Lower Subansiri Dam, India. Credit: Keith Schneider, Circle of Blue

Swindling Rivers

RUN-OF-RIVER HYDRO

Hydropower projects described as run-of-river evoke images of unimpeded rivers delivering clean power without the environmental and social costs of traditional dams. And influential institutions like the World Bank tout the share of run-of-river projects in their hydro portfolios, suggesting such projects have few adverse impacts. However, the reality is often very different.

Run-of-river (ROR) hydropower schemes have become popular among dam proponents as a supposedly "low-impact" alternative to storage dams. Forbes Magazine declared that "Run of river just might be the ultimate in green power." But while run-of-river projects may avoid some of the impacts commonly associated with storage dams, such as widespread resettlement, their overall impacts can be even worse. ROR projects can be particularly detrimental to the ecology of rivers that provide vital services to people living downstream.

Given the trend among the hydropower industry, financiers and government officials to embrace ROR projects, it's an important moment to take stock of what run-of-river projects are, and to revisit their often-unchallenged "green" credentials.

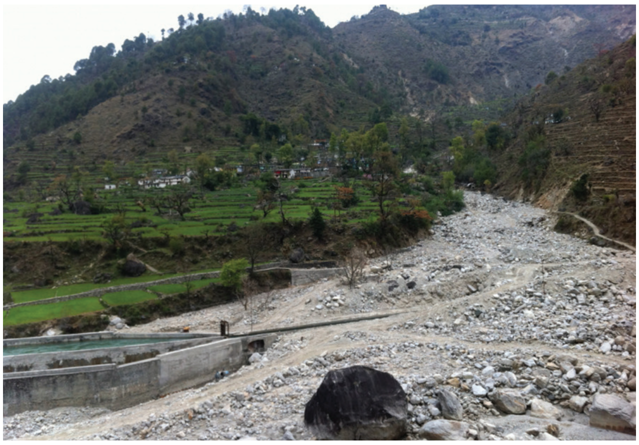
WHAT DOES "RUN-OF-RIVER" MEAN?

The term "run-of-river" is misleading because it suggests harnessing a river's natural flow and generating energy as it passes, but that's not what run-of-river hydro does. All hydropower projects impound water and impact rivers. Most ROR projects withhold water either behind a dam or through diversion tunnels.

There is no common definition of what constitutes a run-of-river project. Generally, "run-of-river" refers to a hydropower project either with a small reservoir or no reservoir. They differ from traditional reservoir dams, which store great quantities of water during the wet season to allow year-round releases to generate power. Instead, because they have comparatively limited storage capacity, ROR projects are generally built on rivers with fairly consistent annual flows, which are either naturally occurring or are regulated by a storage dam upstream.

In practice, the term "run-of-river" is used very loosely. This lack of specificity, and the claimed green credentials the term connotes, gives license to a wide spectrum of projects being indiscriminately referred to as "run-of-river." The term ROR has been applied to everything from micro-hydro projects providing electricity in remote villages to the Belo Monte megadam in Brazil, which will devastate an extensive area of the Brazilian rainforest, displace over 20,000 people, and threaten the survival of indigenous tribes that depend on the river.

While the term suggests otherwise, most run-of-river projects store water, though application varies widely. In some cases, the ROR label has been applied to dams that withhold water for weeks or even months. In India, projects able to store a week's worth of flows are nonetheless classified as ROR. The World Bank generally uses the term to refer to dams that can store up to a day's worth of a river's flows – a definition that is stricter than most, though such projects are not without impacts, as discussed in subsequent sections.



Dry riverbed on India's Nandakini River, whose flows are diverted through a series of tunnels.

WHAT ARE THE DIFFERENT TYPES OF RUN-OF-RIVER PROJECTS?

- **STRICT RUN-OF-RIVER PROJECTS** do not regulate a river's a flow, and they generate power as water passes through turbines in the dam. Because they do not store water, these projects typically have fewer adverse impacts than other ROR projects, but they nevertheless disrupt river biodiversity and other river functions.
- **PONDAGE RUN-OF-RIVER PROJECTS** provide daily or weekly regulation of flows by storing water behind dams, and the reservoirs are referred to as "pondage." Commonly operated as "peaking plants," water is passed through turbines in the dam to maximize power generation during times of peak energy demand. This results in drastic changes, even on an hourly basis, in a river's flow. These projects can also be operated to deliver baseload power.
- **DIVERSION RUN-OF-RIVER PROJECTS** divert a portion of a river through surface or underground tunnels that can stretch anywhere from a few hundred meters to dozens of kilometers to a powerhouse downstream. Once the water is run through turbines, it's returned to the river. These types of projects often dewater long stretches of rivers. Tunnels are most commonly used in mountainous areas like the Himalayas, Canada and Switzerland.

WHAT ARE THE ENVIRONMENTAL AND SOCIAL IMPACTS OF RUN-OF-RIVER PROJECTS?

Run-of-river projects are often presented as having few or no adverse impacts on rivers. The Clean Energy BC industry group in Canada describes run-of-river technology as a "continuous source of clean and green renewable energy with minimal environmental impact." However, ROR projects not only can have significant impacts, particularly downstream, these impacts can be quite severe. Some of these effects are inherent; others depend on how a dam is operated.

IMPACTS ON RIVERINE ECOLOGY:

Run-of-river projects often have significant impacts on fish and other aquatic species. Their dams block the upstream and downstream migration of fish and other biota, and prevent sediment and nutrients from flowing to floodplains downstream. They often inundate important biodiversity hotspots, which tend to occur near the rapids that attract dam developers. These impacts can be exacerbated when a series of dams are built in a cascade. Some of the impacts differ according to the type of project:

DIVERSION DAMS: By diverting water from the river channel, long stretches of river – often dozens of kilometers – are effectively dewatered, turning a river into a continuous series of pools and tunnels for much of the year. Many such projects can divert most or all of a river's flows, causing changes in a river's temperature, velocity and depth that can completely kill off the natural life in a river.

Lower Subansiri Dam

The 2000 MW Lower Subansiri ROR scheme, under construction in Northeast India, illustrates the problems of peaking projects. The 116-meter-high dam will submerge a 47-kilometer stretch of the Subansiri River, a tributary of the Brahmaputra River, and its electricity would be exported from the impoverished mountain region to mainland India.

As Neeraj Vagholikar describes in the 2010 report "Damming Northeast India," the water level in the Subansiri will fluctuate 400-fold every day once the project is in operation. In winter, the dam will release a trickle of only 6 m3/sec for most of the day, but will gush 2,560 m3/sec when electricity demand is highest during the evening hours. "Thus the river will be starved for 20 hours and then flooded for 4 hours with flows fluctuating between 2 percent and 600 percent of normal flows on a daily basis." This will greatly affect agriculture, wildlife and the rich aquatic biodiversity in the floodplains and wetlands of Assam, including the Kaziranga National Park, a World Heritage Site. Meanwhile, the high concentration of dams on the tributaries of the Brahmaputra will pose great ecological disruption on endangered species, including river dolphins and the migratory Mahseer fish. In the face of community protests, the developer has agreed to adjust its operations to reduce fluctuations, though this was done in the absence of a credible downstream assessment.

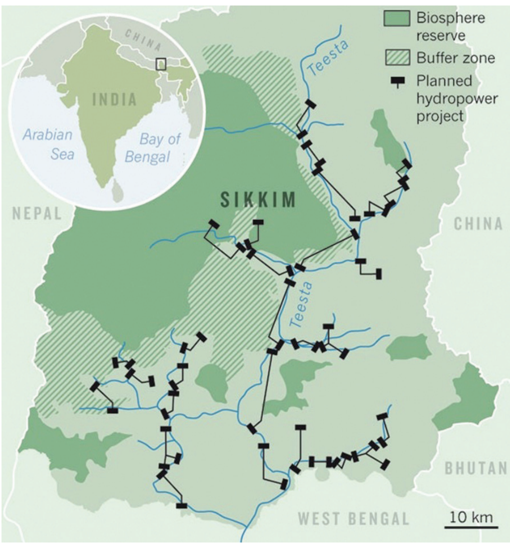
Long stretches of the Teesta River in India's Himalayan region are being dewatered and fragmented by the dozens of river diversion schemes that are built, planned or under construction.

To limit negative impacts, dam operators are often required to ensure that some portion of water is allowed to flow through the river channel to sustain basic river functions. These are called environmental flows or "e-flows." However, the amount of water released is often insufficient. E-flow requirements are often determined arbitrarily, and lack critical baseline studies and input from local communities to properly assess and design plans to mitigate impacts on fish species and other services provided by the river. Even when e-flows are required, dam operators – particularly private companies – often ignore such requirements because assuring e-flows competes directly with energy production, and by extension the project's bottom line.

PEAKING POWER: These projects can be incredibly disruptive to riverine ecology. While strict ROR projects should not change a river's flows for generation, ROR dams with storage, or "pondage," can time releases and generate power for those hours or days when energy demand is at its highest, or is "peaking." However, by releasing an entire day's worth of flows within the span of a few hours, they create daily fluctuations between flood and drought that can wash away or disrupt fish breeding grounds and aquatic biota that are critical to the food chain. Fundamentally, rivers with the most natural flow regimes have the best chance of assuring the survival of important fish species and protecting biodiversity. Although referred to as run-of-river, projects operated in this manner create the opposite of a river's natural flow.

DAM CASCADES: ROR projects are often built in a series, or cascade, along a river, since the construction of the first dam on a river regulates its flow, making the development of subsequent ROR projects downstream more economical. While this approach may maximize the hydro potential of a stretch of river, the cumulative effects of such projects are particularly pronounced. The cumulative impacts of dam cascades on river health cannot be measured by examining each project individually, as such projects can condemn a river to a "death by a thousand cuts."

Dams always jeopardize a river's health by fragmenting it, but connectivity is broken when river flows are impeded by several projects in a line. Cascades often pose impenetrable barriers to migratory fish and exacerbate the impacts on riverine ecology discussed above. Cascades also have a more pronounced effect on blocking sediment from traveling downstream, impacting both dam operation and, most critically, the ecosystems and fertility of floodplains downstream. These impacts can be felt all the way to the mouth of the river, and have significant impacts on coasts, intensifying erosion.



Neeraj Vagholikar/Umesh Bobade/Sanctuary Asia

Long stretches of the Teesta River in India's Himalayan region are being dewatered and fragmented by the dozens of river diversion schemes that are built, planned or under construction.

Pak Mun Dam

Thailand's Pak Mun Dam was built with $24 million in financing from the World Bank. While the project's proponents claimed its footprint would be limited as an ROR project, the dam was highly contested due to the predicted impacts on the rich and productive fisheries of the Mun River, the largest tributary of the Mekong River.

As a direct result of the dam, more than 20,000 people have been affected by drastic reductions in fish populations upstream of the dam site and other changes to their livelihoods. The dam has blocked the migration of fish from the Mekong River to the Mun River, where 265 fish species had previously been prevalent. A fish ladder, promoted by the World Bank's fisheries experts to allow fish migration, has proved useless.

Despite the heightened risks associated with dam cascades, governments rarely require a basin-wide assessment of the cumulative impacts of several projects, or they conduct it too late to influence the siting of projects. ROR projects within a cascade are often built and operated by different private companies who are generally required only to assess and manage the direct impacts of their own projects. As a result, developers and governments often underestimate cumulative impacts, which has led to sharp declines in fertile floodplains and in productive river and coastal fisheries.

Governments and developers also rarely conduct baseline studies of the presence and abundance of aquatic species, including endangered species, before the dam is built. This gap makes assessing impacts difficult, and as a result the cumulative effects of dam cascades are understudied.

SAFETY RISKS OF PEAKING PLANTS:

Peaking plants can pose a significant safety risk to people living downstream, who can be exposed to unexpected dam releases. Peaking plants can release a river's entire flow during just a few hours of peak demand. This can be dangerous to people living downstream, who often receive no advance warning when enormous quantities of water suddenly flood an empty riverbed. Instances of drowning are common in India, which relies heavily on peaking hydropower plants. These safety risks can be mitigated by more advanced warning systems, which require greater investment, or ramping up power generation more gradually, which sacrifices some efficiency. Where required by law, some peaking plants have regulating dams downstream that stabilize a river's flows, though these can have impacts of their own, and are not popular with dam builders because of the additional cost.

OTHER CONCERNS:

ROR projects face most of the same challenges as large reservoir dams, including:

- **PRONE TO COST AND TIME OVERRUNS.** For example, the Bujagali Dam in Uganda came in $65 million over budget and several years behind schedule.

- **VULNERABLE TO CLIMATE CHANGE.** Even more so than conventional reservoir dams, run-of-river projects are particularly susceptible to climate-induced changes in rainfall patterns, because their output is highly dependent on consistent flows.

- **INDUCE ADDITIONAL IMPACTS.** Construction in often remote areas leads to the severe degradation of pristine areas. Access roads into forested areas leave a sizeable footprint and facilitate logging and other activities. The impacts of diversion tunnels can also be significant. Tunnels running through mountains can affect the local hydrology, causing streams and wells to dry up. Meanwhile, the blasting associated with tunneling can damage nearby homes and the excavation of mountains has caused landslides, while the disposal of mountain debris is often done improperly.

CONCLUSION

Rather than serving as a low-impact alternative to large reservoir dams, run-of-river dams can have serious and long-lasting impacts, particularly on downstream ecosystems. These impacts have been long overlooked and understudied because of the widespread assumption that such projects are benign, aided by the lack of any meaningful definition of the term. The term is now being used by dam proponents as a way to "greenwash" projects. However, decision-makers, planners and communities must pay the same scrutiny to run-of-river projects as any other dam.