

Environmental Impact Assessment of Hydro Power Development - A Critical Review

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Abstract— Environmental Impact Assessment (EIA) has been regarded as both a ‘science and art’ reflecting the concern both with technical aspects of appraisal and the effects of EIA upon the decision making process (Kennedy, 1984). This paper reviews EIA of hydro power projects for the past five decades with emphasis on adoption of a holistic planning approach for development of river basin and stresses the need of giving importance to the basics of engineering, environment and economics. This paper gives stress on the practice of EIA being followed in respect with river valley project development in India and stresses the need of carrying out studies related to river basin management, carrying capacity and cumulative environmental impact assessment through an independent proposed Regional Environment Authority (REA) for the north east region of India which has many micro, mini, small and mega hydro power projects proposed in the mountainous rivers and rivulets spread over several river basins across the geographic boundary limit of states and join the river Brahmaputra in Assam. The river during its course flows through India and Bangladesh before culminating in the Bay of Bengal. Over the past five decades in India, we have looked upon the river valley projects from the perspective of individual project and development of the project area as a general routine outcome. Little or no attention has been given upon the overall impact on the river basin. The prime focus have been energy and revenue but now with the receding and depleting water resources and increasing future water requirement to meet the peak demand of all the projects operating simultaneously in the same river basin, there is a need to review the hydro power plan with a holistic approach and with relative to the comprehensive cumulative environment impact assessment of river basins carried out by proposed setup of REA for sustainable development of the entire region. Unplanned power generating system failure will lead to water grabbing and disputes, investment wastage on uncertainty and unsustainable development, justifying overuse as also misuse.

Index Terms— CEIA, Uncertainty, Scoping, River Basin.

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I. INTRODUCTION

EIA is defined as a systematic identification and evaluation of the potential impacts or effects of proposed projects, plans, programs and legislative actions, relative to the physical, chemical, biological, cultural and socio-economic components of the total environment (Canter, 1996). The primary purpose of EIA is to encourage the consideration of the environment in the process of planning and decision making and to ultimately arrive at actions which are more environmental compatible. National Environmental Policy Act (NEPA, 1969) which became effective on January 1st, 1970 signalled the importance of environment and is referred as “Magna Carta” for the environment in the United States of America, (CEQ, 1993a). Since inception of NEPA, EIA a procedure for assessing the environmental implications of a decision to enact legislation, to implement policies and plans to initiate development projects, has become a widely accepted tool in environment management (Wathern, 1986). Moving ahead, United States has formulated legislation giving dimension to land use planning, which has come up a long way in acting as a protective shield for environment and has shown the path to all the countries across the globe to conceive the idea and adopt some approach in having a legislation of some form for the protection of environment in the interest of mankind. The intent of having an “Act”, reflects a thought process, a serious concern for environment and a determination to develop various approach to find compatible measures towards its protection, having a regulatory requirement before the project proponents, a policy for decision makers to think, propose, review and implement regulatory guidelines with a distinct approach to each project and development considering all possible implications arising from physical, chemical, biological, geographical, cultural and socio-economic components.

II. ORIGIN OF ENVIRONMENTAL CONCERN IN INDIA

India has an ancient civilization with settlement on the banks of rivers and sustenance on nature. Human beings had been driven by their basic needs, had little or no money but fresh air, water and food was available in abundance for all the population with self regulatory and sustainable nature. Ancestors used the natural resources judiciously which have been inherited by us and are presently being utilized to its maximum capacity. With the passage of time, increasing population, green revolution, development driven by industrialisation, shrinking land area and depleting natural resources, the country had to seriously think towards protection and prevention of its nature, wildlife, forest and environment in the larger interest of mankind. In June 1972, the then Prime Minister of India, Late (Smt.) Indira Gandhi gave a speech on preservation of nature at the UN Conference

on “Human Environment” held at Stockholm which was unanimously agreed by all the participating countries to take appropriate steps to preserve and safeguard the natural resources of the earth. In consonance with this decision, India began enacting various environmental laws starting with “The Wildlife (Protection) Act 1972” and “The Water (Prevention and Control of Pollution) Act 1974”. Thereafter “The Constitution (42nd Amendment) Act of 1976” explicitly incorporated environmental protection and improvement. Then Article 48A was added to the directive “Principles of State Policy” declaring “the states to protect and improve the environment and to safeguard the forest and wildlife of the country”. Further Article 51A (g) gave “fundamental duties and responsibilities” on every citizen to protect and improve the natural environment including forest, lakes, rivers, wildlife and have compassion for all living creatures. Strengthening further Article 21 of the Indian Constitution protected the “Right to Life” as a fundamental right which is the freedom of “Right to Live” (i.e. pure air to breathe, palatable water and sufficient food with human dignity), encompassing within the ambit of protection and preservation of the environment. Understanding the importance of water and its need for development and growth, the government brought another law “The Water (Prevention and Control of Pollution) Cess Act 1977 which gave the right to use the water for development purpose but at a cost. The government vowed to protect its animals and forest and in doing so enacted “The Wildlife (Protection) Act 1972” and “The Forest (Conservation) Act 1980”. The Government of India established “Department of Environment” in 1980 which became Ministry of Environment and Forest in 1985. This ministry looks on all environment and forest related issues from the concept stage to initiation, implementation, monitoring, policy frameworks, laws & regulations. However, land use planning is still neither integrated with environment nor a part of Ministry. The industrial growth during the decade forced the government to come out with another regulatory framework and a law on “The Air (Prevention and Control of Pollution) Act 1981” was made. The Bhopal gas accident changed the situation and several laws were passed covering newer and broader areas such as ‘The Environment (Protection) Act 1986’, vehicular and noise pollution, hazardous waste management and handling rules, EIA and solid waste management.

III. HYDROPOWER DEVELOPMENT IN NORTH EAST INDIA

The north east region of India is poised for river valley development for harnessing of hydro power for which the area has a potential of approximately 50000+ MW. The basins and catchment of these rivers and rivulets are spread across the Indian states of Assam, Arunachal Pradesh, Manipur, Nagaland, Tripura, Meghalaya, Mizoram and beyond the national boundary in Bhutan, Myanmar and China (Tibet). Past and present practice of EIA has focussed only at the project level and the onus of getting the EIA carried out has been with the project proponent limiting the significance of EIA to the level of mere project clearance and as a report for regulatory compliance with an action plan on mitigation measure, safeguards and monitoring. Thus, overlooking the broader aspects of EIA for river basin development, regional planning and thereby denying justice to nature self regulatory system. Unlike before, now development of project should

not be formulated in isolation but with a holistic approach of comprehensive river basin plan for sustainable development must be adopted. Cumulative Environmental Impact Assessment (CEIA) is the answer for basin wise development in the region as the study will detail on the basin vulnerability due to multiple projects, ecosystem, effect on local weather and climate due to cumulative evaporation effect from all the pondage, adverse effect on the hydrological flow regime, base flows reduced to environmental flow or even to zero flow during season of peak demand, unpredictable flash flood and flood severity. Further river valley projects involve use of water which is also a depleting resource with time and in conditions when multiple projects start their generation in the same river basin, the capacity of any project to meet peak demand may be compromised by other peak load projects. This unplanned power generation system failure leads to water grabbing and disputes, investment wastage on uncertainty and unsustainable development will take place justifying over use as also misuse. Further, the CEIA studies carried out for each basin must be extended to region beyond the geographical boundary of states and should be integrated in the developmental plan of the region with a clear conceptual approach from generation to evacuation in one hand and preserving the ecosystem, environmental safeguards, water management and flood control on the other. It is suggested that the CEIA and carrying capacity study for river basins must be carried out and integrated with regional developmental plan of the entire north east India and it should be within the scope of REA, an independent authorized body which is essential to be established in the region and should be funded by central government as illustrated in Figure: 1. The ambit of this body should not be limited only to all regional environmental study, programmes, policies and recommendations for clearances of projects, but extend beyond to regulate effective management of inter basin and interstate environment and development issues including water management of rivers and for operational projects, thus monitoring, managing and ensuring compliance in interest of nature. The paper is also underlining the conventional practice adopted by the project proponent on project development with development of project area as only a resultant general outcome. Few key trends and issues pertaining to weakness in theory and practice of EIA have been identified with focus on development of the entire region. Most legislated EIA processes refer cumulative effect as one of the characteristic of proposed activity that need to be considered but in practice they are often not addressed or are handled inadequately (Duinker and Greig, 2006) (Gunn and Noble, 2011) (Morgan, 2012). There is also a need to focus on understanding the broad drivers of regional change and influences on the environment. Regional landscape change is often the result of interaction between complex factors such as population, economics, cultural values, policy, science and technology (Seabrook et al, 2006) (Gunn J.H, and Noble B. F, 2009)

IV. ISSUES INVOLVED WITH EIA

Environment legislations are seen by many as a tool against development, which is a concept grossly misunderstood. The law establishes policies on environment to guide the activities of government departments whose action have the power to affect people, communities, animal life and the natural

environment by large in significant ways and was a response to a rise in scientific and popular concern about contemporary environmental changes taking place. There are number of problems and issues involved and associated in the enforcement of environmental laws and we cannot look at environment by keeping them aside. The fact of growing population, illiteracy, ignorance, economic reasons, religious customs, culture, inadequate laws and survival needs of a nation have all to be given due consideration. On the international arena there is growing concern on issues of climatic change, deforestation, depleting quality and quantity of fresh water and natural resources, GHG emissions, eutrophication, ozone depletion, warfare and all these have some relation with environment impact felt by many in most countries across the globe. In India, EIA has emerged as a specialised, inter-disciplinary subject, generated considerable controversy, stimulated the development of new technical, scientific and administrative skills, established itself, gained acceptance in all the sectors, among people, administrators and judiciary at large justifying its own achievement in the process of development. It is to be understood that the environmental systems are dynamic and is constantly changing with time even without human influence. Environmental issues rarely form the sole basis for any decision related to the implementation of developing projects. The country may perceive a pressing need for economic development for the under developed and developing states which is the need for job creation and revenue generation, overriding considerations despite consequent environmental degradations but it must never be assumed that development and protection of environment quality are conflicting. There are several states within the country which have developed hydro power projects with envisaged potential varying between 1 MW to 1500 MW and are operational on perennial rivers and there are lessons learnt from the failure and developmental approach followed. Past experience compel us to look ahead by adopting a holistic regional approach to ensure better plan, technically improved, resource optimised and sustainable hydro power development in the region. Promising results can be achieved by eliminating uncertainties which is obtained by integrating the CEIA for the entire north east region of India with the planning of hydro power development within the region. CEIA will provide mitigation measures with wide variety of solutions for changes identified during EIA which can be incorporated more economically at design stage, there by arriving at solutions which are defined, certain, understood, assured and taken care off. This in the longer run will reduce uncertainty, time and cost, natural and financial risk which is important for any project proponent, financial institutions and the government. Uncertainty is unavoidable in EIA prediction of hydroelectric projects due to reasons of limited access to information about input data and the assumptions underlying predictions by the decision makers. More emphasis should be given to improving the communication of uncertainty in EIA prediction and to making the prediction processes more transparent in order to improve EIA as a decision - aiding tool (Aud Tennoy, et al. 2006). In any hydro power project, the impacts could be primary, secondary, tertiary and unforeseen. For example, without adequate mitigating measures, construction of a dam on a river will prevent the upward movement of migratory fish, which is a direct impact on fish population as they thrive best in turbulent stream flow, which

increases the oxygen content at a particular temperature and maintains their survival rate. Further, impounding structure will bring change in the natural yearly flood cycles of the river which adversely affects aquatic life for which they are not acclimatized. High velocity discharge hardens the river bed due to erosive action of sudden water release, resulting in loss of aquatic habitat in downstream. Sediment deposition increases in upstream thereby restricting the movement of nutrition to downstream aquatic life. EIA can be an aid to design if it is made an integral component of project formulation for which the idea was originally conceived.

V. EIA A TOOL FOR PROJECT DEVELOPMENT

EIA is described as a process for identifying the likely consequences for the bio-geophysical environment and for human health and welfare of implementing particular activities and for conveying this information, at a stage when it can materially affect their decision to those responsible for sanctioning the proposals (Munn ,1979) (Davies and Muller 1983), defended for extending the definition to cover socio economic effects to provide a unified appraisal and this is a statutory requirement adopted for EIA in India. The greatest contribution of EIA to environmental management is in reducing adverse impacts before the project proposals come through the authorization phase. Apart from being a tool of project management, EIA is equally applicable at other levels of planning, assessing legislations, programmes and policies. EIA directives, requires project proponent to highlight areas of uncertainty by indicating technical deficiencies or lack of know-how encountered in compiling information included in an environment assessment (CEC, 1985). EIA is a mandatory regulatory requirement for project clearance in India for any major river valley hydroelectric project. However, EIA is still not an integral component of central or state planning process with respect to land use and resource utilisation. Major river valley projects are being executed by the state and central government undertakings, which are either centrally funded or funded by the World Bank which has clear policies and procedures laid down for environmental and social safeguard. However, of late it is seen that major project developers are shifting to other financial institutions which also have similar requirements of environmental and social assessment and they also ensure that the applicant provide an EIA report with respect to their project. The intent, initiatives are positive and important as they increase the proportion of major development projects being subjected to EIA and social assessment but the task lies in maintaining greater consistency on how these funded projects are scrutinized and future risk associated with assessment minimised. Without adequate safeguards, proponent may be tempted to regard EIA simply as a means of obtaining project clearance and present only those results which show proposals in a favour of light. Further, not all the projects have to undergo EIA, the developmental projects which cross the threshold limit are considered to have significant impact of some magnitude and thus have to carry out EIA involving a careful, through and detailed analysis of the likely implications. Based on the threshold of significance, regulatory agencies have drawn up a list of projects which could categorically be exempted from EIA. However, this should only be done if study of CEIA for the river basin or the region within which the exempted projects are located have been done, for the reasons that

impact due to a single project may be completely different from the cumulative impact of multiple project under operation on the same river basin. EIA guidelines for large-scale hydropower in Pakistan under the National Impact Assessment Programme (NIAP) has detailed on the hydro-power resources, policy, EIA process, addressed environmental and social issues and has also underlined the need for carrying out CEIA studies including river basin and transboundary impacts. A part of guideline states – “Although not formally required in EIA regulations, cumulative impacts of hydropower are increasingly being considered as an essential part of best practice in impact assessment. A cumulative impact assessment (CIA) may be prepared as a stand-alone document or as a section within the main EIA. The IFC good practice handbook of CIA and management recognizes that CIA is evolving and that there is no single accepted state of global practice.” (Meynell, Peter-John and Nazia Zakir, 2014) The World Bank has also prepared specific guidelines for assessing the CEIA of hydropower projects for application in Turkey. (World Bank, 2012)

VI. RECENT DEVELOPMENTS IN EIA

Over the years, the researchers in their quest for having as close as possible a realistic precise result, have focussed on climate change effect, uncertainty minimisation, public concern, socio economic study, health and disaster risk reduction components including mitigation measure for smooth post operational and within controlled conditions of environmental reconstruction. Socio economic impact assessment (SIA) is now a part of EIA which reflects the socio economic conditions of project affected people in context to their land being acquired, lively hood shift, rehabilitation, resettlement, relief for standing crops, people living below the poverty line, marginalised family, endangered tribal communities, tradition, customs, culture and thus predicting their economic status with respect to project setup and giving them their required due with consideration as their fundamental right to get with dignity in lieu of what they give in the larger interest of nation. Regulatory requirement in India takes SIA as a part of EIA, whereas it is obligatory on part of proponent by funding agency like World Bank for all river valley projects to have a SIA carried out separately as per laid down procedure of bank which is in the larger interest of economic growth of the region. Experience with one of the World Bank aided project gave opportunity to understand the ethics, core value and scrutiny system being adopted by the bank which gave satisfaction, assurance and financial security to the project affected people. These processes may be diluted by financial institutions who are more focussed only on lending and payback, for whom all other are checklist requirement rather than a core ethical value in the larger interest of growth and this may lead to creation of a sense of dissatisfaction, insecurity and unease among project affected people and their aspirations which needs serious attention and is a concern. The initiative of World Health Organisation (WHO) gave importance towards Environmental Health Impact Assessment (EHIA) to assess the public health implication and has become important for developing projects which have proven results of affecting the health of people. Disaster Risk Assessment or Risk Assessment (RA) is of late gaining importance due to the fact of several catastrophic incidences of cloud burst and earthquakes that have taken

place. Experience and study relate cloud burst as a natural phenomena, which takes place in the nature especially in the mountainous region since evolution of earth to balance its own atmospheric condition, thereby leading to heavy downpour for a couple of hours. Similarly, earthquake is also a natural phenomenon since evolution of earth and takes place due to plate tectonic movement within the earth crust. These phenomena do not take place due to hydro power projects. The nature by itself is dynamic, evolving, accumulating, and self sustaining, balancing, assimilating and regulating an ever self healing approach. Risk assessment is used frequently to assess the probability and likely consequences of a particular catastrophic event. The assessments are highly numeric appraisals, essentially statistical analyses of likely events based upon certain probabilities of occurrence. In the past, cost benefit analysis was the main consideration of decision makers to ensure that the economic benefits accruing from development exceeds the cost. However integrating EIA has helped in assessing the multiplier effect at the project level, local level and regional level by inclusion as remedial measures for pollution control (Nijkamp, 1980).

VII. EIA AND DECISION MAKING

The structure of an EIA process is developed and depends primarily by the need to accommodate each of the key issues. The nature and practicality of EIA varies at various levels. Uncertainty in the process is cleared on the basis of clarification between data generation and impact feedback over a period of time. Development of a region having the potential of energy generation through hydro power projects in the river valley system should be first integrated in the National Development Policy and a CEIA carried out for the region which should be centric to natural resource availability and people. Thus proposal to build a hydroelectric project must be set within the context of the policies concerned with future energy supply strategies and the programmes with plans devised to implement them. Similarly, it is seen that major developmental project proposals often have such profound implications that they dictate the course of future policy. It is pertinent to mention that an additional tier between developmental plans and projects in order to accommodate strategic development which effect change and this has been well reflected by (Lee and Wood, 1978), at least regional level sector tier must be introduced (Foster, 1984). Hence it is clear that the objective of EIA is not to force decision makers to adopt the least environmentally damaging alternative but to seek a balance between competing demands of any development, environmental protection, social, economic factor and future resource availability. It is seen that most of the EIA studies in respect of hydro power projects, are made on the basis of data made available to them on engineering aspects, concentrate extensively on socio-economic and give a generalised elaboration on fishery, physical, chemical and biological quality aspect of water, soil, air, forest cover with details of species related to terrestrial flora and fauna, but little is mentioned on aquatic life. The EIA reports rarely substantiate on future availability of required quantity of water for which the project is being designed and potential envisaged. For this, it is pertinent that river basin and inter basin studies be carried out along with the carrying capacity of river and basin thereof, relative to which conformity of the projects under consideration be

judged and this is depicted in Figure. 2. Further, in the event of scarcity of water in any particular year, how the water needs is to be managed for all the operating hydroelectric projects insuring no generation loss to the proponents till the period for which they are designed. Development does not mean looking at a project in singularity but having a well conceived backup plan to be operational if need arises and need is bound to arise when multiple projects are operational simultaneously to generate at their full capacity which is reflected from experience of other states. Berube Michel (2007) has conducted CEIA studies of twelve projects at Hydro Quebec since 1999 wherein he has described the problems encountered, solutions found with detailed past baseline description and has stressed upon its requirement by law in several developed countries like Canada, USA and European Nations. In India, the concept of conducting CEIA exercise had not been considered earlier for any hydropower projects due to dire basic developmental needs of developing states and limited projects being given regulatory clearance. However, there is a growing concern within the government on this issue and attention for formulating approach for carrying out CEIA studies is being considered.

VIII. EIA THEORY, PRACTICE AND METHODOLOGY

EIA studies for hydropower plants in Trentino (Italy) has developed an analysis that, starting from the distinctive elements of the environmental sites, projects and EIA studies, recognizes the similarity in data structure by specific index and multivariate statistical tools (Daini Paolo, 2000). Technology has advanced, there are many models available that focus on wide range of parameters considering parameters known or observed to the best of knowledge of the researcher and their results on the basis of the quality and depth of data available. Theory and field based knowledge of practice are still the best teachers and research should be an integrated composite outcome of both and in doing so the fundamental principle of nature comprising of science, art and economics may be adhered to the extent possible. All research must have a value added to it in the present day context and when we study EIA or CEIA and do not quantify it with a value then justification is not justified. Richardson, (2005) cautions against simply looking for new theories or models that may not be there, instead, practitioners should use the stimulus of the theoretical debate to develop their own actions, based on critical and ethical reflection. There is a significant gap between the best practice thinking represented in the research and practice literature and application of EIA on the ground, the resulting practice inertia provides a real challenge to the EIA community as the consequences of poor practice leading to delays, poor decisions, increased costs to proponents tend to be blamed on the EIA process rather than on the practitioners themselves (Morgan, 2012).

Scoping is defined as an early exercise of EIA in which an attempt is made to identify the attributes of components of the environment for which there is public concern upon which EIA should be focussed (Beanlands and Duinker, 1983). Recognizing the need, it is important to establish a focal point for any assessment in the beginning. Over looking it, limits the probability of obtaining useful and realistic results. In India, the primary concern of the public with respect to environment is health, food and financial security. All the other rank below this for any proposed development. It is

important to conduct pre-project scientific studies for engineering, environment and socio-economic and present them for decision making process. This should form the basis of approach to be adopted during and post construction phase for measuring the qualitative and quantitative changes. Simple methods applied for impact identification range from matrices, networks and checklists.

Environmental setting or baseline study is the most commonly recognized and yet the least understood element of EIA (Wither, 1986). There is no universally accepted definition for baseline. Walsh (1983) in his dissertation has recorded more than 15 formal definitions of the term. In general, it is taken to refer to a description of some aspect of the physical, chemical, biological, ecological and social environment which could be affected by the project development. Here the drawback is that the people involved in preparing EIA focus on information and data which are readily available rather than on what data is needed. The concept of base line study as statistical characterization of the state of physical, chemical and biological is limited (Beanlands, 1983).

Environmental Index is a numerical concept of a large quantity of data. By indexing, proper summarization is done for a quantum of data making it easier for evaluation of vulnerability, pollution levels, forecasting – age groups, birth rate, gender differentiation, mortality, displacement and several others. Indexing can also be relative to something, for example, existing water quality to standard water quality or existing emission to standard emission. Assessment and prediction of impacts is done for air, surface water, ground water, soil, noise, environment and biological impact, social, cultural, socioeconomic and public participation. Multi attribute utility theory in EIA has been applied for major power projects (Keeney and Robilliard, 1977) (Kirkwood, 1982). An important feature which distinguishes it from all other EIA methods is the ability to deal with the probability that the likely hood of occurrence of specific levels of environment attributes. Environment systems consist of a complex web of inter related parts, often incorporating feedback loops. No matter how intricate and intellectually satisfying the mathematics involved, it is difficult to characterize system level impacts by considering changes in specific components in isolation and then aggregating the results.

IX. UNCERTAINTY IN EIA

Uncertainties in EIA play a vital role in the planning and decision making processes for major development projects. The reason for uncertainty could be that EIA's are mainly concerned with expected events and phenomena, while problems associated with any project are likely to come from unexpected quarters or events of low probability. Also that the EIA's are conducted for individual projects and it is beyond their scope to understand long term planning and risk concern relative to river basin. Further EIA's are poor in communicating uncertainties because the report sounds more certain than what is actually justified. Canter (1983) reviewing the current status and future direction of EIA points to development and appropriate usage of more scientifically defensible impact prediction techniques, including those that yield a range of predictions and associated probabilities for

those prediction to occur. Minimisation of uncertainty can be done by concentrating on research. All predictive methods involve some model of the environment, mathematical, physical or conceptual. Uncertainties arise because these models cannot exactly reproduce what happens in reality. Errors can also lead to uncertainty and attempts can be made to reduce known errors but detecting an unknown error is a finding, ignorance is also an error. De Jongh (1985b) opines that the researchers and scientists face difficulties in defining the assumptions upon which their method are based and hence, those involved in EIA require training in the explicit handling of uncertainty. Decision analysis deals explicitly with uncertainty. Hobbs (1985) explored the use of an amalgamation method for EIA and recommended that the prudent course for those who use amalgamation for any purpose is to check assumptions. Scoping and public participation are the procedural answers for resolving uncertainty in EIA (CEQ, 1978, 1982) (ERL, 1981). Negotiations, mediations and strategic choice approach are the EIA process oriented solutions to this type of uncertainty. On one hand management of uncertainty is a very old component of our lives, everyone takes decisions daily and in doing so manages uncertainty, but on the other hand for specific field of environmental management it is a new area of concern (De Jongh, 1985a).

CONCLUSION

EIA is an important instrument for assessment of developmental activities through methods which generate information to identify, analyze, evaluate and give mitigation measures at the project level indicating the quality of the environment before, during and after the proposed developmental activity. However, it suffers from the limitation, of being undertaken at the project level only with a limited scope of study. A better approach could be carrying out CEIA incorporating river basin planning integrated with hydro power development plan for the entire region. It should be undertaken at the policy and planning level and integrated with land use and resource availability. CEIA of basin reflect a broader framework of analytical and planning approaches to assess multiple projects with multiple activities at various levels accumulated over time and space over differentiated temporal and spatial attributes. This will contribute to regional planning, optimised land use, threshold indicator analysis, linear programming which are generally not included in any EIA study. Further, the CEIA study will account for cross boundary inter basin study at the same scale and movement between different level and scale from project to basin, basin to inter basin, inter basin to regional and regional to national level and is illustrated in Figure. 3. The study will elaborate on functional effects of environmental flows, water flows, energy flows, nutrient cycle, succession with controlling approaches on assimilation, carrying capacity, threshold and other changes related to climatic, river flow regime, triggers, time orientation, structure on population shift, habitat modification, air, water, and soil quality with respect to effects on cross boundary flows, fragmentation and space crowding. The need for EIA assessment from a wider perspective by carrying out CEIA is to have a better assessment of the carrying capacity of the rivers and basins for a planned predictive development. It is essential to consider EIA within planning at the level of

national economy. In the long run and for the planned development of the north east region of India, it is essential for the government to establish REA, empowered and funded by central government to oversee regional environmental issues, programmes, policies and recommend for clearances of projects after ensuring its conformity, relative with the river basin CEIA and carrying capacity. The scope of REA must be to see but not limited to effective environment planning for holistic developmental solution provider for all the regional states including management of inter basin and interstate environment and issues pertaining to water management of rivers and for operational projects, thus monitoring, co-ordinating with effective management and ensuring compliance in interest of nature towards sustainable development. REA at its level and within defined boundary must get CEIA and carrying capacity done to the magnitude for optimum utilisation for growth, for all the basins and integrate with land use to develop a regional master plan and review energy potential as per present and future resource availability, maintain integrity of basin wise data and ensure that a holistic approach is adopted in the process of hydro power development by mitigating uncertainty and threat to downstream. The task is enormous and the work is a challenge and good quality development cannot take place by running away from realities. It is important to understand that the natural environment which determines the development potential of any country or region and hence the environmental quality, natural resource reserve and structured ecological system should define the limits of planning freedom, within which the development of a region or country should take place. Moulding the environment to the present and future needs of society must take place within a predefined space whose essential component is the natural environment. Hence, in addition to project level EIA, it is essential to look from the perspective of CEIA at basin level for hydropower development within the entire north east region to ensure that quality development is done with quantified economic growth and optimum resource utilisation.

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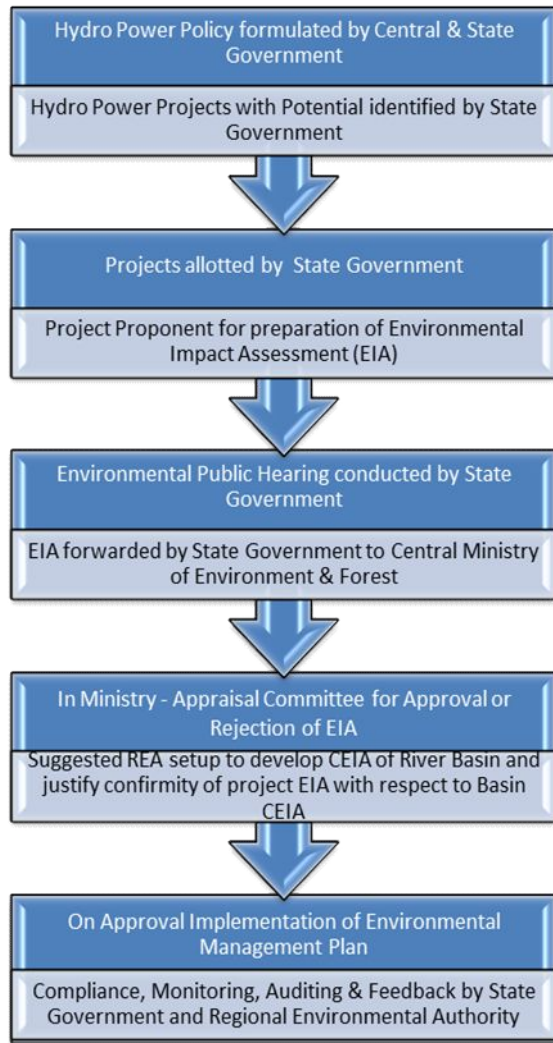


Figure:1. Flow diagram of existing EIA clearance process for hydro power projects and suggested river basin CEIA under ambit of proposed REA
(Source : Prepared by Roy, Bharti & Prasad)

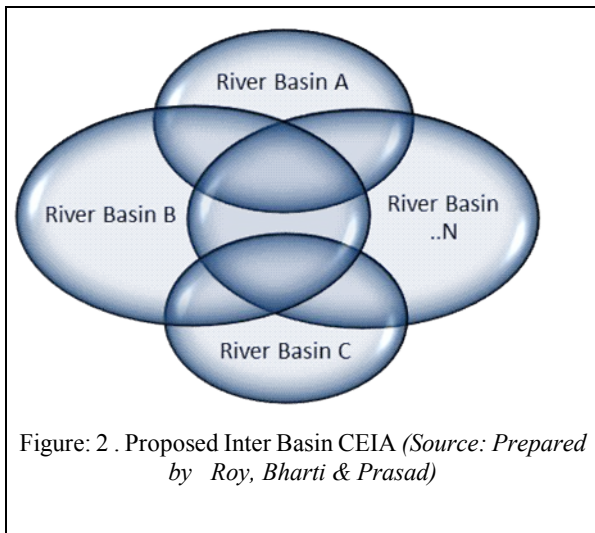


Figure: 2 . Proposed Inter Basin CEIA (Source: Prepared by Roy, Bharti & Prasad)

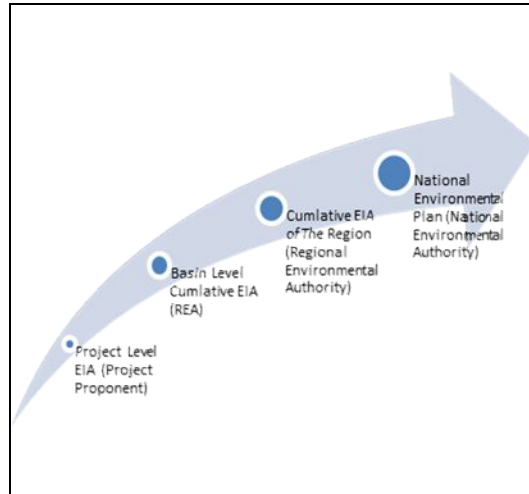


Figure:3. Approach of EIA clearance structure from project to national level with a need for establishment of REA and NEA. (Source : Prepared by Roy, Bharti & Prasad)

Abbreviations

- EIA Environmental Impact Assessment
- CEIA Cumulative Environmental Impact Assessment
- REA Regional Environmental Authority
- NEA National Environmental Authority
- UNEP United Nations Environment Programme
- IUCN International Union for Conservation of Nature and Natural Resources