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Nuclear Disaster Risk Assessment of Pakistan

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Abstract

Disaster management is gaining currency due to increased intensity and frequency of natural disasters. Management of natural disaster requires detailed planning, commitment at national level and sufficient resources which for country like Pakistan is a difficult option. Management of nuclear disasters is even more complex phenomenon. Even developed country like Japan with all sorts of preparations and resources was stunned and helpless when tsunami hit Fukushima. Best option obviously appears to be a risk reduction in this regards. It is also important because of its social, psychological and economical dimensions. Adequate risk reduction can only be taken if risk assessment is realistically done. Element at risk are identified properly and their vulnerabilities in all perspectivesare evaluated pragmatically. Determining the vulnerability of populations exposed to nuclear disaster and enhancing their capacity is a vital component. Vulnerability assessment also provides decision makers with relevant information as to what type of disaster reduction interventions are needed, in what form and to whom these are required.

Keywords

Risk, Risk Assessment, Vulnerability, Exposure, Capacity

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1. Introduction

Risk and vulnerability assessment for nuclear disaster in Pakistan is a relatively new subject. This paper is an effort to explain and apply the risk and vulnerability assessment in the context of nuclear disasters. Despite being a no go area, and availability of limited literature on the subject, an endeavor is made to hypothesize various nuclear disaster eventualities, what type of elements would be at risk and what all are their vulnerabilities. Be it due to nuclear weapon detonation as an act of war, radiation leakage due to design failure, human error or sabotage or natural disaster like earthquake cum tsunami triggering nuclear disaster, the management of such disasters would be an uphill task.The paper also outlineswhy nuclear risk assessment is crucial and how it is undertaken. At the end certain grey areas have been identified which would be incorporated in next paper in the series while formulating the nuclear disaster response plan for Pakistan [1,2].

2. Related Terms

a. *Risk*. "It is a possibility of hazard occurring and its potential to cause harm to lives, livelihoods, property or environment over a period of time. It is also defined as expected losses from a given hazard, to a given element at risk over a specific period of time".

b. *Risk Assessment.* "It is process to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability / capacity that could pose a potential threat or harm to people, property, livelihoods, and the environment".

c. *Risk Management.* "It is a systematic management of administrative decisions, organization, operational skills and responsibilities to apply policies, strategies and practices for disaster risk reduction".

d. *Vulnerability.* "Characteristic and circumstances of a

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community, system, asset or a geographic area that is likely to be damaged or disrupted by the impact of particular hazard. It includes the physical, social and economical vulnerability of that particular asset".

e. *Exposure.*"Exposure means people, property, and system or other elements presents in hazard zones that are subject to potential losses during the occurrence of hazard".

f. *Capacity.* "The capacity is defined as combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals".

3. How Risk is Determined

There are three essential components [3,4]:-

a. *Hazard Occurrence Probability.* It is the possibility of occurring of any natural or technological peril at a place or an area.

b. *Elements at Risk.* It is the identification and preparing of an account of people, assets or other elements which would be affected by the hazard.

c. *Vulnerability of the Elements at Risk.*Vulnerability is the degree of damage to life, people, property or other elements during the occurrence of particular hazard.

4. Why Nuclear Risk Assessment is Required

Pragmatic nuclear risk assessment in Pakistan is important because of mainly three factors: firstly, due to catastrophic and persistent effects of nuclear disaster, especially when seen in the backdrop of densely populated and highly vulnerable South Asian region. Secondly, Pakistan is surrounded by three recognized nuclear powers namely India, China and Russia and potential nuclear power Iran. Indian nuclear capability poses direct threat to the security of Pakistan [5,6]. Thirdly, nuclear risk assessment is vital for formulating risk reduction measures and for preparation of adequate response plan to mitigate the impact of nuclear disaster.

5. Risk Assessment

a. Location of Nuclear Installations.

b. *Risk Calculus*. Calculation of risk is mainly based on factors like perception, estimation, experience of hazard and historical records / data. Therefore, the calculation of risk would be based on approximation and short of being accurate. This difficulty is further compounded in case of nuclear hazards. Possible nuclear hazard scenario in Pakistan can be summarized as under:-

1) Likely Indian nuclear strikesat non military targets against mega cities of Pakistan like Rawalpindi/Islamabad, Karachi or Lahore as a part of retaliatory strike or first strike causing large scale devastation is a leading scenario. US strikes on Japanese cities of Hiroshima and Nagasaki during WW II are the horrified examplesmankind have ever experienced.

2) Nuclear accident during storage, transportation and employment of nuclear weapons is another likely hypothesis. "The captain and seven crew members died due to radiation spread at first Russian nuclear submarine on July 4, 1961 due to rupturing of pipe in the control system of one of the two reactors".

3) Leakage of nuclear radiations / gas from the plants due to failure of cooling system, mistake of the workers or due todesign fault and consequently melting down of the reactor causing causalities is most common type of accident. Nuclear accident history is full such events of varying scale [7]. "Major incidents includesWindscale, Britain on Dec 12, 1952 causing dozens of cancer deaths and Three Mile Island, Harrisburg, USA dated Mar 28, 1979 due to combination of design, training and mechanical failure, forcing 1500 evacuations around 5 miles from the plant site. Chernobyl, Ukraine (former USSR) explosions of nuclear plants due to design failure and human error causing 31 deaths, 250000 evacuations and radiation spill over large part of Europe are the apt examples".

4) "On Dec 3, 1984 in Bhopal, India had encountered one of the worst industrial plant gas leak incident due to chemical reaction of different properties. Approximately 8000 people died and over 300000 received injuries".

5) Earthquake or Tsunami or combination of both damaging nuclear power plant and causing radiation is another kind of nuclear disaster. "Fukushima incident of Mar 11, 2011 is most recent and worst nuclear accidents despite adequate safety measures. Double disaster severely damaged the plant resulting to hydrogen explosions.Our KANUPP is particularly located at similar geography like Fukushima and is also vulnerable to such hazard".

c. *Probability of Occurrence.* "Pakistan's small nuclear industry, operating under state control and IAEA safeguards has done reasonably well and its safety records of last 40 years of operation have been quite satisfactory". Such a magnificent record of nuclear operational history vis-a-viz India can be attributed to stringent safety mechanism, efficient regulatory bodies and competent

expert handling the nuclear installations. However the probability of occurrence of nuclear hazardcannot be ruled out [8]. Even 1% probability will have to be evaluated in its correct perspective as its disastrous impacts on life;livelihoods and environment are lasting both physically and psychologically. Traces of nuclear bombing of 1945 in Japan and Chernobyl, Ukraine accident of 1986are still very prominent. Similarly, such incidents had occurred in whole of the developed world and leading nuclear states like USA, UK, Russia, Japan and Germany as well in France. The chronologies of events suggest that in nuclear business, safe is never safe enough [9].

d. *Frequency and Severity of Nuclear Hazards.*Frequency of nuclear, chemical or biological hazards in comparison to natural hazards though less, yet severity of these incidents increases manifold if seen in the context that natural hazard are triggering the nuclear hazards (Fukushima Phenomenon).

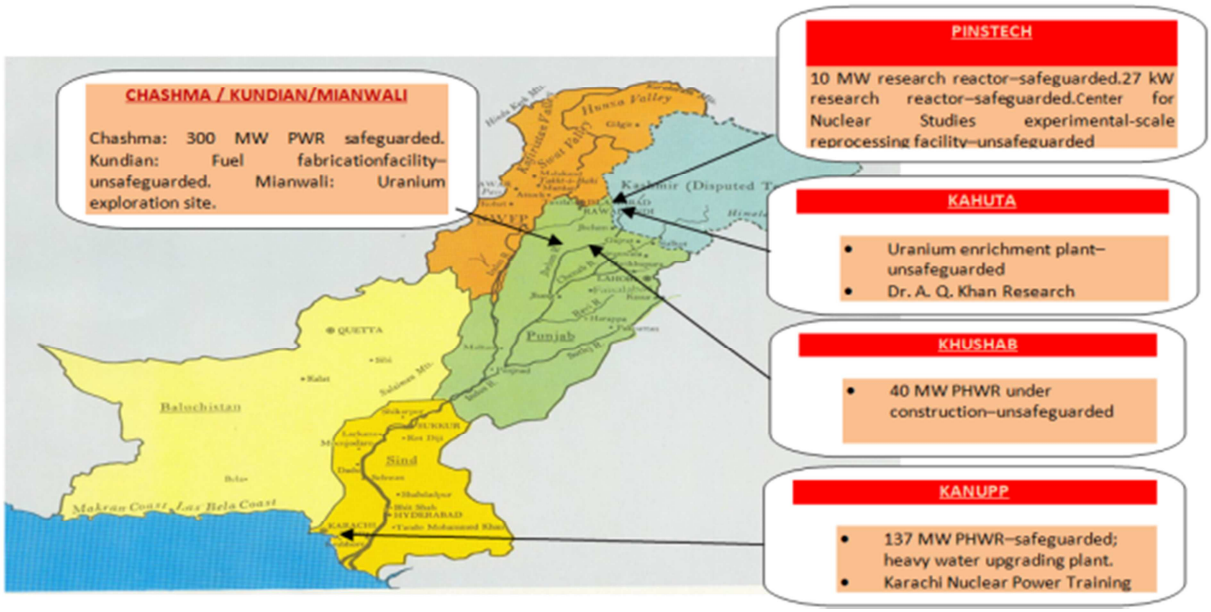

Fig. 1. Locations of nuclear power plants.

6. Exposure

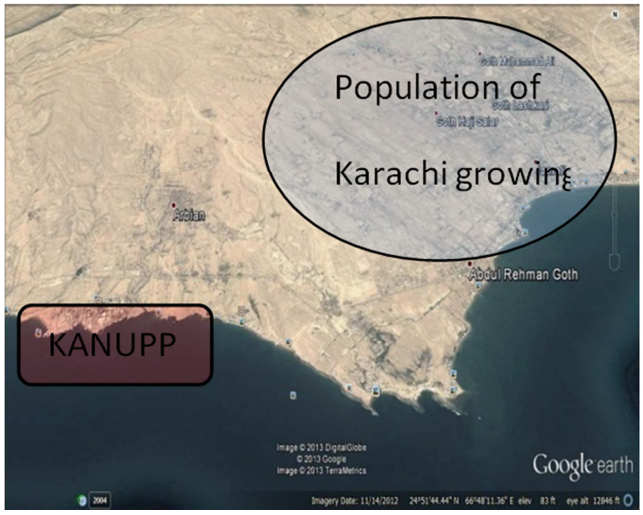

Fig. 2. Google map of KANUPP – Pakistan.

Element exposed to the risk of nuclear radiations / gas leak both in intensity and duration needs to be identified so that adequate measures are initiated to secure them from the risk. Experience reveals that Individuals working inside the nuclear sites are first to be affected. Civil population residing close to these sites and livelihood are next to get the radiation doze. In case of nuclear detonation or explosion the structure/property around GZ will also be destroyed / damaged. Water, foods, vegetables, fruits and other eatables would get contaminated. All these elements exposed to the nuclear hazards would cause enormous direct and indirect economic losses to the nation.

7. Vulnerability

Deliberation on the working of vulnerability of each element at risk is very important for disaster managerin order to mitigate the impact and enhance resilience. The vulnerabilities should be worked out in all dimensions like physical, social, economic and environmental areas [9].

KANUPP is 137 MW PHWR safeguarded plant, located 35 km from Karachi near paradise point of Karachi Coast. Initially, the plant was fairly away from the population centers however, due to rampant urbanization and population

growths, numerous residential colonies nearby have mushroomed. Approximately, 500 people visiting coastal recreational places like Paradise Point, Hawks Bay and 1350 individuals of village Arbian located within 5 km radius remain vulnerable to radiations in case of any accident. “Two questions have been raised about the safety of KANUPP: One is its susceptibility to a tsunami generated by an EQ in the Arabian Sea and two, its location near a major city. More than 8 million people now live in the vicinity”. “Location of Indian, Arabian and Eurasian tectonic plates in the sea as close as 40 km from Karachi makes the area vulnerable to the EQ cum tsunami hazards”13. “1945Tsunami did damage Karachi lighthouse and killed 4000 people despite its main area of impact was Ormara”14. “Although the possibility of EQ or tsunami hitting Karachi and damaging KANUPP is not as strong as Fukushima, yet one lesson that can be learned is moving population away from the KNUPP”15. Social, economical and environmental impact of such disaster would also be enormous.

Fig. 3. Nuclear power plant at Karachi.

PINSTECH. Pakistan Institute of Science and Technology (PINSTECH) located 20 km from Islamabad is mainly a centre for nuclear study and experiment. It has 3 reprocessing research reactors and Plutonium Separation Plant that work under IAEA safeguards. Though it is experimental and teaching facility but also undertakes limited production of sophisticated equipment and special nuclear materials. However, accidental leakage of radiations cannot be ruled out. Like KANUPP, PINSTECH is also located very close to population centre. Beside small villages along Lahtarar Road, Jhang Sayedan, a sizeable town, Bherian Enclave and Gulberg Towns around the site are emerging built up areas. The rising tendency of housing societies and unplanned built up areas if not checked in time are likely to enhance the vulnerability of people, structure and livelihoods.

Chashma Complex. The complex is located along Eastern bank of River Indus near Chashma Barrage 20km South of Mianwali. It has 300 MW PWR safeguarded and fuel fabrication facility unsafeguarded. The site is operational since 1993 and towns / villages like Kundian, Wan Bhachran, Piplan and Mianwali all are loc within the radius of 20 km. Chashma itself is large size residential complex housing WAPDA, PAEC and CPH colonies. Approximately 2000-2500 people including experts/labor reside in the complex. In case of any accident at the site, they will be the first to get affected besides sweat water of River Indus and Chashma-Jehlum-Link-Canal (CJLC) which is likely to be contaminated, adversely affecting the life and livelihood in entire Southern part of DistrictMianwali and Thal Desert.

Khushab. Khushab Nuclear Complexis not under the umbrella of IAEA safeguards. It is plutonium manufacturing facility andheavy water compoundlocated30 km south of Joharabad, District Khushab. The heavy water and uranium reactors at Khushab are the main features of Pakistan’s program for plutonium and tritium production which is likely to be used in light weight nuclear devices. Three presently operative reactors have reportedly different capacities between 40 MW to 50 MW. It is the first domestically developed nuclear reactor of Pakistan that was commissioned in 1996. The site is ideally located along the western bank of River Jehlum inside the Desert away from population however; the scientist and technicians would remain exposed to accidental leakage of radiations besides contamination of River water.

Fig. 4. Proposed layout of the hazardous belts.

8. Capacity and Measures

The coping capacity of PAEC and PNRA are the scarlet thread to the safety of nuclear material, site operations and experts/technicians from accident. PNRA is striving to ensure the safe operation of nuclear installations and to protect workforce, general masses and the environment from the harmful effects of radiations. Itframes and implements effective principles and shapes theassociation of confidence with the licensees and maintainsfairness in its actions and decisions."PNRA maintains highest international regulatory standards which have been reviewed by the experts IAEA and World Association of Nuclear Operators (WANO)". Most important is that entire program has accident free history [10]. However, following apprehensionshave surfaced over a period of time:-

a. There has been very limited debate on local media on nuclear safety in Pakistan.

b. PAEC's website does not contain public safety measures for the awareness of the masses.

c. "An opinion co-authored by disarmament advocates within the Indian and Pakistan scientific communities cautioned the South Asian Nuclear establishments in generic terms about the susceptibility of their atomic reactor to natural disasters, human errors, design failures and poor safety standards".

d. Governmental authorities neither have adequate wherewithal nor capacity to handle nuclear emergency. Even the DCOs and ACs have no institutional training for dealing with such emergencies.

e. Rural medical centers / hospitals located around the nuclear sites do not have required medicines or experts to deal with nuclear medication.

f. Land use measures are neither part of development planning nor any construction code is being followed specially in hazard prone areas.

9. Conclusion

Risk and vulnerability assessment for nuclear disasters in Pakistan is a complex subject. In this paper, an effort has been made to explore various dimensions of the subject. This is a humble beginning and further studies on the subject should unveil more areas. The risk reduction measures undertaken by the PAEC, safety equipment and safety drills for the manpower working inside the sites can only be evaluated if open study for at least safeguarded installations is permitted.

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