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Sustainability suspense of small hydropower projects: A study from western Himalayan region of India

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ABSTRACT

Small hydropower projects (SHPs), though generally considered more environmentally benign and socially acceptable as compared to large projects, yet their overall sustainability is under suspicion in the Himalayan regions. Almost all SHPs in this region are being developed as run of the river mode which generally causes less/no submergence and quite less displacement of people as compared to large reservoir based hydropower production mode. However, in the absence of proper planning and monitoring mechanism, these projects are causing implacable tunnelling of hills, choking of streams, conversion of streams into dry ditches and long term socio-environmental impacts. This paper presents a SHP development study from hydro rich Beas river basin of Himachal Pradesh, a state nestled in western Himalayan region of India. In depth field studies, focus group discussions with the project affected people and interaction with project proponents of five SHPs in this region suggest that sustainability issues with respect to SHPs are not small vis-a-vis size of their installed capacity. There is an urgent need to take steps to include SHPs having an installed capacity of above 10 MW into the ambit of environment clearance process which is absent in many countries of the world at present.

1. Introduction

In many parts of the world, large and medium reservoir based hydropower projects have been in the line of fire for their multiple, large scale socio-economic and environmental impacts such as submergence due to formation of reservoir, displacement of native people and emission of greenhouse gases [1–4]. Hence, the focus is now on construction and development of small hydropower projects (SHPs). It is the form of renewable energy technology which is considered to be mature, economically viable, having long life (50 years or more), highly efficient (70–90%), largely carbon free, robust, flexible, having an attractive energy pay back ratio, easy to install, more publically acceptable and suitable for sensitive mountain ecology particularly in run of the river (RoR) mode [5–8]. In view of these advantages, SHPs have become a peferred mode of power production all over the world in general and Himalayan countries in particular [9–14].

Global small hydropower potential is about 173 GW. The installed small hydropower capacity (up to 10 MW) is estimated to be 75 GW in 2011/2012. Southern Asia (Afghanistan, Bangladesh, Bhutan, India, Iran, Nepal, Pakistan and Sri Lanka) has the small hydropower potential estimated at 18,077 MW (for plants up to 10 MW), of which 3563 MW has been developed. China ranks first in terms of an installed hydropower capacity of 249 GW. In this installed capacity, contribution of small hydropower is significant; with 45,000 stations nationwide and 65 GW installed capacity [15]. In India, hydropower projects having installed capacity >2 MW but ≤25 MW are categorised and named as SHPs. Out of identified small hydropower potential of 19749 MW in India, cumulative installed capacity of 3803.65 MW was installed till 31st May, 2014 [16].

SHPs are important renewable energy source across the globe. Besides underdeveloped and developing countries, in many developed countries (like USA, Australia and Germany), this mode of power generation is expected to be the main source of future growth in hydro electricity generation as most of favourable large hydropower project sites have been already developed [17–19]. Current status of small hydropower development in different countries of the world in terms of planning, development and management has been reviewed in the Table 1. From the table, it is clear that in many countries of the world (e.g. Germany and Turkey), with the adoption of Water Framework Directive (WFD), non-sustainable development of SHPs is not possible.

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Table 1
Current status of small hydropower development in different countries.

Author(s)	Country	Major points with respect to planning, development and management of small hydropower projects
Xingang et al. [20], Chang et al. [21]	China	• China must accelerate the SHPs according to local conditions and take benefit of Clean Development Mechanism (CDM) incentives in order to realise the sustainable development of economy, environment and society. • Building of healthy investment and operation environment is also crucial.
Kosnik [22]	USA	• Streamlining of regulatory process especially catering to SHPs will go a long way towards improving the incentives for small hydropower development. • Site accessibility, transmission and load proximity, and land use sensitivities are main three factors affecting the feasibility of SHPs.
Bahadori et al. [18]	Australia	• SHPs are potentially viable on smaller rivers and streams where large dams are not technically feasible or environmentally acceptable. • SHPs have low water requirement, lower environmental footprint and less development cost.
Spänhoff [19]	Germany	• Stringent norms given by Water Framework Directive (WFD) for protection, enhancement and restoration of streams and rivers are not conducive for development of hydropower plants (even SHPs) in most of European Union nations including Germany.
Kaldellis [23], Malesios and Arabatzis [24]	Greece	• Despite the interest of private investors, growth of SHPs is Greece is not up to expectation mainly due to decision making problems, like the administrative bureaucracy, absence of a rational water resources management plan and over-sizing of existing/proposed installation. • Employment opportunities, socio-economic factors, reasonable rate of small hydropower, publicising the environmental friendliness are important factors to get wider support of local communities for SHPs.
Dursun and Gokcol [25], Kucukali [26]	Turkey	• Site geology and environmental issues are the key risk factors for the success of a SHP project. • Turkish government has taken various measures to attract investors in this largely uptapped sector (like assured buying of electricity, large discount for forest and land acquisition to build SHPs etc.). • With the adoption of WFD, non-sustainable development of SHPs will not be possible.
Martins et al. [27]	Brazil	• CDM may foster investment in SHPs, increasing their financial attractiveness, and drawing the attention of energy sector investors. • In the Brazilian context of SHP project implementation, the CDM might still be considered a time consuming, complex, and bureaucratic mechanism, requiring patience, objectivity and persistence from the project proponents.
Sharma et al. [5], Nautiyal et al. [28]	India	• Involvement of the local communities and direct livelihood benefits to them are essential for the long-term sustainability of the small hydro schemes. However, assessing the local impacts and attributing the benefits to the SHPs is especially a difficult task in case of already grid connected villages. • Central and state governments in India are providing various incentives for development of SHPs.

The focus area of present study is western Indian Himalayan Region (IHR). The states in this region are blessed with good hydropower potential and they are striving hard for fast development of hydropower projects in their respective territories. Many authors in the past had studied environmental and social impacts of hydropower projects in this region for example Sharma et al. [13], Sinclair and Diduck [29], Lata et al. [30], Arjjumend [31], Slariya [32] and Sinclair [33]. However, most of the studies had focussed on large projects. The studies which had been reported with respect to small scale projects have chosen either a single SHP or 2-3 mini projects. There is dearth of studies with respect to multiple small hydropower projects (having capacity > 2 MW and ≤25 MW). This article is an attempt to fill this gap by undertaking study of 5 SHPs from the same river basin.

Present study is primarily aimed at assessing the sustainability of SHPs in the western IHR. Large number of SHPs are presently under different stages of development in this region. However, in the absence of proper planning and monitoring, flouting of norms by developers and ever increasing public rage, sustainability of SHPs in this region is under suspicion [12,34]. Main objectives of the study are (i) to review the factors affecting sustainability of SHPs in the Himalayan region from environmental, social and economic perspectives and (ii) to undertake a case study involving 5 SHPs in the Beas river basin of Himachal Pradesh (India), a hydropower rich state in western Himalayan region of India and (iii) to know and put on record stakeholders' (mainly project affected people and project proponents) perception about SHPs by undertaking focus group discussions and interviews.

2. Sustainability of SHPs

SHPs often carry the tags such as 'sustainable', 'green', 'environment friendly' with them [8,11,35]. These tags have been attributed to the fact that most of these projects are run of the river type. That means a small or no reservoir is constructed for operation of this type of projects. Generally a small dam of small height (up to 5 m height) or a trench weir is constructed for diversion of water. The water after being used for generation of electricity returns back to the same stream on downstream side. In other words, there is no consumption of water for generation of electricity. SHPs are also of interest under the Clean Development Mechanism (CDM) because they directly displace greenhouse gas emissions while contributing to sustainable rural development [36]. Due to so called “sustainability” of small hydro projects, this type of projects has been exempted from environment clearance, environment management plan and public hearing in many countries (including India) no matter how severe their impacts maybe [37,38].

In order to make early profits and generation of revenue, small hydropower projects are now being allotted/coming up even on those streams in Himalayan regions which sustain livelihoods of remotely located poor communities. Large scale development of these projects, disturb the fragile and bio-diverse rich ecosystems of these regions in numerous ways.

Though almost all Himalayan states have formulated hydropower policies for development of small hydropower projects yet the implementation part is very poor. Due to lack of proper planning, inspection and monitoring, many factors have cropped up which are targeting all the three well known aspects of sustainability i.e. environmental, social and economic.

2.1. Environmental sustainability of SHPs

With the increase in awareness about environment, special emphasis is being imparted to this aspect of sustainability by the regulating and funding agencies. Inadequate environmental flow,