



# A local perspective of the socio-environmental vulnerability to environmental pollution and economic crises: a case of locals around a coal power plant in Sri Lanka

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## Abstract

People are vulnerable to increasing environmental pollution and unprecedented economic changes in countries like Sri Lanka. Development projects such as coal power plants have exaggerated the vulnerability of the communities to the threats of environmental pollution coupled with economic crises. This study is to present the concurrent socio-environmental issues related to the largest power plant in Sri Lanka—the Norochcholai coal power plant (NCPP). The vulnerability of the communities to environmental pollution due to the coal power plant and the prevailing economic crisis was studied. Results revealed that communities are extremely exposed to threats and are highly sensitive to poverty and yet they have no adequate sets of strategies to cope and/or adapt to threats or increase their resilience. This study suggests a human-centric approach focused on sustainable and autonomous adaptation strategies for the communities in the vicinity of the NCPP and to address their rising vulnerability to the impacts for both the NCPP and the prevailing economic crisis.

**Keywords** Vulnerability · Environmental pollution · Economic crisis · Resilience · Exposure · Sensitivity

## 1 Introduction

To reduce greenhouse gas emissions, the world is undergoing an energy transformation from fossil fuels to renewable energy sources. The discourse of sustainable development which was initiated at the end of the 20th century (Pasani, 2006) has always been discussed together with energy production from renewable energy sources. Consequently, the continuation of coal-fired power generation has never been the smartest choice since the world is transitioning away from coal, considering its worst impacts. However, Sri Lanka is still in the process of expanding the capacity of the only coal power plant in Sri Lanka—Norochcholai Coal Power Plant (NCPP).

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NCPP is in an environmentally sensitive area, in the Kalpitiya lagoon in the Puttalam District. Studies show the hot water discharged from the NCPP is leading to habitat degradation and pollution of marine organisms (Krishantha, 2017). This power plant is associated with not only air pollution but also producing large amounts of solid waste, heat waste and water pollution as a result of releasing heated water (FECT, 2019). Also, considering the long-term impacts, “environmentalists warn that emissions of sulfur dioxide could contribute to the formation of acid rain which will harm local agriculture; and emissions of carbon dioxide and carbon monoxide will contribute to global warming; coal dust from the station may also cause respiratory diseases to residents living in the vicinity” (IUCN, 2011). Amidst all these chaos, currently in 2022, Sri Lanka is experiencing the worst economic crisis in the country’s history and the country is on the verge of default due to multi-million pounds of debt payments making people more vulnerable. According to the economists, the economic crisis is not solely due to the COVID-19 pandemic that affected the whole world. But the economic crisis largely is attributed to the short-term and unsustainable policy planning that led to drain the foreign reserves of the country and result in the government to default. Ultimately this has caused severe shortage of importation of vital food and fuel. The United Nations oversee the situation in Sri Lanka as seriously impacting on human rights and increasing the vulnerability of communities.

The subject of vulnerability is complex—involved with various characteristics of people, utilized in diverse disciplines including public health and development studies, the definition, measurement and assessment of vulnerability also innumerable (Wisner, 2016). The common meaning of vulnerability is the susceptibility to damage and of the many often used definitions, as used in general to natural hazards, defines vulnerability as:

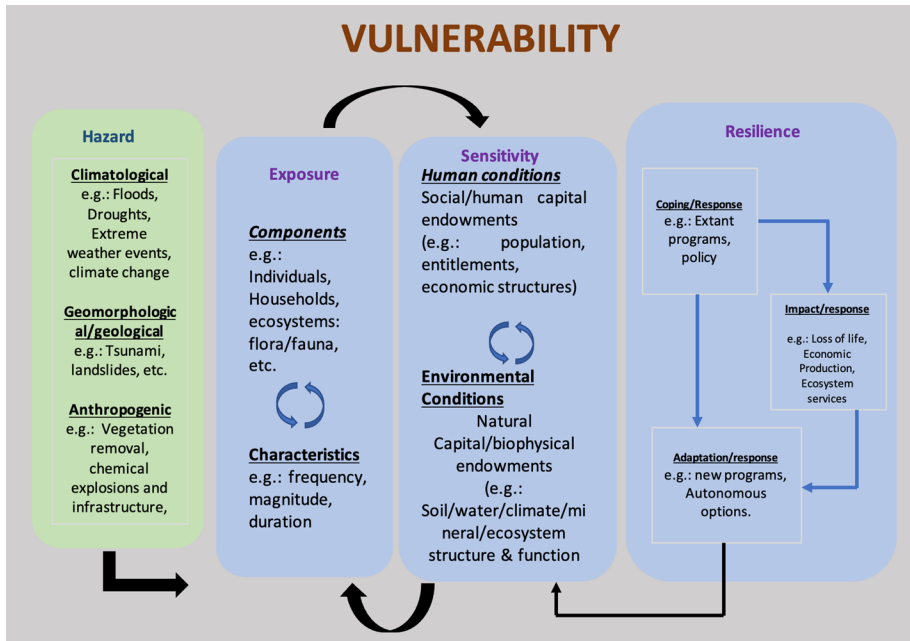
“The characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event or process)” (Wisner et al., 2003, p.11).

Here, a combination of various factors determines the degree of susceptibility of an individual’s life, livelihood, and property to an identifiable event—natural or anthropogenic. During the process of widening out and conceptualizing vulnerability, one of the archetypal models to understand vulnerability, Turner et al., (2003) have developed a Risk-Hazard (RH) model.

Source: Adapted from Turner et al., 2003; Wisner, 2016.

The RH model describes the impact of hazard (or the susceptibility to hazard) as a function of exposure to hazard and the sensitivity of the exposure (Turner et al., 2003). However, inadequacies in the RH model were identified (Martine and Guzman, 2002). For instance, the RH model alone does not disclose the difference between subsystems exposed to hazards and the causes behind the varied consequences of the hazard. Moreover, RH alone does not provide an analysis of how social, economic and political factors, including social structures and institutions, influence exposure and consequences of the hazard. This has led to the recognition of the Pressure-and-Release (PAR) model, which describes the risk of a hazard as a function of stress and the vulnerability of the exposed unit/system (Turner et al., 2003). Figure 1 is based on combined models—RH and PAR—by Turner et al., (2003) and characteristics identified by Wisner (2016).

A hazard is classified into many forms across different landscapes, governments, and research institutions to name a few and also, and each hazard, in general, is triggering a sub-set of hazards (UNDRR, 2017). The example shown by UNDRR was a hurricane shadowed by sub-sets of hazards like—storm surge, intense winds, and heavy rainfall. Classification of hazards includes biological hazards (e.g., disease outbreak due to bacteria/viruses), Environmental Hazards (e.g., Environmental degradation due



**Fig. 1** Framework for understanding vulnerability: extracted from RH and PAR models

to air pollution), and Geological hazards (e.g., earthquakes) to name a few. According to Turner et al., (2003), vulnerability to a hazard is dependent on the community's exposure to hazard impacts. Accordingly, the community as a whole and /or individually may expose to the hazard and the level of exposure shall also be dependent on factors like frequency and duration of the community being exposed to the hazard impact. Further, pre-existing sensitivities of both human and environmental also determine the level of vulnerability of a system/community to a hazard. Human conditions such as the existing capital (e.g., social/financial) and environmental conditions such as how gifted the community with natural endowments (e.g., living in a surrounding with natural forest) determines the level of sensitivity of the community to hazard/s (Turner et al., 2003; Wisner, 2016; Castellani et al., 2021). The community's ability to bounce back to a reference state after a hazard is described by the concept of resilience. The response to a hazard could be varied depending on the level of exposure and the sensitivity of the systems or the community to the hazard—through which they could introduce programs/policies to cope with the hazard. These coping mechanisms/ responses on one hand again impact their lives and livelihoods and also, and they could lead to adaptation responses. These adaptations could also have impacts on their human/environmental conditions.

This paper intends to understand the level of vulnerability of the communities to both environmental pollution and the prevailing economic crisis of the country and thereby understand the effectiveness of existing strategies to curb the impacts of the coal power plant. The study also aims to make recommendations to navigate the development approach of the country toward sustainability.

## 2 Socio-environmental vulnerability to environmental pollution and economic crisis

Research on the vulnerability of social-environmental systems that has a long tradition of scientific considerations has now become a rapidly developing research perspective. Because according to Szewranski & Kazak, (2020), vulnerability to global change is crucial in terms of a geospatial point of view. Hence vulnerability is not simply a function of exposure to hazards, but depends on the sensitivity and resilience of complex systems at a particular place and time. Accordingly, the extent to which vulnerability has been studied across the nations (global south and north in particular) and the time frames they have been studied and the outcomes of the same study sites across different time frames are irregular.

Vulnerability of power plants has been conducted mostly for nuclear power plants and assessments have also been conducted to identify how the power plants are vulnerable to environmental factors. Recent incidents like the Fukushima Daiichi accident have stimulated the gravity of the impact of external hazards on the design basis. Moreover, although nuclear energy has many promising environmental impacts—for instance, improving air quality and dramatically reducing air pollution—issues emerge regarding environmental justice in nuclear power and radioactive contamination (IAEA, 2017; Kyne & Bolin 2016). Moreover, the current military conflicts also compromise the safety of nuclear power plants like the Zaporizhzhia plant, which produced 19% of Ukraine's electricity in 2020 is under threat due to Russian's military invasion of Ukraine (Greenpeace International, 2022). The potential risk of damage to this nuclear power plant is estimated to vast areas of Europe including Russia that would be inhabitable for decades.

The vulnerability assessment of thermal power plants has been conducted especially targeting seismic vulnerability assessment of thermal power plants (Deyuan et al., 2022). However, the majority of such technical assessments have been confined to developed nations where vulnerability assessment of thermal power plants in global south nations are limited. However, the vulnerability of existing power plants to changing climates and the implications of coal-fired power plants to energy generation on the environment have been studied considering the global south nations. According to Wang et al., (2019), in rapidly Developing Asia, coal power dominates the electricity supply. As highlighted by them, specific regions in countries like India and Mongolia are predicted to be most negatively impacted by climate change—like water scarcity. Hence, with the increase in electricity demand due to growing populations, the expansion of coal power plants will have to consider water scarcity to implement climate change mitigation scenarios and different cooling system choices for coal powder production in Developing Asia. Alkon et al., (2022), have also shown, that in Pakistan, regardless of the continued financial support given through China's belt and road initiative to promote coal power production, the climate-induced water stress is likely to increase up to 36–92% by 2055 and with a significant increase in water demand for coal power plants.

Meanwhile, the Turkish government is planning to increase the installed capacities of coal-fired power plants (CFPPs) in the country. Vardar et al., (2022) have emphasized the impact of CFPPs on environmental quality (e.g., through the gaseous emissions, fly ash, fine dust, coal mining, and water use for cooling plants to name a few) while highlighting the fact that Turkey is already a leading air polluter. For instance, 62% of the current SO<sub>2</sub> emissions in Turkey are resulting from energy production including coal power energy. The coal power plants' associated health issues have been widely discussed. Zhang et al., (2022) described there has been a significant relationship between the proximity to the coal

power plant and neurobehavioral problems (e.g., social problems, affective problems, and anxiety problems) among kids through a study of two coal power plants (Cane Run and Milk Creek power plants) in Kentucky, USA.

The vulnerability of communities and the environment to the impacts of threats like coal power plants has widely been discussed in perspective-driven formats. And consequently, scholars across the globe are now assessing how those perspectives on socio-environmental vulnerability are shifting. Long & Steel, (2020) studied to guide vulnerability assessment and adaptation (VAA), generally in Southeast Asia and particularly in a watershed in an environmental park in Thailand together with reviewing recent VAA literature. They have shown how VAA approaches are broadening and shifting over time and the contrast between Asian and American approaches to evaluate vulnerability and adaptation. For instance, Asian studies had more emphasis on social development and community-based approaches. In contrast, vulnerability evaluation in Global North was mostly based on ecology-centric approaches while promoting adaptation through ecological restoration (Long & Steel, 2020). As shown by Ballari et al., (2020), when considering Ecological Restoration (ER) studies, the global north produced twice the amount of ER studies compared to the global south. However, the need for international cooperation in ecological restoration has been emphasized by scholars. Hagen et al., (2013), from a study based on Nordic countries, have found that the fostered differences among the countries in terms of geography, land use, legislation and economy in the extent of emphasis of ecological restoration help determine if, when and where to do the restoration. According to Chrisp (2021), soon the global population will surpass 8 billion and it will only exacerbate the existing issue of natural resource exploitation—including the issues related to fulfilling the energy demand. Therefore, Chrisp (2021) emphasizes that only by promoting pro-environmental behaviors and abiding eco-centric worldview would it accommodate fulfilling the demands of nature for the rising population.

Human-centric nature of vulnerability assessments is consistent in many parts of Asian countries. This might be attributed to the higher population and scarcity of resources and thus a copious amount of people is dependent on one scarce resource (for instance, a water source). And if that resource is threatened due to natural or anthropocentric causes, the dependents are vulnerable both individually and cumulatively. The importance of adaptation planning through the lessons learnt from communities who are living with environmental stress and shock has been highlighted by Ayeb-Karlsson et al., (2016). Their study was based in the Ganges–Brahmaputra delta in Bangladesh which sustains a dense population while exposing those people to natural hazards.

The vulnerability of the communities living in close proximity to coal power plants in global south countries like Sri Lanka and considering the level of vulnerability, if decided to continue to expand the coal power generation, it is necessary to figure out suitable adaptation planning. However, there is a knowledge gap in vulnerability assessment of the communities and the environment to the impacts of coal power plants. The results from this study aim at supporting fulfilling this existing knowledge gap.

### 3 Methodology

To translate the concept of vulnerability into developing practical tools in the field, the term assessing vulnerability does not necessarily be of a quantitative approach. Hence, qualitative assessments of vulnerability have used focus group discussions (including

**Table 1** A summary of key demographic information of the participants

Participant characteristic	Response
Gender	
Male	53%
Female	47%
Age (Average in years)	
Male	45.5
Female	42.7
Education	
Primary education (Grade 1–5)	41%
Junior Secondary (Grade 6–9)	35%
Senior Secondary (Grade 10–13)	12%
Bachelor's degree	6%
Post graduate degree	6%
Number of members per family (Average)	5

participatory rural appraisal tools) with special reference to discussions with the local stakeholders (Wisner, 2016).

To identify the socio-environmental vulnerability of the communities living in the vicinity of the coal power plant, scientific literature and semi-structured interviews were conducted. The fieldwork was carried out in June 2022 in “80-houses village” in Daluwa Norochcholai as they were continuously being affected by the coal power plant. Figure 2 presents the location of the power plant adapted from google earth pro. This village in Norochcholai, consists of 80 families (that is why the name was given as 80-houses village). The research followed both review of the literature and semi-structured interviews with 15 villagers (all were born and living in the study area) and 2 environmental and fishery officials representing local NGOs (NAFSO and MOLNAR). The interviews were conducted in person and via phone. A summary of key demographic information of participants is presented in Table 1.

During this qualitative research, the participants shared their open views on the past and present impacts of the coal power plant together with their opinions on the solutions provided by the government followed by recommendations to enhance their well-being. All the interviews were audio-recorded and transcribed for analysis using NVivo (Version 12) software package. Participant information was kept anonymous and a participant information sheet and a consent form were produced for the participant before starting the interview (Table 2).

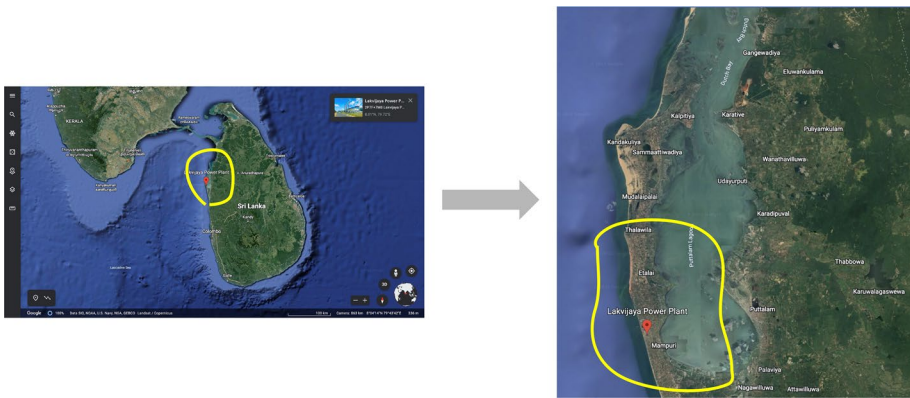
Source: Adapted from Google Earth Pro.

#### 4 Socio-environmental vulnerability of local community system—the hazard/s

Community members living in Norochcholai, in the Puttalam District on the West coast of Kalpitiya peninsula who are at different scales of risk of environmental pollution from the NCPP are currently suffering from the consequences of the economic crisis prevailing in the country. For this study, although the hazard/threat to the community was mainly focused on the impacts from the NCPP, those hazards again can be sub-categorized (see

**Table 2** Key questions put during the interview

Section of the interview	Key question/context
Hazard/threat/risk	What are the types of risks facing currently? According to you, what are their causes?
Exposure	What are the specific impacts of the NCPP? Impacts of NCPP onto lives/livelihoods? Frequency/duration? Impacts of NCPP onto environment?
Sensitivity	Compounding impacts of NCPP and the prevailing economic crisis? Economic background of families before and after constructing NCPP? Impacts of current economic crisis? Social recognition received before and after resettlements due to NCPP/ before and after the resettlements due to NCPP
Resilience	What are the responses/coping strategies to hazard impacts? What need to be changed? What need to be done individually, community-wise and by authorities?



**Fig. 2** The study area

Table 3)—as discussed in the framework for understanding vulnerability in Fig. 1. However, the prime cause was identified to be anthropogenic—an involuntary alteration of the environment/vegetation followed by involuntary human settlement programs by the government to achieve the objective of constructing the NCPP. How sensitive are the community members in the study area to these hazards and sub-sets of hazards based on their level of exposure, sensitivity and resilience will be discussed in the proceeding section.

### 5 Community exposure

Community members living in the vicinity of the NCPP are exposed to various risks related to environmental pollution. Although the management of the power plant is aware of the situation and has already taken some steps in mitigating such risks, people complain that they are still suffering from the same sets of risks since the implemented

**Table 3** Types of hazards and sub-sets of hazards the community members are exposed to

Hazard	Sub-sets of hazards
1. Anthropogenic: removal of vegetation and building construction during the process of NCPP.	Rain water clogging due to alteration of rainwater removal pathways to ocean—leading to unprecedented flooding.
2. Chemical exposure	Fly ash from NCPP stored in landfill and creating leading to air pollution Water pollution and water scarcity Health hazards—exposure to polluted air and water
3. Climatological hazards: unprecedented flooding	Induced by climate change, unprecedented flooding events occur and the existing conditions like altered vegetation and geological conditions by NCPP, further exaggerates flooding.

solutions are not sustainable. The main source of livelihood for these villagers are fishery and agriculture (e.g., cultivating beetroot, tobacco, and radish to name a few). The functionality of the power plant has many times been criticized by environmentalists that it does not meet the regulations nor the requirements made in the feasibility analysis of the proposal. To date, the power plant does not contain a proper environmental license. Owing to all these mismanagement practices, the neighboring community is encountering continued negative externalities from the power plant.

One of the most critical pollutants from the coal power plant is the fly ash containing toxic chemicals (e.g., arsenic, barium, and lead to name a few) that are carcinogenic and many other respiratory illnesses (UCAnews, 2018). Although the NCPP management has plastered this issue by watering the fly ash piles to contain the spreading, the villagers still struggling to survive the fly ash. However, these fly ash piles are stored still in close proximity to the communities surrounding and from those storages, they are now being used for cement production. Regardless of the harmful effects of fly ash, it is a common practice to store fly ash in landfills. This practice is not confined to global south nations but also in developed nations like the USA. However, there is a consistency in storing fly ash in global south nations like Sri Lanka and global north like the USA. There are over 1400 landfills and surface impoundments used specifically for air pollution control devices for fly ash (Chakraborty et al., 2011). These landfill and surface impoundments are frequently placed near low-income generation communities exposing them to an array of health issues. This is consistent with the Sri Lankan situation because due to the disproportionate distribution of the costs and benefits of the coal power plant, those who are living in the close vicinity of the plant have to suffer the negative consequences.

A farming woman from the 80-house village explained her suffering due to fly ash as quoted below.

*“My main livelihood activity is cultivating radish and tobacco while my husband is working as a laborer in a nearby farmland owned by large-scale cultivators. Now, since the fly ashes are removed from the site, we don’t directly get them onto us through the wind but with the rain, the smoke drawn up into the sky from the power plant affects us badly mainly to our cultivations, we can’t get as much as the harvest we obtained before, due to the deposits, we cannot continue and reap the optimum harvest, especially in crops like tobacco.”*



Although these locals are unaware of the scientific terminologies to explain the impacts of the emissions from the power plant, they are surprisingly aware of what is happening in their environment. As shown in the above direct quote, the community members are now experiencing acid rain and the associated negative impacts. Gases like nitrogen oxide and sulfur oxide emitted from burning coal, reside in the atmosphere and react with atmospheric air to create acidic compounds and would return to the ground through precipitation—acid rains (Mathew, 2018).

Besides, the participants also complained that with the wind, the dust particles are still deposited in their cultivations even though measurements were taken to contain the spread of ashes and other waste material.

The livelihoods of the community members are exposed to water shortages—lack of quality water. Tube wells are used for both cultivation and consumption. According to the participants, until a couple of years after the NCPP was built, the water around the area was suitable for both drinking and cultivation. However, now they complain that the water obtained from tube wells is unable to be drunk as they are contaminated and sedimentation is visible. According to the participants, the water from the wells contains waxes or paraffin-like material and a weird taste. They also complain that they can't cook from the water because soon after consuming the well water, severe stomach pain happens and some people have kidney infections and they believe it's due to the well water. This is how one participant explained her problem.

*“Never are we cooking from the well water, can't cook even dhal if you pour some water to a bottle and leave it a day, in the morning you would see some sediments in the bottom and some slimes residing around the inside surface. Even we can't use soap with this water, need to use shampoo when bathing but not soap, never.”*

Implications of coal power plants to water security have been widely acknowledged mainly considering the climate change-induced water scarcities. Scholars have highlighted the urgent need of accounting for increased water requirements when expanding coal power plants in the future and the associated water scarcities, especially in the Asian region (Wang et al., 2019). Such findings are consistent with country-specific studies like that done in Pakistan by Alkon et al., (2019). According to them, considering the increasing demand for electricity, Pakistan will have to expand the coal-powered electricity generation and consequently, the water demand will also increase. However, since Pakistan is highly vulnerable to climate change, they are likely to experience significant water scarcity induced by climate change. Consistent findings have been found in China also where most of their thermal power plants are located in water-stressed areas and climate change impacts have predicted impacts on water resource availability (Jin et al., 2022).

Sri Lanka is no exception for being a victim of climate change impacts because according to Climate Risk Profile: Sri Lanka (2020), regardless of emission scenarios, models for Sri Lanka show a trend of consistent warming. However, the country is not considering climate change data and predictions in the development planning regardless of the subtle and frequent evidence of climate change risks.

All the participants complained about the recent (2022 flooding) flooding events that caused huge damage to their livelihoods. According to the participants, the floods are a side effect of sea walls built by the NCPP as they were dug deep down and blocked the free flow of rain waterways to the ocean. Two of the statements by the participants are shown below regarding the impacts of flooding in the area.

*“We have never had such flooding in like 20 years. The flood water resided in the land for about two days and we were trapped inside our houses as a consequence. Luckily water*

*didn't come inside my house but see those houses built up of coconut branches, they were all affected."*

*And now, when it's raining, we are terrified, even if it's just a small rain, because we don't know whether it would bring the flood. We never know what to do during flooding. We fear as we get used to living with the environmental pollution due to NCPP, we would now have to bear the consequence of flooding also, whom should we complain about this?*

Not only are these communities exposed to harmful substances emitted by the coal power plant, but they are also exposed to heavy metals from water pollution. High mercury levels were identified in women living in the Kalpitiya peninsula<sup>1</sup>. Mercury contamination to the waterways in the Kalpitiya peninsula is from various sources and including industrial effluents including effluents from NCPP and others such as effluents from cement, agriculture run-off, rubbish dumping and overfishing are also causing water contamination and fish tainting. As such, the consumption of tainted fish was found as the main cause of these higher mercury levels among the women in the said area (The Sunday Times, 2018).

Considering the existing economic crisis in the country, it is highly unlikely the authorities would pay attention to attend to these issues rather they are keen to fix the never-ending technical failures of the plant. Consequently, the community's well-being will continue to decay with increasing community unrest. Nevertheless, if such ignorance of negative environmental consequences on communities in the close vicinity of power plant continues, it eventually would become a norm for other development projects to come in the future.

## 6 Sensitivity: pre-existing conditions

The world is struggling to transition to renewable energy production. This depicts the electricity from coal power plants would be obsolete in the future if the world is ready to act along their nationally determined contributions to reduce greenhouse gas emissions and adapt to climate change. However, the increasing demand for energy in general—electricity in particular—and the scarcity of the available resources, coal is still widely used despite its negative impacts. Nevertheless, benefits of phasing out from coal power have shown significant benefits that outweigh the associated costs Potsdam Institute for Climate Impact Research (2020). Yet those associated with coal power plants are disproportionately distributed (Chakraborty et al., 2011). As mentioned in the previous section on community exposure, the negative impacts or the costs are not only associated with burning of coal but also transporting and storing adversely affect the health of the communities living in the close vicinity of the power plant. According to Jha & Muller, (2017), these costs of coal storing and transportation (i.e., costs associated with the power plant induced air pollution) disproportionately affect the economically disadvantaged communities living in the vicinity of power plants. Further, they have highlighted that there are differences in the sensitivity to the threats (in terms of pre-existing conditions) of the communities who live closer and away from the power plant. For instance, in the USA, people living in census tracts with power plants (i.e., communities living within 25 miles of a coal plant) had comparatively lower educational and

<sup>1</sup> The NCPP is located in the southern end of the Kalpitiya peninsula.

per capita income levels relative to communities of census tracts without power plants. These circumstances show some consistency with the sensitivity of the communities in the close vicinity of the NCPP.

The participants in the study areas experienced a higher degree of social marginalization. These communities are considered pro-poor and with the least opportunities in society to enhance their well-being. Strangled in poverty and now they have to struggle to accomplish their basic human needs. According to the participants, they are buying drinking water by paying around Rs. 90/- to Rs. 100/- per 20 L. Exposure to unprecedented flooding has also worsened their living conditions as the majority of the houses are not properly built. With the existing economic crisis in Sri Lanka, now these people have to embrace inflation and yet to feed their kids. The farming communities living around the NCPP are watering their farmlands from tube wells using electric motors. These poor community members now are doubtful whether to continue their cultivation since due to the prevailing economic crisis in the country, the price of an electric unit has increased. On average now they are paying around Rs.10,000/- to Rs.15,000/- for an electricity bill which is, according to the participants, a substantial and unbearable price hike as compared to the prices before the economic crisis. Prior to the economic crisis they had only paid less than a half of these prices for their electricity bills.

Community members from the 80-houses village have been living with the least social recognition for over 10 years. This village is built particularly for the families displaced due to the establishment of the NCPP and they were located in newly built houses in the Daluwa Norochcholai area where the area is now called an 80-houses village. According to the participants, they are regarded as low-class people in society as shown below.

*“Whenever we go to the police to file a complaint and when they get know that we are from 80-houses village, the police without a hesitate to chase us away without giving any consideration to our problem, the same thing happens at the government institutions also.”*

Questions were raised as to why they are being ill-treated by society and the answers have been mentioned below.

*“This village was previously notorious for picking up conflicts with others but now there are no such incidents and people are quite calm, but still people cannot remove those conflicting labels toward our village.”*

Moreover, some of the participants from the 80-houses village do not possess proper deeds for their lands and it has prevented them from acquiring needful financial support from financial institutions in light of disasters. The already existing social discrepancy has resulted in delays and negligence in finding support during environmental disasters and consequences of environmental pollution. The majority of the participants when asked about their future plans regarding the existing and upcoming problems of pollutants and economic crisis, mentioned that they would do nothing but live with the chaos as no one is there to even listen to them and that they are fed up of reaching the government officials in requesting required help. Moreover, the continued blind eye to the environmental and economic demands of these marginalized communities further exaggerates the causes for them being marginalized. For instance, because of marginalization, the interrupted access to financial support to continue their livelihoods deprive these communities of supporting their basic needs. As an example, the education of the next generations and access to health facilities (since negative environmental externalities increase health issues among the communities) are being negatively affected. Consequently, while the impacts from the power plants continue to grow coupled with the consequences of economic crisis, these communities further are entrapped into the vicious circle of poverty and continue to be marginalized.

According to the respondents from the study group, the pre-existing conditions (e.g., marginalized communities) and the negative impacts of the coal power plant coupled with the ongoing economic crisis of the country, NCPP has not helped them overcome poverty but entangled them more into the vicious circle of poverty. This is consistent with studies related to energy poverty and the expansion of coal power plants in the Global South. Energy poverty refers to when there are problems to maintain required temperature in a particular place (for instance, heating or cooling according to the season) and problems related to using appliances, lighting and cooking (Thomson et al., 2019). Moreover, energy poverty is also characterized by socio-demographics and economic factors. According to Nuccitelli (2016), nearly 15% of people in energy poverty are living in close proximity to electric grids. Over 84% of households with energy poverty are living far away from electric grids. Yet, showing examples from China and India, Nuccitelli (2016) highlights that the majority of the coal power projects are not addressing this issue and promote delivering electricity to the poor who are actually living in energy poverty but only targets industrialized areas. Moreover, although coal companies and their allies argue that energy from coal power contributes significantly to poverty eradication, Nuccitelli emphasizes that it is a misconception drawn from countries like India and China, who are one of the biggest coal producers in the world. Because considering the costs incurred from deaths and illnesses by air pollution due to coal power – 13.2% and 9.7% of China's GDP—coal power doesn't help the poor but makes them poorer.

## 7 Resilience

The resilience factor in vulnerability assessments of power plants has widely been targeted to resilience of the energy systems to climate change risks (Wang et al., 2019; Ayeb-Karlsson et al., 2016; Long & Steel, 2020). Next to climate risks, the government stability and related socio-economic factors have also been discussed widely for the energy resilience of the countries. The Electricity Supply Resilience Index (ESRI) suggested for 140 countries by Gasser et al., (2020) consists of 38 indicator combinations—control of corruption, severe accident risks, political stability and absence of violence/terrorism, GDP per capita—to name a few. For the ESRI, Germany, Canada and the USA while Congo, Cameroon and Nepal, like global south nations, rank at the bottom of the index.

Moreover, studies have also shown the dire need of acknowledging the communities' needs and providing socio-economic benefits to the communities through energy infrastructure projects like coal power plant projects. According to Niklas, (2022), such inclusive projects accommodate interactions between government, industry and communities and to encourage collaborative development among the stakeholders. This study has further highlighted that if the energy generation projects are inclusive, the industries and governments shall easily benefit from the perpetuated community actions in climate emergencies and environmental disasters and thus increase the resilience of both the communities and the energy projects (e.g., sustainability of the power plants). However, in the Sri Lankan context, considering the NCPP, such inclusivity was not visible and through the hardships that the communities are encountering to date, there is no light of attempt to increase the community resilience to risks associated with the socio-environmental risks of NCPP.

Depending on the proximity of the villages to the NCPP, the impact of the environmental pollution from the plant could vary. As these community members have long been living in the vicinity of the NCPP, the newly added crises like the COVID-19 pandemic and

economic crises in the country had only worsened their status quo into a position to doubt their existence.

The most recently added threat to their lives was the flooding due to the obstructed water movement due to the NCPP (according to the community members). Because of the severe floods occurring currently, they know their infrastructure would be drastically damaged and they are helpless in such circumstances. The strategy they have already adopted was keeping their belongings in higher positions from the ground level when the water rises or the rain is severe.

A question was raised to understand whether the floods were due to climate change but the respondents are skeptical whether the floods are due to changing climates or due to the NCPP's latest constructions. However, since none of the responsible authorities pay attention to at least assess the damages from the floods and help people with increasing their resilience, these community members are expecting floods in the coming years also. They are prepared to continue the existing adaptation strategies to the coming floods also. Because, although the root causes for flooding associated risks are weighing in-between NCPP constructions and climate change, these communities believe that forthcoming climate risks would be severe. Since, regardless of the impacts on the livelihoods, the new constructions to NCPP are continuing while no light is seen soon to assess and implement adaptation to disaster risks—both anthropogenic and natural.

The continuous impact of dust and soot from the NCPP on the cultivations is yet to be addressed. According to the participants they have very small land parcels and the impact of pollutants on their cultivations is irreparable. To overcome this, in some families, the male members are seeking job opportunities in nearby villages and some are working as laborers in other large-scale cultivations. According to the participants, they do not have financial support in times of disasters and only the owners of the large-scale cultivations are helping them through money lending. Besides, the communities lack any other types of support networks as they are not members of any kind of social networking structure.

When asked about the future of the community members, they have agreed they are relying on their children to have a better education and leave the village in search of well-deserved lives. However, it seems even the education of the children is now challenging. A statement from a community member from the 80-houses village is shown below.

*“Earlier we were living near the town and then we relocated to this village in Daluwa. Now our kids have to travel about 7km to school and we were promised that our kids will have continuous transport back and forth from the school. Now due to this economic crisis in the country and the prevailing fuel shortages, the only bus that transported our kids is not working and kids now have to walk about 14km to and from the school every day and eventually they are reluctant to do it every day.”*

In a situation where the victims of NCPP have limited or no alternatives to cope with the negative impacts from the power plant, it is necessary to assess the existing resilience strategies by the communities. Based on the responses from the communities at the 80-house village the already practiced adaptation strategies were neither effective nor sustainable. For instance, the already available adaptation strategies like, temporary replacement of household items to save them from floods, borrowings at times of financial needs and decision to continue children's education even without transport facilities are not regarded as sustainable especially because these communities lack social capital. Since this study group (community members of the 80-house village) is relocated from their original lands and forced to establish new living in an alien land area due to the construction of the NCPP, to build long-term and sustainable relationships with adjacent communities is delayed. Moreover, since they have continued to live marginalized livelihoods from the

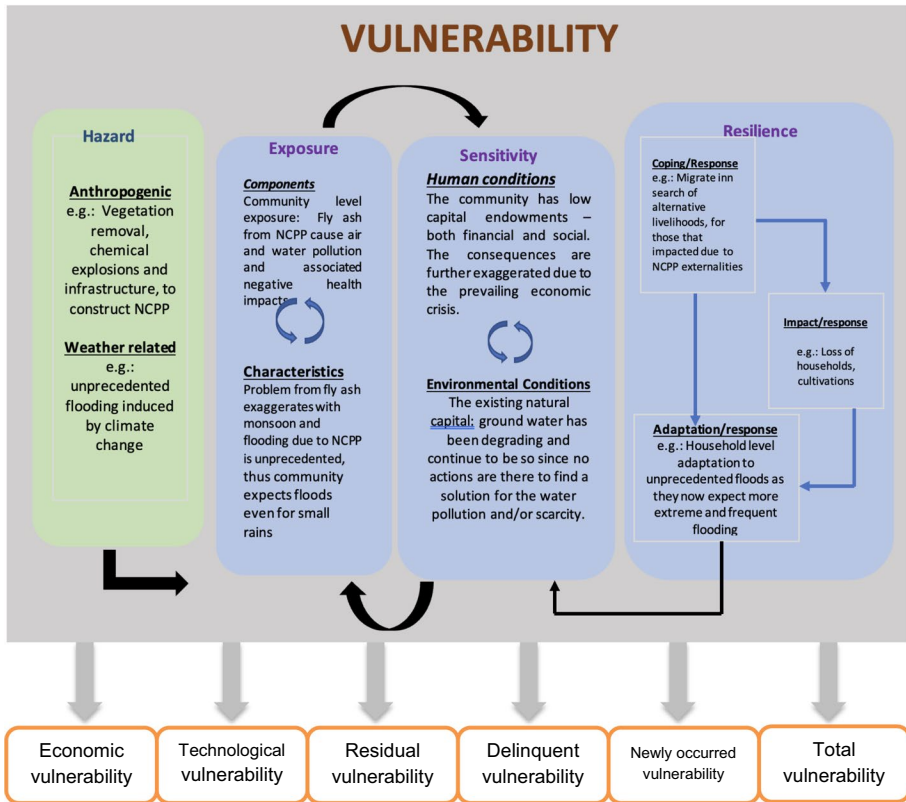


Fig. 3 Vulnerability of communities in “80-houses village” in Daluwa Norochcholai

society, they might require external support to strengthen their relationships with the society in general and adjacent communities in particular.

The success of any training and development programs to upgrade the livelihoods of the victims of NCPP would be determined by the availability of the social capital in the area. This has been highlighted by Saptutyningsih et al., (2020) by highlighting the importance of social capital to sustainable adaptation. According to Saptutyningsih et al., (2020), studies from Indonesian farmers, the willingness of the farmers to take part in training programs to assist with climate change adaptation is higher with those who are with better social capital. For instance, communities with embedded characteristics like trust among the community members and having sustainable relationships with members outside the communities are willing to adapt more positively than those who lack such social capital (Fig. 3).

### 8 Final remarks

There are six vulnerability types described by Alexander (2000)–(1) Economic: people lack adequate occupation, (2) Technological (or technocratic): caused by the riskiness of technology, (3) Residual: caused by lack of modernization, (4) Delinquent: caused by

corruption, negligence, etc., (5) Newly generated: caused by changes in circumstances, (6) Total: life is generally precarious. People living in the “80-houses village” in Daluwa Norochcholai, based on their shared perspectives, are vulnerable to all six types of the vulnerability described by Alexander (2000).

The research findings have shown that the majority of the community members have chosen to continue living in the same areas despite the impacts of the pollution from the power plant due to a lack of potential for relocation and zero opportunity costs in finding new livelihoods. These communities have always lived in marginalized and poor conditions and continued pollution coupled with economic crisis has only skyrocketed their poverty. As in many other global south nations, in Sri Lanka also it is the poor and pro-poor who would be directly and most severely affected by the disasters both natural and anthropogenic. The study is highlighting the consequences of neglected management and/or mismanagement practices by a country where the needs of one part of the nation are being met while some people from the same nation are paying off for the negative externalities induced from unsustainable development initiatives.

These community members are affected by multiple stressors/disasters and the severity and frequency of the stressors are increasing daily. The situation is getting worse as the existing situations in the areas are not favorable. Besides, the level of resilience of the community members is also low since they don't have adequate and sustainable adaptation strategies and nor do they have capital especially social and financial to cope with cumulative stressors. Given the severeness of the stressors on the community and the unfavorable pre-existing situations coupled with lower adaptive strategies and capital availability, these communities in the vicinity of the coal power plant are highly vulnerable to existing and upcoming stressors. The suggestions driven from the community members in terms of upgrading their well-being were short term and unsustainable. For instance, once they were requested to suggest mechanisms or strategies as they think would be ideal to overcome the current situation—they have repeatedly made requests from the research group. This could be attributed to the gravity of the hardships that those people are going through and the fact that none was there even to hear them. Of the many repeated requests, those that are relevant to water are the most common. For instance, see below quote from one of the community members:

My suggestion is that, since we can't pay the rising prices for water like this, I suggest that the price of water should be lowered and affordable to us

To understand their willingness to raise this issue to responsible authorities they have been given counter questions. Their response was that, since they have been tried and still trying to convince the authorities regarding the prevailing situation and their ill-being, they have no faith in the government authorities. For these community members, the first and the most important requirement is to fulfill one of the basic human needs and thereby to realize their right to access to safe drinking water and sanitation. Moreover, almost all the respondents have raised the issue that they have not been consulted during the initial stages of the power plant except at the stage they had to relocate from their origin grounds. This alienation of the locals from the decision-making process of the development process is critical. According to Walsh et al., (2017), stakeholder interactions through community consultations is a way of acquiring social license to operate development projects. Hence, to ensure that people who are directly affected by the development projects, inclusive planning should be necessitated through human-centric approaches like human-rights-based approach. Because participation, accountability, non-discrimination and equality three of the five key principles underpinning the human-rights-based approach (ENNHRI, 2022).

However, under these circumstances this paper argues the sustainability and effectiveness of the governments' continued efforts to expand the NCPP and introduce new coal power plants in Sri Lanka. Because subtle evidence has been shown and misery of the victims from the existing coal power plant would continue while the authorities continue to pay a blind eye to them. Considering all the above, this study is suggesting below policy implications.

## 9 Policy implications

Based on participant information, field observations and existing literature the dilemma of the communities living in Norochcholai of Puttalam District of Sri Lanka must be addressed with immediate effect. There must be a solid approach to identify the causes and address the consequences of the pollutants from the power plant. Moreover, the absence of the required environmental licenses for the power plant must be highlighted as mandatory to continue the power plant. The problems of the community in fulfilling the basic needs are to be addressed in the short term through community consultations and not through a top-down approach.

The absence of a national environmental policy is one of the key issues behind these said dilemma situations. From time to time when regimes are changing, the strategies for fulfilling the basic needs of humans are changing due to a lack of national policies. Constructions of NCPP were initiated in 2006 and completed in 2011 although the proposal for the construction was developed in the year 1995. Delay in implementing the project was attributed to social and economic constraints. According to the project plan published by the Ceylon Electricity Board (CEB), by the year 2015 Sri Lanka would have had coal-dominant power generation. But now, the country has understood the grave danger that the people are in due to the unsustainable electricity generation. However, the consequences on the poor people who are directly affected by the coal power plant are irreversible and also continuing.

There is another issue behind the failed energy production in Sri Lanka. The government has failed to mirror the government policies with the Nationally Determinant Contributions (NDCs) to cut down the carbon emissions by the agreed targets with the international treaties—the Paris Agreement. The 2020 NDCs of Sri Lanka aim at reducing emissions by 30% of which 20% will come from the energy sector (Sri Lanka, 2020). However, the energy planning by the government does not reflect achieving the said targets although the country has agreed to generate electricity through 100% renewable energy by 2050 (ADB & UNDP, 2018). Further, the ADB and UNDP have identified significant technical and financial challenges in Sri Lanka to meet such an ambitious target. It is also arguable whether the government efforts are even adequate to significantly cutoff emission targets from the energy sector. The recent development initiatives like the NCPP provides overwhelming evidence for the inadequate government efforts to even consider the pledged targets to cutoff carbon emissions.

Sri Lanka ratified the Paris agreement in 2016 and the country has built its first-ever coal power plant in 2014 with a capacity of 900 MW. In such a context, cabinet approval has been granted in 2019 to expand the NCPP with a new addition of 300 MW which is planned to operate in 2024 (Colombo Page, 2019; Global Energy Monitor, 2021). Moreover, according to the Sri Lanka commercial guide published by the International Trade Administration U.S. Department of Commerce (2021), the target of the Sri Lankan



government for energy self-sufficiency (2018–2037) will include 2,700 MW of coal power in the electricity generation system along with other sources. Moreover, the energy targets by the Ceylon Electricity Board (CEB) still consist of constructing novel coal power plants—e.g., the Foul Point Power Station in Trincomalee—and the contribution from this plant is also included in the new Long-Term Electricity Generation Plan 2022–2041 by CEB. As such the direction of the energy sector and the mission to cutoff carbon as pledged to international treaties do not mirror. Amidst all these contrasting targets by the governments and the pledges to international treaties, a conflict of interests between non-renewable and renewable energy producers in the country—the traditional (non-renewable) producers keep opposing the efforts to expedite the transition to renewable energy—is another major issue that has not captured the public interest as yet. In essence, the pledges to cutoff carbon have become a white elephant where the policies are confined to papers where actions are never to be realized. In such a situation, the social and environmental issues encountered by the victims of the NCPP must not go unheard as they would be the best lessons to learn when moving forward with the energy industry in the country.

Research to study the localized impacts of changing climates surrounding the NCPP because the number of victims of floods would be higher in the coming years if these communities are paid with no attention. To make informed decisions for sustainable adaptations to disaster events like flooding, first must identify the cause of flooding—whether the floods are induced by climate change or due to expansion of structures related to the NCPP or due to both of those causes. An inclusive approach together with all the stakeholders shall work well at this situation. Stakeholders—community members, government authorities, universities to name a few—shall join hands to furthering the studying on identifying sustainable adaptation strategies to increase the community resilience to NCPP. Additionally, any suggested strategy would be successful if only there is a sustainable relationship with the NCPP authorities and the community members. To support this, the communities must be encouraged to form social capital structures among them and with their adjacent communities. Additionally, research into identifying the causes and consequences of NCPP induced health issues in the area must be expedited. Because due to the rising inflation these people are losing their affordability to clean water—as the price of water is rising day by day. If they had to give up on buying water for their basic needs and turned into consuming contaminated water the severity of their well-being issues would become worse. But solid research findings could convince the authorities to expedite the needful actions to facilitate the basic needs to these communities like the rest of the country is enjoying.

Empirical evidence highlights the importance of fine-grained knowledge of the exposed community during vulnerability assessments and to identify risk mitigation mechanisms (Wisner, 2016; Delica-Willison & Gaillard, 2012; Wisner et al., 2003). Moreover, a situational approach is suggested by scholars when communicating with localities about hazards, vulnerabilities and especially about the barriers to local actions to risk reduction. Additionally, during these dialogues, the knowledge offered by the local people was reported to be subject to the people's trust and mutual respect for the facilitator or the outsider who studying the situation (Kelman & Mercer, 2014).

This paper suggests a human-centric approach focused on sustainable and autonomous adaptation strategies for the communities in the vicinity of the NCPP and to address their rising vulnerability to the impacts for both the NCPP and the prevailing economic crisis. Considering the gravity of the hardships of the communities and the continued impacts to the environment, a human-rights-based approach is suggested in particular. In a historic move, the right to a healthy environment by everyone on the planet is declared by the United Nations General Assembly in 2022 (UN Environment Program, 2022). Based on the

feedback from the affected communities by the NCPP, it is clearly visible that their rights have been violated and they have not been recognized during the decision-making process. The relationship between human rights and environmental protection is significant because two of them are interdependent. Accordingly, environmental issues are human rights issues and thus, good environmental protection is a provision to exercise human rights and vice versa—there will be a positive impact on environmental protection when the good exercise of human rights exists (Pisani, 2006). As such, neither environmental protection nor human rights are possible to achieve unless the realization of both of them is guaranteed. The development process at the same time is essential and challenging to both environmental protection and realizing human rights. In a situation like NCPP, considering the vulnerability of the communities in the vicinity of the power plant, a human-centric approach is suggested but from identification of the grass root issues up to policy implementation an inclusive approach has to be followed to realize the benefits to the victims.

**Data availability** Data are available from the author/s upon reasonable request.

## Declarations

**Competing interest** Not applicable.

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