An electricity pylon. Photo courtesy of Google Images.

Strategic Planning: Before Projects are Chosen

Dams are born in the board rooms of government planners, often including the Ministry of Mines and Energy, the Ministry of Finance, the Ministry of Water, and the Ministry of Development or similar branches of a government. We often refer to this stage as "upstream," because it is when a government decides how much energy is needed, and by whom; what projects should or should not happen; what types of technologies should be used; and how large the budget is for a given project. Different actors have different types of responsibilities. Often, dam builders will only be directly involved in project planning, while policy and overall power sector planning will be the responsibility of the government, and may take place before specific projects are identified. In many countries, however, the distinction between government and developer is blurred; many well-connected companies are also formally or informally involved in writing policy and power sector development plans.

Integrated Energy Resources Planning

In many countries, governments produce yearly or multi-year **power development plans**. These plans allow governments to model energy demand during a given period into the future, and to prioritize what types of energy should be used to meet demand. Unfortunately, the assumptions made during the creation of power development plans may be too simplistic; may not include all social and environmental costs; and may be biased by political interests.

Conventional Energy Planning

Conventional power sector planning practices generally comprise a bundle of practices and assumptions that are generally referred to (especially by utilities) as "least cost planning." What they generally mean is "least cost generation planning from the utility's financial perspective." This "least-cost" planning typically arrives at a power development plan through a process that comprises load forecasting, developing assumptions about investment and operations costs of a limited list of options, and a computerized optimization that chooses among the limited options considered.

Conventional power planning typically includes only generation costs (and not social and environmental costs or even transmission cost). Transmission costs can account for 40% or more of total system expansion costs, but conventional planning simply adds transmission costs "after the fact" once generation costs are minimized. As a result, the optimization in conventional planning misses benefits that accrue from decentralized energy efficiency measures or generation which require no or substantially less investment in transmission.

True least cost planning should instead be based on the economic costs (including environmental externalities) of delivered electricity services to end users.

Conventional planning also treats risk in a very limited way: it makes a fixed assumption about all costs (including, crucially, fuel costs) and then optimizes based on this assumption. This yields a plan that is only optimized for a future that turns out to be similar to the assumptions that were adopted. The conventional planning process provides little or no information about the sensitivity of the selected plan to variations in key assumptions, and even less information on the sensitivity to changes in multiple variables simultaneously (for example, high natural gas price + drought year + carbon pricing). Meanwhile, conventional power planning often occurs behind closed doors, without participation of public stakeholders.

Integrated Resources Planning

In contrast to the conventional practices described above, dam planners should utilize **Integrated Resources Planning (IRP)**. Integrated Resources Planning is a type of long-term (20-30 year) comprehensive needs and options assessment that evaluates all options on an equal basis, internalizing economic, social and environmental costs as risks. Integrated Resources Planning can help prioritize the best energy options.

Energy Options on a Level Playing Field

In contrast to the limited choices considered in conventional power development planning processes, IRP considers a full range of power sector investments on an equal basis to meet new demand for electricity: not only new generation sources, but also transmission, distribution, and – importantly – demand-side measures such as energy efficiency. Investing in helping customers to save electricity is typically many times less expensive than building new power plants and fueling them for decades. IRPs include careful consideration of risk, integrating social, environmental, and other external costs and benefits.

As a result, IRP can be highly relevant to the hydroelectric sector, which is closely associated with high social and environmental costs. IRP is also useful in that it helps to illustrate poor efficiency performance of existing dams, highlighting the need to increase efficiency ratings before constructing new projects. Utilities that rigorously implement IRP consistently report good news: there are many opportunities for energy efficiency investments, and IRP can lead to substantially lower customer bills while avoiding the social and environmental disruptions and destruction that accompany new power plant construction and operation.

Participatory and Transparent

By nature, IRP is a highly participatory and transparent process. It is a public process in which planners work together with stakeholders to establish scope, investigate options, prepare and evaluate integrated plans, select preferred plans, as well as establish mechanisms to monitor, evaluate, and iterate plans as conditions change.

IRP contrasts with traditional, top-down planning, where public consultation occurs only as a last step, after plans are virtually complete. IRP can make planning more open to relevant governmental agencies, consumer groups, and others, thereby incorporating the needs and ideas of all parties and stakeholders, including affected communities, indigenous people, women, and NGOs.

When done properly, IRP provides a structure and an opportunity for utility systems and stakeholders to learn and to develop plans in a co-operative atmosphere. Ultimately, better decision-making processes result in power plans more closely aligned with societal goals.

Although a comprehensive IRP process requires a substantial commitment of time, IRPs lead to better outcomes: lower cost electricity, lower risk from price volatility, and lower social and environmental impact. IRP achieves these by emphasizing services (cooling, heating, lighting, etc.) rather than kilowatt hours of electricity alone; through considering all social and environmental costs rather than narrowly considering only utility finances; and through prioritizing choices that lower costs to society under a full spectrum of scenarios. Generally, these better outcomes involve considerably higher investment in energy efficiency and demand-side management than utilities would deploy without an IRP process.

Feed-In Tariffs and Renewable Energy Portfolio Standards

Two important tools to implement the results of an IRP are Feed-in Tariffs (FiTs) and Renewable Energy Portfolio Standards.

A feed-in tariff (FiT) is a policy mechanism designed to increase investment in renewable energy sources. It creates long-term contracts for large- and small-scale renewable energy producers, usually based on the generation cost of each technology.

FITs typically provide three provisions:

- guaranteed grid access
- long-term contracts
- cost-based purchase prices

Under a feed-in tariff, eligible renewable electricity generators, including homeowners, business owners, farmers and private investors, are paid a cost-based price for the renewable electricity they supply to the grid. This enables diverse technologies (wind, solar, biogas, etc.) to be developed and provides investors a reasonable return.

Typical Components of an IRP

- Creating an electricity load forecast
- Determining reserves and reliability
- Establishing demand-side management options
- Determining supply options
- Calculating fuel prices
- Determining environmental costs and constraints
- Evaluating existing resources
- Performing integrated analysis of supply and demand options to choose an optimal plan and contingent plans
- Establishing a time frame
- Accounting for uncertainty
- Valuing and selecting plans
- Creating an action plan
- Providing documentation
- Creating iterations of the plan

Many computer models exist that can assist in optimizing energy resources to support the creation of an IRP. These include:

- EGEAS: Electric Generation Expansion Analysis System:[49]
- MIDAS: Multi-objective Integrated Decision Analysis System
- Strategist[50]
- System Optimizer[51]
- LEAP[52]

Feed-in tariff policies have been enacted in over 50 countries, including Algeria, Australia, Austria, Belgium, Brazil, Canada, China, Cyprus, the Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Iran, Republic of Ireland, Israel, Italy, Kenya, the Republic of Korea, Lithuania, Luxembourg, the Netherlands, Portugal, South Africa, Spain, Switzerland, Tanzania, Thailand, and Turkey.

In contrast to a feed-in tariff, a **Renewable Energy Portfolio Standard (RPS)** is a regulatory framework that requires utilities' supply-side generation options to include a certain amount of electricity from renewable energy sources such as wind, solar, biomass, and geothermal. An RPS requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources to a pre-determined percentage of total procurement. RPS-type mechanisms have been adopted at either state or federal levels in many countries, including Australia, Belgium, Britain, Chile, China, Germany, Italy, Japan, Poland, Sweden, and the United States.

One of the key elements of an RPS is the types of energy sources that qualify as renewable. Typically, solar, wind, and energy efficiency are the most preferred renewable energy sources in an RPS. Since the goal of an RPS is to encourage the development of new renewable energy sources, many governments don't let existing hydropower qualify. However, each state treats hydropower in its own way. In some states, hydropower is restricted by capacity (e.g. 10 MW), while in others it is restricted by technology. Hydropower generated from efficiency improvements at existing facilities, and hydropower generated from capacity additions at existing facilities should generally qualify.

Germany's Feed-in Tariff in its Renewable Energy Sources (EEG) Act of 2012

On June 30th, 2011, the German Bundestag adopted the "Act on the amendment of the legal framework for the promotion of electricity generation from renewable energies" ("Gesetz zur Neuregelung des Rechtsrahmens für die Förderung der Stromerzeugung aus erneuerbaren Energien.")[53]

Section 3 on "Feed-in Tariffs" states that:

> "Grid system operators shall pay installation operators tariffs... for electricity generated in installations exclusively utilising renewable energy sources or mine gas... Monthly advance payments of an appropriate amount shall be made for the anticipated payments.
>
> The obligation pursuant to subsection (1) above shall also apply where the electricity was
>
> temporarily stored prior to being fed into the grid system. In such cases, the obligation shall apply to the quantity of electricity that is fed into the grid system from the temporary store. The amount of the tariff shall be determined based on the amount of the tariff that the grid system operator would be required to pay to the installation operator in accordance with subsection (1) above if the electricity were fed into the grid system without being temporarily stored. The obligation pursuant to the first sentence above shall also apply where a mixture of renewable energy sources and storage gases are used. Sentence 1 above shall not apply to electricity generated from solar radiation if a tariff has been claimed for this electricity in accordance with section 33(2).
>
> Installation operators who assert the entitlement to tariff payments in accordance with subsection (1) above for electricity from an installation shall, from that time, put at the disposal of the grid system operator the entire electricity generated in that installation:
>
> 1. for which an entitlement to tariff payment exists on the merits under subsection (1) above;
> 2. which the installation operator himself or third parties in the immediate vicinity of the installation are not using; and
> 3. which is transmitted via a grid system; and they may not sell the electricity generated in the installation as balancing energy."

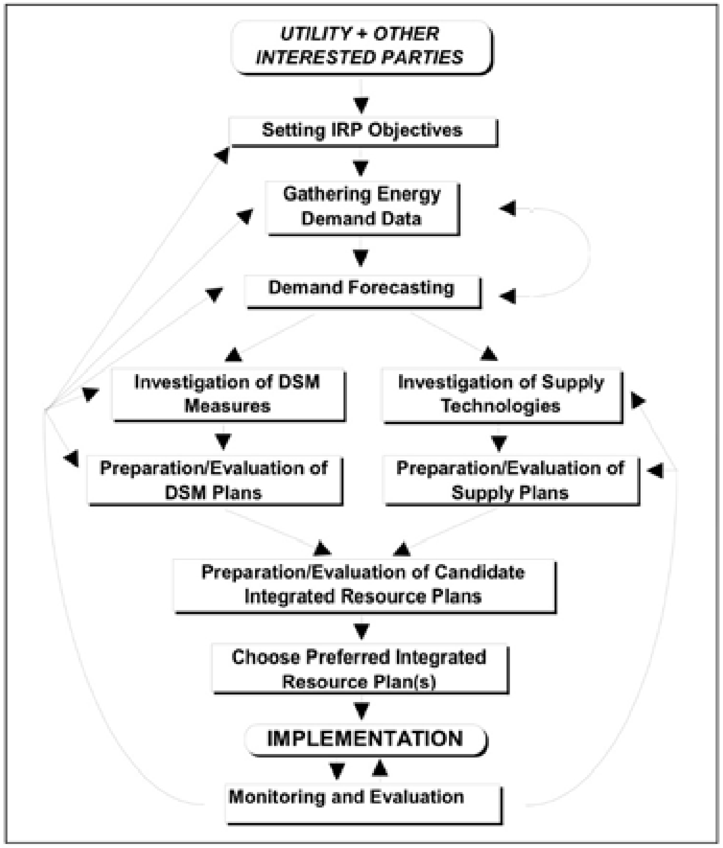

Figure 1. A flow chart describing the Integrated Resources Planning process. Source: Von Hippel and Nichols, 2000. Best Practice Guide: Integrated Resource Planning for Electricity.

Case Study: The State of Oregon's Integrated Resources Plan

In the United States, the State of Oregon's IRP process is one of the brightest examples on the planet. The plan prioritizes energy efficiency over new, greenfield dam projects, and involves stakeholders, including all affected communities, from the earliest stages of planning in a highly transparent manner. Affected communities form a permanent part of the decision-making process for subsequent iterations of the plan.

The plan identifies the "least-cost" energy option not simply as an economic metric of least cost to the developers. Instead, it defines the term as that which integrates both supply and demand management options; fully considers external costs to the utility; and includes the public and all stakeholders in decision-making prior, to rather than after, energy options are chosen.

The state's IRP process not only considers those potential costs faced by the utility, but actually refers to the broader overall costs to society as a whole. As a result, the external costs and risks associated with the process of deciding over energy options include specific particulate emissions, greenhouse gas emissions, public opinion, as well as load requirements, hydroelectric generation, plant forced outages, fuel prices, electricity prices, and costs of complying with regulation. These factors are all integrated into Oregon's IRP.

FURTHER READING:

- Read International Rivers' "An Introduction to Integrated Resources Planning" (2013): http://www.internationalrivers.org/resources/an-introduction-to-integrated-resources-planning-8143
- Read "Best Practices in Electric Utility Integrated Resource Planning," Regulatory Assistance Project (2013): http://www.synapse-energy.com/Downloads/SynapseReport.2013-06.RAP.Best-Practices-in-IRP.13-038.pdf
- Read USAID's "Best Practices Guide in Integrated Resource Planning for Electricity" (2006): http://pdf.usaid.gov/pdf_docs/PNACQ960.pdf

IDEAS FOR ACTION:

- Contact your national and/or state electric utility board. If an IRP process exists, demand to be included in the creation and revision of the plan. If an IRP process does not exist, meet with planners and lawmakers to insist that one be created.

Integrated Water Resources Planning

Parallel to integrated resources planning for electricity is the process of integrated resources planning for water resources. Diverse water assets are demanded by diverse water users within the same river basin or watershed. In many instances, the needs of users ;located outside the basin are also included, either by way of inter-basin transfers, or when administrative or planning boundaries do not coincide with river basin boundaries. Still, a basin-wide approach to water resources planning and management helps decision-makers to strike a balance between resource availability and demand from a multitude of users.

Creating a **Basin Plan** is the first step in creating a responsible social and environmental water resources management system. River basin plans define the ecologically and socially sustainable levels at which groundwater and surface water may be diverted, consumed, and abstracted by the total number of users in a basin.

Such plans should include an **Integrated Water Resources Management Plan.** Integrated Water Resources Management (IWRM) is defined by the Global Water Partnership as: "a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."[54] Ideally, IWRM seeks to allocate water resources among all users in a specific spatial scale, such as a river basin or watershed, while promoting water's equitable and reasonable use towards achieving reduced tensions over the quantity and quality of available water.

Still, IWRM has been criticized as a tool that can help larger, more powerful water users to secure and sustain water access while insufficient attention is paid to the needs of affected communities and ecosystems.

Pertinent International Policies:

- The UNEP Ecosystem Approaches in Integrated Water Resources Management (IWRM)
- The UN Convention on the Non-Navigational Uses of International Watercourses of 1997. However, the Convention has not yet entered into force.
- The Convention of the UN Economic Commission for Europe on the Protection and Use of Trans-boundary Watercourses and International Lakes (Helsinki Convention, UNECE Water Convention) is intended to strengthen national measures for the protection and ecologically sound management of trans-boundary surface waters and groundwaters. The Convention is now open to adherence from countries across the world.
- The Rapid Sustainability Assessment Tool (RSAT) is a desktop assessment auditing tool that assesses a single hydropower project and its relationship to a sub-basin; existing and proposed cascades of hydropower projects within a sub-basin or multiple projects within a sub-basin (or 2nd order sub-basin tributary); a sub-basin as a whole that has hydropower potential; and trans-boundary issues for basins shared by different countries, where hydropower is already developed or could be developed in future.

The confluence of the Baker and Ñadis Rivers, in Chilean Patagonia. Photo by International Rivers.

Case Study: The Murray-Darling River Basin Plan and Water Resources Management Plan[55]

The Government of Australia created the Murray-Darling River Basin Plan under the Water Act of 2007. The Basin Plan provides a coordinated approach to water use across the Basin's four States, Queensland, New South Wales, Victoria, and South Australia, and the Australian Capital Territory. It limits water use at environmentally sustainable levels by determining long-term average Sustainable Diversion Limits for both surface water and groundwater resources.

The Murray-Darling Basin Authority has determined 10,873 gigaliters per year (GL/y) to be the volume of surface water that reflects an environmentally sustainable level of take as a long term average with different limits for every river valley in the Basin. For groundwater, this volume is 3324 GL/yr.

The Plan is an adaptive framework and will be rolled out over seven years. It allows for further improvements in outcomes through a sustainable diversion limits adjustment mechanism and a constraints management strategy. The Plan is supported by Commonwealth investment in modernizing irrigation infrastructure and voluntary water purchasing through the environmental water recovery strategy.

The Basin Plan includes:

- an environmental watering plan to optimize environmental outcomes for the Basin
- a water quality and salinity management plan
- requirements that state water resource plans will need to comply with, if they are to be accredited
- a mechanism to manage critical human water needs
- requirements for monitoring and evaluation the effectiveness of the implementation of the Basin Plan.

For more information, see

- The Murray-Darling Basin Authority Explanatory Statement[56]
- The Murray-Darling Basin Authority Basin Plan (November 2012)[57]

FURTHER READING:

- Take a look at the European Union's Water Framework Directive for an example of trans-boundary basin planning: http://ec.europa.eu/environment/water/water-framework/
- Read the Integrated Tisza River Basin Management Plan as an example of basin planning: http://www.icpdr.org/main/danube-basin/tisza-basin
- Read Australia's Murray-Darling River Basin Plan: http://www.mdba.gov.au/sites/default/files/Basin-Plan/Basin-Plan-Nov2012.pdf

IDEAS FOR ACTION:

- Contact your water resources planning board and demand to participate in the creation and iterative revisions of your watershed's basin plan and water resources management plan.

Basin-Wide Assessment

If, after the elaboration of resource plans for both the electricity and water sectors, dams are still chosen as a viable option, a number of assessment tools that operate at the basin-wide level will help you protect your social and environmental rights. These include Strategic Environmental Assessments (SEAs), Cumulative Impacts Assessments (CIAs), Climate Change Assessments (CCAs), and Environmental Flows Assessments (EFAs).

Strategic Environmental Assessment

Strategic Environmental Assessments (SEA) are an assessment of environmental effects of plans, programs, and policies at broader spatial and temporal scales. They differ from project-level environmental impact assessments, which are limited to the specific scope of a singular project's area of impacts, and which may not assess broader impacts that a project contributes to large-scale processes and assets, such as at the level of a river basin.

The *SEA Protocol to the Espoo Convention* states that an SEA is an early warning tool for the long-term cumulative, induced, and ancillary impacts of a policy, plan, or program, as compared to an environmental impact assessment, which is project-specific and usually conducted at the end of the decision-making cycle. Strategic environmental assessments precede the environmental and social impact assessment process by streamlining their scope and costs by ensuring that project proposals are set within a policy framework that has already been subject to environmental scrutiny.

Cross-Sectoral and Basin-Wide

Ideally, SEAs should assess not only effects from the dam sector itself, but from the larger sector, such as energy, agriculture, water, and the like, which include the full range of options. For this reason, SEAs are most logically developed at the basin-wide level. In contexts where basins span across national borders, SEAs must be trans-boundary assessments. The Convention on Environmental Impact Assessment in a Trans-boundary Context (the Espoo Convention) outlines international norms in trans-boundary SEAs. Basins in which current dam planning justifies the creation and implementation of trans-boundary SEAs include most of the world's major river basins: the Nile Basin, the Congo Basin, the Zambezi Basin, the Ganges-Brahmaputra-Meghna Basin, the Mekong Basin, the Salween Basin, the Irrawaddy Basin, the Amazon Basin, the Orinoco Basin, the Danube Basin, the Dnieper Basin, and others.

"A strategic environmental assessment shall be carried out for plans and programs which are prepared for agriculture, forestry, fisheries, energy, industry including mining, transport, regional development, waste management, water management, telecommunications, tourism, town and country planning or land use, and which set the framework for future development consent for projects that requires an environmental impact assessment under national legislation."

– The Convention on Environmental Impact Assessment in a Trans-boundary Context (the Espoo Convention)

Typical Components of an SEA[58]

- Evaluate the environmental consequences of official draft plans, programs, policies, and legislation;
- Undertake SEA early in the decision-making process, well before the elaboration of project-level EIAs;
- Weigh environmental objectives equally to socio-economic objectives;
- Guarantee public participation in government decision-making across all development sectors. The public not only has the right to know about plans and programs, but also the right to comment, have their comments taken into account, and be told of the final decision and why it was taken. Public Participation in Decision-Making and Access to Justice in Environmental Matters is outlined by the Aarhus Convention;
- Place a special emphasis on human health, going beyond existing legislation in the region.

Case Study: The Mekong River Commission's SEA for the Mekong Mainstream

The Mekong River Commission (MRC) commissioned the Australian firm International Center for Environmental Management (ICEM) to develop a Strategic Environmental Assessment of the mainstream portion of the Mekong River. The SEA provided an "understanding of the implications of mainstream hydropower development and recommendations on whether and how the proposed projects should best be pursued. The SEA was intended as input to feed into the MRC Basin Development Plan (BDP), and ultimately to support national decisions concerning the mainstream proposals."

The SEA focused on proposals in three distinct hydro-ecological zones and assessed them in five different dam groupings: 1) all proposed Lower Mekong Basin mainstream dams, 2) the cluster of 6 Upper Lao projects of Vientiane, 3) the two Middle-Lao projects immediately up and downstream of Pakse (Ban Koum, Lat Sua), 4) the two smaller Lower Lao projects at Khone Falls (Don Sahong, Thakho), and 5) the two Cambodian projects upstream of Kratie (Stung Treng, Sambor).

The SEA ran in four phases over 16 months from May 2009: 1) a scoping phase to define key strategic issues of concern to Mekong River development; 2) a baseline assessment to describe past trends in those issues and their projection to 2030 without mainstream hydropower; 3) an impact assessment of the effects of mainstream hydropower on those trends; and 4) a phase to identify ways of avoiding and mitigating the risks and enhancing the benefits.

The SEA was intensively consultative, involving over 60 line agencies, 40 NGOs and civil society organizations, and some 20 international development organizations in meetings and workshops. The SEA process also included the participation of China through the high-level Ecosystem Study Commission for International Rivers (ESCIR)."

The SEA included a trans-boundary strategic assessment of power generation options; economic development; ecosystems integrity and diversity; fisheries and food security; and livelihoods and cultures of affected communities. The final report included five recommendations for hydropower planning by the Mekong River Commission:

- Decisions on mainstream dams should be deferred for a period of ten years with reviews every three years to ensure that essential deferment period activities are being conducted effectively.
- As the highest priority, the deferment period would include a comprehensive undertaking of feasibility studies for partial in-channel diversion and other innovative systems for tapping the power of the mainstream in ways which do not require dams across the full breadth of the river channel. This would involve governments in partnership with the MRC, multilateral development banks and developers.
- The deferment period would also include a comprehensive assessment and fast tracking of tributary projects that are considered feasible and ecologically sustainable according to current international good practice, including retrofitting of existing projects and innovative schemes.
- The deferment period needs to commence with a systematic distribution of the SEA report within each Lower Mekong Basin country in national language and consultation with line agencies, private sector and the NGO community.
- The Mekong mainstream should never be used as a test case for proving and improving full dam hydropower technologies.

The full assessment was completed in 2010. However, due to politics at the MRC, the final assessment was never officially endorsed by the four governments (Laos refused to endorse it because it did not want to delay Mekong dam-building for 10 years. In contrast, Vietnam openly called for a 10 year delay in Mekong dam building). Despite the fact that it never acquired official status, the SEA has been highly influential and has significantly raised awareness among Mekong government officials of the economic, environmental, and social implications of damming the Lower Mekong. The result has been closer scrutiny by the Cambodian and Vietnamese governments of hydropower projects proposed upstream.

Associated Facilities

A successful strategic environmental assessment should seek to include all components of a project's hydroelectric infrastructure, such as dam walls and dikes, transmission lines, diversion canals, river transport infrastructure such as navigation locks, road improvements, easement areas, worker encampments, and others, and should avoid de-coupling these components from each other during assessment.

Public Participation

A successful SEA also includes a stakeholder analysis framework that assures participation in all stages of the project cycle, a policy matrix of the efficacy of relevant regulations, the integral assessment of environmental and social risks, and an assessment of enacting-agency institutional capacity, particularly in terms of risk management or mitigation systems.

Relevant Policies:

- The OECD Applying Strategic Environmental Assessment: Good Practice Guidance for Development Cooperation
- The European Directive (2001/42/EC) on the Assessment of the Effects of Certain Plans and Programmes on the Environment, known as the SEA Directive came into effect in 2004 and applies to all 25 member states of the European Union. It requires an environmental assessment for certain plans and programs at various levels (national, regional and local) that are likely to have significant effects on the environment.
- A similar provision is contained in the SEA Protocol on Strategic Environmental Assessments (Espoo Convention, UNECE Convention on EIA in a trans-boundary Context), agreed to in Kyiv in May, 2003.[59] The Protocol includes a separate article encouraging the use of SEA in the context of policies and legislation. It will become effective once ratified by at least 16 countries.

FURTHER READING:

- Read the MRC's Mekong Mainstream SEA: http://www.mrcmekong.org/assets/Publications/Consultations/SEA-Hydropower/SEA-FR-summary-13oct.pdf
- Read the OECD's "Applying Strategic Environmental Assessment": http://www.oecd.org/dac/environment-development/37353858.pdf
- Explore resources from the Stockholm Environment Institute: www.sei-international.org
- Read the European Commission's resource page on SEA: http://ec.europa.eu/environment/eia/sea-support.htm
- Read the UNEP report "Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated Approach": http://www.unep.ch/etu/publications/textONUBr.pdf
- Visit the World Bank's page of materials on SEA: http://www.worldbank.org/en/topic/environment/brief/strategic-environmental-assessment

IDEAS FOR ACTION:

- Contact your water resources board and demand the creation of a Strategic Environmental Assessment process in your river basin, and that you be included as a stakeholder.

Cumulative Impact Assessment

A number of specific assessment approaches should be used in the creation of a strategic environmental assessment. One of the most helpful is known as **Cumulative Impact Assessment (CIA)** or, alternatively, a **Cumulative Effects Assessment (CEA).**

A Cumulative Impact Assessment is a multi-stakeholder process that assesses the cumulative and indirect impacts as well as impact interactions of the proposed dam or set of dams, as well as existing and planned projects from other sectors, on ecosystems, communities, and identified Valuable Ecosystem Components (VECs) within a specific spatial and temporal boundary. A cumulative impacts assessment should be completed only after a River Basin Plan has been completed, as river basin plans assess the carrying capacities of diverse valuable ecosystem components.

CIA is highly relevant to dams. It may produce an outcome in which the project developer has satisfactorily assessed the cumulative impacts of one or multiple dams on river basin resources, such as water availability, water quality, soil, vegetation, animal species, or others, and uses of these resources, before any project is approved. It analyzes how project-level impacts accumulate with the impacts from other projects upstream, downstream, and throughout the entire basin. CIA entails thorough analyses of both direct and indirect impacts caused by a dam, other dams, other projects from different sectors, and from any associated facilities.

CIAs must be multi-stakeholder in their nature at all stages of development of the assessment. All parties associated with planning and conducting such studies need to be in agreement regarding the selected VECs and the methods to be utilized.For dams, a CIA is ideally implemented at multiple spatial scales, including individual, multiple, and trans-boundary river basins, and at multiple temporal scales, including individual project, multiple project, and inventory-level timelines (e.g. 5, 10, 30, and 50-year study periods).

What are Types of Impacts Considered in a CIA?

Indirect Impacts:[61]

Impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway. Sometimes referred to as second or third level impacts, or secondary impacts. For example, indirect impacts are caused when a dam affects rate of water flow into a downstream wetland, impacting the ecology of the wetland.

Cumulative Impacts:

Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project. Cumulative impacts are caused by dams when, for example, additional dams are added to a dam cascade, causing incremental changes in a river's soil regime.

Impact Interactions:

The reactions between impacts whether between the impacts of just one project or between the impacts of other projects in the areas. Impact interactions occur, for example, when reductions in fisheries populations due to construction of a dam occur in tandem with stream pollution from a nearby mining operation.

What are Valuable Ecosystem Components?

The term Valuable Ecosystem Component (VEC) has been defined as "the environmental element of an ecosystem that is identified as having scientific, social, cultural, economic, historical, archaeological or aesthetic importance. The value of an ecosystem component may be determined on the basis of cultural ideals or scientific concern.

Valued ecosystem components that have the potential to interact with project components should be included in the assessment of environmental effects."[60]

To select VECs, the following factors are usually considered:

- Abundance at the site and local and regional study areas
- Ecological importance
- Native species
- Exposure
- Sensitivity
- Ecological sustainability
- Human health
- Socioeconomic importance
- Conservation status
- Data availability
- Importance to society in terms of cultural heritage

A Lao Theung woman in Ban Huay Song panning for gold in the Mekong River near Kaeng Luang.
Photo by Suthep Kritsanavarin.

The Six Steps of a Cumulative Impact Assessment

Typically, a cumulative impact assessment[62] is a six-step, iterative process:

Step 1 – Identify the incremental effects of the proposed project, policy, plan, or program on selected VECs within the environs of the project location. The VECs can be selected based on information related to current or anticipated future degraded or stressed conditions, the occurrence of protected species or habitats, and the presence or anticipated presence of other human activities that would (adversely) affect the same VEC.

Step 2 – Identify other past, present, and reasonably foreseeable future actions within the spatial and temporal boundaries that have been, are, or could contribute to cumulative effects (stresses) on the VECs or their indicators. Based on this knowledge, identify appropriate spatial and temporal study boundaries for each VEC.

Step 3 – For the selected VECs, assemble appropriate information on their indicators, and describe and assess their historical to current conditions. The historical information should coincide with the selected past temporal boundary (or historical reference point). Further, and depending upon the availability of information, any identified trends in the conditions of the VECs and their indicators should be determined and analyzed. Further, comparisons to numerical standards or policies, or to identified thresholds of significance, should also be presented for each VEC.

Step 4 – "Connect" the proposed project (or plan, program or policy) and other actions in the CEA study area to the selected VECs and their indicators. Numerous types of tools could be used to establish either descriptive or quantitative connections, such as questionnaires, indicators, conceptual models, matrices and networks, and scenarios. Quantitative examples include matrices and networks, Geographic Information Systems (GIS), habitat suitability modeling, and other modeling.

Step 5 – Assess the significance of the cumulative effects on each VEC over the time horizon for the study. Such significance determinations should begin with the incremental effects (the direct and indirect effects) of the proposed action on specific VECs. The focus is on the VEC, not on the action.

Step 6 – For VECs or their indicators that are expected to be subject to negative incremental impacts from the proposed project and for which the cumulative effects are significant, develop appropriate action-specific "mitigation measures" for such impacts. Further, if significant cumulative effects are anticipated on any VEC or its indicators, consideration should be given to multi-stakeholder collaboration to develop joint cumulative effects management measures, either locally or regionally, or both.

Case Study: Cumulative Impacts in the Environmental Impact Assessment of the Rusumo Falls Hydropower Project

The Rusumo Falls Hydropower Project, part of the Nile Basin Initiative/Nile Equatorial Lakes Subsidiary Action Program (NELSAP), would generate 80 MW for a power pool connecting Burundi, Rwanda and Northwest Tanzania. The dam design includes a 15-meter high dam on the Kagera River, and a 313 square kilometer run-of-river reservoir that will create 15 kilometers of "permanent shallow inundation" upstream from the dam site, located on the Rwanda-Tanzania border. The Rusumo Falls HPP is one dam of a larger cascade of dams planned for the Kagera basin watershed. Upstream, on the Nyaborongo River, Nyaborongo Dams I and II are planned. Downstream, the 53 MW Kabono Dam is planned on the Kagera River in Tanzania, Each dam is planned with a run-of-the-river design.

The Rusumo Falls HPP triggers eight of the environmental and social safeguards policies of the World Bank, the principal project financier. According to the Bank's safeguards information sheet, expected impacts include the flooding of approximately 5,280 hectares of agricultural lands and 20 hectares of built-up lands along the Kagera and Ruvubu Rivers and around Lake Rweru.

Upstream, Rusumo Falls HPP would significantly flood wetlands marsh habitat around and upstream from Lake Rweru, some of which may be designated wetlands of international significance under the Ramsar Convention. Downstream, Rusumo Falls HPP may alter the flow regime of the Akagera National Park in Rwanda. The transmission line associated with the project, funded by the African Development Bank, may also impact natural habitats. According to the World Bank, close to US$32 million has been allocated for mitigation projects, including resettlement and local area development programs. The total number of project-affected people is expected to be between 5,200 to 6,700 households, or roughly 30,000 to 40,000 people.

Although there is no national or regional requirement for cumulative impact assessment in Tanzanian, Rwandan, or Burundian law, cumulative impacts were considered in the environmental impact assessment for Rusumo Falls HPP, written by Artemis, a French project management and engineering firm.

Unfortunately, the scope of the cumulative impacts assessment is mostly concerned with interactions relative to other projects in the basin, including dams, transmission lines, a railway project, and a border post project. For example, the CIA section describes how the upstream Nyaborongo I and II dams may limit water availability for the Rusumo Falls HPP, and how it in turn might limit the water available for the downstream Kakono Dam.

In contrast, there is only passing mention of the effects of cumulative impacts on Valuable Ecosystem Components, including water quality, sedimentation, and socioeconomic patterns. In most cases, the environmental impact assessment concludes that no cumulative impacts are to be expected for these components, because the run-of-the-river design eliminates the possibility they would occur.

In fact, run-of-river dam cascades are some of the most typical candidates to present cumulative impacts on VECs. Indeed, the Rusumo Falls HPP EIA makes little mention of how the dam will add incremental cumulative impacts to species that act as indicators for biodiversity, nor how sedimentation effects will shift the overall balance of water quality, in the basin. Without scientific baseline studies and analyses of incremental effects, this section of the Rusumo Falls HPP EIA is not a good example of a cumulative impacts assessment.

FURTHER READING:

Read the following for more indications on how to do a CIA:

- The Canadian Environmental Assessment Agency's Cumulative Effects Assessment Practitioners Guide (1999): https://www.ceaa-acee.gc.ca/default.asp?lang=En&n=43952694-1
- The U.S. NEPA Analysis Guidance Manual (2007): http://aec.army.mil/Portals/3/nepa/nepa-agm.pdf
- The European Commission's Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions (1999): http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf
- Read the Rusumo Falls Hydropower Project EIA, written by Artemis: http://documents.worldbank.org/curated/en/2013/02/17398776/rwanda-regional-rusumo-falls-hydroelectric-project-environmental-assessment-vol-1-4-main-report

IDEAS FOR ACTION:

- Demand the relevant planning body – for example, a river basin committee, the Ministry of the Environment, or the Ministry of Energy – include a CIA in basin assessments as well as for any project-level environmental impact assessments. Demand that a participatory management plan be created as well.
- Develop your own community-based assessment of impacts on VECs you or your community deem to be important. These could include any cultural, social, environmental, or other resources that will be impacted by a dam or series of dams, including water availability in your community. Publish this assessment in local media to draw attention.

Climate Change Assessment

Another useful approach for Strategic Environmental Assessments is conducting assessments of the effects of climate change on river hydrology. Climate change is altering the hydrological flows that form the basis of river basin ecosystems, livelihoods, resources, and users. Increasing variability in precipitation, temperature and hydrology places greater tension on the ability to preserve downstream ecosystem services, including fish and wildlife, forests, and the communities that depend on them for survival. Increased floods and droughts will lead to dams under-performing (in the case of droughts) or greater floods downstream and dam safety risks (as projects have not been built to withstand bigger inflows).

Yet, current hydrological studies are done based on past records, ignoring the possibility that past trends may change in the future due to climate change. This concept is referred to as Non-Stationarity. In other words, past hydrological records are no longer a reliable indicator of possible future weather patterns. Only by incorporating climate change into hydrological modeling can planners more comprehensively understand how future precipitation is likely to affect the availability of water for a dam project.

Climate Variability

A **Climate Change Assessment (CCA)** projects the probable future availability of a given resource after the effects of climate change are factored into how the availability of the resource may change. These factors may include precipitation, temperature, groundwater storage, and others.

In the climate change assessment, developers should incorporate analyses of the effects of consecutive flood and drought occurrences on the reduction of hydrological flows. They should have access to accurate regional climate models for use in these assessments. Assessment results should directly inform options and needs analyses identified within IRPs for electricity resources, in the creation of Strategic Environmental Assessments and project feasibility studies, as well as in project-level environmental and social impact assessments (ESIAs).

Emissions

Dam infrastructure can also emit greenhouse gases, including reservoir emissions, spillway emissions, emissions associated with project construction, and others. For these reasons, all greenhouse gas emissions

Severe flash floods swept through the Northern Indian state of Uttarakhand in June 2013 as a result of climate change, destroying several hydropower projects including the Vishnuprayag Dam, shown here.
Photo courtesy of Matu Jansangthan.

to be released by a project and its associated facilities should be previously modeled by the developer and made public as an Emissions Assessment. In addition, the developer should create and implement a greenhouse gas mitigation plan, and should monitor, measure, and evaluate project-related greenhouse gas emissions during all project stages. Should also incorporate these emissions into national greenhouse gas emission inventories.

Both climate variability assessments and emissions assessments should be insisted, upon for projects applying for carbon credits, and any emissions from projects should be deducted from the emission reduction claims made by the project developer in their relative project submission to the carbon trading regulator, such as the UNFCCC.

FURTHER READING:

- International Rivers' Guide to Healthy Rivers and Climate Resilience[63]
- The Stockholm Institute's Water Evaluation and Planning (WEAP) model[64]
- The GHG Protocol's Financial Sector Guidance and Corporate Value Chain (Scope 3) Standard[65]
- The IHA/UNESCO Reservoir Emissions Assessment Tool[66]
- The IFC Carbon Emissions Estimation Tool (CEET)[67]
- The Agence Française de Developpment (AFD) Bilan Carbone emissions tool[68]

IDEAS FOR ACTION:

- Demand that dam planners develop and publish the results of climate variability and emissions assessment for any dam or series of dams planned in your basin.
- Demand that dam planners avoid reservoir emissions for any planned dam by reducing the amount of nutrient flow into the reservoir.

Environmental Flows Assessment

Basin Plans and Strategic Environmental Assessments should include benchmarks for **environmental flows** for rivers. Environmental flows may be defined as the naturally-occurring flows within a river system that has not been intervened upon by human activity. However, they are usually defined as the flow regime that has been specifically determined in order to maintain ecosystems and their specific socially- or culturally-defined benefits, after the system has been perturbed and flows regulated by competing water uses.[69]

Examples of environmental flows parameters that may be maintained after river system intervention include:

- Floodplain inundation cycles. A floodplain is an area near a river or a stream that floods when the water level reaches flood stage.
- Soil deposition cycles. Soil deposition is one of the principal functions that free-flowing rivers perform.
- Migration patterns of fish, amphibians, and wildlife. Rivers are the central corridors for the migration of fish, freshwater amphibians, and wildlife; and thus, are central to maintaining the world's biodiversity.
- Flows sustaining riparian vegetation and forests. Rivers sustain the riparian vegetation and forests that make up terrestrial ecosystems. They are the veins which deposit needed minerals and nutrients into the growth of life across the planet. As a result, free-flowing rivers play a

The Kisiizi Falls flows into the Kisiizi River in Uganda. Photo courtesy of the National Association of Professional Environmentalists (NAPE).

Typical Factors and Steps in a BBM Analysis Include:

Natural Flow Characteristics:

- degree of perenniality
- magnitude of base-flows in the dry and wet season
- magnitude, timing and duration of floods in the wet season;
- small pulses of higher flow, or freshes, that occur in the drier months

Steps:

Flow features that are considered most important for maintaining or achieving the desired future condition of the river, and thus should not be eradicated during development of the river's water resources, are determined. The first building block, or low flow (base flow) component, defines the required perenniality or non-perenniality of the river, as well as the timing of wet and dry seasons. Subsequent building blocks add essential higher flows.

In general, establishing environmental flows involves regular meetings with the diversity of basin water users. A workshop may be prepared that links environmental and engineering concerns over water allocation. This workshop can produce a report that assesses environmental flows scenarios, and creates an implementation plan.

This report can include components such as the following: a delineation of the study area; a selection of river sections; an assessment of habitat integrity; an assessment of social uses of riverine resources; an assessment of ecological importance and sensitivities; definition of ecological management classes; assessments of the hydrology, hydraulics, geomorphology, water quality, vegetation, aquatic invertebrates, fish, and groundwater characteristics of the study sites.

central role in maintaining terrestrial carbon sinks and forest resources.

- Flows for sustaining socio-cultural and religious links of the society with the river. In many countries, river flow has a special cultural and religious significance to a majority of population. Many times, this population may not reside on river banks or visit the river, but its flow at a certain level, especially on certain days, holds immense importance.

The tool used to create benchmarks for healthy rivers is called an **Environmental Flows Assessment (EFA)**. An EFA produces a description of a modified flow regime for a regulated river, designed to aid maintenance of valued features of the riverine ecosystem. The assessment is river-specific, as each catchment has its own hydrological character, and each river may have a different blend of valued features that needs to be protected.

An important distinction exists between "bottom-up" and "top-down" environmental flows assessments.

- A bottom-up assessment creates a baseline amount of flows that answers the following question: *What flows are needed for various ecological and social purposes?*
- A top-down assessment creates a baseline of flows that answers this question: *How much can the flow regime be modified without causing too large an effect on ecosystem services?*

The **Building Block Methodology (BBM)** was developed as one bottom-up assessment methodology to establish baseline environmental flows necessary for ecological and social purposes. It was developed first in South Africa and Australia in the 1990s. Environmental flow allocation for maintaining river ecosystems was entrenched in South Africa's new National Water Act (No. 36 of 1998) as the ecological Reserve. This is one of the two components of the Reserve, the other being an allocation for basic human needs.

Case Study: Assessing Environmental Flow Requirements for the Marromeu Complex in the Zambezi Delta

Dr. Richard Belfuss and Dr. Cate Brown applied the DRIFT model to the Marromeu Complex, a Ramsar Wetlands Site in the Zambezi Delta[73] in Mozambique.

The study compared the requirements within and between users with respect to the different flow changes assessed, constructed the relationships between flow and various combinations of users in the Zambezi Delta in order to elucidate the flow requirements for the Delta, evaluated the flow changes against modeled hydropower losses and/or gains to provide an indication of the possible tradeoffs between Delta users and hydropower generation and to evaluate these against the specialist's assessments as to whether or not past changes to the delta are realistically reversible, and summarized the various outputs to provide a recommended way forward.

The study concluded that "there is no 'minimum flow requirement' for the Zambezi River delta. Rather, perceived benefits increase in the delta with an increase in magnitude and duration of the annual flood, provided it occurs sometime in the normal flooding period of December to February. Benefits to the delta users, however, offset by costs in terms of hydropower loss. Thus, in order for improvement in the delta to be achieved some trade off will need to be made, and it seems likely that that trade-off will involve a reduction in hydropower generation. There is a strong and consistent requirement for water in the delta from most users, and a strong and consistent message that reinstating at least some of the historic flow patterns will result in significant improvement in many of the areas that have been shown to be of concern."

Evolution of the building-block methodology led to the creation of the DRIFT model. The DRIFT model is a holistic approach to determining environmental flows baseline requirements. The BBM model, the DRIFT model, and a few other models are described below.

Some E-Flows Methodologies and Models:[70]

- *The Building Block Methodology (BBM)* focuses on "holistic methodology that addresses the health (structure and functioning) of all components of the riverine ecosystem, rather than focusing on selected species as do many similarly resource-intensive international methodologies."

- *The Downstream Response to Imposed Flow Transformation (DRIFT)* model is a "methodology for assessing the flow requirements for maintenance of rivers that are subject to water developments. It has six important attributes. First, it provides an holistic approach to EF assessments, in that it addresses all parts of the intra-annual and inter-annual flow regime, and all living and non-living parts of the river ecosystem from source to sea. Second, it is a scenario-based approach, combining data, experience from a multi-disciplinary team of specialist river scientists, and any other local knowledge on the river of concern, to provide predictions of how the river could change with flow manipulations. Third, it further predicts the social and economic impacts of these river changes on common-property subsistence users of the river's resources. Fourth, its outputs comply with the requirements of the South African Department of Water Affairs and Forestry for use in its management of aquatic ecosystems (Resource Directed Measures – RDM). Fifth, all the data and knowledge used in compilation of the scenarios are stored in a database that can be used to create any number of scenarios and that also acts as a resource in its own right on flow-related responses of rivers. Finally, it is grounded in a growing range of custom-built software that allows much of the application of DRIFT to be automated."

- *The Ecological Limits of Hydrologic Alteration (ELOHA)* model is "a scientifically robust and flexible framework for assessing and managing environmental flows across large regions, when lack of time and resources preclude evaluating individual rivers."[71]

- *The In-stream Flow Incremental Methodology (IFIM)* "integrates concepts of water-supply planning, analytical hydraulic engineering models, and empirically derived habitat-versus-flow functions to address water-use and instream flow issues and questions concerning life-stage-specific effects on selected species and the general well being of aquatic biological populations." IFIM includes the Physical Habitat Simulation Model (PHABSIM). "This model incorporates hydrology, stream morphology, and microhabitat preferences to determine relations between streamflow and habitat availability. Habitat availability is measured by an index called the weighted useable area (WUA), which is the wetted area of a stream weighted by its suitability for use by an organism. PHABSIM simulates streamflow habitat relations for various species and life stages and allows quantitative habitat comparisons at different streamflows."[72]

FURTHER READING:

- Read more about the BBM methodology at "Environmental Flows Assessments for Rivers: Manual for the Building Block Methodology: Updated Edition," Freshwater Research Unit, University of Cape Town, 2008: http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/swrcb/swrcb_king2008.pdf

- See Latha Anantha & Parineeta Dandekar, "Towards Restoring Flows into the Earth's Arteries: A Primer on Environmental Flows," 2012. International Rivers. http://www.internationalrivers.org/files/attached-files/eflows_primer_062012.pdf

IDEAS FOR ACTION:

- Contact the national and/or state water resources utility board and Ministry of the Environment to demand to participate in the creation of environmental flows and ecological management standards in your watershed.

Fishing boats going out on Lake Turkana, Photo by Friends of Lake Turkana

Project Feasibility

The above-mentioned types of assessments establish parameters to measure the feasibility of different dam projects. With these parameters, dam planners are better able to determine which dams should be built and which should not, by creating project feasibility studies. Project feasibility studies analyze the technical, economic, and financial feasibility of any given project, and should fully incorporate all risks and costs identified by strategic-level plans. It is important to assure that feasibility studies internalize a project's entire set of externalized costs, including all social and environmental costs, in order to assure that dam-affected people's rights are protected and standards are being met.

TECHNICAL FEASIBILITY

A dam may be considered technically feasible if its design meets the resource needs of its consumers. For example, if the project is technically capable of exporting electricity or storing water for irrigation purposes. Yet, a project's technical feasibility is intimately tied to its economic and/or financial feasibility. These are described below.

Technical feasibility analysis should draw from all of the information available in the strategic planning assessments described above.

ECONOMIC FEASIBILITY

Any dam must have a positive Economic Internal Rate of Return (EIRR) for it to be economically feasible. An EIRR generally measures the benefit produced by a dam for a government or country, in terms of national security, job creation, industry creation, and other measures that influence Gross Domestic Product (GDP).

Economic feasibility should assess the economic rate of return after all risks and costs have been internalized, including political and governance risks, social and environmental risks, technical risks, and the information cited in the strategic and cross-cutting areas described above.

FINANCIAL FEASIBILITY

Dams also may need a positive Financial Internal Rate of Return (FIRR) in order to be considered feasible. In contrast to the EIRR, the FIRR strictly measures the monetary benefits produced by a project over time, in comparison with the initial investment. In general, private sector developers are more concerned with FIRR, whereas the public sector or government will be more concerned with EIRR.

Financial feasibility should assess the financial rate of return equally after all risks and costs have been internalized, including all credit and financial risks, based on the information cited in the strategic and cross-cutting areas described above.

ENVIRONMENTAL AND SOCIAL FEASIBILITY

Financial institutions and dam developers should also assess the environmental and social feasibility of a project. This should be done prior to the actual environmental and social impact assessment (ESIA) by way of project risk screening. Risk categorization (see box) includes environmental and social factors that can help in screening a project.

What is Risk Categorization?

Feasibility studies ideally involve the classification of the risk of the investment. Usually, Category A risk refers to projects that cause irreversible negative impacts that cannot be mitigated; Category B risk refers to projects that cause severe negative impacts that may be mitigable; and Category C risk refers to projects that cause either no impacts at all or only positive impacts.

Ideally, Category A classification includes all projects that involve displacement and resettlement; that impact indigenous peoples or other vulnerable groups either directly or indirectly; that impact environmentally sensitive locations such as National Parks and other protected areas identified by national or international law; and other sensitive locations of international importance (for example, Ramsar Convention sites, IUCN protected areas and UNESCO World Heritage Sites) or of national or regional importance, such as wetlands, forests with high biodiversity value, areas of archaeological or cultural significance; and any project that includes a dam wall size above 15 meters from the foundation and/or reservoir size equal to or above 3 million m3.[74]

It is important to note that projects are sometimes mis-categorized by financial institutions (for example, as "B" rather than "A"). This can affect which standards are applied to a project. You should watch this and raise concerns about categorization as early as possible.

Finally, you should pressure dam financiers to not invest in projects that cause violent, forced, coercive, or involuntary displacement, and that intervene significantly in previously-established no-go zones such as critical natural habitats.

FURTHER READING:

- For information on best practices in project feasibility and risk categorization, see the IFC's Environmental & Social Review Procedures Manual: http://www.ifc.org/wps/wcm/connect/190d25804886582fb47ef66a6515bb18/ESRP+Manual.pdf?MOD=AJPERES

IDEAS FOR ACTION:

- Contact the dam financier and request a copy of the project feasibility studies, and of the risk categorization report for the project. If copies are not provided to you, use local or international media to highlight the financier's lack of transparency.