

Environmental and Social Impact Assessment (ESIA) of Surrounding Area of Rooppur Nuclear Power Plant Project: A Case Study of Ishwardi Upazila in Bangladesh

Ritu Saha^{a*}, Nowshin Rahman^a, Farhana Tanvin^a, MD. Sakawat Hossain^a

*Corresponding author's Email: ritusaha.pust.bd@gmail.com

^a BURP, Department of Urban & Regional Planning, Pabna University of Science and Technology, Pabna-6600, Bangladesh

Abstract

Bangladesh started its nuclear journey on 02 October 2013 with the inauguration of the first phase of Rooppur Nuclear Power Plant construction. The main purpose of the study is to find out the impacts of Rooppur Nuclear Power plant on the environment, social economy and socio-cultural elements at surrounding areas of the proposed site. Field observations, household surveys, FGD, key informant interviews, daily newspapers, google engine, journal articles, reports, and other relevant sources were used to collect the data. To fulfill the objective of the study, environmental impact value (EIV) tool was applied. After observing and calculating all the components, authors were found positive impact on socio-economic impact (+198) and negative impacts on environmental parameters (-65) and socio-cultural parameters (-130). Finally, the project's total score (+3) indicates the project has a moderately positive impact on the social economy and environment and suggests that the project is acceptable. The significant positive impacts of the Rooppur nuclear power plant will be industrial and infrastructural development, economic growth, employment creation, knowledge transfer, river excavation, tree plantation, no greenhouse gas emission if the project follows national and international laws and legislation, a proper environmental management plan, strong cyber security, and free from any corruption or illegal activities.

Keywords: Economic Growth; ESIA; Power Generation; RNPP; Environmental Impact Value (EIV)

1. Introduction

Bangladesh is working to address its power shortage to secure the country's economic progress and people's well-being. In recent years, the nation has become entirely reliant on gas-based electricity production. Without a single question, gas is a favored fuel choice from an environmental standpoint, but the supply is limited. Bangladesh's 2010 Power System Master Plan targets 24,000MWe by 2021 and 39,000MWe electricity by 2030, using various energy sources including gas, coal, liquid fuel, renewable resources, and nuclear also (Platonov, 2016). To meet up the rising power demand, the government of Bangladesh has taken an initiative to proceed towards nuclear-based power generation. The Rooppur Nuclear Power Plant project is the first and largest project in the history of Bangladesh. The Environmental and Social Impact Assessment (ESIA) process involves forecasting and analyzing the possible environmental and social implications of a proposed project, evaluating alternatives, and developing suitable mitigation, management, and monitoring measures (Business Biodiversity and Offsets Programme (BBOP) Glossary, 2012). This tool is designed to assess the project's

effect on the surrounding environment and determine whether or not the project's impacts are ecologically and socially acceptable. On November 30, 2017, Bangladesh started a journey of its first nuclear reactor at Rooppur in Pabna district and now it would be completed by 2024 (The Financial Express, 2018).

The study's main objective is to find out the impacts of Rooppur Nuclear Power plant on the environment and social economy as well as socio-cultural elements at surrounding areas of the site. This paper also seeks to calculate environmental impact values to identify the severity of the impacts in the study area. Existing and potential impacts (positive or negative) and their consequences are necessary to select further policies to be established afterwards of this project. Any detail study on the environmental impacts of the project cannot be found and social impact study is totally absent. Only a few literatures were carried out that describe some of the potential positive and negative environmental impacts after the construction of the Rooppur nuclear power plant. Mollah et al. made a comparison on present power generation practices of Bangladesh and RNPP where Power will be generated by the fissioning uranium not the burning fuels, also reduce the greenhouse gas emission and atmospheric pollution. But it has catastrophic risks due to the risk of overheated fuel releasing huge amounts of fission products into the environment and nuclear weapons proliferation, which will result in an unforeseen nuclear holocaust (A. S. Mollah, S. Sattar, A. Hossain, Md A. Z. Salahuddin, M. S. H. Khan, 2016). Siddiky I. A. states that Bangladesh is not quite prepared for nuclear power generation due to a lack of technical and regulatory experience and resources (Siddiky, 2015). There will be serious concerns about safety issues in the surrounding areas of the RNPP site due to the unsuitability of the site, the obsolescence of the VVER model, weak financing arrangements, nuclear waste disposal, terror attacks, overpopulation, and natural disasters such as earthquakes and climate change (Laskar, 2015). These all reasons work behind the selection of the study.

2. Materials & Methods

2.1. Study Area Profile

Ishwardi is one of the Upazilas in the district of Pabna under Rajshahi division, Bangladesh. Rooppur Nuclear Power plant situated on the bank of Padma River at Rooppur in Ishwardi Upazila in the northwest of the country. The project site is located between $24^{\circ} 4' 0''$ North latitude and $89^{\circ} 2' 50''$ East longitude (Bangladesh National Portal, 2017). The study area conducted in 3km diameter circle area at RNPP site. Zhautola, Railway officer 's colony, Paksey Babupara, MS colony, Marin para, Paper mill colony, Fisherman colony, Notun Rooppur, Chor Shahapur, Shahapur, Pakuria and Pilot para are covered the study area.

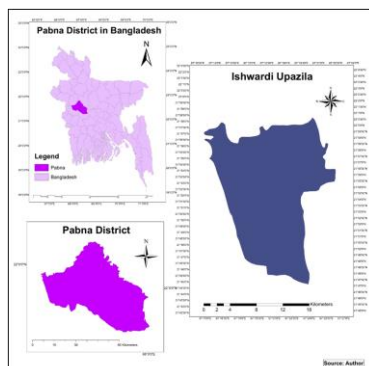
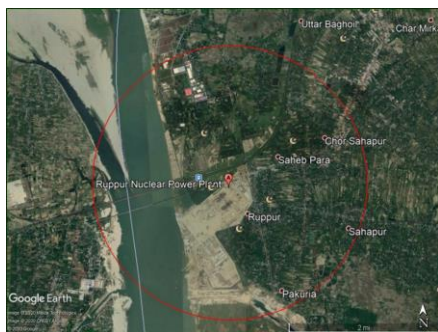


Fig. 1. Ishwardi Upazila in context of Bangladesh



Source: Google Earth Pro, 2020

Fig. 2. 3Km diameter circle area from RNPP Site

2.2. Sample Size determination

This study area is conducted two union under Ishwardi Upazila: Paksey and Sahapur. Paksey union is covered Railway officer's colony, Paper mill colony and Notun Rooppur area and covers Zhautola, Paksey Babupara, MS colony, Marin para, Fisherman colony, Chor Shahapur, Pakuria and Pilot para are included in Sahapur union. Total population of Paksey union is 34664 and Sahapur union is 41489 in 2019 (The Bangladesh Network, 2020). So, total population in the study area is 76153. The sample size is determined by the following equation. (Kabir, 2016):

$$n = \frac{Z^2 \sigma N}{(N - 1)e^2 + Z^2 \sigma}$$

Here, N= Total number of households= 76153;

n= Size of sample;

e= Acceptable error =0.05;

σ = Standard deviation of population= 0.53;

Z= Standard normal variate at a given confidence level = 1.96;

By using the equation, the total same size is 422 (approximately)

2.3 Data Collection

Field observations, household surveys, FGD, and key informant interviews were used to obtain primary data. Office personnel, informed local residents, including community members, merchants, teachers, and political leaders, were questioned to ascertain their perceptions of the project's social and environmental consequences. 3 km circular area at surrounding Rooppur Nuclear Power Plant is selected as the study area for this research. Secondary data were collected from different sources such as web browsing, daily newspapers, official documents, journal articles, photos, reports and so on.

2.3 Data Processing and Analysis

Environmental impact value (EIV) are estimated and calculated in Microsoft Excel spreadsheet by the equation as follows (Willson, 1998):

$$EIV = \sum_{i=1}^n (Vi)Wi$$

Where,

EIV = Environmental Impact Value

Vi =Relative change of the environmental quality of parameters

Wi =Relative importance or weight or parameter

N=total number of environmental parameters.

Impact assessed based on changes of environmental and social parameters was evaluated assigning score ranging from 0 to 5 for both positive (+) and negative (-) impacts. Changes of environmental parameters are considered as

- (a) Severe (+5 or -5);
- (b) Higher (+4 or -4);
- (c) Moderate (+3 or -3);
- (d) Low (+2 or -2);
- (e) Very Low (+1 or -1);
- (f) No change (0).

3. Results and Discussion

The Environmental Impact Value (EIV), which is an actual value of environmental consequences, is used to assess whether an activity positively or negatively impacts the environment. Similar methodology also found in the environmental assessment of Boga Bridge at Patuakhali and Automatic Brick Manufacturing Project at Lebukhali Dumki in Patuakhali (A. Parvez, M. T. Islam, M. Islam, M. F. Haque and M. R. Ahmed, 2018; M. H. Islam, M. Faisal and K. A. Mahmood, 2015). In this paper, EIV was analyzed based on three parameters: environmental parameters, socio-economic parameters, and socio-cultural parameters. This study's relative importance value and relative impact were measured based on respondents' perceptions on change of any components or condition. defined either in the caption or in a legend provided as part of the figure.

Table 1. Estimation of Environmental Impact Value (EIV)

Components	Relative value	importance	Degree of impact	Relative impact	Individual EIV
Environmental Parameters					
Water quality	15		-2	-30	-65
Aquatic ecosystem	15		-3	-45	
Sound Pollution	2		-1	-2	
Rise of temperature	4		-1	-4	
Forest	8		0	0	
Plantation	3		+1	3	

Vegetation Cover	8	-4	-32	
Greenhouse emission	15	+5	75	
Particulate matter	4	-2	-8	
Regional ecosystem Change	8	-2	-16	
Aquaculture	10	-3	-30	
River Excavation	8	+3	24	
Socio-Economic Parameters				
Power Generation	18	+5	90	
Economic development	18	+4	72	
Loss of land	10	-2	-20	
Land use change	10	-3	-30	+198
Land Price	5	-2	-10	
Current use of lands/ resources	8	-3	-24	
Infrastructure development	15	+3	45	
Employment	15	+5	75	
Socio-Cultural Parameters				
Migration	20	-4	-80	
Language	8	0	0	
Religion	7	0	0	
Public Health	10	-2	-20	
Culture	10	0	0	
Community build up	10	-4	-40	-130
Social-well being	12	-3	-36	
Cultural heritage	6	0	0	
Knowledge transfer	12	+3	36	
Attitude of the society to the foreign people	5	+2	10	
Total Environmental Impact Value (EIV)				+3

After observing and calculating all the components, authors were able to find out the results. This result shows positive impact on socio-economic impact (+198) and negative impacts on environmental parameters (-65) and socio-cultural parameters (-130). Most of the negative impacts were land acquisition, construction and operation of warm water after energy production related and it is possible to manage effectively. Finally, calculations revealed that the overall value of the environmental and social impact assessment is +3, indicating that the project has a moderately positive impact on the social economy and environment, and suggested that the project is acceptable.

The idea of constructing a nuclear power plant in Bangladesh was first suggested in 1961. In 1963, Rooppur, on the banks of the Padma River in Pabna district, was chosen for the construction of the project

and 260 acre land for the plant and 32 acre land for the residential area was acquired by the ministry of Science and Technology of Bangladesh. After giving formal approval to a series of project plans, the government accepted a 125 megawatt nuclear power plant project in 1980, but not built (Construction of Rooppur Nuclear Power Plant Project, 2019). The winning political party, Awami League's election manifesto in 2008 promised to implement the Rooppur nuclear power project. Groundwork on the project began in 2016. The Russian government was funded 90% of the \$12.65 billion deal through a loan. In 2023 and 2024, the two 2.4 Gigawatt units are expected to be available. The systems was operated by Rosatom, a Russian agency, for the first year before being handed over to Bangladeshi operators (Nuclear Engineering International, 2016). On October 02, 2013, the Honorable Prime Minister of the Government of the People's Republic of Bangladesh officially inaugurated the first phase of construction of Rooppur Nuclear Power Plant. The RNPP's first 1200MW project is scheduled to be completed in June 2023, followed by the second unit in April 2024 (The Financial Express, 2018).

In Bangladesh, electricity was available to an average of 77.9% of the population (Wayback Machine, 2017). According to ministry of power, energy and mineral resources, Bangladesh's overall power consumption is expected to be over 20,000 megawatts in 2021 (Ministry of Power, Energy and Mineral Resources, 2021). Bangladesh will require an estimated 34,000 megawatts of electricity by 2030 to keep its GDP growth above 7% (The Himalayan, 2018). The Russian technology is being used to build RNPP, which will have two VVER-1200 reactors with a total capacity of 2400 megawatt (Energy of the Future, 2020). The RNPP will be a powerful engine of Bangladesh's social and economic growth and a significant contributor to the country's energy supply. It will contribute to the nation's overall economic development by promoting the nation's industrial sector expansion. It will also create jobs for residents and generate government revenue, contributing to a healthy economy. According to claims in the local media, the project has directly employed around 14,000 Bangladeshi employees. In addition, around 3000 foreign nationals are employed on the project. The increase in employment has provided the local economy a significant boost (Rahman J. , 2020). According to field investigation and open ended questionnaire survey, a number of new shopping centers have opened to accommodate the significant presence of foreign employees, while small businesses have risen by the local people in the study area. Local economy and infrastructure will be developed based on Rooppur Nuclear Power plant. Padma river port, is an example of supporting infrastructures created for the RNPP. A railway line also be developed to link the project site. Compared to gas, coal, and imported energy from India, energy generation at the RNPP is very cost effective. The electricity industry in Bangladesh is heavily reliant on fossil fuels, with natural gas and coal serving as the country's primary power generating sources. Natural gas accounts for about 62.9 percent of Bangladeshi electrical generation, with diesel accounting for 10%, coal for 5%, heavy oil for 3%, and renewables accounting for 3.3 percent (Taheruzzaman M. & Janik P., 2016). Electricity production accounts for over 40% of worldwide carbon dioxide emissions, with fossil fuels being burned to provide the heat required to power steam turbines. When these fuels are burned, carbon dioxide is produced, which is considered for heat-absorbing greenhouse gas responsible for global warming (Abdallah L. & El-Shennawy T., 2013). When in operation, NPPs release no greenhouse gases, and during their lifetimes, they release around the same amount of CO₂ equivalent emissions per unit of energy as wind and one-third of the emissions per unit of power as solar (World Nuclear Association, n.d.). The RNPP will assist to mitigate the negative effects of climate change because it does not emit any carbon dioxide. The primary equipment of the plant has a sixty year lifespan and does not need to be replaced (Rahman J. , 2020). RNPP has five layers of barriers: fuel pallet, fuel cladding, and pressure vessel, 1.2m first containment with thin steel layer and 0.5m second containment, which will be worked as a safeguard for people and the environment by preventing radiation exposure (The Daily Star, 2017). The process of generating nuclear energy is known as nuclear fission, which involves splitting an atom apart and releasing the energy contained inside it. The

energy is delivered in heat and radiant energy, which is used to heat water and generate steam. The steam then drives a generator, which spins a turbine to generate electricity. According to the Nuclear Energy Institute, a nuclear power reactor consumes water between 1,514 and 2,725 liters per megawatt hour. A major nuclear power plant may use up to 1 billion gallons of water each day, that's why they are often located close to rivers, lakes, or seas to take use the waterbodies (Green, 2019). A nuclear power plant's survival depends on cooling water, and a lack of it might result in a catastrophe. The powerful river Padma has dried up and transformed into a bed of sand dunes and silts due to a lack of water flow in summer season in Bangladesh. The water in the river is now only visible for three to four months of the year, with the other eight to nine months of the year seeing the river's lowest ebb, resulting in kilometers of sandy char ground across the river (The Financial Express, 2018). To continue this mega project successfully, there will be no alternative of river excavation, dredging at the dried river beds, and disposal of massive silts of river should be prohibited. Russia will take back the nuclear waste generated by the plant. So there will be no harm due to any nuclear or radioactive waste. Tree plantation program was also seen by authors outside the plant, which will help to keep cool and protect the local environment.

Almost all nuclear power plants are built up near the bank of ocean or big river to meet up the vast amount of water for energy production. Plants located at river banks (14%), results of a few are not satisfactory (Rahman K. M., The Daily Star, 2014). RNPP, the ongoing project also located near the bank of Padma River, one of the largest rivers in Bangladesh, forms in India then meets with Jamuna River and Meghna River and enter to the Bay of Bengal. According to the Bangladesh Water development board (BWDB) almost 230 rivers currently flow in this riverine country and all are connected with their tributary rivers (Hossain, 2014). Heat water cannot store as much DO as cool water, and organic waste decomposes more quickly, causing eutrophication, which prevents underlying aquatic plants from getting enough light. Low oxygen levels can cause damage by establishing hypoxic dead zones that are inhospitable to most aquatic species (J. P. P. Jebakumar, G. Nandhagopal, B. R. Babu, S. Ragumaran, V. Ravichandran, 2018; J. G. Eaton & R. M. Scheller, 1996). Continuously heated water speeds up the metabolism of cold-blooded aquatic species like fish, resulting in starvation owing to a lack of nutrients and altering the biodiversity of both the native and invading areas (F. Moberg, C. Folke, 1999). Legionella, a dangerous bacteria, is found in cooling towers, and if a few water droplets move to neighboring areas, it may cause pneumonia and other respiratory illnesses. When cooling towers are not properly maintained during plant operation, it has a recognized harmful effect on the environment and human health (Rahman K. M., 2015). Padma is regarded an important breeding and feeding ground for Bangladesh's riverine fish species. According to study, there are 71 species in the river, divided into 10 orders, 26 families, and 54 genera (M. A. R. Joadder, S. M. Galib, S. M. M. Haque & N. Chaki, 2015). Fishing is the only profession of many people in the study area. If these resources will be hampered, fishermen, as well as economy of this sector, also be hampered. This river water also be used for irrigation, drinking and domestic purposes, a concern will be occurred when warm water contained bacteria consumed by the people through drinking or eating foods. Padma is also rich of herpeto-mammalian fauna i.e. amphibians, reptiles, and mammals. Warm water from cooling towers will also be a treat for these fauna and regional hydrology biodiversity. There are other challenges too. To keep a nuclear power plant running, it needs clean water for its condenser and cooling systems. However, during the monsoon, the Padma River carries a lot of silt and sand, so the dirty water needs to be cleansed before it can be utilized (Eco-Business, 2015). Another important consequence is the increased quantity of sulfur dioxide in the air, which releases from diesel generators from the plant and generates acid rain, causes pollution of the region's surface water bodies, lower soil productivity, and has a variety of other negative consequences on the region's vegetation and human health (Bond A. J., Bussell M., Sullivan P. & Palerm J. R., 2003). Another significant concern is in the area and its population density. According to international law, the region of a nuclear power plant

should be a minimum circle with a radius of 30km and it was split into three circular zones by the researchers. Only personnel who work in the reactors have access to Area-1 and no civilians are permitted here. The Area-3 will be 30 kilometers from the plant having no man's land. Within the zone, all agricultural and industrial activities are prohibited (Saha S., Roy S., Roy S., Rahman M., A. & Hasan M., Z., 2018). This 2628 square kilometer circular area from the plant covers Baraipara, Bagatipara, and Lalpur Upazila of Natore district with a population density of 933, 937, 837 per square kilometer; Ishwardi, Pabna Sadar, and Atgharia Upazila of Pabna district with a population density of 1251, 1345, 845 per square kilometer; Kusthia Sadar, Bheramara, Daulatpur, and Mirpur Upazila in Kusthia district with a population density of 1340, 1143, 946, 898 per square kilometer respectively (BBS, 2011). It is almost impossible to rehabilitate such a large number of people in a suitable location in this densely populated country. The construction of a NPP in any location is fraught with controversy and criticism from a diverse group of individuals. The respondents, especially the old age group (above 60), were concerned about being exposed to dangerously high amounts of radiation. The air ejector emission is also radioactive generating from boiling water reactors and when it discharges into the environment through delayed pipes, storage tanks and hydrogen recombines before measuring limits, causes severe skin and hair issues (Damian, 1992). Sudden nuclear accidents or radioactive emission may cause a disaster in the study area. Radiation exposure in the wild may cause generations of troubles over a whole ecosystem. Domestic animals and birds in the Rooppur neighborhood may be affected by fetal before birth, mental retardation, or even death depending on the level of radiation exposure. Radiation affects nerve cells and blood vessels in the human heart, which may lead to death. If the radiation exposure is more than 5000 rems, brain cells are harmed. If a person is exposed to 100 rems, the amount of lymphocytic cells in their blood will be decreased. Every organ in the body is made up of specialized cells and nuclear radiation ionizes the cells and damages them. For example, gamma radiation flowing through a cell might ionize the water molecule and damage the DNA. Even though the exposure is just 200 rems, the cells of the reproductive tract are more susceptible to being damaged since they divide quickly (atomicarchive.com, n.d.). These are just a few health problems of radiation exposure noted here; list of impacts on environment and human health of radiation exposure is on beggar description. The another concern is nuclear waste-But Bangladesh Government confirmed that Russia will receive unused uranium and plutonium and nuclear waste, but Bangladesh will bear the cost of handling, shipping, and reprocessing spent fuel, as well as the expense of safely storing high-level radioactive waste (Matin, 2010).

The local people occupied this 272 acre project land over the years as their residence and commercial purposes. Before the construction of RNPP, the project site was used as a pasture for domestic animals. This area had a biodiversity and it make cool in the surrounding area. A large number of trees were cut down for this plant construction and respondents make responsible for the rising temperature in the study area. Shortage of moisture in this area has an adverse effect on future land use. Due to safety, there will be a huge open space left around the plant but the places will be of no use. The plant has reduced 1269 acres of open space beside Padma River & BBC bazar. At present in Rooppur, there is a vast settlement which will be demolished or being demolished for construction of Army camp for national security and other supporting structures. Rooppur Nuclear Power Plant is still under construction process and due to its construction work local people and workers of the plant have faced some health problems. The survey found that the majority of respondents in category-A (RNPP workers) had respiratory illnesses (35%) followed by eye problem (33%), and skin infection (12%), but 20% of them were disease-free. The majority of the respondents in group B (common people) were found to be suffering from severe health issues (62%), mild health issues (30%), and no health issues (8%). The authors around the project site felt a nappy smell from unknown particulates. Here the workers used mask for their health protection. But the surrounding area of RNPP, many commercial structures were developed, and the maximum neighborhood community do not care about this smell and do

not use masks or any protection. A huge amount of land was used for cultivation which was acquired by the government. Many people involved in agricultural production change their profession and some people joined as labor in the plant and it will be hampered in local agro-economy. Bangladesh is an agricultural country. There are many notable manufactories such as Sugar mill, paper mill, spinning mill, cement factory, rice mill, steel mill and some cottage industries i.e. weaving, goldsmith, blacksmith, potteries, wooden product, and so on located in Ishwardi Upazila (Banglapedia, 2015) that play in the vital role in north Bengal economy as well as national economy. If 5km circular area from the plant is prohibited for industrial and agricultural work by the government, these sectors and people who involved in the sector and economy will be hampered a lot. Some of the respondents said that they were become workless for the project, but some of them got the opportunity to work in the project as laborers. Maximum will be jobless after completion the project. Even they also expressed that, they got more economical benefit when worked in the agricultural land. The lifestyle of residents in the study area almost has been changed due to overnight after starting the construction of the project. People built shops, settlements, educational institutions, sports and cultural organizations, bazars, mosque, and so on structures for their living in this acquired land and lived here for a long time. For construction of army camp, offices and apartment for office personnel, authority ordered them to leave in this place with bag and baggage within a short period. A large number of structures have already demolished by the authority. The respondents also said that they could not get any compensation or help from any organization or authority. These shredded people do not know where they will go after the date!

4. Conclusion

The nuclear power plant at Rooppur is not only national but also a worldwide concern. The study shows that the project has a moderate positive impact on the environment and social economy, and cultural elements if the government will be able to take preventive measures to mitigate the project's adverse effects and ensure the victims' well-being of the study area. To ensure the project's safety and security, both local and vendor country regulations and IAEA requirements are being implemented. Bangladesh also need to focus on its safety issues and make a proper environmental management plan to ensure it a successful project.

Abbreviations

DO-Dissolved Oxygen

FGD-Focus Group Discussions

IAEA-International Atomic Energy Agency

NPP-Nuclear Power Plant

RNPP-Rooppur Nuclear Power plant

VVEA- Verordnung über die Vermeidung und die Entsorgung von Abfällen

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