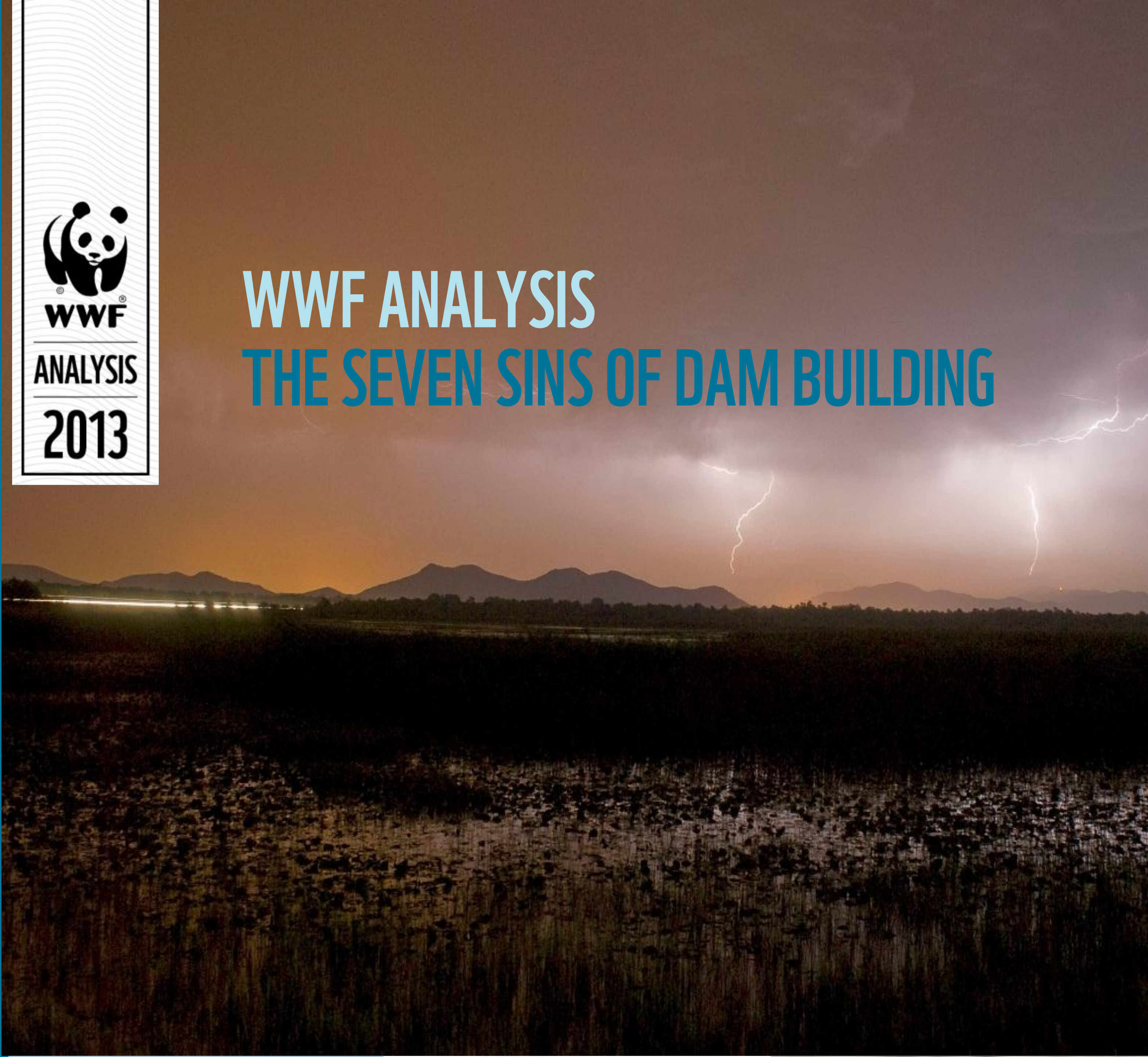
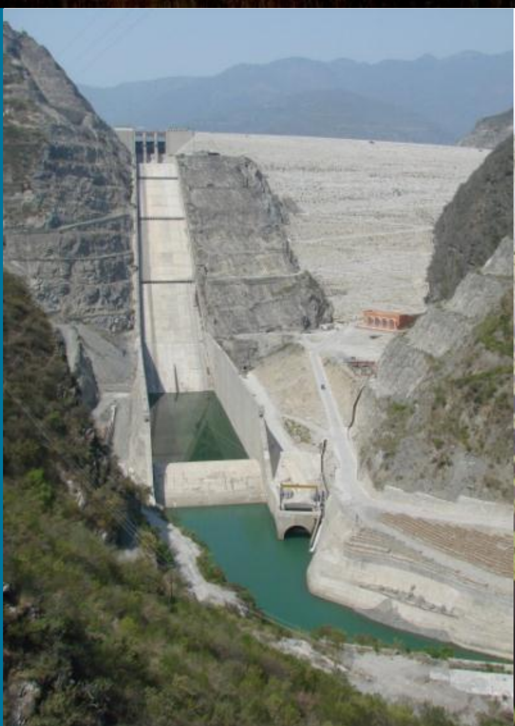
WWF ANALYSIS 2013



WWF ANALYSIS
THE SEVEN SINS OF DAM BUILDING



Cover: Top photo – Storm on Lake Skadar, Montenegro. Bottom left photo – The Tehri dam on the Ganges River, in the state of Uttarakhand, India. Bottom center photo – Skadar lake, Bottom right photo – Whiskered tern (*Chlidonias hybrida*) landing on its nest, Lake Skadar, Montenegro. © WWF-Canon

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"No one tests the depth of a river with both feet."
African Proverb

Fifteen years ago, the World Commission on Dams (WCD) began their mission to conduct an independent review of the development effectiveness of large dams, to assess alternatives, and to develop practical guidelines for decision-making. The resulting 'Framework for Decision-making' was received with a wide range of feelings and reactions: from great relief and enthusiasm, to general acknowledgement of the formulated principles but rejection of the conclusions, to full opposition and rejection. Nevertheless, in the past years, many of the key recommendations have gained traction and are broadly acknowledged. In 2011, the International Hydropower Association released the Hydropower Sustainability Assessment Protocol, which incorporates and operationalizes many of the WCD's ideas. Governments have incorporated elements of the recommendations into their planning and permitting processes, and banks have included them in their safeguards and lending guidelines.

However, in the 13 years since WCD published its findings, many dam projects still get things wrong – the most notorious dam in the news at the moment being Laos' Xayaburi dam on the main stem of the lower Mekong River. But Xayaburi is not alone – all over the world, dams proceed without proper consultation, risk management, or consideration of the natural ecosystems that both dams and people rely on. This report highlights common pitfalls of dam building – the seven sins so to speak – and identifies some of the projects going ahead today (though they may have begun many decades ago) that, despite all that is known about good practices and sustainability, still test the waters with both feet.

1. Introduction

Access to clean water, food, and electricity is a basic need, yet hundreds of millions of people go without. Each year an estimated 3.5 million people die as a result of water related diseases and 1.4 billion, or 20 percent of the world's population, did not have access to electricity in 2009 (WWAP, 2012). By 2030, food demand will increase by 50 percent, and energy demand from renewable energy sources, including hydropower, will rise by 60 percent (WWAP, 2012). However, if water use does not become more efficient, water demand will overshoot supply by 40 percent in 20 years' time (UNEP, 2011). Currently, over 1.4 billion people live in river basins where water use outruns the minimum recharge level (UN Water, 2013).

Rivers have been dammed to meet people's needs since early history, but construction of large and very large dams increased spectacularly in the second half of the 20th century. Dams are planned and built for either single-or multi-purpose human use: water storage and abstractions (mainly for agricultural and urban use and consumption), hydropower, navigation, and flood protection.

Of the nearly 50,000 large dams, most single purpose dams are used to support irrigated agriculture followed by hydropower and water supply (ICOLD, 2013). Irrigation is not only the main purpose of dams, but the agricultural sector in general places the greatest demand on water resources, accounting for 70 percent of freshwater withdrawal globally (WWAP, 2012). As the demand for food continues to grow, it can only be satisfied by making agriculture more productive, ideally through better management practices, but also through expansion and increased irrigation.

Hydropower currently generates approximately 16 percent of the electricity consumed globally and represents 86 percent of all electricity from renewable sources (IPCC, 2011). Though most countries rely on some level of power generation from hydropower, it is China, Canada, Brazil, the USA, and Russia that account for more than half of the world's production (IPCC, 2011). By 2035, it is predicted that hydropower production will increase by 98 percent in Asia-Pacific and 104 percent in Africa. In OECD countries, the majority of economically exploitable hydroelectric resources have already been developed with few opportunities to expand large-scale power projects; thus, only modest increases are expected (US EIA, 2011). Today, the main constraint to expanding hydropower is generally seen in its environmental and social impacts (IPCC, 2011).

Dam projects are usually accompanied by, enable, or trigger significant land use changes, infrastructure development, and socio-economic changes. While dams have brought significant socio-economic benefits, they have also caused environmental damage, contributed to the decline in freshwater biodiversity, and threatened the livelihoods of people in the wider basin by disrupting freshwater ecosystem services. A dam's impact can include the inundation of valuable land: habitats, productive landscapes, infrastructure, and settlements; changes to river flows, water quality, and sediment transport; and fragmentation of terrestrial and aquatic habitats. Impacts specific to hydropower are from the additional infrastructure required for power generation (such as penstocks, powerhouses, switchyards, and transmission lines) and from typical operations such as "peaking" to generate power and increase releases for a few peak demand hours a day. Additionally, hydropower projects with their environmental and social impact, including the potential release of carbon from decaying biomass, face the challenge of being deemed sustainable (UNEP FI, 2010).

A global review in 2005 found that almost 60 percent of the world's large river systems are affected by dams (Nilsson et al., 2005); additionally, the only remaining large free-flowing rivers are found in the tundra regions of North America and Russia, and in smaller coastal basins in Africa and Latin America (UNEP, 2008). In 2006, just 21 rivers longer than 1,000 kilometers retained a direct connection to the sea (WWF, 2006) and some of these last connections are in the process of being severed, as in China, where the construction of several dams has been approved along the Salween (also known as the Nu River) and Brahmaputra rivers.

Impacts vary according to site conditions and every project has to be individually assessed. A dam's impact also depends on context: while the incremental impact of another project in a cascade may seem relatively small compared to building the first dam on a free-flowing river, the cumulative impacts of many projects in a basin must be understood and adequately addressed.

A sustainable approach to water and energy planning is required to avoid further large-scale biodiversity loss and socio-economic impacts. The framework for decision-making outlined by the World Commission on Dams (WCD) in 2000 offers such an approach and is endorsed by WWF. Progressive parts of the hydropower community are promoting continuous improvement towards strong sustainability performance. Significant progress was made by the Hydropower Sustainability Assessment Forum, which over three years developed the Hydropower Sustainability Assessment Protocol (www.hydrosustainability.org), a broadly accepted tool to measure and improve sustainability performance of hydropower projects across a range of criteria, thus identifying its strengths and weaknesses. It is the Protocol's aim and of collective interest that developers, regulators, financiers, and other interested parties adhere to high sustainability standards.

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2. The Seven Sins of Dam Building

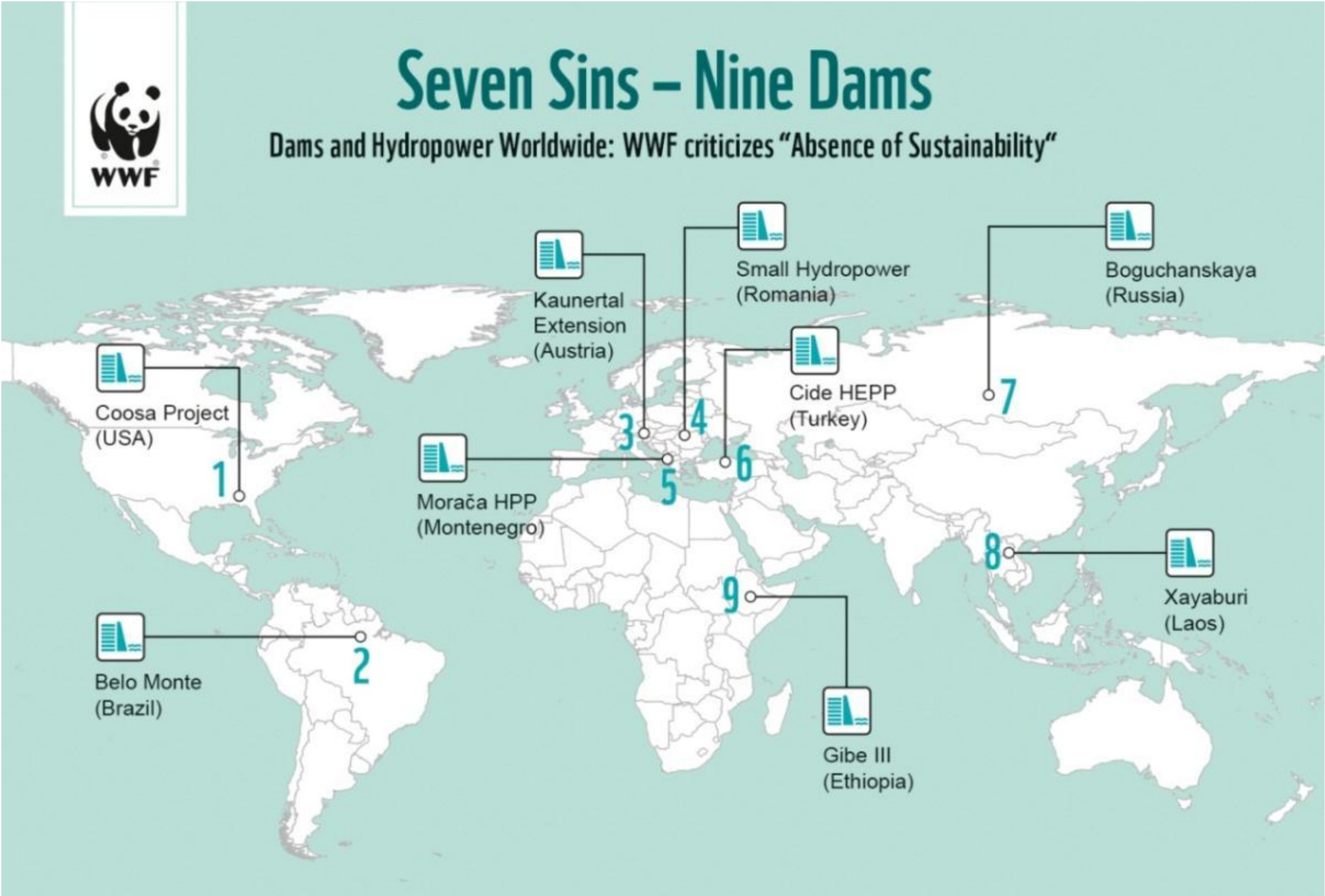
Despite many advances in sustainability thinking in planning and management practices, dam projects around the world continue to get things fundamentally wrong. At times it may be merely a single underperforming aspect that discredits an entire project, but sometimes there are a wide range of flaws and wrongdoings. In today's world, these flaws, wrongdoings, omissions, or short-comings against the natural environment and society, despite all available science, knowledge, and a century of modern experiences, are neither necessary nor permissible.

This report illustrates 'Seven Sins' of dam building. It covers a wide range of sustainability aspects, which are listed in each section and defined in the annexed glossary. Although these aspects are mainly derived from the Hydropower Sustainability Assessment Protocol, they are equally valid for other types of dams and should never be ignored.

Figure 1. Susttainability aspects to consider in dam projects:

Each ‘Sin’ is illustrated by a real life example where a dam, existing or planned, is failing in one (and often more) of these criteria. These dams were selected by the WWF network.

* **First Sin**: *Building on the Wrong River*
* **Second Sin**: *Neglecting Downstream Flows*
* **Third Sin**: *Neglecting Biodiversity*
* **Fourth Sin**: *Falling for Bad Economics*
* **Fifth Sin**: *Failing to Acquire a Social License to Operate*
* **Sixth Sin**: *Mishandling Risks and Impacts*
* **Seventh Sin**: *Blindly Following Temptation / Bias to Build*



2.1. First Sin: Building on the Wrong River

No dam is without an impact, and to anyone affected locally, a dam will always have been built on the wrong river. But in the bigger picture, it is possible to identify locations that, if not good, are at least less wrong than others. Even the most ambitious and expensive eco-friendly design and operations cannot fully heal a flawed choice of location.

A river can be the wrong river to build a dam on for many reasons – building a dam in an area of high seismic activity is a risk easily avoided. But rivers can be wrong for less tangible reasons. To preserve viable freshwater ecosystems, high conservation value sites within river systems should be identified and prioritized for conservation. Simply put – these sites should be off-limits for hydropower (dam) development. There are various tools available to identify priority conservation sites, and it is crucial that these types of assessments are made on a river basin scale. The Mekong River Commission, for example, worked together with WWF and the Asian Development Bank to develop the Rapid Basin-wide Hydropower Sustainable Development Tool (RSAT), which can be used by stakeholders, such as government agencies and regulators, river basin organizations, developers, financial institutions, and civil society groups. The tool uses existing social, environmental, cultural, economic, and financial information on a river basin to make a rapid assessment to inform and guide decision-making.

Sustainability aspects touched:

- Siting & Design
- High Conservation Value Rivers & Stretches
- Environmental Assessment & Management
- Cumulative Impacts
- Avoid-Minimize-Mitigate-Compensate
- Governance
- Heritage
- Social Impact Assessment
- Resettlement
- Economic Displacement
- Free, Prior & Informed Consent (FPIC)
- Vulnerable Social Groups
- Local Capacity
- Community Engagement & Acceptance
- Seismic Activity
- Free-Flowing Rivers

Case Study 1: Extension of the Kaunertal power plant
Rivers: Gurgler and Venter Ache, Königsbach, Ferwallbach, Platzerbach, Austria
Purpose: Hydropower, pumped storage, flood protection
Type of project: Cascade
Status of project: Planned
Capacity of Extension: 900 MW

The Gepatsch reservoir was constructed in 1961 and sits at the head of the Austrian Kaunertal valley. The 153 meter high dam is one of Austria's largest storage power stations and is operated by Tiroler Wasserkraft AG (TIWAG). Upstream, the dam is fed by several rivers of a very pristine character and high ecological value that were classified as Austrian "river-sanctuaries" in 1998. The larger tributaries of the Gurgler Ache and the Venter Ache – such as Königsbach and the Ferwallbach – are classified as rivers with exceptional ecological status, a distinction that only 14 percent of Austrian rivers have (Schmutz et al., 2010). These tributaries have their sources in the Gurgler Kamm, an area that was declared an "UNESCO Biosphere Reserve" due to its specific ecological values.

Today, this area is subject to a series of expansion plans. The planned hydropower project will require a diversion from the brooks of Venter and Gurgler Ache via a tunnel of approximately 25 kilometers. The embankment dam - in the pristine alpine valley of Platzertal - would be 119 meters high and 450 meters wide. Ironically, the energy provider TIWAG submitted this project under a "water management framework plan;" but according to Austrian water laws, such framework plans deal with the restoration and ecological improvement of water bodies and can definitely not serve as planning tools for the implementation of new hydroelectric power plants.

The extension of the Kaunertal power plant would irreversibly change nearly untouched nature. The affected habitats belong to the most threatened in the entire Alps and are therefore of national and broader regional importance. Despite massive local resistance, the energy provider TIWAG has not yet relented on its plans.

This dam is also guilty of:
- Neglecting Downstream Flows
- Neglecting Biodiversity
- Falling for Bad Economics
- Failing to Acquire the Social License to Operate
- Mishandling Risks and Impacts
- Bias to Build

Case Study 2 – Small Hydropower Plants in Romania
Rivers: Sambata, Sebes, Dejani-Lupsa Rivers, Northern Side of Fagaras Mountain–Danube River Basin – Sub-basin Olt, Romania
Purpose: Hydropower & Green Certificates
Type of project: Multiple small hydro in three basins
Status of project: Partially completed, under construction
Capacity: Sambata: 7.6 MW, Sebes: 2.8 MW, Dejani-Lupsa: 1.7 MW

The mountainous Danube-Carpathian region in Europe is the location for an extensive drive for small-scale hydropower. In Romania, over 411 small hydropower are in different stages of planning/authorization and construction, and more than a quarter of them are proposed to be located within or at the limit of protected areas. Nearly 300 projects have been approved for construction nationwide. The Sambata, Sebes, and Dejani-Lupsa rivers are found on the northern side of the Fagaras Mountains in the Southern Carpathians, and are classed as Natura 2000 sites. Beginning about three years ago, this protected area was 'invaded' by small hydropower projects (SHPs) – 53 small hydropower plants with 50 catchments disrupted this Natura 2000 site in 2012. These dams are supported by EU funds and green certificates allocated on the basis of a national scheme with no ecological criteria attached.

The Sambata, Sebes, and Dejani-Lupsa rivers are three examples where small hydropower projects are being developed despite the area's Natura 2000 status. Problems arose right from the planning phase as no spatial planning process, proper public consultation, Environmental Impact Assessment (EIA), nor cumulative impact assessment with other small hydropower projects in the area was undertaken. In most cases, neither the required Natura 2000 assessment or project permit issued by environmental protection authorities was obtained; the connectivity of the Natura 2000 sites was also disregarded. And since hydropower installations are considered under Annex II of the EU's EIA Directive, authorities decided that the SHPs should not be subject to an EIA procedure and pulled out from the EIA study at the screening stage.

In breach of the Water Framework Directive (WFD) and Romanian laws, construction is seriously disrupting the riverbeds and threatening the longitudinal connectivity of the river, which negatively affects the water's ecological status (as defined by the WFD) and ecosystem services. An additional consequence is a slowly dwindling water supply for local communities because of the multiple projects' cumulative impact on the catchments that source the deep groundwater supply.

These dams are also guilty of:
- Neglecting Downstream Flows
- Neglecting Biodiversity
- Falling for Bad Economics
- Failing to Acquire the Social License to Operate
- Mishandling Risks and Impacts
- Bias to Build

2.2. Second Sin: Neglecting Downstream Flows

The most immediate and obvious impacts of a dam are found upstream as land is submerged and flowing rivers become stagnant reservoirs. But possibly the largest effects of dams are found downstream. Storage dams can significantly alter downstream river flows to either a more or less constant flow, or flow releases may follow the daily or even hourly pattern of peak energy demand, or river stretches may dry out to a minimum or no-flow condition. Water abstractions and inter-basin transfers also change the flow regimes. A river's natural flow dynamics maintain and support key ecological processes and vital life-cycle stages, thus alterations can significantly alter the integrity of ecosystems and their ability to deliver ecosystem services to people. Flows carry sediment, which underpin a river's morphological integrity. A single storage dam can affect the entire downstream river system all the way to the sea. Effective environmental flow regimes are key to sustainable dam operations.

Sustainability aspects touched:

- Water Quality
- Environmental Flows
- Erosion & Sedimentation
- Ecosystem Services
- River Delta Integrity
- Riparian Issues
- Community Engagement & Acceptance
- Trans-boundary Issues

Case study 1: Morača Hydropower Cascade
River: Morača, Montenegro
River Length: 113 kilometers
Purpose: Hydropower
Type of project: Cascade of four dams
Status of project: Planned
Capacity: 238 MW

The most outstanding environmental shortcoming of the planned Morača dams cascade is the threat to Lake Skadar. Lake Skadar, the largest lake in the Balkan peninsula and a designated Ramsar site, is a critical wintering and staging site for migratory birds and European waterfowl, which makes it one of the most important bird and fish habitats in the Mediterranean region. The lake's biodiversity is under threat as a cascade of dams is planned upstream on the Morača River, which feeds the lake. The planned hydropower cascade would critically change the seasonal variability of the lake's water level.

Building the dams on the Morača River would drastically affect 90 percent of the 280 bird species, especially the migratory birds that use the northern bank of the lake for reproduction, feeding, and resting. Lake Skadar is also widely known for its population of bleak (*Alburnus alburnus*), which together with carps (*Cyprinus carpio*), account for 70 percent of the total fish catch from the lake. It is estimated that if the water regime in the northern part of the lake was modified, about 20 percent of hatchery habitats could be destroyed, which also means fewer offspring in the next generation. Besides being an ecological loss, this could be a serious economic issue for local fishermen and the tourism industry. Moreover, since the dams are planned on the middle stretch of the Morača River, a large part of brown trout (*Salmon trutta*) and the rare endemic Marble trout (*Salmo marmoratus*) habitat would be destroyed.

This project is also guilty of:

- Neglecting Biodiversity
- Falling for Bad Economics
- Mishandling Risks and Impacts
- Failing to Acquire the Social License to Operate
- Bias to Build

Case study 2: Cide Regulator & Hydropower Electric Power Plant
River: Devrekani, Turkey

River Length: 147 kilometers
Purpose: Run-off-river Hydropower
Type of project: Single Dam
Status of project: Planned
Expected Capacity: 22 MW

The Kure Mountains National Park and buffer zone in northern Turkey received legal protection status in 2000 due to its outstanding natural landforms (canyons, caves, dolines), the natural structure of old-growth forests (and the best intact Black Sea Moist Temperate Karstic Forest), intact river ecosystems, rich wildlife, and biodiversity. The Park's management plans state that "any activities on rivers, in forests and on coastal zones that would deteriorate the natural structure within the buffer zone are forbidden." Nevertheless, plans are afoot to construct the Cide Regulator and Hydropower Electric Power Plant (HEPP) on the Devrekani River within the park's buffer zone. If implemented, the project will alter the intact structure, quantity, and quality of the Devrekani River, which is one of the major water resources of the Kure Mountains National Park.

Modification of the natural flow regime would affect aquatic and riparian ecosystems as well as the terrestrial ecosystems linked with the natural water flow and its microhabitat. With less water running in the river, ambient humidity will be lower, which will affect vegetation and the associated biodiversity near and downstream. The karst systems that make up the Kure Mountains are a dynamic system, meaning that changes in river flow could affect the karstification processes underground. Additionally, the legally required minimum flows regulation is proven insufficient to sustain the environmental integrity of the river (Ülgen et al., 2011).

This project is also guilty of:
- Building on the Wrong River
- Neglecting Biodiversity
- Falling for Bad Economics
- Mishandling Risks and Impacts
- Failing to Acquire the Social License to Operate
- Bias to Build

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2.3. Third Sin: Neglecting Biodiversity

Dams are a barrier not only to water, but to all aquatic organisms as well. Loss of aquatic connectivity prevents migratory fish from reaching their feeding or spawning grounds. Habitats are lost to inundation and terrestrial connectivity is fragmented. Effects on biodiversity can reach long distances both up- and downstream through alterations in the natural food chain and flows (see 'downstream flows').

Minimization and mitigation measures may include proper fish bypasses and fish-friendly turbines, but the effectiveness of these is often limited to certain species of fish. In many countries, fisheries are a vital component of people's livelihoods. The loss of fish species from a river is often felt in the wider communities living downstream from the dams. If after all possible mitigation measures, a dam project is likely to lead to the extinction of populations of endangered species or endanger valuable fisheries (whether commercial or subsistence), it should not proceed.

***Sustainability aspects touched*:**

- Biodiversity & Threatened Species
- Ecosystem Connectivity
- Pest Species
- Avoid-Minimize-Mitigate-Compensate
- High Conservation Value Rivers & Stretches
- Water Quality
- Ecosystem Services
- Community Engagement & Acceptance

Case Study: Alabama Power Coosa Project Relicensing

River: Coosa River, Alabama, USA
River Length: 443 kilometers
Purpose: Hydropower
Type of project: Cascade of seven Dams
Status of project: Undergoing relicensing
Capacity: 691 MW

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Once a river is dammed, not all is necessarily lost. Options exist for recovery and restoration of the ecosystem. Approaches can include dam removal at the end of its useful lifespan or adaptive management. Under US law, the Federal Energy Regulatory Commission (FERC) reconsiders dam licenses every 30 to 50 years, with the U.S. Fish and Wildlife Service (USFWS) responsible for conducting environmental reviews during the relicensing process.

The Coosa River was once one of the most biologically diverse rivers in the world, but today it is the most developed river in Alabama with only some free flowing stretches remaining. The damming of the Coosa has been described by the USFWS as "one of the largest extinction rates in North America during the 20th century, with the extinction or extirpation of nearly 40 freshwater species."

Alabama Power Company has applied to obtain a new 30- to 50-year license to operate a project consisting of seven dams that encompass 362 kilometers of the Coosa River. The FERC relicensing of Alabama Power's dams is the first opportunity in half a century to improve river conditions for people, fish, and wildlife, ensuring a future for 21 federally listed species in the area. However, unless FERC and the USFWS require Alabama Power Company to do better, many of the listed species will likely go extinct. FERC has refused to require Alabama Power to conduct critical studies that could lead to the recovery of imperiled fish and wildlife. Without the data these studies could provide, FERC's finding that the project does not have a significant impact on the environment is unfounded. Unfortunately, the state and federal agencies involved in the relicensing are not addressing the issue of species recovery. While their mission is "to conserve, protect, and enhance fish, wildlife, and plants and their habitats", the U.S. Fish and Wildlife Service has been extraordinarily passive in this process. In addition, the Alabama Department of Environmental Management, the state agency responsible for enforcement of the Clean Water Act, issued a permit containing virtually all of Alabama Power's proposals. Fortunately, there is still time to make a change, as FERC has yet to issue a new license for the project.

This project is also guilty of:

- Neglecting Downstream Flows
- Bias to Build

2.4. Fourth Sin: Falling for Bad Economics

Once all economic, social, and environmental costs and benefits are factored in, a dam project should demonstrate an overall net benefit. In practice though, many projects over-estimate the benefits, while downplaying or externalizing the social and environmental costs. Economic burdens that fall upon society and the regional economy are often neglected or ignored. WWF's 2003 campaign "The true cost of a dam never shows up on a balance sheet" referred to the challenge and often failure of large dams to deliver a net economic benefit.

A dam's financial and economic viability must be thoroughly assessed at the appropriate early stages of planning and decision-making and take into account external influences including e.g. uncertainties of markets and hydrological resources under climate change scenarios.

Sustainability aspects touched:

- Financial Viability
- Economic Viability
- Externalization of Costs
- Governance
- Trans-boundary Issues
- Distribution & Sharing of Benefits
- Livelihoods
- Economic Displacement
- Human Rights
- Community Engagement & Acceptance
- Hydrological Resource & Climate Change
- High Conservation Value Rivers & Stretches

Case Study: Belo Monte, Brazil
River: Xingu, Brazil
River Length: 1,979 kilometers
Human Population: The central mosaic of protected areas and indigenous territories is considered the world's largest socially and environmentally diverse corridor
Purpose: Hydropower
Status of project: Under construction
Capacity: 11,000 MW

Brazil's second largest dam complex is located along the Xingu River in Brazil's northern state of Pará. To accomplish this project, the Xingu River's 'Big Bend' will be cut short and an upstream reservoir of 60 kilometers in length and an off-stream reservoir connected by channels created. The residual flow in the Big Bend will need to sustain ecosystem services and livelihoods for the local indigenous communities through a rigorous environmental flow regime. An estimated 20,000 people living in the area of direct influence will be affected. Ultimately, the Belo Monte hydropower project overestimates the reliable energy generation and underestimates the social, cultural, environmental, and economic costs.

Brazil's energy system depends heavily on hydropower, which relies on the security of the hydrological resources. The Xingu River's flow can be reduced by up to 60 percent during a dry year. A recent study showed that the impact caused by climate change would lead to a reduction in hydropower generation by 30 percent, which would compromise the economic viability of hydropower dams in the Amazon. Yet, analyses referring to climate change impacts and increased hydrological variability are lacking. The recent drought in January 2013 that left reservoirs at critically low levels has once again demonstrated the vulnerability of Brazil's heavily water-dependent energy supply.

This dam is also guilty of:
- Being Built on the Wrong River
- Neglecting Biodiversity
- Mishandling Risks and Impacts
- Bias to Build

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2.5. Fifth Sin: Failing to Acquire a Social License to Operate

The “social license to operate” can be equally or at times even more relevant to the success and sustainability of a dam as the regulatory license. Poor consultation and failure to address resettlement and downstream livelihood issues almost always results in conflict. Some large projects, such as the 6,000 MW Myitsone dam in Myanmar where developers held a government license but failed to obtain a “social license” (i.e. broad acceptance of a project as legitimate by a broad range of stakeholders), are in troubled waters. Often, unclear responsibilities play a role: where a project developer may in certain situations not be legally responsible for e.g. resettlement issues (which are in fact the government’s responsibility), they will de facto be perceived as responsible by the affected population and media. Once adequate consultation mechanisms have been set up, it is in every party’s interest to actively engage in the process to achieve the best possible dam with the broadest stakeholder support. At the same time it should be recognized that many vulnerable social groups do not have the experience, capacity, or mechanisms to engage in these processes. Consultation must be tailored to all stakeholders.

The social license to operate touches on a range of sustainability aspects, most importantly on the concept of Community Engagement & Acceptance. Even projects that have been in operation for a long time must maintain and often improve relations with the various social groups affected by or concerned with the project.

Sustainability aspects touched:
- Demonstrated Need
- Energy System Benefits
- Benefit Sharing
- Resource Use
- Safety
- Community Engagement & Acceptance
- Multiple Use Benefits
- Public Health
- Free, Prior & Informed Consent (FPIC)
- Vulnerable Social Groups
- Resettlement
- Heritage
- Social Impact Assessment
- High Conservation Value Rivers & Stretches
- Economic Displacement

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Case Study: Gilgel Gibe III Dam
River: Omo, East Africa
River Length: 760 kilometers
Purpose: Hydropower, Irrigation
Type of project: Single dam in cascade of five dams
Status of project: Under construction
Capacity: 1,870 MW

The Omo River flows from the Ethiopian highlands to Kenya's Lake Turkana, the world's largest desert lake, which depends on the Omo River for 90 percent of its water supply. The Omo Valley is well known for the different tribes that have managed to carve out an existence in this semi-arid environment. Their way of life relies heavily on the annual flooding of the Omo River, which allows cultivation of the fertile deposits along the riverbanks. The tribal way of life is now under threat from the impacts of Gibe III, the third in a cascade of five on the Omo River.

The Ethiopian government in collaboration with the Kenyan government is pushing an energy agenda that has very little regard for environmental, social, and economic security along the Omo River and particularly on the Lake Turkana ecosystem downstream, upon which local communities depend. The interests of the affected communities and ecosystems have been relegated to the periphery of this project. The project processes (planning, design, impact assessments and construction) have remained secretive; there has been neither public information disclosure nor public accountability on the part of the project proponent. Opportunity for civil society and communities to engage the two governments in dialogue has been scarce.

Impacts extend across the border: a radical reduction of inflow to Lake Turkana would sharply increase salinity and subsequently lead to a decline of aquatic ecosystems, including fish stocks, the loss of potable water for human populations and livestock, and the destruction of significant commercial interests (fishery, tourism, etc) (AWRG, 2009). Neither the tribes of the Omo Valley, nor the pastoralists around Lake Turkana have been adequately consulted. Estimates of the number of people affected run from 200,000 to half a million. Poverty and cross border conflicts over dwindling water resources and pasture land will escalate. Two additional dams planned on the Omo River (Gibe IV and V) will exacerbate these effects.

Recognizing the serious threat posed to Lake Turkana from the Gibe III Dam, UNESCO expressed "its utmost concern" and urged Ethiopia to "immediately halt all construction on the GIBE III dam" in July 2011. The World Bank, African Development Bank, and European Investment Bank refused to get involved with this dam, as it clearly violates their environmental and social safeguards and any transparency by directly awarding the construction contract with no bid.

This dam is also guilty of:
- Being Built on the Wrong River
- Neglecting Downstream Flows
- Neglecting Biodiversity
- Falling for Bad Economics
- Mishandling Risks & Impacts
- Bias to Build

2.6. Sixth Sin: Mishandling Risks and Impacts

As highlighted in the previous sins, a dam project has to contend with an enormous range of issues. Regulatory frameworks exist, but they are often not up to date with international best practices. By applying merely the minimum regulatory standards when these are known to be insufficient, seeking mitigation and compensation options before avoiding and minimizing impacts, ignoring climate change, or gambling with food security, dam developers assume the 'Somebody-Else's-Problem' attitude and close their eyes to the obvious risks and problems.

Worse than applying merely the minimum standards, is the pursuit of short cuts to achieve realization of projects in the shortest possible time. Project proponents may seek to declare emergencies and skip steps of a thorough options assessment and preparation process. Indeed, if little data is available, this process can take years, but jumping from one emergency to the next is hardly a rational process. It always involves the risk that the resulting projects will run into obstacles and delays, and that outcomes will be unsatisfactory or harmful. If robust data is available, open-eyed decision-making becomes possible, trade-offs can be balanced in advance, risks can be reduced, and the willingness of private investors to support projects is increased.

Sustainability aspects touched:

- Avoid-Minimize-Mitigate-Compensate
- Siting & Design
- Environmental Assessment & Management
- Cumulative Impacts
- Financial Viability
- Economic Viability
- Externalization of Costs
- Resource Use
- Hydrological Resource & Climate Change
- High Conservation Value Rivers & Stretches

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Case Study: Boguchanskaya Dam
River: Angara, Russia
River Length: 1,779 kilometers
Purpose: Hydropower
Type of project: Single dam; last dam in Angara Cascade downstream of Lake Baikal
Status of project: Under construction, first two turbines in operation since fall 2012
Capacity: 3,000 MW

The Angara River in remote eastern Siberia has already been dammed three times. Efforts to construct the fourth, Boguchanskaya Dam, date back nearly half a century. Originally designed in the seventies, and after decades of stop-start construction activities due to economic turbulence and fluctuating power demand, the project resumed in 2005 and began generating power in the fall of 2012.

Though the dam is guilty of each of the sins, most remarkable is the developers' mishandling of risks and impacts. Since its' original design, the tools for identifying, avoiding, and mitigating impacts have become widely established. Nevertheless when the project resumed, it did not undergo an Environmental Impact Assessment (EIA) with the excuse that there was no EIA requirement in 1976 when the original construction permit was obtained under Soviet Union law. Initial efforts at public hearings and consultation were terminated once the hope for foreign funding was gone.

The dam's construction phase was marked by major violations of resettlement codes, norms for forest clearing in the reservoir area, and various wildlife conservation norms. Reservoir filling was associated with major neglect to environmental flow norms, which were never formally designed and approved. The dam's design is insufficient to withstand extreme floods and lacks 25-40 percent of the necessary capacity for 1000-year events. The necessity to protect historic sites was dismissed and known archaeological historical sites were removed from the official government register. The risks to the Lake Baikal World Heritage Site from the cascade operation on the only outflowing river, the Angara, remain inadequately addressed.

This dam is also guilty of:
- Being Built on the Wrong River
- Neglecting Downstream Flows
- Neglecting Biodiversity
- Falling for Bad Economics
- Failing to Acquire the Social License to Operate
- Bias to Build

2.7. Seventh Sin: Blindly Following Temptation / Bias to Build

For centuries, water resource management has been dominated by an engineering 'can-do' mindset. In addition, financial and political motives converged to promote structural solutions to water resource management problems. In most developed countries, this has led to the full development, and in some cases over-development, of water resources. There has long been anecdotal evidence of the bias to build and in recent years, more systematic explanations have emerged (for example, see B. Flyvbjerg, 2005. *Policy and Planning for Large Infrastructure Projects: Problems, Causes, Cures)*.

Across all infrastructure sectors, including water infrastructure, planners tend to overplay the benefits and opportunities and underplay the costs and risks. Political decision-makers find it hard to embrace such lessons and to create a regulatory environment where good practices and good governance are incentivized.

There is also increasing scientific insight in the political economy of such scenarios based on the mechanics of self-interest, incentives and collusion of consultants, contractors, developers, bureaucrats, financiers, and politicians.

Seen from another perspective, even if past decision-making had been impartial and only based on honest estimates of costs and benefits at the time, past models were certainly imperfect. Increasingly good knowledge and tools are available today. Just as there is no good reason to use outdated technologies, there is no good reason to make decisions through outdated mechanisms.

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Case Study: Xayaburi Dam
River: Mekong
River Length: 4,900 kilometers
Key Biodiversity: Most biodiverse river in Asia, second only to the Amazon; 781 scientifically described freshwater species. Around 50 percent of the Mekong riparian zones are considered "Key Biodiversity Areas" of international significance, including four of the 10 largest freshwater fish in the world, Irrawaddy dolphin and Cantor soft-shell turtle.
Purpose: Hydropower
Type of project: Single dam, first in a cascade of 11
Status of project: Under construction
Capacity: 1,285 MW

The lower Mekong hosts the most productive inland fisheries in the world and millions of people depend on its rivers and lakes. While tributary dams exist along the Mekong River, and high on the main stem in the Chinese part of the River, Xayaburi will be the first dam on the lower Mekong main stem, putting the livelihoods and food security of 60 million people at risk. The project is currently causing great controversy in the region: with four countries intensely linked to the river, the potential for conflict is great. The technical advisors of the Mekong River Commission (MRC), an inter-governmental agency whose aim is to build a platform among lower Mekong countries that ensures the sustainable use of common water resources, advised in their 2010 Social and Environmental Assessment to delay construction by 10 years of this controversial dam. Nevertheless, Laos began construction, which they labeled as "preparation work" in 2011, claiming it had addressed the other Mekong countries concerns. Cambodia refutes Laos's interpretation, while Vietnam has called for construction to be halted.

The Xayaburi dam design and operation is based on insufficient data and knowledge of aquatic ecology and sediment. Without a thorough understanding of the processes that support downstream landforms, ecosystems, and economic activities, the consequences on ecosystems and human settlements downstream are potentially catastrophic. The proposed solution to manually transport bed load sediments over the dam in barges is utterly impractical and unsustainable. Further, the plans for the dam have not and cannot accommodate the complex migratory patterns of many fish species. By blocking migration routes, fish diversity will decline rapidly with knock-on effects on many other species, subsistence fishermen, and regional food security. The experience of other lower Mekong tributary dams, such as Pak Mun, have shown that fish ladders do not work here as most Mekong fish species are not capable of jumping, unlike salmonid species for which fish ladders have been most successful.

The construction of the dam is driven not by the local need for electricity in Laos, but by the increasing demand for electricity over the border in Thailand. Though it is claimed that Xayaburi will contribute to poverty alleviation, monetary benefits will flow directly to Thai financiers, while serious external costs will be borne by both local people and downstream nations. The biggest potential impacts are likely to be in Cambodia and Vietnam, but the consultation of these countries has been inadequate despite requirements under the 1995 Mekong Agreement. As the first dam to enter the MRC's consultation process, the Xayaburi project is a crucial test case for ten other dams proposed for the river's lower main stem. The MRC process requires countries to jointly review development projects proposed for the Mekong main stem with an aim to reach consensus on whether or not they should proceed. Laos is now constructing Xayaburi dam without consensus among its neighbors; thereby setting the dangerous precedent that future dam projects also ignore the MRC's effort to sustainably manage shared resources.

This dam is also guilty of:
- Being Built on the Wrong River
- Neglecting Downstream Flows
- Neglecting Biodiversity
- Falling for Bad Economics
- Failing to Acquire the Social License to Operate
- Mishandling Risks & Impacts

3. Sin No More: Conclusion and the Way Forward

The world's water resources are limited and the pressures on them keep increasing. We can only hope to satisfy humanity's future demands – for drinking water, a clean environment, clean energy, food that we cannot grow without water – by reforming our approach to water management, including the ways in which we plan and manage dams. Developing water resources involves multiple trade-offs, risks, and conflicts between the different demands on water. Dams may be an acceptable and appropriate solution in some cases, but more care needs to be taken to identify those cases, and to site, design, and operate dams in a way that reduces conflicts.

The organizations and entities investing in dams are primarily interested in their own objectives and agendas. It is the role of public policy, government planning, and permitting agencies to ensure that dams are fulfilling the broader objectives of society. In particular, it is a government's responsibility to ensure that the natural environment, the services it provides to citizens, and the more vulnerable of those citizens are protected. Some dam developers understand these differing objectives and make considerable efforts to avoid, minimize, mitigate, and compensate any negative effects that their projects may have and enhance their positive effects. The closer they get to what would be considered in the public interest, the less risky is their investment and the better they can protect their reputation. This principle is behind many of the guidelines, safeguards, and recommendations published in recent years, including the Hydropower Sustainability Assessment Protocol, which WWF has co-developed as part of our effort to achieve international application of good practices and standards.

The reality however is that many dam developers still pursue narrowly perceived short-term interests. Some appear to genuinely not understand how providing useful things like energy or irrigation water can have negative side effects. Others count on their superior financial power and political connections to get their way. And many governments are not strong, capable, and independent enough to protect the public interest. In these cases, conflicts are almost inevitable. Even if a dam can initially be built against opposition and without incurring costly delays, there is always a risk that over the long life span of water infrastructure, conflicts will catch up with such projects.

The 'seven sins' of dam development are unnecessary; ultimately it is better to avoid them if one is interested in longer-term outcomes and success. It is a matter of applying existing knowledge; good industry and regulatory practices are readily available. WWF calls on governments, banks, and the various industry sectors involved in dams - energy and water utilities, irrigation agencies, contractors, and others - to do their share to avoid the increasingly unacceptable conflicts over dams.

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Sustainability Glossary

Many terms and concepts can be found in the Hydropower Sustainability Assessment Protocol (IHA, 2010) and on the Protocol's Sustainability website.

Avoid, minimize, mitigate and compensate is a concise expression for a sequential process (IHA, 2010). The preference is for impacts to be avoided through appropriate siting, design, and operations. Impacts that cannot be avoided should be minimized as far as possible. Comprehensive mitigation measures can reduce the environmental impact of dam projects and need to be included in all planned and existing schemes. Residual impacts that remain after mitigation may be compensated and offset.

Benefit sharing can include equitable access to electricity services (i.e. project affected communities are among the first to be able to access the benefits of electricity services from the project, subject to contextual constraints (e.g. power safety, preference)); non-monetary entitlements to enhance resource access (i.e. project affected communities receive enhanced local access to natural resources); revenue sharing (i.e. project affected communities share the direct monetary benefits of hydropower according to a formula and approach defined in regulations; this goes beyond a one-time compensation payment or short-term resettlement support; and trust funds) (IHA, 2010).

Biodiversity and Threatened Species are at particular risk due to a change in or inundation of their habitat, altered downstream flow patterns, introduced (pest) species from inter-basin transfers, and inundation. The protection of species should be at the siting and design stage of a dam project so that any necessary options for mitigation are identified and key areas (i.e. Protected Areas, Ramsar site, Important Bird Area, World Heritage site, etc) are avoided.

Acceptance of change by people affected by hydropower scheme developments depends on **community engagement**, participation in decision-making processes, and the demonstrated manifestation of positive benefits from the development. To ensure more sustainable outcomes, community rights need to be recognized and effective stakeholder participation during decision-making processes should be ensured (IHA, 2013).

Cumulative impact is a project's incremental impact considering all past, present, and future actions. The cumulative impact of many small dams may easily be larger than those of one single dam of the same capacity. Though often considered benign, small hydropower schemes tend to occur in large numbers in river basins, which results in a heavy cumulative impact (WWF, 2006).

In order to justify the management and infrastructure investments in water and energy services, a project must meet the **demonstrated need** as identified through broadly agreed local, national, and regional development objectives and in national and regional policies and plans; this avoids over-or under-investment in energy and water services (IHA, 2010).

Distribution and sharing of social and economic benefits among communities impacted by the project can only come about through adequate planning, commitment, and engagement of all stakeholders by the project planners. If benefits are unfairly shared, the potential negative impact can severely impact the project's success or progress.

Economic displacement is the "loss of assets, access to assets, or income sources or means of livelihoods as a result of (i) acquisition of land, (ii) changes in land use or access to land, (iii) restriction on land use or access to natural resources including water resources, legally designated parks, protected areas or restricted access areas such as reservoir catchments and (iv) changes in environment leading to health concerns or impacts on livelihoods" (IHA, 2010).

Economic viability should guarantee that there is a net benefit from the project once all economic, social and environmental costs and benefits are factored in (IHA, 2010).

Ecosystem connectivity throughout a river and its floodplain are essential to the maintenance of riverine populations (O'Keefe & LeQuesne, 2009).

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious, and other nonmaterial benefits (MEA, 2005).

If a project is not designed and planned in the context of a regional energy strategy, then it will not deliver optimal **energy system benefits** to the overall system (IHA, 2013).

An **environmental flow** is the amount of water that is kept flowing down a river in order to maintain the river in a desired environmental condition (O'Keefe & LeQuesne, 2009). All new dams should be designed and operated with environmental flows that mimic natural variability in flows to sustain freshwater ecosystems and associated livelihoods within river basins and deltas. The implementation of environmental flows at existing dams should also be prioritized.

A comprehensive **Environmental Impact Assessment (EIA)** should be conducted by qualified experts and made public prior to the approval and financing of dam schemes. Impacts to be considered include loss of terrestrial and aquatic habitats, changes to water quality including temperature and greenhouse gas emissions, alteration of natural flow and sediment transport regimes, interruption of aquatic and terrestrial connectivity.

Erosion and sedimentation: The alteration of sediment loads due to loss of flood pulses, over-extraction of water, or severed sediment connectivity may lead to heavily altered river characteristics, which can result in increased flood levels during already high flood events with devastating effects. Sediment might not reach the river deltas anymore, making these vulnerable to soil loss, coastal erosion, and storm flooding from the sea. Such long-term effects of infrastructure on river and coastal morphology are often underestimated or even completely overlooked during planning processes and cost-benefit-analyses of new dams or other water infrastructure projects.

External costs are those 'hidden' costs (i.e. biodiversity loss, altered downstream flows, relocation, etc) or benefits (i.e. flood control and recreational use, etc) not reflected in a project's costs. They must be included in the true cost of a dam to accurately assess its economic and financial viability.

Financial viability addresses both access to finance, and the ability of a project to generate the required financial returns to meet project funding requirements, including social and environmental measures, financing for resettlement and livelihood enhancement, delivery of project benefits, and commitments to shareholders/investors (IHA, 2010).

Free-flowing rivers are those that flow undisturbed from their source to their mouth, either at the coast, an inland sea or at the confluence with a larger river, without encountering any dams, weirs, or barrages and without being hemmed in by dykes or levees (WWF, 2006). The degree to which a dam disrupts the services provided by free-flowing rivers depends to some extent on the siting of the dam.

Free, prior and informed consent (FPIC) refers to the principle recognized in the United Nations Declaration on the Rights of Indigenous Peoples that indigenous peoples (and increasingly also non-indigenous communities) have a right to give or withhold consent to actions that will affect them, especially actions affecting their lands, territories and natural resources. FPIC, increasingly recognized as "best practice" in conservation and development, enables communities to assess the potential benefits and risks, influence their design to reduce risks and promote benefits, and decide whether or not to approve or participate in them (WWF, 2011).

Governance broadly refers to the combination of processes and structures that inform, direct, manage and monitor the activities of the project toward the achievement of its objectives. The intent is that the developer has sound corporate business structures, policies and practices; addresses transparency, integrity and accountability issues; can manage external governance issues (e.g. institutional capacity shortfalls, political risks including trans-boundary issues, public sector corruption risks); and can ensure compliance (IHA, 2010).

Heritage is the legacy of physical artifacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations, which should not be put at risk of damage or loss by dam construction (IHA, 2010). Cultural heritage risks may include inundation of important sites or artifacts under the new reservoir, damage or destruction to important sites or artifacts due to construction activities, loss of access to important sites due to changes to access routes (e.g. new canals or linear infrastructure with barrier fencing, major roads), disturbance of spirits associated with special sites; etc (IHA, 2010).

Adequate and timely knowledge about **High Conservation Value rivers and stretches** is crucial for sustainable infrastructure development. Methods for the identification and subsequent prioritization of both terrestrial and freshwater high conservation value areas are increasingly available and used (see WWF's Rivers for Life, 2011). This is a prerequisite to guide the sustainable development and human use of river basins, while protecting important natural assets.

Human rights and freedoms encompass all civil, political, economic, social, and cultural rights to which every individual is entitled.

The **hydrological resource** availability and reliability in the short- and long-term, taking into account other needs, issues, or requirements for the inflows and outflows as well as likely future trends that could affect the project must be properly understood, particularly in light of climate change (IHA, 2010).

Livelihoods, or the means of living that depend on the capabilities, assets, and activities of individuals, must be ensured for those social groups impacted by projects.

Ensuring educational and economic opportunities that empower the **local capacity** to re-establish themselves under changed conditions, particularly as a result of resettlement and lost livelihoods, is key to a project's economic sustainability (IHA, 2013).

Beyond just the generation of electricity, projects can offer **multiple use benefits**, by storing and using water for human consumption, irrigation, flood mitigation, power transport, and recreation. Optimal delivery of intended multi-purpose benefits occurs where a project is developed as part of a regional strategy, costs and benefits are thoroughly assessed, and social and environmental assessments are undertaken, implemented, and monitored (IHA, 2013).

Pest species can have major impacts on waterways and their biota in reservoirs and downstream of projects by directly preying on native species or over-consuming the food and habitat supply for the natives, proliferating to the point of interference with power generation or downstream water use through changes in the quality of discharge water; additionally, they can impact public health through improved breeding grounds for mosquitoes or other diseases (IHA, 2010).

Public health in the immediate catchment area and downstream of projects can be affected by an increase in vector-borne disease transmission due to reservoir development, stress related to relocation and resulting loss of livelihood and traditional ways of life, or increased food source contamination often associated with large reservoirs (IHA, 2013).

If **resettlement** is required as a result of dam construction, then it should be ensured that the dignity and human rights of those displaced are respected, that these matters are dealt with in a fair and equitable manner, the livelihoods and standards of living for those displaced and host communities are improved, and the commitments made to those displaced are fully delivered (IHA, 2010).

Water as a renewable energy source does not lead to long-term **resource use** depletion; however this relies on the efficient design, operation and management of a project.

Riparian issues: With large populations exposed in riparian cities, natural infrastructure with natural flood cycles may not be acceptable any more. But where infrastructure is built, it should be with an awareness of ecosystem services provided by rivers, and the opportunity costs of losing them.

Any **safety** risks for life, property, and the environment as a result of dam or infrastructure failure must be avoided.

While most dams are designed to cope with **seismic activity** and consequently suffer no or little damage should there be any, the issues need to be adequately considered in the project siting and design stage. At a minimum, earthquakes may lead to costs to repair dam walls and associated infrastructure, and in a worst-case scenario it could lead to dam failure with high cost for the community, environment, and power supplies (IHA, 2013).

Siting and design decisions need to consider impacts in the whole river basin and opt for sites with minimum environmental impact. Considerations should include: prioritizing alternatives that provide opportunities for multiple use benefits, are on already developed river systems, minimize the area flooded per unit of energy (GWh) produced, maximize opportunities for and do not pose unsolvable threats to vulnerable social groups, enhance public health and minimize public health risks, minimize population displacement, avoid exceptional natural and human heritage sites (i.e. Protected Areas, Ramsar site, Important Bird Area, World Heritage site, etc), have lower impacts on rare, threatened or vulnerable species, maximize habitat restoration and protect high quality habitats, achieve or complement community supported objectives in downstream areas (i.e. environmental flows), have associated catchment management benefits, have lower sedimentation and erosion risks, and avoid exceptional greenhouse gas emissions from reservoirs (IHA, 2010).

A **Social Impact Assessment** identifies and assesses any potential social impacts so that any avoidance, minimization, mitigation, compensation and enhancement measures can be designed and implemented. Key social issues include project-affected communities, indigenous peoples, ethnic minorities, resettlement, cultural heritage (both physical and non-physical), and public health; and are analyzed with respect to socio-economic indicators (including living standards, livelihoods, and health statistics) as well as gender (IHA, 2010).

As freshwater resources do not adhere to geo-political boundaries, **transboundary issues** become prevalent when no agreements are made among riparian states on how shared water resources will be utilized by the parties involved, and the processes that will be followed to sustain these understandings (IHA, 2010).

Throughout a project's life-cycle, **vulnerable social groups** must be guaranteed that their cultural and spiritual identity, and social and economic integrity are not marginalized or disadvantaged, which can occur by intruding on indigenous land, disadvantaging indigenous peoples and ethnic minorities in the development, transforming the physical landscape, which destroys ancestral sites and conflicts with basic belief and value systems, relocating and resettling a community, increasing encroachment of outside influences on their traditional lands, introducing disease, and the loss of self-determination (IHA, 2013).

Dams and their operations influence **water quality**. Water released from a dam's reservoir can be either too warm or too cold for native species, depending on the depth at which the water is withdrawn and the season. Among many other chemical and physical parameters are dissolved oxygen, pH, dissolved and undissolved organic and inorganic elements. By turning originally flowing waters into stagnant reservoirs, the chemical and nutrient composition fundamentally changes. To ensure that no problems arise and/or how to mitigate should this be the case, adequate data collection and an environmental assessment process that identifies potential water quality problems prior to dam design are essential (IHA, 2013).

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