Pursuing sustainable hydropower in the Coatzacoalcos River basin, Mexico.

Introduction

Demand for electricity in Mexico is growing rapidly due to a population that is urbanizing and expanding industries. To balance economic development for its 112 million people with the sustainable use of its natural resources, Mexico recently announced a commitment to expand use of low-carbon energy sources such as wind, solar and hydropower. In this paper we describe a new partnership focused on improving the environmental sustainability of this expansion of energy generation.

Although hydropower dams produce low-carbon electricity, they can carry significant environmental costs. Dams disrupt watershed connectivity, act as a barrier to the movement of fish and other aquatic species, and alter flow regimes (Ligon et al. 1995). Because of these impacts, dams can reduce a river´s ability to support freshwater biodiversity, fisheries and other economic values and ecological services that freshwater ecosystems provide to human communities (Richter et al. 2010).

In December 2010, culminating two years of building common ground, The Nature Conservancy (TNC), and environmental organization signed a memorandum of understanding (MOU) with the "Comisión Federal de Electricidad (CFE)", the Mexican Federal Agency charged with generating and delivering all electricity within Mexico. The MOU focused reducing negative impacts of the energy sector on biodiversity and other natural resources. The collaborative agreement will focus on wind energy, bird electrocution and sustainable hydropower.

Both organizations acknowledge that increasing low-carbon energy generation is an important goal for Mexico, and they both also acknowledge that hydropower dams can pose threats to Mexican biological and cultural diversity. Thus the organizations agreed to pursue a new approach to hydropower planning and development known as "hydropower by design." Hydropower by design draws on the mitigation hierarchy and seeks to integrate infrastructure planning with planning to protect environmental and cultural resources at large spatial scales (Kiesecker et al. 2010). Hydropower by design is described in greater detail in Opperman and Harrison (Opperman and Harrison 2008) and Opperman et al. 2010.

In this paper we review CFE's traditional hydropower planning process and then describe the collaboration between CFE and TNC to study how incorporate concepts of hydropower by design into that planning process. The collaboration will begin with a pilot project in the Coatzacoalcos River basin.

The products of the pilot project will include social, economic and environmental targets. Overall, the project will seek to identify how a given energy target for the basin can be met with the lowest impacts on the other resources of the Coatzacoalco basin.

The Hydroelectric planning process; traditional and hydropower by design

The traditional CFE planning process in the pre-building phase includes three stages: 1) Wide vision (Gran Visión, GV); 2) Pre-feasibility; and 3) Feasibility. The GV stage develops a portfolio of potential hydropower projects that can contribute toward an integrated plan for regional energy production. This stage includes technical, economic, social, and environmental criteria. The pre-feasibility stage focused at the basin scale draws primarily on existing information to analyze economic data and identify social and ecological issues. Finally, the feasibility stage encompasses field studies to gather detailed information for potential construction projects (project specific). These processes generally take several

years and require a great deal human and economic resources, and only a few projects are ultimately designated as “feasible for construction. ”.

TNC and CFE are seeking to enhance this planning process to incorporate elements of “hydropower by design.” The organizations will draw on a variety of existing protocols and tools that seek to support both energy production and functioning, healthy river systems. Hydropower by design integrates information, objectives and priorities for both energy and natural/social resources into a comprehensive, basin-scale planning framework. Although CFE’s traditional planning process evaluated energy alternatives at the national and regional scales, the process assessed the social and environmental impacts of hydropower dams at the level of individual projects, likely underestimating the potential cumulative impacts.

Conversely, hydropower by design takes an integrated and basin-scale approach to all aspects of the planning process, including environmental review, project selection and design, and mitigation. This approach can quantify cumulative impacts to environmental and social resources at a large spatial scale and, by identifying these impacts at an early stage, potentially steer new projects away from the most sensitive or vulnerable areas. Further, because this approach encompasses a regional assessment of conservation priorities, hydropower by design can move the environmental mitigation requirements of dams away from piecemeal—and often ineffective—measures and towards the creation of integrated, large-scale, functioning freshwater systems that benefit people and nature. CFE and TNC will test hydropower by design at a pilot site, the Coatzacoalcos River basin. The project will assess environmental and social resources and then test and develop methodologies and tools to evaluate different hydropower development scenarios in the basin.

The Coatzacoalcos watershed

Mexico has a wide range of climate variation due to its geographic position and its complex topography. The country has 1,471 basins, although CFE has identified that only approximately 100 of them are suitable for hydropower development, including the Coatzacoalcos. Both organizations recognize that eth Coatzacoalcos has important values for both energy and environmental resources and so they agreed to select the basin as the pilot site.

The Coatzacoalcos river basin is located southeast part of México, with a drainage area of 22 000 km ^{2} producing an average of 36.670 million cubic meters of river discharge annually (Figure 1). Several hydropower projects have been proposed because of its steep topography and reliable water flow. Several small communities are located in the basin. Further, the basin is a high priority for its biodiversity resources and the mainstem of the Coatzacoalcos is free flowing. The basin is the third largest in Mexico, crosses three states and is among the wettest basins in the country (Cotler, 2010).

Figure1. Coatzacoalcos river basin.

Methods for the pilot site

To explore a hydropower by design approach for the Coatzacoalcos, TNC and CFE will draw upon a number of existing comprehensive water management approaches combined with international frameworks on hydropower power development (e.g. those produced by the International Energy Agency, the International Hydropower Association, and the World Commission on Dams). Drawing upon the principles from these concepts, along with the "Development by Design" approach that integrates infrastructure planning with the mitigation hierarchy (Kiesecker et al. 2010) TNC and CFE will design a framework for implementing hydropower by design in the Coatzacoalcos, of the organizations will pursue the following steps:

1) Review global best practices for integrated planning for hydropower and strategic/impact assessments
2) Review and propose adaptions to CFE's current processes
3) Refine a freshwater conservation "blueprint" or "portfolio" that identifies conservation priorities at the national scale and that can be scaled down to individual river basins
4) Conduct a stakeholder and legal framework analysis
5) Develop field protocols for rapid ecological and social assessments
6) Conduct a spatial analysis of the basin's resources using a Geographic Information System
7) Develop a multicriteria decision-support model that can incorporate both hydropower planning objectives and conservation objectives. This model will include a new software method known as the Barrier Analysis Tool (BAT), that measures stream network connectivity.

These methods and tools will be integrated into a framework that can identify cumulative impacts of dam development and compare the ability of various scenarios of dam development to meet objectives for energy and conservation.

Our goal

The partnership between CFE and TNC provides an excellent opportunity to match resources and test methodologies on an integrated basin-scale development and conservation plan. Through this collaboration, we can test whether a hydropower by design approach can produce development plans that meet a broader range of objectives and are consequently less controversial with local communities and the public at large and thus more certain and attractive to developers and funders

This planning approach seeks to address simultaneously objectives for water and power alongside the conservation of environmental and social resources. The project can potentially provide benefits for CFE— greater certainty in the review process and global recognition of innovative solutions—as well as the environment and local communities, including greater scrutiny of cumulative effects and better protection of river resources at the landscape scale.

We envision that this pilot project can lead toward a paradigm shift for dam construction and hydroelectricity generation in Mexico, in which hydropower is positioned as a source of renewable and sustainable energy with lower impacts. Thus, in addition to the pilot project, the collaboration will be extended to address broader planning processes for hydropower in Mexico. Because hydropower dams are proliferating rapidly around the world (Lehner et al. 2011), we believe that this project can serve as an important demonstration of the benefits of integrated, basin-scale hydropower planning and development.

References

Cotler, H. (coord). 2010. Las Cuencas Hidrológráficas de México. Diagnóstico y Priorización. Semarnat-INE-FGRA. México.

Kiesecker, J. M., H. Copeland, A. Pocewicz, and B. McKenney. 2010. Development by design: blending landscape-level planning with the mitigation hierarchy. Frontiers in Ecology and the Environment 8:261-266.

Lehner, B., C. R. Liermann, C. Revenga, C. Vorosmarty, B. Fekete, P. Crouzet, P. Doll, M. Endejan, K. Frenken, J. Magome, C. Nilsson, J. C. Robertson, R. Rodel, N. Sindorf, and D. Wisser. 2011. High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment 9:494-502.

Ligon, F. K., W. E. Dietrich, and W. J. Trush. 1995. Downstream ecological effects of dams. Bioscience 45:183-191.

Opperman, J. J., C. D. Apse, F. Ayer, J. Banks, L. Rose Day, J. Royte, and J. Seebach. 2011. Hydropower, salmon and the Penobscot River (Maine, USA): pursuing improved environmental and energy outcomes through participatory decision-making and basin-scale decision context.in J. Burger, editor. Stakeholders and Scientists: Achieving Implementable Solutions to Energy and Environmental Issues. Springer, New York.

Opperman, J. J. and D. Harrison. 2008. Pursuing sustainability and finding profits: integrated planning at the system scale.in Hydrovision. HCI Publications, Sacramento, CA.

Richter, B. D., S. Postel, T. Scudder, B. Lehner, A. Churchill, and M. Chow. 2010. Lost in development's shadow: the downstream human consequences of dams. Water Alternatives 3:14-42.

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