ASIEN 134 (Januar 2015), S. 121–142

Refereed article

Energy, Hydropower, and Geopolitics — Northeast India and its Neighbors: A Critical Review of the Establishment of India's Largest Hydropower Base

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Summary
India's demand for electricity has recently been increasing at one of the fastest rates of any country in the world. Among renewables, hydropower plays a crucial role as a mature, cost-effective, and reliable power generation technology. India's Northeast (Brahmaputra Basin) holds an immense hydropower potential of 63 gigawatts, which to this day remains virtually untapped. There are 20 projects in the pipeline with a capacity of greater than 1000 megawatts; among them are both the largest hydropower projects of India as well as some of the largest transmission schemes of anywhere worldwide. Sikkim and Arunachal Pradesh are at the forefront of initiatives to exploit this potential, mainly through private developers and as run-of-river schemes. The government of Arunachal alone has to date awarded 153 hydropower projects with a cumulative capacity of 53.2 GW. The exploitation of hydropower resources is also of crucial geopolitical relevance, both nationally (the Northeast is a vulnerable and conflict-ridden region distinct from mainland India) as well as internationally. China claims Arunachal as its own territory and is developing even more large-scale projects upstream. Additionally, India includes the huge hydropower potential of Bhutan in its own development plans. Most of the forthcoming hydropower projects, those from both the public and private sectors, have been considerably delayed hitherto. The major reasons for this are finance- and tariff-related issues, technical problems, difficulties faced in securing land acquisitions, environmental concerns, and heavy anti-dam public agitation. In this context, the public sector Lower Subansiri Project has evolved into being the most contested dam project in the whole of India.

Manuscript received on 2014-07-22, accepted on 2014-12-16
Keywords: India, Northeast, energy and power development, geopolitics, hydropower

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* Research funding has been provided by the DFG (German Research Foundation). Further support came from the universities of Dibrugarh and Guwahati (both in India).

Introduction

In recent years India's demand for electricity has been increasing at one of the fastest rates of anywhere in the world. This appetite is fuelled by economic growth, a rapid rate of industrialization and urbanization, and by the need to improve the living conditions of a large part of the country's population. India is rapidly developing its energy sector; even with a moderate GDP growth scenario, its energy production capacity will have to double by 2030. Concerning electricity generation, India has, after China, the second-largest growth rate worldwide. In 2013 it surpassed Japan as the world's third-largest generator of power (BP 2014). Despite this impressive growth, the country's demand for power continues to outstrip supply by currently about 5 percent — although the supply–demand gap has narrowed in recent years. The failure to meet the power demand has been the bane of India's economic growth story and it has substantially contributed to the country's recent economic slowdown (Baruah 2012). In 2013 India had a total installed capacity of 274 gigawatts, of which 234.6 GW was grid connected and 39.4 GW was captive power (CEA 2014). Only in 2013 did its capacity rise by an impressive 27.8 GW, of which 83 percent fed the grid. Eighty-five percent of this growth was obtained from thermal power (CEA 2014). Hence, currently, India is aggressively developing its thermal power sector, mainly around the major coal mining areas as well as around several ports along the country's coastlines that specialize in handling coal imports (Hennig 2015).

In order to reduce the recent extensive increase in carbon emissions and the rising dependency on coal imports, India is now actively developing renewable energy sources — including hydropower (HP). The International Hydropower Association (2013) estimated that in 2012 about two-thirds of the worldwide installed capacity in renewables came from HP; with regard to electricity generation the percentage is much higher (85 percent). The electricity output from HP worldwide is currently larger than that from nuclear energy (IHA 2013; REN21 2012). Therefore, as things stand HP is currently still the world's most mature, cost-effective, and reliable renewable power generation technology available (Brown et al. 2011). On that basis India has accelerated its development of HP, and plans to exploit its huge potential more effectively in future. Traditionally, HP has ranked second in India's power generation portfolio. Currently the country has an installed HP capacity of 43.7 GW, of which 3.8 GW originate from small HP projects and the remaining 39.9 GW from large HP plants (CEA 2014). India ranks sixth-largest among the HP-producing nations worldwide, both in terms of installed capacity and of electricity production based on HP. Until now India has developed only 29 percent of its estimated economically feasible HP potential, but it is pursuing one of the most ambitious HP development programs anywhere in the world. The HP potential of the Indian Himalaya exceeds 120 GW. The Indian Brahmaputra Basin, which is almost identical in size to the Northeast, is the area with by far the largest HP potential of the entire country. It is estimated to have at least 63 GW capacity thereof, of which a minimum of 50 GW belongs to Arunachal Pradesh alone. Therefore, Arunachal has already been proactively tagged as India's future powerhouse by both the country's media and politicians. The Government of India plans to harness Northeast India's (NE India) huge HP potential as a way to support the economic hubs of the mainland, and has therefore recently accelerated the implementation of a controversial and disputed HP development program.

Hindering these efforts is the fact that the Northeast is characterized by a unique geopolitical situation. The region almost exclusively shares an international border, and it is connected to the rest of India only by a tiny corridor. Additionally, the state of Arunachal Pradesh — which is home to 80 percent of the region's immense HP potential — is a contested, and therefore politically highly sensitive, frontier region between India and China. The Northeast is further marked by being isolated, economically marginalized, underdeveloped, and conflict ridden. Conversely, the remote but resource-rich region is also one of the world's major biodiversity hotspots.

Within this setting, the present paper aims to answer three major research questions: First, what is the present state of NE India's energy and HP development within the relevant policy context? Second, who are the major actors involved herein and what relevance, if any, does the clean development mechanism (CDM) have in the region's HP development? Third, what is the broader geopolitical context as related specifically to India's neighbors?

Framework

HP research and the "powershed" approach

The adverse social and environmental consequences of large HP projects — as well as their undesirable political externalities — are by now well known and well documented (Morgan et al. 2012; Nilsson et al. 2005; WCD 2000; Rosenberg et al. 1997). Global attitudes and paradigms regarding dams are shifting with the emergence of the discourses about sustainability or climate change (Sternberg 2010). This is also reflected in different academic approaches, which describe how large-scale water resource developments are viewed. Inherent to these approaches is the idea that HP development takes place not in a neutral political, social, and environmental vacuum, but rather in a highly politicized environment (Bryant and Baily 1997). Baghel and Nuesser (2010) argue that the analytical framework of Political Ecology is key to looking at both the reasons behind and effects of large dams. Cooper (2010) and Sneddon and Fox (2006), in reference to the Mekong Basin, emphasize the importance of the framework of "hydropolitics" as a way to analyze the relationships between actors across different scalar levels. This frame relates to the ability of geopolitical institutions to manage transnational water resources. Other scholars work with a so-called "hydroscape" approach. For Katus (2012) the concept identifies the encounters between different actors at particular places within the hydroscape — identified as a network having global, national, and local dimensions. Baghel and Nuesser (2010) use the term "technological hydroscape" to describe human dominance over nature and large dams as icons of national prestige, while Molle et al. (2009) use the term "waterscape." They describe HP development in the Mekong Basin as part of contested waterscapes and discourses of landscape transformation, governance reforms, development, and the ensuing impacts on local livelihoods. In the context of the rapid development of HP in Yunnan, southwest China, Darrin Magee (2006) introduced the term "powershed" in his since widely cited article.

Based on Magee's original concept, the present paper uses the framework of the so-called "geographical powershed" approach while also developing it further. By using a research perspective beyond simple deterministic causalities, it provides a lens through which to understand the scalar politics of electricity in a dynamic and process-oriented way. The power shed approach aims to generate a more spatiotemporal, geographical, and empirical analysis of NEW India's distinctive large-scale HP development. It further aims to conceptualize the complex interplay between the region's rapid HP development and the overall lifecycle of electricity (from generation via transmission to consumption), the hydroenvironmental settings and consequences, and the related institutional arrangements (from actors, politics, policy, and governance to asymmetric conflicts). The geographical power shed framework facilitates a multidimensional analysis of HP development, as well as of its various trade-offs and consequences.

Contextualizing

This paper is part of a larger research project studying the implications of massive HP development in the Indian–Burmese–Chinese border region, where the Eastern Himalaya merge with the Hengduan Mountains of Yunnan, southwest China. This cross-border region has the largest HP generation potential of anywhere in the world. It is characterized by five large international river basins (Yarlung Tsangpo/Brahmaputra, Irrawaddy, Nu/Salween, Lancang/Mekong, and Red River), including two large national catchments in China (Upper Yangtze and Upper Pearl River). Scholarly research on the region's unique HP development has been quite imbalanced thus far. On the one hand, certain river sections (for example the mainstream of the Mekong River) or projects (such as that of Lower Subansiri) have been well and extensively studied. On the other, for the entire region there is currently a fundamental lack of data available — and thus, so far, the region's unique HP development has not been studied in a comparative way. Hennig et al. (2013) provided the first analysis of Yunnan's entire large-scale HP development and additionally was the first to study in depth HP's development in a transnational Chinese basin.

The following sections analyze NE India's HP development and compare it with that of Yunnan. Both regions are now being developed as the major HP hubs in their respective countries. Additionally, they are geographically practically adjacent to each other, while they also share similar physical and ethnocultural commonalities.

Data procurement

The present study is based on the contents of a collected and compiled database, which covers almost 400 large-scale power projects in the broader region of study — namely NE India, Yunnan, Bhutan, and Myanmar. The database can be considered the most comprehensive one that exists for this region. Within this database, there are about 165 HP projects from NE India analyzed. According to national classification schemes, the threshold for what constitutes a large-scale power project is 50 MW in China and 25 MW in India. The present paper further differentiates between existing projects: those currently under construction and those that have only been scheduled thus far. The database includes the following information, available for almost all of the HP projects identified: project name, location, capacity [MW], number of turbines, annual output [Gwh], utilization ratio [%], water head [m], average water flow [m^3/s], HP type, dam size [m], storage/reservoir size [m^3], grid connectivity [kV], year of commission, present/previous owner, and whether the project was CDM-funded or had applied for CDM funding.

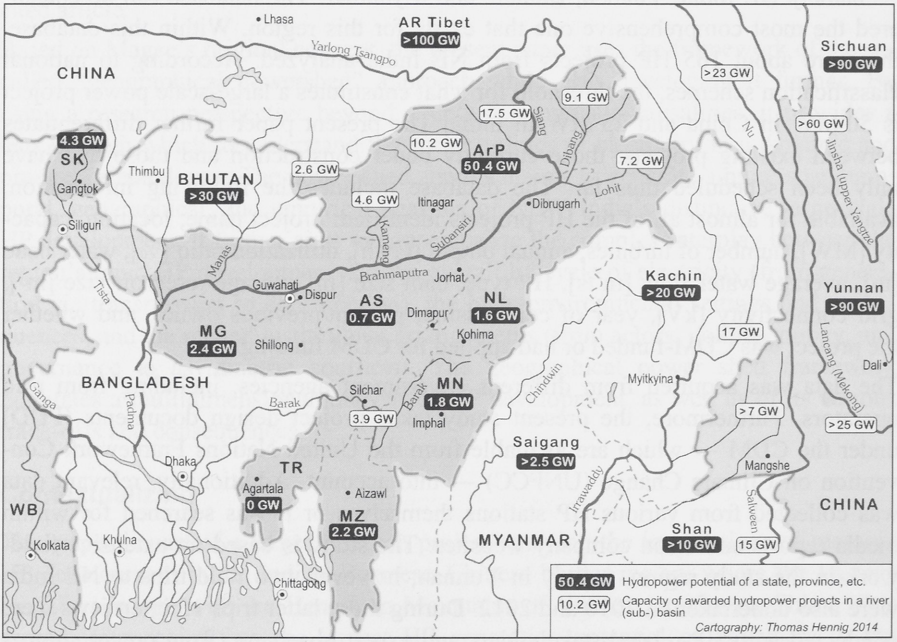
The data was acquired from different government agencies, including from grid operators. Furthermore, the present study takes project design documents (PDD) under the CDM — which are available from the United Nations Framework Convention on Climate Change (UNFCC) — into account. Additionally, relevant data was collected from various HP stations themselves or it was searched for within media reports and/or on company websites. The study is based on extensive fieldwork in the study region, mainly in Yunnan; however, two field trips to NE India were also undertaken in 2010 and 2012. During these latter trips 15 interviews were conducted with HP-related stakeholders and expert observers (from power companies, government departments, academia, and NGOs).

Study region: Northeast India

NE India consists of eight states; seven of them emerged from the erstwhile Assam Province, while Sikkim was appended to that regional assemblage only in 2002. In terms of geographical size NE India is similar to the United Kingdom; however, it has a population of only 46 million people. Geographically it comprises two regions, the densely populated lowlands (mainly the Brahmaputra and Barak basins) and the sparsely populated hills and mountains of the Eastern Himalaya and the Indo–Burmese mountain range. The Northeast counts, as noted, as one of the world's most biodiversity-rich regions (Chatterjee 2008). The rivers draining these mountains have, when considering as well the topography and the climatic setting, one of the largest HP potentials worldwide (see Figure 1).

The term "Northeast" is not simply a geographical characterization, rather it is a politically loaded term that was first used in the 1970s in the context of the reorganization of what was formerly Assam Province (Chowdhuri and Kipgen 2013). Nowadays, India's northeast is labeled as both resource-rich and isolated, underdeveloped, and conflict ridden.

Figure 1: HP Potential in NE India and Adjacent Areas



Source: Author's own map.

With its territory almost entirely encircled (98 percent thereof) by different international states and therefore permanently sequestered on the margins, the Northeast also acts as a vital buffer — mainly against China, but also other Southeast Asian countries beside. In particular, Arunachal Pradesh counts as one of the most geostrategic regions of India. Arunachal's territory is almost entirely claimed by China, and in 1962 both countries fought a border war over it. China has until now not recognized the formalization of the McMahon Line, and it additionally still argues that its representatives were presented with a different version of the area's mapping in 1914. Over the last years China has intensified its territorial claim to the region (for example by blocking an Asian Development Bank credit for India, by issuing stapled visas, and the like). The contested nature of Arunachal's borders also continues to affect the region's HP development.

The complex geopolitical situation of the Northeast lives on in its internal boundaries as well. Today's borders roughly correlate with the "inner line," a demarcation between the Assamese plains and the mountains that the British first established in 1875. Nobody is allowed to cross it without a permit, a requirement still in effect to this day. After independence, when the former East Pakistan (now Bangladesh) broke off from India, the Northeast suddenly became landlocked and almost entirely separated from the Indian mainland. Traditional infrastructure and trade routes were cut off, and the entire region's only remaining access to the rest of India is the narrow Siliguri Corridor. Running between Nepal and Bangladesh, this corridor is only about 22 kilometers wide. Later, it gradually broadens to 42 km wide between Bangladesh and Bhutan.

NE India is home to more than 200 tribal communities, making it the ethnically most diverse region of the entire subcontinent. Since independence, India has struggled to govern the Northeast and has failed to subsume the region and its complex ethnocultural makeup under pan-Indian nation-building initiatives. Instead, the region has slid away into the clasp of the classic center–periphery syndrome. In consequence the Northeast is now marked by sociopolitical complexities, which include a large number of violent struggles for political autonomy or even for outright independence. The central government has identified 79 different armed insurgent groups in the Northeast, but only a handful of these are classified as "terrorist" organizations (Hayes 2012). India's central government has reacted, on the one side, to armed attacks with draconian military measures and, on the other, by establishing a special system of administration (the "Six Schedule" and other constitutional provisions beside). The latter allows certain degrees of autonomy and self-management, including that of natural resources and HP development; however, this is valid only for certain regions and states within the Northeast (Benedikter 2009). Ironically enough, the surge in large-scale HP development alongside other large development projects has become a homogenizing force under the aegis of the Indian nation-state (Chowdhuri and Kipgen 2013).

NE India's energy and HP development

NE India and the energy context

NE India's relatively rich reserves of oil, gas, and coal may not be vast by global standards but they are nevertheless still adequate for helping supply the Indian domestic market. Currently, however, they fulfil only a marginal role therein. This situation was strikingly different prior to India's independence. In Sidrapong, near Darjeeling, India's first HP station was commissioned in 1897. Back in 1867, employees from the colonial Assam Railway and Trading Company (ARTC) discovered crude oil in the upper Brahmaputra Basin. As early as 1901 Asia's second and India's first crude oil refinery was established in Digboi. In the same context and region, in 1881 the ARTC discovered coal near Margherita-Ledo — with the mining of it starting three years later.

Despite its both proven and assumed rich reserves of oil, gas, and coal, NE India's exploitation rate of them is still low these days. The exploration of larger oil and gas fields (for example in the plains of Nagaland or Arunachal) is hindered by ongoing ethnic violence as well as by the region's poor infrastructure and economic performance. Even with its rich HP resources, the Northeast still faces a peak power deficit of 1,000 MW. The region still has by far the lowest installed capacity of all India; in 2013 it was merely 3,790 MW. Of those, about 2,270 MW comes from HP and 1,209 MW from natural gas plants (CEA 2014). The remaining capacity is contributed by diesel and coal (202 MW each) as well as by other renewables (~20 MW). The region's per capita installed capacity (70 W/head) is the lowest in the whole of India (MoP 2012). It is less than half of the Indian average, and only 1 percent of that in adjacent Yunnan.

In contrast to the rest of India, private actors in the Northeast are still irrelevant to the energy sector. This situation may change drastically however with the upcoming HP projects (more on these below). About one-third of the present installed capacity belongs to the relevant generation utilities of the eight states (1,341 MW); all of them have demonstrated financial losses (MoP 2012). The remaining two-thirds of the electricity generated come from entities owned by the central government (2,168 MW). The largest utilities are the: Northeastern Electric Power Corporation (NEEPCO), National Hydropower Corporation (NHPC), and National Thermal Power Corporation (NTPC).

Currently, the prestigious Palatana gas-based project in Tripura (726 MW) — a joint venture between the state-owned ONGC, the Tripura Government, and two private companies — is the largest energy project anywhere in the Northeast. Despite its long-delayed inauguration finally happening in 2013, it is currently still facing technical problems. Another prestigious gas project, the central government-owned Monarchak Plant, was downscaled twice (from 500 MW to now 101 MW) due to problems with subsequent gas delivery. Two small private gas plants in Assam (24 MW) were closed in 2013; they were owned by DLF, one of India's largest real estate companies.

India's "Look East Policy," a campaign first initiated in the 1990s, must also be seen in the context of power and energy development. In particular, Myanmar plays a central role herein. India is currently fairly active in the development of Myanmar's largest offshore oil and gas blocks, as well as in Myanmar's onshore development as well. India also ousted China in the development of the Sittwe deepwater port. Despite this small-scale success, the country has thus far failed in its attempt to build an oil and gas pipeline from Sittwe Port/Shwe Gas Field to the Northeast, and on further to Bangladesh and Kolkata. It is mainly ongoing disputes within the fragile relationship with Bangladesh that have caused related negotiations to collapse. The prestigious Multi-Modal Kaladan Corridor Project is significantly behind schedule as well. It is supposed to connect the ports of eastern India with Sittwe Port, and from there — through a combined riverine and road project — with the state of Mizoram in NE India.

HP policy and its relevance for the Northeast

There is a fundamental difference between India's current HP development and that of the past. In postcolonial India HP projects were part of multipurpose endeavors. HP was often only the method of financing public goods such as large-scale irrigation, flood mitigation, and navigation. The focus was always on the development of river basins (see D'Souza 2008; Briscoe 2005). Today, in postmillennial India, HP should sustain India's energy matrix by offering a rapid increase in additional capacity, while in tandem helping the country to reduce its growth in carbon emissions. Additionally it should serve as a tool for local development in peripheral regions, both by providing electricity and generating large revenues through the exporting of that commodity. Many of NE India's forthcoming HP projects date back to the 1950s, and were originally planned by the central government to be multipurpose dams (including for irrigation, flood control, and so on) with a particular focus on (sub-)basins. Under India's Constitution, water is a state responsibility and its overall governance lies within the jurisdiction of the various state governments. Therefore — mainly to the benefit of states like Arunachal or Sikkim — the earlier plans for multipurpose projects by the public sector were abandoned in favor of single-purpose HP projects overseen by the private sector. Most projects were redesigned as run-of-river ones; only very few of them nowadays still have a significant storage capacity from which downstream areas would also benefit (Choudhury 2010).

In 1998 India's new policy on HP development recognized that the country was achieving on average only about half of its planned goals in this field (Choudury and Ghosh 2013). It identified that finance- and tariff-related issues, technical problems, and sociopolitical circumstances — including difficult land acquisitions and environmental concerns — all cause delays in such projects, as well as compelling the private sector to steer clear of them. The new policy also proposed an easier transfer of statutory clearances from the public to the private sector (Baruah 2012). Despite this gradual liberalization, even as of late 2014 the private sector still occupies a share of less than 5 percent in India's HP portfolio. Karcham Wangtoo (1,000 MW) still remains the country's largest private HP project. In the Northeast, meanwhile, the first private project (99 MW Chuzachen, in Sikkim) was commissioned in 2013.

In 2001 the Central Electricity Authority (CEA) prepared a roadmap for expediting HP. This report ranked about 400 schemes, totaling about 107 GW between them, from the point of view of their attractiveness. The Indian Himalaya were identified as having the largest potential for HP development. The CEA document envisaged for the NE region 168 large and 900 smaller HP schemes. In another step, the government introduced the status of "mega HP projects." Its objective is to substantially bring down tariffs due to reduced levies, taxes, and the like. The threshold for such a megaproject is 500 MW, or 350 MW for peripheral locations like NE India, Jammu, and Kashmir. In yet another step, a three-stage clearance procedure was devised to encourage private entrepreneurs to enter into otherwise high risk HP investments. Stage I culminates in the compiling of a prefeasibility report; Stage II in a detailed project report (including preconstruction activities, infrastructure development, and related land acquisition); and, under Stage III the decision about whether to invest or not is announced after the studying of all the documents. In 2003 the Indian prime minister launched the so-called "50,000 MW hydro initiative" in a landmark move; this encouraged private investments in HP development. Under this scheme, preliminary feasibility reports were prepared for 162 larger projects having a total capacity of 47.9 GW. Out of those, 133 are in the Indian Himalayan Region — mainly in Arunachal Pradesh. Based on these initiatives, the Northeast was finally tagged as India's forthcoming powerhouse.

A strategy report (Rao 2006) by the Indian government emphasized the need for a grand vision for the development of the entire Northeast and for the sharing of the benefits from HP generation, based on a concept of basin development in which all affected states were included. It proposed the constitution of a cohesive, autonomous, and self-contained entity called the Brahmaputra Valley Authority or the NE Water Resource Authority (Baruah 2012). The document was backed by both the Indian prime minister and by the World Bank (2007). The Ministry of Water Resources constituted a related "Inter-Ministerial Group" in 2009. Its mandate is to formulate a suitable framework for sustainable HP development (Vagholikar and Das 2010).

Sikkim, meanwhile, was the first state to spearhead the process of HP liberalization. It invited private actors to participate herein by signing Memoranda of Understanding (MoU) with the state government. Sikkim's example was followed up on by Arunachal. Currently, two of Sikkim's three existing large HP projects belong to the public sector (NHPC). The only existing private HP project in the Northeast was, as noted, commissioned only recently (in 2013). In contrast, with one exception all the other forthcoming projects in Sikkim (either planned or under construction) were awarded to private companies.

In Arunachal Pradesh the first surge of HP allotments started in 2006. As of 2014 the remote state had allocated 153 HP projects, of which 112 were large-scale. Of those, 102 were awarded to private actors (35.1 GW). India's central government originally allocated 22 projects in Arunachal to public sector companies (for example NHPC, NTPC, and NEEPCO), who subsequently prepared detailed project reports for them. Later, the Congress-led state government of Arunachal ignored the attempts of the equally Congress-led Center and awarded 12 of those 22 projects to powerful private actors such as Reliance, Jindal, KSK, and Jaiprakash. Instead of the proposed 30.8 GW, which were formerly allotted to the public sector, it is now developing only 18.4 GW.

In addition, other Himalayan states like Himachal Pradesh and Uttarakhand are now at the forefront of initiatives to sign MoUs with private developers. This policy has had the effect of reducing potentially higher bureaucratic bodies like the mentioned Brahmaputra Valley Authority to now having only a cosmetic function. Historically the performance of India's HP sector vis-à-vis achieving planned targets has been dismal. Over the past 40 years the HP sector has only be able to achieve on average 57.5 percent of its planned goals (Choudhury and Ghosh 2013). Despite the above-described political initiatives to better exploit India's HP potential, the basic principle of not achieving the goals has remained the same throughout. For the NE region, the 11th Five-Year Plan (FYP) (2007–12) targeted a HP generation capacity addition of 1,872 MW — only 531 MW were actually achieved however. The present 12th FYP aims for the NE 4,200 MW (in addition to the remaining 1,341 MW of the 11th FYP); however, under current circumstances only four projects in Sikkim have had the opportunity to be commissioned thus far.

The status quo of HP development in the Northeast

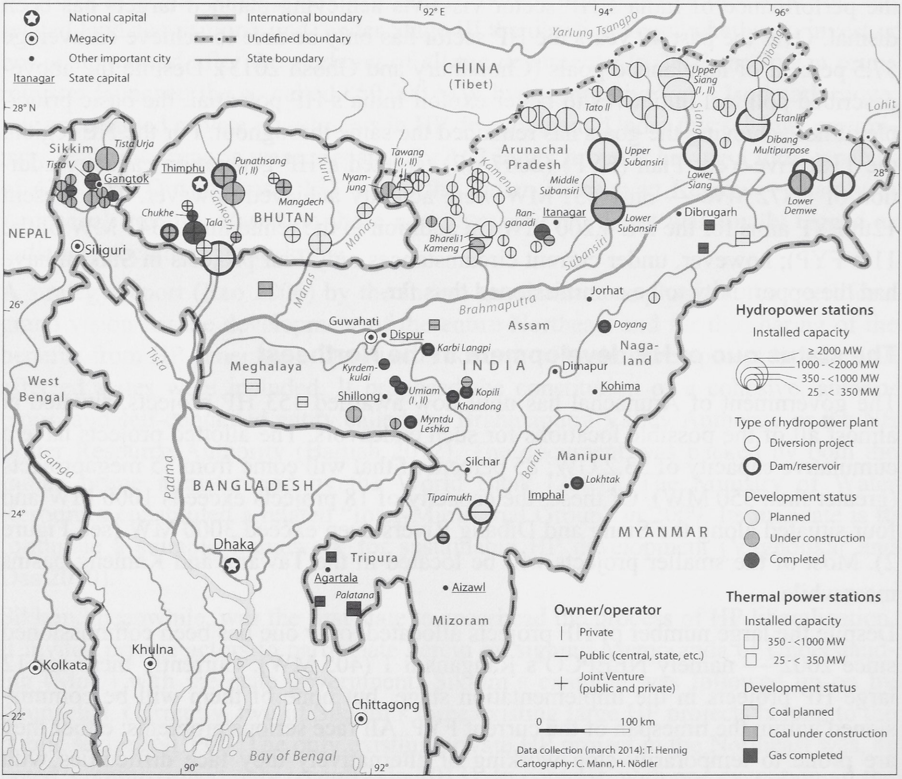
The government of Arunachal has until now awarded 153 HP projects, situated at almost all of the possible locations for such endeavors. The allotted projects have a cumulative capacity of 53.2 GW; 85 percent of that will come from 35 megaprojects (greater than 350 MW). Of these, the capacity of 18 projects exceeds 1000 MW and four situated along the Siang and Dibang Rivers even exceed 3000 MW (see Figure 2). Most of the smaller projects will be located in the Tawang and Kameng basins meanwhile.

Despite the large number of HP projects allocated, only one has been commissioned since 2002 — namely NEEPCO's Ranganadi 1 (405 MW). Currently there are 12 large HP projects in the implementation stage, but none of them will be commissioned within the timespan of the current FYP. All face serious problems; either they are prone to temporarily stop working or alternatively they face difficulties with obtaining final clearances.

The controversial Lower Subansiri Project (2000 MW), sitting along the border between Arunachal and Assam, has become one of the most contested HP projects in India, with it originally scheduled to become operational in 2012. The inadequate environmental clearance and a lack of public hearings caused massive social mobilization against the project, and thus at present its construction is still on hold. It is also a vivid example of a serious interstate conflict related to HP projects between an upper riparian and lower riparian state (Choudhury 2010, 2014). Other HP projects in Arunachal have caused similar tensions, for example those of Lower

Demwe, Nyamchung, and the like. Previously, such serious interstate conflicts in India were only focused on different large irrigation projects (Hennig 2014; Hill 2013). Mediating actors (such as the Group of National Ministers) continue to recommend that Assamese interests should be considered in the decision-making process, as well as in the providing of free and purchasable power from the relevant projects.

Figure 2: Current Status of Northeast India's Large-Scale Power Development and its Actors



Source: Author's own map.

In Arunachal as a whole, a total of 36 different private companies were identified to which all 102 large-scale private HP projects were allotted. Interestingly, about 40 percent of these companies originate from Andhra Pradesh, south India, which was united up until 2014. The companies were categorized into three groups: (i) the first comprises newly established large players in the liberalized Indian power market. These companies (such as Reliance, KSK, Jindal, and Jaiprakash) are often active in the entire energy portfolio, including thermal projects, renewables, and/or transmission. Some of these companies (like Athena) form a consortium through which foreign direct investment flows into a HP project. This group also comprises companies (for example Greenko, REHPL) that focus exclusively on renewable energy production. (ii) The second is formed by EPC (engineering, procurement, and construction) companies that want to move up in their value chain (such as Navayugga, Meenakshi, KVK, DSC, Abir, and Coastal Infrastructure). Many of these companies founded their energy divisions only recently, often in combination with other thermal power projects. In particular, within this group a large number of companies originate from Andhra Pradesh. Despite their prior experience in building dams or of other large infrastructure projects, they lack knowhow in implementing and running HP ones. (iii) The third comprises companies that do not have any specialist relationship to power generation. These can be large and powerful companies from the real estate or finance sectors that view such HP projects only as potential investments offering the option to later sell their shares in them at high profit margins. This group comprises also smaller companies from different fields of endeavor, being businesses that do not have any expertise in the construction or management of power plants. However, in Arunachal they have gained the unique experience of winning projects as developers. Interestingly, so far no project has been realized by this group and many of these companies are now even looking for ways out.

A number of major problems and challenges could be identified when seeking explanations for the limited progress made in NE India's HP development thus far: (i) missing capital and underestimation of the high implementation costs; (ii) challenges in democratic legislation (such as land acquisition problems, environmental and forest clearance issues, resettlement and rehabilitation difficulties, and so on); (iii) difficult to access or even completely inaccessible project sites, due to nonexistent infrastructure and a lack of road connectivity; (iv) technical problems (such as geological surprises, unclear power evacuation responsibilities); and, (v) public agitation against dams (for example in the form of law and order problems; also, interstate tensions between Arunachal as an upper riparian and Assam as a lower riparian state).

All private projects of the Northeast are undertaken as build–operate–transfer projects (BOT) over a concession period ranging between 35 and 40 years. Furthermore, all projects greater than 100 MW are being developed with an equity share of the relevant state government varying between 11 and 26 percent; the relevant state can then either use or sell the acquired electricity. The equity share affects both public and private sector projects. To avoid incurring this share, there are 26 HP projects just below 100 MW. The government of Arunachal follows a double track policy. In the context of smaller projects (less than 100 MW) certain river sections were given to one company, enabling them to construct many HP projects in a line one after the other. In the context of large projects, a maximum of two adjoining projects were awarded to the same company. Both principles differ to the means of HP development in Yunnan and in upper Myanmar.

The role and relevance of CDM

The CDM has emerged in recent years as one of the most important instruments allowing industrialized countries to partially meet their Kyoto Protocol commitments, specifically by funding renewable energy projects — and therefore reducing emissions — in developing and newly industrializing countries (Erlewein and Nuesser 2011). To date (March 2014) the entire Northeast has 42 projects in the CDM pipeline, of which 27 are large HP projects and five are small HP ones. In the context of the study area, the situation is even more striking: all of Sikkim's 10 CDM projects are HP ones while in Arunachal this is true for 18 out of 20 projects. Currently there are six large HP projects in Sikkim already registered, including one small HP one in Assam. All the other projects are still awaiting approval.

Compared to Yunnan's own HP development, four issues are striking when analyzing NE India's CDM-registered HP projects. First, although Yunnan's HP potential is about 50 percent larger than that of the Northeast it also has also five times more HP projects in the CDM pipeline than the latter. Second, all implemented HP projects in the Northeast come from private companies planning to export the electricity to other Indian regions. It actually makes the additionality criteria within the CDM process very critical. Unlike in Yunnan where many state-owned power suppliers are in the CDM pipeline, in India no public sector company has applied to CDM. Third, in contrast to Yunnan the spatial distribution of projects in the Northeast is quite imbalanced: 16 are located in the Kameng-Tawang sub-basins and ten in Sikkim's Teesta basin. Among all other sub-basins there is only one more project in the pipeline, in the Lohit Basin.

The fourth and final issue is NE India's unbalanced company portfolio. All 12 of the Energy Development Company's (EDCL) allotted HP projects in Arunachal are in the CDM pipeline. EDCL is active in small- to medium-sized HP and wind power projects; the company is chaired by Amar Singh, the former general secretary of the Samajwadi Party, who is facing several charges of corruption. Furthermore, all three HP projects in Sikkim belonging to the DANS Group are in the CDM pipeline — two of them are already registered. The other ten HP projects in the CDM pipeline belong to different companies, either to small ones without any power generation experience (like Adishankar) or to big players (like Athena, CESC, and so on). Three of those ten HP projects are very large ones. Athena Ventures is involved in two of these megaprojects: Lower Demwe (1750 MW) and Teesta 3 (1200 MW). Both are very controversial due to their significant environmental impacts. None of NE India's CDM-registered HP projects will support the regional power market; all are built for electricity exports to far away regions of the subcontinent.

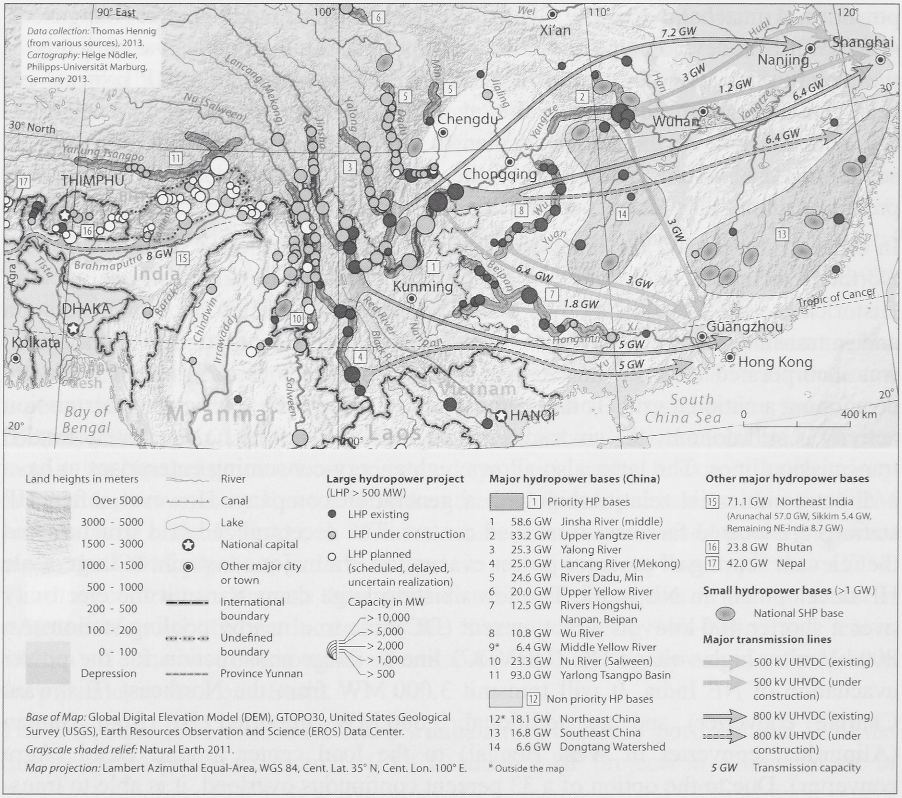
The relevance of power transmission

The Northeast belongs to two of India's six power grid regions (Hennig 2015). Sikkim is part of the Eastern grid, while the remaining seven states belong to the NE Grid. Within the Northeast, NEEPCO is the regional public sector generator of power. In Arunachal, NEEPCO owns the only existing large HP project (Ranganadi, 405 MW). It is developing three further HP projects, with another one currently in the planning stages (combined 1920 MW). All of the other large HP projects are being built to export electricity to the other Indian power regions. Unlike neighboring Yunnan, none of the NE states plan to develop energy-intensive industries — something that would enable use of the electricity locally/regionally, as well as provide regional jobs and/or opportunities for further revenue generation.

In order to understand the dimensions of the forthcoming power transfer from the Northeast to India's mainland, it has to be embedded in a broader historical picture. Historically speaking India's power sector has been state-focused, both in generation and in transmission. In 1991 the (national) Power Grid Corporation of India (PGC) was incorporated to avoid further fragmentation. Since then it has been gradually developing a national grid. Today, almost half of India's present power transmission activity is still done by the six traditional regional grids or by new privately funded transmission lines. The latter also allows high energy-consuming enterprises to have a direct commercial relationship with a generation company. However, often HP stations are located far away from load centers. The decentralized grid structure and the relevant bearing of costs for power evacuation is a major constraint to large-scale HP development in NE India. The few existing large dams transmit the electricity over a shorter 400 kilovolt direct current (DC) line to a nearby pooling station. An 800 kV ultra-high-voltage DC (UHVDC) line is under construction for the power evacuation of NE India. It will transmit 3,000 MW from the Northeast (Bishwant Chariali converter) and an additional 3,000 MW imported HP from Bhutan (Alipurduar converter in West Bengal) to the load center around Delhi (Agra converter). Due to the option of a 33 percent continuous overload, it is able to transmit 8,000 MW — making it one of the largest UHVDC projects anywhere in the world. This long distance bulk transmission project was originally commissioned for 2014/15, but due to the delay of HP projects it was also eventually postponed.

Nevertheless, by 2030 the NE region plans to develop more than 60 GW in HP — including about 25 GW coming from HP imports from Bhutan. In the current geopolitical circumstances, all the electricity (in addition to the forthcoming oil and gas pipelines) will have to pass through the vulnerable and densely populated Siliguri Corridor. The action plan for NE India's HP development discusses up to eight UHVDC lines, which would be a globally unique concentration of this cost-intensive and advanced technology — with only negligible transfer loss. Currently the Chinese provinces of Yunnan and Sichuan are spearheading global UHVDC bulk transmission activities, transporting electricity from HP projects in southwest China to the load centers in the east and south of the country (see Figure 3).

Figure 3: Large-Scale HP and Transmission Development in Southern China and Northeast India



Source: Author's own map (adapted from Hennig et al. 2013).

HP development in the international context

The entire region of NE India drains into the Brahmaputra-Barak/Meghna Basin of Bangladesh, and is therefore international in nature. The transnational Brahmaputra River is called the Siang River on its course through Arunachal and through Yarlung Tsangpo on the Tibetan/Chinese side of the border. Beside that main river, a few other sub-basins of the Brahmaputra originate in China — like the upper courses of the Subansiri, Lohit, and Nyamjanj/Tawang Rivers. Additionally, a few upper rivers of the Indo–Burmese mountain range drain eastward into the Chindwin/Irrawaddy Basin of Myanmar.

Power imports from Bhutan

India, from the beginning a close political ally to Bhutan, has been providing technical and financial support to develop the latter's huge HP resources for a number of years now. Currently about 1488 MW are tapped in joint projects, ones mainly financed by India, drawing criticism from those who see it as a colonial-like behavior of buying loyalty through economic aid. Bhutan still earns more than half of its GDP from its HP sales. By 2020 another 14 projects will be in the pipeline, having a cumulative capacity of 10.3 GW — they are being almost exclusively designed for electricity exports to India. In a second step, after 2020 a further 14.7 GW capacity should be developed out of another 61 joint HP projects.

India takes much pride in what it views as its win-win collaboration with Bhutan so as to generate revenue for the latter while also making available more clean electricity for its own energy-starved and mainly fossil fuel-based energy sector. However certain factors — such as differences over power tariffs, operational aspects, control of assets, and the like — are already creating rifts between the two nations, ones that could easily turn into political conflicts. Additionally, Bhutan's boundary dispute with China remains a crucial matter for India — in particular in the geopolitically sensitive triangle where China could easily strike the so-called "chicken neck." This is also why newly elected Indian Prime Minister Narenda Modi chose tiny Bhutan as his first destination for a foreign visit, in June 2014 (Stobdan 2014; Shah and Giordano 2013).

Power imports from Myanmar

India pursues three major geopolitical interests in Myanmar related to its remote and landlocked Northeast: quelling ethnic militancy along the troubled Indo–Myanmar border; better integrating the peripheral Northeast (for example through the Kaladan Corridor described above); and, increasing its energy and power production so as to be able to meet the now rapidly rising domestic demand. In the context of the latter, the former military junta awarded two large HP projects on the Chindwin River (Irrawaddy tributary) to India's public company NHPC: Tawanthi (1200 MW) and Shwezaye (660 MW), with it intended both would primarily feed into the Indian electricity grid. After long delays, the new Myanmar government scrapped both projects in 2013 — officially due to their related social effects. In contrast, two Chinese HP projects on the same river are still in the pipeline. Unlike the presently halted "Chinese" Myitsone Dam, the cancellation of the two Indian HP projects received no global attention. Furthermore, it is estimated that the Myitsone Dam project will only restart after some modifications and after new elections. Currently, Myanmar's immense HP potential is being almost exclusively developed by various — mostly state-run — Chinese companies. The bulk of generated power will support the Chinese grid.

Competing HP development with China along the Brahmaputra/Yarlung Tsangpo

Not only the mainstream of the Brahmaputra (Siang/Yarlung Tsangpo) itself, but also some of the tributaries thereof are of an international character. Despite impressive plans to exploit the HP potential, the basin remains almost untapped at present. The mainstream holds about half of the basin's potential and is therefore of special geopolitical relevance. China and India, as the largest HP developers, do not share a bilateral water treaty (unlike the Indus Water Treaty between India and Pakistan); they have thus far only agreed to limited flood season data sharing (May to October) and to cooperation in disaster management.

In relation to the massive proposed HP development on both sites, India argues on the basis of the doctrine of prior appropriation — under which priority rights fall to the first user of the river (cp. Hennig 2011). Therefore India's national government tries to push fast-track dam building on the transnational rivers of the basin, mainly the Siang. Thus, it tries to establish its "lower riparian right" and create a strong bargaining position to detract China from its proposed upstream large-scale dam building plans. India is mainly opposed to the proposed megaproject on the Namcha Barwa Gorge. Furthermore, in 2012 China started construction on the first four large dams along the main course of the Yarlung Tsangpo. Consequently, the Nu/Salween remained China's only undammed large river. China's further HP development on other large (adjacent) streams is gradually moving upstream (mainly along the Mekong and upper Yangtze), where it will finally merge with the transmission corridors of the Yarlung Tsangpo.

China recently announced plans to develop the world's largest HP station along the great bend of the Yarlung Tsangpo (Namcha Barwa Gorge), plans which have already been around for a long time. The proposed project will have an installed capacity double that of the Three Gorges Dam. It is discussed as two alternatives: Motuo (38 GW) and Daduqia (43.8 GW). Both are run-of-river types, and do not include a major storage dam (Hennig 2014). However, they fan serious concerns on the Indian side about China being a water hegemon. These fears are mainly fostered due to ongoing discussions about a possible river diversion toward the Huang He and toward northwest China. These plans, given current economic conditions, are not viable. They would be an extension of the ongoing large-scale diversion of water from the Yangtze toward the Huang He (Hennig 2014). Alarmed by China's fast and efficient implementation of large HP and water diversion projects, India recently started several initiatives to expedite its own long-planned but languishing HP projects. For instance in 2013 it established an empowered group of ministers, with them having powers equal to those of the Union Cabinet. One objective, among others, herein is to give "utmost priority" to strategic projects and to ensure that all relevant clearances are given them.

In recent decades China has formally demarcated all 13 of its land borders — with the exception being the frontier between China and India. India still hopes that China will agree to settle the territorial dispute in Arunachal as a result of its own willingness to give up claims to Aksai Chin in Ladakh, and it hopes that Beijing will recognize Arunachal's McMahon Line — just as China once accepted Tibet's British-drawn boundaries with Afghanistan and then Burma (Malik 2007).

In particular, the Tawang region seems to be nonnegotiable for China. This sticking point has to be seen in the context of Tawang Monastery. China claims that it is central to Tibetan Buddhism; others argue that it may be crucial for the choice of the next Dalai Lama and China wants to control this decision. In the context of China's claim, HP development in the Tawang region (3,000 MW) is relatively advanced: 15 HP projects were allotted so far, with two of them belonging to the national NHPC. Some of these projects have met with opposition on the grounds of their environmental impact as well as their negative implications for the respecting of Tibetan Buddhist beliefs.

Conclusion

Compared to other important HP regions around the world, NE India's own HP development is less exposed to the effects of climate change (such as vulnerabilities in HP potential due to modified hydrological regimes). Of much greater threat are the complex geopolitical and structural issues tied up in that peripheral and disputed border region. The transnational Brahmaputra Basin is the lifeline for all the peoples and ethnic groups of the relevant states. The basin is also a matter of national security, and the utilization of its waters is of special geopolitical relevance. In particular, the dispute over the river between India and China seems to be pushing both states toward a new phase in their already complicated relationship. Yet, China has as of now not signed any comprehensive water treaty with its South Asian neighbor that would serve to regulate water distribution.

The future tapping of all of NE India's vast HP resources is viewed very critically. In addition to major problems and challenges like public agitation against dams, inaccessible project sites, and land acquisition problems, the following limitations to further development have been hardly addressed officially to date: The proposed electricity is not needed in the region itself, and therefore has to be exported via long-distance bulk transmission projects, like UHVDC lines, to load centers. These lines all have to run through the politically sensitive Siliguri Corridor, making transmissions extremely vulnerable to disruption.

Also the sharp fall in certified emission reduction prices and the uncertainties about the general future of CDM post-2015 will additionally decrease the value of investments, in particular those of companies who do not have any HP expertise. It is further assumed that mostly projects backed by major players (established (hydro)power companies) will be developed, alongside those large projects that are of geostrategic importance to India's position downstream relative to China.

Due to the transnational nature of the Brahmaputra Basin, a shift from sovereign, state-focused HP development to an integrated international watershed approach is now seen as necessary. However, achieving this implies having a clearly demarcated border and the political sensitivities of the entire watershed having been recognized. The concept should be based on a transboundary, basin-wide roadmap for energy and HP development (power shed), one that is less oriented toward quantitative but more toward qualitative growth. The concerns of downstream countries should be taken more seriously both in China and in India. The authorities should not focus simply on quantitative targets (like increasing installed capacity), particularly if the region has a large surplus of hydroelectricity and produces primarily for the long-distance export market. Instead, they should rather focus on the problematic aspects of the HP development process — like minimizing negative environmental impacts (especially in/around protected areas, safeguarding a guaranteed water flow), reducing any negative social effects on local communities (including those in downstream basins), and improving public participation and/or ensuring better coordination if the project affects the border/border river areas (for example through information and data sharing or convening public hearings that ensure that strategic — and not just operational — issues are discussed). Consequently cross-compliance with environmental directives should be made obligatory, as should effective environmental monitoring. Due to significant seasonal fluctuations, in particular cascaded HP development should benefit more from upstream water regulation and reservoirs.

Northeast India's large-scale HP development is part of a global renaissance of significant HP generation. Therefore, such endeavors are ultimately a broad reflection of the different aspects and discourses of global change — such as finding a balance between economic growth and related interests, the preservation of the environment, the reduction of carbon emissions, political and economic viability, technical and political feasibility, as well as social acceptance and fit. Thus, HP development should be politically planned and scientifically analyzed in its trade-offs and linkages vis-à-vis another crucial aspect of global change: the water–energy–food–environment nexus. This should include better coordination between HP development and agricultural activities (mainly irrigation), forest protection (such as regional stewardship of nature reserves and biodiversity, improved water retention, reduced soil erosion, and the like), as well as environmental and social safeguarding. The focus on the nexus approach should be also reflected in academic research, including through case studies that analyze (for example on a sub-basin level) those trade-offs and linkages between HP development and the water–energy–food–environment nexus. By pursuing this research, relevant data and strategic trends may become of greater public interest and therefore also contribute to the emergence also of better overall transparency.

References

Baghel, R.; Nuesser, M. (2010): "Discussing Large Dams in Asia after the World Commission on Dams. Is a Political Ecology Approach the Way Forward?", in: *Water Alternatives*, 3, 2: 231–248

Baruah, S. (2012): "Whose River is it Anyway? Political Economy of Hydropower in the Eastern Himalayas", in: *Economic and Political Weekly*, XLVII, 29: 41–52

Benedikter, T. (ed.) (2009): *Solving Ethnic Conflict through Self-Government. A Short Guide to Autonomy in South Asia and Europe*. Bolzano: EUR.AC research

British Petrol (BP) (2014): *BP Statistical Review of World Energy 2014*. London: BP

Briscoe, J. (2005): *India's Water Economy. Bracing for a Turbulent Future*. Washington, D.C.: World Bank (WB Report 34750–IN)

Brown, A.; Müller, S.; Dobrotková, Z. (2011): *Renewable Energy Markets and Prospects by Technology*. Paris: IEA

Bryant, R.; Bailey, S. (1996): *Third World Political Ecology. An Introduction*. New York: Routledge

Central Electricity Authority of India (CEA) (2014): "Central Electricity Authority of India", www.cea.nic.in (accessed: 2014-09-16)

— (2002): *Preliminary Ranking of Hydropower Schemes*. New Delhi: CEA

Chatterjee, S. (2008): "Biodiversity Conservation Issues of Northeast India?", in: International Forestry Review, 10, 2: 315–324, doi: 10.1505/ifor.10.2.315

Choudhury, N. (2014): "Legality and Legitimacy of Public Involvement in Infrastructure Planning. Observations from Hydropower Projects in India", in: *Journal of Environmental Planning and Management*, 57, 2: 297–315, doi: 10.1080/09640568.2012.743879

— (2010): *Sustainable Dam Development in India. Between Global Norms and Local Practices*. Bonn: German Development Institute (Discussion Paper, 10)

Chowdhury, A. R.; Kipgen, N. (2013): "Deluge Amidst Conflict. Hydropower Development and Displacement in the Northeast Region of India", in: *Progress in Development Studies*, 13, 3: 195–208, doi: 10.1177/1464993413486545

Choudhury, N.; Ghosh, A. (2013): *Responsible Hydropower Development in India. Challenges for the future*. New Delhi: Council on Energy, Environment and Water (CEEW Working Paper, 5)

Cooper, R. V. (2010): "Promoting and Contesting Hydropower Development. Actors and Narratives in the Lower Mekong Basin's Hydropolitical Constellation", PhD dis., University of Newcastle upon Tyne

D'Souza, R. (2008): "Framing India's Hydraulic Crisis. The Politics of the Modern Large Dam", in: *Monthly Review*, 60, 3: 112–124

Galipeau, B. A.; Ingman, M.; Tilt, B. (2013): "Dam-Induced Displacement and Agricultural Livelihoods in China's Mekong Basin", in: *Human Ecology*, 41, 3: 437–446

Grumbine, R. E.; Xu, J. (2011): "Mekong Hydropower Development", in: *Science*, 332, 6026: 178–179

Grumbine, R. E.; Pandit, M. K. (2013): "Threats from Indian Himalaya Dams", in: *Science*, 339, 6115: 36–37

Erlewein, A. (2013): "Disappearing Rivers. The Limits of Environmental Assessment for Hydropower in India", in: *Environmental Impact Assessment*, 43: 135–143, doi: 10.1016/j.eiar.2013.07.002

Erlewein, A.; Nüsser, M. (2011): "Offsetting Greenhouse Gas Emissions in the Himalaya? Clean Development Dams in Himachal Pradesh, India", in: *Mountain Research and Development*, 31, 4: 293–304

Hayes, B. (2012): "The Other Burma? Conflict, Counter-insurgency and Human Rights in Northeast India", www.tni.org/files/download/theotherburma-webspreads.pdf (accessed: 2014-12-18)

Hennig, T. (2015): "Indiens großer Energiehunger. Der Energiesektor des Subkontinents zwischen hochambitioniertem Ausbau, Fragilität und Reformstau? in: *Geographische Rundschau*, 67, 1

—. (2014): "Yunnan. Ein globaler Hydropower-Hotspot. Chinas ambitionierter Hydroenergie-Ausbau zwischen Kleinwasserkraft und Megastaudämmen", in: Marburger Geographische Gesellschaft (ed.): *Jahrbuch 2013*. Marburg: Selbstverlag, 109–129

— (2013): "Trends, Probleme, Herausforderungen in Indiens Energiesektor", in: Lennartz et al. (eds.): *Aktuelle Forschungsbeiträge zu Südasien* (= Geographien Südasien 1), http://archiv.ub.uni-heidelberg.de/savifadok/2870/ (accessed: 2014-12-18), 23–26

— (2011): "Damming China and India. An Overview Over Challenges and Implications of the Rapid Hydropower Development", in: Samadi-Boroujeni, H. (ed.): *Hydropower. Practice and Application*. Rijeka: Intech Publ., 293–320

Hennig, T.; Wang, W.; Ou, X.; He, D. (2013): "Review of Yunnan's Hydropower Development. Comparing Small and Large Hydropower Projects Regarding Environmental Implications and Socio-economic Consequences", in: *Renewable and Sustainable Energy Review*, 27: 585–595, doi: 10.1016/j.rser.2013.07.023

Hill, P.D. (2013): "Trans-boundary Water Resources and Uneven Development. Crisis Within and Beyond Contemporary India, South Asia", in: *Journal of South Asian Studies*, 36, 2: 243–257

International Hydropower Association (IHA) (2013): *IHA2013 Hydropower Report*. London: IHA

Katus, S. (2012): "Where Local Power Meets Hydropower. Conceptualizing Resettlement Along the Nam Gnouang River in Lao PDR", PhD dis., University of Amsterdam

Kibler, K. M.; Tullos, D. D. (2013): "Cumulative Biophysical Impact of Small and Large Hydropower Development in Nu River, China", in: *Water Resources Research*, 49: 1–15, doi: 10.1002/wrcr.20243

Magee, D. (2006): "Powershed Politics. Yunnan Hydropower Under Great Western Development", in: *The China Quarterly*, 185: 23–41

Malik, M. (2007): "India–China Competition Revealed on Ongoing Border Disputes", Power and Interest News Report (PINR)

Ministry of Power, Government of India (MoP) (2012): "Report of the Working Group on Power for the 12th Plan, 2012–17", Report, Delhi, planningcommission.nic.in/aboutus/committee/wrkgrp12/wg_power1904.pdf (accessed: 2013-05-22)

Molle, F.; Foran, T.; Käkönen, M. (eds.) (2009): *Contested Waterscapes in the Mekong Region. Hydropower, Livelihoods and Governance*. London: Earthscan

Morgan, K. B.; Sardelic, D. N.; Waretini, A. F. (2012): "The Three Gorges Project. How sustainable?" in: *Journal of Hydrology*, 460/461: 1–12, doi: 10.1016/j.jhydrol.2012.05.008

Nilsson, C.; Reidy, C. A.; Dynesius, M.; Revenga, C. (2005): "Fragmentation and Flow Regulation of the World's Large River Systems", in: *Science*, 308: 405–408

Nilsson, C.; Berggren, K. (2000): "Alterations of Riparian Ecosystems Resulting from River Regulation", in: *BioScience*, 50: 783–792

Rao, V. V. K. (2006): "Hydropower in the Northeast. Potential and Harnessing Analysis", Background Paper 6, http://mdoner.gov.in/writereaddata/sublink3images/69706470684.pdf (accessed: 2012-12-18)

REN21 (2012): "Renewables 2012", Global Status Report, Paris: REN21 Secretariat

Rosenberg, M.; Berkes, F.; Bodaly, A.; Hecky, E.; Kelly, A.; Rudd, W. (1997): "Large-scale Impacts of Hydroelectric Development", in: *Environmental Reviews*, 5, 1: 27–54

Shah, T.; Giordano, M. (2013): "Himalayan Water Security. A South Asian Perspective", in: *Asia Policy*, 16, 1: 26–31

Sharma, N. K.; Tiwari, P. K.; Sood, Y. R. (2013): "A Comprehensive Analysis of Strategies, Policies and Development of Hydropower in India. Special Emphasis on Small Hydropower", in: *Renewable and Sustainable Energy Reviews*, 18: 460–470, doi: 10.1016/j.rser.2012.10.017

Sneddon, C.; Fox, C. (2006): "Rethinking Transboundary Waters. A Critical hydropolitics of the Mekong basin", in: *Political Geography*, 25: 181–202, doi: 10.1016/j.polgeo.2005.11.002

Sternberg, R. (2010): "Hydropower's Future, the Environment, and the Global Electricity Systems", in: *Renewable and Sustainable Energy Reviews*, 14, 2: 723–733

Stobdan, P. (2014): "India and Bhutan. The Strategic Imperative", New Delhi: IDSA (IDSA Occasional Paper, 36)

Svensson, J. (2012): "Managing the Rise of a Hydro-hegemon in Asia. China's Strategic Interests in the Yarlung-Tsangpo River", New Delhi: IDSA (IDSA Occasional Paper, 23)

UNEP Risoe Centre (2013): "CDM Pipeline Overview", cdmpipeline.org (accessed: 2013-08-22)

Vagholikar, N.; Das, P.J. (2010): "Damming NE-India. Juggernaut of Hydropower Projects threatens Social and Environmental Security of Region", Pune: Kalpavriksh, Aaranyak and ActionAid

World Commission on Dams (WCD) (2000): *Dams and Development. A New Framework for Decision-making. World Commission on Dams*. London: Earthscan