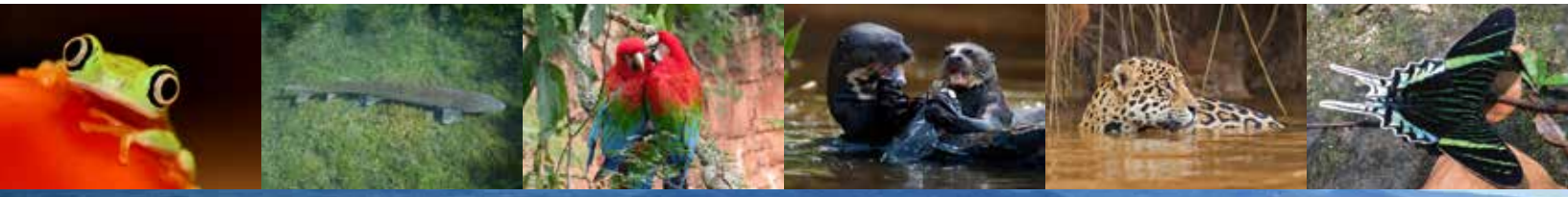
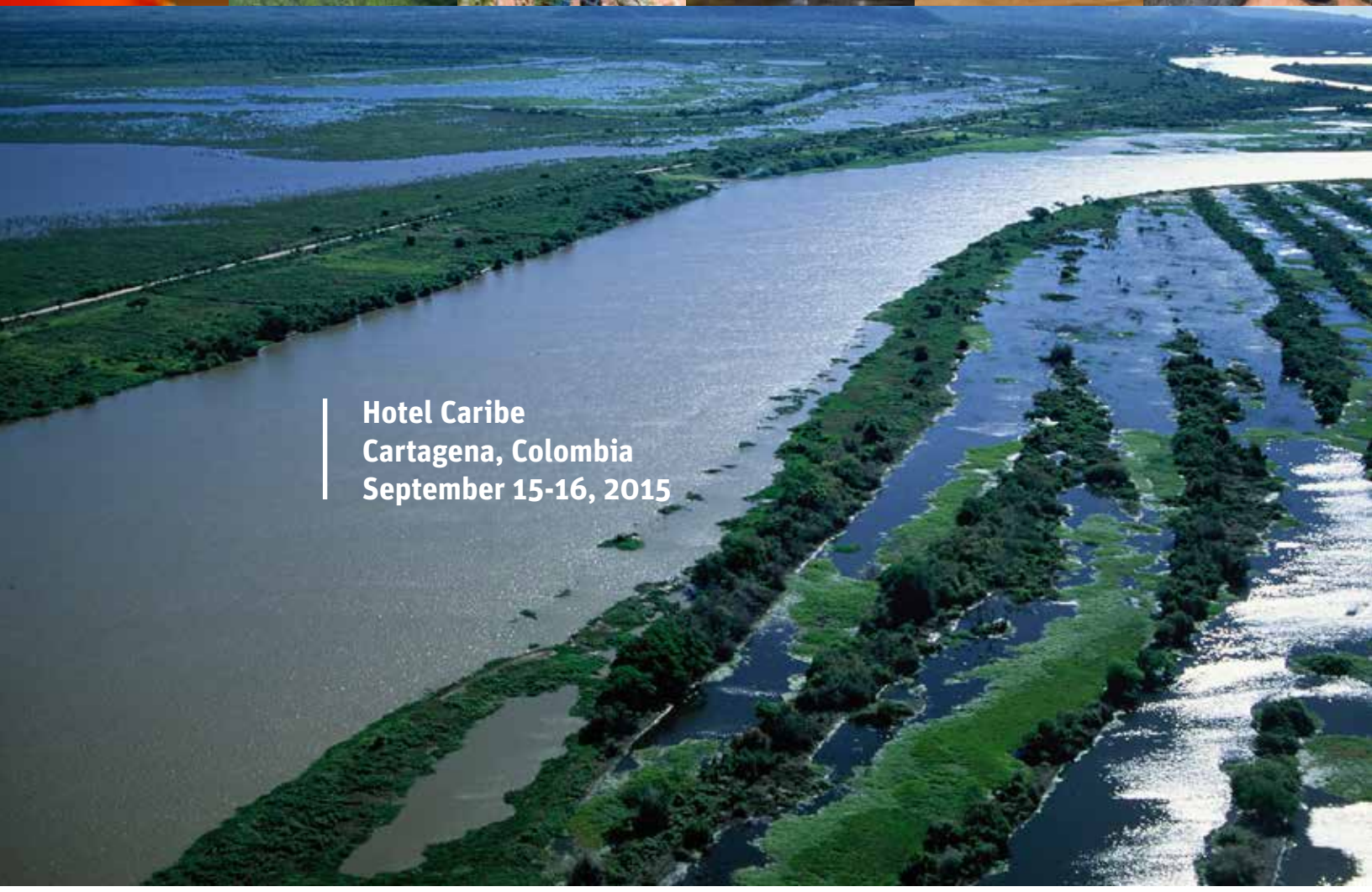
Proceedings of South-South Exchange on Hydropower Planning





Hotel Caribe
Cartagena, Colombia
September 15-16, 2015

The Nature Conservancy
Protecting nature. Preserving life.

IDB
Inter-American Development Bank

Aknowledgements[1]

The authors are grateful to Jerry Touval of TNC. Gratitude is also extended to all the speakers, presenters and participants of the conference.

Giant otters, Brazil. Photo: Thinkstock.com

Cover photos: Thinkstock.com

[1] These Proceedings were prepared by Juan Quintero, environmental specialist and Aradhna Mathur for TNC.

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Blue and yellow macaw. Photo: Thinkstock.com

Summary of the Meeting

● Dams under construction
● Dams planned

The Nature Conservancy (TNC), with support of the Inter-American Development Bank (IDB), convened the South-South Exchange for Hydropower Planning in Cartagena, Colombia on September 15-16, 2015. The objective of this meeting was to promote a regional dialogue among the participating countries to share information and best practices on conserving biodiversity and ecosystem services in the framework of hydropower development, as well as to foster a dialogue between key countries about tools for avoiding, minimizing and compensating impacts from hydropower development on freshwater biodiversity and ecosystem services.

Specific topics focused on integrating planning for conservation with basin-scale planning for hydropower development, building the mitigation hierarchy into licensing policies, and specific instruments such as aquatic offsets.

Government officials from five countries, representatives from the IDB and The World Bank along with the participants, discussed the challenges for integrating biodiversity and ecosystem services into hydropower development in the region and proposed solutions to address the issue. Speakers represented a wide range of institutions, public and private, non-governmental organizations, consultants and hydropower developers in Latin America. The meeting provided an important platform for regional collaboration on sustainable hydropower development.

The meeting covered a broad array of complex topics but more importantly, it recommended specific measures that are required to better integrate and mainstream biodiversity and ecosystem services (BES) conservation into hydropower planning in the region.

Hotel Caribe
Cartagena, Colombia
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Itaipu Dam, Brazil. Photo: Thinkstock.com

Day 1: 15th September

OPENING SESSION

Panel—Maria Claudia García Davila, Aurelio Ramos and Ernani Pila

The panel opened the conference by raising key challenges facing the protection of biodiversity and ecosystem services during hydropower development. It was pointed out that fresh water systems are facing significant biodiversity loss and the modalities of addressing biodiversity and ecosystem services are more complex in aquatic habitats than terrestrial habitats. As there is a proliferation of hydropower projects in Latin America, there is a need for basin scale/regional planning to minimize environmental impacts and maximize social profits. The Mitigation Hierarchy has to be part of the planning process. The effects of climate change also have to be considered as the frequency of extreme weather events is increasing. Tools for better planning including developing environmental compensation schemes are necessary.

Following the opening Panel session, the regulatory framework for compensation in Colombia was presented by one of the Panel members.

setting sun glints off the Amazon River. Photo: NASA

Presentation on Colombia's Compensation Strategy for Biodiversity Loss

Maria Claudia García Davila

Colombia is a mega diverse country having more than 10% of all species globally. The rich biodiversity and the associated ecosystem services are essential for economic development. To promote green growth and sustainable development the "National Strategy for Compensation for Biodiversity Loss" was developed. It lays out strategic priorities which include identification and evaluation of the costs and benefits of production activities and the maintenance of ecosystem services derived from biodiversity and; strengthening institutions for assessing the environmental impacts of projects and the allocation of compensation for loss of biodiversity. The goal is to reach a point where biodiversity losses due to the impacts of a project are balanced with the profits generated by the compensation and can go even beyond to have a net income or positive benefits.

In a number of projects the Mitigation Hierarchy i.e. avoidance, minimization restoration and compensation have been applied. For example, re-routing pipelines or roads to avoid wetlands, slope stabilization to minimize landslides and erosion, restoring topsoil to restore areas affected during construction.

Currently, in Colombia a strategy for compensation for biodiversity loss has been developed and the challenge is to develop laws to compensate for biodiversity in fresh water and marine systems.

Presentation on Regulations on Biodiversity and Ecosystem Services in Latin America

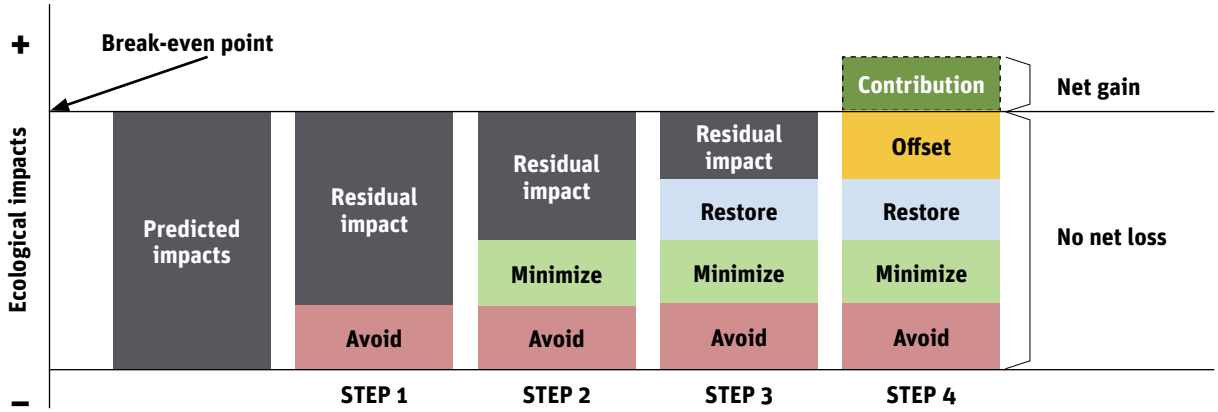
Juan Quintero

The paper "*Integrating biodiversity and ecosystem services into hydropower development in Latin America*" was presented. The paper lays out the status of the regulatory processes incorporating biodiversity and ecosystem services for planning and licensing of hydropower projects in five Latin American countries i.e. Colombia, Peru, Brazil, Mexico and Panama (See Annex I). The paper also describes the management of biodiversity and ecosystem services across four hydropower projects in different stages of development to showcase how these issues can be integrated into hydropower planning and development. The case studies are the Reventazón Hydroelectric Project in Costa Rica, Chaglla Hydropower Project in Peru, the Nam Theun 2 hydropower project in Lao PDR and hydropower planning in Coatzacoalcos river basin in Mexico.

As a best practice, the concept of the Mitigation Hierarchy is introduced. To fully integrate environmental and social sustainability into infrastructure development, a systematic approach is required. Ideally, infrastructure projects should first avoid, then minimize, then rehabilitate, and finally, when the previous options are exhausted, offset its impacts to achieve no net loss in biodiversity.

All countries have well established Environmental Impact Assessment (EIA) systems linked to the licensing process. A review of the regulatory framework of the 5 countries reveals some gaps and well as good policies that encourage biodiversity and ecosystem protection for hydropower projects. Example of such positive policies include:

- The Watershed Law, Colombia: It requires all efforts to be made to maintain and restore the environment of a watershed. 6% of the gross sale of hydroelectricity has to be paid by the operators of the plant.
- Compensation Guidelines, Peru: These strengthen the EIA system to establish mechanisms that guide companies whose projects are capable of producing environmental impacts that cannot be prevented or mitigated. In such cases, these companies must implement a Compensation Plan in order to increase or enhance the status of ecosystems.



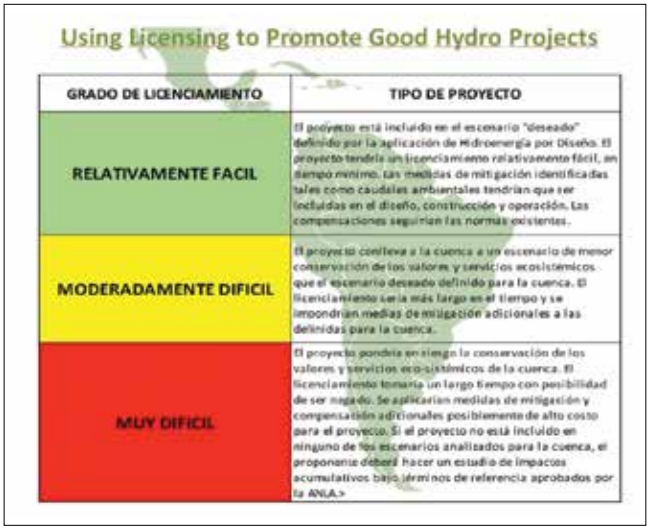
Source: JICA, 2013.

- National Policy on Water Resources, Brazil: The law stipulates that resources generated through the use of water should be used to protect the resource at its origin. Thus, water payments could be directed towards conservation projects.
- General Act on Ecological Equilibrium and Environmental Protection (LGEEPA), Mexico: For projects in which significant environmental impacts have been identified, the LGEEPA expects the payment of economic guarantees (environmental insurances and guarantees) in order to ensure environmental protection or the reparation of damage.
- Legislation on Payment and Compensation Fee for Environmental Services, Panama: This states that projects with high environmental impacts such as power plants, transmission lines etc. shall include in its scheme investment compensation for environmental services. Payments for ecological services of these works or projects activities may not be less than 0.5% (half percent) of the cost of the work or the annual operating budget of the activity.

The four case studies were also presented and during the conference, presentations on three of the Latin American case studies were also given (see presentation summaries for further details). The Nam Theun 2 hydroelectric project in Lao PDR exemplifies an extensive monitoring framework to ensure mitigation measures are implemented and achieving their objectives. There are two levels of monitoring—internal monitoring carried out by the power company and relevant government units and; external monitoring comprising of many layers such as International Panel of Experts, Dam Safety Review Panel, International Financial Institutions etc.

Based on the experiences from the review of the BES legislations as applicable to hydropower projects and the hydropower case studies, a number of issues came to light:

- A regulatory framework to adequately incorporate the effects of hydropower development on biodiversity and ecosystem services is lacking in Latin America.
- Project approval is linked to the licensing process which has its own limitations. For example, most licenses in Latin America require practically the final designs. At this stage all major developmental decisions have already taken place.
- The challenges faced by the environmental impact assessment process impede sound environmental analysis. For example, the EIAs are focused on assessing direct impacts especially concentrating on impacts during construction. There is lesser emphasis given to the determination, prediction and analysis of induced and cumulative impacts.
- Data gathered to meet the licensing and EIA requirements is inadequate for planning and monitoring impacts.
- Institutional capacity is weak across sectors.
- There is lack of strategic planning.



The issue of mainstreaming BES in hydropower planning and a planning approach called "Hydropower by Design" were also presented. There are many restrictions for this in Latin America, including institutional dispersion, the timing of EIAs with respect to the design and construction process, absence of cumulative impact assessments, emphasis on baseline data and monitoring, and unclear responsibilities for watershed management. Often excessive baseline data is gathered without consideration of its usefulness. Indicators to determine impacts are not identified. As a result, copious amounts of data is generated and presented without adequate analysis of its relevance to the proposed project. In addition, social conflicts due to lack of benefit sharing and lack of investment in regional development prior to or as part of hydroelectric development are further constraining the social acceptance of these projects. Finally, the lack of or deficit of technical capacities, especially at the regional and local levels, are impeding factors.

To improve the system, a more effective environmental licensing system based on existing regulations is needed.

For the application of Hydropower by Design, there is a need for carrying out cumulative impacts assessments in order to define the optimal generation scheme while maintaining minimum BES in the watershed. Based on this assessment, the licensing authorities can send "market signals" on potential licensing difficulties and potential high costs for mitigation and compensation for projects that fall in the optimal scheme. For instance, the hydroelectric projects analyzed in the cumulative impact assessment can be grouped as follows:

Red: potential impacts on BES are significant. Mitigation and compensation costs will be very high. Biodiversity surveys will very extensive and lengthy. Licensing might last a few years and/or not be issued.

Yellow: moderate impacts on BES. Mitigation compensation measures will be necessary. Additional studies may be required. Licensing will take a few years.

Green: project is included in the optimal scheme. Licenses will be guaranteed in shorter timeframe. Conventional mitigation and compensation measures will be required.

The findings and recommendations of the paper were discussed by a Panel followed by group discussion.

Panel Discussion on the Findings of the Paper by Juan Quintero

Panelists—Marcela Bonilla Madriñán, Claudia Victoria González Hernández, Sahida Quispe Bellota, Angela Montoya Holguín

The panelists drew attention to the efforts undertaken in their respective countries towards improving the EIA process, data gathering, establishing plans and developing guidelines and handbooks on compensation and integrating BES.

The Panel and discussions emphasized that there is a need to improve the land management system and consultation process to minimize impacts on affected communities. While there are numerous regulations pertaining to biodiversity protection, environmental agencies have limited resources and capacity. Multi-disciplinary support for better basin planning is required. Ideally, strategic planning should be carried out.

Compensation is an important instrument to offset impacts and enhance positive effects of projects but panelists stressed that more guidance is needed on how to develop, implement and monitor compensation programs.

It is essential to consider the effects of climate change on the hydrology, and adaptation strategies have to be incorporated into hydro planning.

The session concluded with an appreciation for the paper and presentation on integrating biodiversity and ecosystem services into hydropower development. It set the stage for the subsequent presentations and discussions during the south-south exchange.

Case Study: Reventazón Hydroelectric Project in Costa Rica

Allan Retana Calvo

The Reventazón Hydropower Project includes the construction and operation of a dam and 305.5 MW hydroelectric power plant on the Reventazón River, located 8 kilometers southeast of the city of Siquirres (Caribbean side of Costa Rica). The Project design includes the construction of a 130-m high dam, flooding of a 6.9 km^2 reservoir, a diversion tunnel, and hydroelectric generation facilities. The Costa Rica Power Authority - Instituto Costarricense de Electricidad (ICE) is in charge of developing the hydroelectric project.

The main environmental impacts identified are:

- Transformation of 8 km of the river into an artificial lake environment (reservoir), eliminating critical habitat for breeding, shelter or food for many fish species.
- Creating a physical barrier that interrupts and fragments aquatic corridors.
- Blocking the passage of fish from upstream to downstream and vice versa, and the consequent fragmentation of fish populations and alteration of their life cycles.

- Negative impacts on the survival of key species of terrestrial and aquatic fauna and flora in the project area such as the jaguar.
- The cumulative effects from other development projects in the basin.

A comprehensive environmental impact assessment and numerous studies were undertaken. To minimize and mitigate the negative impacts, the Project will restore and maintain connectivity within the the Barbilla Destierro Biological Sub-corridor—(Path of the Jaguar) through the restoration and maintenance of habitat at the tail of the reservoir, develop an adaptive management program for the downstream hydro-biological system, develop an environmental and social management plan for construction and compensate for the residual and cumulative effects.

To compensate for the residual impacts on the aquatic habitats and biodiversity and ecosystem services to result in no net loss or net gain for biodiversity in the context of the project, the Project will develop and implement a protected area in an ecologically equivalent river system with no existing barriers to connectivity.

A specific set of criteria was developed for selection of the rivers and basins for the offset.

Selection criteria

- Presence of protected areas
- Connectivity to sea
  - Caribbean
- Topography
  - Slope
- Ecological conditions
  - Habitat
  - Aquatic biodiversity
    - Micro invertebrates
    - Migratory fish
  - Life zones
- Climatic conditions
- Environmental services
  - Tourism

Assessments lead to a preliminary list of nine potential rivers that could qualify as equivalent fluvial ecosystem. All nine rivers were analyzed for a number of criteria such as length, flow, diversity/number of life zones and potential as an equivalent ecosystem. Based on further studies, three ecologically equivalent river systems were identified for the offset. Further, ecological assessments lead to the selection of the Parismina River for implementation of the offset.

As part of the offset development program, a number of activities are being undertaken - physical and ecological monitoring of the Parismina River, improvement of habitat conditions for aquatic communities and associated terrestrial ecosystems, community outreach to empower communities for the management of protected areas and the banks of water resources, working with the agriculture sector and developing a management plan.

Some of the legal options that have been identified

Criterios de selección de sitio "*offset*"

CARACTERÍSTICA	RÍO REVENTAZÓN	RÍO PARISMINA
Longitud del río	180 km	124 km
Caudal promedio	150 m3/s	35 m3/s
Condición	Regulado por 3 represas	Libre
Especies peces en común (CM)	36	36
Especies peces en común (CB y estuario)	25	25
Especies peces tramo afectado/compensación	28	39
Calidad agua	84.5	86.8
Calidad ribera	70	85

for the long term protection of the Parismina offset consist of declaring the watershed as an area of public conservation interest by the Ministry of Environment. A draft decree is already in place. There is also a proposal to create a riverine biological corridor along the Parismina River and further studies being undertaken for conservation.

Case Study: Chaglla Hydroelectric Project in Peru

Rafael Tamashiro

The Chaglla Hydroelectric Project consists of the construction and operation of a dam and 406 MW hydroelectric power plant on the Huallaga River, in the Chaglla and Chinchao districts of the department of Huánuco, Peru. The Project includes three main components: the hydropower facility, the transmission line and the access roads which will be constructed between 800 and 1,000 m above sea level on the left bank of the Huallaga River.

The main environmental impacts are:

- Conversion of over 17 km of river into an artificial lake environment (reservoir).
- Creating a physical barrier that interrupts and fragments connectivity of the channel and generates loss of habitats and environmental services in riverine ecosystems.
- Blocking the passage of fish from upstream to downstream and vice versa, and the consequent fragmentation of fish populations and alteration of their life cycles.
- Significant changes in water regimes, patterns and processes of sedimentation, and water quality in a stretch over 15 km long.
- Adverse impacts on the survival of key species of terrestrial and aquatic fauna and flora in the area of influence of the project.

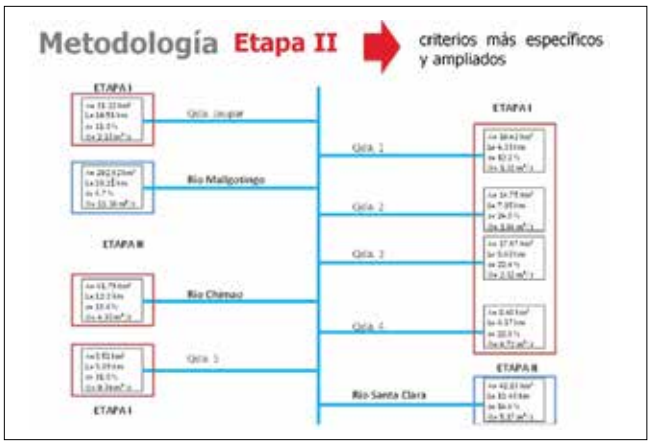
To adequately analyze the impacts and propose mitigation measures, numerous studies and plans were undertaken and developed such as EIA, complementary assessment of terrestrial biodiversity, compensation program, and ecological restoration for river basin management of river Huallaga etc.

To mitigate impacts to the flora and fauna, reforestation program including rescue of native germplasm, propagation and reforestation; rescue program for orchids and; wildlife rescue are taking place. In light of the Government policies and policies of the multilateral banks, three alternative terrestrial offset types were considered for the project: habitat restoration, species conservation and institutional empowerment. In addition to compensate for the impacts to the aquatic ecosystem a fluvial offset scheme is also being developed.

The fluvial offset seeks to compensate the loss of biodiversity and coastal and aquatic habitats due to dam (17km) and the reduced flow stretch (15Km). This fluvial offset system will cover an area of 24,480 ha and a total length of 39.64 km. The river offset program will be implemented in the Mallacutan River (length 28.2 km) to compensate for the reduced flow sector. Restoration activities will be carried out in the Lluto, Chimao and Chulla streams and in some sections of the Santa Clara River.

The restoration and compensation program includes restoration of affected areas, restoration and conservation of the riparian forest in the Lluto, Chimao and Santa Clara streams, rapid ecological and social assessment to strengthen the baseline, ecofluvial monitoring plan, improving riparian habitat, management plan, species specific studies and environmental awareness program.

Given the complexity of the water system of the sub-basin of the Huagalla river, the restoration and compensation program will be implemented in a selected group of micro-watersheds. A multi-criteria methodology consisting of two phases was applied. Phase I used a minimum basic criteria for screening a series of secondary streams from the general list of the tributaries of the Huallaga river. Phase II used a more specific and broader selection criteria that ultimately allowed the selection of the set of streams along with the



micro-watersheds to be included in the Compensation, Restoration and Eco-Fluvial Management Plan.

As part of the rapid environmental and social impact study, the condition of the habitats, species richness, similarities and differences in species composition, diversity and distribution of species was evaluated in the microwatersheds during both the wet and dry season.

A number of characteristics of the fish species were studied in detail such as habitat preferences of target species, seasonal changes in habitat use, physico-chemical limnology, and spatial and temporal changes in the composition, abundance, richness of the fish fauna, benthic invertebrates and periphyton biomass.

For the social assessment both quantitative methods and qualitative methods were used such as questionnaires, in-depth interviews and participatory diagnostic workshops.

An analysis of the legal basis for establishment of the offset was also carried out. As a next step, further analysis will be conducted such as developing a quantitative model of the offset integrating land and aquatic ecology. The compensation scheme for the Mallgotingo and Santa Clara river will also be developed.

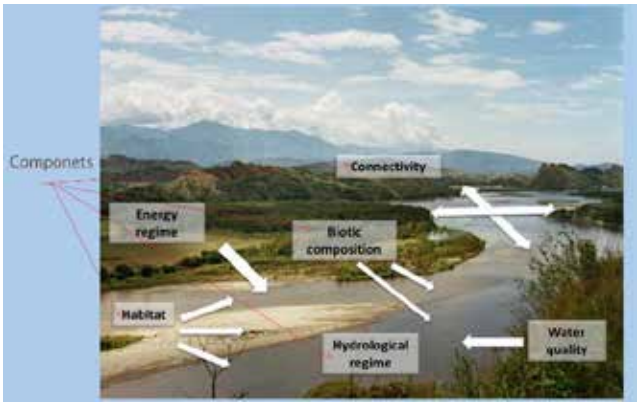
Facing page: Amazon river. Photo: Thinkstock.com

Freshwater Offsets Compensation schemes

Thomas Walschburguer

The methodology proposed to develop fresh water compensation schemes was presented. The scheme is based upon maintaining the integrity of the freshwater ecosystem.

It is important to determine the type of impact to the freshwater system ecosystem—both direct and indirect impacts. Based on the Horton Strahler order, the wetland and rivers in a basin can be classified and mapped. It is also necessary to quantify the impact, for example, the loss in kilometers of river type, areas of freshwater ecosystems, and fragmentation. These can be assessed using various models and methods. Next,



it is necessary to identify the areas to compensate for the loss. Criteria for selecting the compensation sites should be developed and the activities to be included in the compensation plan should be developed. The compensation should be maintained during the lifespan of the project.

Itaipu Dam, Brazil

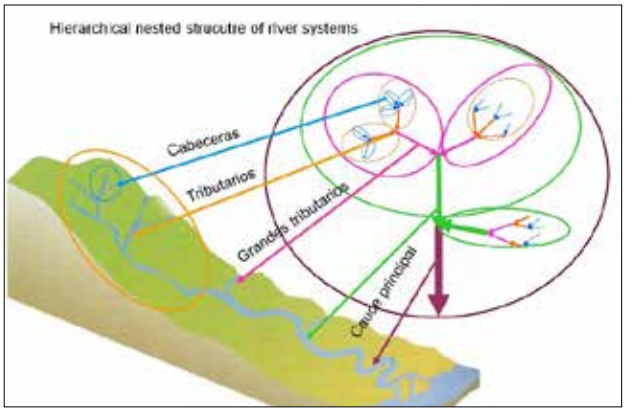
Day 2: 16th September

Overview of Watershed-scale Conservation Planning for Hydropower Development: Developing Conservation Blueprint

Paulo Petry

The Conservation by Design framework of TNC was introduced, the key steps of which are—setting priorities, developing strategies, taking action and measuring results. The TNC publication—'Drafting a conservation blueprint: A practitioner's guide to planning for biodiversity', lays out a number of essential steps that should be taken while planning projects. These include:

- Defining the basin blueprint elements (framework) to maintain long term basin integrity,
- Gathering and consolidating information and data (using spatial analysis technology to generate intelligence),
- Defining goals and criteria,
- Composing a blueprint portfolio,
- Involving all pertinent stakeholders in the review process,
- Consolidating the solution based on the stake holders review, and
- Defining the conservation strategies with stakeholders.

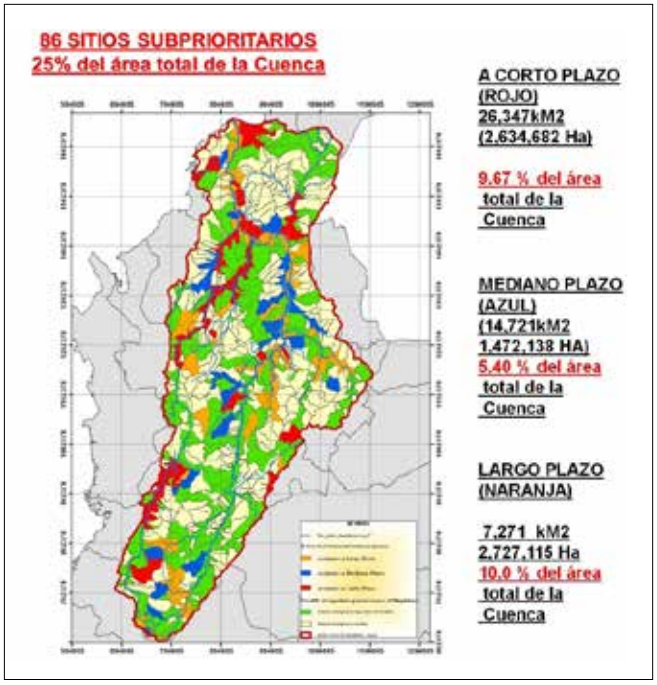


The different components to consider for maintaining the integrity of freshwater systems are the hydrologic regime, water quality, connectivity, biotic composition, and physical habitat. Also, the hierarchy of the rivers systems has to be taken into account.

During river basin planning, it is important to capture the longitudinal, lateral, vertical and temporal domensions of the river as rivers are dynamic—constantly moving, shifting and reshaping themselves.

A draft blueprint for the Magdalena river basin in Colombia has been prepared. Detailed analysis including study of the fish stocks, the dynamics of the flow, lifecycle, and migration patterns have been carried out.

The Magdalena experience has led to the development of an interactive strategic planning tool for planning in the basin. This is further explained in another presentation.



Case Study: Watershed-scale Planning for Hydropower Development in the Coatzacoalcos Basin, Mexico

Victor Morales

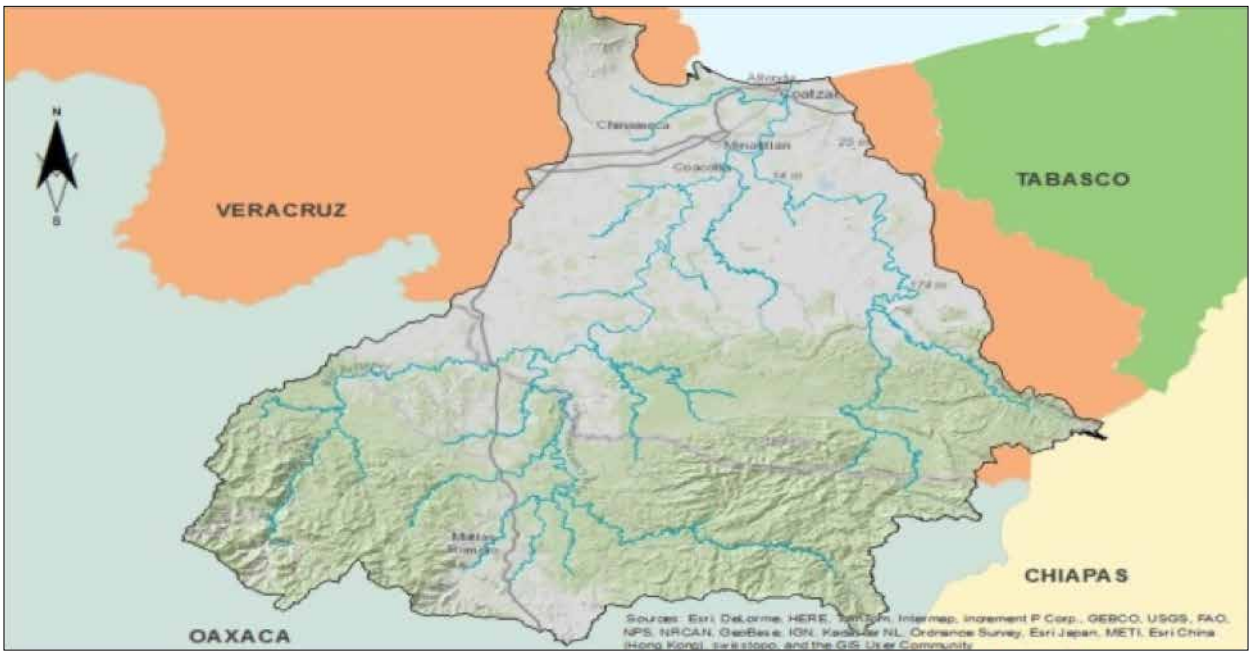
Mexico's Energy Policy aims to reduce the use of fossil fuels for power generation. The 2013-2027 National Strategy for Energy (SENER), states that 35% of the installed capacity of electricity generation should be from renewable sources by 2024.

To develop hydropower sustainably that ensures the quality of life of local communities, as well as natural areas and biodiversity, the Federal Commission of Electricity (CFE), the National Commission for the Knowledge and Use of Biodiversity (CONABIO) and TNC have partnered to work together in the Coatzacoalcos River basin.

Upstream strategic planning to identify projects, that are environmentally, socially and economically sound was carried out based on the concept of Hydropower by Design. The analysis involved 8 steps:

- Identifying the hydroelectric potential of the basin,
- Establishing a working group,
- Establishing a geographic information system,
- Selecting criteria and metrics that facilitate evaluation of projects, scenario creation and decision-making,
- Geographical analysis of the watershed,
- Multi-criteria analysis to determine the viability of the projects,
- Fragmentation or connectivity analysis,
- Developing the sustainability portfolio.

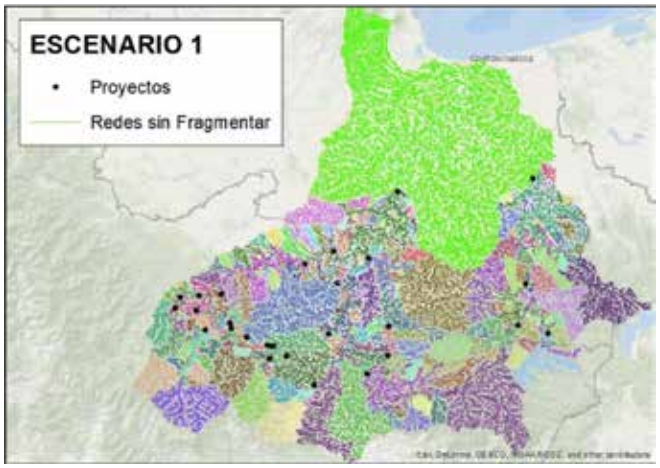
Twenty-eight projects were identified in the basin and different scenarios were generated. Scenario One represents the total hydroelectric potential of the basin and includes the 28 projects analyzed by CFE in their "Grand Vision" stage of the planning process. Collectively, this shows the maximum potential for the basin. Scenario Two represents the group of technically feasible projects. Scenario Three represents the group of socially feasible projects and Scenario Four represents the group of environmentally feasible projects.



In the next stages of design (prefeasibility and feasibility), it will be crucial that the proposed mitigation and compensation measures from hydroelectric power plants provide for cumulative, synergistic and fragmentation effects.

Experience from this approach demonstrates that comprehensive watershed planning at the early stage can offer sustainable options for potential investment in hydropower projects. It can facilitate compliance with international commitments on climate change and biodiversity, and targets of power generation. Inter-agency collaboration is necessary for developing environmentally and viable proposals.

It is important to create watershed conservation plans to avoid fragmentation and to promote the protection of ecosystem services.



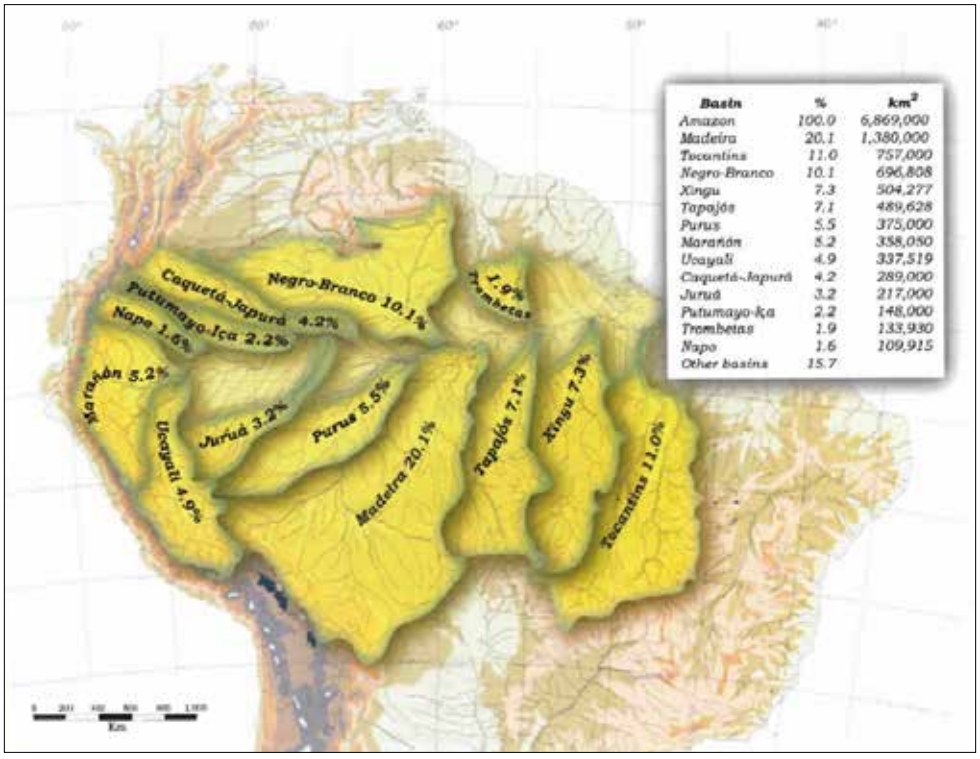
Hydropower development in Brazil: An overview of the Decision Making Process

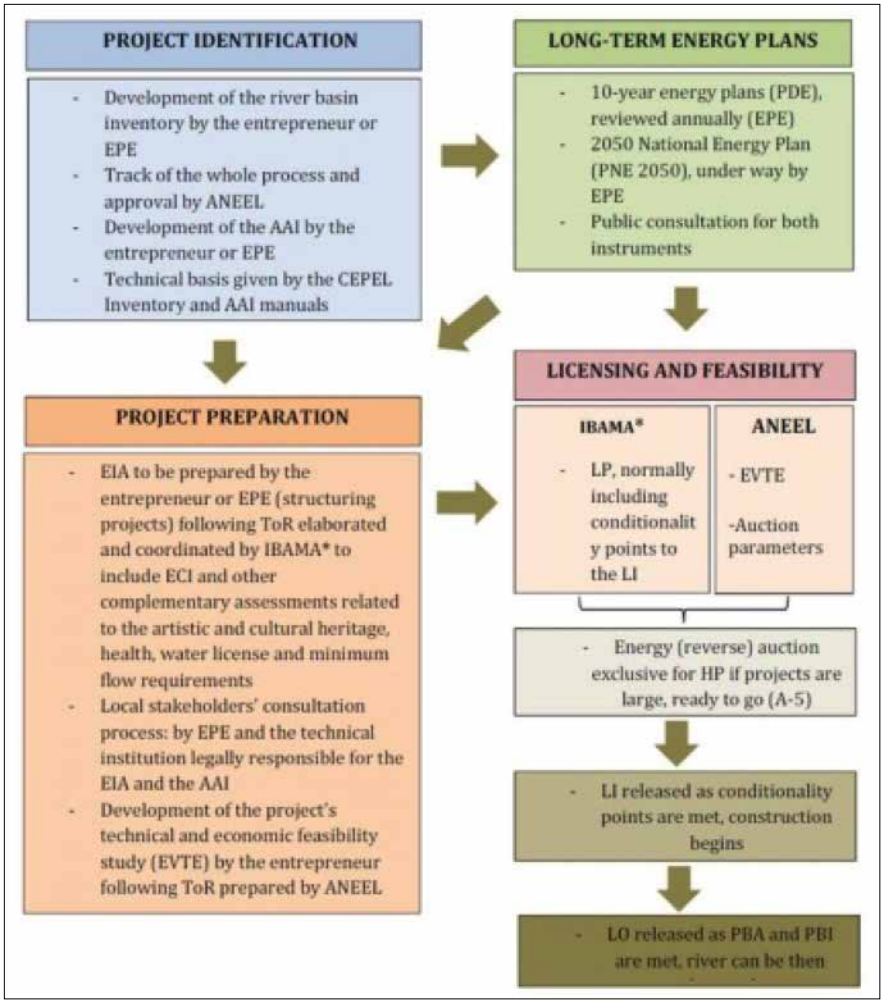
Pedro Bara

The process, actors and instruments involved in the project planning and decision making process were presented.

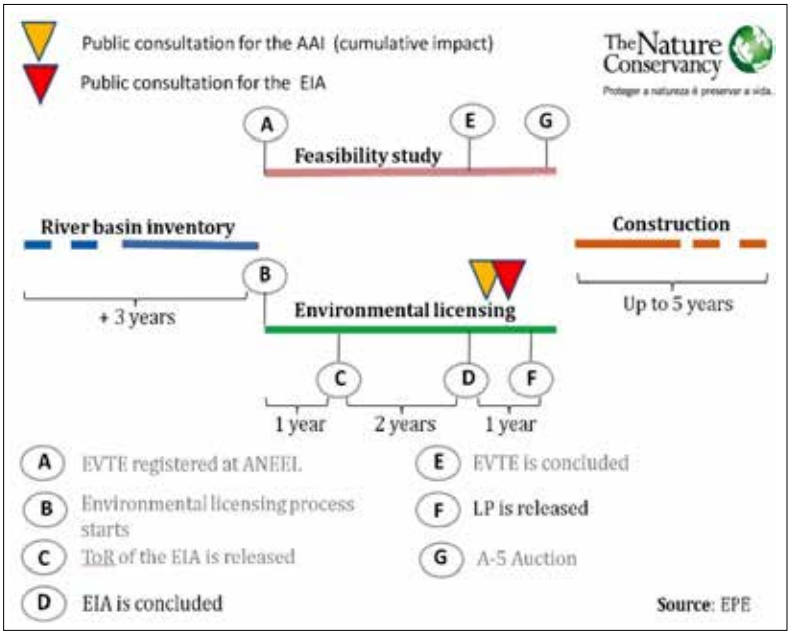
The key issues along the project timeline were highlighted.

- There is need to carry out basin scale planning and develop a vision for the basin. For the Tapajos basin, a blue print is being developed to be able to maintain the hydrological process in the most feasible areas as development has already fragmented and impacted the river systems.
- The number of opportunities for public consultations along the project process timeline is limited. Consultations are carried out too late in the process and the potential to influence the project is low. Decisions regarding the project have already been made. This can create social tension.
- The effectiveness of the integrated environmental evaluation (AAI) is questionable. The methodology calls for guidelines (for the electrical sector) and recommendations (for other sectors) to reach an "ideal" future scenario, where the cumulative impacts will take place. In the lack of AAI governance, the instrument bears very limited value for decision-making.
- There is lack of icthyological information and how to support the definition of free-flowing rivers. Combined Acoustic and Radio Telemetry (CART) for the Xingu river shows deficiencies in the data collection.
- Additional questions included: (1) How to prepare vulnerable regions to receive a megaproject: from impact to risk assessment, (2) What is the role of the commercial banks and their responsibility towards minimizing social and environmental impacts.





(*) State environmental secretariats (SEMAs) for projects up to 300 MW



Magdalena Decision Support System and Hydropower Planning, Colombia

Juliana Delgado

An information system for decision making has been developed for the Magdalena Basin - Sistema de Información para la toma de decisiones en la Macrocuenca Magdalena-Cauca (SIMA).

The objective of this system is to promote Integrated Basin Management through a collaborative process that integrates the conservation and management of water, land and related resources, with various actors in the basin to improve the economic and social benefits derived from the resources in an equitable manner.

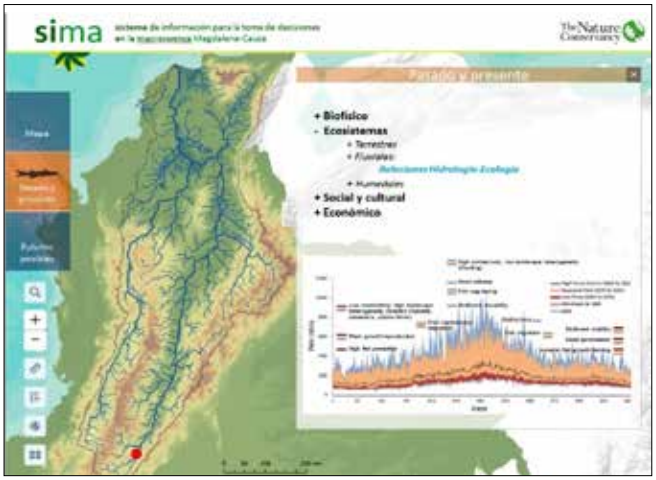
SIMA is an open and transparent platform that allows access and utilizes information from different sources. SIMA incorporates official information available through the Environmental Information System of Colombia, and also incorporates information generated by TNC partners. This information is integrated in the platform with a logical framework to understand the basin as a system.

SIMA can prove beneficial for:

- Organizing and accessing information,
- The long-term monitoring of various indicators (environmental, social and economic),
- Comparing scenarios and alternative management strategies,
- Strengthening decision-making and long-term planning,
- Facilitating dialogue and sectoral coordination,
- Promoting knowledge of the basin and the participation of civil society, strengthening governance.

On the ground, SIMA can prove useful to the hydropower sector and help monitor the investments and effectiveness in conservation and watershed management.

An online version is expected to be ready by September 2016.



Opportunities for Net Conservation Gains from Hydropower

Joerg Hartmann

The presentation discussed the following—can hydropower be positive for communities and the environment, can we overcome the obsession with negative impacts on the status quo, can we learn to actively seek opportunities for positive impacts, and can we learn to embrace change?

There are two categories of environmental benefits that can be obtained from hydropower projects:

1. Direct or in-kind benefits:

- Man-made water bodies can serve as home for aquatic species particularly in regions that have lost natural lakes/wetlands.
- In regions that suffer from seasonal low flows, slow steady releases can benefit aquatic biodiversity directly (e.g. by reducing salinity intrusion and pollution concentrations) and indirectly (e.g. by reducing the need for river dredging for navigation).
- Projects can compensate their biodiversity impacts through offsets such as in the case of the Reventazón Hydropower Project which aims to protect the Parisma River.
- Where climate change raises water temperature, release water having closer to natural temperature can cool the water.
- In regions that suffer from floods, dams can reduce flood peaks reducing the need for downstream flood protection.
- Where land use change increases erosion, river turbidity and organic carbon content can contribute to closer-to-natural water quality by trapping some sediment and carbon in reservoirs.
- Dams can block the spread of invasive species.
- Artificial debris can be removed from trash racks and dams can trap and immobilize contaminated sediments that would otherwise threaten downstream habitats.
- Dams can contribute to downstream conservation such as through payments for flood insurance and support for protected areas.

2. Indirect or out-of-kind benefits: climate change mitigation, improved air quality, terrestrial biodiversity protection, promote fisheries, productive agriculture, better transport, increased revenue for biodiversity protection etc.

The challenge is to overcome the barriers to harness the positive potential of hydropower—EIAs should identify opportunities and not just risks, there should be a global sharing of best practices, regulatory institutions should be more favorable, corporations should be more socially responsible, there should be increased public engagement and a willingness to pay for more.

A number of hydropower projects are already contributing positively such as:

- Significant improvements in environmental and social conditions in Nepali villages which have gained access to hydropower, either through grid expansion or through local micro-hydro stations.
- The Nam Theun 2 project in Lao PDR provided USD 31.5m for the establishment and running costs of a protected area in its watershed
- AES Tietê S.A. is reforesting around 15,000 ha as buffer zones around its ten hydropower reservoirs in the state of São Paulo; thus protecting its reservoirs, providing habitat, and sequestering carbon
- In Colombia, hydropower projects are required to pay 1% of the investment costs and 6% of the revenue to local municipalities and environmental agencies for watershed protection and other environmental investments.
- 60% of China's newly installed generation capacity in 2013 was renewable, part of a major push to improve urban air quality.

Mapping and Valuing Ecosystem Services in the Marañon Basin of Peru

Claudia Veliz and Carlos Cañas

This presentation focused on the benefits of informing communities about the potential impacts of development prior to the project implementation and consultations undertaken as part of the project planning process.

The Pongo de Manseriche which is a major geographical feature in the Marañón Basin that controls the flow regime of lowland sections of the basin was studied. It is the main collector of the ample Andean headwaters network, which receives water flow and passes it to the vast Amazon lowlands.

The Pongo de Manseriche acts as a large filter that controls transport and displacement of sediments in the Amazon lowlands. The Marañon River is a major transportation route and a number of indigenous communities depend upon the river.

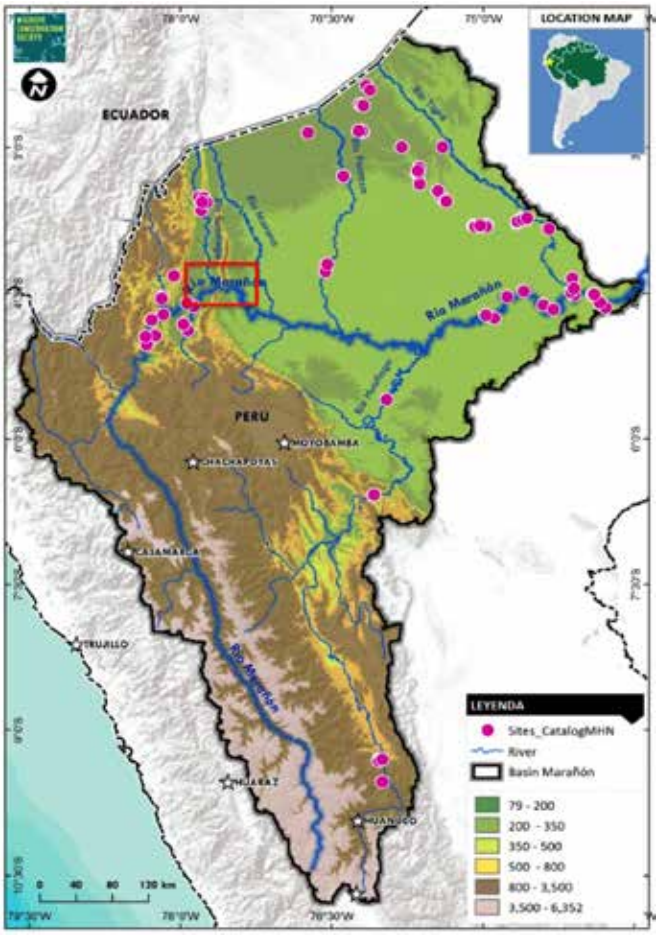
As part of the study undertaken fish biodiversity and its economic value were studied. An environmental services assessment (offset index, HSI index) was conducted and all the information was disseminated to the communities.

The main findings of the fish biodiversity study include:

- The region has about 14.8% of the fish biodiversity of Peru which includes a number of migratory species in the lower Marañón basin,
- More than 80% of annual fish yield is represented by detritivorous species and are thus a vital part of the ecosystem,
- Fishing is an important economic activity and serves as the main source of animal protein.

As a result, maintaining the connectivity of the Marañón is a must for fisheries. Various models were used for the ecosystem services assessment. Agro-framing has increased from 2000-2014 and as the region has dry forest, deforestation is not easily detected. Dam development scenarios were also visualized with the possibility of 9 dams planned. In some aspects data limitations did prove a challenge.

The information analyzed was disseminated and can prove to be a useful tool for communities in the wake of development.



Panel and Group Discussion

Zachary Hurwitz, Roberto Roca, Victor Morales Méndez, Germán Andrade Pérez, Pedro Bara Neto, Raquel Soto

The conference concluded with a panel and group discussion summarizing the key findings from the 2 days of presentations and dialogue. Many concerns were raised covering a range of topics such as environmental governance, promoting aquatic offsets, balancing basin scale planning with energy planning, climate change adaptation, applicability of complex models for conservation, increased social participation and better synergy between all actors.

The need and requirements of the public sector, developer and environmental experts have to be understood and all should work together to ensure compensation and other conservation measures can be implemented on the ground. It is necessary to involve the energy sector in the dialogue.

It was stressed that models and other tools developed for conservation planning should be simple so that all actors involved are able to utilize them. Complex models are difficult to replicate, require specialists, often tough to interpret by non-experts and thus may prove costly to implement.

It was pointed out that often affected communities are not adequately consulted or consulted too late in the process. Revenues or benefits from the hydropower project sometimes do not benefit the local communities as the resources are diverted to areas where the negative impacts may not occur. This creates social tension.

Some key recommendations from the meeting for hydropower planning and development are:

- Developing practical biodiversity assessment tools with simple indicators so that they can readily be incorporated into the decision-making process by government agencies, and so that they are easily understandable and usable by private sector entities that are developing hydropower infrastructure,
- Developing and disseminating standardizing tools so that they can be used across different basins in different countries,
- Promoting better interagency coordination involving all sectors including engineers and specialists with different expertise,
- Developing complimentary tools to support the EIA process,
- Empowering people so that they are well informed and can actively participate in a timely manner during project planning and development,
- Carrying out ecosystems services and cumulative impacts assessments,
- Carrying out environmental analysis and community consultation very early in the project cycle so that modifications can be made that support biodiversity, ecosystem services and local communities in a manner that minimizes costly delays for private sector developers,
- Ensuring open and transparent access to information about potential environmental and social impacts,
- Maintaining long term financial viability for offsets,
- Incorporating climate change mitigation,
- Harnessing the positive opportunities from hydropower projects,
- Disseminating best practices.

The meeting concluded with a call for developing sustainable hydropower projects that are economically, socially and environmentally sound. A task team would be formed to continue working on the issues discussed.

Hotel Caribe
Cartagena, Colombia
September 15-16, 2015

List of Participants

No.	Name	Country	Organization	Email
1.	Amilcar Guerreiro	Brazil	Empresa de Pesquisa Energética	amilcar.guerreiro@epe.gov.br
2.	Marcelo Marcelino de Oliveira	Brazil	Instituto Chico Mendes de Biodiversidade	marcelo.marcelino@icmbio.gov.br
3.	Maria Carvalho	Brazil	FUNAI	maria.carvalho@funai.gov
4.	Maria Claudia García Davila	Colombia	Directora Técnica Bosques Biodiversidad y Servicios Ecosistémicos	
5.	Diego Grajales Campos	Colombia	ACOLGEN	
6.	Angela Montoya Holguín	Colombia	ACOLGEN	amontoyapresidencia@acolgen.org.co
7.	Carlos Andrés Naranjo Bedoya	Colombia	Corantioquia	regionalizacion@corantioquia.gov.co
8.	Marcela Bonilla Madriñán	Colombia	UPME	Marcela.Bonilla@upme.gov.co
9.	Claudia Victoria González Hernández	Colombia	ANLA	srolon@anla.gov.co
10.	German Andrade	Colombia	Humboldt	gandrade@humboldt.org.co
11.	Allan Retana Calvo	Costa Rica	ICE	LRetanaC@ice.go.cr
12.	Victor Morales	Mexico	CFE	
13.	Emmanuel Gómez	Mexico	CFE	Emmanuel.gomez01@cfe.gob.mx
14.	Sahida Quispe Bellota	Peru	SENACE	
15.	José Cari	Peru	Ministerio de Energía y Minas	jcari@minem.gob.pe
16.	Raquel Soto Torre	Peru	MINAM	rsoto@minam.gob.pe
17.	Ernani Pila	USA	IDB	ERNANIP@iadb.org
18.	Zachary Hurwitz		IDB	zacharyh@IADB.ORG
19.	Ramon Gomez	Colombia	IDB	JOSER@iadb.org
20.	Ruth Tiffer Sotomayor	USA	World Bank	Senior Environmental Specialist
21.	Maria Ines Miranda	Brazil	Odebrecht	inesmiranda@odebrecht.com
22.	Rafael Tamashiro	Peru	Chaglla, Odebrecht	
23.	Francisco Dallmeier	USA	Smithsonian	dallmeierf@si.edu
24.	Padru Franco	Colombia	WCS	
25.	Carlos Cañas	Peru	WCS	ccanas@wcs.org
26.	Claudia Veliz	Peru	WWF	claudia.veliz@wwf.panda.org
27.	Juan Quintero	USA	Consultant	eecjdq@gmail.com

List of Participants

No.	Name	Country	Organization	Email
28.	Roberto Roca	Panama	Consultant	robertoroca19@gmail.com
29.	Aradhna Mathur	USA	Consultant	mathuraradhna@gmail.com
30.	Greg Reub	USA	Environcorp	greub@environcorp.com
31.	Libardo Montealegre	Colombia	Consultant	eiconsultores@cable.net.co
32.	Joerg Hartmenn	USA	Consultant	
33.	Jerry Touval	USA	TNC	
34.	Aurelio Ramos		TNC	
35.	Paulo Petry		TNC	
36.	Felipe Osorio		TNC	
37.	Juliana Delgado	Colombia	TNC	
38.	Carolina Aguirre	Colombia	TNC	
39.	Luis Alberto Gonzales		TNC	
40.	Thomas Walschburger		TNC	
41.	Ana Guzman		TNC	
42.	Alejandra Torres		TNC	
43.	Pedro Bara		TNC	

Annex I

Integrating Biodiversity and Ecosystem Services Into Hydropower Development in Latin America

I. Introduction

Investment in hydropower in Latin America and the Caribbean (LAC) is intensifying bringing with it complex set of environmental, social and economic risks. The region is rich in biodiversity with biodiversity and ecosystem services (BES) playing a critical role in supporting life. Cognizant of the importance of protecting the environment from developmental impacts, countries in LAC have instituted legislation particularly environmental assessment legislation incorporating a licensing process. Environmental agencies and regulations are continually being revisited and revised in response to the increasing investments in infrastructure.

This paper presents a status of the regulatory process protecting biodiversity and ecosystem services during hydropower planning and development in five Latin American countries i.e. Colombia, Peru, Brazil, Mexico and Panama. Also, the management of biodiversity and ecosystem services across four hydropower projects in different stages of development are presented to showcase how these issues can be integrated into hydropower planning and development. The case studies are the Reventazón Hydroelectric Project in Costa Rica, Chaglla Hydropower Project in Peru, the Nam Theun 2 hydropower project in Lao PDR and hydropower planning in Coatzacoalcos river basin in Mexico. These case studies and status of legislation in Latin America regarding protection of BES, highlight broader institutional challenges which need to be addressed in order to guarantee the conservation of biodiversity and ecosystem services and are presented as lessons learned in this paper.

II. Hydropower in Latin America

Investment in the hydropower sector is growing globally particularly in Latin America with many such as Hidroaysen complex in Chile or Belo Monte in Brazil either under construction or being planned (**Figure 1**).

The past decade has witnessed a proliferation of hydropower projects in Latin America reaching 150 GW of installed capacity by 2010 and it is expected to grow significantly (**Figure 2**). In 2010, with 80% of the electricity generated coming from hydropower amounting to 84 GW in installed capacity, Brazil was second in the world just behind China (200 GW).

Figure 1. **Global Dam Development**

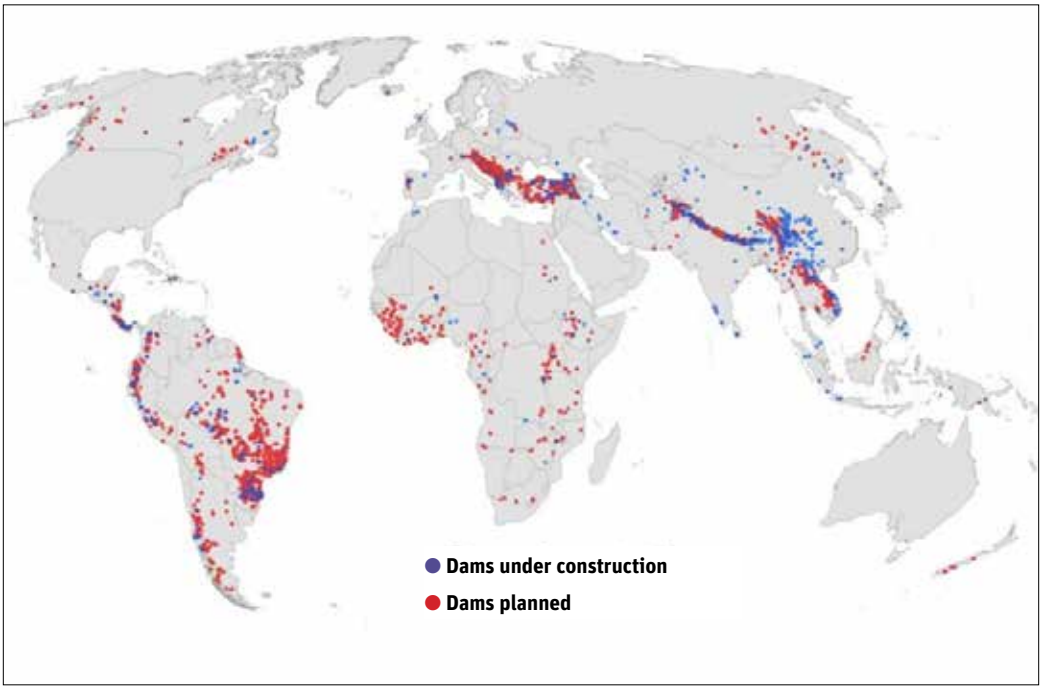
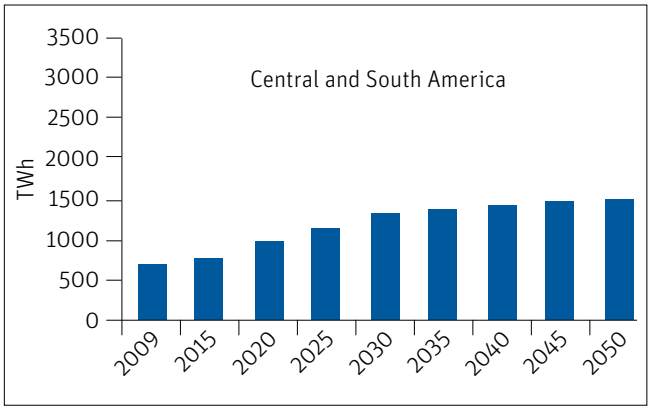


Figure 2. **LAC Hydropower Generation**[2]



Though hydropower is considered as a renewable or clean source of energy, it is not without its share of environmental impacts and controversies. Impacts can range from deforestation and degradation of natural habitats to flooding, sedimentation and barrier to fish migration. The environmental impacts of hydropower projects vary depending on the project's type, size and sensitivity of the project site.

[2] IEA. 2012

III. Biodiversity and Ecosystem Services

Latin America is a biodiverse region having over 40 percent of the Earth's biodiversity with more than one-quarter of its forests. Biodiversity is defined as the "the variability of live organisms from whatever source, included, among other things, terrestrial and marine and other aquatic ecosystems and the ecological complexes of which they form part; it is made up of the diversity within each species, among species and ecosystems" (CBD, 1992). Ecosystem services can be broadly defined as the benefits provided by ecosystems to humans. Biodiversity affects numerous ecosystem services, both indirectly and directly (Chapin III, et al., 2005). Ecosystems services include provisioning services, regulating services, supporting services and cultural services. Biodiversity and the associated ecosystem services they provide are vital for human well-being. For example, they are essential for providing food, drinking water and purifying the air we breathe. As a result, it is imperative that hydropower development proceeds in harmony with the environment avoiding, minimizing, mitigation and where possible compensating for the environmental impacts. Examples of some of the ecosystem services is given in Table 1.

Table 1. Ecosystem Services and their Importance

Ecosystem Service	Definition	Examples
Provisioning Services	The services that describe the material or energy outputs from ecosystems.	Food, fresh water, raw materials, medicinal resources, energy
Regulating Services	The services that ecosystems provide by acting as regulators.	Regulating the quality of air and soil, carbon sequestration and storage, waste water treatment, erosion control, pollination
Supporting Services	Services that are necessary for the production of all other ecosystem services.	Providing habitat for species, maintaining genetic diversity
Cultural services	Nonmaterial benefits people obtain from ecosystems	Tourism, spiritual enrichment, recreation, and aesthetic experiences

Source: TEEB. http://www.teebweb.org/resources/ecosystem-services/

IV. The Mitigation Hierarchy

To fully integrate environmental and social sustainability into infrastructure development, a systematic approach is required. Ideally, infrastructure projects should first avoid, then minimize, then restore, and finally, when the previous options are exhausted, offset its impacts to achieve no net loss in biodiversity (BBOP, 2009; Price Waterhouse Coopers, 2010). To better protect the environment and minimize impacts from the onset, emphasis on the principles of the Mitigation Hierarchy is given as depicted in **Figure 3**. (Quintero *et al*., 2010).

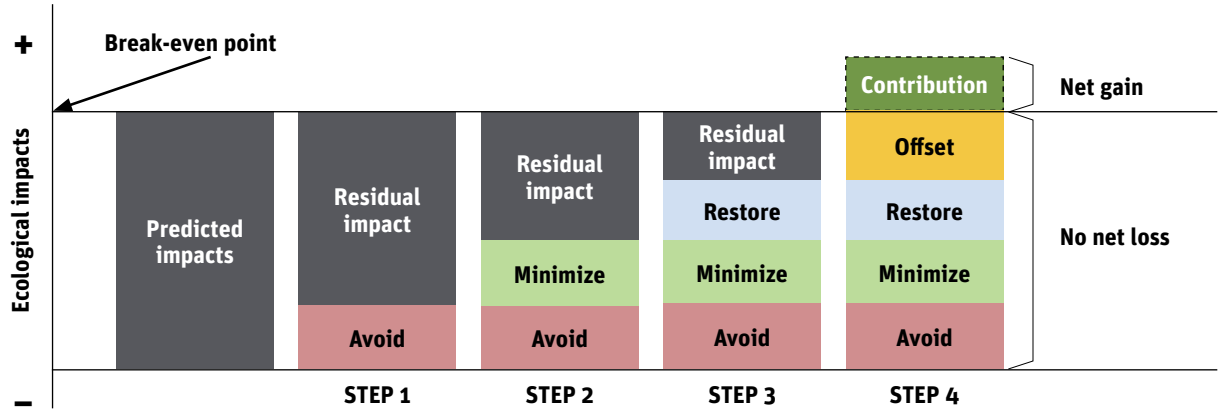
Avoidance: *To prevent impact to sensitive areas by excluding them from consideration for project siting.* This is the preferred option taken to avoid creating impacts from the outset and a vital tool for land use and infrastructure planners.

Minimize: *To reduce potential impact through activities which protect biodiversity and ecosystem function.* It includes measures taken to reduce the duration, intensity and/or extent of impacts that cannot be completely avoided, as far as is practically feasible.

Restore: *Activities to rehabilitate and repair damage to biodiversity and ecosystem function.* Measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimized.

Compensate/Offset: *Measures taken to compensate through offsets or other vehicles any residual significant, adverse impacts that cannot be avoided, minimized and/or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity.*

Figure 3. Mitigation Hierarchy



Source: JICA, 2013.

The mitigation hierarchy is aligned with stages of the project life cycle, from planning to construction and operation. Beyond reduced or positive impacts to the environment, the hierarchy provides for an approach for integrated development at the local level, with expected results in reducing transactions costs for infrastructure development. All involved in the road development process from governments to corporations, and finance institutions have a role in the adoption of the hierarchy.

V. Incorporating BES in Hydropower Projects

In LAC for developmental projects, biodiversity issues are mostly addressed through the environmental impact assessment regulations and explicitly requiring compensation for biodiversity loss is a relatively new concept with legislation instituted in some countries in recent years. There are very few hydropower projects globally and even less in LAC where comprehensive measures are taken to protect the loss of biodiversity and ecosystem services and even go beyond to ensure no net loss and a positive gain in biodiversity. The Reventazón hydropower project in Costa Rica and Chaglla Hydroelectric Project in Peru are unique as they propose aquatic offsets in addition to the measures taken protect biodiversity in terrestrial habitats.

In the Reventazón hydropower project due to the cumulative impacts as well as fragmentation at the project level and at the level of the basin, an aquatic offset is being implemented to result in no net loss or net gain for biodiversity in the context of the project. The aquatic offset protects an ecologically equivalent river system. As the Chaglla Hydroelectric Project in Peru will significantly affect the aquatic habitats, protecting key tributaries to ensure long term conservation and conservation of one tributary outside the affected area in order to compensate for residual impacts is taking place. Both these projects are still under development. In the Nam Theun 2 project in Lao PDR, conservation and protection measures including a biodiversity offset and species specific measures including a robust monitoring and reporting arrangement supported by a state of the art environmental laboratory are in place. Key to successfully avoiding and minimizing impacts on BES is to suitably locate the project. Upstream planning, identifying such locations is the first step. Such upstream planning was carried out in the Coatzacoalcos river basin and of 28 potential sites only 5 were considered to be environmentally, socially and economically suitable.

V. Regulatory Systems Integrating BES

This section presents a status of the regulatory process incorporating biodiversity and ecosystem services for planning and licensing of hydropower projects in five Latin American countries i.e. Colombia, Peru, Brazil, Mexico and Panama.

1. Colombia

Colombia is a mega diverse country ranked in the top 5 globally for species diversity. It has 12% of the vegetal wealth, 19% of bird species and is one of the world's richest countries in aquatic resources. The country's large watersheds feed into the four massive sub-continental basins of the Amazon, the Orinoquía, the Magdalena and the Cauca (Saenz, *et al*., 2013 and MADS, 2012).

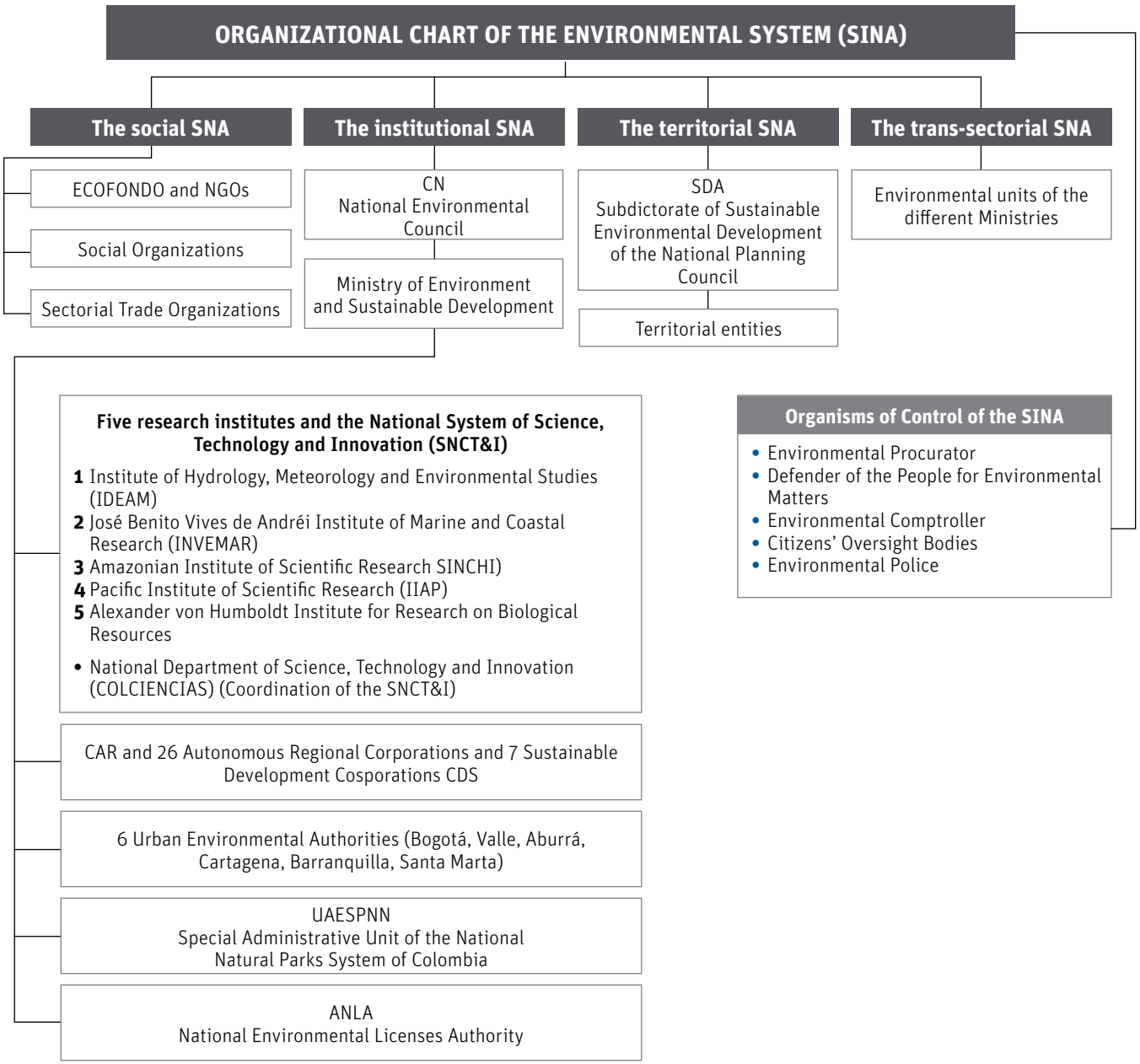
Environmental Institutions

The National Environmental System (SINA) is made up of the Ministry of Environment and Sustainable Development (MADS), National environment licenses

agency (ANLA), autonomous regional corporations, territorial entities, research institutes affiliated and linked with the Ministry, universities, NGOs, civil society and trade bodies (**Figure 4**). There is also the National Environmental Council, whose aim is to ensure the intersectorial coordination of policies, plans and programs for environment and renewable natural resources and advises the national government on the formulation of environmental policies (MADS, 2012).

ANLA is responsible for granting or denying and monitoring licenses, permits and environmental procedures. It manages licensing under the 'one-window' system where developers can apply for all required permits at the same time while applying for the project license.

Figure 4. National Environmental System



BES Regulations

Environmental Impact Assessments have been promoted by MADS, as a tool for sectoral planning aimed at the prevention of the risks and effects of public and private policies, plans and programs. Decree 2820 of 2010 and Resolution 1503 of 2010 require projects to obtain an environmental license. The developer must submit an environmental impact assessment where prevention, mitigation, correction, compensation and management of the environmental impacts are given.

In 2012, MADS introduced the National Policy for Integrated Management of Biodiversity and Their Ecosystem Services (PNGIBSE), in which the need to create opportunities for communication, cooperation and responsibility among the actors who are responsible for the country's biodiversity, including recognizing the direct users of which are part of the extractive industry sectors (mines and Energy), road infrastructure, among other. One of the 'strategic lines' of the document is to "*Strengthen the activities of and institutional framework for the evaluation of environmental impacts, the recuperation of environmental deficits and the allocation of environmental indemnities for environmental loss linked to projects that may receive environmental licenses,...*" as well as "*Identification of the areas apt for the development of productive and extractive activities as well as activities of environmental compensation linked to environmental licensing,....*" (MADS, 2012).

In 2012, a new policy was established that require planned development projects such as power generating projects, mining etc. to offset residual biodiversity impacts by restoring or protecting an equivalent habitat elsewhere. The new regulation is based on two key principles: no net loss and ecological equivalence. Furthermore, it establishes offset ratios that range from 1:4 to 1:10. Biodiversity offset plans have to be presented to the environmental agencies up to one year after the environmental permit has been awarded (Sarmiento, 2013). Under an agreement signed between the Ministry of Environment and Sustainable Development, The Nature Conservancy, World Wildlife Fund and Conservation International, the manual for the allocation of compensation for loss of biodiversity was developed. The manual sets out the steps to determine and quantify the measures for compensation for loss of biodiversity based on: i) how much to offset, ii) where to offset and iii) how to compensate under the mitigation hierarchy (MADS, 2012b). The manual was developed under the guidelines PNGIBSE.

The Manual is compulsory for applicants of an environmental license from ANLA. A series of steps must be performed to identify and quantify biodiversity offsets for terrestrial ecosystems.

Watershed Law

This decree applies to all companies, whether public, private or mixed, owned plants or hydroelectric power generation whose total installed rated power exceeds 10,000 kW gross sales and self-generation. It requires all efforts to be made to maintain and restore the environment of a watershed. 6% of the gross sale of hydroelectricity has to be paid by the operators of the plant. The distribution of the revenues is as follows:

- 3% for the Regional Autonomous Corporations having jurisdiction in watershed and the reservoir; the money is to be for environmental protection and the protection of the watershed and the area of influence of the project.
- 3% for municipalities and districts located in the watershed, distributed as follows:
  - 1.5% for municipalities and districts in the watershed that supplies the reservoir. When more than one municipality or district are located in a watershed, the 1.5% will be distributed prorated to the area each municipality or district may have with respect to the total basin area.
  - 1.5% for municipalities and districts where the reservoir is located. When more than one municipality or district have territory in the reservoir, 1.5% will be distributed prorated to the area each municipality or district may have with respect to the total area of the reservoir.

To receive the funds, municipalities are required to develop a Municipal Development Plan. These funds may only be used by the municipalities to work under the Municipal Development Plan, with priority given to sanitation and environmental improvement projects, construction of urban and rural water supply, sewage, water treatment and management and disposal liquid and solid waste.

2. Peru

Peru having a rich diversity in ecosystems, species, genetic resources and culture, is one of the top 10 megadiverse countries in the world. It has about 10% of the world species of plants of which about with 30% are endemic. It has the highest fish species (10% of the world total) and is ranked second for birds, third for amphibians, third for mammals and fifth in reptiles globally (CBD, undated).

Environmental Institutions

The Ministry of the Environment (MINAM) is the National Environmental Authority of Peru that directs environmental policy for the country. MINAM holds administrative authority for the national environmental sector, which it manages at national, regional and local levels. The Ministry includes the Vice-ministry of Natural Resources and Strategic Development and the Vice-ministry of Environmental Management. At the core of its environmental control and licensing functions is the Environmental Evaluation and Inspection Body (OEFA). OEFA created in 2009, is in charge of oversight, supervision, control and penalties in environmental matters. Some of its functions are to direct and supervise the application of the common regime of environmental oversight and control

The National Service of Environmental Certification of Sustainable Investments (Servicio Nacional de Certificación Ambiental para las Inversiones Sostenibles "SENACE") was created in 2013 by the Peruvian Congress. SENACE is to be a sub-agency of the Ministry of the Environment with the principal function of reviewing and approving detailed environmental impact studies. SENACE would have sole authority to certify and approve EIA-d except for studies conducted on projects that are specifically excluded from SENACE's jurisdiction by Peru's Council of Ministers. In addition, SENACE would maintain a national registry of environmental consultants and a public registry of all national or multi-regional environmental certificates.

The main EIA responsibilities still remain with the sectors. The sectors grant permitting licenses and determine the project risk category based on initial screening carried out and are also responsible for the review and approval of the EIAs. SENACE will review and approve only detailed EIAs and the sector Ministries will continue to be the ones responsible for categorization.

Compensation law: In 2014, Peru's National Congress (Congreso Nacional) passed the Payments for Ecosystem Services Law (Ley de Mecanismos de Retribución por Servicios Ecosistémicos). The law sets out a framework for compensation for ecosystem services between land stewards and beneficiaries, including civil society, businesses, and municipal governments. The law promotes, regulates and supervises payment mechanisms for ecosystem services arising from voluntary agreements that establish conservation actions, recovery and sustainable use (PES law - Ley Nº 30215). The PES Law recognizes contractual freedom for the contributors and beneficiaries to agree on the PES scheme to be implemented. However, such a proposal has to be assessed and approved by the Ministry of the Environment.

The PES Law has appointed the Ministry of the Environment as the PES national authority. Specific functions still need to be detailed through other legal instruments such as regulations, directives, etc. Also, the law establishes that subnational governments may promote the implementation of PES schemes, as well as fund these activities. The Ministry of the Environment is in charge of the management of the Registry of PES schemes to validate, regulate and supervise the PES scheme agreed by both the contributor and the beneficiary (Paniagua *et al.*, 2014).

The PES Law does not resolve existing overlapping rights in the Peruvian Amazon (forest areas, community property, timber concession, protected areas, among other kinds of tenure rights). Also, the PES Law does not complement PES schemes with other laws that regulate land use such as Forest Law or Natural Protected Area Law (Paniagua *et al.,* 2014).

Water laws

In March 2009, a new water law was passed authorizing the creation of a National Water Authority (ANA) and River Basin Councils to implement Integrated Water Resources Management planning (Law No. 29338 Decreto Supremo No. 001-2010-AG, Aprueban Reglamento de la Ley No. 29338, Ley de Recursos Hídricos). The law establishes a clear mandate for basin-scale water resources planning, integration of sectoral policies, participation of stakeholders, decentralization of management to the river basin level, and recognition of water as both a social and economic good (ICIWaRM, undated).

The Regulation provides that water use for human consumption is a priority over any other class or type of use. The objective of Basin Councils is to manage water resources by basin rather than by political jurisdiction. These Councils are considered entities of the National Water Authority and include both regional and local government representatives. The Regulation provides for Management Plans for Water Resources in the Basin that are to be developed by the Councils, with regional, local, water user and public participation and approval of the National Water Authority. The Councils are charged with ensuring compliance and fulfillment of the Management Plans (Beveridge & Diamond, P.C, 2010).

The water legislation was enforced in 2010 and establishes that an environmental-flows implementation is expected by 2020. E-flows in the legislation are defined as "*the volume of water that have to be maintained in awater course to protect or conserve water ecosystems, landscape aesthetics and other aspects of scientific and cultural interest*". The Regulation also includes provisions for, among other things, water use licenses, classification of water bodies, designation of protected zones and desalination projects.

A number of ministries have sectoral inputs on water resources management: Agriculture for Irrigation, Housing and Sanitation for domestic water use, Energy and Mining for hydropower and mining operations, and the Council of Ministries for environmental policy and energy and water tariff and services regulation. In addition, the Ministry of Environment is responsible, among others, for the generation of hydro-meteorological information through its Meteorological and Hydrological National Service (Servicio Nacional de Meteorología e Hidrologia—SENAMHI).

3. Brazil

Brazil is the most biologically diverse country in the world. It is classified at the top among the world's 17 megadiverse countries, and second in terms of species endemism. It contains two biodiversity hotspots (the Atlantic Forest and the Cerrado), six terrestrial biomes and three large marine ecosystems. It has about 70% of the world's catalogued animal and plant species. It is estimated that Brazil hosts between 15-20% of the world's biological diversity, with the greatest number of endemic species on a global scale (CBD, undated).

Environmental Institutions

Environment protection is centralized under the SISNAMA (National Environmental System), which is composed of bodies and agencies of the Union, States, Federal District, the Municipalities and the Foundations established by governmental agencies responsible for the protection and improvement of environmental

quality. SISNAMA has the following structure (Mello, 2012):

- Upper Body: Governing Council, appointed by the Federal Government
- Deliberative, Legislative and Advisory Body: National Council of the Environment (CONAMA)
- Central Authority: Ministry of the Environment (MMA)
- Executing Agency: IBAMA
- Sectional Bodies: state agencies responsible for implementing programs and projects for the control and supervision of activities capable of causing environmental degradation.
- Local Bodies: municipal entities, responsible for the control and supervision of these activities in their respective jurisdictions.

The Brazilian Institute for the Environment and Natural Renewable Resources (IBAMA) is responsible for the licensing and inspection of polluting activities that can have a national or regional impact, concerns two or more states or are located on the border with other countries, on Indian lands.

The National Environmental Policy is the main regulatory framework that supports planning and environmental management, sustained by environmental policy instruments such as environmental zoning, environmental licensing, environmental impact assessment etc. Environmental impact assessment is linked to environmental licensing for those activities that may cause significant environmental degradation (Moretto, 2013).

Licensing

The main guidelines for the implementation of environmental licensing are expressed in Law 6.938/81 and the CONAMA Resolution 001/86 and No. 237/97. Law No. 140/2011 discusses the state and federal jurisdiction for licensing, taking as a basis the location of the project. With respect to the construction of hydropower dams, Law 7804/1989 introduced the obligation of prior environmental licensing together with environmental impact assessments of projects that may have environmental impacts. Environmental licenses are granted by the environmental agencies and bodies composing the National Environmental System (at federal, state and municipal levels). The environmental license creates the legal conditions for the activity or project to operate causing the least possible impact to the environment. Brazil has a three-stage licensing process (Preliminary License, Installation License and Operating License), with separate procedures for granting licenses at all three stages. The Preliminary License is issued by the licensing agency for the planning phase of a project's implementation, modification or expansion. The Installation License then authorizes the beginning of the construction or installation of the project. Finally, the Operating License is required before project operation and may need to be renewed (da Costa, 2010).

With projects likely to cause significant environmental harm, such as hydropower projects the granting of the Preliminary License depends on the approval of both the Environmental Impact Assessment and the corresponding Environmental Impact Report which present an environmental diagnosis for the influence area of the project, an analysis of environmental impacts of the project and alternatives, a list of measures designed to mitigate negative impacts and an indication of survey and monitoring programmes. Investors are expected to bear the cost of environmental licensing, the arrangement of public hearings, the publication in the press of actions related to the licensing process, the implementation of the programs for which the licenses provide (mitigation measures) and environmental compensation (da Costa, 2010).

Project developers are required to offset their residual environmental impacts by supporting the establishment and maintenance of conservation units through a payment as part of the environmental licensing process. The compensation amount varies as a function of the intensity of undesirable effects. The money is used to create and maintain protected areas. Hydropower plants are under a constitutional obligation to pay financial compensation (Darbi, et al. 2009).

PACURA: Environmental Plan for Conservation and Use of the Influence Area of the Reservoirs- Resolution CONAMA No. 302/2002 establishes the limits of the preserved area of artificial reservoirs and demands the elaboration of PACURA for reservoirs used for electric power generation and water supply. This plan

has a group of guidelines and propositions with the objective of regulating conservation, recovery, and land use of the reservoirs area of influence. It is part of the licensing procedure according to the TORs elaborated by the agencies (Maciel Lyra *et al*., 2007).

Payment for watershed services

In 1997, Brazil passed the National Policy on Water Resources (Lei da Política Nacional de Recursos Federal Law 9433/1997), recognizing water as a public "good", whose use must be compensated through a financial payment. The law stipulates that resources generated through this means should be used to protect the resource at its origin. Thus, water payments could be directed towards conservation projects. Water payments relating to the use of resources from a particular watershed are collected by the local water management agency, which charges a usage fee and redistributes a portion of the payment to local watershed management committees (Lerda and Zwick, 2009).

Federal Law 12334/2010 establishes the Dams National Policy for Dams stating safety rules for the planning, construction, management, operation and oversight of dams in order to prevent overflows.

4. Mexico

As a megadiverse country Mexico has about 10%–12% of all the species on the planet. About half of all Mexico's species are endemic. Mexico is ranked 2nd in the world for the diversity of its reptiles, 3rd for its mammals, and 4th for its amphibians. About 36.5% of Mexico's territory is forested. Main threats to Mexico's biodiversity include deforestation for land use change (agriculture, industrial and infrastructural development), forest fires, illegal logging and species over exploitation (CBD, undated).

Environmental Institutions

The Ministry of Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales; SEMARNAT) is the Federal Government agency with a purpose to protect, restore and conserve Mexico's ecosystems and natural resources, and environmental goods and services, in order to promote their sustainable use. The main activities include creating national policy on natural resources, promoting the protection, restoration and conservation of natural resources and environmental goods and services, evaluating the environmental impact statements of development projects, regulating hydrological works in basins, streams and riverbeds and awarding contracts, concessions, licenses and permits (SEMARNAT, 2012).

Procuraduría Federal de Protección de Ambiente (PROFEPA) is the enforcement agency of Secretariat of the Environment, Natural Resources and is responsible for ensuring compliance with standards and regulations. It monitors compliance, investigates claims, conducts inspections and environmental audits, resolves administrative appeals on environmental issues and promotes the participation of the public in environmental law creation.

CONAGUA (National Water Commission) is the executive authority for all water related matters such as designing water policy and constructing, operating, and maintaining dams and irrigation systems.

Comisión Federal de Electricidad (CFE) or Federal Commission of Electricity is the state owned electricity utility and the main electricity company in Mexico. It is the government agency in charge of planning the national electrical system. It generates, transmits, distributes and markets electrical power.

BES Regulations

The General Act on Ecological Equilibrium and Environmental Protection (LGEEPA) regulates the principles of the constitution in relation to environmental matters. Environmental Impact Assessment is mandatory under the LGEEPA and the Biodiversity Code.

The LGEEPA states that, "any activity that causes grave or irreparable damage to the survival of a species must be preceded by an EIA and determination of protective measures". The Biodiversity code stipulates that EIA (or the Manifestación de Impacto Ambiental MIA) will be evaluated by the environmental authorities prior to a project's approval (or rejection). The EIA is designed to identify, predict, interpret, and evaluate the impact on the environment, human health and welfare, of works and activities of public or private nature that can cause an ecologic misbalance and also to identify prevention, mitigation and compensation measures. The mitigation and compensation measures are to be laid down in the Environmental Management Plan and must be linked to the environmental impacts that occur during the different steps of project implementation. In national protected areas, a Resource Management Plan must be developed (Darbi *et al*., 2009).

The Biodiversity Code states that when in-situ reparation of environmental deterioration is impossible, it will instead be subject to indemnification. On determination of the indemnification for environmental deterioration, the amount is transferred to the Biodiversity Restoration and Preservation Fund (Fondo para la Restauración y Preservación de la Biodiversidad). The economic valuation of the indemnity (in monetary terms) can be done either by the Ministry, the Environmental Protection Administration (Procuraduría de Protección al Ambiente del Estado de México), qualified experts, educational institutions or research institutions. Typical compensation measures can include the following (Darbi *et al*., 2009):

- Improvement of water, air and soil, through the application of environmental technologies to prevent and reduce negative impacts,
- Augmentation of vegetation cover through compensation, in order to reforest or conserve forests, shrubs, mangroves etc.,
- Respect for and protection of natural protected areas,
- Recovery and recuperation of species that are threatened, and
- Preventive measures to avoid impacts on endemic population

For EIAs, the LGEEPA expects the payment of economic guarantees (environmental insurances and guarantees) that are used and established in projects for which significant environmental impacts have been identified, in order to ensure environmental protection or the reparation of damage. Art. 2.308 of the Biodiversity Code empowers the Ministry of the Environment to demand these insurances or guarantees. The Biodiversity Code stipulates the creation of the Biodiversity Restoration and Preservation Fund to which compensation payments are issued and which serves as complementary financial support, in cases where the scope of reparation can be neither covered by the environmental insurances nor by the project proponent (Darbi *et al*., 2009.

Similar to the Biodiversity Code, the LGEEPA establishes responsibility to repair damage resulting from the contamination or deterioration of the environment or any impairment of natural resources or biodiversity.

The 1992 Water law amended in 2004 focuses on integrated water management. As per the National Water law, the river basin councils are responsible for proposing, promoting and implementing plans and actions towards the conservation, preservation and improvement of ecosystems in the basin, efficient and sustainable use of water in every phase of the hydrological cycle, amongst others (OECD, 2013).

5. Panama

Panama's biological diversity includes 10,444 species of plants, of which 1,176 are endemic, and a large number and variety of vertebrates, including 1,157 species of ocean fish, 206 species of fresh water fish,

179 species of amphibians, 229 species of reptiles, 957 species of birds, and 259 species of mammals. It is rich in marine life including migratory populations of fish, whales, fur seals, sea lions, sharks, and globally endangered sea turtles and seabirds. Important coastal habitats in the Pacific include coral reefs, large mangrove forests, estuaries, rocky coastal cliffs, and sandy beaches (ANAM, 2009).

Institutions

The National Environment Authority (ANAM)[3] is an autonomous body responsible for the development of national environmental policy, management of natural resources and environmental issues, administration, and enforcement. ANAM issues environmental regulations and can also impose fines for violations of these regulations.

BES Regulations

Panama's Environmental Law (Law No. 41 of July 1, 1998) established the framework legislation for standards of protection, conservation, and recovery of the environment, and created the National System of Protected Areas. The Environmental Law provides a foundation for the development of Offset mechanisms and the conservation of environmental services. Principle 7 states that "*Include, within the conditions for granting special rights for the use of natural resources,* ***the obligation to ecologically compensate for the natural resources utilized****; the economic value of these resources should, for these purposes be determined incorporating its social and conservation costs*."

EIAs or specific voluntary offsets[4] (mostly project driven from the private sector) or compensation regulations associated to preserving/compensating environmental services[5] of interest serve as a driver for biodiversity offsets. Panama is currently developing novel ecosystem service payment/compensation schemes, which can serve as a potential basis for biodiversity offset mechanism.

In 2014, legislation about Payment and Compensation Fee for Environmental Services was introduced. According to Article 23 "*The State shall promote payment for environmental services in the areas of influence of projects of public or private investment such as road infrastructure, irrigation, energy, mining and other activities considered high risk and environmental impact.*" It further states that projects with high environmental impacts such as power plants, transmission lines etc. shall include in its scheme investment compensation for environmental services. Investments in PES of these works or projects **activities may not be less than 0.5% (half percent)** of the cost of the work or the annual operating budget of the activity.

[3] In 2015, the Ministry of Environment was created in Panama.

[4] Voluntary offsets are undertaken either to pre-empt a mandatory requirement on operational grounds or because offsets are a natural follow-on from a business' social and environmental policy and good practice commitments.

[5] Due to the mechanism of ecological mitigation for damage to the environment, the tendency is to compensate with twice or three times (mostly reforestation programs) as indicated in the norm according to Report on Environmental Status of Panama, 2009.

VI. Lessons Learned

Based on the experiences from the hydropower case studies and a review of the BES legislations as applicable to hydropower projects, a number of issues come to light—

1. *A regulatory framework to adequately incorporate the effects of hydropower development on biodiversity and ecosystem services is lacking in Latin America.*

Hydropower projects are required to comply with the environmental impact assessment regulations and water regulations and thus biodiversity issues are addressed through those channels. Implementation of EIAs is linked with the licensing process which is not without its own challenges (as discussed later). Emphasis on the mitigation hierarchy especially avoidance and minimization should be part of planning process. Introduction of compensation laws in countries such as Colombia, Peru and Panama provide an additional opportunity to protect ecosystem services particularly in the watershed of a hydropower project. The idea is to compensate for the residual impacts of development after all options to avoid, minimize and restore have been exhausted. These compensation laws are still in their infancy and protection of ecosystem services will depend upon how these are enforced and the capacity of agencies to implement these legislations. Besides government capacity, the compensation programs have to be robust and realistically funded to ensure the integrity of the ecosystems and biodiversity that the program is meant to protect. For example, in the case of the Nam Theun 2 hydropower project in Lao PDR, even though the Nakai Nam Theun National Protected Area and the corridors linking it to two other protected areas (together referred to as the NT2 Watershed) are to be protected as an offset, due to inadequate funding protection of the watershed is suffering. Wildlife trade, logging and unsustainable harvesting of non-timber forest products are a growing problem in the watershed. The law in Panama stating that projects with high environmental impacts such as power plants and transmission lines shall include payments for compensation for environmental services is a positive step in allocating funding for the compensation program. However, care has to be taken to ensure that this funding is adequate to cover the objectives of the program, otherwise it becomes a paper exercise.

The water regulations are another means to protect biodiversity although these laws focus on basin-scale water resources planning are not explicitly geared towards biodiversity protection. The focus is on using water as an 'economic good'. A step further is development of watershed laws, which are more focused on protecting the ecosystems services in the watershed of a hydroelectric project. In Colombia for example, 6% of the gross sale of hydroelectricity has to be paid by the operators of the plant to maintain and restore the environment of a watershed (for plants whose total installed rated power exceeds 10,000 kW gross sales and self-generation). In Brazil as well, the watershed law states that that resources generated through using the waters should be used to protect the resource at its origin and water payments could be directed towards conservation projects. In general, in Colombia for example, the watersheds that receive the payments are better maintained. The funds are directed towards erosion control, pollution control, reforestation and community development programs benefitting the watershed.

Both the compensation laws and watershed laws include ecosystem services protection but these laws are not present in all countries in Latin America. The treatment of BES in the water laws or other laws is not sufficient to protect the vital ecosystem services that are essential for survival. Incorporating provisions in the law such as the watershed law in Colombia, to directly channel the funds for conservation activities (which is not allowed at the moment) such the creation of protected areas would strengthen biodiversity and ecosystem services protection.

2. *Project approval is linked to the licensing process which has its own limitations.*

Environmental license is granted by the competent environmental authority for the execution of a project, work or activity in accordance with the environmental law and regulations. Most licenses in Latin America require practically the final designs. At this stage all major developmental decisions have already taken place. Exceptions include Colombia which require an analysis of alternatives (Diagnostico Ambiental de Alternativas) prior to issuing an environmental

license for a given project and in Brazil the Preliminary License ("licencia previa") is given before going into a construction and operation licensing. Project assessment invariably takes place in a predetermined policy environment which can negatively affect the environment and lead to costly delays.

There have been some improvements to the licensing process as evidenced from reforms taking place in Brazil, Colombia and Peru. Brazil has strengthened the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) which is the agency in charge of the federal licensing of infrastructure projects in Brazil; Colombia has established the National Environmental Licensing Authority (ANLA) and Peru created the National Service for the Environmental Certification of Sustainable Investments (SENACE) for reviewing and approving Environmental Impact Studies for investment projects that may cause significant environmental damage.

One of the successes of IBAMA is to achieve inter-administrative communication with different Government agencies, efficiently addressing environmental management of infrastructure projects coming for approval. In addition, IBAMA is well staffed with qualified specialists reviewing the environmental documents. These are some of the key challenges faced across Latin American countries as elaborated in point 5 below.[6]

3. *The challenges faced by the environmental impact assessment process impede sound environmental analysis.*

The focus of environmental assessment in most Latin American countries is geared towards approval of the project EIA rather than to ensure long-term environmental management and sustainability. The EIAs are focused on assessing direct impacts especially concentrating on impacts during construction. There is lesser emphasis given to the determination, prediction and analysis of induced and cumulative impacts. For example, induced impacts such as changes to land use from the infrastructure project are not analyzed. In the EIA reports, there is a tendency to disaggregate information at a level of unnecessary detail, which make these studies very voluminous, while at the same time, issues of importance that should be studied in depth such as fragmentation are set aside. For example, in Colombia, the environmental licenses for the HidroSogamos and Porvenir II hydropower projects require entomology surveys (ants, butterflies, bugs, etc.) and determining the food chain relationships of the fauna and in one case, relocation plans for insects. It is becoming the norm to require data at such a detailed level.

Rapid ecological assessments are almost never carried out. Biodiversity assessments including the impacts on the biodiversity and ecosystem services are not analyzed in EIA studies in LAC. Emphasis is placed on terrestrial habitats with mitigation measures geared towards them. Assessing impact on aquatic habitats is virtually non-existent. The effect of indirect impacts, cumulative impacts or impacts from ancillary infrastructure are not typically considered. These shortcomings make the EIA weak directly affecting the Environmental Management Plan. As impacts are poorly assessed, mitigation measures are poorly developed. More than often, aquatic ecosystems are overlooked and not protected (except for wetlands sometimes).

For sustaining the aquatic ecosystem, maintaining the ecological flow is essential. This is one of the weakest components of the environmental assessments and regulatory frameworks guiding ecological flows is lacking. An exception is Peru where the water legislation enforced in 2010 has requirements for environmental-flows but implementation of this is expected by 2020. In the absence of adequate regulations, protecting aquatic habitats or river systems to compensate for the impacts becomes a challenge. While compensation laws are present in some countries, they are geared towards terrestrial ecosystems.

4. *Data gathered is inadequate for planning and monitoring impacts*

To meet the licensing and EIA requirements, often excessive baseline data is gathered without consideration of its usefulness. Monitoring programs are one of the

[6] Both ANLA and SENACE are relatively new organizations and face challenges similar to other agencies in Latin America. By addressing issues highlighted in this paper as well as developing a screening criteria for the identification of projects with significant impacts, requiring cumulative impact assessments and by adopting Environmental Codes of Practice for each sector to address design and construction related impacts, EIAs and the licensing system can be strengthened.

weakest sections of the EIA/EMP reports. Indicators to determine impacts are not identified. As a result, copious amounts of data is generated and presented without adequate analysis of its relevance to the proposed project. As indicators are not indentified and emphasis is placed on fauna and flora inventories for baselines, the same data collected during baseline studies is collected repetitively from which identifying impacts becomes impossible. There is a disconnect between data gathered and its usefulness for adequately protecting biodiversity. This is in part a symptom of the lack of expertise in environmental agencies to adequately assess a project and thus there is over compensation by requiring a large amount of data without understanding its relevance. For example in Chaglla hydroelectric project 4 years of biodiversity monitoring proved useless to assess residual impacts on biodiversity and for the design of an aquatic offset. Additional ecological assessments, fish ecology studies were required.

The focus should be on developing a thorough monitoring program based on comprehensive indicators that can assess impacts. The data sampling process should follow technical protocols and be carried out by trained professions to ensure its scientific accuracy. Furthermore, the data has the potential to contribute to scientific research and should be made publically available.

5. *Institutional capacity is weak across sectors*

From planning to licensing, approving and implementing hydropower projects, numerous agencies are involved both at the national and sub-national level each with a different mandate and different level of environmental expertise. Within countries, differences exist between sectors, especially energy, transport and the environment. In countries such as Peru, the first round of environmental evaluation is conducted by the sector ministry, categorizing the project according to likely environmental impacts. Projects likely to cause significant impacts are then referred to the SENACE for further evaluation. In some countries, regional level sub-agencies are involved in project approval. At the regional level the capacity is practically non-existent in many countries.

In addition, the planning and development of hydropower projects including granting of licenses requires interagency collaboration. As capacity is weak, collaboration and sharing of expertise across sectors suffers. There is a need to create interagency committees comprising of technical experts as part of the licensing process to ensure all agencies participate in the process and provide inputs in a timely manner. Further, a Panel of Experts comprised of environmental experts with sectoral knowledge to provide advice and guidance on complex projects should be instituted.

6. *There is a lack of strategic planning*

With a few exceptions, there is no formal requirement to assess the cumulative effects of single projects, nor an established methodological process to do so. Also, legislation for Strategic Environmental Assessments (SEA) is lacking in many Latin American countries. SEA and cumulative impact assessment are not carried out and often undertaken at the request of the multilateral funding agency like the Inter-American Development Bank or World Bank. Such upstream planning is beneficial in avoiding or minimize environmental impacts of hydropower plants, and can potentially eliminate alternatives with unacceptable or greater environmental consequences. For example, as part of hydropower development planning in Coatzacoalcos river basin, the technical, environmental and social feasibility of 28 potential sites was undertaken. Based on the analysis on 5 sites were identified as meeting all the three criteria inverting the impact on the basin from 70% of river flows fragmented to 70% of river flows un-fragmented.

Providing early financing for upstream planning can promote inclusion of environmental considerations into the decision making process. As lack funding to carry out upstream analysis is a bottleneck, making available dedicated funds to assist with identifying, developing and preparing sustainable infrastructure projects is necessary. Multilateral donors could provide incentives for upstream planning by providing lines of soft credit in Project Financing Facilities and Infrastructure Financing Facilities. Projects that have resulted from upstream planning should also receive special financing conditions.

To further ensure upstream planning, the licensing system can be reformed to provide licenses to programs rather than to projects. For example, the

environmental license for a hydroelectric development program would be a given for a watershed rather than to individual projects. The sector would be responsible for undertaking the planning studies.

Deficiencies within the regulatory and implementation process affect the conservation and protection of biodiversity and ecosystems services particularly aquatic ecosystems. With the development of hydropower intensifying across LAC and development impinging in environmentally sensitive areas in LAC, the need to protect BES from infrastructure development is greater than ever. ■

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