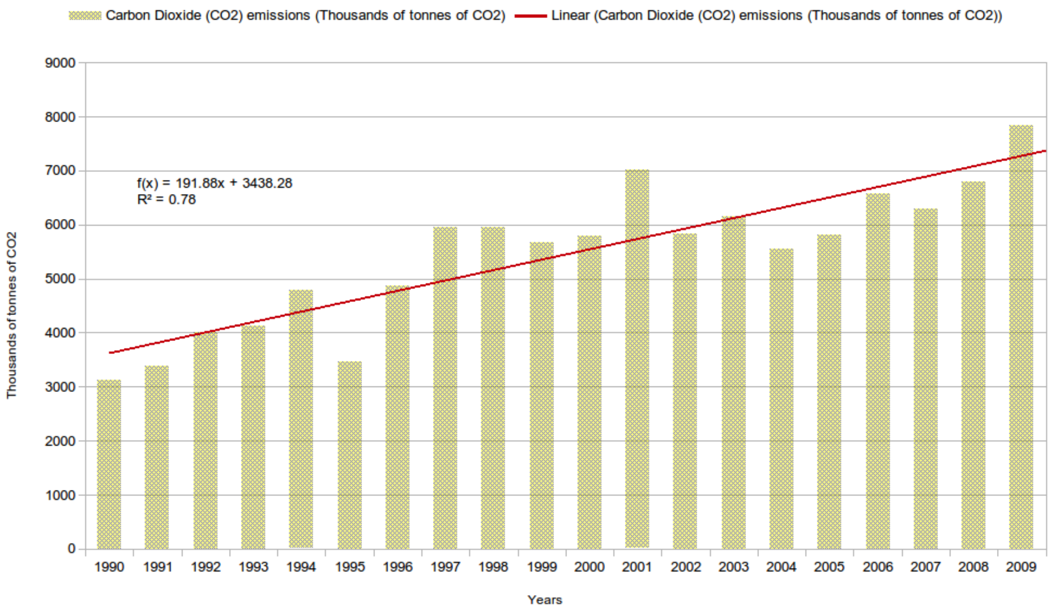

Fig. 39: Panama: Carbon Dioxide emissions between 1990-2009
Source: CEPALSTATS.

It is expected that the trend of increasing CO2 emissions by the growth of the vehicle fleet. The vehicles in Panama is large and growing (Table 24 and Fig. 43). This occurs for two reasons[90]: 1-) good access to bank financing and 2-) reduction rates interest, coupled with the poor structure of urban public transport in the city of Panama.

It should be noted that Panama City is the only major city in Panama. The rest of the cities are not comparable, in size, population and socioeconomic activities.

BBVA report highlights historical values of auto sales in 2011 and higher sales in 2012, at least 47,000 automobiles, especially commercial vehicles. The report notes that the implementation of the Free Trade Agreement between Panama and the United States of America recently ratified for both parts, will further favor the supply of new cars.

90 BBVA Research. 2011. Panamá situación automotriz 2011. Electronic Publication of BBVA.

Combined data from the vehicles in the provinces of Chiriqui and Bocas del Toro show the existence in 2011 of at least 44,810 cars (72% private, 26% and 2% commercial and officers). Specifically for the LAPBR are approximately 16,000 in 2011 (Fig. 44). I have estimated for the period 2007-2011 an average of 6.6 cars per 100 inhabitants.

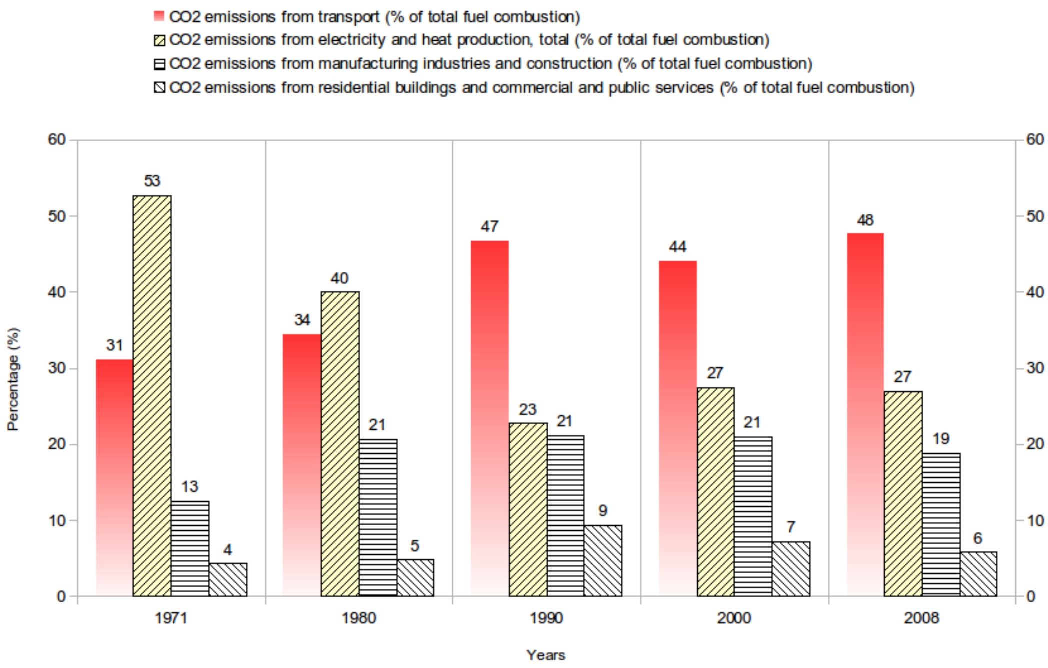

Fig. 40: Panama: Trends of carbon dioxide emissions in percentage from the four major sources from 1971-2008
Source: adapted from CEPALSTAT.

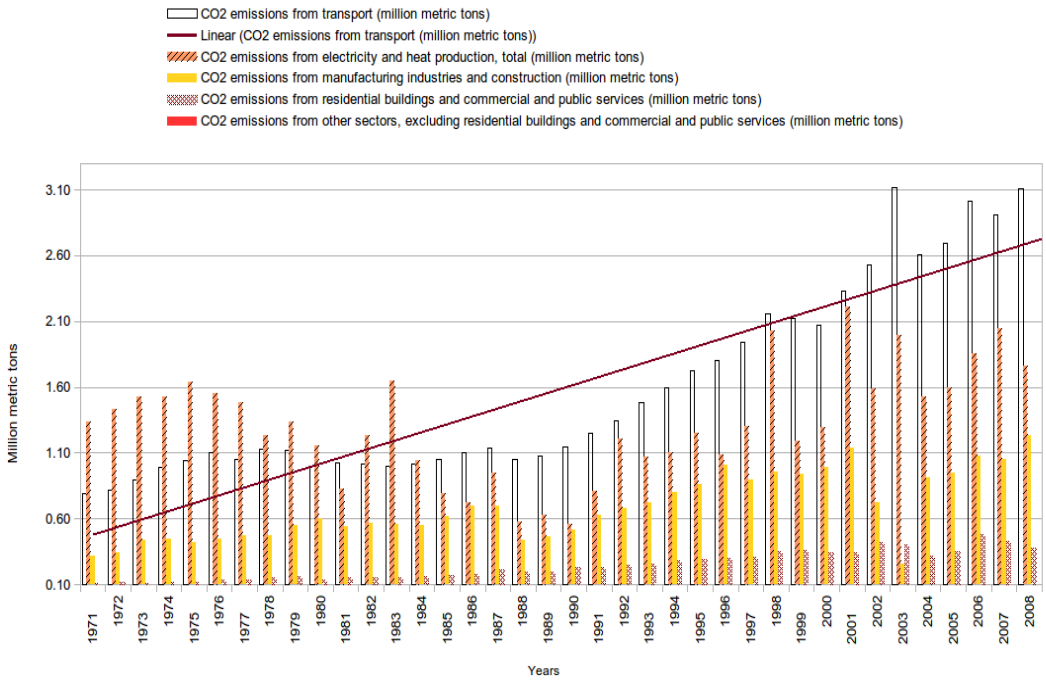

Fig. 41: Panama: carbon dioxide emissions in millions of metric tons in the four major sources
Source: CEPALSTATS.

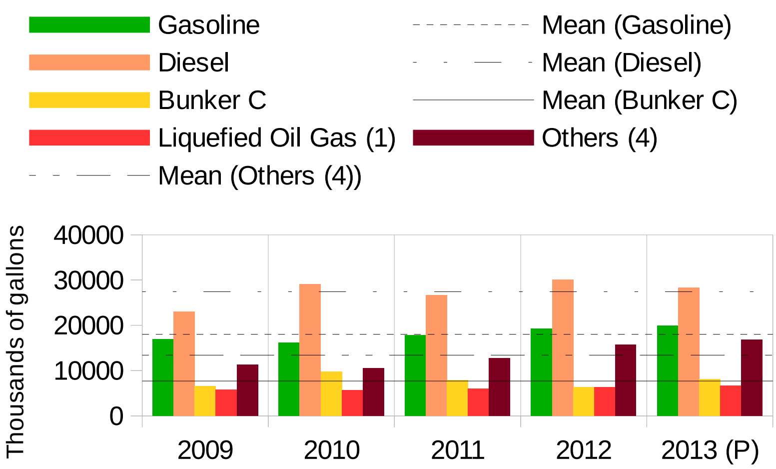

Fig. 42: Panama fuel consumption 2009-2013
Source: INEC.

Table 24: Growth car fleet of Panama (2006-2010)

Year	Autos	Population (in thousands)	Autos/1000 inhabitants
2006	372224	3413.4	109
2007	396705	3475.7	114.1
2008	412625	3538	116.6
2009	441558	3600	122.7
2010	471118	3661.8	128.7

Source: INEC

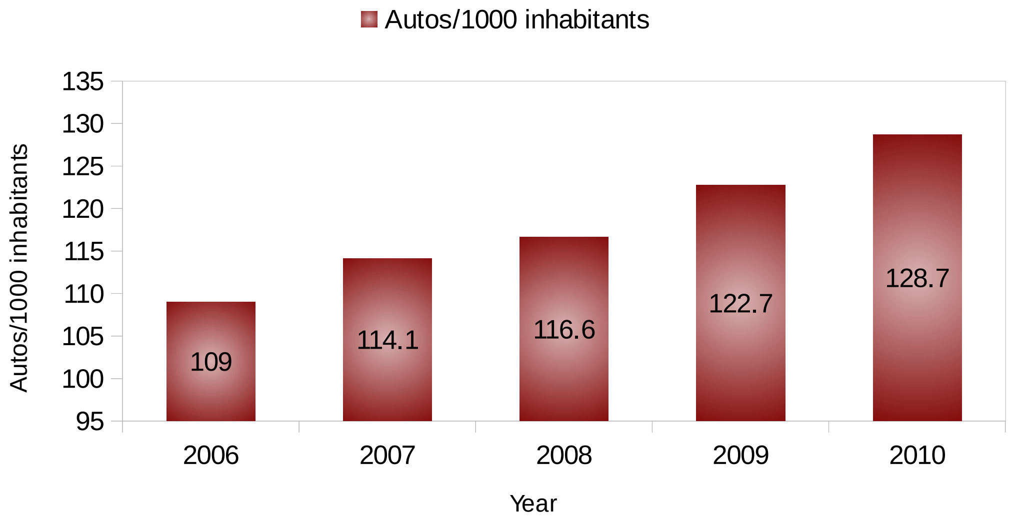

Fig. 43: Growth in the number of cars per 1000 inhabitants in Panama from 2006 to 2010 Source: INEC.

In LAPBR the problem of CO2 emissions is not significant by any factor that I discussed at the national level. On the contrary, the biosphere reserve is providing renewable hydro-power and thus acts as a carbon sink for the country. The evaluation for this indicator is high.

6.1.3. Consumption of ozone depleting substances

It is a core environmental indicator about ozone layer depletion. This indicator shows the consumption trends for ozone depleting substances (ODSs) controlled under the Montreal Protocol on Substance that Deplete the Ozone Layer, thereby allowing inference of the amounts of ODSs being eliminated as a result of the protocol.

This indicator depicts the progress towards the phase out of ODSs by the countries which have ratified the Montreal Protocol on Substances that Deplete the Ozone Layer and its Amendments. The phase-out of ODSs, and their substitution by less harmful substances or new processes, will lead to the recovery of the ozone layer, whose depletion has adverse effects on human health, animals, plants, micro-organisms, marine life, materials, biogeochemical cycles, and air quality.

Ozone Depleting Substances are the called Chloro-fluorocarbons (CFC), halons (CF2ClBr), Carbon tetrachlorides (CCl4), Methyl Chloroform (C2H3Cl3) 1,1,1-trichloroethane, Methyl Bromide (CH3Br), Chloro bromomethanes (CH2BrCl), Carbono-hidro-fluoro-bromo-methanes (CHFBr) and Hydro-chloro-fluoro-carbons (HClFCs)[91].

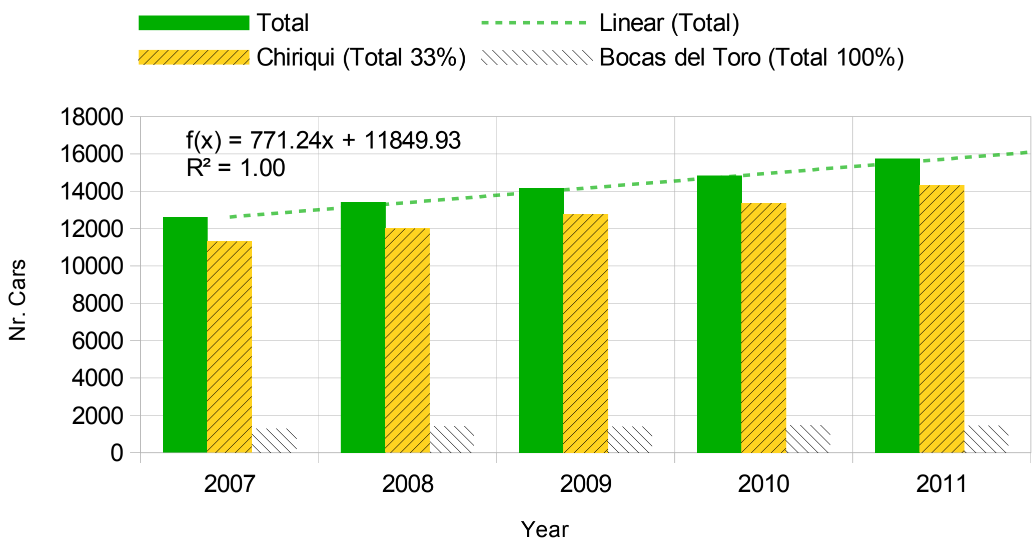

Fig. 44: LAPBR: Total estimated of cars
Source: Adapted from INEC
Data from Chiriqui was based under asumption that LAPBR have a 33% from the total, similar to population distribution in the region.
Comarca Ngobe Bugle does not have specific data and this data is mixed with Bocas del Toro.

The trend in Panama from 1990 to 2011 in HCFCs use is showing a growing use (Fig. 38), however, the country has completely reduced consuming all other ODS[92]. This fact can be described as a breakthrough in the gradual elimination of all forms of

91 Environmental Protection Agency of United States. "Ozone Layer Protection – Science: Class I & II Ozone-depleting Substances, 2010". http://www.epa.gov/ozone/science/ods/classone.html. Accessed: 05/24/13.

pollutants that affect the ozone layer. Fig. 45 shows a comparative graph between Costa Rica and Panama, which clearly shows the drastic reduction in consumption of ODS by Panama compared to Costa Rica.

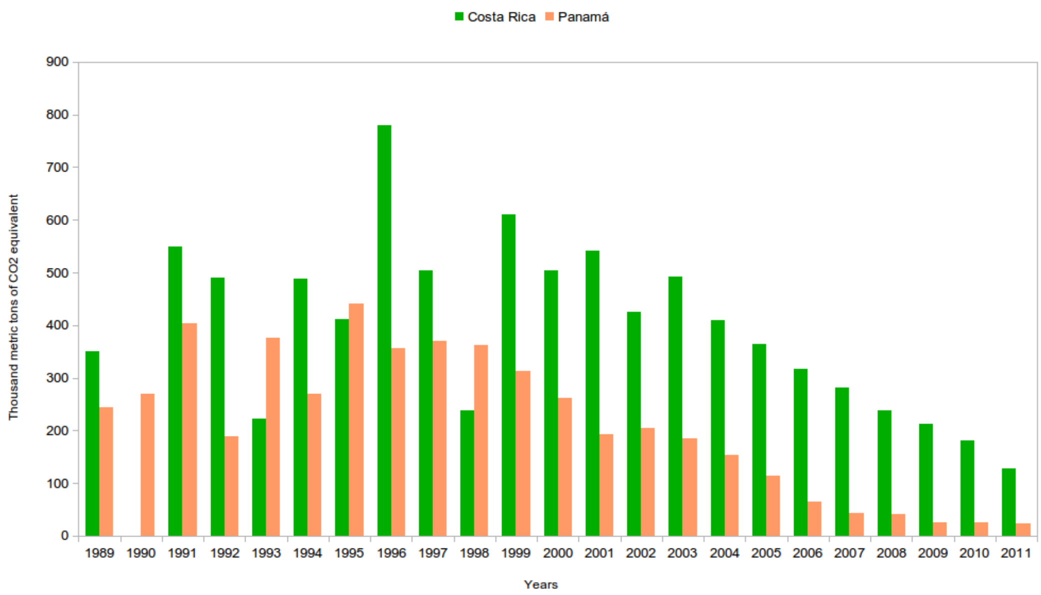

Fig. 45: Comparison in ozone-depleting substances consumption between Panama and Costa Rica 1989-2011

Source: ECLAC statistics 2012

At the level of the LAPBR I have not data, but I can infer given the social, economic, and development conditions in the reserve is there completely reduced consumption (not significant) of ODS on the total consumption in the country. As I know, the consumption of HCFCs occurs in refrigeration systems and air conditioners, so it is quite possible that this level of HCFC consumption is maintained until another technology is used to replace existing technology-based in ODS gases.

The evaluation for this indicator is high, indicating that environmental problems in the reserve related to this indicator are negligible.

6.1.4. Ambient concentration of air pollutants in urban areas

It is a core environmental indicator about air quality. This indicator shows the ambient air pollution concentrations of ozone, particulate matter, sulfur dioxide, nitrogen dioxide, lead. Additional air pollutants are carbon monoxide, nitrogen monoxide and

92 CEPALSTATS. “Statistics and indicators, 2013”. http://estadisticas.cepal.org/cepalstat/WEB_CEPALSTAT/estadisticasIndicadores.asp?idioma=i. Accessed: 05/24/13

volatile organic compounds including benzene (VOCs). The priority is collection of the indicator in large cities (UN DESA, 2007a).

The indicator provides a measure of the state of the environment in terms of air quality and is an indirect measure of population exposure to air pollution of health concern in urban areas. Improving air quality is a significant aspect of promoting sustainable human settlements (UN DESA, 2007a).

This indicator is irrelevant to the case LAPBR because larger communities do not reach the level of city as such, therefore, the air pollution problems in the area are irrelevant.

6.2. Freshwater

6.2.1. Proportion of total water resources used

It is a core environmental indicator about water quantity. It is the total annual volume of groundwater and surface water withdrawn from its sources for human use (in the agricultural, domestic and industrial sectors). It is expressed as a percentage of the total volume of water available annually through the hydrological cycle (total renewable water resources). The terms water resources and water use are understood as freshwater resources and freshwater use (UN DESA, 2007a).

The indicator shows the degree to which total renewable water resources are being exploited to meet the country’s water demands and is thus a measure of water scarcity. Scarce water could have negative effects on sustainability constraining economic and regional development, and leading to loss of biodiversity. It is an important measure of a country’s vulnerability to water shortages (UN DESA, 2007a).

There are no officials or scientific data for RB, however, access to fresh water quality in RB is not a problem for communities, since it is an abundant resource in the whole area of the reserve. There are problems in some communities water supply, but this is due to government failures to install adequate treatment and distribution systems and not by the absence or scarcity.

Currently, the main users of water for industrial purposes, are the hydro-power companies. In these cases the water is returned to the river and are not a permanent removal of the system, but this extraction of water from rivers, is producing significant environmental impact on the biota and the ecosystem of the rivers. This environmental problem deserves to be analyzed properly, in the ecosystem management, social, and economic context.

The second industrial users of river water are agricultural producers, for example, in Cerro Punta, Boqueron, Volcan and Boquete, but there are no data on the amount they are using, but it is presumed that these extractions are not significant.

Our diagnosis suggests the need for a permanent plan for monitoring the use of water for consumption and production activities. The total figures produced by the water cycle in a region can be extrapolated if the existence of enough meteorological stations. At present, it is impossible to obtain with certainty that data.

Despite having no data, this information can be obtained from operational feasibility for a biosphere reserve, within a national, regional or local water monitoring plan to analyze this type of data.

This assessment takes into account as an aspect to improve, the very existence of corroborating data estimates. I am evaluating, that, in the absence of certificated data, the evaluation is medium.

6.2.2. Water use intensity by economic activity

It is a core environmental indicator about water quantity. The indicator is defined as the cubic meters of water used per unit of value added (in US $) by economic activity. Thus, water used by an economic activity consists of the sum of 1-) water directly abstracted from the environment either permanently or temporarily for own use and 2-) water received from other industries including reused water. Value added (gross) by economic activity is defined as in the National Accounts as the value of output less the value of intermediate consumption.

This indicator measures the intensity of water use in terms of volumes of water per unit of value added. It is an indicator of pressure of the economy on the water resources. Over time, it shows whether a country has decoupled water use from economic growth. The indicator also provides information on progress in implementation of integrated water resources management plans (UN DESA, 2007a).

There is no disaggregated data on economic activity and the level of water use in the LAPBR. Without these data, an analysis of this indicator is impossible. In any case, I am considering, that the use of water in the biosphere reserve for all operating hydroelectric projects and other projects, is a growing with competitive pressure among social and economic stakeholders.

Considering the lack of data and that there is not a clear policy of integrated water management, including the analysis required by this indicator, this indicator is evaluated as medium.

6.2.3. Presence of faecal coliforms in freshwater

It is a core environmental indicator about water quality. It is the proportion of freshwater resources destined for potable supply containing concentrations of faecal coliforms which exceed the levels recommended in the World Health Organization Guidelines for Drinking-water Quality (UN DESA, 2007a).

The indicator assesses the microbial quality of water available to communities for basic needs. It identifies communities where contamination of water with human and animal excreta at source or in the supply poses a threat to health. Diarrheal diseases, largely the consequence of faecal contamination of drinking-water supplies, are the major cause for morbidity and mortality in many countries, especially among children. Frequent diarrhea episodes, even without fatal consequences, disrupt children development and education, which, in the longer term, can have serious consequences for sustainable development (UN DESA, 2007a).

There are no official data are available, but a good quality, suitable for potable freshwater is expected. The problem faced by rural communities is the lack of advice and funding to install technology for water supply. Although estimates of water quality throughout the biosphere reserve is good, it is needed to verify in the field.

The evaluation for this indicator is high, but precautionary.

6.2.4. Biological oxygen demand (BOD) in water bodies

It is a non-core environmental indicator about water quality. The BOD measures the amount of oxygen required or consumed for the microbiological decomposition (oxidation) of organic material in water (UN DESA, 2007a).

The purpose of this indicator is to assess the quality of water available to consumers in localities or communities for basic and commercial needs. It is also one of a group of indicators of ecosystem health. The presence of high BOD may indicate faecal contamination or increases in particulate and dissolved organic carbon from non-human and animal sources that can restrict water use and development, necessitate expensive treatment and impair ecosystem health. Human ill health due to water quality problems can reduce work capability and affect children growth and education. High levels of oxygen consumption pose a threat to a variety of aquatic organisms, including fish (UN DESA, 2007a).

In RBLAP as circumstantial evidence, but unconfirmed, is expected to be no significant environmental problem. Therefore, until the contrary is proved, the water quality related to BOD is very good.

The evaluation for this indicator is high, but precautionary.

6.2.5. Waste-water treatment

It is non-core environmental indicator about water quality. It is the proportion of waste-water that is treated, to reduce pollutants before being discharged to the environment, by level of treatment (primary, secondary or tertiary) (UN DESA, 2007a).

This indicator assesses the potential level of pollution from domestic and industrial/commercial point sources entering the aquatic environment, and monitors progress towards reducing this potential within the framework of integrated water resources management. It helps to identify communities where waste-water treatment action is required to protect the ecosystem. Untreated or insufficiently treated waste-water can result in increased nutrient levels, high levels of organic matter and hazardous substances, posing threats to aquatic ecosystems and human health (UN DESA, 2007a).

The biggest problem of sewage disposal in LAPBR community occurs in Changuinola, Bocas del Toro Province. This is a partially urban community, which do not receive adequate wastewater treatment. Much of the sewage flow into drainage channels close to residences and banana plantations in the area. This problem is very serious and affects the quality of life for all residents[93]. This is clear evidence of wastewater mismanagement in the Caribbean sector of the biosphere reserve.

Only the urban community of the island of Bocas del Toro has a water management system that includes a water purification plant. Even so the system is incomplete and is poor. In other communities, medium and large, the waste-water management is through septic tanks, which are not complete, and reliable systems, because they can contaminate groundwater and surface water. In the community of Boquete, despite widespread use of septic tanks, in small creeks there are evidence of water pollution.

Evidence shows that there is a reduced amount of waste water are treated properly and can be considered that water treatment is still very poor in the biosphere reserve. The assessment for this indicator is low.

6.3. Contamination and management indicators

6.3.1. Generation of hazardous waste

It is a core indicator about waste generation and management. This indicator measures the total amount of hazardous wastes generated per year through industrial or other waste generating activities, according to the definition of hazardous waste as referred to in the Basel Convention and other related conventions (UN DESA, 2007a).

This indicator provides a measure of the extent and type of industrialization in a country and the nature of industrial activities including technologies and processes generating hazardous wastes. The generation of hazardous wastes has a direct impact on health and the environment. Normally, long-term exposure is required before harmful effects are seen. Reduced generation of hazardous wastes may

93 Viven rodeados de aguas negras. http://www.elsiglo.com/mensual/2012/06/11/contenido/521389.asp. El Siglo Digital. (08/08/13).

indicate reduced industrial activities in a country, introduction of cleaner production in the industrial processes, changing patterns in consumers' habits, or changes in national hazardous waste legislation (UN DESA, 2007a).

This indicator is only related to national level because require as unit of measurement the tonnes per unit of Gross Domestic Product. Under this condition do not have sense to apply in a biosphere reserve.

6.3.2. Generation of waste

It is a non core indicator about waste generation and management. This indicator measures amount of all waste, both hazardous and non-hazardous, generated by selected main groups of industries or sectors of the economy, expressed per capita and per unit of value added (in US $) by economic activity (at constant prices) (UN DESA, 2007a).

The main purpose of this indicator is to show the trend in the generation of waste produced by different human activities. Waste represents a considerable loss of resources both in the form of materials and energy. The treatment and disposal of the generated waste may cause environmental pollution and expose humans to harmful substances and bacteria, and therefore impact on human health. Waste generated per unit of value-added shows if there is decoupling of waste generation from economic growth (UN DESA, 2007a)

The recommended categories are based on the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 and include: a-) manufacturing; b-) mining and quarrying; c-) construction; d-) electricity, gas, steam, and air conditioning supply; e-) agriculture and forestry; f-) all other economic activities; g-) households (UN DESA, 2007b).

It also can be compiled for the whole economy without the breakdown by economic activity. In this case, it should be divided by Gross Domestic Product (GDP) (at constant prices) (UN DESA, 2007b).

I have not data about this indicator for analysis in LAPBR. The inference indicates low levels of waste production in all levels of local economy. The evaluation for this indicator is high moderate.

6.3.3. Waste treatment and disposal

It is a non-core environmental indicator about waste generation and management . This indicator is more related to environmental indicator instead of economic indicator. It is the percentage of waste which is recycled; composted; incinerated; and land-filled on a controlled site (UN DESA, 2007a).

It gives an indication of the environmental impact of waste management in the country. The proper treatment and disposal of waste is important from an environmental and social viewpoint but can be an economic burden on industries, municipalities and households. The amount of waste recycled and composted reduces the demand for raw materials, leading to a reduction in resource extraction. There may also be a benefit of increased income generation for the urban poor through recycling schemes (UN DESA, 2007a).

All major communities of the Reserve have relatively functional, waste treatment systems. In rural communities, not waste management is practiced and usually have medium quality at the disposal of its waste. In communities that do not receive attention in the management of waste they create improvised disposal systems that usually do not create critical problems on the ecosystems, but it affects the quality of life, if they lacking this basic services.

2010 Census data show that in the province of Bocas del Toro, 54% of households receive municipal waste collection, 53% in the province of Chiriqui and 1.55% in Ngäbe Bugle. The remaining households not receiving the waste collection service, are using pits, incineration or deposited in vacant lots and water bodies such as rivers, lakes and seas.

I have calculated that in LAPBR only 36% of the waste is taken to official sites (municipal crematoria) waste management, another 36% is incinerated at the household level, 14% are buried and 12% are deposited on vacant sites. The 1.78% throws household wastes into the bodies of water.

To summarize this indicator I can say that the solid waste management is poor and is not used to generate added value thereof. Therefore, the evaluation is low.

6.3.4. Management of radioactive waste

It is a non-core environmental indicator about waste generation and management. This indicator is more related to environmental indicator instead of economic indicator. It indicates the progress in the management of radioactive waste is measured against key milestones related to both the processing of waste into forms suitable for either safe storage or for placement into a designated endpoint (the "form factor") and to the placement of waste into an endpoint facility ("endpoint factor"). Radioactive waste from various sources, such as nuclear power generation and other nuclear fuel cycle related activities, radioisotope production and use for applications in medicine, agriculture, industry and research, is considered (UN DESA, 2007a).

This indicator represents the progress in managing the various radioactive wastes that arise from the nuclear fuel cycle and/or from nuclear applications. It provides a measure of both the current status of radioactive waste management at any time and the progress made over time towards the overall sustainability of radioactive waste management. Radioactive waste, if not properly managed, can have a direct impact on health and the environment through exposure to ionizing radiation (UN DESA, 2007a).

This indicator should be used only if a biosphere reserve has facilities that generate or handle radioactive waste.

In LAPBR this indicator does not apply. It is irrelevant.

6.4. Consumption of natural resources in transportation indicators

6.4.1. Energy intensity of transport

It is a non-core environmental indicator about transport. This indicator is more related to environmental indicator instead of economic indicator. The indicator is defined as fuel used per unit of freight- kilometer (km) hauled and per unit of passenger-km traveled by mode.

This indicator measures how much energy is used for moving both goods and people. Transport serves economic and social development through the distribution of goods and services and through personal mobility. At the same time, transport is a major user of energy, mostly in the form of oil products, which makes transport the most important driver behind growth in global oil demand. Energy uses for transport therefore contributes to the depletion of natural resources, to air pollution and to climate change. Reducing energy intensity in transport can reduce the environmental impacts of this sector while maintaining its economic and social benefits.

This indicator is complicated, because that biosphere reserves are not closed or controlled spaces borders, generating too many artifacts in the measurements for this indicator.

The area of the LAPBR is distributed in three provinces that do not have specific data, but partial global data for each province. Despite the fact that this indicator is important to consider the current data is insufficient for analysis. Is required to initiate a system of official statistics to consider this indicator in the geographical space occupied by the biosphere reserve.

Lacking data for this indicator for LAPBR I can not infer the situation, but I do not think that is a problem, given the low population density in the reserve. Evaluation is medium until another condition with data is found.

6.5. Analysis of environmental indicators of sustainability

The Table 25 shows a complete matrix of scores, weights and values observed and expected for every environmental indicator for sustainability. With this table was achieved a mathematical analysis about environmental sustainability in LAPBR, under the analysis as expert.

With the observed percent values of development advances with respect the expected, I am able for to say, with specific results, that the level of advances in this set of environmental indicator in LAPBR is going a good way of development. In this case it has 72.37% in development advances against 27.12% as shortfall.

Table 25. LAPBR: Final mathematical results about environmental indicators for sustainability

Nr.	Environmental Indicators of Sustainable Development	Evaluation (x/10)	Weight (1-3)	Observed Development	Expected Development
1	Emissions of greenhouse gases	10	3	30	30
2	Carbon dioxide emissions	10	1	10	10
3	Consumption of ozone depleting substances	10	1	10	10
4	Ambient concentration of air pollutants in urban areas	*	1	*	*
5	Proportion of total water resources used	6	2	12	20
6	Water use intensity by economic activity	5	2	10	20
7	Biochemical oxygen demand in water bodies	8	1	8	10
8	Presence of faecal coliforms in freshwater	8	1	8	10
9	Wastewater treatment	3	2	6	20
10	Generation of waste	7	2	14	20
11	Generation of hazardous waste	*	3	*	*
12	Waste treatment and disposal	3	3	9	30
13	Management of radioactive waste	*	3	*	*
14	Energy intensity of transport	5	1	5	10
			Sum	**437**	**610**
		71.64%	Advances of Environmental Indicators (%)		
		27.87%	Deficit of Environmental Indicators (%)		

*Source: Indicators adapted from UN DESA (2007a); *= Irrelevant for LAPBR not evaluated*

With the results of Table 25, the community have, for first time, a mathematical or quantitative status of sustainable development analysis of 37 environmental indicators.

With this table, decision makers can improve, with large panels of experts or consultants, an even more accurate assessment, especially by incorporating the missing data.

Each indicator with the definitions adopted by UN DESA (2007a, 2007b) have been self-explanatory on the relevance of sustainability. The data analyzed or incorporated have supported this preliminary assessment, it becomes best reference for mathematical analysis of sustainability and especially to follow the process of sustainable development in the Biosphere Reserve La Amistad Panama and can be applied equally to reserves or other minor political regions and federal states, provinces or counties, among others.

CHAPTER 7

Environmental Indicators: Nature Conservation

7. Nature conservation issues

The current scope of nature conservation was conceptually established in 1980 by the “World Conservation Strategy: Living Resource Conservation for Sustainable Development” launched by IUCN, UNEP and WWF; but politically was adopted, after Brundtland report of 1987 (Plachter et al., 2005). Then, the basic 'phylosophy' of nature conservation was established in the World Conservation Strategy (IUCN et al., 1980). The requirements for achieving the objectives of nature conservation were summarized by this publication as follows, and in essence are included in the CSD indicators of sustainability:

I. *the maintenance of essential ecological processes*[94] *and life-support systems*[95] *primarily requires rational planning and allocation of uses and high quality management of those uses;*

II. *the preservation of genetic diversity primarily requires the timely collection of genetic material and its protection in banks, plantations, and so on, in the case of off site preservation; and ecosystem protection in the case of on site preservation;*

III. *the sustainable utilization of ecosystems and species requires knowledge of the productive capacities of those resources and measures to ensure that utilization does not exceed those capacities.*

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94 “Essential ecological processes are those processes that are governed, supported or strongly moderated by ecosystems and are essential for food production, health and other aspects of human survival and sustainable development” (IUCN et al., 1980)

95 “Life-support systems is shorthand for the main ecosystems involved—for example, watershed forests or coastal wetlands. The maintenance of such processes and systems is vital for all societies regardless of their stage of development. Many archaeological relics, whether of great civilizations or peasant villages, testify to the consequences of not doing so. Today, the most important and most threatened life-support systems are agricultural systems, forests, and coastal and freshwater systems” (IUCN et al., 1980).

Additionally, as society, is necessary to understand that both, the last two objectives of nature conservation, require the achievement of the first, but also, the genetic composition of ecosystems, and the life-support systems, certainly are dependent of the preservation of genetic diversity for to achieve aspects of the first and third objectives (IUCN et al., 1980).

One additional aspect in nature conservation, not less important, is the moral principle relates particularly to species extinction. As society, we are morally obliged -to the descendants and to other creatures- to act prudently. For reasons of ethics and self-interest, therefore, "we should not knowingly cause the extinction of a species" (IUCN et al., 1980).

Priority requirements for to attend the ecological process and life-support systems require some concrete actions (IUCN et al., 1980b) such as:

- *Reserve good cropland for crops.*
- *Manage cropland to high, ecologically sound standards.*
- *Ensure that the principal management goal for watershed forests and pastures is protection of the watershed.*
- *Ensure that the principal management goal for estuaries, mangrove swamps and other coastal wetlands and shallows critical for fisheries is the maintenance of the processes on which the fisheries depend.*
- *Control the discharge of pollutants.*
- *Priority requirements: genetic diversity.*
- *Prevent the extinction of species.*
- *Preserve as many varieties as possible of crop plants, forage plants, timber trees, livestock, animals for aquaculture, microbes and other domesticated organisms and their wild relatives.*
- *Special attention should be paid to the preservation of genetic material for forestry and for aquaculture.*
- *Ensure that on site preservation programmes protect: the wild relatives of economically valuable and other useful plants and animals and their habitats; the habitats of threatened and unique species; unique ecosystems; and*

representative samples of ecosystem types.

- *Determine the size, distribution and management of protected areas on the basis of the needs of the ecosystems and the plant and animal communities they are intended to protect*
- *Coordinate national protected area programmes with international ones, particularly the biosphere reserves programme of Unesco's Man and the Biosphere Project 8 and the initiatives of IUCN's Commission on National Parks and Protected Areas.*

Priority requirements for to attend the sustainable utilization, also require some concrete actions (IUCN et al., 1980b) such as:

- *Determine the productive capacities of exploited species and ecosystems and ensure that utilization does not exceed those capacities.*
- *Adopt conservative management objectives for the utilization of species and ecosystems.*
- *Ensure that access to a resource does not exceed the resource's capacity to sustain exploitation.*
- *Reduce excessive yields to sustainable levels.*
- *Reduce incidental take as much as possible.*
- *Equip subsistence communities to utilize resources sustainably.*
- *Maintain the habitats of resource species.*
- *Regulate international trade in wild plants and animals.*
- *Allocate timber concessions with care and manage them to high standards.*
- *Limit firewood consumption to sustainable levels.*
- *Regulate the stocking of grazing lands so that the long term productivity of plants and animals can be maintained.*
- *Utilize indigenous wild herbivores, alone or in combination with livestock, where the use of domestic stock alone will degrade the land.*

The majority of priorities for nature conservation, above numbered, are included in the CSD indicators that I am analyzing for LAPBR.

The 2007 CSD indicator of sustainable development more related to the original philosophy of classical nature conservation of the World Conservation Strategy are presented in the Table 26, and they are under analysis in this chapter.

Table 26: CSD nature conservation indicators of sustainable development compared with MDG indicators, Agenda 21 and JPOI chapter.

Nr.	Environmental CSD Indicator of Sustainable Development	MDG Indicator	Agenda 21 chapter	JPOI chapter
	Land			
1	Land use change		10 (10.5)	
2	Land degradation		14 (14.45)	IV (41)
3	Land affected by desertification		12	IV (41)
4	Arable and permanent cropland area		14	IV (40)
5	Fertilizer use efficiency		14 (14.85)	IV (40)
6	Use of agricultural pesticides		14 (14.75)	IV (40)
7	Area under organic farming		14	IV (40)
8	Proportion of land area covered by forests	# 25	11 (11.12)	IV (45)
9	Percent of forest trees damaged by defoliation		11	IV (45)
10	Area of forest under sustainable forest management		11 (11.12)	IV (45)
	Oceans, seas and coasts			
11	Percentage of total population living in coastal areas		17	IV (32)
12	Bathing water quality		17	IV (32)
13	Proportion of fish stocks within safe biological limits	New	17 (17.46, 17.75)	IV (31)
14	Proportion of marine area protected	# 26 *	15 (15.5 g), 17	IV (32 a)
15	Marine trophic index		17 (17.46, 17.75)	IV (32 a)
16	Area of coral reef ecosystems and percentage live cover		15 (15.5 g), 17	IV (32 d)
	Biodiversity			
17	Proportion of terrestrial area protected, total and by ecological region	# 26 *	15 (15.5.g)	IV (44)

18	Management effectiveness of protected areas		15 (15.5.g)	IV (44)
19	Area of selected key ecosystems		15 (15.5.g)	IV (44)
20	Fragmentation of habitats		15	IV (44)
21	Abundance of selected key species		15 (15.5.g)	IV (44)
22	Change in threat status of species	New *	15 (15.5.h)	IV (44)
23	Abundance of invasive alien species		15	IV (44)

Source: adapted from UN DESA (2007a).

7.1. Landscape

The indicators associated with the state and land use are key elements for the study of the growth dynamics of human activities on the planet and the environmental impact on terrestrial ecosystems. Indicators of land-use and land cover change (LULCC) also include two non-physical indicators at the landscape level, which are the use of fertilizers and pesticides, and their misuse causes negative impacts on natural ecosystems and human life and therefore sustainable development.

Indicators of land use proposed by UN DESA (2007a) are ten: 1-) proportion of land area covered by forests; 2-) land use change; 3-) land degradation; 4-) arable and permanent crop land area; 5-) land area affected by desertification; 6-) fertilizer use efficiency; 7-) use of agricultural pesticides; 8-) area under organic farming; 9-) forest trees damaged by defoliation; 10-) area of forest under sustainable forest management (SFM).

7.1.1. Proportion of land area covered by forests

It is a core environmental indicator about sustainability in the forests. The indicator measures the proportion of forest area in total land area. In areas with primary forest should also be reported on with good accuracy, because they represent an element of good environmental value in sustainable development model. The indicator may further distinguish between primary and other forests. The primary forest area is defined as natural forest (no plantation), with little or nothing visible signal of impact caused by human activities, and the ecological processes are not significantly disturbed. The area of primary forest is an important indicator of the status of the forest ecosystem as a whole. Forests are associated with high levels of biological diversity, including rare species, specially associated with primary forests (UN DESA, 2007a).

I am proposing the FAO definition for forest endorsed by UN DESA: "*Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use*". It does not include other wooded cover such as shrubs, bushes, and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use (FAO, 2010).

The indicator allows for monitoring changes in the area covered by forests over time, showing trends about decreasing forest area in a country, and might be a signal of unsustainable practices in the forestry, urbanization, and agricultural sector (UN DESA, 2007a).

Forests, with good management, provide many significant resources and functions including wood products and non-wood products, recreational opportunities, habitat for wildlife, conservation of biological diversity, water, and soil; and these forests play a crucial role in the global carbon cycle. Also the forests support employment and traditional uses (UN DESA, 2007a).

LAPBR is predominantly an area of natural forests, in all succession stages (old-grow or primary and secondary). There are some plots of planted forests as a whole do not reach the 0.5% of the total area of the reserve. Mature forest are dominants in all terrestrial area of this reserve, mainly in Caribbean basin and highlands of Chiriqui province (Pacific basin).

With official data of forest cover of Panama in 1992 and 2000 and my estimates for 2010, LAPBR has a total forest area of ~549,632 hectares. Of this total, ~475,880 hectares are primary forests. A 72% of the reserve corresponds to primary forest and 83% is the set of all forms of natural forests under FAO forest definition (Table 27).

This indicator is showing for LAPBR an excellent share of forest area in total land area of this reserve. A strong environmental reason for the existence of this reserve is the biological richness of Talamanca mountains forest.

The state of forest cover can be considered excellent in relation to the total area of the reserve. Any biosphere reserve that contains more than 50% of the original forest cover can be considered as excellent land use. The evaluation for this indicator is high.

7.1.2. Land use change

It is a non-core environmental indicator about land use and status. This indicator measures changes of the distribution of land uses in an area over time, using broad land use categories as arable land, permanent cropland, permanent pasture, forests and woodland, built-up areas, etc. Finer classifications may be chosen, if available and appropriate (UN DESA, 2007a).

The indicator provides information on changes in the productive or protective uses of the land resource to facilitate sustainable land use planning and policy development. Such information is useful in identifying opportunities to protect land uses or promote future allocation aimed at providing the greatest sustainable benefits for people (UN DESA, 2007a).

Economically, changes in land use can produce many results, for example, changes in agricultural production and employment opportunities in local or national terms. From an environmental point of view, unsustainable land use is an important factor in analysis of land use for to demonstrate impacts, such as: land degradation, threats to ecosystems, natural habitat loss and landscape's changes (UN DESA, 2007a).

Table 27: LAPBR: Land area covered by forests 1992, 2000 and 2010

Forest type	1992	2000	2010*	Share (%)*
Mature forest	481916	467319	453164	69
Orey forest***	3657	3658	3658	1
Disturbed forest	79899	76764	73751	11
Flooded mixed forest	19253	19156	19059	3
Pioner forest	49872	48042	46279	7
All forests	584726	566896	549632	83
Only primary forests	504827	490132	475880	72

*Source: ANAM - Forest cover 1992 and 2000; *= own estimation based on trend 1992-2000; ***= The main orey forest patch is located in the south of San San Pond Sak Wetland, just above sea level. This brackish-water swamp forest is dominated by Camnosperma panamensis.*

Panama is a tropical country with a dominant native forest cover in most of the ecological landscape of the Isthmus. The oldest data on the percentage of forest cover dating from 1947. For that year, the entire East (Province of Panama and Darien) sector and the North of the Isthmus (today, Bocas del Toro, Caribbean Ngäbe Buglé, Northern Veraguas, North Cocle, Colon and the Comarca Kuna Yala) were covered with forests in different successional stages, mainly primary forest (Ramírez, 2003)[96].

There are estimates, non-confirmed, in forest cover (all successional levels) in 1947, where there was a forest cover of 70% of the total territory. In 1992 was 49.3% (36,951.60 km ²) in 2000 was 44.9% (34,926.77 km ²) (ANAM, 2010) and in 2010 it was 43.7% (32,924.27 km ²). That is, over 5 decades the country lost ~25% of its forests. From 1992 to 2000 there was a loss of coverage of 8.95% (3305.69 km ²), but in the last decade from 2000 to 2010 the percentage of loss was ~1.6% of the total coverage of mature forests. The latter value indicates a decrease in the annual rate of deforestation, although still mathematically graphs are showing a trend of changing forest use from forest land to agricultural lands with a constant decreasing rate (R = 0.91) (Fig. 46).

In 2010 Panama has permanent forest estate (PFE) of 23000 km² (2.30 x 10^6 hectares) (compared with 19900 km² [1.99 x 10^6 Ha], in 2005), comprising 3500 km² (3.5 x 10^5) hectares of natural production forest, 18800 km² (1.88 x 10^6 hectares) of protection forest and 710 km² (71000 hectares) of planted forest (FAO, 2010). All these values are higher than in 2005, indicating some level of control or slowing deforestation in 2005-2010.

The dynamic of forest reduction showed, during the span of 1992-2000, that the second highest rate of deforestation was in the Ngobe Bugle Comarca with 10,000 hectares per year (ANAM, 2003). The probable cause of this high rate of deforestation in the country is increasing by the expansion of extensive livestock and unregulated forms of subsistence crops (tomb, slashing, burning), and due to inadequate forestry practices (FAO, 2005).

In my opinion the main cause is the erratic forestry policy, where is not under any

96 Carlos A. Ramírez. 2003. Estado de la diversidad biológica de los árboles y bosques de Panamá. Documentos de Trabajo: Recursos Genéticos Forestales. FGR/50S Servicio de Desarrollo de Recursos Forestales, Dirección de Recursos Forestales, FAO, Roma. ftp://ftp.fao.org/docrep/fao/007/j0604s/j0604s00.pdf. 05/27/13

priority of conservation, except in protected areas. The forest lost does not have compensation by a successful policy of human development or a real policy of sustainable development. The forest is being destroyed, owner by owner, only with legal/illegal right as landowner of forested lands. It means that the forest are vanishing by a sum of individual decisions or freewill and not by wisdom decisions from the State or from open and democratic decisions of the stakeholders, looking to the future. In other words, the forest are under unsustainable exploitation. In LAPBR, specially outside of the core zones, the forest are under a serious threat, if the conservation policy does not change through a model of rational use and effective management.

The main natural richness of LAPBR is the existing natural forest. This forest is located, almost entirely on land with strong slope. The suitable areas for residential, agriculture and livestock occupy the rest of the landscape. In some sectors, due quality of soil and climate, are using steeply sloping areas for agriculture and livestock production, especially in the highlands of Chiriqui. Then, is priority to analyze the loss of natural resources by human activities that are changing natural cover with activities than are changing so deeply the forest ecosystems and consequently creating unsustainable development.

If there is loss of natural forests steadily over time, without any parallel activity of reforestation for commercial and conservation purposes, is a way to confirm unsustainable use of these forestas and represents a failure of conservation strategies for the area. This seems to be the current situation, especially in the lowlands forests. If this small-scale deforestation occurs, even in protected areas, the problem should be corrected soon, to prevent further damage to overall forest and biodiversity in the area, most of which are also part of PILA, a UNESCO World Heritage.

In LAPBR can be verified that the change of use of natural forest cover or other uses that degrade the forest has continued in the last two decades. Using data from the 1992 and 2000 shows that the advance of the agricultural frontier continues to affect mature natural forests of the Reserve.

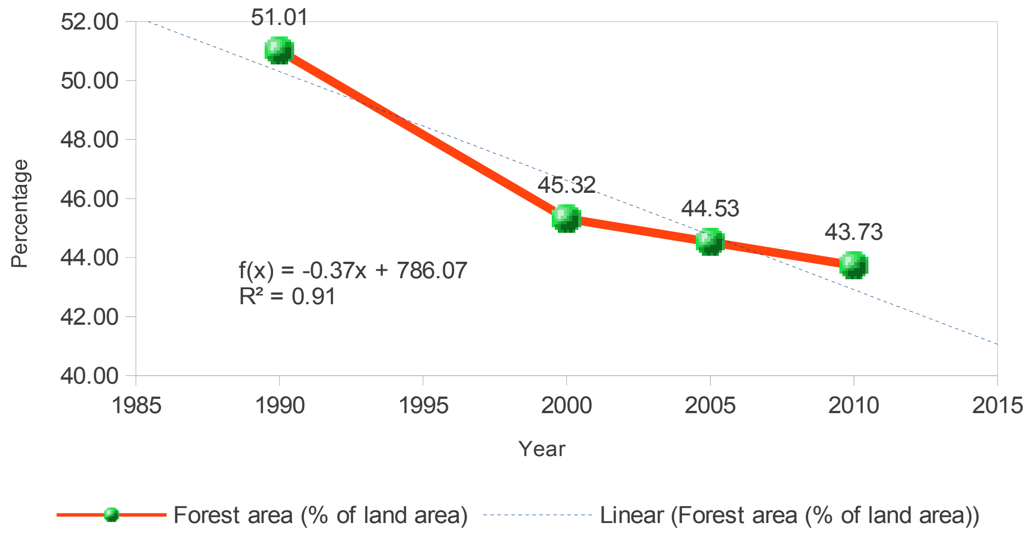

Fig. 46: Panama: Trend of forests in land area (%)
*Source: WB, 2012. **ANAM 2010 tiene datos similares pero no iguales. El estimado del 2010 no es un dato oficial, ya que todavía no se ha terminado de generar el mapa final de cobertura boscosa 2010.*

A study by Hansen et al. (2013) confirmed by data from satellite high resolution photos that for the period 2000 to 2012 in LAPBR continues a slow but continuous pattern over time of deforestation. This deforestation is most evident in the Caribbean sector. The middle and lower reaches of the Changuinola River is being strongly intervened forest and seems to be losing very quickly to other wooded areas of the reserve.

A study by Hansen et al. (2013) confirmed by data from satellite high resolution photos that for the period 2000 to 2012 in this biosphere reserve continues a slow but continuous pattern over time of deforestation. This deforestation is most evident in the Caribbean sector. The middle and lower reaches of the Changuinola River is being strongly intervened forest and seems to be losing very quickly to other wooded areas of the reserve.

For the full context of data LAPBR 2000 versus 1992, I suggest that changes in land use are occurring in LAPBR towards environmental degradation and low productivity of the amended soil. Elsewhere in the biosphere reserve with loss of primary forests, these forests have been transformed due to the advance of subsistence farming, mainly in the area of Comarca Ngäbe Bugle (eastern sector of the biosphere reserve) and the extreme north-west, in the valley of Rio Yorkin, close to Costa Rica-Panama border (Fig. 48). There is also a breakthrough in the agricultural frontier throughout the middle reaches of the valley of the Rio Changuinola (Fig. 52). These new areas of deforestation of primary forests are by effect of increasing transhumant indigenous population and Latinos from the neighboring province of Chiriqui, usually engaged in subsistence farming and extensive ranching.

The environmental impact and the advance of the agricultural frontier and colonization of forest in this area has not been higher due to the existence of protected areas: Palo Seco Basin Protector Forest and La Amistad International Park, which under the legal regime limit partially the tenure and encroachment with mature forests under a special conservation regime.

The positive trend in land use change occurs in the highlands of the Chiriqui province, followed by west of Comarca Ngäbe Bugle area. In Chiriqui is observed that the impact to the forests during the period 1992-2000 was limited and higher invasions or changes in the original forest are not observed. Recent geo-spatial data of Hansen et al. (2013) corroborated the same condition for the period 2000-2012.

However, in the province of Bocas del Toro shows more evident negative change of land use. The land use change from forest to subsistence agriculture, and cattle ranching, is growing at low trend but permanent in the last 20 years. (Fig. 52).

In the same area, in addition to the problems of colonization of new areas of forest in the Palo Seco Basin Protector Forest and La Amistad International Park, have joined hydroelectric projects (Fig. 47 and 49) such as the Chan 75 (opened in 2011) and Bonyic. Other dams are in planning. These projects have created an additional environmental and social chaos in the area[97],which indirectly promotes the colonization frontier and forest destruction in this basin. As they are protected areas, the problem translates into land conflicts between businesses, ethnic groups, other groups of citizens and the state.

The above and other causes led to NGOs from Panama and the United States of America, to execute a request to UNESCO for a reactive monitoring on the outstanding universal value of Talamanca Range-La Amistad Reserves / La Amistad National Park (Thorson et al., 2007). This petition and its monitoring by UNESCO has

97 UNESCO. 2013. UNESCO. 2013. Report on the Reactive Monitoring Mission to Talamanca Range La Amistad Reserves/La Amistad National Park – Costa Rica and Panama, from 17 to 24 January 2013. Online: http://whc.unesco.org/en/documents/123331/. 12/19/13

improved the knowledge and control of the impact of dams, livestock and advancing agricultural frontier in the buffer and core zones of LAPBR[98].

Fig. 47: LAPBR: Changuinola river in Palo Seco Protector Forest (Buffer zone), 6 km downstream of the begining of construction of Dam Chan 75 in Dec. 2007.
Photo: A. Rodriguez

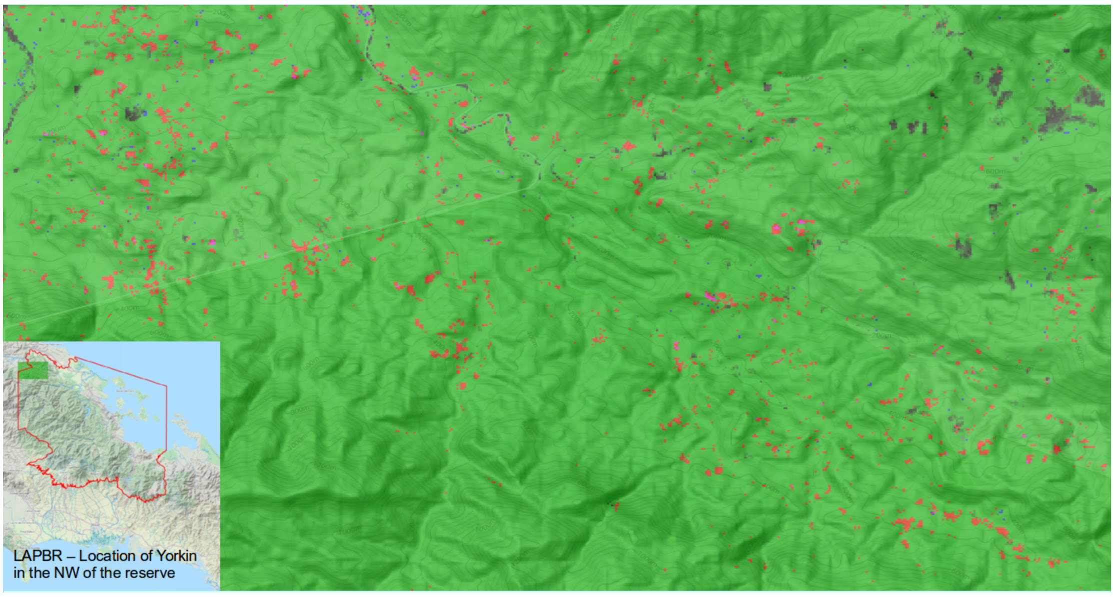

Fig. 48: LAPBR-NW: Yorkin valley is the second most important area with significance deforestation signals
Source: Hansen et al. (2013). Global forest change. Map online: http://goo.gl/dLM1BH with map data Google 2013 as background. Legend: Red spots are most recent loss of mature forests. The small map of location is from Openstreetmap (CC_by_SA) .

98 Idem 97

Fig. 49: LAPBR: Rio Changuinola- Chan 75 Dam site at beginning (14 December 2007)
Photo: A. Rodriguez

A social phenomenon that explains the cause of the spontaneous colonization of forests is the weakness in environmental governance, the absence of laws that regulate the use of land and thereby poor management of natural resources is achieved. Moreover, the problem is aggravated by the social tendency to create a constellation of small isolated communities in the landscape of the area, causing additional social problems, as for the state is costly and difficult to meet basic needs, especially in new communities inside the forests.

This indicator has a high evaluation, but does not have the ideal value it might have.

7.1.3. Land degradation

It is a non-core environmental indicator about land use and status. The proportion or percentage of land which due to natural processes or human activity is no longer able to sustain properly an economic function and/or the original ecological function. Degraded land includes land affected by soil erosion, deterioration of the physical, chemical and biological or economic properties of soil and/or long-term loss of natural vegetation (UN DESA, 2007a).

The indicator measures the extent of land degradation, which is an impediment to sustainable development, and to sustainable agriculture or other useful uses. In many countries it is a major cause of poverty and further environmental damage due to overuse of national resources. The indicator can also be seen as an overall measure of the reduction in quality of land resources (UN DESA, 2007a).

This problem, according the definition of the indicator, does not exist in the reserve, but there are small areas in the Pacific sector, especially in the district of Boquete East (Fig. 50), which have certain characteristics of degradation. This condition occurs due to the topography, soil type, low soil fertility, annual seasonal drought and poor agricultural practices and ranching.

Cerro Punta can be considered partially another area of the biosphere reserve where there is a problem of land degradation due to soil loss by water erosion, but still the soil is suitable for agriculture, but requires more input fertilizers. Details about soil degradation in Cerro Punta in Zúniga-Balbuena (1989).

As a conclusion the LAPBR there are no degraded soils in the strict sense of the definition, therefore, the evaluation for this indicator is high. The 'degraded' areas, still are not at the level of the definition given to this indicator.

Fig. 50. LAPBR: Small areas ot spots are some examples of advances in soil degradation Source: GoogleEarth 2010.

This area corresponds to east of Boquete distric in the Pacific side of LAPBR.

7.1.4. Land area affected by desertification

It is a non-core environmental indicator about desertification. The indicator shows the proportion of land in dry-lands that is affected by desertification. Desertification is defined as land degradation in arid, semiarid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UN DESA, 2007a).

The indicator describes the extent and severity of desertification at the national level. For dry-land areas, desertification is a central problem in sustainable development. While many dry-land ecosystems have generally low levels of absolute productivity, maintenance of that productivity is critical to the present and future livelihood of many hundreds of millions of people. Combating desertification is, therefore, a central sustainable development goal for large areas of the world (UN DESA, 2007a).

Panama is a tropical country. The biosphere reserve is embedded within a context of tropical lowland and upland areas with high humidity throughout the year. The problem of desertification under the definition of UN DESA (2007a) does not occur in LAPBR. Official data showing problems with soil loss in Cerro Punta in the Chiriqui highlands can not be interpreted scientifically as a condition of desertification.

This indicator is obviously very useful in reserves with arid or semi-arid soils. This indicator is irrelevant.

7.1.5. Arable and permanent crop land area

It is a core environmental indicator about sustainability in agriculture. The indicator measures arable and permanent crop land is the total of “arable land” and “land under permanent crops”. Arable land are the following conditions: a-) the land under temporary crops; b-) temporary meadows for mowing or pasture; c-) land under market and kitchen gardens and land temporarily fallow (for less than five years); and d-) land under permanent crops is the land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest (UN DESA, 2007a). These permanent crops include various fruit trees or bushes, nuts, coffee, cocoa, oranges, bananas and the like. In temperate lands includes crops such as olives, vineyards, apple orchards etc.

This indicator shows the amount of land available for agricultural production and, inter alia, the cropland area available for food production. In many countries, rising food and fibre demand and a decline in farm sizes forces small farmers to extend cultivation to new areas, which are fragile and not suitable for cultivation. Crop intensification, which has contributed significantly to agricultural growth in recent years, can ease the pressure on cultivating new lands but farm practices adopted for raising yields can also, in some situations, damage the environment. This indicator is of value to land planning decision making (UN DESA, 2007a).

Official data of the agricultural census for 2010 (Table 28) reveals LAPBR a higher proportion of land under temporary and permanent crops that areas can be defined with the satellite images. The census reveals that a total of 193,880.81 hectares surveyed, the majority (41.79%) is devoted to livestock, followed by forests and scrubs (20.85%), permanent crops (17.83%), temporary crops (7.15%) and fallow (10.18%). Fallow land are normally used for seasonal crops. It is a rotating land use that prevents the rapid depletion of soil fertility. Therefore, fallow land can be considered as part of land under temporary crops, the total would be 17.33%.

Table 28: RBLAP: Land-use areas (Ha) with official agrarian survey data from 2010.

Surveyed categories	B. del Toro	Chiriqui*	N. Bugle*	Total (Ha)	Percentage
Temporary crops	6008.1	6243.7	1606	13857.9	7.15
Permanent crops	23011.5	7252.5	4310.4	34574.4	17.83
Land temporarily fallow	13873.3	3080.6	2781.8	19735.7	10.18
Traditional pasture	25118.9	7453.4	4958.9	37531.2	19.36
Improved pasture	11057.4	17510.6	373.9	28942	14.93
Foraging crops	659.3	796.2	132.6	1588.1	0.82
Native or Natural pasture	8544.6	2624.2	1773.4	12942.1	6.68
Forests and scrubs	27916.5	7049.2	5449.1	40414.8	20.85
Other lands	2652.7	1293.1	348.8	4294.7	2.22
Total by province (Ha)	118842.3	53303.6	21734.9	193880.8	

*Source: INEC / * The values were estimated based in the general data by districts of Pacific Biosphere Reserve.*

These data show that temporary crops and livestock are an important source for the rural economy of the biosphere reserve. Data on seasonal crops reflect a low percentage (less than 10%) in the context of the reserve, but also indicate a major source of agricultural activity.

The scale used in this indicator, based on 1000 hectares, it is not appropriate to apply at the level of a biosphere reserve, as they are small in proportion to the total area of a country. With high-resolution images and field verification can be done mapping accurately, otherwise census data are required.

This indicator currently attempts to identify of the total land, what proportion engaged in productive activities related to land use that generate income for the population. In biosphere reserves these productive lands produce sources of employment in the agricultural industry and models of small-scale self-sustainability (subsistence agriculture and livestock).

Table 29 shows a complementary analysis of land use change and trends between 1992 and 2000. This table is self-explanatory.

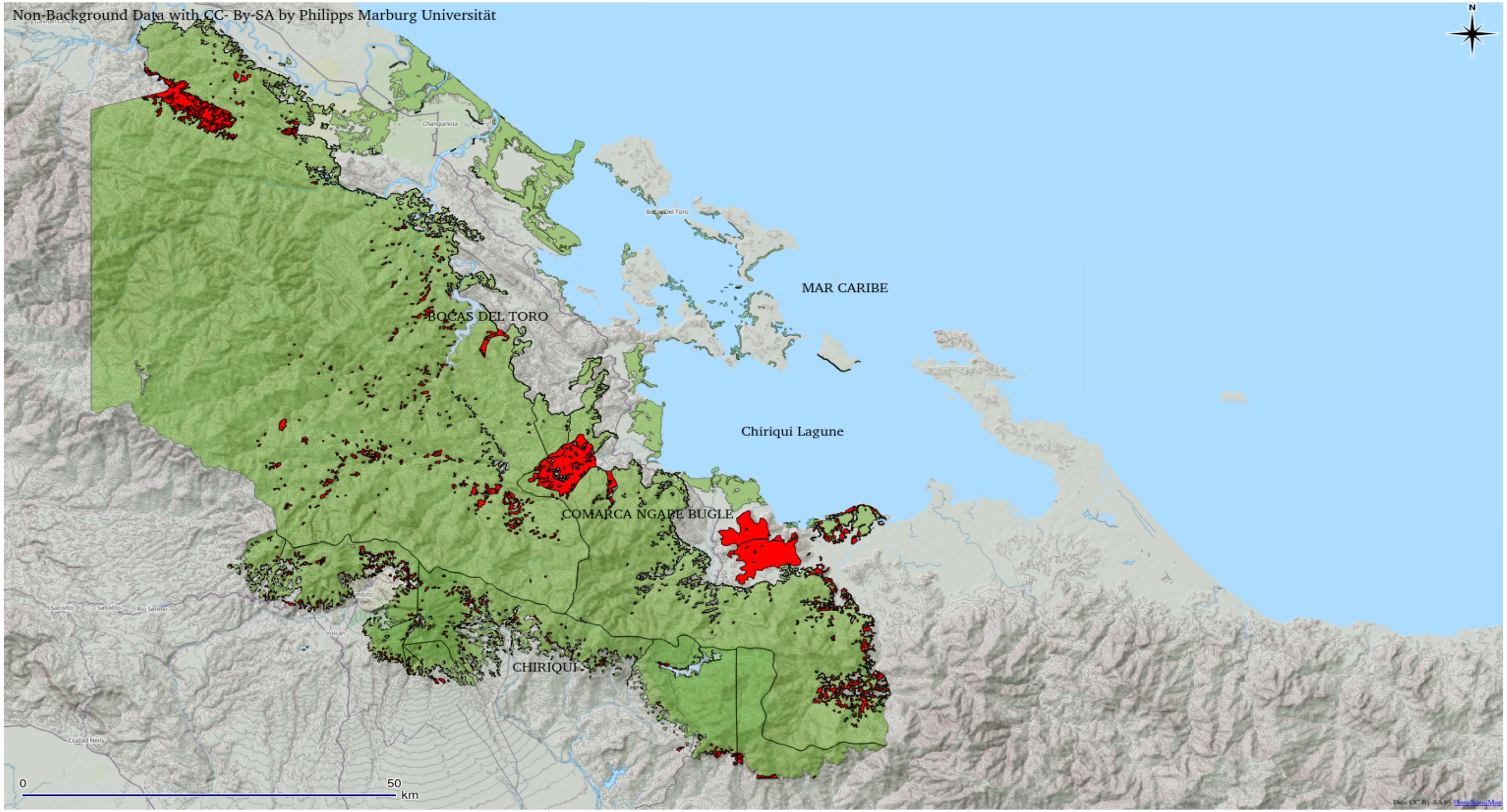

Fig. 51: LAPBR: Primary forest to another land-uses (2000-2012)
Source: Adapted from data from ANAM. Background from Openstreetmap (CC_by_SA)

Table 29: LAPBR: Land-use change between 1992 and 2000

Landuse/LAPBR region	Bocas del Toro province			Chiriqui highlands			Comarca Ngobe Bugle W		
	1992	**2000**	**Trend**	**1992**	**2000**	**Trend**	**1992**	**2000**	**Trend**
Inland water	368.58	176.74	-191.85	60.26	69.36	9.10	-	48.94	48.94
Orey forest	3,637.26	3,635.04	-2.21	-	-	-	-	-	-
Disturbed forest	50,193.83	51,954.63	1,760.80	23,193.14	16,988.51	-6,204.63	5,559.34	7,121.52	1,562.18
Mixed wetland forest	18,750.89	18,658.28	-92.61	.00	.00	.00	168.16	169.59	1.42
Mature forest	322,221.90	312,020.93	-10,200.97	59,866.78	65,955.90	6,089.12	99,603.56	89,035.50	-10,568.06
Mangrove	2,751.95	2,809.78	57.84	-	-	-	103.58	164.87	61.29
Other uses	657.60	658.54	.94	301.10	2,430.50	2,129.40	-	25.00	25.00
Pioner forest	27,641.34	32,431.67	4,790.33	17,506.97	13,106.74	-4,400.23	4,282.48	2,001.67	-2,280.82
Agriculture use	7,996.01	7,837.96	-158.05	7,231.95	6,838.14	-393.81	6.88	6.88	.00
Subsistence agriculture	19,253.01	23,217.03	3,964.02	3,988.84	6,772.42	2,783.58	9,518.89	20,458.99	10,940.10
Low flooded vegetation	4,209.03	4,207.71	-1.32	-	-	-	-	-	-

Source: Adapted from the Panama official forest cover maps 1992 and 2000 (ANAM).

Red means negative trend or loss of natural resources and green means positive trend.

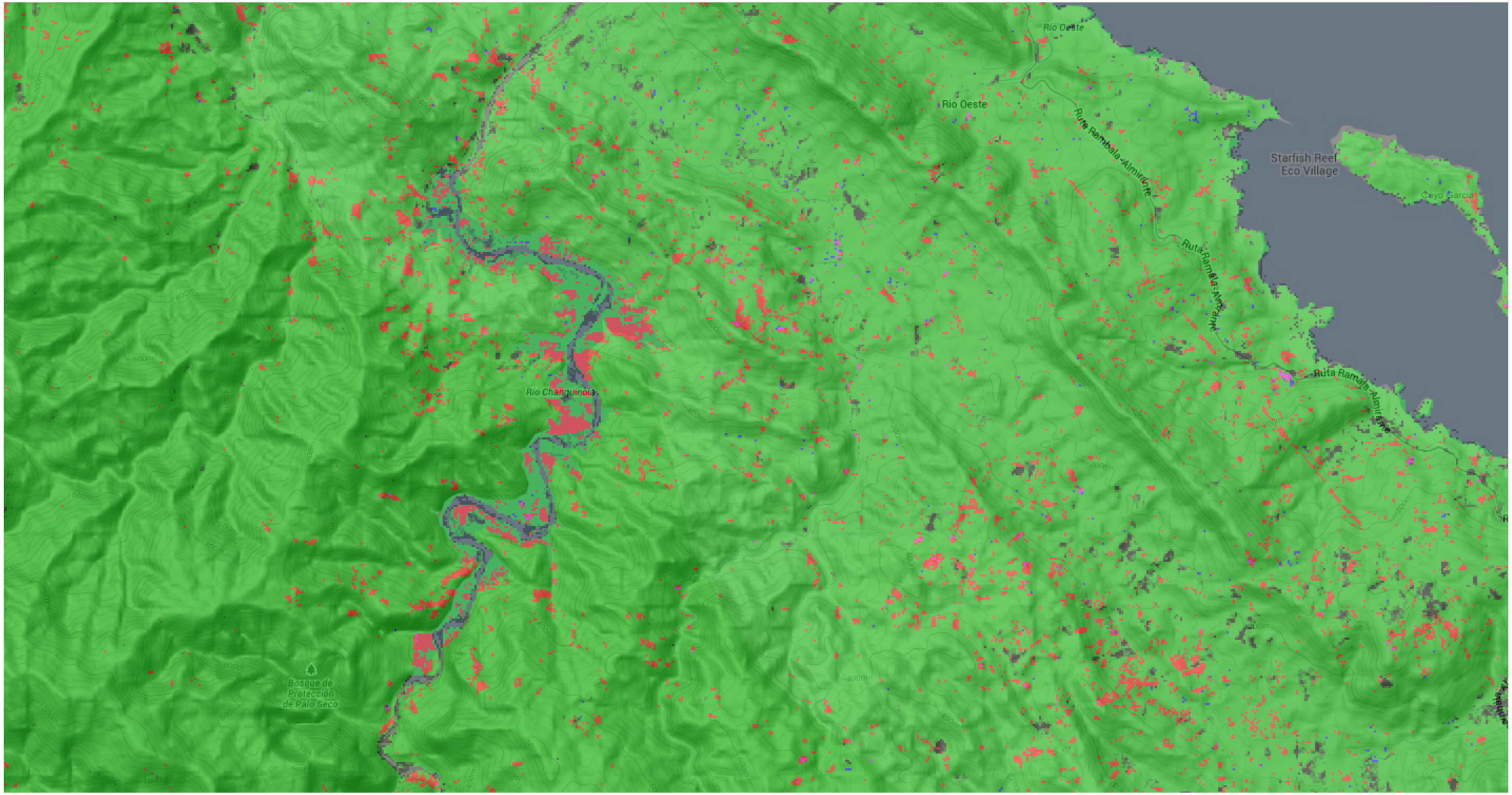

Fig. 52: LAPBR: Changuinola district in Bocas del Toro with red polygons representing forest loss between 2000-2012
Source: Hansen et al. (2013). Global forest change. Map online: http://goo.gl/dLM1BH with map data Google 2013 as background.

A. Arable land area

The reserve has little arable land surface and are located in a small portion of the Caribbean lowlands, in the alluvial plain between the Sixaola, San San and Changuinola rivers. According to my estimates there is a total of 18,577 ha (185.77 km²) of arable land. These lands are currently occupied primarily by bananas (71%) and the rest to other agricultural activities, especially extensive cattle ranching (29%). In the early 1990s, in the wetlands of Chiriqui Grande, rice cultivation developed in mud, but not longer exists.

In 1998, 660 hectares of rice grown in this area (Espinosa, 2000). Currently the production of rice in the reserve is dispersed throughout Bocas del Toro and Ngobe Bugle provinces, only as subsistence crops, which are not using wetlands for cultivation and depend on deforested land for cultivation in the traditional subsistence system.

In the Pacific, LAPBR theoretically has no arable land. This is because they are high land with steep slopes, yet in the area there is an agricultural production system that uses plow for horticulture. This occurs especially in Boquete and Cerro Punta. However, the country depend largely on vegetable production in this region. This situation is a good example of the misuse of the term 'arable' to identify agricultural lands in production.

The concept of arable land is relative, especially in developing countries, since usually there is no clear policy on land use based on soil suitability. It is not uncommon to see in many countries that the land suitable for mechanized and industrial agriculture to be used for other purposes, thus, the fact that a country has arable soils does not necessarily indicate the ability of food production and social welfare would be expected in a scenario of good land use regulation. This applies equally to a biosphere reserve.

Vegetable production in LAPBR, for food, in the country is very important agriculture activity. This makes necessary to account the land used for horticulture as arable land.

The area under cultivation of vegetables in the highlands of Chiriqui, in the biosphere reserve, is about 7,000 ha. There are no comprehensive data to assess additional details.

B. Permanent Crop Land Area

Permanent crops fall into three main categories: coffee in the highlands of the Pacific, cacao, and bananas in the Caribbean lowlands.

a. Cacao

The cultivation of cocoa in the reserve is in the districts of Changuinola, Chiriqui Grande, Bocas del Toro and Ngobe Bugle. There are approximately 4500 ha planted with cacao[99]. In satellite imagery available is very difficult to differentiate natural forest cover with respect to forest mixed with cocoa trees. There are not maps on their own cocoa farms. This is one of the reasons that there is no clear understanding of the distribution and the total area of these crops.

Cocoa farming is a very important item for small farmers and poor families living associated with existing forests in the reserve. There are an estimated 1,500 cocoa farmers throughout the Caribbean biosphere reserve.

Cocoa can be considered an environmentally friendly crop compared with horticulture, extensive agriculture and extensive mono-cultures such as bananas. Cocoa can be grown in combination with forest where producers live. An additional advantage of having the cacao that makes it a sustainable product is that it can easily be grown organically.

Another factor for advantage of this product is the existence of a diversified international market in Europe and North America. This fact has allowed the export of this growing business since 2000. This international trade has helped to revitalize cocoa producing farms in the region[100].

b. Banana plantations

The cultivation of banana (*Musa paradisiaca* and *Musa cultivar*) can be considered a permanent crop, since there is no complete elimination of seasonal plantation production. Production is continuous and rotating within the production area.

The biosphere reserve contains the only place in the country that produces bananas

99 ADN Mundo. 2007. Online: http://www.radiolaprimerisima.com/noticias/13374/industria-del-cacao-resurge-en-panama

100 La Prensa. 2007. Resurge la exportación de cacao. Online: http://mensual.prensa.com/mensual/contenido/2007/05/06/hoy/negocios/971679.html

(*Musa paradisiaca*) for export to the U.S. and European markets. This crop exists in the low, flat and well drained Changuinola district lands (Fig. 53). This land dedicated to banana cultivation are officially considered arable II (ANAM, 2010), but have been occupied since the late nineteenth century to banana production, which has been a profitable business for more than a century.

Our mapping based on 2010 satellite images revealed the existence of at least 14,240 ha of bananas and plantains in Changuinola[101]. In 1998 the banana area in Bocas del Toro was 7000 ha (Espinosa, 2000). This banana production is the main economic activity and the primary source of jobs in the entire Caribbean region of LAPBR. Its existence ensures minimal social stability in the region, which prevents more pressure on other natural resources of the area.

In the Caribbean LAPBR additional to the region of the banana industrial plantations in Changuinola, there are small areas of plantains and banana; but do not represent significant extensions in the overall context of the biosphere reserve. Also exists domestic banana and plantain crops, that is a good source of livelihood in the area, partially guaranteeing food security and sometimes retail sales.

c. Coffee plantations

In LAPBR coffee plantations are located in the highlands of the Pacific. There are five main production locations: Renacimiento, Volcán, Cerro Punta, Boquete and Dolega (Fig. 16). Additionally, there are coffee plantations in the border area of Coto in Costa Rica, adjacent to the territory of the reserve in the south-west. This whole plantation represents an important economic activity in the highlands, especially in the harvest months. Normally for the owners of the crop is a profitable and sustainable business.

Our geo-spatial analysis recorded a total of 7299 ha (73 km²) of coffee plantations in the highlands of Chiriqui, 633 ha in Coto, Costa Rica (adjacent to LAPBR) and estimates unmapped about 300[102] ha of coffee in the Ngobe Bugle inside the biosphere reserve.

101 Additional fresh geo-spatial data for analysis in this area can access to http://osm.org/go/YHM1Sjv.

102 La estimación se ha realizado asumiendo un 10% del total ha de café registradas oficialmente para la Comarca 2011-2012 por la Contraloría General de la República de Panamá.

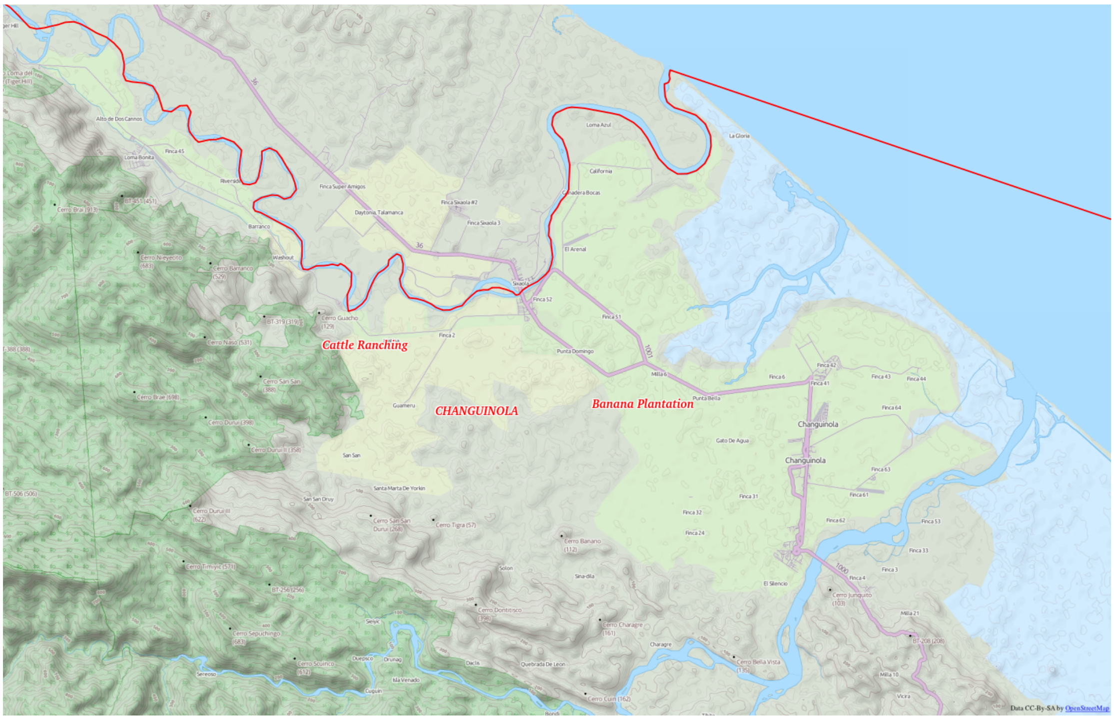

Fig. 53 LAPBR: Location of arable areas in NW

Legend: The flat lands in Changuinola area with banana plantation and cattle ranching activities represent arable lands but also permanent crops for LAPBR. Note the NW red line border of LAPBR. Source: Background from Openstreetmap (CC_by_SA)

Importantly, the surface of coffee crops, according to official data[103] varies and is not static but dynamic. For example, the province of Chiriqui is between 6000 and 10000 hectares[104] of coffee plantations between 2007-2012. The geo-spatial analysis located some abandoned plantations, but also recorded new plantations. A comprehensive analysis requires better aerial imagery.

Coffee is one of the main activities that generate significant income in the highlands of Chiriqui, followed by livestock, horticulture, tourism, and subsistence agriculture. Almost all the labor to plant and cultivate coffee is composed of citizens of the Comarca Ngobe Bugle who migrate to sites of coffee crops in the period of harvest or planting.

d. Orange plantations

The crops of oranges exist in the southern highlands of the LAPBR (Dolega and Boqueron) sector. The surface of this crop inside the Reserve is negligible (appr. 218

103 INEC. 2013. Estadística Agropecuaria. Contraloría General de la República. Panamá. Online: http://www.contraloria.gob.pa/inec/Publicaciones

104 FAO. 2013. FAOSTAT. Online: http://faostat3.fao.org/home/index.html (08/22/13).

ha), but are part of larger areas of at least 4,365 ha (43.6 km²) that are in the immediate border to the Pacific boundary line of the south transition zone (Fig. 54). This industrial orange plantation is the second most important permanent crop in the region.

These crops are important to the local economy because they guarantee jobs to residents of nearby rural communities. It also prevents the advance of the agricultural frontier into the boundaries of the Volcan Baru National Park (a core area of the reserve). This activity also supports the independent production of this product, which creates additional income for farmers with small plots.

Agricultural industry inside and in the immediate periphery of the reserve, are activities that have promoted a stable economy in the last 5 decades. According my opinion, this agricultural activity has been a key to the conservation of existing forests in the area, most of which are now part of protected areas that are the core of the biosphere reserve.

The problem associated with permanent crops is that activity has never been accurately evaluated in terms of environmental impact and environmental adequacies. The footprint of environmental impacts in the area of operation is notorious. A biosphere reserve's goal should be included in future plans of expansion and improvement of the current crops.

I don not have information about land under market and kitchen gardens and land temporarily fallow. For this information is necessary some updated and high-definition imagery, and additional surveys. In most cases it is impossible to have data as required.

The evaluation for this indicator is high, but requires better development and better controls of environmental standards.

7.1.6. Fertilizer use efficiency

It is a non-core environmental indicator about sustainability in agriculture. The indicator measures the extent of fertilizer use recovery in agriculture per crop unit. Data on the quantities of fertilizers used are converted into the three basic nutrient components and aggregated. The three components are nitrogen (N), phosphorous

(P205), and potassium (K20) (UN DESA, 2007a).

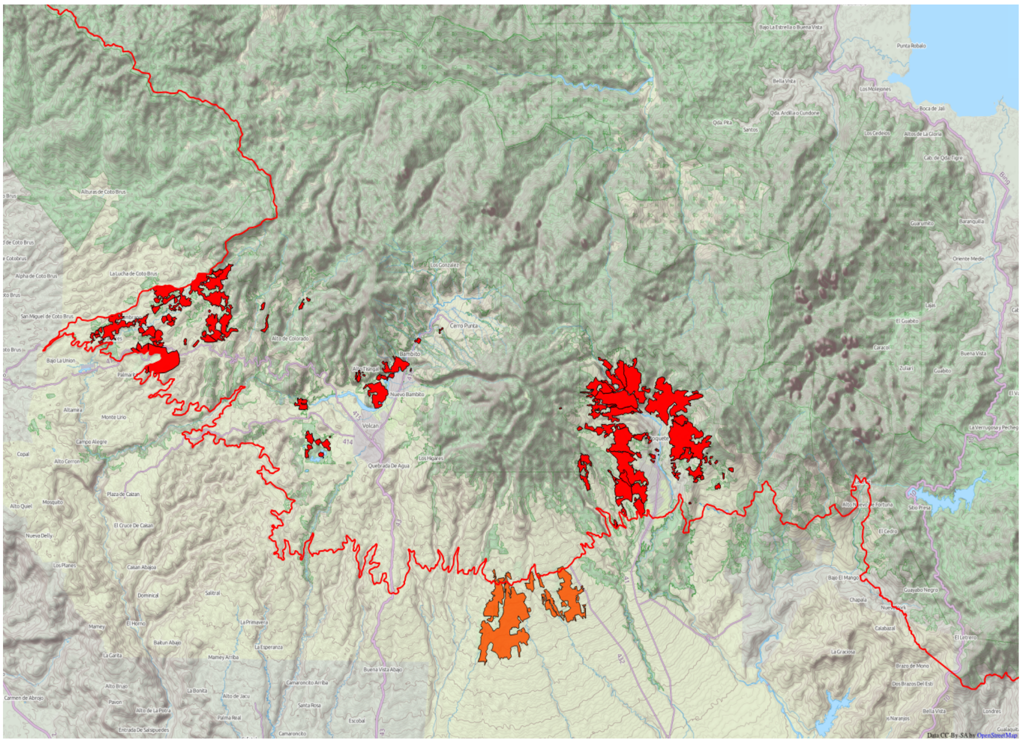

Fig. 54. Coffee (red plots) and oranges plots (orange plots) are two permanent crops in SW of LAPBR.

Source: Background from Openstreetmap (CC_by_SA). Legend: red line is the reserve transition border.

This indicator measures the potential environmental pressure from inappropriate fertilizer application. Intensive fertilizer application is linked to nutrient losses that may lead to eutrophication of water bodies, soil acidification, and potential contamination of water supply with nitrates. In many countries, intensification of agricultural production is a response to increases in food demand and in the scarcity of agricultural land (UN DESA, 2007a).

From 2002-2010 Panama was using 25 tonnes of Nitrogen nutrient per 1000 hectares, 42 tonnes of N+P205, and 13 tonnes of Phosphate on arable and permanent crop area[105]. This value is low with respect majority of American countries, but is relevant to know that Panama does not have political support for to promote agriculture industry. This is evidenced by the low percentage of the equivalent energy used in agricultural production, according to FAO[106], which is less than 2% of total

105 FAOSTAT. 2013. http://faostat3.fao.org/faostat-gateway/go/to/browse/E/EF/E. Online: 09/01/13
106 Idem 105.

energy consumed in the country.

Because there are no specific data for LAPBR area, I rely on circumstantial evidence[107] to infer improper use of fertilizers, especially in Cerro Punta and Boquete, because there are no permanent policies of counseling, monitoring, control, and surveillance for horticultural production. Existing surveillance policies are weak. This is one of the reasons, the environmental problems associated with the loss and soil pollution is still evident in the area of the highlands above.

Meanwhile in the Caribbean area of the reserve, specifically in Changuinola, Bocas del Toro Province, farmers use fertilizers in banana plantations. I do not have verifiable data field or specific use records of fertilizers, on these crops, but I infer a good management use of these products, as the land is flat and there is a tech plantation management. In fact, since 1998 the main producer of bananas, Bocas Fruit Company (United Fruit Company subsidiary), is adjusting all production processes in order to obtain favorable export certifications, specially for European Union. His environmental adaptation includes soil fertilization with organic fertilizer and with the consequent reduction of the gross tonnage of traditional fertilizers.

It is clear that in these times, banana farmers, for convenience of the markets, manage a permanent environmental management plan that guarantees basic controls and promotes the reduction of complex environmental problems caused by this type of industrial agriculture.

Definitely the level of data required for the analysis of this indicator within the biosphere reserve does not exist, but this parameter is feasible to measure specific areas and crops. Understand the whole problem is more costly and complex.

The evaluation for this indicator means, with little evidence that I know the area, I believe it is not a critical problem, but just know that is not handled properly throughout a whole.

7.1.7. Use of agricultural pesticides

It is a non-core environmental indicator about sustainability in agriculture. The

107 En Cerro Punta solicitan regular uso de gallinaza. 2013. Online: http://www.prensa.com/impreso/nacionales/en-cerro-punta-solicitan-regular-uso-de-gallinaza/172048. 12/21/13

indicator analyzes the use of pesticides in metric tons of active ingredients per unit of agricultural land area (UN DESA, 2007a).

This indicator measures the use of pesticides in agriculture, which is linked to the intensification of agriculture. Whereas pesticides may increase agricultural production, they pose challenges to health and environment, including wildlife. Pesticides tend to accumulate in the soil and in biota, and residues may reach surface and groundwater through leaching. Humans can be exposed to pesticides through food or by direct contact in production areas (UN DESA, 2007a).

According FAOSTAT[108] (2013) Panama as a whole country is using ~2.356 tonnes per 1000 ha of pesticides in active ingredient on arable land and permanent crops, during 1992-2010[109].

Banana, coffee, pineapple, and vegetables plantations are the main agricultural activities using agricultural pesticides in this area. Also the livestock industry are using herbicides for management of pasture lands.

The data in metric tone per unit of agricultural land is not available in LAPBR area, but I infer that are significant in quantity capable of affecting the environment and human health. Studies of Carranza & Torremocha (2004) and Carranza (2006) recorded 105 different pesticides in Boquete and 121 in Cerro Punta.

The main areas of intensive use of pesticides in LAPBR are: Cerro Punta (Carranza, 2006), Boquete, Dolega and Changuinola. Additionally there has been widespread use of herbicides to manage pasture of extensive cattle ranching since the 1990s.

The use of commercial pesticides in the area is diversified, including fungicides, nematicides, herbicides, bactericides, insecticides (Carranza and Miret-Torremocha, 2004). All this diversity of pesticides includes highly dangerous species to human health or pollution of the environment (air, water, soil and biodiversity) according to toxicity classification table of the World Health Organization (WHO) (Carranza and Miret-Torremocha, 2004).

Smallholders (~700) of vegetables in the highlands of Chiriqui use pesticides with 'minimal control' (Espinosa, 2000) and with little scientific advice. The lack of advanced education of farmers also contributes heavily to the misuse of pesticides in

108 Idem 105.
109 Panama's data only from 1998 and 2010.

this area. This pattern of massive and uncontrolled consumption in most of the farms producing vegetables in Cerro Punta is still evident in 2013.

In the banana industry in Changuinola in the province of Bocas del Toro, a total of 2500 tons of formulated chemicals are used annually. This figure includes 260 tons of fungicides, nematicides 290 tons, 25 tons of herbicides; 420 tons of pesticide-impregnated plastic and 1,500 tons of mineral oil (Espinosa, 2000).

According to records of the company producing bananas in Bocas del Toro, plantations in 1998-1999 required 240 tons of active ingredients/year (Espinosa, 2000). There are no data from other farms producing bananas, and rice.

The largest recipients of leachates of banana and plantain plantations of Changuinola is the final section of the Rio Changuinola and Rio San San and the rest of the San San Pond Sak Wetland.

Due to the lack of data on amount and frequency of pesticide use in production sites, I evaluate with low score this indicator. Just the absence of these key data, are indicative of poor management of pesticides in the reserve. The overall data of pesticides consumption per capita are not useful for evaluation as extrapolation for the study area. An important point of consideration in the evaluation is that pesticide contamination is not a widespread phenomenon throughout the reserve, but is localized.

7.1.8. Area under organic farming

It is a non-core environmental indicator about sustainability in agriculture. This indicator measures the proportion of total utilized agricultural area occupied by organic farming to total utilized agricultural area. Organic farming involves holistic production management systems, for crops and livestock, emphasizing the use of management practices in preference to the use of off-farm inputs. The indicator may be extended to cover organic forestry and aquaculture (UN DESA, 2007a).

This indicator shows the importance of organic farming. Organic farming contributes to reducing environmental loading on soil and water resources and pressure on biodiversity. The reduction of use of pesticides, herbicides and other chemicals, combined with enhanced management of natural resources, not only improves the health of ecosystems but also fosters the health of animals and people and increases income generation and communities' self-reliance (UN DESA, 2007a).

Organic agriculture is underdeveloped in Panama. Until the year 2013 there is no official policy on the matter, but there are plans to regulate this productive activity[110].

The constraints of organic agriculture in RBLAP as an attractive activity remain the same as defined for Central IICA, among which are: a-) lack of technical and regulatory frameworks, b-) institutional, c-) laws, d-) policies, e-) markets and f-) training of farmers to incorporate this model of agricultural production (Amador et al., 2002).

At the level of the reserve there are no significant areas of organic farming, in fact there are only small areas, which are individual or isolated projects. In the reserve there are some horticultural plots in Boquete and Cerro Punta and Bocas del Toro and Ngobe Bugle with organic cocoa. More development of this activity is a good opportunity to increase the production of organic cocoa in the provinces of Bocas del Toro and Ngobe Bugle, however, still is basic, without real agricultural policy support.

IICA 2002 report states that 'the relationship of the producers with the process of organic certification is minimal'. As occurs in the case of cocoa for export. In Bocas del Toro there are ~4500 hectares of cocoa farms, where 80% of the production is organic and certified (Amador et al., 2002). In Cerro Punta, Chiriqui, production volumes of organic horticultural products are negligible. In the latter region have an additional problem is that most of the soils in that area are already contaminated with pesticide residues, which are used heavily in traditional horticulture.

An additional problem common to all forms of organic production in the LAPBR is that Panama has no organic certification bodies (Amador et al., 2002) and depend on external certifiers, which will increase the cost of certification.

Another problem facing the region for the better development of organic agriculture is the lack of professionals to work in promoting organic farming. Most professionals that exist in the area have no incentive to work on the advice for the development of organic farming.

110 Presentan propuesta para reglamentar agricultura orgánica. La Prensa (23/06/2013). http://www.prensa.com/impreso/economia/presentan-propuesta-reglamentar-agricultura-organica/186863. 08/08/13

While agriculture can be developed in all its forms without professional support is of great value the existence of knowledgeable professionals and impellers of this farming model, which can lead the activity between different actors and stakeholders. This just what should promote a coherent policy. The LAPBR can be a good example to implement a policy of organic farming.

The first step in this policy must be the training of the professionals who typically have been trained in traditional production schools without full vision and paradigms organic farming.

Our global analysis according to my knowledge of the area allows us to determine that in fact there is a low level of development of organic agriculture, although there is a incipient but growing official motivation towards this goal. A positive and significant legal step was the promulgation of the law on organic farming in 2002[111].

The evaluation for this indicator is low. It reflects the impact of organic farming is not significant in the reserve. The absence of specific data and mapping from doing a more positive assessment.

7.1.9. Forest trees damaged by defoliation

It is a non-core environmental indicator about sustainability of the forests. This indicator is defined as the percentage of trees on forest and other wooded land in the defoliation classes moderate, severe and dead. Defoliation is needle or leaf loss in the assessable crown as compared with a reference tree (UN DESA, 2007a).

The indicator provides information on the state of forest defoliation. The extent of defoliation provides an indication of the health of forests. Defoliation is influenced by a combination of climatic factors (especially drought), soil conditions, atmospheric pollution and forest pathogens. The indicator, thus, provides information on the impact of policies which reduce the occurrence of such influencing factors, in particular air pollution (UN DESA, 2007a).

This indicator can be very easy to determine through use of geospatial information and mapping to determine extent of damage trends in the problem and possible contingency measures to address this environmental problem. This type of

111 Ley 8 de 24 de enero de 2002. “Que establece las Regulaciones Nacionales para el Desarrollo de Actividades Agropecuarias Orgánicas. Panama. Official Gazetter 24482.

information is useful and feasible to be applied in a biosphere reserve facing this environmental problem.

The RBLAP lacks this environmental problem. Lacking this problem completely, evaluation for this indicator is highest.

7.1.10. Area of forest under sustainable forest management (SFM)

It is a non-core environmental indicator about sustainability of forests. This indicator measures the forest area that is under sustainable forest management (SFM). It can be based on a variety of information, including data on forest health, the extent to which forests fulfill targets related to their environmental, economic and social functions and on forest management practices (UN DESA, 2007a).

The indicator provides information on forest management practices. Sustainable forest management for a variety of uses is essential to achieving sustainable development. It is a critical means to eradicate poverty, to significantly halt deforestation and to halt degradation of natural resources and the loss of biodiversity (UN DESA, 2007a).

For this indicator is necessary to have the full details of the total forest area and the total area of forest under sustainable management at different yearly intervals (UN DESA, 2007b). Although unpublished official update for the country's forest cover 2010, researchers can make an overall assessment for the area with forest cover data from 1992 y 2000. Nor are there any annual data and can only be inferred. Still, with the data mentioned is possible to establish a frame of reference close to the current reality.

The main strength of the LAPBR in forest management is the extent or area and established the legal status for most of the remaining natural forests in the area. Of the total forest is in 1992, 86.9% were sustainably managed forests; 89.24% in 2000 and 88.57% in 2008 (see details in Table 30).

In practical and legal terms the management of forests sustainably only occurs only within protected areas under the function of forests for conservation, protection or multiple use. The forest biodiversity conservation and water protection are those with the highest standards of physical conservation of forest mass.

In LAPBR, forests designated with the role of 'preservation' are the most extensive (Table 30) and are those that are located inside protected areas of the reserve. Meanwhile, forests that have no real protection policy, or effective, are located outside protected areas. The loss of natural forests on private farms and lack of reforestation with significant area inside or outside protected areas indicates trends and unsustainable pressure on protected areas and forests. Similarly no change of the traditional cultural practices in agriculture or livestock that affects forests has negative effects over time in the total ecosystem assembly.

The multi-use category of protected areas is allowing more forest loss, depending on social and economic demands of the country. In Table 30 is possible to verify that only Bastimentos Island Marine National Park and Lagunas de Volcán are not subject to pressure on managed forests, however, the Palo Seco Protector Forest is under high pressure and it has lost since 1992, a total of 14058 hectares of natural forest.

It is very possible that new hydroelectric projects plans, plus the displacement of rural communities and the natural population growth of the area, Palo Seco may lose additional 15,000 acres in the next 20 years.

This forest loss can be avoided if an appropriate plan of assessment and management of environmental resources in the area, based on a philosophy of ecosystem management and the principles of social sustainability is done.

In any case, the loss of natural, mature forests and rich biodiversity should be a priority in the development agenda of the country. The construction of hydroelectric power is a little model of sustainable development, if it is not framed within an environmental policy development, to ensure that the significant environmental impacts caused by these structures, should be compensated effectively, including a significant improvement in protected areas and buffer zones and transition from LAPBR.

Table 30: LAPBR: Forest cover (Ha) under sustainable forestry management in protected areas

Protected Area	Years			FRA Category
	1992	2000	2008	
Fortuna Forest Reserve	19599	19613 (+)	19472 (-)	Protection
Lagunas de Volcan Wetland	142	171 (+)	171 (=)	Conservation
Volcan Baru NP	12856	12661 (-)	11746 (-)	Conservation
Palo Seco Protection Forest	247913	246006 (-)	233855 (-)	Multi-use
La Amistad NP	214547	213892 (-)	210186 (-)	Conservation
Bastimentos Island MNP	1512	1612 (+)	1634 (+)	Conservation
San San Pond Sak Wetland	11783	11932 (-)	11777 (-)	Conservation
Total (Ha)*	508352	505887	488841	
LAPBR Forest Area (Ha)*	584726	566896	551896	
Forest under sustainable management in LAPBR (%)*	86.94	89.24	88.57	

Source: Adapted from FRA2010, National Report of Panama

The La Amistad International Park, due to its management category, but especially isolation or inaccessibility presents an acceptable condition to protect its forests after the invasions of ranchers, decades ago, mainly in Nueva Zelanda and Culubre area. Do not exist recent evidence of significant, additional interventions on the remnant forest. UNESCO has requested since 2008, to be a complete control of cattle ranching in this core zone.

The Lagunas de Volcán have good standards of conservation and management of natural forests, however there is strong pressure from surrounding farming activities. The problem with this area is that it is too small to establish wider conservation programs in the area. Hence the importance of working with the concept of buffer area of a biosphere reserve. A useful initiative would be to try to implement forest corridors along the headwaters of the rivers surrounding this protected area.

The Palo Seco Forest Reserve or Protector Forest is a protected area that according to the Geo-spatial data that was analyzed, it presents the most obvious impacts of deforestation. Official data corroborate this fact. The ambiguity of its management category has been a negative factor in its administration. Initially, Palo Seco was visualized as a water protection area for hydroelectric projects. Currently the Environmental Authority of Panama considers such an area of multiple use (different legal context set), which in terms of conservation, implies a relaxed policy management and control of forest resources, it just is an ambiguous concept and weak management. Still, this protected area, due to the legal nature of their existence, prevents land titling and mass sale of land, which is a key factor in most cases promotes deforestation and transformation of the landscape of this type of ecological protected areas.

Volcan Baru National Park also has acceptable levels of forest protection, although, in the past 15 years there has been some level of forest loss, especially in secondary forests and forest pioneers. The main problem with this park is that it threatened to become a virtual forested island, given the strong level of agricultural and residential activities outside its boundaries, even in the northern forest that still has a connection to the La Amistad International Park.

Fortuna Forest Reserve contains excellent coverage of forests that protect the upper basin of Rio Chiriqui and Edwin Fabrega Dam. This dam is key to the operation of the hydroelectric Fortuna, the main hidropower in Panama.

One can say that the protection of forests in the area has been successful for over 30 years, however, this large forest is missing oportunities for education or other sustainable uses, because at moment the use in this way is still negligible. This is relevant to reconsider a better conservation strategy, which is based on inclusion and not exclusion of the neighboring population and the national/international scientific community.

The forests of San San Pond Sak Wetland have remained with no significant forest loss. One can assess the condition of the protected area has been effective in protecting the flooded forests of Changuinola and Almirante in Bocas del Toro province.

While the proportion of forests under 'management' is excellent, is not possible to ignore mismanagement and deficiencies in stop the destruction of native forests inside and outside protected areas. If there is good protection and sustainable use of the forest outside the core and buffer zone of the biosphere reserve areas is the best way to continue protecting forests existing inside of protected areas. Destruction means use under unsustainable way, normally outside of plans, rules and law.

The evaluation for this indicator is high.

7.1. Oceans, seas, and coasts

7.1.1. Percentage of total population living in coastal areas

It is a core environmental indicator about sustainability in coastal zone. It is the percentage of total population living within a 100 kilometers from the coast and 50 meters above sea level. Other combinations of distance-to-coast and elevation may be used as definition of coastal zones. Another approach is to measure the population living in river delta areas, which are important areas at the land-ocean interface (UN DESA, 2007a).

This indicator measures the concentration of population in coastal areas, typically due to the economic benefits that accrue from access to ocean navigation, coastal fisheries, tourism, and recreation. The indicator quantifies an important driver of coastal ecosystem pressure, and it also quantifies an important component of vulnerability to sea-level rise and other coastal hazards. Among the most important pressures are habitat conversion, land cover change, pollutant loads, and introduction of invasive species. A high population concentration in the low-elevation coastal zone (defined as less than 10 meters elevation) increases a country's vulnerability to sea-level rise and other coastal hazards such as storm surges (UN DESA, 2007a).

In the case of LAPBR, coastal areas for human populations include all communities from archipelago of Bocas del Toro and the coast of Chiriqui Lagoon, from Guariviara river to Almirante bay. It includes Changuinola community, because its activities and economy is linked to maritime access port for the export of bananas, which is the main economic activity of the region. Not include small rural communities in Bocas del Toro and Ngobe Bugle inland, which do not depend directly on coastal activities.

A total near to 94,000 persons area associated with low coastal areas of Bocas del Toro and Comarca Ngäbe Bugle. This total represent around 66.7% of the total population of the LAPBR. Of this total, one can estimates that 50% of these people live associated with agriculture business activities and 50% to subsistence activities, including fishing and tourism. No census data to support these estimates, but they are based on my own knowledge and experience in the area.

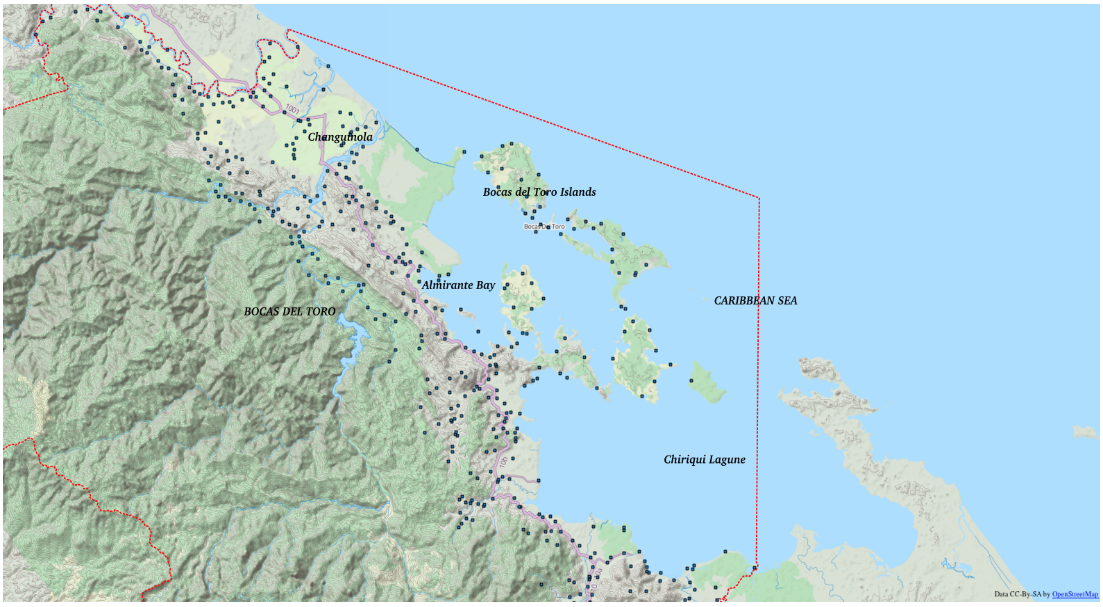

Fig. 55. LAPBR: population living associated with coastal area in the Caribbean Sea. Source: CGRP and background map edited from Openstreetmap (CC_by_SA) .

This indicator has an average evaluation, since most of the population is associated with coastal and marine resources and greatly depends on them. Also a large proportion of this population can be considered vulnerable to sea-level rise and storms.

7.1.2. Bathing waters quality

It is a non-core environmental indicator about sustainability in coastal zone. The indicator describes the changes over time in the quality of designated bathing waters (inland and marine) in terms of compliance with standards for microbiological parameters (total coliforms and faecal coliforms) and physic-chemical parameters (mineral oils, surface-active substances and phenols) (UN DESA, 2007a).

The indicator provides important information on the environmental status of coastal waters. Violation of bathing quality standards poses health risks for the population as well economic risks to the tourism sector. The indicator also provides information on the effectiveness of environmental regulation, especially with regard to waste-water and marine pollution caused by ships (UN DESA, 2007a).

This indicator applies to the coastal area and islands of Bocas del Toro Archipelago in the Caribbean of the biosphere reserve. In this area there is no problem with the water quality for recreation. Even Bocas del Toro city, which is the place with the highest population density, the water is safe for recreation.

It is noteworthy that much of the mainland coast does not have designated places for recreation because of natural conditions are not suitable beaches for recreation. In addition to the Bocas del Toro Archipelago, the other sector that has beaches for recreation with high quality of waters is in the Peninsula Valiente, which is not part polygon the biosphere reserve.

The evaluation for this indicator is high. Any problem with respect to recreational water.

7.1.3. Proportion of fish stocks within their safe biological limits

It is a core environmental indicator about sustainability in fisheries. It is the percentage of fish stocks exploited within their level of maximum biological productivity, i.e., stocks that are either “Underexploited”, “Moderately exploited” or “Fully exploited” according to formal stock assessments based on a FAO procedure. Stocks that are “Overexploited”, “Depleted” and “Recovering” are outside their maximum biological productivity (UN DESA, 2007a).

The indicator provides information on the state of exploitation of fishery resources at the global, regional and national levels. It measures the level of sustainable production from capture fisheries, an important element of food security. It is based on formal stock assessments, derived from national and, for shared fish stocks, regional catch and effort statistics (UN DESA, 2007a).

This indicator will not be analyzed in the context of LAPBR because their analysis assumptions necessarily involve national data. Therefore, this indicator does not apply to a reserve level, which by default, is a small area in relation to the whole territory of the country.

7.1.4. Proportion of marine area protected

It is a core environmental indicator of sustainability in marine environment. The indicator is defined as the share of national marine area (territorial water plus exclusive economic zones) that has been reserved by law or other effective means to protect part or all of the enclosed environment. The indicator may be disaggregated by management category of the protected areas. It could be calculated separately for different marine ecological regions, if appropriate classification systems are available.

The indicator represents the extent to which marine areas important for conserving biodiversity, cultural heritage, scientific research (including baseline monitoring), recreation, natural resource maintenance, and other values, are protected from incompatible uses. Protected marine areas are essential for maintaining marine ecosystem diversity, in conjunction with management of human impacts on the environment.

LAPBR has the Bastimentos Island Marine National Park, protecting a 7% of marine area this reserve. My opinion is that the marine protected area of the reserve should be 3 times the size of the current area because. This indicates that there is a deficit area for conservation of fragile marine ecosystems in Bocas del Toro Archipelago and the western edge of the Laguna de Chiriqui.

In Bocas del Toro, overfishing and sedimentation are increasing threats that can affect the structure and functioning of the reef ecosystem and socio-economic activities that depend on this resource (Guzmán and Guevara, 1998a).

This indicator should be relevant at the level of a biosphere reserve with marine area, specially if this area has valuable ecosystems linked with socioeconomic activities. This indicator tries to see the official effort to preserve its marine resources and its potential for sustainable exploitation.

The evaluation for this indicator is medium, because the existing area is only a third of the expected.

7.1.5. Marine trophic index

It is a non-core environmental indicator about sustainability in marine environment. The marine trophic index measures the change in mean trophic level of fisheries landings by region and globally. Trophic level is defined as the position of an organism in the food chain, and ranges from a value of 1 for primary producers up to a level of 5 for marine mammals and humans (UN DESA, 2007a).

In addition to being an indicator of the sustainability of fisheries, the marine trophic index provides a measure of ecosystem integrity. Declining trophic levels result in shortened food chains, leaving ecosystems less able to cope with natural or human-induced change. The long term sustainability of fisheries is, in turn, directly linked to human livelihoods and well-being. Excessive fishing is the most widespread and dominant human impact on ocean ecosystems and is a major impact on marine biodiversity. The lowered biomasses and fragmented habitats resulting from the impacts of fishing are predicted to lead to local extinctions especially among large, long-lived, slow growing species.

This indicator is irrelevant to the context (or scale) of a biosphere reserve. Fishing industry use large areas of one country, and international waters.

7.1.6. Area of coral reef ecosystems and percentage live cover

It is a non-core environmental indicator about sustainability in marine environment. The indicator measures trends in the extant area of coral reefs (a 'key ecosystem' for many countries), and the percentage live cover of those reefs. Key ecosystems are those ecosystems for which it is most important to measure changes in extent, or those ecosystems for which it is possible to measure changes in extent (UN DESA, 2007a).

The indicator shows the effectiveness of national measures designed to conserve marine biological diversity and ensure its use is sustainable. In many countries, coral reefs contain rare or locally endemic or threatened species, are of particularly high species richness, represent rare or unusual habitat, are severely reduced in area relative to their potential original extent, are under a high degree of threat, and/or are of high existent or potential economic importance (UN DESA, 2007a).

Guzmán and Guevara (2001, 1999, 1998a, 1998b), and Guzmán et al., (2005) made a complete report about the coral reefs ecosystems in the main region of coral reefs of LAPBR. Coral reefs are distributed along the coasts of the islands of Bocas del Toro Archipelago and the mainland coast of Bocas del Toro and Ngobe Bugle in the Chiriqui Lagoon. There are also coral reefs off the coast of the Peninsula Valiente, next to the East of the reserve (Fig. 38). They found that coral reefs in Almirante Bay are well developed down to a maximum depth of 23 m, and a diversity of hard corals of 33 species, which represents approximately a 53% of the total diversity known for Panama (Pacific and Caribbean). Therefore, the reserve has a representative sample of coral species that exist in Panama. With additional data from Guzmán and Guevara (1998a, 1998b), and Guzmán and Guevara (1999) there are 36 confirmed species of octocorals and 57 species of scleractinian corals and hydrocorals for the biosphere reserve record.

According to the data of ARAP (2008), the region of Bocas del Toro, including the Peninsula Valiente, has an area of 87.4 km² coverage reefs. Its diversity represents 88.5% of the total recorded in the Caribbean species of Panama. According to the Coastal Marine Atlas, the Bocas del Toro reefs are the healthiest than all Panama Caribbean and Tropical Atlantic region (ARAP, 2008).

The coral cover in the reserve is not uniform and is a normal fact. For example, corals exposed to strong tides are less alive than those located in inland waters of Bocas del Toro Archipelago. It has been estimated that coral cover in the waters located in windward in Chiriqui Lagoon and Almirante Bay is around 32%, while only 8% downwind (Valdespino and Santamaría, 1997). In Ensenada Grande of Almirante Bay was recorded up to 40% of live coral. Guzman and Guevara (1998) reported living coral percentages between 20% and 50% and an average value of 35%, depending on the depth. These values represent according to these authors the best possible coverage for the country.

Numbers of live coral in Bocas del Toro seem to be strictly related to local natural conditions area. There is, not evidence of significant direct human damage, but is growing a threat in some patches in the south of the Bastimentos island, Carenero Key Island, Zapatilla Key Island, and Bocas del Toro island. The probable causes are due urban and tourist pressure on these points.

In the south of Bocas del Toro Archipelago in the Laguna de Chiriqui, the reef growth is affected by the massive natural flow of continental freshwater and sedimentation caused by these rivers. It is assumed that increasing human activities on the mainland can increase sedimentation of rivers and can be considered an expected environmental impact on the coastal region of the Laguna de Chiriqui (Guzmán and Guevara, 1998b).

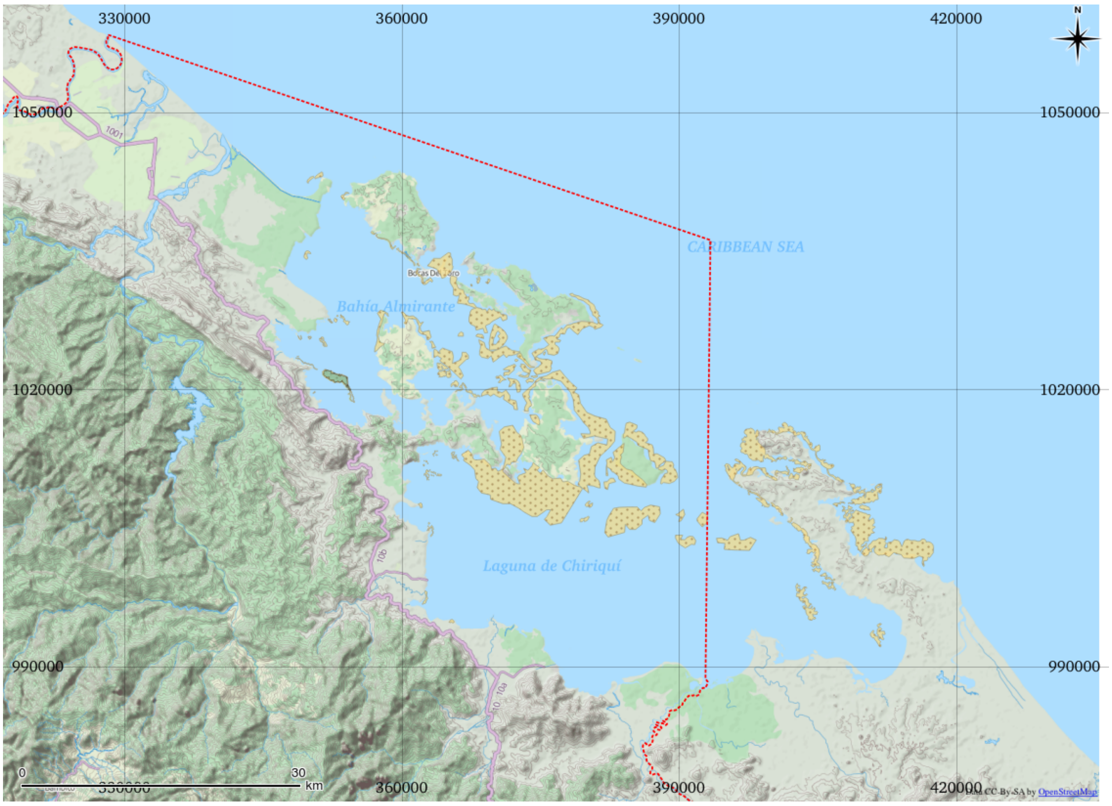

Fig. 56. LAPBR: Coral reefs are distributed in shallow waters of the archipelago of Bocas del Toro and Chiriqui Lagoon.
Source: Guzmán and Guevara (1998a,b and 1999). Background map from Openstreetmap

Given that the coverage of living corals is very high relative to other areas of the country, and knowing that there is little evidence of significant damage by human activities. I am proposing that an ideal generalized average value should be equal or greater than 40% of cover. In the case of the LAPBR, the experts have indicated an average of 35%, which is a high value. This value must be the starting point or reference of a long-term monitoring to track biotic measuring about this parameter.

The evaluation of this indicator is high.

7.2. Biodiversity indicators

7.2.1. Proportion of terrestrial area protected, total and by ecological region

It is a core environmental indicator about ecosystem. The indicator is defined as the proportion of terrestrial area that has been reserved by law or other effective means to protect part or all of the enclosed environment. It can be calculated separately for different terrestrial ecological regions. The indicator may also be disaggregated by management category of the protected areas (UN DESA, 2007a).

The indicator represents the extent to which areas important for conserving biodiversity, cultural heritage, scientific research (including baseline monitoring), recreation, natural resource maintenance, and other values, are protected from incompatible uses. It shows how much of each major ecosystem is dedicated to maintaining its diversity and integrity. Protected areas are essential for maintaining ecosystem diversity in countries and ecological regions, in conjunction with management of human impacts on the environment (UN DESA, 2007a).

LAPBR has an excellent ratio of terrestrial protected area coverage (Table 31) and excellent protection based on ecosystems and ecological regions. Thus, exist the La Amistad International Park (PILA) and the Palo Seco Forest, protecting forests in the altitudinal gradient from 100 meters to over 3200 meters. PILA also protects the cloud forests of the Continental Divide in the Western Caribbean and Pacific sector of Panama. They also protect the unique moor of the country on top of the mountains Fabrega and Echandi.

Bastimentos Island Marine National Park protects the lowland forest of Bastimentos island, besides special coral reefs and another coastal marine systems of Bocas del Toro archipelago. San San Pond Sak Wetland protects orey forests and other forests associated to floodplains; also protects the floodplain wetlands from the Caribbean of the reserve.

Table 31: LAPBR: Proportion of terrestrial area under legal protection

Protected area name	**Area (Ha) (terrestrial)**	**% of total area of LAPBR**	**% from LAPBR terrestrial area**
La Amistad International Park (PILA)	208,181.55	23.69	46.85
Volcan Baru National Park (PNVB)	14,110.28	1.61	3.18
Bastimentos National Park (20% terrestrial)	2,613.92	0.30	0.59
Palo Seco Protector Forest (BPPS)	167,763.37	19.09	37.75
Fortuna Forest Reserve (RFF)	20,653.68	2.35	4.65

Lagunas de Volcan Wetland	255.65	0.03	0.06
San San Pond Sak Wetland	30,811.19	3.51	6.93
Sum	**444,389.65**	**50.56**	**100.00**

Source: Adapted from ANAM

Fortuna Forest Reserve protects the cloud forests of the upper Chiriqui river in the Pacific basin. This area of forest is the bio-geographic confluence of Central Cordillera Talamanca-Caribbean and the confluence Caribbean-Pacific. This forests are rich in biological diversity.

Volcan Baru National Park protects the Pacific slope in cloud forests at an altitudinal gradient from 1500 m to 3474 meters. This mountain is the highest in the country.

The Lagunas de Volcán protect special aquatic ecosystem, upland lakes. Also protects isolated pockets of cloud forest on flat uplands.

In summary protected areas inside the Reserve have excellent coverage ecosystems and represent a large part of the reserve, and that 50% of the total area of the reserve is inside protected areas.

This is one of the best indicators of the Reserve, although it should be noted that forest fragmentation in protected areas is occurring, e.g., Palo Seco Protector Forest. In effect, LAPBR has a large proportion of its territory under official protected areas.

The evaluation for this indicator is excellent.

7.2.2. Management effectiveness of protected areas

It is a non-core environmental indicator about ecosystem. This indicator will measure the effectiveness with which protected areas are being managed based on information about the context, planning and design, resource inputs, management processes, delivery of goods and services, and conservation outcomes of protected areas (UN DESA, 2007a).

Management effectiveness of protected areas is an important indicator of how well protected areas are conserving biodiversity. This is critical as most nations use protected areas as a cornerstone of biodiversity conservation. However, to determine whether this is a successful strategy it is necessary to know not only about the area and systems they cover, but also whether these are effectively managed (UN DESA, 2007a).

The management of protected areas within the reserve have problems of management effectiveness. There are obvious controls, but that alone can not account for effective management. In fact, the management plans of most of these protected areas are applied partially, due to the legal, economic, political or social constraints. Yet the official reports of management effectiveness of protected areas of the Reserve reveal that there have been positive developments in management from 2001 to 2011 but still the recent levels of management effectiveness show an overall figure of efficiency close 60% (Cabrera and Santamaria, 2009; Cabrera, 2012, 2011, 2010; Cabrera et al., 2007, 2006), indicating that it has no appropriate management effectiveness (Table 32).

Table 32: LAPBR: Management effectiveness of protected areas (%) between years 2009-2011

Protected Area	Mean	Social	Adminis-trative	Natural Resources	Politic-Legal	Economic-Financial
San San Pond Sak Wetland	62.07	60.57	62.3	65.2	67.53	54.33
Bastimentos Island National Park	48.3	41	57	55.53	42.97	45.47
La Amistad NP–Caribbean	71.6	68.27	71.67	82.4	79.37	56.67
La Amistad NP–Pacific	66.57	60.77	65.5	83.03	71.03	53.83
Palo Seco Forest Reserve	46	38.9	54.93	41.73	46.47	52.17
Volcan Baru National Park	66.43	59.97	65.17	78.07	71.03	57.23
Lagunas de Volcan Wetland*	-	-	-	-	-	-
Fortuna Forest Reserve*	-	-	-	-	-	-
TOTAL (%)	**60.16**	**54.91**	**62.76**	**67.66**	**63.07**	**53.28**

Source: ANAM

** These protected areas are not in the program for management effectiveness*

Management plans have become technical documents, but are not operational due to lack of political support, specialized or professional staff, operating budget and a robust institution supporting the implementation of these management plans.

Lack of management and staff has resulted in protected areas without sense to the communities surrounding protected areas. They are living outside the reality of what is a protected area. If communities are not widely empowered about management of protected areas, the problems of centralized management will be bigger and unsuccessful.

In many protected areas there are conflicts between the centralist government, decision maker and stakeholders that are not considered in these decisions. Many unilateral and unwise concessions for tourism, agricultural, industrial projects, such as hydroelectric, have produced confrontations that affect governance and undermine the credibility and confidence in the institutions managing protected areas and natural resources.

The UNESCO reactive mission in 2008 and following years, has recommended that the La Amistad International Park as WHS, should have good mechanisms and governance arrangements between state agencies and civil society, particularly indigenous communities who are displaced from their communities.

La evaluation of this indicator is regular.

7.2.3. Area of selected key ecosystems

It is a non-core environmental indicator about ecosystem. This indicator measures the extant area of identified key ecosystems. Ecosystem refers to the plants, animals, micro-organisms, and physical environment of any given place, and the complex relationships linking them into a functional system. Key ecosystems can be defined as either those ecosystems for which it is most important to measure changes in extent, or those ecosystems for which it is possible for measure changes in extent (UN DESA, 2007a).

This indicator assesses the relative effectiveness of measures for conserving biodiversity at ecosystem level. It is a tool to estimate the need for specific conservation measures to maintain the biological diversity in a country or region (UN DESA, 2007a).

'Key ecosystems' can be selected according to a number of criteria (UN DESA 2013[112] and 2007a):

112 http://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/biodiversity/selected_key_ecosystems.pdf

a) Ecosystems of particularly high species richness;

b) Ecosystems that represent rare or unusual habitat types;

c) Ecosystems severely reduced in area relative to their potential original extent;

d) Ecosystems under a high degree of threat;

e) Ecosystems with high actual or potential economic importance

In general terms, the forests from LAPBR can be classified as the biome of tropical forests and subtropical moist broad-leaf, and can be considered as key ecosystems in the reserve due to its richness of species and area. A good environmental management decision has been the legal protection of many of this key ecosystems, along the reserve.

Using general description, LAPBR has at least 7 key ecosystems under high species richness, threatened and rare ecosystems:

a) The Pacific montane forests (species richness)

b) The Caribbean montane forests (species richness)

c) The Caribbean submontane forests (<700 m) (species richness)

d) The wetlands and lowland peat-lands (high degree of threat)

e) The coral reefs of Panama NW (species richness) (60 km^2)

f) The wet lowland forests (species richness and threatened)

g) The highland moors (rare habitat – only tiny plots in Costa Rica and Panama)

Using the UNESCO vegetation classification system, based in Ellenberg and Mueller-Dombois (1967) for details, LAPBR has the following terrestrial key ecosystems with species richness, mainly in the formation of closed forest and subclass of tropical evergreen forests, and formation group of ombrophilous, known as tropical rain forests (Fig. 57):

a) Tropical ombrophilous broadleaf evergreen forest, lowland
b) Tropical ombrophilous broadleaf evergreen forest, submontane (500-1000 m Caribbean, 700-1200 m Pacific)
c) Tropical ombrophilous broadleaf evergreen forest, montane (1000-1500

m Caribbean, 1200-1800 m Pacific)

d) Tropical ombrophilous broadleaf evergreen forest, altimontane (1500-2000 m Caribbean, 1800-2300 m Pacific)

e) Tropical ombrophilous broadleaf evergreen forest, cloudy (2000-3000 m Caribbean, 2300-3000 m Pacfico)

f) Tropical ombrophilous evergreen forest, alluvial, occasionally flooded

g) Tropical ombrophilous swampy evergreen forest dominated by dicotyledonous

h) Tropical ombrophilous swampy evergreen forest dominated by dicotyledonous, palms or Camnosperma species

i) Paramo vegetation (is a rare and small ecosystem in Panama, located in the summit of Cerro Fabrega complex

j) Cyperaceae swamp with abundant accumulation of organic material

k) Lava flow with scarce vegetation (unique natural grass formation in highlands of western of Panama)

Normally, it is expected that an ecosystem with lost of its natural identity by land use change, becomes a productive system under UNESCO classification, based in the scientific study of Ellenberg and Mueller-Dombois (1967). Therefore, the map shown in Fig. 57 shows that LAPBR contains the natural identity of most terrestrial ecosystems of the NW of Panama (see details in Table 33). Of these key ecosystems, stand out by extension, the sub-montane forests (IA1.b. (1)), followed by lowland forests (IA1.a. (1)) and montane forests (A.1. c. (1)).

The following table shows area of each vegetation types of LAPRB and the linking with characteristics of key ecosystems. Plachter (personal communication) consider that a key ecosystem should be by state of conservation of these ecosystems, as the ecosystem severely reduced or ecosystems under high degree of threat.

My field observations and existing general reports show that there is a loss of submontane forests and lowland forests, especially in the Palo Seco Basin Protector Forest and forests of the Yorkin river basin. The other key ecosystems are relatively stable in their original conservation area extension, but they are small in proportional terms, creating threats by this reason, specially the mountain forests.

Within the montane forests of the Biosphere Reserve are three types: a-) montanes, b-) altimontanes and c-) cloudy (Bermúdez and Sánchez, 2000). In Table 33 are classified in detail these categories. They are part of the Talamanca mountain range, extending from northern Costa Rica to the Central area of the Isthmus of Panama. The higher lands as core and steeper land are located south of Costa Rica and western Panama, just inside the La Amistad Biosphere Reserves[113] shared by Costa Rica and Panama.

According to WWF, the forests of this region are rich in flora and fauna, including many endemic species. They estimate that more than 10,000 species of vascular plants and 4,000 non-vascular plants are endemic to this small mountainous region in Central America[114].

Pacific Montane forests of the reserve appear to be more influenced by the topography, texture, and soil moisture. Montane forests of Volcan Baru National Park located in the Pacific are dominated by several species of oaks, while the most humid montane forests that are directly associated with the mountainous Cordillera appear to be more diverse in plant species and vertical structure of the vegetation.

The upland forest ecosystems are considered essential for the conservation of species and for the provision of environmental goods and various functions, including the conservation of the quantity and quality of water from the rivers that provide various services to communities and cities, downstream.

One additional fact related to species richness, in LAPBR forests ecosystems, is that they are part of Important Areas for Bird in Americas (IBAs). La Amistad, Volcán Barú, Palo Seco, Fortuna, San San San Pond Sak, and Bocas del Toro Archipelago are IBAs of Panama (Angher and Miró, 2009).

While there is no complete data for detailed, fine-scale, for detailed studies of key ecosystems, mapping evaluation for this indicator is excellent, as in the reserve there are significant areas relative to the national total of these ecosystems keys, and most are under the categories of legal protection within national parks, forest reserves and wetlands of international importance. In short, the core areas of the reserve are protecting this natural heritage, mainly the highland ecosystems. Also, buffer zones of this reserve with legal protection are diminishing environmental presion against core zone forests.

113 La Amistad Biosphere Reserve (Costa Rica) and La Amistad Panama Biosphere Reserve (Panama) are the official name of these biosphere reserves.

114 WWF. 2013. Tropical and subtropical moist broadleaf forests - Central America: Southern Nicaragua into Costa Rica and Panama. Online: http://worldwildlife.org/ecoregions/nt0129. 02/09/13

Structural characteristic of the forests of LAPBR and diversity

In this study, by a rapid appraisal technique on the structural data of natural forests, especially forests upland and two lowland plots, I demonstrate the structural richness of the forest, which is an alternative way to infer the biotic degree of complexity that can exist between different types of forests, classified theoretically (but not verified in the field), or even within the same forest type.

With the degree of complexity of the forest biotic elements, I'm assuming, for pragmatic decision taking, the degree of biotic richness of a forest or the difference of a forest type with respect to another one. In this case I considering the natural forests as priority.

Density of trees by type of forest

Our results show that the density of trees with DBH > 10 cm is very heterogeneous (Fig. 58), which supports the alternative hypothesis that there is no structural uniformity between and within the various forest types present in the LAPBR (X^2= 85.75, df = 19, p= 0.00) and supports my opinion that this difference between them, are independent between plots in the sites under study. I can infer differential biotic diversity, including diversity of species and rarity of species.

Our frequency data reveal that the highest density of trees/a in upland forests was observed in a montane forest of 1839 m of height and it was 1,700 trees/ha, but also this montane forest plot showed a plot with the lowest density, which verifies that variation is very heterogeneous as said earlier. This differences are multifactorial and it would be speculative to state only a few factors causing these differences. The aim in my study about forest structure is only a little vision for to confirm the biotic richness of natural forest in LAPBR.

This method is based on that it is difficult and expensive to develop systematic inventories of species quickly and efficiently, especially in tropical areas where high biological richness is inferred. The research about species of different kingdoms is complex and difficult to obtain precise data in the short term.

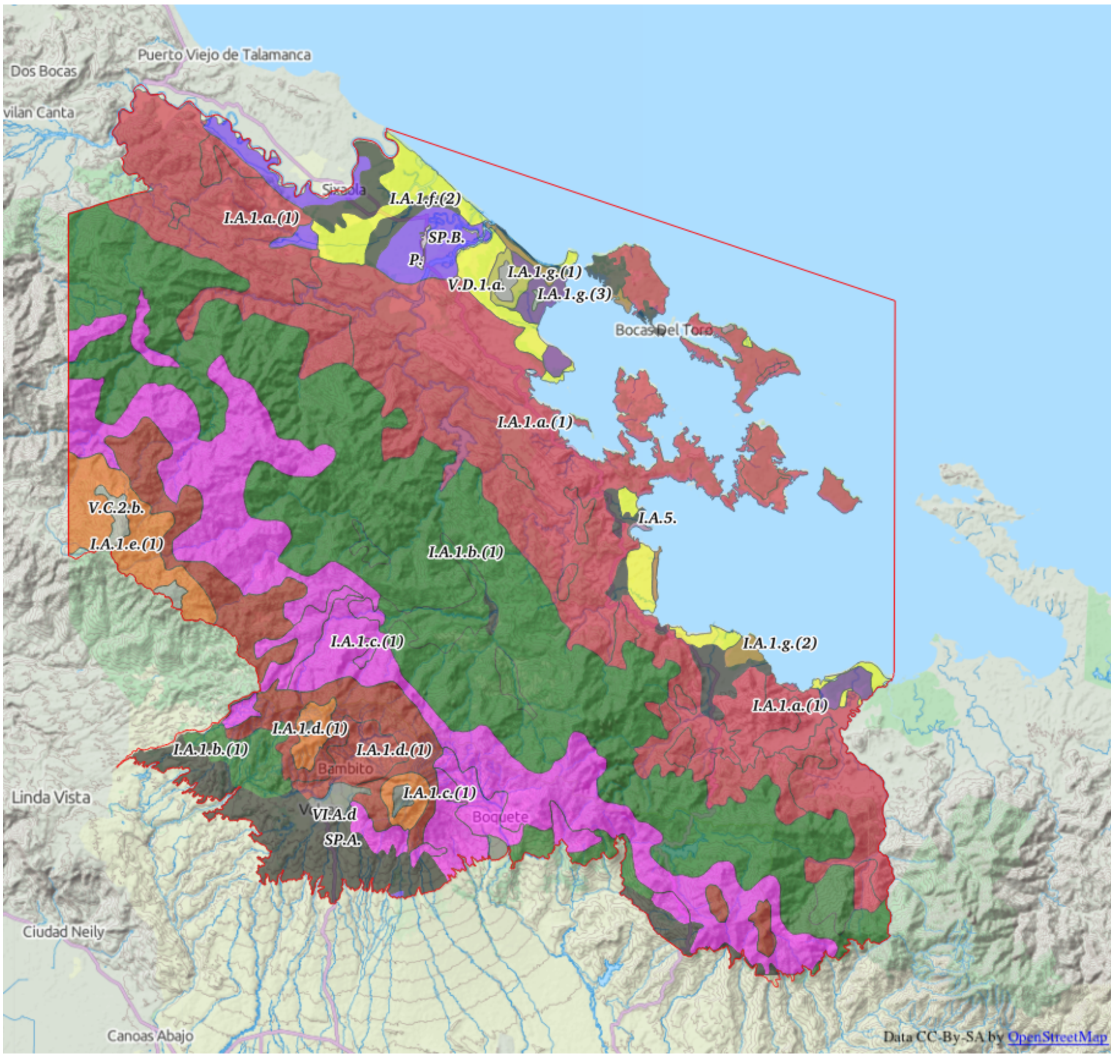

Fig. 57: LAPBR: UNESCO vegetation classification system and key ecosystems Source: ANAM. Note: See Table 33 for extended legend.

Table 33: LAPBR: Terrestrial ecosystems, and key ecosystems

UNESCO Code	**UNESCO vegetation classification**	**Key ecosystem characteristic**	**Area (Ha)**	**Ha by group**
I.A.1.a.(1)	Tropical ombrophilous broadleaf evergreen forest, lowland	High diversity	68,069	212,494
I.A.1.a.(1)	Tropical ombrophilous broadleaf evergreen forest, lowland - highly perturbed		126,078	
I.A.1.a.(1)	Tropical ombrophilous broadleaf evergreen forest, lowland - slightly perturbed		18,347	

UNESCO Code	UNESCO vegetation classification	Key ecosystem characteristic	Area (Ha)	Ha by group
I.A.1.b.(1)	Tropical ombrophilous broadleaf evergreen forest, submontane (500-1000 m Caribbean, 700-1200 m Pacific)	High diversity	196,616	229,275
I.A.1.b.(1)	Tropical ombrophilous broadleaf evergreen forest, submontane (500-1000 m Caribbean, 700-1200 m Pacific) - highly perturbed		32,659	
I.A.1.c.(1)	Tropical ombrophilous broadleaf evergreen forest, montane (1000-1500 m Caribbean, 1200-1800 m Pacific)	High diversity	98,884	117,413
I.A.1.c.(1)	Tropical ombrophilous broadleaf evergreen forest, montane (1000-1500 m Caribbean, 1200-1800 m Pacific) - perturbed		18,529	
I.A.1.d.(1)	Tropical ombrophilous broadleaf evergreen forest, altimontane (1500-2000 m Caribbean, 1800-2300 m Pacific)	High diversity	38,691	45,285
I.A.1.d.(1)	Tropical ombrophilous broadleaf evergreen forest, altimontane (1500-2000 m Caribbean, 1800-2300 m Pacific) - moderately perturbed		6,594	
I.A.1.e.(1)	Tropical ombrophilous broadleaf evergreen forest, cloudy (2000-3000 m Caribbean, 2300-3000 m Pacfico)	High diversity	21,340	-
I.A.1.f.(2)	Tropical ombrophilous evergreen forest, alluvial, occasionally flooded	Threatened	22,564	-
I.A.1.g.(1)	Tropical ombrophilous swampy evergreen forest dominated by dicotyledonous	Rare	1,844	12,898
I.A.1.g.(2)	Tropical ombrophilous swampy evergreen forest dominated by palms		3,070	
I.A.1.g.(3)	Tropical ombrophilous swampy evergreen forest dominated by Campnosperma		7,984	
I.A.5.	Mangrove forest		396	396
V.C.2.b.	Paramo vegetation	Rare	2,485	-
V.D.1.a.	Cyperaceae swamp with abundant accumulation of organic material		1,061	-

UNESCO Code	UNESCO vegetation classification	Key ecosystem characteristic	Area (Ha)	Ha by group
VI.A.d	Lava flow with scarce vegetation	Rare and threatened	5,988	-
Total of natural terrestrial ecosystems (Ha)			**671,199**	-

Source: Adapted from UNESCO Vegetation World Map provided by ANAM in digital format.

Considering only the forests above 1000 m of altitude, LAPBR forests have an average of 851 trees/ha; meanwhile the forests with altitudes, greater than 2250 m, have an average of 767 trees/ha. Orozco-Vilchez (1991) reported in 'highlands' forests (2050-2850 m) of Costa Rica, densities between 409 and 613 trees/ha. This same author cites 13 studies in upland forests of Costa Rica, Venezuela and Colombia (2250-2850 m) with an average of 621 trees/ha. The average of 9 sites Costa Rica was 582 trees/ha. The data only from three sites in Venezuela recorded an average of 780 trees/ha. This indicates that forests in the highlands of the LAPBR has a rich vertical structure of trees, which I can also infer a high biotic richness (but with a precautionary judgment) with similar data, but higher than the highland forests of Costa Rica and Venezuela.

These comparative data indicate that forests in LAPBR corresponding to the altimontane forests and cloud forests, are structurally very dense. I do not have complete data for lowland forests, but two plots on the island of Bastimentos had an average of 384 trees/ha.

Figure 58 shows the density of trees in square meters, and no particular pattern, except data from lowland forest is observed. These values should be viewed with caution and require more replicas for a better conclusion to this variable. In any case the data, viewed as random plots, inside LAPBR, can be interpreted different between them, under the effect of density of trees.

Diameter at breast height (DBH) or diameter at 1.30 m of height

The 20 plots studied in different forest types show no particular pattern in relation to the types of forests of LAPBR (Pearson X^2= 862.63; df= 864; p=0.51), although there is an apparent similarity between submontane forests and montane (Fig. 59). The results of the 20 plots as random sampling, do not show noticeable differences between them, however the DBH does show a strong significant difference, analyzed from the perspective of the altitude of the sampled sites (Pearson X^2 = 8057.10, df= 7776, p= 0.01).

Another analysis I did was to observe the relationship between DBH and density of epiphytes, the results show that there is a significant difference in the recorded data (Pearson X^2=3786.06, df= 3024, p=0.00). Usually trees, in dense forests, with greater DBH have greater ecological opportunity to be colonized by epiphytes.

Average height of trees by type of forest

The results of this variable show some relation to the type of forest, but just looks clearer in the lowland forest (Fig. 60). The upland forests show a more or less homogeneous variation, but the small observed differences are significant (Pearson X^2=793.31, df=588, p=0.00). As in the previous cases, these differences reflect the structural difference is a variable that influences the degree of biotic diversity that can be expected in these forests.

Tree basal area by type of forest

Figure 61 shows a graph showing the great variability in tree basal area, ranging from values of 3 m^2/ha to 111 m^2/ha. This difference in values between different sampling sites is significant (Pearson X^2=368.51, df=19, p=0.00).

These results also show a large variability in the tree structure, which results in a variety of habitats and microhabitats for species of all kingdoms.

Density of shrubs by type of forest

Figure 62 shows a graph with a large variability in the density of lianas among the different sampling sites analyzed. No clear patterns associated with forest type is observed, although it seems that the altimontane and cloud forests are more diverse (Pearson X^2=658.74, df=19, p=0.00). It is important to emphasize the analysis of this variable is that still favors high biotic variability, even within the same forest types.

Density of lianas by type of forest

Lianas are an important component of forest biomass. It is estimated that increasing the concentration of CO_2 in the atmosphere, the lianas continue to increase their dominance in forests (van der Heijden et al., 2013). However, the presence of lianas increase biotic diversity of a forest, because its intrinsic biotic role, not only defining the architecture of the forest, but also creating habitat and ecological niches, etc. From every point of view, lianas define the degrees of biotic diversity within a forest.

LAPBR forests have different densities of lianas, which do significant difference between the one to another forest type, and even within the same forest type. These variations can be seen in Figure 63. In this graph an unclear pattern density related to forest types is observed, but it is clear, is that there are definitely differences, at least, in relation to forest type (Pearson X^2=193.36, df=19, p=0.00).

Density of small trees by type of forest

Small trees may be indicative of many biotic qualities of a forest. They are the basis of the renewal or replacement of bigger trees killed or falling. Furthermore, these small trees are a source of energy for an extensive understory level biotic chain, its presence produces richness and therefore structural biotic richness in the forest. The data reveal that small trees are distributed in different patterns among forest types (Fig. 64)(Pearson X^2=162.29, df=14, p=0.00).

Epiphytes and associations

Epiphytes are key elements in the ecological diversity of forests. Its various structures provide habitat for countless species of all kingdoms. Hence, their presence or abundance in forests can be considered as an important biotic element itself by its diversity and the ability to generate complex biotic and biotic richness. Comparing the density of epiphytes with other ecological variables of forest structure were also highly significant.

The relationship observed between the DBH of trees and density of epiphytes, showed that there is a significant difference related to this variable (Pearson X^2= 3786.06, df=3024, p=0.00). Usually trees with greater DBH have greater ecological opportunity to be colonized by epiphytes. Thus, it can be inferred that the larger is the DBH of a community of trees in a forest, there is most likely high biotic richness associated with this biological element in the ecosystem. The species diversity of epiphytes, is therefore another key factor in biological biodiversity of tropical forests.

The relationship of the density of epiphytes compared with the altitude of the sample plots also showed significant difference (Pearson X^2= 619.46, df= 468, P=0.00). Also appears to be a significant relationship between tree height and density of epiphytes

(Pearson X^2=2606.55, df=1911, p=0.00). A deeper and specific research in relation to this variable can clarify these preliminary observations.

The results of the relationship between epiphytes and forest type in LAPBR also showed significant differences in the density, by effect of this variable (Fig. 65) (Pearson X^2= 173.94, df=68, p=0.00).

Therefore, the presence of epiphytes in the forest is an important biological element and quite accurate to infer biotic diversity in a forest. I may infer that the intrinsic diversity of epiphytes is also different, which magnifies scenarios of biotic differentiation between forests, including gradients, altitude, slope, moisture, temperature, etc. of the forests.

Vegetation cover of the forests

The light into all strata of the forest, at different times of day, is a physical factor that can define biotic differentiation between a forest and another, regardless of forest type. It is expected that the dynamics of direct or indirect sunlight, change the energy dynamics and other physical parameters within the forest, which in turn defines or influences the organisms and habitats that comprise it. Thus, I can infer that at greater play of light and shadow, forest biotic patterns are constantly changing and dynamic, creating biotic diversity.

The data in LAPBR showed that there is significant difference in the measurement of this physical variable among different forest types (Pearson X^2=1599.31, df=68, p=0.00). Additional details for each plot in Fig 49.

These data analyzed above allow to infer a large biotic diversity of forests in LAPBR, as expected according to the theoretical mapping of vegetation types and forest types, presented in Figure 57.

In summary, these data about structure of forest are good model for to validate biotic richness of key ecosystems, furthermore are useful for biological inventories with a standard and rapid method.

The evaluation of extent of selected key ecosystem indicator is high.

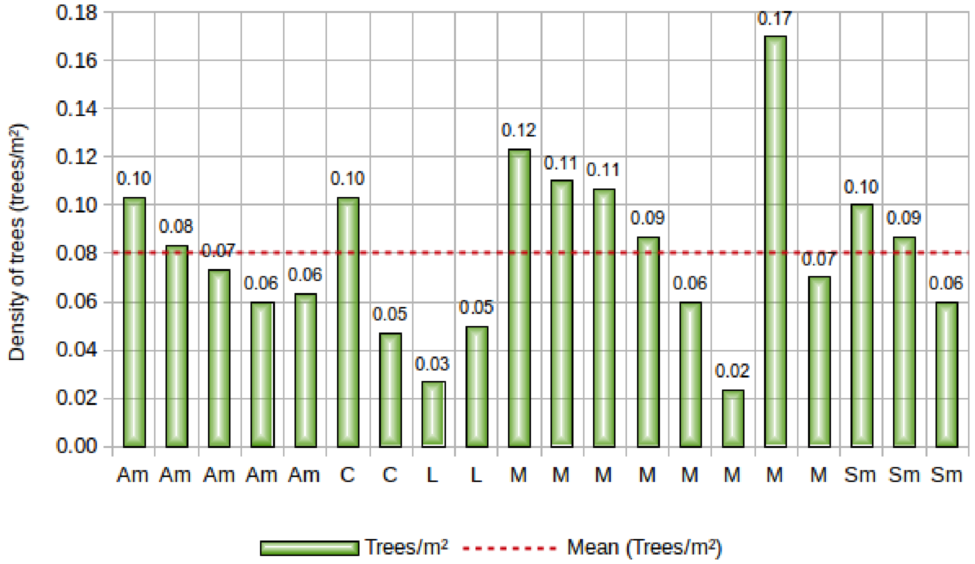

Fig. 58: LAPBR: density of trees by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

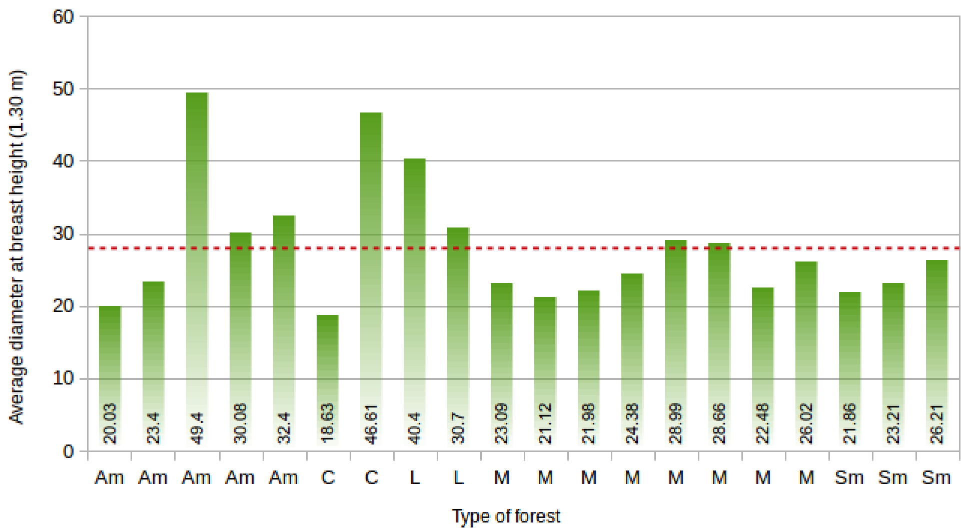

Fig. 59: LAPBR: Average DBH by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the average dashed line.

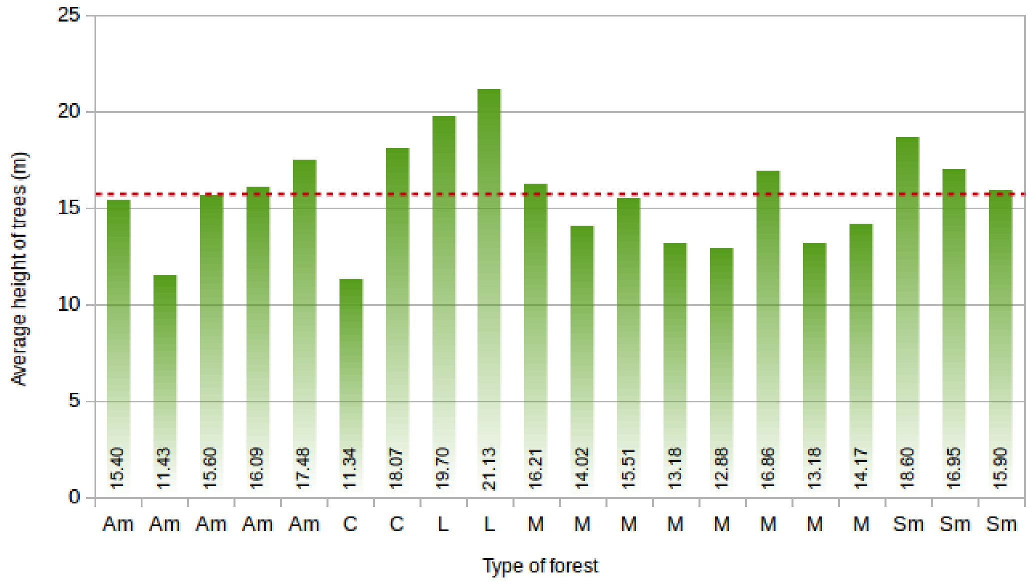

Fig. 60: LAPBR: Average height of trees by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

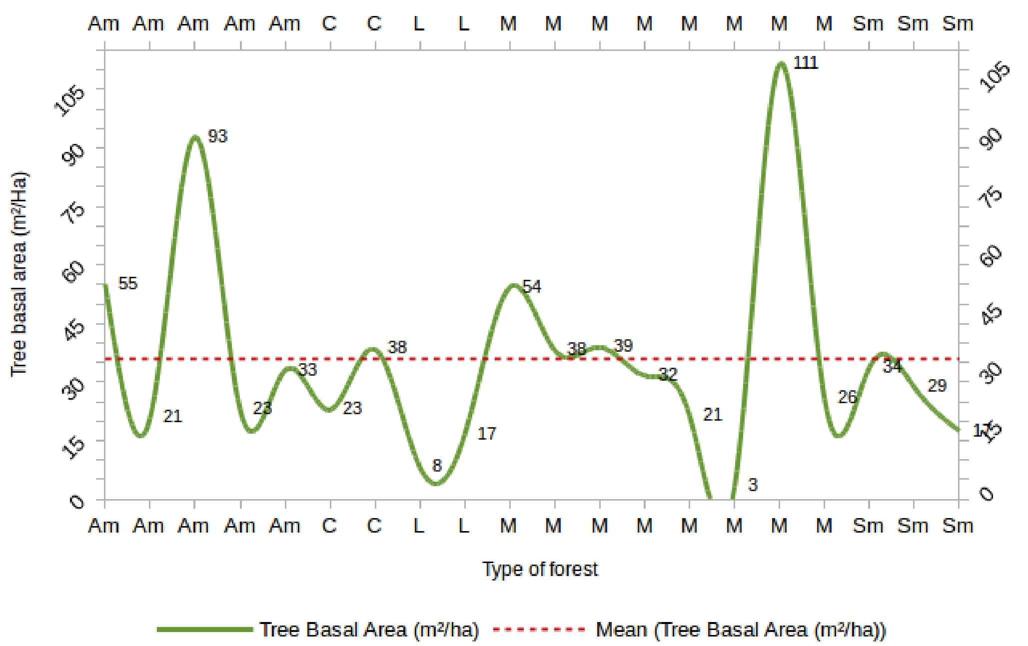

Fig. 61: LAPBR: Tree basal area by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

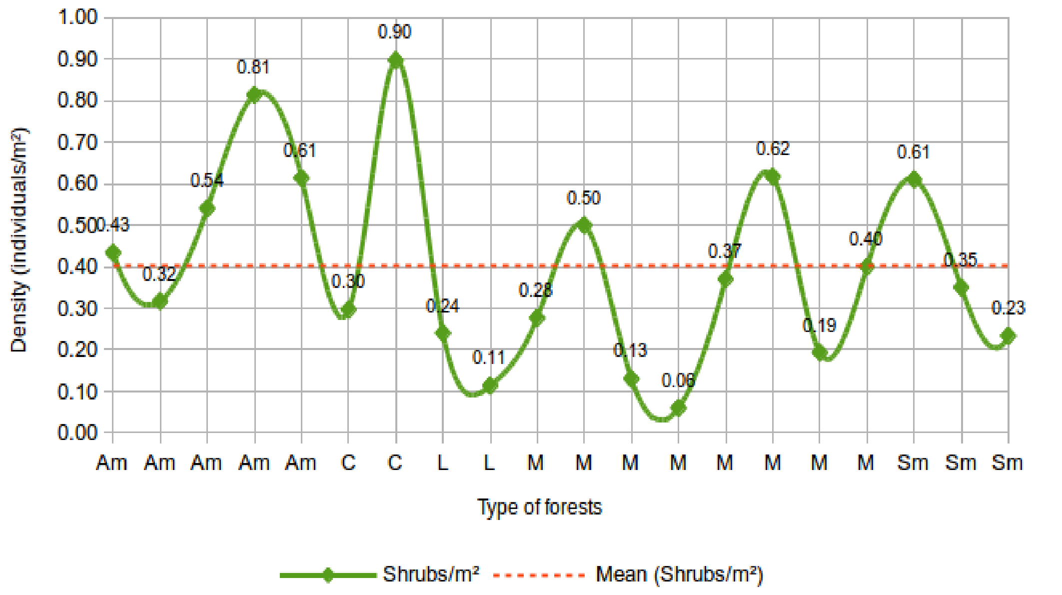

Fig. 62: LAPBR: Density of shrubs by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

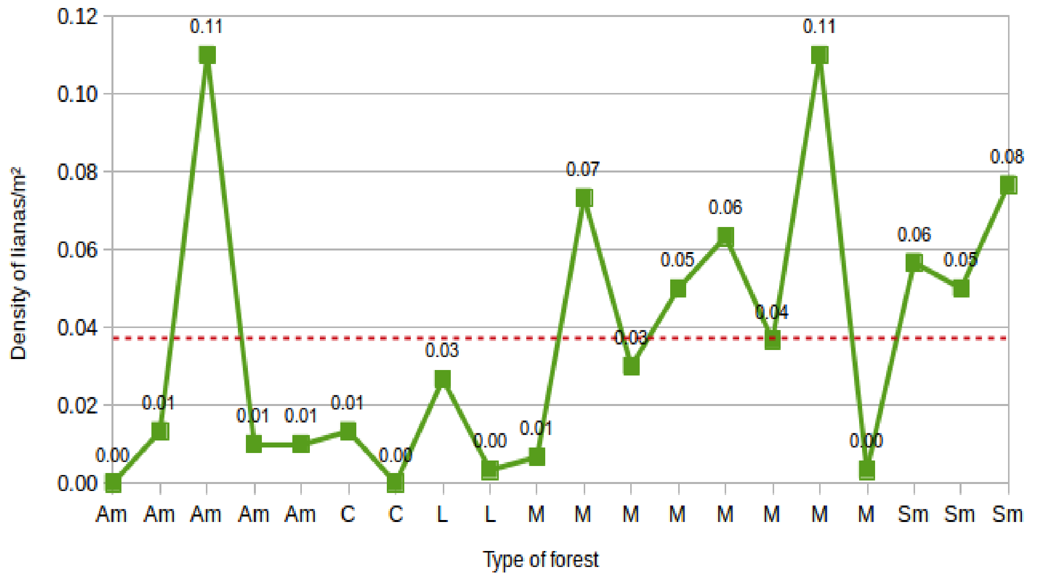

Fig. 63: LAPBR: Density of lianas by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

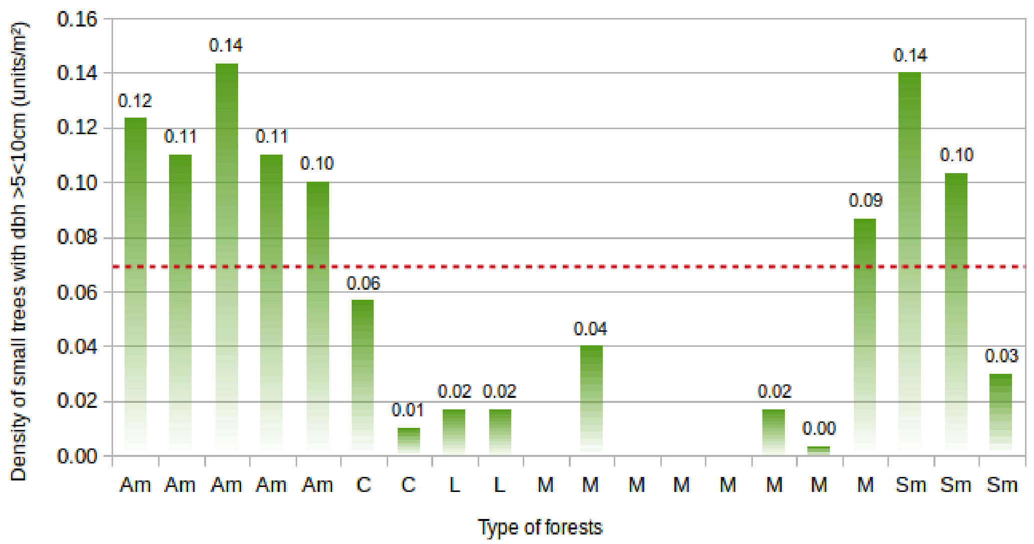

Fig. 64: LAPBR: Density of small trees (DBH >5<10 cm) by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

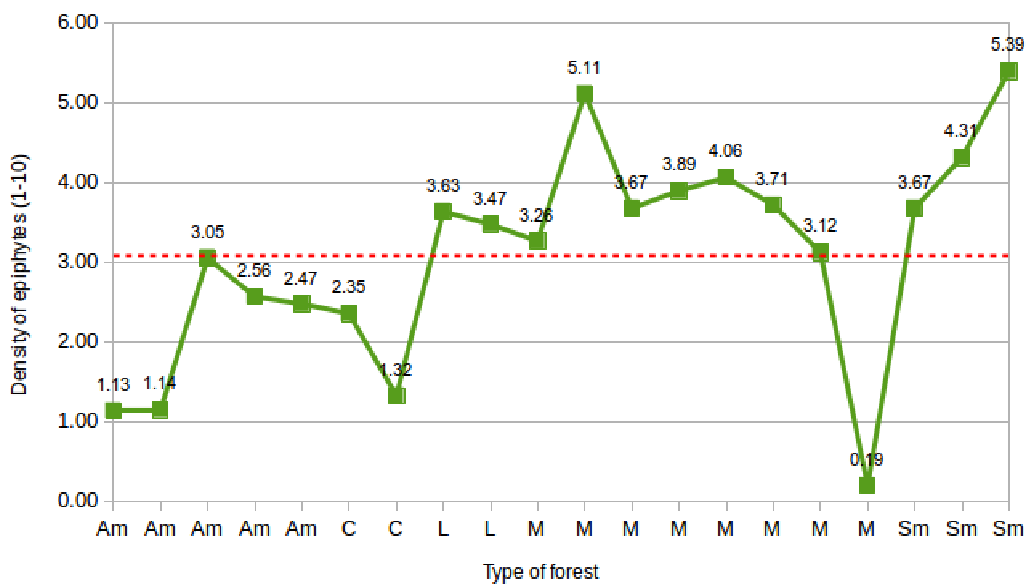

Fig. 65: LAPBR: Density of epiphytes by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest. Note the mean in dashed line.

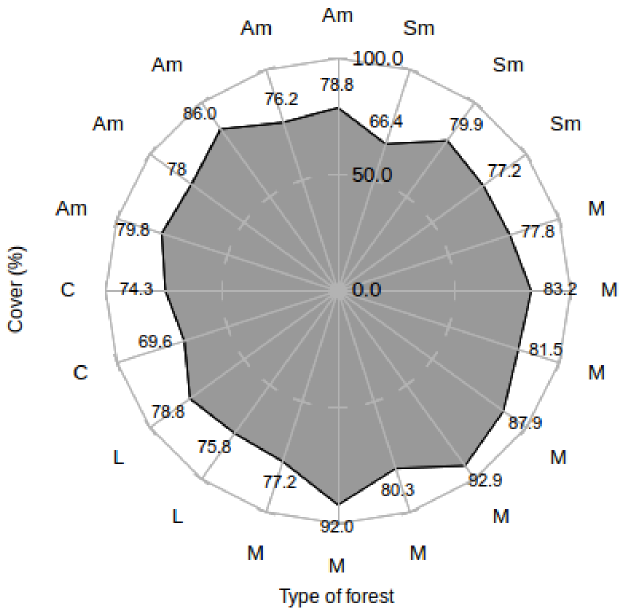

Fig. 66: LAPBR: Vegetative cover by type of forest
Note: Am= Alti-montane forest; C= Cloudy forest; L= Lowland forest; M= Montane forest; Sm= Sub-montane forest

7.3.4. Fragmentation of habitat

It is a non-core environmental indicator about ecosystem. This indicator measures the fragmentation of identified key habitats. For forests and other terrestrial habitat types the patch size distribution of habitats may be derived from vegetation information systems. For river fragmentation, defined as the interruption of a river's natural flow by dams, inter-basin transfers or water withdrawal, fragmentation can be assessed based on number, placement, and amount of water stored behind dams (UN DESA, 2007a).

The fragmentation of habitats caused by human activities has significant, largely negative implications for their native biodiversity, through the effects of area reduction, edge exposure and isolation, as well as through interruption of ecosystem processes and associated ecosystem degradation. The indicator has the potential to illustrate the effectiveness of national measures designed to conserve biological diversity (UN DESA, 2007a).

The largest and most important protected areas of the LAPBR have good connectivity with each other. There is an obvious connection through forests between La Amistad National Park (PILA) and and the Baru Volcano National Park (PNVB), and between PILA and Palo Seco Protector Forest, and between it and the Fortuna Forest Reserve. The PILA also works great as a green belt of highlands. The PNVB also makes corridor between the foothills from Boquete to Cerro Punta and Volcan.

The most important rivers in the area provide additional altitudinal corridors between forested areas of the mountains and the lowlands. Many rivers are partially deforested as a result of livestock or agriculture. In these deforested sites, has clearly lost much of biological connectivity.

One obvious area of forest fragments that are disconnected from other forest areas, it is the San San Pond Sak Wetland and Wetland Lagoons Volcano. These terrestrial ecosystems are surrounded by a matrix of farmland and towns, which is quite limiting its biological connectivity, especially for medium and large terrestrial animals. The biotic aquatic ecosystem's connection still exists, but in the process of decline in quality. Outside of existing protected areas, there are more obvious fragmentation, but particularly affecting sensitive species of flora and fauna, such as large animals and forest trees, or ornamental interest, such as orchids.

The very wet lowland forest is the most threatened ecosystem fragmentation processes, especially biotic East-West dynamics. This ecosystem has the largest number of the population of the reserve in the Caribbean sector. Most agricultural activities occur in this ecosystem, therefore, forest fragmentation is evident. It is sure that the populations of species of large animals or game species are decreased significantly. The road from Punta Peña - Almirante, built in 1998 has been a factor of development that has accelerated the process of settlement and intensive land use in areas with these lowland forests, located in the Comarca Ngobe Bugle (W) and the entire coastal region of the province of Bocas del Toro. Livestock farming has increased and has also increased the valuation of the land for agricultural projects of small and medium scale.

Aparicio, et al., (2006) recognized the feasibility of various biological corridors like Sixaola - San San, Chiriqui Grande - Bocas del Toro, Damani-Guariviara (Chiriqui river). These corridors have excellent ecological and social conditions for to be implemented within a regional conservation strategy, just supporting the biosphere reserve concept.

One factor that produces another form of further fragmentation in forested and aquatic ecosystems of the Reserve constituent newly constructed dams on the Changuinola River Basin (Caribbean) and other rivers of the Pacific slope. In the Caribbean these dams have destroyed mature forests and biotic river dynamics.

The Chan 75 located in the middle basin of the Changuinola River has flooded more than 5000 hectares of mature forests of the Caribbean lowlands of the Reserve and has become an impassable barrier to diadromous fish species and other species that perform altitudinal movements along the course of rivers. It is expected that the environmental impact on aquatic biotic community in the Changuinola mainstem river is permanent for many decades. 80% of the basin has been affected by this dam. The biological dynamics of these rivers is another, very different from the original.

Furthermore, other dams in the Pacific side, have already destroyed biotic dynamics in rivers originated in cloud forests of La Amistad, Volcan Baru, and Fortuna Forest Reserve area. All these dams were built without strategic environmental assessment for energy policy in Panama. The State has simply chosen the hydropower as a good product the market of energy. Environmental considerations are parallels, secondaries, and politics, in the line of decision making. No significant compensation to the protected areas of La Amistad Biosphere Reserve have been planned. In fact, the biosphere reserve is completely ignored in politics decision.

This indicator is evaluated as acceptable, but with caution. In other words, it is expected that the negative situation that increases the current fragmentation of ecosystems can be bigger over time.

7.3.5. Change in threat status of species

It is a core environmental indicator about species. This indicator is an index based on the number of species in each category of the IUCN Red List (Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, Extinct), and the number of species changing categories between assessments as a result of genuine improvement or deterioration in status. The indicator is an adaptation of the IUCN Red List Index, the best known and most accepted methodology for assessing trends in the status of threatened species at a global level

(UN DESA, 2007a).

The indicator allows monitoring the extinction risk of species over time. Extinct and endangered species constitute a major loss of biodiversity, which plays a critical role in overall sustainable development. The indicator also illustrates the effectiveness of local, national, regional and global measures to protect endangered species (UN DESA, 2007a).

IUCN has comparable records from 1996[115], however, is not uniform for each country and depend mostly on data that does not exist to make reliable assessments.

The list of threatened species Panama (Table 34) reveals disparities between one and another assessment. That is because it relies on accurate data vs. inaccurate data. So for each evaluation species are incorporated or are removed from the national list. Often the specialist approach differs.

Table 34: Panama: Amount of total species in red list of IUCN (1996-2013)

Year/Red list status	CR	EN	VU	NT	LR	Total
1996		3	4		3	**10**
1998	18	68	101		62	**249**
2000	2					**2**
2003		1	1	1		**3**
2004	13	16	4	9		**42**
2006	1	1	3	8		**13**
2007		2	1			**3**
2008	7	8	20	14		**49**
2009	1		7	7		**15**
2010	6	11	19	17		**53**
2011	2	1	4	4		**11**
2012		3	19	36		**58**
2013	2	4	4	3		**13**
Sum	**52**	**118**	**187**	**99**	**65**	**2708**

Source: adapted from IUCN database. Legend: CR: Critically endangered; EN: Endangered; LR: Lower Risk; NT: Near to Threatened; VU: Vulnerable.

This indicator does not apply at the level of a biosphere reserve, because this indicator requires the general list of the country and a threat assessment at country

115 IUCN 2013. *The IUCN Red List of Threatened Species. Version 2013.1*. Online: http://www.iucnredlist.org. 10/10/13

level. This list can be functional in a biosphere reserve only with data and evaluation in the small scale. No list of endangered species at reserve or province and it would be an indicator of other kind. It is a matter of scale and is based on data that are IUCN national assessments. This data requires national data and can not be broken down to a specific area.

Only is possible to give list of species in a biosphere reserve linking to the IUCN red list, but it would not be as this current indicator. I my opinion, this linking to the national status do not support the reality inside a biosphere reserve for the conservation status of species.

Anyway I am adding some examples of species or groups of species with high national threat, such as Tajassu pecari or White-lipped Peccary as Vulnerable in the IUCN list 2013. This species require large forested areas for maintain healthy population. This ecological condition exists in LAPBR.

MWH (2008) in a species inventory report in the middle Changuinola river basin, revealed 236 species in the IUCN Red List. 86 species as Endangered and 153 as Vulnerable: 7 tree species (EN) and Tapir species (Tapirus bairdii), four tree species (Vu), 142 epiphytes species (Vu) and one Didelphimorphia species (Vu).

The evaluation under the strict sense of the indicator definition is irrelevant, but is possible to propose for the future a indicator at a biosphere reserve scale, but require analysis of species population in situ and by periods.

7.3.6. Abundance of key species

It is a non-core indicator about species. This indicator uses estimates of population trends in selected species to represent changes in biodiversity, and the relative effectiveness of measures to maintain it. The indicator can be applied to individual species groups (e.g. birds, butterflies), or can be aggregated to incorporate a number of taxa, according to data availability and indicator applicability (UN DESA, 2007a).

The indicator allows monitoring the abundance of species over time. The indicator illustrates the effectiveness of national measures designed to limit the loss in biodiversity (UN DESA, 2007a).

UN DESA (2007b) advise that a ‘key species’ - should be defined under responsibility of nations, but assuring regional and global interests in addition to national priorities. The following categories of species might be considered as ‘key species’ when developing a biodiversity monitoring programme: keystone species, rare or locally endemic species, and threatened species.

This indicator have relevance to sustainable development, because the species as biodiversity has its own intrinsic value and that biodiversity maintenance is essential for human life and sustainable development. Many biological resources, at gene, species, and ecosystem level; are currently at risk of modification, damage or loss. The unit of measurement is the number of mature individuals or other relevant indicator of abundance within a given area or population. (UN DESA, 2007b).

According UN DESA (200b) the purpose of this indicator has the potential to illustrate the effectiveness of national measures designed to conserve biological diversity and ensure its use is sustainable, including the measures implemented in fulfillment of obligations accepted under the Convention on Biological Diversity (CBD).

This indicator can be used to assess sustainability at the level of a reserve of the biosphere, but requires, key species definition and data through time of the population dynamics of these key species.

Up to now in the biosphere reserve no data exists over time on the abundance of selected species and there is not a scientific program that will lead to elucidate this indicator. In the LAPBR there are many species that could be incorporated into a program of monitoring of populations, starting with the species key and determine its population trend in a more scientific way. Table 35 below describes the estimated trend of populations for key species that are registered in the country and which are also recorded in the reserve and is possible that they are still the same national tendency of population decline (Table 35).

The evaluation for this indicator is low due to lack of data and because population estimates suggest widespread population decline, including the identified key species defined by the state. The information of this indicator is key in long term species conservation.

7.3.7. Abundance of invasive alien species

It is non-core environmental indicator about species. The indicator measures the number of invasive alien species in a given country or region. An invasive alien species is a species introduced outside its normal distribution whose establishment and spread modifies ecosystems, habitats or species (UN DESA, 2007a).

The indicator measures an important threat to biodiversity. Invasive alien species (IAS) may threaten native species as direct predators or competitors, as vectors of disease, by modifying the habitat, or altering native species dynamics. Invasive species have been a major cause of extinctions, especially on islands and in freshwater habitats. Species introductions caused by humans may be intentional, but more commonly are unintentional (UN DESA, 2007a).

Table 35: LAPBR: Decreasing trends of some keystone's species and their ecological role

Species*	**Ecological role as key species**
Ateles geoffroyi	Keystone mutualist
Panthera onca	Keystone predator
Puma concolor	Keystone predator
Odoicoleus virginianus	Keystone mutualist
Mazama americana	Keystone mutualist
Trichechus manatus	Keystone mutualist and threatened
Harpia harpyja	Keystone predator and rare
Ortalis cinereiceps	Keystone mutualist
Tajassu pecari	Keystone mutualist & engineer
Pecari tajacu	Keystone mutualist & engineer
Morphnus guianensis	Keystone predator and rare
Penelope purpurascens	Keystone mutualist
Tapirus bairdii	Keystone engineer
Cebus capucinus	Keystone engineer

*Source: Original. * Only basic examples of species can be considered as key species.↓= decreasing.*

From LAPRB do not have data or studies that corroborate the presence and abundance of invasive species affecting a particular ecosystem. However, recently there has been an invasive species in marine waters of the Caribbean. This is the tiger fish (*Pterois volitans*) has recently arrived at the reefs of Bocas del Toro

Archipelago. There are no data on abundance and biology of this species in Panama.

The evaluation for this indicator is high, because although there are no data, most of the ecosystems of the reserve are apparently free of invasive species.

7.4. Analysis of nature conservation indicators

Table 36 shows a complete matrix of scores, weights and values observed and expected for every nature conservation indicator for sustainability. With this table I get a mathematical analysis about environmental sustainability in LAPBR, under my analysis as scientist with experience in the area.

With the observed percent values of development progress with respect the expected I am able for to say, with specific results, that the level of advances in this set of environmental indicator related to nature conservation in LAPBR is going in a good way of sustainable development. In this case, there is a 75% in development advances against 25% as shortfall. The specific details are show in the following table:

Table 36. LAPBR: Final mathematical results about environmental indicators related to nature conservation for sustainability

Nr.	Environmental Indicators of Sustainable Development	Evaluation (x/10)	Weight (1-3)	Observed Development	Expected Development
1	Land use change	9	3	27	30
2	Land degradation	10	3	30	30
3	Land affected by desertification	*	1	*	*
4	Arable and permanent cropland area	7	3	21	30
5	Fertilizer use efficiency	6	1	6	10
6	Use of agricultural pesticides	3	2	6	20
7	Area under organic farming	2	2	4	20
8	Proportion of land area covered by forests	10	3	30	30
9	Percent of forest trees damaged by defoliation	10	1	10	10
10	Area of forest under sustainable forest management	8	3	24	30
11	Percentage of total population living in coastal areas	6	2	12	20
12	Bathing waters quality	10	2	20	20

Nr.	Environmental Indicators of Sustainable Development	Evaluation (x/10)	Weight (1-3)	Observed Development	Expected Development
13	Proportion of fish stocks within safe biological limits	*	2	*	*
14	Proportion of marine area protected	5	2	10	20
15	Marine trophic index	*	2	*	*
16	Area of coral reef ecosystems and percentage live cover	9	1	9	10
17	Proportion of terrestrial area protected, total and by ecological region	10	3	30	30
18	Management effectiveness of protected areas	6	2	12	20
19	Area of selected key ecosystems	10	3	30	30
20	Fragmentation of habitats	7	2	14	20
21	Abundance of selected key species	4	3	12	30
22	Change in threat status of species	*	1	*	*
23	Abundance of invasive alien species	8	1	8	10
			Sum	**315**	**420**
		75.00%	Advances of nature conservation Indicators (%)		
		25.00%	Deficit of nature conservation indicators (%)		

*Source: Indicators adapted from UN DESA (2007a); *= Irrelevant for LAPBR not evaluated*

With this final result, there is by first time a mathematical or quantitative status of sustainable development analysis of 23 nature conservation indicators.

Six indicators are high level of sustainability. Then, LAPBR, have good level of protection against land degradation, good level of proportion of land with natural forest, forest without problems by defoliation, and good bathing water quality. In the other side, the indicators with low evaluation are the following: the abundance of key species, high level of use of pesticides, and low levels of development of organic farming.

With this table, decision makers can improve, with large panels of experts or consultants, an even more accurate assessment, especially by incorporating the missing data.

Each indicator with the definitions adopted by UN DESA (2007a) have been self-explanatory on the relevance of sustainability. The data analyzed or incorporated have supported this preliminary assessment, it becomes best reference for mathematical analysis of sustainability and especially to follow the process of sustainable development in the LAPBR, and can be applied equally to reserves or other minor political regions and federal states, provinces or counties, among others.

CHAPTER 8

Analysis of economic sustainability in La Amistad Panama Biosphere Reserve

8. Economic indicators for sustainable development

The following analysis of economic indicators for La Amistad Biosphere Reserve indicators are following the definitions of Indicators of Sustainable Development: Guidelines and Methodologies developed by the Department of Economic and Social Affairs of the United Nations Secretariat (UN DESA, 2007, Third Edition) by mandate of the United Nations Commission on Sustainable Development in 1995 and 2002.

The indicators suggested by the Commission on Sustainable Development (CSD) of the United Nations include all sustainability guidelines that have been raising on development and the environment since the World Summit in Stockholm in 1972 to the Johannesburg Summit 2002 and others that I have discussed in Chapter 1. In this case, Table 37 shows the social indicators that I am applying to the context of the Biosphere Reserve La Amistad. Also I am showing the linking of these indicators with MDG, Agenda 21 and JPOI goals.

When one of the indicators can not be used for the context of a biosphere reserve, I discuss the reasons or motives about the characteristics of this indicator. Sometimes I am discussing national data as reference for the indicator in analysis. UN DESA (2007a) calls as irrelevant an indicator that is not possible to apply in a country, for example, marine indicators in countries without marine ecosystems or radioactive wastes management in countries without nuclear energy systems.

If the indicator is applicable, I add the information available for the study area. Obviously for most indicators there is no specific statistics for a biosphere reserve, which forces us to use data from the provinces or territories inside the reserve to provide data that can be used directly or extrapolated.

The first two paragraphs of every indicator under discussion in this chapter is basically the international consensus definition, adopted by UN DESA (2007a) publication. These indicators are a complete inclusion of indicators adopted by MDG indicators, Agenda 21 and JPOI chapter. A comparison is presented in the Table 37.

Table 37: CSD economic indicators of sustainable development compared with MDG indicators, Agenda 21 and JPOI chapter.

Nr.	Economic CSD Indicator of Sustainable Development	MDG Indicator	Agenda 21 chapter	JPOI chapter
	Economic Development			
1	GDP per capita		2 (2.34)	X (83)
2	Investment share in GDP		2 (2.34)	X (83)
3	Savings rate – Gross savings		2 (2.34)	X (83)
4	Adjusted net savings as percentage of GNI		2 (2.34)	X (83)
5	Inflation rate		2 (2.34)	X (83)
6	Debt to GNI ratio		2 (2.34), 33 (33.14 e)	X (83, 89)
7	Employment-population ratio	New	7, 14, 24	II (10 b)
8	Vulnerable employment	New*	7, 14, 24	II (10 b)
9	Labor productivity and unit labor costs	New *	14	II (10 a)
10	Share of women in wage employment in the non-agricultural sector	# 11	24	II (7 d)
11	Number of Internet users per 100 population	# 48	40	V (52)
12	Fixed telephone lines per 100 population	# 47 a	40	V (52)
13	Mobile cellular telephone subscribers per 100 population	# 47 b	40	V (52)
14	Gross domestic expenditure on R&D as a percent of GDP		35	X (113)
15	Tourism contribution to GDP		11(11.21), 13 (13.15)	IV (43)
	Global economic partnership			
16	Current account deficit as percentage of GDP		2 (2.9, 2.34)	X (83, 92)
17	Share of imports from developing countries and from LDCs		2 (2.9)	V (47), X (92)
18	Average tariff barriers imposed on exports from developing countries	# 39 *	2 (2.9)	V (47), X (92, 93)

	and LDCs			
19	ODA net given or received as a percentage of GNI	#33 *; #36 *; #37 *	33 (3.13)	X (85)
20	FDI net inflows and net outflows as percentage of GDP		33 (33.15)	X (84)
21	Remittances as percentage of GNI		33	X (83)
	Consumption and production patterns			
23	Material intensity of the economy		4 (4.18)	III (15)
24	Domestic material consumption		4	III (15)
25	Annual energy consumption, total and by main user category		4	III (20)
26	Share of renewable energy sources in total energy use		4	III (20 c, d, e)
27	Intensity of energy use, total and by economic activity		4 (4.18)	III (20 h)
28	Modal split of passenger transportation		4	III (21)
29	Modal split of freight transport		4	III (21)

Source: Adapted from UN DESA (2007a).

According my criteria, the macroeconomic indicators can not be evaluated at the level of a biosphere reserve, since their only scale of measurement is the country as a state or a political community with multiple states. This type of macro-economic indicators are economic, national baseline indicators.

Economic indicators should have tangible elements that can be evaluated and verified in the subject area of analysis. Indicators should be able to measure progress or setbacks in a tangible context of biosphere reserve.

In this chapter I present all economic indicators CSD, tangible or intangible within a biosphere reserve elements, and will indicate in the evaluation, whether are relevant for evaluation of economic sustainability in a reserve. Economic indicators are 29 items (Table 37) and they are subdivided into the following sub-themes: a- economic development; b- global economic partnership; and c-) consumption and production patterns.

8.1. *Economic development*

8.1.1. Gross domestic product per capita

It is a core economic indicator about macroeconomic performance. It measures the levels of gross domestic product (GDP) per capita are obtained by dividing annual or period GDP at current market prices by population. A variation of the indicator could be the growth of real GDP per capita which is derived by computing the annual or period growth rate of GDP in constant basic producers 'or purchasers' prices divided by corresponding population. GDP is the sum of value-added of all production units including all taxes and subsidies on products which are not included in the valuation of output (UN DESA, 2007a).

The indicator is a basic economic growth indicator and measures the level and extent of total economic output. It reflects changes in total production of goods and services in a country or multinational economic region. It is a powerful summary indicator of economic development, even though it does not account for social and environmental cost of production and consumption (UN DESA, 2007a).

Doubts do not exist about the usefulness of the indicator to measure sustainability in the context of a country. The advantage of using this indicator at the country level is that it is always updated and is recognized worldwide as a key indicator of the development of the country, although in itself this macroeconomic indicator is debatable, especially if interpreted as sole or main measuring instrument of development.

This indicator can be interpreted as a reference to determine whether a state can meet plans, programs and sustainability strategies in a specific area, such as a biosphere reserve, but by itself can not be measured on the scale of a biosphere reserve.

This indicator is not without, by default, their counterpoints on sustainability, since in prosperity does increase levels of consumption in a country, which creates challenges and many environmental problems that are usually ignored in the context of that growth. From this fact, for example, if the biosphere reserves have exploitable natural resources, they will be operating under more pressure. As a result is expected greater environmental impacts, such as increased hydroelectric dams, mining, cattle ranching expansion into forests or intensification of unsustainable agriculture, contamination, among other environmental impacts.

A positive view of the use of strong GDP at the national level, is that it allows decision makers to promote policies for sustainable development firm. These policies should be clear alternative to traditional extractive development model route. Should strongly promote equity and social strength. It is understood that a country with strong capacity and extended income can more easily take a good model for sustainable development in a biosphere reserve as a first step for widespread sustainable development in a country.

GDP also opens opportunities for the country to access to credit or international cooperation to develop sustainability plans within a framework of economic growth.

In summary, despite the benefits of using this indicator in the context of a country, the same can not be applied to a mathematical evaluation within a biosphere reserve, as it contains no tangible elements within its definition that can be measured independently or separately within a biosphere reserve, so the indicator is not applicable and can be considered irrelevant.

8.1.2. Investment share in gross domestic product

It is a core indicator of economic indicator about macroeconomic performance. This indicator refers to the share of investment in total production. It is obtained by calculating gross capital formation as percentage of gross domestic product. Gross capital formation (investment) is defined as the total value of gross fixed capital formation plus changes in inventories and acquisitions less disposal of valuables. Gross fixed capital formation is the total value of produced assets used in the production process for more than one year (UN DESA, 2007a).

The investment ratio gives an indication of the relative importance of investment as opposed to, for example, consumption. Acquisitions of capital goods provide important information on future economic performance of a society by widening and deepening the capital stock. The indicator measures, thus, an important element of the sustainable development process, especially in developing countries with low amounts productive capital (UN DESA, 2007a).

I consider that this indicator, as a macroeconomic indicator, it is not feasible to apply on the context of the mathematical evaluation, which is based on tangible elements present in a RB. It is a useful macroeconomic indicator only at country level.

8.1.3. Gross savings

It is a non-core economic indicator about macroeconomic performance. The indicator is defined in national accounts as gross disposable income (i.e. gross national income plus the balance of current transfers with the rest of the world). If available, the alternative net savings, i.e. gross savings less capital depreciation, may provide superior information. Both gross and net savings may be expressed as rates, i.e. as gross (net) savings divided by gross (net) disposable income (UN DESA, 2007a).

The indicator measures the part of income available for investment or, possibly, capital transfers to the rest of the world. It provides important information on domestic means of implementation for sustainable development. If calculated as net savings, it is an important indicator for future net wealth (UN DESA, 2007a).

This indicator is linked to the first two economic indicators. It is understood that a country's savings have positive effects of access to financing for public works (physical and institutional) with quality, and that development are required in the communities living inside of boundaries of a biosphere reserve. However, the indicator does not include tangible elements within the reserve.

I consider that this indicator, as a macroeconomic indicator, it is not feasible to apply on the context of the mathematical evaluation, which is based on tangible elements present in a RB. It is a useful macroeconomic indicator only at country level.

8.1.4. Adjusted net savings as percentage of GNI

It is a non-core economic indicator about macroeconomic performance. It is defined as net savings (i.e. gross national income less capital depreciation plus the balance of current transfers with the rest of the world), plus expenditures for education, less depletion of a variety of natural resources (oil, minerals, forests) and less pollution damage (damage from urban air pollution and carbon dioxide emissions). The indicator is then computed by dividing adjusted net savings by gross national income (UN DESA, 2007a).

This indicator modifies traditional net savings in order to derive an aggregate savings' concept more commensurate to sustainable development. A negative adjusted net savings rate can be interpreted as a reduction in total wealth of the economy, thus implying unsustainable. Education expenditures are added as they can be seen as investments in human capital. Depletion of natural resource is deducted to reflect the decline in asset values associated with their extraction and harvest. Pollution damages are deducted as they reduce human and real capital (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, that technical definition does not contain tangible elements within a biosphere reserve.

8.1.5. Inflation rate

It is a non-core economic indicator about macroeconomic performance. The indicator is defined as the cost of living as measured by the annual percentage increase of the consumer price index. Consumer price indices are based on a representative basket of goods and services purchased by consumers in an economy. Composition and relative weights of the basket are reviewed periodically (UN DESA, 2007a).

The indicator measures inflation, which if too high hampers economic growth. High and unanticipated inflation increases uncertainty and leads to inter-and intra-temporal misallocation of resources as long as prices are not fully flexible. Inflation, especially if unanticipated, has often unwanted distributional effects, as it reduces real income of fixed income earners and shifts wealth away from creditors to debtors. Very high and accelerating inflation rates may be caused by excessive financing of public debts through seigniorage and can be sign of unsustainable public finances (UN DESA, 2007a)

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.1.6. Debt to Gross National income ratio

It is a core economic indicator about sustainable public finance. The indicator can be defined as the total amount of out standing debt issued by the general government divided by gross national income. Total debt consists of external debt (debt held by non-residents) and internal debt (held by residents). For countries where external debt is a major concern, the indicator can alternatively or additionally be defined as total external debt (private and public) divided by GNI (UN DESA, 2007a).

With regard to public debt, the indicator is a standard measure of public finance. Debt constitutes a burden for future generations as it reduces the amount available for their consumption and investments. High and increasing debt ratios can be seen as an indication of unsustainable public finances. With regard to external debt, this is one of the indicators that measures the burden of servicing the external debt of a country in relation to its total income (GNI). While external borrowing is a method of supplementing savings and financing the investment gap in a country, an unsustainable external debt burden will choke development (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.1.7. Employment-to-Population Ratio

It is a core economic indicator about employment. The employment-to-population ratio is defined as the proportion of a country's working-age population that is employed. It is typically disaggregated by sex and by age group (UN DESA, 2007a).

The employment-to-population ratio provides information on the ability of an economy to create employment. Employment, as opposed to unemployment, is viewed as the desired portion of the economically active population (labour force). Employment-to-population ratios are of particular interest when broken down by sex, as they can provide information on gender differences in labour market activity in a given country. For policy purposes, employment-to-population ratios of youth and old are particular relevant (UN DESA, 2007a).

This indicator can be adapted to the context of the Biosphere Reserve because it contains tangible elements that can be measured if there are good local statistics.

For the case of LAPBR, I did the analysis using the data that exists for the associated provinces. In 2010, the employment rate in Bocas del Toro was 41.83%, 44.49% in Chiriqui and no data for the Ngobe Bugle comarca[116]. I am infering for the Ngäbe Bugle comarca, a low percentage of employment.

Making an inference based on the previous data and the recognition of the area, I can conclude that employment rate is low in the whole context of the reserve, especially in the rural area and the Ngobe Bugle comarca. The assessment of this indicator is regular.

8.1.8. Vulnerable employment

It is a non-core economic indicator about employment. The indicator is defined as the share of own-account workers and contributing family members in total employed people. The indicator is based on the broader indicator 'status in employment' which distinguishes between three categories of the total employed. These are: age and salaried workers (also known as employees); self-employed workers (employers, own-account workers and members of producers' cooperatives); contributing family workers (also known as unpaid family workers). The indicator may be broken down by sex (UN DESA, 2007a).

This indicator provides information how many persons are vulnerable to economic risk because of weak institutional employment arrangements. Own-account workers and contributing family members are regarded as especially vulnerable as they have by definition no formal work arrangements and are therefore more likely to have a low degree of job security and to lack access to social security. The indicator provides information on the informalization of labor markets, which may be associated with increasing and persistent poverty. High values of the indicator may also indicate a large agricultural sector in terms of employment, often associated with low labour productivity and economic growth rates (UN DESA, 2007a).

This indicator does not have any old data, and updated available. The evaluation for this indicator is average, precautionary.

116 INEC 2010

8.1.9. Labour productivity and unit labour cost

It is a core economic indicator about employment. labour productivity is defined as output (in constant prices) per unit of labour. The indicator can be reported for the total economy as well as for different sectors. Both hours worked and number of persons employed can be used as unit of labour. Unit labour cost is defined as labour compensation per unit of gross value added produced. Total labour compensation includes gross wages and salaries of employees and other costs of labour that are paid by employers, including employers' contributions to social security and pension schemes (UN DESA, 2007a).

Positive changes in labour productivity measure the part of economic growth due to more effective work by those who are employed. Driving forces behind labour productivity include the accumulation of machinery and equipment, improvements in organization as well as physical and institutional infrastructures, improved health and skills of workers ("human capital") and the generation of new technologies. Unit labor cost represents a direct link between productivity and the cost of labour used in generating output. A rise in a country's unit labour cost represents an increased reward for labour's contribution to output. However, a rise in labour cost that is higher than the rise in labour productivity, especially in tradable goods producing sectors, may indicate a decrease in international competitiveness, if other costs are not adjusted in compensation (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This indicator depend of GDP, hence this indicator with its technical definition does not fix well within a biosphere reserve context.

8.1.10. Share of women in wage employment in the non-agricultural sector

It is a core economic indicator about employment. The indicator is the share of female workers in wage employment in the non-agricultural sector expressed as a percentage of total wage employment in that same sector. The non-agricultural sector includes industry and services (UN DESA, 2007a).

The indicator shows the extent to which women have access to paid employment, which will affect their integration into the monetary economy. It also indicates the degree to which labour markets are open to women in industry and services sectors which affects not only equal employment opportunities for women but also economic efficiency through flexibility of the labour market and the economy's capacity to adapt to changes over time. Promoting gender equality and the empowerment of women thus eliminating all forms of gender-based discrimination in labour markets is essential to defeating poverty and fostering sustainable development (UN DESA, 2007a).

This indicator can be adapted to the context of biosphere reserve, but in the case of LAPBR, have no data to evaluate it. I infer a low percentage of women employed as professionals or semi-professionals. The assessment for this indicator is average, precautionary.

8.1.11. Number of internet users per population

It is a core economic indicator about information and communication technologies. The indicator is computed by first dividing the number of Internet users by total population, and then multiplying by 100. Internet users are those who use the Internet from any location. The Internet is defined as a world-wide public computer network that provides access to a number of communication services including the Worldwide Web and carries email, news, entertainment and data files. Internet access may be via a computer, Internet-enabled mobile phone, digital TV, games machine, etc. Location of use can refer to any location, including work (UN DESA, 2007a).

The number of Internet users is a measure of Internet access and use. As an information distribution system, the Internet and its usage provide opportunities for bringing education and information within the reach of all. It can significantly shorten time lags as well as open up a new range of information resources. It also provides significant, new economic opportunities as well as possibilities for more environment-friendly options for the marketplace (UN DESA, 2007a).

In 2012, Central America and the Caribbean have 32.4% of internet penetration rate in the Americas. This rate represents a lowest value in comparison with South America (48.2%) and North America (78.6%); inclusive is lower than World average

(34.3%)[117]. Meanwhile Panama has 42.8% of penetration of internet in relation to the total population of 3.5 million.

The density of Internet users in Panama, during the period 2007-2012, was 26.3/100 in 2007 to 42/100 inhabitants in 2012. Between 2008 and 2012 also, an average of 1,300,000 people used broadband[118].

Indicates the specific information of living survey of Panama of 2008 (ENV 2008) for the provinces associated with the reservation that the internet penetration rate in households Bocas del Toro was 4.9%, 6.4% in Chiriqui and Ngäbe Bugle was 0.00%. The data was extrapolated to 5.03% LAPBR.

ENV 2008 data was obvious, at least at the level of LABR, that the access to technologies of modern information and communication were completely at basic levels, but as of 2007, according to the Authority of Public Services Panama, is that the rate of Internet users increased significantly in the country. For 2012 it has continued to grow and remains at a rate between 2 and 3% per year.

No user data rate of users per 100 inhabitants, but the inference leads to levels 15-25 users/100 inhabitants, considering that the mobile phone is a popular technological device as a means of internet access. Probably the only limitation to the use of internet is the additional cost to the telephone fee.

Time and continuous improvement of the quality of life the population is needed to improve these indicators.

The evaluation for this indicator is low, since the estimated usage still remains low. In addition, I have the opinion that the use of internet as a pragmatic tool in the daily lives of most people, is still far from a done deal.

8.1.12. Fixed telephone lines per 100 population

It is a non-core economic indicator about information and communication technologies. The indicator is derived by dividing the number of fixed telephone lines by total population and multiplying by 100 (UN DESA, 2007a).

117 InternetWorld Stats (2012). Internet penetration in the Americas. Online: http://www.internetworldstats.com/stats2.htm. 11/21/13
118 ASEP (2012). Estadísticas de telecomunicaciones. Online: http://www.asep.gob.pa/default.asp.

This indicator is one of the broadest and most common measurements of the degree of telecommunication development in a country. Telecommunication is critical to support sustainable development and is closely linked to social, economic, and institutional development. It provides those in rural and remote areas with closer contact to the outside world. It is also a critical factor for many economic activities and improves exchange of information among citizens. Modern communications are considered to be relatively benign to the environment, as they are potential substitutes for transport and induce relatively low levels of environmental pollution. The indicator is also used as a general infrastructure indicator (UN DESA, 2007a).

At the country level, in the period 2007-2012, the fixed telephone lines density (per 100 inhabitants) has maintained an annual growth of 0.6 to 14.3%. In 2007 it was 14.25 to 16.90 fixed telephones per 100 inhabitants in 2012[119].

The ENV 2008 showed that the density of fixed telephone lines in the provinces associated with the reserve were very low. For Comarca Ngäbe Bugle the figure was extremely low, lacking entirely of fixed telephone lines (Table 38). In the Comarca and other rural areas, communities sometimes have access to a community payphone. Data extrapolated for the LAPBR show that in 2008, the population had 17% of households with landlines.

The evaluation with the inferred data and the absence of comprehensive data result in a low evaluation.

8.1.13. Mobile cellular telephone subscribers per 100 population

It is a non-core economic indicator about information and communication technologies. The indicator is derived by dividing the number of mobile cellular subscribers by total population and multiplying by 100 (UN DESA, 2007a).

This indicator is one of the broadest and most common measurements of the degree of telecommunication development in a country. Telecommunication is critical to support sustainable development and is closely linked to social, economic, and institutional development. In many developing countries, mobile telephony has overtaken fixed telephony in its importance as means of communication (UN DESA, 2007a).

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Table 38: LAPBR: Fixed telephone lines, mobiles telephones and internet access per 100 households in 2008

TICs in households (penetration)	Population 2008	Internet penetration (%)	Fixed Telephone (%)	Mobile Telephone (%)
Country	3395346	8.80	30.00	69.40
Bocas del Toro	113180	4.90	16.70	68.10
Chiriqui	418518	6.40	21.20	81.90
Ngäbe Buglé	143189	0.00	0.00	10.60
LAPBR**		5.03	16.98	57.5

*Source: Original design from data from INEC (Panamá en Cifras 2004-2008); ENV2008 from MEF. **= Extrapolation*

In Panama, as a country, since 2008 the annual rate of mobile phones per 100 inhabitants increased significantly above 100 with a median in 2008-2012 to 178.7. While the percentage of coverage of the population from 2007 to 2012 is between 93.2% and 96.1%.

The percentage of coverage of the territory with signal is still low and has fluctuated between 2007 and 2012 between 32.1% and 37.92%. This coverage is associated with the highest densities of population that is mostly in the Pacific slope. It is expected that many rural and remote areas have no signal coverage of the mobile network, and it is very possible that this is one of the main constraints.

In contrast, the numbers for the reserve and the provinces associated to LAPBR show the mobile phone coverage is very low, especially in the Comarca Ngäbe Bugle (10.60%) followed by Bocas del Toro (68.10%). The province of Chiriqui has better coverage (81.90%) (Table 38). The data extrapolated to the reserve as a whole, still shows a low percentage of mobile telephones (57.7%) (Table 38).

The evaluation for this indicator is good, but not enough for people residing inside the boundaries of LAPBR.

8.1.14. Gross domestic expenditure on research and development as a percent of gross domestic product

It is a non-core economic indicator about research and development. Gross domestic expenditure on scientific research and experimental development (R&D) expressed as a percentage of Gross Domestic Product (GDP). Gross domestic expenditure on R&D (GERD) activities are defined as the total intramural expenditure on research and development performed on the national territory during a given period. This includes both current costs and capital expenditures (UN DESA, 2007a).

This ratio provides an indication of the level of financial resources devoted to R&D in terms of their share of the GDP. R&D is essential for expanding the knowledge basis and developing new and improved products in the economy. It is a critical component of future economic growth. Moreover, R&D on issues relevant for sustainable development increases the scientific basis for informed decision-making in this area (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve. It is irrelevant in a biosphere reserve context.

8.1.15. Tourism contribution to GDP

It is a core economic indicator about tourism. The indicator is defined as the sum of the value added (at basic prices) generated by all industries in response to internal tourism consumption and the amount of net taxes on products and imports included within the value of this expenditure. It is based on tourism satellite account (TSA), a satellite account to standard national accounts that serves as the international standard on tourism statistics (UN DESA, 2007a).

GDP generated by visitor consumption is the most comprehensive aggregate illustrating the economic relevance of tourism. There is increasing consensus on the importance of tourism as a strategic sector in the national economy insofar as it provides an essential contribution to the economic well-being of the resident population, contributes to the economic objectives of governments and shows its possible role as a relevant player in moving towards a more innovative economy (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve. It is a national indicator by definition.

8.2. Global economic partnership

8.2.1. Current Account Deficit as percentage of GDP

It is a core economic indicator about trade. The indicator is the balance of the current account divided by gross domestic product. The current account is part of the balance of payments and contains financial transactions of economic value between residents and non-residents of an economy. In the 5th edition of the balance of payment manual, the current account components are the balance of trade in goods and services, balance of income (compensation of employees working abroad and income from foreign investments) and current transfers (workers remittances and government transfers) (UN DESA, 2007a).

Current account balance is part of the measure of an economy's savings. Along with net capital transfers and acquisition/disposal of non- produced, non-financial assets, the current account balance represents the net foreign investment or net lending/borrowing position of a country vis-à-vis the rest of the world. Persistent current account deficits or surpluses indicate a macroeconomic instability that is not conducive to sustained economic growth and, therefore, to sustained means of implementation of sustainable development goals. A current account deficit has to be financed through an increase in financial and non-financial liabilities vis-à-vis the rest of the world or a decrease in reserve assets. Repayment of these liabilities decreases the resources future generations have available for consumption and investment (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.2.2. Share of imports from developing countries and LDCs

It is a non-core economic indicator about trade. The indicator is defined as the share of merchandise imports from least-developed countries (LDCs) and from other developing countries in total imports into the reporting countries in a given year (UN DESA, 2007a).

Trade can play a major role in achieving sustainable development. Exports from developing countries and from LDCs constitute a major source of external financing for sustainable development of those countries. For developed country importers, the indicator is one measure of the relative importance of North-South trade, whereas for developing country importers it is a measure of South-South trade. The indicator also provides information on the implementation of international commitments to increase the trade opportunities of developing countries (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.2.3. Average tariff barriers imposed on exports from developing countries and LDCs

It is a non-core economic indicator about trade. The indicator can be defined as the simple average tariff imposed by country on exports from least-developed countries (LDCs) and from other developing countries to the country. The indicator can be disaggregated by product groups. The simple average tariff is the unweighted average of the effectively applied rates at the most detailed tariff line level. Trade-weighted averages may also be used to compute this indicator (UN DESA, 2007a).

Trade can play a major role in achieving sustainable development. Tariff barriers imposed on exports from developing countries and LDCs may hinder the sustainable development in those countries. Especially if compared with tariffs imposed on exports from developed countries, the indicator provides information on whether the tariff structure of a country is commensurate with fair trade principles. As the basket of exported goods for many developing countries and especially LDCs is relatively small, the indicator may be further broken down into product groups (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.2.4. Net official development assistance given or received as percentage of gross national income

It is a core economic indicator about external financing. This indicator is defined as the total ODA given or received as a share of GNI of the source or recipient country, respectively, net of repayment of principal. When ODA flows by donor countries are measured, ODA comprises bilateral disbursements of concessional funds to developing countries and multilateral institutions. When ODA receipts by developing countries are measured, ODA comprises disbursement of concessional finance from both bilateral and multilateral sources. ODA consists of grants and concessional loans (UN DESA, 2007a).

The indicator is a measure of the size of flows that are both concessional, and aimed mainly at promoting development and welfare of developing countries. ODA remains an important source of external means of implementation for sustainable development in many developing countries. For donor countries, the indicator provides information on the adherence to the internationally agreed target of ODA to be at least 0.7 % of GNI. For developing countries, the indicator provides information on the contribution of foreign countries to sustainable development as well as on their dependency on foreign aid (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve. It is irrelevant.

8.2.5. Foreign direct investment (FDI) NET inflows and NET outflows as percentage of GDP

It is a non-core economic indicator about external financing. This indicator is defined as the share of foreign direct investment (FDI) net inflows and of FDI net outflows in GDP. FDI is investment made to acquire a lasting interest in or effective control over an enterprise operating outside of the economy of the investor. FDI net inflows and net outflows include reinvested earnings and intra-company loans, and are net of repatriation of capital and repayment of loans (UN DESA, 2007a).

The indicator shows the provision of external financing resources in the form of direct investments at home from foreign investors and abroad from domestic investors. For many developing countries, FDI inflows are a major and relatively stable source of external financing and thereby provide important means of implementation of sustainable development goals. In many cases, FDI also contributes to the transfer of technology and management skills. Conversely, FDI outflows have the potential to improve sustainable development in receiving countries. Sustained increases in FDI inflows are often a sign of an improved general investment climate (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.2.6. Remittances as percentage of GNI

It is a non-core economic indicator about external financing . The indicator is defined as total current private transfers received by residents in a country plus compensation of employees earned by nonresident workers and migrants' transfers divided by Gross National Income (GNI) (UN DESA, 2007a).

This indicator shows the extent of financial benefit for a country from temporary and permanent movements of its residents who are able to work abroad. For many countries, remittances are a major and stable source of external financing and thereby provide important means of implementation of sustainable development goals. As a result of increased globalization the importance of remittances has been rapidly increasing in the last decade (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.3. Consumption and production patterns

8.3.1. Material intensity of the economy

It is a core economic indicator about material consumption. The indicator is defined as the ratio of Domestic Material Consumption (DMC) to Gross Domestic Product (GDP) at constant prices. DMC is defined as the total amount of materials (measured by weight) directly used in the economy (used domestic extraction plus imports), minus the materials that are exported (UN DESA, 2007a).

The indicator provides a basis for policies to decouple the growth of the economy from the use of natural resources in order to reduce environment degradation resulting from primary production, material processing, manufacturing and waste disposal. Reducing the material intensity of production and consumption of goods and services is essential to environmental protection and resource conservation. Reductions in intensity of material use can be achieved by more efficient use of natural resources in production and consumption, by recycling used and waste material, and by shifts in consumption patterns to less material intensive goods and services (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.3.2. Domestic material consumption

It is a non-core economic indicator about material consumption. Domestic Material Consumption (DMC) is defined as the weight of the total amount of materials directly used in the economy (used domestic extraction plus imports), minus the materials that are exported. Materials may be broken down by type of material (minerals, biomass, fossil fuels) (UN DESA, 2007a).

DMC is a useful indicator, as it provides an assessment of the absolute level of use of resources. Primary production of raw materials, processing of the materials into products, and ultimate disposal of the waste material has major environmental impacts. The indicator provides a basis for policies to increase the efficient use of raw materials in order to conserve natural resources and reduce environment degradation resulting from primary extraction, material processing, manufacturing and waste disposal (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve.

8.3.3. Annual energy consumption, total and by main user category

It is a core economic indicator about energy. The indicator is defined as the total energy consumption (total primary energy supply or total final consumption) in the economy (in tonnes of oil equivalents). It can be broken down by main user category (UN DESA, 2007a).

This indicator measures the level of energy use and reflects the energy-use patterns in the economy overall and in different sectors. Energy is a key factor in economic development and in providing vital services that improve quality of life. Although energy is a key requirement for economic progress, its production, use and by-products have resulted in major pressures on the environment, both by depleting resources and by creating pollution (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does contain tangible elements within a biosphere reserve, because this indicator is looking for a national level of macro-consumption.

This national indicator can show the pressures that receives the biosphere reserve. The data used in the opposite direction could justify erroneous assessments of the value of existence of a BR.

This indicator at the national level is useful to elucidate, how much power can be generated from BR ecosystems and other protected areas in the country. From this perspective, is more evident the usefulness of its existence and long term conservation.

8.3.4. Share of renewable energy sources in total energy use

It is a non-core economic indicator about energy. The share of renewable sources in total primary energy supply or total energy consumption. Renewable energy sources are divided into non-combustible (geothermal, hydro, solar, wind, tide, and wave) and combustible renewables and waste (biomass, animal products, municipal waste and industrial waste). Non-renewables are fossil fuels (coal, crude oil, petroleum products, and gas), and nuclear (UN DESA, 2007a).

The promotion of energy, and in particular of electricity from renewable sources of energy, is a high priority of sustainable development for several reasons. Energy from renewals can increase energy security and lead to diversification of energy supply. It reduces environmental degradation caused by non-renewable energy sources, contributes to the mitigation of climate change and reduces the depletion of natural resources (UN DESA, 2007a).

This is another national indicator with all forms of energy in use or consumption and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not include all elements within a biosphere reserve, taking account that the consumption scale is at national level.

I think is good idea to adapt an indicator highlighting the production of energy within national context, but without considering consumption, because in small administrative regions (or inside a BR boundary) is difficult to get a reliable data of consumption. In LABR as example, the energy consumption, specially for transport is from outside of the reserve.

8.3.5. Intensity of energy use, total, and by economic activity

It is a non-core economic indicator about energy. The indicator is defined as energy use (of the economy in total and of the main sectors) divided by gross domestic product (or value added in case of a sector) (UN DESA, 2007a).

Declining trends in overall energy use relative to GDP (or value added) indicate that the economy is able to improve its energy efficiency and, hence, to decouple economic growth from energy consumption. Improving energy efficiency has beneficial effects on energy security and reduces pressures from economic activities on the environment (UN DESA, 2007a).

This is another national indicator and does not apply to the context of a biosphere reserve. This as an indicator, the technical definition does not contain tangible elements within a biosphere reserve or contains national variables non aplicable in a biosphere reserve.

8.3.6. Modal split of passenger transport

It is a core economic indicator about transport. The indicator measures the share o proportion of each transport mode or system, such as: a-) passenger cars, b-) buses and coaches, and c-) trains in total inland passenger transport, measured in passenger by km (UN DESA, 2007a).

The indicator provides information on the relative importance of different modes for passenger transport. The use of cars for passenger transportation is generally less energy efficient and has greater environmental and social impacts, such as pollution, global warming as well as a higher accident rate, than mass transit (UN DESA, 2007a).

There are insufficient data to determine the value for this indicator in LAPBR. I only know that the transport system on land is given in buses and private cars. Possibly two thirds of the population regularly use buses and taxis secondly.

Being an area with low population densities, the transportation problem has more to do with access and quality. Throughout the area are missing more efficient and modern transport models.

With no data to support the status of this indicator the evaluation is low.

8.3.7. Modal split of freight transport

It is a non-core economic indicator about transport. The indicator measures the share of each mode (road, rail and inland waterways) in total inland freight transport, measured in tonne-km (UN DESA, 2007a).

The indicator provides information on the relative importance of different modes for freight transport. Road transport is less energy-efficient and produces more emissions per tonne-kilometer than either rail or inland waterways transport.

Therefore, the use of road for freight transport has greater environmental and social impacts, such as pollution, global warming, as well as a higher accident rate, than either rail or inland waterways transport (UN DESA, 2007a).

There are insufficient data to determine the value for this indicator in LAPBR. I only know that the freight system is almost exclusively by truck. Other forms of transport are negligible.

With the known history of the LAPBR and the lack of data supporting, the evaluation of this indicator is low.

8.4. Analysis of economic indicators of sustainability

Table 39 shows the mathematical evaluation of eight indicators that were relevant to the context of LAPBR, the result shows that the evaluation of the economic indicators have a low percentage of progress in sustainable development, with only 36.15% of advances.

Table 39 also shows the 21 indicators that were not relevant to the analysis and explanation is then given as the definition of each indicator in the main text of this chapter.

Each indicator with the definitions adopted by UN DESA (2007a) have been self-explanatory on the relevance of sustainability. The data analyzed or incorporated have supported this preliminary assessment, it becomes best reference for mathematical analysis of sustainability and especially to follow the process of sustainable development in the Biosphere Reserve La Amistad Panama and can be applied equally to reserves or other minor political regions and federal states, provinces or counties, among others.

Table 39: LAPBR: Final mathematical results about CSD economic indicators for sustainability

Nr.	Economic Indicators of Sustainable Development	Evaluation (x/10)	Weight (1-3)	Observed Development	Expected Development
1	GDP per capita	*	*	*	*
2	Investment share in GDP	*	*	*	*
3	Savings rate – Gross savings	*	*	*	*
4	Adjusted net savings as percentage of GNI	*	*	*	*
5	Inflation rate	*	*	*	*
6	Debt to GNI ratio	*	*	*	*
7	Employment-population ratio	5	3	15	30
8	Vulnerable employment	5	1	5	10
9	Labor productivity and unit labor costs	*	*	*	*
10	Share of women in wage employment in the non-agricultural sector	5	1	5	10
11	Number of Internet users per 100 population	2	3	6	30
12	Fixed telephone lines per 100 population	2	2	4	20
13	Mobile cellular telephone subscribers per 100 population	8	1	8	10
14	Gross domestic expenditure on R&D as a percent of GDP	*	*	*	*
15	Tourism contribution to GDP	*	*	*	*
16	Current account deficit as percentage of GDP	*	*	*	*
17	Share of imports from developing countries and from LDCs	*	*	*	*
18	Average tariff barriers imposed on exports from developing countries and LDCs	*	*	*	*
19	ODA net given or received as a percentage of GNI	*	*	*	*

20	FDI net inflows and net outflows as percentage of GDP	*	*	*	*
21	Remittances as percentage of GNI	*	*	*	*
23	Material intensity of the economy	*	*	*	*
24	Domestic material consumption	*	*	*	*
25	Annual energy consumption, total and by main user category	*	*	*	*
26	Share of renewable energy sources in total energy use	*	*	*	*
27	Intensity of energy use, total and by economic activity	*	*	*	*
28	Modal split of passenger transportation	2	1	2	10
29	Modal split of freight transport	2	1	2	10
			Sum	**47**	**130**
		36.15	Advances of Economic Indicators (%)		
		63.85	Deficit of Economic Indicators (%)		

Asterisk (*) means irrelevant indicator in LAPBR – not evaluated.

CHAPTER 9

Synopsis about sustainability in LAPBR

9. The sustainability in La Amistad Biosphere Reserve

Of the total of 96 CSD indicators, I could apply 77 to context and scale of the LAPBR (Map in Annex I). This represents 80% of total number of indicators (Table 40). With this number of indicators linked or complemented by the guidelines goals of Seville Strategy for biosphere reserves from 1995 and addends, a biosphere reserve should be a real sustainable area within a country. I want to highlight that I am not changing the core of original definition of the CSD sustainable development indicators, because the goal ever has been to use these indicators in the original sense.

The goals of Sevilla Strategy include additional key conceptual topics, such as nature conservation and cultural diversity, integration of biosphere reserves to regional planning, public awareness and involvement; strengthen the World Network of Biosphere Reserves, among others (UNESCO-MAB, 1995) (see Annex III).

The current analysis of the sustainability of the 77 relevant CSD indicators collectively shows contrary to the hypothesis, the northwest of the Isthmus of Panama, where the LAPRB is located, the level of sustainable development is low and barely reaches 56.36%. This fact means that the existence of a biosphere reserve by itself does not guarantee a sustainable development without a proper plan for it. The biosphere reserve concept should be the engine that should drive all development issues within the context of sustainability, since from the time the area has been declared as such, it deserves special attention in the path of sustainable development.

Noting the results for development by issues (orange rows in Table 40), is possible to appreciate that LAPBR has no significant problems with emissions of gases that affect the atmosphere, perhaps by the reality of social and economic condition itself. It also has good values of sustainability of indicators grouped by biodiversity, land use, and sea and coasts. The other grouped development issues such as education, governance, natural hazards, freshwater and management, energy, health, waste management, demographics, economic development, poverty and consumption and production patterns are low advances in sustainable development, and therefore becomes a challenge and priority, deep study, and concrete plans of attention for these sets of indicators of development.

An important fact from the results shown, total or pillars or even by subject, shows that this methodology prevents an indicator or set of indicators mask the rest. Which means of ongoing development and monitoring of work depends heavily on the full set of indicators, especially those in higher development deficit. The weights assigned to the indicators are also important for the overall balance evaluation on sustainable development in a biosphere reserve.

Table 40 shows in the last column, the effectiveness or grade of development of each relevant indicator. From them, are in priority of improvement, every indicator with percentage lower than 70%. An deep analysis and action plan is required with high coordination between all stakeholders, government's planners and managers of the Reserve. The sustainable development agenda within biosphere reserves should be known and incorporated into all possible levels: tows, cities and rural communities and authorities, just as it has been doing Germany, Scandinavian countries and United Kingdom, with following up Agenda 21 (Plachter et al., 2005). This agenda should have a set of actions, well planned, consulted and effective in solving social problems, environmental, economic and institutional that are shown by the indicators in a sustainability analysis.

If the interest is nature conservation, as society, we can obtain these specific data, and the rest of indicators for to do a new model of management of nature resources and conservation strategies inside of biosphere reserves or even outside of them. Is required a real integration in the context of sustainibility. The experts in nature conservation should be experts in the big screen of the problem, advising, taking decisions or implementing at different scales, specific nature conservation projects.

Just the analysis of the Table 40 is a big challenge for any individual professional, but the nature conservation problems, linked to the rest of the problems and solutions are there. In my opinion forever should be necessary an interdisciplinary and multidisciplinary team for a deep analysis of this kind of global challenges.

Table 40: LAPBR: Synopsis of analysis of 96 CSD sustainable development indicators showing total and advances by themes of sustainable development.

Sustainable Development by themes	Evaluation (x/10)	Weight (1-3)	Observed values	Expected values	Deficit	Effectivity (1-100%)
Social - Poverty	**3.6**		**85**	**230**	**145**	**37**
Proportion of population living below national poverty line	3	3	9	30	21	30
Proportion of population below $1 a day	3	3	9	30	21	30
Ratio of share in national income of highest to the lowest quintile	3	3	9	30	21	30
Proportion of population using an improved sanitation facility	4	3	12	30	18	40
Proportion of population using improved water source	3	3	9	30	21	30
Share of households without electricity or other modern energy services	2	3	6	30	24	20
Percentage of population using solid fuels for cooking	2	2	4	20	16	20
Proportion of urban population living in slums	9	3	27	30	3	90
Social - Governance	**5.5**		**11**	**20**	**9**	**55**
Percentage of population having paid bribes	3	1	3	10	7	30
Number of intentional homicides per 100,000 population	8	1	8	10	2	80
Social - Health	**5.3**		**102**	**210**	**108**	**49**
Under-five mortality rate	3	3	9	30	21	30
Life expectancy at birth	4	1	4	10	6	40
Healthy life expectancy at birth	7	1	7	10	3	70
Percent of population with access to primary health care facilities	5	3	15	30	15	50
Immunization against infectious childhood diseases	7	3	21	30	9	70
Contraceptive prevalence rate	3	2	6	20	14	30
Nutritional status of children	3	3	9	30	21	30
Prevalence of tobacco use	8	1	8	10	2	80
Suicide rate	8	1	8	10	2	80
Morbidity of major diseases such as HIV/AIDS, malaria, tuberculosis	5	3	15	30	15	50
Social - Education	**5.8**		**85**	**140**	**55**	**61**
Gross intake into last year of primary education	10	3	30	30	0	100
Net enrollment rate in primary	9	3	27	30	3	90

Sustainable Development by themes	Evaluation (x/10)	Weight (1-3)	Observed values	Expected values	Deficit	Effectivity (1-100%)
education						
Adult secondary (tertiary) schooling attainment level	2	2	4	20	16	20
Life long learning	1	3	3	30	27	10
Adult literacy rate	7	3	21	30	9	70
Social - Demographics	**4.8**		**28**	**70**	**42**	**40**
Population growth rate	3	2	6	20	14	30
Total fertility rate	2	2	4	20	16	20
Dependency ratio	4	2	8	20	12	40
Ratio of local residents to tourists in major tourist regions and destinations	10	1	10	10	0	100
Social - Natural hazards	**5.5**		**11**	**20**	**9**	**55**
Percentage of population living in hazard prone areas	5	1	5	10	5	50
Human and economic loss due to natural disasters	6	1	6	10	4	60
Environment- Gases emissions	**10**		**50**	**50**	**0**	**100**
Emissions of greenhouse gases	10	3	30	30	0	100
Carbon dioxide emissions	10	1	10	10	0	100
Consumption of ozone depleting substances	10	1	10	10	0	100
Ambient concentration of air pollutants in urban areas	*	*	*	*	*	*
Nature conservation - Land use	**7.2**		**158**	**210**	**52**	**75.24**
Land use change	9	3	27	30	3	90
Land degradation	10	3	30	30	0	100
Land affected by desertification	*	*	*	*	*	*
Arable and permanent cropland area	7	3	21	30	9	70
Fertilizer use efficiency	6	1	6	10	4	60
Use of agricultural pesticides	3	2	6	20	14	30
Area under organic farming	2	2	4	20	16	20
Proportion of land area covered by forests	10	3	30	30	0	100
Percent of forest trees damaged by defoliation	10	1	10	10	0	100
Area of forest under sustainable forest management	8	3	24	30	6	80
Nature conservation - Sea and coasts	**7.5**		**51**	**70**	**19**	**72.86**
Percentage of total population living in	6	2	12	20	8	60

Sustainable Development by themes	Evaluation (x/10)	Weight (1-3)	Observed values	Expected values	Deficit	Effectivity (1-100%)
coastal areas						
Bathing waters quality	10	2	20	20	0	100
Proportion of fish stocks within safe biological limits	*	*	*	*	*	*
Proportion of marine area protected	5	2	10	20	10	50
Marine trophic index	*	*	*	*	*	*
Area of coral reef ecosystems and percentage live cover	9	1	9	10	1	90
Environment- Freshwater and management	**6**		**44**	**80**	**36**	**55.00**
Proportion of total water resources used	6	2	12	20	8	60
Water use intensity by economic activity	5	2	10	20	10	50
Biochemical oxygen demand in water bodies	8	1	8	10	2	80
Presence of faecal coliforms in freshwater	8	1	8	10	2	80
Waste-water treatment	3	2	6	20	14	30
Nature conservation - Biodiversity	**7.5**		**106**	**140**	**34**	**75.71**
Proportion of terrestrial area protected, total and by ecological region	10	3	30	30	0	100
Management effectiveness of protected areas	6	2	12	20	8	60
Area of selected key ecosystems	10	3	30	30	0	100
Fragmentation of habitats	7	2	14	20	6	70
Abundance of selected key species	4	3	12	30	18	40
Change in threat status of species	*	*	*	*	*	*
Abundance of invasive alien species	8	1	8	10	2	80
Environment -Waste management	**5**		**23**	**50**	**27**	**46.00**
Generation of waste	7	2	14	20	6	70
Generation of hazardous waste	*	*	*	*	*	*
Waste treatment and disposal	3	3	9	30	21	30
Management of radioactive waste	*	*	*	*	*	*
Environment -Energy	**5**		**5**	**10**	**5**	**50.00**
Energy intensity of transport	5	1	5	10	5	50
Economy -Economic Development	**4.5**		**43**	**110**	**67**	**39.09**
GDP per capita	*	*	*	*	*	*
Investment share in GDP	*	*	*	*	*	*

Sustainable Development by themes	Evaluation (x/10)	Weight (1-3)	Observed values	Expected values	Deficit	Effectivity (1-100%)
Savings rate – Gross savings	*	*	*	*	*	*
Adjusted net savings as percentage of GNI	*	*	*	*	*	*
Inflation rate	*	*	*	*	*	*
Debt to GNI ratio	*	*	*	*	*	*
Employment-population ratio	5	3	15	30	15	50
Vulnerable employment	5	1	5	10	5	50
Labor productivity and unit labor costs	*	*	*	*	*	*
Share of women in wage employment in the non-agricultural sector	5	1	5	10	5	50
Number of Internet users per 100 population	2	3	6	30	24	20
Fixed telephone lines per 100 population	2	2	4	20	16	20
Mobile cellular telephone subscribers per 100 population	8	1	8	10	2	80
Gross domestic expenditure on R&D as a percent of GDP	*	*	*	*	*	*
Tourism contribution to GDP	*	*	*	*	*	*
Economy- Global economic partnership	*	*	*	*	*	*
Current account deficit as percentage of GDP	*	*	*	*	*	*
Share of imports from developing countries and from LDCs	*	*	*	*	*	*
Average tariff barriers imposed on exports from developing countries and LDCs	*	*	*	*	*	*
ODA net given or received as a percentage of GNI	*	*	*	*	*	*
FDI net inflows and net outflows as percentage of GDP	*	*	*	*	*	*
Remittances as percentage of GNI	*	*	*	*	*	*

Sustainable Development by themes	Evaluation (x/10)	Weight (1-3)	Observed values	Expected values	Deficit	Effectivity (1-100%)
Economy -Consumption and production patterns	**2**		**4**	**20**		**20**
Material intensity of the economy	*	*	*	*	*	*
Domestic material consumption	*	*	*	*	*	*
Annual energy consumption, total and by main user category	*	*	*	*	*	*
Share of renewable energy sources in total energy use	*	*	*	*	*	*
Intensity of energy use, total and by economic activity	*	*	*	*	*	*
Modal split of passenger transportation	2	1	2	10	8	20
Modal split of freight transport	2	1	2	10	8	20
TOTAL		**Sum**	**806**	**1430**	**608**	
	56.36	Advances of all Sustainable Development Indicators (%)				
	43.63	Deficit of all Sustainable Development Indicators (%)				
	* =	Irrelevant in LAPBR				

Source: Indicators adapted from UN DESA (2007a).

Is worth highlighting that some indicators can work together as a pragmatic way to achieve results, but these results must be in conformity to the methodological frameworks of the CSD indicators.

It is noteworthy that there is an enormous amount of indices and indicators measuring sustainability (Singh et al., 2009), but are special indicators for specific topics and almost none are applicable to the context of biosphere reserve.

Our methodology for evaluating sustainability is simple and is stronger in the same relation to the data needed for the analysis of indicators exist and are up to date.

CHAPTER 10

Conclusions and recommendations

10.1. Conclusions

With all the global discourse and actions for implementing sustainable development in the main agenda of growth and development of countries, it becomes very evident that there must be concrete examples that show how it works and how it can consolidate progress towards sustainable development. The biosphere reserves are called to be one of the models of approaches to sustainable development. This research aimed to study sustainability through widely known indicators and determine the progress of this paradigm in the NW the Isthmus of Panama, which is part of the Biosphere Reserve La Amistad Panama. In this research I have the following conclusions as input for the informed and constructive debate within and beyond this research:

(1) The paradigm of sustainable development must be based on the conservation of nature and resources and ensure the present and future human well-being. Shall not be achieve with a forked way, conservation and human welfare. Making sustainable development includes nature conservation and the insurance for inter-generational human welfare. This implies that the action framework of sustainable development must obey an integrated social welfare and balanced use of natural resources for present and future generations as strategic scenario. The whole society should be involved in this goal.

(2) The existence of a biosphere reserve by itself does not guarantee a good level sustainable development of a region such as the NW of the Isthmus of Panama. It is imperative to achieve development activities based on frameworks established by UNESCO objectives and follow up a comprehensive sustainable development agenda and indicators that can be monitored along time.

(3) This research has required the use of indicators of sustainable development, in order to know the degree of progress of sustainability as a whole, in LAPBR. In

my opinion, the indicators proposed by the United Nations Commission on Sustainable Development (CSD) and launched by UN Department of Economic and Social Affairs (UN DESA) in 2007, are simple indicators that allowed easily arrive to the results of sustainability assessment in a reserve biosphere. Even with missing data, the mathematical matrix of these indicators is suitable to show the level of progress in sustainability.

(4) CSD indicators have the advantage to be used easily, because their definitions are self-explanatory and have methodological framework and can be applied mostly to the analysis of sustainability in a biosphere reserve. The indicators do not apply to the scale of the biosphere reserve was due to their own definition, which does not weaken the analysis and does not affect the results obtained.

(5) Another advantage of CDS indicators is that they represent the vision of the world's largest multilateral institution and who has led global efforts to promote sustainable development in the development agenda of all countries of the world, and are also one of the main promoters of the birth of the concept.

(6) From the above statements it is clear that it makes no sense the existence of a biosphere reserve without a strategic plan for sustainable development, but to establish a plan of this type an initial assessment base is required as the one presented in this study. The analysis of each indicator shows the strength or weakness of the existing data and promotes data collection plan for the future.

(7) The total sustainability, considering all the pillars of development within the LAPBR can be considered low, as is 56.4%. This low percentage is far from a good value of 80% or higher than 90% as ideal or excelent. This low level is below a minimum acceptable value of 70%. Therefore, the Reserve is not properly following the guidelines of sustainable development that have arisen globally to achieve those goals.

(8) It is imperative to clarify that sustainable development indicators should be used in whole and not individually or cluster or pillars, if desired to have a robust sustainability analysis. The environmental, social, economic and institutional or themes within these pillars are didactic and pragmatic to visualize the level of sustainable development, but never as independent units of assessment or

actions. I am highlighting on the multidimensional platform of sustainable development, because all have links with each other and between development issues of a different nature and strength.

(9) The use of indicators should be based on a practical way to display the progress of development in each of these indicators and to link the analysis of all relevant indicators mathematical forms of tangible display of these advances. These are the matrices for analysis of sustainability indicators that I presented at the end of chapters 5, 6, 7 and 8.

(10) The analysis of these indicators in a matrix by pillars or unified into a single simple mathematical matrix is one of the best ways to visualize and to follow the sustainable development of an area under study, especially a biosphere reserve or a country.

(11) Indicators for the sustainable development of the social pillar reveal that progress on sustainability reached only 46.7%, considered low and it becomes a big challenge to achieve acceptable or optimal levels.

(12) Indicators for the sustainable development of the environmental pillar reveal that progress on sustainability reached 73.3%, considered and minimum acceptable, but it required to reach optimal levels over 80% or ideal values higher than 90%.

(13) Indicators for sustainable development about nature conservation issues reveal progress of 75%. It is the higher progress in sustainability in LAPBR.

(14) Indicators for sustainable development about general-physical environmental issues reveal progress of 71.64%. It is the second higher progress in sustainability in LAPBR.

(15) Indicators for the sustainable development of the economic pillar reveal that progress on sustainability reached only 36.1%, considered extremely low and it becomes a big challenge to reach acceptable or optimal levels. The worst conditions are the topic related to economic development indicators.

(16) The implementation and demonstration of sustainable development should have a route-map of action and monitoring permanent for the decision makers and all stakeholders.

(17) The conservation function in LAPBR through the conservation of landscapes, ecosystems, species and genetic variation is currently working, specially in the six core zones, although some core areas are heavily pressured by human activities. These include Lagunas de Volcan, the Baru volcano, Bastimentos Island and San San Pond Sak wetland.

(18) The conservation function in LAPBR can be monitored clearly with the CSD indicators of biodiversity and landuse, such as: a-) proportion of terrestrial area protected, total and by ecological region; b-) management effectiveness of protected areas; c-) area of selected key ecosystems; d-) fragmentation of habitats; e-) abundance of selected key species; f-) change in threat status of species; g-) abundance of invasive alien species; h-) area of coral reef ecosystems and percentage live cover; i-) percent of forest trees damaged by defoliation; j-) land use change; k-) land degradation, and others.

(19) The set of indicators framed within the function for biodiversity conservation shows progress in sustainability around 74.5%, indicating an acceptable value, but they need to reach an optimal level over 80% or ideal values over 90%.

(20) The study of vertical structure diversity of the terrestrial and key ecosystems of LAPBR, shows a clear high diversity inside or outside protected areas of the reserve. These data can be used for to infer a high rate of diversity between different kind of forest, or even, significant differences between plots with the same kind of forest. The physical variables such as, altitude, temperature, moisture, soil, etc, can be key factors for to produce this huge differences in vertical structure.

(21) The development -to foster economic and human development which is socially, culturally and ecologically sustainable as function in LAPB can be monitored with the majority of social and economic indicators, adaptable to a biosphere reserve. Currently the set of indicators framed within this function show a poor percentage of progress in sustainability, around 46.6%.

(22) The linking between development of logistic- to provide support for research, monitoring, education, and information exchange related to local, national and global issues of conservation and development is not completely clear with the

indicators proposed by UN DESA (2007a), anyway, doing a test with 11 indicators, the result show a deficient advance in sustainability, reaching only 64.2%. Is required to better investigate a coupling of the definitions of these indicators (or other) and the logistic function of a biosphere reserve.

(23) Regarding the definition of the boundaries of the biosphere reserve is necessary to reaffirm that for sustainability analysis in a biosphere reserve is essential to have well-defined boundaries and areas of the zones of a biosphere reserve, because many indicators require Geo-spatial analysis taking into account the study area to define scientific facts proportions of socioeconomic, political and biophysical characteristics.

(24) The boundaries well defined, are important to analyze the political and administrative context in which is located the biosphere reserve under study. The defined boundaries of a reserve are also suitable for the society and all stakeholders, making sense of regional identity and defining the correct spatial scale of the reservation.

(25) LAPBR lacked a complete definition of total area and its buffer zones and transition. Much of the limits of the buffer zones and transition issues had overlapping areas, which prevented making a basic mapping of these areas. This research has corrected these errors.

(26) The spatial rearrangements that I have done have clarified all areas and zones of the biosphere reserve, and this now allows a mapping without contradictions and can be used to be officially adopted as the most understandable map for LAPBR.

(27) One of the best strengths of the biosphere reserve is the strategic location of the seven protected areas, of which 6 are the core of the reserve area and the seventh is officially part of the buffer zone.

(28) I recognize that for many of the indicators presented, is required more specific studies on sustainability data. These data should be required to update, to update or clarify with certainty, the current status of the indicators. This multidisciplinary research team can include ecologists, biologists, geographers, urban planners, conservation experts, sociologists, economists, statisticians, hydrologists, bio-

physical, geographical, etc. is required. This need must be administered by the Man and Biosphere National Committee for Biosphere Reserves.

10.2. Recommendations

My recommendations to promote actions to improve levels of sustainability with nature conservation, social and economic good advances n LAPBR are the following:

(1) As first step is the formal creation of the Man and Biosphere National Committee for Biosphere Reserves, using the UNESCO Guidelines for establishing MAB National Committees (1997) and this Committee should be adopt all UNESCO guidelines and recommendations for biosphere reserves.

(2) Man and Biosphere National Committee should fully adopt all the recommendations, guidelines and implementation indicators of the Seville Strategy for Biosphere Reserves 1995 (Annex III). This will organize foundations of strategy or road-map that is required in the management of the reserve.

(3) Make a detailed gap analysis for sustainable development in the Seville Strategy and complement the analysis with CSD indicators and incorporate them into the road-map of the Reserve.

(4) The route-map of action and monitoring indicators must use recognized, clear sustainability and broad consensus, especially the international consensus, but always considering national and local priorities. The important thing is to always have indicators together as a adequate method of assessment of the progress in sustainable development of the target area. The weighting system on indicators evaluated in this study give an idea or example of setting priorities for sustainable development.

(5) The sustainable development agenda within biosphere reserves should be known by all stakeholders and incorporated into all possible levels: tows, cities and rural communities as has happened in many European countries[120].

(6) Develop a complete mapping database for the LAPBR for to support the good management, research, and a database sharing with the UNESCO Biosphere Reserves Network.

120 Plachter et al 2005 (See references)

(7) Increase reserve area eastward to include Chiriqui River Basin in the Caribbean, the Valiente Peninsula and the island of Escudo de Veraguas. This new definition of the reserve include Damani Guariviara Wetland and Isla Escudo de Veraguas-Tobobe Protected Landscape as new core zones and the buffer zone should be established according to the management plans for these areas. The rest of the polygon the reserve, including an additional marine area would be part of the transition zone. This new area polygons must include the following corregimientos from Ngäbe Bugle Comarca: Guariviara East, Kankintú, Bisira, Kusapín, Tobobe, Rio Chiriqui, Guoroní, Piedra Roja, Cascabel, Niba, Boca del Balsa, Soloy, Mününi, Roka, Peña Blanca, Jädeberi, Krua and Bahia Azul (Annex II). The additional marine zone is rich in coral reefs.

(8) Modify the buffer zone of San San Pond Sak, in order to include the entire area of banana and other crops and livestock, and the city of Changuinola in the transition zone, in order to better fit the definition and meaning of these areas within a biosphere reserve.

(9) Establish an indicator to determine the strength of the participation of civil society in the governance of the reserve. This indicator can be disaggregated at the district level, corregimientos or provinces. With data from living standards of households is possible to determine the level of involvement of civil society and stakeholders in governance.

(10) Promoting strategic objective within national development priorities including social problem solving inequality in the population of the Reserve. Eliminating or significantly reducing the deficits of social care in the area, the biosphere reserve can be a model of sustainable development, which in my opinion must have a sustainability ratio above 70%.

(11) Therefore, the associated provinces to LAPBR requires heavy investments in health, education and improving the quality of life of citizens through the extension of all basic social services, basic public infrastructure and the promotion of corporative creativity and the strengthening of civil society organizations. It is also required to provide reliable drinking water systems, wastewater management in all communities, free access to all citizens to formal and informal education, and others.

(12) Urgently study the problem of fragmentation of the human population in the Reserve, as hundreds of communities isolated from each other and isolated from urban or semi-urban centers cause enormous problems of planning and attention to social and economic needs of the residents. In the present condition of fragmentation, with rural communities, social attention to their needs becomes a complex and costly problem.

(13) Improve further the education system that operates in the reserve. Educational coverage must pass the stage of the current bad quality of education.

(14) Adopt and adapt the recommendations of the UNESCO Declaration on Continuing Education to ensure that society grow intellectually and with that knowledge capital to become engines of their own development.

(15) Establish a public health policy that ensures no contamination of waters suitable recreation and tourism. This policy establishes parameters must follow to ensure their implementation and success.

(16) Define in scientific consensus, using expert workshops, the set of key species of plants and animals in the reserve, their conservation status, as well as monitoring protocols.

(17) Improve the management of protected areas (national parks, forestry reserves and wetlands) in the reserve granting more staffs for control, monitoring, and environmental education in these areas.

(18) Update the current tourism plans with a zonation of the tourism industry in the archipelago of Bocas del Toro and also in Chiriqui highlands, taking into account the characteristics of the biosphere reserve zones.

(19) Incorporate in the next official agricultural census sheets, all information useful for update sustainable development indicators related to agriculture and other related issues, following the goals of CSD sustainable development indicators.

(20) Develop a specific and detailed study about pesticides and fertilizers in the reserve, following the CSD sustainable development indicators methodology.

(21) Develop a complete plan for sustainable agriculture with emphasis in soil conservation, protection of freshwater, pesticides contamination, and nature

conservation in the high basin of Chiriqui Viejo river en Cerro Punta and in Boquete, specially in the vegetable production area. The biosphere reserve zonation should be under consideration inside of this plan.

(22) Conduct a study on reforestation and the use of fallow and secondary forests of the entire reservation.

(23) Conduct a detailed study of nature conservation about the patterns of land use and changes in time.

(24) Conduct a study on the uses of natural forest products in the reserve. Conduct a study of the status of conservation and use of natural forests located outside existing protected areas.

(25) Embrace and extend to the entire context of LAPBR recommendations for La Amistad International Park as WHS, given by the UNESCO in 2008, 2009 and 2013 through the Reactive Monitoring of La Amistad Panama and Costa Rica, which among includes other (with modified text for the BR):

- ✔ Provide the necessary logistical and financial support, to increased the presence of the authorities in the property by at least fifty per cent.
- ✔ Strengthen, at the local level, the management and control capacity of the relevant environmental authorities, specially the authorities for nature conservation.
- ✔ Promote good governance mechanisms and agreements, with other governmental and civil society stakeholders, nearby communities and especially indigenous communities to make the management of protected areas more effective.
- ✔ Update information on the use, occupation and tenure of land within the area, and prepare a strategy to consolidate the state ownership, acquire private land rights and eradicate the inappropriate use of land inside the La Amistad National Park or La Amistad International Park (PILA).
- ✔ CBMP should develop, within the next two years (2014 and 2015), proposals to connect the biological corridors (especially the high-altitude ones), to contribute to mitigating and adapting to climate change,

- ✔ Determine the cumulative effect of hydroelectric dam projects through a Strategic Environmental Assessment process (SEA) in the biosphere reserve area and nearby area.
- ✔ Guarantee the long term integrity of complete (from source to sea) unaffected watersheds, including Sixaola and Teribe rivers.
- ✔ Monitor the measures to mitigate environmental impact to prevent any impact on the life cycle of aquatic fauna from hydroelectric projects.
- ✔ The companies that build and operate the CHAN 75 and Bonyic dams should be required to implement optimal compensation mechanisms for the affected freshwater biodiversity, including but not limited to cultivation of affected freshwater species, particularly endemics.
- ✔ ANAM should monitor and coordinate the mobilization of indigenous communities, while considering the respect for the rights of these populations, to maintain living conditions and welfare and to avoid the creation of new threats to the integrity of the property by the movement of their homes or the areas where they use resources.
- ✔ Establish a mechanism for payment for environmental services to ensure that the revenue generated by energy and water-use projects from the property reinforce the management of the property and benefit the local populations.

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ANNEXES

This research contains three annexes:

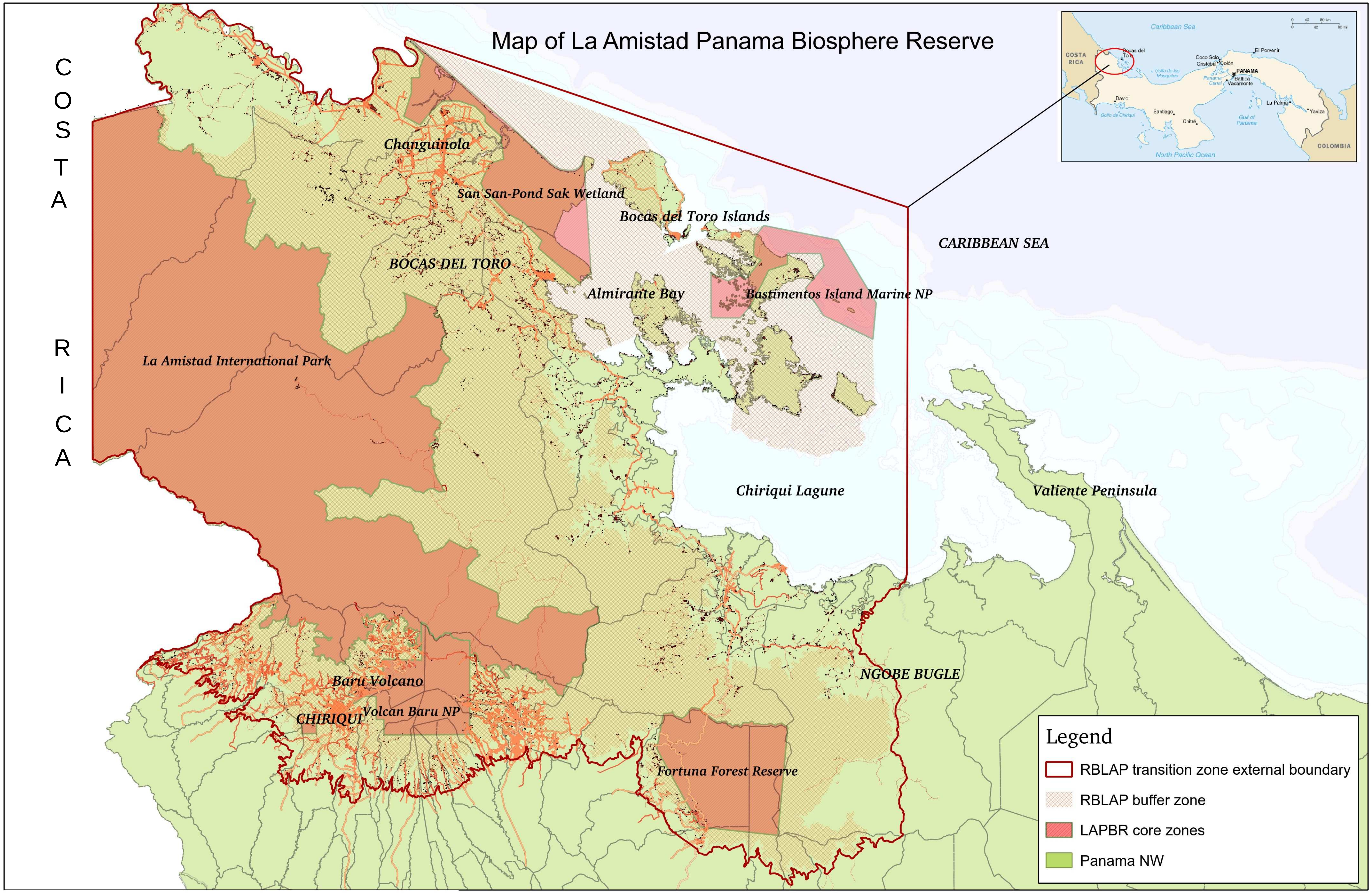
1- A map of La Amistad Biosphere Reserve, showing the three zones: core, buffer and transition (1 page).

2- A map of the proposal of expansion of La Amistad Bioshpere Reserves (1 page).

3- The UNESCO official document about Bisphere Reserves: The Sevilla Strategy and the Statutory Framework of the World Network (19 pages).

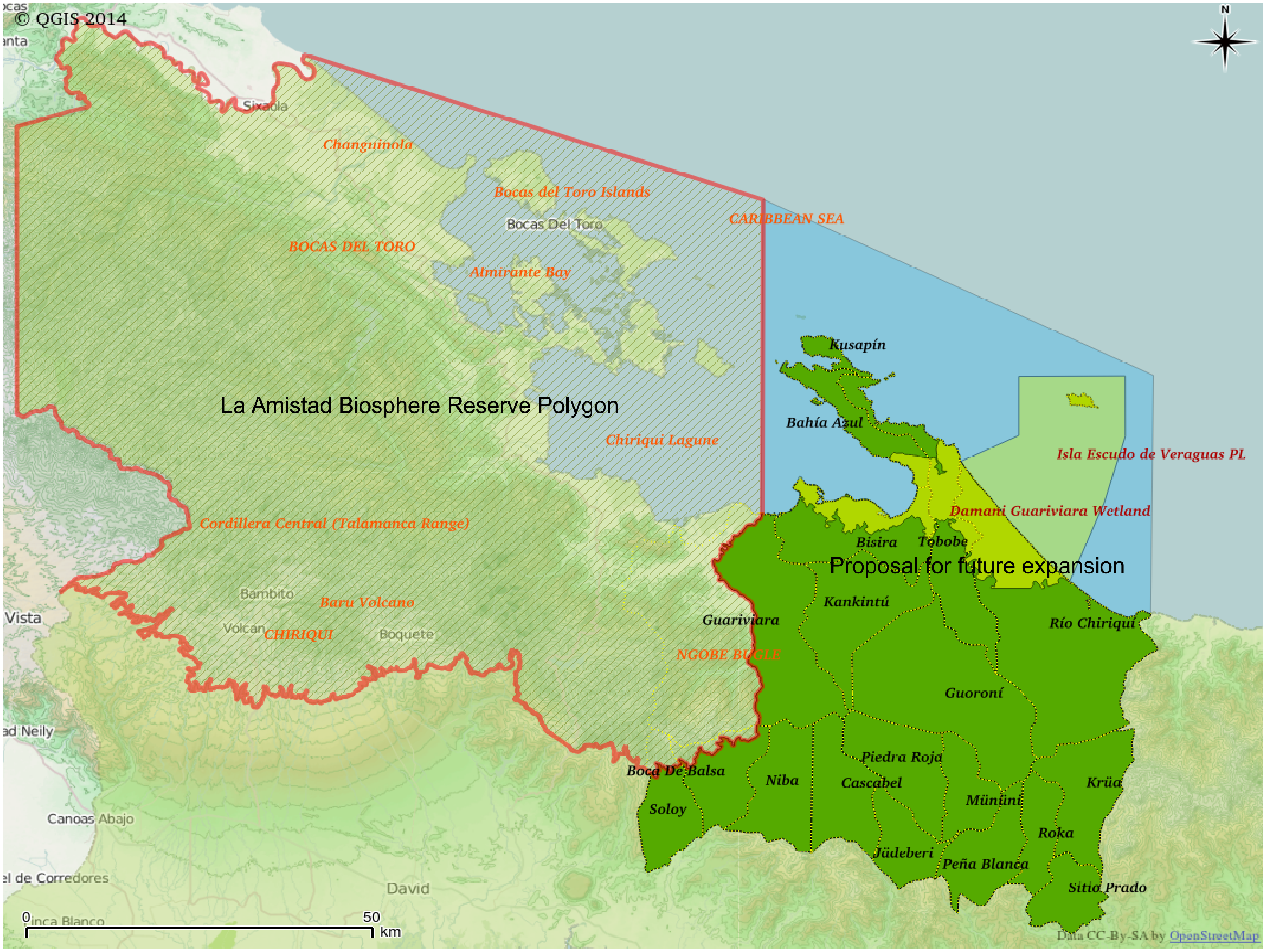
4- Statement of “Eidesstattliche Erklärung”

Annex I. La Amistad Panama Biosphere Reserve (LAPBR) map with the three zones: cores, buffers and transition



Source: IGNTG, CGRP, ANAM, CIA

Annex II. LAPBR: a proposal of expansion toward the East from the current boundary



Source: IGNTG, Openstreetmap. The current LAPBR includes the orange polygon.

BIOSPHERE RESERVES

THE SEVILLE STRATEGY
&
THE STATUTORY FRAMEWORK OF THE WORLD NETWORK

UNESCO

MAN AND THE BIOSPHERE PROGRAMME

CONTENTS

Reference:

UNESCO, 1996. *Biosphere reserves: The Seville Strategy and the Statutory Framework of the World Network.* UNESCO, Paris

Biosphere reserves are designed to deal with one of the most important questions the world faces today: How can we reconcile the conservation of biodiversity, the quest for economic and social development and the maintenance of associated cultural values? Biosphere reserves are areas of terrestrial and coastal/marine ecosystems which are internationally recognized under UNESCO's Man and the Biosphere (MAB) Programme. In March 1995, an international conference of experts was organized by UNESCO in Seville (Spain). The strategy that was elaborated there, known as the 'Seville Strategy', recommends the action to be taken for the future development of biosphere reserves in the 21st century. The Seville Conference also helped to finalize a Statutory Framework setting out the conditions for the functioning of the World Network of Biosphere Reserves. Both these documents were adopted under 28 C/Resolution 2.4 of the UNESCO General Conference in November 1995 and are presented in this brochure. One of the highlights of these documents is the new role that biosphere reserves can play in serving to respond to some of the concerns of Agenda 21, which resulted from the United Nations Conference on Environment and Development (Rio, 1995). At the same time, they underline the important contribution that biosphere reserves can play in the implementation of the Convention on Biological Diversity.

BIOSPHERE RESERVES

THE SEVILLE STRATEGY
&
THE STATUTORY FRAMEWORK OF THE WORLD NETWORK

UNESCO

MAN AND THE BIOSPHERE PROGRAMME

28 C/RESOLUTION 2.4 OF THE UNESCO GENERAL CONFERENCE (November 1995)

The General Conference,

Emphasizing that the Seville Conference has confirmed the special importance of the biosphere reserves established within the framework of the programme on Man and the Biosphere (MAB) for the conservation of biological diversity, in harmony with the safeguarding of the cultural values associated with them,

Considering that biosphere reserves constitute ideal sites for research, long-term monitoring, training, education and the promotion of public awareness while enabling local communities to become fully involved in the conservation and sustainable use of resources,

Considering that they are also demonstration sites and hubs of action in the context of regional development and land-use planning,

Considering that the World Network of Biosphere Reserves thus makes a major contribution to the implementation of the goals set by Agenda 21 and by the international conventions adopted at and after the Rio Conference, in particular the Convention on Biological Diversity,

Believing that it is necessary to expand and improve the present Network and to encourage regional and world-level exchanges, in particular by providing support for the efforts of the developing countries to establish, strengthen and promote biosphere reserves,

1. *Approves* the Seville Strategy and invites the Director-General to deploy the resources necessary for its effective implementation and to ensure that it enjoys the widest possible dissemination to all parties concerned;
2. *Invites* Member States to implement the Seville Strategy and to muster the resources necessary for that purpose;
3. *Invites* international and regional intergovernmental organizations and the appropriate non-governmental organizations to co-operate with UNESCO to ensure the operational development of the World Network of Biosphere Reserves and appeals to the funding bodies to mobilize the corresponding resources;
4. *Adopts* the Statutory Framework of the World Network of Biosphere Reserves, annexed hereto, and invites:
   (a) Member States to have regard to it in determining and implementing their policies in respect of biosphere reserves;
   (b) the Director-General to provide the secretariat of the World Network of Biosphere Reserves in accordance with the provisions of the Statutory Framework and thus contribute to the smooth functioning and strengthening of the Network.

THE SEVILLE STRATEGY FOR BIOSPHERE RESERVES

BIOSPHERE RESERVES: THE FIRST TWENTY YEARS

Biosphere reserves are designed to deal with one of the most important questions the World faces today: How can we reconcile conservation of biodiversity and biological resources with their sustainable use? An effective Biosphere reserve involves natural and social scientists; conservation and development groups; management authorities and local communities – all working together on this complex issue.

The concept of biosphere reserves as originated by a Task Force of UNESCO's Man and the Biosphere (MAB) Programme in 1974. The biosphere reserve network was launched in 1976 and, as of March 1995, had grown to include 324 reserves in 82 countries. The network is a key component in MAB's objective of achieving a sustainable balance between the sometimes-conflicting goals of conserving biological diversity, promoting economic development, and maintaining associated cultural values. Biosphere reserves are sites where this objective is tested, refined, demonstrated and implemented.

In 1983, UNESCO and UNEP jointly convened the First International Biosphere Reserve Congress in Minsk (Belarus), in cooperation with FAO and IUCN. The Congress's activities gave rise in 1984 to an 'Action Plan for Biosphere Reserves.' which was formally endorsed by the UNESCO General Conference and by the Governing Council of UNEP. While much of this Action Plan remains valid today, the context in which biosphere reserves operate has changed considerably as was shown by the UNCED process and, in particular, the Convention on Biological Diversity. The Convention was signed at the 'Earth Summit' in Rio de Janeiro in June 1992, entered into force in December 1993 and has now been ratified by more than 100 countries. The major objectives of the Convention are: conservation of biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from the utilization of genetic resources. Biosphere reserves promote this integrated approach and are thus well placed to contribute to the implementation of the Convention.

In the decade since the Minsk Congress, thinking about protected areas as a whole and about the biosphere reserves has been developing along parallel lines. Most importantly, the link between conservation of biodiversity and the development needs of local communities – a central component of the biosphere reserve approach – is now recognized as a key feature of the successful management of most national parks, nature reserves and other protected areas. At the Fourth World Congress on National Parks and Protected Areas, held in Caracas, Venezuela, in February 1992, the world's protected-area planners and managers adopted many of the ideas (community involvement, the links between conservation and development, the importance of international collaboration) that are essential aspects of biosphere reserves. The Congress also approved a resolution in support of biosphere reserves.

There have also been important innovations in the management of biosphere reserves themselves. New methodologies for involving stakeholders in decision-making processes and resolving conflicts have been developed, and increased attention has been given to the need to use regional approaches. New kinds of biosphere reserves, such as cluster and transboundary reserves, have been devised, and many biosphere reserves have evolved considerably, from a primary focus on conservation to a greater integration of conservation and development through increasing cooperation among stakeholders. And new international networks, fuelled by technological advances, including more powerful computers and the Internet, have greatly facilitated communication and cooperation between biosphere reserves in different countries.

In this context, the Executive Board of UNESCO decided in 1991 to establish an Advisory Committee for Biosphere Reserves. This Advisory Committee considered that it was time to evaluate the effectiveness of the 1984 Action Plan, to analyse its implementation, and to develop a strategy for biosphere reserves as we move into the 21st century.

To this end, and in accordance with Resolution 27/C/2.3 of the General Conference, UNESCO organized the International Conference on Biosphere Reserves at the invitation of the Spanish authorities in Seville (Spain) from 20 to 25 March 1995. This Conference was attended by some 400 experts from 102 countries and 15 international and regional organizations. The Conference was organized to enable an evaluation of the experience in implementing the 1984 Action Plan, a reflection on the role for biosphere reserves in the context of the 21st century (which gave rise to the vision statement) and the elaboration of a draft Statutory Framework for the World Network. The Conference drew up the Seville Strategy, which is presented below. The International Co-ordinating Council of the Man and the Biosphere (MAB) Programme, meeting for its 13th session (12-16 June 1995) gave its strong support to the Seville Strategy.

THE BIOSPHERE RESERVE CONCEPT

Biosphere reserves are 'areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognized within the framework of UNESCO's Programme on Man and the Biosphere (MAB)' (*Statutory Framework of the World Network of Biosphere Reserves*). Reserves are nominated by national governments; each reserve must meet a minimal set of criteria and adhere to a minimal set of conditions before being admitted to the Network. Each biosphere reserve is intended to fulfil three complementary functions: a conservation function, to preserve genetic resources, species, ecosystems and landscapes; a development function, to foster sustainable economic and human development, and a logistic support function, to support demonstration projects, environmental education and training, and research and monitoring related to local, national and global issues of conservation and sustainable development.

Physically, each biosphere reserve should contain three elements: one or more core areas, which are securely protected sites for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses (such as education); a clearly identified buffer zone, which usually surrounds or adjoins the core areas, and is used for co-operative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied and basic research; and a flexible transition area, or area of co-operation, which may contain a variety of agricultural activities, settlements and other uses and in which local communities, management agencies, scientists, non-governmental organizations, cultural groups, economic interests and other stakeholders work together to manage and sustainably develop the area's resources. Although originally envisioned as a series of concentric rings, the three zones have been implemented in many different ways in order to meet local needs and conditions. In fact, one of the greatest strengths of the biosphere reserve concept has been the flexibility and creativity with which it has been realized in various situations.

Some countries have enacted legislation specifically to establish biosphere reserves. In many others, the core areas and buffer zones are designated (in whole or in part) as protected areas under national law. A number of biosphere reserves simultaneously encompass areas protected under other systems (such as national parks or nature reserves) and other internationally recognized sites (such as World Heritage or Ramsar sites).

Ownership arrangements may vary, too. The core areas of biosphere reserves are mostly public land but can be also privately owned or belong to non-governmental organizations. In many cases, the buffer zone is in private or community ownership, and this is generally the case for the transition area. The Seville Strategy for Biosphere Reserves reflects this wide range of circumstances.

THE VISION FROM SEVILLE FOR THE 21ST CENTURY

What future does the world face as we move towards the 21st century ? Current trends in population growth and distribution, increasing demands for energy and natural resources, globalisation of the economy and the effects of trade patterns on rural areas, the erosion of cultural distinctiveness, centralization and difficulty of access to relevant information, and uneven spread of technological innovations – all these paint a sobering picture of environment and development prospects in the near future.

The UNCED process laid out the alternative of working towards sustainable development, incorporating care of the environment and greater social equity, including respect for rural communities and their accumulated wisdom. Agenda 21, the Conventions on Biological Diversity, Climate Change, and Desertification, and other multilateral agreements, show the way forward at the international level.

But the global community also needs working examples that encapsulate the ideas of UNCED for promoting both conservation and sustainable development. These examples can only work if they express all the social, cultural, spiritual and economic needs of society, and are also based on sound science.

Biosphere reserves offer such examples. Rather than forming islands in a world increasingly affected by severe human impacts, they can become theatres for reconciling people and nature, they can bring knowledge of the past to the needs of the future, they can demonstrate how to overcome the problems of the sectoral nature of our institutions. In short, biosphere reserves are much more than just protected areas.

Thus biosphere reserves are poised to take on a new role. Not only will they be a means for the people who live and work within and around them to attain a balanced relationship with the natural world, they will also contribute to the needs of society as a whole by showing a way to a more sustainable future. This is at the heart of the vision for biosphere reserves in the 21st century.

The International Conference on Biosphere Reserves, organized by UNESCO in Seville (Spain) from 20-25 March 1995, adopted a two-pronged approach:

- to examine past experience in implementing the innovative concept of the biosphere reserve;
- to look to the future to identify what emphases should now be given to their three functions of conservation, development and logistical support.

The Seville Conference concluded that in spite of the problems and limitations encountered with the establishment of biosphere reserves, the programme as a whole had been innovative and had had much success. In particular, the three basic functions would be as valid as ever in the coming years. In the implementation of these functions and in the light of the analysis undertaken, the following ten key directions were identified by the Conference and are the foundations of the new Seville Strategy.

1. Strengthen the contribution which biosphere reserves make to the implementation of international agreements promoting conservation and sustainable development, especially to the Convention on Biological Diversity and other agreements such as those on climate change, desertification and forests.
2. Develop biosphere reserves that include a wide variety of environmental, biological, economic and cultural situations, going from largely undisturbed regions and spreading towards cities. There is a particular potential, and need, to apply the biosphere reserve concept in the coastal and marine environment.
3. Strengthen the emerging regional, interregional and thematic networks of biosphere reserves as components within the World Network of Biosphere Reserves.
4. Reinforce scientific research, monitoring, training and education in biosphere reserves since conservation and rational use of resources in these areas require a sound base in the natural and social sciences as well as the humanities. This need is particularly acute in countries where biosphere reserves lack human and financial resources and should receive priority attention.

5. Ensure that all zones of biosphere reserves contribute appropriately to conservation, sustainable development and scientific understanding.
6. Extend the transition area to embrace large areas suitable for approaches such as ecosystem management, and use biosphere reserves to explore and demonstrate approaches to sustainable development at the regional scale. For this, more attention should be given to the transition area.
7. Reflect more fully the human dimensions of biosphere reserves. Connections should be made between cultural and biological diversity. Traditional knowledge and genetic resources should be conserved and their role in sustainable development should be recognized and encouraged.
8. Promote the management of each biosphere reserve essentially as a 'pact' between the local community and society as a whole. Management should be open, evolving and adaptive. Such an approach will help ensure that biosphere reserves – and their local communities – are better placed to respond to external political, economic and social pressures.
9. Bring together all interest groups and sectors in a partnership approach to biosphere reserves both at site and network levels. Information should flow freely among all concerned.
10. Invest in the future. Biosphere reserves should be used to further our understanding of humanity's relationship with the natural world, through programmes of public awareness, information and formal and informal education, based on a long-term, inter-generational perspective.

In sum, biosphere reserves should preserve and generate natural and cultural values through management that is scientifically correct, culturally creative and operationally sustainable. The World Network of Biosphere Reserves, as implemented through the Seville Strategy, is thus an integrating tool which can help to create greater solidarity among peoples and nations of the world.

THE STRATEGY

The following Strategy provides recommendations for developing effective biosphere reserves and for setting out the conditions for the appropriate functioning of the World Network of Biosphere Reserves. It does not repeat the general principles of the Convention on Biological Diversity nor Agenda 21, but instead identifies the specific role of biosphere reserves in developing a new vision of the relationship between conservation and development. Thus, the document is deliberately focused on a few priorities.

The Strategy suggests the level (international, national, individual biosphere reserve) at which each recommendation will be most effective. However, given the large variety of different national and local management situations, these recommended levels of actions should be seen merely as guidelines, and adapted to fit the situation at hand. Especially note that the 'national' level should be interpreted to include other governmental levels higher than the individual reserve (e.g., provincial, state, county, etc.). In some countries, national or local NGOs may also be appropriate substitutes for this level. Similarly, the 'international' level often includes regional and inter-regional activities.

The Strategy also includes recommended Implementation Indicators, *i.e.* a check-list of actions that will enable all involved to follow and evaluate the implementation of the Strategy. Criteria used in developing the Indicators were: availability (Can the information be gathered relatively easily?); simplicity (Are the data unambiguous?), and usefulness (Will the information be useful to reserve managers, National Committees, and/or the Network at large?). One role of the Implementation Indicators is to assemble a database of successful implementation mechanisms and to exchange this information among all members of the Network.

GOAL I: USE BIOSPHERE RESERVES TO CONSERVE NATURAL AND CULTURAL DIVERSITY

Objective I.1: Improve the coverage of natural and cultural biodiversity by means of the World Network of Biosphere Reserves.

Recommended at the international level:

1. Promote biosphere reserves as means of implementing the goals of the Convention on Biological Diversity.
2. Promote a comprehensive approach to biogeographical classification that takes into account such ideas as vulnerability analysis, in order to develop a system encompassing socio-ecological factors.

Recommended at the national level:

3. Prepare a biogeographical analysis of the country as a basis, *inter alia,* for assessing coverage of the World Network of Biosphere Reserves.
4. In light of the analysis, and taking into account existing protected areas, establish, strengthen or extend biosphere reserves as necessary, giving special attention to fragmented habitats, threatened ecosystems, and fragile and vulnerable environments, both natural and cultural.

Objective I.2: Integrate biosphere reserves into conservation planning.

Recommended at the international level:

1. Encourage the establishment of transboundary biosphere reserves as a means of dealing with the conservation of organisms, ecosystems, and genetic resources that cross national boundaries.

Recommended at the national level:

2. Integrate biosphere reserves in strategies for biodiversity conservation and sustainable use, in plans for protected areas, and in the national biodiversity strategies and action plans provided for in Article 6 of the Convention on Biological Diversity.
3. When applicable, include projects to strengthen and develop biosphere reserves in programmes to be initiated and funded under the Convention on Biological Diversity and other multilateral conventions.
4. Link biosphere reserves with each other, and with other protected areas, through green corridors and in other ways that enhance biodiversity conservation, and ensure that these links are maintained.
5. Use biosphere reserves for *in situ* conservation of genetic resources, including wild relatives of cultivated and domesticated species, and consider using the reserves as rehabilitation/re-introduction sites, and link them as appropriate with *ex situ* conservation and use programmes.

GOAL II: UTILIZE BIOSPHERE RESERVES AS MODELS OF LAND MANAGEMENT AND OF APPROACHES TO SUSTAINABLE DEVELOPMENT

Objective II.1: Secure the support and involvement of local people.

Recommended at the international level:

1. Prepare guidelines for key aspects of biosphere reserve management, including the resolution of conflicts, provision of local benefits, and involvement of stakeholders in decision-making and in responsibility for management.

Recommended at the national level:

2. Incorporate biosphere reserves into plans for implementing the sustainable use goals of Agenda 21 and the Convention on Biological Diversity.
3. Establish, strengthen or extend biosphere reserves to include areas where traditional life styles and indigenous uses of biodiversity are practiced (including sacred sites), and/or where there are critical interactions between people and their environment (e.g., peri-urban areas, degraded rural areas, coastal areas, freshwater environments and wetlands).
4. Identify and promote the establishment of activities compatible with the goals of conservation through the transfer of appropriate technologies which include traditional knowledge and which promote sustainable development in the buffer and transition zones.

Recommended at the individual reserve level:

5. Survey the interests of the various stakeholders and fully involve them in planning and decision-making regarding the management and use of the reserve.
6. Identify and address factors that lead to environmental degradation and unsustainable use of biological resources.
7. Evaluate the natural products and services of the reserve and use these evaluations to promote environmentally sound and economically sustainable income opportunities for local people.
8. Develop incentives for the conservation and sustainable use of natural resources, and develop alternative means of livelihood for local populations when existing activities are limited or prohibited within the biosphere reserve.
9. Ensure that the benefits derived from the use of natural resources are equitably shared with the stakeholders, by such means as sharing the entrance fees, sale of natural products or handicrafts, use of local construction techniques and labour, and development of sustainable activities (e.g., agriculture, forestry, etc.).

Objective II.2: Ensure better harmonization and interaction among the different biosphere reserve zones.

Recommended at the national level:

1. Ensure that each biosphere reserve has an effective management policy or plan and an appropriate authority or mechanism to implement it.
2. Develop means of identifying incompatibilities between the conservation and sustainable use functions of biosphere reserves and take measures to ensure that an appropriate balance between the functions is maintained.

Recommended at the individual reserve level:

3. Develop and establish institutional mechanisms to manage, co-ordinate and integrate the biosphere reserve's programmes and activities.
4. Establish a local consultative framework in which the reserve's economic and social stakeholders are represented, including the full range of interests (e.g., agriculture, forestry, hunting and extracting, water and energy supply, fisheries, tourism, recreation, research).

Objective II.3: Integrate biosphere reserves into regional planning.

Recommended at the national level:

1. Include biosphere reserves in regional development policies and in regional land-use planning projects.
2. Encourage the major land-use sectors near each biosphere reserve to adopt practices favouring sustainable land use.

Recommended at the individual reserve level:

3. Organize forums and set up demonstration sites for the examination of socio-economic and environmental problems of the region and for the sustainable utilization of biological resources important to the region.

GOAL III: USE BIOSPHERE RESERVES FOR RESEARCH, MONITORING, EDUCATION AND TRAINING

Objective III.1: Improve knowledge of the interactions between humans and the biosphere.

Recommended at the international level:

1. Use the World Network of Biosphere Reserves to conduct comparative environmental and socio-economic research, including long-term research that will require decades to complete.
2. Use the World Network of Biosphere Reserves for international research programmes that deal with topics such as biological diversity, desertification, water cycles, ethnobiology, and global change.
3. Use the World Network of Biosphere Reserves for co-operative research programmes at the regional and inter-regional levels, such as those existing for the Southern Hemisphere, East Asia and Latin America.
4. Encourage the development of innovative, interdisciplinary research tools for biosphere reserves, including flexible modelling

systems for integrating social, economic and ecological data.

5. Develop a clearing house for research tools and methodologies in biosphere reserves.
6. Encourage interactions between the World Network of Biosphere Reserves and other research and education networks, and facilitate the use of the biosphere reserves for collaborative research projects of consortia of universities and other institutions of higher learning and research, in the private as well as public sector, and at non-governmental as well as governmental levels.

Recommended at the national level:

7. Integrate biosphere reserves with national and regional scientific research programmes, and link these research activities to national and regional policies on conservation and sustainable development.

Recommended at the individual reserve level:

8. Use biosphere reserves for basic and applied research, particularly projects with a focus on local issues, interdisciplinary projects incorporating both the natural and the social sciences, and projects involving the rehabilitation of degraded ecosystems, the conservation of soils and water and the sustainable use of natural resources.
9. Develop a functional system of data management for rational use of research and monitoring results in the management of the biosphere reserve.

Objective III.2: Improve monitoring activities.

Recommended at the international level:

1. Use the World Network of Biosphere Reserves, at the international, regional, national and local levels, as priority long-term monitoring sites for international programmes focused on topics such as terrestrial and marine observing systems, global change, biodiversity, and forest health.
2. Encourage the adoption of standardized protocols for meta-data concerning the description of flora and fauna, to facilitate the interchange, accessibility and utilization of scientific information generated in biosphere reserves.

Recommended at the national level:

3. Encourage the participation of biosphere reserves in national programmes of ecological and environmental monitoring and development of linkages between biosphere reserves and other monitoring sites and networks.

Recommended at the individual reserve level:

4. Use the reserve for making inventories of fauna and flora, collecting ecological and socio-economic data, making meteorological and hydrological observations, studying the effects of pollution, etc., for scientific purposes and as the basis for sound site management.
5. Use the reserve as an experimental area for the development and testing of methods and approaches for the evaluation and monitoring of biodiversity, sustainability and quality of life of its inhabitants.
6. Use the reserve for developing indicators of sustainability (in ecological, economic, social and institutional terms) for the different productive activities carried out within the buffer zones and transition areas.
7. Develop a functional system of data management for rational use of research and monitoring results in the management of the biosphere reserve.

Objective III.3: Improve education, public awareness and involvement.

Recommended at the international level:

1. Facilitate exchange of experience and information between biosphere reserves, with a view to strengthening the involvement of volunteers and local people in biosphere reserve activities.
2. Promote the development of communication systems for diffusing information on biosphere reserves and on experiences at the field level.

Recommended at the national level:

3. Include information on conservation and sustainable use, as practiced in biosphere reserves, in school programmes and teaching manuals, and in media efforts.

4. Encourage participation of biosphere reserves in international networks and programmes, to promote cross-cutting linkages in education and public awareness.

Recommended at the individual reserve level:

5. Encourage involvement of local communities, schoolchildren and other stakeholders in education and training programmes and in research and monitoring activities within biosphere reserves.
6. Produce visitors' information about the reserve, its importance for conservation and sustainable use of biodiversity, its socio-cultural aspects, and its recreational and educational programmes and resources.
7. Promote the development of ecology field educational centres within individual reserves, as facilities for contributing to the education of schoolchildren and other groups.

Objective III.4: Improve training for specialists and managers.

Recommended at the international level:

1. Utilize the World Network of Biosphere Reserves to support and encourage international training opportunities and programmes.
2. Identify representative biosphere reserves to serve as regional training centres.

Recommended at the national level:

3. Define the training needed by biosphere reserve managers in the 21st century and develop model training programmes on such topics as how to design and implement inventory and monitoring programmes in biosphere reserves, how to analyze and study socio-cultural conditions, how to solve conflicts, and how to manage resources co-operatively in an ecosystem or landscape context.

Recommended at the individual reserve level:

4. Use the reserve for on-site training and for national, regional and local seminars.
5. Encourage appropriate training and employment of local people and other stakeholders to allow their full participation in inventory, monitoring and research in programmes in biosphere reserves.
6. Encourage training programmes for local communities and other local agents (such as decision-makers, local leaders and agents working in production, technology transfer, and community development programmes) in order to allow their full participation in the planning, management and monitoring processes of biosphere reserves.

GOAL IV: IMPLEMENT THE BIOSPHERE RESERVE CONCEPT

Objective IV.1: Integrate the functions of biosphere reserves.

Recommended at the international level:

1. Identify and publicize demonstration (model or illustrative examples of) biosphere reserves, whose experiences will be beneficial to others, at the national, regional and international levels.
2. Give guidance/advice on the elaboration and periodic review of strategies and national action plans for biosphere reserves.
3. Organize forums and other information exchange mechanisms for biosphere reserve managers.
4. Prepare and disseminate information on how to develop management plans or policies for biosphere reserves.
5. Prepare guidance on management issues at biosphere reserve sites, including, *inter alia*, methods to ensure local participation, case studies of various management options, and techniques of conflict resolution.

Recommended at the national level:

6. Ensure that each biosphere reserve has an effective management policy or plan and an appropriate authority or mechanism to implement it.
7. Encourage private sector initiatives to establish and maintain environmentally and socially sustainable activities in appropriate zones of biosphere reserves and in surrounding areas, in order to stimulate community development.
8. Develop and periodically review strategies

and national action plans for biosphere reserves; these strategies should strive for complementarity and added value of biosphere reserves with respect to other national instruments for conservation.

9. Organize forums and other information exchange mechanisms for biosphere reserve managers.

Recommended at the individual reserve level:

10. Identify and map the different zones of biosphere reserves and define their respective status.
11. Prepare, implement and monitor an overall management plan or policy that includes all of the zones of biosphere reserves.
12. Where necessary, in order to preserve the core area, re-plan the buffer and transition zones according to sustainable development criteria.
13. Define and establish institutional mechanisms to manage, co-ordinate and integrate the reserve's programmes and activities.
14. Ensure that the local community participate in planning and management of biosphere reserves.
15. Encourage private sector initiatives to establish and maintain environmentally and socially sustainable activities in the reserve and surrounding areas.

Objective IV.2: Strengthen the World Network of Biosphere Reserves.

Recommended at the international level:

1. Facilitate provision of adequate resources for implementation of the Statutory Framework of the World Network of Biosphere Reserves.
2. Facilitate the periodic review by each country of its biosphere reserves, as required in the Statutory Framework of the World Network of Biosphere Reserves, and assist countries in taking measures to make their biosphere reserves functional.
3. Support the functioning of the Advisory Committee for Biosphere Reserves and fully consider and utilize its recommendations and guidance.
4. Lead the development of communication among biosphere reserves, taking into account their communication and technical capabilities, and strengthen existing and planned regional or thematic networks.
5. Develop creative connections and partnerships with other networks of similar managed areas, and with international governmental and non-governmental organizations with goals congruent with those of biosphere reserves.
6. Promote and facilitate twinning between biosphere reserve sites and foster transboundary reserves.
7. Give biosphere reserves more visibility by disseminating information materials, developing communication policies, and highlighting their roles as members of the World Network of Biosphere Reserves.
8. Wherever possible, advocate the inclusion of biosphere reserves in projects financed by bilateral and multilateral aid organizations
9. Mobilize private funds, from businesses, NGOs and foundations, for the benefit of biosphere reserves.
10. Develop standards and methodologies for collecting and exchanging various types of data, and assist their application across the Network of Biosphere Reserves.
11. Monitor, assess and follow up on the implementation of the Seville Strategy, utilizing the Implementation Indicators, and analyze the factors that aid in attainment of the indicators, as well as those that hinder such attainment.

Recommended at the national level:

12. Facilitate provision of adequate resources for implementation of the Statutory Framework of the World Network of Biosphere Reserves.
13. Develop a national-level mechanism to advise and co-ordinate the biosphere reserves; and fully consider and utilize its recommendations and guidance.
14. Prepare an evaluation of the status and operations of each of the country's biosphere reserves, as required in the Statutory Framework, and provide appropriate resources to address any deficiencies.
15. Develop creative connections and partnerships with other networks of similar

managed areas and with international governmental and non-governmental organizations with goals congruent with those of the biosphere reserves.

16. Seek opportunities for twinning between biosphere reserves and establish transboundary biosphere reserves, where appropriate.
17. Give biosphere reserves more visibility by disseminating information materials, developing communication policies, and highlighting their roles as members of the Network.
18. Include biosphere reserves in proposals for financing from international and bilateral funding mechanisms, including the Global Environment Facility.
19. Mobilize private funds, from businesses, NGOs and foundations, for the benefit of biosphere reserves.
20. Monitor, assess and follow up on the implementation of the Seville Strategy, utilizing the Implementation Indicators, and analyze the factors that aid in attainment of the indicators, as well as those that hinder such attainment.

Recommended at the individual reserve level:

21. Give biosphere reserves more visibility by disseminating information materials, developing communication policies, and highlighting their roles as members of the Network.
22. Mobilize private funds, from businesses, NGOs and foundations, for the benefit of biosphere reserves.
23. Monitor, assess and follow up on the implementation of the Seville Strategy, utilizing the Implementation Indicators, and analyze the factors that aid in attainment of the indicators, as well as those that hinder such attainment.

IMPLEMENTATION INDICATORS	CROSS REFERENCE
International level	
Biosphere reserves included in implementation of the Convention on Biological Diversity	I.1.1
Improved biogeographical system developed	I.1.2
New trans-boundary biosphere reserves developed	I.2.1; IV.2.6
Guidelines developed and published	II.1.1; IV.1.4 ; IV.1.5
Comparative research programmes implemented	III.1.1
Biosphere reserves incorporated into international research programmes	III.1.2
Regional and inter-regional research programmes developed	III.1.3
Interdisciplinary research tools developed	III.1.4
Clearing house for research tools and methodologies developed	III.1.5
Interactions developed with other research and education networks	III.1.6
Biosphere reserves incorporated into international monitoring programmes	III.2.1
Standardized protocols and methodologies adopted for data and for data exchange	III.2.2; IV.2.10
Mechanism developed for exchanging experiences and information between biosphere reserves	III.3.1
Biosphere reserve communication system implemented	III.3.2; IV.2.4; IV.2.7
International training opportunities and programmes developed	III.4.1
Regional training centres identified and developed	III.4.2
Demonstration biosphere reserves identified and publicized	IV.1.1
Guidance provided on elaboration and review of strategies and national action plans for biosphere reserves	IV.1.2
Mechanisms developed for information exchange among biosphere reserve managers	IV.1.3
Statutory Framework of the World Network of Biosphere Reserves is implemented at the international and national levels	IV.2.1;IV.2.2
Advisory Committee for Biosphere Reserves is functional and effective	IV.2.3
Regional or thematic networks developed or strengthened	IV.2.4
Interactions developed between biosphere reserves and similar managed areas and organizations	IV.2.5
Mechanisms developed to foster twinning between biosphere reserves	IV.2.6
Information and promotional materials developed for the World Network of Biosphere Reserves	IV.2.7
Strategies developed for including biosphere reserves in bilateral and multilateral aid projects	IV.2.8
Strategies developed for mobilizing funds from businesses, NGOs and foundations	IV.2.9
Data standards and methodologies applied across the World Network	IV.2.10
Mechanisms developed for monitoring and assessing the implementation of the Seville Strategy at national level	IV.2.11

IMPLEMENTATION INDICATORS — CROSS REFERENCE

National level

Implementation indicators	Cross reference
Biogeographical analysis prepared	I.1.3
Analysis of need for new or extended biosphere reserves is completed	I.1.4 ; II.1.3
Biosphere reserves included in national strategies and other responses to the Convention on Biological Diversity and other conventions	I.2.2; I.1. 3
Links developed between biosphere reserves	I.2.4
In situ conservation plans for genetic resources in biosphere reserves	I.2.5
Biosphere reserves incorporated into sustainable development plans	II.1.2
Biosphere reserves developed or strengthened to include traditional life styles and in areas of critical people-environment interactions	II.1.3
Conservation and sustainable use activities identified and promoted	II.1.4
Effective management plans or policies in place at all biosphere reserves	II.2.1; IV.1.6
Mechanisms developed for identifying incompatibilities between conservation and sustainable use functions and to ensure an appropriate balance between these functions	II.2.2
Biosphere reserves included in regional development and land-use planning projects	II.3.1
Land-use sectors near biosphere reserves are encouraged to adopt sustainable practices	II.3.2; IV.1.7
Biosphere reserves are integrated into national and regional research programmes which are linked to conservation and development policies	III.1.7
Biosphere reserves are integrated into national monitoring programmes and are linked to similar monitoring sites and networks	III.2.3
Principles of conservation and sustainable use, as practiced in biosphere reserves, integrated into school programmes	III.3.3
Biosphere reserves participate in international education networks and programmes	III.3.4
Model training programmes for biosphere reserve managers are developed	III.4.3
Mechanisms developed to review national strategies and action plans for biosphere reserves	IV.1.8
Mechanisms developed for information exchange among biosphere reserve managers	IV.1.9
Statutory Framework of the World Network of Biosphere Reserves are implemented at the national level	IV.2.12; IV.2.14
National-level mechanism developed to advise and co-ordinate biosphere reserves	IV.2.13
Interactions developed between biosphere reserves and similar managed areas and organizations with congruent goals	IV.2.15
Mechanisms developed to foster twinning between biosphere reserves	IV.2.16
Information and promotional materials developed for Biosphere Reserves	IV.2.17
Strategies developed for including biosphere reserves in bilateral and multilateral aid projects	IV.2.18
Strategies developed for mobilizing funds from businesses, NGOs and foundations	IV.2.19
Mechanisms developed for monitoring and assessing the implementation of the Seville Strategy	IV.2.20

IMPLEMENTATION INDICATORS	CROSS REFERENCE
Individual reserve level	
Survey made of stakeholders' interests	II.1.5
Factors leading to environmental degradation and unsustainable use are identified	II.1.6
Survey made of the natural products and services of the biosphere reserve	II.1.7
Incentives identified for sustainable use by local populations	II.1.8
Plan prepared for equitable sharing of benefits	II.1.9
Mechanisms developed to manage, co-ordinate and integrate the biosphere reserve's programmes and activities	II.2.3; IV.1.10; IV.1.12
Local consultative framework implemented	II.2.4
Regional demonstration sites developed	II.3.3
Co-ordinated research and monitoring plan implemented	III.1.8; III.2.4
Functional data management system implemented	III.1.9; III.2.7
Biosphere reserve is used for developing and testing of monitoring methods	III.2.5
Biosphere reserve is used for developing indicators of sustainability relevant to local populations	III.2.5 ; II.2.6
Local stakeholders are included in education, training, research and monitoring programmes	III.3.5; III.4.5
Information for visitors to the biosphere reserve developed	III.3.6
Ecology field centre developed at the biosphere reserve	III.3.7
Biosphere reserve is used for on-site training activities	III.4.4
A local educational and training programme is in place	III.4.6
Different zones of biosphere reserves identified and mapped	IV.1.10.
Buffer and transition zones replaned to promote sustainable development and preserve the core area.	IV.1.12
Local community involved in planning and managing the biosphere reserve	IV.1.14
Private sector initiatives to establish and maintain environmentally and socially sustainable activities are encouraged.	IV.1.15
Information and promotional materials developed for individual biosphere reserves	IV.2.21
Strategies developed for mobilizing funds from businesses, NGOs and foundations	IV.2.22
Mechanisms developed for monitoring and assessing the implementation of the Seville Strategy at individual level	IV.2.23

THE STATUTORY FRAMEWORK OF THE WORLD NETWORK OF BIOSPHERE RESERVES

Introduction

Within UNESCO's Man and the Biosphere (MAB) programme, biosphere reserves are established to promote and demonstrate a balanced relationship between humans and the biosphere. Biosphere reserves are designated by the International Co-ordinating Council of the MAB Programme, at the request of the State concerned. Biosphere reserves, each of which remains under the sole sovereignty of the State where it is situated and thereby submitted to State legislation only, form a World Network in which participation by the States is voluntary.

The present Statutory Framework of the World Network of Biosphere Reserves has been formulated with the objectives of enhancing the effectiveness of individual biosphere reserves and strengthening common understanding, communication and co-operation at regional and international levels.

This Statutory Framework is intended to contribute to the widespread recognition of biosphere reserves and to encourage and promote good working examples. The delisting procedure foreseen should be considered as an exception to this basically positive approach, and should be applied only after careful examination, paying due respect to the cultural and socio-economic situation of the country, and after consulting the government concerned.

The text provides for the designation, support and promotion of biosphere reserves, while taking account of the diversity of national and local situations. States are encouraged to elaborate and implement national criteria for biosphere reserves which take into account the special conditions of the State concerned.

Article 1 - Definition

Biosphere reserves are areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognized within the framework of UNESCO's programme on Man and the Biosphere (MAB), in accordance with the present Statutory Framework.

Article 2 - World Network of Biosphere Reserves

1. Biosphere reserves form a worldwide network, known as the World Network of Biosphere Reserves, hereafter called the Network.
2. The Network constitutes a tool for the conservation of biological diversity and the sustainable use of its components, thus contributing to the objectives of the Convention on Biological Diversity and other pertinent conventions and instruments.
3. Individual biosphere reserves remain under the sovereign jurisdiction of the States where they are situated. Under the present Statutory Framework, States take the measures which they deem necessary according to their national legislation.

Article 3 - Functions

In combining the three functions below, biosphere reserves should strive to be sites of excellence to explore and demonstrate approaches to conservation and sustainable development on a regional scale:

(i) conservation - contribute to the conservation of landscapes, ecosystems, species and genetic variation;

(ii) development - foster economic and human development which is socio-culturally and ecologically sustainable;

(iii) logistic support - support for demonstration projects, environmental education and training, research and monitoring related to local, regional, national and global issues of conservation and sustainable development.

Article 4 - Criteria

General criteria for an area to be qualified for designation as a biosphere reserve:

1. It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions.
2. It should be of significance for biological diversity conservation.
3. It should provide an opportunity to explore

and demonstrate approaches to sustainable development on a regional scale.

4. It should have an appropriate size to serve the three functions of biosphere reserves, as set out in Article 3.
5. It should include these functions, through appropriate zonation, recognizing:
   (a) a legally constituted core area or areas devoted to long-term protection, according to the conservation objectives of the biosphere reserve, and of sufficient size to meet these objectives;
   (b) a buffer zone or zones clearly identified and surrounding or contiguous to the core area or areas, where only activities compatible with the conservation objectives can take place;
   (c) an outer transition area where sustainable resource management practices are promoted and developed.
6. Organizational arrangements should be provided for the involvement and participation of a suitable range of *inter alia* public authorities, local communities and private interests in the design and carrying out the functions of a biosphere reserve.
7. In addition, provisions should be made for:
   (a) mechanisms to manage human use and activities in the buffer zone or zones;
   (b) a management policy or plan for the area as a biosphere reserve;
   (c) a designated authority or mechanism to implement this policy or plan;
   (d) programmes for research, monitoring, education and training.

Article 5 - Designation procedure

1. Biosphere reserves are designated for inclusion in the Network by the International Co-ordinating Council (ICC) of the MAB programme in accordance with the following procedure:
   (a) States, through National MAB Committees where appropriate, forward nominations with supporting documentation to the secretariat after having reviewed potential sites, taking into account the criteria as defined in Article 4;
   (b) the secretariat verifies the content and supporting documentation: in the case of incomplete nomination, the secretariat requests the missing information from the nominating State;
   (c) nominations will be considered by the Advisory Committee for Biosphere Reserves for recommendation to ICC;
   (d) ICC of the MAB programme takes a decision on nominations for designation.

   The Director-General of UNESCO notifies the State concerned of the decision of ICC.
2. States are encouraged to examine and improve the adequacy of any existing biosphere reserve, and to propose extension as appropriate, to enable it to function fully within the Network. Proposals for extension follow the same procedure as described above for new designations.
3. Biosphere reserves which have been designated before the adoption of the present Statutory Framework are considered to be already part of the Network. The provisions of the Statutory Framework therefore apply to them.

Article 6 - Publicity

1. The designation of an area as a biosphere reserve should be given appropriate publicity by the State and authorities concerned, including commemorative plaques and dissemination of information material.
2. Biosphere reserves within the Network, as well as the objectives, should be given appropriate and continuing promotion.

Article 7 - Participation in the Network

1. States participate in or facilitate co-operative activities of the Network, including scientific research and monitoring, at the global, regional and subregional levels.
2. The appropriate authorities should make available the results of research, associated publications and other data, taking into account intellectual property rights, in order to ensure the proper functioning of the Network and maximize the benefits from information exchanges.
3. States and appropriate authorities should

promote environmental education and training, as well as the development of human resources, in co-operation with other biosphere reserves in the Network.

Article 8 - Regional and thematic subnetworks

States should encourage the constitution and co-operative operation of regional and/or thematic subnetworks of biosphere reserves, and promote development of information exchanges, including electronic information, within the framework of these subnetworks.

Article 9 - Periodic review

1. The status of each biosphere reserve should be subject to a periodic review every ten years, based on a report prepared by the concerned authority, on the basis of the criteria of Article 4, and forwarded to the secretariat by the State concerned.
2. The report will be considered by the Advisory Committee for Biosphere Reserves for recommendation to ICC.
3. ICC will examine the periodic reports from States concerned.
4. If ICC considers that the status or management of the biosphere reserve is satisfactory, or has improved since designation or the last review, this will be formally recognized by ICC.
5. If ICC considers that the biosphere reserve no longer satisfies the criteria contained in Article 4, it may recommend that the State concerned take measures to ensure conformity with the provisions of Article 4, taking into account the cultural and socio-economic context of the State concerned. ICC indicates to the secretariat actions that it should take to assist the State concerned in the implementation of such measures.
6. Should ICC find that the biosphere reserve in question still does not satisfy the criteria contained in Article 4, within a reasonable period, the area will no longer be referred to as a biosphere reserve which is part of the Network.
7. The Director-General of UNESCO notifies the State concerned of the decision of ICC.
8. Should a State wish to remove a biosphere reserve under its jurisdiction from the Network, it notifies the secretariat. This notification shall be transmitted to ICC for information. The area will then no longer be referred to as a biosphere reserve which is part of the Network.

Article 10 - Secretariat

1. UNESCO shall act as the secretariat of the Network and be responsible for its functioning and promotion. The secretariat shall facilitate communication and interaction among individual biosphere reserves and among experts. UNESCO shall also develop and maintain a worldwide accessible information system on biosphere reserves, to be linked to other relevant initiatives.
2. In order to reinforce individual biosphere reserves and the functioning of the Network and subnetworks, UNESCO shall seek financial support from bilateral and multilateral sources.
3. The list of biosphere reserves forming part of the Network, their objectives and descriptive details, shall be updated, published and distributed by the secretariat periodically.

For more information
about biosphere reserves contact:

World Network of Biosphere Reserves
Division of Ecological Sciences
UNESCO
1, rue Miollis
75732 Paris Cédex 15
France

Tel: + 33.1.45.68.41.51
Fax: + 33.1.40.65.98.97
e-mail: mab@unesco.org

Eidesstattliche Erklärung

Hiermit erkläre ich, Ariel Rodríguez-Vargas, daß meine bei dem Promotionsausschuß der Biologie Fakultät der Philipps-Universität Marburg eingereichte Dissertation mit dem Thema: „**Sustainability Analysis in La Amistad Panama Biosphere Reserve**“:

1. von mir selbständig angefertigt wurde und andere Quellen und Hilfsmittel als die angegebenen nicht benutzt wurden,
2. daß die Dissertation weder in dieser noch in einer anderen Form einer anderen Fakultät vorgelegt worden ist,
3. daß die Dissertation weder als Ganzes noch Teile daraus anderweitig als Prüfungsarbeit bei einer akademischen oder Staatsprüfung verwendet worden ist und daß von mir keine, von einer anderen Prüfungsbehörde zurückgewiesene
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Marburg, im 28 Februar 2014 Unterschrift