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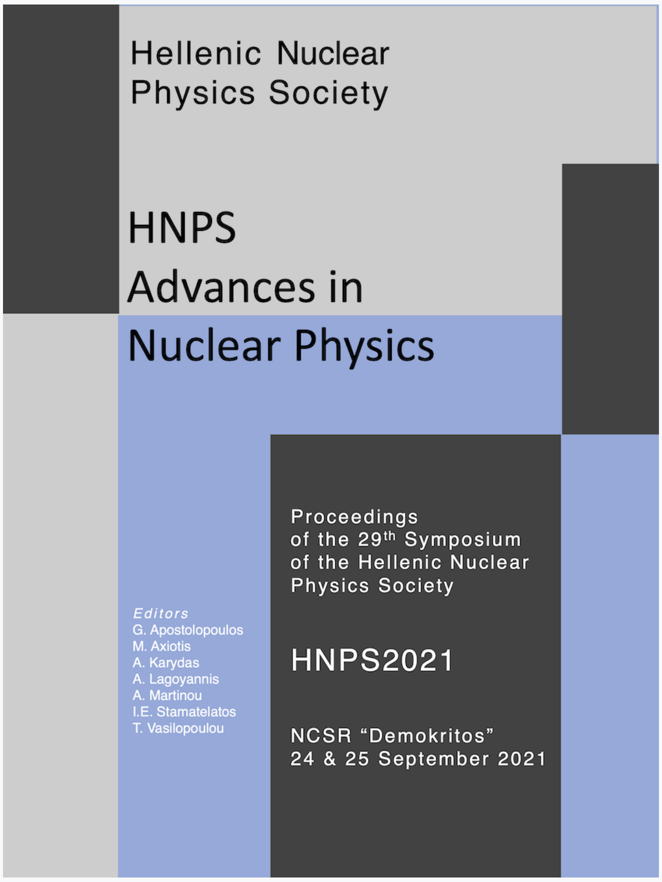

Suffering in the Name of Protecting: The Case of the Fukushima Population

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Abstract Major nuclear accidents are rare events causing large and long-lasting medical, environmental, economic, and societal consequences. Urgent mass evacuation and long-term displacement of about 165.000 persons and their long-term resettlement after the 2011 Fukushima-1 accident destabilized Japan. As of March 2020, the official number of displaced persons from their home in Fukushima Prefecture was reduced to 40.335, an action that averted a collective effective dose of about 3,000 man·Sv. Most of the causalities were elderely volunarable pesons, such as patients with chronic diseases, instititionalized individuals, and very poor persons. However, no early radiation-induced somatic effects to public were reported. This article seeks to compare the benefit of the evacuation/resettlement procedure with its cost. The accident-related death toll in Fukushima Prefecture has to be differantiated from that due to the earthquaque and the tsunami that trigered the foressen and prevenatble nuclear 2011 accident. Taking into acount the ratio of the direct and the indirect deaths at the Miyagi and Iwate Prefectures, can be assumed that out the 2.313 indirect life losses in Fukushima registered up at to 2020, only about 165 could be attributed to the eartquake and the tsuami, and few tens due to the radiation induced cancer among the dispaced persons. The mass dispacement resulted in increased incidence of severe somatic effects, mental and psychic disorders, social isolation, insecurity, unemployment, poverty, urbanization, and exploitation. Therefore, the mitigation actions, as designed and implemented, led in a secondary tragedy larger than that due the accident itself, resulting among other things to the death of about 2.100 persons in the name of sparing, in theory, about 150 lives with a latency time of decades.

Keywords nuclear accidents, Fukushima, displacement

INTRODUCTION

During the 2000 to 2019 period about 7.500 natural disaster events were recorded world-wide claiming a total of approximately 1.2 million lives and affecting more than 4 billion people [1]. Among the causalities about 450.000 were related to the 2010 Haiti earthquake and the 2004 Indian Ocean earthquake that was followed by a verry strong tsunami.

Mass evacuation of disaster-stricken populations is often an essential element of the disaster mitigation policy. As a result of such disasters, almost 25 million persons were displaced in 2019 in both low- and high-income countries. Similarly, human factors may cause technological disasters, often leading to the release of hazardous materials requiring mass evacuation of the population of the heavily affected areas and their resettlement up to the time required for adequate recovery. At the new location, appropriate housing, services and economic base has to be built.

Large nuclear accidents are rare, unexpected events that require long-term mobilisation of considerable human and financial resources and a complex recovery process, because they may cause long-lasting medical, psychological, economic, societal and environmental consequences over large areas and affecting all aspects of individual and social life. Justification of decisions based on flexible preplanned protection strategies and optimization of protection are essential in the mitigation of their consequences by actions taken in a timely and safe manner under the existing radiological and social conditions [2]. Off-site actions have to be carried out in close collabortion with the local communities, ensuring sustainable living conditions to the affected persons.

Short-term sheltering, evacuation and temporary relocation, iodine thyroid blocking, decontamination of people, and restrictions of fresh foodstuffs are short-term protective actions taken during the ealry phase, if justified by creating more good than harm. The potential of long-term displacement (or dislocation) of massive numbers of people in the name of their radiation protection has to be justified by persintence of elevated exposure levels, taking into account a large number of factors. In addition, the authorities have to decide on due time on the future of the affected areas and restore and revitalize those that seem reasonable and allow those that wish to return under appropriate conditions.

The gradual mass evacuation of the near-by population after the 1986 Chernobyl and the 2011 Fukushima-1 nuclear accidents were followed by protracked mandatoty or voluntary displacement of a total of about half million persons in attempt to reduce their exposure. These mitigiation actions caused alot of suffering and contributed to the distabilization of USSR and Japan, two countries with substantial different conditions at that time. The knowlegde and experience acquired by these actions could help the response to future accidents. The scope of this study was to find retrospectively if the benefit of the evacuation and long-term internal dispacement of so many persons following the Fukushima-1 accident was in practice higher than their cost.

THE FUKUSHIMA EVACUATION CASE

Japan is one of the most affected countries of the world by natural disasters. In the early afternoon of March 11, 2001, the Great East Japan Earthquake (also known as the Great Sendai Earthquake) was followed by huge tsunami that flooded a coastal area with a total population of about 550.000 persons, mainly of the Prefectures of Miyagi, Iwate and Fukushima and triggered the nuclear accident. The affected areas were mainly agricultural, forestry and fishery. As of March 2021, the tipple disaster resulted in the death of 19.729 persons (2.559 were still missing and presumed dead), the injury of 6.233, the complete destruction of 121.996 buildings and the displacement of about 470.000 persons in Northeastern Japan, according to the Japanese Reconstruction Agency. The size of the hazards initially overwhelmed the capacity of Japan, a county with considerable experience on serious geophysical hazards.

The accident at the Fukushima-1 nuclear power was the result of collusion between the government, the regulators and the owner and operator of the plant (TEPCO), and the lack of governance by said parties [3]. The accident occurred because a) the private corporation TEPCO did not take the required preventive measures, and b) the inspection and regulatory bodies went along in spite they were aware of the risk from such natural disasters. The spatial distribution of the fallout, as anticipated, was not uniform. Most of the fallout outside the power plant was concentrated on approximately 400 km^2.

A total of about 165.000 persons were evacuated (146.520 following the government's evacuation orders and an inadequtely known number voluntarely) due to the partial melt-down of the cores of three nuclear power reactors. Most residents in the plant's vicinity evacuated under chaotic conditions without accurate information [3].

During the first decade after the preventable accident, the cummualtive collective effective and thyroid doses to the entire population of the country from both external and internal exposure were ~44.000 man·Sv and ~57,000 man·Gy, respectively, i.e. 0.35 mSv and 0.45 mSv, on the average [4]. UNSCEAR in its 2020 report concluding that cancer cases in the public, including thyroid cancer in children due to the accident, is not likely to be desscernible.

The massive number of the evacuated displaced persons was related to the low dose evacuation reference level of 1.0 mSv/year adopted in practice by the authorities few months after the accident under severe and provoced public pressure. Such a level is widely recommended for the additional effective dose to the members of public for planned (medical exposures are excluded) but not for emergency exposure situations. Note that ICRP proposed a reference level not exceeding 100 mSv during both the early and the intermediate phase of a large nuclear accident (emergency exposure situation). The Greek legilation by 2018 allows the authorities to choose a reference value in the 20 to 100 mSv band according to existing conditions. Recent dose calculations by UNSCEAR indicated that the potential use by the Japanesse authorities of the 20 mSv reference evacuation level during the first year, could reduce by a factor of almost ten the number of the evacuated persons, i.e. only those living in Okuma and Futuba [4], two manucipalities with a total poppulation of 17.234 in 2010. The projected mean doses to the 32.288 persons living in the neaby municipalities of Tomioka, Namie and Itate were between 12 and 18 mSv, and in the range 1.6 to 7.4 mSv of those at the remaining evacuated areas.

For practical reasons an area was characterized in Japan as contaminated if the ambient dose rate at 1.0 m above the ground was least 0.23 μSv/h (including 0.04 μSv/h from the natural background). Thus about 2.5% of the countries total area was designated intially as contaminated, hosting about 1.5% of its population. After the attainment of cold shutdown status at the plant in December 2011, its was decided to divide the contaminated off-site areas, all in the eastern part of Fukusima Prefecture, in three groups [5]. In type 1 areas, the projected mean annual effective doses under the given conditions were estimated to be between 1 to 20 mSv. The authoririties stated that "the evacuation orders for these areas were ready to be lifted provided the essential infrastructues were restored" and their goal is to reduce dose rate by a factor of about two. In type 2 areas, the esimated mean doses during the first year were between 20 mSv to 50 mSv and it was not permited temororaly to reurn. In type 3 areas, the estimated annual doses were at least 50 mSv or/and the doses during the first six years after the accident were expected to exceed 120 mSv. In these "restricted areas", residents is antiicipated not be be allowed to move in for a long time.

Unlike the Chernobyl case, permanent resettlement sites were not build for the "nuclear refugees". The authorities decided to lift the evacuation orders in due time based on the reduction of the external dose-rate in each area by radioactive decay, natural processes, the outcome of the emplyoed expensive decontamination program and at a later stage, by increasing the radiation thresholds for re-occupation. Thus in April 2012 the first orders allowing the return to some type-1 areas. Four years after accident about ¾ were still dipslaced and diluted mainly among the remainming population of Fukushima Prefecture with a total population of about two millions. As of March 2021, the evacuation orders were not lifted in some areas (hot radiation spots), not allowing the return to their home-site of 36.000 persons. Almost half of the those that returned were eldely people.

Meanwhile, many young people resettled inside or outside the Prefecture and refuse in mass to return.

RESULTS

The initial emergency evacuation was followed by a mandated or voluntary evacuation and resettlement of the vulnerable population to reduce their further radiation exposure, a long-lasting and pain causing process. No radiation induced tissue reactions (deterministic effects) were reported so far to public, due to the low doses. Radiation induced mortalibity and morbidity could be also caused by stochastic radiobiological effecs, as well as many other side-effects due to the response to the radiation hazards.

Mortality: According to the Japanese legal system, the claimed lives due to a large-scale disaster are divided in those caused directly by the hazard and those indirectly or related, usually happening at a much later stage. Up to September 2017, 15.827 registered caused deaths, mainly by drawing, were attributed to the geophysical hazards, i.e., 14.213 in the heavily hit Prefectures of Miyagi and Iwate and only 1.614 in Fukushima. The number of accumulated related (indirect) deaths was increased from

829 in 2012 to 1.454 in Miyagi and Iwate and from 761 to 2.313 in 2020 in Fukushima Prefecture. Thus, the ratios of related to caused deaths were about 0.102 and 1.43 at the areas hit by the double and the triple disaster, respectively. In addition, most of the related deaths in Fukushima, but not in the other two prefectures, corresponded to persons over 65 years in age. Both factors indicate differences in their cause.

Assuming that the 0.102 ratio of related to caused deaths is applicable to Fukushima, only 165 out of the 2.313 related deaths were caused by geophysical hazards. Taking into account the committed effective dose of about 700 man·Sv was given to the displaced persons in name of their radiological protection, so far less than 200 out of the 2,313 related live losses in Fukushima could be attributed to either the geophysical phenomena or to accident-related exposures. The remaining, about 2.100, have to attributed to the mitigation of the accident consequences. Under the conservative assumption that the probability of death at long-term in a large population receiving low doses is 5% per Sv, the averted life losses by a reduction of their collective effective dose by 3.000 man·Sv could in theory spare 150 lives at long term. Thus, in an attempt to spare 150 lives (in theory about 50 were anticipated during this time period), about 2.100 lives were lost during the first decade after the accident due to the mitigation action.

Morbidity: Evacuation and long-term radiation-driven displacement resulted in increased incidence of a number of somatic disorders (e.g., pneumonia, diabetes, hyperlipidaemia, diseases due to changes in lifestyle) as well as of mental and psychic disorders (e.g. post-traumatic stress syndrom, distress, increase in suicide rate, sleep problems, alcoholism, discrimination, psychologic insecurity due to uncertainty about the future), related among other things to radiophobia, social isolation, and loss of dignity and autonomy. Most of the causalities, diseases or deaths, were vulenrable pesons, such as patients with chronic diseases, institutionalized individuals, and very poor persons. For example, an analysis of data on 86 patients transferred from hospitals in the evacuated areas to the Aizu Chuo Hospital located about 100 km west of the plant site, almost half of them have died by the end of the year [6]. In another group of 328 of evacuated nursing home residents, 23% have died by December 2011.

Other side-effects of the action: In general, reconstrucing and reconstituting of communities after a major disaster need to be carried out with realism about the extent of existing capacities. In case of the 2011 accident, the radiation-driven evacuation and displacement caused among other things, sudden disruption of social networks, economic and social insecurity, unemployment, poverty, urbanization, proletarianization, exploitation, social stigmatization (e.g., school buliling and discriminations in marriage). In some cases it also led to tensions between the displaced persons and their host communities (e.g., due to competion for jobs and services, overcrawded schools, increase in rental cost).

The accident resulted in large demographic changes, widened the pre-existing regional inequalities as those among individuals, and caused wide distrust to the auhtorities, the experts, and the media. In addition, it resulted in a public demand to upgdrage the safety of the nuclear power installations, contributing among other things to a substantial increase in the customer's elecric power cost per kWh, a factor with substantial financial impact to Japan, a country with very limited power resources and strong ties between the industry and the ruling cycles. The heavy, direct and indirect, burden to the country from the natural castastrophe was enhanced by the nuclear accident led in increased taxation (most of the costs due to accident were covered by the tax-payers) and in a political turmoil.

In late 2012 the (mis)mismanagement of the nuclear crisis contributed to the return to power for good of the Liberal Democatic Party, despite the fact that this party put in place the systems that lay behind the accident and the mitigation actions. In addition, the Tokyo District Court decided on 2019 that there is no sufficient evidence of criminal negligence by the former top-executives of the company that owned and operated the plant (TEPCO is one of the largest energy production and distribution companies in the world), despite the numerous evidence presented against this decision.

DISCUSSION AND CONCLUSIONS

The accident was triggered by a devastating tsunami causing during the following days the sequenetial partial melt of the cores of the ageing reactors No1, No2 and No3, that were in operation at liscence power level at the time (reactors develped by General Electric and in commercial operation since March 1971, 1974 and 1976, respectively).

The accident itself and the mitigation of its consequences caused an immense uncertainty on the future of nuclear power in Japan, and not only, and debunked the myth of absolute safety of the USA-designed power reactors. It shakedup the country, as well as the life of the individuals. The long-term displacement of surrounding people, as designed and carried out, had a much more significant impact in deterioting health, economy, and social conditions of the affected people and communities than the radioactive releases. The actions taken in the name of protection, led in a secondary tragedy larger than that due the accident itself leading among other things to the death of about 2.100 persons in the name of sparing, in theory, about 150 lives at long-term.

The failure of the response to the accident was related with severe limitations in crisis management, such as in pre-planing, decision-aiding tools and decision-making processes. The decision-makers prioritized short-term planning without taking into account the existing conditions. For example, many decisions were biased by the pressure from people bombarded with overemphasis of the low-dose risks. The politically biased processing of probabilities along with the media coverage contributed to the catastrophe. In addition, the primary purpose of the nuclear laws and regulation at the time was the promotion of nuclear energy with limited emphasis in public safety, health and welfare [3]. However, the structure of the Japanese society and culture in general was considered by many to be the root-cause of the tragety [3].

Experience from past nuclear and radiological emergnecies indicate the need to face radiological health hazards in prospective to both the authorities and the members of the public in order to avoid unjustified and potentalially disatatrous "protection" actions. The 2011 nuclear accident shows clearly that while it is important to protect the public from excessive radiation exposure, it is critical to weigh the damage done by the potentional mitigation actions against the anticipated benefits to both individuals and society. Only a transparent organization structure totally independent from the interests of the industry and the ruling cycles may assure appropriate response. In case of departure from such a policy, any well-intended radiation protection scheme may fail.

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