



水沙龙视点

——中国的水资源与水电开发

中国发展水电是必然选择

中国是世界上最大的煤炭生产国和消费国。¹近年来在气候变化和碳减排、空气污染、水资源短缺等压力的影响下，中国一直在强调优化能源结构、控制煤炭的生产和消费、提高可再生能源比重，并向世界承诺到 2020 年，碳排放强度较 2005 年减少 40%–45%。同时中国还提出，到 2030 年，二氧化碳排放达到峰值且将努力早日达峰，非化石能源占一次能源消费比重提高到 20% 左右。

在应对气候变化、能源结构调整、确保能源供应安全的大背景下，发展水电就成为了我国社会经济发展的一种必然选择。首先，水电作为一种公认的清洁可再生能源，其开发利用本身几乎不产生传统污染物质和温室气体排放²。其次，水电在我国的可再生能源发展战略中具有重要地位，原因在于：第一，我国水能资源丰富，居世界首位³；第二，我国水电开发潜力大：按技术可开发量计算，我国目前的水电开发程度为 63.8%，而世界上许多发达国家的水电开发量均已达到 80%⁴；第三，水电是目前技术最成熟、经济成本竞争力最强、最具大规模开发条件的可再生能源⁵，水力发电只是利用水流所携带的能量，无需消耗其他动力，而且上一级电站使用过的水流仍可为下一级电站利用；另外由于水电站的设备比较简单，其检修、维护费用也较低，而目前其他可再生能源成本仍较高，大规模应用仍然存在限制⁶。因此，我国在当前和未来积极开发水电的格局不可回避。如何可持续地开发水电，减少其对生态系统的负面影响，实现其对促进我国可再生能源发展以及流域和区域经济社会发展的不可替代的作用，是我们需要关注和解决的问题。

水电开发对生态环境所造成的负面影响未得到充分评估和重视

虽然水电开发为保障我国能源安全、调整能源结构以及实现减排目标做出了重要贡献，但其不可持续的开发方式对环境和社会产生了极大的不利影响⁷。例如，很多水电站的建设会切断河流的连通性，特别是梯级电站的建设会对河流水生生态产生累积效应，水文情势时空分布在水电站开发建设过程中会产生变化并影响水体环境，进而影响水生生物的生存状态，造成生态系统破坏。同时，水库大坝的建设还可能会带来水库移民和水库淹没等问题，导致景观格局的演变，甚至对整个流域的生态环境产生深远的影响。⁸这些不利影响会增加水电开发的社会成本。然而，由于各种原因，这些真实成本在我国尚未得到充分评估和重视。目前关于水电工程对生态环境所可能造成的影响及影响机理还不十分清楚，且相关保障制度的设计和实施仍存在缺陷，还很难有效地减少和消除对生态的不利影响，同时生态保护技术的研究在我国也刚刚起步，难以满足需求。以三峡工程为例，自 2003 年蓄水发电以来，在防洪、发电、航运等方面发挥了巨大作用。但同时也由于其开发前对环境影响的评估和重视不够而引发了一些新的环境问题，如局部河床淤积、水位抬升、水质恶化、中下游河床冲刷加剧、四大家鱼产卵规模明显下降。近年来，长江三峡集团公司开展了生态调度试验，尝试对生态影响实施修复。2011 年以来的监测结果显示，四大家鱼产卵苗径流量⁹已逐年回升、库区泥沙淤积问题得到缓解，但在高强度的人类活动影响下，长江流域水生生物资源衰退、水域生态不断恶化的趋势目前并未得到遏制。三峡工程是长江干流上的第一个高坝，其影响还远没有达到稳定状态，且长江上游金沙江段还在进行梯级水电的开发，所以当前尚难以对三峡工程的影响进行系统性的整体评估。

应加强水电开发对生态系统影响的基础性研究工作

要想实现水电的可持续发展，减少其对生态环境的负面影响，应系统全面地评估水电开发对生态系统的影响，并研究水电站建设和运行当中能够减少负面影响的缓解措施和补偿方案。

应以健全的并且具有战略意义的环境和社会评估为基础，利用最有效的知识和科学分析，充分考虑水文的不确定性和可调节性，包括现今及未来的气候变化预测、用水方式和用水主体的多样化所带来的叠加影响以及人们对环境需求和环境服务功能的认知。这种评估体系将以一种多维考量的、透明的方式，在适当的流域或区域应用。只有这样，决策者才能够用基于事实和数据的结论回应可能的质疑，这也是水利工程进行合理选址、科学规划、安全运营的先决条件。¹⁰

应对水电站建设和运行中的生态环境负面影响缓解措施和补偿方案进行全面研究。环保部颁布的《关于深化落实水电开发生态环境保护措施的通知》中强调，水电项目建设应严格落实生态环境保护措施。其中规定，应对环评已批复、项目已核准（审批）的水电工程进行回顾性研究或环境影响后评价；评价后确定需要变更设计的，应对变更工作开展专题研究，必要时进行模型试验，以保障工程安全和稳定运行。具体研究内容包括：合理确定生态流量，认真落实生态流量泄放措施；充分论证水库下泄低温水影响，落实下泄低温水减缓措施；科学确定水生生态敏感保护对象，严格落实栖息地保护措施；充分论证过鱼方式，认真落实过鱼措施；论证鱼类增殖放流目标和规模，落实鱼类增殖放流措施；科学确定陆生生态敏感保护对象，落实陆生生态保护措施。¹¹

水电开发规划必须考虑国家生态安全，其规模、布局 and 开发时序要遵循生态保护要求

随着我国水电开发的规模扩大、程度提高以及领域深入，其经济成本优势正在降低，而且对于物种及其栖息地的潜在破坏与割裂等自然生态成本也逐渐凸显出来，引发各界对进一步大规模水电开发的疑虑。¹²在生态文明被列为建设中国特色社会主义的“五位一体”总布局之一、国家战略发展目标的新常态下，我国的水电开发应将环境保护放在第一位。因此，我国的水电开发在满足国家能源需求和减排需求的同时，也必须考虑国家的生态安全。

首先，在规划时应应对重要的自然资产进行评估，合理划定生

态保护红线。由于缺乏生态红线规划，建国后我国水电开发速度与力度持续递增，在创造社会、经济利益的同时也造成了不可逆转的环境生态问题。例如，我国西部地区蕴藏着丰富的水电资源，同时也是许多国家级甚至世界级自然保护区和稀有物种的所在地，并具有许多珍贵而独特的地质地貌景观。但水电生态红线政策规划的滞后使许多具有珍贵资源的生态保护区遭到破坏。¹³因此，应从不可替代性¹⁴、普遍价值¹⁵、生态系统服务功能¹⁶以及社会因素¹⁷这几个角度出发，评估一个地区的生态价值，从而划定流域的生态禁止开发区、有条件开发区以及可开发区。¹⁸应避免在高保护价值区域开发水电项目，并确保该区域免受水电站的影响。这些高保护价值区包括：生态地位突出的淡水生态系统；具有丰富的生物多样性或优良的生态服务价值的区域、干流或支流，或是能够作为应对未来环境压力如气候变化的“庇护所”；以及获得国际、国家或地区认可的保护地（如国际重要湿地、世界遗产保护地等）和原住民领地。¹⁹应积极寻求替代方案，首先考虑更加高效地利用现有资源，提高已建水电站的管理水平，并寻求更加合理的替代方案，将新建水利设施作为最后的方案。

其次，对于不可避免的水电开发项目，在选址时，应尽可能地考虑能够最大化保留生态系统或生态过程完整性的方案。²⁰同时，应合理确定其规模和开发时序，并在其规划和设计过程中尽量减少对环境的影响。此外，还应寻找低影响的非工程方案（如恢复湿地、维护蓄洪区等）和非永久性替代方案，从而确保水电项目建设导致的环境不利影响最小化。²¹

制定国家层面的水电开发流域规划，重视流域开发与地方经济发展的协调

在考虑国家生态安全的前提下，我国水电开发需要按照“电调服从水调，水调服从生态调度”的原则进行。同时，水电开发也要兼顾地方经济的发展。因此，制定国家层面的流域生态保护规划，统一协调国家生态保护和地方经济社会发展之间的关系显得尤为重要。²²

然而，目前我国缺乏流域协同保护机制，加之水电开发权限按流域综合规划实行分级管理，这导致水电开发程序复杂、资源分散和各自为政的问题越来越突出。因此，对于水电开发所涉及的不同行政区域之间的协调，需要超越地方政府的更高层面的协同。水电生态保护的空间格局如何划分，既要基于全国水资源整体格局研究，又要结合地方资源特色，结合地方产业经济和环境保护的需要，在积极发挥水电开发的正面影响的同时带动流域和地域的可持续发展。²³

管部门、学术机构、非政府组织、金融发展机构、企业等专家的平等的民间交流平台，关注水管理的焦点和难点问题，为水管理的决策提供支持，旨在与多部门共同为为建设水安全的未来贡献力量。

2015年5月11日水沙龙召开第一次活动，讨论中国的水资源与水电开发。我们衷心感谢所有与会的专家和嘉宾，石秋池、唐克旺、姜鲁光、廖四辉、刘桂环、李丹宁、王龙柱、尹乐、张大志以及朱劲吉，他们自始至终的参与、指导与支持帮助我们对于中国未来的水资源与水电开发问题达成共识。

注释

¹ 我国是世界上最大的煤炭生产国和消费国。 <http://www.docin.com/p-4379793.html>

² 中国生态保护与水电开发冲突与对策研究。

³ 中国生态保护与水电开发冲突与对策研究。

⁴ 中国生态保护与水电开发冲突与对策研究。

⁵ 国家能源局. 水电发展“十二五”规划。 http://www.cusdn.org.cn/news_detail.php?id=228372

⁶ 中国生态保护与水电开发冲突与对策研究。

⁷ WWF 水坝立场。

⁸ 中国生态保护与水电开发冲突与对策研究。

⁹ 注：即河流单位横截面积在单位时间内的卵苗数。

¹⁰ WWF 水坝立场。

¹¹ 关于深化落实水电开发生态环境保护措施的通知。 http://www.zhb.gov.cn/gkml/hbb/bwj/201406/t20140617_277066.htm

¹² 中国生态保护与水电开发冲突与对策研究。

¹³ 中国生态保护与水电开发冲突与对策研究。

¹⁴ “不可替代性”是基于物种的，反映出一个区域对实现保护目标的潜在贡献，或者丧失该区域将会在多大程度上导致保护目标的失败。选自“开发”或“禁止开发”。WWF China。

¹⁵ 《联合国世界遗产公约》中采用的“普遍价值”的概念。选自“开发”或“禁止开发”。WWF China。

¹⁶ 指自然资本以及其提供的生态系统服务。选自“开发”或“禁止开发”。WWF China。

¹⁷ 社会因素包括生计效益和长期创造就业的机会、获取能源、水和食物以及进入市场的机会。选自“开发”或“禁止开发”。WWF China。

¹⁸ “开发”或“禁止开发”。WWF China。

¹⁹ WWF 水坝立场。

²⁰ WWF 水坝立场。

²¹ WWF 水坝立场。

²² 中国生态保护与水电开发冲突与对策研究。

²³ 中国生态保护与水电开发冲突与对策研究。

²⁴ 中国生态保护与水电开发冲突与对策研究。

²⁵ 中国生态保护与水电开发冲突与对策研究。

²⁶ 中国生态保护与水电开发冲突与对策研究。

²⁷ WWF 水坝立场。

²⁸ 中国生态保护与水电开发冲突与对策研究。

²⁹ 发改委：2015年底全面完成投资项目核准制度改革。 <http://www.chinanews.com/gn/2015/01-08/6948138.shtml>

³⁰ 中国生态保护与水电开发冲突与对策研究。

³¹ NGO 在水电开发中的作用。 <http://www.docin.com/p-675575179.html>



Water Salon Insights

——Water and Hydropower Development in China

China needs hydropower

China produces and burns more coal than any other country in the world. The nation has been optimizing its energy mix, regulating coal production and consumption, and boosting renewables over the past few years under pressure from the need to tackle climate change, air pollution and water scarcity. It has made a commitment to reduce its carbon emissions by 40%-50% by 2020 over 2005 levels. It has also pledged to peak carbon emissions by 2030 and ensure that about 20% of its energy comes from non-fossil fuel sources by the same year.

Hydropower development is inevitable in China because the country needs deal with climate change, adjust its energy mix and ensure energy security to support stable socio-economic development. Hydropower is considered a clean and renewable energy because it does not significantly contribute to the emissions of conventional pollutants or greenhouse gases. It also plays a key role in China's strategy to develop renewable resources. China has a great hydropower potential. Currently it has only developed about 63.8% of its hydropower resources. But the percentage for many developed countries is 80%. Existing technologies for hydropower are well developed; it is cost effective and can generate huge amounts of energy. Hydropower harvests the energy of water flow without consuming any other resources. One river can also have several hydropower stations. These plants use simple technologies that are easy and cheap to maintain. Alternative renewable resources in comparison are more costly to develop and are beset by barriers in terms of their large-scale uptake. Thus, China clearly needs to further develop its hydropower resources. The key problem is to find a solution

to sustainably develop these resources without damaging the environment.

Insufficient attention is given to the negative environmental impacts of hydropower development

Although hydropower has made a great contribution to state energy security, adjustments to the energy structure and emissions reduction, its unsustainable development has had significant negative effects on the environment and society. For example, many hydropower projects have cut the connectivity of rivers. An excessive number of hydropower stations on one stretch will produce a cumulative effect that can harm marine ecosystems. Some hydropower projects impact the landscape alongside the river – requiring resettling of communities for example – and this may have a long-term impact on the environment of the entire river basin. These negative effects drive up the social costs of hydropower development but they are not reflected in official assessments. There has been little research undertaken on the principles behind or the actual impacts of hydropower development on the environment. The Three Gorges Project, for example, has played a significant part in flood control, electricity generation and shipping since its launch in 2003. However, during the planning stage, little attention was given to the environmental impact of the project which meant that when it was rolled out, it triggered a number of environmental problems, including the dumping of sediment on the river bed, rising water levels, deterioration of water

quality, river bed degradation and problems with the spawning of fish. The China Three Gorges Project Corporation (CTGPC) has studied how it can solve or repair some of these problems. The results of these studies in 2011 indicated that Asian carp are now spawning properly and the problem of sedimentation has also been alleviated. However, the project is still destroying the aquatic environment of the Yangtze River Basin and the river ecology has not been recovered. Three Gorges Project is the first high dam on the main stream of the Yangtze River and its impacts are far from stability. A cascade of hydropower stations upstream on the Jinsha River (a tributary of the Yangtze) is under construction. Therefore, currently it is difficult to make a systematic and integrated assessment on the impacts of the Three Gorges Project.

China should study the impacts of hydropower development on ecosystem

The sustainable development of hydropower requires China to use an integrated evaluation system to assess the impacts of a hydropower project on the ecosystem, and to study the mitigation measures and compensation schemes to reduce the negative impacts during the construction and operation of the hydropower stations.

Such a system needs good data and a sound scientific basis. It should examine data on climate change forecasting, diversity of water use, the influence of water consumers, and the level of public awareness. The system should focus on a single river basin that should help to provide the facts or data on which to base solutions. It can also be used in the planning stage when deciding where to locate a project.

Research should also look at the mitigation and compensation measures in connection with the impacts of hydropower construction or operation. The Ministry of Environmental Protection's Eco-Environmental Protection in Hydropower Development stipulates that all hydropower projects must conduct assessments on environmental impacts and the results of these assessments should determine revisions to the plans. Areas that should be studied among others are: the influence of low-temperature water of reservoir discharge flow; the protection of vulnerable species and protection measures; fish habitat and protection; and protection measures for affected land-based ecologies.

Hydropower development plans must not endanger the country's ecological security

As hydropower develops in China, their economic advantages are falling while environmental costs are rising. Under the new central government administration, environmental protection should be the first priority of any hydropower project and it must feature prominently when drawing up plans.

First of all, important natural capitals should be evaluated and ecological protection red lines should be designated on a sound basis. After the founding of the People's Republic of China in 1949, the country developed its hydropower resources at a rapid speed. However, at that time, the environment was never a consideration and many of those projects have caused irreversible environmental damage even though they also contributed a great deal to the socio-economic growth. West China, for example, has rich water resources and nature reserves that are home to rare species. There are also many unique landforms and ecosystems. Because several hydropower projects did not incorporate measures to protect the environment these plants have harmed a number of protected areas with rare resources. An area's environment should be graded on its "irreplaceability", "universal value", "ecosystem services" and "social factors" and should then be divided into regions that can be developed, that can be partially developed or should be closed to development. Hydropower projects should not be allowed in areas which are extremely environmentally valuable. Such areas are those with important fresh water ecosystems, areas rich in biodiversity or ecological value, zones that can help the region deal with climate change or other environmental pressures, and official protected areas (such as internationally important wetlands, world heritage sites, etc.). Instead use existing resources more efficiently and improve the management of power stations. New power stations should be built as a last resort.

When the project is inevitable, its site selection should be packed with a proposal for a maximal reservation of ecosystem or an overall ecological process. Meanwhile, the scale and time series of development should be reasonably designated. In addition, it should be sought to have non-engineering schemes that have little influence on ecosystem, (i.e. wetland restoration, flood storage, etc.) and nonpermanent alternative schemes for minimizing damages of projects to environment.

The public and NGOs should be involved in the development of hydropower projects

The public is a key stakeholder in hydropower development. The public consumes hydropower (electricity) and people's lives are affected by power plant construction and operation (flood control and navigation) while others need to be resettled. It is clear, therefore, that public participation is important to ensure the sustainable development of hydropower resources so that public interests are protected and negative impacts are minimized.

Projects should be open to public scrutiny throughout all stages, right through from planning, approval, and implementation to management. The public should be part of the monitoring process over hydropower plants' impacts on the environment. The National Development and Reform Commission (NDRC) will complete its reform of the rules governing the approval process by the end of 2015. This reform will open all projects to public scrutiny on its website as part of a public right to know initiative. In many developed countries, public participation is a key part in the evaluation of a project's environmental impact. However, in China the mechanism that supports public participation in evaluating environmental impacts has some problems and it should be supplemented with details on how the public can get involved. Public participation allows everyone to take part in the evaluation process and it promotes communication between governments, corporations and the public, so that open and transparent hydropower development is possible.

It's important to make the results of environmental impact assessments available and comprehensible to the public and engage local people to help monitor the impacts of existing hydropower plants on the environment.

NGOs should also play a key role in the development of hydropower projects, particularly in the planning process. Environmental NGOs have supervised, supported and assisted in the approval of hydropower plants in recent years. NGOs have no commercial interests and they have more technical knowledge than the general public so they can provide constructive recommendations and ideas in an objective and professional manner. Furthermore, some NGOs with international experience can help by offering examples and case studies from overseas to act as a reference for local projects.

It is important to protect the public's right to know and the right to participate as well as allowing NGOs to participate fully in guiding hydropower development.

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